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**UNIVERSITI TEKNOLOGI MARA**

**PERFORMANCE AND TECHNO-ECONOMIC  
ANALYSIS OF MONOCRYSTALLINE,  
MULTICRYSTALLINE AND AMORPHOUS  
SILICON-BASED STAND-ALONE  
PHOTOVOLTAIC POWER SYSTEM IN  
MALAYSIAN FIELD CONDITIONS**

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**Thesis submitted in fulfilment of the requirements  
for the degree of  
Master of Science**

**Faculty of Applied Sciences**

**July 2005**

## **ACKNOWLEDGEMENT**

In the name of Allah, Most Beneficent, Most Merciful. Alhamdulillah to Allah who has given me the time and ability to complete this Master's thesis project. I would like to acknowledge with gratitude the help, guidance, comments, suggestions and encouragement to those who had given me much invaluable support in the preparation of this research project.

My deepest gratitude is expressed to my main supervisor, Prof Madya Dr Sulaiman Shaari for his assistance and guidance through the duration of my research. My gratitude is also expressed to Prof Dr Kamaruzzaman Sopian as my second supervisor. Special expression of gratitude is due to my beloved family especially my wife who has been supporting and motivating me and is extended to all my friends.

Finally, my appreciation goes to those who have been directly and indirectly involved in the preparation and accomplishment of my thesis. Thank you for all the commitment and cooperation. May ALLAH bless all of you.

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## ABSTRACT

This research involves the use of renewable energy technology, vis-a-vis solar photovoltaic (PV) technology for providing power. It involves the design, installation, testing, commissioning, monitoring, performance analysis and economic evaluation of three different sets of stand-alone solar PV-battery power PVP systems in Malaysian field conditions, specifically in the Shah Alam area. There were three complete sets of PVP systems using three different types of modules with their own sets Balance of System (BOS) components. The PV modules used were amorphous silicon (a-Si), monocrystalline silicon (mono-Si) and multicrystalline silicon (multi-Si) technologies, each coupled to a bank of lead acid solar application batteries to meet the designed daily load demands. The monitoring of the PVP systems, along with the relevant environment parameters were done using an automated monitoring system. Details of each systems set-up are presented in this study. Based on the field data, a comparative study between the three PVP systems in terms of their techno-economic performance indices were then done. It was found that the a-Si modules gave the highest normalized annual yield at  $901\text{kWhkWp}^{-1}$ , followed by the mono-Si at  $760\text{kWhkWp}^{-1}$  and then the multi-Si at  $730\text{kWhkWp}^{-1}$ . The a-Si modules also gave the highest PR value at 56%, followed by the mono-Si at 47% and then the multi-Si at 46%. However in term of array efficiency the highest was the mono-Si at 8.8%, followed by the multi-Si at 7.4% and lastly the a-Si at 3.4%. The a-Si modules had the lowest voltage drop of  $-31.8\text{mV}^{\circ\text{C}^{-1}}$ , the highest current rise of  $4.9\text{mA}^{\circ\text{C}^{-1}}$  and the lowest power drop at  $-0.11\text{W}^{\circ\text{C}^{-1}}$ , followed by the mono-Si at  $-32.8\text{mV}^{\circ\text{C}^{-1}}$ ,  $4.19\text{mA}^{\circ\text{C}^{-1}}$  and  $-0.7\text{W}^{\circ\text{C}^{-1}}$ , lastly the multi-Si at  $-39.4\text{mV}^{\circ\text{C}^{-1}}$ ,  $3.2\text{mA}^{\circ\text{C}^{-1}}$  and  $-0.17\text{W}^{\circ\text{C}^{-1}}$  respectively. In addition, the NOCT values were: a-Si module at  $38^{\circ}\text{C}$ , multi-Si at  $57^{\circ}\text{C}$  and mono-Si at  $43^{\circ}\text{C}$  and these field values differ from the manufacturer specification by 17%, 9% and 0% respectively. Thus it was proven that the a-Si modules worked best in an equatorial climate country. The costs of PV technology and energy generations from the Systems I, II and III were RM 11.7 per kWh, RM 6.4 per kWh and RM 6.2 per kWh respectively which are still high compared to that from the grid. Several recommendations for further study have also been included at the end of this thesis.