UNIVERSITI TEKNOLOGI MARA

DEVELOPING SMART GRID ENABLER FOR HOUSING COMPONENT PARAMETER FRAMEWORK TOWARDS ENERGY CONSERVATION IN MALAYSIA

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Thesis submitted in fulfilment
of the requirements for the degree of
Doctor of Philosophy
(Built Environment)

College of Built Environment

March 2025

AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Postgraduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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Thesis Title	:	Developing Smart Grid Enabler for Housing Component Parameter Framework Towards Energy Conservation in Malaysia
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ABSTRACT

Modern Malaysians' energy-intensive lifestyles contribute significantly to energy consumption, with households accounting for 21% of national electricity use. Environmental concerns, evolving lifestyles, and the rise of renewable energy have driven the global shift from conventional electricity systems to smart grids. Since 2020, Tenaga Nasional Berhad (TNB) has deployed smart meters nationwide, driving the shift to a Smart Grid system. Aligning housing components with this system is key to enhancing energy efficiency and benefiting Malaysia's energy and housing sectors. The Malaysian smart grid's relatively new implementation reveals gap in integrating housing components, exposing a knowledge shortfall in a potential energy conservation strategy for households. This warrants further investigation identifying probable links between the system and the housing sector. Thus, this research examines suitable housing components for the smart grid system to establish a Smart Grid Enabler-House Component Parameter framework, consisting of components from the smart grid system and housing units. Also, three models were studied: Trias Energetica, Smart Grid Conceptual Model and Smart Grid Optimised Building. Utilising pragmatism approach, a sequential exploratory mixed method process is adopted to achieve this research's aim. It is supported by three objectives; identify the significant smart grid components applicable to the housing sector in Malaysia towards achieving energy conservation, analyse the significant enablers of Smart Grid that could utilise suitable housing components for future residential development in Malaysia towards achieving energy conservation and propose Smart Grid Enabler (SGE) for Housing Component Parameter (HCP) Framework in Malaysia towards achieving energy conservation. This research process involves three phases of Phase 1 (preliminary study), Phase 2 (data collection), Phase 3 (data analysis) and Phase 4 (result and findings). Mixed method approach for this research process includes extensive literature review, thematic and content analysis, survey research through questionnaires, case study, observation and Fuzzy Delphi Method. Expert consensus attained via Fuzzy Delphi Method verifies the findings of the research, establishing the SGE – HCP framework. The framework demonstrates the achievement of Research Objective 1 (RO1) by highlighting the components of the Smart Grid Enabler (SGE), categorized into two segments: outdoor and indoor. It identifies 11 outdoor housing components and 8 passive indoor components, along with 1 active indoor component, addressing Research Objective 2 (RO2). For Research Objective 3 (RO3), the framework integrates the SGE and HCP components, applying the Trias Energetica model to develop strategies for energy conservation. Overall, the findings of this research are vital for stakeholders in residential development, serving as a supplementary reference for future policy changes or enhancements to current practices. Specifically, it aims to support the development of sustainable homes for the future. Proposed framework may guide relevant ministries, government agencies, designers, builders, and homeowners to construct energy conserving homes linked to the smart grid system for the future housing stock.

ACKNOWLEDGEMENT

In the name of Allah, The Most Beneficent, The Most Merciful.

Alhamdulillah, for the opportunity bestowed upon me for this great journey of knowledge, discovery and exploration into this PhD adventure. Indeed, it was a journey of many ups and downs, tears and laughter, triumph and failure, and pleasure and frustration; of which that has come to an end.

My utmost gratitude towards my supervisor, Assoc. Prof. Sr. Dr. Nur Azfahani Ahmad for her willingness to guide me, inspire me and relentlessly showing me the path to immense knowledge discovery. Her continuous support, encouragement and determination to assist me until the end, have motivated me to finish what I have started years ago. Also, to Professor Dr. Sabarinah Sheikh Ahmad who has always been a great mentor to me, during the beginning of this journey, I am forever grateful for your guidance and support. Sincerely, I am thankful to both wise, enthusiastic and great figures for their kindness and patience during the years of supervision. May Allah S.W.T reward them abundantly and grant them Jannah. I would also like to extend my appreciation to my former mentor, Dr Paola M. Leardini who played a significant role in guiding me at the very most beginning of this doctoral journey.

I would also like to extend my heartfelt gratitude to the 11 expert panel members for their invaluable input, insightful comments, and innovative ideas during the Fuzzy Delphi Method session. Their contributions were instrumental in shaping the success of this project. My special thanks to Prof. Ts. Dr. Hamdan Ahmad and Ts. Steve Anthony Lojuntin for your time, comments and guidance.

My sincere appreciation goes towards my dearest wife, Nuriylia Abdul Jalil for always giving me the support I needed, for being the person I could depend on during the toughest times, for your sacrifice and your undivided love throughout this journey. To my children, Ahmad Thaqif, Safiyya Al Zahra and Hana Maryam, thank you for your patience and moral support. You have been my motivation and strength to endure the journey. Not to forget, to both of my parents; Hj Abdul Razak Osman and

my deepest gratitude for your support and love since the beginning of this PhD. To my siblings, thank you for your patience and understanding. I am forever in debt, payable only by Allah for your kindness, love and patience. Also, to both of my in-laws, Abdul Jalil Ismail and Roszina Abd Rahim, thank you for your continuous support, patience and love in spite of the challenges. I pray to Allah to grant you all the highest Jannah.

I am also thankful the team at the School of Graduate Studies, College of Built Environment especially the Coordinator of Postgraduate Studies, Dr Farrah Zuhaira Ismail, Pn Rafidah Wahab and the whole team (former and current) for their patience, assistance and advice throughout our postgraduate journey.

To my colleagues, my salute and thanks for your support and encouragement, especially for their understanding during times that needed their lending hand.

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