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Literature Review of Renewable Energy Policies and Impacts

Tarek Safwat Kabel¹

¹Department of Economics and International Studies, University of Buckingham, UK

Mohga Bassim¹

¹Department of Economics and International Studies, University of Buckingham, UK

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Abstract

By 2017, 128 countries have adopted renewable energy support policies, compared to just 48 countries in 2005. These policies played a crucial role in helping countries to shift from conventional energy to renewable energy by overcoming the barriers facing the development of renewable energy. This paper reviews the studies, which outlined the policies used by different governments to support the development of renewable energy, which includes: Tax incentives, Loans, Feed-in tariff, and Renewable portfolio standard. The literature review covers different studies that examined the impacts of renewable energy on economic growth, job creation, welfare, CO₂ emissions, electricity prices, and fuel imports. Researches have used different methodological approaches, different periods, and different countries to examine the impacts of renewable energy. The studies found that the policies used were essential to shift to renewable energy substantially reduced carbon emission, and the majority concluded that renewable energy has a positive correlation with economic growth, job creation and welfare

Keywords: renewable policy, Feed-in Tariff (FiT), impacts, economic growth, CO₂ emissions. **JEL Classification Codes:** Q42, Q43, Q48

1. Introduction

In the past decade, many countries have planned to shift from traditional energy to renewable energy, but this has faced different barriers. Several studies highlighted the importance of relying on supportive policies for renewable energy. For example, Ciarreta, Espinosa, & Pizarro-irizar (2017) argue that currently, without supportive policies, renewable technologies cannot compete against conventional energy

technologies. According to a recent report by REN21 (2018), 128 countries have implemented renewable energy regulatory policies by 2017. There are many support policies such as feed-in tariffs, renewable portfolio standards, quota systems, tax credits, and competitive tenders (UNEP, 2012).

According to various studies, feed-in tariff is the most common renewable energy policy that is used by different countries to support the deployment of renewables (Grover & Daniels, 2017; Jenner, Groba, & Indvik, 2013; Wang & Cheng, 2012). IRENA (2018) shows that feed-in tariffs (FITs) and feed-in premiums (FIPs) played a significant role in supporting renewable energy projects around the world by offering a stable income to generators and improve the returns of renewable energy projects. According to REN21 (2018), The number of countries using feed-in tariff and premiums was 113 in 2017, up from only three in 1990.

The studies used different periods, different models and different countries to examine the impacts of renewable energy consumption on economic growth, job creation, CO₂ emissions, welfare, electricity prices, and fuel imports (Garrett-peltier, 2016; Kahia, Kadria, & Aissa, 2016; Mathews & Xin, 2018; Rahman, Khan, Mustafa, & Ullah, 2017). According to a study by IRENA (2016) when doubling the renewable energy share in the final global energy mix, the global GDP is projected to grow in 2030 between 0.6% and 1.1%, if the reduction of CO₂ emissions is one of the essential impacts of increasing renewable energy.

Renewable energy created 9.8 million jobs in 2016 around the world, with an increase of 1.1 percent from 2015. Countries leading in renewable energy jobs were China, Brazil, the United States, India, Japan, and Germany. Out of the 4.5 million jobs in renewable energy that exist in Asia, 3.6 million work in the sector in China. In Brazil the number of jobs in renewable energy reached 876,000, in Europe 1.2 million, and 61,000 in Africa (Gioutsos & Ochs, 2017). EEA (2017) shows that the EU ranked fifth in terms of the share of renewable energy jobs per capita in the labour force.

2. Renewable energy policies

In order to support renewable energy, many countries are pursuing policies which played a critical role in encouraging investment in renewable energy (Rennkamp, Haunss, Wongs, Ortega, & Casamadrid, 2017). Rennkamp et al. (2017) Pointed out that China's renewables growth is due to implementing a number of government policies. According to Donastorg, Renukappa, & Suresh, (2017), at least 164 countries have renewable energy policy targets, and to achieve these targets it must depend on dedicated policies. Different studies have confirmed the importance of dedicated policies in supporting renewable energy development. For example, Donastorg et al. (2017) showed that these policies play a crucial role in promoting innovation in renewable energy technologies, which reduces costs and thus increases their competitiveness against traditional energy. The major renewable energy policies include tax incentives, loans, feed-in tariffs, and renewable portfolio standards.

2.1 Financial incentives

Ciarreta et al. (2017) define financial incentives for renewable energy as incentives offered to make renewable energy systems or equipment more accessible by decreasing the financial burden for purchasing. Also, Cox (2016) reveals the importance of financial incentives to overcome the barriers facing the growth of renewable energy. In addition, financial incentives reduce the risk associated with investment in renewable energy projects (Hogg & Regan, 2010).

Governments worldwide have used financial incentives to encourage renewable energy use. According to Cox (2016), at least 48 countries have developed financial incentives to support the development of renewable energy in 2015. Several EU governments provide financial incentives for renewable energy. Financial incentives include tax incentives, loans, or feed-in tariff (UN Environment, 2017).

2.1.1 Tax incentives

To encourage the growth of renewable energy worldwide, governments have used a range of tax incentives (Clement, Lehman, Hamrin, & Wiser, 2005). IISD (2014) points out that governments prefer tax incentives over subsidies to encourage investment in renewable energy because these incentives increase the profitability of renewable energy projects by decreasing the tax liabilities of project development. Furthermore, Lantz & Doris (2009) conclude that the tax incentives that support renewable energy development played an important role in supporting energy goals, economic growth, and energy security. In the same regard, Abolhosseini & Heshmati (2014a) referred to the role that tax incentives play in reducing conventional energy consumption. The major forms of tax incentives are tax deductions, tax exemption, and tax credit (Fowler & Breen, 2014). For example, China used tax incentives to promote electricity generation from renewable energy; these incentives such as tax refunds, rebates on taxes, and the tax exemptions (Ben Hagan, 2015).

According to Ogunlana & Goryunova (2016), the United States became the first country to provide tax incentives for renewable energy. During the period from 1978 to 2012, the United States issued several laws containing various types of incentives, aimed at encouraging energy producers to shift from traditional energy production to renewable energy production (Harrison, 2015). Tax credit is one of the tax incentives that the United States provide to households or corporate taxpayer to support the deployment of renewable energy (Anwar & Mulyadi, 2011). These incentives encourage people to consume renewable energy in return for granting them a tax credit. Tax credits can reduce the difference between the purchase price and the cost of generation (Loiter & Norberg-bohm, 1999). (Abolhosseini & Heshmati, 2014b) considers that tax credit can help to support renewable energy, especially in

countries that suffer from the absence of competitiveness in traditional sources of energy.

Dippenaar (2018) investigated the impact of tax incentives on the business decision in South Africa regarding investment in renewable energy and energy efficiency projects. The study found that there are factors other than tax incentives that affect the decision to invest in renewable energy projects and that companies view tax incentives as an ineffective way of changing their environmental behaviour. Consumers benefit from tax incentives by reducing the upfront costs of renewable energy projects.

2.1.2 Loans

Different governments encourage local banks to finance renewable energy by using different forms of financing (IRENA, 2013). By the end of 2016, around 100 countries compared to 17 countries in 2005 used Public investments, loans, and grants as an incentive to shift from conventional energy to renewable energy (IRENA & CPI, 2018).

For example, in Thailand, they established a revolving loan funds (RLFs) to encourage financial institutions to finance renewable energy projects. This scheme allows banks to borrow money at zero percent interest rate. The banks offer these funds to renewable energy projects; the maximum interest rate on loan is likely to be 4% for a maximum loan period of seven years. (Beerepoot, Laosiripojana, Sujjakulnukij, Tippichai, & Kamsamrong, 2013). The United States government offers different types of loan programs designed to overcome the barriers facing renewable energy financings such as higher interest rates, and higher capital cost. These loans programs such as low-interest rates, longer amortisation, low hassle and administrative fees, unsecured loans aimed to increase investment in renewable energy (Fowler & Breen, 2014).

Singh (2015) shows that loans programs can play an essential role in financing an investment gap for renewable energy in India. According to Shrimali et al., (2014) government of India offer a lower interest rate loans for renewable energy projects compared to commercial debt. Currently, Indian Banks can lend up to a limit of INR 150 million (\$2.15 million) to renewable energy projects (Fowler & Breen, 2014).

In order to support the development of renewable energy industries, local governments in China provided low-interest loans (Wallace, n.d.). Ernst & Young (2014) highlights that corporate collateralised loans are a widespread financing vehicle in China for wind and solar projects. Hussain(2013b) argues that dependence on loans reduces market participants and does not necessarily encourage financing high-quality projects.

2.1.3 Feed-in tariff (FIT)

Many studies have demonstrated that feed-in tariff (FIT) is the most common renewable energy policy that is used by different countries to support the development of renewable energy. Haselip (2011) points out that feed-in tariff has played a crucial role in encouraging investment in electricity generation through renewable energy in developed countries, because (FIT) reduce the financial risk associated with individual projects. Nicolini & Tavoni (2017) Show that an increase in feed-in tariff by 1 percent contributes to a growth in incentivised renewable production of 0.4 percent -1percent.

Christoph, Rivers, Rutherford, & Wigle (2012) investigate the employment impacts of renewable energy policies in the Canadian province of Ontario using a computable general equilibrium model. The results suggest that feed-in tariff (FIT) will create a direct job related to manufacturing and operation. Hejazi, Shakouri G, Sedaghat, & Mashayekhi (2016) used a System Dynamics model to estimate the impact of a feed-in tariff scheme on the development of renewable energy in Iran. The study indicates that during the short term there will be a temporary growth period because of the amount of initial funding, which was allocated when implementing feed-in tariff.

Dijkgraaf, Dorp, & Maasland (2014) assessed the impact of (FIT) policies on the development of photovoltaic solar cells (PV) in 30 OECD member countries using Panel data estimations for the period from 1990 to 2011. The results suggested that feed-in tariff (FIT) policies have a positive impact on the evolution of a country's share of PV in the electricity mix.

The Indonesian government has adopted feed-in tariffs in 2012 (Damuri & Atje, 2013). These schemes differ by technology and installed capacity (Beerepoot et al., 2013). Yuliani (2016) assess the feed-in tariff policy in Indonesia. The study reveals that different barriers are facing the development of renewable energy, which makes it challenging to transfer from conventional to renewable energy in developing countries such as Indonesia.

According to IEA (2013), the German feed-in-Tariff is a successful one, and other countries should benefit from this experience in introducing a FIT supporting mechanism to support the development of renewable energy. Germany defined feed-in tariff scheme in 1990 when the tariff law was introduced, which obliged electricity distributors to purchase electricity produced by renewable energy sources at high prices compared to traditional energy sources (Shokri & Heo, 2012). In the same regard, Hitaj, Schymura, & Löschel (2014) investigate the effects of FIT policy in Germany for renewable power on wind power investment by using the counterfactual analysis between 1996 and 2010. Their results show that feed-in tariff played a notable role in supporting wind power development.

2.2 Renewable Portfolio Standard (RPS)

Renewable Portfolio Standard (RPS) is another incentive that different governments are using to support the development of renewable energy. It is a scheme that requires energy suppliers to provide a specified amount of their electricity portfolio from renewable sources (LCA, 2006). This requirement can be imposed on consumers, retail sellers or producers (de Jager et al., 2011). Renewable Portfolio Standard Play a role in encouraging renewable energy generators to enter the market by increasing the price that the generator will receive when generating electricity from renewable sources (Johnson, 2014).

According to Shrimali, Jenner, Groba, Chan, & Indvik (2012), Renewable Portfolio Standard policies are one of the significant political forms for support of renewable power generation in the United States. Thirty states have Renewable Portfolio Standards (RPSs) to support renewable energy generation (Upton Jr. & Snyder, 2017). Several studies have tested the impacts of state Renewable Portfolio Standard policies on CO₂ emissions. For example, M.Bento, Garg, & Kaffine (2018) analysed the impacts of Renewable Portfolio Standards in the United States, and the results show that increase in the RPS has positive effects on considerable resources booms or emissions savings but not both, because the RPS can be met by increasing renewable production or decreasing fossil production. Wiser et al. (2016) show that Renewable Portfolio Standard policies in the United States reduced Greenhouse Gas Emissions (GHGs) and air pollution, water pollution, creating additional green jobs. The result of the study testified that in 2013 environmental benefits saved \$7.4 billion in the United States. Young & Bistline (2018) argue that future natural gas prices impact powerfully on the effectiveness of Renewable Portfolio Standards due to its reduced CO₂ emissions.

According to Xin-gang, Yu-zhuo, Ling-zhi, Yi, & Zhi-gong (2017), the most common renewable energy policies to encourage the deployment of renewable energy sources are Feed-In Tariff (FIT) and Renewable Portfolio Standard (RPS). Different studies have compared Feed-In Tariff (FIT) and Renewable Portfolio Standard (RPS) policies. For example, García-Álvarez, Cabeza-García, & Soaresc (2017) investigated the impact of the feed-in tariff and Renewable Portfolio Standard policies on onshore wind power for 28 European countries for the period 2000-2014, using an empirical evaluation. The results indicated that FIT policies only have significant effects on onshore wind installed capacity. A similar analysis by Sun & Nie (2015) shows that feed-in tariff is more efficient than Renewable Portfolio Standard at increasing renewable generating capacity, and Renewable Portfolio Standard policy is substantially more efficient at reducing CO₂ emissions and enhancing the consumer surplus.

3. Impacts of renewable energy

3.1 Impact on economic growth

For the OECD regions, Inglesi-lotz (2015) used a Pedroni cointegration test to investigate the effect of renewable energy consumption on the economic conditions over the period 1990-2010. The analysis shows that a 1 % increase of renewable energy consumption will increase GDP by 0.105% and GDP per capita by 0.100%, while a 1 % increase of the share of renewable energy to the energy mix of the countries will increase GDP by 0.089% and GDP per capita by 0.090%. (Shafiei, Salim, & Cabalu, 2013) Examined the effects of renewable and non-renewable energy consumption on economic growth for selected OECD countries. The study was conducted over a period between 1980 and 2011. The study shows that there is bidirectional causality between economic growth and both renewable and non-renewable energy consumption in the short- and long run. They concluded that non-renewables are still the major source of energy in the process of economic growth.

Several studies have used the Auto-Regressive Distributed Lag (ARDL) approach to examine the relationship between renewable energy consumption and economic growth. For example, Maji (2015) examined the long run relationship between clean energy indicators and economic growth in Nigeria by employing the ARDL approach. The study indicates that alternative and nuclear energy are significant and negatively related to economic growth. The study suggests that Nigeria should develop renewable energy sources, and highlights the absence of an independent legal and institutional framework responsible for renewable energy. Taghvaei et al., (2017) investigated the relationship between economic growth and energy consumption in Iran for the period from 1981–2012 using the Auto-Regressive Distributed Lag (ARDL) model. The study concluded that renewable energy is ineffective in the economic growth of Iran. They suggested that the Iranian government should formulate policies to increase the consumption of renewable energy, especially as low fossil fuel prices discourage the development of renewable energy.

Khobai & Roux (2017) investigated the causal relationship between renewable energy consumption and economic growth in South Africa. The study incorporates carbon dioxide emissions, capital formation and trade openness as additional variables to form a multivariate framework. It covered the period from 1990 to 2014 using quarterly data. The researchers used an Autoregressive distributed lag (ARDL) approach to explore the long run relationship among the variables and the Vector Error Correction model (VECM) to determine the direction of causality between the variables. The findings of the study suggested that a growth hypothesis in the long run and conservation in the short run.

S. Silva, Soares, & Pinho (2012) investigated the impact of the increasing share of renewable energy sources for generating electricity on Gross Domestic Product (GDP) and carbon dioxide (CO₂) emissions. By using a three variable SVAR model for a sample of four countries (Holland, Portugal, Spain, and the USA) in efforts to invest in renewable energy in the previous years, although they represent relatively different

levels of economic growth, social and economic structures. Over the period 1997–2006, it finds that for Holland, Portugal and Spain, rising renewable energy sources on electricity generation had economic costs in terms of GDP per capita and decline in CO₂ emissions per capita. While in the USA, the RES support can be least costly. The study recommended the Danish, Portuguese and Spanish governments to use other policies that could play a role in achieving environmental goals at the least cost, such as demand-side management and energy conservation. On the other hand, Dees & Auktor (2017) showed that renewable electricity generation has a significant and positive effect on economic growth in the MENA region, using a neoclassical growth function that contains capital, labour, and energy use as additional input factors. The study suggested that MENA countries intensify the current policy towards renewable energy because investment in renewable energy sources is beneficial to the region.

Bhattacharya et al. (2016) analysed the impact of renewable energy consumption on the economic growth in 38 top renewable energy consuming countries in the 1991 to 2012 period using panel estimation techniques. The long-run output elasticities suggested that renewable energy consumption has a significant positive relationship on the economic output for 57 percent of the chosen countries.

Ohlan (2016) reveals that while the non-renewable energy consumption has a long run significant positive impact on India's economic growth, the long-run elasticity indicate that there is a statistically insignificant relation between renewable energy consumption and economic growth in the 1971-2012 period.

3.2 Impact on job creation

Different studies compared the job creation impacts of investing in renewable energy to investing in fossil fuels. Haerer & Pratson (2015) estimate that the natural gas, solar, and wind industries, in the United States added about 220,000 new jobs, while the coal industry lost more than 49,000 jobs during 2008 - 2012 by using input-output model. Within the same context, Garrett-Peltier (2017) shows that energy efficiency and renewable energy industries create almost three times as many jobs as fossil fuels industries, at the same level of spending. The study finds that every \$1 million spent on fossil fuels created an average of 2.65 full-time-equivalent jobs, while that same amount of spending on renewable energy would create 7.49 or 7.72 full-time-equivalent jobs. DOE (2017) concluded that the solar industry in the United States employs more people than coal in the Electric Power Generation sector. In 2016, solar energy employed about 374000 people that made up 43% of the Electric Power Generation workforce, while the traditional fossil fuels employed 187,117, making up only 22 % of the workforce.

Bulavskaya & Reynès (2017) argue that creating power using renewable energy sources is more valuable to the national economy than producing it with fossil fuels, because wind and solar power generation is more intensive in capital and labour than fossil power plants but less intensive in energy. The study finds that the transition to

renewable energy in the Netherlands will create approximately 50,000 new jobs by 2030 and add about 1 percent of GDP. This positive effect is due to higher labour and capital intensity of the wind and solar technologies, compared to gas and coal plants. Due to low oil prices and oversupply, jobs in the fossil fuel industry have continued to be shed, more than 440,000 jobs have gone during 2015 and 2016 (IRENA, 2017b).

Several studies use various methodologies to estimate employment generated by renewable energy. GIZ (2012) estimated that 2,500 direct jobs generated within the framework of national sustainable energy programmes, for Tunisia using an adjusted Input-Output-Analysis from 2005-2010. P. P. Silva (2013) used input-output to estimate the impact of renewable energy development on employment in Portugal. The results indicate that the deployment of renewable energy sources technologies has significant employment benefits. Markandya et al. (2016) estimated that 530,000 new jobs created between 1995 and 2009 because of shifting away from the more carbon-intensive sources, to gas and renewables, by using a multi-regional input-output model and the world input-output database. In this regard, A recent study by Mu, Cai, Evans, Wang, & Roland-holst (2018) shows that per 1 TW h expansion of solar PV and wind power would create up to 45.1 thousand and 15.8 thousand, respectively, direct and indirect jobs in China, by using Computable General Equilibrium (CGE) model.

Pestel (2014) argues that green energy policy can have positive and negative employment impacts, creating additional green jobs, but it would crowd out investment-induced employment in other sectors. This negative impact comes when subsidies to electricity generation from renewable energy sources are financed by labour taxes (Böhringer, Keller, & Werf, 2013). To estimate the employment effect of renewable energy, we must take into account both gross employment and net employment. Gross employment refers to the sum of positive employment impacts resulting from investments in renewable energy and does not account for any loss in employment in other sectors. Net employment accounts for both positive and negative impacts (IRENA, 2011).

IRENA (2011) suggests that the government should formulate policies to encourage employment creation associated with renewable energy that aimed at developing and deploying renewable energy, taking into account the associated opportunity costs and balance them against the expected benefits. Blazejczak *et al.* (2014) also highlight the importance of labour market policies to support the development of renewable energy sources. Net employment impacts of renewable energy development strongly rely on labour market conditions.

According to IRENA (2017a), the number of renewable energy jobs globally could increase to 24 million by 2030. By 2050, the renewable energy sector could create about 25 million jobs globally. New job creation in renewables and energy efficiency would be more than the job losses in the traditional energy sector (IRENA, 2017b).

3.3 Impact on CO₂ emissions

According to a study by EEA (2017), the share of renewable energy in total energy consumption in the EU rose to 16.7 percent in 2015, from 15 percent in 2013. This allowed a gross reduction of 436 Mt CO₂ emissions, accounting for 10 percent of the total GHGs emitted by the EU in 2015. In the EEA (2018), further improvements are seen in 2016 and 2017 and the share climbed up to 17 and expected 17.4 respectively leading to reductions of 460 Mt and 499 Mt of CO₂. EU-wide renewable energy target of a minimum of 20% at 2020 and 32 % of gross final consumption by 2030.

IEA (2017) shows that the amount of global carbon dioxide (CO₂) emitted from the energy sector have not changed since 2014 reaching 32.1 gigawatts in 2016, despite the global economy grew by 3.1 percent. This was the effect of rising renewable power generation, shifts from coal to natural gas, and improvements in energy efficiency. The U.S., carbon dioxide emissions, declined by 160 million metric tons, although the economy grew by 1.6 percent. IEA (2018) however, shows that carbon dioxide (CO₂) related to global energy emissions rose by 1.6% in 2017 and is expected to continued growth in 2018. This is not in line with the climate goal to reduce air pollution, which is causing premature deaths for millions of people each year.

Shafiei & Salim (2014) investigate the determinants of CO₂ emissions using Stochastic Impacts by Regression on Population, Affluence, and Technology (STIRPAT) model on OECD countries over 1980-2011 periods. They find that nonrenewable energy consumption raises CO₂ emissions, while renewable energy consumption reduces CO₂ emissions. Bilgili, Koçak, & Bulut (2016) also show a negative impact of renewable energy consumption on CO₂ emissions. The study indicates the importance of implementing short term-midterm policies and long-term policies to increase the production and consumption of renewable energy sources. Similarly, Ito (2016) find for 31 developed countries that consumption of renewable energy decreased CO₂ emissions, using panel data for the period from 1996 to 2011.

Khanalizadeh, Khoshnevis, & Mastorakis (2014) use the ARDL approach to examine the relationship between CO₂ emissions, economic growth and renewable energy consumption, non-renewable energy consumption and population in Iran for the period from 1975-2011. The results show that the variables are cointegrated. Moreover, there is a long-run relationship between CO₂ emissions and GDP. BUŞU & BUŞU (2017) investigate the impact of renewable energy consumption, total population, and urbanisation on CO₂ emission using a time series cross-sectional multiple linear regression analysis with panel data for the EU countries for ten years. The study states that the population growth and levels of urbanisation have a positive impact on CO₂ emissions, while renewable energy has a negative impact on the level of CO₂ emissions. EU countries should increase the share of renewable energy by using public policy, while population growth and level of urbanisation should come with more restriction regarding CO₂ emissions.

Few studies were investigating the impact of renewable energy on CO₂ emissions in the MENA region. For example, Arouri et al. (2012) examine the relationship between energy consumption, real GDP, and CO₂ emissions using data of twelve MENA countries, between 1981 and 2005. They conclude that in the long-run energy consumption has a significant positive impact on CO₂ emissions. Kahia, Kadria, & Aissa (2016) assess the impact of renewable energy consumption on CO₂ emissions and the economic and financial development. They use a PVAR approach covering 24 Middle East and North African Countries (MENA) for the period from 1980 until 2012. Increasing consumption of renewable energy sources plays a critical role in reducing CO₂ emissions. The study suggests that the examined countries should implement effective support policies to increase investment in renewable energy technologies to reduce CO₂ emissions and to achieve economic growth.

Twumasi (2017) argues that it is not a necessity that increased production of renewable energy leads to a reduction in CO₂ emissions. The study shows that despite the increase in renewable energy production in the U.S. in 2009, CO₂ emissions have not decreased. The study concludes that there was a positive and significant relationship between population and CO₂ emissions and between GDP and CO₂ emissions, while there was no particular pattern between renewable energy and CO₂ emissions. Bulut (2017) shows a positive relationship for electricity production from nonrenewable energy as well as renewable energy on CO₂ emissions, using fixed parameter and time-varying parameter estimation methods in Turkey during the period from 1970 to 2013. The study suggests that the Turkish authority should implement long-term energy policies to reduce CO₂ emissions. Despite increasing renewable energy to about 30% of Germany's energy mix in 2016, CO₂ emissions did not decrease much. Germany's carbon emissions per person rose slightly in 2013 and 2015. This is because the diversity of renewable energy sources requires Germany to continue to use coal in operating its plants (Conca, 2017).

According to OECD /IEA, & IRENA (2017), Renewable energy and energy efficiency will play a critical role in reducing emissions by 90 percent by 2050, while fossil fuels will reduce emissions by 10 percent. The study recommends that renewable energy sources should represent 65 percent of the total primary energy supply in 2050, compared to 15 percent in 2015.

3.4 Impact on welfare

Lotz (2013) investigates the impact of renewable energy consumption on economic welfare in all the OECD countries using panel data techniques. The study finds that renewable energy consumption has a significant positive impact on economic growth. Terrapon-pfaff, Dienst, König, & Ortiz (2014) analyzed 23 small-scale local renewable energy projects within developing countries. The result of the analysis testified that most projects have a positive impact on factors such as energy access, employment, communication and/or access to information, energy costs, and health. World Wide

Fund for Nature(WWF, 2016) also provided evidence that renewable energy is an effective way to better livelihoods and health, improved education and gender balance and better learning conditions, which in turn can facilitate environmental protection.

Renewable energy can play a crucial role in reducing poverty around the world. For example, in Bangladesh, more than 3.5 million households have electricity from the solar home system since 2002. The solar home system can help poor households save kerosene costs of over \$600 million and reduce CO₂ emissions by 1.7 million tons during the 20-years of solar home system life cycle (Marro & Bertsch, 2015). Kyte (2015) shows that small-scale solar power plays a significant role in changing the lives of the poor in both Bangladesh and Macedonia. Jairaj, Dekka, Martin, & Kumar (2017) highlight the importance of renewable energy for India in reducing poverty by generating jobs for poor people.

Liu (2016) examines the impact of renewable energy use on GDP growth and local rural income in a panel data framework for 31 provinces of China for the period from 2000 to 2010. The study indicates that energy consumption has a significant positive impact on income increase of rural households. In this regard, Nepal (2012) highlights the importance of renewable energy in improving access-to electricity in rural areas and reducing the dependence on conventional fossil fuels. Rahman, Khan, Mustafa, & Ullah (2017) investigated the socioeconomic and environmental impacts to the households of a far-flung village of Bajaur agency in Pakistan using house holds survey, after the installation of the solar home system. The study concluded that the solar system has positive impacts on human and physical capital of these households.

Böhringer et al. (2013) argue that subsidised electricity production from renewable energy sources (RES-E) in Germany have a little impact on employment and welfare. The study used a Computable General Equilibrium (CGE) model, and they found a negative impact on welfare and employment that will appear if labour taxes finance RES-E subsidies. Cebotari, Cristea, Moldovan, & Zubascu (2017) compare villages with deployed renewable energy projects and villages without such project to investigate the impact of renewable energy projects on four variables evolution of employment, revenues, demographics and processed agriculture. This comparison reveals that a renewable energy project has no positive impact on any of the four variables. Private investors deploy the vast majority of renewable energy projects in urban centres.

IRENA (2016) estimates that the impact of renewable energy expansion on welfare by using Energy-Environment-Economy Global Macro-Economic (E3ME) model will be three to four times more than its impact on GDP, with global welfare set to grow by around 3.7 percent.

3.5 Impact on electricity prices

Martinez-anido, Brinkman, & Hodge (2016) analyse the influence of wind power on electricity prices using the production cost model of the ISO-NE power system. The study shows that increasing wind penetration leads to lower electricity prices and increase electricity price volatility. In the short term, the effect of wind power on volatility is more significant. Ketterer (2012) found a similar result for Germany but highlighted the risk of building new plants because of the profitability of traditional or renewable power plants is uncertain, which greatly affects the energy market and the security of supply. In Germany and Denmark, solar and wind power production have an economically significant impact (Rintamaki, Siddiqui, & Salo, 2017).

Pham & Lemoine (2015) Used GARCH model under a panel data framework to estimate the impact of the subsidised renewable electricity on spot prices in Germany. The study found that, over the period from October 2009 to December 2012, wind and solar power generation decreased the electricity spot prices and increased their volatility. The total merit order effect of renewable energy ranges from 3.86 to 8.34 €/MWh. Meneguzzo, Ciriminna, Albanese, & Pagliaro (2016) revealed the positive impact of solar PV and wind energy in Sicily on electricity price. In 2015, high penetration of renewable energy sources led the zonal electricity price in Sicily to be below the national wholesale price in Italy. Trujillo-baute, Río, & Mir-artigues (2018) tested the impact of support schemes for electricity from renewable energy sources (RES-E) on the retail electricity prices for households and industrial consumers at the EU members over the period 2007-2013, using panel data. They indicated that renewable energy promotion costs have a positive effect and statistically significant on retail electricity prices, but this impact is relatively small compared to other variables. A 1% increase in renewable energy promotion costs non-renewable energy consumption increases the industrial, retail prices by 0.023% and an increase of 0.008% in the residential, as well as retail prices.

Paraschiv, Erni, & Pietsch (2014) find that electricity day-ahead prices in Germany dropped due to the promotion of wind and PV. Clò, Cataldi, & Zoppoli (2015) show that the rise in the hourly average of daily production from solar and wind sources by 1 GWh, resulted in a decrease of 2.3€/MWh and 4.2€/MWh respectively decrease in the wholesale electricity prices in Italy. Gulli & Balbo (2015) investigate the influence of photovoltaic energy (PV) generation on the wholesale electricity prices in Italy, using a hybrid analysis. The results indicate that photovoltaic energy growth can reduce electricity prices if combined with other influences.

Pereira, Pesquita, & Rodrigues (2017) use an ARX-GARCHX model to examine the influence of wind generation and hydro availability on the electricity price in Spain. The study applied over the period from 2007 to 2014 and finds that hydro energy availability reduces the volatility of electricity prices, while wind availability raises the volatility.

Jonathan (2015) compared the effects of four different types of renewable energy and energy efficiency DSM base, DSM peak, Solar PV, and Wind on public health and climate in six different locations within the Mid-Atlantic and Lower Great Lakes in the United States by using Environmental Policy Simulation Tool for Electrical grid Interventions (EPSTEIN) model. The study estimated that the annual benefits ranged from the US \$5.7 million to \$210 million. Abrar-ul-haq (2017) shows that solar energy in developing countries played a key role in improving the health of the population, increasing their income, improving the level of education, and improving their social life, which has improved people's ability to adapt to climate change. Gibon, Hertwich, Arvesen, Bhawna, & Verones (2017) concluded that most renewable energy projects have a positive impact on the environment and human health compared to fossil fuels, especially coal.

3.6 Impacts on fuel imports

According to Hager (2013), The growing share of wind power in the energy mix in America has reduced dependence on imported fossil fuels. Arapogianni & Moccia (2014) indicated that it is possible to reduce dependence on domestic and imported fuels by replacing energy generation from fossil fuels with wind energy, thereby reducing the cost of fuel imports and greenhouse gas emissions. Investigated the relationship between renewable energy generation and imports dynamics by using import demand equations. The study highlighted the importance of generating renewable energy for the economy in reducing its external dependence and debt by reducing import growth.

Ebinger, Banks, & Potvin (2014) estimated that Germany's shift to renewable energy in the electricity sector had saved the country €11 billion in fossil fuel imports during the period from 2009 to 2012. Valodka & Valodkienė (2015) predicted that the expansion of renewable energy in Lithuania would save 278 million euros in fuel imports per year. In 2016, Ireland managed to save about € 70 million in foreign energy imports as a result of the expansion of wind energy (IWEA, 2016).

A recent study by Mathews & Xin (2018) argues that China's shifting from conventional energy to renewable energy has not only reduced its dependence on fossil fuel imports but also expanded to increase energy security. In the same context, Richardson believes that improving trade balance and GDP can be by reducing imports of fossil fuels.

4. Conclusion

Numerous authors believed that renewable energy policies could be used to overcome the barriers facing the growth of renewable energy, which increases its competitiveness against traditional energy. The major renewable energy policies include tax incentives, loans, feed-in tariffs, and renewable portfolio standards. Tax incentives played a critical role in encouraging renewable energy investors,

companies, and households to transfer from conventional energy to renewable energy. Also, loans are another supporting scheme that is used by about 100 countries to support the development of a renewable energy.

Scholars have recognised that Feed-in tariff (FIT) and renewable portfolio standard (RPS) are the most popular renewable energy policies to support the development of renewable energy. The German feed-in-Tariff has been wildly successful in promoting electricity from renewable energy sources. Different studies have tested the impacts of Feed-in tariff (FIT) policy on the deployment of renewable energy by using different models and different countries. These studies found positive impacts on the deployment of renewable energy.

By reviewing the existing research literature, there are many impacts due to the development of renewable energy, including the impacts on economic growth, job creation, CO₂ emissions, welfare, electricity prices, and fuel imports. Renewable consumption has a positive impact on economic growth in different countries. However, renewable energy can have negative impacts in some countries like Nigeria and Iran, because the absence of institutional framework and policies used to support renewable energy.

Many studies documented that the deployment of renewable energy sources generates significant direct employment in different countries. However, some studies find that there are negative employment impacts because renewable energy employment could crowd out other sectors employment. Although most studies have confirmed that renewable energy consumption leads to declines in emissions, some studies have confirmed that it is not necessarily an increase in renewable energy that leads to lower emissions. Different studies show that renewable energy plays a significant role in improving public health and the life of the poor.

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