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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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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 901kWhkWp^{-1}, followed by the mono-Si at 760kWhkWp^{-1} and then the multi-Si at 730kWhkWp^{-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 -31.8mV^{o}C^{-1}, the highest current rise of 4.9mA^{o}C^{-1} and the lowest power drop at -0.11W^{o}C^{-1}, followed by the mono-Si at -32.8mV^{o}C^{-1}, 4.19mA^{o}C^{-1} and -0.7W^{o}C^{-1}, lastly the multi-Si at -39.4mV^{o}C^{-1}, 3.2mA^{o}C^{-1} and -0.17W^{o}C^{-1} respectively. In addition, the NOCT values were: a-Si module at 38^{o}C, multi-Si at 57^{o}C and mono-Si at 43^{o}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.