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LEGAL ASPECTS OF TECHNOLOGY TRANSFER IN THE ENERGY SECTOR

ENERJİ SEKTÖRÜNDE TEKNOLOJİ TRANSFERİNİN HUKUKİ YÖNLERİ

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ABSTRACT

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The energy sector has undergone significant changes in recent decades, marked primarily by the liberalization of markets and the formation of regulatory bodies to facilitate market competition. The sector with greater technological complexity, more rapid changes, and more centralized R&D will tend to be driven more by foreign investors that control technology to be transferred. It is agreed that access to new technologies is a crucial factor in promoting development. Within the energy sector, technology transfer pertains to the transfer of capital goods, expertise, knowledge, and the acquisition of licenses for intellectual property rights. If energy technologies are transferred successfully into developing countries, benefits will accrue for developing countries and thus the world environment. This study considers the role of government policies to promote technology transfer within the energy sector and which of such measures prove to be successful and the leading barriers to transferring technology in developing countries and concludes with several policy recommendations to overcome these barriers.

Keywords: *Energy Law, Technology Transfer, International Trade Law, Foreign Direct Investment, Intellectual Property Rights*

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ÖZET

Enerji sektörü, son yıllarda, piyasaların serbestleşmesi ve piyasa rekabetini kolaylaştırmak için düzenleyici kurumların oluşumu ile belirginleşen önemli değişikliklere uğramıştır. Daha fazla yüksek teknolojiye, daha hızlı değişime ve daha merkezi Ar-Ge'ye sahip sektör, transfer edilecek teknolojiyi kontrol eden yabancı yatırımcılar tarafından yönlendirilme eğilimindedir. Yeni teknolojiye erişimin, gelişmeyi teşvik etmek için ana koşullardan biri olduğu kabul edilmektedir. Enerji sektöründe teknoloji transferi, sermaye mallarının, uzmanlığın, bilginin transferini ve fikri mülkiyet hakları için lisansların transferini kapsamaktadır. Enerji teknolojileri gelişmekte olan ülkelere başarılı bir şekilde aktarılırsa, gelişmekte olan ülkeler ve dolayısıyla dünya için fayda sağlayacaktır. Bu çalışma, enerji sektöründe teknoloji transferini teşvik etmek için hükümet politikalarının rolünü ve bu tür düzenlemelerden hangilerinin başarılı olduğunu ve gelişmekte olan ülkelerde teknoloji transferinin önündeki ana engelleri ele almaktadır ve bu engellerin üstesinden gelmek için bazı politika önerileri sunmaktadır.

Anahtar Kelimeler: *Enerji Hukuku, Teknoloji Transferi, Uluslararası Ticaret Hukuku, Doğrudan Yabancı Yatırım, Fikri Mülkiyet Hakları*

INTRODUCTION

The global energy landscape is undergoing a profound transformation, driven by the urgent need to address environmental concerns, increase energy efficiency, and ensure sustainable energy sources for the future. Furthermore, in recent decades, the energy sector has experienced notable transformations, primarily characterized by market liberalization and the establishment of regulatory authorities to promote competition[1]. The sector with greater technological complexity, more rapid changes, and more centralized Research & Development (hereinafter "R&D") will tend to be driven more by foreign investors that control technology to be transferred[2]. The consensus is that access to new technologies plays a vital role in facilitating development. Data indicates that technology transfer is of utmost importance as it enables

[1] United Nations Department of Economic and Social Affair, "High Level Dialogue on Energy, Theme Report on Energy Transition: Towards the Achievement of SDG 7 and Net-Zero Emissions", *UN Theme Report,* 2021, <https://www.un.org/sites/un2.un.org/files/2021-twg_2-062321.pdf >, Accessed 12 September 2023, p.1.

[2] United Nations Conference on Trade and Development, "Transfer of Technology UNCTAD Series on Issues in International Investment Agreements", *UNCTAD/ITE/IIT/28*, 2001, <https://unctad.org/system/files/official-document/psiteiitd28.en.pdf >, Accessed 12 September 2023, p. 23-24.

developing countries to gain access to novel technologies that are new to them[3]. Technology transfer in the energy sector involves the transfer of capital goods, expertise, knowledge, and the acquisition of licenses for intellectual property rights. If energy technologies are transferred successfully into developing countries, benefits will accrue for developing countries and thus the world environment. However, developing countries often face significant barriers to accessing new technologies due to legal, economic and political barriers such as limited financial resources, inadequate infrastructure, and inadequate policies to facilities technology transfer[4].

This paper considers the role of government policies to promote technology transfer within the energy sector and which of such measures prove to be successful and the leading barriers of transferring technology in developing countries. This paper concludes with several policy recommendations to overcome these barriers.

I. GENERAL OVERVIEW OF ENERGY SECTOR IN DEVELOPING COUNTRIES

The energy sector occupies a significant position with regard to sustainable international investment. Although, many developing countries have significant potential for solar, geothermal, and wind energy they lack modern energy services. Developing countries need for sustainable, affordable, and environmentally sound energy system as their population and energy demand increase[5]. Such system is also important to expand and modernize developing countries' energy sector[6].

In developing countries, the energy sector is usually characterized by the fossil fuels (natural gas, oil and coal), nuclear, and renewable energy. Given the harmful effects of fossil fuels, today's world more concerns clean energy and sustainable development[7]. Renewable energy sources are environmentally

[3] Mostafe Elsan and Mehdi Yousefichehreghani, "Legal Aspects of Technology Transfer Through Foreign Investment in Oil and Gas Industry", *Petroleum Business Review*, (3), 2019, p. 55.

[4] United Nations Conference on Trade and Development, *Transfer of Technology,* p. 16-18.

[5] Gill Wilkin**,** *Technology Transfer for Renewable Energy Overcoming Barriers in Developing Countries,* London Earthscan, 2002, p. 6.

[6] Ambuj D. Sagar/ Hongyan H. Oliver/ Ananth P. Chikkatur, "Climate Change, Energy, and Developing Countries", *Vermont Journal Enviromental Law,* (7), 2006, p. 117.

[7] Siddharth S. Kulkarni/ Lin Wang/ Demetrios Venetsanos, "Managing Technology Transfer Challenges in the Renewable Energy Sector within the European Union", *Wind,* 2(1), 2022,

cleaner than fossil fuels, and they are available in most parts of world[8]. The category of renewables comprises the main energy sources such as hydro, geothermal, wind, solar, wave, and tide[9]. In addition, it encompasses energy obtained from solid biofuels, bio-gasoline, biogases, other liquid biofuels, and the renewable component of municipal waste[10]. The emergence of a new global energy economy is being driven by faster-than-ever expansion of renewable energy, as per the reports of the International Energy Agency (hereinafter "IEA")[11]. Renewables will have the fastest growth in the sector, providing almost 35% of global power demand by 2025 according to the IEA[12]. It is foreseen that by 2026, the global capacity of renewable electricity will increase by over 60% compared to the 2020 levels, reaching a total of more than 4800 GW, which is comparable to the current global power capacity of fossil fuels and nuclear combined[13].

The priority renewable energy technology needs on a regional basis are presented in the figure below[14]. The priority technology needs were found to be for solar PV, biomass, hydro, and wind systems for Africa and Asia, geothermal technologies for Latin America and Caribbean, and municipal solid waste treatment technologies for Europe[15].

p. 150-151.

[8] Eric Moll, "Importance of Renewable Resources of Energy", *Home Guides SF Gates,* 2015, <http://homeguides.sfgate.com/importancerenewable-resources-energy-79690.html >, Accessed 12 January 2023.

[9] OECD, OECD Factbook Economic, "Environmental and Social Statistics", *OECD Publishing*, 2015-2016, <https://read.oecd.org/10.1787/factbook-2015-en?format=html >, Accessed 11 September 2023, p. 106.

[10] OECD, p. 106.

[11] International Energy Agency, "Renewables 2021 Analysis and Forecasts to 2026", *IEA,* Paris, 2021, <https://iea.blob.core.windows.net/assets/5ae32253-7409-4f9a-a91d-1493ffb9777a/Renewables2021-Analysisandforecastto2026.pdf >, Accessed 3 March 2023, p. 3.

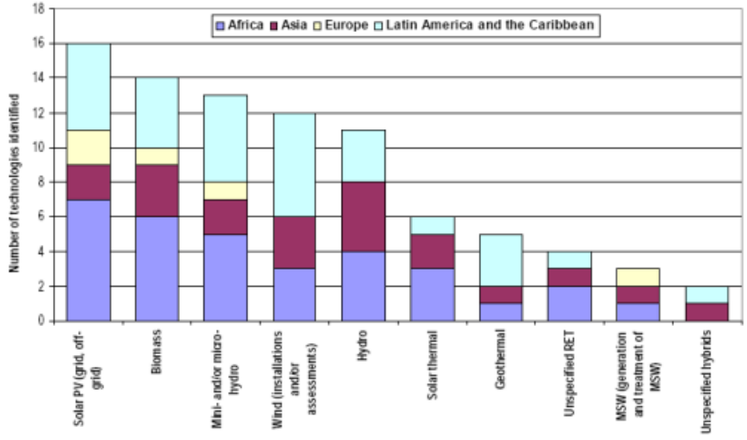
[12] Stefan Ellerbeck, *IEA: More Than A Third of The World's Electricity Will Come from Renewables In 2025,* (World Economic Forum*,* 16 March 2023), <https://www.weforum.org/agenda/2023/03/electricity-generation-renewables-power-iea/>, Accessed 22 July 2023, p.1.

[13] International Energy Agency, p. 14.

[14] United Nations, Department of Economic and Social Affairs, "Climate Change: Technology Development and Technology Transfer*", UN Background Paper*, 7-8 November 2008, <https://www.un.org/esa/sustdev/sdissues/energy/op/beijing_hlccc_nov08/back_paper.pdf>, Accessed 12 September 2023, p. 23.

[15] United Nations, *Climate Change,* p. 23.

Figure: Commonly identified renewable energy technology needs[16].



Note: Solar PV - solar photovoltaic; MSW - municipal solid waste; RET - renewable energy technology

The table below shows that category of countries for renewable energy technology transfer. First, the groups of technology developer countries relatively have large economies, high income per capita, and high Intellectual Property Rights (hereinafter "IPRs") protection[17]. Hence, they are more successful for attracting foreign flows of energy technologies. Compared to other members of this section, Argentina has a low performance in respect to private sector credit availability and protection of IPRs[18]. As a result of this, Argentina is classified as one of the countries that require structural changes[19].

Second, the "technology implementers" category consists of with small economies, yet favorable conditions for private investment and protection of

[16] United Nations, *Climate Change,* p. 23.

[17] Ana Pueyo/ Pedro Linares, "Renewable Technology Transfer to Developing Countries: One Size Does Not Fit All", *Institute of Development Studies IDS Working Paper*, C.V, No, 412, 2012, <https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.2040-0209.2012.00412.x >, Accessed: 1 March 2023, p. 25.

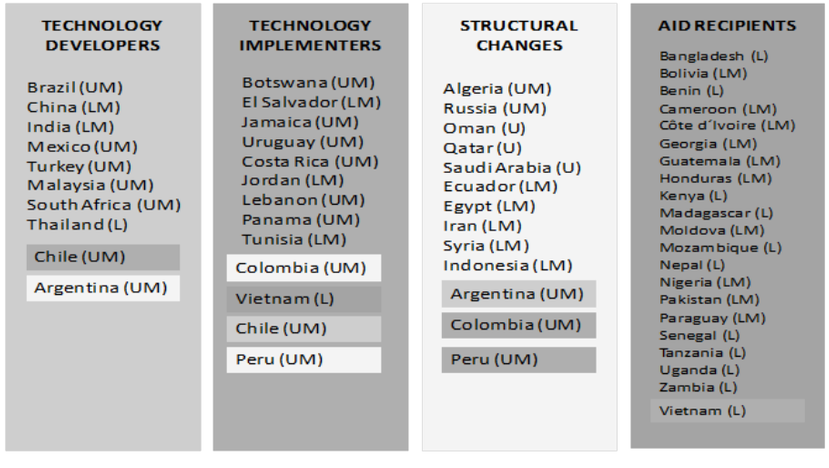
[18] Ana Velasco Pueyo: "Climate Change Technology Transferred to Developing Countries: Evidence Analysis and Policy Recommendations", *Thesis Doctoral,* E.T.S. Industriales UPM 2012, p. 240.

[19] Pueyo / Linares, p. 17.

IPRs[20]. These countries are mostly located in Africa, Latin America, and the Middle East and have an upper-middle-income status. Chile, due to its relatively small economy, could also be classifies as a "technology developer"[21].

Third, the countries in "structural changes" need to develop their investment climate. This group of countries exhibits comparatively elevated levels of per capita income, and "fossil-fuel protection", but low-level credit availability for private firms and IPRs protection[22]. Among other members of this section, Russia outdoes in the matter of "per capita income, credit availability, and protection of IPRs"[23].

Finally, the group of countries in "aid recipients" category require foreign aid for facilitate successful technology transfer. These low and lower-middle income countries from Africa, Asia and Latin America, lack the necessary economic and institutional frameworks to attract private investment due to insufficient demand[24]. Vietnam, which could also be categorized as a "technology implementer," performs well with regards to credit availability for foreign investors and size of its economy[25].



Note: UM: Upper-middle income, LM: Lower-middle income; L: Low income

[20] Pueyo / Linares, p. 17.

[21] Pueyo / Linares, p. 17.

[22] Pueyo / Linares, p. 17, 26.

[23] Pueyo / Linares, p. 17, 26.

[24] Pueyo / Linares, p. 17.

[25] Pueyo / Linares, p. 17.

II. MEASURES FOR PROMOTING TECHNOLOGY TRANSFER IN ENERGY SECTOR

Technology transfer is contingent upon various factors, including government policies, legal frameworks, market conditions, access to finance and information, and human resource capacities.

Governments have unquestionably a pivotal role in promoting energy technology transfer. Their involvement is particularly critical during the initial stages of research and development[26]. Developed countries are at the forefront of investing in energy R&D, while some of the larger developing countries also possess the resources to make significant technology investments[27]. In China, as a socialist country, governmental plans play an essential role. As an example, the government placed supercritical coal-fired power plants on the list of high-tech companies that need intensive R&D support by the government[28]. Further, in order to encourage foreign investors, the clear government policies, targets, and incentives are essential. A valuable lesson is "cogeneration from bagasse in India," where the Indian government has established cogeneration targets, and the electricity supply industry is purchasing the power at appealing rates, making it a desirable option for sugar mill operators[29].

Moreover, research shows that technology transfer in energy is more successful when the host state has technical and managerial skills[30]. A study states that India and China have employed distinct methods to obtain the necessary technologies in the wind energy sector such as acquisition of firms, forming strategic partnership, and leveraging national policies like incentives[31]. Furthermore, technology emerging economies are increasingly exporting technologies and manufacturing capacities abroad. China, for instance, is

[26] Susarla Ananta Rama Sastry / Ponnada Sreenu, 'New Energy Sources and their Sustainability' in *2012 IEEE International Conference on Engineering Education: Innovative Practices and Future Trends,* (Aicera, 2012) p. 1-15.

[27] Sastry / Sreenu, p. 1-15.

[28] Takahiro Ueno, "Technology Transfer to China to Address Climate Change Mitigation: U.S. Global Leadership: An Initiative of The Climate Policy Program at RFF, *Resources for The Future*, 9(1), 09 August 2009, <https://media.rff.org/documents/RFF-IB-09-09.pdf >, Accessed 1 March 2023, p. 12-13.

[29] Wilkin, p. 229.

[30] The Academy of Sciences for The Developing World Twas, *Sustainable Energy for Developing Countries*, 2008, p. 42.

[31] The Academy of Sciences, p. 36.

a global front-runner in renewable energy production, solar PV, and wind through Suntech, Sinovel, China Wind system and gold wind energy[32].

Technology transfer usually occurs through two type of channels: (i) Commercial channels such as foreign direct investment; joint venture; licensing agreements; international subcontracting; and turnkey contracts, and (ii) non-commercial channels such as exchange of info at global symposiums, trade fairs; education and training of host state labor force[33].

A. Foreign Direct Investment ("FDI")

The presence of a strong energy sector often serves as a precursor to attracting foreign direct investment in other sectors, as investors consider it as a factor when choosing where to direct their investments[34]. Given the significant investment cost and requisite skills, foreign direct investment (hereinafter "FDI") is deemed a suitable approach for manufacturing renewable energy systems, like solar cells and PV modules[35]. The introduction of new energy technologies in developing countries is increasingly reliant on FDI, which entails direct investment in plant or equipment[36]. Numerous developing countries aspire to leverage FDI as a means of obtaining technology, management and marketing expertise, and promoting access to foreign markets for local enterprises[37]. Therefore, many developing countries

[32] Loren Brandt / Luhang Wang, 'China's Development Of Wind And Solar Power, Loren Brandt' in Thomas G. Rawski (eds), *Policy, Regulation, And Innovation In China's Electricity And Telecom Industries,* (Cambridge University Press 2019), p. 373-418; Xiaomei Tan / Yingzhen Zhao / Clifford Polycarp/ Jianwen Bai, "China's Overseas Investments in the Wind and Solar Industries: Trends and Drivers", *World Resources Institute Working Papers,* 2013, <http://pdf.wri.org/chinas_overseas_investments_in_wind_and_solar_trends_and_drivers.pdf>, Accessed 10 July 2023, p. 1-22; Gavin Maguire 'Column: China Widens Renewable Energy Supply Lead with Wind Power Push' *Reuters (*1 March 2023), p.1.

[33] Thomas U Able, "Models of Renewable Energy Technology to Developing Countries", *Elsevier,* 9(1), 1996, p. 1104-1107.

[34] Polina Knutsson / Perla Ibarlucea Flores, "Trends, Investors Types and Drivers of Renewable Energy FDI", *OECD Working Papers on International Investment* 2022/02, < https://www.oecd-ilibrary.org/finance-and-investment/trends-investor-types-and-drivers-of-renewable-energy-fdi_4390289d-en > Accessed 17 March 2023, p. 5-6; Syed F. Mahmud / Selahattin M. Sirin, "A Review of Foreign Direct Investments in Turkish Energy Sector", *International Journal of Energy Studies,* 3(6), 2018, p.1-16.

[35] Knutsson / Flores, p. 5-6.

[36] Wilkins, p. 73-100.

[37] Moses M. Ikiara, "Foreign Direct Investments (FDI), Technology Transfer, and Poverty Alleviation: African's Hopes and Dilemma", *ATPS Special Paper Series,* (16), 2003, < https://atpsnet.org/wp-content/uploads/2017/05/special_paper_series_16.pdf > Accessed 2 February 2023, p. 1.

have improved their investment environments, and intellectual property rights to attract FDI. While the efficacy of FDI remains a topic of controversial, there are several benefits for host countries with regards to their economic growth. These benefits encompass hiring of local workforce, generation of new employment opportunities leading to a reduction in unemployment rates, transfer of financial resources, transfer of technical and managerial skills[38].

B. Joint Ventures ("JVs")

As an alternative to FDI, joint venture could be a more viable approach for facilitating technology transfer to developing countries as setting up joint ventures (hereinafter "JVs") reduce costs significantly on account of cheaper labour and materials in developing countries[39]. Joint venture is described as "business association between two or more parties who agree to share the provision of equity capital, the investment risk, the control and decision-making authority, and the profits or other benefits of the operation"[40].

In some cases, governments mandate foreign investors establish joint ventures with their local firms, as is the case with the Chinese government[41]. Nonetheless, foreign investors in China often have concerns about entering into JVs as they may be required to transfer their technology to their JV partner, or they may apprehend that their intellectual property will be outright stolen[42]. On the other hand, in certain instances, Chinese manufacturers are hesitant to adopt Japanese, German, or American technology in terms of crystalline silicon PV technology[43].

[38] ResearchFDI**,** "16 Advantages and Disadvantages of Foreign Direct Investment", *ResearchFDI Investment Attraction,* 11 March 2021, < https://researchfdi.com/resources/articles/foreign-direct-investment-advantages-disadvantages/ > Accessed 24 March 2023, p. 1.

[39] Able, p. 1104-1107.

[40] G.S Namusonge, "The Rule of Development Financial Institutions in the Acquisition of Technological Capacities by Small and Medium Enterprises in Kenya", *ATPS Working Paper Series*, 2004, < https://atpsnet.org/wp-content/uploads/2017/05/working_paper_series_41.pdf> Accessed: 27 March 2023, p. 41, 49.

[41] ChinaGlobalTrade, "China's Solar Industry and the U.S. Anti-Dumping/Anti-Subsidy Trade Case", *Hinrich Foundation,* 2012, p. 1.

[42] ChinaGlobalTrade, p. 1.

[43] Shyam Mehta / Yasmeen Hossain, "Photovoltaic Technology Characterization Review", *Sepa Report,* (16 September 2010), <Https://Www.Prweb.Com/Releases/Solar-Energy/

C. Public - Private Partnerships ("PPPs"): A New Kind of Joint Venture?

In recent times, several governments have adopted innovative public private partnerships (hereinafter "PPPs") as collaborative efforts between the public and private sectors play a significant role in driving development[44]. The main and more complex form of PPP transfers more risk from the public to the private partner while the basic form of PPP involves the private sector in the public structure[45]. One of the benefits of this approach is allowing governments and private investors to better align their incentives[46]. If technology transfer is a government priority, it can be directly incorporated into the agreement with the investor[47]. Moreover, governments are responsible for retaining sufficient expertise in the selection of PPP models that best suit their needs[48].

PPPs are important to financing renewable energy projects in developing countries[49]. During the 1990s, the Philippines experienced an energy crisis, despite having proven potential for using geothermal power generation to expand its generating capacity[50]. The Global Environmental Facility (hereinafter "GEF") approved a grant of US$30 million to the Philippine National Oil Company (hereinafter "PNOC") to invest in development of geothermal fields[51]. Following this, PNOC launched an international bidding process to develop geothermal projects, with private sector firms from the United States (such as ORMAT, Magma, California Energy and Oxbow) and Japan (Toshiba and Fuji) participating[52]. These private sector companies

Sepa-Photovoltaic/Prweb4528884.Htm>, Accessed 20 March 2023, p. 1.

[44] Albena Vutsova/ Olga Ignatova, "The Role of Public-Private Partnership for Effective Technology Transfer" *Applied Technologies & Innovations*, 10(3), 2014, p. 83.

[45] Vutsova / Ignatova, p. 85.

[46] The World Bank Public-Private Partnership Legal Resource Center, "Government Objectives: Benefits and Risks of PPPs", *The World Bank*, 21 June 2022, < https://ppp.worldbank.org/public-private-partnership/overview/ppp-objectives > Accessed 19 March 2023, p. 2.

[47] The World Bank, p. 2.

[48] The World Bank, p. 2.

[49] Jorge Fleta-Asín / Fernando Muñoz, "Renewable Energy Public-Private Partnerships in Developing Countries: Determinants of Private Investment", *Sustainable Development*, 29(4), 2021, p. 653.

[50] Wilkin, p.101.

[51] Wilkin, p.101.

[52] Wilkin, p.101.

played a critical role in facilitating technology transfer, as well as the transfer of skills and know-how[53].

Another worthy example, "In the Philippines, a Filipino subsidiary of an American wind energy development company sought to develop hybrid wind-diesel energy systems and worked closely with the Department of Energy that sought to use indigenous energy resources to improve electricity systems on remote islands, while a number of financial institutions expressed interest in increasing their renewable energy portfolios"[54].

Furthermore, Canada, collaborated with the World Bank to create a fund of $60 million aimed at supporting the dissemination of environmental technology and know-how within India's energy sectors[55]. Canada intends to use the fund to facilitate the establishment of joint ventures between Indian and Canadian firms[56]. Canada's recognition of India's lucrative and expanding environmental market was a primary motivating factor in establishing the fund. According to Raymond Chan, Former Canadian Secretary of State for Asia Pacific, "[t]his fund intends to help environmental companies from Canada market their expertise in India and take advantage of the attractive business opportunities there"[57].

During a meeting of the European Parliament in January 1994, member states recommended establishment of a code of conduct for technology transfer. This code is "to be based on the right of the less developed countries to sustainable development and conservation of their natural resources as having priority over patent rights"[58]. In 1993, the British government establishes a task force to promote transfer of environmental protection technology through business cooperation[59]. During 1994, the task force hosted a series

[53] Wilkin, p.101.

[54] David M. Kline / Laura Vimmerstedt/ Ron Benioff, "Clean Energy Technology Transfer: A Review Of Programs Under The Unfccc1", *Springer,* (9), 2003, p. 29.

[55] Michael J. Baks, "Technology Transfer and Developing Countries", *Geo. Int'l Envtl. L. Rev*., 7(3), 1995, p. 905.

[56] Baks, p. 904-905.

[57] Baks, p. 905; Indo-Canadian Joint Venture Announces Ground Breaking Investment Fund In Environment, Energy-Efficiency Sectors, *Can. Newswire*, Mar. 24, 1994, Available In Lexis, Envirn Library, Curnws File. The Fund Is A Limited Partnership Model Between Sb Capital International Inc. Of Toronto And Il&Fs Venture Corporation Of Bombay.

[58] Baks, p. 906.

[59] Baks, p. 906.

environmental protection technology seminar, including one in Taiwan[60].

In addition, for low-carbon technology transfer, partnerships between the private and public sectors are an essential for introducing low-carbon technology to poor countries[61]. In Asia, one of the most important countries to the development of Asian renewable market is China. In recent years, China has improved renewable energy development, at least in part due to climate change[62]. In addition, India and Japan are notable participants of this sector. The Asia Development Bank (hereinafter "ADB") has encouraged the implementation of renewable and environmentally friendly energy projects across all tiers[63].

D. Licensing Agreements and Turnkey Contracts

Licensing agreements provide private firms less risk in setting up an associate in another country. Licenses are granted for patents, technology, and trademarks[64]. Turnkey contracts are described as "operations which are basically sales to a host country by foreign firm of plants including equipment and technical assistance. In many circumstances, the turnkey contracts are the most practical methods way for transferring energy technologies because it is good to the first stage of industrial development, and it gives access to all supportive resources of the foreign firms"[65]. However, Japanese government in the early stage of development decided to minimize technology transfer through turnkey contracts, because "mastery of technology cannot be bough, it has to be learned. Thus, in case of turnkey plants, local technical personnel

[60] Baks, p. 906.

[61] Cath Bremner, 'Technology Transfer to Developing Countries Is an Impossible Dream', *The Guardian,* (9 December 2009).

[62] Dorothy Mei / Martin Weil / Shradhey Prased / Kasandra O'Malia / Ingrid Behrsin, 'A Race to the Top: China' (2023) Global Energy Monitor, < https://globalenergymonitor.org/wp-content/uploads/2023/06/GEM-RTTT-China-2023-report-English.pdf > Accessed 19 July 2023, p. 3.

[63] Mark Raymont, "Timely Boost for Renewables in China", *J. of Energy& Natural Resources L.*, 24(1), 2015, p.122; Ram M. Shrestha, 'Clean Energy Resources, Utilization, Investments, and Prospects in Asia' in Bambang Susantono / Yongping Zhai / Ram M. Shrestha / Lingshui Mo (eds), *Financing Clean Energy in Developing Asia*, (Asian Development Bank, 2021), 1, p. 9-10.

[64] David M. Haug, "The International Transfer of Technology: Lessons That East Europe Can Learn From The Failed Third World Experience*", Harvard J. L. & Tech.,* (5), 1992, p. 214.

[65] Able, p. 1104-1107.

were not involved from the initial process…"[66].

E. Research and Development (R&D) Effort

Research and development play a crucial role in order to realign technology to local requirements of the 21st century, including electronics, nuclear power, transition to low-carbon technologies and thus governments' R&D spending in 2019 "grew by 3% to USD 30 billion"[67]. Although most Asian countries have high potentials for renewable energy resources, they are unable to obtain the technology due to the lack of capacity for R&D, and financial constraint. Unlike numerous developing countries, China has established a vast R&D network[68]. In regard to wind energy, "the case of Suzlon of India and Goldwind of China" indicated that both firms have their R&D units[69]. In order to getting access to technology by acquisition, they are investing heavily in R&D[70].

In addition, for successful technology transfer skilled and educated workers are also important. As an example, "[t]he founder of Suntech, had been a research director of an Australian PV company, and before that, a senior research scientist at the Thin Film Solar Cells Research Group in the Centre of Excellence for Photovoltaic Engineering at the University of New South Wales in Australia. Four of the six members of the Suntech Board studied or worked in the U.S. or the UK. At Trina Solar, half of the 12-person management team have studied or worked abroad. The CEO of Yingli has studied abroad and the company's Chief Technology Officer had worked at the Photovoltaics Centre of Excellence at the University of New South Wales. On average, 61 percent of the board members of the three largest Chinese PV

[66] Able, p. 1104-1107.

[67] International Energy Agency, "R&D and Technology Innovation", *World Energy Investment,* 2020, <https://www.iea.org/reports/world-energy-investment-2020/rd-and-technology-innovation >, Accessed 10 March 2023, p. 1.

[68] U.S. Congress, Office Of Technology Assessment, "Energy Technology Transfer To China—A Technical Memorandum", *OTA-TM-ISC-30 Washington, Dc: U.S. Government Printing Office*, September 1985, < *https://ota.fas.org/reports/8510.pdf>,* Accessed 12 September 2023; Albert G. Z. Hu / Gary H. Jefferson / Qian Jinchang, "R&D And Technology Transfer: Firm-Level Evidence From Chinese Industry", *The Review Of Economics And Statistics*, 87(4), 2005, p. 780.

[69] K. Ravi Srinivas, "Climate Change, Technology Transfer and Intellectual Property Rights" *RIS Discussion Papers RIS-DP,* (153), 2009, <https://Sdg.Ris.Org.In/Sites/Sdg.Ris.Org.In/Files/2021-08/Ris_Tfm_Discussionpapers2009.Pdf >, Accessed 1 March 2023, p. 8.

[70] Srinivas, p. 8.

firms have studied or worked abroad"[71].

III. BARRIERS OF ENERGY TECHNOLOGY TRANSFER

Political, institutional, legislative, local capacity, and technical obstacles are the primary forms of barriers encountered when transferring renewable energy technologies to developing countries. However, perhaps, the main barrier is related to financing issues, such as lack of access to capital, lack of investment, and poor credit rating. In comparison to other developing countries China, Brazil, India, and Mexico have advantages in terms of their market size, large economies, and relatively high income per capita[72].

As stated in the U.S. Congress's technical memorandum, "China's energy sector remains severely under-capitalized in spite of the fact that it receives 45 percent of industrial investment. This affects China's ability to solve the technological needs of its energy sector through technology transfer. While the energy industry is a foreign exchange earner, reportedly only 10 percent of the foreign exchange it generates is reallocated to the energy sector for its foreign procurement uses. Thus, financing is an important constraint on energy development"[73]. Additionally, Nigeria, similar to many developing countries, possesses abundant renewable energy resources, but the technology and financial resources required to stimulate investment in renewable energy are not readily accessible within the country[74].

Furthermore, the legal framework also plays a critical role in the success of technology transfer in the energy sector considering if a host country has weak legal institutions and regulations, then a foreign investor may have

[71] Ana Pueyo/ Pedro Linares, "Renewable Technology Transfer to Developing Countries: One Size Does Not Fit All", *Institute Of Development Studies Ids Working Paper*, (412), 2012, <https://Onlinelibrary.Wiley.Com/Doi/Pdf/10.1111/J.2040-0209.2012.00412.X >, Accessed 1 March 2023, p.25.

[72] Ahmad Zaker, "WTO Law and Trade Policy Reform For Low-Carbon Technology Diffusion Common Concern Of Humankind, Carbon Pricing, And Export Credit Support", *World Trade Institute Advanced Studies,* (5), 2021, p. 80; United Nations Framework Convention On Climate Change, "The Contribution Of The Clean Development Mechanism Under The Kyoto Protocol to Technology Transfer", *UNFCCC,* 2010, <https://cdm.unfccc.int/Reference/Reports/TTreport/TTrep10.pdf>, Accessed 12 September 2023, p. 18,22; Wilkin, p. 122, 123.

[73] U.S. Congress, *Energy Technology Transfer to China*, p. 25.

[74] Peter Kayode Oniemola, "Integrating Renewable Energy into Nigeria's Energy Mix Through the Law: Lesson from Germany", *Renewable Energy Law and Policy Review*, 2(1), 2011, p. 29.

problems enforcing contracts or recovering costs through courts[75]. Thusly, legal framework that support innovation, intellectual property, and encourage competition can help a favorable environment for technology transfer.

Farther, in some cases, security can be a barrier. In terms of solar energy PV, their batteries and other parts could be stolen, as they are good to resale and easily transported[76]. The security issue "has been addressed in the Shell-ESKOM joint venture in South Africa"[77]. In this case, "[E]ach component of solar home system that they install (e.g., the battery, controller, PV panel etc.) is electronically coded. They are then connected to a central unit called the 'powerhouse', which houses the battery and controller. Each component connected to the powerhouse initialized before the system can work. After that, if at any point the components are removed, they will not work connected to any other system. Even if the whole system is stolen it will not work, as the powerhouse has an anti-tamper device which is set off if moved, after which the system has to be reset with a special code"[78]. Another fundamental barrier "is that the technology being transferred is not appropriate to the local context and demands or is not adapted to the local environmental"[79].

IV. INTELLECTUAL PROPERTY RIGHTS (IPRs) LAW: A DRIVER OR BARRIER?

Many developing countries have insufficient or ambiguous regulations regarding intellectual property rights (hereinafter "IPRs"); these countries often lack legal institutions that could provide support, as well as technical standards, and quality management[80]. Private firms fear that their technology designs may be stolen[81]. Although unprotected technology is not attractive to investors, too strong IPRs also could be barriers to tech transfer such as restricted access to technology and increased cost to users[82]. A study by UNIDO, about

[75] John H. Barton, "New Trends in Technology Transfer Implications for National and International Policy' *ICTDS Programme on IPRs And Sustainable Development,* (18), 2007, p. 29-30.

[76] Wilkin, p. 141.

[77] Wilkin, p. 141.

[78] Wilkin, p. 141.

[79] Wilkin, p. 122.

[80] Wilkin, p. 126, 127.

[81] Wilkin, p.126, 127.

[82] Wilkin, p.126, 127.

whether stronger IP protections help to increase technology transfer or not, states that "The results are far from definitive as a consequence. But while it would be premature to make strong claims on the basis of the limited evidence to date, the overall pattern of results justifies certain inferences"[83]. Attaining the "right balance" with IPRs is crucial to ensure that they are unambiguous and foster investment, as well as facilitate the transfer of energy technology[84].

A study on technology transfer in China's wind energy sector suggests that foreign technology providers are reluctant to share their technology with Chinese companies, mainly due to local content requirements and concerns surrounding IPRs[85]. Moreover, a research on the transfer of clean coal technology to China indicated that concerns over copying of technologies acts as a deterrent in the willingness to transfer technologies[86]. Additionally, another study examining the transfer of clean coal technology to China has revealed that insufficient protection for IPRs possess a challenge to both domestic and foreign manufacturers[87].

Likewise, the success of Suntech Power Co Ltd, a Chinese company, serves as an example of a "developing country firm acquiring technology through overseas acquisition and emerging as the fourth largest producer of photovoltaic (hereinafter "PV")"[88]. This demonstrates that the growth of developing country firms may not always be hindered by patents. In the technology sector, economic viability is influenced by the support for renewable energy in the form of subsidies and the declining cost of generating solar power[89]. The competitiveness of costs depends on the price of conventional electricity.[90] Therefore, access to advanced technologies that can lead to a reduction in production costs is crucial for the widespread adoption of this technology[91]. However, IPRs can present a barrier when licensing and

[83] Srinivas, p. 8.

[84] Wilkin, p. 128.

[85] Srinivas, p. 8.

[86] Srinivas, p. 15.

[87] Srinivas, p. 15.

[88] Wilkin, p. 7.

[89] Wilkin, p. 7.

[90] Wilkin, p. 7.

[91] Wilkin, p. 7.

technology usage are limited due to restrictions imposed by the patent holder[92].

According to a report, the participation of developing countries in Australian- US- and EU- supported Carbon Capture and Storage (hereinafter "CCS") projects indicates that knowledge dissemination on CCS technology is in progress[93]. However, the responses from the mentioned IPPs suggest that further knowledge transfer and on-site demonstrations in developing countries might be required[94]. It is essential to consider providing access to low-cost IPRs for CCS technologies to facilitate their wider adaptation and implementation[95].

Furthermore, empirical research on transfer of technology and IP protection indicates that there is no direct positive correlation between them. Scholar argue that robust IP protection could impede technology transfer during the initial stages[96]. Moreover, the experiences of developing countries in Asia and Japan illustrate weak IP protection facilitated the enhancement of local capacities, even in cases where countries had a low level of development, and stronger IPRs may only benefit technologically advance countries[97].

IPRs could be a driver or barrier depending on the level of development, technology maturity, and the type of technology[98]. While some researchers have demonstrated that IPRs may be barriers to technology transfer in developing countries with lower incomes, where patents are registered but technologies are not implemented, they can aid middle-income emerging countries in attracting greater investment in advanced technologies[99].

[92] Wilkin, p. 7.

[93] Srinivas, p. 15, 16.

[94] Srinivas, p.16.

[95] Srinivas, p.16.

[96] Srinivas, p.17.

[97] Srinivas, p.17.

[98] Maruf Sanni / Caleb Muyiwa Adelowo / David Ademola Ogunkanbi / Adesina Ayobami Oyewale, "Climate Change and Intellectual Property Rights in Africa: Environmental Necessity-Economic Opportunity", *African Journal Science, Technology, Innovation and Development,* 8(5), 2016, p.1-9.

[99] Keith E. Maskus/ Ruth L. Okediji, "Intellectual Property Rights And International Technology Transfer To Address Climate Change: Risk, Opportunities And Policy Options", *ICTSD Programme On Intellectual Property Rights And Sustainable Development Series Issue Paper*, (32), 2010, < Http://Admin.Indiaenvironmentportal.Org.In/Files/Ipr%20technology%20transfer.Pdf >, Accessed: 2 February 2023, p. 7.

Another study from Barton finds that "at the moment, there seems unlikely to be significant IP barriers to developing nation access to solar, biofuel and wind technologies. Further, research is needed. IP may become a more significant obstacle in accordance with the evolution of market structure. The wind sector is of particular concern"[100].

CONCLUSION

The energy sector, serving as a cornerstone for economic growth and social development, plays a pivotal role in advancing societies towards a sustainable future. The legal aspects of technology transfer in the energy sector represent a complex and multifaceted domain, intersecting various areas of law, from intellectual property rights and trade regulations to environmental and energy laws. As developing countries strive to meet their increasing energy demands, the importance of technology transfer within the energy sector cannot be overstated. Despite the increasing global demand for energy, particularly within the electricity market, developing countries encounter significant obstacles in obtaining new technologies. In order to address these challenges, various recommendations have been put forth.

First, government policies in promoting technology transfer is critical in developing countries. Governments should shift their focus from formulating requirements or incentives encouraging technology transfer to promoting a technological infrastructure that encourage the private sector to make such transfers naturally[101]. Host governments can urge the technology transfer by establishing legal and regulatory structures and incentives, supporting investment in R&D, information exchange, education and training, and cutting red tape. Moreover, foreign investors would benefit from governments enhancing economic and institutional circumstances, as strict technology transfer prerequisites could potentially impede the international investment climate. Furthermore, ensuring stable and foreseeable regulations, especially for extended power purchase agreements, is crucial[102].

[100] John H. Barton, "Intellectual Property and Access To Clean Energy Technologies In Developing Countries: An Analysis Of Solar Photovoltaic, Biofuel And Wind Technologies", *ICTSD Programme On Trade And Sustainable Energy Series Issue Paper*, (2), 2007, p. 2.

[101] OECD Environment Directorate and International Energy Agency, "Technology Innovation, Development and Diffusion", *OECD And IEA Information Paper COM/ENV/EPOC/IEA/SLT*, 2003, 4(5), <Https://Www.Oecd.Org/Env/Cc/2956490.Pdf >, Accessed 2 March 2023, p.17.

[102] Pueyo / Linares; Dalindyebo Shabalala, 'Intellectual Property, Climate Change and Development', in Professor Peter K. Yu (eds), *The WIPO Journal: Analysis of Intellectual Property Issues,* 8(1), 2016, p.64-74.

Second, in terms of IPRs and other legal issues, governments must ensure that private firms' technology is confident in national law. Weak or non-existent IPRs can discourage foreign direct investors from their technology to developing countries, as they fear that their IP will be stolen or copied without compensation. Therefore, clear IP policies that balance the interests of technology providers and recipient countries. These policies should encourage the licensing and adaptation of technologies, ensuring fair compensation for innovators while firstly facilitating technology transfer. In this respect, governments need to give confidence to potential foreign investors that the legal system works and that they can recover their costs, if there are any legal disputes occur.

Moreover, PPPs play a crucial role in funding energy initiatives in developing countries[103]. In terms of energy projects, PPPs can help address the financing and investment challenges faced in developing countries. Hence, PPPs can be efficient tools for financing energy projects in developing countries, particularly where traditional financing mechanism are insufficient. By leveraging the strengths of both the public and private sectors, PPPs can aid overcome the challenges of project implementation and contribute to achieving successful technology transfer.

Finally, the promotion of technology transfer in the energy sector is heavily reliant on government policies. Implementing effective policies, such as creating a stable and predictable regulatory framework and offering tax incentives for research and development, can attract private sector investment.

To sum, there is no one fit solution for successful energy technology transfer. However, learning from the past and other countries' experiences is perhaps the best way to overcome certain barriers. The success stories highlighted in this study underscore the immense potential for technology transfer to catalyze growth and improve the overall well-being of citizens in developing nations. Successful lessons can be learned from "India, with leading wind turbine manufacturers; China, with leading wind turbine and Solar PV technology manufacturers; and Malaysia, with leading biomass energy technologies"[104]. Hence, the crucial significance of government policies

[103] Wilkin, p.100.

[104] Pueyo/ Linares, p. 28; Brandt/ Wang; Nor Adilla Rashidi/ Chai, Yee Ho / Yusup, Suzana,

cannot be overemphasized when it comes to fostering technology transfer within the energy sector. Several successful policies can help attract private sector investments by providing a more stable and predictable regulatory environment and tax incentives for R&D and innovation. By implementing the above policy recommendations, governments can create an environment conducive to technology transfer, enhance energy infrastructure, and ultimately contribute to their economic growth and improve living standards. It is through these strategic steps that developing nations can harness the full potential of advanced technologies, ensuring a brighter, cleaner, and more sustainable energy future for all.

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