Towards A Greener Planet: International Legal Mechanisms for Sustainable Energy Technologies

[1]Nurul Iman Aleeya Binti Azmi, [2]Nasha Nazira Binti Nazri, [3]Nurul Balqis Binti Mohd Hassan, [4]Mohd Haris Bin Abdul Rani, [5]Farah Adibah Binti Zulkifli*, [6]Nazihah Binti Zulkifli

[1,2,3]Research Associate, Faculty of Law, University Teknologi Mara (UiTM), Malaysia

[4]Senior Lecturer, Faculty of Law, University Teknologi Mara (UiTM), Malaysia

[5]Lecturer, Faculty of Law, University Teknologi Mara (UiTM), Malaysia

[6]Messrs. Adi Nazihah Farah

***Corresponding Author**

DOI: https://doi.org/10.47772/IJRISS.2026.101000620

Received: 25 October 2026; Accepted: 30 October 2026; Published: 12 November 2026

ABSTRACT

Given the fact that there has been a sudden shift in the climate, there is an urge for the world to adopt sustainable energy practices. This article aims to examine the role of the international legal mechanism in promoting the usage of sustainable energy and its widespread implementation. Aside from that, this article also analyzes some significant agreements, such as the Paris Agreement and other relevant multilateral agreements that hold the purpose to promote the use of energy that can meet current energy needs without jeopardizing future resources and energy supplies. By examining the effectiveness of the international legal mechanisms in achieving mutual understanding between countries, this article demonstrates the potential role of international law in this holistic global issue of energy sustainability. Further, it identifies the spectrum of challenges within the current legal framework in fostering energy sustainability, as well as suggesting reformation to enhance their effectiveness. This study applies a library-based doctrinal approach which focuses on analyzing primary and secondary literature including the Paris Agreement, the Sustainable Development Goals from the United Nations and ASEAN frameworks, such as the ASEAN Plan of Action for Energy Cooperation (APAEC). The results show that there is a significant relationship between international legal mechanisms and sustainable energy technologies, leading towards a desired greener world. These findings underscore the importance of international legal mechanisms in advancing sustainable energy technologies' practices. Ultimately, this article advocates for an international legal mechanism that not only supports the advancement of technology, but also ensures equitable access to sustainable energy resources, thereby contributing to a more sustainable and greener global future.

Keywords: Sustainable Energy Technologies; International Legal Mechanism; Climate Change; Paris Agreement; Energy Law; Environmental Law

INTRODUCTION

According to The World Energy Issue Monitor 2024, since COVID-19 is no longer a pandemic, its effect on the economy began to subside, and energy demand has increased (World Energy Council, 2024). The rapid development of the global population has led to an exponential increase in energy demand. Despite the fact that fossil fuel is not sustainable and may harm mother nature, it remains a primary source in the energy industry. It is a well-known fact that fossil fuel combustion releases harmful gasses and particles into the atmosphere, including carbon dioxide (CO2), a co-pollutant that is a primary cause of climate change (Perera, 2017). Hence, addressing environmental issues necessitates a shift to sustainable energy.

The significant issue that will be addressed through the development of sustainable energy technology is the

issue of depletion of resources. The shift towards sustainable energy aligns with the principle of prudent, rational, and sustainable use of natural resources (Heffron et al., 2018). The importance of fulfilling the current demand of energy while maintaining the energy for the following generations is included in this principle. Nonetheless, this principle advocates for a better energy efficiency while simultaneously saving the environment. Thus, renewable energy sources, which include solar, wind, hydropower, biomass, and hydrogen, are crucial to convert today's fossil fuels into a much more eco-friendly alternative with significantly low impact on the environment.

The development of sustainable energy technologies would contribute immensely to reduce the greenhouse gas emissions, preserve mother nature and conserve energy security. As these developments are being widely implemented, more significant economic benefits would emerge, for instance, leading to more job opportunities, encouraging technological innovation and prompt development of a robust energy infrastructure for a more sustainable future.

Over the years, sustainable energy technologies have faced several challenges in adopting this practice. It involves technical, financial, regulatory aspects that hinders their widespread implementation. For example, high-cost implications, resource availability whereby certain renewable energy sources like solar energy is more viable in areas with high sunlight exposure, complexity of the international legal mechanisms and other more significant challenges.

International law plays a vital role as well in maintaining sustainable energy worldwide as climate change and energy issues are daunting for every country in this world. Hence, it is important to address this issue properly through the international legal mechanisms. There are several international legal mechanisms that are binding and moving towards achieving sustainable energy which are the Paris Agreement, the Sustainable Development Goals from the United Nations and ASEAN frameworks, such as the ASEAN Plan of Action for Energy Cooperation (APAEC). International treaties, agreements, and regulations have been very crucial in ensuring that the standard is enhanced to develop technologies that help in fostering cooperation among nations around the world.

The United Nations Framework Convention on Climate Change (UNFCCC) has ratified the Paris Agreement, a legally binding agreement on climate change issues. According to the UNFCCC, the Paris Agreement seeks to keep global warming to 1.5°C and below 2°C (UNFCCC, 2015). Nonetheless, each participating nation is required to submit Nationally Determined Contributions (NDCs), which are revised every five years to maintain accountability and transparency. The involved nations must provide reports detailing their progress towards their NDCs and submit them to an international review.

Furthermore, Goal 7 of United Nations' Sustainable Development Goals (SDGs) emphasizes on the promotion of universal access to clean, affordable, reliable and sustainable energy (United Nations, 2015). To cater for an accessible energy transition for both developed and developing countries, the international mechanism plays a vital role in reducing energy poverty and guarantee equitable access to resources. Additionally, the Asean Plan of Action for Energy Cooperation (APAEC), is a legal framework that is aligned with the Paris Agreement, to prompt the implementation of sustainable energy development throughout Southeast Asia. Through its ASEAN Power Grid program, APAEC also promotes renewable energy projects in an effort to develop a more resilient and cooperative regional energy network (ASEAN Centre for Energy, 2020).

Nevertheless, a greener global future is what we aim for. It is to preserve our nature for the use of future generations. In achieving this, shifting towards sustainable energy technologies is one of the many alternatives. By shifting towards sustainable energy technologies, we can mitigate climate change, reduce the release of greenhouse gas emission, and achieve the objectives laid down in the Paris Agreement as well as preserving our world's limited resources for a long term. It is widely understood that climate change poses an imminent threat for us as it comes with several critical environmental issues such as rising temperature and sea levels, drought, famine and so on. Shifting towards sustainable energy technology promotes cleaner air, safer water for consumption, lower health risk, providing a better environment for all inhabitants to live in. Undeniably, embracing a greener global future is significant because it brings more positive impacts for us.

In addition to that, it is important to instill the principle of energy law, which emphasizes the wise, rational, and sustainable use of natural resources. The Paris Agreement (2015) has also utilised the principle which contributes in developing a better use of renewable energy, energy efficiency and the evolution of the green economies. It should be highlighted that the principle assisted in the regulation of the non-renewable resources to maintain the sustainability of the energy. Likewise, by applying this principle, the shared resources for future generations, encouraging intergenerational equality and international cooperation can be protected in addressing any relevant issues within it.

Therefore, conducting a comprehensive analysis of the relationship between international legal mechanisms and sustainable energy technologies is important to help us understand the substantial role of international mechanisms in promoting sustainable energy technologies. It aims to examine how international legal mechanisms can promote the use of sustainable energy technologies among the countries, achieving a greener global future. By analyzing current legal frameworks, agreements, regulations and policies, this journal seeks to offer insights on how international cooperation and legal structures can enhance the shift towards sustainable energy for the benefit of a greener and more sustainable world for the coming generations.

LITERATURE REVIEW

The impacts of fossil fuel usage and the importance of renewable energy

Literature suggests that the detrimental effects of fossil fuel usage is exacting a big toll on humanity and the environment (Ahmad et al., 2022). According to Wang and Azam, fossil fuel usage has contributed to significant carbon dioxide emissions, a greenhouse gas that leads to global warming (Wang & Azam, 2024). The harmful environmental impact includes air pollution, acid rain, and ecosystem degradation which accelerate to a range of health issues such as respiratory issues (Bilal et al., 2022). Moreover, natural resources scarcity shows that the over-reliance on limited fossil fuel resources demonstrates the long-term risks to economic and energy sustainability. Hence, literature reveals that in order to curb this issue, transitioning to renewable energy sources is crucial (Zakari & Khan, 2022). The renewable energy sources include solar, wind, hydropower, biomass, and hydrogen (Ukpanah, 2024).

A study by International Institute for Applied Systems Analysis (IIASA) researchers, simulated up to 2050, and one other published in Nature Climate Change, evaluated the impact of decreasing emissions on co-emitted air pollutants, which in turn benefits health (Gomez-Echeverri, 2018). The IIASA study demonstrates that strict climate mitigation strategies benefit air quality, human health, and ecosystems in Europe by lowering acidification exposure on forests and reducing eutrophication due to lower ammonia emissions from agriculture by 35%, 46%, and 63%, respectively (Gomez-Echeverri, 2018). Thus, the development towards sustainable energy is vital in addressing climate change. These renewable sources supply cleaner and replenishable energy solutions, mitigating the negative impacts of fossil fuels (Zakari & Khan, 2022). The usage of sustainable energy technologies is beneficial especially to reduce the greenhouse gas emissions and improve the energy security likewise it encourages the reduction of reliance on the limited natural energy resources (Ukpanah, 2024). Nonetheless, these alternatives assist in economic growth by offering job opportunities and advancing the development of the renewable energy infrastructure (ASEAN Centre for Energy, 2020).

Sustainable energy technologies

According to Pawar and Farooqui, renewable energy sources like sun, wind, and hydropower are sustainable and will not run out, in contrast to fossil fuels, which are limited resources that will eventually be depleted (Pawar & Farooqui, 2023). Therefore, investing in renewable energy technologies can result in a long term, dependable, and environmentally friendly energy source (Pawar & Farooqui, 2023).

Daut et al. (2012) indicate that wind turbines generate clean energy without the need for fuel transportation, which could pose a threat to the environment. Renewability, low pollution, and widespread distribution are the attributes of biomass energy (Gao, 2022). All plants, microbes, animals that consume plants and microorganisms, and their waste products are included. Crop waste, wood waste, animal manure, and crop waste are examples of representative biomass (Gao, 2022). Furthermore, there can be significant energy and cost savings using solar

energy technology that directly harnesses the sun's limitless potential to provide electricity, heat, and light (NREL, 2001).

International legal mechanism for sustainable energy technologies

Undoubtedly, the international legal framework plays an important role in promoting sustainable energy growth. Evidently, the United Nations Framework Convention on Climate Change (UNFCCC) has accepted the Paris Agreement, which served as a key pact in preventing climate change at the international level. At the regional level, the ASEAN Plan of Action for Energy Cooperation (APAEC) seeks to increase Southeast Asia's use of renewable energy sources and encourage energy efficiency. Both instruments are in line with SDG 7 of the Sustainable Development Goals (SDGs) of the UN which emphasised the need for clean and sustainable energy. Each of these international legal mechanisms is addressed further below.

The Paris Agreement

The Paris Agreement is a legally binding international agreement to address climate change that was created under the United Nations Framework Convention on Climate Change (UNFCCC). This deal is significant because it marks a turning point in the multinational climate change process. For the first time, a legally binding pact unites all countries to fight climate change and prepare for its consequences. UNFCCC (2015). Its principal goal is to keep "the increase in the global average temperature to well below 2°C above pre-industrial levels" and pursue initiatives "to limit the temperature increase to 1.5°C above pre-industrial levels." (UNFCCC, 2015).

The Paris Agreement seeks to mitigate the strict approach taken by its predecessor, the Kyoto Protocol. It took a bottom-up approach in climate change policy by allowing parties to nationally determine their contributions to address climate change, in contrast to Kyoto Protocol that took the top-down approach by prescribing emissions limitation target to countries. The Paris Agreement also represents a landmark treaty under international law even though not all of its provisions establish legal obligations Parties do not have an obligation to achieve their Nationally Determined Contributions (NDC), hence making the NDC not legally binding. In addition, unlike the Kyoto Protocol which sharply differentiate between the obligations of developed and developing countries, the Paris Agreement take a more nuanced approach by establishing the same basic procedural obligations for all parties, but allows countries to self-differentiate their substantive mitigation contributions through their NDCs. With respect to finance, it imposes financial obligations only on developed country parties, but encourages other parties to provide support voluntarily. And with respect to transparency, it establishes a common transparency framework but gives carefully defined flexibility to those developing countries that need it based on lack of capacity (Bodansky, *et. al,* 2021).

The approach taken by the Paris Agreement resulted in dual legal accountability; the procedural requirement for countries to prepare, submit and maintain NDCs every five years is strictly binding, while the substantive achievent of these NDCs is legally non-binding (Bodansky, 2016). The Paris Agreement also established the Green Climate Fund which provides financial assistance for the sustainable energy projects. The fund intends to close the financial gaps between the developed and developing countries in the sustainable energy projects. The Green Climate Fund serves an important function by implementing the principle of common but differentiated responsibilities by legally codifying the obligation of developed nations to provide support to developing countries and ensuring global cooperation without rigid state liability (UNFCCC, 2015)..The Paris Agreement encourage the countries to cooperate with each other and establish a clear approach to cultivate perseverance against the environmental impact of climate change (Zakari & Khan, 2022).

The ASEAN Plan of Action for Energy Cooperation (APAEC)

At the regional level, policy frameworks such as the non-binding ASEAN Plan of Action for Energy Cooperation (APAEC) are a form of cooperation between ASEAN countries to improve their resilience by transitioning the energy sources as well as encouraging sustainable practices worldwide to avoid scarcity of the current energy sources (ASEAN Centre for Energy, 2020). The ASEAN Power Grid (APG) is one of the crucial initiatives under APAEC designed to address the needs of the ASEAN region to embrace sustainable energy solutions amidst the global energy transition by facilitating cross-border power interconnections and promoting efficient

utilization of regional energy resources (Anugrah *et. al.,* 2026). However, since APAEC operates on a voluntary, consensus-driven model instead of a binding international legal mandates, successful implementation depends heavily on tackling institutional coordination issues e.g. harmonizing grid codes and resolving cross-border tariff structures among its members (Wong & Onn, 2022). Despite these institutional challenges, aligning regional strategies with broader global commitments such as the Paris Agreement and the United Nations Sustainable Development Goals provides the ASEAN countries with a legal framework to navigate rapid energy demand growth and long-term decarbonisation (ASEAN Centre for Energy, 2020).

United Nations Sustainable Development Goal 7 (SDG 7)

The United Nations General Assembly adopted 17 Sustainable Development Goals (SDGs) in 2015, including Sustainable Development Goal 7 (SDG 7), which aims to "ensure access to affordable, reliable, sustainable and modern energy for all." (United Nations, 2015). Unlike binding international treaties like the Paris Agreement, which imposes strict legal obligations and enforcement mechanisms under international law, the SDGs merely function as a non-binding policy framework, relying on voluntary state commitments, shared aspirations, and cooperative global governance through global reporting mechanisms and collective diplomatic pressure instead of judicial sanctions (Guiry, 2024). Nevertheless, the availability of energy is a crucial component of economic growth, poverty reduction, and public well-being. (United Nations, 2015). By 2030, this goal's five targets must be met alongside six tracking indicators (Ritchie*, et. al.* 2018). Three of the five goals are outcome goals i.e. doubling energy efficiency, increasing the proportion of renewable energy worldwide, and providing universal access to modern energy. The remaining two targets focus on implementation such as promoting clean energy research, technology and investments as well as expanding energy services for developing countries. In other words, these goals include improving access to affordable and reliable energy, as well as increasing the proportion of renewable energy in the global energy mix.

Hence, even though SDG 7 operates primarily as a soft-law instrument rather than a legally enforceable obligation, the UN 2030 Agenda highlights the importance of clean and sustainable energy through SDG 7 (United Nations, 2015). Applying SDG 7 targets and shifting away from fossil-fuel dependency toward renewable energy infrastructure is important in order to mitigate climate change, fostering long-term economic resilience, and alleviating energy poverty (Chipangamate & Nwaila, 2024).

Challenges faced by sustainable energy technologies

If the road to global environmental cooperation is long, the road to global energy cooperation is even longer. (Bruce, 2013). Notwithstanding the concerted efforts through the legal mechanisms, there are still challenges that have to be addressed as well (Chipangamate & Nwaila, 2024). Financial burden is one of the issues in transitioning to sustainable energy technologies. In developing countries, they incurred substantial debt burdens, limiting their ability to invest in the high cost of renewable energy infrastructure (Chipangamate & Nwaila, 2024). The high costs for developing and deploying the technology might be an issue for some countries hence a financial measure must be taken and the developing countries may seek for financial assistance from other countries. Additionally, some renewable energy sources including solar and wind mainly rely on the climatic condition which makes it a technical challenge of resource availability (Zakari & Khan, 2022).

Besides, the lack of a robust ICT system and obsolete infrastructure lead to problems in incorporating renewable energy into the networks (Chipangamate & Nwaila, 2024). Similarly, the inconsistency of energy policies hinders the investment in renewable energy which deter regulatory barriers as the cost is exorbitant. Hence, a transparent framework is crucial to engage with the stakeholders to participate in the energy transition (Chipangamate & Nwaila, 2024). In order to overcome these challenges, a clear approach is needed as it involves reformation of policies, financial assistance and technology to ensure effective transition to sustainable energy systems.

Principle of energy law

The energy law principle of prudent, rational and sustainable use of natural resources is the most relevant one in ensuring the international legal mechanism for the sustainable energy technologies to curb the climate change

issue (Heffron et al., 2018). Moreover, Article 10 of the Paris Agreement highlighted the importance of technology framework to encourage innovation, deployment, and accessibility of sustainable energy technology which is in line with the principle (UNFCCC, 2015). As illustration, there is also a mechanism under the International Energy Agency (IRENA) that is formed to foster international cooperation for renewable energy use within the nations (Heffron et al., 2018). The literature reveals that by integrating these principles of sustainable use in international law, the countries can effectively implement energy technologies and ensure intergenerational equity and global resource conservation (Heffron et al., 2018).

To conclude, the current literature highlights the role of international legal mechanisms which increases the sustainability of energy technologies. A clear legal framework can contribute to the success of transitioning to renewable energy sources that are sustainable by addressing and solving the issues related (Chipangamate & Nwaila, 2024).

METHODOLOGY

In this study, the method adopted is the doctrinal research methodology. The findings of this study will be based on both primary and secondary data to examine the role of international legal mechanisms in promoting sustainable energy technologies. The methodology is established to discover the interconnection between international law and sustainable energy practices. This study focuses on three international instruments i.e. the Paris Agreement (which was created under the United Nations Framework Convention on Climate Change), the ASEAN Plan of Action for Energy Cooperation (APAEC) as well as the United Nation's Sustainable Development Goals (SDGs), particularly SDG7. The criteria for selecting these specific sources are based on their global and regional applicability, their authoritative status in international environmental law, and their direct relevance in mandating or facilitating renewable energy transitions. This study also evaluates how these international legal structures influence institutional governance, national policy formulation, and financial mechanisms. The following criteria were assessed through library-based research:

1. The frameworks' ability to foster good governance standards, such as transparency and accountability, and their success in driving national policy changes like carbon emission pricing and renewable energy adoption targets.

2. The capacity of these legal mechanisms to produce tangible public co-benefits, including job creation, enhanced public health through reduced air pollutant emissions, and increased national energy independence.

3. The frameworks' practical capability to address structural barriers, specifically by evaluating their provisions for closing the severe financial and technological disparities between developed and developing nations; and

4. The robustness of the legal protections and institutional frameworks provided to attract and secure the massive private sector investments required for transitioning away from fossil-fuel dominance.

This methodological approach identified specific areas where international cooperation and legal reforms are needed, offering recommendations to strengthen these legal mechanisms. Through this method, this study establishes a solid foundation for evaluating how international law can foster the continuous development of sustainable energy technologies while actively mitigating global climate change and global energy inequality.

Findings

The terms "quality of government" and "good governance" describe a set of normative guidelines that specify how nations or other political bodies shall conduct their internal affairs. These standards include transparency, accountability, efficacy, impartiality, and inclusivity (Teorell & Rothstein, 2015). The successful transition to sustainable energy is fundamentally dependent on the establishment of integrated legal and institutional frameworks, rather than relying solely on technological or economic advancements.In energy sector, effective governance acts as the primary mechanism to reflect international commitments like the Paris Agreement and

the Sustainable Development Goals into enforceable national action plans (Gomez-Echeverri, 2018). The effectiveness of these international instruments relies heavily on countries' regulatory capacity to implement coordinated and comprehensive climate change policies. Institutions, governance, and **structured** financing play crucial roles in supporting these initiatives (Salman et al., 2022). For example, the adoption of mandatory standards for energy efficiency, the legal imposition of carbon pricing, and statutory incentives for renewable energy adoption are examples of regulatory changes required to encourage sustainable energy practices (Lv, 2023).

In evaluating the impact of low-carbon energy policies, evidence shows that comprehensive legal instruments can result in quantifiable socio-environmental benefits. When supported by adequate policy and legislative assistance, renewable energies have the capacity to meet 77% of global energy demand by 2050 (Intergovernmental Panel on Climate Change, 2011). Furthermore, data from other Asian countries e.g. China also reflects the direct public health and environmental impacts derived from strict regulatory compliance. For example, models of low-carbon energy policies implemented in Shanghai show that legally enforced emission reductions averted between 9,870 and 23,100 avoidable deaths in 2020. Similarly, policies to lower coal-burning emissions introduced in Taiyuan, China, resulted in a 57% decrease in disability-adjusted life years due to improved ambient air quality (Tang et al. 2014). Beyond Asia, the sustainable development policies and measures (SD-PAMs) in South Africa also indicates that a well-structured policy framework could reduce the nation's projected energy CO2 emissions by 5% in 2020 (Winkler et al., 2007). In the EU, scenario analyses confirmed that proactive, legally integrated climate protection strategies could enable member states to reduce GHG emissions by 30% over a 15-year period (Wuppertal, 2005). The proof of success from other countries supports the contention that statutory low-carbon policies not only mitigate greenhouse gas emissions but are also vital mechanisms for enhancing public health.

Hence, establishing a legal framework for next-generation energy technologies is essential to secure adequate financial access in shifting towards a world with sustainable energy technologies. According to Salman et al. (2022), the policy impact of the Paris Agreement was greater in developed countries due to stronger pre-existing financial governance. For instance, backed by financial incentives and government mandates, China launched the developing world's largest energy efficiency program in the 1980s, reducing overall energy intensity by 50% between 1980 and 1987 (Jefferson, 2000). Similarly, Egypt has conducted energy audits since 1985 to improve industrial, commercial, and government energy efficiency (Jefferson, 2000). On the contrary, developing and least-developed nations face the challenges of underdeveloped regulatory infrastructure and widespread poverty (Salman et al., 2022). To transition to greener economies while not compromising their developmental and poverty-alleviation goals, these nations require international agreements that balance reduction goals with their respective capacities, ensuring equitable access to green resources and technology.

Both developed and developing nations have placed the blame on one another for environmental destruction; developed nations have accused developing nations of environmental degradation because of increased consumption brought on by population growth, while developing nations have accused developed nations of environmental destruction due to excessive energy consumption brought on by increased demand (Nnabuife et al., 2022; Meydani, 2023, cited by Lv, 2023). While these arguments are correct, research shows that developing and developed countries have unique environmental and energy concerns. According to Lv (2023) by citing Luo et al. (2023), developing countries experience scarcity and limited access to energy resources, whereas wealthy countries face pollution and waste of energy.

Presently, almost 2.7 billion people cook using traditional biomass, while about 1.4 billion people do not have access to electricity (Sathaye et al., 2011). Access to modern energy services is critical to many areas of human growth, such as health, education, gender equality, and environmental protection. A community or home can greatly benefit from improved lighting, communication, and healthcare alternatives, even at the most basic levels. Rural areas far from national grids now have greater access to energy thanks to decentralised systems based on renewable energy in developing countries (Sathaye et al., 2011). This basically shows renewable energy that helps improve quality of life even towards people in rural areas due to its accessibility, compared to fossil fuel. Investment in renewable energy technologies, regulatory measures to encourage sustainable energy development are necessary. The process of transitioning to sustainable energy sources requires careful consideration of these opportunities such as more job opportunities and difficulties as well as the advantages and

disadvantages of each energy source.

According to Lv (2023), adopting sustainable energy options can significantly reduce economic costs associated with air pollution. Burning fossil fuels emits pollutants into the air, leading to negative health effects and higher healthcare expenditures (Lv, 2023). Adopting sustainable energy options can reduce reliance on traditional energy sources, leading to lower air pollution and health costs. This can generate significant economic benefits for individuals, corporations, and governments. Transitioning to sustainable energy can lead to greater energy independence, which is a significant benefit to the economy Lv (2023). Renewable energy sources are abundant and widely available, reducing countries' reliance on foreign energy supplies and their vulnerability to geopolitical tension (Van Der Schoor & Scholtens, 2014).

Despite the long-term cost benefits of renewable energy, governments, investors, and corporations must be prepared to invest a significant amount of money in modernising old infrastructure and creating new sustainable energy projects. Asia, which presently contributes 40% of global greenhouse gas emissions and is predicted to increase by another 50% if policies are not implemented, has the fastest rate of urban population development, with an estimated 67% of the world's population living in cities by 2030 (Gomez-Echeverri, 2018). Hence, it necessitates the enforcement of policy in addressing the development and climate issues. Furthermore, the Asian Development Bank estimates that implementing low-carbon development in line with the Paris Agreement will cost approximately US$300 billion annually until 2050 (Gomez-Echeverri, 2018).

Nevertheless, the International Energy Agency (IEA)'s World Energy Outlook summarises developments in renewable energy technology deployment and costs, as follows: In 2016, solar PV capacity increased more than any other kind of power. Since 2010, the cost of new solar PV has decreased by 70%, wind by 25%, and battery by 40% (Gomez-Echeverri, 2018). Therefore, it appears that the ongoing development of sustainable energy technology will make it possible for every country to change its energy system into sustainable energy. According to the IEA, achieving a low-carbon energy sector will require an additional cumulative investment of USD 36 trillion by 2050, with USD 7.35 trillion in the power sector (IEA, 2012). Even for a developed country, public finance would not be enough. Engaging in a sustainable energy transition necessitates the use of private investment. This encompasses both national and international private financing. In fact, many emerging countries still have limited domestic financial markets, preventing them from narrowing the infrastructure gap on their own (IEA, 2012). For instance, according to Foster and BriceñoGarmendia (2010), 71% of investment needs in 2009 in Africa were accounted for by the expected financing shortfall in the power industry. Correspondingly, instead of depending solely on a project-based strategy, a framework approach is required, in which proper investment regimes and institutional frameworks pave the way for optimum private sector engagement in development of sustainable energy technology (IEA, 2012). Clearly, investment will not take place without sufficient legal protection for investors, and it will take significant investment to shift from a fossil fuel-dominated energy market to sustainable energy technology development. Thus, the interested parties need to know that their legal position is safeguarded since investing is inherently dangerous, and investors will weigh the possibility of financial benefits against sovereign risk.

Therefore, to remove barriers to adoption and hasten the shift to sustainable energy development, the implementation of laws and incentives are vital to support such development in the energy sector. The usage of sustainable energy is not only known for the preservation of the energy to the future generation, but also for the development of technology and creation of many job opportunities in this modern era. The renewable energy business offers several job opportunities in manufacturing, technology, installation, and other fields. Shifting to locally available renewable sources improves energy security and independence. Renewable energy systems have high startup expenses, but cheap operational costs due to the availability of free fuel sources, such as the sun and wind, for instance New York, California, and several European nations where there are many start-ups that support these energy trading networks nowadays (Lv, 2023). Comprehensively, the legal framework serves as a backbone in every sector of life, particularly in the context of shifting towards sustainable energy development, to guarantee that the people adhere to the rules and regulations in achieving their initial goals.

DISCUSSION

Based on the findings, it can be concluded that that this study highlights the importance of international

mechanisms such as the Paris Agreement, the Sustainable Development Goals from United Nations, ASEAN framework such as the ASEAN Plan of Action for Energy Cooperation (APAEC) and the United Nations Framework Convention on Climate Change (UNFCCC) in promoting sustainable energy technologies. There are few significant precedents that have been established by these frameworks. Nonetheless, their impact is often hindered by the inefficient enforcement and irregular implementation across the regions. A critical analysis portrays some limitations that affect the implementation of such frameworks in attaining the climate and energy goals. This is due to the inconsistency between economics and the different capabilities of each nation in this world. For instance, although the Paris Agreement encourages nations to achieve each of their goals in reducing climate change, the reliance on each country's voluntary contribution had led to insufficient progress since some countries have fall short due to their political challenges, economic constraints or shifting priorities, as seen in many major emitters that have delayed in updating and implementing their nationally determined contributions (NDCs).

Limited resources and lack of opportunities are one of the major challenges. Developing countries, which are prone to climate change, usually struggle with insufficient funds and the lack of accessibility towards sustainable energy technology. Hence, without an inclusive approach, the developing countries would be left behind in the process of transitioning towards sustainable energy development. Nevertheless, there is light in this issue since the European Union's Renewable Energy Directive has demonstrated that legally binding international frameworks can spur innovation and widen the availability of sustainable energy technologies worldwide. The legal framework has not only encouraged collaborative projects between states, yet also marked a blueprint for integrating renewable energy into larger markets.

To be exact, there are clear opportunities to strengthen these legal frameworks in the future. Incorporating a provision relating to sustainable energy into trade agreements could advocate a wider adoption of sustainable energy at the same time fostering economic growth. Furthermore, there is a need for a new legal framework to address the modern technologies such as energy storage, smart grids, and cross-border energy sharing. In the meantime, global financial tools, for instance green bonds and carbon markets, can fund the expenses for the development of sustainable energy. The private sector also plays an important role in this development, together with advancement in digital technologies.

Policy making and future research shall emphasize on the exploration of innovative technologies for cross-border energy sharing, dispute resolution, and capacity building in underdeveloped countries since these areas hold a great potential for advancing sustainable energy development. Cross-border energy sharing may help in strengthening the energy security and reduce the reliance on fossil fuel by its distribution system of renewable energy across national borders. However, developing legal frameworks to govern these arrangements will necessitate careful consideration, especially on sovereignty issues, technical compatibility and distribution of resources. A successful example is the Nordic electricity market where it illustrates regional cooperation can enable seamless integration of energy trade and grid among the nations. This also extends to other regions, such as Sub-Saharan Africa or Southeast Asia, which are blessed with abundant renewable energy resources for them to achieve transformative results.

Not to mention, the mechanism for dispute resolution also shall be taken into consideration as conflicts over shared resources, infrastructure and a contrary regulatory standard can prolong the progress. A legal framework shall incorporate a transparent, fair and enforceable system to resolve disputes. This might guarantee the position of the stakeholders regardless of small nations or small communities, to ensure that they are being heard and no biases throughout the process. This is particularly vital in areas where historical tensions or economic constraints may intensify the disagreement over energy policies.

The capacity building in underdeveloped countries also shall be prioritized. Many developing and underdeveloped countries face obstacles such as substandard infrastructure, insufficient funds, and inadequate technical expertise may hinder their ability to transition towards sustainable development. Therefore, there ostensibly an urge for technology transfer, skill development and financial assistance to empower these nations to participate in transitioning towards sustainable development. For instance, there shall be a program to educate local engineers to maintain renewable energy systems, establishment of research centers for energy efficiency innovations, and create a financial instrument to alleviate the cost for sustainable energy development

in low-income regions.

The socio-political complexities of energy transition shall also be addressed since it involves more than just technological and economic development. This transition also requires navigating deeply rooted cultural, political and institutional dynamics. Hence, legal frameworks shall be adaptable in the context of diversity, since what works in one region does not necessarily work in another region. For instance, policies promoting solar energy may need to account for cultural practices or social equity concerns that vary widely across regions. Thus, policymakers should engage with local communities in the beginning of transition to build trust and support to ensure the benefit of the project towards the community as a whole.

Although this study is limited by its reliance on secondary data and a narrow focus on specific legal instruments, it makes a meaningful contribution to the broader discourse by identifying critical gaps in existing frameworks and proposing actionable solutions. These findings underscore the importance of interdisciplinary approaches that integrate insights from law, policy, economics, and social sciences. Future research could expand on this work by conducting empirical studies to analyze the effectiveness of suggested reforms, assessing the socio-economic implications of energy policies and examining the emerging legal mechanism tailored to the developing energy sector. By continuing and strengthening the global legal framework for sustainable energy, the global community can pave the way for a more equitable path to a greener future.

The focus of this study not only consists of legal frameworks and their limitations but it also highlights the broader demand for a cohesive, inclusive and a progressive approach to international energy law. Addressing the gaps and fostering global collaboration will bring the international community closer to realize its dual goals of combating climate change and to safeguard energy security. Ultimately, the path to a greener planet is complex, hence the need for collaborative efforts. Through the findings, it can be found that with a stronger legal framework, a focus on equity and innovation and collaborative efforts, the world can achieve significant progress. The question is not whether sustainable energy can revolutionize our future since they most certainly can. However, the question remains whether we have the legal, political and societal right to make the dream come true.

CONCLUSION

To strengthen the global legal architecture for sustainable energy, reforms are urgently needed. First, international agreements should incorporate more binding commitments and robust accountability mechanisms to ensure compliance. Second, trade agreements could integrate provisions that incentivize the development and distribution of renewable energy technologies, making them more accessible, especially to developing nations. Third, new legal norms are required to address emerging challenges such as energy storage, grid modernization, and cross-border energy sharing. Moreover, financial tools such as green bonds, carbon pricing mechanisms, and investment guarantees should be woven into international frameworks to attract private-sector participation and accelerate clean energy transitions. Through these, the development of sustainable energy can even be accessible in less developed countries.

Effective policy-making relies on the ability of decision-makers to establish and implement comprehensive programs to address climate change and development across sectors, regions, and constituents. This applies to climate policy and action across various industries. To achieve sustainable energy development, countries will need to be able to establish and implement action plans that address their climate and development goals in an integrated, coordinated, and comprehensive manner. Institutions, policy, governance, and funding will all play important roles in advancing these efforts. Although the current SDGs represent the most comprehensive and balanced global development agenda to date, the fossil fuel industry's substantial position in many countries may hinder efforts to switch to sustainable energy.

To simplify, international legal mechanisms such as the Paris Agreement, SDGs and regional framework play an important role in promoting the transition towards sustainable energy development. Although the current frameworks are making notable progress in addressing the environmental destruction at international level, there is still a room for improvement for policy changes and its implementation. This can be seen through the financial barriers, resource inequities and regulatory complexities. As previously mentioned, policy changes shall be

enacted to promote sustainable energy practices including the adoption of standards and incentives for energy efficiency improvements, the installation of a carbon tax, and the introduction of incentives and targets for renewable energy adoption. By addressing these challenges, the global community can pave the way for a greener, sustainable world for future generations.

The transition to sustainable energy sources prompts both opportunities and challenges. One of the most major challenges is the need to invest in renewable energy technology, as the current energy infrastructure is primarily reliant on traditional energy sources. The adoption of sustainable energy sources involves significant investment in renewable energy technologies such as hydro, wind, solar, and geothermal, which is critical to assuring their accessibility and affordability, allowing for wider deployment. Another key difficulty is policy reforms to encourage sustainable energy consumption. Governments have an important role in promoting sustainable energy consumption through legislative reforms. These policies foster a favourable climate for renewable energy technologies to grow, making them more accessible and inexpensive to consumers. However, adopting these policies can be tough and requires public support.

Despite these hurdles, the shift to sustainable energy sources offers enormous potential, including energy security and employment development in the sustainable energy sector. The sustainable energy business is quickly increasing and has the potential to provide many new jobs. Job prospects in the sustainable energy sector extend from production and installation to research and development, providing a diversified range of options for people with a variety of skill sets. The transition to renewable energy sources also provides an opportunity for a more sustainable world. The use of sustainable energy sources such as hydro, wind, and solar can reduce the negative environmental effects of traditional energy sources, resulting in a cleaner and healthier world. Additionally, renewable energy technologies are inexhaustible and do not emit greenhouse gases.

To address these issues, there shall be collaborative projects between the governments, industries, and educational institutions to provide the skills, legislation, and funds needed to enable employment creation in this crucial industry. This effort may include upgrading the skill of workers in specialized technological skills, providing training and education programs to gain experience, and enacting more predictable and supportive government regulations. Furthermore, financial possibilities and incentives can be devised to promote the expansion of the sustainable energy sector and lower the risk associated with investing in it. Last but not least, policy measures incentivising sustainable energy use and investment in renewable energy technology can encourage sustainable energy development.

ACKNOWLEDGMENTS

The authors would like to express their sincere gratitude to all those who provided support and assistance throughout the research process.

REFERENCES

1. Ahmad, M., Khan, I., Qaiser, M., & Jabeen, G. (2022). Households' perception-based factors influencing biogas adoption: Innovation diffusion framework. Energy, 263, 126155. https://doi.org/10.1016/j.energy.2022.126155
2. Anugrah, P., Shah, R., Mithulananthan, N., & Alzahrani, S. (2026). Review of Cross-border Interconnections: Lessons Learned for RE Integration and Market Establishment in ASEAN Power Grid. IEEE Access.
3. ASEAN Centre for Energy. (2020). ASEAN Plan of Action for Energy Cooperation (APAEC) 2016-2025: Phase II (2021-2025). Retrieved from https://asean.org/wp-content/uploads/2023/04/ASEAN-Plan-of-Action-for-Energy-C ooperation-APAEC-2016-2025-Phase-II-2021-2025.pdf
4. Bilal, Khan, I., Tan, D., Azam, W., & Tauseef Hassan, S. (2022). Alternate energy sources and environmental quality: The impact of inflation dynamics. Gondwana Research, 106, 51–63. https://doi.org/10.1016/j.gr.2021.12.011
5. Bodansky, D., Brunnée, J., & Rajamani, L. (2021). Paris agreement. Audiovisual Library of International Law, 1-9.
6. Bodansky, D. (2016). The Legal Character of the Paris Agreement. Review of European, Comparative

& International Environmental Law, 25, 142–150.
7. Bruce, S. (2013). International Law and Renewable Energy: Facilitating sustainable energy for all? https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2327090
8. Chipangamate, N. S., & Nwaila, G. T. (2024). Assessment of challenges and strategies for driving energy transitions in emerging markets: A socio-technological systems perspective. Energy Geoscience, 5, 100257. https://doi.org/10.1016/j.engeos.2023.100257
9. Daut, I., Razliana, A. R. N., Irwan, Y. M., & Farhana, Z. (2012). A study on the wind as renewable energy in perlis, northern Malaysia. Energy Procedia, 18, 1428–1433. https://doi.org/10.1016/j.egypro.2012.05.159
10. Foster, V., & Briceño-Garmendia, C. (Eds.). (2010). Africa's Infrastructure: A Time for Transformation. World Bank. worldbank.org
11. Gao, C. (2022). Risk Assessment and Analysis of Biomass Energy Engineering Project Management under the Concept of Sustainable Development. Adsorption Science & Technology, 2022. https://doi.org/10.1155/2022/5323021
12. Gomez-Echeverri, L. (2018). Climate and development: enhancing impact through stronger linkages in the implementation of the Paris Agreement and the Sustainable Development Goals (SDGs). Philosophical Transactions of the Royal Society a Mathematical Physical and Engineering Sciences, 376(2119), 20160444. https://doi.org/10.1098/rsta.2016.0444
13. Guiry, N. (2024). Why do states adhere to the Sustainable Development Goals? Transnational Environmental Law, 13(2), 400–427. https://doi.org/10.1017/s2047102524000190
14. Heffron, R. J., Rønne, A., Tomain, J. P., Bradbrook, A., & Talus, K. (2018). A treatise for energy law. Journal of World Energy Law and Business, 11(1), 34–48. https://doi.org/10.1093/jwelb/jwx039
15. International Energy Agency. (2012). Energy Technology Perspectives 2012: Pathways to a Clean Energy System. OECD Publishing. https://www.iea.org/reports/energy-technology-perspectives-2012
16. IPCC (2011). Renewable Energy Sources and Climate Change Mitigation: Special Report of the Intergovernmental Panel on Climate Change. (O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlömer, & C. von Stechow, Eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1075 pp.
17. Lv, Y. (2023). Transitioning to sustainable energy: opportunities, challenges, and the potential of blockchain technology. Frontiers in Energy Research, 11. https://doi.org/10.3389/fenrg.2023.1258044
18. National Renewable Energy Laboratory. (2001). **Renewable energy: An overview** (Report No. DOE/GO-102001-1102; NREL/BR-810-27955). U.S. Department of Energy
19. Pawar, V., & Farooqui, S. (2023). The effectiveness of renewable energy technologies in reducing greenhouse gas emissions. https://www.researchgate.net/ publication/373453524 THE EFFECTIVENESS_OF_ RENEWABLE_ENERGY TECHNOLOGIES IN_REDUCING GREENHOUSE_ GAS_EMISSIONS.pdf
20. Perera F. (2017). Pollution from Fossil-Fuel Combustion is the Leading Environmental Threat to Global Pediatric Health and Equity: Solutions Exist. International journal of environmental research and public health, 15(1), 16. https://doi.org/10.3390/ijerph15010016
21. Ritchie, R., Roser, M., Mispy, J., & Ortiz-Ospina, E. (2018). Measuring progress towards the sustainable development goals. SDG-Tracker. org. https://sdg-tracker.org/energy
22. Salman, M., Long, X., Wang, G., & Sharafat, A. (2022). Finance, technology, and environmental efficiency: Measuring the progress of developed, developing, and least developed countries. Land Use Policy, 120
23. Sathaye, J., O. Lucon, A. Rahman, J. Christensen, F. Denton, J. Fujino, G. Heath, S. Kadner, M. Mirza, H. Rudnick, A. Schlaepfer, A. Shmakin. (2011). Renewable Energy in the Context of Sustainable Development. In IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation. IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA
24. Tang, D., Wang, C., Nie, J., Chen, R., Niu, Q., Kan, H., Chen, B., & Perera, F. (2014). Health benefits of improving air quality in Taiyuan, China. Environment International, 73, 235–242
25. Teorell, J., & Rothstein, B. (2015). Quality of Government. In J. D. Wright (Ed.), International Encyclopedia of the Social & Behavioral Sciences (2nd edition ed., pp. 690-694). Elsevier.

https://doi.org/10.1016/B978-0-08-097086-8.75048-3
26. UNDP, UNDESA, & WEC. (2000). World energy assessment: Energy and the challenge of sustainability (J. Goldemberg, Ed.). United Nations Development Programme. Chapter 12: Energy Policies for Sustainable Development (pp. 415–442) by Michael Jefferson
27. United Nations Framework Convention on Climate Change (UNFCCC). (2015). Paris Agreement. Retrieved from https://unfccc.int/sites/default/files/english_paris_agreement.pdf
28. United Nations. (n.d.). Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all. Department of Economic and Social Affairs. https://sdgs.un.org/goals/goal7
29. U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. https://www.nrel.gov/docs/fy00osti/27955.pdf
30. Ukpanah, I. (2024, April 26). Fossil fuel analysis: Understanding its impact and alternatives. GreenMatch. https://www.greenmatch.co.uk/fossil-fuel-analysis
31. Van Der Schoor, T., & Scholtens, B. (2014). Power to the people: Local community initiatives and the transition to sustainable energy. Renewable and Sustainable Energy Reviews, 43, 666–675. https://doi.org/10.1016/j.rser.2014.10.089
32. Wang, J., & Azam, W. (2024). Natural resource scarcity, fossil fuel energy consumption, and total greenhouse gas emissions in top emitting countries. Geoscience Frontiers, 15, 101757. https://doi.org/10.1016/j.gsf.2023.101757
33. Winkler, H., Howells, M., & Baumert, K. (2007). Sustainable development policies and measures: Institutional issues and electrical efficiency in South Africa. Climate Policy, 7(3), 212–229
34. World Energy Council. (2024). World Energy Issues Monitor 2024: Redesigning Energy in 5D. World Energy Council. Available at World Energy Council
35. Wong, R., & Onn, L. P. (2022). The intractable challenges facing energy trade in Southeast Asia. ISEAS Perspective, 2022(19), 1–9. https://www.iseas.edu.sg/articles-commentaries/iseas-perspective/2022-19-the-intractable-challenges-facing-energy-trade-in-southeast-asia-by-ryan-wong-and-lee-poh-onn/
36. Wuppertal Institute for Climate, Environment and Energy. (2005). Target 2020: An integrated climate protection policy strategy for Germany and the EU. Wuppertal Institute.
37. Zakari, A., & Khan, I. (2022). Towards a sustainable future: Evaluating the role of renewable energy and green technologies in mitigating climate change. Environmental Science and Policy, 127, 235–246. https://doi.org/10.1016/j.envsci.2022.03.011