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Building energy for sustainable development in Malaysia: A review

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ABSTRACT

Malaysia is located in Southeast Asia near the equator within the typical tropical climatic zone. The efficient use of energy is vital due to the dependency on fossil resources that are being exhausted, which ultimately cause CO_2 emissions. Economic development and population growth are deemed to affect the growing energy demand in the country. Therefore, sustainability, energy security, and climate change are crucial challenges for the power sector in Malaysia. The aforementioned issues can be tackled with energy efficient measures in the building sector. Buildings in Malaysia consume 14.3% of the overall energy and 53% of only electrical energy is being consumed in residential and commercial sectors. Therefore, energy efficiency in buildings is crucial in order to reduce the energy use and improve the local environmental sustainability. This paper discusses a review on the building energy scenario, the policy perspectives, building energy efficiency programs along with landmark buildings and their characteristics. Besides, the potential of renewable energy resources in buildings and various prospective issues and challenges faced by the country have also been discussed. The significant review content thus benefits researchers, scientists and practitioners for a better understanding on energy efficiency and the sustainable measures that have been so far taken. The review also puts forward some actions to promote building energy efficiency and conservation.

1. Introduction

Energy is a lifeline and crucial element for the social, economic and sustainable development of various countries. Due to rapid infrastructure development and economic growth, this continues to affect the growing energy demand in Malaysia. This energy demand is influenced by population growth, per capita income, and demographic changes (such as increasing urbanization and economic growth). The increase in energy consumption recorded in 2012 was 7.5% and expected to rise in the range of 6–8% in subsequent years [1]. However, challenges of sustainability, energy security, rapid exhaustion of indigenous fossil resources and climate change have made the country to take into account the building energy efficiency in its policy road map. Hence, efficient usage of energy is significant for preserving the available energy resources, and consequently alleviates the growing energy demand. Moreover, in 2009, Malaysia ranked 52 on the climate change performance index, an instrument that evaluates and compares 90% of the global CO_2 emissions of 57 countries [2]. One of the potential sectors that appear to be tackling these aforementioned challenges is the building sector. Since buildings and the built environment contribute significantly to the greenhouse gas (GHG) emissions.

Malaysia is located in Southeast Asia near the equator with coordinates of 2° 30′ N and 112° 30′ E, and a total area of 329,750 sq. km. It is divided into two parts by the South China Sea; named as Peninsular Malaysia bordering the south of Thailand, and East Malaysia bordering northern Singapore and the Indonesian islands. Its climate is generally hot and humid (tropical) throughout the year with an average rainfall of 250 cm a year, and an average temperature

Abbreviations: ACEM, Association of Consulting Engineers Malaysia; ASHRAE, American Society of Heating, Refrigerating and Air Conditioning Engineers; BIPV, Building Integrated Photovoltaic; EE, Energy Efficiency; EQ, Environment Quality; FiT, Feed-in-Tariff; GBC, Green Building Council; GBI, Green Building Index; GEF, Global Environment Facility; GGC, Green Grading and Certification; GHG, Green House Gas; GWp, Giga Watt Peak; GoM, Government of Malaysia; IEM, Institution of Engineers Malaysia; IN, Innovation; MBIPV, Malaysia Building Integrated Photo-Voltaic; MEWC, Ministry of Energy, Water and Communications; MEGTW, Ministry of Energy, Green Technology and Water; MoW, Ministry of Works; MR, Materials and Resources; NGO, Non-Government Organization; PAM, Malaysian Institute of Architects; PTM, PusatTenaga Malaysia; PWD, Public Works Department; RE, Renewable Energy; SSPM, Sustainable Site Planning and Management; UNDP, United Nations Development Program; WE, Water Efficiency; WGBC, World Green Building Council

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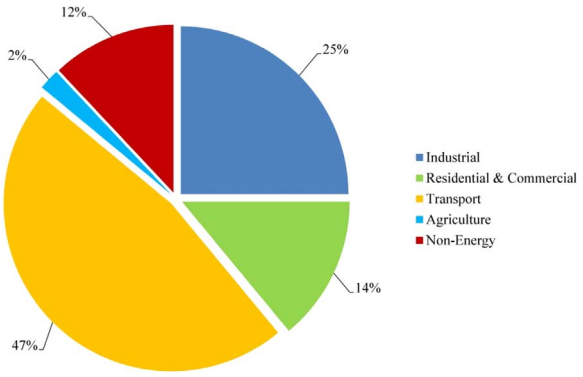

Fig. 1. Sectorial final energy consumption of Malaysia [1].

of 27 °C [5]. These typical subtropical climatic conditions of Malaysia closely affect the indoor environmental comfort conditions in buildings.

Malaysia's overall energy demand for the year 2014 is shared by various sectors, such as Industry 25%, commercial & residential 14%, transport 47%, agriculture 2% and non-energy 12.0%, as depicted in Fig. 1. The electrical energy consumption in Industry is 45.9%, commercial 32.3%, residential 21.2%, transport 0.2% and agriculture 0.4% [1] in the year 2014 as shown in Fig. 2. This represents nearly 14.3% of the overall energy. Of which 53% of electrical energy is being consumed in residential and commercial sectors, which mainly comprise of buildings; this may include some non-buildings that are relatively small contributors, such as water and sewage treatments, street out-door lightings and losses. Moreover, industrial building-related facilities have not been taken into account, which may surely increase the percentage of energy consumed in buildings. Thus, it is a leading contributor of greenhouse gas (GHG) emissions for the country according to resources utilized to generate electrical energy. Since, only 80.9% of energy is being supplied through fossil resources, the rest is being supplied through renewables at 3.2% and hydro 15.9%. as shown in Fig. 3 [1]. The fuel mix has been comparatively diversified as compared to the year 2012 that is 92.4% fossil fuel, renewables 0.2% and hydro 7.4%. This scenario leads Malaysia towards sustainable and environment friendly future of buildings. Since, it has almost reduced its dependency on fossil fuel by 10%, besides almost doubled its hydroelectric and solar resources and added the use of biomass and biogas as renewable resources. The chronic electrical energy consumption in Malaysia's residential and commercial sectors is shown in Fig. 4 [1], which shows a linear increase in consumption over the years. This also depicts the growing energy demands in contrast to the industrial sector which was surpassed in the year 2006, and has continued to increase yearly till date. Further, it will increase in the future due to climate changes and economic developments. Furthermore, building

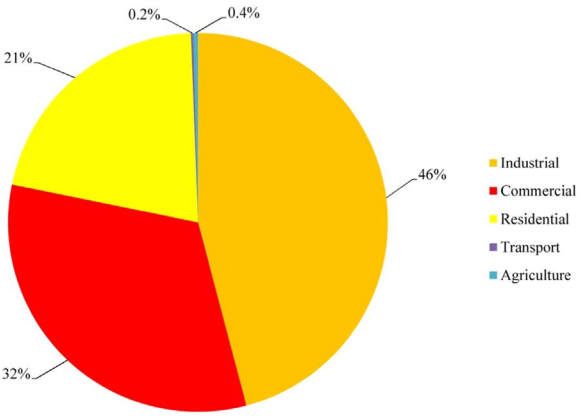

Fig. 2. Sectorial electrical energy consumption of Malaysia [1].

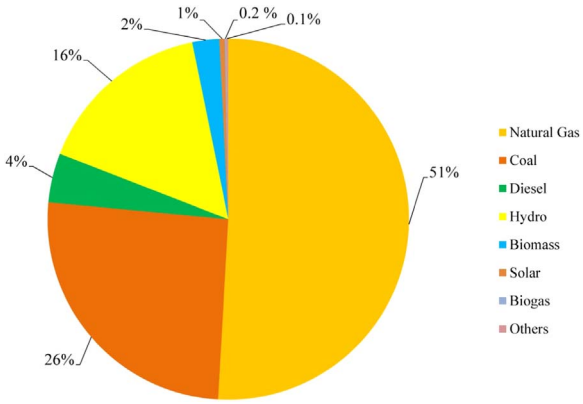

Fig. 3. Fuel mix of Malaysia electricity generation [1].

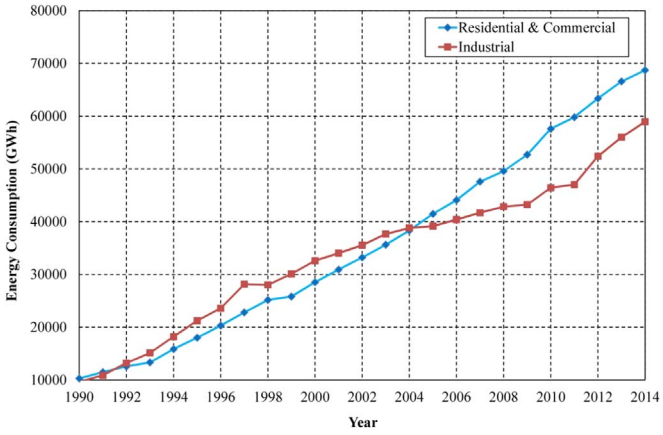

Fig. 4. Chronological building energy consumption in Malaysia [1].

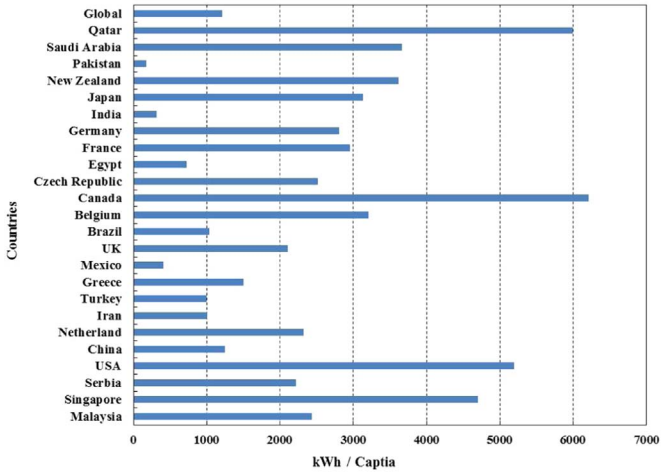

Fig. 5. Building energy consumption in Kwh per Captia for various Countries.

energy consumption in kilo watt hour (kWh) per capita for normalized population has been depicted in Fig. 5. The total electricity consumption in kWh per population has been obtained from the key energy statistics 2015 report from the international energy agency [3]. Whereas the percentage building energy consumption was reported elsewhere [4], therefore, the kWh per capita energy consumption in building has been computed. The developed countries such as Canada, Qatar, Singapore, and USA have been consuming highest per capita electricity consumption in buildings. Whereas, the developing industrialized countries are taking the lead in medium per capita consumption. In addition, Malaysia's per capita electricity consumption falls in the industrialized state having 2434 kWh/capita consumption in

buildings. The underdeveloped and developing countries have lowest per capita consumption in buildings as demonstrated in Fig. 5.

Besides outdoor environment conditions, the behavior of energy in buildings is significantly influenced by various factors, such as construction material and location, appliances used inside the building, its specific use and type, occupancy pattern, user's behavior. Moreover, 90% of people spend most of their time inside buildings, thus they are the central and most dynamic part of indoor building envelope. Due to the rising quality of life, the building's energy consumption has increased dramatically over a few decades. Therefore, the landscape of energy in a building and its indoor environment seem to be the major challenge for the research community, government and society in the country.

This paper aims to review the current scenario on building energy in Malaysia, and discusses the policies, programs, and landmark building and their characteristics. The paper has been organized systematically in order to conduct the literature review on building energy in Malaysia. This analyzes and identifies various aspects that are useful for the research community at large, practitioners, and stakeholders to get in-depth and systematic knowledge on the case of Malaysia's building energy. The information on building energy is quite scattered in the literature; hence it is challenging for practitioners and policy makers to identify the key factors for the purpose of advancements in building energy projects in the world, specifically in Malaysia. Therefore, an attempt has been made to review, analyze and assess the building energy scenario, and identify the key factors to mobilize this sector in the world, and Malaysia for sustainable future of buildings energy demands.

1.1. Motivation of review

So far various reviews have been conducted; these include energy efficiency in buildings, considering air conditioning, and artificial lighting for sustenance of occupants comfort [6]. Chua et al. presented the green initiatives along with their progress and development; mainly, the national green technology policy (NGTP) and green building index (GBI) [7]. ShingChyi et al. studied Malaysia's energy development considering renewable energy and energy efficiency aspects [8]. Hashim and Shin have studied the progress and development of renewable energies over the past decade [9]. Hawl et al. reported five major initiatives, which included renewable energy, energy efficiency in commercial buildings, Kyoto protocol, Malaysian Building Integrated Photovoltaic (MBIPV) program and Biomass [10]. Ong et al. studied the current energy scenario and exploration of alternative energies considering biomass, solar, wind and mini-hydro for ensuring energy security and reliability [11]. Ahmad et al. reported the main sources of alternative energies and their potential with their solutions for selecting Malaysia's future energy [12]. Oh et al. examined and reported the energy policy issues, challenges and their intricacy [13]. Chua et al. presented the outlook of feed-in-tariff (FiT) from the perspective of the renewable energy (RE) policy [14]. Oh et al. reviewed efforts of various energy efficiency programs and carbon trading potential by the Government of Malaysia (GoM) [15]. Manan et al. presented a framework for putting into practice a Malaysian energy efficiency award considering the current energy situation and issues relevant to the implementation of energy efficiency [16]. Besides, Foo [17] has addressed the energy security and green developments offering various opportunities, dynamic pressure, and coping strategies in Malaysia. In addition, the renewable and non-renewable scenario and research breakthroughs along with joint co-operations for the promotion of green energy management have been outlined. The details of previous reviews have overlapped with elements of energy efficiency in buildings; however, a clear gap is identified for the energy situation in Malaysian buildings. In this paper, the building energy scenario, the policy perspectives, building energy efficiency programs along with landmark buildings and their characteristics have been discussed. Besides, the potential of renewable energy resources in buildings of Malaysia and various prospective issues and challenges have been reviewed and critically discussed.

The contents of this paper are organized as follows; Section 2 reviews the various energy policy perspectives considering energy supplies, energy efficiency and management, and renewable energy policy matters in Malaysia. Section 3 discusses the showcase buildings in the country for promoting energy efficiency measures, waste and water management, and renewable energy resource integration. Section 4 discusses the potential of renewable energy and its integration in buildings. Section 5 presents the issues and challenges concerning buildings and finally the conclusion has been presented in Section 6.

2. Energy policy perspectives

Policy trends have evolved since the discovery of fossil petroleum, promoting the awareness of the significance of energy efficiency (EE) in Malaysia's Energy Development (MED) goals. The MED framework is primarily tied to the National Energy Policy (NEP) - 1979, National Depletion Policy (NDP) - 1980, Fuel Diversification Policy (FDP) - 1981, Four Fuel Diversification Policy, and Renewable Energy and the Fifth Fuel Policy - 2000. Moreover, with the rising oil prices and degradation of environmental concern in 2001, the Government of Malaysia (GoM) introduced renewable energy into the energy mix with a significant concern on energy efficiency and sustainability. The primitive history of several energy acts and policies in national energy development are comprehensively discussed in the chronological order, as follows [8] and as depicted in Fig. 6:

National Petroleum Policy (NPP), 1975, represents the optimal utilization of petroleum resources, its regulations, operational management, and economic, social and environmental safety concerns for the petroleum industry.

National Energy Policy (NEP), 1979, formulated an energy strategy and objectives for the long-term ensuring secure, efficient and environmental sustainability. Its supply objective offers the provision of secure, adequate and cost-effective energy resources considering both conventional and non-conventional resources. The objective of energy utilization is to be efficient and overcome waste and a non-productive consumption profile.

National Depletion Policy (NDP), 1980, limits the over exploitation of oil and gas reserves. This also offers a fuel diversity plan for the reduction of oil dependency and emphasis on hydro and coal in an energy mix.

Electricity Supply Act (ESA), 1990, provides the regulation and licensing of the generation, transmission and distribution of electrical supplies.

Gas Supply Act (GSA), 1993, provides the regulation and licensing of gas for its consumers, installations, appliances and safety.

Fifth Fuel Policy (FFP), 2000, promotes the potential of renewable energy resources in an energy supply mix.

Energy Commission Act (ECA), 2001, provides technical, safety and performance regulations for electrical energy and gas supplies. It also deals with energy efficiency and renewable energy challenges.

National Biofuel Policy (NBP), 2006, aimed at fuel diversification policy at reducing dependency on fossil fuels and promoting palm oil demand.

National Green Technology Policy (NGTP), 2009, promotes sustainable development, low carbon technology and conserving resources and environment (development and application of products, equipment and systems). This would help alleviate the anthropogenic effects of human activities. The NGTP's satisfactory criteria are reducing environmental degradation, and are providing low/zero greenhouse gas (GHG) emissions, safe usage and promotion of an improved healthy environment for quality of life. Conservation of natural resources and the utilization of energy and encouragement of renew-

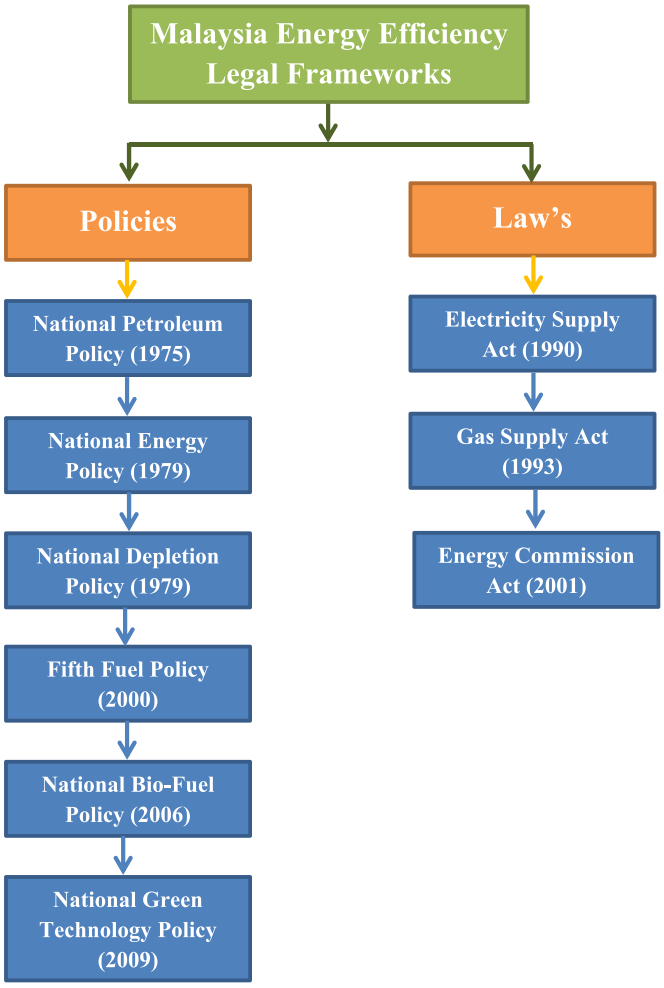

Fig. 6. Development flow chart for Malaysia energy efficiency legal frameworks.

ables in the country's energy diversity are additional benefits. Others are the utilization of energy and its application of green technology, and demand side management (DSM) programs along with the adoption and application of green technology in the construction, maintenance, demolition and management in buildings.

The economic planning unit (EPU) of Malaysia is continuously striving for its economic and social development. In view of the rapidly growing trends over a decade, national economic development has been aligned and envisioned in the Malaysian Plan (MP) and policies. The energy development has been the key emphasis of the country. During the seventh MP (1996–2000), sustainable development of depleting fossil energy resources and its diversification were ensured for an adequate generation capacity. In addition, the infrastructure for transmission and distribution were highlighted. Alternative energy sources and efficient utilization of energy were also a part of the plan.

Moreover, focus was given on the existing strategy of the 7th MP during the eighth MP (2001–2005) for sustainable energy resources; majorly, with five fuels for the energy mix including oil, gas, coal, hydro and renewables. The security, quality and adequacy of energy supply efforts were strengthened. In relation to that, emphasis was first given in this plan on energy efficiency (EE) for encouraging efficient usage of electrical energy, gas supply and renewable energies. Additionally, this plan also promoted incentives for EE, renewable energy and supply quality. The ninth MP (2006–2010) reinforced the EE initiatives in the 8th MP; it also broadened its EE vision to various sectors includes transport sector, along with commercial, industrial and governmental buildings. Besides that, it also intended to decrease fossil fuel dependency and exploit alternate resources. Renewable energy and EE incentives strategy have been intensified and elaborated for the attainment of MED targets. Furthermore, the tenth MP (2011–2015) conferred green technology, its products, appliances and systems along with their applications and adoption through public awareness, commitment and advocacy programs. It strengthens the expansions of research, innovation, development and its commercialization through the appropriate mechanism. In the 21st century, Malaysia is supposed to face various dynamic challenges as it moves through the uncharted pathway of globalization. Thus, keeping in view, the rising energy trends and the national economic developments are considered to be aligned in the Malaysian Plan (MP).

The Government of Malaysia (GoM) over the past three decades has developed its key policy and strategies in order to attain the nation's planned objectives. These have been primarily designed to alleviate the challenges of energy security, efficiency and environmental impacts to meet the growing energy demand of the country. Thus, making possible to attain sustainability, reliability and security of energy supplies for the continuous progression in economy and society. It is currently focusing on alternative energy objectives to lessen the energy dependency on fossil resources that ultimately leads to mitigate the environmental challenge. Currently, the various renewable energy projects have been embarked to materialize, and penetration mechanisms have been incorporated with concerted efforts by the Government of Malaysia (GoM) policy initiatives and various stakeholders' interest. This has offered the boost in utilizing renewable energy technologies and biomass including palm oil, rice husk, wood and biomass co-generation projects. This has been encouraged especially through the private sector for small power generation projects that includes mini-hydro, solar, wind, biogas and biomass etc.

3. Building energy efficiency programs and developments

3.1. Landmark building models

The Government of Malaysia (GoM) is leading in the energy efficiency measures through setting up of the state-of-art energy efficient and green buildings. In relation to that, it has displayed energy efficient buildings of which the Low Energy Office (LEO) is the first energy efficient building that was built in the country, housing the Ministry of Energy, Green technology and Water. The Green Energy Office (GEO) is another energy efficient building built by the Government, the first green building in Malaysia and was followed by the development of the Diamond Building. These buildings serve as landmark projects to encourage more energy efficient and green buildings to be built in the future especially in the private sector.

3.1.1. Low energy office (LEO)

This building aimed at promoting the energy efficiency and developing capacity of Malaysian building industry, is momentous for being a national demonstration project. The Government of Malaysia (GoM) needs their Ministry of Energy, Water and Communication (MEWC) to display their building for energy efficiency and conserve the overall environmental impact. The building design was supported under the Danish International Development Assistance (DINIDA) program that was requested and granted.

The 10% extra cost target for the energy efficiency measures inside the building have been confirmed with its design and building tender. Besides that, the simulation modeling with the Energy-10 tool has predicted more than 50% energy savings, followed by subsequent energy monitoring. Thus, adding to the vital credibility for significant energy savings and environmental benefits that can be predicted and achieved within the building sector of Malaysia. The building design was supposed to have an energy consumption of less than 135 kWh/m2/year but the prediction has been shown to have an energy index that is approximately 100 kWh/m2/year.

The energy efficiency measures that contribute to the aforemen-

tioned energy index include green environment creation around and on top of the building. Orientation optimization was with preference to the north and south window facing and the minimum solar radiation, space planning, insulated building roof and facades, natural ventilation, and efficient cooling system. Optimized day lighting along with automated and efficient artificial lightings is controlled based on daylight and occupancy. Moreover, the energy efficient office equipment is followed by an energy management system to meet the occupants' comfort index with minimum energy costs. In addition to that, the LEO building also exhibits the use of renewable energy as a 3-kWp grid connected photovoltaic system is installed on the roof top [18].

3.1.2. Green tech Malaysia building

Malaysia Energy Center (MEC) locally known as Pusat Tenaga Malaysia (PTM), formerly called the zero energy office (ZEO) building was developed in 2005 and was planned to be displayed as the most energy efficient office building in Malaysia. However, it is officially Malaysia's first GBI certified and green rated office building; now, commonly known as the green energy office (GEO) building. The GEO building was first project of its kind in South East Asia. It was planned to display a sustainable energy efficient office building in Malaysia and in ASEAN countries and that the commercial building can be independent of the grid supply. The construction of the building utilized advanced green technologies with the combination of energy efficiency (EE), renewable energy and rainwater harvesting system. The GEO building does not consume electricity more than the generated electricity from its renewable energy sources on site. This is the only building in Malaysia that has integrated EE and renewable energy both in one working demonstrator building. The building has photovoltaic (BIPV) panels integrated into the design, provides electricity around 120, 000 kWh/year that fulfills 50% of its energy needs. It possesses four different types of solar cells (including mono-crystalline, poly-crystalline, semi-transparent and amorphous) which are integrated aesthetically and architecturally into the building design. The built design faces both north and south utilizing 100% of the natural day light. Moreover, it optimizes sunlight through strategically positioned workspaces, reflective ceilings and mirrored lighted shelves along with sky lighting and tunneling. Energy efficient or sensor controlled artificial lamps have been installed in the building where required. Radiantly cooled floor-slabs are embedded in the floors, which are more efficient than pumping air around the building. Besides that, it also features a rainwater-harvesting system used for topping-up the condenser cooling system, irrigation and general cooling purposes [19].

The design of the GEO building is considered sustainable and energy efficient thus utilizing little fossil fuel with an energy index of 65 kWh/m2 year in contrast to conventional office buildings of 250 – 300 kWh/m2 year. The building normally focuses on green technology innovation in order to minimize energy demand, efficient usage of fossil fuel considering climate concerns, and renewable energy utilization; thus, not compromising user environmental comfort and safety.

3.1.3. Diamond building

The Diamond Building was constructed in 2010 and has been certified by GBI to showcase its sustainable design. The design features include reduction in fossil fuels, energy efficiency, water conservation, sustainable building materials, waste reduction, indoor environment quality, management of traffic and transport, and thorough construction and demolition plans. Its diamond shape view affects the climatic design of the building with four self-shading slanting sides, an inverted pyramid and sharp pointed corners demonstrating its name. Moreover, the intended design of the façade cladding appears like a diamond ring. It is the first building to obtain the highest Platinum rating of both green building certifications, namely, the Green Building Index (GBI) and Singapore's Green Mark. The building has also won several awards, such as the ASEAN Energy Awards (AEA), 2012, and the ASHRAE technology award, 2013, in 2nd place. This building was designed for the fulfillment of the lowest energy consumption building in South East Asia. Thus, maintaining the criterion, which is a building energy index of 135 kWh/m2/year or lower; this is according to code of practice on EE and renewable energy use for non-residential buildings of the Malaysian Standard (MS) 1525: 2001. The building has a targeted Building Energy Index (BEI) of 85 kWh/m2/year, excluding PV solar energy, compared to typical new office buildings in Malaysia and the Southeast Asian region, which have energy indices within the range of 200–300 kWh/m2/year. The building design captures natural daylight abundantly from both the façade and atrium. Moreover, the highest floor has a light trough, automated blinds, varying window size and reflective aluminum panels along with reflected roof light, which are used to optimize the daylight into the deepest floor space area. Light sensors are also incorporated inside the building to encourage the optimal usage of daylight. Moreover, the occupants are encouraged to utilize LED task lights and efficient T5 lighting tubes. The energy efficient strategies of day lighting, radiant floor cooling and efficient artificial lightings possess the capability to reduce CO_2 emissions up to 1,673 metric tons per annum. Besides that, thin film solar panels (suitable for tropical climate zones) have been integrated on the roof with the capacity of 71.4 kWp. Thus, reducing the building energy consumption by 10%. The efficiency of these cells is 1400 kWh/kWp, which is significant in contrast to conventional solar PV that is 1150 kWh/kWp [20].

The building employs recycled materials that represent 31% of the material cost employed in the content in dry walls, ceiling boards, carpet and floor finishes. It also constitutes water efficient fittings that save around 67% of the portable water compared with the conventional water fittings. Furthermore, 35% of the portable water consumption is saved from harvesting the rainwater for toilet, irrigation, and grey water usage. In addition, 10% of the parking spaces are designated to serve car pool and fuel-efficient vehicles, secure bicycle racks and public transportation services. Thus, various energy saving features have been incorporated into the building design at an extra cost of 6% of the base building cost; this has resulted in a simple payback period of 12.3 years. During building operations, the energy monitoring systems add credibility to the substantial energy savings and achieve indoor environmental benefits.

3.2. Malaysia green building confederation (MGBC)

The like-minded group of companies was coined the green building council (GBC) for Malaysia in their very first meeting on May 05, 2007 [21]. This non-profit and non-governmental organization (NGO) was a rigorous effort to guide and spur the building industry towards sustainable built solutions. Furthermore, in compliance to the Malaysian Registrar of Societies' requirement, the name was consequently altered to the Malaysian Green Building Confederation (MGBC) and is the only building organization in Malaysia that is supported by the world green building council (WGBC). Its vision is to make buildings and communities green, and within the reach of all Malaysians. This promotes green buildings for sustainable built environments for one and all. Thus, it has reformed the way of its planning, designing, construction, maintenance and operation in the building sector. It also promotes green building programs, technologies, design practices and processes. Green labels for liable and sustainable measures, besides considering other requirements of social, economic and environmental benefits. Its core objectives are to involve professionals, policymakers and society that embrace green practices in the building industry, which respects the Malaysian environmental effects on their indoor climate comfort.

The MGBC technical committee on rating tools commenced and established the inventive framework, initial benchmarks and classifications of the Green Building Index (GBI). In forming that, the Malaysian Institute of Architects (PAM), and The Association of Consulting

Engineers Malaysia (ACEM) funded and provided resources in the development of a green building rating tool catered to the specific needs of the Malaysian landscape. Generally, taking advantage of the perception of involving participants from these two organizations has turned out to be the best fit providing the acquaintance and expertise of the local building industry. Provisionally, MGBC plays an active role in GBI with the support, promotion and channeling of the industry input for the improvement of locally grown green building rating tools. Moreover, MGBC works in partnership with other professional organizations, such as the Institution of Engineers Malaysia (IEM) as well as the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) Malaysia. In addition, various links with public and private sector universities have been established with a diverse representation of stakeholders including governmental organizations, professional institutions, academicians, contractors, manufacturers and others related to the building and construction industry. MGBC is Malaysia's leading green building NGO that encourages the launch of building industry products and services with an eco-label framework and green pages in Malaysia, striving for a cleaner environment.

3.3. Green building index (GBI)

GBI was launched in April 2009, with the help of the Malaysian Institute of Architects (MIA) and the Association of Consulting Engineers Malaysia (ACEM) supported by MGBC along with the building industry [22]. Green Grading and Certification (GGC) of buildings in Malaysia through the GBI rating tool provides an opportunity to the building developers, stakeholders and owners for the design and construction of sustainable green buildings. These buildings must be able to provide energy and water savings, healthier indoor environment, public transport connectivity, adoption of recycling, and the reduction of the inhabitant's carbon footprints. Malaysia's GBI rating tool is like LEED in the USA, Green Star in Australia, and Green Mark in Singapore and BREEAM in the UK as shown in Table 1. Along with their comparative benchmark analysis of the surveys, the assessments from these tools are also shown in Table 1.

Furthermore, considering holistic approach these rating tools within their respective countries proposes the specific targeted characteristic within their building industry. In that, BREEAM is primarily focusing on environmental assessments and technological research in building sector. Besides, LEED offers the certification for buildings to perform environment friendly in both indoor and outdoor climate of building envelope. The design and construction of buildings to attain sustainability is offered by both green star (GS) and the green mark (GM), however primitively NABERS focuses on the operation performance targets that measures and rate the building energy utilization. Built Green Canada is a voluntary program for supporting the green practices in building sector for attaining green future. China's 3-star rating tool encourages the stakeholders for green developments of envelopes and attains sustainability. The development and promotion of energy, environment and ecological sustainable techniques and policies are been offered by CASBEE. HKBEAM offers eco-efficiency and sustainability for building practices to utilize less energy resources. KGBC focuses on the facilitation for transforming best practices in building sustainability. Relatively, GBI looks for the design and operation of the buildings for overall impact analysis of the built environment. It proposes Energy efficiency, sustainable site and management, indoor environmental quality, water efficiency, materials and resources and innovation. These aforementioned factors make Malaysia on the cutting edge for the transformation of building sector. Ultimately, these designs and developments lead the researchers and practitioner not only to implement in their countries but also may advance those ideas for further enhancements may be obtained in the buildings.

These countries have embarked for sustainable development trends in green buildings. Thus, transforming their building envelopes on either regulated entirely, voluntary adoption of building codes and guidelines and standards or a mix of all. Moreover, the Malaysia has embarked for green building practices for cutting edge benefits of energy savings and reduction in greenhouse gas target attainments. The widespread adoption of green building practices could realize the outcomes of security of energy supplies, enhanced competitiveness among stakeholders and success towards green developments.

The Malaysian Government (GoM), through the support of the MGBC by its Ministry of Energy, Green Technology and Water (MEGTW) along with the Public Works Department (PWD) under the Ministry of Works (MoW) is compassionate of an objective, unbiased and impartial Green Building Assessment and Certification Scheme, professed and pursued by the MGBC through its continued support of the GBI. However, more than 550 buildings have signed up to be certified under the GBI and only 214 have achieved their GBI certifications as of March 31, 2013 [21].

The GBI has been specifically developed considering Malaysia's tropical environmental and developmental context with social and cultural needs. It has been formed to establish a common language and measurement standards that define green buildings. It aims to provide a better environment for all by promoting integrated whole building designs. It also offers environmental leadership by recognition and reward, to reduce negative environmental impacts by transforming the built environment. It ensures future relevancy of new buildings, refurbishes, and upgrades existing buildings for the overall quality improvement of building stock throughout the country. GBI provides certification after assessing points, various benchmarks for three years after which the building will be reassessed for its efficient and sustainable operation. These buildings are awarded with four types of ratings including Certified, Silver, Gold and Platinum depending on the scores achieved through the energy efficiency measures. The GBI rating tool has various benchmarks that include enhanced energy efficiency (EE) through orientation, natural light harvesting, indoor solar heat gain, ensuring regular and proper maintenance, testing and commissioning along with adopting the best practices in building services and promoting the use of renewable technology. Furthermore, attaining good indoor environment quality (EQ), such as indoor air quality, acoustics, visual and thermal comfort, involving low volatile organic materials, quality air filtration, appropriate control of air temperature, movement and humidity levels. In addition, sustainable site planning and management (SSPM) with easy access to public transportation, landscaping, community services and open spaces, thus, avoiding and conserving environmentally sensitive locations, feasible construction for storm water management and reduction of the strain of existing infrastructure capacity are also considered. Promotion of sustainable and environment friendly use of materials and resources (MR), implementation of suitable waste collection and a recycle management framework are yet other considerations. The harvest and reuse of rainwater and water saving fittings to attain water efficiency (WE) are also considered. Consequently, the innovative (IN) design initiatives are the criteria that can deal with the challenging objectives of GBI [34].

In critical evaluation, the green tool indexing for building due to their roles and nature are highly dependent on location and environment. A survey of various rating tools have been studied shows moderate climatic zones. Of-which Malaysia's GBI and Singapore's GREENMARK have been designed for the tropical climate zone so far within the region. Though the operational factors of GREENMARK are for tropical climate but the score preferences have been have been customized for the country. This only includes energy and water efficiency preferences, while transport has already been up to mark, thus less priority have been given. However, GBI differs markedly depending on local climatic variations, development progressions and existing resources.

The GBI existence within the country pose a positive sign provides opportunities for the developers, designers, practitioners and stake-

Table 1
GBI rating tool for building with their benchmark in various Countries.

Sr. #	Ref.	Year	Country	Rating tool	Abbreviation	Benchmark	Observations
1	[23]	1990	UK	Building Research Establishment Environmental Assessment Method	BREEAM	Energy, t ransport, land use, ecology, pollution, water, health and wellbeing, materials, waste and management	The tool presents the world's foremost environmental assessment method and rating system for buildings. It sets standards for sustainable building design construction and operation, use and measures building environmental performance. It focuses on low carbon and impact designs, minimizing energy demands within the building.
2	[24]	1998	USA	Leadership in Energy and Environment Design	LEED	Energy and atmosphere, transport, water efficiency, sustainable site, indoor environmental quality, materials and resources, innovation in design and construction	LEED certification provides independent, third party verification that the building project is an environmentally responsible. It provides green building certification that recognizes best-in-class building strategies and practices, design, operation and construction of high performance green buildings. Thus ensures buildings are environmentally compatible, provide a healthy work environment and are profitable
3	[25]	2003	Australia	Green Star	GS	Energy, materials, ecology, land use, indoor environmental quality, emissions, management and innovation	It is the trusted mark of quality for the design and construction of sustainable buildings, fit-outs and communities. It has also grown into a comprehensive rating system for various types of projects, from apartment buildings to schools, university buildings, hospitals, offices, shopping malls and industrial facilities. The Performance measures of your building's, identification of opportunities for improvement and realize the many benefits of sustainable building operations
4	[26]	2005	Singapore	Green Mark	GM	Energy efficiency, environmental protection, water efficiency, indoor environmental quality, innovation and green features	Green Mark is an initiative to drive the construction industry towards more environment-friendly buildings. It is intended to promote sustainability in the built environment and raise environmental awareness among developers, designers and builders when they start project conception and design, as well as during construction.
5	[27]	2009	Malaysia	Green Building Index	GBI	Energy efficiency, sustainable site and management, indoor environmental quality, water efficiency, materials and resources and innovation.	This tool focuses on enhancing the efficiency of resource use that include; energy, water, and materials. Besides, decreasing the impact of buildings on human health and the environment during its lifecycle, with the better placement, design, construction, operation, maintenance, and removal. The motto of the Green Buildings Indexis to design and operate buildings that can reduce the overall impact of the built environment on its surroundings.
6	[28]	2003	Canada	Built Green Canada	BuiltGreenCan	Energy conservation, efficiency, indoor environment quality, emissions, water recycle, waste management, design and construction innovation.	This is an industry oriented voluntary program, which promotes “green” building practices in order to reduce the environmental impact of buildings. Thus, benefits the homebuilder, the community, and the environment, and offer everyone an prospect to choose a “green” future.
7	[29]	2006	China	Three Star System	3-Star	Land savings and outdoor environment, Energy savings, Water savings, Materials savings, Indoor environmental quality, Operations and management	China's nascent green building market is the introduction of the rating system in the country. The purpose is to create a voluntary rating system that will encourage green developments and ensure energy sustainability.
8	[30]	2004	Japan	Comprehensive Assessment System for Built Environment Efficiency	CASBEE	Energy use and GHG emissions, water use, materials and their safety, biodiversity, land use and indoor environment.	This deal with the buildings, that consume and discard resources and energy in enormous quantities, to act instantly for the development and promotion of techniques and policies that are capable to assist the drive towards energy, environment sustainability and ecological quality of the buildings.
9	[31]	1996	Hong Kong	Hong Kong Building Environmental Assessment Method	HKBEAM	Lessen energy, reduce water, material usage, comfort, life cycle analysis	Green buildings use less energy and reduce water and material usages than conventional buildings, which in turn limit greenhouse gas emissions, thus, turned toeco-efficiency and sustainability. Thus, provide healthier, high quality, durable and efficient working and living environments for building occupants.
10	[32]	2000	Korea	Korea Green Building Council	KGBC	Energy conservation, efficiency, water and waste management	This tool primarily focuses on environmental best practices to facilitate the transformation of

(continued on next page)

Table 1 *(continued)*

Sr. #	Ref.	Year	Country	Rating tool	Abbreviation	Benchmark	Observations
11	[33]	1998	Australia	The National Australian Built Environment Rating System	NABERS	Energy use, greenhouse gas emissions, Water, Waste, comfort, local bio-diversity, and water flows, toxic materials transport.	the global sustainable building industry. Set operational performance targets and measure that can rate the actual performance within the building envelopes.

holders to build sustainable buildings. This can offer energy and water savings, indoor environment comfort, accessible public transport and recycling and green landscaping their societies and projects. Besides, for heat islanding effect the green rating promotes open spacing and landscaping. It also encourages the harvesting rain water. In spite of various handful practices in Malaysia, the reality is so far fairly convincing. Since, the practice has been obliged by the limited number of buildings. This could be due to unawareness, limited budgets, government in-effective policies, market penetration challenges, real-estate worth of building, community services obligations. Therefore, it is suggested that GBI tool should be entirely accessible to attain the national five year development targets set by the government and offer various awareness programs for convincing results from the built sector.

4. Renewable energy potential in buildings

Renewable energy in buildings has been designed to enhance the energy security and interdependence on utility supplies whilst reducing long-term energy costs and environmental impact. Malaysia's energy efficiency strategy constitutes environment friendly solutions that will not only help reduce building energy costs but also provide the tools to reduce carbon footprints. Moreover, embracing the best energy efficient measures in buildings available so far is not enough; the energy would still be required to power day-by-day building operations. This can be achieved with building integrated renewable energy resources to power the building for its operation for making the building zero or low energy dependent.

Renewable energy includes energy that has been derived from natural processes that do not involve the consumption of exhaustible resources; meaning that the energy can be reproduced in a short period. So far, various renewable resources are available, such as biomass, solar, hydropower, biofuel, wind, geothermal etc. However, the major renewable energy technologies that are commonly adopted and are feasible to be easily integrated into buildings include solar photovoltaic (PV), solar water heaters (SWH), wind turbines and their hybrids. Moreover, biomass can be utilized for some specific remote area buildings subject to the availability of organic materials like plant and animal waste.

PV is one of the most promising renewable energy technologies in achieving sustainable development. In Malaysia's urban and suburban areas, photovoltaic systems are mounted and installed on rooftops or facades of the residential as well as non-residential buildings (offices, malls, hotels, schools etc.). These systems are termed as building-integrated photovoltaic (BIPV) and help to increase the power generated per unit floor area of the building. Transforming solar energy as a viable alternative supplement for the electricity grid and buildings in Malaysia. The project of MBIPV was officially launched on July 25th, 2005, by the Ministry of Energy, Water and Communications (MEWC). The Government of Malaysia (GoM) initiated this project with the co-financer Global Environment Facility (GEF) and was distributed through the United Nations Development Program (UNDP). During the span of the 9th Malaysian Plan (MP) from 2006 to 2010, the MBIPV project was the last for the promotion and development of renewable energy in the country's planning documents.

The objective was to induce Building Integrated Photovoltaic (BIPV) technology for the long-term cost reduction and decrease of the greenhouse gas (GHG) emissions via its integration within the building design. This was along with the development of the sustainable market for BIPV that would generate widespread application. Moreover, this project was supposed to establish market development and set targets for the follow-up in the 10th Malaysian Plan (MP). The BIPV technology and enhancement of the national capacities on three major areas included (i) education and policy, (ii) technical skill and market implementation, and (iii) technology development support. It is expected over the lifetime of the BIPV project, that it will avoid 65.1 kt of CO2 emissions from primarily the power sector, contributing towards the objectives of the national energy policy [34]. The main components of the MBIPV project were to ensure (a) Services, awareness and a capacity-building program, (b) Market enhancement and infrastructure development, (c) Policies and a financing mechanism, and (d) Industry development and technology localization. Moreover, the target was to increase the BIPV capacity to 330% and have a reduction of the BIPV unit cost by 20%, both against the baseline [36]. Besides that, the BIPV plan was to grow its capacity by 30% annually with an average cost reduction of 30% from the year 2010–2020. MBIPV technology is significantly contributing to the potential renewable energy in urban regions where the bulk of Malaysia's energy is consumed. This project has offered synergy to various demand side management and energy efficiency programs; thus, recognizing the long-term potential of solar energy specifically in buildings. Technically, BIPV is able to generate 11GWp of electricity depending on the available roof spaces of residential and commercial buildings in Malaysia. This potential capability would produce 12,000 GWh of peak electricity, which could curtail 20% of the current electricity demand of Malaysia [35].

SURIA 1000 is another of Malaysia's national BIPV programs targeting the residential and commercial sectors, which will develop a new market. The Government of Malaysia (GoM) with the support of the United Nations Development Program (UNDP), global environmental facility (GEF), Suruhanjaya Tenaga and the private sector, funds the project. The project will provide direct opportunities to the public and industry to be involved in renewable energy and environmental protection initiatives. It targets at least 1,000 kWp of building integrated photovoltaic (BIPV) installations in residential and commercial buildings. These allow buildings to generate their own electricity from solar energy and effectively reduce reliance on conventional electricity from the utilities. Thus, the project will facilitate the creation of a sustainable BIPV market upon the completion of the program [35].

The Solar Water Heating (SWH) System is the ultimate solution, fulfilling the energy needs for hot water and space heating that requires a significant proportion of the building's energy consumption. Thus, combining the latest technology and sustainable design will provide a system that caters to the needs of the hot water requirements in the buildings. The SWH system is designed to fit naturally onto building rooftops as the collector tank that can be installed both above and under the roof; thus, giving a choice to have a trendy roof design. Moreover, it has been conceptualized to create a smooth integration between the functional and aesthetic parts of your roof. There are several advantages of SWH systems for buildings including the minimization of electricity use by just utilizing the natural resource of the sun. It provides the comfort of a warm shower during rainy days or cold mornings and eliminates the potential of electrical hazards. Hence, minimizing the impact on the environment through the efficient

and environmentally friendly use of energy.

The renewable wind energy conversion in Malaysia is a serious consideration by the government. Considering that the tropical weather of Malaysia is normally influenced with monsoon climate conditions due to its coordinates along latitude and longitude, the tropical climate throughout the year gives hot summers with light winds. However, the potential for wind energy generation in Malaysia depends on the availability of the wind resource that varies with location. The utmost potential is in east peninsular Malaysia with an annual vector resultant wind speed of 4.1 m/s [37]. This wind potential varies with location. Therefore, for buildings integrated with wind turbines, it must require a detailed study of on-site wind potential for estimating its performance. Besides that, it is highly recommended for wind energy systems in commercial tourist resorts and hotels or nearby shore locality buildings to be studied. Wind energy is considered as a green power technology with minor impacts on the environment. Therefore, funding for research and development in this field of renewable energy should be allocated with the objectives of solving fundamental problems and product development.

Buildings in Malaysia are yet heavily dependent on utility supply systems. The implementation of various renewable energy policies and programs in buildings by the Government of Malaysia (GoM) has increased the awareness of the sustainable energy system. Despite the effort for renewable energy options in buildings, the Government of Malaysia (GoM) needs to promote the maximum of its potentials. The Malaysian Plans also support the utilization of renewable energies and alternative energies in the generation mix, but unfortunately, the penetration and acceptability from the society is quite unsupportive due to the lack of awareness of long term benefits of these technologies. However, there is a gradual increase of awareness campaigns for installation of various renewable technologies that ultimately motivates the consumers for their interests in these technologies and particularly cost savings.

5. Discussion and viewpoints

The unprecedented transitions in the urban landscape have been experienced in Malaysia since half a century. The iconic PETRONAS Twin Towers, Kuala Lumpur international airport and township in Putrajaya are the landmark symbols for its development in the international arena. Besides, fast and sustained economic growth and determination for the sustainable development within the country boosts various sectors to take charge. In context to that sustainable practice in the built environment has huge potential for advanced developments and transitions have been observed.

5.1. Rationale impact of green buildings

In Malaysia, so far the directed efforts have been initiated towards sustainable building industry. The promising factors making possible building sector sustainability includes rating tool, transforming generous ownership from the stakeholders, enhanced knowledge and awareness dissemination campaigns among public, Government of Malaysia (GoM) interests and sustenance, support from the local manufacturers and suppliers and competitive market based approach. However, the unpromising factors include public interests and demands, status quo in rules and regulations, developers, population, project cost and construction players' awareness.

The iconic green buildings so far did not attract much of the consumers towards the adaptation of the technology, due to the purposeful awareness among the building consumers and the capital investment for their retrofitting. The impact can be quantifiable in terms of human health, living quality and climate change. Besides, higher costs for buying efficient equipment usually unpersuasive by the consumers. This is one of the significant barriers for application of energy regulations for buildings within the country as a result of meager funding opportunities that has lagged behind for technical expertise attainment. Thus, the crucial hindrance in production ability for energy efficient and cost-effective products and services along with their implementation, stipulation and compliance has been observed. If sudden change can be observed in the building industry, the country's most liability sector would turned out to be energy efficient and conserve huge amount of energy and costs.

Malaysia's impact on extensive development of infrastructure and buildings has been primarily on the environment. The building sector contributes towards domestic wealth, property investments and assets generation has grown with the exponential rise in population. Thus, the perception for green building industry has sought out holding various positive and negative views of the stakeholders. However, the effective ways have been under consideration, initiated through motivating young generation for keeping their environment green. The positive attitude have been developed and ultimately educating the effective system. In addition, campaigns have to be conducted about global climate challenges for building a society with mentally more environment friendly attitude.

It has been observed through the literature regarding the strategies adopted to promote green aspects in building sector includes; showcase energy efficient buildings, public awareness campaigns, incentives on less energy consumption, use of efficient appliances thus targeting general public and private sector with pulling strategy. However, bounding them with energy efficient practices, codes and other mandatory requirements lead them with push strategy. This also includes energy efficiency measures, smart and sustainable designs and use of renewable energy technologies. In addition, the Government of Malaysia (GoM) proposes their 5-year plans for up gradation and innovations that have been penetrated within the local market. These push and pull strategic forms leads to noticeable environmental benefits along with safeguard consumers from rise in energy prices, enhance comfort level, alleviate capital cost of ownership, enhance reliability and support added market value of the building.

Thus, in making green choices for Malaysia's building industry, the behavioral aspects are crucial in order to attain sustainability targets. So far these green practices are primarily government driven to mobilize resident's behavior for attaining long term socio-economic benefits. Moreover, green buildings have the potential for business transition at the corporate level. It also attracts the customers and building users, depending on their level of understanding and awareness regarding social, environmental and economy savings. The rapid transition can be expected once the complete life cycle assessments, awareness, significant benefits, and technological advancements accepted by the consumers, owners and tenants.

5.2. Behavioral aspect for green choice

The behavior among the users, technology and performance rating tool has been found inevitable to significantly improve building performance. Thus study regarding attitude of consumers towards building energy savings would offer considerable part in Malaysia's construction industry. Building sustainability throughout the delivery process and its lifecycle assessment in improving functional requirements would be associated with the roles and habits of the consumers. Therefore, vesting building users as benchmark for building performance evaluation helps enhance quality, sensitivity and simultaneously improve technical performance of this sector. Towards effective learning process for the needs of occupants and their changing attitudes would be sophisticated in attaining sustainability.

Individuals and organizational behavioral characteristics impede the energy regulation practices within buildings. The implementation of energy standard strategies and opportunities are usually overlooked and changing attitudes and behaviors of consumers are quite challenging. This bounded rationality among consumers argues about the human actions and decide partly on rationale basis such as tendency to

ignore small energy opportunities, organizational letdowns, theft and non-payment of bills, traditions, life styles, corruption, energy expertise transition, traditional knowledge and non-suitability of technology etc. Hence, these challenges disregard the voluntary agreements that are assumed to promote energy efficiency and conservation practices, thus, poses the adverse impact on energy regulation practices within the country. This in most countries a common barrier due to the political instability, corruption etc.

5.3. Socio-economic benefits

This is significant to consider the building energy performance can be observed as an owner or tenant energy consumer and a real-estate business developer. This in terms of short term incentives that are energy and cost savings, transaction price enhancements and interests in energy performance would allure to consumers for investment in the business. The owners in such a case may be fascinated with other reasons for attaining energy performance may include there, living standard, cost spending on energy and technology availability etc. They usually focus on efficiency due to rising prices for energy, thus, follows the market demand to remain competitive and up-to-date property stakes within the country instead of obsolete structures.

Besides, there are listed companies stakeholders that have to look for corporate social responsibility (CSR) that not only includes sustainability and environmental aspects but energy conservation and efficiency as prime responsibility. In context to that Malaysian construction industry plan for the year 2005–2015 states the mandatory changes to drive the local construction market within the country [38]. Thus, an attempt to track sustainability for long terms and also ensure sustainable capabilities of the stakeholders has been proposed to enhance. It has been challenging for the building industry in Malaysia to make certain of financial affordability to the owners/tenants and businesses, employment prospects in the sector, benefit to the environment, profitable returns, competitiveness and maintenance of future generation needs. Moreover, the emphasis on the possibility for stakeholders and developers to alleviate expenditures, materials cost and increase future profits.

5.4. Corporate transitions of green buildings

The practice of developing structures and processes that are involved for entire resources efficiency of building's life cycle are characterized in green structures. These environment friendly structures buildings implicates favorable impacts on society and economy. Socially these building structures quality living and working efficiency of the consumers, whereas, the economically it saves life cycle costs to the owners and consumers. Besides, they can be leased or sold more rapidly due to their attributes offering the possibility of huge profits. The corporate transition involves social, environmental, political and economic viability of building envelopes as shown in Table 2.

Table 2
Corporate parameters and their characteristics for green buildings.

Sr. #	Corporate parameter	Characteristics
1	Economic	● Creation of green jobs ● Create foreign direct investments (FDIs) for export and manufacturing ● Conventional fuel price volatility ● Security provision for renewable energy investor ● Economic development drive ● Market growth for creation of stable conditions ● Simple, transparent policy structure helps encourage new start-ups and innovators
2	Political	● Demonstrate commitment to RE deployment ● Increase energy security and autonomy ● Promote a more decentralized and democratized form of ● electricity system ● Create mechanism for achieving RE and emissions reduction ● targets ● Increase the stakeholder base supporting RE policies
3	Social	● Impartial distribution of wealth ● Empowerment of citizens and communities ● Public support enhancement for renewable resource utilization through direct stake ● Enhanced disclosure to renewables ● Encourage activities of citizens and communities ● Climate and environment protection ● Landscape and cityscape must comprise of renewable energy
4	Environmental	● Carbon emission and pollution reductions ● Energy efficiency measures Encouragement ● Reduction on fossil fuel dependency

6. Prospective issues and challenges

The country has undergone over 50 years of fast growing industrialization, with 5–9% annual growth. It has a relatively high rate of economic growth, and a significant spurt in CO_2 emission due to its emerging economy. Tactlessly, the development process of the country has been quite unsustainable so far; thus, there is a need for a holistic sustainable approach. The building energy efficiency can play a vital role towards sustainable energy and alleviating the environmental impact. The Government of Malaysia (GoM) has already recognized the potential benefits and significance of building energy efficiency hence, striving for the effective measurements to ensure economic and environmental sustainability in connection with energy within the buildings sector.

In relation to that, Malaysia should strive to enhance and increase its determination towards attaining energy efficiency overall in energy conversion, transmission and utilization. In general, it seems that the Government of Malaysia (GoM) has a stronger focus on energy supply and its use in buildings; this is based on energy supply security, reliability and competitiveness in the industry. Although in the presence of various obstacles in securing building energy efficiency, such as the lack of incentives for promoting demand side management, awareness, inadequate measures to ensure quality services, fragmented and dispersed building energy programs, lack in legal and regulatory frameworks, standards of occupant's indoor comfort, there is a need for attention to this area. Besides that, inadequate research and development progress and more importantly the appropriate building integrated renewable energy options as well as their policy, market penetration, promotion and funding matters along with energy and resource efficiency, sustainable transport and waste management are paramount challenges and need to be stepped-up.

In order to cater to local prevailing climatic conditions, it would require a specific building envelope design [39]. Considering the aforementioned scenario of Malaysia, various other factors that affect the final energy demand in buildings are its shape, orientation, the ratio between the external building surface and building volume, window size etc. Thus, the benefits of refurbishing and creating new building designs should be evaluated for the entire life cycle analysis (LCA) from its construction, operation and demolition phases. Moreover, some focus should be made to establish standardized requirements for building assessment tools for the investigation, assessment and measurement of building sustainability. Efforts should be taken considering the standards like ASHRAE-55 [40] and EN15251 [41] in order to establish indoor environmental parameters, such as thermal, visual, humidity, air quality and air speed that aid building energy managers to allow environmental conditions acceptable to the

majority of the users.

Malaysia buildings and technologies are the point of discussions within the business community due to sustainability challenges. Along with this market competition and commercial pressure lean towards performance rating, that is what needed to push for sustainable practices. The real steps for change would be the businesses are encouraged to utilize resources and develop their own services and products. The number of opportunities is available such as large developers incorporate environmental considerations in their property projects; also public banks within the country initiated their own CSR program for sustainable offices. In similar manner businesses can certify their sustainability criteria whereas tenants can demand certain building standards. Even banks can lend their loan to ensure sustainable practices for large development projects that would be the policy criteria to meet the issues of sustainability.

The building energy policy needs to ensure the expansion of the scope of the Malaysian Standard MS1525 code for inclusion of new buildings, comfort related issues, water and waste management, and the renewable resource integration within the buildings. In addition, is the placement of certain incentives on the follow-up of the MS1525 ratings in buildings that can be given in the form of taxes and stamp duty exemptions.

Energy audits can play a significant role and it has been demonstrated that energy savings of about 10% or more can readily be available at low or no cost, just with best practices and reducing wastage in the buildings. Although, the Government of Malaysia (GoM) is auditing and retrofitting some of the buildings and complexes to be refurbished into energy efficient facilities and has shown approximately 20% reductions of energy with only the retrofitting strategy. This can be a kick-start activity for Government of Malaysia (GoM) and may be subjected to government buildings at their early stages.

7. Conclusion

Malaysia's rapid economic growth offers the energy and environmental challenges for sustainable developments in the present and future. The key in achieving balance between the economic growth, energy and environment that we use and live in is through sustainable developments. Building energy efficiency is a prominent sector that can help lessen the problems concerning the depletion of energy resources, and the deterioration of the environment. Broadly, it involves two sets of strategies to minimize the need of energy in buildings; that is through energy efficiency measures and integration of renewable energy technologies to meet the building energy demand in the country. This article has discussed up-to-date energy consumption in buildings and energy efficiency measures within the building sector. The policies and laws so far implemented for the sustainable developments have included energy efficiency and the potential of renewable energy resources in the Malaysia's industry. The state-of-the-art designs of buildings have been proposed in the country as landmarks; thus, playing the prominent role of energy efficiency programs. The Malaysia's building industry heading towards the comprehensive attainment of green development in the country with various potential impacts so far. The cause by maturing its policy plans thus transforming its framework from government regulated to self-regulated industry.

i) Devised policy mechanisms for energy security, efficiency and environment challenges to be tackled.
ii) Certification of green buildings to motivate consumers through energy efficiency
iii) Provision of incentives for conserving and savings.
iv) Utilization of renewable and alternative energies in the generation mix within building sector.
v) Public awareness for building energy wastage and its methods to tackle.
vi) Educating young generation for efficiency and conservation following campaigns.
vii) Consumer's behavior is changing at slow pace, but so far effective within the sector.
viii) Developing the real-estate market for energy efficient buildings.
ix) Competitive environment has been developed within the technology market turning consumers to think about their energy costs.
x) Promote suitable financial instruments such as tax relief, feed in tariff mechanism, capital grants in order to offer financial rewards to all stakeholders.
xi) Sustainability services would have wealth opportunities for the growth of social, economic and environmental business perception within the country.

This also considers the prospective issues and challenges faced by the building industry with their potential impact to-date. Moreover, there is further potential of research to be conducted in the building sector for the proper life cycle analysis, policy development and most importantly the methodologies for providing awareness to the building users in the country.

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