IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

PHOTOVOLTAIC SYSTEMS AND JUST ENERGY TRANSITION: BRIDGING THE ENERGY GAP IN DEVELOPING NATIONS UNDER THE INTERNNATIONAL SOLAR ALLIANCE FRAMEWORK

Ashutosh Kumar, Ph.D. Scholar, Energy Studies Programme, School of International Studies, Jawaharlal Nehru University, New Delhi & Asstt. Prof., Deshabandhu College, Delhi University.

Abstract

In the last three years, global investments in renewable energy capacity have outpaced those in fossil fuels. The considerable possibilities for harnessing solar and wind energy in various regions remain largely untapped, mainly due to the hesitance of risk-averse investors to commit resources to markets they view as challenging. Established in 2015, the International Solar Alliance (ISA) serves by way of a strategic inventiveness designed to unite nations abundant in solar resources to foster a larger market. This partnership aims to improve the implementation of current solar technologies, further reduce costs, and promote collaborative research and development in solar energy, along with capacity building. The ISA possesses significant potential to propel climate action in developing nations, particularly in regions of the global south, including Asia, Africa, Europe, and Latin America, provided it can successfully mobilize financing, technology, and large-scale solar initiatives. This document delineates the ISA as a strategic instrument for economic diplomacy among Global South nations, focusing on its economic goals—particularly in finance and technology aimed at facilitating a clean energy transition and fostering global leadership. By leveraging insights derived from the ISA's structure and operations, this brief emphasizes the necessity aimed at countries in the Global South to reassess as well as expand their involvement in this climate system. Ultimately, it provides strategy suggestions aimed at India toward effectively harnessing ISA's stage toward further its key cooperation aims of augmenting financial resources aimed at climate initiatives, thereby strengthening its broader strategy to enhance its position as a prominent global power.

Keywords: solar energy, International Solar Alliance (ISA), climate system, developing nations, energy transition, bridging the gap.

1. Introduction

As the global community progresses along its designated trajectory towards development, economic expansion, and job creation to enhance the quality of life for millions [1], it is essential to recognize the significant consequences of environmental degradation and ecological imbalances, particularly as evidenced by carbon emissions resulting from climate change [2]. Recently, the rise in emissions has been closely associated with overall economic growth, and this correlation is anticipated to continue in the foreseeable future [3]. Concurrently, there is a growing acknowledgment that climate change is an undeniable reality, making it crucial for international collaborative efforts to foster a response that is effective, efficient, and equitable in addressing this pressing issue [4, 5]. On November 30, 2015, coinciding with Paris Climate Conference inaugural day of India as well as France collaboratively established an ISA [6] to enhance solar energy utilization in developing nations. India faced considerable scrutiny regarding its potential influence on the success or failure of a global climate agreement in Paris, and this initiative demonstrated India's commitment to actively participate in international climate collaboration [7]. The ISA was originally proposed via India as a partnership of nations abundant in solar resources, aimed at meeting their energy requirements and working together to tackle the challenges associated with solar energy implementation [8]. The countries identified as solar-rich or prospective members of an ISA are those situated among Tropic of Cancer as well as Tropic of Capricorn. These nations are geographically positioned to maximize the absorption of solar radiation [9].

It is essential to note that a significant number of these nations are developing countries that either lack adequate energy access or have no access at all. The primary objective behind the establishment of ISA was supposed toward tackle the solar energy deficiencies implementation within these countries [10]. On December 6, 2017, slightly more than 2 years after its inception, ISA, spearheaded by India and also predominantly supported by developing nations in Asia as well as Africa, was officially established as a legal entity [11]. Currently, 116 nations have endorsed the primary legal document of the ISA, known as the Framework Agreement. Of these, Ninety-four nations have officially ratified the treaty, thereby achieving complete membership [12]. India, through ISA, aspires to establish a future in which solar energy holds considerable importance in the worldwide energy landscape [13], thus alleviating the negative effects of climate change and fostering inclusive development. ISA assists nations with limited energy access by providing them a platform for international dialogue, facilitating collaborative initiatives, and exchanging ideas to bridge technological divides and foster global partnerships [14]. Furthermore, it facilitates the expansion of renewable energy solutions that lower expenses for nations, rendering investments in this sector financially viable [15]. This is particularly advantageous aimed at creating nations in the global south, which possess abundant natural resources yet do not possess the necessary technical skills necessary to capitalize on these opportunities for attaining energy security [16]. Addressing these challenges can effectively trigger a series of developments that will allow these countries to fulfill a significant portion of their energy needs autonomously, thereby fostering a more equitable global power structure [17]. ISA is dedicated to this very purpose. By ISA levaraging, India can provide renewable energy explanations toward Global South [18]. Notably, target aimed at the capacity of solar power was significantly enlarged, nearly quintupled, toward touching 100 GW by the year 2022 [19]. India's Nationally Determined Contributions (NDCs) presented below Paris Agreement highlight nation's commitment to renewable energy, aiming to achieve [20] half of its overall power capacity will be derived from non-fossil fuel sources by the year 2030 (UNFCCC, 2022). In light of the significant increase in solar energy within India's energy portfolio, this strategy short-term aims to elucidate foreign policy of India motivations behind an establishment of an ISA [21]. The understanding emerged that the expansive Indian market could be utilized to promote low-carbon technologies adoption; thereby lowering their costs as well as bolstering the marketplaces aimed at these skills in [22] another emerging nation.

The ISA was designed as a mechanism for "market-making," aimed at channeling financial resources and technological advancements to countries abundant in solar energy, which possess significant market opportunities for the implementation of solar power [23]. As we progress through the intricate challenges associated with the shift towards a sustainable energy future, the ISA is pleased to unveil this detailed report on the pivotal role of solar energy in achieving a threefold increase in global renewable energy capacity by 2030, prepared for the COP 28 summit. This document provides an in-depth analysis of the diverse factors influencing solar adoption, addressing both the obstacles and incentives, while underscoring the significance of solar energy in NDCs and its critical

function in combating change in climate, plus the goal of tripling renewable energy capacity as articulated in the G20 New Delhi Leaders Declaration and the COP 28 presidency.

2. Research Merhodology

The research is exploratory and qualitative in nature. It is based on the critical analysis of the published reports, documents and research papers. The article also uses stakeholders interviews.

3. Solar energy

Solar energy presents a significant opportunity for creating a low-carbon, resilient, and inclusive global energy framework. It has driven impressive advancements, with installations reaching 226 GW in 2022, representing a notable 38% increase compared to the previous year. Forecasts for future solar capacity, derived from various long-term and short-term analyses by prominent experts, clearly indicate one fundamental reality: solar energy is set for remarkable growth. The photovoltaic (PV) capacity is anticipated to increase as of 1 TW in 2022 to an estimated 10 TW by 2030, and potentially escalate to an ambitious 60 TW by 2050 in the most optimistic scenario, underscoring the exponential nature of solar energy's growth trajectory.

3.1 Importance of Solar Energy

Crucial for Global Energy Transition: Solar energy serves an essential function in the worldwide shift towards sustainable energy, essential for tackling climate change. It is the most rapidly expanding renewable energy source, and despite its intermittent nature, it has become the most cost-effective energy option in many areas when accessible.

Cost-Effectiveness and Growth Potential: The cost-effectiveness of solar photovoltaic (PV) technology has significantly contributed to its expansion. According to projections from the International Energy Agency (IEA), solar PV is expected to represent 4.5% of the whole global electricity generation by the year 2024. In a scenario characterized by a high reliance on renewable energy, this figure could increase to 4.7 terawatts (4,674 gigawatts) by 2050, positioning solar energy as the predominant source of electricity worldwide.

Projected Growth Scenarios for Net-Zero Targets: Toward obtaining global net-zero emissions by 2050, a significant enhancement in solar PV capacity is essential. The ISA goal toward deploy 1,000 gigawatts (GW) of solar energy by 2030., which is following international climate objectives.

4. Photovoltaic system and energy transition

India has positioned itself as "Vishwaguru," a leader in the realm of renewable energy, demonstrating a steadfast dedication to sustainable initiatives. The nation intends to decrease emissions of CO_2 via 1 billion metric tons to attain a fuel energy of non-fossil volume of 500 GW in 2030 [24], with a long-term objective of net-zero emissions achieving in 2070. This assurance is summarized in principle of "Panchamrit," which refers to five essential components, and was prominently highlighted at COP26. Notably, India has surpassed its objectives for reducing productions before an anticipated timeline, reaching 40% of its electricity as non-fossil goal in 2021, a full 9 years prior to 2030 deadline, also has since established novel, much-determined objectives. In August 2022 [25] India revised its NDC to achieve a 45% decrease in emissions intensity relative to GDP and a target of 50% for energy capacity derived from non-fossil fuel sources via year 2030 [26]. Since then, India has achieved considerable progress in advancing in the direction of its non-fossil fuel objectives, having already reached 42% and is on track to exceed the 50% target in 2030.

A key factor contributing to this rapid expansion has been India's systematic initiatives toward advancing renewable energy across together urban as well as rural landscapes, emphasizing the widespread implementation of solar technologies in inhabited also farming sectors, correspondingly. For example, several government initiatives have

been introduced, including phase two of Rooftop Solar Initiative launched via Ministry of New plus Renewable Energy (MNRE) in 2019, which purposes toward achieving the installation of rooftop solar capacity of 40 GW in 2026, supported by a financial allocation of Rs. 11,814 crores.

The initiative primarily targets residential zones, offering qualified participants funding for the central government to facilitate installation procedures. This program has resulted in a notable rise in solar capacity rooftop connections, which have achieved an impressive Compound Annual Growth Rate (CAGR) of around 46% [27].

The Production Linked Incentive (PLI) Scheme, propelled via Ministry of New Renewable Energy (MNRE), is designed to enhance manufacturing capabilities of extraordinary efficiency in India of PV modules, through a substantial investment of Rs. 24,000 [28] crores. This initiative seeks to strengthen the manufacturing sector by fostering a local supply chain for solar materials, which will, in turn, promote job creation and technological independence. The scheme is structured in two phases: Phase-I and Phase-II, with a combined capacity target of 48,337 MW and an investment of Rs. 18,500 crores. Furthermore, Phase II is projected to attract an investment of Rs. 93,041 crores also generate above 100,000 direct and indirect employment opportunities.

The National Green Hydrogen Mission represents a significant initiative aimed at creating a comprehensive green hydrogen ecosystem across the nation. This mission seeks to enhance the capability toward create 5 Million Metric Tons (MMT) or more of green hydrogen annually in the year 2030, alongside achieving an electrolyzer capacity of 60–100 GW within the same timeframe, supported by a financial allocation of Rs. 19,744 crores. The task is designed to stimulate substantial investment, projected at $100 billion, generate approximately 600,000 jobs, and foster expansion of the green hydrogen industry. Additionally, it aims to decrease fossil fuel significances via ₹1 lakh crore also also prevent approximately 50 MMT of CO2 emissions each year in 2030.

India, population stands at 1.44 billion. a wealth of Specialized knowledge and assets for infrastructure development is advancing towards its objective of becoming "Aatmanirbhar." This ambition serves as a source of inspiration for emerging countries globally as they strive for a future that is both environmentally friendly and encompassing. In this context, India is eager toward promote international collaboration to deliver a future characterized by sustainability and inclusivity encompassing not only the African continent as well as the distant Pacific region.

4.1 Economic and social benefits of solar power generation system

4.1.1 Economic Benefits:

Reduction in Utility Bills: Installing solar panels in your residence can result in considerable reductions in your electricity expenses. As a renewable energy source, solar power enables households to lessen their reliance on the conventional power grid, which can lead to notable financial benefits [29].
Energy Generation Estimation: The assessment of solar energy production generally relies on an average that presumes uniform sunlight exposure over the year. Nevertheless, the actual effective sunlight may be lower and can differ based on geographical location. A 1KW solar system, when considering various losses and optimal performance, is capable of producing around 2.8 kilowatt-hours daily under typical conditions.
Government Incentives: Numerous governments provide financial incentives and subsidies to promote the utilization of solar energy, which can greatly reduce the initial installation expenses.
Decreased Operational Costs: Solar systems can assist households in decreasing their total energy usage, particularly for high-demand appliances such as air conditioners, which in turn decrease energy.

4.1.2 Social Benefits

Environmental Conservation: Solar energy contributes substantially to the advancement of environmental sustainability by preserving natural resources and minimizing pollution. Each kilowatt-hour saved leads to a reduction in fossil fuel usage as well as a reduction in the release of harmful pollutants, thereby enhancing air quality and helping to alleviate climate change.

Job Creation: The expansion of the solar industry fosters employment opportunities throughout the entire value chain, encompassing manufacturing, installation, maintenance, and support services [31]. Home solar power systems, such as a 1KW installation, offer significant economic advantages through cost savings while also advancing broader social objectives, including environmental conservation and job creation. These substantial benefits establish solar energy as a highly endorsed and feasible green energy alternative for widespread implementation.

5. ISA: Overcoming the Challenges in Solar

The ISA is envisioned as a group of nations endowed with abundant solar properties, situated among Tropic of Cancer as well as Tropic of Capricorn. Its purpose is toward tackle the unique energy requirements of these nations and to establish a collaborative platform aimed at responding to the identified issues by a unified and mutually decided strategy. At present, there is a lack of a dedicated international organization to cater to the specific needs related to the placement of solar technology in these resource-rich countries.

The ISA embodies a significant variety in electricity access among its members. An examination of data from the 121 countries within this Alliance indicates that, as of 2012, merely 23 nations achieved complete electricity access for their entire populations, whereas 54 countries reported that less than 66% of their populations had access to electricity. The 66% threshold is regarded as a standard, representing the average level of electricity access across the 121 ISA member nations.

These nations have the potential to effectively utilize solar energy in a cost-efficient manner, provided there is a unified and coordinated initiative to exchange experiences with other comparable countries. Additionally, efforts should focus on developing solutions that are tailored to local conditions while maintaining affordability. Many of these nations face challenges such as restricted admittance to knowledge also an absence of financial resources, which obstruct large-scale application. Forming a coalition dedicated to solar energy development as well as an application of solar technologies would assist in meeting the unique energy requirements of these countries and, over time, diminish the requirement for fossil fuels by enhancing the proportion of solar energy within their energy portfolios.

6. International Solar Alliance (ISA): Aims and Objectives

ISA remained declared during Paris Climate Conferences happened on 2015 as a collaborative initiative between the governments of India as well as France. The French government viewed ISA as a strategy to encourage India to adopt a more favorable stance towards the last contract. Given India's unique strengths, solar energy emerged as a clear opportunity for Indian leadership. The Indian government, particularly under the leadership of its Prime Minister, was enthusiastic about this initiative, aiming to demonstrate that India could be an innovator within the global framework rather than merely a protector of its interests, aligning with the nation's aspirations to engage in a greater capacity part in global organizations [44].

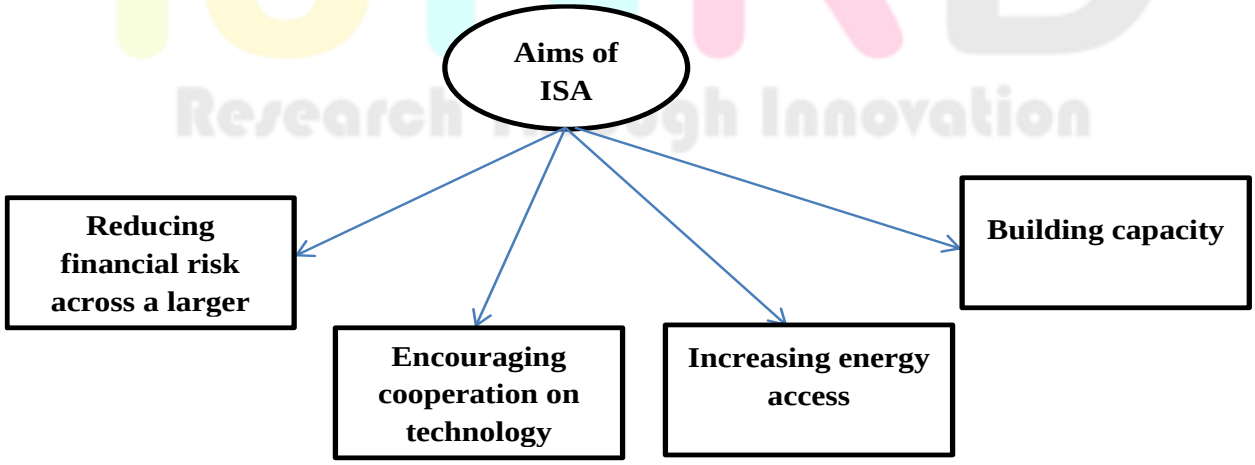

Figure 1: Main aims of ISA

ISA was originally established to serve 121 nations placed in the sun-drenched area among Tropic of Cancer plus Tropic of Capricorn. These nations, predominantly less affluent, represent nearly 75% of the global population while contributing merely 23% to the total solar energy capacity worldwide. Following interest from nations such as Germany, the ISA was made accessible to every United Nations member country in late 2018 [45]. The primary objective of the ISA is to attract $1 trillion in investments plus to increase solar capacity by 1000 GW among its states of members in 2030.

The ISA has implemented a framework that minimizes obligations for its members, avoiding binding commitments and substantial government funding. Instead, the focus is on harnessing primarily private investment to facilitate the adoption of solar energy in less affluent nations. For instance, these countries face significantly higher financing costs, and solar energy projects are capital-intensive, sometimes comprising up to 75% of the total expenses. There is also a pressing need for enhanced standards and design specifications for solar certification, such as agricultural pumps.

ISA projects that, if executed effectively, demand aggregation could potentially reduce the costs associated with solar projects by up to fifty percent. The Center for Energy, Environment plus Water (CEEW), an Indian think tank, has put forth proposals aimed at risk pooling via a unified platform. Various financial instruments have been employed in different settings to mitigate risks, thereby making the entire investment appear less hazardous. The World Bank has acknowledged this proposal in a revised format, which may not entirely meet CEEW's goal of achieving pooled credit risk diagonally within national boundaries. Nevertheless, ISA may persist in exploring additional programmatic initiatives to reduce borrowing costs [46, 47].

In alignment with these objectives for the ISA, a commitment of $1 billion in kernel funding has been secured from private investors, multilateral banks plus Green Climate Fund, which is anticipated toward attract an extra $15 billion from the isolated sector. Additional creativities encompass the training of numerous solar technicians also the establishment of invention, research, as well as development hubs in the member nations which will also address standards related to the assessment of apparatus as well as quality assurance.

Since its establishment, ISA has undertaken various initiatives to enhance global collaboration under India's leadership. Notably, India has bolstered its ties with the Global South via the implementation of Country Partnership Agreements (CPAs), which enable tailored interventions aimed at advancing the sector of solar energy for sustainable development. To date, ISA has successfully signed its inaugural CPA by Bangladesh (AIR, 2023) also it is actively engaging in deliberations with additional countries, including Nigeria, Comoros, Niger, Ethiopia, Cambodia, Seychelles, Fiji, and Kiribati as of Global South.

ISA has established a Corporate Advisory Group aimed at attracting investments in private, recognizing that private sector constitutes more than 90% of global investments in solar. This collection comprises notable businesses including NHPC, SolarPower Europe, CLP Group, and SBI, among others (ISA, 2023). Via its initiatives, ISA facilitates financial assistance plus essential information to enable private investors and governmental bodies across the Global South, enabling them to make well-informed choices.

6.1 ISA Initiatives

ISA CARES Initiative: Initiated in 2020, ISA CARES seeks to improve healthcare infrastructure in Least Developed Countries (LDCs) as well as Small Island Developing States (SIDS) through an execution of solar energy solutions.

Secure 1000 Initiative: Encourage investment in underrepresented areas, especially in Africa, to advance solar energy initiatives. Launched at COP27 in 2022, this program seeks to assist pioneering solar enterprises within ISA member nations.

STAR-C Creativity: Enhance solar technology competencies in emerging economies by establishing Solar Technology and Applications Resource (STAR) centers. These centers are dedicated to building capacity, cultivating local expertise, and creating a supportive atmosphere for the adoption of solar technology.

Global Solar Facility: Facilitate the financial resources mobilization toward promoting the implementation of solar energy in LDCs as well as SIDS. This initiative aims to mitigate the financial risks associated with solar initiatives, especially in areas with restricted energy access, by employing standardized policies and financial instruments.

6.2. Geopolitical Significance

The subsequent subheadings, which represent the primary objectives of the ISA, elucidate its geopolitical significance. Consequently, a careful examination of these subheadings necessitates a focus on the associated concerns and the outcomes achieved to date. Despite the ISA's establishment approximately seven years ago, there is an ongoing endeavor to assess whether the organization is progressing in the right direction.

Combating Climate Change

ISA as well as United Nations Framework Convention on Climate Change (UNFCCC) established an obligation toward address change in climate during COP26 conference held in Glasgow. The two organizations will work together via UN Climate Change secretariat on various initiatives aimed at executing mitigation plans within an energy sector, supporting the realization of Nationally Determined Contributions, as well as encouraging the adoption of Long-term Low Emission Development Strategies. Furthermore, this collaboration will assist parties of developing countries, including SIDs plus LDCs, in hastening the deployment of decarbonization technologies and policy measures. Ajay Mathur underscored the importance of making the battle in contradiction of climate change more attainable via the implementation of solar and renewable energy during the signing of the agreement. Consequently, both organizations are committed to working together to deliver sustainable, economically feasible, and impactful solutions [49].

"Towards 1000" inventiveness aims to secure $1 trillion in savings for solar energy technologies in 2030, while also ensuring that 1 billion individuals gain access to electricity through clean energy solutions, which is overseen by ISA. This policy is expected to lead to the fitting of 1,000 gigawatts of solar energy capacity. Consequently, solar emissions are projected to decrease by 1 billion tonnes annually. The ISA is committed to combating global warming, also given the sustainability of its energy sources; these determinations are likely to yield long-term success.

Enhancing Energy Supply

To effectively address the energy requirements of the local population and enhance their quality of life, it is essential to harness solar energy for electricity production. Furthermore, it has been noted that nations situated among Tropic of Cancer as well as Tropic of Capricorn benefit from consistent sunlight, making it crucial to utilize these materials for the advancement of society. The viability of this coalition, established through COP21, came into question when India as well as France led efforts toward exploring alternative energy solutions.

The ISA needs to collaborate with organizations operating in related or complementary fields, like the International Renewable Energy Agency (IRENA), to stop the repetition of exertions. Emphasis should be directed towards the creation of projects that are attractive for investment, and successful solar enterprises should be encouraged to contribute significantly to an initiative aimed at mobilizing equal towatd $1 trillion aimed at solar energy. It is clear that such a substantial amount can’t be solely sourced as public funding, plus that private sector investment is necessary to achieve carefully sustainable outcomes. ISA, in partnership with Mission Innovation, Breakthrough Coalition, as well as an Indian government, has the potential to globalize initiatives such as Renewable Energy Investment Program (RE Invest), which receives backing from the US government plus other entities. Additionally, there could be the establishment of solar energy invention incubators akin to those proposed by an Indian National Institute aimed at Solar Innovation.

Promoting Cooperation

As stated in the ISA Annual Report 2022, approximately 90 countries have both signed as well as authorized the Outline Contract, while an additional 20 countries have employed but not yet ratified it. This brings the total to 110 member countries. Notably, this group includes both developed nations and less developed countries such as Somalia and Fiji, highlighting a commitment to global equity [50]. Furthermore, various organizations are collaborating to promote solar energy as a feasible option worldwide. The World Bank, UNDP, and ICAO are among the organizations involved. This position is noteworthy, as highlighted by Prime Minister Modi during a speech at the inaugural Assembly of ISA in October 2018, where he referred to the initiative as a move towards "One World, One Sun, and One Grid." The primary objective of ISA's is to fund developing countries, particularly in areas comprised of Africa plus certain areas of Southeast Asia as well as Latin America, which aligns with India's strategic geopolitical interests.

Less affluent nations within the ISA have the opportunity to unite and engage in negotiations with oil-rich countries toward dismantling their dominance in the oil and gas sector resources. This collaboration could significantly reduce their dependence on West Asian countries for energy supplies and lead to substantial savings in currency. Additionally, countries such as Afghanistan, Uzbekistan, and Turkmenistan, which possess abundant solar energy potential, can collaborate to establish an institutional framework dedicated to harnessing solar energy. This initiative may pave the way for the establishment of a solar-powered alternative energy framework. Efforts in this direction have already been commenced within the ISA, with a notable milestone achieved during Indian Ocean Renewable Ministerial (IORM) conference apprehended in October 2018. The partnership between India and Bolivia in the field of solar energy exemplifies how trans-regional cooperation in this sector can create opportunities for equity and a fair energy framework on the global stage. Through Indian President Ram Nath Kovind's visit to Bolivia, together countries pledged toward collaborate on the development of lithium batteries. Additionally, Bolivia expressed its desire to become a member of ISA. This collaboration in solar energy among various regions revitalizes the concept of the Global South [51].

The Democratic Republic of Congo, which has endorsed the agreement, is home to 60% of the global cobalt reserves. Meanwhile, Chile, while only a participant, is included in the "lithium triangle," a coalition of countries that collectively hold approximately 54% of world's lithium resources. Though Chile has not up till now completed the ratification of the ISA agreement by these mineral-abundant ISA nations could result in substantial progress in solar energy development [52].

6.3. Bridging the gap-ISA

6.3.1 Leveraging a New Geography

The establishment of ISA signifies a significant transformation in India's foreign policy, which encompasses the climate change issue and has been strategically leveraged to advance the nation's interests. This initiative serves two primary purposes: first, to make India as a frontrunner in the solar energy sector, thereby reinforcing its dedication toward climate action; second, toward enhancing its global stature by founding a new treaty-based international organization (Jha, in press). By 2015, below the leadership of Prime Minister Narendra Modi, India experienced a notable shift in its foreign policy objectives, as the country sought to assume a prominent character in global [32] governance as well as assert its influence alongside other significant nations in the international arena. Following the shift in political leadership, the negotiators were granted the authority to finalize an agreement, leading to the swift ratification of the Paris Agreement [33]. This development alleviated fears that India would demand that established nations first meet their pre-2020 obligations below the 2nd stage of Kyoto Protocol. Concurrently, the establishment of ISA represented a diplomatic achievement aimed at India, as it sought to address an exact supremacy issue while bridging G77 plus G20 groups to facilitate the creation of a novel intergovernmental organization.

During an inaugural assembly of ISA in October 2018, Prime Minister Modi articulated the vision of OSOWOG, aimed at establishing an international electricity grid that would facilitate the distribution of solar power worldwide. As said by a draft plan developed via MNRE, OSOWOG is set to link 140 nations through a unified grid designed for the transfer of solar energy. This initiative will unfold in three distinct phases: the initial stages will integrate an Indian grid by those of Middle East, South Asia, as well as Southeast Asia to enable the sharing of solar as well as other renewable energy resources [34]; the subsequent phase will establish a connection to the nations involved in the initial stage by Africa's renewable energy sources; and the final phase will focus on achieving global interconnection. At the Glasgow Climate Conference, India, UK, as well as ISA formally introduced Green Grids Initiative (GGI), which aims to establish a globally organized grid aimed at solar energy trading [35].

ISA's theory of change is structured around three key components: firstly, promoting Energy accessibility at the community level, secondly, guaranteeing national level energy security; and thirdly, facilitating an energy transition on a global scale. Given the regions targeted by the OSOWOG initiative, it is evident that the ISA represents an initial move towards positioning India as a prominent leader in the global dialogue on solar energy. However, it remains to be seen whether ISA is simply a reflection of the soft power in india otherwise if it will effectively achieve its ambitious goals of advancing the worldwide adoption of solar energy also thereby ensuring the energy future of India.

6.4. Solar Energy in Developing Countries: Bridging the Energy Gap

Developing nations are currently at a pivotal moment as the global community confronts the pressing issue of providing access to dependable and sustainable energy. Numerous countries experience energy poverty, which is marked by insufficient access to electricity and dependence on conventional energy sources that are frequently detrimental to the environment. This article delves into the revolutionary potential of solar energy in emerging countries, analyzing its capacity to close the energy divide, stimulate economic growth, and promote a more sustainable future. Several stakelders who were interviewed expressed the opinion that the ISA will play a lead role in times to come to provide clean energy access in rural areas. Its focus on capacity building will help the developing countries to be self sustained in energy infrastructure.

6.4.1 Energy Poverty in Developing Countries: A Persistent Challenge

Access to dependable energy is a crucial catalyst for economic advancement and human progress. Nevertheless, a considerable segment of the global population in developing nations remains without electricity. Conventional energy sources such as biomass, kerosene, and diesel generators frequently represent the sole alternatives, resulting in detrimental health impacts, environmental degradation, and the continuation of poverty cycles.

6.4.2. The Solar Advantage: Clean, Abundant, and Sustainable

Solar energy offers a distinctive approach to addressing the energy challenges encountered by developing nations. The sun, a plentiful and readily accessible resource, can be utilized through photovoltaic (PV) panels to produce electricity. In contrast to conventional energy sources, solar power is environmentally friendly, renewable, and exerts a minimal impact on the ecosystem, positioning it as an excellent option for sustainable development.

6.4.3 Off-Grid Solutions: Empowering Rural Communities

One notable feature of solar energy is its suitability for off-grid applications. Solar power presents a decentralized alternative in remote and rural regions where the establishment of conventional grid infrastructure is not economically viable. Off-grid solar systems, typically manifested as solar lanterns or compact solar home systems, deliver crucial electricity for lighting, cooking, and operating small appliances, thereby enhancing the quality of life in these communities.

6.4.4. Mini-Grids: Connecting Communities for Economic Growth

In areas where a centralized electrical grid has yet to be developed, solar-powered mini-grids are proving to be transformative solutions. These localized distribution systems serve groups of residences and commercial

establishments, promoting economic growth. By delivering dependable electricity, solar mini-grids facilitate the expansion of small businesses, including local retail outlets, educational institutions, and healthcare services, thereby establishing a basis for sustainable development.

6.4.5. Large-Scale Solar Projects: Powering Urban Centers

In urban regions of developing nations, extensive solar initiatives play a crucial part in addressing the increasing energy requirements. Solar parks and large-scale installations make substantial contributions to the energy grid, thereby decreasing dependence on fossil fuels. These initiatives not only bolster energy security but also aid in alleviating the effects of climate change, supporting worldwide endeavors to shift towards sustainable energy sources.

6.4.6 Economic Empowerment and Job Creation

The implementation of solar energy in developing nations extends beyond merely supplying electricity; it fosters economic empowerment and generates employment opportunities. The solar sector presents various job prospects, encompassing manufacturing, installation, and maintenance roles. As local communities participate in the production and upkeep of solar technology, it initiates a positive chain reaction, promoting economic development and lowering unemployment levels.

6.4.7 Health and Environmental Benefits

Conventional energy sources such as kerosene and biomass are significant contributors to Indoor air pollution presents significant health hazards, particularly affecting women and children. The adoption of solar energy removes the reliance on these detrimental sources, thereby enhancing respiratory health and lowering healthcare costs. Additionally, by decreasing reliance on fossil fuels, solar energy plays a crucial role in alleviating environmental damage and fostering climate resilience.

7. ISA and Developing World

7.1. Asia-Pacific region

ISA held the Fifth Meeting of the ISA Regional Committee aimed at Asia as well as the Pacific Region, reaffirming its dedication toward advancing the implementation of solar energy for a more environmentally friendly and sustainable future. This conference, conducted in partnership collaboration with the UAE government in Abu Dhabi commenced on July 24 to July 26, 2023, focused on the pressing need to develop and implement innovative solar power solutions on a large scale, improve organization as well as grid systems, also meet renewable energy objectives by 2030. Through the discussions, speakers emphasized the critical actions required to maintain a trajectory aligned with the 1.5°C climate goal and to tackle the challenges associated with climate change. The dialogues at the ISA's fifth meeting, which saw significant participation from various SIDS) revolved concerning the mobilization of resources to expedite a just energy transition. Main topics include the advancement of technologies aimed at mitigating climate change was incorporated the enhancement of socioeconomic opportunities, as well as the commitment to ensuring inclusivity in the pursuit of a sustainable future.

7.2. Europe (EU)

The recent global energy crisis, characterized by disruptions in supply chains, fluctuations in prices, and geopolitical tensions, has highlighted the importance of energy security. European countries are actively pursuing strategies to bolster their energy security by decreasing reliance on fossil fuel imports also diversifying their energy sources through renewable energy initiatives. A notable example of this commitment is the European Union's REPowerEU initiative, which aims to align regional energy supply with demand by promoting acceptance of renewable energy sources. These initiatives are crucial for establishing a more secure as well as sustainable energy future for the region. Additionally, the UNDP's Climate Promise initiative is assisting 18 out of the 54 countries in the region in updating and revising their Nationally Determined Contributions (NDCs) and in preparing second-generation NDCs.

Among the 54 countries, 46 have already submitted their second-generation Nationally Determined Contributions (NDCs), with an additional five currently in progress. Europe has achieved considerable progress in the production of renewable fuels, contributing 18% to the global total. Furthermore, renewable energy share in the overall area's overall electricity generation has experienced notable growth, rising from 25% to 36% over the past decade. In 2022, Europe continued to excel in PV capacity, adding an impressive 45 GW to its total installed capacity, which now stands at approximately 237 GW. Various countries in Europe have been instrumental in this expansion, with Spain at the forefront, contributing 8.1 GW, followed by the Netherlands with 3.9 GW, Poland with 4.9 GW, Germany with 7.5 GW, and France with 2.9 GW of additional solar PV capacity. These collective efforts underscore the region's dedication to enhancing solar energy and facilitating make the switch to more sustainable and clean energy solutions.

7.3. Latin America

Among the 33 nations in Latin America and the Caribbean (LAC), 16 are classified as Small Island and Developing States (SIDS), one is designated as a Least Developed Country, and four are identified as high emitters, with an average per capita income of $7,243. The American continent accounts for 20% of global greenhouse gas (GHG) emissions, with North American countries contributing a substantial 81%. Climate change affects every part of the region. Central America and the Caribbean are confronted with numerous challenges, including increasingly severe hurricanes that result in economic losses and heightened migration from the most affected areas, rising sea levels that threaten infrastructure and natural resources, and the ongoing degradation of the Amazon rainforest, which could exacerbate global warming and serve as a potential hotspot for future pandemics. Concurrently, nations in this region are pioneering low-carbon development, viewing it as an opportunity to enhance the long-term welfare of their populations.

7.4. Africa

Africa is a region characterized by significant complexity, rich in natural resources and biodiversity, and inhabited by 1.13 billion individuals who speak one-third of the world's languages, contributing to a vibrant and diverse cultural landscape. Nevertheless, the continent faces numerous challenges, including conflict and various crises that obstruct essential activities such as food production, local economic growth, and access to healthcare. Among the 46 nations in sub-Saharan Africa, 32 are designated as LDCs, 6 as SIDS, and 33 are identified as fragile states. According to the UNDP's Climate Promise report released in July 2022, 40 out of the 55 African countries have submitted their Nationally Determined Contributions (NDCs), with an additional five anticipated to follow suit. Of these, 44 countries are receiving support through the UNDP's Climate Promise and are progressing towards the submission of their second-generation NDCs, with 39 countries having already submitted theirs and four more expected to do so prior to COP 28.

Access to electricity remains a considerable challenge in numerous regions of Africa. The IEA World Energy Outlook 2023 indicates that approximately 600 million individuals in Africa currently lack electricity, representing about 80% of the global population without access, with the majority residing in sub-Saharan Africa. Africa is witnessing substantial growth in renewable energy installations, with PV projects, wind farms, as well as small-scale hydropower becoming increasingly prevalent. Additionally, off-grid solar solutions, comprised of solar home systems plus mini-grids, are aimed at electrifying rural communities.

In 2022, Africa achieved the installation of 870 MW of new solar photovoltaic capacity, marking an approximate 10% rise from the 797 MW added in the prior year. The leading countries in the region regarding total solar installed capacity are South Africa, Egypt, Morocco, Algeria, and Kenya, which together account for an impressive 9,671 MW. This collective capacity represents 77% of the continent's total installed solar capacity.

7.5. Middle-East

The Middle East consists of 19 nations and is inhabited by approximately 394 million individuals, which includes four Least Developed Countries, in addition to several of the largest oil and gas producers globally. This region accounts for 7% of greenhouse gas emissions. Furthermore, the Middle East receives the highest levels of solar radiation. Over, the last ten years, the region has seen a tenfold surge in its renewable energy capacity. Nevertheless,

the temperature in this area is rising at a rate that surpasses the global average. Projections indicate that by the year 2100, the Middle East may experience an increase of 5°C in average temperatures compared to pre-industrial levels. As of 2022, the whole installed capacity of solar PV systems in the Middle East reached 13.4 GW, with an addition of 3.5 GW in 2022, marking a 55% increase in capacity contrasted to the preceding year. Notable capacity expansions in 2022 were observed in Qatar (increasing from 5 MW in 2021 to 805 MW in 2022) and Oman (rising from 155 MW in 2021 to 655 MW in 2022). However, Israel and the United Arab Emirates, which lead in solar PV installed capacity, have seen a decline in capacity additions in 2022.

8. India's Global Leadership Perspective

ISA represents a significant advancement for India as it broadens its influence in the global arena while addressing two pressing challenges of our time: energy production as well as climate change. By investing in domestic solar initiatives and promoting the ISA, India has possible to transmute the utilization of solar energy and reinforce its status as a global leader in this sector, thereby improving its global standing and soft power. Many interviewees expressed that the establishment of ISA marked a diplomatic victory of India at the COP21 in 2015. However, to materialise this soft power ambition, India must convert it into tangible benefits within the global framework, the interviewees argued. Consistent with R.K. Singh, the Union Minister of New as well as Renewable Energy, solar energy is projected to become the dominant source of power generation in a large part of the world by 2030 [41]. Consequently, initiatives such as the distribution of LED lights, the provision of 500 training opportunities for ISA member countries, also the launch of a mission toward promoting solar technology represent significant advancements. It was noted that there are currently six programs plus 2 projects underway, each talking about different aspects of solar energy. To meet the drinking water, irrigation, lighting, as well as productive energy requirements of member nations of ISA, which have largely lacked up-to-date energy services a significant pipeline exceeding $5 billion has been established aimed at solar energy requests. Through its various programs, ISA has reported a request aimed at over 270,000 solar pumps through 22 countries, more than 1 GW of solar rooftop installations in 11 countries, also over 10 GW of solar mini-grids in nine countries [42].

To maximize the benefits of ISA, India must ensure that the majority of its objectives are met. While progress in its domestic solar initiatives is necessary, it is not sufficient on its own. This advancement will demonstrate New Delhi's capabilities as the principal ISA architect. It is essential to globalize India's methodology for solar energy production, which encompasses strategies for auctioning power distribution plants also and initiatives toward fostering favorable circumstances for distributed solar systems on rooftops and off-grid. Consequently, India's domestic efforts toward encouraging this framework may be perceived as unilateral actions; however, its endeavors to unite other nations under ISA toward sharing insights on the Indian solar production model exemplify effective leadership. To be recognized as the leading contributor to the organization, India must present its accomplishments to a broader international audience.

Establishing a clear link between specific geopolitical advantages and the enhancement of soft power can be challenging. Nevertheless, India's recognition as a "global solar powerhouse" is expected to benefit the nation in various contexts, particularly in upcoming climate discussions or in influencing global green investment trends to its advantage. India aspires for its elevated status to encompass areas beyond just energy and environmental issues. Consequently, India's objectives at the United Nations, such as obtaining a permanent seat on Security Council otherwise fostering a comprehensive global anti-terrorism agreement, may receive increased support from countries that benefit as of the ISA. The most significant challenge may lie in translating enhanced influence in one sector to other areas. To accomplish this, India must adeptly leverage its soft power [48].

8.1. India's Climate Leadership in the Global South

In the forthcoming years, as India gained greater economic confidence, its perspective on global climate change negotiations began to evolve. There emerged an understanding that attaining the future net-zero emissions objective, essential for curbing further increases in global temperatures, would be unattainable without significant emission reductions from countries such as India. Consequently, on the sidelines of CoP 21 in Paris, Narendra Modi plus French President Francois Hollande inaugurated an ISA on November 30, 2015 [36]. This initiative was driven by

the recognition of a lack of an international organization dedicated specifically to advancing global efforts in solar energy.

ISA marked India's inaugural initiative to establish a treaty-based organization with the support of nations from Asia and Africa. The ISA framework officially came into effect on December 6, 2017. Initially, it was designed exclusively for tropical countries; however, a 2020 amendment expanded its membership to include all United Nations member states. The primary objective of the ISA is to mobilize over 1 trillion USD in investments by 2030 to develop the essential infrastructure required for generating 1000 GW of solar energy. Additionally, it seeks to reduce the costs of solar energy by consolidating various elements such as demand, technology, finance, research, and capacity building. The organization is headquartered in Gurugram and currently comprises 103 member states [38].

In 2019, India took the lead in founding a Coalition aimed at Disaster Resilient Infrastructure. This initiative was introduced at the New York Climate Summit and is designed to enhance the flexibility of both novels as well as present organizations toward easing the influences of disasters exacerbated by climate change. The organization serves as a collaborative platform for nations that are most affected by climate-related challenges and those that possess the capacity to develop climate-resilient infrastructure. Among its initiatives is the Infrastructure for Resilient Island States (IRIS), which was launched during CoP 26 in Glasgow. This program aims to offer essential technical assistance to small island nations in their efforts to create infrastructure for disaster-resilient [39]. The Coalition aimed at Disaster Resilient Infrastructure is notable for being the second international organization to be based in India, comprising 31 member countries, 6 international organizations, and 2 private sector entities [40].

The fundamental tenet of India's present diplomatic stance can be traced back to its enduring policy of non-alignment, which was initially articulated by Prime Minister Jawaharlal Nehru. This approach has evolved into what modern analysts refer to as "multi-alignment," enabling India to maintain productive relationships with diverse and often opposing groups of countries while safeguarding its strategic independence. With projections indicating GDP growth exceeding 6% through 2024, India has enhanced its ability to engage constructively with both developed and developing nations. In this context, the Indian government has demonstrated significant initiative in creating platforms that unite various countries around shared interests, as illustrated by an ISA also CDRI.

8.2. Climate Action in the Global South

Climate change represents a worldwide challenge that necessitates collaborative efforts and creative solutions. As we find ourselves at the cusp of significant transformation, it is essential to assess the advancements achieved in climate initiatives, especially within the Global South. The pursuit of climate action in the Global South is closely associated with the principles of climate and energy justice. Given that a substantial portion of the vulnerable population resides in Global South nations, the transition to sustainable energy must be viewed not only as an environmental necessity but also as a moral and economic obligation.

9. Achievements in Clean Energy Transition

Numerous nations in the Global South have already embarked on the journey toward achieving net zero goals ahead of the established timeline. They have set ambitious objectives aimed at decreasing the carbon intensity of their economies. Publicly accessible data supporting these efforts can be found in the INDC declarations required by the Paris Climate Agreement, as well as on the official websites of various Global South countries. These nations are increasingly acknowledging renewable energy source's potential toward fulfilling their energy needs sustainably. Solar, wind, hydro, and geothermal energy have emerged as effective alternatives, providing cleaner options compared to conventional fuels. Initiatives such as GEAPP have been instrumental in facilitating this transition, promoting collaboration, and advancing innovative financing strategies.

9.1. Addressing Energy Poverty and Promoting Economic Development

A significant milestone in climate action is the recognition that clean energy serves not only as an environmental necessity but also as a catalyst for economic advancement. GEAPP’s dedication to enhancing energy access and facilitating a fair energy transition is in harmony with this concept. By guaranteeing that clean energy consistently

reaches underserved communities, we enable changes aimed at local economic growth, innovation, as well as employment generation. This strategy highlights connections among energy use as well as economic growth, especially in the Global South.

9.2. ISA post and Pre-projects

Substantial progress has been achieved through the initiatives established prior to 2018, with India leading the International Solar Alliance (ISA). Nine distinct programmes concentrate on three main importance areas: capacity building, analytics and advocacy, and programmatic support. The programmes encompass:

- Inexpensive Finance at Scale
- Scaling Solar Applications for Agricultural Use (SSAAU)
- Scaling Solar Mini-Grids
- Scaling Solar Rooftops
- Solarizing Heating & Cooling Systems
- Scaling Solar E-Mobility & Storage
- Solar Park
- Solar for Green Hydrogen
- Solar Battery & Waste Management

Five initiatives undertaken by India and France aim to enhance capacity building for the expansion of solar energy and financing. These initiatives encompass Indian Technical as well as Economic Cooperation (ITEC) Scheme, ISA Solar Fellowship aimed at Mid-Career Professionals, Solar Technology Application Resource Centres (STAR C), Infopedia, and the Global Solar Facility (GSF).

These programs have commenced in Africa, a continent with immense solar energy potential yet minimal global installed solar capacity. Furthermore, Africa has a considerable population lacking access to electricity, rendering it an optimal area for these initiatives. Following their implementation in Africa, these projects will be adapted and introduced in other regions, including South America and Asia, tailored to meet the specific requirements of each area.

9.3. ISA demonstration project

In May 2020, ISA launched Demonstration Projects designed to address the requirements of LDCs and SIDS. The objective was to showcase scalable solar technology uses and enhance the capabilities of Member Countries toward repeating these solar energy answers.

- **Bhutan:** National Post Harvest Centre in Paro for Solar cold storage.
- **Burkina Faso:** The solarization of 2 main healthcare facilities located in the rural communes of Louda plus Korsimoro in central northern area.
- **Cambodia:** primary as well as secondary schools of solarization in Koh Rong city.
- **Cuba:** Solar water pumping system has been implemented at Hatuey Indian Experimental Station (EEIH) placed in Perico, Matanzas.
- **Djibouti:** The deployment of two off-grid solar-powered cold storage facilities is set to take place in Omar Jaga'a within Arta region also in Dougoum village located in the Tadjourah region.
- **Ethiopia:** Gedeo Zone Solar-powered water pumps, specifically within the Irgachefe Woreda community.
- **Mauritius:** Solarization of Jawaharlal Nehru Hospital located in Rose Belle.
- **Samoa:** In 46 locations, solar streetlights have been installed.
- **Senegal:** Solar cold storage located in Ndande Borough, situated inside the Municipality of Theippe in Kebemer Department.
- **The Gambia:** In Wassadou and Julangel, solar water pumping systems have been installed.
- **Tonga:** Solar water pumping project implemented in 4 villages on Tongatapu
- The ministry highlighted that with the support of grants provided by the ISA, a remote medical facility and three elementary schools in Uganda have been equipped with solar energy systems. These

installations feature an 8.5-kilowatt peak capacity and a battery storage system of 17.2 kilowatt hours, all at a total expenditure of USD 48,835.

9.4. Solar Parks implementation as well as ISA project Member Countries- ISA Program 06

NTPC is tasked with the implementation of solar parks plus projects amounting to 10,000 MW across ISA member nations. In line with this initiative, NTPC is presently undertaking consultancy projects totaling 6,620 MW in 13 distinct countries in Africa and Latin America. Of this total, 2,870 MW of projects are designated for execution in Africa, while the remaining 3,750 MW will be developed in Latin America. The project management consultancy assignments are currently at different stages of progress.

The ISA has recently undertaken initiatives in nations including Fiji, Comoros, Madagascar, Seychelles, and Malawi. These projects are designed to enhance energy accessibility, lower carbon emissions, and generate employment opportunities.

10. Advantages of ISA

It will provide the necessary impetus for clean energy as the global community confronts the challenges posed by the effects of climate change caused by pollution from energy production facilities such as coal plants.

The Alliance operates a Solar Cyber Centre that is accessible around the clock. This facility will provide all nations with guidance and information regarding various projects and financial innovations.

Additionally, the Alliance can assume an advocacy role by encouraging financial institutions to allocate a portion of their lending towards solar energy initiatives. This approach mirrors the actions taken by the Reserve Bank of India, which designates investments of up to 15 crore in renewable energy as priority sector lending, while also allowing for priority sector lending of up to 10 lakh for rooftop solar panel installations.

11. Challenges of ISA

Underutilization of ISA's Potential: The ISA has encountered difficulties in executing its projects and in generating enthusiasm for solar energy in nations that urgently require energy access, despite its lofty objectives. Nevertheless, with the foundational work established in recent years, numerous countries are approaching the tendering phase for solar initiatives, indicating a possible increase in solar energy deployment.

Funding and Staffing Issues: The ISA has faced challenges related to funding and staffing, which have adversely affected its capacity to achieve its goals. It is essential to resolve these issues to improve its overall effectiveness.

Relationship with Indian Government Ministries: The ISA has experienced a challenging relationship with Indian government ministries, especially the Ministry of New as well as Renewable Energy, which has hindered its advancement and financial support.

Need for Creating Excitement about Solar Energy: Fostering enthusiasm for solar energy is crucial for its extensive acceptance. The ISA should focus on raising awareness and generating excitement to achieve its ambitious goals and promote a more equitable global solar market.

12. Recommendations

The alliance places a particular emphasis on enhancing the utilization of solar energy in emerging regions, especially in Africa, Asia, plus Latin America, with the [53] overarching aim of augmenting the contribution of solar power to the global energy portfolio. Recommendations aimed at ISA may contain:

1. Urging member nations to establish bold objectives aimed at the implementation of solar energy and also to offer assistance in reaching these objectives.

2. Creating programs to enhance the adoption of solar energy in countryside plus isolated regions, where electricity admittance is frequently restricted.

3. Offering financial resources plus technical support aimed at the advancement of solar initiatives in member nations, especially in those with lower income levels.

4. engaging with various global organizations as well as private sector stakeholders to foster the solar industry development also facilitate an implementation of solar technologies.

5. Promoting strategies plus rules that encourage the expansion of solar industry also an integration of solar technologies.

6. In summary, the ISA has the potential to significantly enhance the application of solar energy and also aid in the transition towards an additional maintainable global energy framework.

13. Conclusion and future scope

Energy insecurity presents a significant challenge in numerous developing nations, particularly in regions such as Asia, Africa, Europe, and Latin America. This issue is especially pronounced among poorer and more vulnerable populations residing in rural areas. The utilization of solar energy holds promise for addressing the energy deficit while providing socio-economic and environmental benefits. As a clean and sustainable resource, solar energy adoption contributes toward reduction of Greenhouse Gas Emissions (GHG), which is the leading contributor toward climate change. Furthermore, it guarantees access to cost-effective and dependable resources and sustainable energy for all by the year 2030, in conformity with the United Nations' Sustainable Development Goal 7. An evaluation of the initiatives and activities undertaken by the ISA within the framework of developing countries reveals their substantial impact on livelihood resources, fostering economic diplomacy in the Global South, and aligning financial and technological objectives for a clean energy transition. The benefits derived from climate change mitigation efforts spread outside merely safeguarding the global climate scheme; they also promote the integration of climate adaptation strategies and the promotion of sustainable livelihoods in nations.

ISA has developed into a dynamic diplomatic platform aimed at advancing and supporting the solar energy industry worldwide. Over afterward five years, the ISA intends to secure universal membership from all United Nations member states, achieve financial sustainability, enhance resource mobilization for its members—particularly for LDCs as well as SIDS—and reach the ambitious goal of implementing 1001 solar projects within its member nations. These initiatives are expected to attract investments and generate employment opportunities within the solar sector in the foreseeable future. The ISA stands as one of the largest and most influential thematic science diplomatic initiatives dedicated to the global promotion of solar energy.

Reference

[1] Espinosa Garcés, M.F., 2024. Saving the planet: Revitalizing the UN for our common future. *Environmental Policy and Law*, *54*(2-3), pp.89-100.

[2] Wang, Q., Wang, X., Li, R. and Jiang, X., 2024. Reinvestigating the environmental Kuznets curve (EKC) of carbon emissions and ecological footprint in 147 countries: a matter of trade protectionism. *Humanities and Social Sciences Communications*, *11*(1), pp.1-17.

[3] Azzeddine, B.B., Hossaini, F. and Savard, L., 2024. Greenhouse gas emissions and economic growth in Morocco: A decoupling analysis. *Journal of Cleaner Production*, *450*, p.141857.

[4] Selje, T., Schmid, L.A. and Heinz, B., 2024. Community-Based Adaptation to Climate Change: Core Issues and Implications for Practical Implementations. *Climate*, *12*(10), p.155.

[5] Bhaskar, U. (2020, May 28). India invites bid for One Sun One World One Grid to take on China's Belt and Road Initiative. Mint. Retrieved from https://www. livemint.com/industry/energy/india-answer-to china-belt-and-road-initiative-one-sun-one-world one-grid.

[6] IRENA. (2023). Country rankings. International Renewable Energy Agency. Retrieved from https:// www.irena.org/Data/View-data-by-topic/Capacity and-Generation/Country-Rankings.

[7] Dietl, G., 2024. *The Global Game of Coal: Retreat, Resurgence and Eventual Retreat*. Taylor & Francis.

[8] Yadav, V.K., 2025. Influence of Green Finance on Growth of Indian Economy: An Empirical Study on Non-Conventional Energy Sources. *Challenges and Opportunities for Innovation in India*, p.248.

[9] Todd, I., 2024. Solar energy and the just transition. In *The Future of Just Transitions* (pp. 142-159). Edward Elgar Publishing.

[10] Riahi, E. and Islam, M.S., 2024. Employees' information security awareness (ISA) in public organisations: insights from cross-cultural studies in Sweden, France, and Tunisia. *Behaviour & Information Technology*, pp.1-23.

[11] Deshpande, T., Mukherji, R. and Sastry, M., 2025. Policy styles and India's national action plan on climate change (NAPCC). *Policy Studies*, *46*(1), pp.46-63.

[12] Abegón-Novella, M., 2024. Making sense of the agreement on biodiversity beyond national jurisdiction: the road ahead. *Environmental Policy and Law*, *53*(5-6), pp.439-458.

[13] Invest India. (2024, February 7). Renewable Energy in India - Indian Power Industry Investment. Retrieved February 1, 2024,

[14] Saraswat, A., 2025. *Evolving legal framework for solar energy in India: a study in the context of energy justice and sustainable development* (Doctoral dissertation, Bennett university).

[15] Mishra, S., Empowering the Global South: India's Role in Renewable Energy via International Solar Alliance (ISA). *Journal homepage: www. ijrpr. com ISSN*, *2582*, p.7421.

[16] Barrie, I., Agupugo, C.P., Iguare, H.O. and Folarin, A., 2024. Leveraging machine learning to optimize renewable energy integration in developing economies. *Global Journal of Engineering and Technology Advances*, *20*(03), pp.080-093.

[17] Mertens, J., Dewulf, J., Breyer, C., Belmans, R., Gendron, C., Geoffron, P., Goossens, L., Fischer, C., Du Fornel, E., Hayhoe, K. and Hirose, K., 2024. From emissions to resources: mitigating the critical raw material supply chain vulnerability of renewable energy technologies. *Mineral Economics*, pp.1-8.

[18] Stock, R. and Sovacool, B.K., 2024. Blinded by sunspots: Revealing the multidimensional and intersectional inequities of solar energy in India. *Global Environmental Change*, *84*, p.102796.

[19] Miyake, S., Teske, S., Rispler, J. and Feenstra, M., 2024. Solar and wind energy potential under land-resource constrained conditions in the Group of Twenty (G20). *Renewable and Sustainable Energy Reviews*, *202*, p.114622.

[20] Jeudy-Hugo, S., Re, L.L., Pouille, C. and Errendal, S., 2024. Insights for designing mitigation elements in the next round of Nationally Determined Contributions (NDCs). *OECD/IEA Climate Change Expert Group Papers*.

[21] Vhatkar, M.S., Raut, R.D., Gokhale, R., Kumar, M., Akarte, M. and Ghoshal, S., 2024. Leveraging digital technology in retailing business: Unboxing synergy between omnichannel retail adoption and sustainable retail performance. *Journal of Retailing and Consumer Services*, *81*, p.104047.

[22] Zeng, L., Wong, W.K., Fu, H., Mahmoud, H.A., Cong, P.T., Thuy, D.T.T. and Bach, P.X., 2024. FinTech and sustainable financing for low carbon energy transitions: A biodiversity and natural resource perspective in BRICS economies. *Resources Policy*, *88*, p.104486.

[23] "Soft Law in a Hard Shell": India, international rulemaking and the International Solar Alliance. Transnational Environmental Law, 10(3), 517-541.

[24] Gupta, B. and Jose, M.M., 2024. Intersecting Priorities: India's Approach to the Politics of Climate Change—Domestic Development and Global Commitments. In *BRICS and Climate Change: Balancing National Interests, National Development Goals and Global Environmental Sustainability* (pp. 97-117). Singapore: Springer Nature Singapore.

[25] Singh, K., Meena, R.S., Kumar, S., Dhyani, S., Sheoran, S., Singh, H.M., Pathak, V.V., Khalid, Z., Singh, A., Chopra, K. and Bajar, S., 2023. India's renewable energy research and policies to phase down coal: Success after Paris agreement and possibilities post-Glasgow Climate Pact. *Biomass and Bioenergy*, *177*, p.106944.

[26] Chaturvedi, V., Koti, P.N. and Chordia, A.R., 2021. Pathways towards India's nationally determined contribution and mid-century strategy. *Energy and Climate Change*, *2*, p.100031.

[27] Seel, J., Kemp, J.M., Cheyette, A., Millstein, D., Gorman, W., Jeong, S., Robson, D., Setiawan, R. and Bolinger, M., 2024. Utility-Scale Solar, 2024 Edition: Empirical Trends in Deployment, Technology, Cost, Performance, PPA Pricing, and Value in the United States.

[28] Dubey, B., Agrawal, S. and Sharma, A.K., 2023. India's Renewable Energy Portfolio: An Investigation of the Untapped Potential of RE, Policies, and Incentives Favoring Energy Security in the Country. *Energies*, *16*(14), p.5491.

[29] Maggu, P., Singh, S., Sinha, A., Biamba, C.N., Iwendi, C. and Hashmi, A., 2024. Sustainable and optimized power solution using hybrid energy system. *Energy Exploration & Exploitation*, p.01445987241284689.

[30] Pai, L., Senjyu, T. and Elkholy, M.H., 2024. Integrated Home Energy Management with Hybrid Backup Storage and Vehicle-to-Home Systems for Enhanced Resilience, Efficiency, and Energy Independence in Green Buildings. *Applied Sciences*, *14*(17), p.7747.

[31] Wandera, D.F. and Olonde, J., 2024. Enhancing Industrialization And Job Creation In The Context Of Just Energy.

[32] JOHNNY, D., 2024. SOFT POWER DIPLOMACY TACKLING ANTHROPOCENTRIC ABUSES: ANALYSIS ON INDIA'S CLIMATE GOVERNANCE (Doctoral dissertation, MAHATMA GANDHI UNIVERSITY).

[33] Falk, R.A. and von Sponeck, H., 2024. *Liberating the United Nations: Realism with Hope*. Stanford University Press.

[34] Jai, S. (2020, August 15). One Sun, One World, One Grid: All you need to know about mega solar plan. *Business Standard*.

[35] UN Climate Change Conference. (2021, November 2). Green grids initiative—One Sun One World One Grid: One sun declaration.

[36] Ananthakrishnan, G. (2021, November 16). *Modi launches International Solar Alliance*. The Hindu.

[37] *nternational Solar Alliance: Ministry of new and renewable energy: India*. MINISTRY OF NEW AND RENEWABLE ENERGY | India. (n.d.).

[38] International Solar Alliance. (2024). Programmes.

[39] Sablok, A. (2023, September 14). *Examining the Role of the Coalition for Disaster Resilient Infrastructure (CDRI)*. Indian Council of World Affairs.

[40] *Members*. Coalition for disaster resilient infrastructure. (2024).

[41] PTI. (2020, October 15). India re-elected as president of International Solar Alliance. The Hindu. Retrieved from https://www.thehindu.com/news/international/india-re-elected-as-president-of-international-solar alliance/article32859827.ece.

[42] PTI. (2020, October 15). India re-elected as president of International Solar Alliance. The Hindu. Retrieved from https://www.thehindu.com/news/international/india-re-elected-as-president-of-international-solar alliance/article32859827.ece.

[43] Tripling Global Renewable Energy Capacity by 2030 Leading the Wayhttps://isolaralliance.org/uploads/docs/e1af69b3b0d1820b3b03d0fd7c8c2f.pdf.

[44] Interview with French Government Official, "Interview", (05-Jun-2019).

[45] V. Sivaram, G. Shrimali, D. Reicher, "Reach for the Sun: How India's Audacious Solar Ambitions Could Make or Break its Climate Commitments, Stanford Law School, 08-Dec-2015 [Online].
[46] CEEW, Common Risk Mitigation Mechanism (CRMM), CEEW, 20-Jun-2018 [Online]. Available: https://www.ceew.in/common-risk-mitigation-mechanismcrmm, Accessed date: 16 January 2019.
[47] V. Sivaram, G. Shrimali, D. Reicher, "Reach for the Sun: How India's Audacious Solar Ambitions Could Make or Break its Climate Commitments, Stanford Law School, 08-Dec-2015 [Online].
[48] Shidore, S., & Busby, J. W. (2019). One more try: The International Solar Alliance and India's search for geopolitical influence. Energy Strategy Reviews, 26.
[49] PTI. (2021b, November 12). ISA, UNFCCC ink pact to fight climate change. The Economic Times. Retrieved from https://economictimes.indiatimes.com/industry/renewables/isa-unfccc-ink-pact-to-fight-climate-change/articleshow/87671101.cms.
[50] International Solar Alliance. (2022). Annual Report 2022. Gurugram, Haryana: International Solar Alliance. Retrieved from International Solar Alliance website: https://isolaralliance.org/uploads/docs/dd0a4816e4970cc4541d064603d61d.pdf.
[51] Mohapatra, N. K. (2019, April 19). Why the International Solar Alliance is geopolitically significant. Retrieved October 6, 2022, from www.downtoearth.org.in website: https://www.downtoearth.org.in/blog/energy/why-the-international-solar-alliance-is-geopolitically-significant-64080.
[52] Bhattacharya, S., Niranjan, E., & Purushothaman, C. (2018, March 16). India and the International Solar Alliance | Manohar Parrikar Institute for Defence Studies and Analyses. Retrieved December 19, 2022, from www.idsa.in website: https://www.idsa.in/backgrounder/india-and-the-international solaralliance_shreya.ekta.chithra_160318.
[53] Kadam, S., Dhole, K., Kumar, A., Gupta, N. and Mishra, S., Impact of International Solar Alliance on World.