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# Power Generation using Tidal and Wind Energy

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**ABSTRACT**
The power generation changes from conventional to renewable generators resulting in new challenges for the grid operators. One important aspect is reserve power. Due to fluctuating resources as wind and photovoltaics, the need for reserve power even increases. In this paper, it is studied, how tidal energy conversion systems can be controlled providing primary response. The innovative renewable energy conversion system called "Hybrid Offshore wind and Tidal Turbine (HOTT) Generation System" is proposed. "Offshore-wind and Tidal Turbine" hybrid and autonomous power system research will demonstrate the feasibility of using hybrid wind and tidal current power to provide reliable electrical energy, and to create a push toward the development of a sustainable commercial market for this technology. Thereby, the rotor speed is an important control parameter varying the power output for a given tidal current velocity as desired. A network model is proposed containing a synchronous motor load for testing the tidal turbine influence on the grid. Simulation is carried out in Matlab/Simulink. The results validate the proposed control for primary response. the creation of a Matlab-Simulink model for a tidal current turbine system through the modeling of the source, the rotor, drive train and the generator. The aim of the simulation model is to illustrate how the tidal current energy system works and how to make use of it in power generation. Harnessing tidal currents power done through various types of water current turbines. Owing to its advantages in producing power from tidal currents,
**Index Terms**—Tidal energy conversion system, modeling, primary reserve, simulation, power system, Tidal Turbine

## 1. INTRODUCTION

The Wind energy is the energy produced from the simple air in motion and this motion is caused by the uneven heating of the earth's surface by the sun. The air over the sea absorbs the heats faster than the land and so the air moves from the sea to the land causing the wind but in the night the air motion is changed from the land to the sea because the air over the sea cools faster than the air over the land. This wind is hardly predictable source of energy. Tidal energy is due to the gravitational influence of the moon and the sun on the earth due to the rotation of the earth relative to the moon and the sun which produces two high and two low waters each day (12.4 h cycle). This rotation makes the rise and fall of the tides and these tides are predictable. Wind at sea is more powerful and more constant than that of onshore. This assures a greater energy production.

Electricity generation is an important process before transmitting and distributing the electricity to consumers, where there are many alternative sources of energy to generate electricity. Nowadays, the green technologies are frequently used, spreading and expanding in terms of generation for power utilities. This technology consists of renewable energy sources such as solar, wind, geothermal and wave. In The, fossil fuel or coal was heavily used to fulfill the electricity demand and happen to increase the emissions of greenhouse gases. In addition, the energy consumption and

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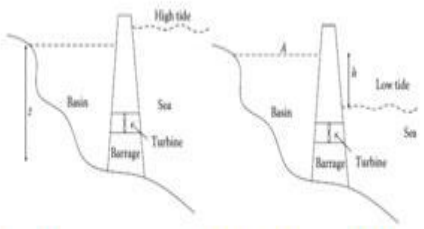
electricity demand was increased proportional to the rising of population in The year by year. Recently, the researches of harnessing energy from the ocean are being actively carried out. Moreover, tidal energy that comes with few advantages such as lower environment impact and highly predictable than wind or solar energy seems suitable and expected to be the most reliable alternative energy than wind and solar in the future. Basically, tidal energy was extracted from moving masses of water which was known as tides. According to previous published paper; ocean energy is one of the sources with huge potential to generate electricity where it was abundance as almost 70% of our Earth covers with waters which are best describe as a huge reservoir with many kind of energy that can be extracted from it such as waves, thermal differences, tides, salinity gradient and marine current [1]. Generally, there are three methods or approach that were often used in order to harness the energy and generate electricity from the ocean sources, which are tidal barrage, tidal stream and dynamic tidal power.

*A. Tidal Barrage*

Tidal barrage as shown in figure 1 is a popular method that was builds across a bay or an estuary at high tides differential at least five to ten meters of tidal ranges, to achieve valuable and worth value of electrical power generation. The bottom of the barrage is located on the sea floor and the top is above the highest level that the water can get at high tide. The estuary was characterized by narrow, shallow channels with a relatively constant width and depth. [7] It applies the same principle as hydroelectric generation except that tidal currents flow in both directions. [8]




(a) High Tide (b) Low Tide Fig.1. Tidal Barrage approach [2]

- The sea offers lager open spaces. Then, they can install wind turbines lager than onshore.
- A tidal turbine has the role to extract energy from marine current. Its principle is the same than wind turbine. As offshore wind and tidal turbines are both installed at the sea, it will be interested to conceive and run together an offshore wind and tidal power system.

During high tide, the water level on sea side was increased and only then the sluice gates opened and the water was forced to flow through the narrow openings and flow into the basin that create forces. The forces create speeds that rotate the turbines and generating the electricity. After the basin was filled with water, the sluice gates will close and this process was repeated everyday to generate electricity. That is why the tidal energy is said to be abundance and highly predictable. By using equation 1 below, the potential energy of a tidal turbine can be calculated [4][5]:

$$E = {}^{1/2}C_p(\lambda)\, g\rho A h^2 \qquad (1)$$

Where:

$E_p$ = Potential Energy (J)

$C_p$ = power coefficient

$\boldsymbol{\lambda}$ = tip speed ratio

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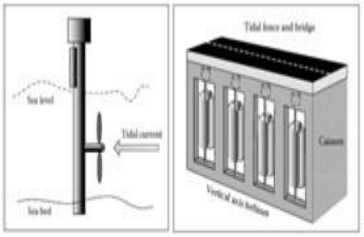
g = acceleration due to gravity ($ms^{-2}$)
ρ = density of the water (seawater is 1025 $kgm^{-3}$) A = the sweep area of the turbine ($m^3$)
H = tide amplitude (m)

*B. Tidal Current*

Tidal current or stream is an energy that was extracted from free flowing water. [3] It extracts the energy from currents in similar way with wind turbines but in different density where water is 832 times denser than air which means it will harness the same amount of power although the water speeds are slower (one-tenth) than wind speed in meter per second (m/s) for same size of turbine. [4] Currently, there are two types of turbines which are horizontal and vertical axis turbines. Figure 2 illustrates the types of turbines blade for tidal stream approach.



(a) Horizontal axis turbine (b) Vertical axis turbine Fig. 2. Types of tidal stream turbines [2]

In order to harvest tidal stream energy, the conversion systems are required to convert water kinetic energy into motion of mechanical system which can drive the generators [2]. Thus, equation 2 was used to assume the output power from capture kinetic energy [9][10]:

$$P = \frac{\xi \rho A V^3}{2}$$

## 2. LITERATURE REVIEW

Every The potential energy of tides can be harnessed by constructing tidal barrages. A tidal barrage is a dam, which is constructed crossway an estuary. Tidal barrage blocks the entering and leaving tides and then shapes a head of water [2, 6]. Generation of electricity using tidal barrages is same as that of hydroelectric power generation excluding that the tidal currents flow in both ways [7]. Electrical power is created by permitting water to flow from one side to other side of barrage [8]. The tidal barrage contains turbines that are either unidirectional or bidirectional [7]. Tidal barrage generate electricity either by the ebb or flood or both modes equally [2]. Construction of tidal barrage needs a high cost [9]. Change in water level due to construction of barrage and possible flooding would disturb the coastline ecosystems around shore. Water quality and turbidity in the basin can disturb the animals that live in water. However, these issues are very gentle, and need to be separately assessed [10]. The present tidal schemes need larger tidal ranges for produce a big amount of energy output. For a suitable location A 7 m minimum tidal range is required [11]. A lower tidal range is 5 m. however, 2 to 3 m tidal ranges can be used [12] Tidal turbine can be operated with small head of water ranging 1 to 1.5 m. while large tidal ranges are encouraging [13].

## 3. METHODOLOGY

The basic diagram of tidal energy conversion and transmission system as shown in figure 3 is chosen. Since the tidal energy system is huge to be build, the focus in this project is to design the simulation from tidal turbine until machine side converter or rectifier.

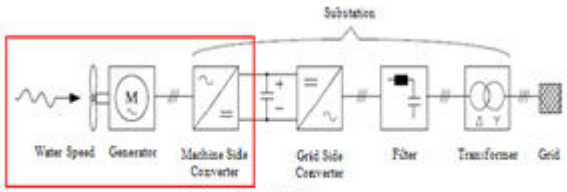



Fig. 3. Tidal energy system

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MATLAB/Simulink program is the practical software that can ever design and used to simulate the system. Since there are three approaches that have been introduced earlier in the previous topic, tidal streams are the most suitable for The Sea and river conditionFigure 4 shows the block diagram of the proposed system designed of the simulation from tidal turbine until machine side converter.

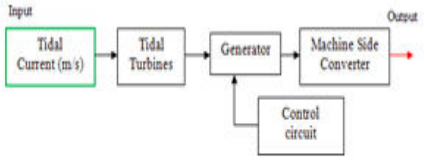


Fig. 4. Block diagram of designed system

The input of the system is tidal currents or tidalstreams that were obtained from books of tidesprediction using equation 3. The
tidal ranges however are using equation 4.

$$\text{Tidal stream (knots)} = \frac{\text{Positive tidal streams}}{2} - \frac{\text{Negative tidal stream}}{2} \quad (3)$$

$$\text{Tidal range (m)} = \frac{\text{High Tide}}{2} - \frac{\text{Low Tide}}{2} \quad (4)$$

A. Simulation System via MATLAB Simulink

The condition according to the tidal stream results was used for this simulation of tidal energy. The tidal streams were converted into meter per second (m/s) unit by applying the conversion calculation using equation 4 [1][11] below:

$Tidal\ stream\ (ms{-}1)$
$= tidal\ stream\quad knots\quad x\ 0.51444\ ms{-}1$

Where:

One Fathom Bank = 2.1 knots x 0.51444 ms-1
= 1.080324 ≈ 1.08 ms-1

Off Raleigh Shoal = 2.05 knots x 0.51444 ms-1
=1.054602 ≈ 1.05 ms-1

Off Tanjung Segenting = 1.85 knots x 0.51444 ms-1

` = 0.951714 ≈ 0.95 ms-1

Therefore, the tidal streams were completely converted into the m/s unit

## *4.* SIMULATION RESULT

Output stator voltage, current, power and angular rated speed in transient state at 1 m/s tidal current speed and fixed zero pitch angle is cleared as shown in Figure 9.

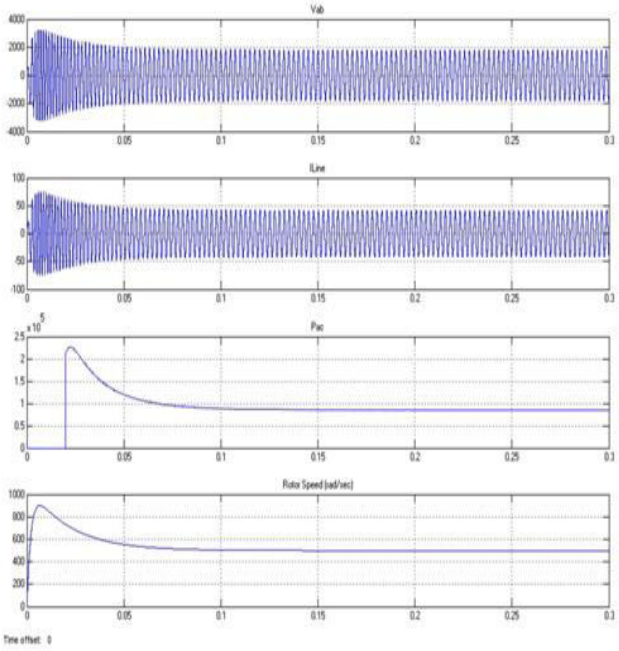


Figure 5. Transient state load voltage, current, power and rotor angular speed at tidal current speed v=1 m/s.

It is clear that the output reaches steady state within a very short time approximately 0.075 second resulting power =84.55 kW which is approximately equal to that from equation 1 and according to turbine parameter and power curve verifying the validity of the generated Simulink

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model. Voltage and current also has the same frequency, which is 50Hz

## 5. CONCLUSION

In a conclusion, tidal energy will be a great impact for The's electricity generation if the scheme is implemented. It is environment friendly as it not going to emit any gases. Compare to other renewable sources such as wind and solar, tidal is predictable as the tides occur two times per day without any affection from the weather such as climate change, melting snow, low of rain or storm. In addition, it is abundance where the earth is majority covered with water. Furthermore, it is a trend to try out anything new for the facilities generation where it can be combined with other energy known as hybrid technology. Hence, it can compliment each other as a backup and it is believed to be a reliable and operate efficiently. Thus, this problem had solves as it reflects the problem statement previously to reduce the usage of coal and fossil fuel while fulfilling the increasing of electricity. Furthermore, all of the proposed objectives were achieved with intermediate level in providing relevant results.

## REFERENCES

[1] Shafie, S. M., Mahlia, T. M. I., Masjuki, H. H., & Andriyana, A. (2011). Current energy usage and sustainable energy in Malaysia: A review. Renewable and Sustainable Energy Reviews, 15(9), 4370-4377.

[2] Xia, J., Falconer, R.A., Lin, B., & Tan, G. (2012). Estimation of annual energy output from a tidal barrage using two different methods. Applied Energy, 93(0), 327-336.

[3] International Renewable Energy Agency. (2014). Tidal energy technology brief. Available at: http://www.irena.org/documentdownloads/publications/tidal_energy_v4_web.pdf

[4] Waters, S., & Aggidis, G. (2016). Tidal range technologies and state of the art in review. Renewable and Sustainable Energy Reviews. Elsevier Ltd.

[5] Leong, H. Y. (2011). Enter a new era of green energy. Retrieved from http://www.thestar.com.my/business/business-news/2011/12/03/enter-a-neweraof-green-energy/

[6] Lim, Y.S., & Koh, S.L. (2009). Marine tidal current electric power generation: state of art and current status, Renewable Energy, T. J Hammons, Intech. 211-226. Available from: http://www.intechopen.com/books/renewable-energy/marine-tidal-current-electric-power-generationstate-ofart-and-current-status

[7] Rourke, F.O., Boyle, F., & Reynolds, A. (2010). Tidal energy update 2009. Applied Energy, 87(2), 398- 409.

[8] Meisen, P., & Loiseau, A. (2009). Ocean energy technologies for renewable energy generation. Global Energy Network Institute.

[9] Denny, E. (2009) The economics of tidal energy. Energy Policy, 37(5), 1914–1924.

[10] Jakhrani, A.Q., Rigit, A.R.H., & Samo, S.R. (2013). Estimation of Tidal Stream Energy Resources at Sarawak Coastline and Their Potential Impact on

Environment. Australian Journal of Basic and Applied Sciences, 7(6), 503-514.

[11] Helston, C. (2012). Tidal Power. Available at http: //www.energybc.ca/profiles/tidal.html

[12] Leghari, R.H., Uqaili, M.A., & Harijan, K. (2012). Technologies for harnessing tidal power in Pakistan. In M. A. Uqaili, & K. Harijan (Eds.), Energy, environment and sustainable development, 111-119. Vienna: Springer.

[12] Xia, J., Falconer, R.A., & Lin, B. (2010). Impact of different operating modes for a Severn Barrage on the tidal power and flood inundation in the Severn Estuary, UK. Applied Energy, 87(7), 2374-2391