



Energy Efficiency and Optimization of Buildings for Sustainable Development in Malaysia

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ABSTRACT

Energy is the core requirement for all sectors to operate efficiently and successfully. Many sectors in Malaysia progressively uses more energy as its economy grows rapidly. The main four energy expending sectors are Industry, transportation, business and private structures. Decisively, business and private structures contribute about one third of its whole energy utilization. Corresponding to high energy utilization in Malaysia, Building Energy Efficiency (BEE) has been pulling in progressively added enthusiastically by the government of Malaysia. At present state the main difficulties faced by the organizations to achieve the BEE target are due to design restrictions of the constructions and financial obstacles that are faced by the developers. To overcome such obstacles solid energy saving tactics are in reach if early preventions are engaged, that may allow Malaysian government to progress with social and financial development in the next 50 years to come while guaranteeing the energy supply and upgrading nations territorial and global ecological standards. The particular ideal energy prospects won't happen with the current approach of Malaysian government. Recognizing the flaws and barriers met under earlier initiatives, the Malaysian government launched National Energy Efficiency Action Plan (NEEAP). These activities brought out by the government, thus to ensure the sustainability of the future energy framework of BEE. As highlighted the Malaysian government must focus monitoring on compliance and requirements of the BEE, thus to ensure the sustainability of the future energy framework. This paper uncovers the advancement and current situation of BEE in Malaysia, highlights its focus issues, and propose recommendation for its development which includes choices to improve the energy frameworks designed for better overall maintenance.

1. Introduction

Building developers are one of the biggest energy purchasers known to mankind, making up one-quarter of overall energy utilized and emission of harmful substance to the ozone layer. Unfortunately, little thought been given to confirm the energy effectiveness in structures, disregarding the momentous effect which structures have on the overall expenses and the wellbeing

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of the earth. At current situation with high energy cost likely for many years to come, the world may have minimal decision making power yet to endeavor to utilize energy in buildings more effectively. Overall energy utilized in all type of structures has rapidly come into attention as there are basic difficulties to meet the changes that occur in the environment. Positively no other industrial sector has more concern on energy use and related ozone harmful emissions. Other industries don't have this kind of harmful emissions that has to be reduced through energy proficiency improvement. With the expansion of structure energy utilization, the development of Building Energy Efficiency (BEE) turns into a crucial piece of this puzzle to reduce the energy consumption. BEE is significant since Malaysian's business and private structures represents 13 % of all energy consumption and 48 % of the nation's power utilization [1].

Statistical data show that structures consume up to 40 % of the entire worldwide energy. By the end of 2030, the energy utilization is anticipated to surge up to 50 %. Additionally, energy utilization of Malaysia structures has been one of the reasons for over 25 % of ozone depleting emissions while Carbon dioxide (CO₂) discharge in the country has surged by 221 %, that lists the country at 26th place between the top 30 greenhouse gas emitters in the world [2].

As a longtime energy exporter, Malaysia is now at a point of becoming a net energy importer. Besides, that Malaysia's structure energy utilization per unit zone represents multiple times as that of the ASEAN nations with comparable climatic circumstances [3]. In this manner, if the Malaysian government wants to guarantee energy productivity in the mid of this fast financial growth, it should have laid out energy proficiency polices for the structure division and keep on updating progressively strict actions to develop BEE. Around three decades, extraordinary monetary development in Malaysia caused a sensational increment in energy utilization. Few investigations achieved the positive association between power utilization and the financial development. From 1980 to 2009, the absolute power utilization and residential item with gross domestic product (GDP) expanded by 9.2 % and 6.2 % correspondingly [2]. In Asian market, Malaysia is considered to have one of the best GDP growths of 6.5 % annually since 1957 to 2005. In 2021 the GDP fell 0.5 % in the first quarter, moderating significantly from the 3.4 % compared to fourth quarter of last year [4]. Figure 1 shows the current GDP trend of Malaysia.

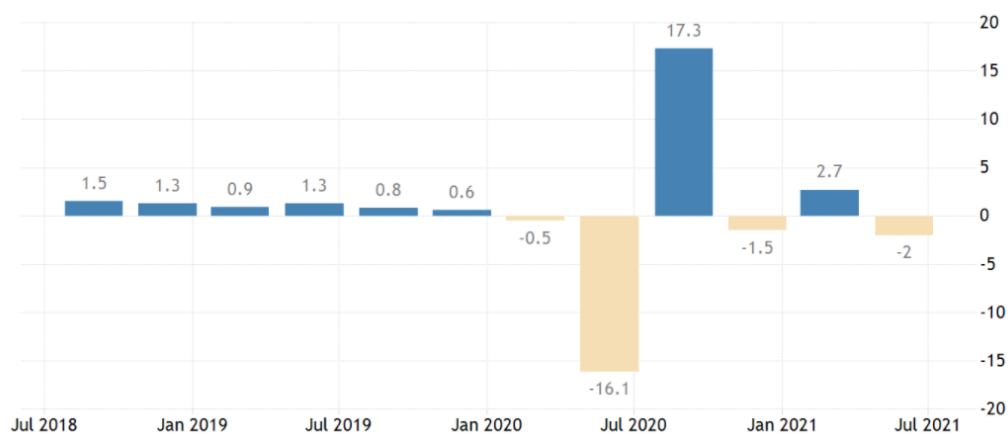


Fig. 1. Malaysia GDP growth rate [4]

At present state, economic sectors can't proceed with energy productivity in buildings without the help of legitimate government rules. Numerous administrations at the national and local stages seeks detailed information regarding the BEE policies which are available and could be effective within Malaysia. Nevertheless, upgrades in structure energy proficiency will proceed at a slower pace

if both the interested and supply parties carry out the activities without a well-structured strategy. Government needs to prepare the guidelines that will help the industries to set the limits.

Recognizing the weaknesses and obstacles met under earlier initiatives, the particular ideal energy prospects won't happen with the current approach of Malaysian government. Currently there are insufficient rules which relates to reasonable funding persuading BEE which creates a weakness in the system where there are lack of assessment been done, poor financial planning related assistance, monetary arrogations, and so forth thus to advance BEE development. Moreover, measurable data and facts are getting harder to acquire from the government bodies as a lot information are not transparent enough for the organization to excess and assets for further development to achieve targeted goals. In addition, government bodies lack of assisting and managing on the present BEE laws and guidelines which creates difficulties or misguidance among organization that makes it challenging to achieve the targeted BEE. Therefore, this article considers a few of Malaysian BEE approaches and it prescribes the preeminent conceivable answer intended for different BEE strategic activities conducted within the country [5].

2. Literature Review

2.1 Energy Efficient Buildings

The energy efficiency of a building is the degree to which the energy utilization per square meter of floor area of the structure measures up to conventional energy utilization guidelines for that specific type of construction under distinct climatic conditions [6]. Focusing on developing green structures and improving the current structures alone won't address the world's environmental issues. Presumably the greatest fundamental solitary area that we will observe advanced accentuation meanwhile the entire nation facing difficulties towards acclimate to environmental revolution. Our objective is structure energy productivity and it is not just about reducing the usage of lighting, it is linked with carrying out more constructive activities towards energy consumptions which yields enhancement that will enable countless individuals to live and work in progressively quality workplaces and living space. The manner in which structures are planned and developed nowadays doesn't just affect their expenses yet will also affect the world's energy utilization and ecological conditions in the longer run. Thus, ensuring usage of expenses through careful structure configuration assigned to engineer's practices of the structure administrators and tenants. It reflects money related observation for organizations to examine, respond, and drive the improvement headed for improved structure energy productivity. As guidance to developers, brilliant plan systems and great proficiency structure components acts as the answer for expanding energy effectiveness. The initiation point for administrators and users is to create awareness on energy utilization for the executives thus to prevent energy wastage. As frequent as possible, analyzing whole expenses inside the life span of the building necessity support basic management for everyone related by a structure [7].

2.2 Energy Efficiency Building Features

The essential standards of a structure energy effectiveness are to smear substantially lower energy for warming, cooling, and lighting, deprived of sacrificing the accommodation comfort of individuals that utilizing it. Elite structures save energy expenses and characteristic assets, and yet infer a higher-quality indoor condition. The fundamental focal points of structure energy effectiveness comprise of the following:

- i. More indoor environment quality efficient structures will lead to more beneficial indoor condition for any individual who can work well in them essentially with agreeable temperatures and a serene work climate which are normally qualities of elite structures.
- ii. Limited life-cycle cost strengthens the building energy productivity thus by brings down the energy requirement needed to work in a structure and decreases the expenditures for occupancies.
- iii. Diminished supply intake. By increasing energy effectiveness will generously diminish requirement for fresh oil supplies and latest power plant venture.
- iv. Buildings that head towards lower environmental impact led to the arrival of four fundamental contaminations, mono-nitrogen oxides (NOX), sulfur oxide (SOX), CO₂, and particulates. Constructing a structure with energy proficiency limits the reliance on petroleum products and diminishes ozone harming emanations [8].

2.3 Malaysia Building Energy-Efficiency (BEE) Initiatives, Policies and Guidelines

Building energy valuation and reviews are one of the furthermost incredibly engaging projects for developing enterprises and building owners to review their energy use for minimizing energy cost and developing its effectiveness. Under this program, around 40 structures and businesses are as of now inspected since 1993-1995 continuously two-sided and many-sided coordinated effort. This is the principal energy review platform completed within the Malaysian development plan 1991-1995. Additional energy reviews have been completed from that point forward, of reviewing 12 government structures in 2002 and 48 enterprises within the Malaysian Industrial energy productivity growth plan from July 2000. Malaysia built up its 1st draft of energy effectiveness rules of business structures in 1986 to 1987, and implementing it as deliberate rule in December 1989. The extent of the rules contained complete package; cooling, light and electrical power [9]. Figure 2 shows the projected overall energy consumption from 1980 to 2030.

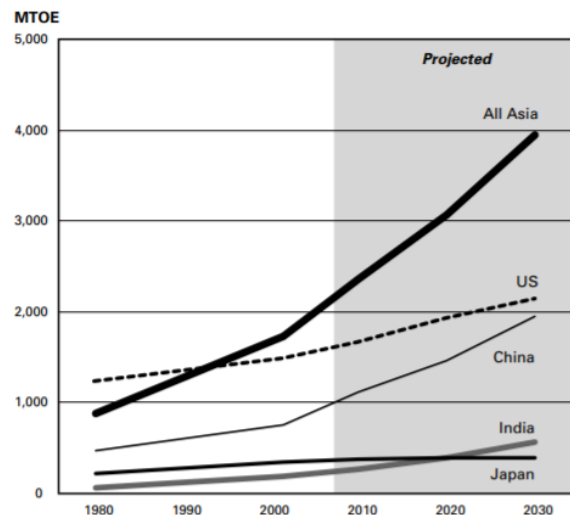


Fig. 2. Overall energy consumption [9]

On 2019 onwards Malaysia started to more focus on policies related on Green Building Index (GIB) which is based on evaluating the environmental performance based on six major criteria's: energy efficiency, sustainable site planning and management, indoor environmental quality, water efficiency, material and resources and innovation [10]. The GIB is specifically intended for hot and humid climate countries. It has a distinct rating system for different type of structures which are

separated into new and existing structures. As of 2019, over 500 structures have participated and been certified in this evaluation. At current policy Malaysia aims to achieve 20 % renewable energy capacity mix by end of 2025 [11]. Figure 3 shows the breakdown of energy used in Malaysia.

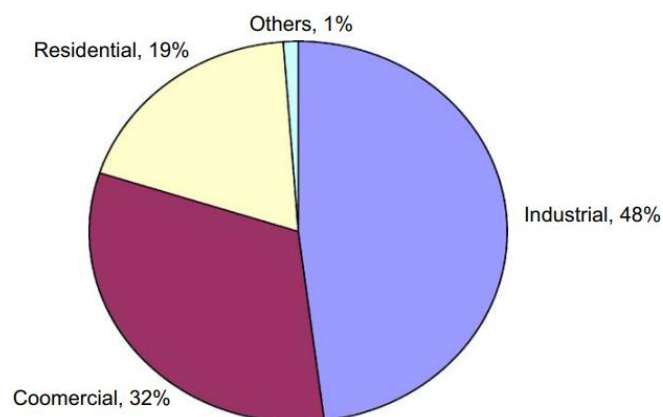


Fig. 3. Statistics energy used in Malaysia [11]

The underlying form of this guidelines got a great deal of its absolute system and considerable input from Singapore standards (1983) and first drafts from the seeming 1989 ASHRAE90 policy in the United States. The approaches contain inputs on energy and valuation impacts. In 2001, the rules had been altered and incorporated into Malaysian Standard (MS) 1525 as a code of practice on energy efficiency and utilization of renewable energy for commercial buildings. Various structures in Malaysia from 1990 executed energy productivity plans which past the particulars of MS 1525:2001. Malaysia local energy efficiency organizations effectively participates in ASEAN provincial energy effectiveness programs. Such projects include inclusion in the development and advancement of territorial energy regulations of structures and local energy productive structure grant plans. Latest energy rate and cost control for business related structures are exceptionally employed in Malaysia. Another power levy was executed in mid of 2006 to dishearten inefficient energy usage among the bigger buyers. Whereby budgets related to Incentives and prizes, there is coordinated arrangements for import obligation and deals charges with an exception on machines utilized for energy proficiency which aren't made locally. Like a gear purchased from local organizations is offered exception [12]. Recognizing the flaws and barriers met under earlier initiatives and programs, the Malaysian government launched National Energy Efficiency Action Plan (NEEAP) which to be implemented in the next 10 years within the period of 2016-2025. The NEEAP is based on four strategies which are Implementation of Energy Efficiency Plan, Strengthen Institutional Framework, Capacity Development and Establishment of Sustainable Funding Mechanism [13].

3. Challenges and Recommendation for BEE in Malaysia

3.1 Challenges to Improvement of Building Energy Efficiency in Malaysia

Obstacles from political organizational and influential restrictions basically occurs in emerging countries and compromises of issues related to poor administration contribution with energy effectiveness and lacking of organization strategies because of the following reasons: (1) restricted requirement structures and foundations and (2) Financial obstacles in buying productive gear contains higher initial costs which numerous buyers would not prefer to spend, and which low-pay buyers can't bear the cost with limited capital. Basically this can be the most critical obstructions for energy productivity in structures and other divisions in developing countries around the globe and most of the time may not be implicit in detail. In such countries, customers generally don't have to

pay significant amount in advance meanwhile they don't comprehend or sense energy productivity is at its fullest. Data barriers in absence of information concerning the chances in the system and potential outcome of energy productivity choices can be a primary concern in developing countries. As a rule, arrangement of energy administrations or control of passage to the national network is perceived as a fundamental without understanding the advantages of blending these with inspections of energy proficiency thus to have the choice to decrease the power utilized. Next to conduct and administrative constraints behavioral characteristics of people and authoritative qualities of organizations impede energy effectiveness advancements and practices [14].

Open doors for energy preservation are regularly neglected and its difficult of changing the way of life. A default of mindfulness and data approximately the prospects and little expenses of energy investment funds are interconnected issue and considerably more in creating barriers with developing nation. In such nations, presumably the utmost imperative test concerning reinforcing energy proficiency is the little offer subsequently confined significance of energy use in the dispensable revenue or budgetary return of rich mortgage holders and organizations which prompts constrained given to this issue in addition to other matters. Market flops avoid the predictable interpretation of explicit energy proficient speculations into energy saving advantages. Absence of rewards unquestionably are a fundamental downside inside the business seeing that building occupants pay the energy charge most likely consider limiting it, although it does not have power on the framework, while structure administrators are not keen on energy proficiency improvements [15].

In like manner, administrators have no immediate association in measures diminishing their customers' energy use. While, money related requirements without a doubt are primary obstacle avoiding energy proficiency speculations. However, when dealing with higher initial expenses there are foreseeable hidden cost and advantages for the customer not caught legitimately in money related streams, for example exchange costs related with gaining the energy proficient arrangement and dangers related with the substitution innovation. Exchange expenses are typically high because of the divided parts of the structures part with various owners. Nevertheless, new innovations probably won't be perfect with current energy proficiency [16].

3.2 Recommendation for Malaysia Building Efficiency

There is an insufficient of reasonable money related rules persuading BEE, and the current industry doesn't implement its total obligations in Malaysia [17]. Effective involvement of developing nation uncovers administration specialists should think about assessment motivators, fund related assistance, monetary appropriations, and so forth thus to advance BEE development. Building energy effectiveness acts as a long-term instrument empowering BEE isn't yet been set up. Whereby the abilities of the Malaysian government in BEE assessment will be enhanced, and a market package offering BEE arrangements is to be created. Consequently, the important segments of the government requirement to initially reflect the above mentioned subject when developing monetary rules that supports BEE. At the same time, the Malaysian government must stay away from adding the expense of engineers when undertaking BEE since unreasonably forceful rules may make manufacturers move BEE rate to lodging rates. There is a nonattendance of legitimate, far reaching, exact and opportune measurable data on BEE in Malaysia which creates potential hazard in BEE basic leadership or appraisal after the proper areas of the administration.

Moreover, nearby measurable data and facts are increasingly hard to acquire. Along these lines, as an analyst I may propose that the appropriate sections and associations of the government ought

to charge their endeavors in social occasion nations and nearby BEE factual data just as in granting permission to these information [17].

The realistic cost of energy concerning structures, for example are power and water which prompts the thoughtlessness of structure proprietors to energy expenditures, in which the venture for BEE advancements is considerably more prominent than of the task fee of structures. This may prompt an unexpected consequence that structure proprietors need monetary assurance to think about BEE innovations. Subsequently, I recommend that the suitable divisions of the Malaysia government should change energy expenditures adaptably as per Malaysian monetary improvement and quality BEE promulgation to help the overall population comprehension of energy productivity and natural security. Malaysia's present BEE framework and organizations are insufficient thus advancing BEE in a nation is troublesome and in this way testing as it for the most part requires the consideration of different organization parties. Accordingly, it is recommending that the quality of ministry of energy and green innovation and Construction industrial development board (CIDB) be broadened with the goal that it could be an amazing opportunity during BEE advancement and bring together the authority of Malaysia's BEE growth. Concurrently various BEE laws and guidelines are now being prescribed from the Malaysian organizations, which points out that usage and supervision appear to be consistently deficient. Despite the fact that few BEE laws and policies have incredible goals, their execution is inclined to difficulties and protections as a result of the difference in structure portions. Therefore, it is suggested all the concern branches of the Malaysian government must focus on assisting the usage and management of the present BEE laws and guidelines starting now and till foreseeable future [18]. Figure 4 shows recommended practice principles suggested to government bodies as guideline to assess performance.



Fig. 4. Practice principles to assess organization [18]

4. Conclusions

By recognizing the overall impact that structures cultivate on a regular habit, government authorities must optimize the systems to achieve better manageability of the constructed structure. This pressure upon for achieving required energy consumption and expanded structure maintainability is a continuous business related issue. Industry-drove activities have tried to change the current market practice through the energy proficient structures. The advancement towards energy proficient structures have been introduced in Malaysia over the recent years, with significant national government crusades in advancing the structure energy productivity which was driven since year of 2000. More prominent enthusiasm to the environmental effect of structures has showed up as a source of more extensive approach contemplation. These activities brought out by government, modern associations, and companies are established for changes in the market towards higher supportability in the manufactured conditions. Insignificantly information that exists on the impact of the strategy instruments are the reasons for this impact. In this manner, Important research gaps keep on existing on the conditions in Malaysia clearly shows the need of extra strategical plans along with additional evaluation as few of these have not yet been propelled or are essentially display for

diminishing GHG within structures [19]. In conclusion the Malaysian government must focus monitoring on compliance and requirements of the BEE, thus to ensure the sustainability of the future energy framework.

References

- [1] Koepfel, Sonja, and Diana Ürge-Vorsatz. "Assessment of policy instruments for reducing greenhouse gas emissions from buildings." *Report for the United Nations Environment Programme-Sustainable Buildings and Construction Initiative*. Central European University, Budapest (2007).
- [2] IEA. *World Energy Outlook 2010*. International Energy Agency, Paris, 2010.
- [3] Overland, Indra, Haakon Fossum Sagbakken, Hoy-Yen Chan, Monika Merdekawati, Beni Suryadi, Nuki Agya Utama, and Roman Vakulchuk. "The ASEAN climate and energy paradox." *Energy and Climate Change 2* (2021): 100019. <https://doi.org/10.1016/j.egycc.2020.100019>
- [4] Zulkifli, Zaharin. "Malaysia Country Report." In *Energy Outlook and Energy Saving Potential in East Asia*, p. 170-190. Jakarta: ERIA, 2021.
- [5] Sadzadehrafiei, S., K. Sopian S. Mat, and C. Lim. "Energy consumption and energy saving in Malaysian office buildings." *Models and Methods in Applied Sciences 75* (2011): 1392-1403.
- [6] Bertoldi, Paolo, Thomas M. Lawrence, David Gattie, Lin Lu, and Chuanshuai Dong. "Policies, Recommendations and Standards (International Technical Standards, Main Laws and Regulations; EU Directives; Energy Labeling)." *Handbook of Energy Efficiency in Buildings* (2019): 5-73. <https://doi.org/10.1016/B978-0-12-812817-6.00002-4>
- [7] Xie, Hao, Zhuang Yu, and Jing Wu. "The current situation and problems in china's building energy efficiency." *Procedia Engineering 21* (2011): 1145-1151. <https://doi.org/10.1016/j.proeng.2011.11.2123>
- [8] Bekhet, Hussain Ali, and Nor Salwati bt Othman. "Causality analysis among electricity consumption, consumer expenditure, gross domestic product (GDP) and foreign direct investment (FDI): Case study of Malaysia." *Journal of Economics and International Finance 3*, no. 4 (2011): 228-235.
- [9] Council, Asia Business. "Building Energy Efficiency: Why green buildings are key to Asia's future." *Asia Business Council Publication*, Hong Kong (2007).
- [10] Resources Green Building Index. "Green Building Developments and Opportunities: Malaysia." *Green Building Index*, September 22, 2021. <https://www.greenbuildingindex.org/resources>.
- [11] Sustainable Energy Development Authority. "National Renewable Energy Policy." SEDA, 2019. <http://www.seda.gov.my/policies/national-renewable-energy-policy-and-action-plan>.
- [12] Saidur, Rahman. "Energy consumption, energy savings, and emission analysis in Malaysian office buildings." *Energy Policy 37*, no. 10 (2009): 4104-4113. <https://doi.org/10.1016/j.enpol.2009.04.052>
- [13] Abd Rahman, Nurul Asra, Syahrul Nizam Kamaruzzaman, and Farid Wajdi Akashah. "Scenario and Strategy towards Energy Efficiency in Malaysia: A Review." In *MATEC Web of Conferences*, vol. 266, p. 02012. EDP Sciences, 2019. <https://doi.org/10.1051/mateconf/201926602012>
- [14] Deringer, Joseph, Maithili Iyer, Yu Joe Huang, J. Deringer, and M. Iyer. "Transferred just on paper? Why doesn't the reality of transferring/adapting energy efficiency codes and standards come close to the potential." *Proceedings of the 2004 American Council for an Energy-Efficient Economy (ACEEE) Summer Study on Energy Efficiency in Buildings* (2004).
- [15] Vine, Edward. "An international survey of the energy service company (ESCO) industry." *Energy Policy 33*, no. 5 (2005): 691-704. <https://doi.org/10.1016/j.enpol.2003.09.014>
- [16] Carbon Trust. *Potential Evolution for Business and the Public Sector*. The UK Climate Change Programmed, 2005.
- [17] Chappells, Heather, and Elizabeth Shove. "Debating the future of comfort: environmental sustainability, energy consumption and the indoor environment." *Building Research & Information 33*, no. 1 (2005): 32-40. <https://doi.org/10.1080/0961321042000322762>
- [18] Ürge-Vorsatz, D., S. Köppl, C. Liang, B. Kiss, G. G. Nair, and G. Celikyilmaz. "An assessment of energy service companies worldwide." *Report submitted to the World Energy Council* (2007).
- [19] Westling, Hans. "Performance contracting. Summary report from the IEA DSM Task X within the IEA DSM implementing agreement." *International Energy Agency*, Paris (2003).
- [20] Hassan, J. S., R. M. Zin, M. Z. Abd Majid, S. Balubaid, and M. R. Hainin. "Building energy consumption in Malaysia: An overview." *Jurnal Teknologi 70*, no. 7 (2014). <https://doi.org/10.11113/jt.v70.3574>
- [21] Berghout, N. A., M. A. van den Broek, E. Worrell, and Dolf Gielen. "Synergies between renewable energy and energy efficiency: a working paper based on remap 2030." *IRENA (International Renewable Energy Agency)* (2017).
- [22] IEA. *Analysis and Forecasts to 2022-Executive Summary*. Tech. Rep., International Energy Agency, 2017.

- [23] Chel, Arvind, and Geetanjali Kaushik. "Renewable energy technologies for sustainable development of energy efficient building." *Alexandria Engineering Journal* 57, no. 2 (2018): 655-669. <https://doi.org/10.1016/j.aej.2017.02.027>
- [24] Energy Commission of Malaysia. *National Energy Balance 2017*. Suruhanjaya Tenaga, 2017.
- [25] Ministry of Energy, Science, Technology, Environment and Climate Change. "Malaysia Third National Communication and Second Biennial Update Report to the UNFCCC." UNFCCC, June 9, 2020. https://unfccc.int/sites/default/files/resource/Malaysia%20NC3%20BUR2_final%20high%20res.pdf.
- [26] Department of Statistics. "Population Projections (Revised) Malaysia 2010-2040." *NEWSS*, June 9, 2020. <https://newss.statistics.gov.my/newssportalxep/epFreeDownloadContentSearch.seam?cid=74634>.
- [27] IEA. *World Energy Balances*. International Renewable Energy Agency, Paris: OECD Publishing, 2020.
- [28] Hor, Kevin, and Mohd Khairil Rahmat. "Analysis and recommendations for building energy efficiency financing in Malaysia." *Energy Efficiency* 11, no. 1 (2018): 79-95. <https://doi.org/10.1007/s12053-017-9551-2>
- [29] Moghimi, S., F. Azizpour, S. Mat, C. H. Lim, E. Salleh, and K. Sopian. "Building energy index and end-use energy analysis in large-scale hospitals-case study in Malaysia." *Energy Efficiency* 7, no. 2 (2014): 243-256. <https://doi.org/10.1007/s12053-013-9221-y>
- [30] Mohsenzadeh, Maryam, Massoomeh Hedayati Marzbali, Mohammad Javad Maghsoodi Tilaki, and Aldrin Abdullah. "Building form and energy efficiency in tropical climates: A case study of Penang, Malaysia." *urbe. Revista Brasileira de Gestão Urbana* 13 (2021). <https://doi.org/10.1590/2175-3369.013.e20200280>
- [31] Lee, Mohammad Syabilee Nikman, Sulzakimin Mohamed, Md Asrul Nasid Masrom, Muhamad Azahar Abas, and Seow Ta Wee. "Risk in green retrofits projects: A preliminary study on energy efficiency." In *IOP Conference Series: Earth and Environmental Science*, vol. 549, no. 1, p. 012084. IOP Publishing, 2020. <https://doi.org/10.1088/1755-1315/549/1/012084>
- [32] Usman, Abdullahi Mohammed, Kamil Abdullah, and Mohd Faizal Mohideen Batcha. "Comparative Study on Energy Management and Efficiency Category in Sustainable Building Rating Schemes." *Journal of Advanced Research in Fluid Mechanics and Thermal Sciences* 49, no. 1 (2018): 25-35.
- [33] Azizi, Nurul Sakina Mokhtar, Suzanne Wilkinson, Mokhtar Azizi Mohd Din, and Nuzaihan Aras Agus Salim. "An analysis of occupants response to thermal discomfort in green and conventional buildings in Malaysia." *Journal of Advanced Research in Fluid Mechanics and Thermal Sciences* 47, no. 1 (2018): 159-171.
- [34] Usman, Abdullahi Mohammed, Akmal Nizam Mohammed, Mohd Faizal Mohideen, Mas Fawzi Mohd Ali, Kamil Abdullah, and Juntakan Taweekun. "Energy Profiling for Residential College Buildings." *Journal of Advanced Research in Fluid Mechanics and Thermal Sciences* 81, no. 2 (2021): 139-145. <https://doi.org/10.37934/arfmts.81.2.139145>
- [35] Khattak, Muhammad Adil, Lee Jun Keat, Khairul Anwar Bapujee, Tan Xin Hui, Amirul Syafiq Othman, Afiq Danial Abd Rasid, Lailatul Fitriyah Ahmad Shafii, and Suhail Kazi. "Global energy security and Malaysian perspective: A review." *Progress in Energy and Environment* 6 (2018): 1-18.