

Energy Transformation for Sustainable Future: Issues and Challenges for Malaysian Micro, Small and Medium Enterprises

Ahmad Saiful Azlin Puteh Salin, Norliana Omar, Siti Marlia Shamsudin, Suryani Abdul Raman

Universiti Teknologi MARA, Malaysia

DOI: <https://doi.org/10.47772/IJRISS.2026.100700092>

Received: 09 July 2026; Accepted: 14 July 2026; Published: 25 July 2026

ABSTRACT

The effort of transition to more environmentally friendly energy is required recently due to awareness on severe climate change, environmental damage, and to ensure a long-term environmental, economic and social sustainability. In Malaysia, Micro, Small and Medium Enterprises (MSMEs) type of business are importance in supporting and accelerating the national economic development. This type of business make up a large part of the country's human workforce and contributed to more than 90 percent on the gross domestic product (GDP). Unfortunately, MSMEs have many reasons and experience several challenges to adopt energy transformation practices. Thus, the aim of the study is to explore the challenges and barriers faced by MSMEs in adopting sustainable energy solutions. A review from literature finds that among of these problems include high initial investment costs of renewable energy technologies, insufficient government support, lack of skilled workforce and poor knowledge on energy efficiency measures. The study also wishes to examine the role of policy, frameworks, financial incentives and capacity building in assisting MSMEs to transform their energy efficiency. This research also intend to assess the current state of energy use among Malaysian MSMEs and understand their needs to provide recommendations to overcome these obstacles. Implementation of renewable energy and elevation of energy-efficient practices by Malaysian MSMEs can contribute significantly to carbon emissions reduction. This will lead to a more sustainable low-carbon economy and hence achievement of Malaysian Net Zero target by 2030. Besides, stakeholder collaboration such as government agencies, industry players, regulatory bodies and financial institutions, are also critical in expediting a impactful energy transformation for small business in Malaysia.

Keywords: energy transformation, sustainability, SDGs, climate change, MSMEs

INTRODUCTION

Micro, Small and Medium Enterprises (MSMEs) are the fundamental support system of economies globally, stimulating innovation, generating employment opportunities, and fostering economic expansion. As worldwide worries about climate change escalate, the urgent need to shift from fossil fuels to renewable energy sources has become a fundamental principle of sustainable development. MSMEs are also the crucial contributors to the Malaysian economy. Empowering communities like MSMEs to engage with the energy transformation is vital to meet climate change mitigation and sustainable development goals. Communities have a key role to play in the energy transformation, through the uptake of new technologies and changing how they engage with energy (Coy et al., 2021). They account for more over 60 percent of the nation's gross domestic product (GDP) and provide employment to over 60 percent of the labour force. Given the vital role that MSMEs play in global economies, their shift from fossil fuels to clean energy sources has substantial potential for both environmental and economic advantages.

However, MSMEs also contribute significantly to the nation's energy usage. The primary energy source for Malaysian country is fossil fuels and coals for electricity. In 2022, Malaysia was ranked 28th worldwide in terms of its energy oil consumption (Aziz et al., 2024). This phenomenon can be attributed to the affordability of fossil fuels and the presence of infrastructure to facilitate their utilisation. Nevertheless, the utilisation of fossil fuels by MSMEs has several adverse environmental and economic consequences.

Greenhouse gases emitted into the atmosphere by the combustion of fossil fuels contribute to climate change. The Malaysian economy is already being adversely affected by climate change, characterised by increased frequency and intensity of meteorological phenomena, inland sea level rise, and alterations in agricultural productivity. The combustion of fossil fuels also exacerbates air pollution. Adverse health effects of air pollution include respiratory disorders, cardiovascular illness, and malignancy. Furthermore, it can result in untimely mortality.

Therefore, it is crucial for MSMEs in Malaysia to undertake energy optimisation. Essentially, energy transformation refers to the conversion of energy from one form to another. Energy in physics refers to the amount of energy that enables the execution of work or movement, such as lifting an item, or results in the generation of heat. In addition to undergoing conversion, energy, as per the principle of conservation of energy, can be transferred to another place or object, but it is incapable of being generated or reduced. Various forms of energy conversion processes take place in our surroundings, including the conversion of mechanical energy into electrical energy (generators), chemical energy into electrical energy (batteries), light energy into electrical energy (solar panels), heat energy into electrical energy (fire or a steam engine), and gravitational potential energy into kinetic energy (hydroelectric power plants).

The process of energy transformation is a fundamental aspect of our contemporary society. It enables us to generate electricity for our residences, commercial spaces, and transportation infrastructure. Regrettably, the present global society is excessively reliant on fossil fuels, which have served as the predominant energy source for millennia. An inherent drawback of this energy is its limited availability, which is exacerbating the issue of climate change. Consequently, there is an increasing trend to shift from fossil fuels to renewable energy sources. Gielen et al. (2019) suggest that renewable energy can supply two-thirds of the total global energy demand, and contribute to the bulk of the greenhouse gas emissions reduction. In Malaysian context, renewable energy policy transition successfully contributed up to 0.16 percent in carbon emission reduction of environmental impacts from 2012 to 2018 (Chachuli et al., 2021). Another study by Phuang (2022) documented that large scale solar projects shows 77 percent less environmental burden than palm biodiesel.

For millennia, the burning of fossil fuels, including coal, oil, and natural gas, has been the fundamental source of worldwide energy provision. Nevertheless, the adverse environmental consequences of using fossil fuels, such as the release of greenhouse gases and the contamination of the air, have led to a fundamental change in perspectives towards more environmentally friendly options.

Although energy costs are a substantial financial burden for MSMEs, adopting renewable energy sources can enable MSMEs to decrease their energy expenses and enhance their financial performance. There exist several renewable energy sources available for MSMEs, such as solar, wind, and hydro electricity. Renewable sources are characterised by their lack of greenhouse gas emissions and air pollution. They are also becoming more cost-effective, making them a feasible choice for MSMEs.

Unfortunately, the energy transformation by MSMEs is under research and does not get proper attention from the government and regulatory authority. No guidelines and policy that produce by the government specifically on energy transformation for MSMEs. Thus, the purpose of this paper is to discuss the benefits of energy transformation by MSMEs, and to recommend the effort that can take by policy makers, practitioners and MSMEs itself to overcome the obstacles in embarking the transformation effort.

LITERATURE REVIEW

Green Energy Practices

Clean energy sources are defined as technologies that do not generate any greenhouse gas emissions. The

renewable energy sources encompass solar, wind, hydro, geothermal, and nuclear power resources. Renewable sources are characterised by their perpetual availability. Furthermore, they typically exhibit higher efficiency compared to fossil fuels, resulting in reduced pollutant emissions per unit of energy produced. Recent technological developments are continuously enhancing our capacity to exploit and control energy conversions.

Investigation of more effective and environmentally friendly energy conversion techniques is essential for tackling worldwide energy issues and reducing detrimental effects on the environment.

The United States has a lengthy historical record of dependence on fossil fuels as a source of energy. However there has been a growing trend in recent years to move toward sustainable energy sources. This trend is being driven by factors such as the need to fight climate change, rising costs of fossil fuels and the availability of clean energy technologies. The share of the nation's electrical generation from renewable energy sources increased year by year while solar and wind have gotten a lot cheaper in recent years and are now more economically competitive than fossil fuels. Governments at all levels are also setting ambitious targets for greenhouse gas emission reductions.

The United Kingdom is now in the midst of a transition from fossil fuels to clean energy. Back in 2000, only 15 % of the country's electrical generation was from renewable energy sources. Today, it's increased to 43 %. The UK's commitment to tackling climate change and reducing carbon emissions has led to a major shift in the country's energy sector. Shifting from a fossil fuel paradigm to a low carbon, sustainable energy system has become a fundamental principle of the nation's environmental and economic strategies. The policy landscape in the UK is crucial for the transition, not least through the introduction of the Climate Change Act (2008). The law set ambitious targets for carbon reduction and a legal framework for climate action.

Examples of practical energy transformation that can be implemented by MSMEs

There are several ways how MSMEs can participate in real energy transformation. The organisation can choose to upgrade their equipment to energy efficient based technology. This is accomplished by changing obsolete and inefficient equipment like lighting (changing to LED), heating and cooling systems, which can make a big difference to energy efficiency. A small manufacturing firm, for example, could replace old motors with high-efficiency motors, which would reduce total electricity use.

MSMEs with roof space can consider solar panels as a good solution. A small retail business, say, can install photovoltaic panels on its roof and offset a large percentage of its electricity needs. MSMEs can adopt solar power as a practical and green way to reduce their electricity bills and carbon emissions. This is particularly beneficial to companies that have a lot of roof space such as retail stores, warehouses, manufacturing plants or office condominiums. Solar energy is a cost-effective alternative because businesses can lock in energy rates and hedge against future energy price increases. The initial costs are recovered through lower electricity bills, usually within 5 to 10 years for a total cost payback depending on variables such as regional solar incentives and electricity rates.

In regions or geographic location characterised by abundant wind resources, small wind turbines can be a feasible alternative for the development of wind power. An agricultural MSMEs could employ a compact wind turbine to provide energy for its activities. The utilisation of wind energy is a viable and economically viable alternative to diminish reliance on fossil fuels for enterprises, particularly those situated in rural or semi-rural areas such as farms. Wind turbines produce electricity whenever wind speeds reach a certain threshold, resulting in significant cost reductions on electricity expenses, particularly in areas with strong winds where turbines demonstrate high efficiency throughout the majority of the year. Notably, in certain areas, MSMEs equipped with wind turbines have the opportunity to sell surplus electricity to the power grid by means of feed-in tariffs or net metering schemes. This can generate a supplementary source of income, therefore improving the financial feasibility of the wind turbine investment.

Rose (2014) found that bioenergy has a high potential future energy transformation and hence, climate change management. Hence, MSMEs that engaged in food processing or agriculture can utilise organic waste to produce biogas or biomass energy, therefore transforming waste into a highly valued energy asset. Organic resources, including agricultural wastes, food processing waste, animal manure, and other organic matter, serve as the source of biogas and biomass energy. These energy sources use natural processes, such as anaerobic digestion and combustion, to transform organic waste into economically viable energy forms—biogas, predominantly composed of methane, and biomass energy in the form of heat or electricity. MSMEs engaged in food processing and agricultural can produce significant quantities of organic waste. In the context of a circular economy, biogas

and biomass systems offer a productive application for this waste, therefore facilitating the recycling of waste into valuable commodities. In addition, the procedure decreases the amount of waste disposed in landfills, therefore tackling waste management issues and mitigating environmental consequences.

A viable option for MSMEs who lack the financial means to invest in on-site renewable energy production is to acquire green energy from the grid or through power purchase agreements (PPAs) with renewable energy suppliers. Numerous utility companies provide green energy tariffs, enabling MSMEs to acquire electricity produced from renewable sources including wind, solar, hydro, or biomass. Although these tariffs sometimes incur a little higher cost compared to ordinary rates, they offer MSMEs the guarantee that their energy usage is offset by the utility's acquisition of renewable energy certificates (RECs) or other instruments that confirm the renewable source of the electricity. Independent purchase of RECs is also possible for MSMEs. RECs serve as evidence that a single megawatt-hour (MWh) of electricity was produced from a renewable energy source and supplied to the power system. By acquiring RECs, MSMEs can compensate for their electricity consumption with renewable energy, even if their primary electricity source consists of fossil fuels. MSMEs in some areas have the option to engage in green supply agreements with energy providers, who pledge to get a predetermined proportion of the energy from renewable sources. The contracts can be customised to suits the energy consumption profile and sustainability objectives of the MSMEs. The many approaches to acquiring green energy enable MSMEs to contribute to the growth of renewable energy and decrease their carbon emissions without requiring substantial initial investment.

Benefits And Advantages of Transforming to Cleaner Energy

Energy transformation offers numerous advantages. Renewable energy sources are devoid of greenhouse gas emissions, which are the main driver of climate change. Implementing this measure can effectively alleviate the impacts of climate change, including the escalation of sea levels, intensification of severe weather phenomena, and alterations in agricultural productivity. Furthermore, the combustion of fossil fuels is the main origin of carbon dioxide emissions, which significantly contribute to the phenomenon of global warming. By transitioning to renewable energy sources, greenhouse gas emissions are reduced, therefore alleviating the effects of climate change. Furthermore, clean energy sources are devoid of toxins that lead to air pollution, such as smog and particle matter. This has the potential to enhance air quality and mitigate the likelihood of respiratory ailments. At present, the combustion of fossil fuels emits pollutants that are detrimental to both human health and ecosystems. The adoption of cleaner energy sources helps to alleviate health problems associated with air pollution.

Moving to green energy also will increase the energy security. Clean energy sources are domestic resources that are not subject to price volatility or supply disruptions from foreign countries. This can help to reduce our reliance on imported oil and gas and make our energy supply more secure. This is particularly truth especially during the crisis when every country is safeguarding their own resources rather than exporting the other countries. With the geopolitical tension like war between Russia and Ukraine, trade war between US and China, energy security is become more important than ever. Dependence on fossil fuel imports can expose nations to geopolitical risks. Localized clean energy sources enhance energy security.

MSMEs that embrace sustainable energy sources have the potential to enhance their brand image and appeal to a larger client base. This is due to the growing demand from customers for enterprises that demonstrate a strong dedication to sustainability. MSMEs that aim to reduce their carbon emissions and help address climate change are being more acknowledged for their contribution to environmental stewardship strategies. The implementation of clean energy is in line with worldwide endeavours to alleviate climate change by decreasing greenhouse gas emissions and minimising ecological consequences.

Workers operating in a clean energy setting generally exhibit higher levels of productivity and engagement as a result of heightened job satisfaction and a defined sense of purpose. If workers understand that their jobs are contributing to the environment then they are more likely to develop a personal connection to the principles of the company and this can create a more positive and inspiring work environment. This sense of purpose can translate into higher employee engagement, with employees viewing themselves as contributing to a meaningful mission to tackle pressing global issues like climate change and resource preservation. Also, a company that

values renewable energy highly usually shows a stronger commitment to innovation, health, and corporate responsibility, which can lead to increased staff morale and general involvement. Thus workers in such environments are not only more satisfied but also more proactive, cooperative and motivated to execute their roles.

Technological progress in clean energy is a powerful driver of innovation, job creation, and economic growth, and thus contributes significantly to a more sustainable future. Chachuli (2021) observed that the solar PV industry in Malaysia could create up to seven times more jobs with the deployment of renewable energy.

To enable the transition to sustainable energy, it is necessary to develop and deploy technologies such as solar, wind, battery storage, and energy efficiency solutions. These technologies need a skilled workforce in various sectors like manufacturing, installation, operation and maintenance. The need for increased work opportunities in those areas increases with the demand for clean energy, helping to develop a wide range of job opportunities that can contribute to economic resilience and community development.

Energy expenses account for a substantial portion of the costs incurred by MSMEs. Implementing sustainable energy sources can enable MSMEs to decrease their energy expenses and enhance their financial performance. Furthermore, certain clean energy technologies, including as solar panels and energy-efficient lighting and heating systems, have the potential to provide financial benefits and decrease total operating costs in the long run. Ongoing cost reductions in sustainable energy technologies enhance their affordability for MSMEs.

Deploying renewable energy sources can improve a company's reputation and appeal to environmentally aware clientele. The market difference will provide a significant advantage to MSMEs as the use of clean energy can distinguish them from their competitors in an age of conscientious consumerism. Corporate entities that prioritise sustainability tend to appeal to environmentally aware consumers who favour products and services with reduced environmental impact.

Reliance on fossil fuels makes small and medium-sized enterprises vulnerable to market instability and interruptions in the supply chain. Deploying clean energy sources improves energy security and resilience by using renewable resources that are less vulnerable to market volatility. Enhanced energy security and stability are achieved by decreasing reliance on volatile fossil fuel prices.

Problems and Challenges

Malaysia is a fast growing country at an intersection in its energy trajectory. Malaysia's growing economy has historically depended on fossil fuels for its energy needs. However, increasing concerns over environmental degradation, energy security and global climate commitments are forcing the country to look at greener energy landscape.

The initial expense of clean energy technologies can be a major barrier, particularly for companies operating on tight budgets. The transition from fossil fuel-based systems to clean energy options such as solar panels, wind turbines, or battery storage may be prohibitively expensive initially to purchase and install new equipment, and may need upgrades to existing infrastructure, such as alterations to energy grids, to facilitate renewable energy inputs.

These types of capital intensive investments can be daunting for smaller businesses or those operating on a shoestring budget, as they frequently lack the financial flexibility to absorb the large upfront costs.

Also, the long payback periods of clean energy projects could deter businesses from switching, even with the prospect of long-term savings and environmental benefits. As such, high initial costs of clean energy technologies may slow the adoption rate, especially in sectors or regions with limited access to financial incentives, subsidies or financing options to support the transition.

MSMEs can face a major barrier in adopting clean energy technologies due to lack of technical expertise. Many MSMEs lack in-house knowledge or experience to assess, install and maintain clean energy systems such as

solar panels, wind turbines or energy storage solutions. This knowledge gap can foster uncertainty and a hesitancy to invest in clean energy, as companies may feel unprepared to handle the complex nature of these technologies, from understanding the technical requirements to navigating the installation process and carrying out ongoing maintenance.

Inadequate technical support for MSMEs can result in difficulties in optimising the performance of the system, troubleshooting problems or incorporating clean energy solutions into current operations. Decision-making becomes harder and the perception of risk for clean energy investments rises because of this barrier. This points out that a deficiency of technical expertise can be an obstacle to cleaner energy sources that could bring cost benefits and reduce environmental impacts.

Navigating policies, incentives and regulations in the clean energy landscape is challenging due to current regulatory complexity. The complexity of regulations, incentives and permits associated with clean energy adoption can be overwhelming for MSMEs with limited resources. Also, clear policies and regulations are essential to incentivise the transition and level the playing field for clean energy sources.

MSMEs often face severe resource constraints in the transition to clean energy, both human and financial resources. Implementing clean energy solutions can demand significant investments in time, expertise, and capital that may be out of reach for smaller businesses. MSMEs may not have the resources to assess, implement and maintain new technologies, especially when their staff is already overburdened with current operations.

Also, there may be resistance to the transition to clean energy from traditional fossil fuel industries concerned about potential job losses and economic shifts away from established practices. This resistance can also pose additional challenges for MSMEs, particularly where they are part of a supply chain or industry that is heavily reliant on fossil fuels. Limited resources and external resistance can combine to slow the adoption of clean energy technologies, and thus impede the overall transition to more environmentally friendly methods.

Recommended Strategies for Successful Energy Transformation

MSMEs have available several measures and approaches to shift from fossil fuels to sustainable energy sources. Among these activities is performing an energy audit to pinpoint possibilities for decreasing energy usage. Furthermore, the firm can pinpoint areas of energy wastage and inefficiency, leading to a strategic plan for implementing sustainable energy technology that deliver the greatest return on investment.

MSMEs also have the option to allocate funds towards energy-efficient equipment and appliances, such as the installation of solar panels or wind turbines, and therefore produce their own electricity. Furthermore, the firm has the option to enrol in a green rate offered by its electrical retailer. Corporate entities with substantial cash reserves have the option to purchase carbon offsets as a means of offsetting their residual emissions.

MSMEs can engage in collaboration and establish partnerships with renewable energy providers, suppliers, and industry networks to access specialised knowledge and resources. Strategic alliances with sustainable energy solution providers, suppliers, and industry networks can provide MSMEs with access to specialised knowledge, resources, and possible agreements to share costs. The government can bolster these efforts by facilitating the networking platforms. MSMEs can gain advantages by actively participating in networking events, workshops, and industry conferences facilitated by the government, which enable them to connect with clean energy practitioners, peers, and specialists. Non-governmental organisations, industry groups, and local energy agencies can provide specialised knowledge, direction, and resources to help effectively manage the intricacies of implementing renewable energy.

MSMEs can take advantage of a variety of government grants, subsidies, tax benefits and specialised financing schemes to ease the financial burden of investing in clean energy technologies (Salin et al., 2026). For example, Nepal et al. (2024) documented evidence of favourable impact of green financing on low carbon energy transformation in developing countries. Government grants provide non-repayable cash to help fund renewable energy projects, while subsidies reduce the cost of such investments directly. Tax incentives, in the form of credits and deductions, lower the overall tax burden and therefore serve as an effective offset to some of the cost

of investment. Moreover, tailored financing schemes offer incentive to lend to small & MSMEs with loan terms or lease options which improves the availability of cash to small & MSMEs. For instance, the Malaysian government had introduced green technology financing scheme to encourage and enlarge utilisation of green technology and supply among the business players (Vaka et al., 2020). These funding sources can go a long way to help bring down upfront costs and speed up the deployment of sustainable energy technology.

MSMEs should also include training and education of its staff on sustainable energy systems in its capacity building efforts to increase awareness and operational efficiency. Training and educating staff on clean energy systems and practices improves their understanding, allows them to perform effectively and fosters a culture of sustainability.

CONCLUSION

The transition to clean energy is an advantageous opportunity for MSMEs. It's good for the environment, good for the employees and good for the bottom line. MSMEs adopting clean energy sources are preparing themselves for the future. Transitioning to clean energy is a challenge, but it is a challenge that MSMEs can overcome. With the right government support and the right investment, MSMEs can be leading the transition to a clean energy future.

The transition from fossil fuels to clean energy sources is not only an environmental imperative but also a strategic opportunity for MSMEs. It is also a significant step for MSMEs to align their activities with environmental sustainability, economic viability and long term growth. MSMEs may capitalise on the resources, partnerships and policy incentives at their disposal to position themselves as sustainability leaders, drive positive change and reduce their carbon footprint, helping to build a cleaner, more prosperous future. As the clean energy revolution takes hold, MSMEs will not only ensure their own survival, but will also be major players in building a greener global economy.

ACKNOWLEDGEMENT

This research was supported by the Ministry of Higher Education through the Fundamental Research Grant Scheme (Grant No. FRGS/1/2024/SS01/UITM/02/8) and Universiti Teknologi MARA.

REFERENCES

1. Abd Aziz, A. J., Baharuddin, N. A., Khalid, R. M., & Kamarudin, S. K. (2024). Review of the policies and development programs for renewable energy in Malaysia: Progress, achievements and challenges. *Energy Exploration & Exploitation*, 42(4), 1472-1501.
2. Chachuli, F. S. M., Ludin, N. A., Jedi, M. A. M., & Hamid, N. H. (2021). Transition of renewable energy policies in Malaysia: Benchmarking with data envelopment analysis. *Renewable and Sustainable Energy Reviews*, 150, 111456.
3. Coy, D., Malekpour, S., Saeri, A. K., & Dargaville, R. (2021). Rethinking community empowerment in the energy transformation: A critical review of the definitions, drivers and outcomes. *Energy Research & Social Science*, 72, 101871.
4. Gielen, D., Boshell, F., Saygin, D., Bazilian, M. D., Wagner, N., & Gorini, R. (2019). The role of renewable energy in the global energy transformation. *Energy Strategy Reviews*, 24, 38–50.
5. Nepal, R., Liu, Y., Dong, K., & Jamasb, T. (2024). Green financing, energy transformation, and the moderating effect of digital economy in developing countries. *Environmental and Resource Economics*, 87(12), 3357-3386.
6. Phuang, Z. X., Lin, Z., Liew, P. Y., Hanafiah, M. M., & Woon, K. S. (2022). The dilemma in energy transition in Malaysia: A comparative life cycle assessment of large scale solar and biodiesel production from palm oil. *Journal of Cleaner Production*, 350, 131475.
7. Rose, S. K., Kriegler, E., Bibas, R., Calvin, K., Popp, A., van Vuuren, D. P., & Weyant, J. (2014). Bioenergy in energy transformation and climate management. *Climatic Change*, 123(3), 477-493.

-
8. Salin, A. S. A. P., Ghuslan, M. I., Mahmud, N. M., Zawawi, M. M., Che Hasan, H., Halid, S., Abd. Wahab, R., & Abdullah, W. R. W. (2026). The impact of green tax incentives on ESG performance of SMEs. *Advanced International Journal of Business Entrepreneurship and SMEs*, 8(28), 137-149
 9. Vaka, M., Walvekar, R., Rasheed, A. K., & Khalid, M. (2020). A review on Malaysia's solar energy pathway towards carbon-neutral Malaysia beyond Covid'19 pandemic. *Journal of Cleaner Production*, 273, 122834.