Yenilenebilir enerji potansiyeli ve enerji transfer sistemlerinin gelişimi

Ahmad OMAİS[1]
Zafer ASLAN[2]

Geliş tarihi / *Received:* 10.08.2021
Düzeltilerek geliş tarihi / *Received in revised form:* 13.10.2021
Kabul tarihi / *Accepted:* 15.10.2021
DOI: 10.17932/IAU.ABMYOD.2006.005/abmyod_v17i65005

Öz

Son zamanlarda, enerji talebi, çoğu ekonominin fosil yakıtlara dayanması nedeniyle sektörlerini etkileyen bir artış göstermiştir. Çalışmanın amacı, Beyrut limanında farklı kaynaklardan enerji üreten bir enerji üretim sisteminin geliştirilmesinin etkinliğinin belirlenmesi ve kendi üçlü tasarımının rüzgar, güneş ve dalga enerjisi ile etkinliğinin iyileştirilmesine yol açacağını belirlemektir. Operasyonların kilit önlemler olarak alınması, enerji arzının artırılması ve artan enerji talebinin karşılanmasında farklı enerji kaynaklarının kullanılması, limanın yıl boyunca aydınlatılmasına yardımcı olacaktır.

***Anahtar Kelimeler**: Dalga enerjisi, Güneş enerjisi, Rüzgar enerjisi, Elektrik, Lübnan Beyrut limanı, Fazla watt.*

[1] *İstanbul Aydın University, Institute of Graduate Study, Mechanical Engineering Program, 34295, Küçükçekmece, İstanbul, ahmadomais99@hotmail.com, iauenstitu@aydin.edu.tr, ORCID: 0000-0003-3824-576X*

[2] *İstanbul Aydın University, Institute of Graduate Study, Mechanical Engineering Program, 34295, Küçükçekmece, İstanbul, ahmadomais99@hotmail.com, iauenstitu@aydin.edu.tr, ORCID: 0000-0003-3824-576X*

Renewable energy potential and development of energy transferring systems

Abstract

Recently, the energy demand has shown an increase which has affected its sectors since most economies rely on fossil fuels. The purpose of the study is to determine the efficacy of the development of an energy production system producing energy from different sources in Beirut port, and an own triple design with a wind, solar and wave energy which will lead to the improvement on the effectiveness of the operations so as the key measures, increasing the supply of energy and utilizing different energy sources in addressing the increasing energy demand which will help in lighting the port all over the year.

Keywords: *Wave energy, Solar energy, Wind energy, Electricity, Lebanon Beirut port, Excess watts.*

Introduction

The Covid-19 pandemic has had a negative impact on energy markets, with primary energy consumption falling 4.5% in 2020. Although there has been a reduction in energy consumption from petroleum, renewable energy has increased by 9.7% as the population focuses on using solar and wind energy. (Harajli & Queffeulou 2013).

2019 recorded a 1.3% increase in global gross electricity generation compared to 2018. Electricity produced from combustible fuels was higher in this period, corresponding to 57.1%. Waves are critical in generating energy that can be used for lighting and operations in the port of Beirut (Braun & Edler, 2014).

According to Julian, Bassil & Dellagi (2020), most of the electricity supplied is provided in more centralized plant locations, which are often located far from the end users of such electricity power. As such, there is

a loss of about 10% of the electricity before reaching the consumers. This loss, capped with the demand for energy and diversification of energy production sources, raises questions on significance of development of an energy production system producing energy from different sources such as solar, winds, and waves.

Literature review

Overview of Lebanon energy production

Like most developing economies, Lebanon faces energy problems as the country's production capacity is below consumption. As such, this has led to air pollution and environmental degradation with the economy using various energy sources that are not environmentally friendly. Lebanon's electricity generation problem is linked to four main challenges related to electricity generation, distribution and transmission. This population growth also means increased energy consumption, straining the capacity to generate EDL as it has a lacking in production for more than three hours (Dolatabadi, Ivatloo, Abapour, 2017).

Rebuilding the energy sector is seen as an effective way to sustain energy demand and consumption in Lebanon. Although there has been an increase in domestic consumption, the increase in economic activities has significantly increased the demand for energy and electricity in Lebanon. There are not enough settings and this reduces the amount of electrical power supplied. In addition, energy privatization means an increase in the supply of electricity, which improves consumption levels in the industry. The energy sector requires immediate assistance from other stakeholders to resolve the issue (Shihadeh 2018).

Reduction in energy consumption

In 2010, the concept of 'nearly zero-energy building' was introduced, a concept developed by the Energy Performance Buildings Directive. The intention was always to reduce the carbon emission and energy consumption of families, which led them to bet on changing design paradigms for the development of energy-efficient buildings. Therefore, energy-saving is essential for the country, considering the economic needs of the population. Having this position can increase the region's economic growth and sustainability.

Suggested strategies that can influence the sustainable construction of buildings as a way of conserving energy. Concerns have arisen about implementing effective measures to reduce the use of fossil fuels as there is a way to improve energy savings. Salem and others were concerned about the placement of these buildings, emphasizing the risk of overheating. Buildings are likely to overheat, which can affect the level of consumption of this energy (Salem, 2019).

Triple energy descriptions

Solar energy is considered an effective and favorable method of renewable energy sources in regions where climatic conditions are favorable. There are several techniques that are used to increase the efficiency of solar panels, some being considered as cooling techniques such as active cooling and passive cooling. Solar panel efficiency is effective in implementing measures that are essential to succeed in the dynamic industry.

Wind energy use has increased significantly in recent years due to the focus on renewable energy. Numerous countries have developed wind turbines in an attempt to increase energy production and distribute them across different sectors. The stochastic nature of wind speed means that there is fluctuation in power generation with some of the regions reportedly having problems with wind power generation.

Most countries have not used wave energy due to its complicated nature and uncertainty in how it is implemented. As the wave is a random oscillation, the direct absorption of this energy can be difficult and requires sophisticated equipment to be used in the energy transmission. The use of waves in energy production can be advantageous for the country in several ways. First, it provides high energy density compared to other energy sources. The intensity of solar energy is often given in 0.1 – 0.3 kW/m2, while the intensity of wave energy is 2 – 3 kW/m2, which indicates a better efficiency of the energy use in these regions. The impact on the environment is limited as the life cycle emissions from these devices tend to be generally low, improving the nature of the country's sustainability and environmental conservation (Miller (2004).

Cost and requirements

As of 2019, the average cost of building solar energy is $1,796 per KW, which is down 2.8% from the amount reported in 2018. Such a decline in the cost of building a power distribution system solar energy can be attributed to the decline in the cost of crystalline silicon. Having this in place means there is an improvement in the development of key solar technologies for power generation, which impacts the overall productivity level in the long run. As such, it is necessary to consider emerging trends in the industry and improve the cost implications of solar panels offered in the industry.

In favorable weather conditions, the flattened cost of electricity for wind power is about $7.9c per KWH. Depending on the region where the wind turbines are located, the cost can vary, which can influence the level of productivity and the investment needs of different companies.

In the case of solar energy, the main materials needed are solar panels and the energy converter to transform heat into energy.

Methodology

In the next section of the study, a case analysis of the port of Beirut and the energy distribution in the port can be carried out. It can form the basis for the implementation of strategic measures that are critical to the success of the energies to be delivered from the turbines in the region.

The focus is on maximizing the location in the port of Beirut and the Solar Pathfinder can be used to determine the correct location of the plant. Other factors to consider when selecting the location for the solar panels such as the angle of inclination of the solar panels.The energy from each developed system can be determined by this calculator, which can calculate a voltage system and a power generated from solar energy. In addition, panel sizing, battery system are used in solar panels with a focus on maximizing their usage.As the turbines and location are dependent on speed and workforce, their influence can be effective in determining the wind. This may be essential to improve the amount of wind energy being produced.

The design of the wave augmentation production system is based on the increase in wave energy which attracts the possibility of high production of increased wave energy. When the turbines are synchronized with the wave motion and can be created to be maximized through the wheels, they are easier to maximize performance without technical problems.

The project takes place in the damaged port of Beirut the location has been successful wind studies for the parameters that are necessary for the project to be in all circumstances to satisfy the needs of solar, wave and systems (URL-1).

Modeling and simulations

The project was undertaken by many industrial platforms to be applied as a real-time development to solve the electricity shortage in the port of

Beirut and to support Lebanon's main grid in case of excess power. These platforms are popular with industrial companies and are used to simulate and design the system. This system uses renewable sources provided by the ecological system like sun, wind and water to take advantage of the well-being of these free resources, to produce energy from the law of energy conservation.

What is the System Design?

After the explosion of the port of Beirut on the 4th of August 2020 at 17:58, electrical breakdowns occurred more frequently throughout the Beirut district, to cover the economic losses due to the incident and reduce the dark hours in the port, project is ready to navigate.First, we have solar energy, which is obtained by storing particles of solar rays and the wind stimulates the mechanical turbines to perform a rotating movement sustained by the energy of the waves that are colliding on the steel plate. Different times of the year cause us to have variables in system depending on what time of year the daylight hours, wavelength and wind speed fluctuate. Figure 1 represents the system drawn on SolidWorks.

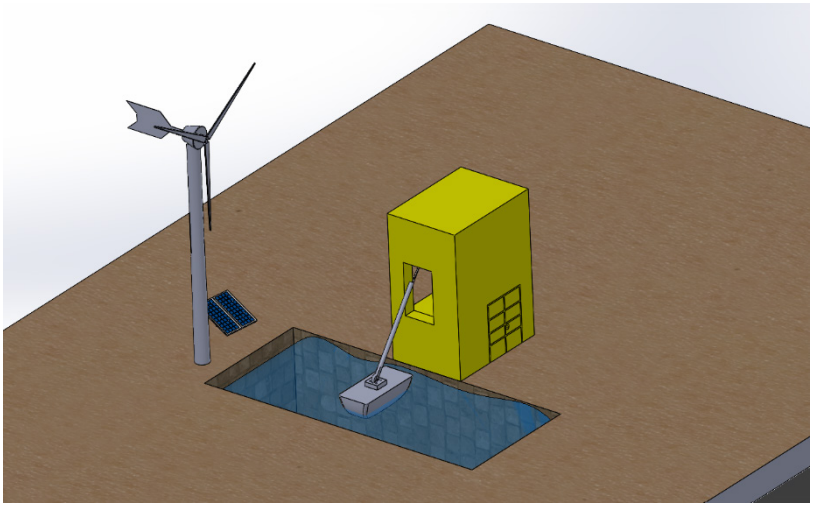

***Figure1**: System Representation on SolidWorks.*

Wave energy

The transmission of energy from surface ocean waves and its use in beneficial mechanical operations such as producing electricity, desalination of water or pumping water to water reserves is known as wave energy. It is a type of renewable energy. Not to be confused with tidal energy.The original wave power system contains a polycarbonate plastic shaped mobile boat that withstands salt water, heavy weights and UV rays, never forgetting its light weight which is essential for task. Starting with the wave motion coming from any direction towards the plastic boat, regardless of its situation, will amplify the height of the track which in turn will increase the sensitivity on the main train.

Take it for granted that the boat is the pendulum, this system works like the pendulum clock, in which it generates energy going to the ends, not when it remains in equilibrium, so when the pendulum is at one end it is considered potential energy, however, when moving in any direction, it will be transformed into kinetic energy, where it will produce all the power needed by the system. Therefore, to avoid system failures, the rail and main gears have a spiral tooth profile, they do not change anything in terms of main direction, but help to protect against unusual movement. After many studies and research, we got wave periods for each month which are used for wave power equation (URL-2).

Solar energy

Photovoltaic panels are used to produce electricity at a domestic level, as well as for industrial and heating swimming pools in cold countries. System uses two Panasonic monocrystalline solar panels with an efficiency of approximately 19.7% located in an open area facing south at 45°.

Wind energy

Wind energy is energy extracted from the kinetic energy of the wind through wind turbines to produce electrical energy, and is considered a type of electromechanical energy.

Also, the wind has better speed compared to other nearby areas and this is due to the nature of Lebanese lands containing mountains and small distances from the coast.

This placement decision is based on using the north wind which is popular in Lebanon for its speed and consistency, but the wind coming from the west coast is also directly connected to an inverter to turn it into proper, ready-to-use electricity.

Programs used in the System

SolidWorks allows you to streamline the design process by transferring the same data and knowledge base from concept to end result. When compared to other solutions, it can save up to 30% of time. Because of its reduced operations and very efficient interactivity, this is possible. We created a fully functional prototype of the system using SolidWorks that improved the system results and employed the research more effectively (URL-3).

Labview

LabVIEW is a popular engineering program developed by American electronics manufacturer National Instruments. LabVIEW makes some things more efficient, which can minimize training or development time and expense. LabVIEW was used as a data implementer where it takes user data and gives results of the work where several variables can be included such as air density and efficiency, but working on the equations we chose and giving a real interface with the system (URL-4).

Figure 2 represents the coding and the usage of data collected to see if the system fails in any month, and the flow chart of the whole system

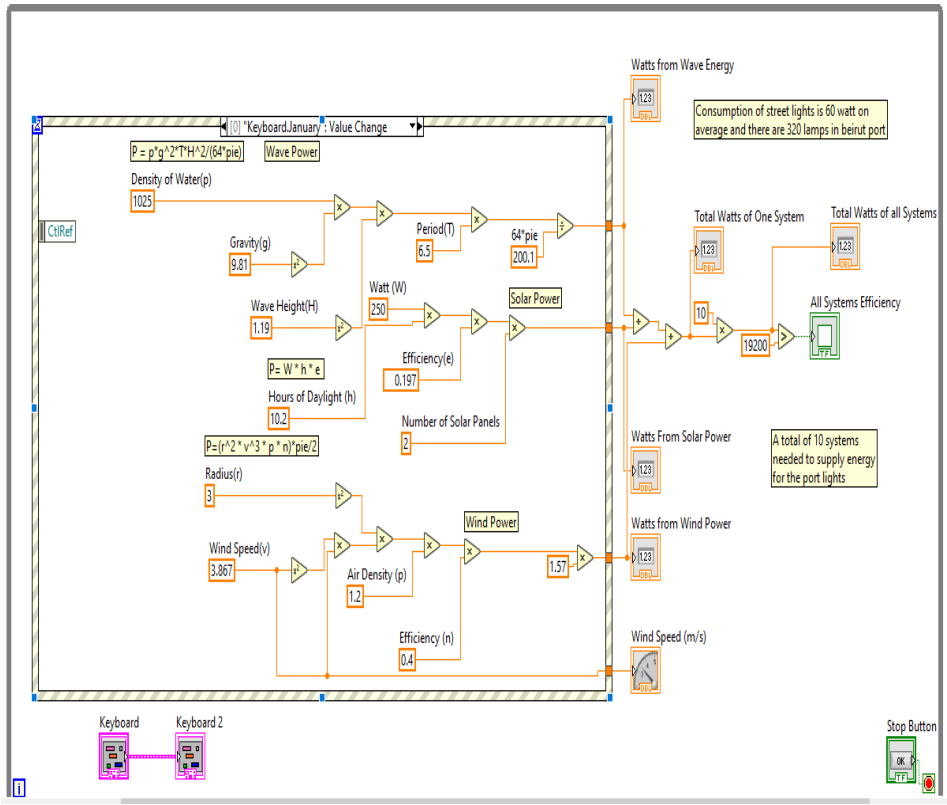

Figure 2: *Block Programing*

Results and discussion

Lebanon is important in the renewable energy sector due to its geographical position and prosperity that it has as a country. The System achieved success by exploring ten units that are similar to each other, each unit contains two solar panels, a wind turbine and a wave system.

Maintenance is all around grease and labor, each month we need a worker for one day a month to lubricate and clean all ten units, which roughly converts to twenty dollars a month, on the other hand, the system makes $537.4815 per year. Any surplus money will be saved in case of an unusual problem.

After a quick review of the comparison tables based on simulations performed in LabVIEW, we determined the lowest and highest months in the energy values which are August and February respectively, due to the nature of Lebanon a wide variety of influences occur over the course of the year. year depending on what season they are currently in. Therefore, a huge difference in value is found between the extreme months, but it is in fact enough for the energy usage we want. (URL-5).

The reason behind having these low values in these two systems refers to pumping numbers and keeping a higher minimum value like the whole complete system, in the worst months which are August, where these two parts play a regulatory role with the aim main one which is the wave power system. The constant consumption that we have each month in the project is what makes us more flexible with the choices, so meeting these standards is the only goal in terms of production rate, consumption is 19200 Watts per month across the port where we have an output of 20610.7 Watts at least that saves us with 1410.7 Watts that can be sold or saved for any unusual increase in consumption. Otherwise, there are months that contribute a lot and save a lot more electricity to be sold to the government, like February with 75587.5 Watts which gives an excess of energy with about 56387.5 Watts that could also be sold to the government.

The system cost efficiency is higher than other systems that generate more power when expanding with more units, this result is due to the component selection and the nature of Lebanon as a whole. Table 1 shows the power flow each month over the year.

***Table 1**: Theoretical Power Assessment.*

	Watts from wind power	Watts from solar power	Watts from wave power	Total Watts from one system	Total Watts from 10 systems	Excess Watts
January	392.198	1004.7	4537.56	5934.46	59344.6	40144.6
February	484.761	1083.5	5990.49	7558.75	75587.5	56387.5
March	384.041	1182	1499.6	3065.64	30656.4	11456.4
April	276.095	1300.2	1256.07	2832.37	28373.7	9173.7
May	207.978	1379	1064.8	2651.78	26517.8	7317.8
June	202.054	1418.4	1011.58	2632.04	26320.4	7120.4
July	207.978	1388.85	1028.05	2624.78	26248.7	7048.7
August	183.125	1310.05	567.894	2061.07	20610.7	1410.7
September	174.12	1221.55	909.577	2295.25	22952.5	3752.5
October	188.674	1113.05	940.574	2242.3	22423	3223
November	234.983	1024.4	1046.76	2306.15	23061.5	3861.5
December	335.26	975.15	3435.96	4746.37	47463.7	28263.7

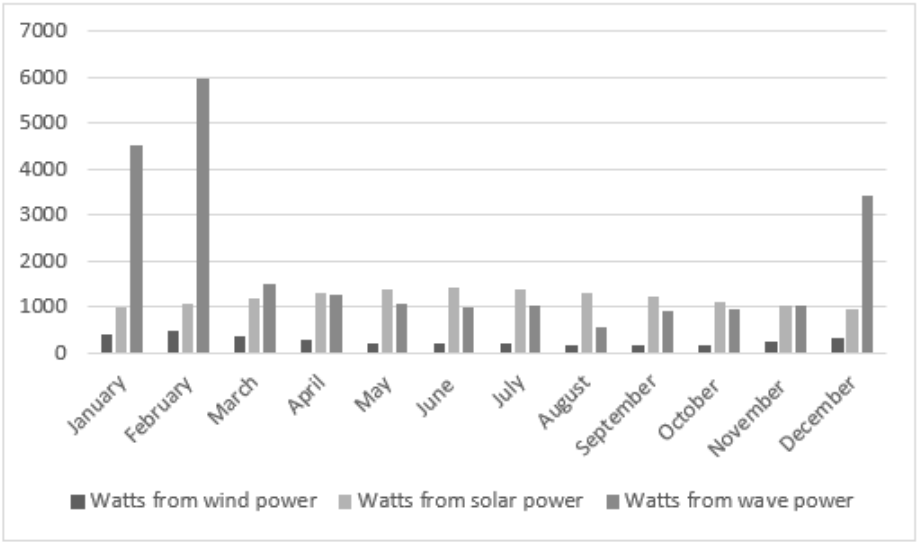

***Figure 3**: Power Generation Per System.*

Conclusion

The project done in Beirut port decreased the costs built up on the port management to help focusing on other damaged parts in the port after the explosion, also made an increase in the money flow. The money advancements from it will allow to either invest in the Lebanese economy or increase the number of units implanted, where every year the project returns can cover a wave system to be implemented in project or it can be a way for increasing the electricity time in the poor places at the south of Beirut and help the hydropower plant that becomes old and didn't have the ability for covering all Lebanon. Moreover, this system can be upgraded in many fields to be able to satisfy the whole city of Beirut in electricity under good commitment and supervision of the project. This project covered the goals with minimal costs and was successful upon all the fields chosen from durability to power coverage. The wind has better speed compared to other nearby areas and this is due to the nature of Lebanese lands containing mountains and small distances from the coast.

The intensity of solar energy is often given in 0.1 – 0.3 kW/m2, while the intensity of wave energy is 2 – 3 kW/m2, which indicates a better efficiency of the energy use in these regions. Wave energy has a better performance in winter. The forthcoming study would be related with future prediction of these three energy potential for hybrid systems.

References

[1] Aoun, N., Harajli, H. & Queffeulou, P. (2013). Preliminary appraisal of wave power prospects in Lebanon. *Renewable Energy*, 53, 165 – 173.

[2] Blazejczak, J., Braun, F. & Edler, D. (2014). Economic effects of renewable energy expansion: A model-based analysis for Germany. *Renewable and Sustainable Energy Reviews* 40, 1070 – 1080. doi:http://dx.doi.org/10.1016/j.rser.2014.07.134.

[3] Dolatabadi, A., Mohammadi-Ivatloo, B., Abapour, M., et al. (2017). Optimal stochastic design of wind integrated energy hub. IEEE *Transactions on Industrial Informatics*, 13, 2379–2388.

[4] Shihadeh, A., Al Helou, M., Saliba, N., Jaber, S., Alaeddine, N., & Ibrahim, E. (2018). Effect of distributed electric power generation on household exposure to airborne carcinogens in Beirut. *Climate Change and Environment in the Arab World*, 4(2), 11 – 19.

[5] Wei, N. T. J., Nan, W. J., & Guiping, C. (2017, July). Experimental study of efficiency of solar panel by phase change material cooling. In *IOP Conference Series: Materials Science and Engineering*, 12(1), 1 – 7.

[6] Gipe, P. (1993). The wind industry's experience with aesthetic criticism. *Leonardo*, *26*(3), 243-248.

[7] Miller, Christine (August, 2004). "Wave and Tidal Energy Experiments in San Francisco and Santa Cruz".

Internet References

[1] URL-1 Weather Spark (2021). Climate and average weather yearround in Beirut, Lebanon. Available at: https://weatherspark.com/y/99217/Average-Weather-in-Beirut-Lebanon-Year-Round

[2] URL-2 Wacop (2021). Mean available wave power. Available at: https://wacop.gsd.spc.int/RegionalWaveEnergy.html

[3] URL-3 What Is Solidworks and Its Importance? Cetpa Infotech (2015) Available at: https://www.cetpainfotech.com/blogs/what-is-solidworks-and-its-importance/

[4] URL-4 Samar, Pitsmarty.(2021) What is LabVIEW? Available at: https://www.geeksforgeeks.org/what-is-labview/

[5] URL-5 (2021) Powerwall. Available at: https://www.tesla.com/powerwall