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Solar radiation based benefit and cost evaluation for solar water heater expansion in Malaysia

Ong Li Jing^a, Mohammed J.K. Bashir^{a,*}, Jehng-Jung Kao^b^a Faculty of Engineering and Green Technology, Universiti Tunku Abdul Rahman, Jalan Universiti, Bandar Barat, 31900 Kampar, Perak, Malaysia^b Institute of Environmental Engineering, National Chiao Tung University, Hsinchu 30010, Taiwan, ROC

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ABSTRACT

Malaysia is highly depending on fossil fuel to produce electricity. Undesirably, the excessive usage of fossil fuels releases harmful gases which can cause serious environmental problems. A potential solution to curb the fossil fuel consumption and environmental problems is the utilization of renewable energy such as solar energy. Malaysia has abundant solar energy resources throughout the year due to its location near to equator, promises the highest beneficial in using solar energy for technology development such as solar water heater (SWH). However, people in Malaysia are not aware of SWH's benefits due to high initial installation cost of SWH. Thus, this study presents financial evaluation of SWH in Malaysia which takes into account cost benefit and payback period of using SWH. The benefits are reanalysed bases on annual effective solar radiation. The result reveals that the utilization of a SWH can save up to RM 704 of energy cost per year. The payback periods of a SWH in Malaysia vary from 7.4 to 10.7 years, depending on the initial installation cost of SWH. Promoting the use of SWH by all EWH's owners in Malaysia can save 2 billion kWh of electricity and notably prevent emissions of 1,560,370 t CO₂, 11,830 t SO₂, and 4930 t NO_x per year.

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* Corresponding author. Tel.: +60 5 4688888x4559; fax: +60 5 4667449.

E-mail address: jkbashir@utar.edu.my (M.J.K. Bashir).

1. Introduction

The usage of electricity in Malaysia has enormously increased in last few years. This is due to the technological development, population growth, economic and industrial activities [1]. To meet the increased demand for electricity, the electricity generation in Malaysia increased by almost 100% in a decade between 2000 and 2010. Unluckily, Malaysia is highly depending on fossil fuels to produce electricity [2]. In 2010, fossil fuels, such as crude oil, coal and natural gas, contributed to almost 93% of electricity demand [1,3]. Fig. 1 shows the generation mix of electricity since 2000–2010 in Malaysia [4].

The excessive usage of fossil fuels releases several gases such as greenhouse gases (GHGs), carbon monoxide (CO), nitrogen oxide (NO_x), sulphur dioxide (SO₂) and particulate matter (PM). These gases can cause detrimental effects to the environment such as

smog, ozone depletion, acid rain and global warming [1,5,6]. A potential solution to curb these environmental problems is the utilization of renewable energy. Currently, many countries considered solar, wind, hydro, bio-energy and other renewable energy to create a clean energy future [6,7]. Besides its environmental advantages, renewable energy also has beneficial impacts on socio-economic development of the world [7]. The benefits obtained from the utilization of renewable energy fall into three categories: conservation of conventional energy, pollution mitigation and generation of working opportunities [6].

Among all renewable energy sources, solar energy is the most potential energy source as it has many benefits over other sources. Solar energy is costless energy source from the sun. It is clean and naturally accessible source that does not emit any GHGs and air pollutants [8]. The solar energy is either harnessed directly from the sun for heating purpose or converted into electricity by using

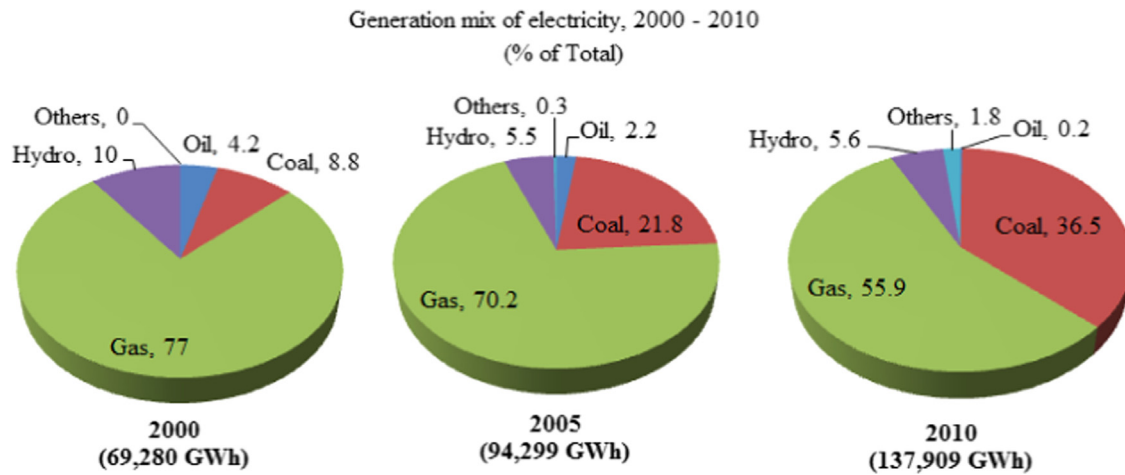


Fig. 1. Malaysia generation mix of electricity between year 2000 and 2010 [4].

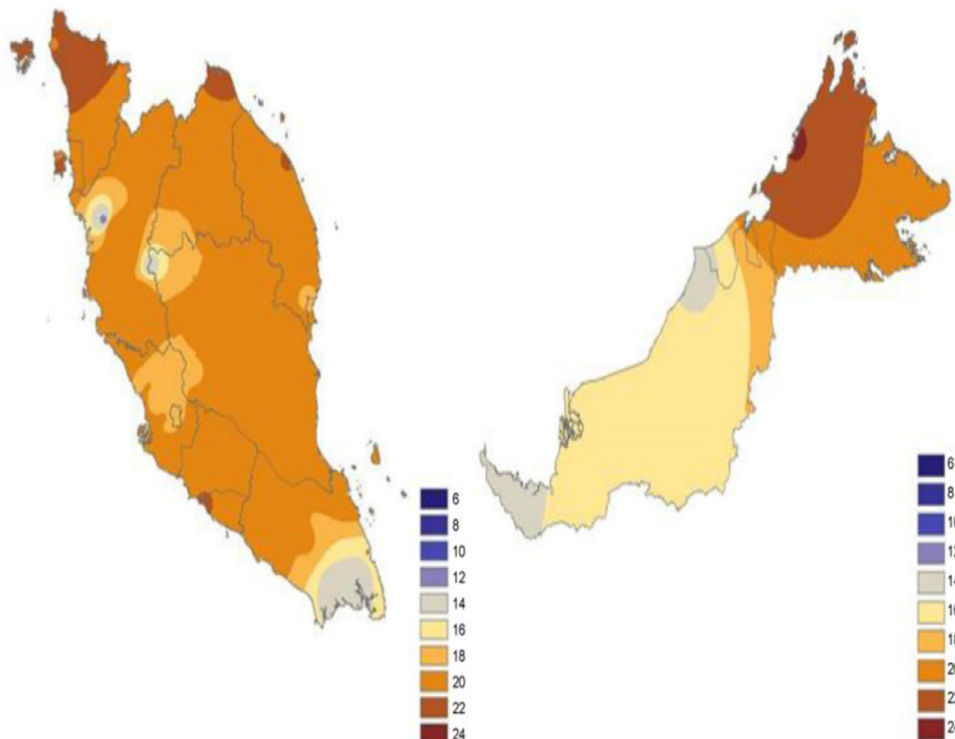


Fig. 2. Daily solar radiation in MJ/m²/day [8].

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