

## ENGINEERING APPLICATIONS IN RAINWATER HARVESTING TO INCULCATE SCIENCE AND TECHNOLOGY IN EDUCATION

Rafidah H.<sup>1,2\*</sup>, Abdul Talib D.<sup>1,2</sup>, Nazlin Ruziah M. S.<sup>3</sup>, Zakiah A. H.<sup>1,2</sup>, Norasra A R.<sup>1,2</sup>, Zamrah P.<sup>3</sup>, Habibah A.<sup>3</sup>, Yazid A.<sup>3</sup>, Ghazali H.<sup>3</sup>

<sup>1</sup>) Faculty of Mechanical Engineering, Universiti Teknikal Malaysia Melaka,  
Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia

<sup>2</sup>) Centre for Advanced Research on Energy, Universiti Teknikal Malaysia Melaka,  
Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia

<sup>3</sup>) Sekolah Menengah Kebangsaan Iskandar Shah,  
77000 Jasin, Melaka

\*Corresponding e-mail: rafidahhasan@utem.edu.my

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**ABSTRACT** – Abundance resource of rainwater at hilly surrounding can highly benefit the community. This research aims to inculcate science and technology in secondary education by converting energy from hilly nature rainwater resource to engineering applications. Initial innovation idea from school was improved with engineering knowledge and practice. Integration of university's professional guide and school's dedicated members has resulted to a promising small scale energy harvesting unit that can fulfill secondary education syllabus. The outcome from this research can assist inculcating basics of science and technology in secondary school pupils. Besides, the innovation can lead to potential scientific research in energy.

### 1. INTRODUCTION

Studies in rainwater harvesting in Malaysia were usually looking at the potential of the resource as an alternative water resource to be consumed by the community for daily usage, at both large and small scales [1, 2]. A study in Taiwan suggested that both water consumption and energy conservation should be considered together in hilly communities [3]. A research in Malaysia has integrated the rainwater harvesting system with solar and wind harvesters to be used for renewable energy generation [4]. These advancements in technology need to be really understood and appreciated by the community since early ages. Therefore, abundance resource of rainwater at hilly school surroundings can be utilized in the realization of renewable energy system which can educate the school pupils using a practical hands-on, minds-on approach [5]. However, it is difficult for only school members to carry out this task, hence, cooperation from institute of higher learning as research-based education centre is a must to ensure the sustainability of the developed technology. In this paper, early efforts on the development of engineering applications for rainwater harvesting system to benefit secondary education are discussed. The project is located at Sekolah Menengah Kebangsaan Iskandar Shah (SMKIS), Jasin, Melaka, with cooperation from Universiti Teknikal Malaysia Melaka (UTeM).

## 2. MOTIVATION AND ACTION

The abundance of rainwater during heavy fall at SMKIS as shown in Figure 1 (a) and (b) can lead to harmful effects to both environment and education facilities, if no action is taken in nearest future.



Figure 1 (a) Drainage at steep hill during heavy rainfall; (b) Drainage system with excess rainwater.

It was an idea from the school to apply innovation and technology in the management of rainwater through the platform of networking under ‘Sekolah Kluster Kecemerlangan – Universiti Awam (SKK-UA)’ initiative [6]. Early solution from school is as shown in Figure 2.

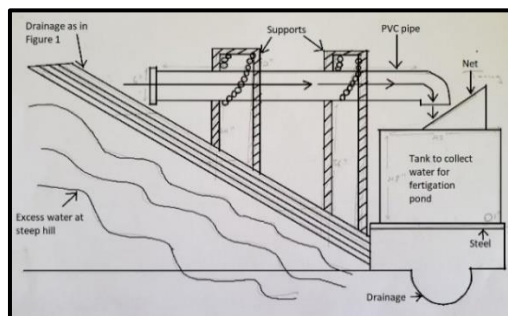
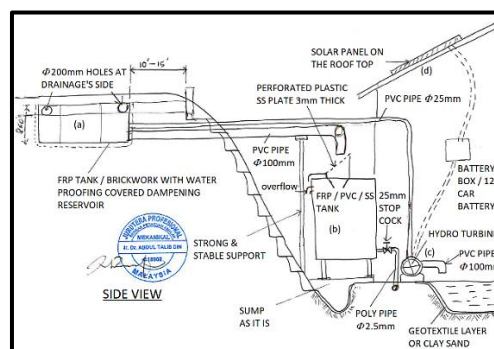


Figure 2 Initial idea to manage rainwater (side view).

To further improve the idea, engineering applications that can generate sustainable energy from rainwater harvesting were proposed. Amongst the reason to embed more engineering applications was to add value in the research so that it can be used in teaching and learning by hands-on and minds-on approach.

## 3. OUTCOME AND DISCUSSION

Figure 3 shows the improved proposal for rainwater management at SMKIS after including suggestions from UTeM’s professional personnel.

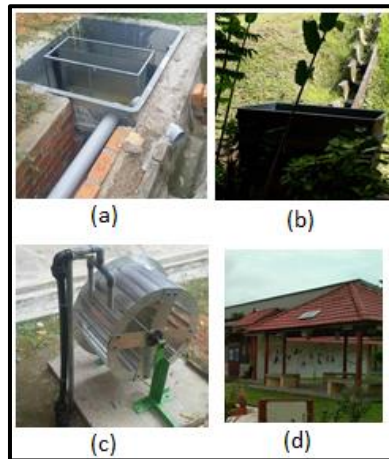


### Figure 3 Proposal for rainwater management at SMKIS.

An important consideration was to slow down the water flow along the drainage at steep hill during heavy rainfall which caused erosion. This can be done by harvesting the rainwater, which can then be stored and used for energy generation. The generated energy can be used to power a small LED display nearby. Solar harvesting was also integrated in the proposal to sustain energy generation during sunny weather.

Amongst distinguished engineering applications in the proposed system as labelled in Figure 3 are:

- a) **Dampening reservoir:** To decrease water flow.
- b) **Water storage:** For sustainable water saving.
- c) **Water turbine:** For energy generation.
- d) **Solar power:** For energy generation.



**Figure 4 The developed engineering applications; (a) dampening reservoir; (b) water storage tank; (c) water turbine; (d) solar panel on roof top.**

Figure 4 shows main engineering applications in rainwater harvesting research at SMKIS. On top of that, the water storage was intended to be used for fertigation pond as shown in Figure 5, which was concurrently developed by the Science teachers to add value of the project. All the physical works in the project were done together by five experts from UTeM, five teachers from SMKIS, and a group of five SMKIS pupils who were groomed to be school representatives in renewable energy project.



**Figure 5 Fertigation pond at SMKIS.**

**Table 1 Subjects matched to rainwater harvesting unit.**

SUB-PROJECT	SUBJECTS
Reservoir	Physics, Mathematics
Water storage	Physics, Mathematics
Water turbine	Physics, Mathematics
Solar panel	Physics, Mathematics
LED display	Design and Technology, Languages
Fertigation	Biology, Chemistry, Environment

Table 1 lists secondary subjects which can be benefited from this research project. The energy harvesting unit can assist hands-on, minds-on approach for school pupils. On top of that, other subjects such as language can also be involved.

#### 4. SUMMARY

This research project of rainwater harvesting system at SMKIS has led to the development of small scale renewable energy harvesting unit. The outcome shows that 100% of the engineering applications can be matched to science subjects, thus it is very helpful in inculcating science and technology in school pupils. Further research to evaluate the effectiveness of hand-on, minds-on approach using this research outcome is yet to be done in nearest future. At least 20% from nine hundred school pupils and 10% from eighty school teachers are to be involved in the assessment of the effectiveness for this project.

#### 5. ACKNOWLEDGEMENT

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