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Hybrid PV and Fuel Cell Generating System for Shipboard Applications Based on Optimal Dispatch Evaluator Algorithm

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ABSTRACT

The construction of an Energy Management System (EMS) for ships has been designed to improve the electrical performance of cruise lines. According to the target requirement, the specified electrical plant is an integrated power system characteristic of contemporary electric ships. Battery backup, low performance, and voltage instability are the drawbacks of the existing method. To overcome the limitations of the proposed method-based Photovoltaic (PV) renewable source using SEPIC DC–DC converters and a bidirectional fuel cell as an additional input power source. Power generation from the two different input sources is controlled through a DC bus and conversion through a centralized high-gain DC–DC converter. In this conversion, Pulse Width Modulation (PWM), which is the maximum power obtained using the optimal dispatch evaluation algorithm using an Artificial Neural Network (ANN), is obtained by adjusting the duty ratio of the Single-Ended Primary Inductance DC–DC converters (SEPIC). The electrochemical power source is a fuel cell. Hydrogen and oxygen are combined in fuel cells to create electricity, along with the consequences of heat and water being transformed into mechanical energy; in the battery management system, the battery is employed as an energy storage system to regulate any power imbalance or excess while taking the battery's state of charge into account Electric Ships (AESs). The outcomes of the MATLAB Simulink output, fuel cell and battery storage performance analysis, efficiency, and THD analysis are summarized as follows.

1. Introduction

Hybrid power generation transfer, which combines both types of storage systems, with one with a high energy density (fuel cell) and the other with a high-power density (superconducting magnetic storage device), is required to improve power quality. The batteries used in electric cars have a high energy density, meaning they can store a lot of electrical power, but have a low electrical concentration, indicating the charging and discharging process takes a while. The Superconducting Magnetic Energy Storage (SMES), on the other hand, serves as a power buffer and has a high-power density, which means it can supply a lot of energy quickly. When DC current passes through the

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superconducting magnetic energy storage technology, energy is stored as magnetized particles. The combined power generation consists of a fuel cell and PV power generation mounted on the home in strategic locations.

The solar panels can be installed on the roof, and bidirectional models with high power capacity might be placed on top and linked to an energy storage battery. A fuel cell functions similarly to a battery in that it converts compound vitality into electrical power, but it differs from a battery in that it will continuously produce DC power as long as hydrogen and oxygen are available. Fuel cells play an important role in the scattered era because of their advantages, such as high production, reduced toxic gases, and specific structural flexibility.

Batteries are required in total because, in addition to the batteries in the cars, batteries in the exchange stations, which are recharged while the batteries used for driving, are also required. Ultra-fast charging stations, which allow batteries to be recharged in minutes, provide another option for overcoming charge and range limits. The marine shipboard battery is only intended for a small range under this idea, allowing for a reduction in the volume and weight of the battery and an increase in driving range due to the quick recharge time. It allows for high cycle counts of several thousand and ultra-fast charging of up. Figure 1 shows a system that comprises a unidirectional high-power DC-DC converter system for ultra-rapid charging of EVs and a DC-DC input stage that enables charging the stationary storage system as well as providing energy feedback to the grid.

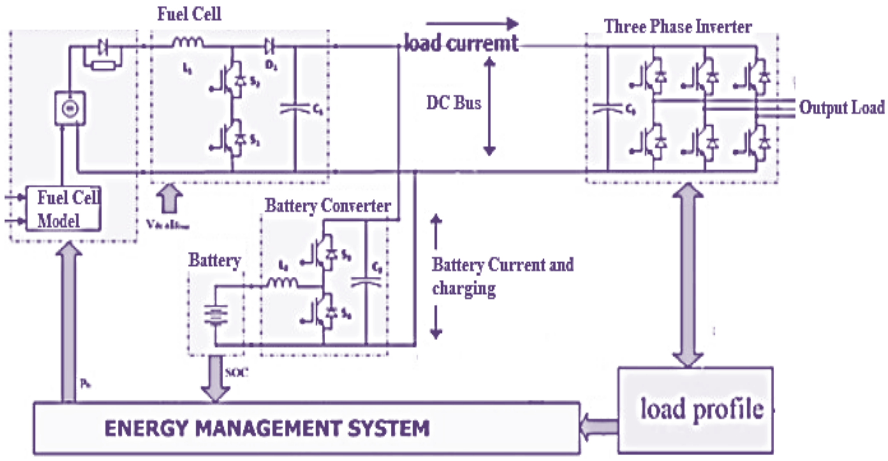

Fig. 1. Schematic diagram of Energy Management system for EV application

The marine shipboard is electrically assisted equipment that supplies electromagnetic accelerations to an existing racing bike, alleviating the operator's need to generate the energy required to power the motor. It has a powerful engine and sufficient battery power that just has to be charged to aid with ascending hills, provide faster motoring speeds, and offer free electric transportation. Compared to their gasoline-powered equivalents, marine ships perform better.

1.1 Objective

To obtain consistent electricity from two separate renewable energy sources, PV and fuel cell. It enhances power quality effectively by applying Single-Ended Primary Inductance (SEPIC) DC-DC conversion in buck and boost performance. To improve backup in an Energy Management system for electric vehicles, contain additional energy storage equipment with high performance such as long-range and discharge capabilities. In electrical marine shipboard usage, soft switching galvanic isolation is efficient.

2. Previous Research Work

A bridgeless single-edged primary Inductive Converter (SEPIC) with higher power quality to address the losses associated with the DBR. A full changing cycle of the charger's input current demonstrates unity power factor operation. Conduction losses are greatly reduced as a result of the absence of DBR. With the aid of several operating modes, the overall performance of the proposed bridgeless SEPIC converter is assessed as 100 volts (p-p) in our hardware, and the battery's output is 12 volts. In the simulation, supply 400 volts (p-p), resulting in 48 volts [1].

The voltage gain of this converter is limited to less than five because to significant power losses, including switching and diode reverse recovery losses, which are the principal sources of power dissipation, and high voltage stress on switched and diode under heavy-duty cycles. In the past decade, a variety of modified boost DC-DC topologies have been proposed to achieve significant voltage gains and high effectiveness while including three-level boost, quadratic boost, Cascaded Inductor Boost (CLB), Integrated Inductor Boost (ILB), Interleaved Boost (IB), and Tapped-Inductor Boost (TLB). Additionally, several voltage-amplifying methods, such as Switched Capacitors (SC), Switched Inductors (SL), and Voltage Lifts (VL), have been used to enhance the performance of these conversion devices [2].

An examination of many voltages step-up cells put on both the main and secondary ends of a SPEIC converter is being done in order to increase its static gain and develop a family of converters. They include a description of each converter, then tables and curves with essential information, such as element counts, voltage stresses, gain, and the selection of the coupled inductor or inductor based on the study of the DC magnetizing current. To support the suggested theory, theoretical examination and practical findings on a 50 kHz and 200 W prototype of a chosen isolated zeta with a voltage double cell are provided [3].

A wind-solar hybrid renewable energy system (HRES) suitable for off-grid applications is described in the current study. For the conversion of wind energy, a typical single-phase, two-winding induction generator (IG) with a wide speed range is used. As part of the hybrid generation, a suitable Photovoltaic (PV) panel is connected to the shared DC bus. In order to balance the currents in the two stator windings, the present enquiry suggests a sequential current-based control for the IG. Self-Excited Induction Generators (SEIG) rely heavily on terminal Excitation Capacitors (ECs) to generate voltage, which has the drawback of having poor voltage control when loads or wind speeds vary challenging [4].

Various data controllers planned to increase the capacity of the transmission line. UPFC is a data controller that produces complete control over an electric network. This model comprises a PV array, a wind turbine, battery storage, a Cuk converter, a voltage controller, and a UPFC controller. To maximize power, use the MPPT approach for both energy sources and DC-DC converters to raise the output voltage. In this case, a voltage regulator controls the pulse for the inverter, which converts the generated DC to AC. UPFC is used to reduce voltage rise in the output voltage of a grid-connected hybrid system, hence improving system power quality. This battery subsystem stores energy during normal power system operation and uses it when it is in an abnormal state [5].

The hybrid converter's efficiency is far higher than 90% and stays that way for the system's operation. The concept is straightforward and small and will be highly helpful when 24/7 high-efficiency performance is crucial. The suggested bridgeless Zeta converter's functioning during both supply halves is examined as follows: The duty cycle for the application is taken into consideration to be 0.25 to produce 65V DC from the rated 220V AC supply, where the average input supply voltage, Vs, is supplied by. The duty cycle value is used to determine the HFT turn frequency [6].

Design for an invariant input current, Quasi-Resonant High-Gain, High-Efficiency Single-Ended Primary Inductor Converter (QRHGHE-SEPIC). To increase the voltage conversion ratio, the proposed single-switch design uses a Coupled-Inductor (CI), a voltage multiplier coupled with a regenerative passive lossless clamp circuit. At zero current switching, the principal electrical switch in the recommended converter operates. The procedure's validity was demonstrated by experimental results from a 20 V-200 V /160 W laboratory configuration. The suggested converter's major performance metrics have been evaluated to those of other equivalent step-up converters, and the benefits of the QRHGHE-SEPIC have been displayed [7].

A multi-stage Switch Inductor Switch Capacitor High Gain DC-DC Converter for micro grid applications incorporates Active Switch Capacitor (ASC) and Active Passive Inductor Cell (APIC). A proposed voltage raising DC-DC converter operates in a closed loop to maintain a constant output voltage independent of input voltage variations. The novel extendable high-gain DC-DC boost converter technology can offer high-gain voltage with a short duty cycle and can be scaled up by increasing the APIC communication. The proposed converter's 200 W (18/200 V at 50% duty ratio) hardware prototype is built on a controller and tested in an open loop to validate the simulation results. [8].

HG SEPIC converting and ripple-eliminating circuits’ work together to eliminate Photovoltaic (PV) current ripples. Because they are independent of duty cycle regulation, they are simple to integrate into the main power circuit of a design. Active switches that are needed, control circuits, or drive circuits are not required to operate this circuit. The electrolytic capacitance linked alongside the PV array is completely removed by the ripple-eliminating course, and the inductance of the HG SEPIC converter is greatly decreased. Additionally, the DC-DC converter's responsiveness and power density are enhanced [9].

A hybrid non-isolated DC–DC commutation cell created by fusing a ladder-type passive switching capacitor cell with a traditional transmission cell. A KY converters-based buck-boost converter. However, this converter uses two electrical switches with a 2D voltage gain. A transformer-less buck-boost DC-DC converter with voltage gain 2D/1-D is also suggested; however, the converter's input current must also be considered. Operating it will be simple because there is just one power switch on this converter's control panel. The output voltage exceeds the voltage stress across the diodes and power switch. The suggested converter can be employed in renewable energy applications since its input current is constant [10].

At the converter's output end, three output capacitors are connected in series to prevent the converter from functioning at its maximum duty cycle, enhance voltage gain, and reduce switch voltage stress. As a consequence, low resistance and voltage level MOSFETs may be employed as switching devices. Leakage conductance and resonant frequency are used to reduce current during switch off. The steady-state features and operational theory of the converter are fully investigated. The essential parameter design concept is provided, and the converter's efficiency and loss are evaluated. The efficiency of a 100 W prototype achieves 95.79% at rated power, according to the experiment data [11].

PV panel's voltage and contribution to a continuous input current, respectively, the suggested conversion device addresses two major issues: the low voltage generated by PV solar panels and the discontinuous input current caused by switching power supply. The recommended converter is created by supplementing the conventional boost converter with a changed capacitor/inductor cell and a voltage multiplier process. The working prototype is tested using a range of output powers (50–150 W), a 20 V input voltage, and a 50% duty cycle. When the output demand draws 100 W, the suggested converter successfully steps the 20 V up to 200 V while supplying a constant input current at 96% accuracy [12].

The use of coupled inductors and voltage multipliers offers significant gain at low demand and turn ratios. Another way for reducing voltage stress across the switch is to use an active clamp circuit. As a consequence, switches with lower on-state resistance and lower voltage needs are used, lowering the overall cost of the system. As a result, switching losses are reduced and efficiency improves. It also contributes to the achievement of Zero Voltage Switching (ZVS) turn-on across both MOSFETs [13].

A hybrid system includes photovoltaic, wind energy, and fuel cell technologies. Photovoltaic and wind energy-distributed power systems are important in renewable energy infrastructure. Fuel cell technologies have an excellent opportunity in DG usage due to their rapid technological progress and benefits. Wind energy and fuel electrical power systems have ratings of 17KW and 16KW, respectively, for an 11 kV, 50MW power grid connection with a load attached to the system. The hybrid system must meet a pack of 55.2KW and 13 KVAR. In the first example, a wind energy system with a Doubly Fed Induction Generator (DFIG), as well as a PV and fuel cell system, is evaluated, with a system of hybrid providing 27.8 KW and 8.5 KVAR while the difference is supplied by the PV and fuel cell systems [14].

All switching elements in both power flow directions employ Zero Voltage Switching (ZVS); this converter's circuit needs just two auxiliary switches, two snubber capacitors, one diode, and one connected inductor. The few materials and the ZVS condition may be used to produce a highly efficient converter with several uses in industries. The proposed converter has a maximum load dependability of roughly 97% in both boost and buck operations. Because of this, the recommended soft-switching cell may be used in various fundamental non-isolated bidirectional converters, including the cascade buck-boost, buck-boost/buck-boost, Single-Ended Primary-Inductor Converter (SEPIC). The tests that were performed on a computer corroborate the theoretical waveforms and investigate the recommended construction [15].

Solar photovoltaic and wind energy have garnered increased attention as a result of the advancement of these technologies. This section discusses the options for establishing a grid-connected hybrid renewable energy network on a university campus to service a daily load of 4,658 kWh. This document explains the technical and economical details of the best solution, which comprises 585 kW of solar PV capacity and 15 kW of wind turbine capacity. Renewable energy accounts for 46.98% of total energy consumption on the university campus, according to the conclusions of the enquiry [16].

Building a hybrid system that employs two or more energy sources simultaneously to assure their constant accessibility is one technique for increasing the availability of renewable energy sources. This purpose is served by hybrid renewable energy systems, which combine two or more power sources. The efficiency of the system improves when the energy sources are combined. Particularly when renewable energy sources like wind and solar energy are deployed to provide the best answer to rapidly expanding energy demand. Previously, hybridizing renewable sources got less attention since renewable systems were expensive and grid accessibility for energy evacuated was confined.

Power converters are mostly used to adjust the input voltage according to the application's needs. Since many years ago, power converters have been a key component of power engineering and applications. Conversion devices have several uses in both industrial applications and RES systems. The standard voltage divider circuits, which contain rheostat and power conversion electrical systems, have been modified to be replaced with energy converters [17].

The suggested SFSN combines deep neural network (DNN) and stochastic fractal search (SFS) optimization methods. The DNN approach gathers the input parameters of load demand power and battery SoC throughout the operation to efficiently regulate energy on an electric shipboard. The output voltage of hybridized energy sources while reducing ripple switching stress, voltage loss, and distortions, these converters are predominantly utilized. Time Complexity is 37 (per unit =1) Predict the fuel cell's output power, [18]. With the help of the DO algorithm, this mechanism computes the weight value of the FNN in the best possible way The fuel cell Average current 1.21(A), and Dandelion Optimized Network Control (DONC) combines the FNN and DO techniques for energy effectively on an electric shipboard, the FNN technology collects the input parameters of load demand power and battery SoC during this process [19].

Using a lossless snubber and a DC-DC converter with an isolated Single-Ended Primary-Inductor (SEPIC) with the ripple-free input current. Using a linked inductor, the traditional isolated SEPIC converter may provide significant voltage gain and electrical isolation. The input current ripple is greatly diminished by using an auxiliary circuit that simultaneously serves as a lossless snubber circuit with an extra diode. Additionally, the snubber circuit limits the maximum switch voltage stress to a low value. SEPIC also benefits from minimal input current ripple thanks to a front inductor. A big input inductor can be employed to further lower the current ripple. However, due to the short lifespan of these power sources, this approach increases the size and weight of the converter pulse considerably less [20].

Shipboard electric engineered experience significant power and torque changes on their driving shaft because to propeller rotational motion and waves. By incorporating a Hybrid Energy Storage System (HESS) and exploring Energy Management (EM) techniques, this methodology analyses fresh solutions for coping with these variations. The HESS combines power sources and ultra-capacitor banking organizations. For real-time EM of HESS, a pair of methods are under consideration: one splits the amount of electricity needed so that high- and low-frequency power fluctuations can be accounted for by ultra-conductive capacitors and battery power; the other considers the HESS as a single entity and designs an EM strategy to coordinate the operations of the ultra-capacitors and rechargeable batteries. Power measurement and conserving energy are handled by predictive modelling and control under a variety of operational constraints. [21,22].

An extremely short listening period, which would cut energy usage during communications. The findings indicate that the suggested MAC protocol outperforms both the Sensor-MAC (S-MAC) and Multi-Layer MAC (ML-MAC) protocols in terms of conserving energy. The suggested method saves approximately 73% more energy than the S-MAC technique. It also saves 23.1% more energy than the ML-MAC protocol in coherence configuration [23]. The techniques of optional harmonics reduction through pulse width modulation (SHEPWM) and Equal Phase (EP) switching angle configuration are used to a cascaded H-Bridge multilevel converter. PSIM application is used to assess and evaluate the functioning of a 9-level cascaded H-Bridge multilevel inverter using two switching width configuration strategies [24].

2.1 Problem Statement

Non-hybrid solar PV or wind renewable energy does not generate enough electrical energy to provide steady power regardless of weather conditions. Power quality is inefficient in DC-DC conversion for buck and boost operation in the KY converter. Using ultra-capacitors for EV charging and discharging situations, as well as other energy storage devices with a limited range and performance. Based on weather circumstances, voltage imbalance in wind renewable energy source employing Doubly Fed Induction Generator (DFIG).

3. Materials and Method

Solar power is the indirect or immediate transformation of sunlight into energy using Photovoltaic (PV) or Concentration Solar Power (CSP). SEPIC, or single-ended primary inductor converter, is a form of Buck/Boost DC-DC Converters that produces a DC output that is more, less, or equal to the DC input. It comprises two inductors, a second at the input and one at the connection to the ground, and these two capacitors are linked by a linkage component. A BMS's ability to determine the battery's state of charge is always significant in Electric Ships (AESs). The suitable power of the control system and vehicle energy handling can benefit from the precise and reliable calculation of pack SOC. As an outcome, an Optimal Dispatch Evaluator Algorithm using ANN (Artificial Neural Network) Algorithm techniques has been put out for real-time based estimation of battery SoC.

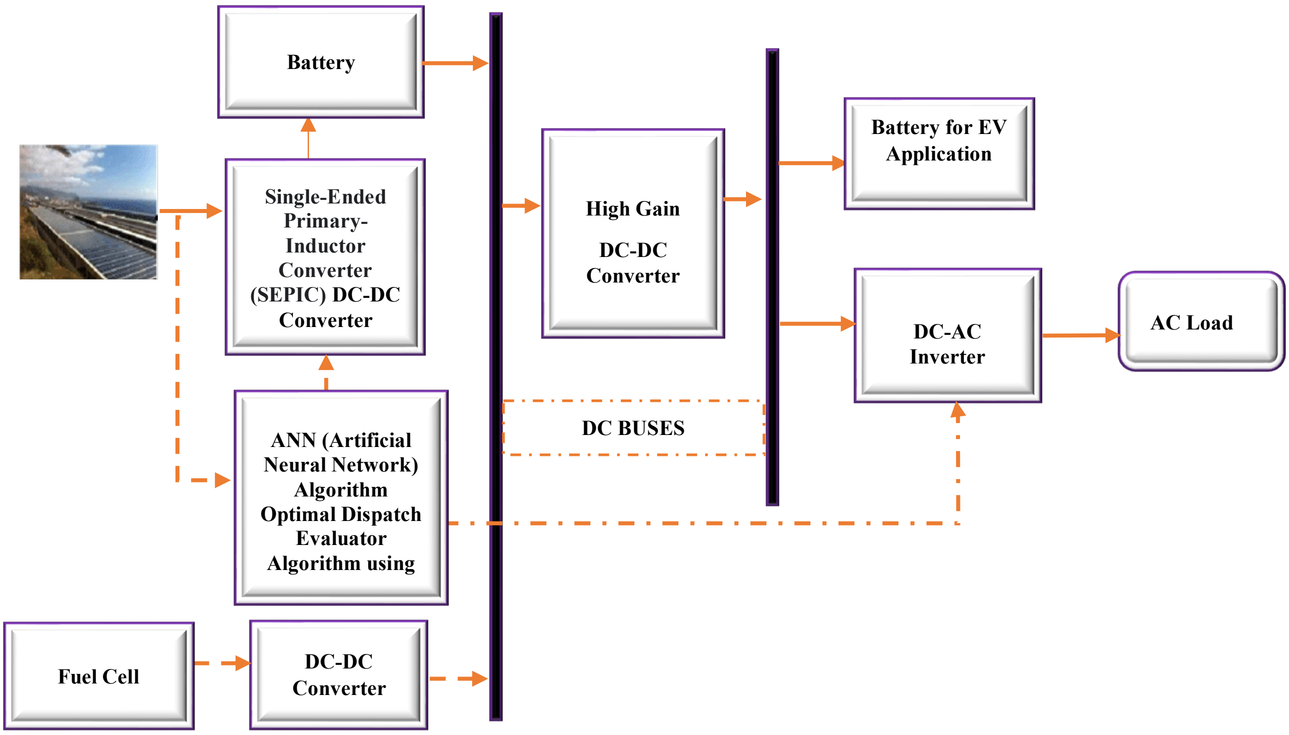

Fig. 2. Overall Proposed Block diagram

3.1 Battery for EV Application

The battery management system is a digital device that examines the battery's condition, generates extra information, circulates that data, regulates its surrounding environment, validates it, and/or balances it for optimum performance. The SOC (State of charge) is calculated primarily by integrating the current flow through time, modifying it to account for the numerous variables that impact cell performance, and then decreasing the result from the known capacity of the fully charged battery. Figure 3 shows the autonomous vehicle is an electric vehicle that does not require external charging, such as stations.

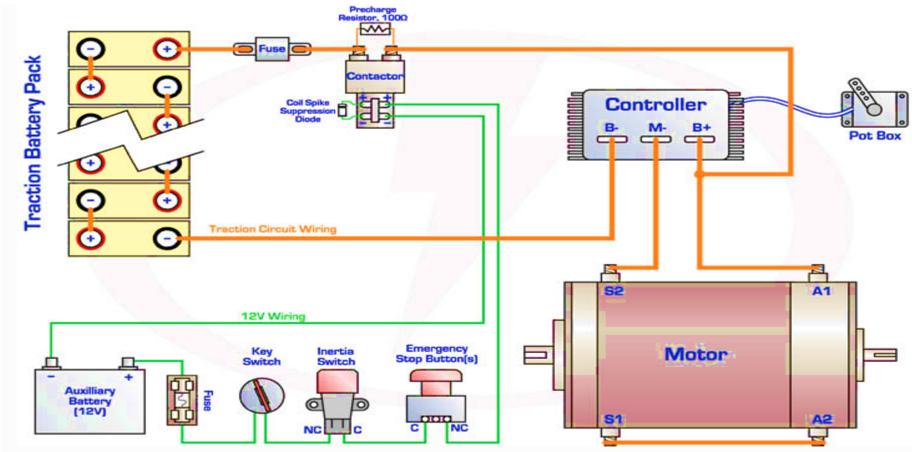

Fig. 3. Basic Working Diagram of Electrical Vehicle

This method transfers electricity from the PV to the car batteries. Furthermore, this configuration may wirelessly discharge the vehicle battery to the AC outputs or the primary-side DC bus, which can be linked to battery-powered energy storage equipment.

$$XAB = X(A) - X(B) = C1 - Ir1 \quad (1)$$

The energy storage system linked to the primary-side DC bus may also supply power to the load or charge the vehicle battery. This characteristic might be very beneficial for time-of-use energy expenditure control solutions. In this unique battery management strategy, divide the lithium-ion battery in two. The charging half charges, while the discharged half discharges. The car is charged using solar panels, regenerative braking, regenerated suspension, and additional renewable energy resources.

$$X = X1 - X2 + \ldots \text{ and } req = c1 + c2 + \cdots \quad (2)$$

One side is charging while the other is discharging. When the other half of the battery is completely depleted, the charged portion is kept for charging. Because of this management, the car can charge itself and does not need to apply two distinct batteries, which $\mathbf{X}$ removes the need for charging stations in the case of an occurrence like this. Designers may also get enough strength from this strategy to transcend every pattern.

3.2 DC-DC Converter

A power electronics arrangement that effectively transforms a direct current from one voltage to another is known as a direct current to direct current converting. Without an issue, DC-DC converters are essential components of contemporary electronics because they have various benefits over linear regulators for voltage. Figure 4 works based on linear voltage regulators, in particular, generating a lot of power and having inadequate efficiency when compared with the switching regulators used in converters that convert between DC and DC.

A buck-boost converter steps up or down the voltage, ultimately producing a voltage that is equal to, higher than, or less than the input voltage. A buck-boost may produce 12 V from a 12 V battery. A 12V battery's voltage can range between 10 and 14.7 volts. A buck boost could potentially be used to power an LED with a single battery. A buck converter reduces a voltage to produce less than the input voltage. A buck converter might charge a lithium-ion battery to 4.2 V from a 5 V USB connection.

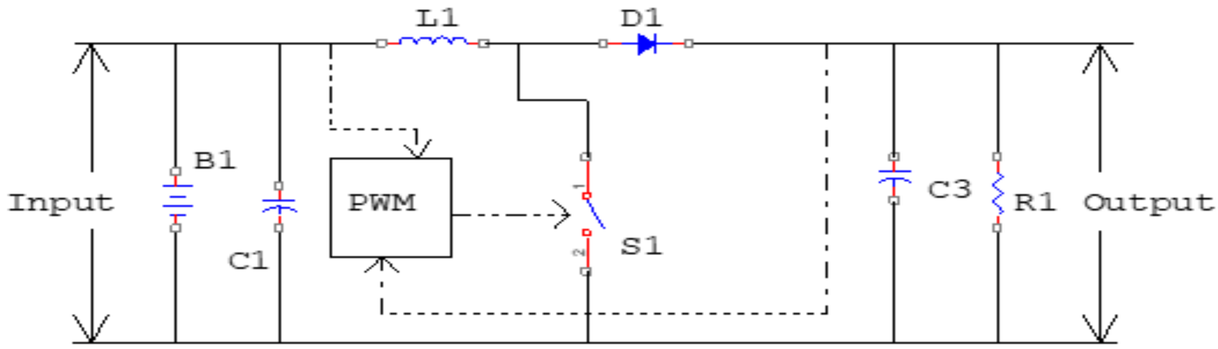

Fig. 4. Diagram of a DC-DC Converter

3.2.1 Single-ended primary inductor converter (SEPIC)

The Single-Ended Primary Inductor Converter (SEPIC) is a DC/DC converter design that produces a positive regulated voltage output from an input value ranging from the output voltage to zero. The transformation is important when a design uses voltages (e.g., 12 V) from a regulated input power source, such as a low-cost wall wart.

$$\frac{V_0}{V_{in}} = \left(\frac{1}{1-D}\right) \tag{3}$$

However, the SEPIC architecture can be challenging to grasp and requires two inductors, resulting in a huge power supply profile. Several inductor producers have recently begun providing off-the-shelf linked inductors in a single package at prices just marginally more than a similar single component.

Figure 5 circuit represents the SEPIC converter layout consists of the input power source Vg, coupling capacitor C1, output capacitor C2, two inductors L1 and L2, diode D, and load resistance. In SEPIC converter devices, the input and output devices share a common ground. The converter's circuit transfers energies between inductor L1, capacitor C1, and inductor L2 to convert the input DC voltage to the desired output voltage amplitude.

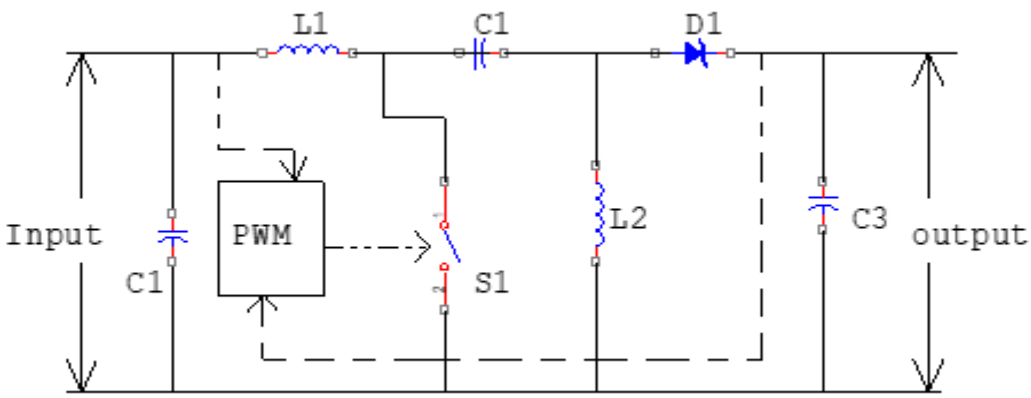

Fig. 5. Circuit diagram of Single-Ended Primary Inductor Converter (SEPIC)

A power transistor switch (S1), such as a MOSFET, is often used to regulate the quantity of energy transferred. Instead of applying separate inductors (L1 and L2), the SEPIC converter may be constructed using coupling inductors, which increases efficiency and reduces PCB space. Coupling inductors interconnect two windings (L1 & L2) in a single core.

3.3 Fuel Cell

Fuel cells immediately convert a fuel cell's chemical energy into electrical energy. In the cells depicted below, fuels such as Hydrogen (H2), Carbon Dioxide (CO2), Methane (CH4), propane (C3H8), Methanol (CH3OH), and others are employed to generate electrical energy. Figure 6 shows the fuel cell is continuously fed while its by-products are constantly eliminated. There are several fuel cells on the market. A hydrogen-oxygen fuel cell is the most common form. A hybrid system based on solar-PV and fuel cells operates as an independent unit coupled to a DC bus, lowering the overall energy harness production per m2 of land inhabited. As a result, a unique design of a PV & fuel cell hybrid system might better manage the current area in terms of productivity increase and energy/m2 harvested from the employed land. Furthermore, a solar PV array's pointed (angled) structure would reduce shade and give maximum duration and intensity of sunlight exposure, resulting in increased power generation.

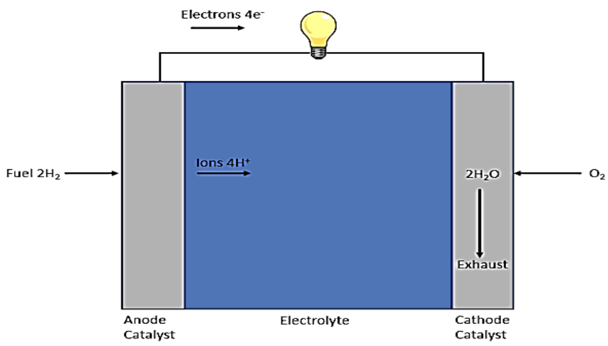

Fig. 6. Basic Working schematic diagram of Fuel Cell

3.4 DC-AC Inverter

The inverter mechanism's objective is to adjust the voltage and frequency of the power supply as well as to change the rotation speed of motors used in household appliances and industrial machines. The most significant aspect to remember when learning about the internal structure of an inverter machine is that the conversion circuit converts Alternating Current (AC) from sources of energy into direct current (DC), and the inverter circuit then processes the resultant Direct Current (DC) back into Alternating Current (AC). After that, the inverter circuit generates alternating current with variable voltage and frequency.

Figure 7 is the DC/AC conversion process that changes the ON/OFF intervals of power transistors such as "IGBT (Insulated Gate Bipolar Transistor)" to create pulse waves of variable durations. Then it combines them to create a false sine wave known as "Pulse Width Modulation (PWM)." The integrated system controls the pulse width automatically. Some one-chip processors that control the motor include a built-in PWM functionality. This allows you to produce changing frequency pseudo-sine waves and control the engine's rotation speed by giving the parameters needed.

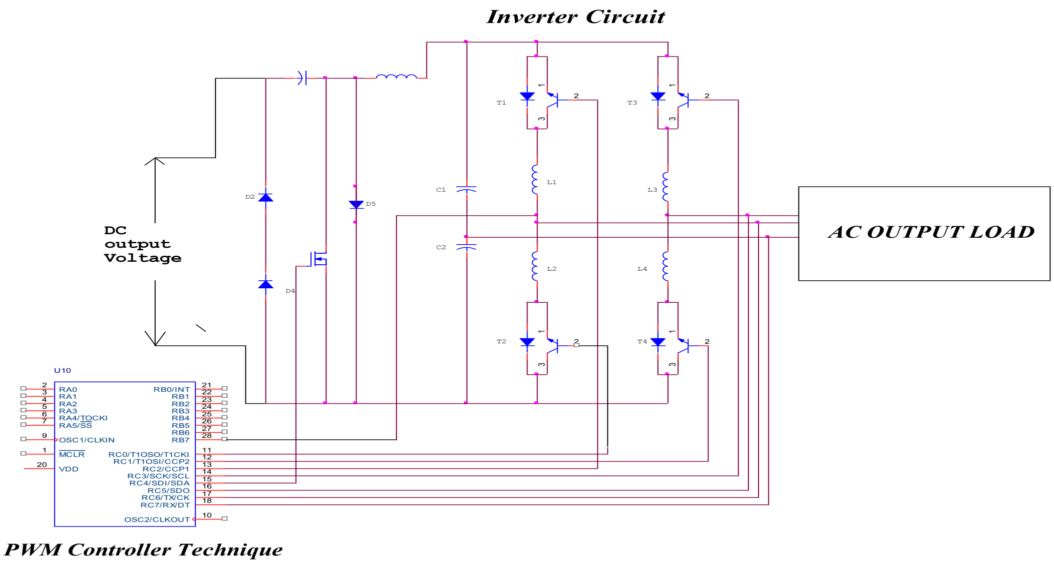

Fig. 7. Working schematic diagram of DC-AC Circuit

4. Result and Discussion

This suggested Battery Energy Management-based Single-Ended Primary Inductor Converter (SEPIC) approach will be used to simulate the entire system function and integrated into the simulation model of a controller using MATLAB2017b technology.

Figure 8 shows that a switch achieves the power flow among the fuel cell and the PV panel. The controller will enable electrical energy from the PV panels to be given to the load when there is PV irradiance, but it won't allow power from the fuel cell to be provided. The switch will, therefore, enable the fuel cell to continue supplying power to the load when the PV panel power hits zero and the irradiance level decreases to zero. The battery power will provide any residual capacity. As a result, the fuel cell produces more energy and less battery power is needed. The battery is linked to buck-boost, and the fuel cell and PV panel are connected to the boost converter to surge the voltage level.

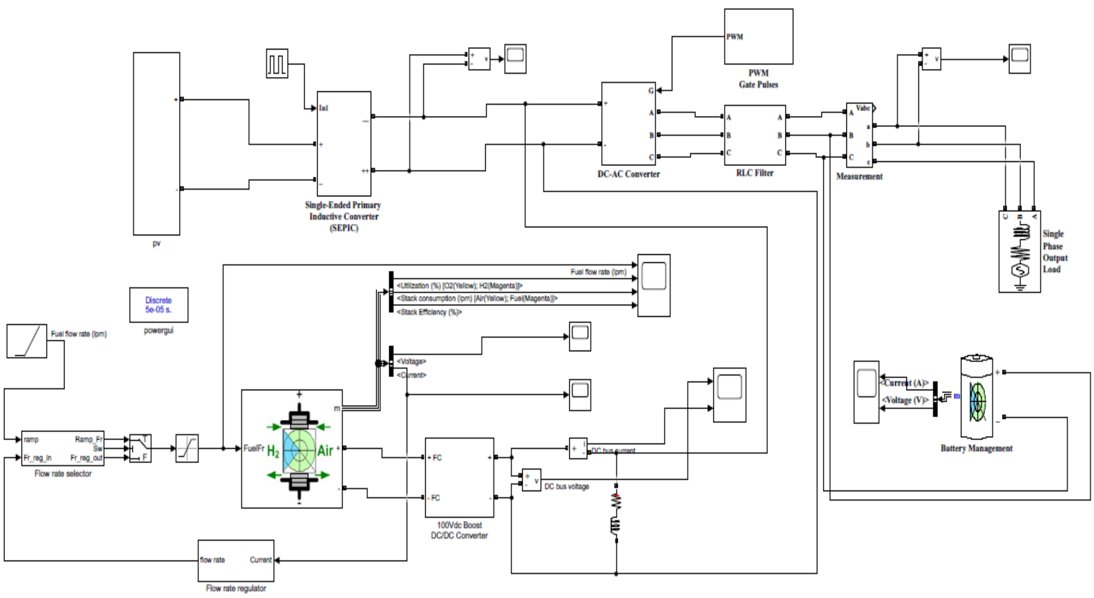

Fig. 8. Mat lab Simulink of Proposed SEPIC

Figure 9 shows the PV output voltage that generated input is 100 V gain form Temperature 10 and irradiance 250.

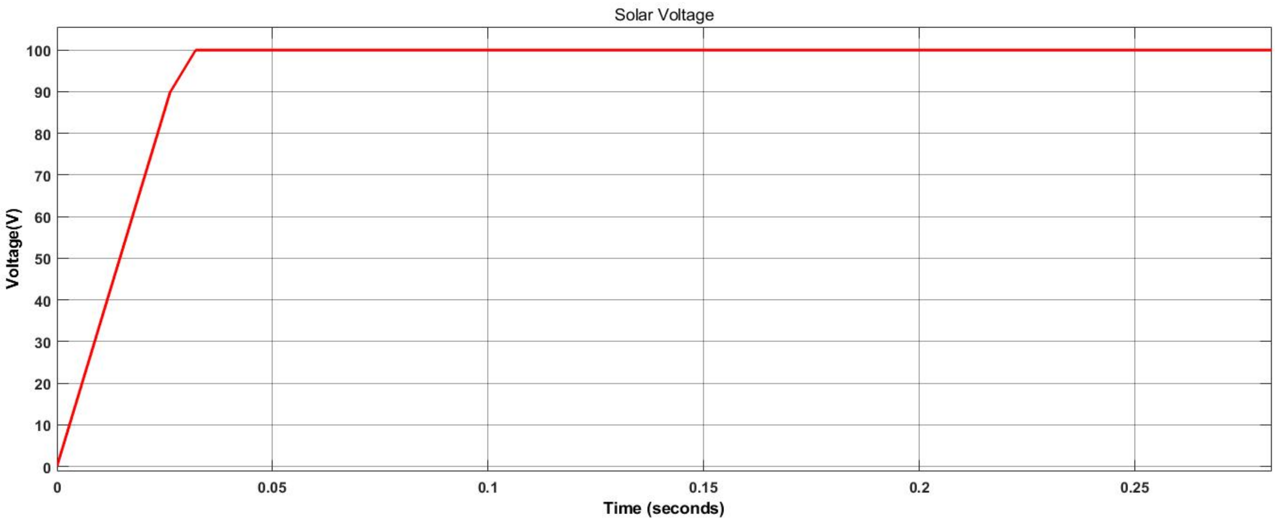

Fig. 9. PV output Voltage

Figure 10 shows DC– DC SEPIC converter with a gain of 103 V. The output voltage was obtained from a renewable solar power source.

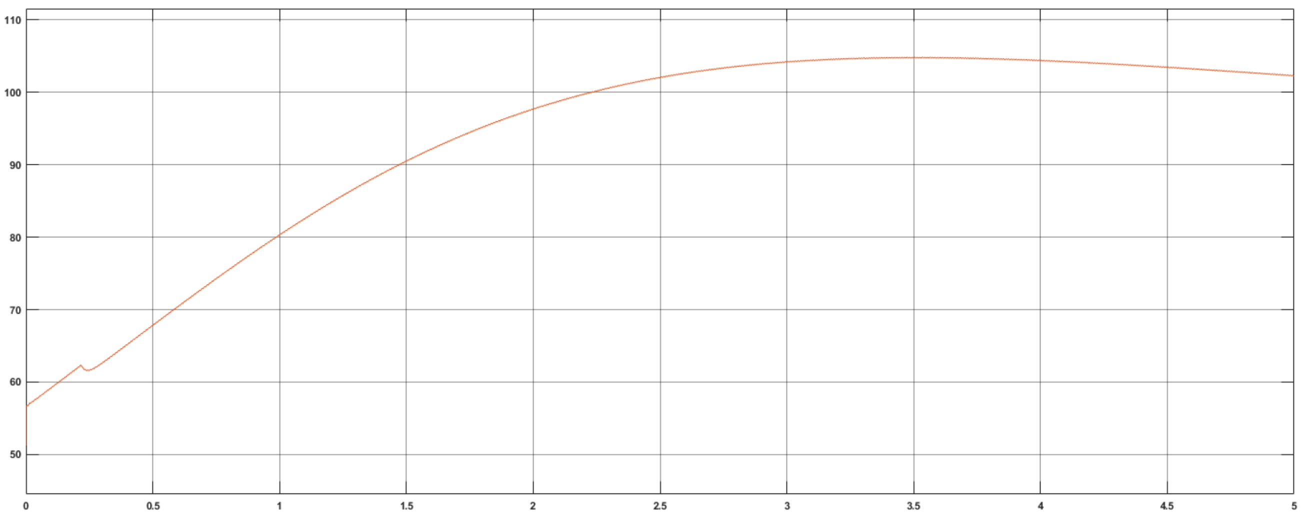

Fig. 10. Output waveform of Single-Ended Primary-Inductor Converter (SEPIC) DC-DC Converter

Figure 11 shows 230 V achieved from the DC– AC inverter without distortion is completed with better efficiency and gain power quality for single-phase output.

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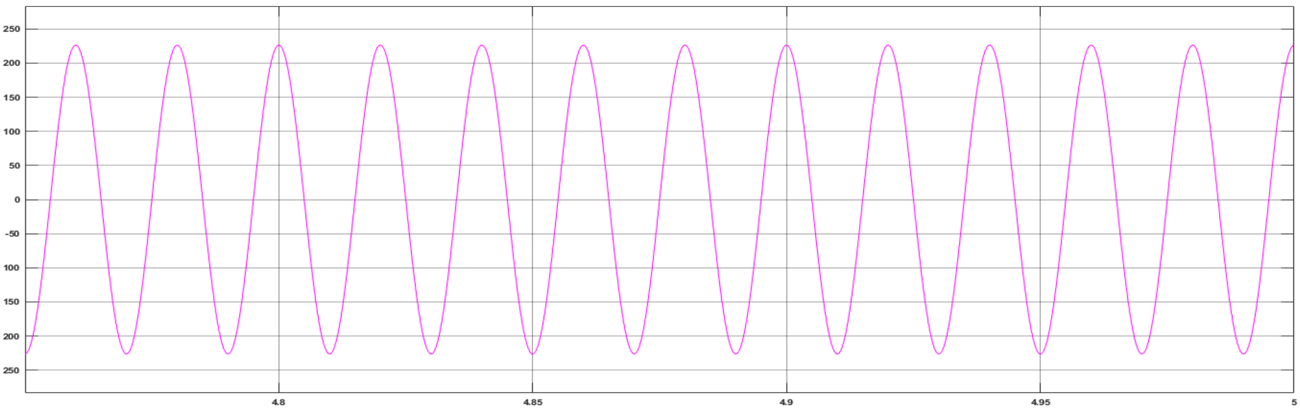

Fig. 11. Single Phase Output of Proposed Method

Figure 12 shows the activation voltage drop caused by the slowness of the chemical processes happening at electrode surfaces, represented by the first area. This fuel is more or less broad depending on the stock consumption, fuel flow rate, air (o_2), and Fuel flow rate (I_{pm}). The second zone shows the resistive losses brought on by the fuel cell stacks inside resistance.

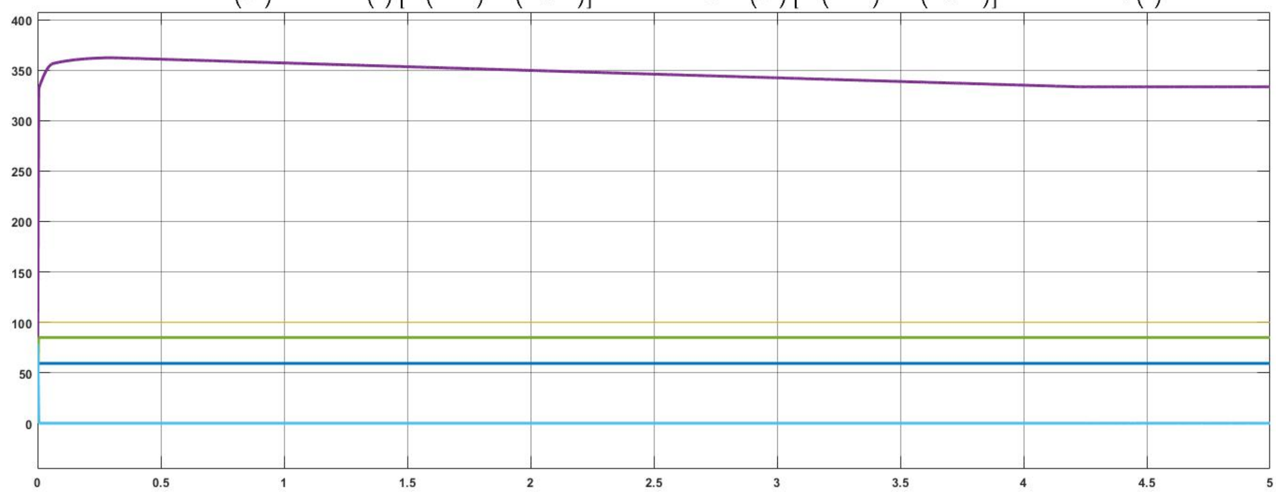

Fig. 12. Fuel Cell output waveform

Table 1 shows the parameters of SOC_{min}, which is a minimal SOC set to prevent the battery from being harmed by excessive discharge; for this option, selecting values between 30% and 50% is typical. SOC_{mod} Is a level of SOC established to keep the battery operating within its ideal operating region. SOC_{max} Is the maximum SOC set to prevent overcharging from harming the battery. $P_{load,}$Which includes the propulsion loading and the auxiliary pressure, is the power needed by the ship's loads.

$$Time\ complexity = \frac{Total\ operating\ time}{runing\ time} \tag{4}$$

Table 1
Energy management created parameter specifications

Parameter	Min value	Max value
Fuel cell power	1 kW	10 kW
Battery power	−1.2 kW (charging)	4 kW (discharging)
Battery SoC (high)	84%	99%
Battery SoC (normal)	65%	98%
Battery SoC (low)	32%	38%
D.C. bus voltage	200V	250 V

Table 2
Assessment of Time Complexity

Methods	Dandelion Optimized Network Control (DONC)	Stochastic Fractal Search Network (SFSN)	Optimal Dispatch Evaluator Algorithm using ANN (Artificial Neural Network
Time Complexity (per unit =1)	69	37	25
Average current (A)	0.78A	1.21A	1.4A

Figure 12 shows the maximum amount of energy a diesel generator can produce is known as Peng; max, the speed at which the diesel engine is started, is known as the limit. In order to keep the diesel engine from operating in its poor-efficiency mode, batteries are frequently used in hybrid cars at low speeds.

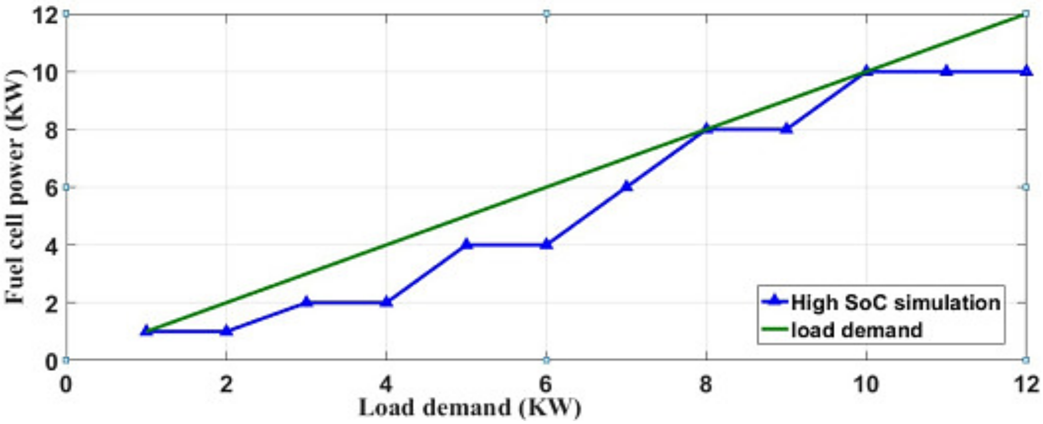

Fig. 12. Fuel cell power obtained from Optimal Dispatch Evaluator Algorithm using ANN (Artificial Neural Network) at high SoC mode

Table 3 shows comparison analysis of output power per unit = 0.94%, switching losses = 4%, and maximum output power efficiency = 97.25 % based on Cuk, SEPIC, and Zeta DC –DC converters are compared with varying changes in solar radiation and the temperature of the PV system**.**

Table 3
Performance analysis Based different types of Converters

Methods	Cuk Converter [5]	Zeta Converter [6]	Single-Ended Primary-Inductor Converter (SEPIC
Output power in per unit	0.84	0.89	0.94
Switching Losses (%)	16	11	4
Maximum output Power Efficiency (%)	84.72	89.55	97.25

5. Conclusion

This work experiments with an energy management challenge for electric ships in order to improve performance of the recharging devices used in electric shop vehicle batteries. Fuel Cell and PV regenerating systems are the input power source, and the battery energy management loop were generated, considering a wide range of factors such as vehicle loads, sequential mathematical modelling of each portion, and an in-depth description of the needed electronic components and a simulated using the MATLAB/Simulink programmers. An output power Time Complexity and load demand variable from solar arrays of elements causes harmonic or voltage fluctuations from nominal values in electrical devices; hence, SEPIC DC-DC converters equipped with MPPT are employed to eliminate such difficulties.

5.1 Future scope

In future centralized multiport converters using PV and Fuel cell for Backup Storage Units (BSC), the in-progress enquiry will be expanded to the next level of thermal analysis, with new other substances accessible to satisfy contemporary issues such as charge level, weight, and thermal efficiency. Another area that might be examined for a subsequent examination is the maximum power with temperature changes, such as whether the maximum strength would be at the lowest temperature and the opposite direction.

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