J. Basic. Appl. Sci. Res., 3(2s)133-140, 2013

ISSN 2090-4304
Journal of Basic and Applied Scientific Research
www.textroad.com

Assessment and Technical Simulation of Biomass Fuel Instead of Diesel Fuel Supply System and Its Advantages for Sustainable Development of Power Generators in National Iranian Tankers Company (Ship in Question: Caey Praid)

Milad Karimi1* Alireza Moride

Sama Technical and Vocational Training College, Islamic Azad University, Bandar Abbas Branch, Bandar Abbas, Iran

Received: June 10 2013
Accepted: July 10 2013

ABSTRACT

Since Hormozgan Province, especially Bandar Abbas Exclusive Zone is a potential region for municipal waste disposal. Thus, construction of a biomass power plant in the area is inevitable. In this paper, use of biomass in place of diesel for generators of Caeypraid using Homer software was technically analyzed, when all generator and their loading capacity were examined and monthly demand curve was obtained during a one-period in this vessel. Then a composite system consisted of 4 synchronized biomass generators (3 main and 1 for emergency cases), which were used to inject the load (2.4 MWPeak) were explored. Finally, conditions of each biofilm-fuelled generator were evaluated against required demand. Also in this paper, the analysis of environmental contaminants was calculated using Homer software in two options: use of diesel and biomass fuels.

KEYWORDS: Biomass, diesel,Caeypraid, sustainable development, Homer software.

1- INTRODUCTION

In the middle of 20st prior to 1970s, demand for electric energy shows a constant growth rate at 6-7%. Introduction of environmental issues and oil crisis resulting from political events in the Middle East in 1970s, developed new challenges for world's electricity industry. This, added to global economic changes resulted in decrease of consumption of electrical energy from 6-7 % to 1.6-3% in 1980s [1].At the same time, energy transmission and distribution costs unprecedentedly inflated from 25% to 150%. In fact, two thirds of investments were allocated this sector. Also, followed by decline in demand, unexpected increase of costs, public concern about environmental health, advanced technologies and adoption of changes in networks, centralized massive power plants were no longer considered by suppliers. In other words, energy production pattern shifted from searching for economic cost-effectiveness in dimensions and sizes to batch and non-centralized production [2].

Biomass-fuelled power plants (in the form of biogas or liquid such as methanol, ethanol and biodiesel) are used to produce electricity and heat. It is estimated that if only 10% of agricultural lands, forests and plantations are used for preparing biofuel, then annual energy production will be equal to four fifth of current energy consumption rate. In developed communities- three forth of world population-35% of energy consumption will through biomass. On the other hand, biofuel resources are a very favorable and economic way to meet fundamental needs of the poor in the remote areas for energy [3,4].

1- Presentation of National Iranian Tankers Company (N.I.T.C) and the vessel in question

N.I.T.C is a subsidiary of National Iranian Oil Company, which was established in 1995 and entrusted to private sector in 1388. At present, it is the largest tanker company in the Middle East and fourth in the world. This company exports Iranian crude oil to overseas markets and forwards oil shipments for almost 150 oil-distribting companies throughout the world including Royal Dutch Shell, Total, K.S.A Armaco, and those based in Kuwait and Abu Zabi.

The revenues of N.I.T.C was 1.5 billion dollars by March 2009 (EU 51%, Asia 26%, Africa 15%, 8% other parts of the world including Canada, Venezuela and Latin America). In 2008, the company has exported 103 million tons of oil-related products to overseas.

In this paper, the case study was Caeypraid. This ship weighing approx. 100 thousand tons is a supertanker capable of carrying crude oil and even high-grade petrol which belongs to the fleet of NITC. It can contain a population of ???? persons including the Captain, senior officers, sailors, etc.

***Corresponding Author:** Milad Karimi, Sama technical and vocational training college, Islamic Azad University, Bandar Abbas Branch, Bandar abbas, Iran. milad.karimi@bndsama.ir

2-1- Generator load and shipment profile curve of the ship during a 24-hour period

Caeypraid is a type A tanker ship in tanker fleet of Iran, which uses four diesel generators (3 main ones and 1 for emergency cases). Diesel used in these vessels is Wartsila-6l20 c made in Finland. These diesel generators have 6 cylinders, each with a power of 480 kW and velocity of 900 rpm.

Rate of power generation depends on the load of the vessel. Normally, a ship docks for loading/unloading at a quay, for which needs 700kW. Also 1100 kW is required for the work of load discharge pumps. In this case, 2 generators must be working and the third one activates only when ship is moving and is in the maximum rate of energy consumption.

Emergency Diesel Generator, with a lower capacity than other generators and in a variety of models depending on company orders, turns on automatically when any of three main generators fail and it is used for lighting, fire fighting pumps or live-saving devices. Fig.2 shows the rate of monthly energy consumption during one year.

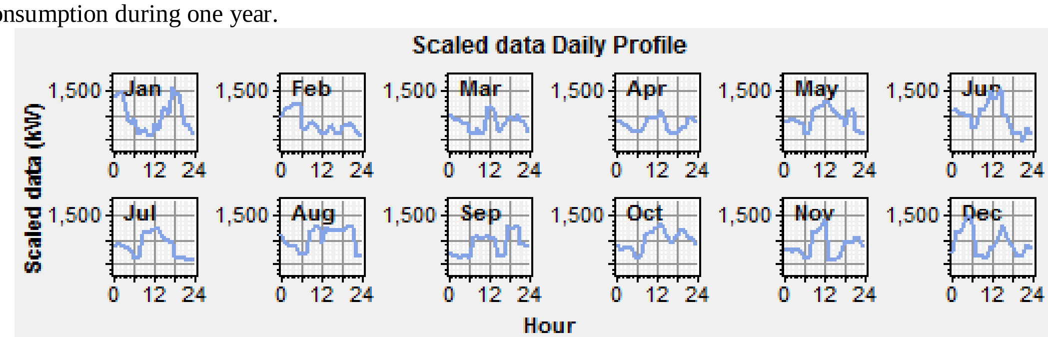

***Figure1**. Demand report for the load in various months of a year during a 24-hour period*

2- Biomass energy

There are several definitions for biomass and biomass energy. But they are all in common in one aspect, i.e. degradable organic matter. Based on a definition, biomass is "any materials with bio-molecular structure which can grow and propagate in accordance to natural rules". The energy existing in agricultural, gardening, forestry wastes as well as latent energy in degradable municipal and industrial solid wastes, livestock matters, municipal sewage and corruptible industry refuses are major sources of biomass, which can save energy through photosynthesis. Presently, in many countries of the world, degradable municipal solid wastes (trash) are disposed of in engineered sites known as 'landfill'. In these landfills, in addition of disposal of degradable wastes, there are facilities for collecting biogas resulting from anaerobic fermentation of wastes. The biogas is refined and after harmful gases (CO2, sulfur, chlorine and other compounds, etc.) were removed, it is converted to electricity by electric energy generators. In general, incineration is a process in which the waste is inflamed by heat producing residues such as ash, chimney gases as combustion products. If the wastes entering the combustion tanks are not fully segregated, most metals and metallic compounds remain unchanged and they can extracted from ash. The most important advantages of incineration are: reduction of volume and weight without need for long time or vast surface area, removal of most hazardous wastes followed by reduction of environmental degradation impacts, recyclability of energy in the form of electricity or heat released from the combustion and recycling metals (including iron-based or non-iron-based objects). Practical potential of power generation in an incinerator plant is presented in equation (2) [5] [6].

$$P(MW) = (\sum(R \times CV) \times 1.1157 \times 10^{-5}) \quad (1)$$

where P= Practical potential of energy generation from incineration

R= Rate of production of energy-containing degradable waste (tons/day)

CV= Coulomb Volt (kJ).

***Table 1**. Overall comparison between types of renewable energy [10]*

Energy Source	Place limits	Time limit	Efficiency	Cost
Wind Energy	0	0	Average	**Low to moderate**
Solar Energy	0	0	Low to moderate	**Medium to high**
Geothermal Energy	0	Low	Average	**Low to moderate**
Biomass Energy	0	Low	Medium to high	**Average**
Sea and Ocean Energy	0	0	Low to moderate	**Medium to high**

3- Rate of waste disposal in Bandar Abbass and outskirts

According to a report published by Municipal Organization of Hormozgan Province, on average 1200 tons per day of waste are collected in Bandar Abbass and outskirts (Khoonsorkh, all industrial complexes such as Persian Gulf Power Plant, Harbor Complex of Shahid Rajaee and Bahonar, Hormozgan Steel Complex, Al-Mahdi Aluminum Complex, etc.) calculated in this report during months of a year by a software in the form of a profile.

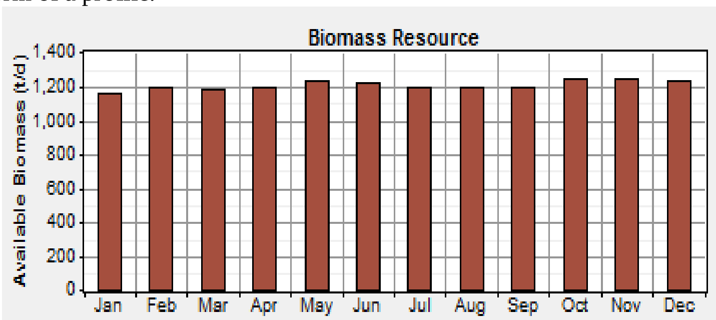

***Figure 2**. Rate of waste production in the area in months of a year*

4- Homer software

Homer software is applied to optimize composite models of renewable energy such as wind energy, solar energy, and biomass energy and so on. Modeling heat and hydrogen load can also be executed using this software. The most important objectives of Homer are:

- Finding least cost using a combination of electric and thermal load components
- Simulating a myriad of system settings
- Optimizing costs of life cycle assessment and sensitivity analysis for the composite system

Achievement of aforementioned items enables the software to make a comparison between a variety of design options based on technical and economic principals. It can also exert numerous changes and uncertainties to the inputs. Homer models functionality of a particular system arrangement for any hour in a year by identification of feasible methodologies, provision of required energy content and its life cycle costing. The software applies NPC equation to determine life cycle costs including costs incurred for primary construction, replacement, repair, refueling, electricity, air pollution fines, sales of power to the network. By inputting technical and economic information of the system, its cost-effectiveness can be found using Homer software. Therefore, having accurate information of the system being studied, composite systems of renewable energy can easily be optimized in the most desirable (technical and economic) configuration [9-11].

5- Introduction of a composite system and the capacity of generators of Caeypraid

Biomass refueling simulator required for generators of Caeypraid is a potential substitute of diesel generators presently used with regard to the rate of waste production in the area under technical evaluation (due to cost-effective fuel). In this simulation, a composite system consisted of 3 synchronized generators (with a capacity of 840kW) and an emergency synchronized generator (with a capacity of 400kW) are planned for annual demand of the ship.

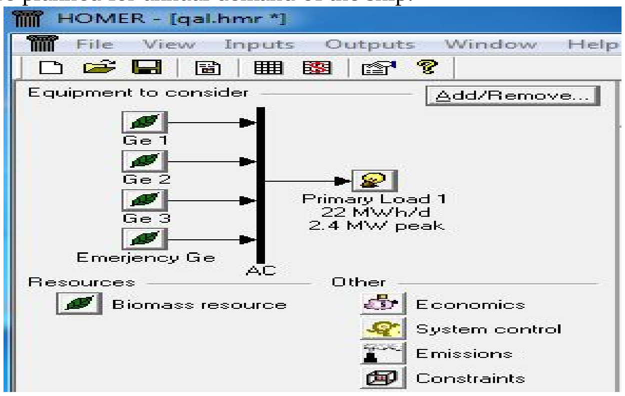

***Figure 3**. Technical schematic of a composed system*

***Table 2**. Type and capacity selected for each generator*

Type of generator	Nominal Capacity (kw)
Synchronous Generator	840
Synchronous Generator	840
Synchronous Generator	840
Synchronous generator (Emergency)	400

6- Results of simulation of the system

7-1- Eximination of load of each generator in its peak production

Quantity	Value	Units
Hours of operation	8,611	hr/yr
Number of starts	135	starts/yr
Operational life	3.48	yr
Capacity factor	86.0	%
Fixed generation cost	13.3	$/hr
Marginal generation cost	0.00	$/kWh

Quantity	Value	Units
Electrical production	6,327,977	kWh/yr
Mean electrical output	735	kW
Min. electrical output	364	kW
Max. electrical output	840	kW

Quantity	Value	Units
Bio. feedstock consump.	3,087	t/yr
Specific fuel consumption	0.341	kg/kWh
Fuel energy input	3,301,137	kWh/yr
Mean electrical efficiency	191.7	%

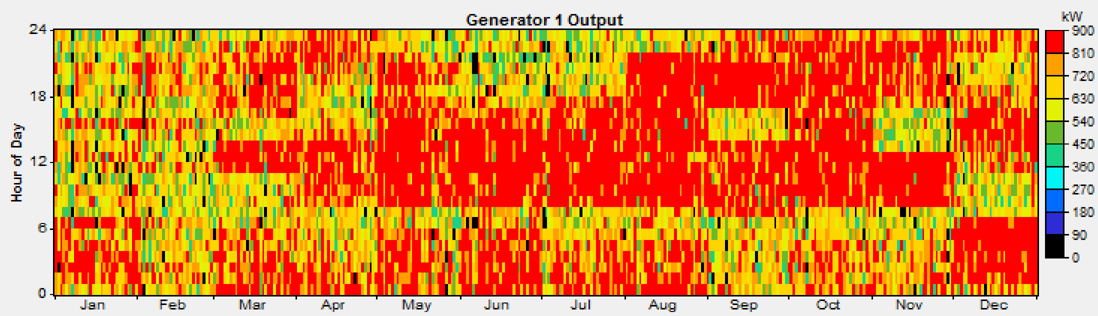

***Figure 4**. Maximum capacity of GE1 generator in months of a year (day and night)*

Quantity	Value	Units
Hours of operation	2,167	hr/yr
Number of starts	998	starts/yr
Operational life	6.92	yr
Capacity factor	14.7	%
Fixed generation cost	16.7	$/hr
Marginal generation cost	0.00	$/kWh

Quantity	Value	Units
Electrical production	1,083,613	kWh/yr
Mean electrical output	500	kW
Min. electrical output	287	kW
Max. electrical output	840	kW

Quantity	Value	Units
Bio. feedstock consump.	595	t/yr
Specific fuel consumption	0.384	kg/kWh
Fuel energy input	636,358	kWh/yr
Mean electrical efficiency	170.3	%

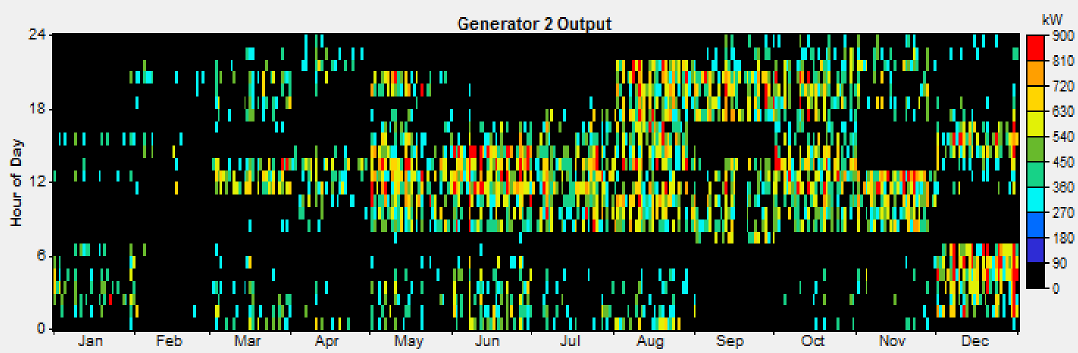

***Figure 5**. Maximum capacity of GE2 generator in months of a year (day and night)*

Quantity	Value	Units
Hours of operation	58	hr/yr
Number of starts	46	starts/yr
Operational life	259	yr
Capacity factor	0.286	%
Fixed generation cost	16.7	$/hr
Marginal generation cost	0.00	$/kWh

Quantity	Value	Units
Electrical production	21,071	kWh/yr
Mean electrical output	363	kW
Min. electrical output	252	kW
Max. electrical output	632	kW

Quantity	Value	Units
Bio. feedstock consump.	13.1	t/yr
Specific fuel consumption	0.435	kg/kWh
Fuel energy input	14,003	kWh/yr
Mean electrical efficiency	150.5	%

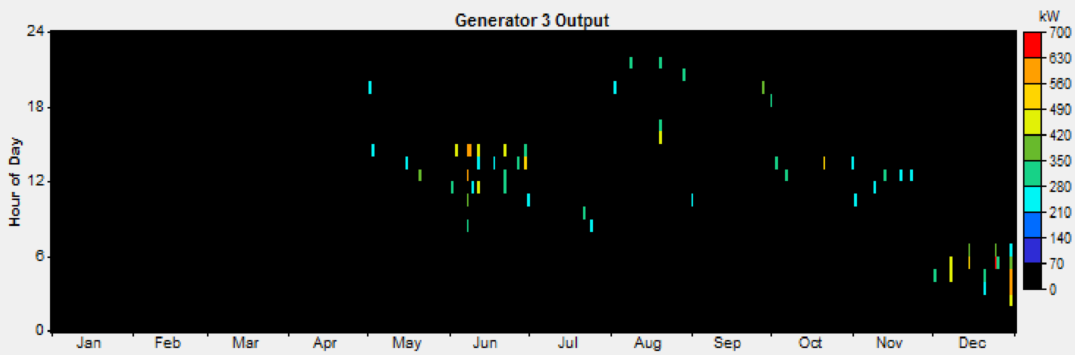

***Figure 6**. Maximum capacity of GE3 generator in months of a year (day and night)*

Quantity	Value	Units
Hours of operation	3,893	hr/yr
Number of starts	2,014	starts/yr
Operational life	3.85	yr
Capacity factor	17.0	%
Fixed generation cost	10.0	$/hr
Marginal generation cost	0.00	$/kWh

Quantity	Value	Units
Electrical production	597,400	kWh/yr
Mean electrical output	153	kW
Min. electrical output	120	kW
Max. electrical output	363	kW

Quantity	Value	Units
Bio. feedstock consump.	391	t/yr
Specific fuel consumption	0.459	kg/kWh
Fuel energy input	418,498	kWh/yr
Mean electrical efficiency	142.7	%

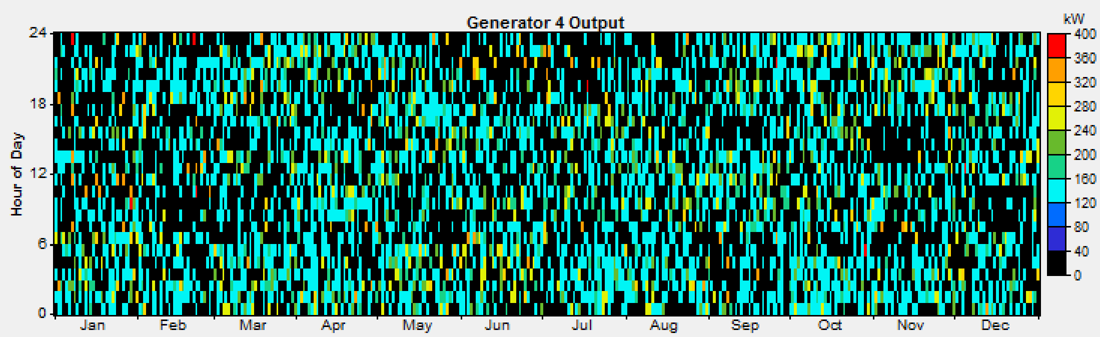

***Figure 7**. Maximum capacity of GE Emergency generator in months of a year (day and night)*

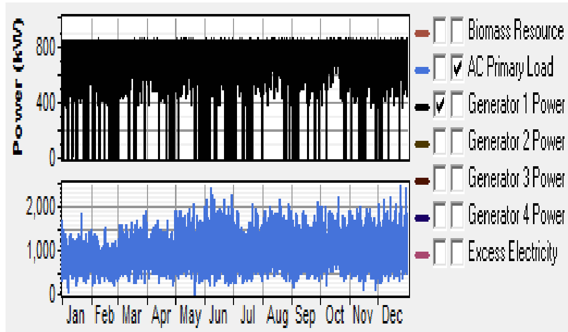

Figure 8. *Analysis of maximum capacity of GE1 generator against maximum predicted demand*

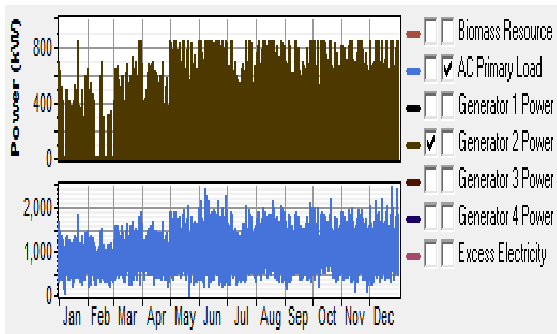

Figure 9. *Analysis of maximum capacity of GE2 generator against maximum predicted demand*

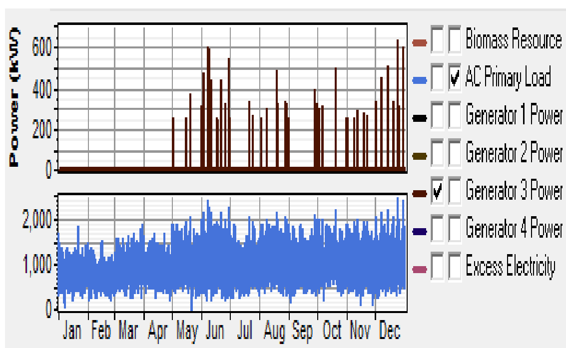

Figure 10. *Analysis of maximum capacity of GE3 generator against maximum predicted demand*

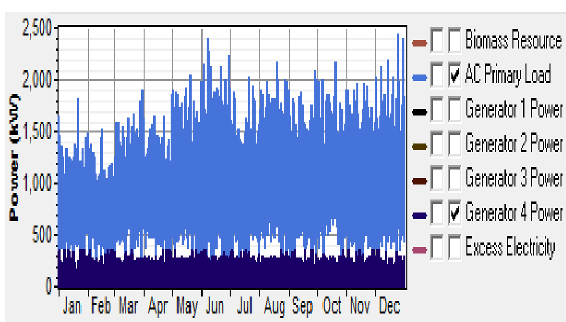

Figure 11. *Analysis of maximum capacity of GE Emergency generator against maximum predicted demand*

Production	kWh/yr	%
Ge 1	6,327,977	79
Ge 2	1,083,613	13
Ge 3	21,071	0
Emerjency Ge	597,400	7
Total	8,030,061	100

Consumption	kWh/yr	%
AC primary load	8,030,003	100
Total	8,030,003	100

Quantity	kWh/yr	%
Excess electricity	62.3	0.00
Unmet electric load	0.00	0.00
Capacity shortage	0.00	0.00

Quantity	Value
Renewable fraction	1.00

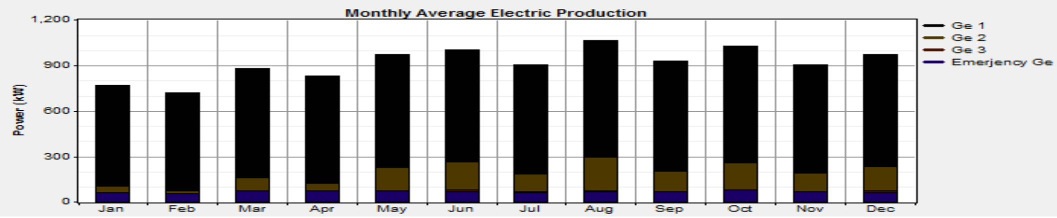

Figure 12*. General analysis of capacity of each generator against feeding a predicted load*

7- Environmental analysis

In terms of environmental analysis, significant reduction of green house gases in the ship's powerhouse, where generators are located has been reported in results of simulation for diesel as shown in Fig.13. Fig.14 shows effects of biomass in instead of diesel on greenhouse gas emission, which has resulted in an extremely positive effect on reduction of greenhouse gases.

Pollutant	Emissions (kg/yr)
Carbon dioxide	7,532,272
Carbon monoxide	18,592
Unburned hydrocarbons	2,059
Particulate matter	1,402
Sulfur dioxide	15,126
Nitrogen oxides	165,901

Figure 13*. Type of pollutants created due to diesel fuel (kg/yr)*

Pollutant	Emissions (kg/yr)
Carbon dioxide	707
Carbon monoxide	26.6
Unburned hydrocarbons	2.94
Particulate matter	2
Sulfur dioxide	0
Nitrogen oxides	237

Figure 14*. Type of pollutants created due to biomass fuel (kg/yr)*

8- Comparison of efficiency of biomass VS diesel used in synchronized generators

9-1- diesel fuel

Table 3. Main properties of diesel

Main characteristics	Rated capacity
Minimum value of the heat (MJ/KG)	43.2
Density (KG/M3)	820
Total Carbon (%)	88
Total sulfur (%)	0.33

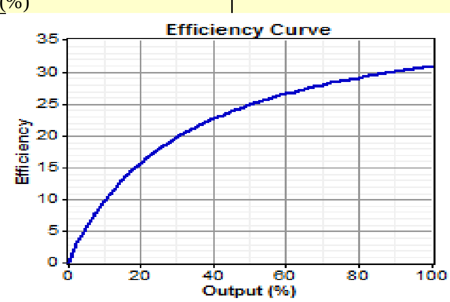

Figure15*. Efficiency of Diesel at its maximum capacity*

9-2- biomass fuel

***Table 3**. Main properties of Biomass*

Main characteristics	Rated capacity
Minimum value of the heat (MJ/KG)	5.5
Density (KG/M3)	0.72
Total Carbon (%)	5
Total sulfur (%)	0

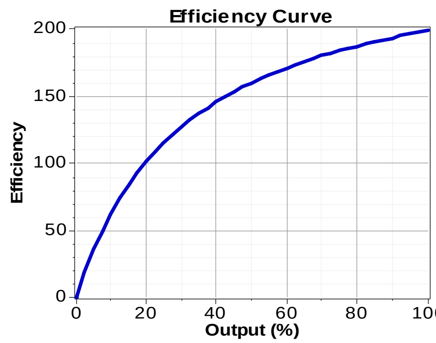

***Figure15**. Efficiency of Biomass at its maximum capacity*

Comparing these proposed fuels reveals that biomass has a higher efficiency than diesel. Also, biomass contains less carbonate and sulfuric content compared to diesel.

9- Conclusion

The results suggest that use of biomass instead of diesel considering a suited vast landfill in the wharf of steel industry in Bandar Abbass (anchorage site of CaeyPraid for unloading petroleum) is technically and environmentally viable and remarkable in order to reach the peak pwer generation in the ship.

REFERENCES

[1] Brown, R. E. (1999): Reliability Assessment and Design Optimization in Electric Power Distribution System, Ph.D. Dissertation, University of Washington, WA,.

[2] Lamarre l. (1996): The Vision of Distributed Generation, EPRI Journal: 7-17.

[3] Renewable Energy Organization of Iran. www.suna.org.ir

[4] www.fa.wikipedia.org

[5] Bvghlan Dashti, B.H., (2004): Economic Studies biomass plants at landfills Shiraz" Nineteenth International Power System Conference, Tehran.

[6] Haghparast Kashani, A.R., Bvqlan Dashti, B.H.. (2009): Feasibility of waste incineration plants in the city of Tabriz, Twenty-Fourth International Conference on Electrical, Tehran.

[7] Dragos C.R., Adrian D.U. (2011): Analysis of Hybrid Renewable Energy System on the Mures Vallery Using Homer, Scientific Bulletion of the Petru maior 'University of Tragu Mures' Vol.8, no. 2.

[8] Dalton, G.J., Lockington, D.A. (2008): Feasibility Analysis of Stand-alone Renewable Energy Supply Option for a Large Hotel. Science Direct. Renewable Energy: 1475- 1490.

[9] Shiroudi, A.B., Rahim Zadeh, M.A., (2009): The economic and technical analysis of hydrogen energy systems in Taleghan site using emulation software HOMER. Twenty-Fourth International Conference on Electrical, Tehran.

[10] Rocky, D.A., (2012): Technical assessment of potential renewable plants wind and biomass in Khuzestan province, using software HOMER power fifth national conference, Ahvaz, Winter.