**Journal of Telematics and Informatics (JTI)**
Vol.6, No.1, March 2018, pp. 1~6
ISSN: 2303-3703 

# Low Cost Solar Energy Efficiency for Desalination System Using Simulation Matlab

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***Abstract***

*Freshwater and energy scarce are now becoming most important issues worldwide. Freshwater or potable water is the most important for human life. The rapid growth of population and industrialization contribute on the freshwater scarce. Conventional energy such as fossil fuel faces the similar trend with freshwater scarce since it is not renewable. The price of conventional energy is increased along with the scarcity. Desalination techniques have been developed for decades to be alterative way in providing freshwater. The desalination processes are driven by energy either thermal, mechanical and electricity.Efficiency for desalination system using simulation/Matlab, driven by renewable energy has derived great attention from scholars and engineer worldwide to get over freshwater need and energy issues. One of major concern in this field is to develop low cost desalination system that driven by renewable energy.*

***Keywords***: *Desalination, Low Efficiency, PV Panels, MATLAB*

## 1. Introduction

Efficiency for desalination system using simulation/MATLAB, driven by renewable energy has derived great attention from scholars and engineer worldwide to get over freshwater need and energy issues. One of major concern in this field is to develop low cost desalination system that driven by renewable energy.Solar and wind energy sources have been greatly exploited and found to be more promising in terms of economic and technological feasibility. Process hybridization is another way to improve the process economics and energy requirements of dual technologies that are involved in hybridization. Water reuse option to recover pre-treated wastewater can be achieved with low pressure membranes involving minimum production costs. In most cases, can be combined with the process whose effluent is the feed source. The recovered water can be used for non-potable uses while precious desalinated water can be used for better purposes.

Desalination plant generally uses a very large electrical power. If we use electricity provided by the government power station then the cost of electricity will be very expensive because the electrical energy used is calculated based on electric energy used every hour (watt-hour), making the electricity bill will huge to make the system inefficient. Moreover, this system is depending on certain power plant. If this system is applied in rural areas where the electricity source is hard to obtain or very far from the existing power plant, it is difficult to run this system without sufficient power source. As a solution to the problem, alternative sources of electricity that can be utilized. One of them is by utilizing the source of electricity with renewable energy. In this case the alternative power source that will be used is by utilizing sunlight. To convert sunlight energy into electricity we need some tools, Solar PV Panel.

## 2. Related Study

Gude et al [1], has presented a study discussion about existing and emerging desalination technologies and possible combinations of renewable energy. Alternatives to confront the water and energy sustainability are discussed based on availability, applicability and cost factors. These alternatives include proposing renewable energy sources, developing new hybrid processes, inventing low-cost, low-energy desalination processes to utilize low-grade or waste heat sources and finally water reuse.

Lindblom [2] studied solar thermal technologies for seawater desalination. The use of solar thermal energy in seawater desalination applications has so far been restricted to small-scale systems in rural areas.

Karaigiannis [3] reviewed and assessed the water desalination cost literature. This paper attempts the taxonomy of a large number of related publications, classified in a systematic method and format, in order to allow meaningful comparisons and facilitate the derivation of useful conclusions.

**3. Research Method**

**3.1. Design Calculation for PV Panels**

To accomodate power need that support jet pump operation works for desalination, PV panels is proposed. The PV panels works by absorbing the sun lights, converted to electricity energy. Then the electricity energy transferred to the batteries to be stored. After that the electricity converted from DC to AC signal, directly powered the jet pump in desalination process.Refers to Ramadhan [4], the requirements of PV panels is assumed as follows:

Table 1. The requirements of PV panels

| | |
|---|---|
| Manufacture (Type) | : Shinyoku (Polycrystalline) |
| Max. Power (Pmax) | : 300W |
| Max. Power Voltage (Vmp) | : 36.2 V |
| Max. Power Current (Imp) | : 8.28 A |
| Open Circuit Voltage (Voc) | : 43.4 V |
| Short Circuit Current (Isc) | : 9.27 A |
| Nominal Operating Cell Temp (NOTC) | : 45±2˚C |
| Max. System Voltage | : 1000V |
| Max Series Fuse | : 16A |
| Weight | : 20.65 Kg |
| Dimension | : 1956 x 992 x 40 mm |

From the specification above the dimension of the PV panels is 1956 x 992 x 40 mm or 1,956 x 0,9 m in width.According Ramadhan [13], the average of sun radiation per month for Jakarta (1983 – 2005) is listed on Table 1.

From the PV panels specification and sun insulation tabels refers to Ramadhan [4], the output from the PV panels can be calculated using the following formula:

$$P_G = A_G \, x \, S \, x \, t \, x \, ŋ \quad \ldots\ldots\ldots\ldots \quad (1)$$

$$P_G = \left((1{,}952 \, x \, 0{,}992) x 3\right) x \, 3{,}96 \, x \, 1 \, x 0{,}15$$

$$P_G = 5{,}8 \, x \, 3{,}96 \, x \, 0{,}15$$

$$P_G = 3{,}45 \; kWh/Day$$

$$P_G = 1.259{,}48 \; kWh/Year$$

Where:

ŋ = efficiency
A = width of PV panels
S = sun insulation
t = time duration of sunlight

**3.2. Modelling of PV Panel DC-AC**

To addressing the huge power are needed in desalination process, PV panels that combined with DC-AC Converter could be considered as an alternative power source. The overall main process system could be simplified as follows:

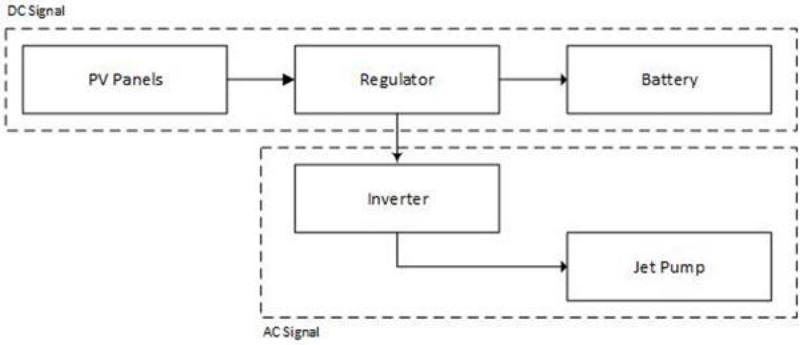


Figure 1. Simplified Block Diagram of PV Panel DC-AC Converter System

The complete system model involves the components and integration of every model discussed earlier. The goal here was to piece together a model that would function like the transfer model shown in above picture. The use of display blocksprovide a quick check to assess the functionality of the system. In the MATLAB simulink circuit are given Display and Scope blocks at input and output points considered to be observed in this study. For example, in the output of the PV solar panels a voltage and current measuring block is used to convert the value of the signal into a simulink data in order to be processed and displayed blocked "Scope" and "Display". Based on its function, each block diagram is grouped into several parts connected to each other. The first is a solar PV panel circuit, containing simulink blocks that simulate how PV solar panels work. Then the second is a DC-AC converter circuit, which functions to convert DC electrical signals into AC power signals. And the third is a water jet jump circuit, which is a circuit that simulates how the water pump works. From this study will be able to observe the form of output graph from each point that has been connected with Scope to see how the output when simulation is running.

## 4. Result and Analysis

In this term will discussing about the results and the proposed models, explaining it's features in general, and how it works. There are three major group of circuit in the proposed models consist of PV Panels circuit, DC-AC Converter circuit, and the Water Jet Pump circuit.

### 4.1. PV Panel Analysis

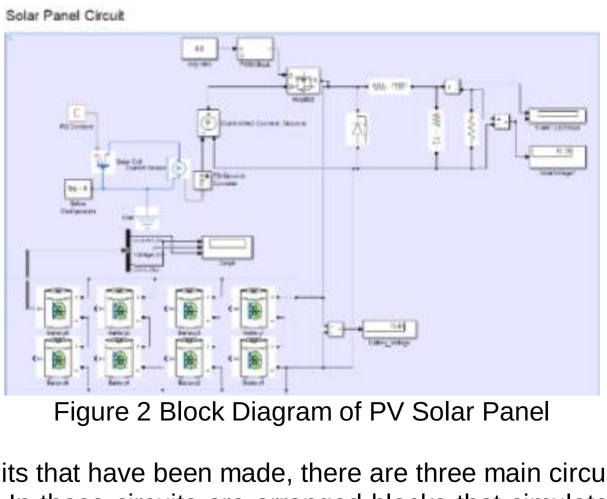


Figure 2 Block Diagram of PV Solar Panel

From the circuits that have been made, there are three main circuit groups. The first is a solar PV panel circuit. In these circuits are arranged blocks that simulate how PV solar panels work, such as the intensity of the sunlight that is converted into electrical energy in certain values. Then the electrical energy is measured using the block of voltage and current measurement module to know the value of voltage and current generated. In the MATLAB simulation the magnitude of the current and voltage can be arranged in such a way as to get the desired result as closely as possible with the reality on the field. The electrical energy generated is stored in battery storage, in which there are eight batteries used to store the electrical energy generated by the solar panel. The magnitude of the output voltage value of the battery determined by the connection on each circuit of the battery.

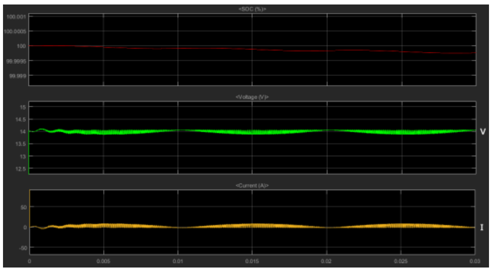

Figure 3. Output Graph from Batteries

Shows the voltage and current flow from the batteries. From the graph we can see that the voltage and current is not constant, this is caused by many factors that involving PV panels generating the electricity power such as sun light intensity, surface temperature, and the circuits. Many methods available to optimize the output from the PV panels, such as replacing the PV panels with better material, change the location of the PV panels to the place with more coverage of sunlight, and using better components on the main circuit’s system.

### 4.2. DC-AC Converter Analysis

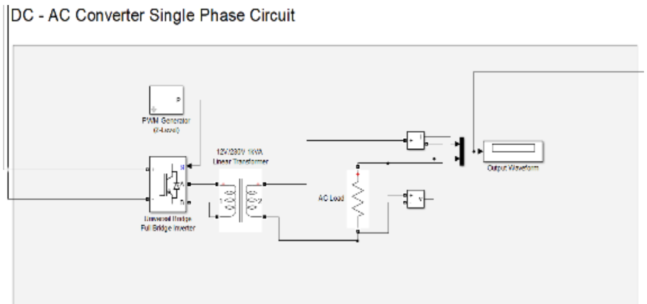


Figure 4. Block Diagram of DC-AC Converter

For the second group the circuit is a DC-AC converter. The input voltage, output voltage and frequency, and overall power handling depend on the design of the specific device or circuitry. The inverter does not produce any power; the power provided by the DC source. There are two basic designs for producing household plug-in voltage from a lower-voltage DC source, the first of which uses a switching boost converter to produce a higher-voltage DC and then converts to AC. The second method converts DC to AC at battery level and uses a line-frequency transformer to create the output voltage. This circuit is required if the energy already stored on the battery will be used to power a device or circuit that requires AC power source, in this study the tool is a water jet pump.

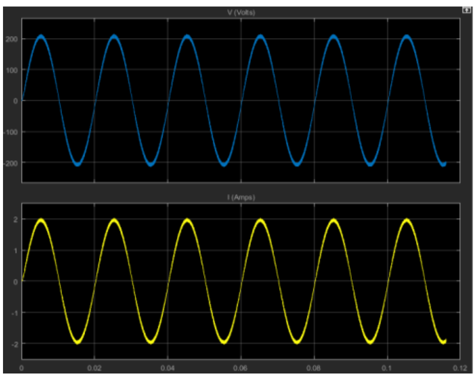

Figure 5. Output Signal From DC-AC Converter

The AC output voltage of a converter as refer to Figure 4.4 often regulated to be the same as the grid line voltage, typically 120 or 240 VAC at the distribution level, even when there are changes in the load that the inverter is driving. This allows the converter to power numerous devices designed for standard line power. In this simulation DC voltage generated by battery will be changed from 18VDC to 230VAC with frequency 50Hz.

### 4.3. Water Jet Pump Analysis

In the third circuit group is a series of water jet pump. In this group contains blocks that simulate how a water pump system works. Water jet pump will be powered by electrical energy stored on batteries that have been converted into AC voltage. In the simulation, many parameters can be adjusted to obtain the desired output result, since the jet pump blocks require adjustment of parameters that used in real environment such as pump capability parameters, storage tank volume, size of pipe used, water pressure, velocity motor rotation, etc.

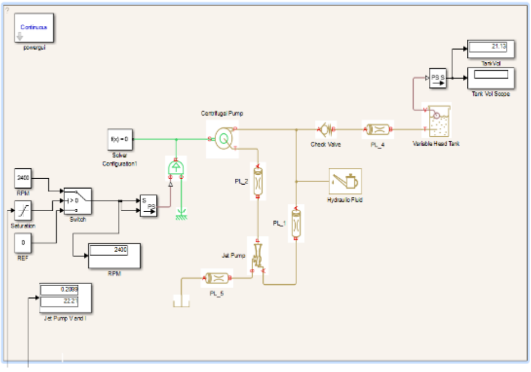

Figure 6. Block Diagram of Water Jet Pump

MATLAB to assist the calculating simulation. The “RPM” constant block is used to simulate maximum speed water jet pump when it operates, and the “REF” constant block is to simulate the motor’s rotation when the jet pump is inactive. The “Saturation” blocks used to saturate input from the converter to split the jet pump active condition based on the voltage’s presence. The “Switch” block will control the jet pump if there is voltage present in the jet pump it will activate the pump with defined RPM block. The “S-PS” block is used to convert Simulink data to physical signal.

## 5. Conclusion

To cut the bills for providing power source to desalination system, instead using government power station which is expensive, we are utilizing the source of electricity with renewable energy, in this case is sunlight using solar PV panels to produce electrical energy from sunlight. With this method it will reduce the cost for maintaining the desalination system in long term.

Based on the modules design, the jet pump have ability to running for 6 hours using batteries with a total capacity of 253 AH after fully recharged. This system is designed to addresing the desalination problem especially in rural area that have limited power sources.

Since this research is a simulation study, the results of the system are iterative and can be timed for as long as needed. The time scale could be easily adjusted to run for hours or for a few seconds, depending on the input parameters.

## References

[1] Gude, V. G., Nirmalakhandan, N., & Deng, S. (2010). Renewable and sustainable approaches for desalination. *Renewable and Sustainable Energy Reviews*, *14*(9), 2641-2654.
[2] Lindblom, J. (2003). Solar thermal technologies for seawater desalination: state of the art.
[3] Karagiannis, I. C., & Soldatos, P. G. (2008). Water desalination cost literature: review and

[4] Ramadhan, S.G, & Rangkuti, Ch. (2016). Planning a Solar Power Plant On The Roof Of The Harry Building Hartanto Trisakti University. *Seminar Nasional Cendekiawan 2016 ISSN (E) : 2540-7589.*
[5] Qiblawey, H. M., & Banat, F. (2008). Solar thermal desalination technologies. *Desalination*, *220*(1-3), 633-644.
[6] Azevedo, F. D. A. S. M. (2014). *Renewable energy powered desalination systems: technologies and market analysis* (Doctoral dissertation).
[7] Energy, U. R. (2012). *Water Desalination Using Renewable Energy.*
[8] Peñate, B., &García-Rodríguez, L. (2012). Current trends and future prospects in the design of seawater reverse osmosis desalination technology. *Desalination*, *284*, 1-8.