

KEY FACTORS IN DESIGNING SELF-EXCITED RENEWABLE ENERGY SYSTEM

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Abstract. For many people, powering their homes or small businesses using a small renewable energy system that is not connected to the electricity grid – is called a self-excited system. In remote locations, self-excited systems can be more cost-effective than extending a power line to the electricity grid, but these systems are also used by people who live near the grid and wish to obtain independence from the power provider or demonstrate a commitment to non-polluting energy sources. Thus, this paper focuses on key factors of using self-excited renewable energy system namely cost effective, environmental friendly and independent from power sources. Existing research is highlighted and reviewed based on its findings.

Keywords: self-excited, renewable energy, cost effective, environmental friendly, independence power sources.

Abstrak. Bagi kebanyakan orang, menjanakan rumah mereka atau perniagaan kecil dengan menggunakan sistem tenaga kecil yang boleh diperbaharui dan tidak disambung kepada grid elektrik dipanggil sistem “self-excited”. Di lokasi yang terpencil, sistem ini boleh menjadi lebih kos efektif berbanding dengan melanjutkan talian kuasa kepada grid elektrik, tetapi sistem ini juga digunakan oleh orang-orang yang tinggal berhampiran dengan grid dengan sebab tidak mahu menggunakan bekalan kuasa daripada pembekal atau mahu menunjukkan komitmen kepada sumber tenaga yang tidak memberi apa-apa pencemaran. Oleh itu, kertas kerja ini memberi tumpuan kepada faktor utama dalam menggunakan sistem tenaga yang boleh diperbaharui iaitu kos efektif, mesra alam sekitar dan tidak menggunakan bekalan kuasa dari pembekal. Beberapa penyelidikan yang sedia ada diketengahkan dan dianalisis berdasarkan hasil kajian mereka.

Kata Kunci: teruja, tenaga boleh diperbaharui, kos efektif, mesra, sumber kuasa bebas alam sekitar

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1.0

Introduction

Renewable energy system is one of the alternative power energy to replace the existing power supply in the off-grid area. In common off-grid area, conventional generator is the most typical system that is used, which is costly to maintain and operate. On the other hand, the increase in fuel price has had a major impact on the usage of the conventional generator in general. Therefore, to overcome this, other alternative power source solution needs to be considered as a replacement of the conventional generator system. One of the promising solution is the use of a renewable energy system (Dincer I., 2000). The renewable energy system is worth a look as it has less installation set-up without the need of a big power plant set-up. It is also almost maintenance free and thus the cost can be further trimmed down. Furthermore, the renewable energy system is cost effective, environmental friendly, independent from power sources and available for long term application (Dincer I., & Rosen M. A., 1998)

S.A. Abbasi et al. mentioned that the small hydro umbrella excludes the renewable energy sources from sea waves, coastal tides and ocean water even though hydropower is a central to those concepts (S.A. Abbasi, and Naseema Abbasi, 2008). According to K. Sopian et al., most experts agree that the more than 1 MW hydropower, such as large hydropower, is not considered a renewable energy (Kamaruzzaman Sopian, and Juhari Ab. Razak, 2009). In fact, building a big dam and storage reservoir can cause environmental damages and displace the original resident from their habitat. Conversely, it is well known that big dam hydropower generation has been used for more than hundreds of years as this is the only plausible way to produce the energy for electricity (The Pembina Institute, 2003). However, the development of large reservoirs will disturb and damage the natural ecology system. Besides that, A.A. Williams et al. reported that the extensive deforestation for the purpose of establishing a large reservoirs emit significant greenhouse effect in the form of methane gas (A.A. Williams, and R. Simpson, 2009).

Based on this issue, it is accepted that the impact on environmental damages from operating big scale hydropower plants is similar with fuel scheme plants. Thus, with the intention to avoid interference on the environments; pico hydro is the promising technique in generating small scale green electricity without the development of a big dam. According to J.A. Razak et al. to build a crossflow turbine for pico hydro will cost only RM2500 (J.A. Razak, M. Musa, Md. R. Ayob, M. Z. Hassan, M. N. A. Rahman, K. Sopian, 2010). Therefore, these paper were focus on pico hydro as a case study to explain the key factors of designing small scale renewable energy because it is cost effective which is also environmental friendly, independence power sources and available for long term application.

2.0 Status Application

Nowadays, the awareness of environmental impact and the scarcity of fuels sources are of high concern around the globe. Thus renewable energy such as pico hydro is one potential to overcome this issue. Many countries are now setting up their own renewable energy policy to develop a renewable energy system. Since this research is within the context of Malaysia, it requires a comprehensive review of pico hydro application that has been developed successfully in this country. During 2010, a new renewable energy policy announced by the Ministry of Energy, Green Technology and Water (KeTTHA), is intended to increase the use of local resources and to contribute towards the national electricity supply security and sustainable socio-economic development. In addition, the Malaysian government has set a vision, targeting the year of 2020; small hydro (mini, micro and pico) will contribute up to 500MW to the national power supply (The Pembina Institute, 2010)

In 2011, Othman, M. M. et all (Othman, M. M., J. A. Razak, M. R. Ayob, M. A. Rosli, S. G. Herawan, and K. Sopian, 2011) had de- veloped an independent test-rig for pico hydro model and simulated the turbine by using the ANSYS software. The test-rig consists of axial-flow turbine and cross-flow turbine. The axial-flow turbine is out-sourced while the cross-flow turbine is fabricated in-house. The model system of the test rig consists of main supporting structure, axial-flow turbine water tank, cross-flow water tank, main storage water tank, pump, pipeline system, pressure gauge, flow meter, control valves, electrical module and water level sensor. The water source is tapped from the domestic water supply. Figure 1 shows the proposed model system of the test rig.

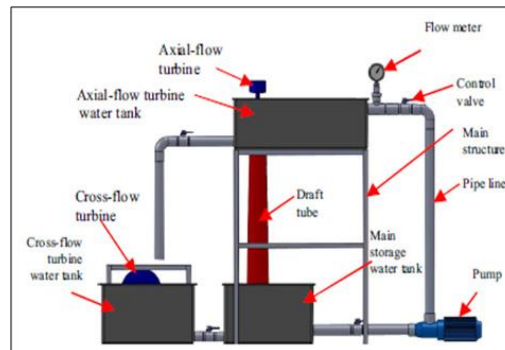


Figure 1. Schematic Diagram of Test-Rig

In the same year (2011), University Malaysia Pahang (UMP) (Haidar, Ahmed, Mohd FM Senan, Abdulhakim Noman, and Taha Radman, 2011), has developed pico hydro by consider the exiting pressure via headwater reservoir pipeline to generate the electricity power. Figure 2 shows the schematic diagram of the pico hydro generation in UMP. In this type of installation, the dissipation of energy at the lower end of the pipe at the entrance to the water treatment plant is achieved through the use of special valves. The fitting of a turbine at the end of the pipe to convert this otherwise lost energy to electricity, an attractive option provided that the water hammer phenomenon is avoided. Water hammer overpressures are especially critical when the turbine is fitted on an old pressure pipe (European Small Hydropower Association, 2004). To ensure the water supply at all times, a system of bypass valves should be installed. In some water supply systems, the turbine discharges to an open-air pond and the control system maintain the level of the pond.

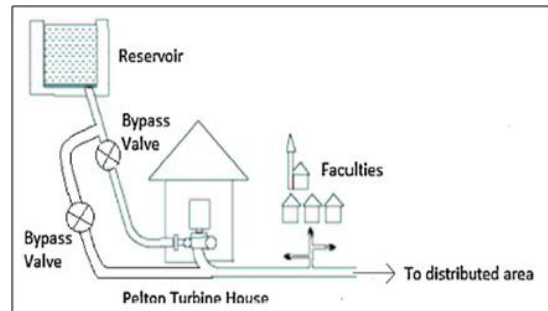


Figure 2. Schematic Diagram of the Pico Hydro Generation in UMP

In 2009 H. Zainuddin et al. (H. Zainuddin, M. S. Yahaya, J. M. Lazi, M. F. M. Basar and Z. Ibrahim, 2009) reported that, pico hydro can be developed by using processed water distributed to a number of houses. Figure 3 shows the typical pico hydro system application using processed water distributed to houses at hilly area. The water flow inside the pipelines generates potential kinetic energy to spin the small scale generator turbine for electricity power. This research shows the additional use of processed water distributed to houses for electrical power generation instead of daily activities such as bathing, laundry and dish washing. The electricity is generated without extra charge on the water bill. The main function of the system is to store the generated power by means of battery charging for future use particularly during electricity blackouts.

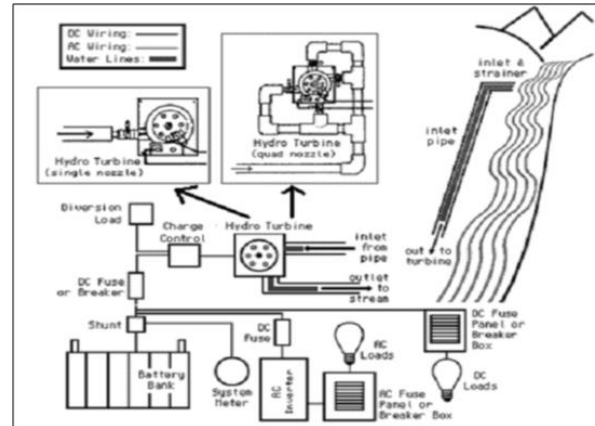


Figure 3. Schematic Diagram of Pico Hydro Generations from Processed Water Distributed to Houses at Hilly Area

During the same year, K. Sopian et al. (Kamaruzzaman Sopian, and Juhari Ab. Razak, 2009) claimed that the low head and low flow pico hydro turbine can be developed by using natural flowing pond. The research has been done successfully at UKM by using the natural flowing pond within the university as shown in Figure 4. The research focuses on investigating the performance of propeller turbine (reaction turbine) and crossflow turbines (impulse turbine). Results from experimental tests show that, the crossflow turbine, which was fabricated in house, perform better than the propeller, which was outsourced. Both turbines were connected with the gearing system, alternator, charger controller and a set of battery in the pico hydro system. Instead of taking turbine and alternator as the main components in pico system, the researchers prove that the gearing system is also important in order to obtain a better power output.



Figure 4. Pico Hydro Generation in UKM

Alternatively, K. Sopian et al. (Kamaruzzaman Sopian, and Juhari Ab. Razak, 2009) also developed a project on pico hydro generation installed at Kampung Tuil, Kelantan, an Orang Asli (indigenous people) village. This project was done with the collaboration of Global Peace Mission and funded by the Ministry of Science Technology and Innovation Malaysia. The pico hydro scheme was able to produce up to 220V AC voltage and 22 A current after harnessing two small streams with 40 meters head and width of 3 meter and

5 meter. To ensure that the project is successfully implemented, 47 polypipes with 6 meters long have been installed to connect the water intake to the turbine. The thickness of the polypipes used is 3mm with the outside diameter of 200mm. As a result, 5kW electric power has been generated by this technology and this power was successfully delivered to a factory processing agriculture product.

On the other hand, M. Anyi et al. (Martin Anyi, Brian Kirke, and Sam Ali, 2010) have designed and built the pico hydro in remote villages in Sri Aman, Sarawak as shown in Figure 5. The system was able to produce 3kW power by utilizing very limited head. The head is about 1.5 m created from a man-made lake. Due to the ultra low head, the all-steel water wheel with 1m diameter and 0.76 width have been developed. The wheel turns about 8 to 10 rpm when loaded. However, using sprockets and chain, the speed increases to 1,500 rpm and simultaneously drives the 3kW ac generator. Then, the power produced is regulated manually before being delivered to every house using the 16mm² aluminium wires. Surprisingly, the cost per kW for this system is only \$1,070.



Figure 5. 3 KW Overshoot Water Wheel Generator

3.0 Key Factor of Designing Self-Excited Pico Hydro

According to above discussion, it is proven that the pico hydro can offer a very promising solution for the places ranging from a tiny scheme (ultra low head and ultra low flow) to electrified single home especially at remote areas. Meanwhile, pico hydro power system also has a variety of approaches in the planning, design and installation. Table 1 below shows the key factor of designing the inventions of pico hydro generation done by various researchers. It has a compact size compared to what have been used in a larger hydro power in order to gain benefits in term of cost, independence of design and environmental friendliness.

Table 1. Key Factor of Designing Pico Hydro Generations.

Inventor	Key factor		
	Cost effective	Environmental friendly	Independence power sources
Othman, M. M. et all (2011)	In house fabrication	Yes	Independent small reservoir
Haidar, Ahmed et all (2011)	Using exiting pump house	Yes	Headwater reservoir
H. Zainuddin et al. (2009)	Homemade system	Yes	Consuming water distributed
K. Sopian et al. (2009)	Almost maintenance free	Yes	Natural flowing pond
K. Sopian et al. (2009)	Almost maintenance free	Yes	Run-off river
M. Anyi et al. (2010)	Using plug & play component	Yes	Run-off river

4.0 Conclusions

As a conclusion, the entire discussion in this paper, it is clear that the existence of pico hydro technology provides the people in remote areas, an alternative for generating electricity. In addition, it can also replace the conventional fuel generator. Therefore, self-excited pico hydro offers a technology which is of a compact size yet high in efficiency, cost effective, environmental friendly, independent from power sources and available for long term application (Dincer I., & Rosen, M. A., 1998)

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