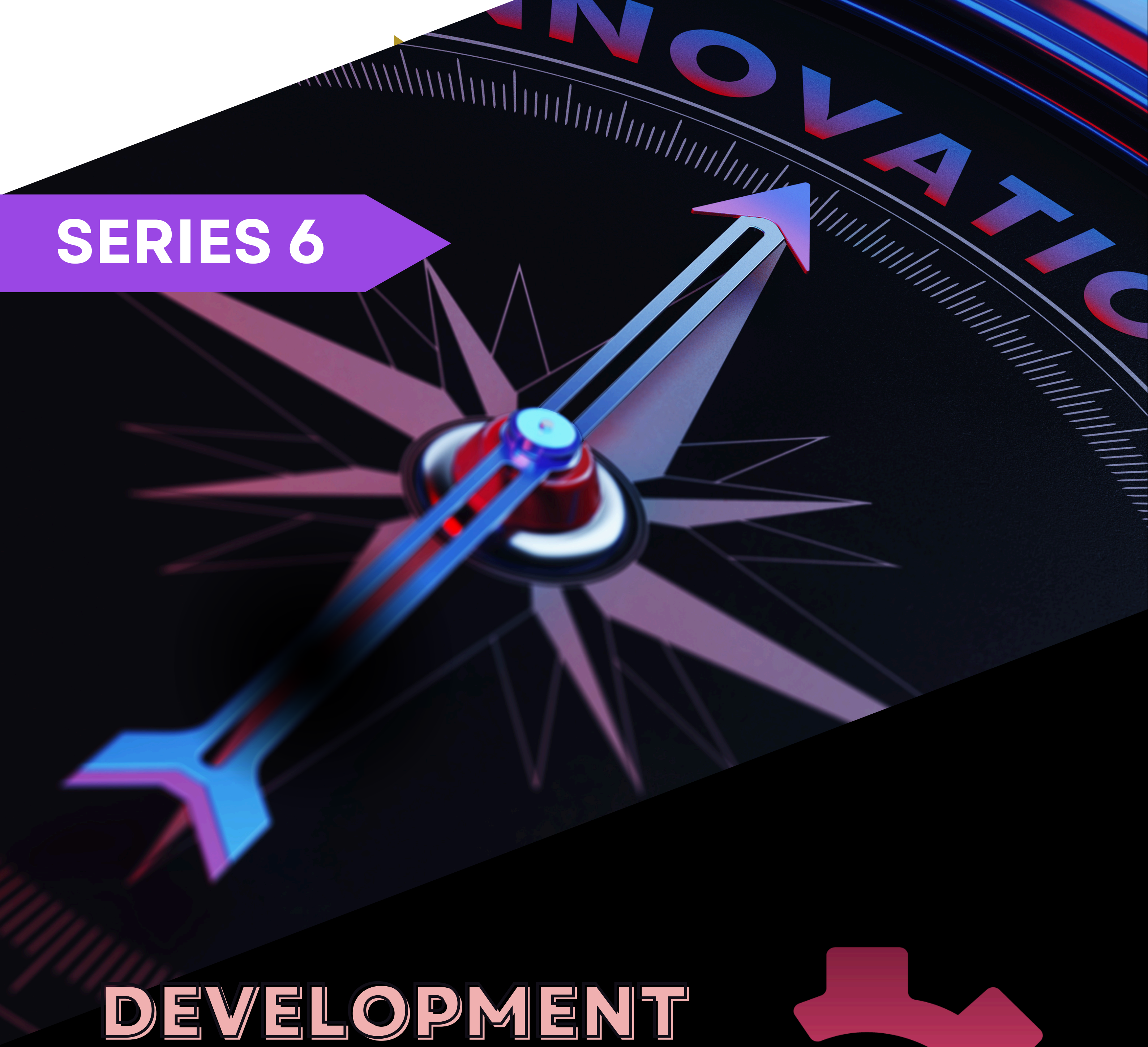

SERIES 6

DEVELOPMENT RESEARCH & INNOVATION

Bridging Borders: Global Innovations for Sustainable Development

NURAMIRAH JUMA'AT

Penerbit UTHM

Development, Research & Innovation Series 6

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EDITOR:
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Penerbit UTHM
2024

Editor:
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Published by:
Penerbit UTHM
Universiti Tun Hussein Onn Malaysia
86400 Parit Raja,
Batu Pahat, Johor
Tel: 07-453 7051
Fax: 07-453 6145

Website: http://penerbit.uthm.edu.my
E-mail: pt@uthm.edu.my
http://e-bookstore.uthm.edu.my

Penerbit UTHM is a member of
Majlis Penerbitan Ilmiah Malaysia
(MAPIM)

Cataloguing-in-Publication Data

Perpustakaan Negara Malaysia

A catalogue record for this book is available from the National Library of Malaysia

ISBN 978-629-490-065-3

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PREFACE

In an era defined by rapid technological advancements and increasingly complex global challenges, the need for interdisciplinary collaboration and innovation has never been more critical. It is with this understanding that we present this collection of articles, titled "Bridging Borders: Global Innovations for Sustainable Development."

This book is a testament to the power of integrating diverse fields of study to generate groundbreaking solutions and insights. The chapters within this series span a wide array of disciplines, including engineering, healthcare, environmental science, social sciences, and the arts. Each contribution showcases unique research initiatives that transcend traditional academic boundaries, illustrating how collaborative efforts can drive progress and innovation.

Through this compilation, we aim to provide readers with a comprehensive understanding of the multifaceted nature of innovation and research. By showcasing the remarkable work of our contributors, we hope to inspire new ideas, stimulate further research, and contribute to the ongoing dialogue on how we can harness the power of innovation to address the world's most pressing challenges.

As we navigate the complexities of our rapidly changing world, it is our belief that the interdisciplinary approach embodied in this book will be crucial in shaping a more sustainable and equitable future. We invite you, the reader, to dive into these pages and explore the transformative potential that emerges when we bridge the gaps between disciplines and embrace the collaborative spirit of innovation.

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Editor
Development, Research & Innovation Series 6

ISBN 978-629-490-065-3

CHAPTER 7

Sustainable Grid With An Intelligent Local Hybrid Renewable Energy Control Using IoT

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Abstract

Energy management, emission reductions, and sustainable development are directly linked. The use of renewable energy and intelligent control systems serves two goals: sustainable development and energy supply. In this project, we propose an improved intelligent hybrid renewable energy management system to utilize local renewable energy. The penetration of renewable energy in this study starts from 20 and 50% and reaches 100%. The innovation of this research is the use of a dynamic decision algorithm in an intelligent system microcontroller that can determine the maximum possibility of hybridization of local solar and wind energy sources and optimize the electricity demand of the residential unit. The results show that the proposed control strategy, with average daily fuel consumption of 1.11 L, the total energy produced by the hybrid renewable energy conversion system is equal to 1697 kWh/year. The intelligent power control system received the electricity generated by the renewable energy subsystems and provides the electricity needed by the green cottage based on the proposed decision algorithm.

1.0 Methodology or Project Approach

A hybrid renewable energy conversion system is developed and built to coordinate, manage and control solar and wind renewable energy sources in real-time. A battery energy storage subsystem including two 100 amp-hour batteries and a diesel generator support unit is connected to the main system. Diesel generators can be renewable or non-renewable energy sources depending on the fuel consumed. This resource is included in the technical and economic calculations as the backbone of the off grid system. The control system intervention and hybridization process have a voltage-based intervention approach with the PIC16F877A microcontroller and integrates to predict the increase or decrease in regulated output voltages or climate change between solar and wind renewable energy sources. Fig 1 the hybrid renewable energy conversion system shows an environmental test. The components of the dynamic hybrid renewable energy converter are as follows: green cottages, electronic circuits, flexible solar panels, charging controller, battery bank, temperature sensor, humidity sensor, wind speed sensor, voltage and power sensor, battery fuses, digital to analog converters, analog to digital converters, voltage divider, voltage intervention circuits, relay switch circuits, DC to DC and data logger and computer.

Modeling and simulation of hardware system in realtime using MATLAB-State Flow software. Simulation in Simulink MATLAB software is the input of optimization analysis of intelligent renewable energy conversion system. Dynamic decision-making, on the other hand, is programmed to continually understand the current state of each subsystem and to make any changes in the event of a felt and measured change. Thus, the electronic database and dynamic decision control subsystems have been integrated to monitor the performance of the DC direct current combinatorial renewable energy conversion system. DC to DC to increase the output voltages set from 7 to 12 V, solar and wind renewable energy sources are used to the desired output voltage. The power supply is also connected to the AC load via DC to AC inverter or charging the battery energy storage system. The inverter is integrated to adjust the output voltage from 12 to 15 V from renewable energy sources and the battery energy storage system to one voltage. Convert AC. DC to AC inverter operation is controlled using a PWM signal. Development and simulation of control circuits and decision- making of renewable energy conversion systems have been done using Proteus software. At this step, C programming was used to develop the decision algorithm and finally installed on the microcontroller. The electronic circuit of the PIC16F877A microcontroller was modeled and designed in Proteus software. Electronic circuits include the following units. Voltage control units, PIC16F877A microcontroller unit, switching units, converters units, and inverter unit. The switching units have been divided into two parts:

- Switching units and control subsystems that are self-intervening between output voltages set from renewable energy sources of the sun and wind.
- Charging or discharging switching circuits are used for self-interference during the charging or discharging process.

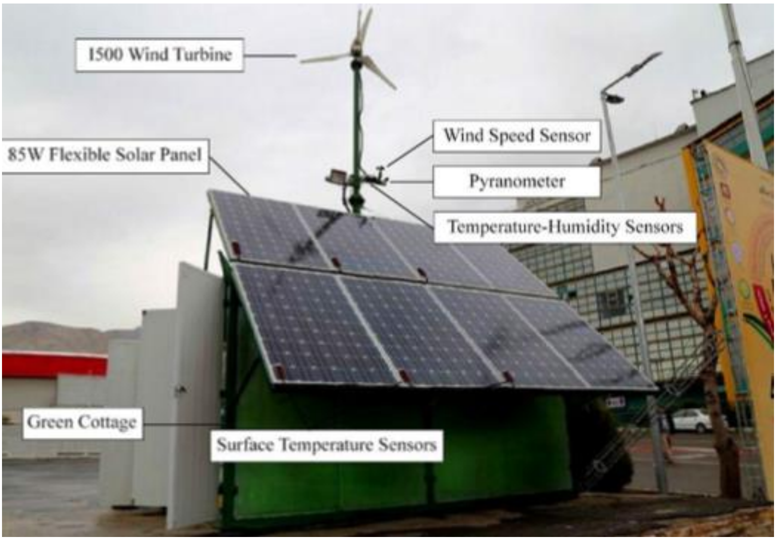

Figure 1: Renewable energy system installed on the green cottage

ISBN 978-629-490-065-3

2.0 Result and discussion

To optimize the life cycle cost of the hybrid renewable energy conversion system, several green cottage power supply strategies were studied. For modest renewable energy generating systems, particularly those that use intermittent renewable energy sources, the one-hour step model estimates renewable energy and scales it. If the goal is to power the Green Cottage using solar, wind (with an average wind speed of 7.97 m/s), and batteries without the use of a diesel generator, the initial start-up cost will be approximately $ 2210. If the wind speed is at a point close to the minimum 3 m/s, the same system arrangement to supply electricity will require an initial cost of $ 3961. For the arrangement of the subsystems, we will have 13 logic modes with sensitivity analysis, combinations using diesel generators and fuel consumption, and combinations with 100% renewable energy penetration. A combination that uses all the subsystems and the levelized cost of energy (COE) of $ 0.396 per kW has 0.205 kW of solar subsystems (initial cost $ 410) with 1 wind turbine Model i500 (initial cost $ 1000) and diesel generator (electric motor) model 2500DC with a nominal capacity of 0.890 kW and 2 batteries of 100 amps.

This system has a penetration of 54% of renewable energy and has 253 L of gasoline consumption during one year of operation. Also, the electric motor works in this arrangement for 1345 hours to produce 675 kWh of energy. The battery can be recharged in this arrangement for 7.03 hours and the total annual transient energy from the battery energy storage source is 499kWh. In the simulation process, all possible scenarios are simulated to select the optimal arrangement, the ones with the lowest net present cost are introduced. Also, the summary of the annual production results of the model shows that the annual production of the solar subsystem with a penetration of 20% is equal to 331 kWh/year and the wind subsystem with a penetration of 40.8% equal to 675 kWh/year and diesel generators with a penetration of 39.2% is equal to 647 kWh/year. The total energy produced by the model system is equal to 1652 kWh/year. The AC load produced by the system for the green cottage was calculated at 1468 kWh/year.

3.0 Benefit of the product

- The main benefit of Hybrid renewable energy systems (HRES) is that it improves the efficiency of renewable energy generation technologies compared to a single power source. It may also address fuel flexibility, efficiency, reliability, pollution, and economics. Many things must be addressed while using hybrid energy systems to generate power.
- The others benefit of this project are dependability and cost; hybrid generating systems are frequently more reliable and less costly than single-source systems. However, some features might be stressed to speed up the development of HRES.

4.0 Acknowledgement

The authors are grateful to the University Malaysia Kelantan (UMK) and Tarbiat Modares University for financial supports for this renewable Energies research project.

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This book of chapter captures the essence of the Development, Research, and Innovation, showcasing a diverse range of groundbreaking projects across various fields. It delves deeper than a typical exhibition catalogue, offering extended abstracts that provide a comprehensive overview of each innovation.
Step inside and explore the cutting edge:

- Internet of Things (IoT): Discover revolutionary applications of connected devices, transforming industries and streamlining processes.
- Mechanical Engineering: Witness ingenious solutions for real-world challenges, pushing the boundaries of design and functionality.
- Green Energy: Dive into the future of sustainability with projects harnessing renewable resources and advocating for a cleaner tomorrow.
- Information Technology (IT): Explore the latest advancements in data, software, and communication, shaping the digital landscape.
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ISBN 978-629-490-065-3
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