Study the model of a ship which is manufacturing by utilization of wind and solar energy

A thesis
By

Md.Riazul Haque	ID: BME 1802015145
Md.Miraz Hossain	ID: BME 1802015043
Sahed Molla	ID: BME1802015061
Md Shuvo Munshi	ID: BME 1802015090
Jahirul Hoque	ID: BME1802015059

Supervised by

Md.Din Al-Amin

Lecturer

Department of Mechanical Engineering

Sonargaon University (SU)

MAY 2022

ACKNOWLEDGEMENT

First, we started in the name of almighty Allah. The authors would like to explicating their gratitude to the subjective supervisor Md. Din Al-AminLecturer, Department of Mechanical Engineering, Sonargaon university for having composure and continuous support & collaboration for author's thesis study and related research, for his patience and continuous motivation.

His guidance helped the author's during the time of research and for the preparation, compilation and execution of the thesis work.

The authors would also like to express their sincere gratitude towards all who contributed and support in any way for completing the thesis.

[Authors]

Full Name: Md.Riazul Haque
ID: BME1802015145

Full Name: Md.Miraz Hossain
ID: BME1802015043

Full Name: Sahed molla
ID: BME1802015061

Full Name: Md.Shuvo Munshi
ID: BME1802015090

Full Name: Jahirul Hoque
ID: BME1802015059

ABSTRACT

The shipping industry is facing three major challenges: climate change, increasing bunker fuel price and tightening international rules on pollution and CO_2 emissions. All these challenges can be met by reducing fuel consumption. The energy efficiency of shipping is already very good in comparison with other means of transportation but can still be and must be improved. There exist many technical and operational solutions to that extent. But assessing their true and final impact on fuel consumption is far from easy as ships are complex systems. The use of clean and renewable energies, such as solar energy for instance, is proposed as a method to improve the ship efficiency. Ships can get the benefits from solar energy since most of their upper decks are always exposed to the Sun, especially in tropical regions.

The use of renewable energy is increasingly being seen as part of the energy mix for the shipping sector and the power of the wind and sun will most likely play an important role in helping to reduce fuel use and emissions from ships, especially as further renewable energy related technologies are developed.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Chapter 1
Introduction

1.1 Introduction

World transport relies principally on petroleum that supplies 95 % of the total energy. Transport is now responsible for almost a quarter of world energy-related emissions. Over the past decade, transport emissions have increased at a faster rate than any other energy sector. Transport activity will continue to increase in the future as economic growth fuels transport demand. Moreover, international freight has been dominated by ocean shipping. As fossil fuel usage commences to bring important concerns if not challenges such as climate change and supply cost increases, it has become relevant to seek for alternate sources of energy. The US Navy has estimated that changing to fuel cell technology could save more than $1 million per ship per year in fuel costs. Since the sun and wind provide an unlimited source of renewable energy, modern ships could surely take advantage of their implementation as it has been shown on an increasing number of projects. In that context, at the Toros University and Memorial University, two researchers are collaborating with Navimar, one Turkish ship constructor in the investigation of “green” yacht and cargo prototypes, based on hydrogen fuel through the application of revertible fuel cells. The inboard electrolysis fuel cells would be running from electricity produced by either solar panels, wind mills or a combination of both to increase the chances to scavenge more renewable energy.

Up to now, vehicle development proved that powering electrical motors directly from solar panels or implementing sails for direct motion are plagued by performance variability and sometimes interruption. Moreover, actual modern green ships designs have proven some level of worthiness of the photo-voltaic solar panels providing they are implemented with energy storage techniques such as batteries. Despite recent important performance and efficiency improvements, newly developed batteries feature serious problems such as limited lifespan (3 to 5 years), energy capture capacity degradation over lifespan, large weight and charge duration degradation over time. Similar results were obtained on automobiles and airplanes. This publication attempted to classify the condition of the ship’s hull and equipment. Today, ship classification is related to one specific ship design being repeated.

Each time a new ship is designed, it is considered a class. However, ships can also be regrouped in broader classes of similar designs such as cargo ships, container transport vessel, tankers, etc. They could also be classified as sailing ships, internal combustion ships, etc. Moreover, their structures, operations and equipment were classified and studied. With the advent of novel ship designs to implement renewable and clean energy systems, in this paper, typical ship classification shall be further developed to include all topologies resulting from this original design process. Part of the first step of the design process, topological classification is specified to envision and abstract general design configurations without taking into account specific physical dimensions reflecting geometric and construction specificity. This ship design step is part of the preliminary design steps and is essential.

Chapter 2
Energy

2.1 Some definitions:

We will now state some basic physical connections between the three very important physical quantities of energy, force, and power. These connections are 3 taken from classical mechanics but generally valid. We start with the force F, which is any influence on an object that changes its motion. According to Newton's second law, the force is related to the acceleration a of a body via F = ma, where m is the mass of the body. The bold characters denote that F and a are vectors. The unit of force is Newton (N), named after Isaac Newton (1642-1727). It is defined as the force required to accelerate the mass of 1 kg at an acceleration rate of 1 m/s^2, hence 1 N = 1 $kg \cdot m/s^2$. In mechanics, energy E, the central quantity of this book, is given as the product of force times distance, E = Z F(s) ds, where s denotes distance. Energy is usually measured in the unit of Joule (J), named after the English physicist James Prescott Joule (1818-1889), which it defined as the amount of energy required applying the force of 1 Newton through the distance of 1 m, 1 J = 1 Nm. Another important physical quantity is the power P, which tells us the rate of doing work, or, which is equivalent, the amount of energy consumed per time unit. It is related to energy via E = Z P(t) dt, where t denotes the time. The power is usually measured in Watt (W), after the Scottish engineer James Watt (1736-1819). 1 W is defined as one Joule per second, 1 W = 1 J/s and 1 J = 1 Ws. As we will see later on, 1 J is a very small amount of energy compared to the human energy consumption. Therefore, in the energy markets, such as the electricity market, often the unit Kilowatt hour (kWh) is used. It is given as 1 kWh = 1000 Wh × 3600 s h = 3 600 000 Ws. On the other hand, the amounts of energy in solid state physics, the branch of physics that we will use to explain how solar cells work, are very small. Therefore, we will use the unit of electron volt, which is the energy a body with a charge of one elementary charge (e = 1.602 × 10−19 C) gains or losses when it is moved across an electric potential difference of 1 Volt (V), 1 eV = e × 1 V = 1.602 × 10−19 J.

2.2 Human and world energy consumption

After this somewhat abstract definitions we will look at the human energy consumption. The human body is at a constant temperature of about 37°C. It hence contains thermal energy. As the body is continuously cooled by the surroundings, 4 thermal energy is lost to the outside. Further, blood is pumped through the blood vessels. As it travels through the vessels, its

kinetic energy is reduced because of internal friction and friction at the walls of the blood vessels, i.e., the kinetic energy is converted into heat. To keep the blood moving, the heart consumes energy. Also, if we want our body to move this consumes energy. Further, the human brain consumes a lot of energy. All this energy has to be supplied to the body from the outside, in the form of food. A grown-up average body requires about 10 000 Kilojoule every day.1 We can easily show that this consumption corresponds to an average power of the human body of 115.7 W. We will come back to this value later. In modern society,
humans do not only require energy to keep their body running, but in fact we consume energy for many different purposes. We use energy for heating the water in our houses and for heating our houses. If water is heated, its thermal energy increases, and this energy must be supplied. Further, we use a lot of energy for transportation of people and products by cars, trains, trucks and planes. We use energy to produce our goods and also to produce food. At the moment, you are consuming energy if you read this book on a computer or tablet. But also, if you read this book in a printed version, you implicitly consumed the energy that was required to print it and to transport it to you place. As we mentioned already above, energy is never produced but always converted from one form to another. The form of energy may change in time, but the total amount does not change. If we want to utilize energy to work for us, we usually convert it from one form to another more useable form. An example is the electric motor, in which we convert electrical energy to mechanical energy. Modern society is very much based on the capability of us humans to covert energy from one form to another form. The most prosperous and technologically developed nations are also the ones which have access to and are consuming the most energy per inhabitant. Table 2.1 shows the primary energy consumption per capita and the average power consumed per capita for several countries. We see that the average U.S. citizen uses an average power of 9 319 W, which is about 80 times what his body needs. In contract, an average citizen from India only uses about 800 W, which is less than a tenth of the US consumption.

Table 2.1: Total primary energy consumption per capita and average power used per capita of some countries.

Country	Energy Consumption (kWh/capita)	Average power use (W/capita)
USA	81642	9319
Netherlands	53663	6160
Germany	44310	5058
China	23608	2695
India	6987	797
Canada	7123	4223

Many people believe that tackling the energy problem is amongst the biggest challenges for human kind in the 21st century. It is a challenge because of several problems: The first challenge the human kind is facing is a supply-demand problem. The demand is continuously growing. The world population is still rapidly growing, and some studies predict a world population of 9 billion around 2040 in contrast to the 7 billion people living on the planet today. All these people will need energy, which increases the global energy demand. Further, in many countries the living standard is rapidly increasing like China and India, where approximately 2.5 billion people are living, which represents more than a third of the World's population. Also, the increasing living standards lead to an increased energy demand.

Fig 2.1: The history of the oil price normalized

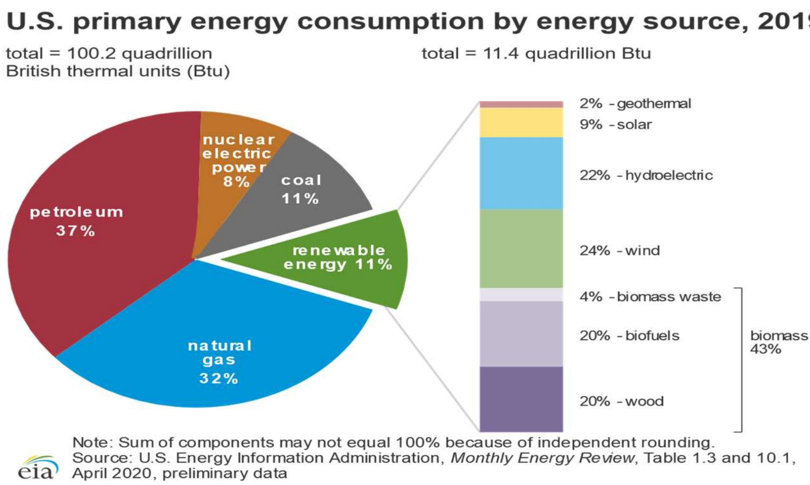


Fig 2.2 The primary energy consumption of the world by source in 2019

World primary energy consumption fell to 556.63 exajoules in 2020. The coronavirus pandemic and its impact on transportation fuel demand and overall economic performance resulted in primary energy consumption declining to 2016 levels. Nevertheless, worldwide energy consumption is projected to increase over the next few decades.

A second challenge that we are facing is related to the fact that our energy infrastructure heavily depends on fossil fuels like oil, coal and gas. Fossil fuels are nothing but millions and millions of years of solar energy stored in the form of chemical energy. The problem is that humans deplete these fossil fuels much faster than they are generated through the photosynthetic process in nature.

2.3 Methods of Energy Conversion

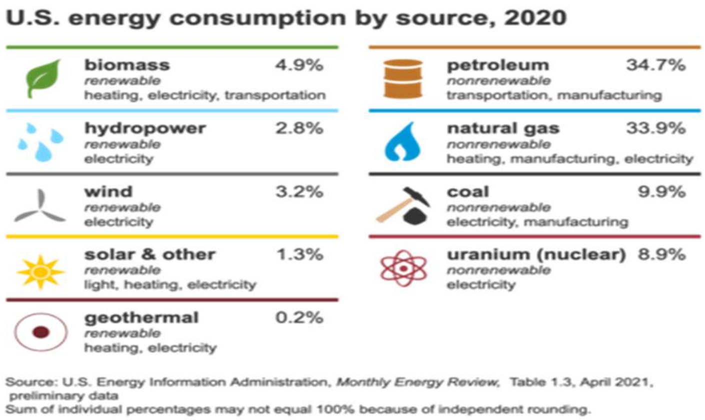


Fig 2.3: The different energy carriers and how we utilize them

An energy transition is underway. The landmark 2016 Paris Climate Accord sent a clear signal that a worldwide move toward low-carbon energy is imperative. Even though the US intends to pull out of the Paris agreement, the switch to clean energy continues unabated, led by other nations worldwide, as well as by US states, cities, and corporations.

The origins of our energy supply are an exciting and engaging topic for students and is an excellent way to learn about different ways that energy can be generated, as well as the impacts and societal implications of various types of energy. These concepts revolve around energy that is used for human purposes, including renewable and nonrenewable sources of energy, storage of energy, generation of electricity, and transportation of energy from place to place.

As essential starting place for this topic is the concept of renewable vs. non-renewable energy sources. Many students will already be familiar with the idea that fossil fuels regenerate at a rate far slower than we use them, which is why they are non-renewable. Renewable energy comes in many forms: hydroelectric, solar, wind, geothermal, and biofuels. Each of those offers a host of related topics and nuances. For example, solar energy can be generated on a single rooftop or in large, utility-scale solar farms. Solar energy can also be generated in concentrating solar power plants that use an array of mirrors to direct the Sun's energy to a central tower. This type of solar power can deliver energy even at night. A detailed study of energy generation can prevent an overly simplistic labeling of particular types of energy as good or bad.

It's also worthwhile to address the practical and technological aspects of energy. The distribution of energy resources across the globe is uneven, as some regions have an abundance of energy sources while others do not. The areas where energy is used most intensively are not necessarily the same places where energy resources naturally exist. For example, rich oil and gas deposits are found in offshore marine environments and wind farms are located in rural settings. In both cases this energy is transported to a location where the energy is consumed. Moreover, the end uses of energy vary with geography, time of year, and time of day. Thus, energy needs to be transported, stored and converted from one form to another so that it is available when and where it is needed.

2.2 Renewable energy carriers

All the energy carriers discussed above are either fossil or nuclear fuels. They are not renewable because they are not “refilled” by nature, at least not in a useful amount of time. In contrast, renewable energy carriers are energy carriers that are replenished by natural processes at a rate comparable or faster than its rate of consumption by humans. Consequently, hydro-, wind and solar energy are renewable energy sources. Hydroelectricity is an example of an energy conversion technology that is not based on heat generated by fossil or nuclear fuels. The potential energy of rain falling in mountainous areas or elevated plateaus is converted into electrical energy via a water turbine. With tidal pools the potential energy stored in the tides can also be converted to mechanical energy and subsequently electricity. The kinetic energy of wind can be converted into mechanical energy using wind mills. Finally, the energy contained in sunlight, called solar energy, can be converted into electricity as well. If this energy is converted into electricity directly using devices based on semiconductor materials, we call it photovoltaics (PV). The term photovoltaic consists of the Greek word φως (phos), which means light, and -volt, which refers to electricity and is a reverence to the Italian physicist Alessandro Volta (1745-1827) who invented the battery. As we will discuss in great detail in this book, typical efficiencies of the most commercial solar modules are in the range of 15-20%. Solar light can also be converted into heat. Examples are the heating of water flowing through a black absorber material that is heated in the sunlight. This heat can be used for water heating, heating of buildings or even cooling. If concentrated solar power systems are temperatures of several hundreds of degrees are achieved, which is sufficient to generate steam and hence drive a steam turbine and a generator to produce electricity. Next to generating heat and electricity, solar energy can be converted in to chemical energy as well. This is what we refer to as solar fuels. For producing solar fuels, photovoltaics and regenerative fuel cells can be combined. In addition, sunlight can also be directly converted into fuels using photoelectrochemical devices. We thus see that solar energy can be converted into electricity, heat and chemical energy. The sun has is energy source for almost all the processes that happen on the surface of our planet. Wind is a result of temperature difference in the atmosphere induced by solar irradiation, waves are generated by the wind, 9 clouds and rain are initially formed by the evaporation of water due to sun light. As the sun is the only real energy source we have, we need to move to an era in which we start to utilize the energy provided by the sun directly to satisfy our energy needs. The aim of this book is to teach the reader how solar energy can be utilized directly.

Chapter 3
Solar Energy

3.1 Basic of Solar Energy

Energy is defined as capacity to produce an effect to do work. Energy has been an important component to meet the day to day needs of human beings. Human society require increasing amount of energy for industrial, commercial, domestic, agriculture, and transport uses. Different forms of energy are defined as primary and secondary energy, commercial and noncommercial energy, renewable and nonrenewable energy.

<u>Primary and Secondary energy</u>

Primary energy refers to all types of energy extracted or captured directly from natural resources. Primary energy can be further divided into two parts namely renewable and nonrenewable energy. Primary energy is transformed into more convenient form of energy such as electricity, steam etc. these forms of energy are called secondary energy.

<u>Commercial and Noncommercial energy</u>

Energy that is available in the market for a definite price is known as commercial energy. The most important forms of commercial energy are electricity, coal, refined petroleum products and natural gas. Any kind of energy which is sourced within a community and its surrounding area, and which is not normally treated in the commercial market is termed as noncommercial energy such as firewood, cattle dung, agriculture waste etc.

<u>Renewable and nonrenewable energy</u>

Renewable energy is obtained from natural sources. These resources can be used to produce energy again and again e.g., Solar energy, wind energy, tidal energy etc. nonrenewable resources cannot be replaced once they are used e.g., Coal, oil, gas etc. these energy resources are limited and would be exhausted within prescribed period of time.

<u>Solar energy and solar radiation</u>

The earth receives the solar energy in the form of solar radiation. These radiations comprising of ultra-violet, visible and infrared radiation. The amount of solar radiation that reaches any given location is dependent on several factors like geographic location, time of day, season, land scope and local weather. Because the earth is round, the sun rays strike the earth surface at different angles (ranging from 0° to 90°). When sun rays are vertical, the earth's surface gets maximum possible energy. Most of the part of India receives 4 to 7 kWh of solar radiation per square meter per day. India receives solar energy equivalent more than 5000 trillion kWh per year.

Solar radiation (Direct, diffuse and total solar radiation)

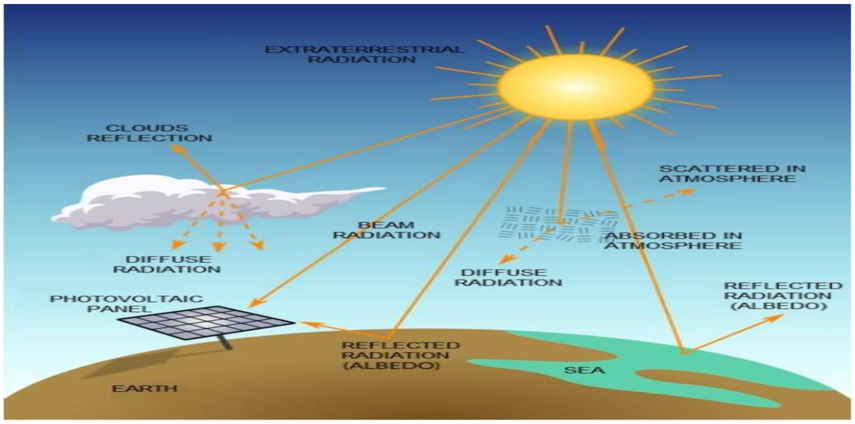


Fig 3.1: Solar radiation

The solar radiation that reaches the surface of the earth without being diffused is called direct beam solar radiation. It is measured by instrument named as pyrheliometer. As sun light passes through the atmosphere, some part of it is absorbed, scattered and reflected by air molecule, water vapors, clouds, dust and 12 pollutants. This is called diffuse solar radiation. The diffuse solar radiation does not have unique path. The sum of the direct and diffuse solar radiations is called total radiation or global solar radiation. Pyranometer is used for measuring the total radiation.

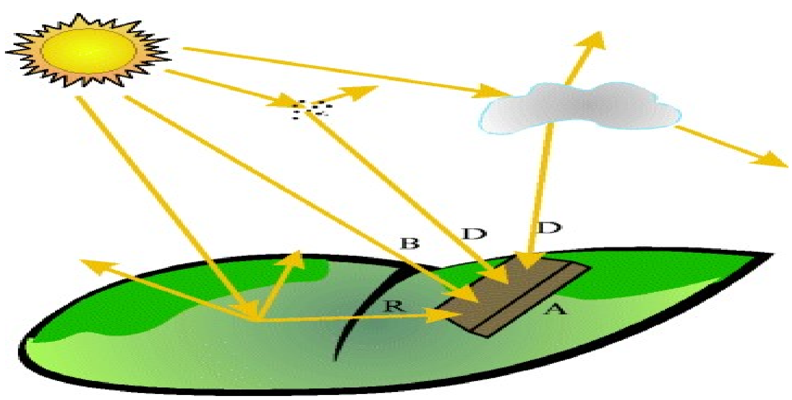


Fig 3.2: Direct, diffuse and total solar radiation

If, Rb- Beam Radiation (direct solar radiation) Rd- Diffuse Radiation (solar radiation after diffusion) Rr- Reflected radiation (solar radiation after reflection from surface) Rt- Total solar radiation on tilted surface. Then,

Rt = Rb + Rd + Rr --------------- (3.1)

3.2 Solar Thermal Energy

The Sun is most prominent source of energy in our system. The source of solar energy is process of thermonuclear fusion in the sun’s core. This energy is radiated from sun in all directions and a fraction of this energy is reaches to the earth. The sun’s outer visible layer is called the photosphere and has a temperature of about 6000°C. Above the photosphere there is a transparent layer of gases known as chromospheres. The light emitted by the chromospheres is of short wave length. Finally, there is the corona. The corona is the outer part of the sun's atmosphere. in this region, prominence appear. Prominence is immense clouds of glowing gas that erupt from upper chromospheres. The corona can only be seen during total solar eclipse.

Solar thermal energy application: Solar thermal energy is used for water heating, space heating, electric power generation, solar cooker for cooking of food etc.

Flat plate solar collector: Solar collector absorbs the incident solar radiation and converts it to the useful heat which is use for heating a collector fluid such as water, oil or air. Flat plate collector is used where temperature below 100°C are required.

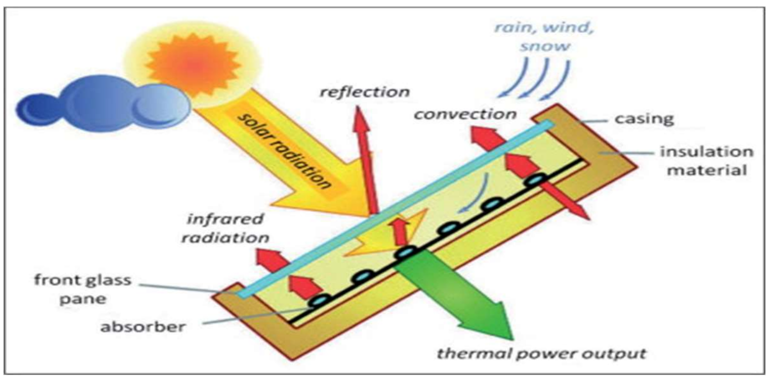


Fig 3.3: Flat plate solar collector Construction

This allows solar energy to pass through, but reduces the heat loss examples are tempered glass, transparent plastic materials etc. Absorber plate is blackened in order to absorb the maximum amount of solar radiations. The absorber consists of a thin sheet. This sheet is made of conductor material (aluminum, steel, copper etc.) because the metal is a good conductor of heat. Black coating is applied to this conductor / metal plate in order to absorb the maximum amount of solar radiations. Copper is best material for absorber plate because it has high thermal conductivity, adequate tensile strength and good corrosion resistance. Series of tubes the absorber plate with several parallel tubes is fabricated from copper tube and sheet by soft soldering.

3.3 Solar Energy in Ship

Eco Marine Power is a technology-focused company working on ways to introduce renewable energy to the shipping industry. The new solution under development is called Aquarius Marine Renewable Energy, and it will allow ships to make use of solar energy both while in port and while they sail. The company will combine its Energy Sails technology, which includes solar panels mounted on the covers of large bulk carrier ships, with energy storage applications controlled with a computer-based monitoring system.

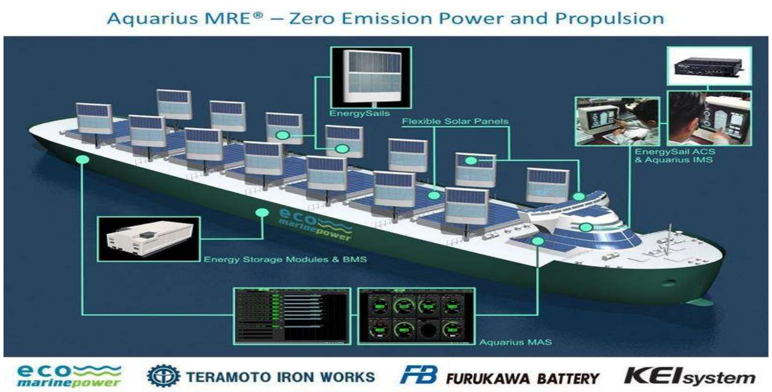


Fig 3.4: Solar Panel in Ship.

The rigid sails can be configured with a mix of sensors, not limited to photovoltaic panels. The company states that “other power generation devices” can be applied including wind turbines. During 2018, the two partners will conduct feasibility studies using multiple large bulk carrier ships in order to estimate the share of energy needs that can be met through solar power during each trip, and the number of solar arrays that can be installed. Depending on the results of the testing, one ship will be selected for the complete installation of the new system. This specific ship will be monitored for 12 to 18 months to identify the benefits and measure the cost reductions the technology can achieve. In 2016, European Union figures showed that the maritime transport industry is responsible for more than 1000 million tons of carbon annually, accounting for approximately 2.5 percent of greenhouse gas emissions. However, a ship’s energy consumption could be reduced by up to 75 percent.

3.4 Solar Energy in Bangladesh

The long-term average sunshine data indicates that the period of bright sunshine hours in the coastal regions of Bangladesh varies from 3 to 11 hours daily. The insolation in Bangladesh varies from 3.8 kWh/m2 /day to 6.4 kWh/m2 /day at an average of 5 kWh/m2 /day. These indicate that there are good prospects for solar thermal and photovoltaic application in the country. With an estimated 40% of the population in Bangladesh having no access to electricity, the government introduced a scheme known as solar home systems (SHS) to provide electricity to households with no grid access. The program reached 3 million households as of late 2014 and, with more than 50,000 systems 17 being added per month since 2009, the World Bank has called it "the fastest growing solar home system program in the world. The Bangladeshi government is working towards universal electricity access by 2021 with the SHS program projected to cover 6 million households by 2017.

Chapter 4
Wind Power

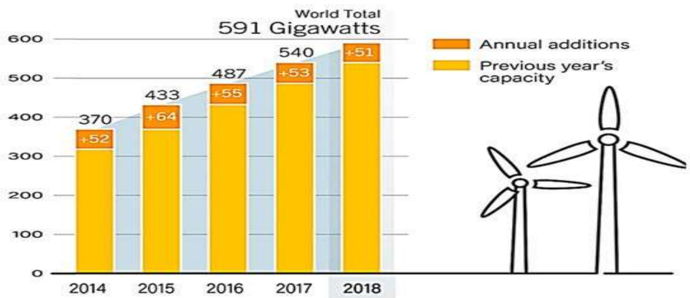
4.1 Wind physics basics

Wind is atmospheric air in motion. It is ubiquitous and one of the basic physical elements of our environment. Depending on the speed of the moving air, wind might feel light and ethereal, being silent and invisible to the naked eye. Or, it can be a strong and destructive force, loud and visible as a result of the heavy debris it carries along. The velocity of the air motion defines the strength of wind and is directly related to the amount of energy in the wind, that is -- its kinetic energy. The source of this energy, however, is solar radiation. The electro-magnetic radiation from the sun unevenly heats the earth surface, stronger in the tropics and weaker in the high latitudes. Also, as a result of a differential absorption of sun light by soil, rock, water and vegetation, air in different regions warms up at different rate. This uneven heating is converted through convective processes to air motion, which is adjusted by the rotation of the earth. The convective processes are disturbances of the hydrostatic balance whereby otherwise stagnant air masses are displaced and move in reaction to forces induced by changes in air density and buoyancy due to temperature differences. Air is pushed from high to low pressure regions, balancing friction and inertial forces due to the rotation of the earth. The patterns of differential earth surface heating as well as other thermal processes such as evaporation, precipitation, clouds, shade and variations of surface radiation absorption appear on different space and time scales. These are coupled with dynamical forces due to earth rotation and flow momentum redistribution to drive a variety of wind generation processes, leading to the existence of a large variety of wind phenomena. These winds can be categorized based on their spatial scale and physical generation mechanisms.

4.2 wind power meteorology

Wind systems span a wide range of spatial scales, from global circulation on the planetary scale, through synoptic scale weather systems, to mesoscale regional and microscale local winds. Table 4.1 lists the spatial scales of these broad wind type 19 categories. Example of planetary circulations are sustained zonal flows such as the jet stream, trade winds and polar jets. Mesoscale winds include orographic and thermally induced circulations. On the microscale wind systems include flow channeling by urban topography as well as sub-mesoscale convective wind storm phenomena as an example.

Table 4.1 Spatial scales of wind systems and a sample of associated wind types.



A long list of various wind types can be assembled from scientific and colloquial names of different winds around the world. The associated physical phenomena enable a finer classification across the spatial scales. Generating physical mechanisms define geostrophic winds, thermal winds, gradient winds. Katabatic and anabatic winds are local topographic winds generated by cooling and heating of mountain slopes. Bora, Foehn and Chinook are locale specific names for strong downslope wind storms. In Greenland -- Piteraq is a downslope storm as strong as a hurricane, with sustained wind speeds of 70 m s -1 (160 miles per hour). In coastal areas sea breeze and land breeze circulations are regular daily occurrences. Convective storms generate strong transient winds, with downdrafts which can be particularly dangerous (and not very useful for wind power harvesting). Disastrous hurricanes and typhoons, as well as smaller scale tornadoes are examples of very energetic and destructive wind systems. A micro scale version of these winds are gusts, dust devils and microbursts. Nocturnal jets appear in regular cycles in regions with specific vertical atmospheric structure. Atmospheric waves driven by gravity and modulated by topography are common in many places. Locale specific regional wind names include Santa Anas, nor'easters and etesian winds, to mention just few. Meteorology is the scientific field involved in the study and explanation of all these wind phenomena. It enables both a theoretical 20 understanding and the practical forecasting capabilities of wind. Statistics of observed wind occurrences define wind climates in different regions. Mathematical and computer models are used for theoretical simulation, exploratory resource assessment and operational forecasting of winds. Meteorology literature, focusing on wind power is available, in the form of introductory texts and reviews.

4.3 Fundamental Equation of Wind Power

The fundamental equation of wind power answers the most basic quantitative question - how much energy is in the wind. First, we distinguish between concepts of power and energy. Power is the time-rate of energy. For example, we will need to know how much energy can be generated by a wind turbine per unit time. On a more homely front, the power of the wind is the rate of wind energy flow through an open window.

Wind energy by definition is the energy content of air flow due to its motion. This type of energy is called the kinetic energy and is a function of its mass and velocity, given by

$KE = \frac{1}{2} . m . v^2$ (4.1)
Wind power is the rate of kinetic energy flow. In derivation similar to the other flow rate quantities discussed above, the amount of kinetic energy flowing per unit time through a given area is equal the kinetic energy.

$P = \frac{1}{2} \, dm/dt . v^2$ (4.2)

Here mass flow rate substituted for air mass in (4.1). The resultant equation for wind power is

$P = \frac{1}{2} . p . A . v^3$ (4.3)

Table 4.2 Wind power classes measured at 50 m above ground according to NREL wind power density based classification

Wind Power Class		Wind Power Density (W/m^2)	Mean Wind Speed (m/s)*	Resource Potential
1	1-	0-100	0-4.381	Very Poor
	1+	100-200	4.381-5.588	
2	2-	200-250	5.588-6.035	Poor
	2+	250-300	6.035-6.393	
3	3-	300-350	6.393-6.706	Marginal
	3+	350-400	6.706-7.018	
4	4-	400-450	7.018-7.287	Good
	4+	450-500	7.287-7.510	
5	5-	500-550	7.510-7.778	Very Good
	5+	550-600	7.778-8.002	
6	6-	600-700	8.002-8.404	Excellent
	6+	700-800	8.404-8.807	

*Mean wind speed is based on Weibull shape parameter value of 2.

.

Figure 4.1: Wind turbine in ship

4.4 Wind Power in Bangladesh

With its sub-tropical climate, with monsoon and typhoon seasons, Bangladesh is confronted with large amounts of rainfall and periodically high wind speeds (gusts) during typhoon season. The mean annual wind speeds in Bangladesh are not well documented and few data is available. The readily available data shows that low wind speeds predominate on the Bangladeshi lands. Next to onshore wind speeds, no (extensive) data is readily available concerning (far) offshore wind speeds. The 'Solar and Wind Energy Resources Assessment' initiative also calculated the annual wind speeds in Bangladesh, this at a height of 50 meter. The maximum annual onshore wind speeds at 50 meters in Bangladesh do not outreach 5 meters per second, and 6 meter per second for offshore wind. These can be considered as low wind resources. During the typhoon season however, there can be wind gusts with speeds well over 35 meters per second (>126 km/h). The international program Enhancing Capacity for Low-Emission Development Strategy (ECLEDS) is part of the USAID LEAD program, which supports and complements the US Government's Enhancing Capacity for Low Emission Development Strategies (ECLEDS) initiative. EC-LEDS supports developing countries' efforts to pursue long term, transformative development and accelerate sustainable, climate-resilient economic growth while slowing the growth of greenhouse gas emissions. Through 24 this initiative, a current operational wind mapping project is funded. This project consists of 9 sites where a two-year wind speed metering programme is in progress at heights between 20 and 200 meters (with a met mast at 20, 40, 60 and 80 meters and two SODAR's up to 200 meters). See appendix F for a short description of the program. The preliminary results of the measurement campaign are still under embargo with the Ministry of Power. Final results of the measurement campaign are expected to become public in 2018. In appendix D a rough map of the wind resources of Bangladesh is included to give an impression of the wind climate. Also, Vestas, a Danish wind turbine manufacturer, has been performing wind monitoring and site assessments in Bangladesh; these results are not made public.

Table 4.3: Average wind speed in Bangladesh.

Stations	wind speed (m\s)	power density (W\m2)
Barisal	2.66	11.29
Bogra	2.88	13.45
Chittagong	4.65	60.33
Cox's Bazar	3.81	33.18
Dhaka	4.52	55.41
Dinajpur	2.82	13.60
Hatiya	3.74	31.39
Jessore	4.93	71.89
Khepupara	4.24	45.76
Khulna	2.89	14.18
Kutubdia	2.32	7.49
Patenga	7.48	251.12
Sandip	2.76	12.61
Shatkhira	4.37	50.07
Teknaf	3.17	19.11
Thakurgaon	6.59	171.71
Comilla	2.78	12.89
Mongla	2.20	6.38
Rangamati	2.15	5.96

Chapter 5
About Our Small Scale Model Ship

5.1 Working principal

Fig 5.1: model ship construction by utilizing solar and wind power.

we have used solar panel and wind turbine to collects natural energy. The solar panel collects energy from sunlight and stores it in the battery. The wind turbine collects energy from the air and stores it in the battery. Then energy stored from the battery is supplied to DC motor. Then the Ship is operated by DC motor with the help of propeller.

5.2 Essential equipment

- Ply wood
- PVC plastic sheet
- Solar panel
- DC motor 7.4 volt
- DC motor 4 volt
- 2 face electric switch
- Boat propeller shaft
- propeller shaft connector
- Nat bolt
- Battery case
- pencil battery

- ➢ Electric cable
- ➢ Wind turbine propeller

5.3 Instrument Specifications

DC motor 7.4 volt:

- Voltage: DC 7.4V
- Speed: 13200RPM
- Current:1.6A
- Shaft Diameter: 3mm;
- Shaft length: 11mm;
- Commutation: Brush

Fig 5.2: DC motor 7.4 volt

DC motor 4 volt:

- Voltage: DC 4V
- Current: 0.2A
- No-load Speed:20000r/min
- Shaft Diameters: 2mm
- Shaft Lengths: 7.5mm
- Enclosure Type: TEAAC

Fig 5.3: DC motor 4 volt

Solar panel:

- Material: Polycrystalline
- Dimension: 110mm x 110mm
- Thickness: 3mm
- Voltage: 7V
- Current: 120mA

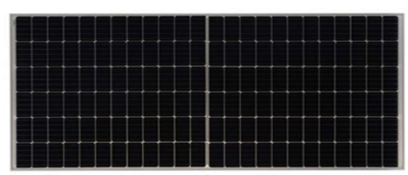


Fig 5.4: Solar panel 7 volt

Wind turbine propeller:

- Thickness: 10mm
- Motor Shaft Hole Día: 3mm

Fig 5.5: Wind turbine propeller

5.4 Advantages

- It reduces carbon emissions; diesel costs and drastically reduces noise levels.
- Through the installation of solar panels and wind propeller, the cost of maintaining and running a ship could be drastically reduced.
- It's good for The Environment Wind and Solar energy is one of the most environmentally friendly energy sources known to man.

5.5 Disadvantages

- constructing turbines and wind facilities is extremely expensive.
- Electricity generation depends entirely on a country's exposure to sunlight this could be limited by a country.

5.6 Future Recommendation

- The future of wind energy seems bright. Wind energy has been one of the fastest growing sources of renewable energy over the past few decades.

- The year 2025 seems like a long time away to only have 25% of America's electricity come from renewable energy sources. However, when you think about the history of other technological booms – the shipping industry the internet, smart phones, etc. – the new future of wind energy and solar could be upon us must faster than you think.

5.7 SOME PICTURES OF OUR PROJECT

Top view of our model ship

Battery & switch

Front view of our model ship

Side view of our model ship

Fig 5.6: Some images of our ship.

5.8 Conclusion

At sea, the shift towards the widespread adoption of alternative energy is only now beginning to take shape. Recently the shipping industry has begun to seriously look at ways to reduce fossil fuel consumption and operate in a more environmentally friendly way. So, it is the best project now this time.

References

1. Power Development Department, Bangladesh (2011 Jul). Planning for sustainable Future. explosion-of-solar-power-in-Bangladesh. Available: http://cdkn.org.pdf

2. Wikipedia Corporation (2013 oct). Online Available: http://en.wikipedia.org/wiki/Fuel

3. "Power System Master Plan," Power Cell, Power Division, Ministry of Power, Energy and Mineral Resources, Dhaka-100, 2005. [From: http://www.powerdivision.gov.bd/]

4. "Annual Report," Bangladesh Power Development Board, Dhaka-1000, 2006. [From: http://www.bpdb.gov.bd/]

5. http://en.wikipedia.org/wiki/Solar_energy#Applications_of_solar_technology

6. Bangladesh Bureau of Statistics (2013 Dec.): Statistical Yearbook of Bangladesh 2013 Dhaka. Available http://www.bbs.gov.bd

7. M. Ibrahim, M. Anisuzzaman, S. Kumar, & S. C. Bhattacharya, "Demonstration of PV microutility system for rural electrification," Solar Energy 72(6), 521-530, 2002.

8. Local Government Engineering Department (LGED), “Sustainable Rural Energy” web site (http://www.lged.org/sre).

9. Mohammad Golam Kibria Khan, Talha Rahman and M.M. Alam, “WIND ENERGY IN BANGLADESH: PROSPECTS AND UTILIZATION INITIATIVES”. 3rd International Conference on Electrical & Computer Engineering ICECE 2004, 28-30 December 2004, Dhaka, Bangladesh.

10. “Wind Energy Resources Mapping in Coastal Regions of Bangladesh”, a project of Local Government Engineering Department (LGED) financed by United Nation Development Program (UNDP) in 2003.

11. http://en.wikipedia.org/wiki/Geography_of_Bangladesh