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Design of Intelligent Hybrid Energy Ambulatory Surgical Center Ship in Efficient Way

Tawheed Hasan[a], Shahrizan Jamaludin[a*] & W.B. Wan Nik[b]

[a]*Faculty of Ocean Engineering Technology; Universiti Malaysia Terengganu (UMT), Malaysia*

[b]*Faculty of Maritime Studies and Marine Science; Universiti Malaysia Terengganu (UMT), Malaysia*

[*]*Corresponding author: shahrizanj@umt.edu.my*

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ABSTRACT

An Ambulatory Surgical Center (ASC), also known as an outpatient surgery center, is a medical facility that provides same-day surgical procedures to patients who do not require an overnight stay in a hospital. ASCs are equipped with state-of-the-art medical equipment and staffed by highly trained healthcare professionals, including surgeons, anaesthesiologists and nurses. There are many areas along the river where people do not have easy access to any surgery. They have to go far to get this service, for which they do not even take the service. This research is for them. This research will ensure their basic medical services. The contribution of this research, this world-class surgical ship goes to ensure the basic medical needs of poor people in remote areas where good healthcare is not available. Another great contribution that will surprise the world is that no conventional fuel is needed to ensure this healthcare service. So undoubtedly this research has a great contribution in the global energy crisis. To ensure efficient ambulatory surgical center (ASC) ship, conducting site assessment, sizing the hybrid system appropriately, selecting the right components, improving hybrid energy system design, implement intelligent system is important. And these are the scope of our research. A detailed analysis of all possible aspects has shown that using intelligent hybrid energy ships instead of conventional ships improves the quality of service. Long lasting service is achieved with low energy consumption, sustainability and no pollution even without compromising performance. In this research details of ASC will be critically discussed.

Keywords: Hybrid energy system, Ambulatory Surgical Center Ship, intelligent system, outpatient surgery center, efficient system

INTRODUCTION

The history of Ambulatory Surgical Centers (ASCs) dates back to the early 20th century, when outpatient surgical procedures began to be performed in hospitals. However, the concept of dedicated ASCs did not emerge until the 1970s, in response to rising healthcare costs and advancements in surgical techniques (Tiao et al. 2023). The first ASC is widely credited to Dr. Wallace Reed, a California ophthalmologist who opened the first freestanding surgery center in 1970. Reed's center was designed specifically for outpatient procedures and offered a more efficient, cost-effective alternative to traditional hospital-based surgery. In the years that followed, ASCs grew in popularity, particularly in the United States. By the 1980s, there were more than 1,500 ASCs in the US, and the number continued to grow rapidly. Many of these centers were physician-owned and operated, offering a more entrepreneurial model of healthcare delivery. In the 1990s, the growth of managed care and cost containment efforts led to increased utilization of ASCs, as they offered a more affordable and efficient alternative to hospital-based surgery. The Medicare program also began to cover ASC services, further fueling their growth. Today, ASCs are an important part of the healthcare landscape, offering a range of surgical procedures in a cost-effective, patient-centered environment (Daniel et al. 2023). They are regulated by state and federal agencies to ensure that they meet certain quality and safety standards. As technology continues to advance and healthcare costs continue to rise, ASCs are likely to remain an important component of the healthcare system.

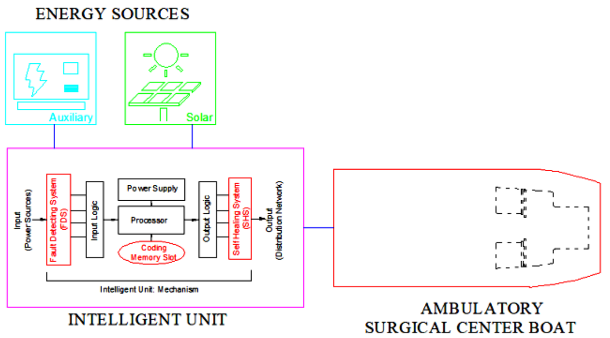

FIGURE 1. Operational diagram of Hybrid Energy Ambulatory Surgical Center Ship

In this research, the primary source is solar energy (Figure 1). When solar is not sufficient, a secondary source is a diesel generator (Ghenai et al. 2019). Both of these sources run the ship through an intelligent system'. This intelligent system regulates the total operation of the ship (Figure 2). Some basic knowledge of solar energy is necessary to understand this research. Solar energy can help ASCs reduce their operational costs, increase their energy independence, and contribute to a more sustainable healthcare system (Yin et al. 2023). By harnessing the power of the sun, ASCs can ensure that they have access to reliable, affordable, and sustainable energy for years to come. Solar energy can help Ambulatory Surgical Centers (ASCs) in several ways: Cost savings: ASCs can use solar energy to offset their electricity costs, reducing their operational expenses and allowing them to direct more resources towards patient care. Energy independence: solar energy can provide ASCs with a reliable and sustainable source of electricity, reducing their dependence on traditional energy sources and ensuring that critical surgical procedures can continue uninterrupted, even in the event of a power outage (Rohanim et al. 2019).

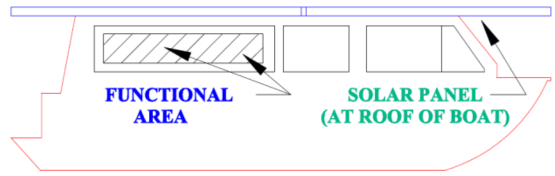

FIGURE 2. Illustration of Hybrid Energy Ambulatory Surgical Center Ship

Environmental benefits; The specialty of this research is to provide basic need to the riverside people. Keeping that in mind, the sunlight has been considered for the environment and sustainability. Flexibility; For designing this ship required some creative changes to our energy system, including size, capacity, and energy storage requirements. Along with the energy sources an intelligence unit has been added which has shown remarkable performance in terms of results. This allows ASCs to tailor their solar energy systems to their unique operational needs and to expand their systems as their needs evolve over time (Sunaryo et al. 2019). In remote or underserved areas where access to traditional energy sources may be limited, solar energy can help power ASCs and provide access to critical surgical care.

MODEL OF AMBULATORY SURGICAL CENTER SHIP

IMPORTANCE OF AMBULATORY SURGICAL CENTER SHIP

One of the contributions of this research is to ensure basic rights to large sections of deprived population without even using conventional energy. Hybrid Energy Ambulatory Surgical Center Ships (HASCs) are important because they can help to address several healthcare and environmental challenges, particularly in remote or underserved areas. Here are some reasons why HASCs are important.

Access to healthcare: HASCs can provide surgical care to people who would otherwise not have access to such services due to geographical or economic barriers (F. Dexter et al. 2019).

This can help to improve health outcomes and reduce health disparities. Sustainability: By relying on hybrid energy, SASCs can operate sustainably, reducing the environmental impact of healthcare services (Franklin et al. 2020). This can be particularly important in areas where the electricity grid is unreliable or nonexistent. Emergency response: HASCs can provide surgical care in emergency situations where traditional medical facilities may not be able to operate due to power outages or other disruptions (Neal D et al. 2023). This can be critical in disaster response scenarios. Cost savings: HASCs can be more cost-effective than traditional ASCs, as they do not require a constant supply of electricity from the grid (Yang et al. 2019). This can help to reduce healthcare costs and make surgical care more accessible to a wider range of people. Technology development: The development of HASCs has led to advancements in solar power technology, as well as innovations in medical equipment and infrastructure design. These innovations can have broader applications beyond healthcare, contributing to sustainable development more broadly.

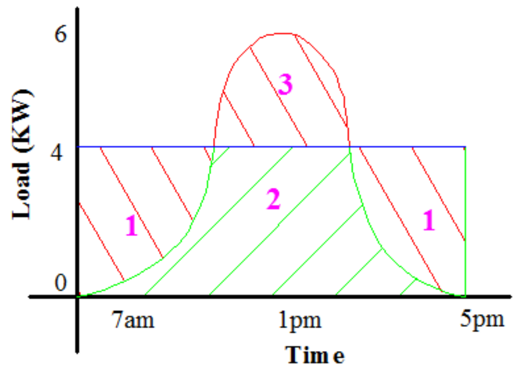

FIGURE 3. Functional graph of the 'Hybrid Energy Ambulatory Surgical Center Ship'

This graph (Figure 3) is the main concept of this research work (Khan et al. 2018). From 7 a.m. on, solar energy is not enough. So area '1' is backed up by a diesel generator. At 1 p.m., solar energy is more than enough. The total load of the ship is run by solar (area 2), and there is some extra energy (area 3). At 5 p.m., again, solar was not enough, and a backup diesel generator was needed (area 1). This is an ideal case. Diesel generators can be an alternative on rainy days when there is a lack of sunlight. Intelligent capability is adapted for this Ambulatory Surgical Center ship. The mechanism of the ship has been reflected in Figure 4. The priority energy source is direct solar energy. At first, all requirements are fulfilled by solar energy. When solar energy is not sufficient, the second priority is a diesel generator. In this experiment, there is also a fault detection and correction facility. The total mechanism is controlled and monitored by an intelligent unit. In the check the system' step, this mechanism basically ensures both improvements and faults.

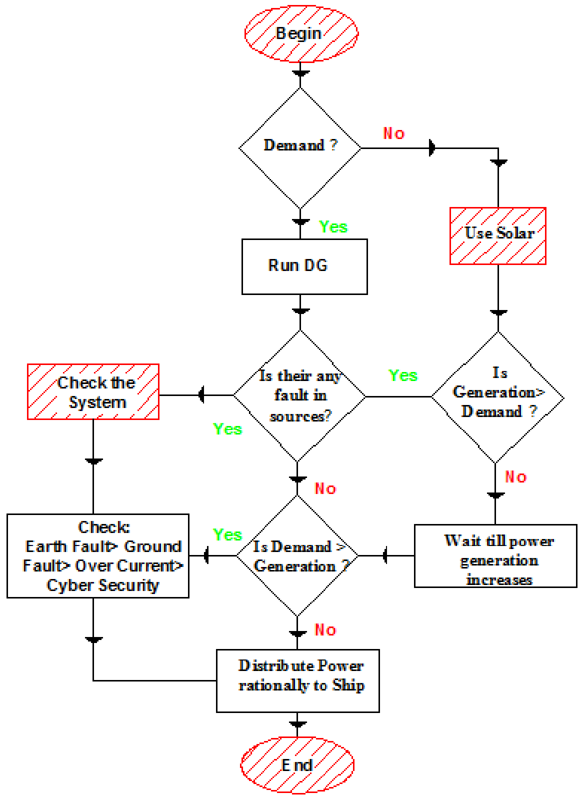

FIGURE 4. Mechanism of the ship

At the same time, this model contributes to the energy crisis by using solar energy primarily. And also contributing to the health sector. This is the contribution of this research and utilization of this method.

MAKING OF AMBULATORY SURGICAL CENTER SHIP EFFICIENT

To make a Hybrid Energy Ambulatory Surgical Center Ship (HASC) technically sound, there are several important considerations. By addressing these key considerations, a SASC can be designed to be technically sound, reliable, and effective in providing surgical care in remote or underserved areas. Here are some suggestions: solar power system: The solar power system is the backbone of a SASC, so it's important to ensure that it is properly designed, installed, and maintained (Gong et al. 2019). This includes selecting the right components, sizing the system appropriately, and designing for redundancy and reliability. Medical equipment: The medical equipment used in a SASC must be reliable and appropriate for the setting. This may require selecting equipment that is designed for use in low-resource settings or that can operate on lower power inputs. Infrastructure: The physical infrastructure of a SASC must be designed to support the solar power system and medical equipment (Obaid et al. 2018). This may include incorporating passive cooling and ventilation systems, ensuring proper lighting and electrical outlets, and designing for accessibility and infection control. Staff training: Staff members must be trained on the proper use and maintenance of the solar power system and medical equipment, as well as emergency procedures and infection control practices. Quality assurance: Regular quality assurance checks and maintenance procedures should be implemented to ensure that the solar power system, medical equipment, and infrastructure are functioning properly (Guangul et al 2019). Emergency preparedness: The SASC must be designed to operate in emergency situations, such as power outages or natural disasters. This may require incorporating backup power sources, developing emergency response plans, and ensuring that staff members are trained on emergency procedures.

INSIGHTS OF PATIENT STATUS OF THE SHIP

This intelligent system has a great impact on patients associated with this project.

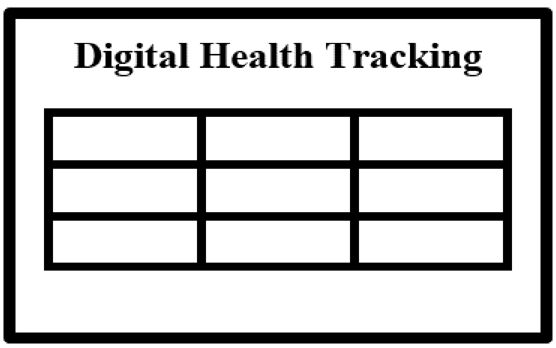

FIGURE. 5 Digital health tracking of patients

Digital health records (Fig-5) of all patients who are getting support from this ship can be tracked. For furture dignosis, physicians will be able to take support from this record. Health condition, treatment outcome, everything can be analysed easily with this tracking system. This system will open a dynamic research horizon. This will make treatment fast, effective and economical. The telemedicine network will have new dimension with this tracking system. Both direct and remote monitoring systems will be upgraded with integration of digital health tracking (DHT). This is an identical feature of technology and has a greater impact. possible to bring more people under the facility of treatment.

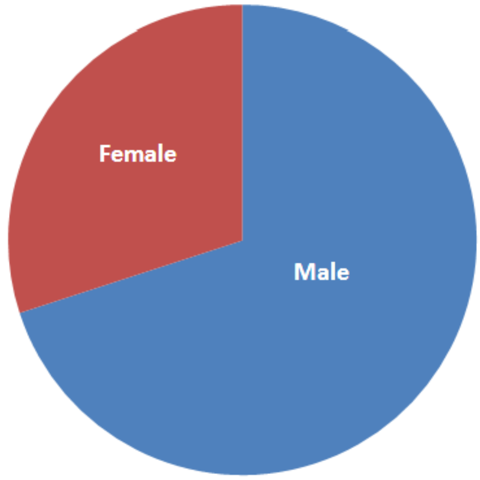

FIGURE 6. Gender ration patients in the ship

Female patients are fewer compared to males (fig-6). So reasons should be identified and measures should to be taken. If the issue of more privacy there is female patients, then be changes must be brought to future ship designs. But if the reason is lack of awareness, then proper authorities should be notified about this. So data of this research has a very important impact on the health sector.

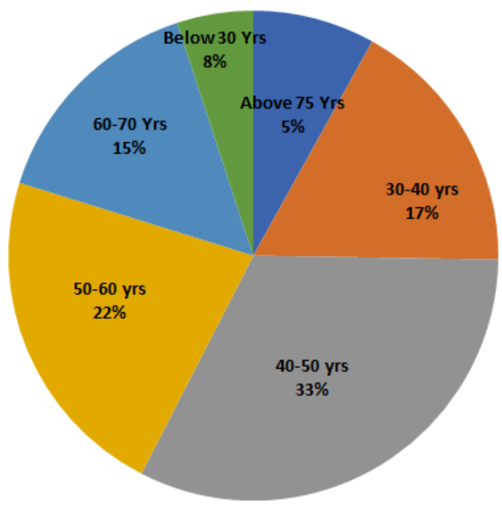

FIGURE 7. Gender ration of patients in the ship

The service of this center is open to all. Analysis of databases of patients reflects the ration of number of patients is more middle age people (Fig-7). With this analysis, a more effective strategy can be made. A strong follow-up system should be introduced shortly. In this research location there are many complexities for the middle age group. But because of lack of money and some other limitations sometimes they cannot reach, to a hospital.

DESIGN AND CALCULATION OF HYBRID ENERGY AMBULATORY SURGICAL CENTER (ASC)

BASIC EQUIPMENT OF AMBULATORY SURGICAL CENTER (ASC)

Here details technical analysis will be described (Al Mehedi et al. 2021, Reza et al 2018, Gaber et al 2019). These specifications are very important while designing a ship.

TABLE 1. This is the list of medical equipment with wattage

Sl	Equipment	Volt	Watt
1	Anesthesia machine	240 V	1440Watt
2	Operating room lighting	220 V	35 Watt
3	Electrosurgical unit	220 V	200 Watt
4	Patient monitoring equipment	220 V	100 Watt
5	Suction machine	220 V	40 Watt
6	Oxygen tank and regulator	220 V	250 Watt
7	Defibrillator	220 V	100 Watt
8	Oxygen tank and regulator	220 V	275 Watt
9	IV infusion pump and supplies	220 V	150 Watt
Total Wattage		2590 Watt	

BASIC ELECTRICAL EQUIPMENT OF AMBULATORY SURGICAL CENTER (ASC) INCLUDES

Here details electrical analysis will be described (Rana et al 2018, Singh et al. 2018, Baykara et al 2018). Without perfect specification, it would be not easy to have a effective design.

TABLE 2. This is the list of electrical equipment with wattage

Sl	Equipment	Load
1	Electrical outlets	
2	Electrical safety systems	
3	Lighting systems	
4	HVAC systems	
5	Computer systems	
6	Communication systems	
7	Audiovisual systems	
8	Security systems	
	Approx. Load (Watt)	1410 Watt

continue ...

... cont.

This is the list of electrical equipment with wattage

Total Load= 2590+1410 Watt = 4000 Watt

SPECIFICATION OF SOLAR ENERGY SYSTEM OF AMBULATORY SURGICAL CENTER (ASC)

It is important to note that the specific equipment needed for a 4000-watt solar energy system may vary depending on factors such as the type of solar panels used, the location and orientation of the property, and energy consumption needs (Ammari et al 2021). Additionally, it is recommended that clients consult with a licensed professional or solar energy expert to determine the best equipment and configuration for the specific situation. The equipment needed for a 4000-watt solar energy system typically includes a few basic components. Solar panels: To generate electricity from sunlight For a 4000-watt system, users need around 12–16 panels, depending on the wattage and efficiency of each panel (Haratian et al. 2018). Inverter: To convert the DC (direct current) electricity produced by the solar panels into AC (alternating current) electricity that can be used to power appliances and devices in the home. Mounting system: To securely attach the solar panels to the user's roof or another location on the property. Solar charge controller: To regulate the amount of electricity that goes into the battery storage system, if the customer has one (Jiang et al. 2018). Batteries: To store excess electricity generated by the solar panels for use during times when there is not enough sunlight. Monitoring system: To track the performance of the solar energy system and detect any issues or malfunctions. Electrical wiring and safety equipment: To safely connect the solar energy system to the user's home electrical system (Abd et al. 2020).

DETAILS CALCULATION

Number of solar panels = [Daily energy consumption (A) x Inverter efficiency x Losses factor (B)] / [Panel Wattage (C) x Peak Sun Hours]

(A) Calculate the daily energy consumption of the AC: Daily energy consumption = Power x Time

= 4000 watts x 4 hours = 16000 watt-hours

(B) Determine the inverter efficiency and losses factor: Assuming an inverter efficiency of 85% and a losses factor of 1.3, the combined efficiency would be: Combined efficiency = Inverter efficiency x Losses factor = 0.85 x 1.3 = 1.105

(C) Determine the panel wattage and peak sun hours: Assuming we have 250-watt solar panels and an average of 5 peak sun hours per day, we can calculate the total energy generated per panel per day: Total energy generated per panel per day = Panel Wattage x Peak Sun Hours = 250 watts x 5 hours = 1250 watt-hours

Calculate the number of solar panels required:

Number of solar panels = (Daily energy consumption x Combined efficiency) / Total energy generated per panel per day

= (16000 watt-hours x 1.105) / 1250 watt-hours = 14.13

Therefore, approximately 15 solar panels to power the 4000-watt AC running at 220 volts, assuming the AC is used for 4 hours per day, with 250-watt solar panels, an average of 5 peak sun hours per day, an inverter efficiency of 85%, and a losses factor of 1.3

RESULT

Performance curve of solar panel is very important in such research.

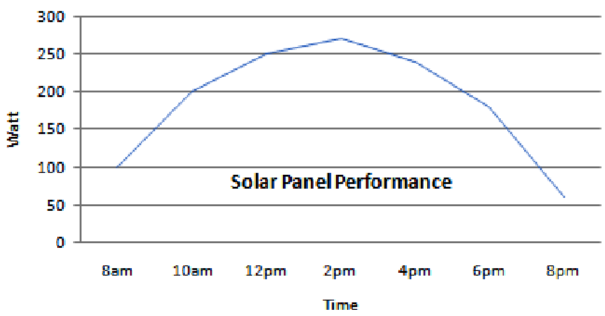

FIGURE 8. Performance curve of Solar Panel

The performance curve of a solar panel, also known as an IV curve that is showing the relationship (Fig-8) between the voltage and current produced by the solar panel at different levels of sunlight intensity and temperature (Nasir et al. 2021). Here the curve is plotted by measuring the output voltage and current of the solar panel at various combinations of voltage and current, while exposing the panel to different light intensities and temperatures.

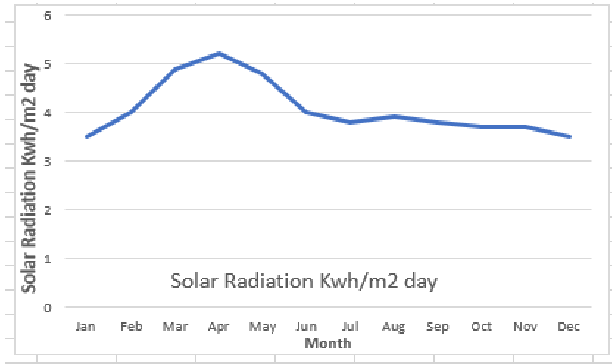

FIGURE 9. Solar radiation graph.

Dhaka city is located in Bangladesh, which lies in the tropical region. The amount of solar radiation (Fig-9) received by Dhaka city varies throughout the year due to changes in the angle of the sun and cloud cover (Aghenta et al. 2019). Typically, the city receives the highest amount of solar radiation during the summer months (April to September), and the lowest amount during the winter months (October to March). The average annual solar radiation in Dhaka city is approximately 4.5 kWh/m²/day. However, this value can vary depending on the specific location within the city, as well as other factors such as air pollution and shading from buildings.

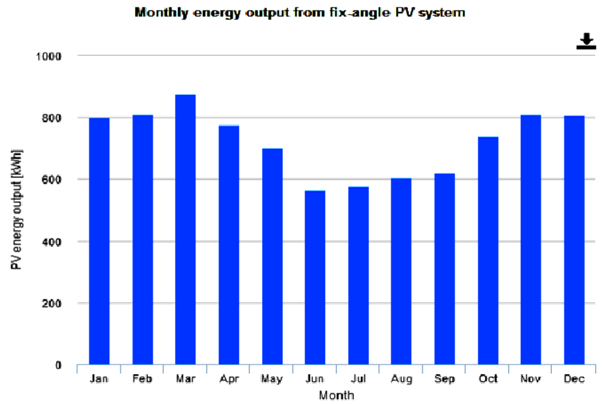

FIGURE 10. Simulation of the driving force (solar energy) of the hybrid system for efficient design

This is simulation graph (Fig-10) of energy output of the ship. It reflects the energy status of the system. In summer season energy is more than any other time. In this time period energy generation is top most and this is characteristics of solar PV energized hybrid system.

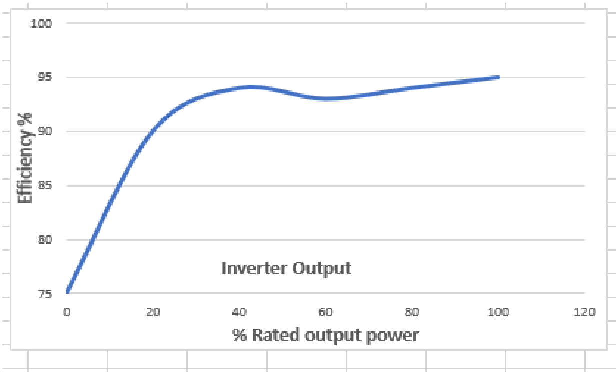

FIGURE 11. P-V curve of a solar inverter.

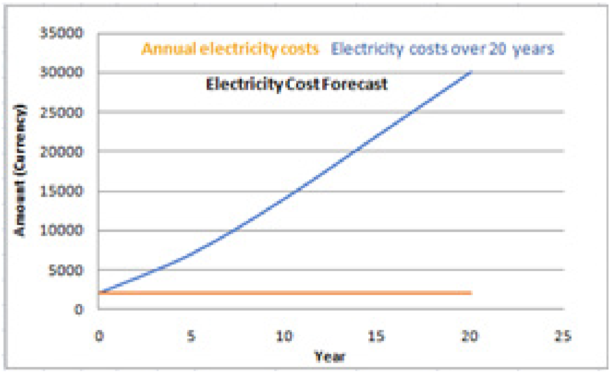

FIGURE 13. Cost forecasting

The inverter is one of the most important pieces of equipment in a solar energy system. It's a device that converts direct current (DC) electricity, which is what a solar panel generates, to alternating current (AC) electricity. This graph (Fig-11) helps us with the performance of the system. The power-voltage (P-V) curve of a solar inverter shows how the inverter's output power changes as the input voltage from the solar panels varies (R. Zhang et al. 2022). The curve typically shows a maximum power point where the inverter can achieve its maximum efficiency and produce the most power. The MPP is the optimal operating point of the solar array, and the inverter's job is to track it as closely as possible.

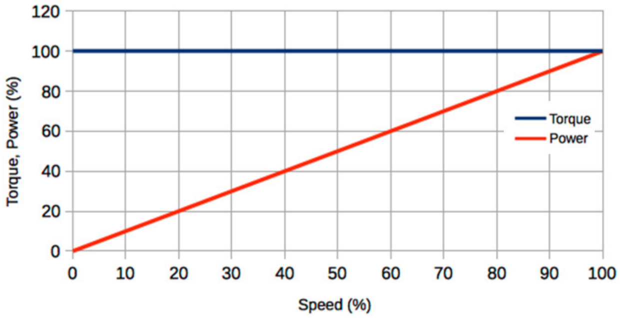

FIGURE 12. Graph of Torque Vs Speed of motor

The torque speed curve (Fig-12) of the ship is a plot showing its torque requirement on the y- axis versus the speed on the x-axis. It's the torque requirement of the ship from zero speed to full speed. Here, torque does not change but the rate of power changes with time.

One of the most significant ways that a solar energy system can save money (Fig-13) is by reducing or eliminating energy bills. By generating electricity from the sun, solar panels can reduce a home or business's reliance on traditional energy sources, resulting in lower energy bills over time (Montoya et al. 2022). Solar energy systems require relatively little maintenance, which can save money on upkeep and repair costs compared to traditional energy systems.

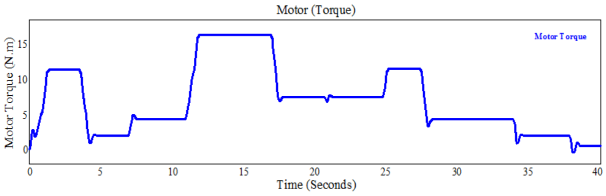

FIGURE 14. Motor Speed (rpm), Armature Current (A), Torque (N.m) VS Time

The motor performance graph for a solar electric ship includes the motor speed (rpm), motor armature current (A), and motor torque (N.M) plotted against time (seconds). This graph (Fig-14) provides valuable information about the performance of the motor and the ship's propulsion system under different operating conditions. The x-axis represents time, which is measured in seconds. The y-axis on the left side of the graph represents the motor speed, which is measured in revolutions per minute (rpm). The y-axis on the right side of the graph represents both motor armature current and motor torque, which are measured in amperes (A) and Newton-meters (N.M), respectively. The graph shows three continuous lines, each representing the variation of motor speed, armature current, and torque over time. During acceleration, the motor speed current line increases, and the current armature increases as well, indicating the demand for more power from the motor. The torque line also increases, showing that the motor is generating more force to move the ship forward. During deceleration, the motor speed decreases, and the armature current line decreases as well, indicating that the motor is using less power. The torque line also decreases, showing that the motor is generating less force to slow down the ship.

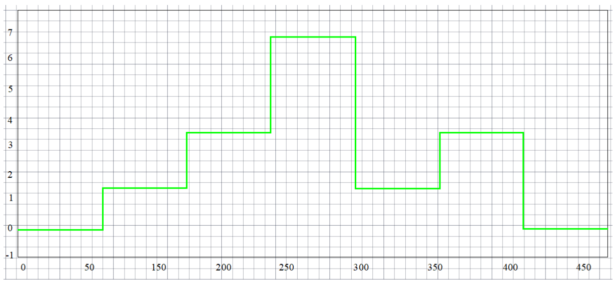

FIGURE 15. Speed control via voltage profile with Simulink model simulator

Speed control via load profile graph is a graphical representation of the relationship between the speed of a motor and the load profile that it is operating under. The graph (Fig-15) shows the speed of the motor on the y-axis and the load profile on the x-axis. The load profile represents the level of demand that the motor is facing over time. This includes variations in the load due to changes in the production process, changes in the materials being processed, or changes in the environmental conditions in which the motor is operating. The speed of the motor is controlled by adjusting the input voltage or current to the motor. As the load on the motor changes, the voltage or current input to the motor must be adjusted to maintain a consistent speed. This is achieved through the use of a motor controller, which monitors the load on the motor and adjusts the input voltage or current as needed to maintain a constant speed. There would be an indication system for energy shortage. In the case of a cut of energy supply, the diesel generator is the alternative the most reliable source, even at the time of operation.

CONCLUSION

Hybrid energy Ambulatory Surgical Center Ship (ASCs) is an innovative approach to healthcare facilities that combine traditional energy sources with renewable energy technologies. These facilities are designed to be environmentally sustainable and economically efficient, while also providing high-quality care for patients. Hybrid energy ASCs can help reduce energy costs and dependence on non-renewable sources of energy, while also contributing to the reduction of greenhouse gas emissions. By incorporating renewable energy technologies, such as solar panels or waves, these facilities can generate their own power and potentially even sell excess energy back to the grid. Moreover, hybrid energy ASCs can help improve patient care by ensuring a reliable source of energy, even during power outages or natural disasters. This can be especially important for ASCs, which often perform surgical procedures that require a constant and uninterrupted supply of electricity. In this paper all technical issues has been focused on. It can be said, Hybrid energy ASCs represent a promising model for healthcare facilities that prioritize environmental sustainability, economic efficiency, and high-quality patient care. As renewable energy technologies continue to advance and become more affordable, we can expect to see more healthcare facilities adopt hybrid energy systems as a way to reduce their carbon footprint and improve their bottom line.

RECOMMENDATIONS

This is helpful for implementing future practical project.

1. Select appropriate hybrid energy technologies
2. Ensure reliability and resilience of the energy and power system
3. Conduct a feasibility study before going to operation
4. Work with experienced professionals
5. Monitor and improve the performance of the system.

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DECLARATION OF COMPETING INTEREST

None

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