ENERGY POLICIES FOR THE PROMOTION OF RENEWABLE ENERGY IN THE GEOGRAPHICAL AXIS COMPARISON BETWEEN ASIA AND EUROPE

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Abstract
The limitation of conventional energy sources, on the one hand, and environmental concerns, on the other, have led countries to try to promote renewable energy technologies. Energy policy instruments play a crucial role in implementing innovation and reducing costs in renewable energy production. Different countries have implemented various policies to promote renewable energy technologies, such as capital subsidies, feed-in tariffs, tradable certificates and renewable portfolio standards. However, some policies are more effective than others. Learning from the experiences of advanced countries and combining these with indigenous factors will help other countries develop renewable energy technologies in their energy supply structures.
This paper analyses the effect of different policy instruments in the renewable energy sectors in the Geographical Axis. Measures are analysed and policy recommendations which, when taken into account, contribute to the achievement of renewable energy, thereby reducing emissions, mitigating climate change and providing a clean environment and clean energy for all and future generations.
Also, it examined the opportunities associated with renewable energy sources, which include: Energy security, energy access, social and economic development, climate change mitigation and reducing environmental and health impacts.

Keywords: Renewable energy, Energy policy, Geographical axis, Energy Access, Social and Economic Development.

JEL Classification: N70, O13 , Q20 , Q40 , Q50

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Introduction

The world is fast becoming a global village, a place where supply chains are disrupted due to the increasing daily requirement of energy by all populations across the world while the earth in its form cannot change. The need for energy and its related services to satisfy human social and economic development, welfare and health is increasing.

All regions of society call for the services of energy and the resource distribution network to meet basic human needs such as health, lighting, cooking, space comfort, mobility and communication and serve as generative processes (Edenhofer et al., 2011). Securing the energy supply and curbing energy contribution to climate change are the two overriding challenges of the energy sector on the road to a sustainable future (Abbasi & Abbasi, 2010; Kaygusuz, 2012). It is overwhelming to know in today's world that 1.4 billion people lack access to electricity, while 85% of them live in rural areas. As a result of this, the number of rural communities relying on the traditional use of biomass is projected to rise from 2.7 billion today to 2.8 billion in2030 (Kaygusuz, 2012).

In recent decades, Asian countries have experienced a rapid economic growth rate and their need for secure energy sources is becoming more important due to this economic growth. The lack of fossil energy sources in these countries and environmental issues have led to their tendency to use renewable energy sources such as solar, wind and tide energy. Meanwhile, these countries have good potential to use renewable energy sources. Some benefit from strong wind streams and others from sun rays. There are, nonetheless, the development of renewable energy technologies encounters some problems.

The main barrier to renewable energy development is the high production cost the production cost of renewable energies like solar and wind energy remains higher than conventional energy sources.

In this regard, the government's effective policy at the level of the geographical axis can deploy innovation and cost reduction as a consequence of innovation. Different policy tools like feed-in tariffs, tradable certificates, renewable portfolio standards, tax incentives, and production quotas have a crucial role to promote innovation in renewable energy technologies.

Considering the importance of these policies this paper compares the effects of various policy tools on renewable energy development among specific countries.

I selected two Asian countries the Republic of Korea, and the People's Republic of China as our case studies even though some policy tools are in the initial stages in these countries and it's early to evaluate the effectiveness of such policies.

We added two advanced countries including European Union (EU) and the United Kingdom to the geographical axis.

Research into alternate sources of energy dates back to the late 90s when the world started receiving the shock from oil producers in terms of price hiking (Abbasi et al., 2011). It is evident in the literature that replacing fossil fuel-based energy sources with renewable energy sources, including bioenergy, direct solar energy, geothermal energy, hydropower, wind, and ocean energy (tide and wave), would gradually help the world achieve sustainability.

Governments, intergovernmental agencies, interested parties and individuals in the world today look forward to achieving a sustainable future due to the opportunities created in recent decades to replace petroleum-derived materials from fossil fuel-based energy sources with alternatives in renewable energy sources.

Sustainable development has become the centre of many countries' national policies, strategies, and development plans. International groups proposed a set of worldwide Sustainable Development Goals (SDGs) which included 17 goals and 169 targets at the UN in New York by the Open Working Group. These goals form a core element in the analysis of the work. A preliminary set of indicators was introduced in March 2015 to promote and implement renewable resources (Lu, Nakicenovic, Visbeck, & Stevance, 2015).

The SDGs place more excellent value and demands on the scientific community than the Millennium Development Goals. In addressing climate change, renewable energy, food, health, and water provision requires a coordinated global monitoring and modelling of many factors which are socially, economically, and environmentally oriented (Hák, Janoušková, & Moldan, 2016; Owusu, Asumadu-Sarkodie, & Ameyo, 2016).

The recent launch of a set of global SDGs is helping to make sure that climate change for the twenty-first century and its impacts are combated, and a sustainable future is ensured and made as a bequest for future generations (Edenhofer et al., 2011; Lu et al., 2015).

The remainder of the paper is sectioned into five: In the first step case study of some selected countries including South Korea, China, the UK + UE will be evaluated and after identifying their advantages and system failures the results will be compared and finally, a comprehensive pattern will be developed for other countries Section 2 discusses renewable energy sources and sustainability and climate change, Section 3 elaborates on the various

renewable energy sources and technologies, Section 4 elaborates on renewable energy sources and sustainable development, Section 5 elaborates on challenges affecting renewable energy sources and policy recommendations and Section 6 conclude the study.

Review of the scientific literature

A. Renewable energy sources and sustainability

Renewable energy sources replenish themselves naturally without being depleted in the earth; they include bioenergy, hydropower, geothermal energy, solar energy, wind energy and ocean (tide and wave) points. Principal types of renewable energy forms and their uses are presented in Table 1.

An analysis of the sustainability of new resources is that of Tester (2005) who defines sustainable energy as, "a dynamic harmony between the equitable availability of energy-intensive goods and services to all people and preservation of the earth for future generations".

The increasing regional demand for power requirements, alongside increasing population, led to the continual use of fossil fuel-based energy sources (Coal, Oil and Gas) and unequal distribution of resources to the population which became problematic by creating several challenges such as depletion of fossil fuel reserves, greenhouse gas emissions and other environmental concerns, geopolitical and military conflicts, and the continual fuel price fluctuations in the geographical axis.

These problems will create unsustainable situations which will eventually result in a potentially irreversible threat to human societies (UNFCC, 2015) leading to the severing of economic links and disruption in the grid.

Notwithstanding, renewable energy sources are the most outstanding alternative and the only solution to the growing challenges in modern societies' need for energy when a comparison between Asia and Europe in terms of green energy development potential is analysed (Tiwari & Mishra, 2011)

In 2012, renewable energy sources supplied 22% of the total world energy generation (U.S. Energy Information Administration, 2012) which was not possible a decade ago While 2022 did see an increase in fossil fuel electricity generation for the EU, Ember is expecting it to decline in 2023 by as much as 20%. Provided the EU's geographical focus can support this accelerated transition away from fossil fuels, this electricity generation primary source grid could include many more renewable and low-carbon energy sources shortly. (https://www.weforum.org/)

A reliable energy supply is essential in all economies for heating, lighting, industrial equipment, transport, etc. (International Energy Agency, 2014). Renewable energy sources are important because they significantly reduce greenhouse gas emissions if replaced by fossil fuels. As renewable power resources are naturally derived from the continuous flow of energy in our environment, they should be sustainable. To be sustainable, renewable sources of green electricity must be unlimited and provide green goods and services. For instance, a real sustainable biofuel should not increase net CO2 emissions, negatively affect food security, or threaten biodiversity (Twidell & Weir, 2015).

Besides the notable advantages of renewable energy sources, economic efficiency analysis has some shortcomings, such as the interruption of production due to seasonal variations, because most renewable energy resources are climate-dependent, which is why their exploitation requires complex design, planning and control optimisation methods. Thankfully, continuous technological progress in hardware and software allows scientific researchers to solve these optimisation difficulties using computational resources applicable to renewable and sustainable power. (Baños et al., 2011).

Table 1. Renewable energy sources and their use

Energy sources	Energy conversion and usage options

Hydropower	Power generation
Biomass Energy	Heat and power generation, pyrolysis, gasification, anaerobic
Geothermal Power	Urban heating, power generation, hydrothermal, hot dry rock
Solar electric power	Solar home systems, solar dryers, solar cookers
Direct solar energy	Photovoltaic, thermal power generation, water heaters
Wind energy	Power generation, wind generators, windmills, water pump
Wave and tide energy power	Numerous projects under consideration, barrage, tidal stream

Source : Panwar et al., 2011

B. Renewable energy and climate change

Presently, the term "climate change" is of great interest to the world, in scientific and political discussions. Climate has been changing since the beginning of creation, but what is alarming is the speed of change in recent years and it may be one of the threats facing the earth. The growth rate of carbon dioxide has increased over the past 36 years (1979–2014) (Asumadu-Sarkodie& Owusu, 2016c, 2016f), "averaging about 1.4 ppm per year before 1995 and 2.0 ppm per year thereafter" (Earth System Research Laboratory, 2015).

The United Nations Framework Convention on Climate Change defines climate change as being attributed directly or indirectly to human activities that alter the composition of climate observed over comparable periods (Fräss-Ehrfeld, 2009).

Renewable technologies are considered clean resources of power and the optimal use of these resources reduces their environmental impact, produces minimal secondary waste and is sustainable based on current and future economic and social demand renewable energy technologies provide an exceptional opportunity for the mitigation of greenhouse emissions and reducing global warming through substituting conventional energy sources (fossil fuel-based) (Panwar, Kaushik, & Kothari, 2011).

C. Renewable energy sources and technology

Today, the development of countries worldwide depends on the energy resources the industry needs. In this way, increasing the social welfare of the countries and increasing their competitiveness in the global arena depends on their energy potential energy use directly or indirectly affects human life in many areas such as transportation, heating, communication, lighting, industry, tourism, and agriculture

Regenerative power sources are energy supplies derived from the natural and persistent flow of energy that occurs in our environment.

They include bioenergy, direct solar energy, geothermal energy, hydropower, wind, and ocean energy (tide and wave). (Table 2)

.From a household perspective, the use of renewable energy technologies offers a considerable number of benefits, i.e., it improves living conditions by using energy more productively, contributes to sustainable spatial planning and architecture, helps to protect the quality of the environment, and distributes energy in a balanced way and thus gives financial autonomy Solar photovoltaic (PV) and solar thermal, micro-wind, heat pumps,

and small-scale biomass heating technologies can be distinguished as the main renewable energy technologies in households. (Weihua Su; Mengling Liu; Shouzhen Zeng; Dalia Streimikiene; Tomas Balezentis; Ilona Ališauskaitė-Šeškienė; 2018)

Table 2 Summary functional list of Renewable energy

Hydropower	Hydropower is an essential renewable power source extracted from water moving from higher to lower levels, mainly to turn turbines and generate electricity. Hydropower projects include Dam projects with reservoirs, run-of-river and in-stream projects and cover a range of project scale projects technologies are technically mature and their projects exploit a resource that varies temporarily. The operation of hydropower reservoirs often reflects their multiple uses, for example, flood and drought control (Asumadu-Sarkodie, Owusu, & Jayaweera, 2015; Asumadu-Sarkodie, Owusu, & Rufangura, 2015), irrigation, drinking water and navigation (Edenhofer et al., 2011). The primary energy is provided by gravity and the height at which the water falls onto the turbine. The potential energy of the stored water is the mass of the water, the gravity factor (g = 9.81 ms−2) and the head are defined as the difference between the dam level and the tailwater level The storage tank level changes somewhat downwards when water is released and consequently influences electricity production. Turbines are constructed for an optional flow of water (Førsund, 2015). Hydropower produces no polluting particles, can be upgraded quickly and is capable of storing energy for several hours. (Hamann, 2015).
Hydropower source potential on Geographical Axis	Hydropower generation technical annual. The potential is 14,576 TWh, with an estimated total capacity potential of 3,721 GW; but currently, the global installed capacity of hydropower is much less than its potential. According to the World Energy Council Report, about 50% of hydropower installed capacity is among four countries namely China, almost 650 TWh are generated in an average hydrological year, which equates to about 65% of the economically feasible hydropower potential within the Europe Union include the UK.

	World Energy Council, 2013). (https://hydropower-europe.eu/) The resource potential of hydropower could be altered due to climate change. Globally, the alterations caused by climate change in the existing hydropower production system are estimated to be less than 0.1%, even though additional research is needed to lower the uncertainties of these projections (Edenhofer et al., 2011). As the second largest renewable electricity source, hydropower continues to be an important energy source today. According to Eurostat, it accounted 2020 for 33% of the EU's renewable electricity production and provided 17% of the EU's electricity.
Bioenergy	Bioenergy is a renewable source of energy derived from biological supplies. Bioenergy is an important source of energy, which can be used for transport using biodiesel, power generation, cooking and warming. Electricity from bioenergy attracts a large range of different sources, including forest by-products such as wood residues; agricultural residues such as sugar cane waste; and animal husbandry residue such as cow dung. Another advantage of biomass electricity is that the fuel is often a by-product, residue, or waste from the above sources. Significantly, it does not create competition between land for food and land for fuel (Urban & Mitchell, 2011). Presently, global production of biofuels is comparatively low, but continuously increasing (Ajanovic, 2011). The annual biodiesel consumption in the United States was 15 billion litres in 2006. It has been growing at a rate of 30–50% per year to achieve an annual target of 30 billion litres at the end of the year 2012 (Ayouthe b & Abdullah, 2012).
Bioenergy source potential	Biomass has a large potential to meet the greenhouse gas reduction target and could secure future fuel supplies. A lot of work is being done in this field to quantify the overall biomass

	technology. According to Hoogwijk, Faaij, Eickhout, de Vries and Turkenburg (2005), the theory. The potential of bioenergy at the total terrestrial surface is about 3,500 EJ/year. With biomass, much research is focusing on an environmentally acceptable and sustainable source to mitigate climate change (Demirbas, Balat, & Balat, 2009).
Bioenergy's Environmental and social impact	Using biological products (of plant and animal origin) to produce renewable sources of energy has always been a cause for concern, especially for the general public and for concerns about whether its food products will be used to provide fuel, given that there are cases of needy food aid around the world in disadvantaged countries. About 99.7% of human food is obtained from the terrestrial environment, while about 0.3% comes from the aquatic domain. Most of the suitable land for biomass production is already in use (Ajanovic, 2011). Current studies have underlined both positive and negative environmental and socio-economic effects of bioenergy. Like orthodox agriculture and forestry systems, bioenergy can worsen soil and vegetation breakdown as a result of overexploitation of forests, excessive removal of crops and forest waste and excessive water use (Koch & Ghazoul, 2008; Robertson et al., 2008).
	Diversion of crops or land into bioenergy production can induce food commodity prices and food security(Headey & Fan, 2008). Proper operational management can bring about some positive effects which include enhanced biodiversity (Baum, Leinweber, Weih, Lamersdorf, & Dimitriou, 2009; Schulz, Brauner, & Gruß, 2009), soil carbon increases and improved soil productivity (Baum, Weih, Busch, Kroiher, & Bolte, 2009; Edenhofer et al., 2011; Tilman, Hill, & Lehman, 2006).

Solar energy	The word "direct" solar energy refers to the energy base for those renewable energy source technologies that draw on the Sun's energy directly. Some renewable technologies, such as wind and ocean thermal, use solar energy after it has been absorbed on the earth and converted into other forms. Solar energy technology is obtained from solar irradiance to generate electricity using photovoltaic(PV) (Asumadu-Sarkodie & Owusu, 2016d) and concentrating solar power (CSP), to produce thermal energy, to meet direct lighting needs and, potentially, to produce fuels that might be used for transport and other purposes (Edenhofer et al., 2011). According to the World Energy Council(2013), "the total energy from solar radiation falling on the earth was more than 7,500 times the World's total annual primary energy consumption of 450 EJ" (Urban & Mitchell, 2011).
Wind energy	The emergence of wind as an important source of renewable global power has taken the lead among renewable sources. Wind exists all over the world, in some places with high energy density (Manwell, McGowan, & Rogers, 2010). Wind energy harnesses kinetic energy from moving air. The primary application of the importance of climate change mitigation is to produce electricity from large turbines located onshore (land) or offshore (in the sea freshwater Sarkodie & Owusu, 2016e). Onshore wind energy technologies are already being manufactured and deployed on a large scale (Edenhofer et al., 2011). Wind turbines convert the energy of wind into electricity.

Source: Created by the author

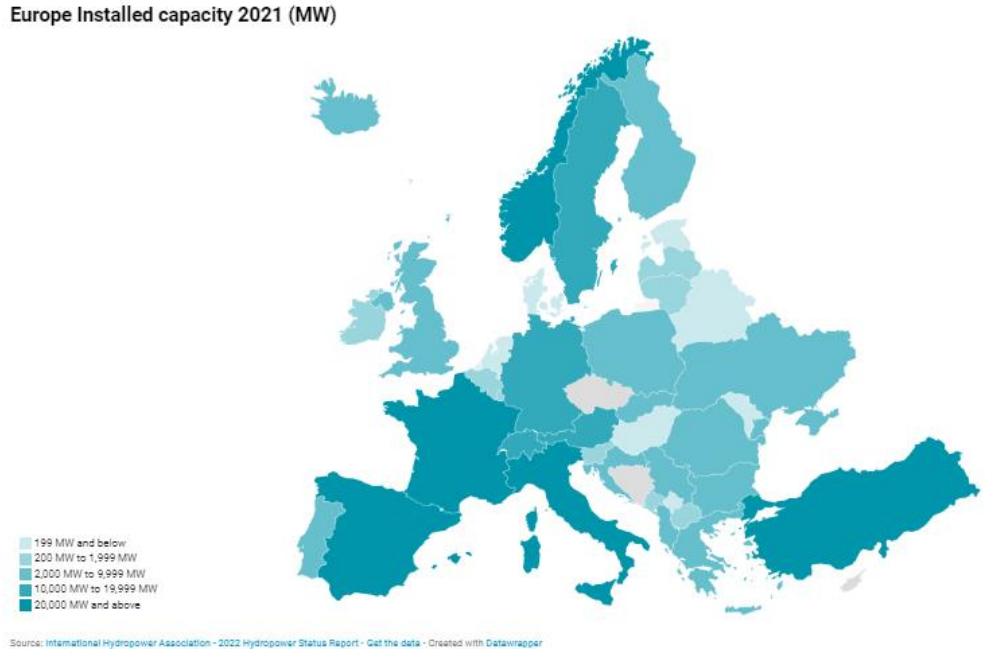

Fig.1 The difference in hydropower capacity between the geographical axis in the European Union and countries outside the European Union.

It is worth mentioning that the European Union is a political axis that unites the geographical area of Europe.

Source: https://app.datawrapper.de/

D. Renewable energy promotion policies

Policies whose specific goal is to promote renewable energy fall into three main categories: (a) price-setting and quantity-forcing policies, which mandate prices or quantities; (b) investment cost reduction policies, which provide incentives in the form of lower investment costs; and (c) public investments and market facilitation activities, which offer a wide range of public policies that reduce market barriers and facilitate or accelerate renewable energy markets. Historically, governments have enacted these policies in an ad-hoc manner.

More recently, national renewable energy targets (also referred to as goals) have emerged as a political context for promoting specific combinations of policies from all three categories. Such targets focus on the aggregate energy production of an entire country or group of countries. Targets may specify total primary energy from renewables and/or minimum renewable energy shares of electricity generation. In June 2021, the EU adopted a European Climate Law, establishing the aim of reaching net zero greenhouse gas emissions (GHG) in the EU by 2050. The law sets an intermediate target of reducing GHG by at least 55% by 2030 compared to 1990. The ‘ Fit for 55’ package is a set of policy proposals by the European Commission to achieve this 55% reduction target. For these proposals to come into effect, the European Parliament and the Council must jointly approve them. (https://www.unsdsn.org/european-commission-launches-proposals-to-reach-55-emissions-reduction-by-2030)

China and India are the first developing countries to propose renewable energy targets. India has proposed that by 2012, 10% of annual additions to power generation would be from renewable energy; China has a similar goal of 5% by 2010, and South Korea has 30% of the total energy used to come from renewable resources.

Research Methodology

In the methodology used at multiple stages in a policy design and implementation cycle, it becomes an iterative process, such that previous experience informs improvements to policy design and implementation, and the development of new policies and comparison between Asia and Europe

Incentive mechanisms are a core driver of the expansion in renewable energy capacity. The methodology focuses on renewable energy policies that are widely implemented and are successful in advancing renewable energy deployment:

- supply network policies, including geographical supply axis: policies aimed at promoting renewable energy renewables through the realisation of geographical axis energy;
- discusses renewable energy sources and sustainability and climate change, elaborates on the various renewable energy sources and technologies, elaborates on renewable energy sources and sustainable development, elaborates on challenges affecting renewable energy sources and policy recommendations;
- determine the objective of the assessment, Social and economic development;
- Estimate the renewable energy addition of the policy.

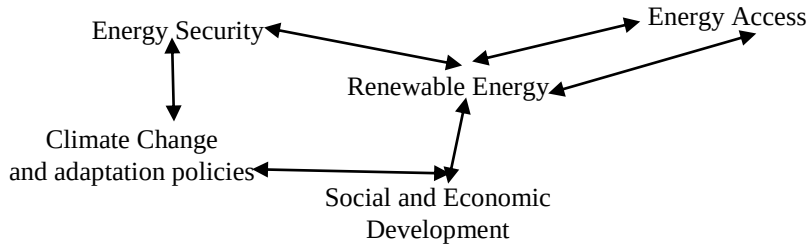

Figure 2**.** Methodological model for organising renewable energy sources in the context of promotion policies

Policies to support renewable resources provide opportunities for energy security, social and economic development, energy access, climate change mitigation and reduction of environmental and health impacts (Asumadu-Sarkodie & Owusu, 2016g).

Figure 2 shows the opportunities for renewable energy sources towards sustainable development.

Results and discussion

To consolidate the analysis conducted efficiently, the results of the chapter have been structured as follows: Renewable energy and sustainable development, Challenges affecting renewable energy sources and Renewable Energy Policies, and Comparative analysis in the geographical axis between Asia and Europe in terms of share of green energy used.

A. Renewable energy and sustainable development

Renewable forms of power have a direct relationship with sustainable growth through their impact on human development and economic performance. (Asumadu-Sarkodie & Owusu, 2016b). Renewable energy sources provide opportunities for energy security, social and economic development, energy access, climate change mitigation and reduction of environmental and health impacts (Asumadu-Sarkodie & Owusu, 2016g).

The definition of sustainable energy management is widely used, but there is no consensus on its exact definition. Still, the concern for energy security is based on the idea that there is a continuous supply of renewable energy, which is essential for the functioning of an economy. (Kruyt, van Vuuren, de Vries, & Groenenberg, 2009).

Given the interdependence of economic growth and energy consumption, access to a stable energy supply is of importance to the political world and a technical and monetary challenge for both developed and developing countries

because prolonged interferences would generate serious economic and basic functionality difficulties for most societies (Edenhofer et al., 2011; Larsen et al. 2009). Renewable resources are evenly distributed around the world compared to conventional fossil fuels and are generally less traded on the market. Renewable energy reduces energy imports and contributes diversification of the portfolio of supply options and reduces an economy's vulnerability to price volatility and represents opportunities to enhance energy security across the globe.

Renewables can also help increase the reliability of power services, especially in areas that often suffer from poor grid connectivity. A diversified portfolio of energy sources, together with good system management and design, can help increase safety. (Edenhofer et al., 2011).

More generally, the power supply sector was seen as a key element for economic development, with a strong correlation between economic growth and growth in energy consumption. At a worldwide level, per capita income is positively correlated with per capita energy consumption and economic growth can be identified as the most important factor driving energy consumption growth in recent decades. It in turn creates employment; a renewable energy study in 2008, proved that employment from renewable energy technologies was about 2.3 million jobs worldwide, which also has improved health, education gender equality and environmental safety (Edenhofer et al., 2011).

Sustainable Growth Goal 7 (clean and affordable energy) aims to ensure that sustainable sources of power are clean, affordable, available, and accessible to all, and this can be achieved with the help of renewable energy sources as they are generally distributed around the globe. Access concerns need to be understood in a local context and in most countries, there is an obvious difference between electrification in the urban and rural areas, this is especially true in the South Asian region (Brew Hammond, 2010).

Distributed grids based on renewable energy are generally more competitive in rural areas with significant distances to the national grid and low levels of rural electrification offer substantial openings for renewable energy-based mini-grid systems to provide them with electricity access(Edenhofer et al., 2011).

Renewable energy sources used in energy generation help to reduce greenhouse gases which mitigates climate change and reduces environmental and health complications associated with pollutants from fossil fuel sources of energy. The change in total GHG emissions in European Environmental Agency (EEA) comparison between 1990, 2000, 2010 and 2020 their GHG emissions per capita.

Table.3 Data viewer on greenhouse gas emissions and removals, sent by countries to UNFCCC and the EU + UK Greenhouse Gas Monitoring Mechanism (EU Member States) and GHG emissions per capita

EU-27+UK	Total net emissions with international aviation (EU NDC)	All greenhouse gases –(CO_2 equivalent) per/years	Emissions (kt CO eq)	GHG emissions per capita
		1990	5.509.495	11,54
		2000	4.997.345	10,21
		2010	4.594.656	9,12
		2020	3.544.794	6,89

Source: https://www.eea.europa.eu/data-and-maps/data/data-viewers/greenhouse-gases-viewer

It should be noted that the result is an average of the European Union plus Great Britain. Values may vary at the level of individual EU countries.

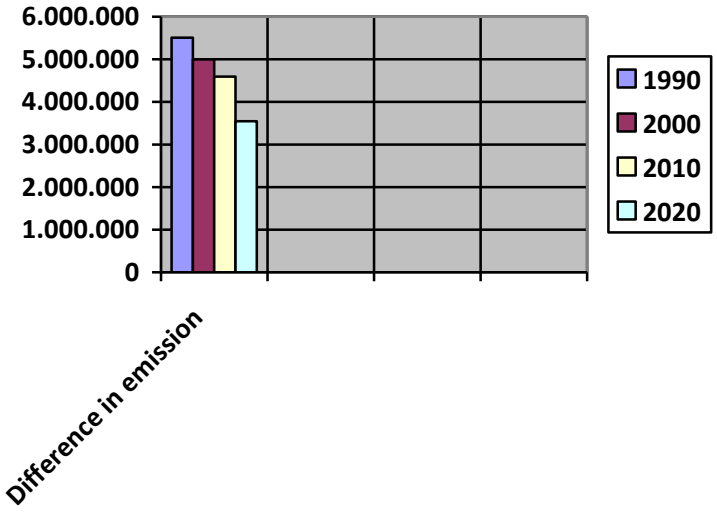

Fig.3 Difference in emission

The percentage difference between 1990 and 2020 (30 years) is: 1,964.701

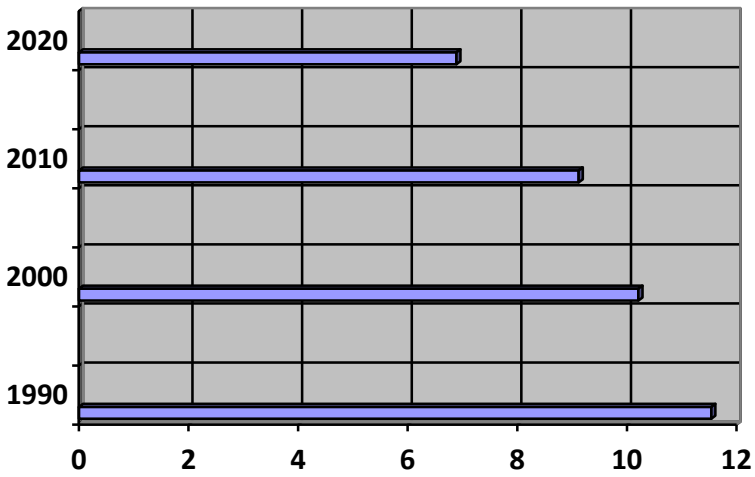

Fig.4 Difference in emission per capita

The percentage difference between 1990 and 2020 (30 years) is: 4,65

China's 20th Party Congress in October 2022, outlining President Xi Jinping's vision for the next five years, delivered no new headline policy updates on climate and environment but re-emphasised key trends of the last year. This includes pushing for modernisation and efficiency gains in industry and energy systems, evolving the economy towards higher value and cleaner production, and the necessity of coal as a "backstop for energy security".

Ahead of COP26 in November 2021, China officially submitted to the UNFCCC its carbon neutrality "before 2060" target and updated NDC targets, strengthening its previous non-fossil share and carbon intensity targets, while adding a new renewable energy capacity target. However, while China's updated NDC was an improvement on previous targets, it leaves room for further target-raising ambition. We project that China is likely to comfortably overachieve its targets without substantially increasing its current mitigation efforts, despite increasing emissions in the short term. (Figure 5)

Renewable energy will also continue to be a national priority in parallel; installed capacity for renewables surpassed 1,000 GW in 2021. Energy from non-fossil sources in China needs to grow by around 13% by 2025 and 52% by 2030 (from 2020 levels) to achieve its FYP and NDC targets. China issued new renewable targets in 2022, aiming to generate 3300 TWh of electricity from renewable sources by 2025, approximately 35% more than it did in 2020.

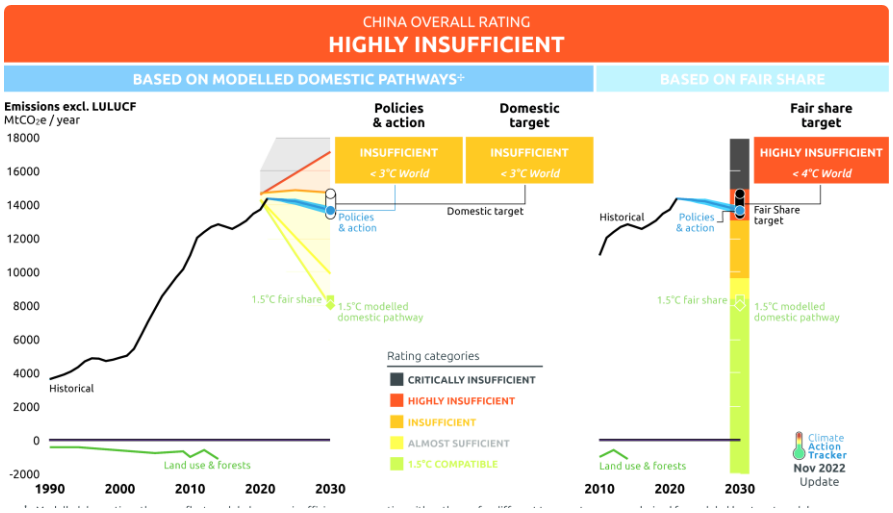

Fig.5 China energy policies

Source: https://climateactiontracker.org/countries/china/

Korea's energy transition and the Green New Deal

Korea's energy sector is characterised by the dominance of fossil fuels, which in 2018 accounted for 85% of the total primary energy supply (TPES), a strong dependence on energy imports at 84% of TPES, and the dominance of industrial energy use at 55% of total final consumption, the highest share among IEA countries.

In 2018, Korea had the lowest share of energy from renewable sources in energy supply among all IEA countries. (https://www.iea.org/reports/korea-2020)

The Korean government is committed to advancing the country's energy transition by increasing the share of renewable electricity to 20% by 2030 and to 30-35% by 2040, to gradually phase out coal and nuclear from the energy mix while significantly improving energy efficiency and fostering the country's nascent hydrogen industry.

Under the Paris Agreement, Korea is committed to limiting its emissions to 536 million tonnes of carbon dioxide equivalent (Mt CO2-eq) in 2030; in 2018, emissions were 709 Mt CO2-eq. (https://www.iea.org/reports/korea-2020)

B. Challenges affecting renewable energy sources and Renewable Energy Policies

Renewable energy sources could become the major energy supply option in low-carbon energy economies. Disruptive alterations in all energy systems are necessary for tapping widely available renewable Energy sources. Organizing the energy transition from non-sustainable to renewable energy is often described as the major challenge of the first half of the twenty-first century (Verbruggen et al., 2010).

The following are policy recommendations emanating from the study that can help mitigate climate change and its impacts:

- All sectors and regions have the potential to contribute by investing in Renewable energy technologies and policies to help reduce it;
- Reducing our carbon footprint through changes in lifestyle and behaviour patterns can contribute a great deal to the mitigation of climate change;

- Research into innovations and technologies that can reduce land use and also reduce accidents from renewable energy sources and the risk of resource competition, for example in Bioenergy where food for consumption competes with energy production;
- Enhancing international cooperation and support for developing countries towards the expansion of infrastructure and upgrading technology for modern supply and sustainable energy services as a way of mitigating climate change and its impacts.

C. Comparative analysis in the geographical axis between Asia (China, South Korea) and the EU in terms of the share of green energy used

In total, 15 of the 27 EU members reported a share over the 21.8 per cent average in 2022: Belgium, Bulgaria, Czechia, Germany, Ireland, Spain, France, Italy, Cyprus, Luxembourg, Hungary, Malta, Netherlands, Poland and Slovakia.

The lowest proportions of renewables were recorded in Luxembourg (11.7 per cent), Malta (12.2 per cent), the Netherlands (12.3 per cent), Ireland (12.5 per cent) and Belgium (13 per cent). The average share of renewable energy in the EU is 22 per cent (Eurostat)

The UK appears towards the bottom of the European rankings, with only 14 per cent of its energy coming from renewables in 2022.

In China, Renewable energy sources accounted for 14.95% of the primary energy consumption mix in 2021 (https://www.mordorintelligence.com/)

According to the Korea Power Exchange, the capacity of renewable energy came to 27,103 megawatts as of September, which marked 20.1 per cent of 134,719 megawatts in collective power generation facilities.(https://www.koreaherald.com)

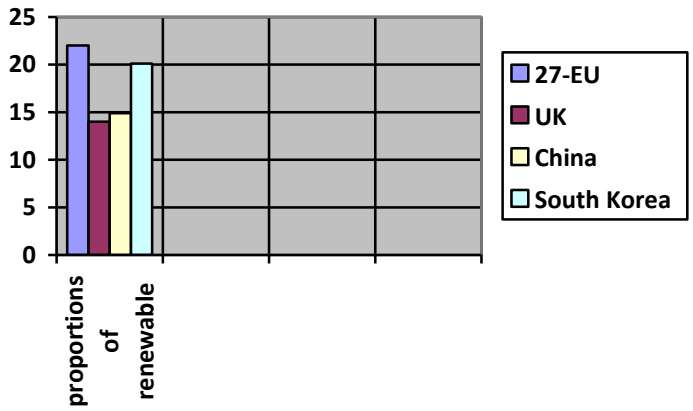

Fig.6 Proportion of renewable in geographical axis 27-EU-UK-China -South Korea

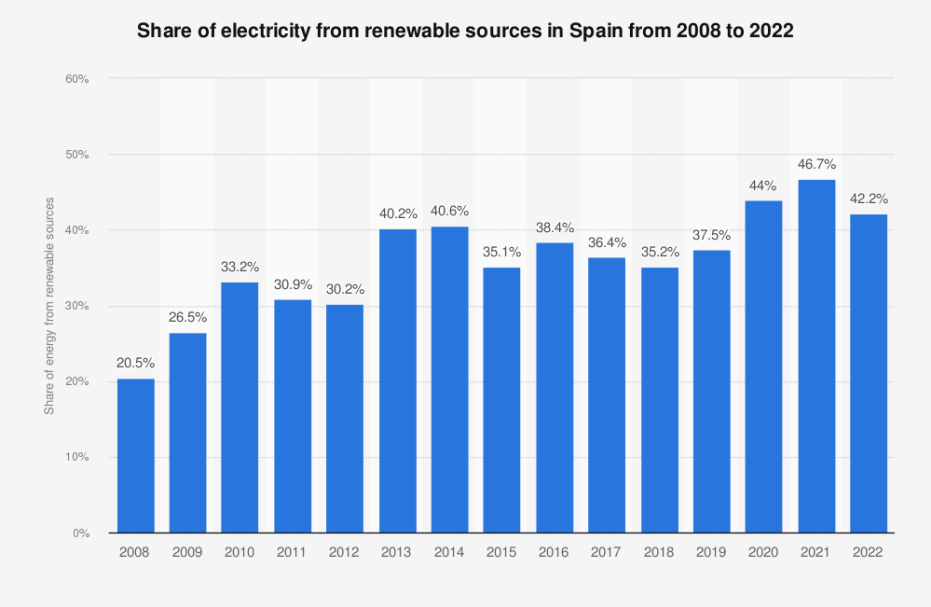

Fig.7 Renewable source in Spain

Source: https://www.statista.com/statistics/419432/spain-share-of-electricity-from-renewable-sources/

From 2008 to 2022, the share of energy from renewable sources in electricity generation in Spain climbed from 20.5 per cent to 42.2 per cent. Renewable electricity generation in the country peaked in 2021 at 46.7per cent

From the graph above it can be seen that the European Union has invested in environmental policies (with which the UK is associated) promoting renewable energies. Still, China and South Korea have come strongly from behind the economic potential with strong policies to adapt industry and economy to sustainable green points.

The leading countries for installed renewable energy in 2022 were China, the U.S., and Brazil. China was the leader in renewable energy installations, with a capacity of around 1,161 gigawatts. The U.S., in second place, had a capacity of around 352 gigawatts. Renewable energy is an important step in addressing climate change and mitigating the consequences of this phenomenon. (see Figure 8)

Renewable power capacity is defined as the maximum generating capacity of installations that use renewable sources to generate electricity.

Recent data suggests that renewable energy as a share of the world's power production is increasing. Renewable energy consumption varies from country to country. The top Geographic Axis for renewable energy consumption is China, the United States, and Brazil, respectively.

There are various types of renewable energy sources used globally including, bioenergy, solar energy, hydropower, and geothermal energy, to name a few. Globally, China and Canada are the top two countries in terms of generating the most energy through hydropower. Geothermal energy has been on the rise as well. Data shows an increase in geothermal energy capacity globally in the last 10 years. Likewise, there has been a dramatic increase in the capacity of global solar energy in recent years.

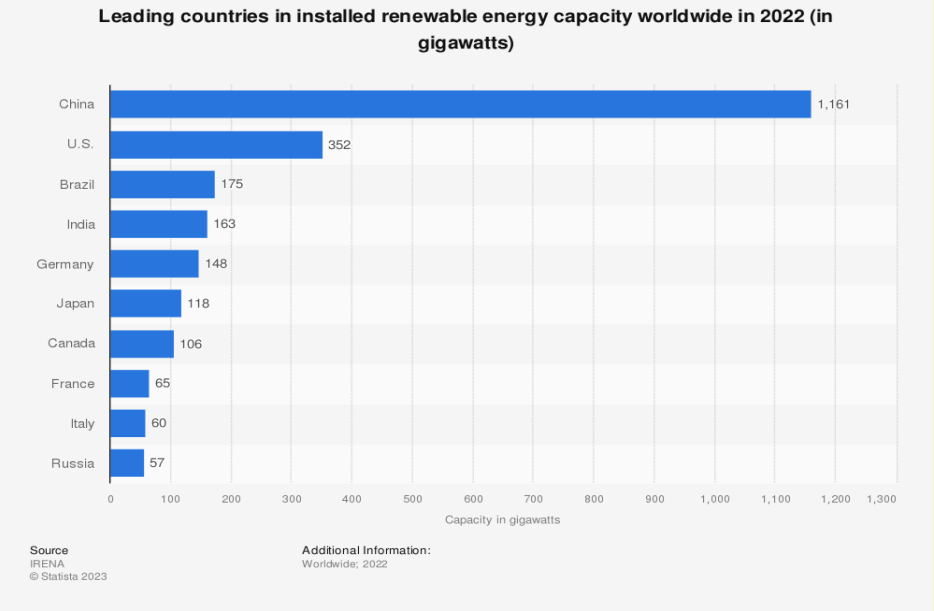

Fig.8 Geographic Axis of renewable energy capacity
Source: https://www.statista.com/statistics/267233/renewable-energy-capacity-worldwide-by-country/

Conclusions

Power is a requirement in our daily lives, as it is a means of enhancing human development leading to economic development and higher productivity. The return-to-renewables will help mitigate climate change excellently but needs to be sustainable to ensure a sustainable future for generations to meet their energy needs.

In particular, knowledge of the interrelationships between sustainable development and renewable sources of electricity is still limited. The paper aimed to ascertain if renewable energy sources were sustainable and how a shift from fossil fuel-based energy sources to renewable energy sources would help reduce climate change and its impact. Qualitative research was employed by reviewing papers in the scope of the study.

Although the entire life cycle of renewable resources has no net emissions, it will contribute to limiting future global greenhouse gas emissions. Nevertheless, the cost, price, political environment, and market conditions have become barriers preventing developing, least developed and developed countries from fully utilising their potential.

In this way, a creation of global opportunity through international cooperation that supports least developed and developing countries towards the accessibility of renewable energy, energy efficiency, clean energy technology and research and energy infrastructure investment will reduce the cost of renewable energy, eliminate barriers to energy efficiency (high discount rate) and promote new potentials towards climate change mitigation

The study brought to light the opportunities associated with renewable energy sources; energy security, energy access, social and economic development and climate change mitigation and reduction of environmental and health impacts. Some challenges tend to hinder the sustainability of renewable energy sources and their ability to mitigate climate change. These challenges are market failures, lack of information, access to raw materials for future renewable resource deployment, and most importantly our (humans) way of utilizing energy inefficiently.

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