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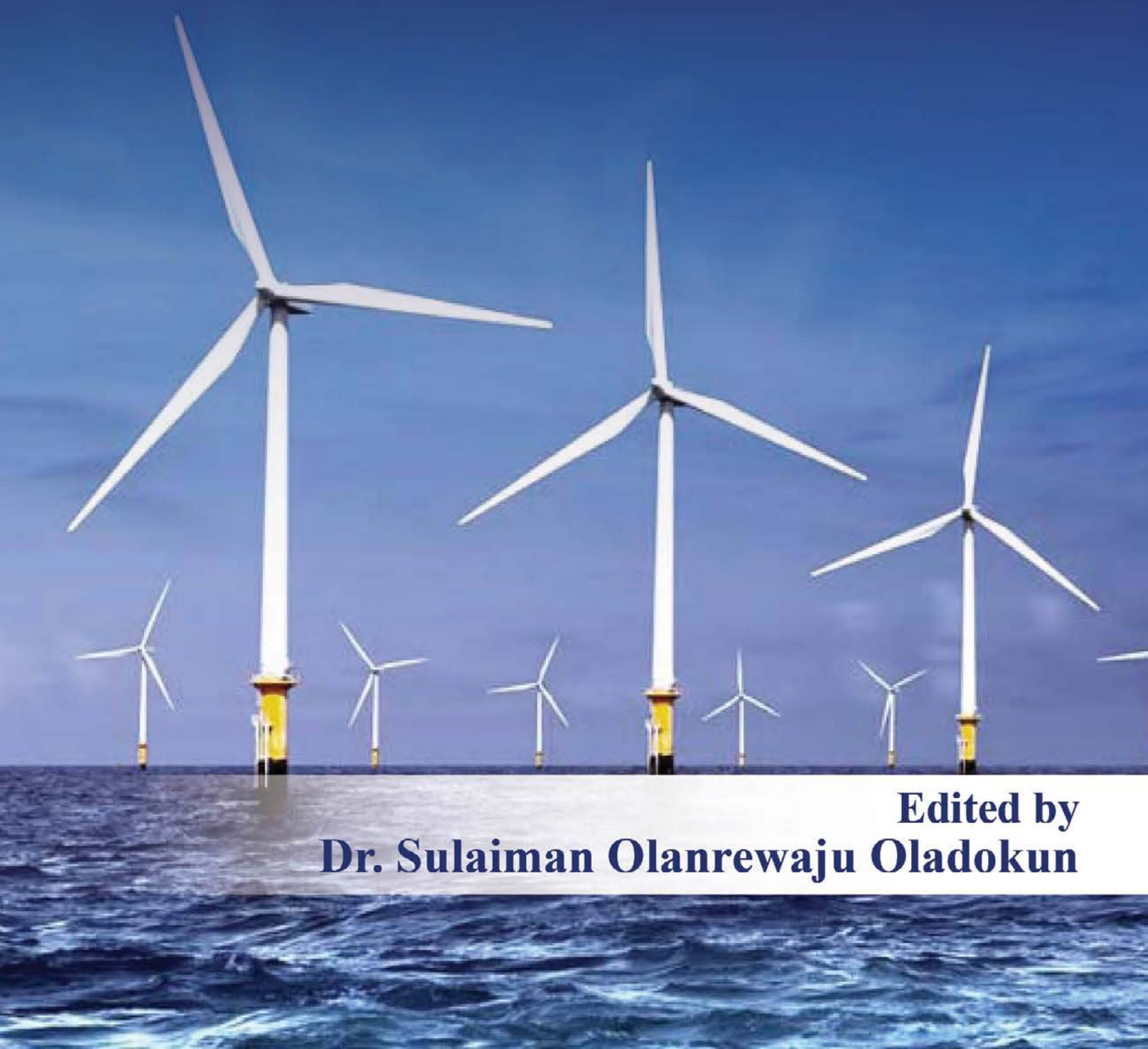
Maritime Energy and Environment Systems Series



Edited by
Dr. Sulaiman Olanrewaju Oladokun

Maritime Energy and Environment Systems Series

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Preface

The vastness of the ocean and its various processes that support life and earth remain a big challenge for humanity. Despite so much achievement in human civilization, logistic, to information technology to multimedia and sensor technology, the knowledge of water and ocean has left man with much more work to do on innovation front and new discovery. Modern day challenges are cluster of alternative energy, protection of the environment, ocean space exploration, sensing technology and material science. The book presents recent studies that have been carried out in maritime research and innovation front. Potential users of the books are library, societies, universities, research centers, professional bodies, government and NGO.

- Dr. Sulaiman Olanrewaju Oladokun

About Author

Dr. O. O. Sulaiman is Associate Professor of Ocean Engineering, and coordinator for Maritime Technology International program, University Malaysia Terengganu. His specialization is in Safety and Environmental risk and reliability for maritime and ocean systems, maritime and ocean energy and environment, sustainable maritime system design. He is chartered engineer with diverse academic and professional background. He has taught and mentor courses and research projects on contemporary issues in maritime and ocean engineering field. He has authored and co-authored a total of about more than 120 publications which include proceeding papers, journal papers, technical report and chapters in book, monograph, seminar papers and other types of academic publications. He has authored more than 60 peer review journals and 6 books. He has patented research work on marine green technology. He is chattered engineer registered under UK Engineering Council. He is the member of royal Institute of Naval Architecture (RINA) and Institute of Marine Engineering, Science and Technology (IMarEST), PIANC, IEEE, ASME.

Acknowledgement

A book that cover wide range of salient information on contemporary sustainable marine maritime technology and systems in coastal and ocean environment owe much appreciation to various individuals, equipment manufacturers and organizations. I am grateful for those who helped in different ways during the preparation of the book.

Introduction

The book will represent a master piece that provides information and guidance on future direction of marine technology and sustainability requirement. The book focuses on various contemporary issues that make its contents richer, more informative and beneficial to the wide number of readers in industry and academic sphere. This book provides the most recent information about proactive approach to sustainable development technology for readers about requirements of sustainable marine system. The book will be useful as followed:

- Reference material for academician, students, researcher, universities library, research institution as well as classroom subject.
- Networking, literature citation
- Useful information for maritime industry and organization Industry and regulatory institution.

Maritime Energy and Environment Systems Series

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Abstract

Multi-junction solar cells quantum based nanomaterial recently demonstrated conversion efficiencies above of 40% under sunlight concentration of several hundred suns (1 sun 1 mW/mm2). Multi-gap solar cells and thin-film solar cells are promising techniques to achieve higher efficiency at reasonable cost. The process involves synthesis and characteristics of compound nano-wires and nano-needles that are monolithically grown on Si and sapphire. The nano-wires are promising for ultra low threshold lasers and high-efficiency solar cells due to their excellent crystalline and optical quality. The nano-needles on the other hand have an extremely sharp tip of a few atoms in diameter. Quantum dots and graphene are playing a noteworthy role in such nanostructure based solar cells. Quantum dots will boost the effectiveness and decrease the cost of today's usual silicon photovoltaic cells. Marine system requires high level of reliability product that can sustain vibration, dynamic and corrosive environment. Inherently, fully developed land based technology are always adapted for marine application. Most current technology sample only part of incident solar energy and use it with reduced efficiency because they employ only just one material that has poor absorption coefficient across some parts of the solar spectrum. Application of nanotechnology for marine system will provide lower cost and give better efficiency by enabling more efficient use of the spectrum directed towards marine system. This paper discuss potential explore development of nanotechnology for low-cost, reliable and efficient novel nano-solar cells/material compatible for hybrid marine power system.

Human status today can best be defined as an age of knowledge, efficiency, cooperative, sensitive, sustainable developments towards fulfilling and satisfying human existence in this planet. Technology development has gone through various experimentation knowledge acquisitions that have resulted to new discovery and philosophy of doing things. The challenge of the day is sustainability, the art of longevity (reliability, safety

(security) cost effective, system integration (miniaturization, reduced weight) recycling environment (ecology) and efficient (speed, energy), process (risk, simulation) for system design. Especially, the requirement to maintain balance relating to the factors of economic, technical, environmental, social, energy are driving the 21st century technology to satisfy sustainable development, healthy planet and the right of future generation. Energy and environment are seen to so much inseparable like never before. The search for new source of energy to mitigate threat of climate change is becoming an urgent matter. New knowledge and technology have emerged and race is on for the choice of the best. Ports of the world collect massive waste from the ship and oil platform. There is no drain in this planet, the waste got nowhere to go but to return back to the system with consequential environmental damage, contamination of rivers, estuarine and the ocean and landfill and associated degradation as well as cost treatment. The greatest challenge for humanity lies in recycling waste for production of energy. This paper discusses reviews of various energy sources and intends to bring awareness about reciprocal advantage of using waste for the production of energy for marine system. The paper emphasizes the advantage of waste derived biofuel over food derived biofuel and the use of multicriteria risk technique for best practice sustainable bioenergy generation for marine system.

Keywords: Biomass; Marine System; Renewable Energy; Risk; Waste

Introduction

Major technological break through and development have been driven by necessity, competition which focuses toward reducing time, space on which efficiency largely depends on all in the name of making life simple and easier for mankind. Most technological development and war has led to innovation where dreams about things that were never believe that can happened did happen.The semiconductor work of Shockley and his two friends in bell lab and the discovery of semiconductor transistor in Shockley lab are a major invention that spring the computer, digital and information revolution. Ever since the discovery of the first transistor that was use to make super computers industries have focused on research geared towards miniaturization. Today millions of transistors can be network through wafer fabrication to make single IC that can perform multifunction operation. Due to mobility and complexity need for more memory of today system and space, there is new challenge to further scale things down.

Nanotechnology is a new multidciplinary field of science, technology and engineering that can provide answer and solution to this challenge. Thought history of manufacturing, things have been made from top to bottom bulk technology this new area of science is about building from bottom-up by using atoms, molecules of different material. Material properties and characteristics of atom and molecules of material that can withstand building small scale product will be studies and paddle of their arrangement will be assembled to produce Nano product. This paper discusses the following:

Material available for nanofabrication of MOSFET gate

Advantages and disadvantages of materials

New nanotechnology for the preparation of gate material

Preparation of nanomaterial as a gate electrode for MOSFET

Potential use of nanotechnology for marine system

Need of Prospect of Nanotechnology: Figure1

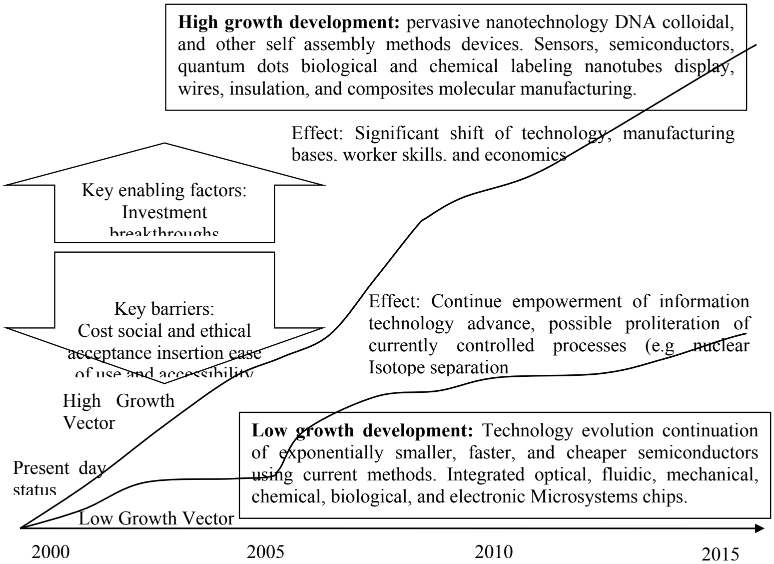


Figure 1: Prospect of Nanotechnology.

Exploring the bottom-up nano-material concept to build solar cell that can capture more sunlight will be helpful to lower the current cost of producing efficient solar power. Nanomaterial Geometric with nano technology compromises to get the best optics while minimizes recombination (electrical) losses. The photo-generated electrical carriers produced cannot get to the outside world because they have to transverse to large a distance in the junction. The use of nano-solar thin-film cell systems by putting stacks of different types of semiconductor junctions on top of each other to overcome the spectral problem. Integrative approach through incorporation of arrays of internal nano-wires with conducting carbon nano-tube quantum dot array could further augment the result.

Malaysia is an emerging economy. With its faster growth process, its energy requirements are high and increasing day by day. Malaysia is a market where there is huge potential for energy producing saving technologies and equipments. Solar energy remains one of the promising answers to quest for alternative energy. Exploring Nanotechnology to collect large amount of solar per unit time is much more of the answer, in the sense that such process will allow opportunity to make solar energy production cheaper, cleaner as well as decentralized. The applications of nano-solar cell technology can make Malaysia the hub of non-renewable energy, particularly the solar energy [1,2]. Figure 1 shows the important projection for rising use of nanotechnology and requirement to fulfill this need.

Adapting Nanotechnology for marine application requires reliability in terms of vibration, water tightness, corrosion/antifouling resistance/anticathode, size and of course, storage. Construction of nano-material to meet this requirement has room for potential of novel solar research product. This research intends to explore this potential and open and lead new market for use of nano-solar for marine power. Potential advancements in Nanotechnology may open the door to the production of cheaper and more efficient solar cells for marine industry. Currently, there are few nano-particles/material based solar cells [3] such as:

Thin-film solar cell

Multi-gap solar cell

Multi-junction solar cell

Nano-quantum dot solar cell

Nano – electronics semiconductor MOSFET Solar cell

Integration of the entire hybrid of above nano-material to construct the desired material that will absorbed sun light and deliver energy efficiently is key to the future of Nanotechnology. Choosing nano material depends on the following:

Thermodynamic stability

Electronics properties

Process stability

In Thin-film solar cells, nano-structured components are used as the basis for creating printable semiconductors, printable transparent electrodes, novel forms of advanced nano-composite solar cell design and powerful new forms of barrier films. Leveraging recent science advances in nano-structured materials, a proprietary ink is used which makes it possible to simply print the semiconductor of a high-performance solar cell. This ink is based on various proprietary forms of nano-particles and associated organic dispersion chemistry and processing techniques suitable for delivering a semiconductor of high-electronic quality [4]. Table 1 shows the challenges of the Nano technology [5]. In Multi-junction solar cell, the molecular beam epitaxial involves growth of $Al_{0.3}Ga_{0.7}As/GaAs$ multi-junction solar cells with epitaxial, semi metallic ErAs nano-particles at the interface of the tunnel junction. The states provided by these nano-particles reduce the bias required to pass current through the tunnel junction by three orders of magnitude and therefore drastically reduce the voltage losses in the tunnel junction. It is measured that open-circuit voltages which are 97% of the sum of the constituent cells, which result in nearly doubling the efficiency of the multi-junction cell with a conventional tunnel junction.

Major issues	Nano-solar cells
Conventional energy is too expensive	Nano-solar cells technology has possibility of producing cheap power and enough for everyone.
Conventional energy is too centralized	Nano-solar cells embedded in flexible plastics will be able to adjust to the shape and terrain of application.
Conventional energy is polluting	Nano-energy is clean
Solar energy again is too costly	Nanotechnology has possibility of producing solar energy which is cheaper than that from the conventional sources.
How will it be stored	Nanotechnology enabled super capacitors in local storage of energy.
How to reduce wastage of energy: transmission losses.	Nano-superconductors will replace current transmission facilities and they will have better performance on this front.
Present day photovoltaic cells are: • Made up of crystalline silicon, which requires clean manufacturing free of dust and airborne microbes. • Silicon is in short supply and expensive. • High manufacturing costs that lead to high wattage prices	With Nanotechnology, tiny solar cells can be printed onto very thin light-retaining materials, bypassing the cost of silicon production. Thin rolls of highly efficient light-collecting plastics spread across rooftops or built into marine structure materials. Nano-cells made up of materials, several thousand times smaller than the hair, will have more light capturing capabilities than photovoltaic cells. Flexible sheets of tiny solar cells made by using nano- science applications may be used to harness the sun's energy and will ultimately provide a cheaper, more efficient source of energy.
What are further possibilities	Nano-tubes: because of their structure, exhibit electrical and optical properties, which help in the absorption of solar energy and its conversion to electrical energy. Nano-particles like quantum-dots with a polymer to make the plastic can detect energy in the infrared solar rays. This will strategically capture more solar energy. Nanotechnology also enables production of solar cell glass that will not only generate energy, but also act as windows. This also reduces overheating of the house, thereby reducing the need for cooling.

A Multi-gap solar cell has only a single layer of material but multiple band-gaps allow it to respond to a range of different frequencies. The difference between the material's valence band and the lower of the split-bands forms one band-gap. In ZnMnTe multigap, incorporating oxygen impurities (written ZnMnOTe), this first gap absorbs 1.8 eV photons. The difference between the two split-bands that the second band-gap in ZnMnOTe, this gap absorbs 0.7 eV photons. Finally, the difference between the valence band and the upper conduction band forms a third band-gap in ZnMnOTe, this gap can absorb 2.6 eV photons. Together, these three gaps respond to virtually the entire solar spectrum. The calculated efficiency of a single-junction solar cell made with this material would be a remarkable 57 percent [6].

New material that could compete with silicon oxide for MOSFET based nano-electronic for energy production will require to have High-k material and Polysilicon metal gate. Overall summary of material and their k-values are shown in the following Table 2. Candidate material and their respective k-value are shown below.

<table>
<tr><th>Metal oxide</th><th>k-value</th><th>Average k-value</th><th rowspan="8">1-10 nm</th></tr>
<tr><td>AlO</td><td>9-11.5</td><td>10.5</td></tr>
<tr><td>BaO</td><td>31-37</td><td>15.5</td></tr>
<tr><td>CeO</td><td>18-28</td><td>21.5</td></tr>
<tr><td>HfO</td><td>20-22</td><td>21</td></tr>
<tr><td>CaO</td><td>25-30</td><td>27.5</td></tr>
<tr><td>TaO</td><td>25-45</td><td>35</td></tr>
<tr><td>TiO</td><td>Sep-90</td><td>49.5</td></tr>
</table>

Table 2: Metal oxide.

Nano-structured semiconductors can be graphene Nano Wires (NW) and Quantum Dots (QD) provides promising opportunities for improved efficiency in Photovoltaics (PV) [3,7]. Nanostructures show tunable electro-optic properties with their size reduction leading to quantum confinement effects that can be beneficially engineered for PV devices. Use of QDs and NWs not only as photon converting/shifting layers but also as electrically active layers leads to advanced device structures with band-gap of the base material effectively tuned to enhance the cell collection efficiency [1,2,8]. Nano particles/material based multi-junction or multi-gap solar cells are inevitable to achieve the desire solar cells efficiency at cheaper cost.

According to an research from 2006, research done at Multimedia University (MMU), quantum dots of lead selenide can make as numerous as seven excitons from one high power photon of sunlight (7.8 times the band gap energy) [9]. This compares favorably to today's photovoltaic units which can only organize one exciton per high energy photon with high kinetic power carriers mislaying their power as heat. This would not outcome in a 7-fold boost in last yield although but could increase the greatest theoretical effectiveness from 31% to 42%. Quantum dots photovoltaics would theoretically be lower to construct, as they can be made using simple chemical reactions especially the generation of more than one exciton by a single photon which is called Multiple Exciton Generation (MEG) or carrier multiplication [3]. Quantum dots tunable band gap property makes it most desirable for solar cell use. It not only can transfer electrons or holes much efficiently but also has a good photovoltaic property. So, we see a great potential making a hybrid solar cell with grapheme and quantum dots. Quantum dot and Grahene transferred to Quantum dots array by Chemical Vapor Deposition (CVD) which is a relatively simple process, is proposed in this research paper. This research will examine the current nano-solar cells material and technologies available and then study the drawbacks that need to be tackled in order to deduce the brand new/hybrid nano-solar cells for marine system. Considering this, result from this research will substantially improve solar power system especially marine power system and could have dramatic impact in terms of efficiency and cost.

Reasons for Miniaturization: Saving space and shifting from microchip to nanaochip is not impetus behind the push for extreme miniaturization, main reason and advantage that will be derived from this scheme are as follows:

Reduce unit cost

Reduce gate will foster on and off activities of the gate, hence increasing speed of device.

Every time circuit are doubled to produce new one, there is increase in higher performance

Double circuit result in increase in memory in the factor of four

Challenges in Nanoelectronics Fabrication: Primary challenging facing high speed or high density device technology or molecular electronics is:

Material patterning and tolerance control

Reliability

Interconnects and parasitoids

Charge transport (including device speed and interface)

Power and heat dissipation

Circuit and system design and integration

Requirements to build sequential switching circuit including micro processor of any kind in principle and of unlimited size are:

Nonlinearity

Power amplification

Cancatenability

Feedback prevention

Basic logic function

In order to build high performance MOSFET gate using nano technology, the following areas will remain center of our focus:

Material science new material candidacy for building nanotechnology

Scaling to dimensions: To increase package density and speed and reduce power consumption. Constant scaling concept is common scaling concept being used.

New technology available: New transistor concept or technology.

Material Science: To build logic gate materials proposal, there is need to fulfill certain criterion that include equipment to be satisfied and other additional features that could maximize conditions of operations of equipments. Choosing material is one of these, in selecting material for digital logic, there is always need to analyze factors derived from principles of thermodynamic, quantum theory and electromagnetism, that are liable to limit system performance, those factors includes :

Type of material

Time and energy parameter

Circuit concept

System configuration

Device type

Preparation of Nonomaterial as a Gate Electrode for MOSFET: Gate electrode involve two terminal device that are attractive for building densely integrated, nanoeletronics circuit logic device, the value of lower number of terminal reduce the huge inter connection problem. Real two terminals integrated MOSFET is an electrical switch (between source and drain) which is control by electrical potential at the terminal of the gate, MOSFET two terminal characteristics gives it advantage over other device for possibility to build first logical gate from metal oxide silicon semiconductor. Manufacturing of MOSFET using nanotechnology will sprang and generate a real and revolution electronics fabrication.

Conventional Material Being use in the Fabrication of MOSPFET: Metal oxide is widely being used for semi conductor fabrication for years in fabrication of modern integrated circuit. This is due to because of low cost, small size and lower power consumption. Among them, silicon oxide is the most effective oxide because of the following:

Devices exhibit good properties

Grown thermally

Device cost less

Found in abundance

Bonds difficult to break, no free electron

Conventional MOSFET is produced using oxide or mixture of oxidizing agent as gate dielectric at thickness of 1.5-2.0 nm and maintaining temperature at 900-1000. Standard thermal diffusion is used to grow the transistors layer on layer on a substrate by grove reaction model. MOSFET materials are:

Metal = aluminum

Oxide = silicon dioxide

Semiconctor silicon

Conventional MOSFET fabrication steps is given in Table 3

Lithography step	Process step	Process
1	Field oxide growth Oxide etch Source-drain diffusion	Thermal oxidation HF etch Boron diffusion
2	Oxide etch Gate oxide diffusion	HF etch Thermal oxidation
3	Via hole etch	HF etch
4	Aluminum metal deposition Aluminum etch Contact aneal and surface reduction	Evaporation Wet chemical etch Furnace anneals in H2/N2

Table 3: Mosphet fabrication steps.

Barrier being faced in the use of nanotechnology to fabricate MOSFET is:

i) Increasing need for semiconductor built with nanoscale feature has brought a lot barrier for silicon oxide these barriers include:

a) Need to reduce oxide scale to blow 1.5-2.0nm

b) Leakage is experience between gate dielectric when scale reduction is attempted to the above scale. Exponential variation to thickness.

c) Impurities i.e. of boron are form at excess doping of poly silicon gate.

d) Reliability life time problem for devices.

ii) New Material Candidate

a) Need for solution to these problems is leading to changing the concept of using top to bottom system in building thing to top to bottom. Because of difficulty to increase thickness of silicon. Nano technology technique will continue to result to numerous problems as described above. Choosing material depends on the following:

- Thermonamic stability
- Electronics properties
- Process stability

b) New material could be categorized into the following:

- High k material
- Polysilicon and metal gate

c) According to recent research development, the following solution is required by material that will compete with silicon oxide.

- High K-Material
- Gordon Moore prophesies was very right and did really happen according to how he put it. Ever since the discovery of transistor and ITS manufacturing, there has always been increase in component per chip in the factor of two as defined by Moore. Theory. Silicon oxide scale limitation, exceedance of this limit, leads to leakage that in turn result to undesirable result and silicon low oxide dielectric. Researcher has come up with possibility of replacing silicon oxide with silicon. Material selection under this category follows the following properties:
- High break down voltage to with stand large electric field
- No build in charge
- Good adhesive to other process material(silicon substrate and gate material)
- Low defect density (no pinhole)
- Easy to be etch
- Permeable to hydrogen
- Flat surface gate and metal interconnection manufacturing Thermal stability (high temperature steps)
- Low processing temperature)

Material under this category could be considerations as followed:

i) Ferroelectric material for DRAM

ii) Metal oxide

iii) Polymers

Advantage:

i) Material with high k material have tendency to trap more electron to low k material.

ii) Decrease band gap of dielectrics that electron can easily pass through the dielectric.

iii) Capacitance is increases

iv) Control power consumption of high performance integrated circuit

Poly Silicon and Metal Gate: Leakage can be rescued by improving oxide quality of different metal, using oxinitride we can achieve the following:

i) Need to slow down thermal growth rate

ii) Improving interval uniformity

iii) Reducing boron penetration from highly doped polysilicon gate stack.

iv) Use of metal oxide less sensitive to hot electron.

Every time we scale down MOSFET we achieve low power, high speed and high packing density. A few successes have been made in using oxinitride to scaling down CMOS success approach in this direction could be helpful Figure 2:

Al thing being the same the following precaution need to be practice in the process.

Control of silicon is highly required at polysilicon side to stop boron, penetration into the oxide

Too much nitrogen at the intercept degrade career mobility and transistors transconduction

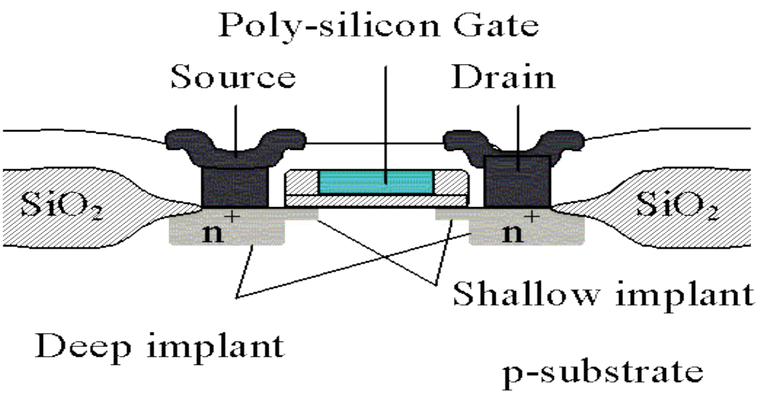


Figure 2: Poly Silicon and Metal Gate.

Metal Oxide

Advantages

Use of metal gate allow possibility to make material thick and reduce gate leakage

Tin, ta, nb has high work function and sufficient high melting point (>>1000 degree cel.) they are good for n-MOS

Co, re, ni and ru because of high melting point characteristics. Ru and pt are good for pmos but cannot survive hydrogen pasivation as they are thermodynamically unstable.

High metal metalic alloy

Silicide

nitrides

Disadvantages

i. Polysilicon has disadvantaged of formation of depleting layer and resistivity

ii. High k material subject gate to high temperature, therefore there is need for annealing, hydrogen pasivation is an option

iii. New nanotechnology for the preparation of material gate

iv. Replacing silicon oxide gate with high dielectric k-material is combined with metal gate strained silicon and metal gates are promising choices available now.

v. High k oxide material takes care of leakage problem that arise from scaling down silicon oxide to say 1.5 nm for the later.

vi. Strain silicon is good to increase speed of performance of devices.

vii. Tin is mid gap metal gate candidate, it is stable, high melting point, compatibility with polysilicon

Metal under considerations are: i. Silicon oxide

ii. Silicon nitrite

iii.Oxynitrides

iv. Aluminium oxide

v. Tantalum pentoxide

vi. Hafnium oxide

vii. Zirconium oxide

viii. Barium Strontium Titanate (BST)

Multi Component Oxide Table 4-6

Advantage: More efficient MOSFET gate

Multi Component Strochiometer

Advantage: Improved efficient MOSFET gate

Overall summary of material and their k values are shown in the following table.

Metal oxide	K value	Average k-value
AlO	9-11.5	10.5
BaO	31-37	15.5
CeO	18-28	21.5
HfO	20-22	21
CaO	25-30	27.5
TaO	25-45	35
TiO	Sep-90	49.5

Table 4: Metal Oxide.

Metal oxide	K value	Average k-value
Hfo-SiO	10-13	11.5
Lao-SiO	18-20	21.5
Yo-SiO	10-11	10.5
Ro-SiO	11-13	12
HfO-RrO	20-25	22.5
HfO2-AlO	14-17	15.5

Table 5: Multi Components Oxide.

LaAlO	25
SrZrO	25
SrTO	<25
BaSrTO	400

Table 6: Multi component strochiometer.

BST: From above summary it can be deducted that BST is our best bet, I composition of barium strontium and titanium for building high frequency, millimeter/microwave devices. Properties of this material

i. High dielectric loss

ii. High tenability

i. Polarizability

ii. Piezoelectricity

iii. Piezoelectricity

iv. Electro optical capability

v. Performance under Curie temperature during processing

vi. High tunerbility

vii. High quality structure

New Technology Available: New technology available is: electrodeposition technique is new technology considered to be suitable for preparation of nanomaterial for gate of Metal Oxide Semiconductor Field Effect Transistor.some of them is achieved using the following process techniques.

Silicon on Oxide (SOI): Replace bulk silicon wafer, wafer Bonding or Etch Back (BESOI) or ion implantation is used Figure 3.

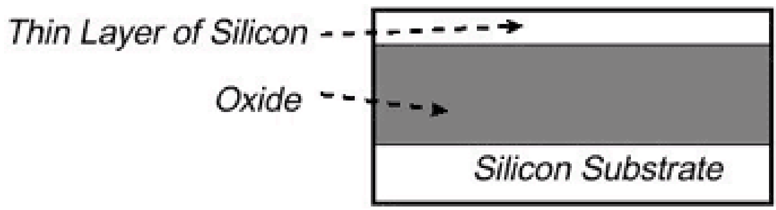


Figure 3: Replace bulk silicon wafer.

Advantages

i. Smaller paretic capacitance

ii. Small source/drain leakage

iii. Immune to soft error cause by alpha particle

iv. High speed

v. Low power consumption

vi. SOI also has advantage of in production of high frequency application and solve dual metal gate technological problem

Disadvantages

i. Expensive

ii. Poor thermal conductivity

SIMOX- improved SIO silicon with implantation of oxide (atom or ion)

Advantage: Provide physical support to the structure.

Disadvantages

iii. Defective

iv. Hard to clean

Precaution/Solution:

i. Proper heating is needed to mend crystal lattice.

ii. Reservation for expensive chip makes its use economical for companies.

Precision slicing method used by a French company called SOITEC (soitec smart cut) hydrogen bombardment on silicon and its oxide Table 7

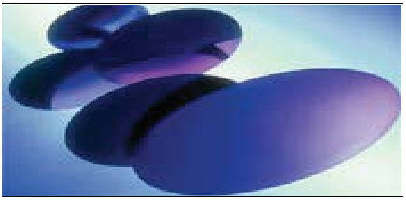
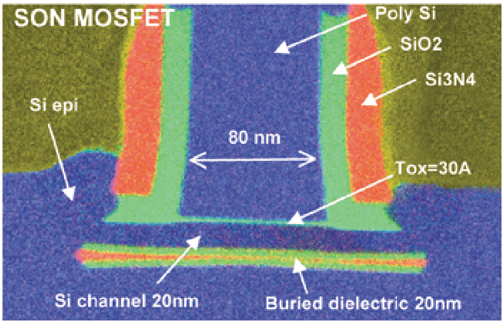
	100 to 300 mm UNIBOND™ standard products specification Multiple applications can be addressed by the very wide UNIBOND™ product range, thanks to Smart Cut™ process flexibility. Crystal & doping types, film thicknesses and uniformities could be combined to obtain the UNIBOND™ SOI wafers you need.
Wafer diameter	100 to 300 mm
Wafer thickness	375 to 775 µm (varies by wafer diameter)
SOI thickness	50 nm to 100 µm*
SOI thickness uniformity	Down to ± 5 nm**
Silicon crystal orientation	< 100 >
Buried oxide thickness	100 nm to 3 µm
Box thickness uniformity	± 10 nm
Wafer crystal (active & handle wafers)	COP's free material, CZ
Box thickness uniformity	± 10 nm
Wafer type & resistivity (active layer & handle wafer)	P&N type Standard: 1-100 Ohm.cm High resistivity: >1KOhm.cm***
*Thick film SOI >1.5 µm requires epitaxial deposition after Smart Cut™ process **All sites of all wafers are within ± x nm using Acumap measurement (3 sigma calculation) ***High resistivity substrate is fully compatible with Smart Cut™ process	

Table 7: Precision slicing method used by a French company called SOITEC.

Silicon on Nothing (SON): Here region under the gate is removed and refilled with dielectric material germanium alloy layer is preferable for SON structure. 80 nm SON NMOS TransistorCross section of a SON transistor obtained by Transmission Electron Beam using energyloss analysis where blue represents Silicon, green represents Silicon Dioxide SiO_2 and red is Silicon Nitride Si_3N_4



Advantages

Less expensive

Very promising

Silicon channel kept at 10-20 nm

Ultra Thin Body (UTB): This is made on SOI Figure 4

Figure 4: Utra-thin-body MOSFET with high-k Schematic of a high-k gate dielectric gate dielectric

Advantages

i. Gate length can be maintain at <10 nm

ii. Reduce area of transistor

iii. Improve scaling

iv) Doubling number of transistors on a chip.

Double-Gate MOSFET-arrangement of 2 symmetric gates in planar Figure 5.

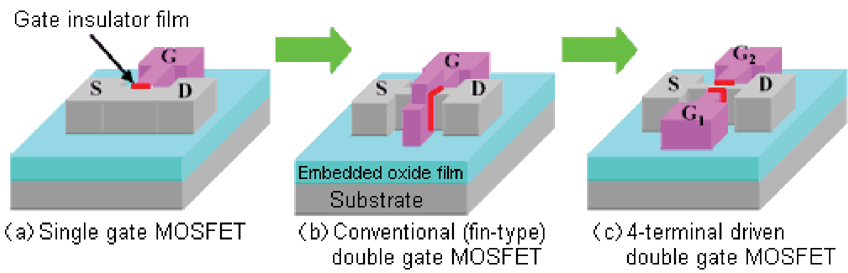


Figure 5: Evolution of the MOSFET: (a) Single gate MOSFET (b) Conventional (fin-type) double gate MOSFET and (c) Four-terminal double gate MOSFET.

Prospect of Quantum Nano Fabrication: Recent revolution we have had recently in the improvement and development of semiconductor give us hope that we can use to produced semiconductor through bottom to top model. Invariably silicon layer by layer deposition and using wafer machinery to cut it as a very good similitude to nanomanufacturing and it seem it has been exiting all what is need right now is studying the arrangement and doing it at atomic and molecular level. International Technology Roadmap for Semiconductor @ http://public.itrs.net is working on necessary goal to achieve nanoelctronics objective.

Typical nanogrowth process start with characterization of nano particles/material follow by fabrication of nano-solar cell. The characterization involve matching with energy band-gap, single band-gap and multi band-gap, thin-film technique, crystalline silicon as well as emerging PV and methods to minimize on the energy loss, either in single-junction or multi-junction solar cell will be carried out. Accurate knowledge of material tolerance of the processed nano-solar power material for marine system is important.

Quantification of nano-solar cell efficiency as well as cost effective required trade off comparison of nano-particles/materials (e.g. carbon nano-tube, graphite nano-wire, quantum-dots, nano-needles fullerenes and polysilicon). Based on the performance indicators, system optimization will further be studied and modification will be done on either particles or junctions (e.g., single/multi junction) to improvise the system robustness and efficiency.This in order to come out with an optimum combination of both.

Simulation of the system could provide better reliability on the plan and active work require, exemple of available software that can be use for simulation of the behavior of nano material is Virtual Nanolab 2.0.1. The following material has been employed in the Nano material research at MMU. Exploring this foundation for marine system requirement characterization could evolve development of new nano material that will be suitable for marine environment, higher efficiency and acceptable cost that do not compromise between quality and low-cost solar cell. This includes:

e. g. Pt-group metal over nanoporous Au-group nanorod array.

e.g.Semiconductor ZnO nanoparticles has been used to synthesize core/shell quantum dots embedded with organic, passivation shells

Others: Ni, Pd & Cu, Ag pairs.

Quantum dots and graphene play a noteworthy role in such nanostructure-based solar cells. The dispersion of quantum dots in an answer of an electron pledging conjugated polymer is possibly the most widespread scheme to apply quantum dots components into organic photovoltaic devices to get higher efficiency.The generation of more than one exciton by a single photon is called Multiple Exciton Generation (MEG) or carrier multiplication [1,3]. Graphene's high electrical conductivity and high optical transparency make it a candidate for transparent conducting electrodes, required for applications such as touch screens, displays, organic and organic light-emitting diodes. In particular, graphene's mechanical strength and flexibility are advantageous compared to indium tin oxide, which is brittle and graphene films can be deposited from solution over large areas [5]. Large-area, continuous, transparent and highly conducting few-layered graphene films will be produced by chemical vapor deposition and used as anodes for application in photovoltaic devices [10]. The efficiency under application in marine environment will be examined.

Motivated by the concepts that the quantum dots itself can be a high effective photovoltaic diode device and that the grapheme thin film has been well illustrated to be a clear electrode [2,4,6-8,11]. We suggest a likely way to blend quantum dots and graphene to fabricate highly effective solar cells. Basically, grapheme attached by Quantum dots is utilized as anode, if we can conceive a p-n junction in the Quantum dots and glowing the lightweight, as asserted by multiple electron-hole in two that will be developed effectively in Quantum dots and eventually get the photocurrent. We require managing some initial trials to clarify some matters for example comprehending and characterization of the junction between Quantum dots and grapheme as mentioned in part1. Numerous other hybrid components for future solar cells are under development, this hybrid structure-graphene on Quantum dots arrays may furthermore offer one of the possibilities [12,13]. Below in Figure 6 is the image of quantum dots and graphene layer which has been taken from the reference number 2.

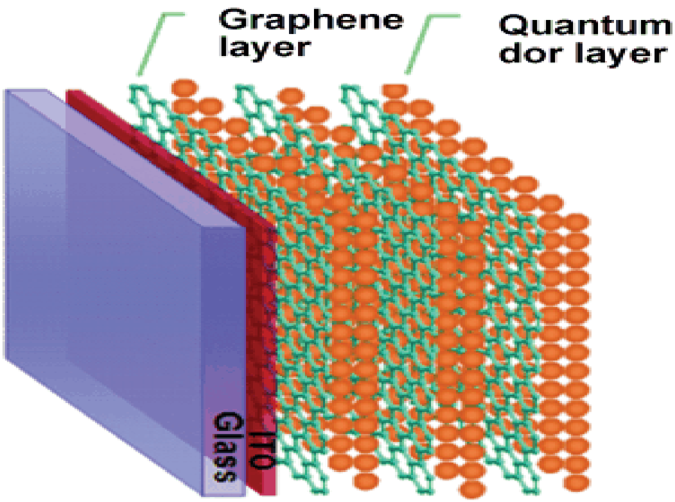


Figure 6: Image of quantum dot and grapheme

Graphene Transferred to Quantum Dots Array by Chemical Vapor Deposition (CVD): graphene can be produced in high quality and successfully transferred to quantum dots by cvd method. It would not be a complex process to generate electron hole pairs from a thin single layer graphen and quantum dots. However, it would be interesting to see the behavior of their junction and must be carefully observed. Figure 7 shows that how direct deposition of graphene on various dielectric substrates is demonstrated using a single-step chemical vapor deposition process.

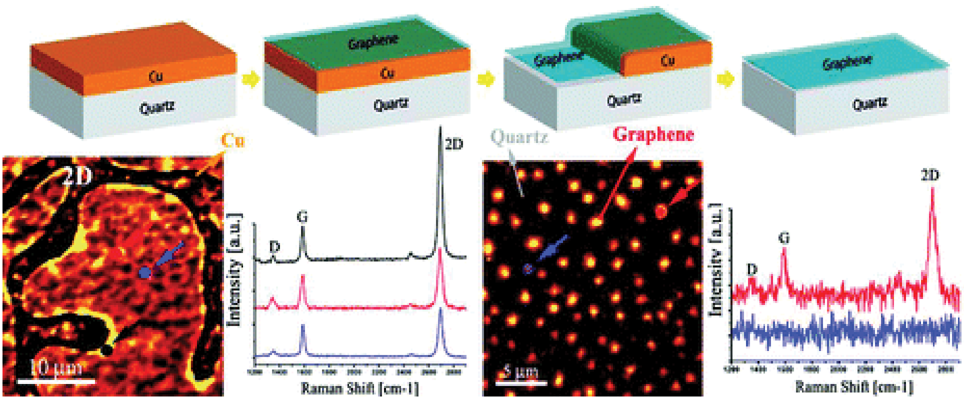


Figure 7: To make a graphene thin film, Berkeley researchers

(a) Evaporated a thin layer of copper on a dielectric surface.

(b) Then used CVDto lay down a graphene film over the copper.

(c) The copper dewets and evaporates leaving

(d) The graphene film directly on the dielectric substrate [6].

Single-layer graphene is formed through surface catalytic decomposition of hydrocarbon precursors on thin copper films pre-deposited on dielectric substrates. The copper films dewet and evaporate during or immediately after graphene growth, resulting in graphene deposition directly on the bare dielectric substrates. Scanning Raman mapping and spectroscopy, scanning electron microscopy and atomic force microscopy confirm the presence of continuous graphene layers on tens of micrometer square metal-free areas. The revealed growth mechanism opens new opportunities for deposition of higher quality graphene films on dielectric materials [6,14].

Figure 8, the graphene electrodes were synthesized by chemical vapor deposition of methane on thin Ni layers formed on SiO2/Si [14].

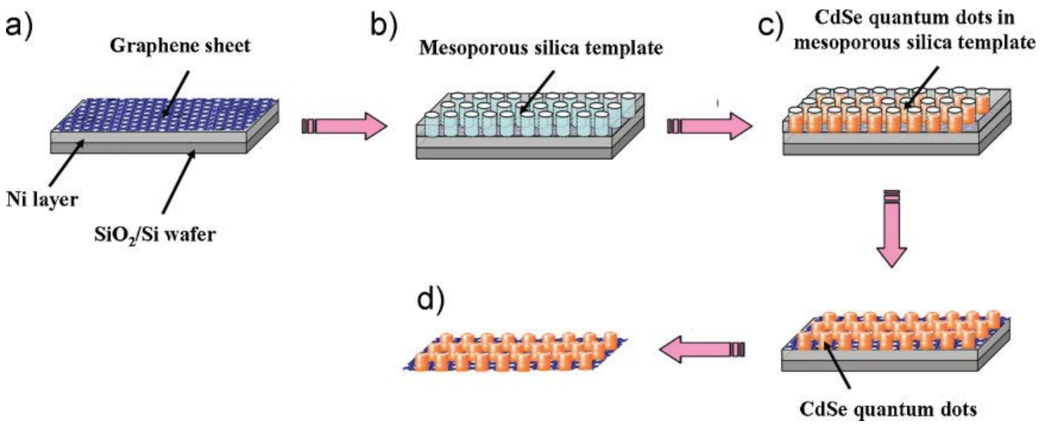


Figure 8: Procedure to synthesize a CdSe quantum dot array on the basal plane of a grapheme sheet using a mesoporous silica thin film as a template.

a) Formation of a mesoporous silica film on the graphene surface by spin-casting, aging and calcination.

b) Electrochemical deposition of CdSe onto the graphene surface through the pores of the mesoporous silica film template.

c) Removal of the mesoporous silica template and

d) Removal of the Ni layer underneath the graphene sheet.

Graphene can be made in high value by CVD procedure and moved to any substrate, while carbon Quantum dots arrays, even single-walled Quantum dots arrays, can be obtained. The graphene thin film can be narrower, and the Quantum dots arrays can be single layer which simpler to develop electron-hole pairs. If we can effectively move the graphene film to the Quantum dots array, the optical and electric property of this material is itself would be very interesting. Efficiency of available approach are Efficiency is (Multifunction) 42% (Singlejunction), 25% (Organic), 5.5% can be achieved. The present approach is targeted to improve the state of the art solar cell efficiency. Wavelength of quantum resonance emission (absorption) is related to nano-particle's size. Smaller QDs absorption peak shifts to higher energy (wider band gap) whilst larger QDs absorption peak shifts to lesser energy (narrower bandgap). Sylvaco & AMPS-ID will be used for simulation of the theoretical studies. The emission and absorption spectra corresponding to the energy band gap of the quantum dot is governed by the quantum confinement principles in an infinite square well potential. The energy band gap increases with a decrease in size of the quantum dot. The energy band gap associated with semiconductor must exist between the conduction bands (See Figure 9).

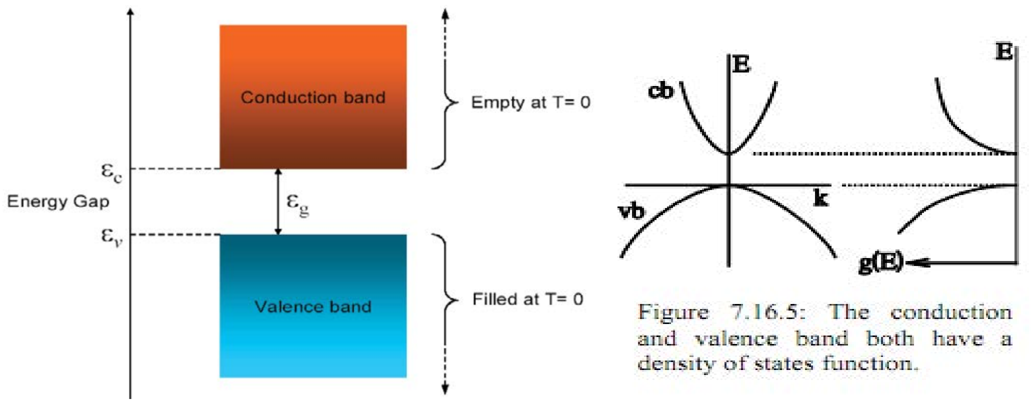


Figure 9: a) Energy band gap b) The Conductive and valence band both have a density of states function.

Theoretically, the quantum dot is defined by the Hamiltonian as followed (see Figure 10) [15].

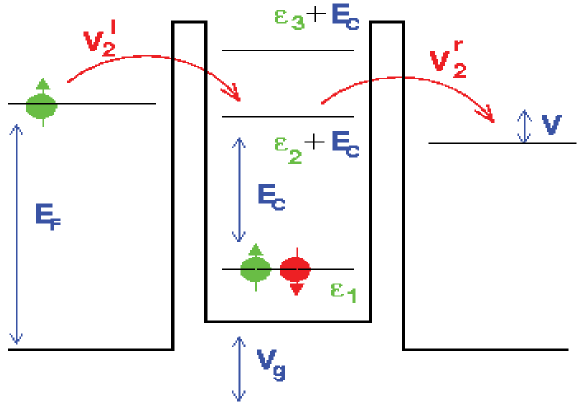


Figure 10: Theoretical quantum dot

$$H = \hat{H}_{LD} + \hat{H}_L + \hat{H}_D + \hat{H}_C \tag{1}$$

$$H = \sum_{ij=1}^{M} \hat{d}_i^t h_{ij}^D \hat{d}_j + \frac{E_c}{2}\hat{n}_d^2 - eV_g \hat{n}_d + \sum_{\lambda k}\sum_{i=1}^{M} V_i^{\lambda} \hat{I}_{k\lambda}^t \hat{d}_i + h.c + \sum_{\lambda k}\left(v_f k - \delta_{\lambda l} eV\right)\hat{I}_{\lambda k}^t \hat{I}_{\lambda k} \tag{2}$$

Contains the energy levels ε_i of independent electrons via the eigenvalues of an M×M matrix h_{ij}^D [$d_i^\dagger$ ($l_{\lambda k}$) is the creation (annihilation) operator for an electron in the dot (lead), the Coulomb interaction (charging energy) E_C between all electrons n_d on the dot, the gate voltage V_G. These charging (H_C) and single particle term (H_D) describe the isolated dot. It couples to the leads (H_{LD}) via the hopping of an electron from the dot to the left (λ=l) and right (λ=r) (or source and drain) electrode (term V_i^λ $l_{\lambda k}^\dagger$ d_i) and vice versa (h.c.). H_L describes electrons in the electrodes by the linearized Eigen energies $v_F k$ and a possible voltage difference V between left and right electrode. With so many parameters, we either study the generic effects qualitatively or employ random matrix theory to describe the parameters statistically. Figure 11 shows process for nano-MOSFET Gate-junction growth where cross section of Silicon on Nothing (SON) transistor obtained by Transmission Electron Beam using energy loss analysis where blue represents Silicon, green represents Silicon Dioxide SiO_2 and red is Silicon Nitride Si_3 N_4.

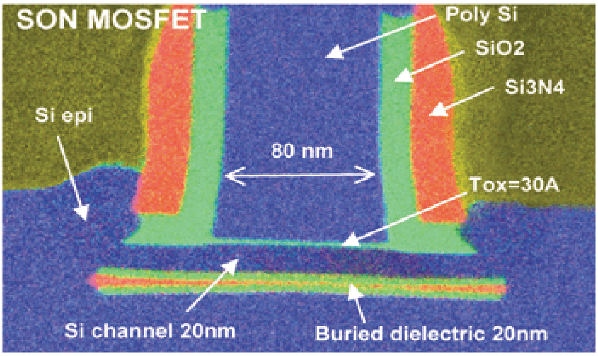


Figure 11: SON MOSFET process.

The nano-solar is intended to build in the structure shown in Figure 12 shows nano system connection for quantum dot solar cell, when a quantum absorb a photon from the sun, it gives off 2 holes which contribute to the electric current flowing from the cell`s terminal into the storage battery.

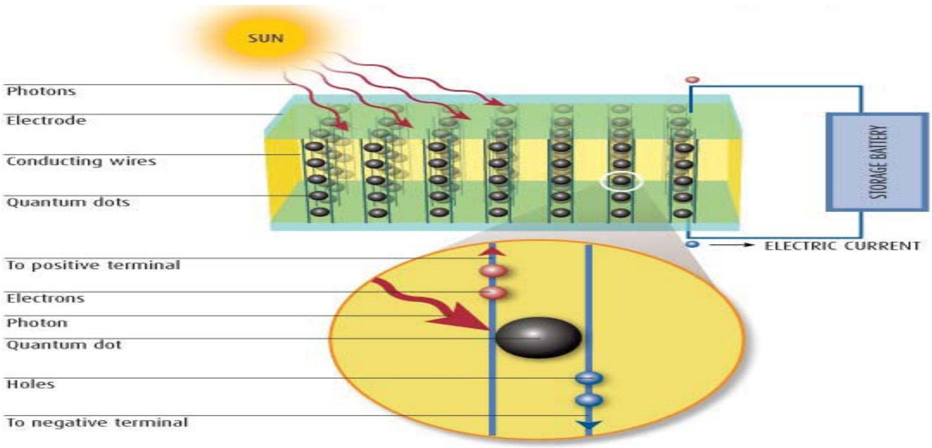


Figure 12: Quantum-dot process.

Figure 13 shows the Spectrometer that will be used to characterization of nano-crystals, quantum-dots and nan-wires on a wide range of the absorption spectrum. The spectrometer also provides the power and control signals for the light sources.

Figure 13: Ocean Optics CHEM4-VIS-NIR.

Figure 14 and 15 show Multimedia University (MMU) high end workstation that will be preliminary used for the research.

Figure 14: MMU High-end work station.

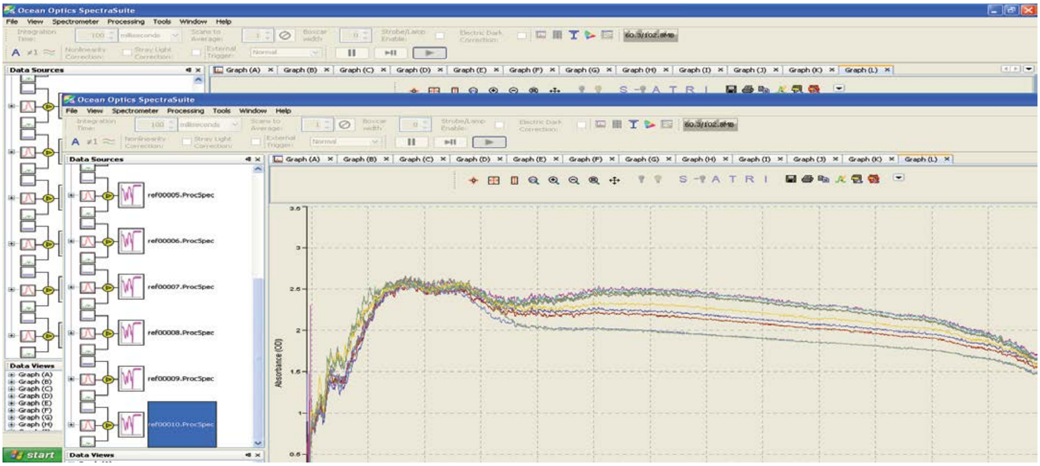


Figure 15: The photon behavior of semiconductor nano crystal quantum dots (23rd March, 2011. Multimedia University Lab).

Conclusion

Recent research engaging graphene nanowire and carbon nanotube quantum dots in creating next generation solar cells have been briefly reviewed. The graphene can be utilised as clear conductive electrodes for solar cells, its high electron mobility can furthermore be utilised to advance separation and assemblage of carriers. Quantum dots not only can transfer electrons or holes much effectively, but furthermore has a good photovoltaic property. Combining graphene and quantum dots may be undertaking to get a new kind of solar cells. We have suggested a likely way to arrange this hybrid components founded on the present synthesis techniques. Considering this, Result from this research will substantially improve existence solar cell efficiency and could have dramatic impact in terms and cost.

2. Potential for Waste Recycled Based Bioenergy for Marine System

Introduction

The 21st century is becoming age of recycling where a lots of emphasize is placed on reducing waste and reuse of material to curb current environmental problems, maximizing use of depleting natural resources and conserve energy. Modern day sustainable use and management of resource recommend incorporating recycling culture in human ways and the use of modest process. Biomass is not left behind in this. The use of biomass energy resource derived from the carbonaceous waste of various natural and human activities to produce electricity is becoming popular. Biomass is considered one of the clean, more efficient and stable means of power generation. Enormous being generated from marine system make it imperative for marine industry to tap this new evolving green technology to employ mobile based micro generation biomass for mobile for marine energy system.

Advantage of biomass compared to other renewable based energy systems is that biomass can generate electricity with the same type of equipment and power plants that burn fossil fuels. Innovations in power generation of fossil fuels may also be adaptable to the use of biomass fuels. Also the ashes from biomass consumption, which are very low in heavy metals, can be recycled. Various factors notably have hindered the growth of the renewable energy resource, especially efficiency, like wise most biomass power plants operating today are characterized by low boiler and thermal plant efficiencies. Both the fuel's characteristics and the small size of most facilities contribute to these efficiencies. In addition, such plants are costly to build. All in all, converting waste into fuel is beneficial even without an energy gain, if that waste will otherwise pollute the environment. Biomass has low sulfur content, this give biomass combustion advantage of less acidification than fossil fuel source.

Biomass remains potential renewable energy contributor to net reduction in greenhouse gas emissions and offsetting of oxide of carbon dioxide (CO_2) from fossil generation. The current method of generating biomass power is biomass fired boilers and Rankine steam turbines, recent research work in developing sustainable and economic biomass focus on high pressure supercritical steam cycles. It uses feedstock supply system and conversion of biomass to a low or medium Btu gas that can be fired in combustion turbine cycles. It results in efficiencies of one and a half times that of a simple steam turbine. Biofuels has potential to influence marine industry and it has become importance for ship designers and ship owners to accept their influence on the world fleet of the future. Especially the micro generation concept with co generation for cargo and fuel can be a good biomass system for ship. Taste being dumped by ships in port can be use to power land based and coastal infrastructure.

This paper discusses review of conceptual work, trend, sociopolitical driver, economic, development, risk approach and future of biomass with hope to bring awareness to local, national and multinational bodies making to adopt biofuels policies. The maritime industry is always slow to adopt new technology. The paper direct awareness call to maritime multidisciplinary expertise in regulation, economics, engineering, vessel design and operation to break slow adoption of technology barrier. Time has come for the shipping industry to take advantage of growing tide to tap benefit promised by use of waste to power generation for marine system.

Biomass Developmental Trend

The concept of using of biofuels for energy generation has been existing for a long time. In the face of challenges posed by environmental need, the treat of climate change, pollution of water resources, and its growth is likely to dominate renewable energy market. The production and use of biofuels worldwide has grown significantly in recent years. Biofuels exist in solid, liquid or gas form, thereby potentially affecting three main core energy markets of materials. Solid biofuels or biomass is used in external combustion. Biomass use in use in the shipping industry is limited to liquid biofuel due to lack of appropriate information, economics forecasts, sources of solid biomass include by-products from the timber industry, agricultural crops, raw material from the forest, major parts of household waste and demolition wood. All things being equal using pure biomass that does not affect human and ecological food chain is suitable energy source for biomass. The current world biofuels market is focused on: Bioethanol blended into fossil motor gasoline (petrol) or used directly and biodiesel or Fatty Acid Methyl Ester diesel blended into fossil diesel. The Fischer-Tropsch model involves catalyzed chemical reaction to produce a synthetic petroleum substitute, typically from coal, natural gas or biomass.

It is used to runs diesel engines and some aircraft engines. The use as synthetic biofuel lubrication oil or aid synthetic fuel from waste seems promising and negates risk posed by food based biomass. Oil product and chemical tankers being constructed now are likely to benefit from the use of biomass. However use on gasoline engines ignites the vapors at much higher temperatures pose limitation to inland water craft as more oxide of nitrogen can be released to the atmosphere [16]. Meeting biomass demands and supply can be empirically by employing multi criteria decision support system based equation below simulation and risk analysis presented in Figure 16 Design of biomass system energy analysis that include:

i. Preliminary information and motivation
ii. Energy auditing
iii. Process analysis
iv. Risk cost benefit analysis
v. Reliability, uncertainty and sustainability analysis

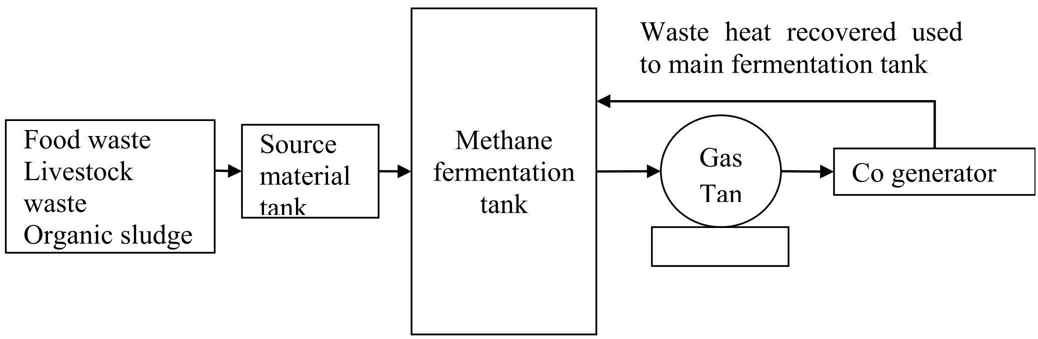


Figure 16: Biomass process.

Details of the process are described below:

i. Food Waste, Livestock waste and organic sludge is collected by prime mover (truck).
ii. **Source Material Tank:** Airtight tank filled with the organic waste and which can be emptied of digested slurry with some means of catching the produced gas. Design differences mainly depend on the type of organic waste to be used as raw material, the temperatures to be used in digestion and the materials available for construction.
iii. **Methane Fermentation Tank:** Process to remove sulfidric components and humidity from biogas, occurs in tree steps. In the first step the most of biogas humidity is removed, by a recipient where the water is condensed. After that, in second step, biogas is directed to purification system, composed by two molecular screens, removing the remainder humidity and the sulfídrico components (H_2S). In the third step, biogas pass through an amount of iron chip, removing the H_2S residual.
iv. **Gas Tank:** The last process to collect the biogas to store in the drum, in this process, biogas will store in liquid condition. After finish the process collecting biogas, the drum will supply to industry or power plant to use as combustion. '

Biomass Developmental Trend Spillage to Shipping: Just like tanker revolution influence on ship type, demand for biomass will bring capacity, biomaterial change from source to production area to the point of use. Technological, environmental change will also require ships of different configuration, size and tank coating type as well as impact on the tonne mile demand. Recently biofuel is driving a new technology world-wide the use of biofuels for cars and public vehicles has grown significantly. Effect on shipping is likely to be followed by shipping of large scale growth on exports and seaborne trade of biomass product from key exporting regions in order to balance supply and demand. With excess capacity waiting for source material it seems inevitable that shipping demand will increase. Figure 17 shows typical energy configuration for conventional ship technology, biomass system can be strategically located near the gas turbine.

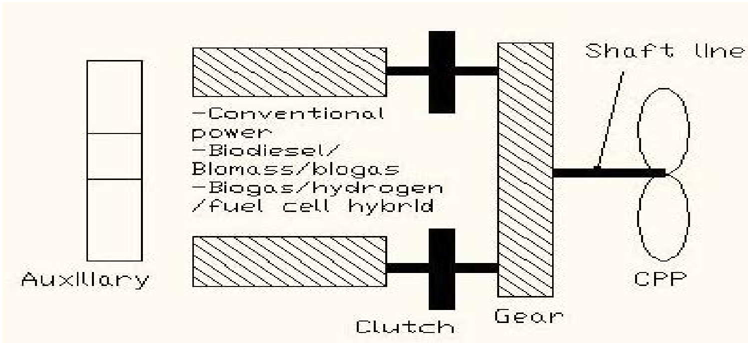


Figure 17: Typical energy configuration of conventional ship propulsion system.

Meeting Biomass Demand and Supply: Ecent year has witnessed emerging trade on biofuel product between the US, EU and Asia. Particularly South America, Brazil has already been branded to be producing mass production of ethanol from sugar cane since the 1970s with a cost per unit reportedly the lowest in the world. The top importers from US, EU, Japan and Korea have increasing demand that will have to be satisfied by increased shipping capacity. Also seaborne vegetable oil supply is increasingly growing. The EU imports 5.7 mt in 2001 and rise to 10.3 mt for 2008, an almost 50% of total capacity. Table 8 shows the present global percentage of consumption for ethanol according to Energy Information Administration (EIA). Brazil exports the most ethanol globally at about 2.9 million tonnes per year. Table 9 show statistic of present food related biofuel this reflects future food scarcity according to National Renewable Energy Laboratory [17].

Region	Consumption
World ethanol consumption	51 million tones, 2007
US and brazil	68%
EU and China	17% - surplus of 0.1 million tones
US deficit	1.7mt
EU deficit	1.3 mt
World deficit	1mt

Table 8: World Ethanol Consumption 2007 [EIA].

Biofuel source	Growth in 2008	Gowth per annum
Vegetable oil	33 mt in 2000 to 59 mt	7.5%
Palm oil	13 mt in 2000 to 32 mt	8.9%
Soya bean	7 mt to some 11.5 mt	39%

Table 9: Biofuel growth [NREL].

Classification of Biomass

According to Generation Types: Here biomass generation and growing trend can be classified into three generation types:

1. First generation biofuels are made from food like from sugar or starch, vegetable oil or animal fats to produce biodiesel. This type of biofuel provokes increasing criticism

because of their dependence on food crops, biodiversity and land use. Hybrid technology using percentage blending is being employed to mitigate food production impact.

vii. Second generation biofuels are waste derived biomass from agricultural and forestry, fast growing grasses and trees specially grown as so called energy crops. They mitigate problem posed by the first generation biofuels. With technology, sustainability and cost issues to overcome, this second generation biofuels are still several years away from commercial viability and many of them are still under development including the biomass to liquid Fischer-Tropsch production technique.

viii. Third generation biofuels, use green fuels like algae biofuel made from energy and biomass crops that have been designed in such a way that their structure or properties conform to the requirements of a particular bioconversion process. They are made from sources such as sewage and algae grown on ponds.

According to Sources Types: North American Electric Reliability Council (NERC) region supply has classified biofuel into the following four types: agricultural residues, energy crops, forestry residues, and urban wood waste and mill residues. A brief description of each type of biomass is provided below:

Agricultural residues from the remaining stalks and biomass material left on the ground can be collected and used for energy generation purposes this include residues of wheat straw

Energy crops are produced solely or primarily for use as feedstock in energy generation processes. Energy crops includes hybrid, switch grassgrown on idled or in pasture. The most important agricultural commodity crops being planted in the United States are corn, wheat, and soybeans represent about 70% of total crop land harvested. Thus, this is not encouraged to prevent food scarcity.

Forestry residues are composed of logging residues, rough rotten salvageable dead wood and excess small pole trees.

Urban wood, waste and mill residues are waste woods from manufacturing operations that would otherwise be landfilled. The urban wood waste and mill residue category includes primary mill residues and urban wood such as pallets, construction waste and demolition debris, which are not otherwise useful.

National Energy Modeling System (NEMS) classification: Biomass for electricity generation is treated in the following four ways in NEMS:

New dedicated biomass or biomass gasification

Existing and new plants that co-fire biomass with coal

Existing plants that combust biomass directly in an open-loop process and

Biomass use in industrial cogeneration applications. Existing biomass plants are accounted for using information such as on-line years, efficiencies, heat rates and retirement dates, obtained through Environmental Impact Assessment (EIA) surveys of the electricity generation sector.

Inter Industry Best Practice: Land Based Use

The following are a few development of land based biomass (Lane NW and Beale WT 1996a) (see Table 10).

Industry	Progress
United Kingdom (UK) on June 2007	First train to run on biodiesel went into service for a six month trial period. The train uses a blended fuel, which is Central. 20% biodiesel hybrid mix augmentation possibility to at least a 50% mix. It has future possibility to run trains on fuels entirely from non-carbon sources.
Argent Energy in UK on 26th of October 2007.	A UK pilot project where buses are run on B100 Argent Energy (UK) Limited is working together with Stage coach to supply biodiesel made by recycling and processing animal fat and used cooking oil for marine system. Limited is working together with Stagecoach to supply biodiesel made by recycling and processing animal fat and use of cooking oil for the pilot project.
Ohio Transit Authority (COTA) on January 15, 2006	Successfully tested a 20% blend of biodiesel (B20) in its buses wich eventually leads to approval of fleet wise use of biodiesel. In April 2006. COTA is working to use 50-90% biodiesel blends (B50 - B90) during the summer months.
United States (US), Department of Environment (DOE) development projects in 2001(Vermont project)	Funding of five new advanced biomass gasification research. A projection to decrease of diesel fuel consumption by over one million gallons per year.
Ford on 2008,	Announce £1 billion research project to convert more of its vehicles to new biofuel sources.
British Petroleum (BP) Australia	Sold over 100 million liters of 10% ethanol content fuel to Australian motorists, and Brazil sells both 22% ethanol petrol nationwide and 100% ethanol to over 4 million cars.
The Swedish National Board for Industrial and Technical Development in Stockholm	Several Swedish universities, companies, and utilities, In 2008, Collaboration to accelerate the demonstration of the gas turbine natural-gas firing plant (0.6 megawatts of power output for a simple gas /turbine cycle). It is a trend that is gathering momentum.
AES Corporation	Recently completed a successful trial to convert the plant to burn a mixture of coal and biomass. With further investment in the technology, nearly half of Northern Ireland's 2012 renewable target could be met from AES Kilroot alone.
For power stations	B&W have orders in the EU for 45 MW of two-stroke biofuel engines with a thermal efficiency of 51-52%. Specifically, these operate on palm oil of varying quality.
Aero industry progress	Virgin Atlantic Air transport is receiving increasing attention because of environmental research on CO_2 emissions, air quality and noise. Virgin Atlantic in collaboration with Boeing and General Electric aircraft are developing alternative fuels for aircraft. A successful test flight from London to Amsterdam flight took place on 24th February.

Table 10: Land based industry progress.

Maritime Industry Progress: The use of biofuel for land based transportation is growing; however the use for sea based transportation need to be explored. Biofuels for marine systems will be advantageous.

i. Royal Caribbean Cruise Lines (RCCL) unveiled a palm oil based biodiesel in 2005. Optimistic outcome of the trial made RCCL confident enough to sign a contract in August 2007 for delivery a minimum of 18 millions gallons of biodiesel for its cruise ships fleet. The contract marked the single largest long-term biodiesel sales contract in the United States.

ii. United States Coast Guard, in 2007, indicated that their fleet will augment increase use of biofuels by 15% over the next four years.

iii. Marine engines with their inherent lower speed and more tolerant to burning alternative fuels than smaller, higher speed engines tolerance will allow them to run on lower grade and cheaper biofuels.

iv. In the marine industry, beside energy substitute advantage, biolubricants and biodegradable oil are particularly advantageous from an environmental and pollution perspective. Bio lubrication also offer higher viscosity, flash point and better technical properties such as increased sealing and lower machine operating temperature advantageous use in ship operation.

v. It is expected that more engines, whether stationary or marine will be developed to run on biofuels.

Time has gone when maritime industry could not afford delay in adopting new technology, other industry are already on a fast track preparing themselves technically for evitable changes driven by environmental problem, global energy demands and political debate that add pressures to find alternative energy especially bio energy. The implication is that shipping could be caught ill prepared for any rapid change in demand or supply of biofuel. Thus this technology is in the early stages of development but the shipping industry need to be prepared for the impacts of its breakthrough because shipping will eventually be required at the centre of this supply and demand logistics chain. System integration hybridization of old and new system offers advantage for require change. Figure 18 shows the regional projection for biofuel usage and demand for the US and Europe which are the current main user in future.

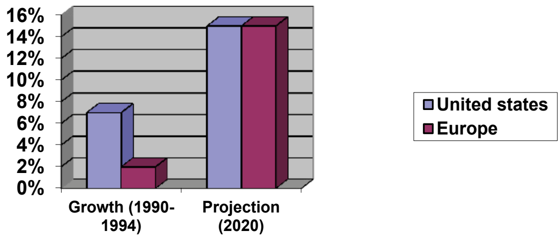


Figure 18: Bio Energy Usage Projection [Doe].

Potential Impacts to Marine System

Impact to Marine System: The use of biofuels as a fuel has increased in most transportation sectors. Adopting this technology in marine industry is still slow despite flexibility offered by use of energy on ship compare to mass requirement for land based industry and ambient temperature performance for aviation industry. Cost remain one of the main driver, slow speed diesel engines can run on lower quality fuels, they can replace distillate marine oils associated technical difficult. Calorific energy value for main propulsion could also result in a reduced service speed, range or larger bunker tanks.

Potential for Port Coastal and Port Infrastructure: Variety of methods could turn an age-old natural resource into a new and efficient means of generating electricity. Biomass in large amounts is available in many areas and is being considered as a fuel source for future generation of electricity. Biomass is bulky, widely distributed and electricity from conventional, centralized power plants requires an extensive distribution network. Traditionally power is generated through centralized, conventional power plant, where biomass is transported to the central plant. Typically a steam or gas turbine power plant and the electricity are then distributed through the grid to the end users. Costs include fuel transportation, power plant construction, maintenance operation and distribution of the electric power, including losses in transmission. This is system is ideal for coastal and port infrastructure marine system powering. Table 11 shows efficiency comparison.

	Electrical efficiency	Capacity
Biomass	thermal efficiency - 40%	$2,000 per kilowatt
Coal	45%	$1,500 per kilowatt

Table 11: Efficiency comparison [EIA].

Potential for Ship and Offshore Sustainable System: Micro-biomass power generators seem to offer a path for new solution for energy at end user disposal. Recent development towards use of micro biomass can offer best practice adaptation for marine unitized biomass power. Such biomass can be used near the site of end use with heat from external combustion converted directly to electricity by a biomass fired free piston genset. Costs of installation include fuel acquisition and maintenance of the genset and burner. Since the electricity is used on site, both transmission losses and distribution costs are minimal. Thus, in areas without existing infrastructure to transmit power, there are no additional costs. It is also possible to cogenerate using the rejected heat for space or hot water heating or absorption cooling. This is ideal for ship and offshore system.

Micro-biomass power generation is a more advantageous and cost-effective means of providing power than centralised biomass power generation. Especially in area where there is a need for both power and heating. Domestic hot water, space heat and absorption chilling are attractive for cogeneration configurations of microbiofuel plant. Biomass can be generated using single or ganged free-piston Stirling engines gensets. They can be placed at the end-user location taking advantage of local fuel prices and do not require a distribution grid. They can directly provide electrical output with integral linear alternators or where power requirements are larger they can be connected in series and parallel to drive a conventional rotary turbine. They are hermetically sealed and offer long lives through their non-contact operation.

Emissions offsets and waste reduction could help enhance the appeal of biomass to utilities. An important consideration for the future use of biomass-fired power plants is the treatment of biomass flue gases. Biomass combustion flue gases have high moisture content. When the flue gas is cooled to a temperature below the dew point, water vapor starts to condense. By using flue gas condensation, sensible and latent heat can be recovered for district heating or other heat consuming processes. This increases the heat generation from a cogeneration plant by more than 30%. Flue gas condensation not only recovers heat but also captures dust and hazardous pollutants from flue gases at the same time. Most dioxins, chlorine, mercury and dust are removed and sulfur oxides are separated out to some extent. Another feature of flue gas condensation is water recovery, which helps solve the problem of water consumption in evaporative gas turbines [18].

Biomass is a substantial opportunity to generate micro-biomass electric power, at power levels from fractions of kilowatts through to tens or hundreds of kilowatts, at the point of end use. Neither small internal combustion engines, which cannot use biomass directly, nor reciprocating steam engines, with low efficiency and limited life, can offer the end user economic electric power. Free-piston Stirling micro biomass engine are an economic alternative. Stirling offers the following advantages over significantly larger systems:

i) Stirling machines have reasonable overall efficiencies at moderate heater head temperatures (~600ƒC) [17].

ii) Cogeneration is simple

iii) Large amounts of capital do not have to be raised to build a single evaluation plant with its associated technical and economic risks

iv) A large fraction of the value of the engine alternator can be reused at the end of its life

v) Stirling systems can be ganged with multiple units operating in parallel.

Biodiesel machinery design, installation, operation and maintenance requirements are [19].

Fuel Management: Fuel management is complex in this new era because fuel aging and oxidation can lead to high acid number, high viscosity, the formation of gums and sediments. Supply chain supply of biofuel to ship can be done through pre-mixed to the required blend. Here the biofuel and diesel are supplied separately to the ship, and then mixed on board. This gives the operator the chance to dictate the exact blend of biofuels depending on conditions. But that would require retrofitting or new technology to be installed on board together with additional complexity for the crew. It is also important to monitor the fuel acid number value to ensure that no rancid, acidic fuel is introduced to the injection system. A typical layout should involve separators to ensure that water is removed from the fuel, as well as heaters at various stages to ensure the fuel is at the correct temperature before they enter engine.

i) Temperature Monitoring System: Technical problem that need to be further mitigated is the indication of low temperature operability of range between 0°C and 15°C for different types of biodiesels. This can cause problems with filter clogging this can only be overcome by carefully monitoring of the fuel tank temperatures. This can affect ships operating in cold climates, where additional tank heating coils and heating may be required to avoid this from happening.

ii) Corrosion Control: Biodiesels are hygroscopic and require to be maintained at 1200-1500 ppm water, which can cause significant corrosion damage to fuel injection systems. Mitigation can be exercise through appropriate fuel conditioning prior to injection. Biodiesels. Injector fouling especially the blend type produces deposits due to presence of fatty acid and water in the fuel. This can result to increased corrosion of the injector system. Also viscous glycerides can contribute to further injector coking. Biodiesel due to its chemical properties degrades, softens or seeps through some gaskets and seals with prolonged exposure. Biodiesels are knows to be good solvents and therefore cause coating complexity. Reports of aggressiveness of biodiesel and bioethanol on tank coatings have been reported. In its pure form biodiesel, as a methyl ester, is less aggressive to epoxy coatings than ethanol. Therefore ethanol should be carried in tanks coated with dedicated tank coatings such a phenolic epoxy or zinc silicate tank coatings.

iii) **Lubrication:** Biofuel lubricant may have impact on engine crankcase cleanliness and the potential consequences of fuel dilution. The droplet characteristics and lower volatility of biodiesel compared with conventional diesel, together with spray pattern and wall impingement in the modern diesel engines, can help non-combusted biodiesel past the piston rings. And also to make contact with the cylinder liner and be scrapped down into the oil sump. The unburnt biodiesel tends to remain in the sump and the level of contamination may progressively build up over time. This can result in reduced lubricant viscosity and higher risk of component wear. A serious concern is the possibility that the unburnt biodiesel entering the oil sump may be oxidised, thus promoting oil thickening and requiring greater oil changes.

Potential for Hybrid Configuration: Alternative energy can reliably stand alone, hybrid use of engine and fuel and regeneration system remain the main in line under use of technology to mitigate energy and environment problem. Figure 19 shows hybrid configuration of diesel and gas turbine engine model study at university Malaysia Terengganu (UMT), Department of Maritime Technology (JTM). Figure 20 shows performance relationship for the system where the gas turbine with regeneration gives high thermal efficiency at low pressure ratio.Figure 21 shows a typical multihybrid system of solar and hydrogen that can work with a biogas system.

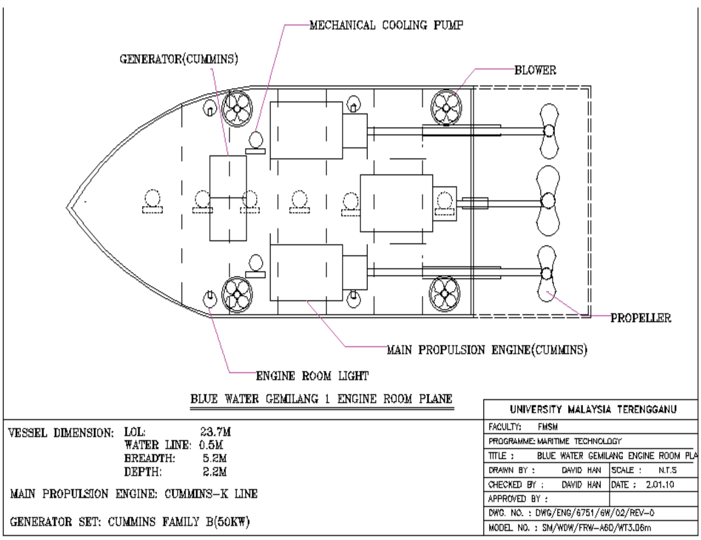


Figure 19: Hybrid configuration of gas turbine and diesel engine, UMT, 2010.

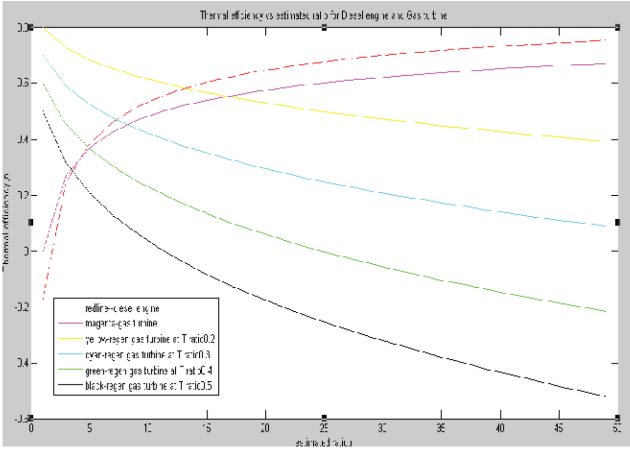


Figure 20: Hybrid configuration of gas turbine and diesel engine, UMT, 2010.

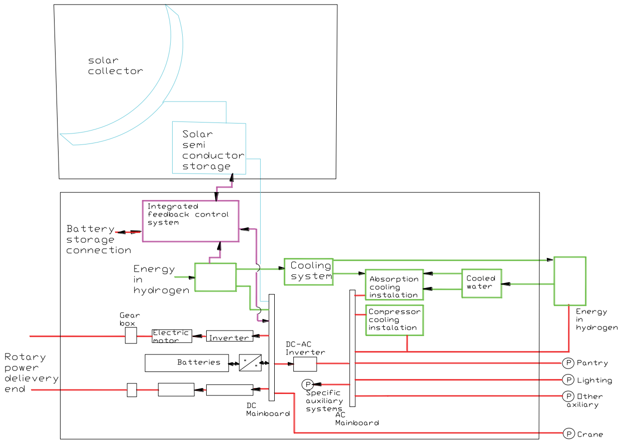


Figure 21: Mutihybrid of solar and hydrogen alternative energy system [UMT].

Impact to Shipping: Adoption of biomass will fuel freight increase as well as specialized new design of chemical tankers. Biodiesel is an Internatonal Maritime Organization (IMO), IMO 2 cargo, its vegetable oil feed stocks are IMO cargoes with double hull IMO 3 vessel configuration required. Ethanol typically transports in chemical tankers due to its cargo requirement but technological change break through could bring potential regulatory design change. Flexibility for ship conversion and retrofitting system could upset initial cost problem [20].

Port, Inland Waterways and Coastal Vessel: There is potential for use of biodiesels for small craft that operate within inland water because of air and water pollution sensitivity associated within inland water and coastline transportation. The port facilities in Malaysia and strait of Melacca are being improved to handle Handysize and Panamax tankers. There is also potential requirement for transshipment and supply vessel, supply chain for short sea service.

Cargo: 3rd generation biofuels will required to be processed from solid cargoes to liquid cargoes of the wood currently being harvested, 30% of which is waste. This is not going to be a waste in the future and will be converted by a Fischer Tropsch biomass to liquid processing plant. For coastal shipping to handle this trade, there will be need for new generation of 5,000 tonne dead weight dry cargo vessels. It is expected that these voyages will be regulated under the new Dry Bulk Cargo Code (BC Code) which is due to be enforced in 2011. Larger vessels will develop if the trade develops, but longer journeys will require design attention to for condensation, ventilation and fire fighting aspects. In addition to wood chips and wood pellets, the other main type of common solid biofuel is palm seed cake, which is the residue of the palm oil production process. This is used as a cargo in co fired power stations as it is easy to light. As a cargo, seed cake comes under the BC Code as a fire hazard. The necessary changes in design are required to accommodate bulk liquid carriage. Ethanol is listed in chapter 18 of the IBC code as a mild pollutant and not a safety hazard but it has a low flash point requiring explosion proof equipment. One complication of ethanol is that it absorbs water from atmosphere. To stop this occurring there is a current provision for a nitrogen blanket in the tank. This is usually supplied from shore before the cargo is loaded in the tanks and it is kept topped up by nitrogen bottles on the vessel [21].

Restricted water requirement include:

i. **Panamax Vessels:** The Panama Canal is a crucial gateway for transport by sea and future vessels to support the biofuel trade. It is important to consider the constraints of the current and opportunities of the future Panama Canal dimensions. Chemical tanker conversion and upgrade offer a good advantage. This could lead to need for economies of scale to build large tankers which require midship section to have double bottom height of 2.15 meter and side protection according to Marine Pollution (MARPOL) Annex I of 2 meter. If a vessel has to carry higher proportions of vegetable oil and ethanol compare to petroleum oil of more than 15%, it may require a chemical tanker notation with additional requirements both structural and equipment capability. The pre-mixing of biofuel on the vessel in the refinery and terminal is equally a subject that is being discussed at IMO at the bulk liquid and gas meeting in February 2008, IMO stated that at present it does not come under any international requirements, but may be developed further by the IMO in the future.

ii. **Aframax Vessels:** Brazil is looking to increase its ethanol export capacity. They are investigating carriage of ethanol in even larger than Panamax size, possibly Aframax size. For an oil and ethanol Aframax tanker. Noxious liquid substances require certificate that need an approved procedures and arrangements manual in accordance to MARPOL 73/78 Annex II. This includes shipboard marine pollution Emergency plan for noxious liquid substance, a stripping test and an initial survey. The stripping test requirement will be 75 litres if built after 1st January 2007 or best possible extent if built before 1st January 2007. Achieving these figures on a new Aframax size vessel may be difficult.

Shipping Routes and Economics Impacts: The above trend analysis discussed indicate potential capacity requirement from shipping. So far North America, Europe and South East Asia are the key importing regions where this growth is concentrated. Latin American counties of Brazil, Argentina, Bolivia and Paraguay and Southeast Asia's Indonesia and Malaysia, Malaysian Government recently unveil all out plant to use biofuel. Philippines and Papua New Guinea have potentials for vegetable oil and agricultural while Thailand has potential for sugarcane. This trade potential will determine future trade route from Malacca Straits to Europe, ballast to Argentina, to load soybean oil to China. And then make a short ballast voyage to the Malacca Straits, where the pattern begins again. A typical complicated front haul and backhaul combinations that can initiate economies of scale would need to reduce freight costs and subsequent push for bigger ship production and short sea services like recent experience of today's tankers. According to case study the following regional impact shown in Table 12 can be deduced for shipping performance [16].

i. **North America Demand:** policy work support biofuel use in the US. 32 Handy size equivalent tankers will be needed to meet US demand in 2015. With technological breakthrough there will be need for 125 vessels in 2030.

ii. **European Demand:** environmental requirement and energy security is believed to be politically acceptable in the EU but economics may drive a different outcome. 80 Handysizes with some due to the growth in trade and longer voyage distance. With technological break through for 2nd and 3rd generation biofuel growth will need growth of 145 by 2030 Aframax vessels if the technical issues can be overcome.

iii. **Asia Demand:** In plateau case 50 Handysize equivalents are required by 2015 and 2030 with forecast vessel sizes being handysizes with total of 162 Panamax vessels in the three regions.

	Biofuel	Demand
North America	Ethanol	33 million tons
Europe	ethanol and biodiesel.: 50:50	30 million tons
Asia	ethanol and biodiesel.: 50:50	18 million tons

Table 12: Regional impact [EIA].

By adding up all the regions, with biofuels, only 3% of world transport demand. There is potential need for a fleet of about 400 Handy size vessels to accommodate the demand and supply drivers by 2030 and 162 by 2015. The total vessel forecast for 2030 could mean 2,560 vessels of 81 million dead weight tons. As regions identify these growth markets and recognize the economies of $/tonne scale that can be achieved, with bigger tonnage, there will be natural investment occurring. New port developments in concerned trade route will be required to accommodate large Panamax vessel and parcel size for palm oil exports.

Regulatory Framework Impact: In many parts of the world, environmental concerns are the leading political driver for biofuels. This driving force evolved regulation like Kyoto protocoal, Marpol Annex VI and other environmental regulation. The tonne mile demand for future tankers will be greatly affected by national, regional, global policy and political decision making. There is a greater flexibility in the sourcing of biofuels than there is in hydrocarbon energy sources and this may be attractive to particular governments. Once the regulatory framework is clear, economics will determine how the regulations will best be met and seaborne trade will be at the centre of the outcome.

The EU has 2020 legislation projection that target 20% of community wide renewable energy. All member states are expected to achieve a mandatory 10% minimum target for the share of biofuels in transporting petrol and diesel consumption. The legislation provides a phase-in for biofuel blends hybrid, including availability of high percentage biofuel blends at filling stations. The United States Congress passed the Renewable Fuels Standards (RFS) in February 2008, which will require 35 billion gallons of renewable and alternative fuels in 2022 in parallel to work on biogas to reduce emissions from vehicles. Political driver in Asia varies according to region. Southeast Asia, the centre of world production for palm oil, coconut oil and other tropical oils has political support for farming which is the key driver.

The issue affecting shipping is whether to refine and use biodiesel locally or export the unrefined oil for product production elsewhere. In the short term the economics have favored the exports of unrefined oil which is good news for shipping. With the cost of oil rising and strict emission reductions growing, the need for increased biofuel production is likely to increase as well as creating a net positive balance fuel. According to EIA, world biofuels demand for transport could increase to about 3% of overall world oil demand in 2015. This could be double by 2030 over the 2008 figure. This could also have significant impact on the specialist fleet capacity demand. Predicting the trade pattern of biofuels adds a layer of complexity to the overall energy supply picture and oil distribution system. The best way to go on this is by employing risk cost benefit analysis of all factors of concern [22].

Fuel quality and standards issue is also a barrier as power generation will definitely depend on energy source and property of biofuel. Currently the fuel standard for marine applications, ISO 8217 relates solely to fossil fuels and has no provision for biofuels. Thus land based standards has been developed which can be adapted as required for marine application, for example the European Standard (EN 14214) for automobile. The new MARPOL Annex VI has in the definitions of fuel oil any fuel delivered to and intended for combustion purposes for propulsion or operation on board a ship. This leaves the door open for biofuels.

Political pressures could also cause the level of growth to rise beyond 3%. The world oil tanker fleet of vessels 10,000 dwt or larger comprises of some 4,600 vessels amounting to 386 million dwt. These include about 2,560 Handysize tankers. Additionally, there are some 4,400 more small tankers from 1,000 to 10,000 dwt accounting for 16 million dwt. Further projection show significant role for seaborne transport. This is a significant fleet segment that poses technical and regulatory challenges. The requirements cannot be fully defined because many market factors are uncertain. It is recommended that ship owners who are building new vessels or operating existing vessels should consider this future trade through flexible design options that an be introduced later to stay prepared and beyond compliance for energy and environment regulation [23].

Risk and Uncertainties Requirement: A significant amount of effort has gone into estimating the available quantities of biomass supply, the following risk and uncertainties that need to be incorporated into design and decision work on biodiesel use are [24].

i. Risk to land use:the planet only have 35% land, for example Brazil has 200 million acres of farmland available, more than the 46 million acres of land is required to grow the sugarcane needed to satisfy the projection for 2022 bioenergy growth.

ii. Evolving competing uses of biomass materials, the large market consumption, pricing and growing need.

iii. In agricultural waste, the impact of biomass removal on soil quality pose treat to agricultural residues that need to be left on the soil to maintain soil quality. This could result in significant losses of biomass for electric power generation purposes.

iv. Impact of changes in forest fire prevention policies on biomass availability could cause vegetation in forests to minimize significantly increase in the quantity of forestry residues available.

v. Potential attempt to recycle more of the municipal solid waste stream might translate into less available biomass for electricity generation.

vi. Impact on the food production industry has witness in recent year food scarcity and crisis.

Conclusion

The main challenge to use of biomass for power generation is to develop more efficient, lower cost systems like micro biomass system. Advanced biomass based systems for power generation require fuel upgrading, combustion cycle improvement and better flue gas treatment. Future biomass based power generation technologies need to provide superior environmental protection at lower cost by combining sophisticated biomass preparation, combustion and conversion processes with post combustion cleanup. Such systems include fluidized combustion, biomass integrated gasification and biomass externally fired gas turbines. Ships life cycle is around 20-25 for ship owners to make the most of the upcoming markets, it is necessary to be prepared for the new cargoes of biofuel. Current ship designs may not be suited for biofuel ships. Therefore there is potential for pressure on organizations to adopt new standards to accommodate the demand driven by governmental legislation.

This in itself has some risk involved also the trade routes could create economy of large scale leading to larger ship production and sub sequential requirement from designer. Other evolving challenges to secure energy and environment are Fuel cell technology, nuclear, natural gas and fuels made from waste plastics which can be integrated with biomass system under hybrid configuration. In general the initial cost of biomass system is considered high the use of biomass for marine system will mean new rearrangement for marine system, evolvement of new shipping route and formulation of regulation for carriage of biomass cargo. On reliability from, the use of hybrid system can provide opportunity to collect good data that provide good understanding of the system and opportunity to simulate extreme condition of uncertainty that comes with deployment of total biomass system.

3. Feasibility of Using Solar as a Supporting Hybrid Power System for Marine Diesel Engine: Umt Vessel Experimentation Experience

Abstract

Environmental challenges drive new generation of technology, global economy and policy change and community endorsement. Like all modes of transportation that use fossil fuels, ships produce carbon dioxide emissions that significantly contribute to global climate change and ocean acidification. Besides carbon dioxide and other handful of oxide of greenhouse gases that contribute to climate change and called for ways for mitigation. Currently, most ship ships currently in term air pollution impact burn the dirtiest fuel. Ship emissions pose significant threat to human health. As the ocean is exposed to vast amount of sun rays, solar energy has great potential to be explored and it is a right impetus for the maritime sector to move towards green power system. This paper discuss experimental outcome of using hybrid of solar energy supporting auxiliary power to assist conventional diesel power plant to supply the instruments onboard the vessel. The study determines the feasibility of using solar energy as a supporting power for marine vessel auxiliaries. The vessel that is used as case study is Discovery ix. It is a 16.50 meters diving boat owned by University Malaysia Terengganu. The reduction of fuel usage and economic analysis after installing solar PV system on the vessel is determined. The power requirement for vessel electrical system is calculated. The fuel and money saved were obtained by make a comparison on the vessel using solar PV system and vessel without PV system. Economic analysis were performed and the Annual Average Cost (AAC) between vessel using solar PV system and vessel without solar PV system is obtained and the period of the return investment for vessel with solar PV system is determined. The use of photovoltaic solar system to assist the boat power requirement hopes to bring the benefit to the environment through the Green House Gas (GHG) reduction. The application solar hybrid is observed to contribute to cut the cost of the vessel operation through the fuel saving.

Keywords: Auxiliaries; Discovery IX; Energy; Marine; Solar; Vessel;

Introduction

The current oil price is a global issue driving environmental technology and other issues related to climate change, GHG and ozone depletion. The rise in oil prices has exacerbated global imbalances. Most ships today use diesel engine to drive and power up the ships. When the diesel fuel burnt inside the engine, it produces a complex mixture of thousands of gases and fine particles that contain more than 40 toxic air contaminants. To tackle these issues, an effort in finding the alternative energy is essential. A lot of researches and studies had been carried out in order to find an alternative energy to replace the fossil fuel with other renewable energy resources. In maritime sector, solar energy has a great potential to be explore and it is a right impetus for the maritime sector to move towards marine green power industry. Solar energy is promising to reduce usage of fossil fuels with consequent economic and environmental benefits. Mostly, solar energy can be extract by using of concentrator cells system, Thermophotovoltaic system and photovoltaic system. Photovoltaic system is a system that directly convert sunlight into Direct Current (DC) and can be fed to any DC power load. Problem associated with today energy usage include high dependent on natural resources causes decrease of these sources, thus increasing the market prices whose fluctuation depends on the global economy, Like all modes of transportation, the use fossil fuels, ships produce carbon dioxide emissions that significantly contribute to global climate change and ocean acidification. Although shipping may be a more efficient mode of transport than planes or trucks, it is indisputably a major source of carbon dioxide and other greenhouse gases considering volume of ships in the world ocean.

The study presented in this paper focus on determining the the potential use of solar energy as a supporting power to the marine vessel auxiliaries to reduce fuel usage. The objectives of this study are to compare the diesel fuel used by the generator of the vessel before and after used of the solar PV panels. Solar PV panel experiment and numerical analysis power, efficiency and fuel saving is determined, the investment return by carrying out economic analysis. The study is divided into two parts. The first part is field involved work where solar experiment is conducted on board of Discovery IX. The vessel is navigated around Kuala Terengganu river mouth and around Kuala Terengganu coast within 2 day. The principal particular of the vessel are obtained. The second part is laboratory analysis where the collected data is analyzed using Microsoft Office Excel.

Methodology

The study methodology is divide into three parts, first part involve data collection by field work, the second is numerical modelling for power requirement and the third part involve economical analysis.

Data Collection: Data collected from the diving boat, Discovery ix are the plan and electrical distribution drawing, the data on how much auxiliary power consumption, Data on solar radiation intensity is collected from Renewable Energy Research Center, data on the specification of solar panel and other data and facts required include the current market price of the fuel and solar panel is obtained from the internet.

Field Work: This field work involved solar experiment that is setup onboard of Discovery ix. The solar PV panels are deployed from 9.00 am until 5.00 pm and these experiments are run in two days. The experiments is break into three part. The first experiment to investigate the power output from solar panel with the equivalence solar radiation intensity without the disturbance of load from boat electrical system, the second experiment is to find the fuel consumption of the generator and the experiment investigate the capabilities of the solar panels to support the boat electrical load.

Experiment Procedures

Experiment 1

i. Two solar panels are placed on the top roof of the boat.

ii. The solar panel is tightly tied to avoid solar panels falls down.

iii. The battery is connected to the charge controller.

iv. The solar panel is connected to the charge controller.

v. The solar panels voltage and current output is recorded.

vi. Those steps are repeated for every 15 minutes.

Experiment 2

i. Two empty batteries are put in the battery bank.

ii. The battery is connected to the generator.

iii. Three liters fuel is filled into the empty generator.

iv. The generator is turn on and the time is recorded.

v. The time when the generator is self turn off is recorded.

Experiment 3

i. Two solar panels are placed on the top roof of the boat.

ii. The solar panel is tightly tied to avoid solar panels falls down.

iii. The battery is connected to the charge controller.

iv. The solar panel is connected to the charge controller.

v. All onboard electric and electrical devices are turn on.

vi. The battery voltage, solar panels voltage and current output are recorded for every 15 minutes.

Solar Power Requirement is calculated as followed:

i) Current output at non standard condition

$$I,(G) = I_{SC} \times G \tag{1}$$

Where,

I, (G) = Current output at particular solar radiation intensity, A

I_{SC} = Short circuit current at standard condition, A

G = Solar radiation intensity, kW/m^2

ii) Cell surface temperature at non standard condition is

$$T_C = T_A + \frac{NOCT - 20}{0.8} \times G \tag{2}$$

Where,

T_C = Cell surface temperature at non standard condition,°C

T_A = Surrounding temperature,°C

NOCT = Normal operating cell temperature,°C

G = Solar radiation intensity, kW/m^2

iii) Voltage output at non standard condition

$$V_{TC} = V_{OC}(25°C) - 0.0023 \times n \times (T_C - 25°C) \tag{3}$$

Where,

V_{TC} = Voltage at particular cell surface temperature, V

V_{OC} (25°C) = Voltage open circuit at standard condition, V

n = Number of cell

T_C = Cell surface temperature,°C

iv) Fill factor, FF

$$FF = \frac{P_{Max}}{I_{SC} V_{OC}} \tag{4}$$

Where,

FF = Fill factor

P_{Max} = Maximum operating power at standard condition, W

I_{SC} = Short circuit current at standard condition, A

V_{OC} = Open circuit voltage at standard condition, V

Maximum power output at non standard condition

$$P_{max} = I(G) \times V(T_C) \times FF \tag{5}$$

Where,

P_{max} = Maximum power output at non standard condition, W

I (G) = Current output at particular solar radiation intensity, A

V (T_C) = Voltage at particular cell surface temperature, V

FF = Fill factor

Battery Storage Requirement

$$\frac{\text{Batterty storage requirement}}{\text{Battery storage capacity}} \tag{6}$$

Power and Fuel Saving Analysis

$$\frac{\text{Fuel used before installing PV panel} - \text{Fuel used after installing PV panel}}{\text{Fuel used before installing PV panel} - \text{Fuel used after installing PV panel}} \times 100\% \tag{7}$$

Economic Analysis

Annual Average Cost (AAC): Annual Average Cost (AAC) between the boat with assisting of solar PV panels and the boat without solar PV panels were determined. To calculate AAC, the PV (Present Value) and NPV (Net Present Value) are obtained first. To formula to obtain the PV value for each cost is shown below.

i) PV(maintenance cost)

$$\left[\frac{\left(\frac{1 \quad e}{1 \quad i} \right)}{e \quad i} \right] \tag{8}$$

Where,

e = 3%

i = 2%

n = 15 year

D = Maintenance cost for 1year

ii) PV(operation cost)

$$P\left[\frac{(1+i)^n - 1}{i(1+i)^n} \right] \tag{9}$$

Where;

i = 2%

n = 15 year

P = Operation cost

PV(salvage value)

$$P(1+i)^{-n} \quad (10)$$

Where,

i = 2%

n = 15 year

P = Salvage value

iv) Net Present Value(NPV)

With solar panel

$$\Sigma\left[-PV\left(\text{maintenance cost}\right)-PV\left(\text{operation cost}\right)+PV\left(\text{salvage value}\right)+PV\left(\text{investment cost on solar panels}\right)\right] \quad (11)$$

Without solar panel

$$\sum[-PV(\text{maintenance cost})-PV(\text{operation cost})+PV(\text{salvage value})+PV(\text{Present value})] \quad (12)$$

Annual Average Cost(AAC)

$$NPV\frac{i(1+i)^n}{(1+i)^n-1} \quad (13)$$

Where;

NPV = Net Present Value

i = 2%

n = 15 year

Returned Investment: Return investment is carried out to determine the numbers of years that the investment will be returned.

$$\frac{\text{Investment cost for boat with solar PV system}}{\text{Cost saved}} \quad (14)$$

Result and Discussion

The analysis is break into two parts, the first part is technical analysis which compare the diesel fuel used by the generator of the vessel before and after used of the solar PV panels and the second part is economic analysis which to evaluate the investment return Table 13 and 14.

Technical Analysis:

	Experimental	Theoretical
Solar radiation intensity, W/m^2	733.06	538.75
Voltage output, V	19.39	20.21
Current output, A	1.24	1.37
Power output, Wh	24.09	19.94

Table 13: Differences between experiment and theoretical result.

Solar Power Requirement:

	ET – M53620	ET – P660245
Power output in December	15.63Wh	94.94Wh
Numbers of panel required	59	11
Total weight	318.6kg	212.3kg
Total area	23.35m²	17.90m²

Table 14: Differences between ET-M53620 and ET-P660245 in the month of December

Table 13 shows the differences between experimental method and theoretical method. There is a slightly differences between them, in the experimental analysis, the solar radiation intensity is 733.06 W/m² while by theoretical analysis shows just 538.75 W/m². The power output of the experimental method is 24.09Wh while the theoretical value is 19.94 Wh. These differences occurred due to the some errors like heat and other natural losses. Table 14 shows differences between ET-M53620 and ET-P660245 in the month of December. An ET-M53620 has 15.63 Wh power output in December. It is observed that the required 59 panels to support the load in December and has a total weight and area of 318.6 Kg and 23.35 m². An ET-P660245 has 94.94 Wh power output in December. It will require 11 panels to support the load in December and it has a total weight and area of 212.3 Kg and 17.90 Kg Figure 22.

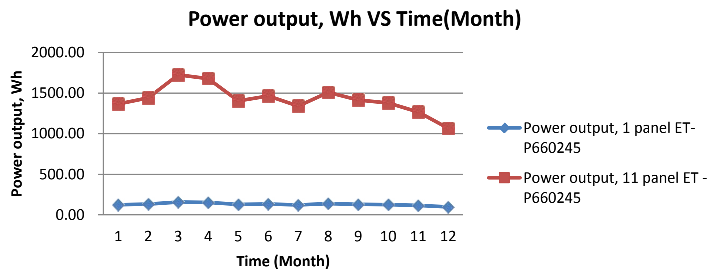


Figure 22: Graph of power output by using one and eleven solar panel versus time-2006.

Figure 22 shows a graph of power output by using one and eleven solar panel versus time in 2006. Eleven panel of ET-P660245 produce 1066.34 Wh while one solar panel of ET-P660245 is just produce 96.94 Wh.

Power and Fuel Saving

It is indentified that the power produce by the solar panel is not constant throughout the year. There are months where solar radiation is low and there are also months where surrounding temperature is high. These two parameters is the most important factor that alters the power output of the PV panels. Figure 22 indicated that December is the lowest power output. But with eleven solar panels ET-P660245 and two of 24 V 200AH batteries, the generator only should operate in just 9 hours in 24 hours no matter what season weather it is wet or dry. The reason is that the system consumed 976.56Wh while eleven solar modules ET-P660245 supply 1066.34Wh in December which is most wet month. Therefore, In 9 hours of operation, the system requirement is support by the generator.

$$976.56 \text{ W} \times 9 \text{ hours} = 8.79 \text{ kWh}$$

The system demand in 9 hours is 8.79 Kwh and the generator need to supply 8.79 Kwh too. So, in one years the generator need to supply 8.79 Kwh x 365 days = 3208.35 Kwh of power into the system. If the generator work without assistance of solar panel, it need to supply power in the amount of 976.56 W x 24 hours x 365 day = 8554.67 Kw.h in one years.

From the experiment, it is found that 6.6 Kw.h uses 1.5 liters of fuel. If the generator work alone, the amount of fuel consumes is x is the amount of fuel in liters.

$$\frac{6.6\ \text{kWh}}{1.5\ \text{liters}} = \frac{8554.67\ \text{kWh}}{\text{x liters}}$$

$$x = 1944.24\ \text{liters}$$

If the generator work with the assistance of solar panel, the amount of fuel consumes is y is the amount of fuel in liters.

$$\frac{6.6\ \text{kWh}}{1.5\ \text{liters}} = \frac{3208.35\ \text{kWh}}{\text{y liters}}$$

$$y = 729.17\ \text{liters}$$

To find the amount of fuel save by solar panel in one year, the amount of fuel used by generator alone minus the amount of fuel used by the generator with the assistance of solar panel.

Where,

$$x - y = \text{Amount of fuel save by solar panel in one year}$$

By using solar panel to the maximum, the generator can save 1215.07 liters of fuel per year. Nowadays, Malaysia set diesel fuel price for industrial purposes to RM 2.40 (Anthony Lim, 2011). To get the amount of money saved in one year, the amount of fuel saved in liters multiply by price of fuel per liters.

$$1215.07\ \text{liters} \times \frac{\text{RM2.40}}{\text{liters}} = \text{RM2916.168 per year}$$

The percentage of fuel saving in one year is determined from

$$\frac{\text{Fuel used before installing solar} - \text{Fuel used after solar installed}}{\text{Fuel used before installing solar}} \times 100\ \%$$

$$\left[\frac{1944.24 - 729.17}{1944.24}\right] \times 100\ \% = 62.50\ \%$$

By using solar PV panel as an assisted power to the generator, the owner saves 62.50% of fuel in one year.

Economic Analysis: Economic analysis is a type of analysis to find the beneficial of new alternative or investment (retrofitted with solar PV system). It focused on the comparison of total annual cost between boat with PV system and boat without PV system.

Return Investment: In this section, the return investment of the boat with solar PV system is determined by the number of years that the investment will recover. The cost saving per year if solar PV system is installed on Discovery ix is RM 22,046.75 and the investment value of RM 34,732.81 is found to be recovering in 12 years. Investment cost for solar is RM 34,732.81 Table 15.

$$\text{Investment return} = \frac{\text{RM34, 732.81}}{2916.118} \sim 12\ \text{years}$$

Aspect	Without solar PV system	With solar PV system	Saving
Annual generator output	8554.67 Kw.h	3208.35 Kw.h	5346.32
Liters of fuel required by generator	1944.24 liters	729.17 liters	1215.07 liters
Fuel cost	RM 4666.18	RM 1750.01	RM 2916.17
Annual Average cost	RM 33, 617. 70	RM 11, 570. 95	RM 22, 046. 75

Table 15: Overall saving.

Conclusion

The economic analysis shows that the Annual Average Cost (AAC) for the vessel with solar PV system is lower than AAC for the vessel without solar PV system. This proves that by using the solar PV system on the vessel, it is more economical than using the generator alone. In conclusion, the use of photovoltaic solar system to assist the boat power requirement will bring benefit to the environment through the Green House Gas (GHG) reduction. Furthermore, this solar application will cut the cost of the boat operation through the fuel saving.

Recommendation: There are a lot more of factors and aspects in a photovoltaic disciplines that could be investigated for improve in the future better result. Some recommendations for improvement:

Study on the angle of the solar panel to track the sun rays would lead the maximum usage of solar panel applications and segmentation of efficiency, Study on the environmental analysis, Study on boat stability.

4. Magneto Electric Co-Generator Plant for Sustainable Marine Vessel Power System

Abstract

The number of vessel around the world continued to increase yearly to fill the world trade demand. Consequently, the fuel usage increase due to increasing requirement for propulsion and electricity. Generator is the heart of a vessel that supplies electricity to most ship's components. This study involves how to reduce the usage of generator in ship's operations. The Magneto Electric Co-generator Plant (MECP) is the combination of some equipment, electronic, circuit and recycling the shaft rotational energy for additional electrical distribution. MECP proposed to be installed at propeller shaft and main engine flywheel of UMT vessel. The regeneration system can supply electricity to auxiliaries' component of ship machineries. The total produced energy by MECP is computed by modeling numerically. Cost saved yearly is estimated based on the power produced and fuel cost. In this study, the possibility of the co-generator plant to be used for vessel is determined by considering the efficiency and cost saving. Cost saved is compared with initial installation cost in order to determine the cost beneficial. The MEPC produced 3.74 KW of power that can be used to supply the ship auxiliaries. It saved 1054 liters diesel per hour and RM 2.62 per hour in general operation cost. Major advantage included in this system is its environmental benefit because it reduces the amount of carbon dioxide footage approximated to 4.13 kg of CO_2 per hour that could be emitted to atmosphere. The system could help in commitment maritime industry to climate change compliance.

Keywords: Co generator; Discovery 2; Magneto Electric; Numerical Modeling; Vessel Power;

Introduction

Shipping is a very important industry, 90% of world trade capability relies on shipping industry because it is the most economical transportation, considering a large amount of freights. The number of vessels around the world increased to meet the trade demand. This is good in economical aspect but on the other hand, this increases the usage of diesel oil for the main engine or generator. Major problems that humans face now are natural disaster resulting from self made system. Diesel oil combustion releases heat to the atmosphere and contributes to air pollution and greenhouse effect. Other problem that shipping companies face is the increasing diesel price, they are burdened by the high operational cost and the consequential increase service rate to traders, rise in price of goods as well as negative impact to consumers. People provide new technologies to overcome these matters. Magneto Electric Co-generator Plant (MECP) is the system that supplies electrical energy to auxiliaries which recycle power from the rotation of the shaft and flywheel. MECP 1 is proposed to be located at the propeller shaft and MECP 2 is located at the main engine flywheel. Neodymium-iron-boron magnet is considered in this study as the material of the MECP due to its strong magnetic characteristic. This study assesses the magneto electric co-generation plant so that it will generate more power and it will act as a support system for the generator in order to reduce usage of generator. From the result the most effective location to harvest the energy (propeller shaft and engine flywheel) is determined. The paper also includes vessel's electrical load analysis and determines the amount of generated power from MECP that can support the auxiliaries and consequentially reduce the amount of carbon dioxide released to environment [25-27].

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Research Background and Research Approach

Magneto electric co-generator plant is the combination of permanent magnet, copper coils and electronic circuit. It is proposed to be installed at two locations. The first system will be installed at the propeller shaft and the second system at the flywheel of the main engine. Data collected from UMT boat, Discovery 2. The diameter is measured in order to determine the size of the stator core. Vessel's data is also collected to use in the calculation to find the vessel power, before and after installation. Then, all the related empirical equation is introduced. This includes the equation for the power produced by the co-generator, vessel's effective horse power, cost benefit and the amount of CO_2 that can be reduced from the generator operation to support the electrical system. After all the empirical equation introduced, the magneto electric co-generator plant are designed. Its design depends on the diameter of the propeller shaft and the available space around the shaft and flywheel. Standard book of permanent magnet is referred in order to determine the best magnet chosen as the stator. All the collected data and system design are implemented into empirical equation [25,26,28]. Figure 23 shows the system architecture.

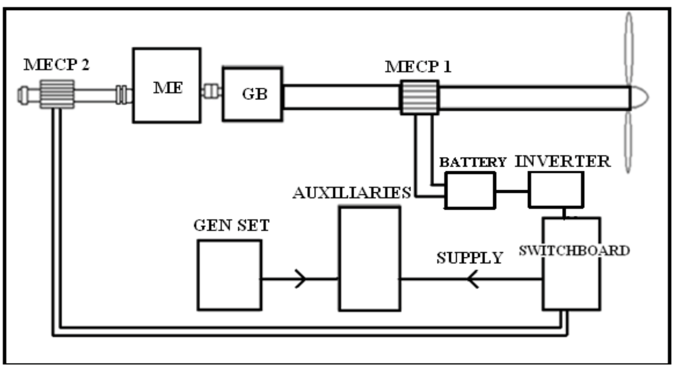


Figure 23: The MECP system architecture .

Result and Discussion

Power Produced by MECP Figure 24

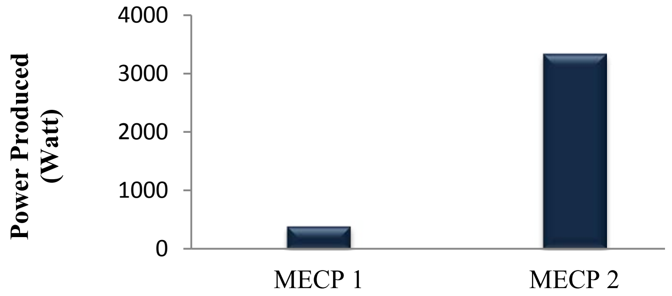


Figure 24: Power produced by MECP 1 and MECP 2.

Figure 24 shows the power produced by MECP 1 and MECP 2 which are 0.4 kW and 3.34 kW each system. There is a large difference between both systems because of the rotating speed of the shaft. From the result of numerical modeling, we can see that the power produced by MECP 1 is low, compared to the power required by electric component in the ship electrical system. The power produced is far from the power requirement, which is 12.02 kW. The shaft speed of the propeller shaft is 400 rpm with 13.33 Hz frequency which means it cuts the magnetic field really slow and consequently cannot generate high electric power [29,30].

MECP 2, it produces higher electric power because it is installed at extended at the extended shaft where it is connected directly to the main engine's flywheel. It has high angular speed and frequency which is 1800 rpm and 60 Hz. This consequently affected the power produced. When the rotational speed is higher, it can cut the magnetic flux more frequently. Although the output power is low, it still can be used to supply electric component that use low power. The power produced by MECP 1 is connected to the battery before it is connected to auxiliaries. While the MECP 2 connected directly to the switchboard and auxiliaries. As the frequency of both systems is different, it cannot be connected directly [31].

Neodymium magnet is used as the material in both systems. It is available in two types, bonded and sintered. Bonded NdFeB has lower magnetic field than the sintered. One purpose of choosing the bonded type is to minimize the effect of the efficiency of the propulsion system. The sintered neodymium has large magnetic force and it can give bad effect to the shaft. Although the plant did not have contact with the shaft, the magnetic force can give stress to it. Theoretically it can disturb the angular speed of the shaft [32-34]. Figure 25 shows result of the power supply and demand.

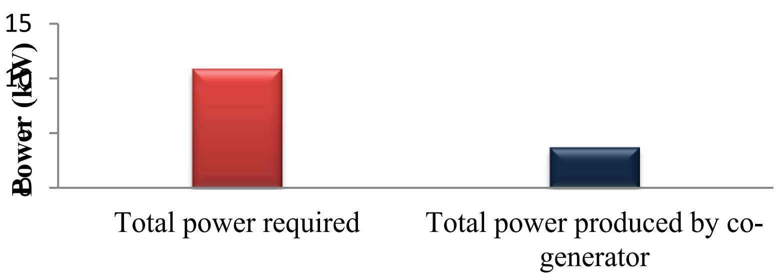


Figure 25: Comparison between powers required with total power produced by MECP.

Power Distribution and Sharing: The total power required by all electrical components in Discovery 2 is 10.93 kW while the total power produced by MECP is 3.74 kW. The total amount of power requirement is determined by preparing the 'Electrical Power Analysis (ELA). From ELA, the power distribution can be determined. The MECP is connected to lighting, refrigerator and communication and navigational aids. On the other hand, air conditioner, fresh water transfer pump and other equipments are still supplied by the main generator. The total power covered by MECP is 3.71 kW and 8.32 kW for main generator with 10% margin for both. It is observed that MECP can be cover a satisfactory amount of power needed to support the auxiliaries. The power sharing is shown in Table 16 and Figure 26 [35,36].

Main Generator		MECP	
Equipment	kW	Equipment	kW
Air conditioner	5.54	Lighting	0.68
Fresh water transfer pump	0.13	Refrigerator	0.19
Others	1.89	Communication and navigational	2.5
TOTAL	7.56	TOTAL	3.37

Table 16: Power Distribution of the system.

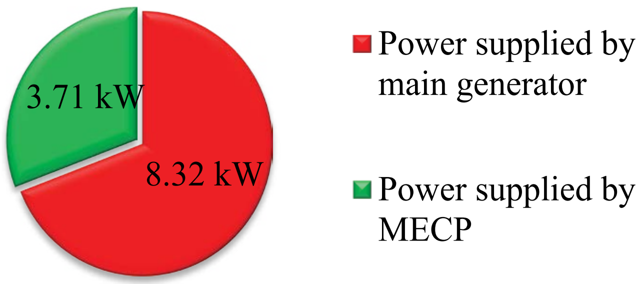


Figure 26: Power sharing of the system with 10% margin.

Fuel Saving in Generator: By reducing the work done by generator, proportionally it can reduce the fuel consumption. The generator needed approximately 5 liters of diesel per hour in order to supply electricity to all components. Fuel consumption is the major part of diesel plant capital and operating cost for power applications, whereas capital cost is the primary concern for backup generators. Specific consumption varies, but a modern diesel plant consume between 0.28 and 0.4 liters of fuel per kilo watt hour at the generator terminals. From Figure 27 and 28 the fuel consumption in generator after MECP installation is 3.46 liter per hour, which is a reduction of about 1.54 liter diesels per hour [37].

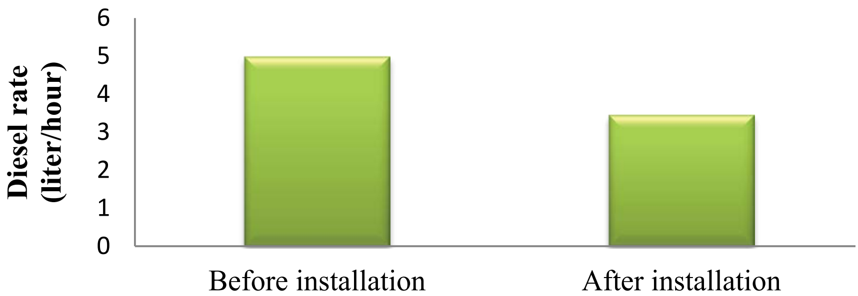


Figure 27: Diesel rate before and after system installation.

Cost Benefit

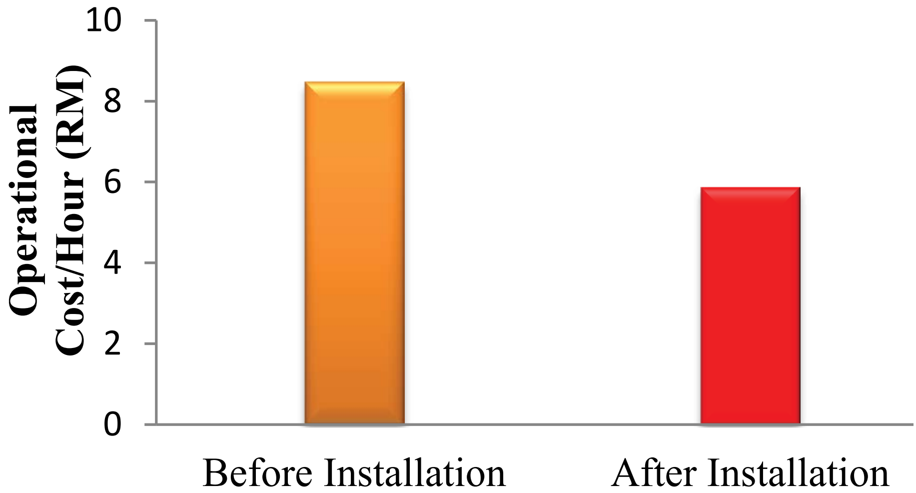


Figure 28: Cost saving in generator operation.

Figure 28 shows cost benefit analysis for the system. By reducing the fuel consumption in generator, the operational cost of the vessel can be cut off. Market price of diesel oil in Malaysia is RM 1.70 per liter. So this means Discovery 2 spend about RM 8.50 per hour just on generator operation. UMT is burdened by high operational cost due to the crucial diesel price. With MECP, the operational cost can be deducted.

From Table 16, the expenditure of generator after MECP is installed is RM 5.88, which means UMT can save RM 2.62 per hour. The cost saving is compared with installation cost. The installation cost is estimated at approximately RM 500 including material and payment for workers. An interview is made with MITED Engineering Sdn Bhd workers to get the cost estimation. Payment for workers including the installation cost and construction of the seating for the system is valued at RM 210 with three working days. And the cost of the material is about RM 300. To cover this installation cost, Discovery 2 needed 48 trips to Bidong Island, after which they can permanently give benefits to the ship owner.

Environmental Benefit: Figure 7 shows environmental Green House Gas release analysis for the system. In environment aspect, MECP system is environmental friendly because they can reduce the amount of carbon dioxide (CO_2) released by reducing generator operation. Diesel releases very harmful pollutant which threatens human health. Recent emission quantification reported that a liter of diesel combustion emitted approximately 2.68 kg of CO_2. Besides, it also includes hydrocarbons, carbon monoxide, nitrogen oxides, sulphur dioxide, benzene and particulate matter. The estimated amount of CO_2 emission in every single hour for generator operation is about 13.4 kg. It is a large number and can be assumed as a great contributor to air pollutant. After the installation of MECP, the amount of emitted CO_2 is 9.27 kg per hour. With the system, it reduced 1.54 liters of diesel in generator operation and positively reduces about 4.13 kg of CO_2 per hour. Although the amount can be reduced lower than the emitted, at least this system can reduce the amount of contributor to atmosphere stress, which is the major concern for environmentalist. The amount of emitted CO_2 is shows in Figure 29 [38]. Figure 30 shows efficiency comparison. Figure 31 shows speed reduction impact.

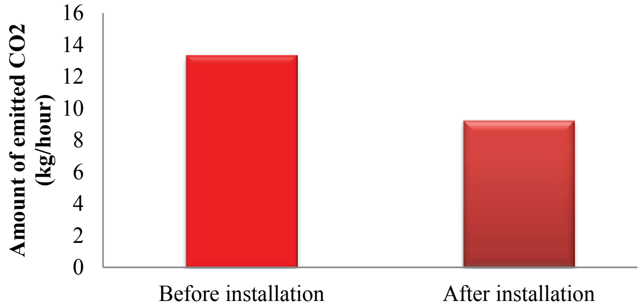


Figure 29: Amount of emitted CO2.

Vessel Power Efficiency

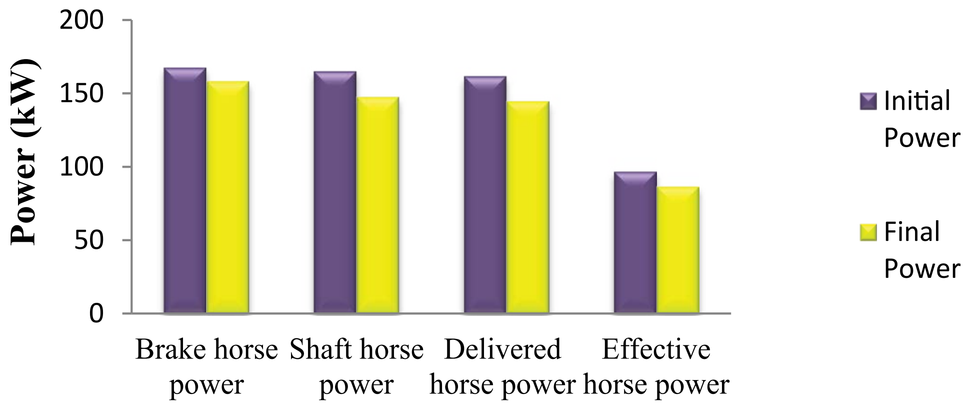


Figure 30: Vessel power calculation.

From the calculated data, the Effective Horse Power (EHP) for Discovery 2 is 97.17 kW. But, the EHP after the system installation is 87.05 kW, a reduction of about 10.12 kW. MECP 2 which is located at the flywheel affects the Brake Horse Power (BHP) with 9.09 kW power losses and consequently reduces the power output from the main engine. Then MECP 1 which is located at the propeller shaft reduces the Shaft Horse Power (SHP). Power losses at MECP 2 are 8.27 kW. The losses happen due to air gap loss, copper loss, eddy current loss and rotational loss [39]. Table 17 shows power analysis of the system.

Power section	Initial kW	Final kW
Brake horse power	167.78	158.69
Shaft horse power	165.26	148.04
Delivered horse power	161.95	145.08
Effective horse power	97.17	87.05

Table 17: Value of power in every section

Consequently, these losses give effect to the propulsion efficiency and vessel's speed. The propulsion efficiency after the system installation is 89.09%. With the calculated data, it is clear that the system just gives a little impact to the propulsion system. Figure 31 shows the speed reduction of the vessel. With the system, it just reduce 0.5 knot. So, the system installation did not give effect to the operation of the vessel.

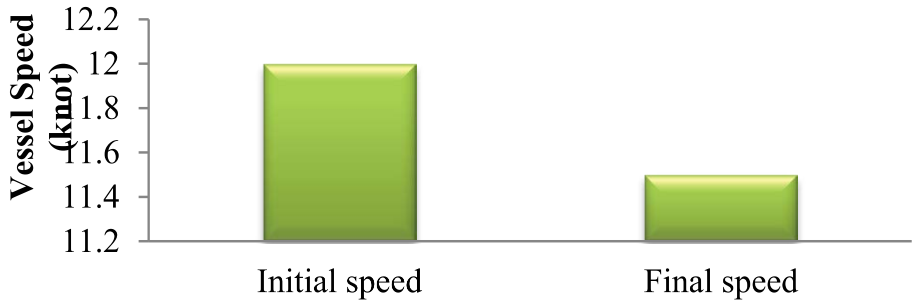


Figure 31: Speed reduction of the vessel.

Conclusion

From the calculated data and result, we can conclude that magneto electric co-generation plant is a practical system to be installed at the propeller shaft and flywheel. MECP can produce satisfied electric power to be fed up the vessel's auxiliaries, which commonly get the electricity from the generator. For this case study at Discovery 2, the system produces 0.4 kW for MECP 1 and 3.34 kW for MECP 2 and both total at 3.74 kW. The system can be connected to lighting, refrigerator and communication and navigational aids.

Power sharing by MECP can reduce the generator operation and consequently reduce vessel operational cost. UMT can deduct about RM 2.60 per hour operation. This value can be considered as a large amount because Discovery 2 operates frequently due to the student and lecturers activities and research. In worldwide shipping industry, if a system can reduce a few dollars in an hour operation, it means that they can save thousands of dollars annually because mostly their vessels operate 24 hour a day. So, this MECP is an exact system to be installed to most vessels in this world because they can cover up a large amount of capital and give high cost beneficial to ship owner [40].

MECP system is environmental friendly because it can reduce the emission of CO_2 by reducing the generator operation. For this case study, MECP reduce approximately 4.13 kg of CO_2 emission for a single hour. Nowadays, many shipping company show their commitment to provide green shipping. They keep figuring out the solution to reduce the threat to Earth, which is already burdened by high menace caused by human activities. A further study should be made to ensure this system can be one of the useful equipment in shipping industry. The study about the construction and prototype of the system should be continued in order to show the commitment to reduce the pollution and provide a better environment as well as reduce the cost of the shipping operation.

5. Potential of Waste Based Biomass Cogeneration for Malaysia Energy Sector

Abstract

Reuse of waste as source energy remains sustainable energy source for humanity. The processing of waste provide fuels for electricity, heat generation and transportation fuels environmental advantages in term of energy production that lead to vast reduction in the waste stream, production of valuable by products, waste land reduction and the killing of the pathogens and bacteria that cause disease as well as provision of reliability for food safety and mitigation go Green House Gas release. The process calorific content of biomass is considered less than fossil fuel, but can be more sustainable by using hybrid

cogeneration biomass system for marine system. Recent global political will has provided spill in Malaysia policy to pursue production of renewable energy of modest percentage increase of 20 percent by 2020. This paper present the status of biomass, constrain and the way forward in Malaysia.

Keywords: Biomass; Environment; Energy; Hybrid; Power; Recycle; Sustainability; Waste;

Introduction

Human technological energy activities are contributor to climate change and associated consequence. The costs of inaction to avert catastrophic impacts is greater than expected, require action can be achieved by moving rapidly to transform the global energy system. According to UN (cf. IPCC) sustainability requirement can be solved through renewable energy, energy conservation and energy efficiency and associated quarto balance of cost, development, social and environmental preservation and community participation (government's consumers, industry. Adopting new energy system will make a lot of difference large number of people integrating hybrid of hydrogen and solar couple with bioenergy into the existing system will be a good way for the community to adapt to new emerging clean energy concept [41,42].

The search for new source of energy to mitigate threat of climate change is becoming an urgent matter. New knowledge and technology have emerged. And race is on for the choice of the best. There is no drain in this planet, the waste got nowhere to go, but to return back to the system with consequential environmental damage, contamination of rivers, estuarine and the ocean and land fill and associated degradation as well as cost treatment. The greatest challenge for humanity lies in recycling waste for production of energy.

Sources of alternative energy are natural for their zero carbon. There has been a lot of research about the use of free fall energy from the sun to the use of reverse electrolysis to produce fuel cell. For one reason or the other these sources of energy are not economical to produce. Most of the problems lie on efficiency and storage capability. Early human civilization use nature facilities of soil, in land waterways, waterpower which is renewable for various human needs. Modern technology eventually replaces renewable nature with non renewable sources which requires more energy and produces more waste. Energy, Economic and Efficiency (EEE) have been the main driving force to technological advancement in shipping. Environmental problem linkage to source of energy poses need and challenge for new energy source. The paper discuss risk based iterative and integrative sustainability balancing work required between the 4 Es in order to enhance and incorporate use of right hybrid combination of alternative energy source (Biomass, solar and hydrogen) with existing energy source (steam diesel or steam) to meet marine system energy demands (port powering).

Since most alternatively energy cannot currently stand alone, Hybrid use of alternative source of energy remains the next in line for the port and ship power. Public acceptability of hybrid energy will continue to grow especially if awareness is drawn to risk cost benefit analysis result from energy source comparison and visual reality simulation of the system for effectiveness to curb climate change contributing factor, price of oil, reducing treat of depletion of global oil reserve. Malaysia tropical climate with reasonable sunlight fall promise usage of source of sun hybrid candidate energy, also hydrolysis from various components to produce fuel cell and hybridization with conventional system and combined extraction of heat from entire system seem very promising to deliver the requirement for future energy supply.

This paper discuss case study of Malaysia biomass renewable energy, available source of energy today, evolution of alternative energy, especially policy change due to the needs of the time and the barrier of storage requirement, system matching of hybrid design feasibility, regulations consideration and environmental stewardship. The paper also discusses holistic assessment requirement, stochastic evaluation, using system based doctrine, recycling and integrated approach to produce energy. Also discuss is the road ahead for Malaysia in the use of bioenergy. The paper hope to contribute to the ongoing strives towards reducing green house gases, ozone gas depletion agents and depletion of oxygen for safety of the planet in order to sustain it for the right of future generation.

Energy, Environment and Sustainable Development

Sustainable design can be described as system work that which enhances ecological, social and economic well being, both now and in the future. The global requirement for sustainable energy provision is become increasingly important over the next fifty years as the environmental effects of fossil fuel use become apparent.

Various measures must be taken to reduce emission targets. The current reliance on fossil fuels for electricity generation, heating and transport must be greatly reduced and alternative generation methods and fuels for heating and transport must be developed and used. As new and renewable energy supply technologies become more cost effective and attractive, a greater level of both small scale and large scale deployment of these technologies will become evident. Currently there is increasing global energy use of potential alternative energy supply system options, complex integration and switching for design requirement for sustainable, reliable and efficient system. The issues surrounding integration of renewable energy supplies need to be considered carefully.

Current Use of Renewable Energy

Renewable energy development and supply are in small-scale, particularly on islands and in remote areas, where the import of energy sources through transport, pipeline or electricity grid is difficult or expensive. Individual buildings, industries and farms are also looking to the possibility of energy self-sufficiency to reduce fuel bills and make good use of waste materials which are becoming increasingly difficult and expensive to dispose of various studies have been carried out into the extensive use of new and renewable resources, to generate electricity, on a small scale, for rural communities, grid-isolated islands and individual farms. Recent studies focus on:

Security of Supply: where consideration is given to intermittent sources, demand and supply must be as well matched as possible and this is generally a function of climate. Available supply sources should be considered in order to find the best possible correlation between demand and supply.

Hybrid with Conventional System: where energy limited sources used as spinning reserve for times when the intermittent supply does not meet the demand. If this type of spinning reserve is not available, the need for adequate electricity storage was shown to be an important consideration, especially in smaller scale projects.

There are many possible supply combinations that can be employed and the optimum combination for a given area depends on many factors. The balances being considered can be complex and this highlights the need for a decision support framework through which the relative merits of many different scenarios and control strategies for a chosen area can be quickly and easily analyzed [42].

The intermittent nature of most easily exploited sources of alternative energy remains the major problem for the supply the electricity network. This has implications for the management of this transitional period as the balance between supply and demand must be maintained as efficiently and reliably as possible while the system moves towards the ultimate goal of a 100% renewable energy supply over the next fifty to one hundred years. It important to take the of amount intermittent electricity sources that can be integrated into a larger-scale electricity supply network into consideration. Figure 32 shows current use of renewable energy in Malaysia and where biomass stands.

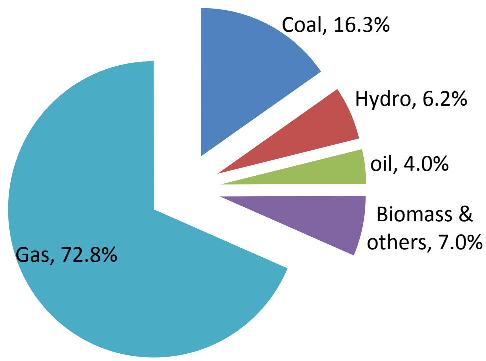


Figure 32: Current use of renewable energy in Malaysia, [41].

Excess supply could be supplied by plant run on fuels derived from biomass and waste. The renewable hybrid age require utilities, local authorities and other decision makers to be able to optimization that beat constraints, potentials and other energy requirements from port powering. When intermittent electricity generating sources are used in a sustainable energy supply system, it is important to consider how well the profiles of demand and supply of electricity match. It is advisable to seek the best possible match by using varying amounts of a range of different intermittent sources. It is prudent to use as diverse a mix of generators as possible [43].

Biomass Development Trend and Best Practice in Malaysia

Malaysia Population is 25.58 million people, with GDP of RM 250 billion in 2004 and GDP per capita of RM9, 732. Malaysia is committed to sustainable development to become a developed country by 2020. Energy development is a significant part of sustainable development and crucial to success of industrialization process. Approved application for biomass energy project is 21 with total potential grid connection estimated at 139 MW. Figure 33 shows composition of solid waste for biomass in Malaysia.

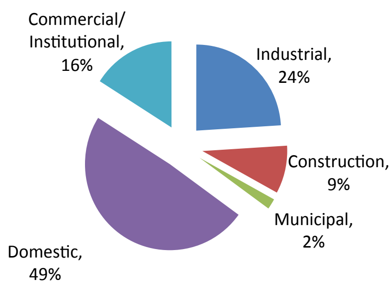


Figure 33: Composition of municipal solid waste in Malaysia.

Malaysia energy development problem being addressed include alternative energy. Electricity accounts for about 18% of the total final energy consumption in Malaysia. Presently, this form of energy is generated using natural gas (71%), diesel oil (1%), fuel oil (7%), hydro (12%) and coal (9%). The reported electricity generation in the country does not account for the electricity that is self-generated by industries. In 1999, the total installed power generation capacity in all of Malaysia was 13.632 GW (11.975 GW in Peninsular Malaysia and 1.657 GW in Eastern Malaysia). The power demand in Peninsular Malaysia was 8.82 GW while in Eastern Malaysia it was 0.871 GW. Projections show that electricity demand in the country will grow by 6-10% annually during the next 5 years and it will be necessary to plan new generation capacity [44,45].

Malaysia electricity supply industry is in the process of being restructured. The Government is relooking at the numerous options available to ensure it puts in place the most optimal and suitable structure in light of recent experiences in other countries. The restructuring has no specific time frame set at the moment. TNB is now divesting its share of power generation and eventually its monopoly in distribution will be broken but it intends to retain control of transmission.

With the recent introduction of a grid system operator and a future power market pool, there will be significant changes in the electricity supply industry. This is a long-term strategy being envisaged for the power industry, but with no specific time frame set at the moment. The government is presently considering adoption of EE and RE as the fifth fuel for electricity generation. Hence, this project will play an important role in providing the learning curve for pragmatic policy support to be instituted by the Ministry. Table 18 depicts conventional energy reserve in Malaysia [46-48].

Oil reserve:	4.83 billion barrels
Gas reserve	2.46 trillion cu m
Coal reserve	1,483 million tonnes
Hydropower reserve	27,000 MW
Biomass	2 million tonne of oil equivalent
Mini-hydro	1,640 MW

Table 18: Malaysia Conventional Energy Reserve in 2004.

Sources of biomass energy in Malaysia: Biomass fuels consist of both woody and non-woody biomass. The first come from trees and shrubs, the latter from crop residues and other vegetation. Both can be converted into charcoal. In Malaysian economies, important biomass fuels are wood and residues from coconut, rubber and oilpalm trees, as well as sawdust, biogases and husks and straw from rice plants. They are used in both traditional and modern applications. Figure 34 shows sources available for Malaysia renewable energy.

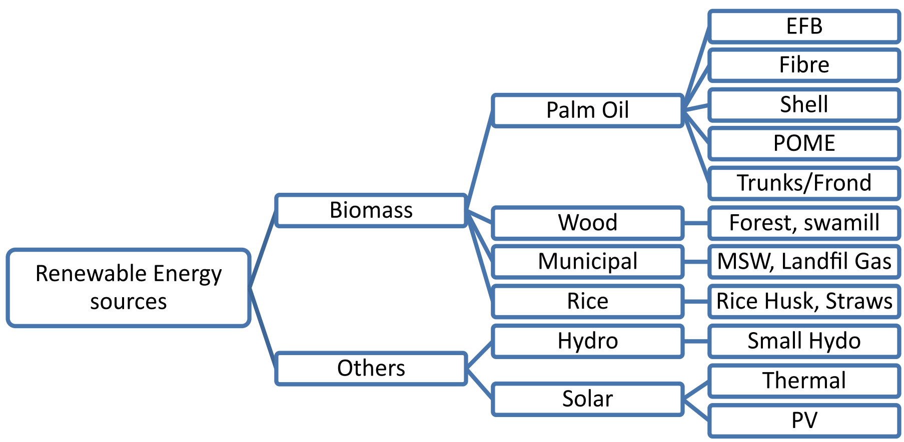


Figure 34: Malaysia renewable energy source.

Source: Pusat Tenega Malaysia, 2003

Recent year has seen increases in the use of conventional energy like oil, coal and electricity by an average annual growth rate of 7%. The challenge of global warming and impact on climate has fueled acceptability across humanity driving force use of renewable energy. Biomass has been living source of energy in human civilization, thus, the share of biomass energy in total energy consumption has been decreasing for most countries, due to substitution by modern energy source [49]. In reality, conventional energy is mostly used for new applications such as new industries, transport and household electricity, whereas wood and other biomass continue to dominate in domestic activities such as cooking and in many traditional industries. Biomass energy includes fuel wood, charcoal and agriculture residues used as fuel. In Malaysia biomass is an important energy source, consumption increased on average 2% per year between 1985 and 1994 due to population growth. Population growth has been used lately to fore cast use of biomass, yet, due to lack of data to validate the trend, policy regarding biomass has not been solidified. But lately the Government has made a giant step to encourage the use of waste derived biomass in Malaysia.

Forest and non-forest sources produce woodfuels by the felling of trees which have grown naturally, or trees which were raised on single or multi-purpose plantations (i.e. as the main products of dedicated woodfuel plantations or as by-products of non-industrial plantations). Alternatively, woodfuels are obtained as lops and tops from forest harvesting, as dead wood, fallen branches, twigs and dead stumps at site as by-products of wood-based industries (e.g. waste and scrap wood, sawdust) as surplus non-commercial wood derived from land clearing or as recovered wood from replacement or demolition of old structures and constructions (e.g. wood from old poles, posts, buildings, scaffolding).

The latter are used mostly by the urban poor. Other biomass Agro residues like rice husk and straw, coconut husk and shells, palm oil kernel shells and fibre and bagasse are the other main sources of biomass fuels. They are important for both the domestic and the industrial sectors. The forest source is one of many sources of woodfuel production. It consists of government owned and managed natural forests and tree plantations. However, this is not the only or even the main source. In Malaysia non-industrial plantations of different types (e.g. coconut, rubber and oil palm plantations, fruit orchards, and trees in home steads and home gardens) have gained recognition as important sources of woodfuel supply. These non-forest sources, managed and operated mostly by the private sector as informal business enterprises, are gaining prominence in supplying traded woodfuels to markets.

In Malaysia the energy balance shows that bagasse and rice husk accounted for 15–16% in 1990. These amounts are basically consumed in the industrial sector (palm oil, coconut, sugar and rice milling). Data for the domestic sector are often not available, but evidence from limited surveys indicates that biomass in the form of residues plays an important role, in particular in areas where wood as a source of energy is in short supply [50,51].

More than 70 million tonnes annually Production of biomass throughout the year with high sunlight intensity/time and high rainfall Main contributor of biomass. Figure 35 present biomass resources map in Malaysia. Palm predominatly cover 94% of the sources while wood is at 4%, risce and sugar case are 1 percent. Palm oil industry source are mainly:

i. Empty Fruit Bunches (EFB)

ii. Palm Oil Mill Effluent (POME)

iii. Mesocarp fibre

iv. Palm kernel shells

v. Palm kernel cake (residue): Mainly ligno-cellulosic materials

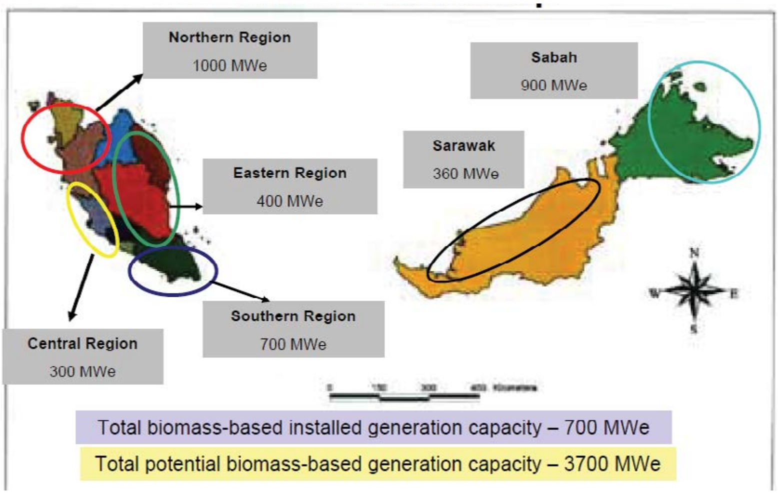


Figure 35: Biomass resource map.

Bioenergy Process: Major Conversion Process of Bioenergy

Thermal conversion of biomass

Biological conversion of biomass (organic acid)

Biological conversion of biomass (methane)

Biological conversion of biomass (bioplastic)

Biological conversion of biomass (biocompost)

Municipal waste (biomass)

Figure 36: shows process that leads to clean and sustainable biomass.

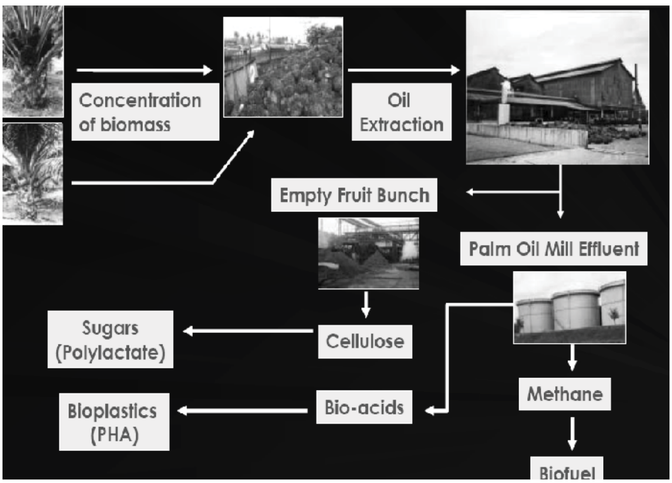


Figure 36: Clean palm oil

Thermal conversion of biomass is mainly use in power/electricity generation

Commercially used in the industries

i. Palm oil mills - boilers and steam turbines

ii. Landfills - methane combustion

It has high demand for energy Low efficiency boiler system – meant for waste disposal in the mill

Biological conversion animal feedstock

Palm-based feedstock:

i. Oil palm fronds with added nutrient supplements

ii. Palm press fiber

a) Palm kernel cake

b) POME sludge

Sago-based feedstock: Pith residue (starch)

Most of the feedstock from palm-based and sago-based is commercially available

Others:

i. Enzyme production by SSF (cellulase, amylase)

ii. Acetone-butanol-ethanol

Municipal solid waste involve Energy (methane) for power/ electricity generation: 1st IPP Ayer Hitam Landfill

Chemicals: Organic acids production lactic, acetic, propionic and butyric acids, bioplastics, polylactate Fertilizer, Bio-compost

Malaysia generates in excess of 15000 tons of solid waste per day. The life span of land fill is 5-10 years, which means that 80% of the 230 landfil will be closed in 2 years. Non biodegradable plastics are widely used in super market and the idea of recycling and using waste for energy ring well with this situation. POME sludge Domestic sewage has been used to form organic compost having good properties of PH 6-8 suitable for generation and ornamental plants [52]

Classification of Biomass

According to generation types: Second generation biofuels are waste derived biomass from agricultural and forestry, fast-growing grasses and trees specially grown as so-called energy crops. Third generation biofuels, use green fuels like algae biofuel made from energy and biomass crops that have been designed in such a way that their structure or properties conform to the requirements of a particular bioconversion process.

According to sources types: North American Electric Reliability Council (NERC) region supply has classified biofuel into the following four types: agricultural residues, energy crops, forestry residues, and urban wood waste and mill residues. A brief description of each type of biomass is provided below [53].

i. Agricultural residues from the remaining stalks and biomass material left on the ground can be collected and used for energy generation purposes this include residues of wheat straw.

ii. Energy crops are produced solely or primarily for use as feedstocks in energy generation processes. Energy crops includes hybrid, switch grassgrown on idled or in pasture. The most important agricultural commodity crops being planted in the United States are corn, wheat, and soybeans represent about 70% of total cropland harvested. Thus, this is not encouraged to prevent food scarcity.

iii. Forestry residues are composed of logging residues, rough rotten salvageable dead wood and excess small pole trees.

iv. Urban wood, waste and mill residues are waste woods from manufacturing operations that would otherwise be land filled. The urban wood waste and mill residue category includes primary mill residues and urban wood such as pallets, construction waste and demolition debris, which are not otherwise useful.

Biomass for electricity generation is treated in four ways in NEMS:

i. New dedicated biomass or biomass gasification,

ii. Existing and new plants that co-fire biomass with coal,

iii. Existing plants that combust biomass directly in an open-loop process and

iv. Biomass use in industrial cogeneration applications. Existing biomass plants are accounted for using information such as online years, efficiencies, heat rates and retirement dates, obtained through EIA surveys of the electricity

Choice of Conventional Power System

i. Internal Combustion and Diesel Engines:

ii. Steam Turbines:

iii. Stirling Engines:

iv. Gas Turbines:

Biomass Power Generation and Cogeneration Technologies: Since the palm oil mills have abundant biomass waste resources, their energy systems were designed to be cheap rather than efficient. Most of the existing biomass combustion systems in Malaysia utilize low efficiency low pressure boilers. The average conversion efficiencies in process steam and electricity generation are 35% and 3% respectively. The average overall cogeneration efficiency is 38%. An additional source of energy in palm oil mills is the biogas produced in the anaerobic decomposition (for waste water treatment purposes) of POME.

Presently, POME derived biogas is not recovered and used. This CH4 rich (65%) gas is just allowed to dissipate freely into the atmosphere. Commercially proven technologies are available in the international market for efficient production of power and heat from major biomass resources bagasse, wood waste, palm oil waste, straw and rice husk. The state-of-the-art modern technologies utilize efficient high pressure boilers. Some of these boilers are capable of dual fuel burning, utilizing either liquid (e.g., diesel oil) or gas (e.g., natural gas) fuel as supplementary energy source. Dual fired boilers will be used in palm oil waste-fired boilers to facilitate the use of POME derived biogas as supplementary fuel.

Local manufacturing capacity of efficient high-pressure steam generators in Malaysia is presently low. Most of the equipment for a biomass-based power generation has to be imported, making the capital cost of a conventional biomass power plant or CHP facility in the country high (typically around US$ 1,500/kW). Assistance (technical and/or financial) to local steam and power generation equipment manufacturers is critical in motivating them to improve their equipment designs and manufacturing methods [54,55].

Such assistance is provided in the current UNDP-GEF funded Malaysia Industrial Energy Efficiency Improvement Project (MIEEIP). Moreover, with the market potentials of biomassbased power projects and a suitable government policy on power pricing, the local boiler industry could possibly take up the manufacturing of high-pressure biomass boilers, when the market and demand for efficient biomass power technology takes off. Technologies for the effective treatment and handling of POME have been applied in several palm oil mills in Malaysia.

The present systems typically involve the anaerobic decomposition of the organic components of POME and are sufficient to meet the required final effluent BOD limits imposed by the government. As to the biogas (65% CH_4, 35% CO_2 and traces of H_2S) produced during POME treatment, there are no government regulations yet requiring palm oil mills to prevent its release to the atmosphere. In case the palm oil mills consider the recovery and energy use of POME derived biogas, the biogas can be piped from the anaerobic digestion tanks and POME lagoons/ponds and collected in a central storage tank. The biogas can then be treated to remove the corrosive components prior to use. Typical piping system design and installation (including safety and controls) in fuel gas reticulation systems can be applied for this purpose [54].

Choice of Cogeneration Alternative Energy

Fuel Cells: The principle of the fuel cell was discovered over 150 years ago. NASA has improved the system in their emission free operation for space craft. Recent years has also seen improvement in vehicles, stationary and portable applications. As a result of this increased interest, stationary power plants from 200 W to 2 MW are now commercially available, with efficiencies ranging from 30 to 50% and heat to electricity ratios from 0.5:1 to 2:1. Hydrogen is the lightest chemical element as demonstrated by the periodic table. Thus, other lighter gas gases exist that can be used as fuel cell, but hydrogen offer greater energy per unit weight compare to other element candidate for alternative energy, and it is completely cyclic as it can be readily combined and decompose. Table 18 shows types of electrolyte source for fuel cell energy. Phosphoric acid fuel cell distribution: Fuel cell can be distributed directly through the following ways [56].

Direct supply to residential and commercial facilities through pipelines. Modular cell that can be stack according to power need

Building hydrogen fuel cell power plant in remote location and distribute energy through power grid.

Comparing the efficiency of fuel cell to other source of alternative energy source, fuel cell is the most promising and economical source that guarantee future replacement of fossil fuel. However efficiency maximization of fuel cell power plant remains important issue that needs consideration for its commercialization. As a result the following are important consideration for efficient fuel cell power plant efficiency calculation can be done through the following formula Figure 37.

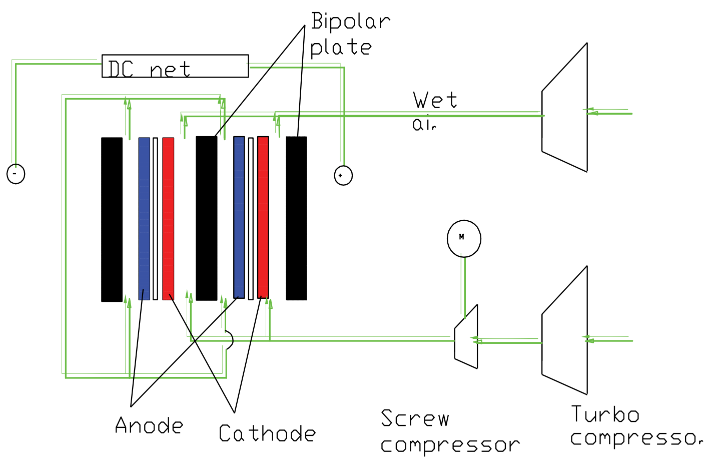


Figure 37: Fuel cell hybrid configuration.

Solar energy system: Harnessing energy from sun requires production, distribution, control and consumer utilization at low cost. Risk work for the system should address the back drop and hybrid system alternative energy system that can be installing as auxiliary for synchronization through automatic control system that activate storage supply whenever supply is approaching the minimum setup limit. Prior to installing solar, it is important to collect, analyze data and information to determined initial condition necessary to start the project and come with acceptable design. Such data should be use for simulation and construction of prototype model of the system that include existing system, central receiver, collectors, power conversion, control system, sunlight storage, solar radiation to supply a solar system to convert sunlight to electricity and distribute through existing channel.

Hybrid system: Various types of engine, turbine and fuel cell may be run on a variety of fuels for combined heat and power production. Hybrid system can provide control over power needs, green and sustainable energy that delivers a price that is acceptable and competitive. The power plants can be located where it is needed less high power lines are required, not only reducing costs but assisting health by reducing magnetic fields that people are so worried about, Global warming is addressed by direct action by providing power that does not release any emissions or discharges of any kind. The technology associated with the design, manufacture and operation of marine equipment is changing rapidly. The traditional manner in which regulatory requirements for marine electrical power supply systems have developed, based largely on incidents and failures is no longer acceptable Figure 38 and 39.

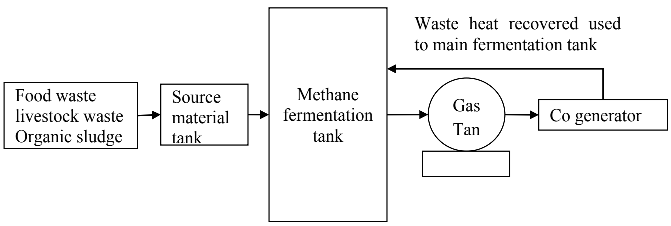


Figure 38: Biogas hybrid.

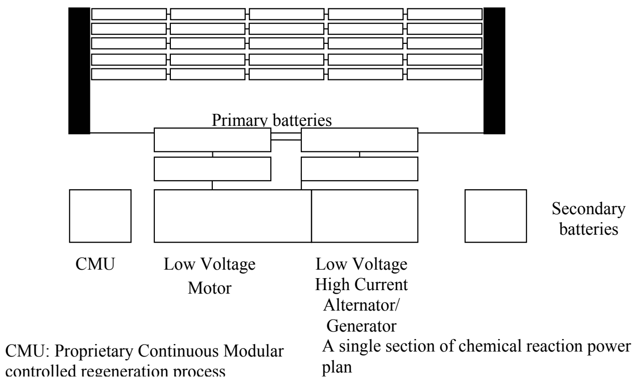


Figure 39: Fuel cell hybrid.

Figure 40 shows a typical hybrid power arrangement for solar hydrogen and conventional power. Figure 41 and Figure 42 can be hybrid to the same system to provide integrated alternative energy power. Various technologies have been employed towards the use of alternative free energy of the sun since the first discovery in the 18th century. Improvement and development has been made towards making it available for use like existing reigning source of energy. The power plants can be built in small units combined, which allow greater control over the output and maintains full operational output 100% of the time. The plant produces fewer emissions, the plant can be located close to the areas where the power is required cutting down on the need for expensive high power lines. Excess energy produced can be connected to the grid under power purchase arrangement.

The system can be built in independent power configuration and user will be free from supply cut out. In a typical off-grid scenario a large battery bank is required to store energy. Solar hydrogen hybrid energy is stored in the form of hydrogen gas. When it is dark out, instead of drawing energy from a battery bank, hydrogen gas is converted into electricity through a fuel cell. Like wise, during the day when there is plenty of energy from the sun, water is converted into hydrogen gas through the use of a hydrogen generator. Most electrical power systems are a combination of small units of power group to provide the larger output.

Hybrid system design should begin with problem definition of providing a port with power, follow by refining the design so that each individual units power output could be combined to provide the input for a larger unit and ensure efficient, effect operation, maintenance.

The hybrid system should be able to provide more power that can keep the stress and strain of operation to a minimum and reduces the failure of the component parts. The system should be designed with built in redundancy to compensate for failure of a component. The system has advantage of maintenance that can be carries out while keeping the system delivering the full capacity as well as alternation of delivery devices to extend their operational life. One of the unique features of hybrid system is the sustainable, clean energy system that uses a hydrogen storage system as opposed to traditional battery. Its design construction and functionality are inspired by the theme of regeneration and the philosophy of reuse. High efficiency solar panels works with an electrolyser to generate the hydrogen for fuel cell. The system can universal solar energy for marine application and other energy application as needed in equal capacity to existing fossil power plants. Figure 42 shows a typical control system arrangement for the switching.

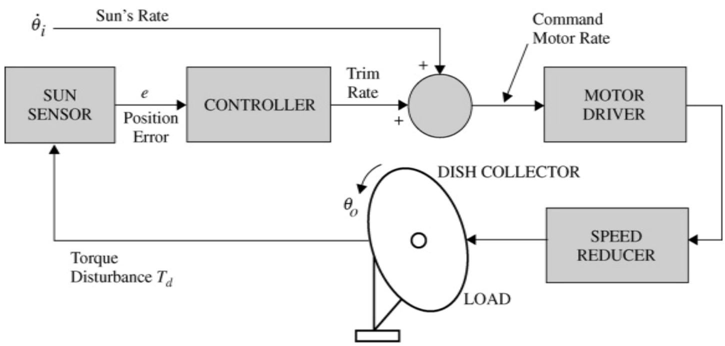


Figure 40-42: Typical solar collector control system.

The hybrid system can provide means to by pass and overcome limitation posed by past work in generating replaceable natural energy of the sun and other renewable energy source that can be designed in hybrid system. Reliable deployment of hybrid system developments of mathematical model follow by prototyping, experimentation and simulation of the system are key to the design and its implementation. The main advantages of hybrid configurations are Redundancy and modularity, high reliability of hybrid circuitry embedded control system improve emergency energy switching and transfer, low operating cost through integrated design, low environmental impacts due to nature of the energy source [57].

Application Biomass Fuels in Malaysia: Malaysia has abundant biomass waste resources coming mainly from its palm oil, wood and agro-industries. A total of about 665 mw capacities can be expected if the estimated overall potential of about 20.8 million tons of biomass residues from these main sources in addition to 31.5 million m^3 of palm oil mill effluents (pome) is used for power generation and cogeneration. In addition, there is a substantial amount of unexploited biomass waste resources in the form of logging wood residues, rice straw, palm tree trunks and other residues. These biomass residues could further supplement future biomass based power generation in the country if necessary. The palm oil industry accounts for the largest biomass waste production in Malaysia. Palm oil industry waste (including pome) represents the biggest potential for biomass energy utilization in the country, in as much as these are easily available and are presently requiring cost effective means of disposal. Currently, most of these residues are disposed of through incineration and dumping. A small portion is used as fuel for the mills heat and power requirements in a very inefficient manner.

Domestic: The domestic sector is the main user of biomass fuels, primarily for cooking and space heating. The main user groups are farmers and villagers, but daily wage earners, industrial workers and food vendors in cities all use biomass fuels to some extent. Villagers also use biomass fuels to process agricultural products either for preservation or for conversion into tradable commodities.

Industrial: Many industries in Malaysia use small-scale biomass fuels based on traditional technology for process heat and drying of the final product. These industries usually purchase the fuel, but some also collect biomass fuels from free supply sources. The industries include: agricultural and food processing (like sugar, rubber and coconut processing, rice parboiling, fish and meat drying and smoking) metal processing and mineral based activities (e.g. brick making, lime burning, ceramics and pottery, smithing, foundry and jewellery) and forest products and textile industries (e.g. bamboo and cane, distilleries, timber drying, match factories, silk and textiles).

Bio-energy using industrial and other commercial activities is mainly found in rural areas, but also exist in townships and even metropolitan cities, Also, many house holds in large urban centres use biomass fuels, in particular charcoal. Densified biofuels (briquettes of charcoal fines and loose residues) are becoming more popular in urban centres where different forms of woodfuels have already been accepted as traded commodities. At present, many higher income rural families, urban households and industrial enterprises are purchasing biomass fuels, especially wood and charcoal, to meet their energy needs.

Modern Applications of Biomass: Modern bio-energy has developed through adoption of technologies like cogeneration (generation of heat and power in wood and agro-based industries) and dendrothermal power plants (generation of electricity by burning woody biomass). Co-generation is gaining increasing acceptance. Efficient, mature and proven biomass-based energy conversion technologies are available. Co-generation of heat and power from residues in forest-based and agroindustries is being increasingly promoted in Malaysia and asean countries by the private sector, mostly for own use. Utility companies in western countries already supply electricity and heat from biomass to national grids and local communities

Many palm oil mills utilized oil palm Residues for production of electrical energy & heat in co-generation for their own use. In 1990's EC-ASEAN COGEN built 5 Full Scale Demonstration Projects (FSDP) in Malaysia utilizing wastes in wood industries using cogeneration systems. In 1980's national electrical utility company developed many mini hydro plants supplying electricity to remote communities.

Third Outline Perspective Plan (OPP3) 2001-2010 and the 8th Malaysia Plan 2006-2010 forcasted That Malaysia may net oil importer by 2008 Air pollution reduction in transportation & industrial sectors using natural gas and clean coal technology Sustainable energy development through secure cost-effective supply Efficient utilization & minimization of environmental effects of energy Introduction of renewable energy as the fifth fuel Promotion of energy efficiency

In 1999, renewable energy added as fifth fuel in addition to oil, coal, gas & hydropower with target for renewable energy 5% by 2005 & 10% by 2010 Fuel mix in 2010 Malaysia currently target 40% coal, 10% hydropower and 10% renewable energy Biomass resources utilized for electricity generation and connection to the national grid. The total generating capacity of oil palm based biomass for own use in 2002 is 150 MW with Total capacity oil palm biomass: 2400 MW [41,58].

The Malaysia Small Renewable Power program attracted. He following is the breakdown of 115 applications for biomass out of which 65 equivalent of 368.9 MW are approved Table 19.

oil palm biomass	27	214.7 MW
rice husks projects	2	12 MW
wood residue project	1	6.6 MW
municipal solid wastes project	1	5 MW
mixed biomass projects	3	19.2 MW
landfill gas (biogas) projects	5	10.2 MW
mini-hydroelectric projects	26	101.6 MW

Table 19: Sources of biomass in Malaysia

Source: Energy commission,2006

Other best practice includes:

i. UNDP & Malaysian Government implemented Biomass based Power Generation and Cogeneration in the Malaysian Palm Oil Industry (BIOGEN), whose main objective include Reduction in the growth rate of green-house gas emissions from fossil fuel by utilizing excess oil palm biomass residues through development and exploitation of the energy potentials of other biomass wastes. The elements of BIOGEN include:

a. Development of the grid connected biomass fuelled small power systems.

b. Disseminating awareness information in palm oil Industry.

c. Capacity building and technical assistance in policy formulation.

d. Facilities of financial assistance through favourable bank loans and tax exemption.

e. Establishment of real live demonstration plants and development of biomass energy technology.

f. Target of Phase 1 (2 years) of BIOGEN 15% of palm oil mills (50 palm oil mills) to implement biomass power generation & cogeneration. Target of phase 2 (year 5), green house gas emissions from power generation reduced by. 3.8% Upto 2004 there were only 1 major BIOGEN project 14 MW oil palm residues mitigate 40,000 to 50,000 tonnes CO_2.

ii) Palm Oil Research Institute of Malaysia (PORIM) now Malaysian Palm Oil Board (MPOB) has been involved in biodiesel program for along time. In the early 80's, PORIM developed biodiesel using transesterification technology that was used 100% on special engines from Germany. Lack of interest from transportation & automobile industry. Currently there is no policy from government. On High price of palm oil & low price of oil. Recent revival of interest due to increasing oil prices and falling palm oil prices.

iii) German based train operator Prignitzer Eisenbahn (PE) Arriva tested 50 tonnes of Malaysia's biodiesel & ordering additional 100 tonnes of the fuel

iv) Legislation to require oil companies to sell. Bio-diesel at their petrol stations three biodiesel plants with capacity of 60,000 tonne/yr. are planned for 2006. Each Total capacity by next year is 180,000. Tonne/yr biodiesel mainly for export only. Raw material is Refined, Bleached and Deodorised (RBD) palm oil Biodiesel composition: 5% processed palm. oil blended with 95% petroleum diesel for diesel engine vehicles and industrial and power generation

v) Felda together with Kyushu institute of technology and sumitoto heavy industry project utilized biological conversion that involve methane generated from POME anerobic treatment, 5000 cubic metre methane tank, POME holdiong tank, settling tank, gas scruber, gas storagetank and gaversion to electricity use gas turbine as prime mover. Figure 43 shows typical biomass production process.

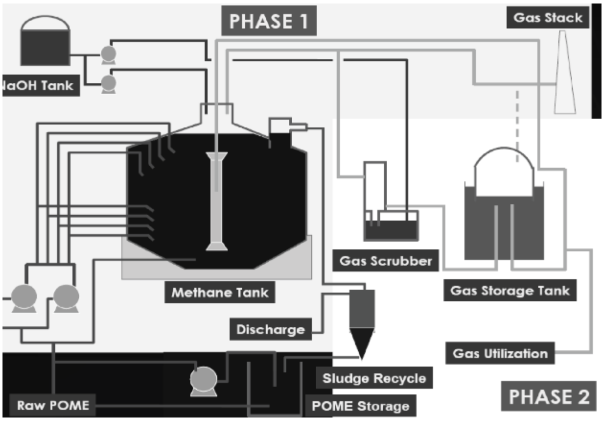


Figure 43: Biomass production process.

Another felda project utilized bioplastic and organic acid (acelic propianic and bulyric acids from POME) that fermenti organic acid into poly-hyroxyalkanoates. The process use excess energy from biogas plant and subsequent distillation of organic acid.

TSH bioenergy project is another case in Malsyia, located in Sabah, with generation capacity of 14 MW, the system use palm oil as fuel source Figure 44.

Figure 44: THS bioenergy plant.

Source: Pusat tenaga Malaysia

Janal land fill sdn located at air hitam, Selangor, also lunched biomass project with 2 MW capacity, fuel by biogas captured from land fill Figure 45.

Figure 45: Janal Landfilbiogas power plant.

Biomass Development Trend Spillage to Shipping

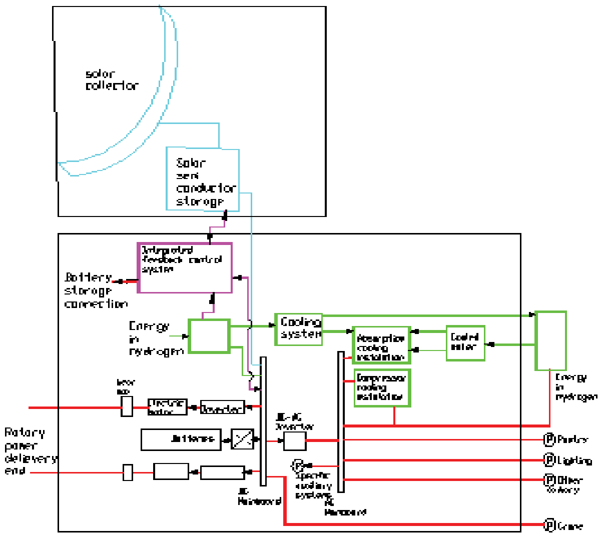


Figure 46: Cogeneration for marine ship system.

Just like tanker revolution influence on ship type, demand for biomass will bring capacity, bio- material change from source to production area to the point of use. Technological, environmental change will also require ships of different configuration, size and tank coating type as well as impact on the tonne mile demand. Recently biofuel is driving a new technology worldwide the use of biofuels for cars and public vehicles has grown significantly. Effect on shipping is likely to be followed by shipping of large scale growth on exports and seaborne trade of biomass product from key exporting regions in order to balance supply and demand. With excess capacity waiting for source material it seems inevitable that shipping demand will increase. Figure 46 shows a typical co-generation for marine system.

In many parts of the world, environmental concerns are the leading political driver for biofuels. This driving force evolved regulation like Kyoto protocoal, Marpol Annex VI and other environmental regulation. The tonne mile demand for future tankers will be greatly affected by national, regional, global policy and political decision making. There is a greater flexibility in the sourcing of biofuels than there is in hydrocarbon energy sources and this may be attractive to particular governments. Once the regulatory frame work is clear, economics will determine how the regulations will best be met and seaborne trade will be at the centre of the outcome [57,59,60].

Sustainability Requirement for Biomass

Environment: If the supply source is properly managed, woodfuel can contribute positively to both the local and the global environment. Degradation of watershed and catchment areas occurs only when woodfuel is extracted in an unsustainable manner from environment. Biomass resources, particularly residues from forests, wood processing, agricultural crops and agro-processing, are under-utilised in Malaysia and ASEAN countries. These resources are renewable, environmentally friendly in energy production and sustainable in terms of supply. Some of these residues are already used as raw materials for other products (such as particle board and fibre board) as fodder and fertilizer or as household and industrial fuels. However, large portions are still unused and represent potential sources of energy. Energy generation technologies specifically designed to use biomass residues are available and are becoming more and more economical. Countries have yet to make optimum use of the additional power generation potential from their biomass residue resources, which could help them to partially overcome the long-term problem of energy supply. However, in order to make the most of biomass energy, various aspects must be taken into account [55,56]

Financial: There are several factors limiting the potential for large-scale fast-growing fuelwood plantations on a commercial scale: international petroleum fuel prices, remaining subsidies on commercial fuels and large initial investment requirements for woodfuel plantations, long gestation period between planting and harvesting and conversion and transportation costs. This implies that the development of woodfuel should focus on the by-products of agroforestry and on the use of wood and biomass residues from relevant processing industries at their source. Biomass fuels are mostly used in the household sector, primarily by the rural and urban poor and middle class people in small towns. These people usually end up paying more for their household energy than their counter parts in larger urban centres. Cost-benefit analyses should incorporate avoided costs. The low income level of the majority of rural wood fuel users cannot support high investments in modern biomass based energy generation. Governments should come in with financial schemes.

Technological: Biomass has a lower calorific value than fossil fuels. Densification (briquetting) of biomass residues increases accessibility but involves a cost, which may be out of reach of those present users who get their biomass fuels free. Detailed study of the local fuel market and careful selection of technology should precede major investments in biomass energy development. Prevailing practices of technology transfer do not sufficiently take into account the local conditions under which imported technology has to be operated and managed, the training required for its use, maintenance requirements and capabilities and backstopping arrangements. Promoters need to consider both hardware and software aspects of technology transfer. Research and development for biomass production and use on a commercial basis has not yet received adequate attention in the region.

Community participation: Numerous actors play specific roles in the supply and distribution of traded biomass fuels from their sources to final users (e.g. collectors or gatherers, transporters, middlemen, wholesalers and retailers). Woodfuel collection for self-use and for the market can be an important occupation in rural areas. For the better-off it may be part-time off-season work but for the poor it can very well be a full-time occupation for livelihood. And for yet others it may provide an opportunity for self-employment in woodfuel-related business to earn cash income and supplement house hold income. Most fuelwood gatherers live in villages close to the forests. They may be poor with very small land holdings or landless labourers. Estimated employment of woodfuel on the basis of person days involved in production of one Terajoule (TJ) of energy, compared to other commercial fuel alternatives, shows just 10 person days per TJ for kerosene, compared to 200 to 350 person days for charcoal, depending upon productivity of site, efficiency of producers and the distance to the market. Also, woodfuel is a carbon neutral energy source (that is, the

CO_2 released by its burning is matched by the amount used up in its production), provided the rate of harvest of the wood is equal to the rate of regrowth, so it need not contribute to the greenhouse effect. With present improvements in wood combustion technologies, other emissions like carbon monoxide (CO), polycyclo-aromoatic-hydrocarbons (PACs), nitrous oxides (NOx) and particulate matter can also be significantly reduced.

Considering the important contribution from non-forest production sources, most areas sustainable production of wood for energy can be viable. The present supply demand imbalances may not be as serious as has been projected for most countries. It is also observed that, except in some highly populated forest deficit areas, the use of woodfuel by a majority of rural households is not the root cause of deforestation. In the present context of warnings against deforestation and growing concernsnabout biodiversity and environmental conservation, the role of government raised plantations as newly emerging additional sources of woodfuel becomes more prominent as far as traded woodfuel is concerned.

Institutional Engagement: Governments policies relating to biomass energy development and the role of the private sector are not yet clearly defined.

Advantages

Economy: Modern applications in both industrialized countries and in South-East Asia have demonstrated that biomass energy has potential for larger scale industrial applications. For fuel-importing countries, the use of local biomass can save substantial amounts of foreign exchange. The value of agricultural waste fuels currently being used in Malaysia economies is equivalent to an estimated US$ 7 billion annually.

Environment: The sustainable use of biomass energy sources helps to manage the local environment. When wood and other biomass are properly valued by local populations as an important resource base, they are more likely to be protected. Sustainable use of biomass is also beneficial for the global climate, because it is carbon neutral and greenhouse effect mitigation. This is the main reason why many industrialized countries have embarked upon policies for increasing the share of biomass in national energy consumption. The same policy is currently being announced in Malaysia.

Rural income: The use of wood and some other forms of biomass energy generates at least 20 times more local employment within the national economy. A large amount of unskilled labour is engaged in growing, harvesting, processing, transporting and trading the fuels, which generates off farm income for rural populations, either regularly or off-season. Policy makers in the Malaysia are increasingly coming to recognise the employment benefits for their own countries.

Social: In times of hardship, or when harvests are inadequate for subsistence, the opportunity to generate income in woodfuel business provides a safety net for the people affected [58,61].

Efficiency: The application of biomass energy in modern technologies allows for increased energy efficiency by combined heat and power generation (cogeneration). Applications of cogeneration in decentralised systems based on locally available fuel resources help to further reduce losses in the transmission and distribution of power. Energy mix: Incorporation of biomass fuels in national energy supply policy improves the energy mix by increasing the diversity of energy sources. This helps to reduce vulnerability to market fluctuations and can improve stabilization of prices [58,61].

Constraints: Planned demonstration programs in Malaysia that aims to showcase technologies on power generation using biomass and/or biomass-derived energy forms have to contend with several barriers Major barrier for development and implementation of biomass are issue of concern includes [60]

Lack of awareness: It is sometimes assumed that biomass energy is a traditional commodity which will phase out in the near future. Some people even believe that woodfuel collection poses a major threat to tropical rainforests. Misconceptions such as these hamper the development of sound energy policies. There is lack of Information Services to Promote Biomass Energy Development and Applications. There is a general misconception that biomass based grid connected power generation is an unproven technology and business venture and that the use of biomass fuels goes against the industrialization goals of the country. There is the common notion that the industry lacks the technical capability and experience in this particular field of biomass energy technology. The potential biomass energy project developers do not know where to obtain sufficient information as well as competent advise in matters related to the choice of technology, legal issues, preparation of agreements/contracts, financing and etc. Since biomass based power generation and sales is new to and not within, the core business of the palm oil industry, the palm oil mills and potential investors usually do not have enough information related to the implementation of such kind of projects.

Lack of accessible and favourable financing schemes Financial, institutional and legal issues have to be resolved to make the best use of available technologies. Due to lack of support policies and information; it is difficult to obtain financing for biomass based power generation projects in Malaysia. This is further aggravated by the fact that financial/banking institutions in the country are not familiar with the financing of such business ventures.

Lack of policies on biomass energy technology development and applications: Currently, there is no formal government policy concerning the development and utilization of biomass energy. Thus, there is an existing policy regarding IPPs selling power to TNB, there is no basic regulatory framework for biomass power projects to sell excess power to the utility grid. The Ministry of Energy, Communications and Multimedia has set up a Special Committee on Renewable Energy (SCORE) that will be responsible for policy and institutional arrangements to promote the development of renewable energy resources in the country. SCORE includes TNB Distribution, EPU, JBEG and the Ministry of Finance. It is important for biomass projects to use SCORE in developing an appropriate regulatory framework.

Uncertainty: Major uncertainties are described below:

Uncertainty financial viability: Due to the perceived high risks, these institutions are cautious in providing financial assistance for such kind of projects. Only a few of the existing technology financing schemes in the country include renewable energy in their portfolios. Base on past experience, such schemes usually require a long application and approval process. Biomass based power generation in the palm oil industry has long been practiced but power sales to the grid have not been done due to poor economics arising mainly from the inability to sell to the grid and to sell at favorable rates. It is important to have a central system for relevant stake holders (including Energy Service Industries (ESIs)), aside from the pertinent government support policies and regulations in order for biomass based power generation to be attractive business venture. Negotiations have been ongoing amongst concerned stakeholders to arrive at a final level playing field.

Lack of data, successful technology, and models to demonstrate the viability of biomass based grid connected power generation systems: The experience so far in Malaysia is limited to the existing inefficient biomass fired systems in the palm oil and wood industries. There has been no successful experience utilizing efficient biomass based power generation systems that sell excess electricity to the grid or to other electricity user. Generating and selling electricity is beyond the scope of the palm oil mills core business and is not within their area of competence. Moreover, while some of the palm oil millers are interested in the technology, they are reluctant to take the risks of being the first to implement this commonly regarded new technology. Also data are still inadequate or unavailable for biomass energy planning and for developing specific energy policies for supply and demand. Technologies for biomass combustion which are at present widely used in Malaysia need to be improved towards best practice.

Uncertainties of Biomass Fuel Supply: Overall, the potential for biomass-based power generation looks good. There is presently the general perception that with the overall amount of palm oil industry waste resources, it would be possible to achieve the target % share (i.e., 5%) of renewable energy resources in the national power generation mix by year 2005. The reliability of continuous supply of biomass waste (particularly solid waste) fuels from the nearby mills is critical to the full operation of the power generation facility in each demo site. The National Utility (TNB), which is expected to purchase the electricity generated perceives that the supply of would be unreliable due to Uncertainty in the actual volume and quality of the palm oil milling operations and absence of standard contract procedures concerning the supply and pricing. It could also be costly to transport biomass waste residues from various palm oil mills to the biomass based power generation facility. The price of biomass residues might also increase in the future, as other value added uses and opportunities are identified.

Uncertainties of Meeting Minimum Energy off Take: Solid-fuel fired power plants would usually be base loaded. These would generally have an

Availability factor of 90%. Spare capacity would normally be provided to ensure meeting Minimum Energy Off-Take (MEOT) requirements as stipulated in Purchase Power Agreements (PPA), and to allow for maintenance and force outages. Considering the uncertainty in the long-term supply of the EFBs from other mills, the demo sites may not be able to operate at levels that would meet MEOT requirements of TNB. The seasonal availability of biomass residues is a major risk for grid-connected biomass-based IPP, operating under a PPA with TNB.

Uncertainties in the Implementation of Biomass-based Energy Technology: There is a general apprehension that should palm oil mills be allowed to sell electricity to the grid, the power supply from these sites is unreliable judging from the way they presently operate their facilities. The common knowledge that the mills deliberately operate their facilities inefficiently in order to get rid of their biomass waste gives the impression that the mills are not up to the stringent reliability and efficiency requirements in the operation of grid connected power plants. Like in the wood and agro-based industries, which also use biomass waste for energy purposes, biomass combustion in the palm oil industry needs to be improved towards best practice. Power sales to the grid require more efficient power and steam generation equipment, reliable interconnection safety and synchronization devices, as well as more sophisticated power project development skills to deal with broader technical and contractual issues. Moreover, there are limited manpower skills in the palm oil industry to operate and maintain the modern efficient biomass fuel-fired power equipment. Although the palm oil mill operators have good knowledge of power generation at the 500 kW levels, grid connection knowledge and expertise are lacking.

Uncertainty of Power Purchase by TNB Distribution: The realization of the demo schemes is very much dependent on the purchase of the generated electricity by TNB Distribution. The issue here is the return on investment and the ease. The above barriers continue to hinder the replication of any biomass-based power generation initiatives that palm oil industry may be interested to invest in. with which the grid connection will be made between TNB Distribution and the host companies. Presently, there is no framework to accommodate this business relationship. TNB Distribution will most likely exercise its right to insist on due diligence on host company's proposal on the interconnection. This is to at least satisfy TNB Distribution that the link between power plant and its distribution system will be adequately and suitably protected from frequency and voltage variations, etc.

Measure and mitigation option are sumarrised in Table 20 Main supporting measure by Malaysia government can be summarized into the following:

i. Local authority facilitation

ii. Lower tariff

iii. Technical and financial consulting

iv. Application facilitation

v. Soft loan facilitation

Components	Barriers	Possible Solution
Technical	• Lack of successful reference • Seen as complicated to operate • The quality of biomass as a fuel is not homogeneous	• Implementation of demonstration projects • Suppliers to simplify operation, training of operators • Adequate testing of samples
Human	• Energy not a core business of potential user • Risk of being the first to fail	• Create awareness of benefits and opportunities • Reference in similar environment, demonstration projects
Information	• Lack of institutions giving information and advice • Lack of awareness among user on government rules and incentives • Not enough technical and economic information to make a decision	• Strengthening of relevant networks • Information drive • Availability of funds or services to conduct feasibility studies
Organizational	• Structure of the industries: 1) Size of mills 2) Transportation problems 3) Seasonality • Uncertainty of biomassfuel supply • Policy, legal and government issue • Financial barriers	• Through investigation of these aspect in the feasibility of projects • Initiative to boost yield and productivity • Government incentive/support measure • Innovative financial strategies, government incentives

Table 20: Summary of barriers and ways to overcome them.

Risk and Sustainability

Risks and taken to minimize them: For future projects, the potential risk will have to be carefully evaluated and mitigated by a relevant government policy. Among main issue that hinder development of biomass is lack of support policies regarding the development and use of biomass energy and the pricing of biomass generated electricity sold to the grid. The potential conversion of land into plantations and to use monoculture techniques carries the risk that biodiversity may be lost due to the conversion of forest into farmland and that soil may be lost due to erosion. The oil palm plantation industry in Malaysia is at a mature stage where regulations have been established to mitigate its negative environmental impact. Soil erosion is not a significant problem due to well developed terracing techniques and the fact that oil palms are mainly grown on level land. The 8th Malaysia Plan, risk aversion strategy focus on the following:

i. Uncertainties of Biomass Source Fuel Supply: there is threat of oil palm plantations conversion to real estate developments in Peninsular Malaysia. The supply of biomass fuel will also be sustained by the availability of biomass residues resulting from the annual replanting of palm oil trees, which typically involve about 100,000 hectares of plantation land. The availability of POME-biogas will also ensure the availability of supplementary fuel for power generation.

ii. Uncertainties of meeting Minimum Energy Off Take requirement: With the availability of standard long-term biomass supply agreements and its implementation, biomass-based power grid connected power plants facilities are supposed to operate reliably to meet requirements.

iii. Uncertainties of Power Purchase by TNB: Malaysia currently plan for open electricity market which might discourage TNB power purchase. In case of an open market, TNB Distribution is still expected to honor its PPA arrangements with IPPs. The Ministry of Energy, Communications and Multimedia's will be responsible for ensuring the promotion of grid connected power generation from renewable energy resources. The Ministry currently pledge special attention will be given for power purchase from biomass power plants.

iv. Uncertainties in the Malaysian Financial Sector: Malaysia is currently withstanding the impact of the US slowdown. The financial institution sector is wary about their financing deals with industries. With the current political will, enforcement of the relevant policies concerning the use of biomass energy, the implementation of attractive RE electricity tariffs, granting of financial incentives, issuance of PPAs to biomass-based power generators, financial risk can be mitigated [56,59].

v. Operating Risks: Currently there are limited manpower skills in the palm oil industry to operate and maintain the modern efficient biomass fuel-fired power equipment. This can however be easily addressed by the capacity building, training to be provided by the power and steam generation equipment suppliers.

Sustainability: sustainability will require addressing issue related to policies, regulations (including tax, incentives etc.), financing and numerous stakeholders and institutional roles. biomass-based power generation remain a reliable and cost effective technology in the international market. this could be further sustained by building capacity to provide technical information and advisory services to potential biomass based power project developers and investors. sustainable demand for and supply of biomass power systems could also be achieved through disseminating information, supporting the demonstration schemes and carrying out barrier removal activities to ensure successful implementation and subsequent replications.

The Malaysia fifth fuel plan has sustainable potential by helping to formulate and enforce policies and regulations regarding the use biomass energy for power generation in Malaysia. It will facilitate the review and improvement of electricity pricing policies, particularly concerning biomass generated electricity or RE electricity and facilitate policy dialogue for smooth adoption and implementation of the pricing policy and incentives, which will ensure the commercial viability of future biomass based power projects.

To sustain the momentum that will be generated by the initial project activities, it is imperative to set up a financing mechanism for Re-based power projects by providing financial assistance for the replication of the technologies. It is also important to train the financial institutions in financing biomass power projects to ensure continuity in the financing of future projects, as well as promote investment opportunities for potential investors in Malaysia. The government policies and regulations that will be put in place and implemented through this project will influence growing interest in biomass-related industries (e.g., wood and agriculture) in developing and implementing biomass based power generation in other to ensure the institutional sustainability of this project.

Stakeholder of biomass energy in Malaysia: The interests of primary stakeholders in the project are described below:

i. Ministry of Energy, Communications and Multimedia (MECM) MECM is the co-coordinating and implementing agency for energy policies in Malaysia who is responsible for inter-ministerial co-ordination in matters concerning the energy sector. It chairs the Electricity Supply Planning Committee formed in 1997 to monitor and review the supply and demand situation regularly. The MECM is involved in the approval of electricity tariffs and issues licenses to supply electricity. It is also responsible for the development and implementation of renewable energy and energy efficiency programs. Department of Electricity and Gas Supply (JBEG) JBEG is a department under the control of MECM. This department develops legal and regulatory frameworks, advises the Ministry on policy, tariff and other matters. JBEG is

ii. Malaysian Energy Centre (PTM) PTM is non-profit company and administered by MECM. The establishment of PTM is to fulfill the need for national energy research center that will co-ordinate various activities, specifically energy planning and research, EE, technological research and R&D demonstration. PTM will eventually become the one stop focal point for linkages with the universities, research institutions, industries and various national and international organizations on energy matters.

iii. Economic Planning Unit (EPU): EPU formulates privatization policies and evaluates and selects and approves Independent Power Producers (IPPs) responsible for the formulation of energy strategies and policies including national energy planning and policy development in renewable energy. EPU is interested in the palm oil biomass project to clarify the potential for integration of renewable energy into the Malaysian electricity supply system. There are a number of RE projects being supported by the Electricity Supply Industry Trust Account (MESITA), which is managed by the MECM.

iv. Ministry of Science, Technology and the Environment (MOSTE) MOSTE is responsible to promote research and development activities, which can be commercialized and support environmental conservation and sustainable development such as renewable energy project utilization.

v. Ministry of Finance (MOF) The MOF is responsible in determining the annual budget for all the government departments and Ministries. It is the Ministry to finally approve matters related to investment incentives and tax exemptions. Ministry of Primary Industries (MPI): MPI is responsible to establish and enhance Malaysia's competitive advantage in a global market for selected export commodities as well as their value added products. It promotes specific commodities considered to be economically and socially strategic to national development. The palm oil industry is under this Ministry. The ministry is in supportive of cogeneration and provides guidelines for interconnection between the biomass power plant and Tenaga Nasional.

vi. Malaysian Palm Oil Board (MPOB) MPOB is department merged between the former Palm Oil Research Institute of Malaysia and Palm Oil Research Licensing Authority) under the control of MPI. MPOB carries out R&D activities and approval of processing plant on palm oil industry. It is the focal point for the palm oil industries R&D activities and is strongly supported by the industries. MPOB has commissioned an efficient biomass boiler system at its palm oil mill.

vii. Malaysia Palm Oil Millers Association (POMA): The Association comprises about 60 members, mainly from the private millers. POMA has three regional offices covering northern, central and southern regions of Malaysia. The main responsibilities of POMA is to coordinate the activities of its member companies and hold dialogues with government agencies such as the Department of Environment, MPOB, MPI and MoF.

viii. Malaysian Palm Oil Association (MPOA): MPOA's mission is to ensure the long term profitability and growth of the Malaysian palm oil industry and other plantation crops. Its role includes shaping R&D policies and priorities and dissemination of industry relevant information to members. Among its priority issues are environmental concerns.

ix. Tenaga Nasional Berhad (TNB): TNB is the national power company own by the government. It has a few subsidiaries namely TNB Distribution, TNB Generation, TNB

Engineering and Consultancy, TSPL and TNB Research. TSPL is the main subsidiary responsible for the development of renewable energy projects. TNB purchase the excess power from the small biomass power plant at a price to be negotiated between buyer and seller.

x. SIRIM Berhad (SIRIM): SIRIM Berhad is the national organization on industrial R&D activities and quality standards. It has been active in promoting the renewable energy and energy efficiency projects. The energy projects are handled by the Environmental and Energy Technology Centre, which carried out the preliminary feasibility study on grid connected power generation using biomass. The Centre has managing the national and international project such as ASEANEC COGEN Programme me. The program supports projects involving the installation of cogeneration plants from various type of biomass was and the generation capacity between 500 kW to 2000 kW. Universities UKM, USM, UTM and UPM have been active in promoting RE and EE activities. The universities offer courses and carry out research in RE and EE.

xi. The Government, through the IRPA (Intensified Research in Priority Areas) funding mechanism, funds most of the research grants. The universities also offer consultancy services to industries and work closely with government agencies.

Future of Biomass in Malaysia: Limited opportunity exists for exchange of information and sharing of experiences with regard to the use of modern biomass energy technologies amongst implementing organisations within Malaysia It is important to facilitate transfer of knowhow through development and institutionalization of a system for facilitating information sharing and technology transfer within the region. Bases with regard to prices, competing uses, cost of biomass energy in relation to alternatives, energy market, size and supply sources.

i. Data bases should be accessible to agencies willing to finance, implement, monitor or use biomass energy. Exchange of information between countries in the region can be promoted by networking and through collaboration with regional and international agencies. It is important to integrate wood and biomass energy information into energy data bases, identify data gaps which limit the integration of wood/biomass energy considerations into long-term development programmes. Identify data collection activities which countries need to undertake to fill these data gaps, Data on supply and demand of biomass energy should be collected systematically and periodically. The data should be used by planning units as a basis for energy policies and incentive [61,57].

ii. No dedicated system exists for information flow on research and development in biomass energy. This needs to be established and regularly upgraded. Legislation

iii. Most policies and legislation today are not conducive to biomass energy development, e.g. sectoral policies and legislation governing private trees in non-forest lands, including planting, harvesting, utilisation, transport of tree and wood products, tree and land ownership and tenure systems.

iv. Current policies use subsidies to promote the use of commercial fuels, instead of developing the sources and supply of biomass energy, which could contribute positively to the balance of trade. Assist in the development of sustainable energy policies. Fiscal and pricing policies should be reviewed, so as to remove discrimination in favour of certain fuel sources. Biomass energy should be allowed a level playing field in competition with other renewable and fossil fuels.

v. Lack of awareness about use of biomass fuel being the root cause of deforestation and environmental degradation do not provide a conductive atmosphere for bio-energy development. Appropriate legislation which regulates only indiscriminate biomass use needs to be promoted.

vi. Prevailing arrangements do not encourage private-sector participation in the development of biomass resources in forest and nonforest areas. Utilisation of biomass for commercial energy production and marketing requires legislative provisions and incentives. Wherever feasible, countries should encourage, through legal and financial provisions, the plantation of fast-growing multipurpose trees, if not as single-purpose plantations then as part of larger, multiple-use production systems.

Conclusion

Geographical location provides favorable conditions for growing biomass, which can strengthen their self-reliance in terms of energy. Clear and consistent policies are needed to make the most of this. Modern power generation from biomass sources should be further developed. Energy sector, 8 MP focuses on renewable energy & energy efficiency as the fifth fuel by expanding four fuel diversification policies introduced in 1979. Fiscal incentives, policy instruments renewable energy strategies. Thus they need to be improved to achieve national target. Malaysia is targetting 500 MW (5% of current electricity demand) of power generation from RE to be grid-connected by end of 8 MP (2005), Its only a soft approach. Financing remain one major barrier in smooth progress of the SREP programme. Other challenge to use of biomass for power generation, therefore, is to develop more efficient, lower-cost systems. Advanced biomass based systems for power generation require fuel upgrading, combustion cycle improvement and better flue gas treatment. Future biomass based power. Generation technologies need to provide superior environmental protection at lower cost by combining sophisticated biomass preparation, combustion and conversion processes with post combustion cleanup. Such systems include fluidized combustion, biomass integrated gasification and biomass externally fired gas turbines.

6. Modeling of Gas Turbine Co-Propulsion Engine to Ecotourism Vessel for Improvement of the Sailing Speed

Abstract

Sailing speed is important factor in choosing marine engines. The uses of gas turbine as co-propulsion engine for improving sailing speed of ecotourism vessels to fulfil requirement of SAR operation. Gas turbine co-propulsion engine have an advantage of high power to weight ratio in comparative to other heat engines. This paper presents the results and study on diesel engine, simple cycle gas turbine and regenerative gas turbine performances The relation between the thermal efficiency of heat engine to fuel consumption is used to estimate fuel consumption rate. The design of heat engine can be determined the specific heat ratio and pressure ratio of the operation cycle which will give necessary impacts to the thermal efficiency of the heat engine. Results from the numerical calculation for the implementation of gas turbine will provide the decision support. The paper also discusses the impact of co-propulsion engine to the ships stability and proper power rating of gas turbine co-propulsion engine estimated by numerical calculation in order to achieve maximum sailing speed up to 35 knots.

Keywords: Fuel consumption; Gas turbine; Sailing speed thermal efficiency; Regeneration,

Introduction

The sailing speed of ecotourism can be improved by several methods. In this research implementation of gas is proposed as co-propulsion engine to improve the ecotourism vessel sailing speed up to 35 knots. The vessel under study is the important transport connecting the mainland from Mersing jetty to Tioman Island. High speed sailing is necessary for the vessel to carry out the search and rescue operation in open sea under emergency circumstances. Besides, improving passenger ferry sailing speed will overcome the problem of vessels movement delays during peak season in May. Gas turbine also called a combustion turbine is a rotary engine that extracts energy from a flow of combustion gas. In order to adapt the function, the gas turbine composes of four important components, which are compressor, combustion chamber, turbines and exhaust. Energy is added to gas stream by combustor through ignition of the mixture of atomized fuel and air. The gaseous streams are then directed through a nozzle toward a turbine. The hot gases stream will spin the turbine and empower the compressor.

Comparative to others heat engine, gas turbine will have the advantages of high power to weight ratio. The gas turbine provides the same output power as the diesel engine having more compact design and smaller in sizes and weight in comparison with diesel engine. However, under certain circumstances, the diesel engine will show higher in fuel efficiency in comparative to gas turbine [62,63]. The design of gas turbine will give impacts to the performances of gas turbine. Design must take into account on specific heat ratio and the pressure ratio in order to produce high performance gas turbine co-propulsion engine. These two variables give significant change of thermal efficiency of gas turbine co-propulsion engine Figure 47.

Modelling Process: the thermodynamic properties of the each heat engine were emphasized three types of heat engine were selected and put into study. Diesel cycle, bryton cycle and combine cycle are studies to examine the properties of individual heat engine.

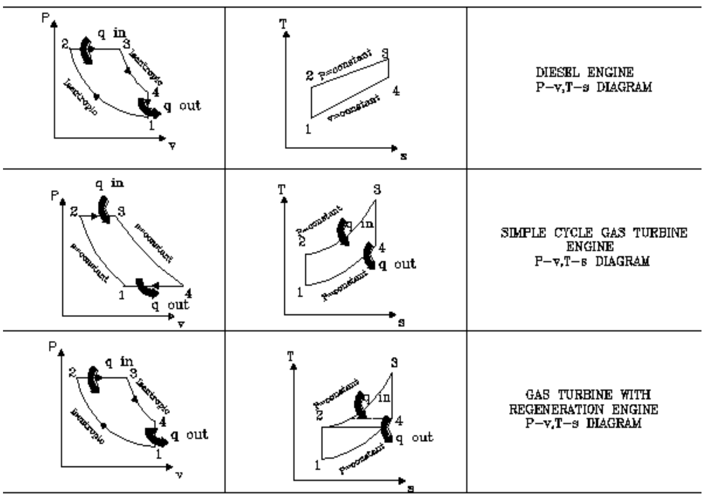


Figure 47: Thermodynamic properties of co-propulsion engine.

A survey is done by a visiting the passenger Fast Ferry Company located at Mersing jetty, Johor. Data collections are done on the vessel understudy. These included ship's particular general arrangement, propulsion engine specification, sailing speeds and fuel consumption rate [64,65]. The thermodynamic properties of the following heat engine were presented in curve to examine the properties of each heat engine. The plotting tools; Mathlab is applied for plotting purposes. The thermodynamic formula needs to translate to the M-code in order to present a relation curve [66,67]. Table 21-25a show the M-code for propulsion engines.

Types of co-propulsion engine	Thermal efficiency formula
Diesel engine	$n_{th,diesel} = 1 - \frac{1}{r^{k-1}}\left[\frac{r_c^{\,k} - 1}{k\left(r_c - 1\right)}\right]$

Simple cycle Gas turbine	$n_{th\ bryton} = 1 - \frac{1}{r_p^{(k-1)/k}}$
Regeneration gas turbine	$n_{th\ regen} = 1 - \left(\frac{T_1}{T_3}\right)\left(r_p\right)^{k(k-1)}$

Table 21: Thermal efficiency of co-propulsion engine.

%M code for thermodynamic properties of diesel engine

```
k=1.4;
r=[2:2:24];
rco=2;
a=r.^(k1);
b=(rco^k)1;
c=k*(rco1);
e=b./(a*c);
nD=1e;
plot(r,nD,'red');
legend('at k=1.4');
xlabel('compress ratio,r');
ylabel('Dieselefficiency,nD');
title('thermal efficiency vs comprssion ratio');
```

Table 22: M-code for Diesel engine.

%M-code for thermodynamic properties of simple gas turbine

```
k=1.4;
rp=[1:2:24];
x=(k-1)/k;
nB=1-rp.^-xplot(rp,nB,'magenta');
 xlabel('pressure ratio,rp');
ylabel('Thermal efficiency,nB');
legend('at k=1.4');
title('Thermal efficiency of gas turbine vs pressure ratio');
```

Table 23: M-code for simple cycle gas turbine.

%M-code for thermodynamic properties of regeneration gas turbine

```
k=1.4;
r=[1:2:50];
t=0.5;
x=(k-1)/k;
nR=1-t*(r.^x);
plot(r,nR,'black');
xlabel('pressure ratio,r');
ylabel('Thermal efficiency,n');
legend('regen turbine at k=1.4');
title('regen gas turbine thermal efficiency');
```

Table 24: M-code for regeneration gas turbine.

The fuel consumption rate of each heat engine will then translate from the thermal efficiency using formula state below:

$$Fuel\ consumption = \frac{\left(\frac{3415Btu}{n_{th}}\right)}{netheating\ value\ of\ diesel}$$

After determining the types of co-propulsion engine to implement, the power output selection can be performed by numerical calculation by using the related formula follow the sequence as shown in Figure 48.

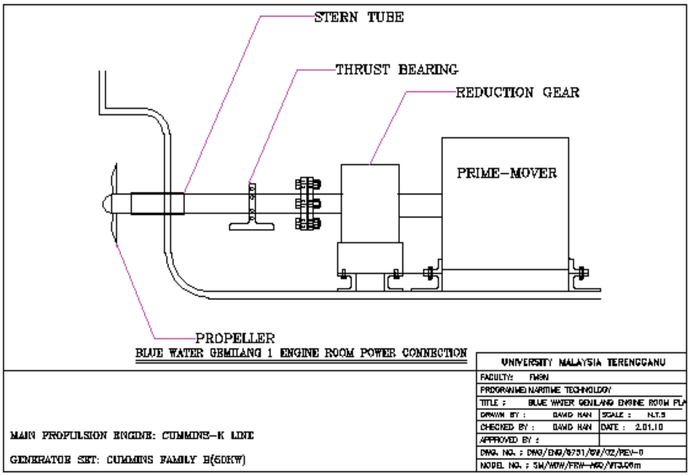


Figure 48: Arrangement of machinery onboard ship.

Types of power	Simplified	Formula
Effective horse power (EHP)	EHP=RV	Effective horse power required to tow a hull without a propeller.
Thrust horsepower (THP)	$THP = T \times V_a$	thrust horsepower is power delivered by propeller to the water
Delivered Horsepower	$DHP = \frac{THP}{n_P}$	Delivered horsepower (DHP) is the power that is delivered by the shaft to the propeller.
Shaft horsepower	$SHP = \frac{DHP}{n_B n_S} = \frac{DHP}{n_M}$	Shaft horse power is the power delivered by engine to the shaft after gearing and thrust bearing.
Brake horse power	$BHP = \frac{SHP}{n_G}$	The power delivered by the prime mover at its connection flange is called brake horsepower.

Table 25a: Formula for numerical power calculation

Result and Discussion

The data acquired during the survey are presented in table form. The Table 25 below shows the detail of the passenger ferry company. Blue water Express ferry services are a company established in 1999. The core business offered are the ferry services to the passengers coming to Pulau Tioman. The company currently owned 8 fast ferries for the passenger services. Besides, the company owned a few cargo ships modified from the ordinary fisherman boat to transfer cargoes in between Pulau Tioman to the mainland to full fill the demands in the Tioman Island Figure 49. (Refer to Table 25b and Table 26).

Company name:	BlueWater Express
Location:	Mersing,Johor
Name of Company's owner:	En.Rizam Bin Ali
Types of business:	passenger fast ferry

Routine:	Mersing jetty to Tioman
Distance:	35n miles
Name of Vessel:	Gemilang 1
Types of vessel:	Fiber single hull vessel
Vessel Manufacturer:	PT.Bintan Shipping Bioteknik Tanjung Pinang Shipyard
Maximum number passenger:	100 passengers

Table 25: Details of the ferry company.

Length overall	23.7m
beam	5.20m
draft	2.20m
Hull types:	Single hull
Materials	Fiber class
Detail of lighting system	12fluerecent light(45watt),12 others light bulb(24watt)
Number of pump required	6 batt pump,1 electrical pump,2 mechanical pump(ramp pump)
Vessel average sailing speed	20knots
DWT(base on dimension)	271.2tonnes

Table 26: Ship Hull details.

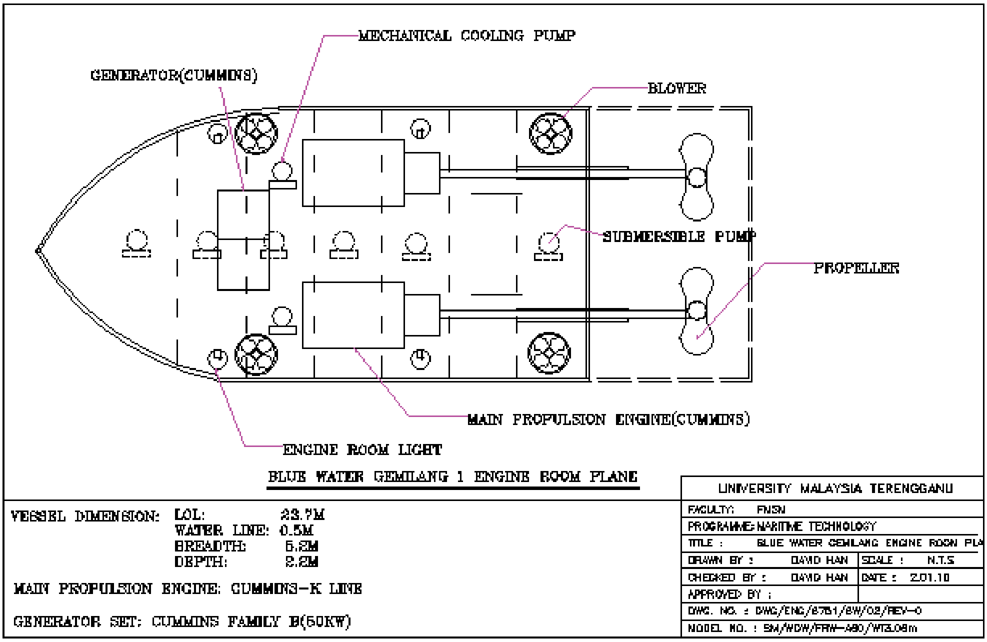


Figure 49 a: Machinery arrangement in Gemilang 1 engine room

The vessel under studies named Gemilang 1. The vessel was constructed by PT. Bintan Shipping Bioteknik in Tanjung Pinang, Indonesia. The ship hull has the dimension as shown in the Table. The machinery used onboard was drafted for the reason of recommendation on the implementation of co-propulsion engine (See Figure 49a, b and Figure 50).

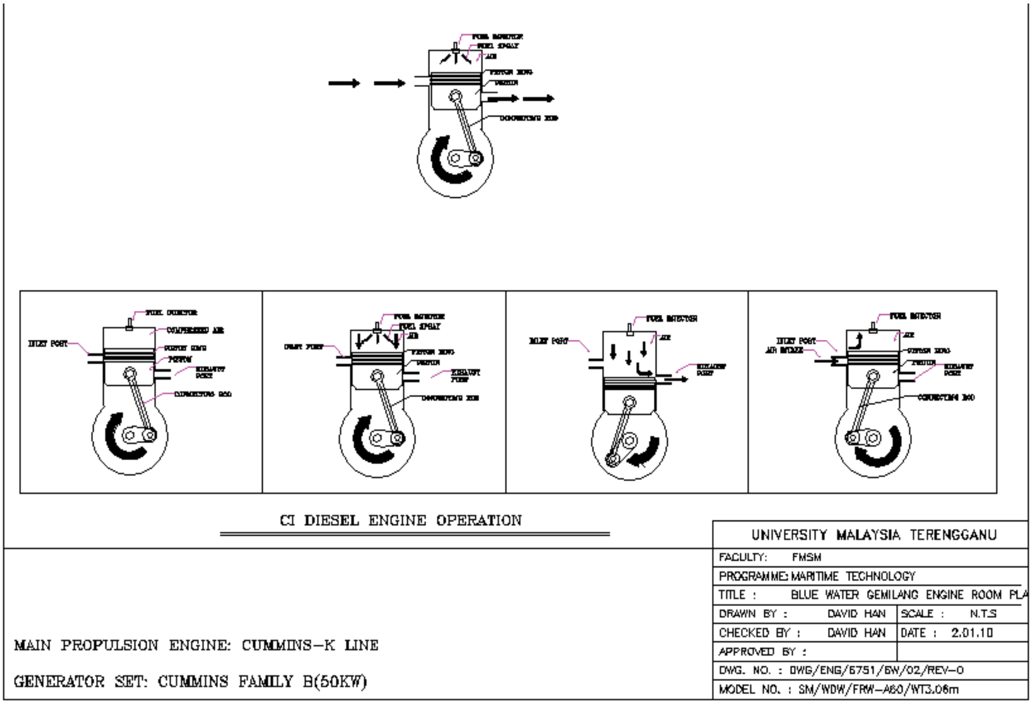
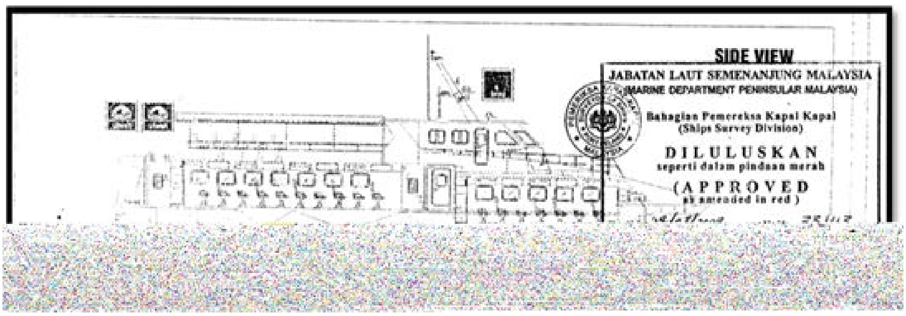
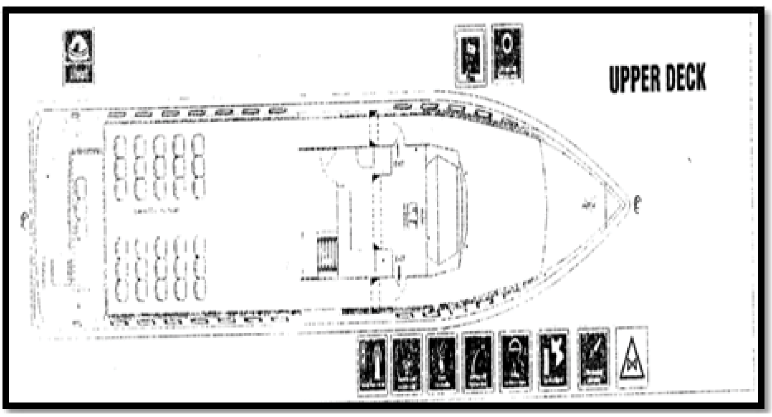


Figure 49 b : Mechanism of CI diesel propulsion engine in Gemilang 1.





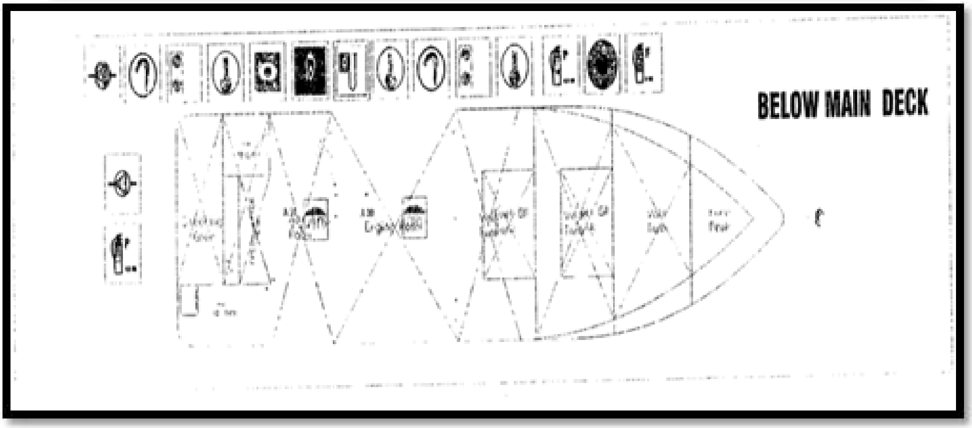


Figure 50 : GA-plan of Gemilang 1 (general arrangement plan).

Gemilang 1 is equipped with 2 propulsion engines and capable to propel the ship at sailing speed up to 20 knots. In order to fulfill the demand of the machinery that is necessary for sailing the desired sailing speed, redundant systems such as water pump system, lighting system, and the electronics devices for the navigational purposes are installed. The vessel is also equipped with a generator power rating up to 50 kW. The properties of the propulsion engine are presented in the Table 27 below.

Engine Details	Description
Engine Mode	KTA-M4 Marine propulsion engine
Engine types	In-Line, 6 cylinder, 4 stroke diesel
Bore & Stroke	159mm x 159mm (6.25 in x 6.25 in)
Displacement	19 L (1150 in3)
Rotation direction	Counter clockwise facing flywheel
Aspiration	Turbo charger after cooled
Fuel Consumption	135.1 (35.7) Rated, 94.6 (25) ISO
Number of engine used	2 pcs
Rating definition	Heavy Duty
Emission	IMO standards
Engine rotation (RPN)	2100 revolution per second
Power rating	522 kW

Table 27: Propulsion engine specification.

In predicting the efficiency of gas turbine and diesel engine, assumption has been made in order to standardize the condition at where the cycles performed. In comparing the performance of gas turbine versus diesel engine; we need to make some assumption on the working fluid for both of the system. The air is necessary in carrying out the combustion process. Fresh air entering the combustion chamber was considered under the cold air standard assumptions [68,69]. Where by the specific heat ratio k, is represented by k =1.4 (specific heat ratio value under room temperature) (See Figure 51).

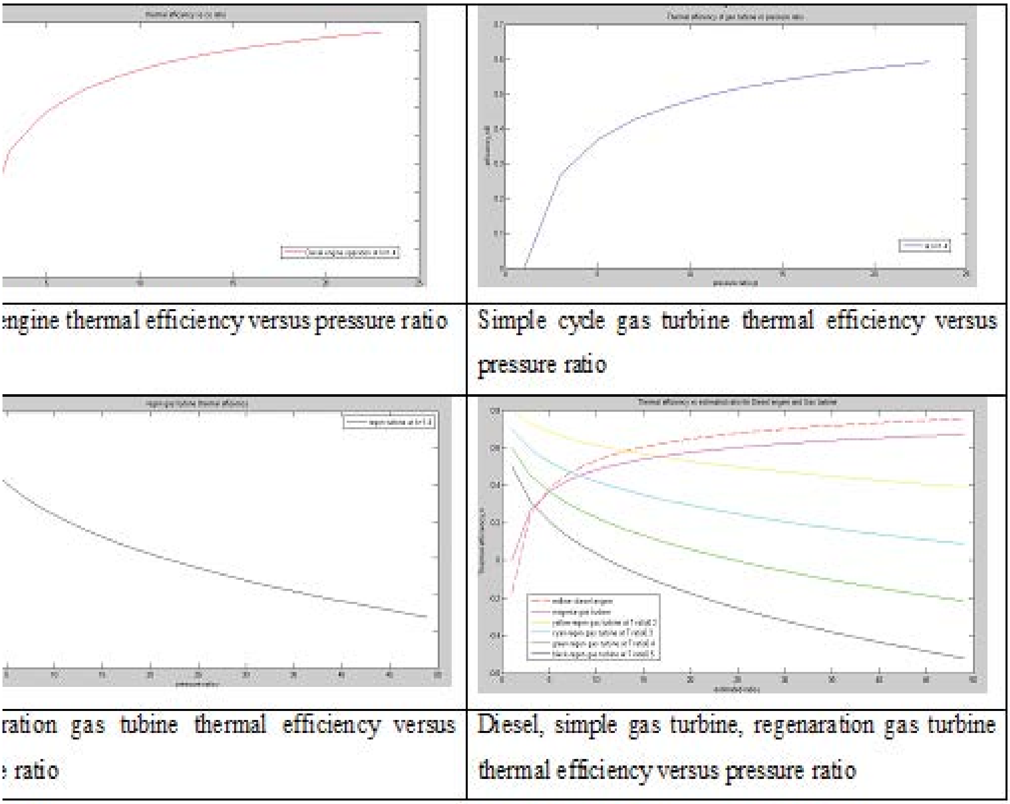


Figure 51 : Thermal efficiency of each type's co-propulsion engine.

Besides, assumption is made on that the pressure ratio and cut-off ratio are similar in term of working condition. Compression ratio r is defined as the ratio of the volume of its combustion chamber from its largest capacity to its smallest capacity. It is a fundamental specification for many common combustion engines. While the pressure ratio r_p, for gas turbine is defined as ratio of the pressure at the core engine exhaust and fan discharge pressure compared to the intake pressure to the gas turbine engine.

$$r_p = \frac{p_2}{p_1} = \frac{v_2}{v_1} = r$$

$$r_p = r_c = r_A$$

Where:

$$r_A = Estimated\ ratio\ on\ working\ condition$$

The study involved the feasibility of implementing a gas turbine to improve the vessel sailing speed up to 35 knots. The study relates the operation of the gas turbine and diesel engine with thermal efficiency of the cycle. Figure 52 illustrates the relation between thermal efficiency with pressure ratio for simple cycle of gas turbine and diesel engine. It shows that at the early state of the curve, gas turbine show steeper increment in thermal efficiency with the increasing pressure ratio.

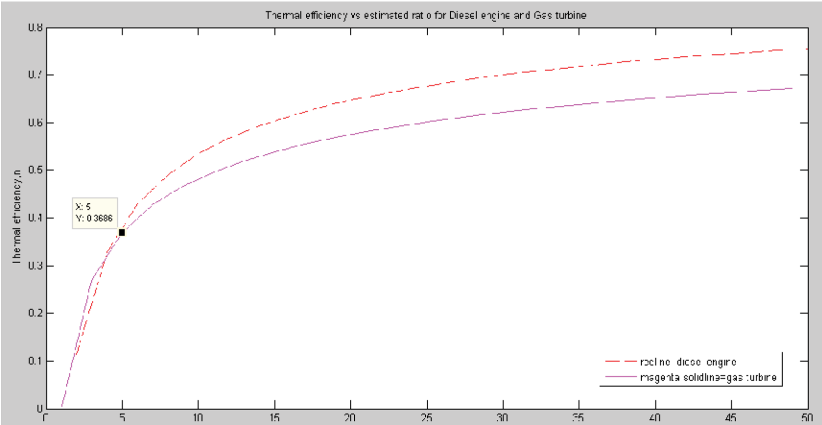


Figure 52 : Thermal efficiency of each types co-propulsion engine

The performance of gas turbine and diesel engine overlaps at pressure ratio 5. In the middle state of the curve, the diesel engine has higher thermal efficiency with the increasing pressure ratio. From the curve shown, it is observed that the simple cycle gas turbine engine is less efficient in comparison to diesel engine. The gas turbine operation can be improved by applying the regeneration cycle. The temperature of exhaust gas leaving the turbine is higher than the temperature of the air leaving the compressor. By leading the heat exhaust gaseous through the heat recuperates to preheat the compressed air from the compressor can improve the thermal efficiency of the gas turbine. Figure 52 shows the thermal efficiency curve between diesel engine, simple cycle gas turbine and the regenerative gas turbine at variable temperature ratio [67,70].

Figure 53 illustrates the regenerative gas turbine with the minimum temperature ratio between the exhaust gas and the compressed air shows higher thermal efficiency in the early stage, the thermal efficiency of the following gas turbine decrease gradually with the increasing of the pressure ratio. From the diagram it is that the gas turbine with regenraton is the ideal selection for the co-propulsion engine because it shows high thermal efficiency in low pressure ratio. Low pressure ratio carries significant information of low back work ratio and horse power of the following engine [71,72].

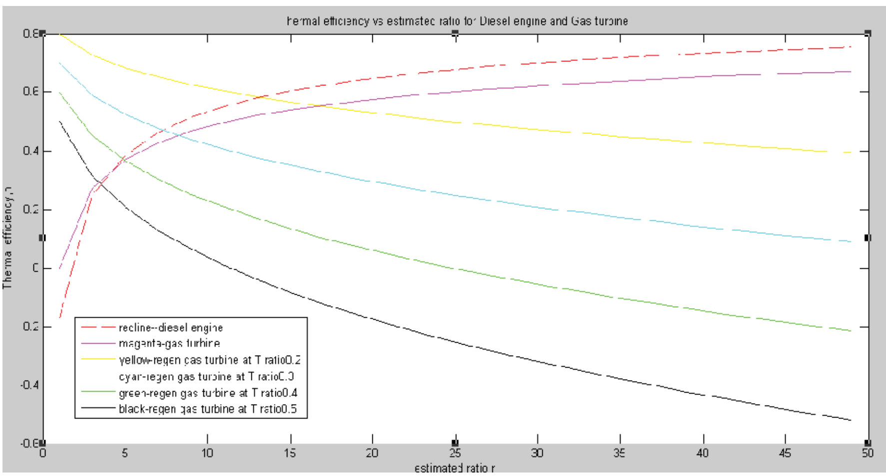


Figure 53: Thermal efficiency of each types co-propulsion engine.

Fuel consumption of co-propulsion engine: The fuel consumption always the criteria to consider during the marine engine selection, the optimum usage of fuel will ensure profits to the passenger company. By using the formula as stated below, the thermal efficiency of co-propulsion engine can be interrelated.

$$Fuel\,consumption = \frac{\left(\dfrac{3415Btu}{n_{th}}\right)}{netheating\,value\,of\,diesel}$$

In this case, we select the diesel fuel as the source for the heat engine. The diesel fuel having the net heating value of 130000 btu/gallon. Substitute the net heating value, then the fuel consumption rate can be represented by the curve plotted by MATLAB as shown in Figure 54.

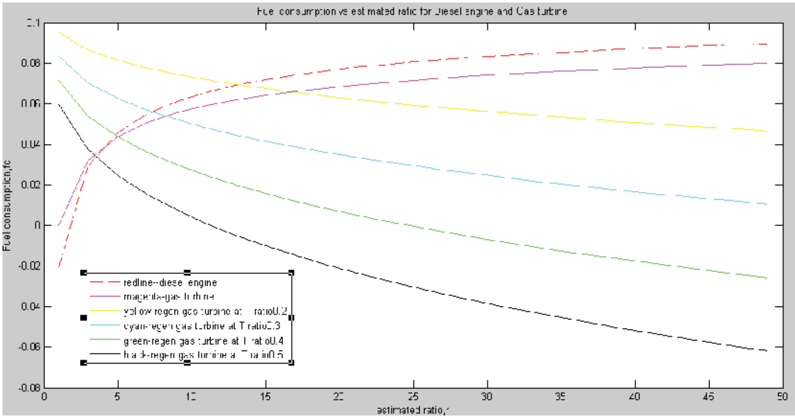


Figure 54: Fuel consumption (gallon) of each types co-propulsion engine.

From the curve shown in Figure 55 it can be concluded that the fuel consumption rate versus estimated ratio for the diesel engine, simple cycle gas turbine and regenerative gas turbine shows the similar trend. The regeneration gas turbine with the temperature ratio 0.3 showing a moderate fuel spent over the power production. Hence, the regenerative gas turbine will be the ideal selection as co-propulsion engine among the others. Location for the regeneration gas turbine in engine room [68,71].

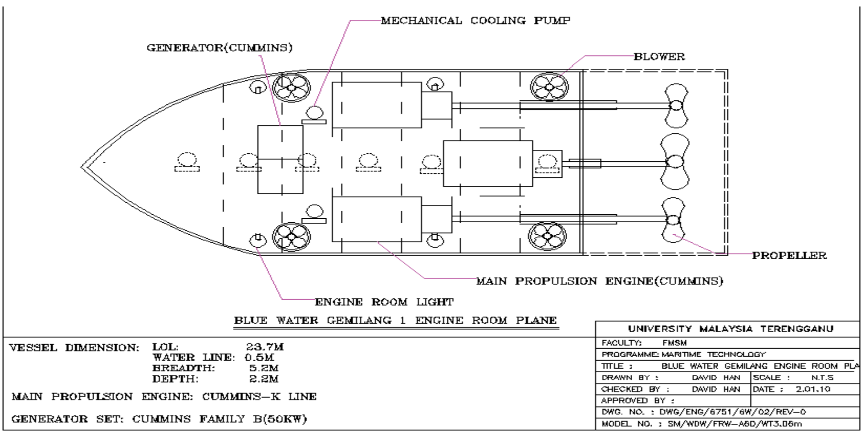


Figure 55: Recommendation for distribute the co-propulsion engine.

Power Calculation: the current existing diesel engines remain as a main propulsion engine to sail the ship at economic speed. The minimum power required to propel the vessel is computed theoretically. the numerical modeling involves assumption on the numbers of crews, weight of luggage and cargoes carried to estimate the dead weight tonnes of the vessel under studies. The brake horse power obtained base on theoretical calculation at variable speed is shown in the Figure 56, Table 28.

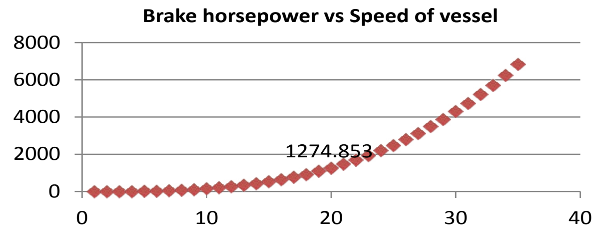


Figure 56: Brake horse power at various speeds.

Description	Theoretical Calculation	Engine applied onboard ship
hp	1274.85 hp	1400 hp
kW	950.66 kW	10434.98 kW

Table 28: Validation on the power calculation.

From the diagram the power rating of the diesel engine calculated based on theoretical calculation are closed to the diesel engines currently applied on that following vessel. From the survey, we knew that there were 2 diesel engines with power rating of 700 hp each applied on the vessel to propel the vessel to sail at optimum speed. On economy aspect, the selection of higher horsepower propulsion engines is necessary for the vessel to sail at optimum speed instead of sailing a vessel with full speed at engine maximum performances. The speed control can be done by adjusting on the throttling valve located at fuel pump attached to diesel engine. Besides, in real environment, there are some other factors to take into consideration. Air resistant due to the size of the superstructure of the vessel may require higher power propulsion to propelling the vessel to move forward [69,73].

For the co-propulsion engine, the output power becomes the terminology chosen in select the marine engine. Referring to the curve shown, the resistances of the vessel differ at variable speed. Hence, numerical calculation on the power at various speeds is necessary in order to ensure the vessel can sail at desired speed (See Figure 57a and b). Figure 57b shows the types of power at various speeds. The minimum power required to propel a vessel to move forward is the effective horse power. The brake horsepower is the highest power and will encounter power loss in each transition state from the engine to the shaft following with the propeller.

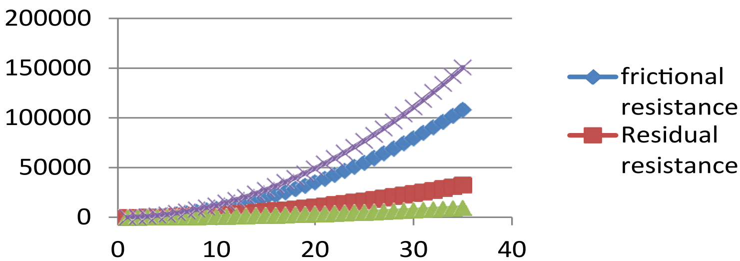


Figure 57a: Types of resistances at variable speed.

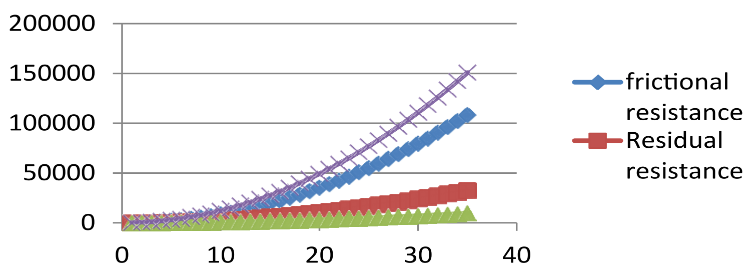


Figure 57a: Types of resistances at variable speed.

The result from the numerical calculation on the power output of co-propulsion engine shown that the minimum brake horsepower required for the co-propulsion engine is 1274.85 hp. The recommended horse power for co-propulsion to implement is 1300 hp.That is 10% margin of power excess to suit the speed of vessel. The regeneration gas turbine is selected after performing the analysis by plotting curve. The exhaust gas released by regeneration gas turbine was retracted and used to reheat the compressed gas existing from the compressor.

The paper aimed to improve ecotourism vessel sailing speed by implement a gas turbine as co-propulsion engine. The objective is to improve the speed of vessel up to 35 knots with minimum fuel consumption is demonstrated in the power curve. Numerical calculation on the power output of co-propulsion engine shown that the minimum brake horsepower required for the co-propulsion engine is 6263.35 hp [74]. The recommended horse power for co-propulsion to implement is ranging from 6890 hp up to 6900 hp. That is 10% margin of power excess to suit the speed of vessel. The result of regenerative gas turbine have an advantages by reduces the heat release to the environment. In economy aspect, although gas turbine co-propulsion engine display higher initial cost, but the lower operating and maintenances cost will reduced the payback period of the following investment [73,74].

Conclusion

The paper proposed to improve ecotourism vessel sailing speed by implementing a gas turbine as co-propulsion engine. The study of feasibility of implementing a gas turbine as co-propulsion engine relates the performances of the gas turbine to the thermal efficiency and fuel consumption. The objective of this research is to improve the speed of vessel up to 35 knots with minimum fuel consumption. From the result of this study, the gas turbine is a practical system recommended to install into ecotourism vessel. The recommended gas turbine to be installed lay in the power output ranging 6890 hp to 6900 hp.

Potential of Biomass Cogeneration for Port Powering

Abstract

Waste disposal from is becoming an increasing problem in today's society. Thus various ways are being promoted to minimize, re-use and recycle waste streams there will always be residual wastes in a safe and beneficial way. The classification of fuels derived from waste sources as sustainable controversial especially when it is linked carbon cycle and food. The processing of these waste types, by various means, to provide fuels for electricity and heat generation, and transportation fuels, can provide many environmental advantages in term of energy production that lead to vast reduction in the waste stream, production of valuable byproducts, waste land reduction and the

killing of the pathogens and bacteria that cause disease. The process can be more sustainable by using hybrid cogeneration biomass system for marine system. This paper will consider how enormous waste from ship and port and discuss potential of hybrid biomass cogeneration for marine system for port powering.

Keywords: Alternative energy; Assessment; Bio-derived; Energy; Environment; Hybrid; Marine; Port; Power; Waste; Recycle; Sustainability;

Introduction

Green house gas (GHG) pollution is linked to energy source. Large amount of pollution affecting air quality is prone by reckless industrial development. For years, many think that everything that run into the trio of nature, the atmosphere, ocean and soil is infinite. The atmosphere and the ocean that is providing us source of freshening, winds and current are far more vulnerable to polluting activities from manmade energy sources that have run off into them too many poisons that the air, the ocean and land may cease to serve more purpose if care is not taking to prevent pollution affluence. Human activities are altering the atmosphere and the planet is warming. It is now clear that the costs of inaction are far greater than the costs of action. Aversion of catastrophic impacts can be achieved by moving rapidly to transform the global energy system.

Sustainability requirement that can be solved through energy conservation (cf. IPCC 2007: 13) are energy and associated efficiency, development, environment, poverty. Stakeholder from government's consumers, industry transportation, buildings, product designs (equipment networks and infrastructures) must participate in the decision work for sustainable system. Recently the marine industry is getting the following compliance pressure regarding environmental issues related to emission to air under IMO MARPOL Annex 6. A world without port means a lot to economy transfer of goods, availability of ships and many things. Large volume of hinterland transportation activities import tells a lot about intolerant to air quality in port area. Adopting new energy system will make a lot of difference large number of people residing and working in the port. Most port facilities are powered by diesel plant. Integrating hybrid of hydrogen and solar into the existing system will be a good way for the port community to adapt to new emerging clean energy concept [18,75].

The search for new source of energy to mitigate threat of climate change is becoming an urgent matter. New knowledge and technology have emerged. and race is on for the choice of the best. Ports of the world collect massive waste from the ship and oil platform. There is no drain in this planet, the waste got nowhere to go, but to return back to the system with consequential environmental damage, contamination of rivers, estuarine and the ocean and landfill and associated degradation as well as cost treatment. The greatest challenge for humanity lies in recycling waste for production of energy.

Sources of alternative energy are natural. There has been a lot of research about the use of free fall energy from the sun to the use of reverse electrolysis to produce fuel cell. For one reason or the other these sources of energy are not economical to produce. Most of the problems lie on efficiency and storage capability. Early human civilization use nature facilities of soil, inland waterways, waterpower which are renewable for various human needs. Modern technology eventually replaces renewable nature with non renewable sources which requires more energy and produces more waste. Energy, Economic and Efficiency (EEE) have been the main driving force to technological advancement in shipping. Environmental problem linkage to source of energy poses need and challenge for new energy source. The paper discuss risk based iterative and integrative sustainability balancing work required between the 4 Es in order to enhance and incorporate use of right hybrid combination of alternative energy source (Biomass, solar and hydrogen) with existing energy source (steam diesel or steam) to meet marine system energy demands (port powering).

Hybrid use of alternative source of energy remains the next in line for the port and ship power. Public acceptability of hybrid energy will continue to grow especially if awareness is drawn to risk cost benefit analysis result from energy source comparison and visual reality simulation of the system for effectiveness to curb climate change contributing factor, price of oil, reducing treat of depletion of global oil reserve. Malaysia tropical climate with reasonable sunlight fall promise usage of source of sun hybrid candidate energy, also hydrolysis from various components to produce fuel cell and hybridization with conventional system and combined extraction of heat from entire system seem very promising to deliver the requirement for future energy for ports.

This paper discuss available marine environmental issues, source of energy today, evolution of alternative energy due to the needs of the time and the barrier of storage requirement, system matching of hybrid design feasibility, regulations consideration and environmental stewardship. The paper also discusses holistic assessment requirement, stochastic evaluation, using system based doctrine, recycling and integrated approach to produce energy. With hope to contribute to the ongoing strives towards reducing green house gases, ozone gas depletion agents and depletion of oxygen for safety of the planet in order to sustain it for the right of future generation.

Energy, Environment and Sustainable Development

Since the discovery of fire and the harnessing of animal power, mankind has captured and used energy in various forms for different purposes. This include the use of animal for transportation, use of fire, fuelled by wood, biomass, waste for cooking, heating, the melting of metals, windmills, waterwheels and animals to produce mechanical work. Extensive reliance on energy started during industrial revolution. For years there has been increased understanding of the environmental effects of burning fossil fuels has led to stringent international agreements, policies and legislation regarding the control of the harmful emissions related to their use.

Despite this knowledge, global energy consumption continues to increase due to rapid population growth and increased global industrialization. In order to meet the emission target, various measures must be taken, greater awareness of energy efficiency among domestic and industrial users throughout the world will be required and domestic, commercial and industrial buildings, industrial processes, and vehicles will need to be designed to keep energy use at a minimum. Figure 58a shows that the use of fossil fuels (coal, oil and gas) accounted continue to increase. Figure 58b shows the contribution of total energy consumption in the by global region. And Figure 59 show natural gas consumption [18,76].

Various measures must be taken to reduce emission targets. The current reliance on fossil fuels for electricity generation, heating and transport must be greatly reduced, and alternative generation methods and fuels for heating and transport must be developed and used. Sustainable design can be described as system work that which enhances ecological, social and economic well being, both now and in the future.

The global requirement for sustainable energy provision is become increasingly important over the next fifty years as the environmental effects of fossil fuel use become apparent. As new and renewable energy supply technologies become more cost effective and attractive, a greater level of both small scale and large scale deployment of these technologies will become evident. Currently there is increasing global energy use of potential alternative energy supply system options, complex integration and switching for design requirement for sustainable, reliable and efficient system. The issues surrounding integration of renewable energy supplies need to be considered carefully.

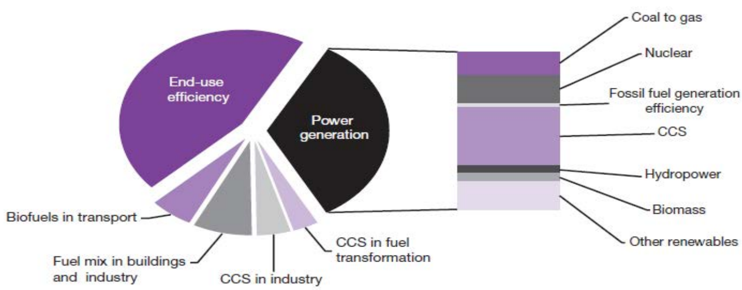


Figure 58a: GHG Emissions Reductions through 2050, by Consuming Sector.

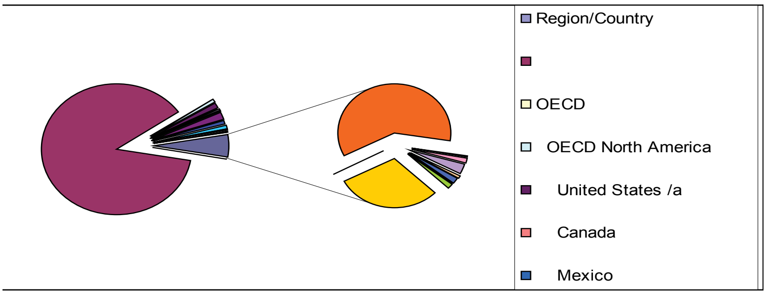


Figure 58b: World consumption of energy by region.

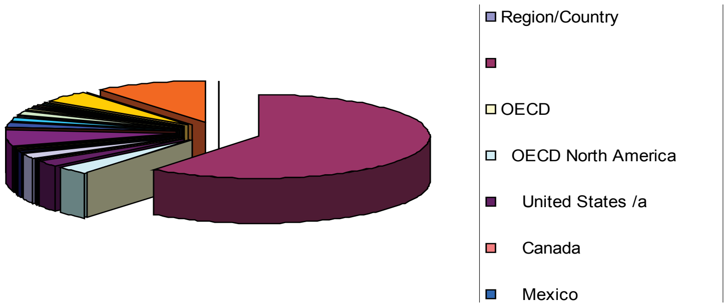


Figure 59: World consumption of natural gas (EIA).

Current Use of Renewable Energy: most renewable energy development and supply is in small scale, particularly on islands and in remote areas, where the import of energy sources through transport, pipeline or electricity grid is difficult or expensive. individual buildings, industries and farms are also looking to the possibility of energy self-sufficiency to reduce fuel bills and make good use of waste materials which are becoming increasingly difficult and expensive to dispose of various studies have been carried out into the extensive use of new and renewable resources to generate electricity, on a small scale, for rural communities, grid-isolated islands and individual farms. Recent studies focus on:

i. Security of supply: where consideration is given to intermittent sources, demand and supply must be as well matched as possible and this is generally a function of climate. Available supply sources should be considered in order to find the best possible correlation between demand and supply.

ii. Hybrid with conventional system: where energy limited sources used as spinning reserve for times when the intermittent supply does not meet the demand. If this type of spinning reserve is not available, the need for adequate electricity storage was shown to be an important consideration, especially in smaller scale projects.

Emerging Renewable Energy System: In order to provide a reliable electricity supply, reduce energy wastage, and enable the energy requirements for heat and transport to be met, the outputs of these intermittent sources may be supplemented by various means. These may include the use of storage devices and the use of biomass and waste materials in engines, turbines and fuel cells for the production of electricity and heat, in vehicles for transportation or in heating supply or storage systems. The integration and control strategies for all of these components must be carefully considered and implemented and this complexity has been seen as a barrier to renewable energy system deployment. There are many possible supply combinations that can be employed and the optimum combination for a given area depends on many factors. the balances being considered can be complex, and this highlights the need for a decision support framework through which the relative merits of many different scenarios and control strategies for a chosen area can be quickly and easily analyzed [20,42].

The intermittent nature of most easily exploited sources of alternative energy remains the major problem for the supply the electricity network. This has implications for the management of this transitional period as the balance between supply and demand must be maintained as efficiently and reliably as possible while the system moves towards the ultimate goal of a 100% renewable energy supply over the next fifty to one hundred years. It important to take the of amount intermittent electricity sources that can be integrated into a larger-scale electricity supply network into consideration.

Excess supply could be supplied by plant run on fuels derived from biomass and waste. The renewable hybrid age require utilities, local authorities and other decision makers to be able to optimization that beat constraints, potentials, and other energy requirements from port powering. When intermittent electricity generating sources are used in a sustainable energy supply system, it is important to consider how well the profiles of demand and supply of electricity match. It is advisable to seek the best possible match by using varying amounts of a range of different intermittent sources. It is prudent to use as diverse a mix of generators as possible.

Where substantial amounts of intermittent sources are used in a system, it is useful to have an outlet for excess electricity, in order to avoid wastage. The electricity stored, using various means, depending on the scale of storage required can be available for use at times when there is not enough being generated to meet demand. The sizing and type of storage system required depends on the relationship between the supply and demand profiles. For excess amount electricity produced this could be used to make hydrogen via the electrolysis of water. This hydrogen could then be stored, used in heaters or converted back into electricity via a fuel cell later as required. Using excess electricity, this hydrogen could be produced centrally and piped to for port or produced at vehicle filling stations for haulage, or at individual facilities in the port [42,49].

Energy Consumption, Demand and Supply: Energy is considered essential for economic development, Malaysia has taken aggressive step in recent year to face challenges of the world of tomorrow and this includes research activities strategic partnership. One example is partnership with the Japanese government for construction on sustainable energy power station in the port klang power station, pasir gudang power station, terengganu hydro-electric power station and batang ai hydro-electric power station which are main supply to major Malaysian port. The above enumerated power stations are constructed with energy-efficient and resource-efficient technologies. Where power station are upgraded the power station by demolishing the existing aging, inefficient and high emission conventional natural gas/oil-fired plant (360 mw) and installing new 750 mw high efficiency and environment friendly combined cycle gas fired power plant built at amount of jpy 102.9 billion. Table 29 shows Malaysia energy and environmental data from eia and Table 30 shows energy outlook for Malaysia.

Energy-Related Carbon Dioxide Emissions (2006E)	163.5 million Metric tons, of which Oil (44%), Natural Gas (41%), Coal (15%)
Per-Capita, Energy-Related Carbon Dioxide Emissions ((Metric Tons of Carbon Dioxide) (2006E)	6.7 Metric tons
Carbon Dioxide Intensity (2006E)	0.6 Metric tons per thousand \$2000-PPP** 96.0 billion kilowatt hours

Table 29: Malaysia environmental review [EIA].

The combined-cycle generation plant is estimated to reduce the power station's environmental impact, raise generation efficiency and make the system more stable. The total capacity of power generation of 1,500 MW is equal to 14% of total capacity of TNB in peninsula of 10,835 MW and indeed this power station is one of the best thermal power stations with highest generation efficiency in Malaysia of more than 55%. The rehabilitation, the emissions of Nitride oxide (NOx) is reduced by 60%, Sulfur dioxide (SO_2) per unit is reduced by almost 100% and Carbon dioxide (CO_2) emission is reduced by 30%. Port operation energy demands are for transportation, hot water and heat. This third generation plan can easily be integrated with alternative energy. Table 30 shows Malaysia energy and environment outlook and Figure 60 show Malaysia energy consumption. Figure 61 shows the statistic of energy use in Malaysia. The energy use in all sectors has increased in recent years, most especially the energy use for transport has almost doubled it continues to grow and becoming problem. This trend is being experienced in industrialized and developing world.

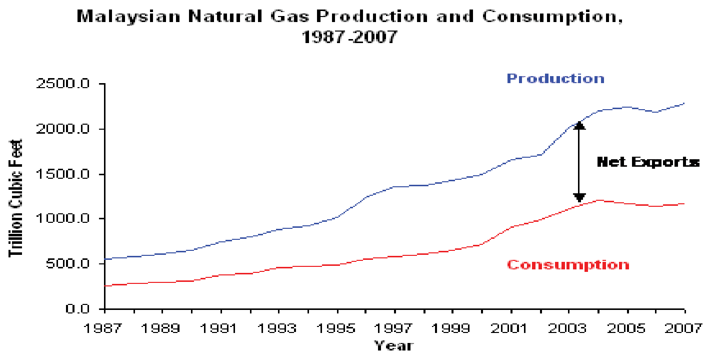


Figure 60: Malaysia Natural gas production and consumption trend.

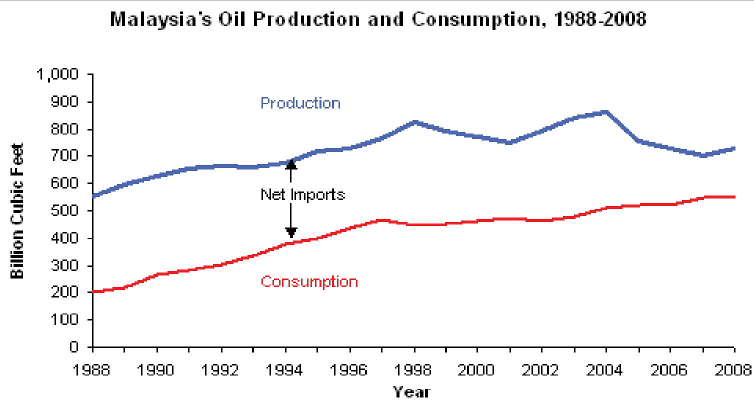


Figure 61: Malaysia Natural electricity consumption (EIA, 2007).

Energy demand for port work is supply from grids which are well established in most developed world. The method and sitting of generating conventional energy and renewable energy determine system configuration. Hierarchy systems that can be deduced from these two variables are:

i. Limited capacity energy: This includes traditional thermal plants coal fired, gas fired, oil fired and nuclear power plants, which supply almost all of the electricity to the national grid in. The amount of electricity that can be generated is limited by the physical capacity of the plant, time for maintenance and unplanned outages Table 30.

ii. Limited energy plant: they are Renewable Energy Generators plant that are limited by the amount of energy or fuel available to them at a certain time from a certain area (e.g. rainfall, waste, seasonal energy crop yields) and cannot always run at their rated capacity.

iii. Intermittent energy plant: recent year has seen increased hybrid generators. Growing distributed renewable generating plants has implications for the organisation of the electricity supply network. Inter-connectivity network electrical system configuration. For centralized system it is better to have minor generators throughout the network that will allow many smaller areas of that network to become mainly self sufficient, with the grid stand as backup.

proven oil reservoir(January 2009)	4 Billion barrels
oil production (2008)	727, 2000 bbl/d, of which 84% is crude oil
oil consumption (2008)	547,000 bbl/d
crude oil Idistilation capacity (January 2009)	514,832 bbl/d
proven natural reserve (2007)	83 trillion cubic feet
Natural gas production (2007)	2.3 trillion cubic feet
Natural gas consumption (2007)	1.2 trillion cubic feet
Recoverable coal reserves (2008)	4.4 million short tons
Coal production (2007)	1.1 million short tons
Coal consumption (2007)	18.5 million short tons
Electricity Installed Capacity (2006E)	23.3 gigawatts
Electricity Production (2006E)	99.1 billion kilowatt hours
Total Energy Consumption (2006E)	2.56 quadrillion Btu*, of which Natural Gas (35%), Oil (41%), Coal (15%), Hydroelectricity (2%)
Energy Intensity (2006E)	99.4 million Btu per person
Total Per Capita Energy Consumption ((Million Btu) (2006E)	8,891 Btu per $2000-PPP**

Table 30: Malaysia Energy outlook (EIA).

Fossil fuel use for transportation and port activities has increased dramatically over the past decade, and shows little signs of abating. This has caused concern about related environmental and health effects. There is need for to develop alternatively fuel system that produces little or no pollution. The main fuels that can be used in a variety of land, sea and air vehicles are biogas in natural gas and fuel cell vehicles, biodiesel in diesel vehicles, ethanol and methanol in adapted petrol and fuel cell. Biogas can be converted to run on natural gas and in some fuel cell. It must be cleaned first to create a high heating value gas (around 95% methane, a minimum of heavy gases and no water or other particles). Fuel cell powered engine can run on pure hydrogen, producing clean water as the only emission. Biodiesel can be used directly in a diesel engine with little or no modifications and burns much more cleanly and thoroughly than diesel, giving a substantial reduction in unburned hydrocarbons, carbon monoxide and particulate matter. The main barriers to the implementation of alternative fuels is the requirement for a choice of fuel at a national level, the necessity to create a suitable refuelling infrastructure, the length of time it will take to replace or convert existing vehicles, and the need for a strong public incentive to change [49,76,77].

Biomass Demand and Supply: recent year has witnessed emerging trade on biofuel product between the us, eu, and Asia. Particularly South America, Brazil has already been branded to be producing en-mass ethanol from sugar cane since the 1970s with a cost per unit reportedly the lowest in the world. The top importers from us, eu, japan and Korea have increasing demand that will have to be satisfied by increased shipping capacity. Also seaborne vegetable oil supply is increasingly growing. The eu imports 5.7 mt in 2001 and rise to 10.3 mt for 2008, an almost 50% of total capacity. Figure 2 show statistic of present food related biofuel, this reflect future food scarcity. Figure 1 shows the present global percentage of consumption for ethanol. Brazil exports the most ethanol globally at about 2.9 million tonnes per year [49,78].

Bioenergy: The 21st century is becoming age of recycling where a lots of emphasize is placed on reducing waste and reuse of material to curb current environmental problems, maximizing use of depleting natural resources and conserve energy. Modern day sustainable use and management of resource recommend incorporating recycling culture in human ways and the use of modest process. Biomass is not left behind in this. The use of biomass energy resource derived from the carbonaceous waste of various natural and human activities to produce electricity is becoming popular. Biomass is considered one of the clean, more efficient and stable means of power generation. Enormous being generated from marine system make it imperative for marine industry to tap this new evolving green technology to employ mobile based micro generation biomass for mobile for marine energy system.

Advantage of biomass compared to other renewable based energy systems is that biomass can generate electricity with the same type of equipment and power plants that burn fossil fuels. Innovations in power generation of fossil fuels may also be adaptable to the use of biomass fuels. Also the ashes from biomass consumption, which are very low in heavy metals, can be recycled. Various factors notably have hindered the growth of the renewable energy resource, especially efficiency, like wise most biomass power plants operating today are characterized by low boiler and thermal plant efficiencies. Both the fuel's characteristics and the small size of most facilities contribute to these efficiencies. In addition, such plants are costly to build. All in all, converting waste into fuel is beneficial even without a energy gain, if that waste will otherwise pollute the environment. Biomass has low sulfur content, this give biomass combustion advantage of less acidification than fossil fuel source.

Biomass remains potential renewable energy contributor to net reduction in greenhouse gas emissions and offsetting of CO_2 from fossil generation. The current method of generating biomass power is biomass fired boilers and Rankine steam turbines, recent research work in developing sustainable and economic biomass focus on high-pressure supercritical steam cycles. It uses feedstock supply system, and conversion of biomass to a low or medium Btu gas that can be fired in combustion turbine cycles. It result in efficiencies of one-and-a-half times that of a simple steam turbine. Biofuels has potential to influence marine industry and it has become importance for ship designers and ship owners to accept their influence on the world fleet of the future. Especially the micro generation concept with co generation for cargo and fuel can be a good biomass system for ship. And the waste being dumped by ships in port can be use to power land based and coastal infrastructure.

This paper discuss review of conceptual work, trend, sociopolitical driver, economic, development, risk approach and future of biomass with hope to bring awareness to local, national and multinational bodies making to adopt biofuels policies. The maritime industry is always slow to adopt new technology. The paper direct awareness call to maritime multidisciplinary expertise in regulation, economics, engineering, vessel design and operation to break the nity gritty barrier. Time has come for the shipping industry to take advantage of growing tide to tap benefit promised by use of waste to power generation for marine system.

Biomass Developmental Trend: The concept of using of biofuels for energy generation has been existing for a long time. In the face of challenges posed by environmental need, the treat of climate change, pollution of water resources, and its growth is likely to dominate renewable energy market. the production and use of biofuels worldwide has grown significantly in recent years. Bio-fuels exist in solid, liquid or gas form, there by potentially affecting three main core energy markets of materials. solid biofuels or biomass is used in external combustion. Table 31 shows trend in biomass development. biomass use in use in the shipping industry is limited to liquid biofuel due to lack of appropriate information, economics forecasts, sources of solid biomass include by-products from the timber industry, agricultural crops, raw material from the forest, major parts of household waste, and demolition wood. All things being.Table 32 biomass development trend equal using pure biomass that does not affect human and ecological food chain is suitable energy source for biomass.

Region	Consumption
World ethanol consumption	51 million tones, 2007
US and brazil	68%
EU and China	17% - surplus of 0.1 million tones
US deficit	1.7mt
EU deficit	1.3 mt
World deficit	1mt

Table 31: World ethanol consumption 2007 [EIA]

Biofuel source	Growth in 2008	Gowth per annum
Vegetable oil	33 mt in 2000 to 59 mt	7.5%
Palm oil	13 mt in 2000 to 32 mt	8.9%
Soya bean	7 mt to some 11.5 mt	39%

Table 32: Biofuel growth [NREL].

The current world biofuels market is focused on: Bioethanol blended into fossil motor gasoline (petrol) or used directly and biodiesel or Fatty Acid Methyl Ester diesel blended into fossil diesel. The Fischer-Tropsch model involves catalyzed chemical reaction to produce a synthetic petroleum substitute, typically from coal, natural gas or biomass. It is used to runs diesel engines and some aircraft engines. The use as synthetic biofuel lubrication oil or aid synthetic fuel from waste seems promising and negates risk posed by food based biomass. Oil product and chemical tankers being constructed now are likely to benefit from the use of biomass. However use on gasoline engines ignites the vapors at much higher temperatures pose limitation to inland water craft as more oxide of nitrogen can be released to the atmosphere [43,79].

Biomass Developmental Trend Spillage to Shipping: just like tanker revolution influence on ship type, demand for biomass will bring capacity, bio - material change from source to production area to the point of use.Technological, environmental change will also require ships of different configuration, size and tank coating type as well as impact on the tonne mile demand. Recently biofuel is driving a new technology worldwide; the use of biofuels for cars and public vehicles has grown significantly. Effect on shipping is likely to be followed by shipping of large scale growth on exports and seaborne trade of biomass product from key exporting regions in order to balance supply and demand. With excess capacity waiting for source material it seems inevitable that shipping demand will increase.

Classification of Biomass

According to generation types: Biomass generation and growing trend can be classified into 3 generation types.

i. First generation biofuels are made from food like from sugar or starch, vegetable oil or animal fats to produce biodiesel Table 33.

ii. Second generation biofuels are waste derived biomass from agricultural and forestry, fast growing grasses and trees specially grown as so called energy crops.

iii. Third generation biofuels, use green fuels like algae biofuel made from energy and biomass crops that have been designed in such a way that their structure or properties conform to the requirements of a particular bioconversion process.

Industry	progress
UK on June 2007	First train to run on biodiesel went into service for a six month trial period. The train uses a blended fuel, which is Central. 20% biodiesel hybrid mix augmentation possibility to at least a 50% mix. It has future possibility to run trains on fuels entirely from non-carbon sources.
Argent Energy (UK) on 26th of October 2007.	UK buses running on B100 was launched A UK pilot project where buses are run on B100 Argent Energy (UK) Limited is working together with Stage coach to supply biodiesel made by recycling and processing animal fat and used cooking oil for marine system. Limited is working together with Stagecoach to supply biodiesel made by recycling and processing animal fat and use of cooking oil for the pilot project.
Ohio Transit Authority (COTA) on January 15, 2006	Successfully tested a 20% blend of biodiesel (B20) in its buses wich eventually leads to approval of fleet wise use of biodiesel. In April 2006. COTA is working to use 50-90% biodiesel blends (B50 - B90) during the summer months.
US DOE development projects in 2001(Vermont project)	Funded five new advanced biomass gasification research and a projection for regular decrease of diesel fuel consumption by over one million gallons per year.
Ford on 2008,	Announce £1 billion research project to convert more of its vehicles to new biofuel sources.
BP Australia	Sold over 100 million liters of 10% ethanol content fuel to Australian motorists, and Brazil sells both 22% ethanol petrol nationwide and 100% ethanol to over 4 million cars.
The Swedish National Board for Industrial and Technical Development in Stockholm	Several Swedish universities, companies, and utilities, In 2008,Collaboration to accelerate the demonstration of the gas turbine natural-gas firing plant (0.6 megawatts of power output for a simple gas /.turbine cycle). It is a trend that is gathering momentum.
`AES Corporation	Recently completed a successful trial to convert the plant to burn a mixture of coal and biomass. With further investment in the technology, nearly half of Northern Ireland's 2012 renewable target could be met from AES Kilroot alone.
For power stations	B&W have orders in the EU for 45 MW of two-stroke biofuel engines with a thermal efficiency of 51-52%. Specifically, these operate on palm oil of varying quality.

According to sources types: North American Electric Reliability Council (NERC) region supply has classified biofuel into the following four types: agricultural residues, energy crops, forestry residues, and urban wood waste and mill residues. A brief description of each type of biomass is provided below:

i. Agricultural residues from the remaining stalks and biomass material left on the ground can be collected and used for energy generation purposes this include residues of wheat straw

ii. Energy crops are produced solely or primarily for use as feedstocks in energy generation processes. Energy crops includes hybrid, switch grass grown on idled or in pasture. The most important agricultural commodity crops being planted in the United States are corn, wheat, and soybeans represent about 70% of total cropland harvested. Thus, this is not encouraged to prevent food scarcity.

iii. Forestry residues are composed of logging residues, rough rotten salvageable dead wood and excess small pole trees.

iv. Urban wood, waste and mill residues are waste woods from manufacturing operations that would otherwise be landfilled. The urban wood waste and mill residue category includes primary mill residues and urban wood such as pallets, construction waste, and demolition debris, which are not otherwise useful.

Biomass for electricity generation is treated in four ways in NEMS:

i) New dedicated biomass or biomass gasification,

ii)Existing and new plants that co-fire biomass with coal,

iii) Existing plants that combust biomass directly in an open-loop process

iv) Biomass use in industrial cogeneration applications. Existing biomass plants are accounted for using information such as on-line years, efficiencies, heat rates, and retirement dates, obtained through EIA surveys of the electricity generation sector.

Choice of Conventional Power System

Internal Combustion and Diesel Engines: Two common load following generation technologies involve the use of diesel in compression ignition engines (diesel engines) and natural gas in Internal Combustion Engines (ICEs). Both of these engine types may also be run on sustainable fuels derived from biomass and waste with diesel engines running on biodiesel, pyrolysis oil or vegetable oil and ICEs running on biogas, ethanol or methanol and this requires little or no modification. Diesel engine generating sets with rated outputs from 50 kWe to 10 MWe and ICE generating sets with rated outputs of between 100 kWe and 2 MWe are available. Figure 62 shows diesel engine retrofit option towards reducing emission. Typically in the order of 2:1 and electrical efficiencies at full load are around 25 to 30%, again varying with partial load. Figure 62 shows a typical internal combustion engine.

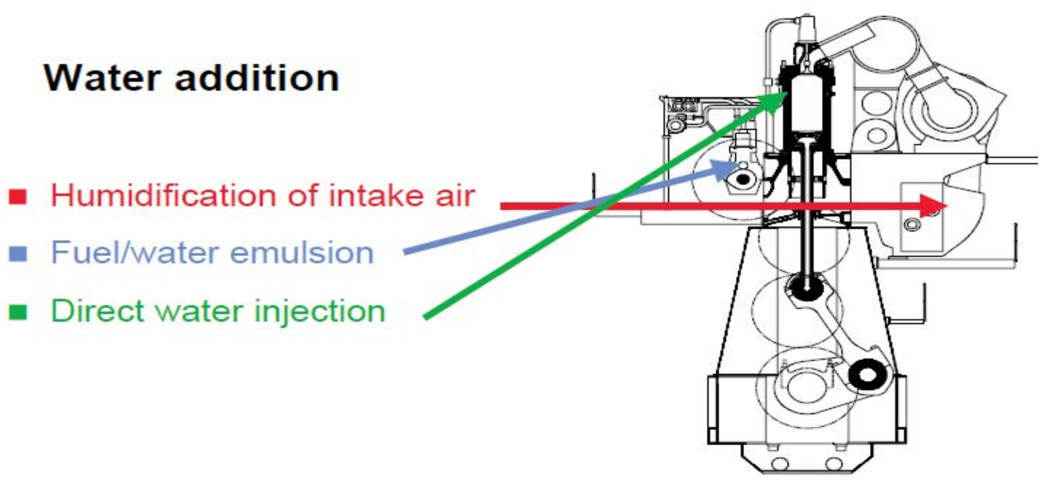


Figure 62: Typical steam plant unit system.

Steam Turbines: Steam turbines may be used for larger applications (between 1 and 1000 MW). These use an external boiler to raise steam, which may be fuelled by any type of solid, liquid or gaseous fuel desired. This steam is then expanded across turbine blades to produce rotary motion, and when coupled with a generator, electricity. Again, waste heat may be recovered for use. Figure 63 shows typical staem engine system. Electrical efficiencies at full load can range from 15 to 50%, depending on the complexity of design. This means that heat to electricity ratios can vary from 1:1 to 5:1. This generation method is particularly suited to the use of large quantities of solid waste or biomass, provided suitable boilers are used, though start-up times are slow.

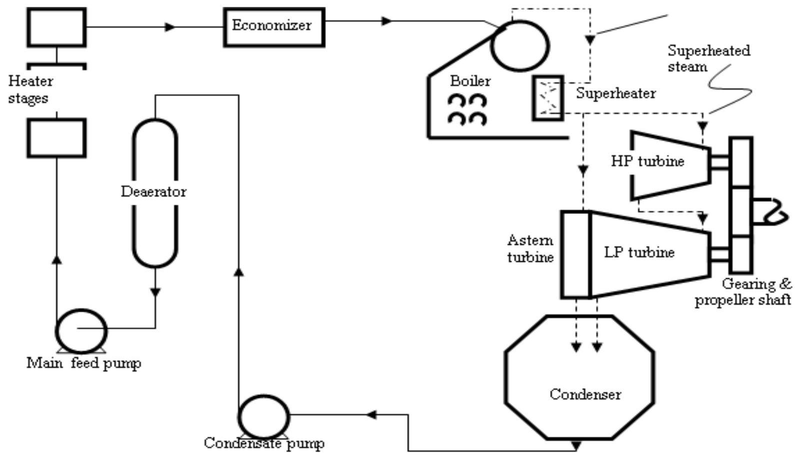


Figure 63: Steam engine system.

Stirling Engines: A Stirling engine is an external combustion engine, where combustion of the fuel does not take place inside the engine, but in an external boiler. Mechanical work is derived from the pressure changes that result from the cyclic heating and cooling of an enclosed working gas. Heat from any source may be used to run a Stirling engine, including concentrated solar rays and waste heat but only fuelled Stirling engines will be considered here. This type of engine has many advantages over other engines and turbines as it allows the use of fuels that are hard to process and it has a fairly simple design, which makes it suitable for small-scale applications, gives the plant a lower capital cost and reduces maintenance costs. Interest in Stirling engines is beginning to re-emerge due to increased interest in biofuel use. Currently available Stirling engine generating set outputs vary from 1 kWe to 200 kWe, although larger engines are feasible. Figure 63 shows typical gas turbine engine.

Gas Turbines: Gas turbines may be run on biogas and are available with rated outputs of between 3 and 50 MWe. Their operation is based on the Brayton Cycle, where incoming air is compressed to a high pressure, fuel added to the air is burned to increase the gas temperature and pressure and the resulting gases are expanded across the turbine blades, giving rotational movement. Coupled to a generator, this provides electricity generation and waste heat may also be recovered for use. Figure 64 shows a typical gas turbine engine operation system.

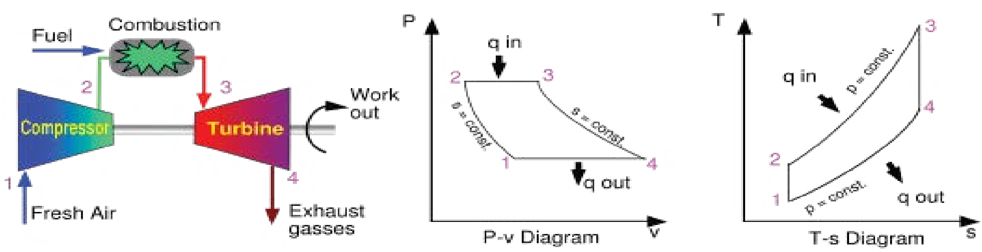


Figure 64: Typical gas turbine engine.

Choice of Cogeneration Alternative Energy

Fuel Cells: The principle of the fuel cell was discovered over 150 years ago. NASA has improved the system in their emission free operation for spacecraft. Recent years has also seen improvement in vehicles, stationary and portable applications. As a result of this increased interest, stationary power plants from 200 W to 2 MW are now commercially available, with efficiencies ranging from 30 to 50% and heat to electricity ratios from 0.5:1 to 2:1. Fuel cell reload follower energy, the efficiency of a fuel cell typically increases at lower loadings. Fuel cell system also has fast response. This make them well suited to load following and transport applications. .

Fuel cell is advanced alternative energy technology with electrochemical conversion of fuel directly into electricity without intermediate stage, the combustion of fuel hence by-pass the restriction of second law of thermodynamic. The basic fuel supply in the fuel cell systems is hydrogen and carbon dioxide. The former has to be produced and feed in large quantity as pure hydrogen. Hydrogen is the lightest chemical element as demonstrated by the periodic table. Thus, other lighter gas gases exist that can be use as fuel cell, but hydrogen offer greater energy per unit weight compare to other element candidate for alternative energy and it is completely cyclic as it can be readily combined and decompose [43,78,79]. Table 34 shows types of electrolyte source for fuel cell energy.

$$2H2->4e- \quad +4H+ \tag{1}$$

$$4h+ \quad +4e- \quad +O2->2H20 \tag{2}$$

$$2H2+02 \; -> \; 2H20 \; +Heat \tag{3}$$

Phosphoric acid fuel cell distribution: Fuel cell can be distributed directly through the following ways:

i) Direct supply to residential and commercial facilities through pipelines. Modular cell that can be stack according to power need

ii) Building hydrogen fuel cell power plant in remote location and distribute energy through power grid.

Types	Electrolyte	Operating temperature
Alkaline	Potassium hydroxide	50-200
polymer	Polymer membrane	50-100
Direct methanol	Polymer membrane	50-200
Phosphoric acid	Phosphoric acid	160-210
Molten carbonate	Lithium and potassium carbonate	600-800
Solid oxide	Ceramic compose of calcium	500-1000

Table 34: Type of electrolyte fuel cell.

Comparing the efficiency of fuel cell to other source of alternative energy source, fuel cell is the most promising and economical source that guarantee future replacement of fossil fuel. However efficiency maximization of fuel cell power plant remains important issue that needs consideration for its commercialization. As a result the following are important consideration for efficient fuel cell power plant efficiency calculation can be done through the following formula fi9 shows a typical fuel cell power system Figure 65:

$$E_C = g\frac{G}{nF} \tag{4}$$

$$G = H * T * Si \quad (5)$$

Where: Ec=EMF, G =Gibbs function nF = Number of Faraday transfer in the reaction, H= Enthalpy, T=Absolute temperature, S=Entropy change i=Ideal efficiency

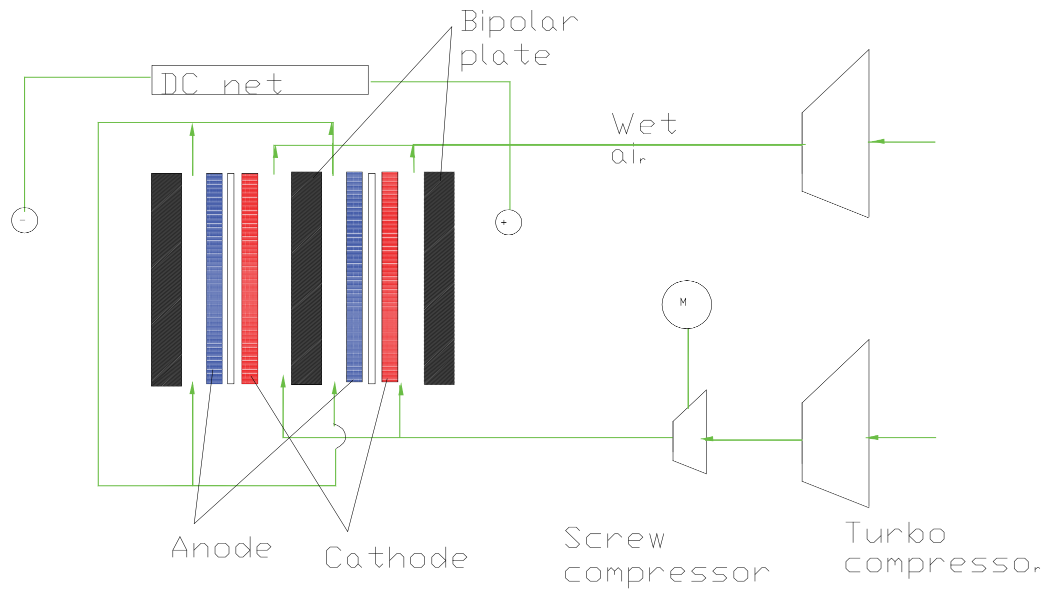


Figure 65: Fuel cell hybrid configuration.

Advantages of fuel cell include size, weigh, flexibility, efficiency, safety, topography, cleanliness. Mostly use as catalyst in PAFC and however recovery of platinum from worn-out cell can reduce the cost and market of the use of PACF economical. It has cost advantage over conventional fossil fuel energy and alternative energy. Disadvantages of fuel cell are adaptation, training and cost of disposal. Fuel cell has found application in transportation, commercial facility, residential faculty, space craft and battery. Figure 65 shows a typical arrangement fuel cell hybrid power configuration.

Solar energy system: History and human existent has proved that the sun is the source of all existing energy on earth. From plant photosynthesis to formation of biomass earth fossil fuel including oil and coal, to the generation of wind and hydrogen power, the sun has his mark on almost every planetary system. For decades, people have worked to generate renewable and cost saving solar energy. But little has been achieved to get a lot out f its abundant supply of sun light. Harnessing energy from sun require production, distribution, control and consumer utilization at low cost. Risk work for the system should address the back drop and hybrid system alternative energy system that can be installing as auxiliary for synchronization through automatic control system that activate storage supply whenever supply is approaching the minimum setup limit. Prior to installing solar, it is important to collect, analyze data and information to determined initial condition necessary to start the project and come with acceptable design. Such data should be use for simulation and construction of prototype model of the system that include existing system, central receiver, collectors, power conversion, control system, sunlight storage, solar radiation to supply a solar system to convert sunlight to electricity and distribute through existing channel. Solar collector can be plate or dish type. Stefan law relates the radiated power to temperature and types of surface:

$$\frac{P}{T} = \varepsilon\sigma T^4 \quad (6)$$

Where P/A is the power in watts radiated per square meter, € is surface emissivity,σ is Stefan Boltzmann constant= 5.67x10e8 W/m^2K^4

The maximum intensity point of the spectrum of emitted radiation is given by:

$$\lambda_{max} = \frac{2898}{T(K)} \quad (7)$$

Hybrid system: With a focus on developing applications for clean, renewable, non-fossil fuel, energy systems. Our final emphasis is on maritime related activities; however, as marine engineers we are devoted to promoting all types of alternative & sustainable energy technologies. Various types of engine, turbine and fuel cell may be run on a variety of fuels for combined heat and power production. Hybrid system can provide control over power needs, green and sustainable energy that delivers a price that is acceptable and competitive. The power plants can be located where it is needed less high power lines are required, not only reducing costs but assisting health by reducing magnetic fields that people are so worried about, Global warming is addressed by direct action by providing power that does not release any emissions or discharges of any kind. The technology associated with the design, manufacture and operation of marine equipment is changing rapidly. The traditional manner in which regulatory requirements for marine electrical power supply systems have developed, based largely on incidents and failures, is no longer acceptable. Figure 66 shows a typical hybrid power arrangement for solar hydrogen and conventional power. Figure 67-69 can be hybrid to the same system to provide integrated alternative energy power

Current international requirements for marine electrical power supply equipment and machinery such as engines, turbines and batteries have evolved over decades and their applicability to new technologies and operating regimes is now being questioned by organizations responsible for the regulation of safety and reliability of ships [49,79]. Various technologies have been employed towards the use of alternative free energy of the sun since the first discovery in the 18th century. Improvement and development has been made towards making it available for use like existing reigning source of energy. Major equipment and hardware for the hybrid configuration are:

i. Semiconductor solar with high efficient storage capability will be designed
ii. Hybrid back up power will be design based with integrative capability to other alternative power source like wind and hydrogen
iii. Controller design for power synchronization will be designed and prototyped
iv. Inverter and other power conversion units will be selected based on power needs
v. Solar collector or receiver with high efficiency collection capacity will be designed
vi. Software development and simulation
vii. Steam will be used as energy transfer medium

The power plants can be built in small units combined, which allow greater control over the output and maintains full operational output 100% of the time. The plant produces fewer emissions, the plant can be located close to the areas where the power is required cutting down on the need for expensive high power lines. Excess energy produced can be connected to the grid under power purchase arrangement Figure 66-68.

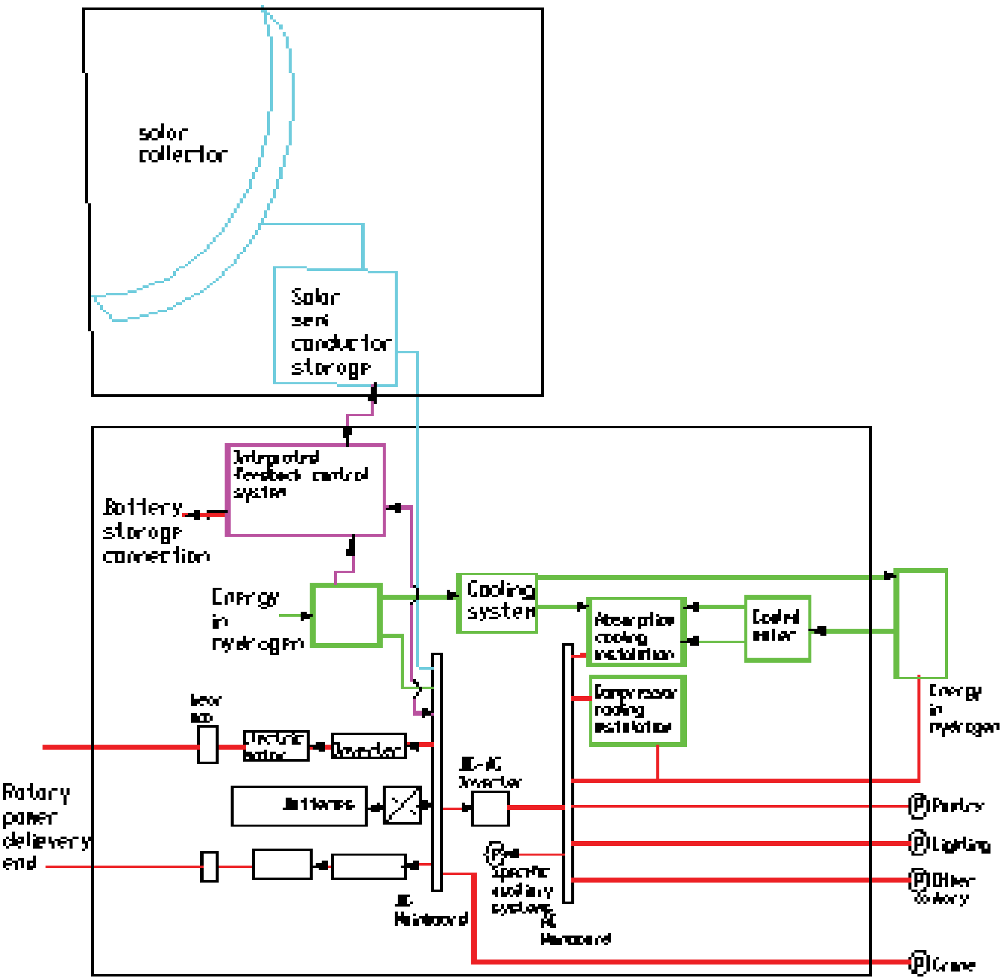


Figure 66: Hybrid configuration.

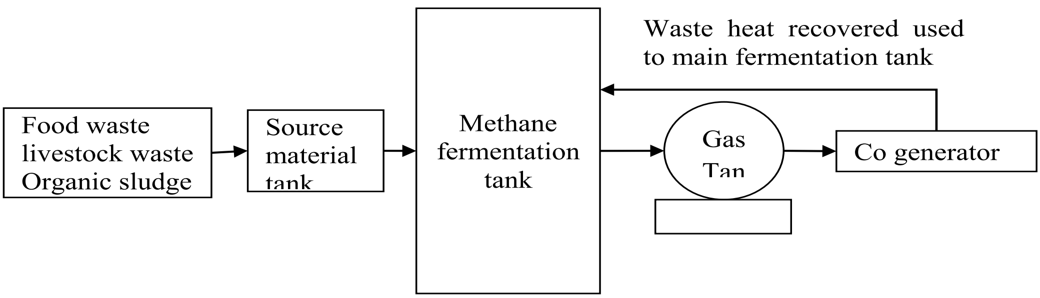


Figure 67: Biogas hybrid.

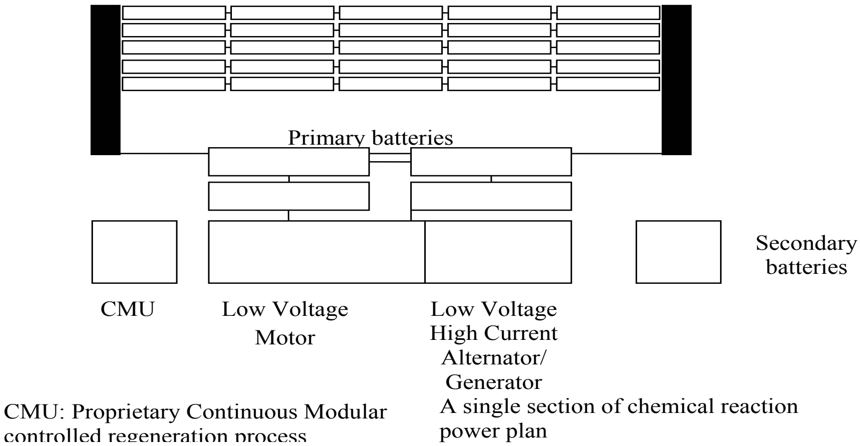


Figure 68: Fuel cell hybrid.

The system can be built in independent power configuration and user will be free from supply cut out. In a typical off-grid scenario a large battery bank is required to store energy. Solar hydrogen hybrid energy is stored in the form of hydrogen gas. When it is dark out, instead of drawing energy from a battery bank, hydrogen gas is converted into electricity through a fuel-cell. Likewise, during the day when there is plenty of energy from the sun, water is converted into hydrogen gas through the use of a hydrogen generator. Most electrical power systems are a combination of small units of power group to provide the larger output.

Hybrid system design should begin with problem definition of providing a port with power, follow by refining the design so that each individual units power output could be combined to provide the input for a larger unit and ensure efficient, effect operation, maintenance. The hybrid system should be able to provide more power that can keep the stress and strain of operation to a minimum and reduces the failure of the component parts. The system should be designed with built in redundancy to compensate for failure of a component. The system has advantage of maintenance that can be carries out while keeping the system delivering the full capacity as well as alternation of delivery devices to extend their operational life Figure 69.

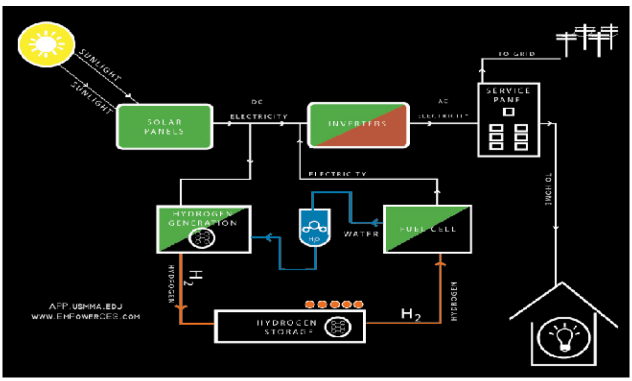


Figure 69: Typical hybrid system (USMMA, 2008).

One of the unique features of hybrid system is the sustainable, clean energy system that uses a hydrogen storage system as opposed to traditional battery. Its design construction and functionality are inspired by the theme of regeneration and the philosophy of reuse. High efficiency solar panels works with an electrolyser to generate the hydrogen for fuel cell. The system can universal solar energy for marine application and other energy application as needed in equal capacity to existing fossil power plants. Figure 70 shows a typical control system arrangement for the switching.

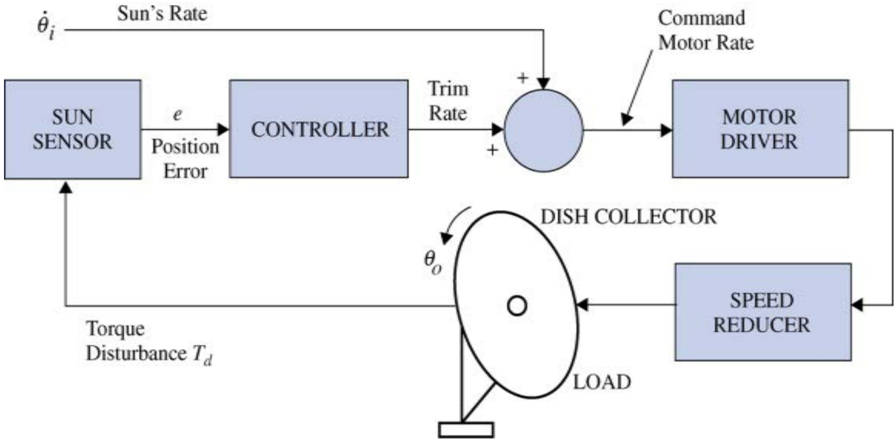


Figure 70: Typical solar collector control system.

The hybrid system can provide means to by-pass and overcome limitation posed by past work in generating replaceable natural energy of the sun and other renewable energy source that can be designed in hybrid system. Reliable deployment of hybrid system developments of mathematical model follow by prototyping, experimentation and simulation of the system are key to the design and its implementation. The main advantages of hybrid configurations are Redundancy and modularity, high reliability of hybrid circuitry embedded control systems; improve emergency energy switching and transfer, low operating cost through integrated design, low environmental impacts due to nature of the energy source. System optimization with combined heat and alternative power production technologies:

i. The Production and Storage of Heat

ii. Space Heating Storage Heaters

iii. Hot Water Storage

iv. Instantaneous Space and Water Heaters

v. Uses for Excess Electricity

vi. Electricity Storage Devices

Time has gone when maritime industry could not afford nitty gritty in adopting new technology, other industry are already on a fast track preparing themselves technically for evitable changes driven by environmental problem, global energy demands and political debate that add pressures to find alternative energy especially bio energy. The implication is that shipping could be caught ill prepared for any rapid change in demand or supply of biofuel. Thus this technology is in the early stages of development but the shipping industry need to be prepared for the impacts of its breakthrough because shipping will eventually be required at the centre of this supply and demand logistics chain. System integration hybridization of old and new system offers advantage for require change. Figure 71 shows the regional projection for biofuel usage and demand for the US and Europe which are the current main user in future.

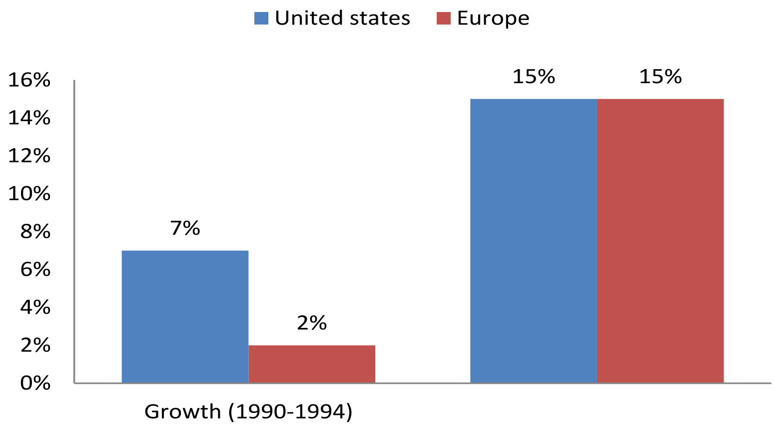


Figure 71: Bio energy usage projection [DOE, 2008].

Potential Impacts to Marine System

Impact to marine system: The use of biofuels as a fuel has increased in most transportation sectors. Adopting this technology in marine industry is still slow despite flexibility offered by use of energy on ship compare to mass requirement for land based industry and ambient temperature performance for aviation industry. Cost remain one of the main driver, slow speed diesel engines can run on lower quality fuels, they can replace distillate marine oils associated technical difficult. Calorific energy value for main propulsion could also result in a reduced service speed, range or larger bunker tanks. Major benefit of using environmental friendly engine is illustrated in Figure 72.

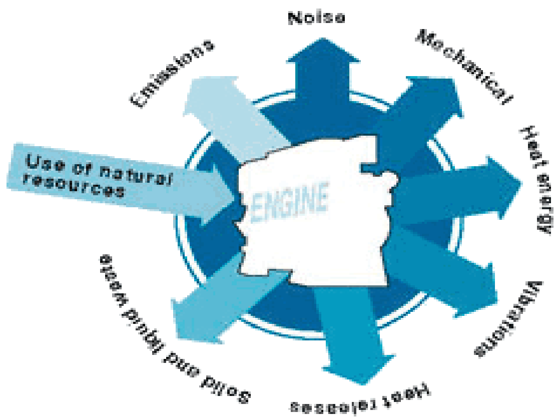


Figure 72: Benefit of using environmental friendly engine.

Potential for port coastal and port infrastructure: A variety of methods could turn an age-old natural resource into a new and efficient means of generating electricity. Biomass in large amounts is available in many areas and is being considered as a fuel source for future generation of electricity. Biomass is bulky, widely distributed and electricity from conventional, centralized power plants requires an extensive distribution network. Traditionally power is generated through centralized, conventional power plant, where biomass is transported to the central plant. Typically a steam or gas turbine power plant and the electricity are then distributed through the grid to the end users. Costs include fuel transportation, power plant construction, maintenance operation and distribution of the electric power, including losses in transmission. This is system is ideal for coastal and port infrastructure marine system powering. Table 35 shows efficiency comparison between coal and biomass.

	Electrical efficiency	Capacity
Biomass	Thermal efficiency-40 %	$2,000 per kilowatt
Coal	45 %	$1,500 per kilowatt,

Table 35: Efficiency comparison [EIA].

Potential for ship and offshore system: Micro-biomass power generators seem to offer a path for new solution for energy at end user disposal. Recent development towards use of micro biomass can offer best practice adaptation for marine unitized biomass power. Such biomass can be used near the site of end-use, with heat from external combustion converted directly to electricity by a biomass fired free-piston genset. Costs of installation include fuel acquisition and maintenance of the genset and burner. Since the electricity is used on site, both transmission losses and distribution costs are minimal. Thus, in areas without existing infrastructure to transmit power, there are no additional costs. It is also possible to cogenerate using the rejected heat for space or hot water heating or absorption cooling. This is ideal for ship and offshore system. Figure 35 shows typical prime moreover arrangement for ship.

Micro-biomass power generation is a more advantageous and cost-effective means of providing power than centralised biomass power generation. Especially in area where there is a need for both power and heating. Domestic hot water, space heat and absorption chilling are attractive for cogeneration configurations of microbiofuel plant. Biomass can be generated using single or ganged free piston Stirling engines gensets. They can be placed at the end-user location taking advantage of local fuel prices and do not require a distribution grid. They can directly provide electrical output with integral linear alternators, or where power requirements are larger they can be connected in series and parallel to drive a conventional rotary turbine Figure 73. They are hermetically sealed and offer long lives through their non-contact operation [44].

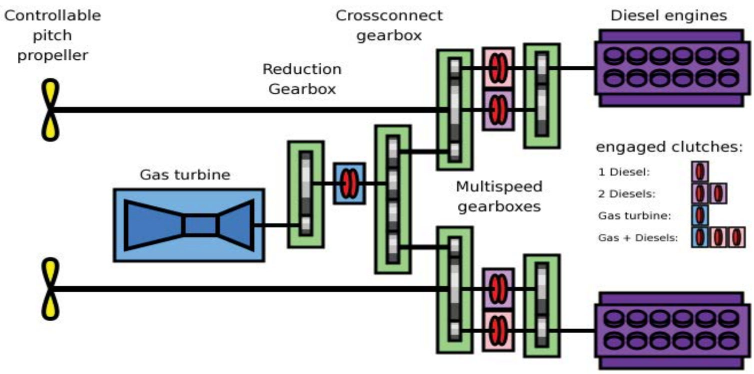


Figure 73: Typical prime mover arrangement on board ship.

Emissions offsets and waste reduction could help enhance the appeal of biomass to utilities. An important consideration for the future use of biomass fired power plants is the treatment of biomass flue gases. Biomass combustion flue gases have high moisture content. When the flue gas is cooled to a temperature below the dew point, water vapor starts to condense. By using flue-gas condensation, sensible and latent heat can be recovered for district heating or other heat consuming processes. This increases the heat generation from a cogeneration plant by more than 30%. Flue-gas condensation not only recovers heat but also captures dust and hazardous pollutants from flue gases at the same time. Most dioxins, chlorine, mercury and dust are removed and sulfur oxides are separated out to some extent. Another feature of flue gas condensation is water recovery, which helps solve the problem of water consumption in evaporative gas turbines.

Biomass is a substantial opportunity to generate micro-biomass electric power, at power levels from fractions of kilowatts through to tens or hundreds of kilowatts, at the point of end use. Neither small internal combustion engines, which cannot use biomass directly, nor reciprocating steam engines, with low efficiency and limited life, can offer the end user economic electric power. Free-piston Stirling micro biomass engine are an economic alternative. Stirling offers the following advantages over significantly larger systems:

i. Stirling machines have reasonable overall efficiencies at moderate heater head temperatures (~600 ƒC)
ii. Cogeneration is simple
iii. Large amounts of capital do not have to be raised to build a single evaluation plant with its associated technical and economic risks
iv. A large fraction of the value of the engine alternator can be reused at the end of its life
v. Stirling systems can be ganged with multiple units operating in parallel.

Biodiesel machinery design, installation, operation and maontaonace requirements are:

i. Fuel management: Fuel management is complex in this new era because fuel aging and oxidation can lead to high acid number, high viscosity, the formation of gums and sediments. Supply chain supply of biofuel to ship can be done through pre-mixed to the required blend. Here the biofuel and diesel are supplied separately to the ship and then mixed on board. This gives the operator the chance to dictate the exact blend of biofuels depending on conditions. But that would require retrofitting or new technology to be installed on board together with additional complexity for the crew. It is also important to monitor the fuel acid number value to ensure that no rancid, acidic fuel is introduced to the injection system. A typical layout should involve separators to ensure that water is removed from the fuel, as well as heaters at various stages to ensure the fuel is at the correct temperature before they enter engine.
ii. Temperature monitoring system: Technical problem that need to be further mitigated is the CFPP indication of low temperature operability of range between 0°C and 15°C for different types of biodiesels. This can cause problems with filter clogging, this can only be overcome by carefully monitoring of the fuel tank temperatures. This can affect ships operating in cold climates, where additional tank heating coils and heating may be required to avoid this from happening.
iii. Corrosion control: Biodiesels are hygroscopic and require to be maintained at 1200-1500 ppm water, which can cause significant corrosion damage to fuel injection systems. Mitigation can be exercise through appropriate fuel conditioning prior to injection. Biodiesels. Injector fouling especially the blend type produces deposits due to presence of fatty acid and water in the fuel. This can result to increased corrosion of the injector system. Also viscous glycerides can contribute to further injector coking. Biodiesel due to its chemical properties degrades, softens or seeps through some gaskets and seals with prolonged exposure. Biodiesels are knows to be good solvents and therefore cause coating complexity. Reports of aggressiveness of biodiesel and bioethanol on tank coatings have been reported. In its pure form biodiesel, as a methyl ester, is less aggressive to epoxy coatings than ethanol. Therefore ethanol

should be carried in tanks coated with dedicated tank coatings such a phenolic epoxy or zinc silicate tank coatings.

iv. Lubrication: Biofuel lubricant may have impact on engine crankcase cleanliness and the potential consequences of fuel dilution. The droplet characteristics and lower volatility of biodiesel compared with conventional diesel, together with spray pattern and wall impingement in the modern diesel engines, can help noncombusted biodiesel past the piston rings. And also to make contact with the cylinder liner and be scrapped down into the oil sump. The unburnt biodiesel tends to remain in the sump and the level of contamination may progressively build up over time. This can result in reduced lubricant viscosity and higher risk of component wear. A serious concern is the possibility that the unburnt biodiesel entering the oil sump may be oxidised, thus promoting oil thickening and requiring greater oil changes.

Impact to shipping: It is clear that biomass will fuel freight increase as well as specialized new design of chemical tankers. Biodiesel is an IMO 2 cargo, its vegetable oil feedstocks are IMO cargoes with double hull IMO 3 vessel configuration required. Ethanol typically transports in chemical tankers due to its cargo requirement but technological change break through could bring potential regulatory design change. Flexibility for ship conversion and retrofitting system could upset initial cost problem.

Port, Inland waterways and coastal vessel: There is potential for us of biodiesels for small craft that operate within inland water because of air and water pollution sensitivity associated with inland water transportation. The port facilities in Malaysia and Indonesia are already being improved to handle Handysize and Panamax tankers. There is also potential requirement for transshipment and supply vessel, supply chain for short sea service.

Cargo: 3rd generation biofuels wil required to be processed from solid cargoes to liquid cargoes. Of the wood currently harvested, 30% is waste. This is not going to be a waste in the future and will be converted by a Fischer Tropsch biomass to liquid processing plant. For coastal shipping to handle this trade, there wil be need for new generation of 5,000 tonne dead weight dry cargo vessels. It is expected that these voyages will be regulated under the new Dry Bulk Cargo Code (BC Code). This is due to become mandatory in 2011.

Shipping Routes and Economics Impacts: The above trend analysis discussed indicate potential capacity requirement from shipping. So far North America, Europe and South East Asia are the key importing regions where this growth is concentrated. Latin American contries of Brazil, Argentina, Bolivia and Paraguay and Southeast Asia's Indonesia and Malaysia will remain key suppliers for the palm oil, Philippines and Papua New Guinea have potentials for vegetable oil and agricultural while Thailand has potential for sugarcane. Table 36

	Biofuel	Demand
North America	Ethanol	33 million tons
Europe	ethanol and biodiesel.: 50:50	30 million tons
Asia	ethanol and biodiesel.: 50:50	18 million tons

Table 36: Regional impact [EIA].

Regulatory Framework Impact: In many parts of the world, environmental concerns are the leading political driver for biofuels. This driving force evolved regulation like Kyoto protocoal, Marpol Annex VI and other environmental regulation. The tonne mile demand for future tankers will be greatly affected by national, regional, global policy and political decision making. There is a greater flexibility in the sourcing of biofuels than there is in hydrocarbon energy sources and this may be attractive to particular governments. Once the regulatory framework is clear, economics will determine how the regulations will best be met and seaborne trade will be at the centre of the outcome.

Conclusion

The main challenge to use of biomass for power generation, therefore, is to develop more-efficient, lower-cost systems. Advanced biomass-based systems for power generation require fuel upgrading, combustion cycle improvement, and better flue-gas treatment. Future biomass based power. Generation technologies need to provide superior environmental protection at lower cost by combining sophisticated biomass preparation, combustion and conversion processes with post combustion cleanup. Such systems include fluidized combustion, biomass integrated gasification, and biomass externally fired gas turbines. Ships life cycle is around 20-25, for ship owners to make the most of the upcoming markets, it is necessary to be prepared for the new cargoes. Current ship designs may not be suited for biofuel ships. Therefore there is potential for pressure on organizations to adopt new standards to accommodate the demand driven by governmental legislation. This in itself has some risk involved also the trade routes could create economy of large scale leading to larger ship production and sub sequential requirement from designer. Other evolving challenges to secure energy and environment are Fuel cell technology, nuclear, natural gas and fuels made from waste plastics.

References

1. Rainer Waser (ED), Professor Dr. Rainer Waiser, WILEY-VCH GmbH & Co.KGaA,Weihem, Nanoelectronics and information technology (ISBN 3-527-40363-9)
2. William a.Goddard, III, Donald W Brenner Sergey Edward Lyshevski,Gerald J. Lafrate, Handbook on nanocsience, engineering and technology, CRC press 2002,
3. Hutcheson GD (2004) The first nanochips. Sci Am 290: 76-83.
4. Roshini Ratnasingam, Indept study of oxide material for high frequency application
5. M. Ito, N.Myojin, M.Kondo and A.Matsuda, Light-Soaking Stability of Nano-Structure Tailored Silicon Thin Film Solar Cells, 3rd World Conference On Photovoltaic Energy Conversion May 11-18, 2003, Osaka. Japan.
6. Wolfgang Palz, A Vision for Solar Energy, 3rd World Conference on Phorovolroic Enera Conversion, May11-18, 2003, Osaka, Japan.
7. Solin SA1 (2004) Magnetic field nano sensors. Sci Am 291: 70-77.
8. Zaeem M. Moosavi & Hassan Zohoor, Improving The Capability Of Solar Thermal Energy Storage ByUsing A Hybrid Energy Storage System, International Journal of Engineering and Applied Sciences 6:5, 2010
9. R. Mertens, Trends In Solar Cell Research, IEEEXplore, 2008
10. M. Zeman' And J. Krc, Nano-Structures For Light Management In Optoelectronic Devices, IEEE Xplore, (2008)
11. A Step Closer To The Optimum Solar Cell: Retrieved from Http://Www.Lbl.Gov/Science-Articles/Archive/Sb-Msd-Multibandsolar-Panels.Html, accessed on November, 2010
12. Harold J. Hovel, Photovoltaic Materials and Devices for Terrestrial Solar Energy Applications, Solar Energy Materials 2(1980) 277-312, lorth-Holland Publishing Company
13. Shinya Iwasita, Toshihisa Inoue, Kazunori Koga, Masaharu Shiratani, Shota Nunomura, And Michio Kondo, Properties Of Nano-Crystalline Silicon Films For Top Solar Cells, IEEE Xplore, pg 1664-1667, 2006
14. Prashant V. Kamat, Brian Patrick and Ryan Muszynski, Decorating Carbon Nanotubes and Graphene with Semiconductor and Metal Nanoparticles, 213th ECS Meeting, Abstract #993, (2008)
15. Hybrid Materials for Future Solar Cells under Development. ScienceDaily (Nov. 7, 2008)
16. K. Craig and M. K. Mann. (1996). “PerformanceAnalysis of Biomass-Based Integrated Gasification Combined-Cycle (BIGCC) Power Systems”. 1996. http://www.eren.doe.gov/biopower/snowpapr.html
17. Fuldner, A. H. (1997). “Upgrading Transmission Capacity for Wholesale Electric Power Trade”. http://www.eia.doe.gov/fuelelectric.html, April 1997

18. M. K. Mann and P. L. Spath, "A Comparison of the Environmental Consequences of Power from Biomass, Coal, and Natural Gas". Presentation at the Energy Analysis Forum. Golden, CO, May 29-30, 2002. web site www.nrel.gov/analysis/pdfs/m_mann.pdf.

19. G. Wiltsee. (2000). "Lessons Learned from Existing Biomass Power Plants." NREL/SR-570-26946 Golden, CO: National Renewable Energy Laboratory, February web site www.nrel.gov/docs/fy00osti/26946.pdf.

20. R.L. Graham, B.C. English, and C.E. Noon,(2000) "A Geographic Information System-based Modeling System for Evaluating the Cost of Delivered Energy Crop Feedstocks" Biomass and Bioenergy, Vol. 18, pp. 309-329.

21. J. Sheehan, V. Camobreco, J. Duffield, M. Graboski, and H. Shapouri. (1998). "Life Cycle Inventory of Biodiesel and Petroleum Diesel for Use in an Urban Bus": Final Report. 1998.

22. C. R. McGowin, G. A. Wiltsee. (1996)."Strategic analysis of biomass and wastefuels for electric power generation". Biomass and Bioenergy. 1996, Vol. 10 (2-3). pp 167-175.

23. O.Sulaiman. Ab Saman.Saharudeen.W. Sani. K. B. Samo.(2010) "Environmetal and SafetyRisk and Reliability Process for Sustainable Marine System". Journal of Marine Environmental Engineering. p. 145-173.

24. C. P. Mitchell, (2000)"Development of decision support systems for bioenergy applications". Biomass and Bioenergy, Vol. 18, pp 265-278

25. A.E. Fitzgerald, Charles Kingsley Jr, and Stephen D. Umans (2003). Electric Machineries, 6th ed. The McGraw-Hill Companies, Inc. New York. Chapter 1-3

26. Cell Vehicle: Fundamental, Theory and Design, Taylorand Francis Group. New York: 5, 159-185.

27. Mohamed A. El-Sharkawi (2009). Electric Energy: An Introduction, 2nd edition, Taylor and Francis Group. New York: 309, 339- 349.

28. Mohibullah, Noman Mariun, Noor Izzri, Abdul Wahab, Ong Yoke Teng (2005). Design and Testing of Inverter for Emergency Load. Universiti Putra Malaysia. Selangor: 4-10.

29. Cheryl Saponia. 2007. Ship and Boat International. The Royal Institution of Naval Architects. London: 49

30. Charles A. Gross (2007). Electric Machines. Taylor and Francis Group. New York: 19, 327-330.

31. Christoper R. Robertson (2008). Fundamental Electrical and Electronic Principles. 3rd Edition. Elsevier's Science and Technology. Oxford: 48-54, 111-134, 144, 235-243.

32. Christoper R. Robertson (2008). Futher Electrical and Electronic Principles. 3rd Edition. Elsevier's Science and Technology. Oxford: 85-94, 175-200.

33. Mulukutla S. Sarma (2001). Introduction to Electrical Engineering. Oxford University Press, Inc. New York: Chapter 11-13: 471-594

34. S.R Trout and Gary D. Wooten (2001). Selection and Specification of Permanent Magnet Material, Magnetic Material Producers Association (MMPA), 8 South Michigan Aveneu, Suite 1000, Chicago, IL 60603.

35. Colonel Wm. T. McLyman (2004). Transformer and Inductor Design Handbook. 3rd Edition, Revise and Expanded, Marcel Dekker Inc. New York: 3-22.

36. Rollin J. Parker (1987). Permanent Magnet Guildelines. Magnetic Material Producers Association (MMPA). 8 South Michigan Aveneu, Suite 1000, Chicago, IL 60603.

37. HD McGeorge (1993). Marine Electrical Equipment and Practice, Second Edition. Butterworth Heinemannn Ltd: 130-135

38. J. Micheal Jacob (2002). Power Electronics: Principal and Application. Delmar Thomson Learning. Indiana: 464, 481-489, 502.

39. Mehrad Ehsani, Yimin Gao, Sebastian E. Gay, Ali

40. Ehmadi (2004). Modern Electric, Hybrid Electric, Fuel

41. Pusat Tenaga Malaysia, 2005. National BIPV Program "Suria 1000". http://www.ptm.org.my/bipv/pdf/suria1000-concept.pdf

42. M. J. Grubb. "The Integration of Renewable Electricity Sources". Energy Policy. 1991. Vol. 19, No. 7.pp 670-688.

43. D. McEvoy, D. C. Gibbs, J. W. S. Longhurst, "City-regions and the Development of Sustainable Energy Supply Systems". Int. J. Energy Res. 2000, 24. pp 215-237.

44. R. Chedid, S. Rahman, “Unit sizing and control of hybrid wind-solar power systems”. IEEE Transactions on Energy Conversion. 1997. Vol. 12, No. 1. pp 79-85.

45. EC-ASEAN COGEN Program Phase III, December 2004. Malaysia Final Report. Unpublished report Electricity, Windows to Malaysia, http://www.windowstomalaysia.com.my/nation/14_3_1.htm.

46. Intergovernmental Panel on Climate Change, “Greenhouse Gas Inventory Reference Manual”, Vol. 3, IPCC WGI Technical Support Unit, United Kingdom, 1995.

47. G. Wiltsee. “Lessons Learned from Existing Biomass Power Plants.” NREL/SR-570-26946 Golden, CO: National Renewable Energy Laboratory, February 2000. web site www.nrel.gov/docs/fy00osti/26946.pdf.

48. K.O.Lim, Zainal Alauddin, Z.A,Chulam A, Quadir and Mohd Zulkifly Abdullah, 1999. Energy Productivity of Some Plantation Crops in Malaysia and the Status of Bioenergy Utilizationin Malaysia, Proceedings of World Renewable Energy Congress 1999, pp 37-45.

49. F. R. McLarnon, E. J. Cairns, “Energy Storage”, Review of Energy, Vol. 14, pp 241-271.

50. Energy Data and Modeling Center, IEEJ, 2005.

51. http://www.ieej.or.jp/egeda/database/database-top.html Energy KTM, KTKM, 2005. http://www.ktkm.gov.my.

52. Malaysian Standard, 2005. http://www.aseansec.org/8274.htm MST, 2004. Malaysian-Danish Country Program for Cooperation in Environment and Development (2002-2006), http://www.mst.dk/udgiv/publications/2001/87-7944-557-8/html/helepubl_eng.htm.

53. RWEDP, 1997. Proceeding of the regional expert consultation on Modern Application of Biomass Energy, No.36.

54. Ahmad Hadri Haris, UNDP, 2004. Biomass-based Power Generation and Cogeneration in the Malaysian Palm Oil Industry. UNDP, 2004. Malaysia:

55. Michael Brown, 1998. Emission Trading and Joint Implementation: The implications for cogeneration. Cogen Europe, May 1998.Joule-Thermie Programme of the European Commission, “Environmental Aspects of CHPSystems: NOX Abatement Techniques”, United Kingdom, 1997.

56. O. O. Sulaiman. (2010). Risk and Reliability Based Multi- Hybrid Alternative Energy For Marine System: The Case Of Solar, Hydrogen And Convention Power Steam Energy For Sustainable Port Powering, Jurnal Mechanical, December 2010, No. 31, 78- 91.

57. OECD, Energy and Environmental Technologies to Respond to Global Climate Change Concerns. International Energy Agency. Organisation for Economic Co-operation and Development, France, 1994.

58. O. O. Sulaiman. (2011) Review on Potential for Waste Recycled Based Bioenergy for Marine System, Int. Journal Environmental Technology and Management (IJETM) Inderscience, Switzerland, Pg 339-357, Vol. 14, Nos 1/2/3/4, 2011, H index (6).

59. O. O. Sulaiman. (2010). Potential Of Biomass Cogeneration For Port Powering Bioscience, Biotechnology Research Asia, Vol 7, No 2, Pg559-578, 2010, SCOPUS , H Index (3).

60. World Bank, “Energy Investments and the Environment”, ed. C. M. Siddayao, Washington D.C., 1990. World Bank

61. Boyce, M.P., (2001) “Cogeneration and combined Cycle Power Plant”, Chapter 1, ASME Press, NY

62. Boyce M.P., (1196) “Cogeneration and Combined Cycle Power Plant”, Chapter 1, Gas turbine Engineering Handbook (third edition)

63. Yousef S.Najjar.,(1996), “Enhancement of performances of gas turbine engines by inlet air, 1996

64. Farmer.R., (1995)“Design 60% Net Efficiency in Frame 7/9H Steam Cooled CCGT” Gas turbine World Life Assessment Techniques For Gas Turbine Hot-Section Components Iii.1411

65. Yoshioka Y.. Saito D., Fujiyama K.. Kashiwaya H.Roy L. Harrigton., “Marine Engineering”, Engineering Technical Department, New port News shipbuilding and Dry Dock Company

66. Roberto Carapellucci , Adriano Milazzo, “Thermodynamic optimiation of the reheat chemically recuparated gas turbine” Department of Engineering University of L’Aquila, Italy

67. C.B Barras (2004). “ Ship Design and Performance for Master and Mates” Elsevier’s Science and Technology. Oxford: 55-81

68. Parks WP., Jr,Hoffman P., Karnitz MA., Wright IG. (1789), "The advance gas turbine systems program in the USA."

69. Yunus A cengel.,"Thermodynamic an engineering approach six edition" University of Nevada, Reno, Michael A.Boles, University of north Carolins

70. O.Sulaiman et al. (2010), "Potential of Biomass cogereation for Marne System Powering, Bioscience, Biotechnology Journal, Vol (7) 2,

71. Blake,J.W and R.W.Tumy., (1950), " Huey Gas Turbine Ticks Off 3400 Hours."Powe, Vol. 94, February, pp96-102

72. J, Schubert F,Ennis PJ, editor. Materials for advanced power engineering, Forschungszentum Julich; pp 1789-1805

73. I.G.wright and T.B.Gribbons.,(2006) "Recent Development in Gas Turbine and Technology and Their implication forSyngas Firing" Material Sciences and Technology Division, Oak Ridge National Laboratory, USA; 3612-3619

74. Sustainable Energy Ireland. "CO2 and Other Environmental Emissions Data" Table 7D, web site www.irish-energy.ie/publications/ index.html.

75. G. Wiltsee. "Lessons Learned from Existing Biomass Power Plants." NREL/SR-570-26946 Golden, CO: National Renewable Energy Laboratory, February 2000. web site www.nrel.gov/docs/fy00osti/26946.pdf.

76. IMO, "Marine Environmental Protection Committee". 44th session available at: http: www.imo.org/meeting/44.html, 2000.

77. H. Lund, P. A. Ostergaard. "Electric Grid and Heat Planning Scenarios with Centralised and Distributed Sources of Conventional. CHP and Wind generation". Energy 25. 2000, pp 299-312.

78. G. C. Seeling-Hochmuth, "A combined optimisation concept for the design and operation strategy of hybrid-PV energy systems". Solar Energy. 1997. Vol. 61, No. 2. pp 77-87.