

**RESEARCH PAPER****Green Energy Cooperation between Pakistan and Poland: Prospects and Challenges for Sustainable Development**

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ABSTRACT

Energy is a pre-requisite for sustainable socio-economic development of the states in the contemporary era whereas extensive use of fossil fuel energy resources is damaging not only the strategic reserves but environmental degradation has come afore as a serious consequence. Green energy can be an effective alternative to fossil fuels which, in addition, ensures protected, sustainable environment. Cooperation between Pakistan and European countries particularly Poland in the green energy sector would prove quite efficient, due to expertise of Poland in green energy production. Since renewable and green energy is a potential area of cooperation between the two states hence this research aims at analysing prospects for their mutual trade while focusing on challenges in terms of green energy cooperation between Pakistan and Poland. The study relies upon explanatory research methods to analyse the qualitative data and suggests that the increased bilateral cooperation according to the framework of neo-functionalism will pave the way for further economic ventures, eventually bringing positive impact on society and environment of Pakistan. This research will become a precursor for future research and socio-economic cooperation between Pakistan and Poland in particular whereas Pakistan and European Union in general.

KEYWORDS Green Energy, Pakistan-Poland Economic Relations, Sustainable Development

Introduction

Prompt power supply is imminent for energy security and state's viability. In this era of globalisation, energy demand is ascending quickly whereas comity of nations is experiencing energy shortages. Incessant and massive use of conventional energy reserves is endangering ecological, socio-economic situation and also impending world's sustainability (Twas, 2008). Therefore, world is shifting to environment-friendly green energy (Kalyani, *et al.*, 2015). The pursuit of alternate energy sources has now become crucial for nations. Now a days, green energy multipurpose technologies are successfully being used in domestic as well as commercial sectors (Almasri and Narayan, 2021). The green energy concept had been envisaged in November 2006 as part of a mission to make renewable energy commonplace (Kalyani, *et al.*, 2015). Therefore, section (1) of this research paper portray the brief introduction of energy, its pivotal role and significance in global economy. Section (2) entails green energy analysis and highlighted necessity to overcome energy crisis. In this section efficacy of renewable energy is discussed and compared to the states' economies, global climate change and sustainable development. Further, it explores viable green energy solutions to eradicate socio-economic challenges.

The EU is adamantly increasing its reliance on Alternate Energy Resources (AER) for efficiency and connectivity (Matthias Buck *et al.*, 2019). In view of its economic efficacy, Europe is rapidly switching to green energy (Michalak and Zimny 2011). The EU is aspiring renewable energy technology in region compatible on global scale as well as producing industrial goods of highest calibre (Leonard *et al.*, 2021). Only conducive integrated European energy market can embolden this energy revolution. Section (3) describes European green energy initiatives and its leading role in clean and green energy advancement, commitment, achievement and prominent share in smart and green technological innovation around the world. It also elucidates Europe's ambitions to accelerate in renewable energy sector to meet energy needs.

In particular, Poland being in the heart of Europe, is utilizing innovative green energy technologies effectively to fulfil its energy demands (Oniszk-Popławska, Rogulska, and Wiśniewski 2003). It is making substantial efforts to reform its energy system, curtailing disproportionate reliance on coal for power production (Turlej and Banaś 2018). Polish government has implemented an excellent and ambitious offshore wind programme pledging strong commitment to energy security (Gnatowska 2019). Poland is greatest supplier of rooftop solar in European market and will be the fastest growing state in Europe till next decade (IEA 2022). Section (4) of this research study illustrates Poland tremendous efforts, green strategies, market support mechanism and comprehensive renewable energy policies. It ascertains Polish endeavours in green energy distribution, consumption and production. This section also elaborates renewable energy technological advancement, innovation and inexpensive clean energy solutions implied in Poland.

Poland and Pakistan are alike states. Both the countries have similar ecological conditions and abundant green energy potential (Yazdanie and Rutherford 2010). Besides, they are observing long standing cordial relations. A large difference between the states is scale of green energy resources utilization. Poland having sufficient resources exploiting green sources for sustainable development and socio-economic growth (Javed *et al.* 2016). Whereas Pakistan is lagging far behind, devoid of resources to develop green energy sector. However, Pakistan envisions various green energy projects to diminish energy problems. Lessening energy demand and supply gap is core objective of state (Malik, Qasim, and Saeed 2018). Pakistan can overcome energy gap acquiring cooperation of other countries like Poland in green energy sector (Ministers and Minister 2019). Both the states can attain mutual benefits in various sectors prominently green energy cooperation which will strengthen geo-political and social interaction in return. Poland can extend advanced green energy technologies in renewable power generation to sustain mutual socio-economic interests whereas Pakistan has remarkable opportunities for Poland to invest in green energy sector. Renewable energy prospective for Pakistan is critically analysed in section (5). It explores current energy gap, mode of energy production, green energy potential, economic crisis and necessity of bilateral energy cooperation. Pakistan's renewable energy policies, energy infrastructure development, subsidizing green energy sector and FDI initiatives are also the part of this section.

Literature Review

Europe attained significant progress in green energy sector by the year 2000 comprising 20% of the world's solar photovoltaic installations and more than 70% of all wind power turbines built worldwide (Turlej and Banaś 2018). The EU is pioneer of renewable energy. Currently, 173 nations throughout the world have similar goals.

The Renewable Energy Progress Report (RED II) indicates that renewable energy sources at EU position had been steadily increasing in recent years (Schöpe 2008).

Although the EU has improved manifold its renewable energy sector yet several managerial shortcomings are found. As small energy providers are unable to connect to the grid because large firms capture transmission network and production, therefore, Europe is reshaping energy market ensuring energy efficiency, liberalisation and structural development of internal market (Langsdorf 2011). The EU has made renewable energy sector as foundation of its future energy system and climate pact. In recent years Europe has succeeded in achieving targets of cutting carbon emissions. Remarkably, in 2014 European Union's carbon dioxide (CO₂) emissions reduced were equal to Spain's yearly emissions (Commission 2015). Now, renewable energy shares over 27% of EU's electricity output and more than 15% of its total energy production (Krawczyk, Witkowska, and Bernadetta 2021).

Performing efficiently, EU's renewable energy sector provided 0.5M new jobs spanning over last five years period and generated 140 billion euros revenue (Michalak and Zimny 2011). That is why, Europe becomes significant player in the global market and a heaven for green energy firms. By extensive green energy usage Europe has successfully cut half GHS emissions during last two decades (Siddi 2020). Further, EU achieved a high GDP rate of about 45% from 1990 to 2012 while reducing overall greenhouse gases to 19% (European Environment Agency 2012). Consequently, Europe reduced its need for fossil fuels by 98 Mtoe since 2005, which is equal to Poland's total energy consumption. Treading the same path, 50% power production is anticipated from green resources till 2030.

Europe has pivotal role in ongoing shift to renewable energy and European made green energy technologies are more economical than others (Connolly, Lund, and Mathiesen 2016). Using public research funds, EU innovated and produced impressive technology in the green sector. Region harnessed four types of green technologies in a single year investing 3.8 billion euros in development and research. Additionally, 1 billion from state budgets and 2.6 billion euros from corporate financing were contributed for advancement in this sector. Green energy is becoming more and more cost-competitive as the proportion rises. Nearly, 15.5% of its total energy consumption depends on renewable sources. Being highly developed in this field, Europe in 2020 invested 43bn euro to install wind farms whereas installation of 460 MW of new marine energy projects in next three years is under consideration (Saur News Bureau, 2021).

Europe's renewable energy industry generated 137 billion euros in revenue in 2013, with an increase of 6% from the previous year (European Parliament 2017). Moreover, EU has implemented a variety of mechanisms, including the European Investment Bank (EIB) and Emission Trading System (ETS) (European Parliament 2017). By 2030, the EU has been committed to incorporating at least 27% of green energy sources in its energy grid (Connolly, Lund, and Mathiesen 2016).

Theoretical framework

Theoretical framework is befitting research tool help to handle structural issues and provides alternative perspectives. It also provides right track to undertake a research. This instant research paper elucidates advancement of green energy sector, entails scientific and international cooperation as well as the transfer of green technologies through the lens of neo-functionalism. Since long Pakistan and Poland have been engaged in bilateral trade. Development in green energy sector in Poland is remarkable. Pakistan has huge renewable energy potential but unable to exploit to meet its energy requirement and seeking cooperation to cope with energy crisis. Whereas both states have strong political and economic ties therefore neo-functionalism provides practicable framework of solutions. Pakistan-Poland green energy cooperation is the case of Neo-functionalism. The trade

volume between both states is in millions of Dollars in different areas except energy sector. Poland is major green energy market in the centre of Europe and is already engaged with Pakistan in trade ventures. Therefore, neo-functionalism approach is befitting to build up strong relationship to establish strong green energy cooperation. Section (6) consist on theoretical framework which describes neo-functionalism and its functions. Further, it provides structural framework for energy collaboration between Pakistan and Poland comprehensively.

What is Neo-Functionalism?

Neo-functionalism contends that when nations decide to collaborate in one sector, this encourages them to do the same in other related or similar fields (Lj and Ilievski 2015). To lobby their political leaders, sub-state actors start collaborating politically across boundaries. In order to achieve a political community greater than a nation-state, neo-functionalism seeks to create the conditions necessary for its emergence (Kovacevic, 2016). Both depict a hypothetical transnational state or political community as the final result. Neo-functionalists argue that integration, which begins in one economic sector, will extend to others by forging a close dependency and prosperity (Dunn 2012). Neo-functionalists believe that after national economies and markets have been integrated, people's loyalty will shift from the national level to the supranational level (Ozen 1998). A new regional political community that exceeds the bounds of a nation-state is thus created.

Energy: Its Role and Significance

Utilisation of energy around the world depends on nature of human activities. It is imperative for industrial production and Sustainable Development and crucial component towards achieving Millennium Development Goals (MDGs)(Twas 2008). Energy is essential for socio-economic development and prosperity(Asghar 2008; Giannola 2011) as well as it is a key tool for human welfare and economic expansion. Ever increasing energy consumption is crucial to industrialisation process and economic development. The correlation of use of energy and economic expansion is still very strong (International Energy Agency 2020).

The contemporary economies evolve on energy usage, it accelerates economic productivity and industrial expansion (Lloyd 2017). The amount of energy consumed *per se* has a high correlation with several development metrics. Energy is an indispensable constituent of all industrial activities and major element of economic growth. The effects of growing use of energy on development are still being perceived. The levels and trends of global energy intensity varies at large. Table No. 1 below reflects deviations in economic structure and energy efficiency advancements. Similarly, Table 2 explains high energy intensity in the CIS (the Commonwealth of Independent States), the Middle East and Asia by the dominance of industries and commodity exporting-based economies.

Table 1
Energy Intensity of GDP at Constant Purchasing Power Parities (Koe/\$15p)

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|
| Europe | 0092 | 0087 | 0086 | 0084 | 0080 | 0079 | 0078 | 0077 | 0075 | 0072 | 0071 | 0071 |
| CIS | 0216 | 0213 | 0206 | 0198 | 0191 | 0187 | 0192 | 0191 | 0198 | 0166 | 0164 | 0171 |
| America | 0125 | 0122 | 0118 | 0118 | 0117 | 0114 | 0112 | 0110 | 0109 | 0107 | 0103 | 0102 |
| Asia | 0152 | 0149 | 0146 | 0141 | 0138 | 0131 | 0125 | 0122 | 0121 | 0119 | 0119 | 0118 |
| Pacific | 0130 | 0127 | 0123 | 0122 | 0118 | 0115 | 0112 | 0110 | 0108 | 0106 | 0105 | 0097 |
| Africa | 0135 | 0139 | 0138 | 0135 | 0137 | 0132 | 0133 | 0131 | 0129 | 0124 | 0124 | 0125 |
| Middle-East | 0142 | 0137 | 0144 | 0145 | 0148 | 0150 | 0146 | 0148 | 0148 | 0149 | 0152 | 0146 |

(EnerData, 2022)

Table 2
Total Energy Consumption (Mtoe)

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|
| Europe | 1991 | 1875 | 1866 | 1846 | 1779 | 1808 | 1825 | 1859 | 1847 | 1817 | 1701 | 1787 |
| CIS | 847 | 1043 | 1043 | 1025 | 1000 | 960 | 991 | 1006 | 1076 | 1072 | 1029 | 1124 |
| America | 3431 | 3259 | 3246 | 3324 | 3355 | 3324 | 3302 | 3301 | 3353 | 3355 | 3075 | 3217 |
| Asia | 4309 | 4977 | 5128 | 5264 | 5412 | 5452 | 5492 | 5690 | 5905 | 6082 | 6024 | 6310 |
| Pacific | 150 | 150 | 150 | 152 | 153 | 153 | 152 | 154 | 154 | 156 | 153 | 149 |
| Africa | 644 | 700 | 712 | 723 | 760 | 755 | 779 | 791 | 806 | 834 | 817 | 874 |
| Middle-East | 589 | 642 | 676 | 686 | 722 | 740 | 758 | 775 | 776 | 783 | 763 | 760 |

(EnerData, 2022)

Fossil fuels dominates the energy supply causing a lot of paradox between development and goal to minimise emissions. With 80% share, fossil fuels emerge as primary source of energy on the globe (Botto 2007). These unrenowable energy sources had driven the industrialisation of countries for varying purposes such as power generation and vehicle fuel. Fossil fuels are also required for the manufacturing a number of everyday items, including paints, plastics, chemicals and pharmaceuticals etc. Some fossil fuels, like coal, are a plentiful and affordable source of energy with certain ecological impacts (Giannola 2011). Other fuel such as oil has varying prices based on location and logistics. Regional distribution of these extremely valuable resources raising geopolitical challenges and jeopardizing the global peace (Clairmont 2007). On the other side extensive use of fossil fuels is alarming for climate change situation and threatening sustenance of world. In this regard serious consequences may be seen in different states.

Green Energy

Green energy resources are abundant and purified in their nature (Aktar et al. 2020). Approximately 38% energy needs of world are being met through green energy (Jones, 2022). It is an alternative rather than prime source of energy. Green Energy refers to energy generated with minimal harm, completely renewable in its character. Prominent green sources include solar, hydropower, geothermal and wind are AER having negligible or no global warming impact (Kalyani, *et al.*, 2015). Notably, extensive renewable energy utilisation would slow down the rate of climate change amidst providing suitable and cheaper solutions of energy problems (DolfGielen, 2019). Green energy sources are available profusely for individuals as well as enterprises and are equally beneficial to achieve sustainable environment.

Green energy is also termed as clean energy because there is no hazardous gas emission during the process of its production (Panwar, Kaushik, and Kothari 2011). With passage of time, people's living standards improve, developing nations industrialise and world population grows hence, energy needs are also increased in parallel. To fulfil extended energy needs excessive fossil fuel consumption is made (Wang et al. 2018). Consequently, it not only accelerated the depletion of fossil fuel sources but also increased health hazards, adversely effected environment and also jeopardize global climate (Almasri and Narayan 2021). Further, rapid increase in energy demands started competition among the world states to hold energy reserves (Giannola 2011). Therefore, renewables are the best solution to meet mounting energy needs of developing world.

Most frequently available renewable sources are solar and wind. Another prominent renewable energy source is biomass. Marine energy is yet another major renewable energy source. It is derived from a variety of sources including tidal energy and energy created by ocean waves (Kalyani, *et al.*, 2015). Geothermal energy, on the other

hand, is also a source of electric power generation. These sources are more beneficial and less harmful as compared to fossil fuels.

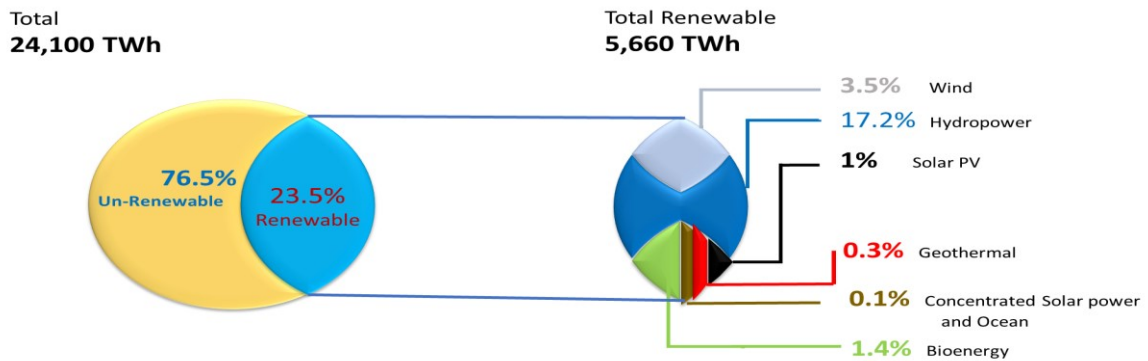


Fig 1 Source: (IRENA, 2018)-Authors' Illustration

All renewable or green resources are significant and may perform safeguarding role to world pollution and to maintain steady and persistent supply of energy (Aktar et al. 2020). Green energy has absolute capability to fulfil energy requirement of domestic as well as industrial sector conveniently (Parra, Kirschke, and Ali 2020). Energy supplies from renewables surely help to prevent global warming and safeguard ecosystems by lowering CO₂ levels (Holt and Pengelly, 2008). Climate change conditions are the most importunate issue coercing humanity in the twenty-first century. Low-income groups are more imperilled to injurious effects over hygiene conditions (Twas, 2008). Global climate change causes precarious environmental trepidation relating to energy. Our ecology bears a heavier burden and the damage is irreparable. The objective of producing green energy is to minimise waste and pollution and lessen the environmental effect of energy production (Pegels et al. 2018).

The investments have been dramatically increased to fulfil the growing demand for renewable energy, consequently production and consumption expanded. Therefore, significant politico-economic efforts and huge investment required to develop green energy to meet present needs. It is much difficult for developing nations to produce green energy without adequate cooperation from industrialised nations (Papathanasiou, 2022). Pakistan and Poland have recently placed high priority to advancement of green energy. Poland has been advancing efficiently in order to keep up its dominant position in production and distribution of renewable energy. Hence, this research aims at analysing green energy development, cooperation and technological transfers from Poland to Pakistan.

Green Energy Development in Poland

Poland rapidly shifted its dependence to renewable energy. Ratification of a special renewable energy law by Polish President procreated multiple ventures. Technology shift over to green energy showed remarkable increase of 14% share of total power production in 2017 (Niekurzak 2021; Turlej and Banaś 2018). In this pursuit, Poland made huge investments of 15 billion euros to boost renewable energy production (Oniszk-Popławska, Rogulska, and Wiśniewski 2003). The target of sharing 15% green energy of its total energy production, envisaged in National Renewable Energy Action Plan 2020 achieved conveniently, ranking the state as fifth EU nation regarding quantum of installed solar panels in 2020 (International Renewable Energy Association 2015) which position was achieved by ensuring certain measures and incentives i.e. support scheme, green certificates, support mechanism of RES auctions put in place to facilitate alternative

technologies development (Paska and Surma 2014). The National Energy Action Plan could not bring about tremendous expansion as anticipated. With thorough and concrete offshore strategy, Poland would be capable in proliferating 27% wind energy of total power production till 2050 (Gnatowska 2019).

Poland propounded and approved national energy policy in Feb 2021 aiming to mitigate reliance on coal for electricity generation and heating of building purposes. To meet the objectives, notable subsidies were provided for renewables besides supporting payments to offshore wind programmes. Raising PV (photovoltaics) capacity up to 7.7 GW during last 5 years Poland has emerged fastest growing solar PV market in Europe (IEA 2022). Comprehensive offshore capacity would lead the country to 5.9 GW voracious agreements until 2027 (Turlej and Banaś 2018). Besides, various energy and environmental goals including gas emissions, green energy and energy efficiency will be achieved up to 2030. Whereas 195 billion euro estimated for modernizing the energy sector and achieving NECP (National Energy and Climate Plans) targets from 2021 to 2030 (IEA 2022).

The most coveted objective of Poland's energy policy is to lessen energy supply's carbon impact by intensifying usage of renewable energy resources. Energy security and impartial transmission guarantying everyone's access to affordable energy is topmost priority. Poland has near missed the target of energy consumption for 2020 by 0.1 Mtoe (IEA 2022). Alongside, a target of reducing energy poverty less than 6% of population by 2030 has been fixed. In this regard, quick deployment of distribution solar PV in Poland is significant accomplishment.

Table 3
Poland 2020 and 2030 Energy Status/Targets

| | Renewable Energy Share | | | | Energy Efficiency (Mtoe) | | Non-ETS GHG Emissions |
|-----------------|--------------------------------------|-------------|---------------------------|-----------|----------------------------------|-----------------------------|---|
| | Gross final energy consumption | Electricity | Heating and cooling | Transport | Primary energy consumption | Final energy consumption | CO ₂ -eq emissions versus 2005 |
| 2020 Status | 16.1% | 16.2% | 22.1% | 6.6% | 96.5 | 71.0 | +10% |
| 2020 Targets | 15% | 19% | 17.4% | 10% | 96.4 | 71.6 | +14% |
| 2030 Targets | 23% | 32% | 28.4% | 14% | 91.3 | 67.1 | -7% |

(IEA 2022)

Poland has fixed green energy consumption goals for 2020 to 2030 under EU Renewable Energy Directive (RED) (Siddi 2020). According to IEA, Poland's renewable energy usage has been raised 9.5% to 16% of total energy consumption over the last decade (Niekurzak 2021). Here, Green energy is taken as major replacement of coal fired electricity espoused with decrease in imports. The emphasis of Polish energy strategy is to evolve culture of diminishing coal fired power and enhancing green viz. a viz. improving renewable energy generation. For that purpose, government is disseminating large subsidies to promote green energy technologies and trade (Kiciński 2021). Good results of the policy are being observed as IEA figures corroborates significant increase of 3% in recent years. It has prescribed 32% power generation from renewable sources till 2030 (IEA 2022). In this way, Polish government is adopting an impressive distributed energy strategy to increase industrial as well as community involvement to strengthen its economy. The Government is exploring a number of options to boost consumer market involvement to facilitate integration of distributed green production (Gnatowska 2019).

Pakistan's Green Energy Prospective

Pakistan has produced approximately 553.5 MW electric power from renewable resources using Modern Technologies (Uddin et al. 2021). To exploit and manage green energy resources, Pakistan established two departments i.e. Pakistan Council of Renewable Energy Technologies (PCERT) and the other is Alternative Energy Development Board (AEDB). Both the departments take over responsibilities of decreasing dependency over fossil fuels and assist economy to gain strength in meeting energy demand and supply gap sustainably. Pakistan's power generation from renewable energy is only 3%, the bare minimum in face of State's green energy potential (Kanwal, Khan, and Rauf 2020).

Electricity consumption of Pakistan grew 19% in 2018 and deems to grow by 28% till 2040 (Ilyas 2022). Resultantly Pakistan's oil imports have been grown from \$14.6 billion in 2017-18 to \$ 17 billion in 2019-2020 (Aslam, Nazir, and Zia 2021). In view of the situation, green energy resources have been developed in recent years mainly derived by socio-political sensitivity to environmental concerns and energy security. Now, Pakistan is seeking foreign direct investment (FDI) in renewable energy sector to reduce expenditures on oil imports. Prioritizing and promoting green energy investments incepted while modernizing energy infrastructure including RE trackers, micro-grids, technology transfer initiatives and skill building (Aslam, Nazir, and Zia 2021).

Pakistan's total energy supply would increase to 115 MTOE by 2023 with CAGR (Compound Annual Growth Rate) of 5.8% (Habib et al. 2021). At Present Pakistan depends disproportionately on expensive imported oil and indigenous gas reserves to generate thermal electricity. Almost all nations are taking concrete measures to exploit green energy resources for electricity production. According to research undertaken by National Renewable Energy Lab (NREL), USA in partnership with USAID Pakistan has a lot of potential in renewable energy resources, solar and thermal power extending up to 29,00,000 MW whereas southern and coastal regions of Sindh and Balochistan have significant wind power potential (Farooq and Kumar 2013; Habib et al. 2021; Ilyas 2022).

Pakistan is reshaping its policies to meet energy demands by harnessing green resources. In this regard, \$34 billion investment through the China-Pakistan Economic Corridor deal of 2015 is a significant landmark in Pakistan's energy infrastructure development (Minister et al. 2020). By 2025 and 2030, 20% of world's total power generation would be expected to come out from renewable resources (Chaudhry, Raza, and Hayat 2009; Matthias Buck et al. 2019). Renewable energy has several benefits as compare to polluting and expensive thermal coal power plants since it does not require fuel.

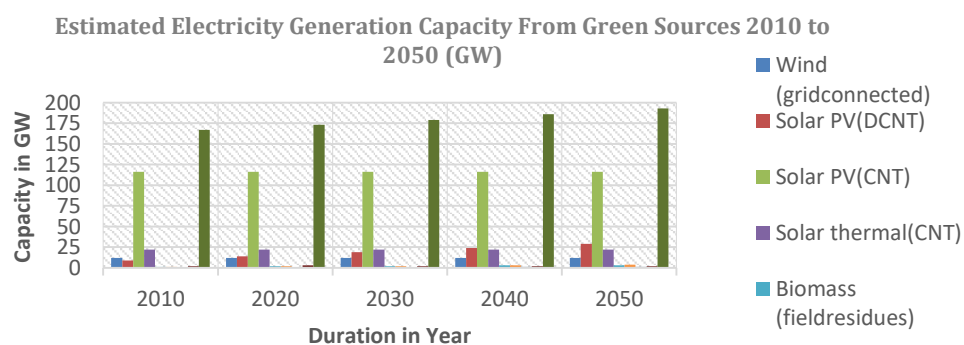


Fig 2: (Farooq and Kumar 2013)

Pakistan's Renewable Energy Initiatives

In order to complete green energy transformation by April 2022, NEPRA had to enhance capacity of several institutions and bilateral agreements or through the CTBCM (Competitive Trading Bilateral Contracts Market) model (National Electric Power Regulatory Authority, 2020). A mix of 30% renewable and hydro energy was planned by Pakistan according to 2020 green energy strategy (Khan, 2020). In addition, Pakistan has formed a network for renewable energy research and advocacy to attain SDG 7.

Green Energy and Sustainable Development

Sustainable development pretends for energy security to future generation with least expense and emissions (Parra, Kirschke, and Ali 2020; Sen and Ganguly 2017). Sustainability goals are achievable merely through green energy which features least expensive and most effective way of up-raising national production sector (Wang et al. 2018). In this pursuit UN Commission on Environment and Development, in 1992, suggested measures through agenda 21 which contained fundamentals aiming sustainable development (Aktar et al. 2020). In perspective of sustainable development, green energy had more relevance over other types of energy. Dincer and Rosen propounded three basic justifications towards using green energy as effective and crucial tool for sustainable development. Renewable energy capacity of reducing social, political, economic and environmental conflict necessitate it for sustainable development. Dominant factor of ever increasing green energy demand is its efficacy towards climate change.

Pollution of air and water has become a serious consequence in highly industrialized societies as they entangle high climate risk because of neglecting necessary precautions for environment protection (Javed et al. 2016; Nayyer Alam Zaigham 2005; Turlej and Banaś 2018; Twas 2008). World bank group rightly articulated "green finance" as an essential for attaining balanced economic growth (Pegels et al. 2018). Consequently, environmental innovation has a favourable impact on states' competitiveness and productivity. It further works as catalyst for lowering down economic costs and achieving ecologically sustainable growth. Following this drive, Pakistan also established "Green Finance" to improve connections between private sector for improvised use of technical advancement and innovations (Smith 2019). State Bank of Pakistan opted for green banking to support eco-friendly operations by funding various economic sectors (Hassan, Afridi, and Khan 2019). The emerging nations has now realized value of green finance on the cost of environmental deterioration.

Environmental innovation acting as catalyst may reduce economic cost of production and promote ecologically sustainable growth (Niekurzak 2021). Green finance devoid of environmental innovation would prove weak leading to extinction of green products (Smith 2019). Banks inability to evaluate green performance proves a barrier towards green finance development. Prudent proof is that out of 1870 signatories for principles of responsible commitments, 122 were from Asia with weak green finance system (Volz 2018). Asian financial institution still makes up small portion of sustainable financing projects. The situation requires improvement by raising green finance awareness. For the very purpose, Green Finance Initiative was established in London in 2016 (Finance 2016).

Pakistan is among the countries badly affected by climate change. Main cause includes CO₂ emissions, deforestation and over-population. Aiming to improve ecological conditions, State Bank of Pakistan (SBP) has developed framework for Green Banking in Pakistan. Further to this initiative, a consultation agreement was made by International

Finance Cooperation with SBP (Malik, Qasim, and Saeed 2018). Sufficient enactments to safeguard Pakistan's environmental situation was also made in 1997 (Sial 2018).

Although all SDGs, mutually interacted, assisted and effected each other for green energy development yet their exploitation level is far behind. Green energy revolution directly linked with SDG 7 and accelerate the process to achieve level prescribed by other SDGs (Nations 2022). Whereas, main goal of sustainable cities (SDG 11) is to raise life quality by assisting cities in their transition to sustainability and carbon neutrality. Furthermore, High water quality (SDG 6), safeguarding the soil from deterioration (SDG 15), minimising the negative effects of noise and electromagnetic fields on society (SDG 3), increasing the amount of water resources available (SDG 6), managing terrestrial resources sustainably (SDG 15), and ensuring effective waste management (SDG 12) are also Sustainable goals associated with SGD 7. These all kind of activities are aimed at engaging stakeholders in the development of government plans for SDG action that have an environmental component.

Neo-Functionalism and Pakistan-Poland Cooperation

The first Polish explorers arrived in what is now Pakistan in the Middle Ages. Excellent and friendly ties started between Poland and Pakistan from 1962 (Government of Poland, n.d.). Through frequent meetings and talks, a deep political conversation developed between the Deputy Foreign Ministers. Among the most important official encounters were President Musharraf's trip to Warsaw in 2007 and the visits of the foreign ministers to Warsaw in 2010 and Islamabad in 2011. Between 2016 to 2020, the trade volume between the two countries grew by a compound annual growth rate of 5%. The amount of trade between Pakistan and Poland surpassed €500 million in 2018 and is continuing to grow. Poland has been a strong advocate for Pakistan's inclusion in the GSP+ programme, which has eliminated duties on more than 66% of EU tariff lines. Since receiving GSP+, Pakistan's exports to Europe have grown very quickly, by 50% to €6.7 billion in 2013-19

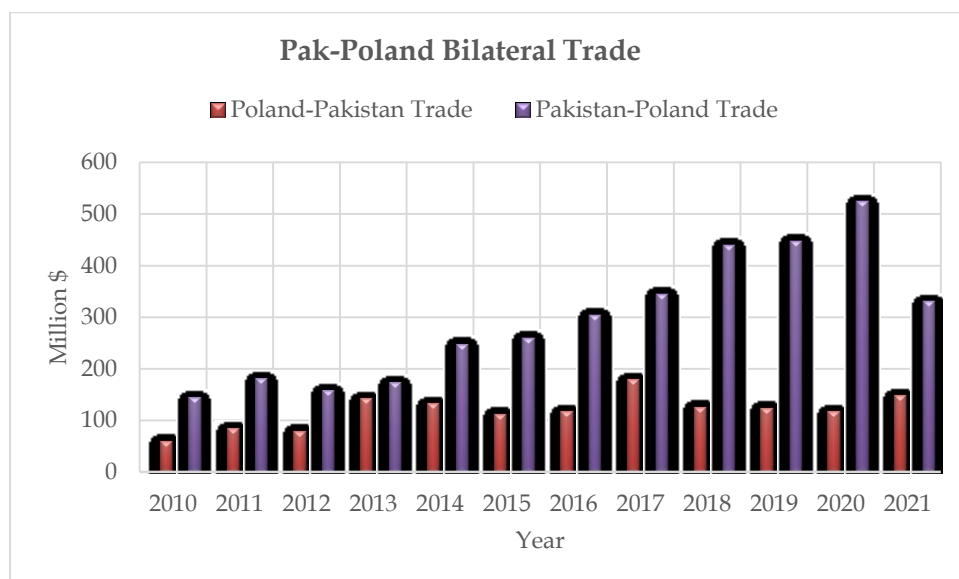


Fig 3: Source; <https://oec.world/en/profile/bilateral-country/pol/partner/pak>

Exploring potential avenues for creating economic cooperation between these two governments is the main goal of this study. Neofunctionalism has been utilised as a method for researching future possibilities for managing trade between Pakistan and

Poland. Neofunctionalism by David Mitrany offers a paradigm for deriving the interaction between Pakistan and Poland. Functionalism contends that any functional activity has the capacity to foster cooperation in more challenging contexts. Neofunctionalism thus appropriately explains Pakistan and Poland collaboration through a variety of functional activities and bilateral trade. In the long run, this process might result in continued economic cooperation that benefits both nations and yields mutually beneficial outcomes.

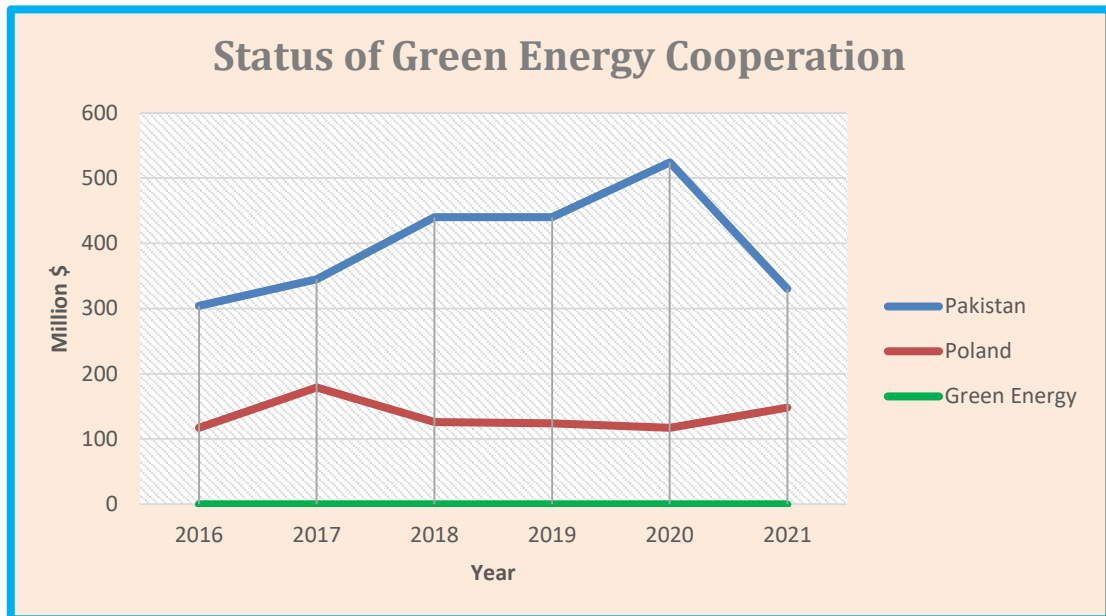


Fig 4: Source: <https://ember-climate.org/countries-and-regions/countries/pakistan/>

Pakistani business community urges to look at Poland's trade potential, investments, import/export links and marketing initiatives. Poland has a sound, free-market economy that abides by the highest quality standards of Europe. It is also fast evolving market with combination of knowledge and technology advancement of established economies and growth rate of developing nations. Neo-functionalism may be used to elaborate how the spill-over effects from the somewhat unconnected policy are redressed.

In green energy sector both states have an opportunity to enhance economic cooperation. Pakistan's solar potential is enormous. According to a recent World Bank research, using only 0.071 percent of the country's land area for solar PV will be enough to supply Pakistan's current energy consumption (Knight, 2021). By 2030, Pakistan would need to install around 24,000 MW of solar and wind energy. Similarly, wind is also a plentiful resource. Pakistan's wind corridors are well-known, with average wind speeds of 7.87 m/s in 10% of the country's windiest places (The World Bank, 2020). Despite a handful of successful projects, Pakistan's installed capacity of solar and wind energy, at slightly over 1,500 Megawatts, accounts for about 4% of total capacity, or around 2% of total power. On the other side, in Poland, solar energy has been developing quickly. Poland's total installed PV capacity was close to 5.7 GW in October 2021 (Bartłomiej Igliński, 2022). About 10% of Poland's power will be produced by solar energy by 2025. The remarkable growth of PV is attributable to picking the appropriate timing to launch and lowering technological prices.

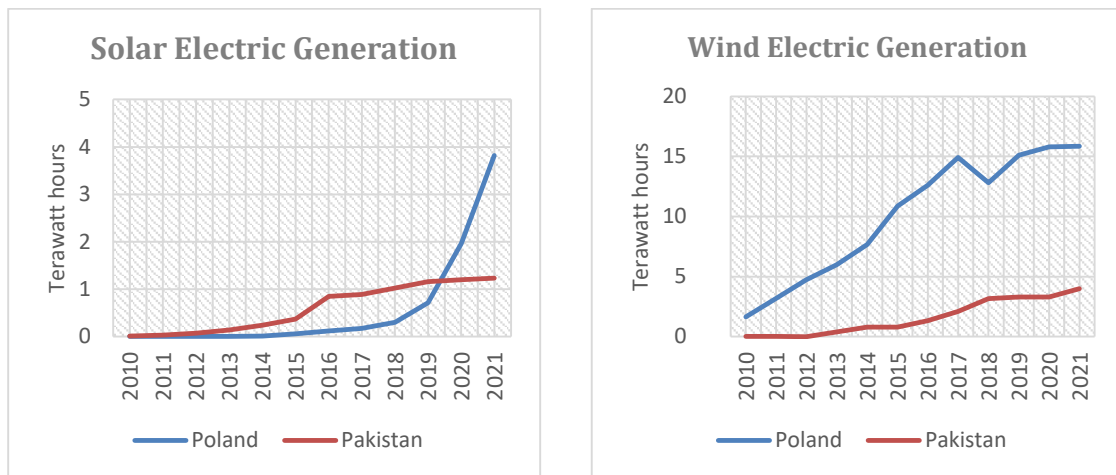


Fig 5: Source: <https://ember-climate.org/countries-and-regions/countries/poland/>

Discussion

In Poland, enormous capital venture investments in solar, wind, and bioenergy had been seen since last few years. By 2030, Poland envisioned to invest 135bn euro for energy transition (Romano, 2022). Pakistan is the biggest consumer of foreign renewable energy firms whereas its overall investment share lagged behind Poland's investment.

Currently world is shifting over green energy, solar energy. In this regard, industrial usage of global PV potential reached 40% recently (Joshi et al. 2021). The well-known international solar markets are European green energy markets such as Poland, Germany and France. Some Asian states including Pakistan are subsidising the green energy sector to attain advancement and to ensure energy security (Li et al. 2022).

Poland enacted renewable energy policy which has the defined objective of growth of green energy. Therefore, its proportion of power produced from renewables raised from 6.9% in 2010 to 16.9% in 2021 (Ptak, 2022). Pakistan inaugurated departments for comprehensive and applicable green energy policies and putting efforts to develop renewable energy and promote jobs. According to World Economic Forum (WEF) Pakistan ranked 104th out of 115 in exploiting green sources (Ali, 2021).

Pakistan set 2020-2023 energy plan for its strategic energy development to generate 30% of its total energy production from solar and wind resources (International Trade Administration, 2022). Due to economic crisis and technological inefficiency Pakistan had been unable to produce significant production. Pakistan is framing new policies and laws to diminish energy crisis and is aiming to reach green power capacities of 60% from renewable sources by 2030 (International Trade Administration, 2022). Poland is focusing to stimulate utilization of green energy in industrial sector, upgrading energy transmission and distribution network, obliging investors by providing subsidies. Poland's wind and PV technology is an important part of European market, expected to become one of the biggest renewable energy market around the world (IRENA, 2018). Pakistan and Poland have efficient integrated green energy management infrastructure which is conducive for cooperation among different types of energy utilization.

Pakistan is focusing to subsidize green energy sector to encourage businesses in solar and wind energy generation (Aslam, Nazir, and Zia 2021). Poland has enacted enough legislation for green energy development, legal safeguards and market support measures. In order to achieve sustainable development and green growth, bilateral

cooperation is essential. Poland already engaged with different states in green energy cooperation and Pakistan still seeking it, both states have a similar core objective of clean and green energy as well as reducing emissions.

Following are the recommendations for Pakistan based on the aforementioned analysis and a comparison of green energy development in Pakistan and Poland.

- i. PV and wind industry must be major sector to develop green energy.
- ii. Energy policies should be governed by the federal government while continuing legislation and market-support mechanism side by side.
- iii. In order to assure the security of new energy and cooperation with other states financing and trade mechanisms must meet international standards.

Transfer of Technology

Technology transfer is a prominent way for developing countries to access and utilize cutting-edge technologies (Mahmoud et al. 2012). Regulations enacted to promote trade liberalization also have impacts on developing states to acquire foreign innovations. A popular pathway for technology transfer is FDI, having implications for economic development (Newman et al. 2015). However, to entice investors for developing states and obtaining technology via FDI, robust IPR (Intellectual Property Rights) protection and skilled labour is essential. Joint venture is another reliable method for financial collaboration, which consists upon commercial objectives to surmount barriers in technology transfer. Hence, Green certificates and eco-taxes are the two key viable market instruments for transferring technology easily and also encouraging clean energy production (Fei 2012). Transfer of technology at global level is being drawn through political dialogues. Therefore, policies to stimulate technology transfer from advance to under-developed nations is gaining more importance.

Poland has established green energy-based market mechanisms and effectively advancing to achieve clean energy production targets. Currently, Poland's 17% of total energy consumption comes from renewable resources (International Trade Administration, 2022). The case of Pakistan is very different because culture has a big impact on the transition to green energy.

Conclusion

Today energy is pre-requisite of life, therefore its need and demand is increasing day by day. To cover up gap in energy supply fossil fuels are extensively used which causes environmental degradation. Energy supply and climate change has correlation. Limitless use of conventional resources has incessantly polluted the environment and some developing countries paid enormous prices and faced large scale destruction. Pakistan is one amongst most effected countries.

Profused energy production is causing irreparable damage to countries. Therefore, world is shifting to renewable or green energy. Europe is pioneer of this sector. Like other world Pakistan is also struggling to exploit green energy sources. Pakistan has abundant green energy resources whereas its trade partner Poland is proficient in green energy technology and rapidly shifting over green energy. Both countries have trade relations. Therefore, Pakistan can utilize Poland's experience and technology in green energy sector. Therefore, Poland has intensive investment opportunities in Pakistan to increase its trade. With transfer of green energy technology from Poland, Pakistan can decrease its

dependence on expensive imported oil and help itself in decreasing imports. Further, by switching to green energy, Pakistan can safeguard its environment and diminish climate change perils. At home, subsidies to green energy sector may be extended to decrease dependency over conventional power. Like Poland, Pakistan has to made sufficient legislation for green energy development. Therefore, bilateral relationship of both states needs to be extended essentially towards sustainable development and green growth. Pakistan can take following steps to enhance exploitation its green energy resources: -

- I. Bilateral relationship with Poland towards green energy must be enhanced. In this regard, agreements may be entered into for technology transfer. Investment venues may be introduced to entice Poland in green energy sector development.
- II. Sufficient law enactment be ensured for energy security and facilitation to private sector.
- III. PV and wind industry must be the major sector to develop green energy.
- IV. Energy policies should be governed by the federal government while continuing enacting legislation and market-support mechanism side by side.
- V. In order to ensure the security of new energy and cooperation with other states, financing and trade mechanisms must meet international standards.

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