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**Article**

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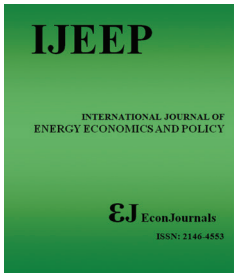
*Reference:* Kabel, Tarek Safwat/Bassim, Mohga (2020). Reasons for shifting and barriers to renewable energy : literature review. In: International Journal of Energy Economics and Policy 10 (2), S. 89 - 94. https://www.econjournals.com/index.php/ijeep/article/download/8710/4869. doi:10.32479/ijeep.8710.



International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2020, 10(2), 89-94.

# Reasons for Shifting and Barriers to Renewable Energy: A Literature Review

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**Received:** 11 September 2019 **Accepted:** 13 December 2019 **DOI:** https://doi.org/10.32479/ijeep.8710

**ABSTRACT**

Consumption of fossil fuel resources leads to serious economic and environmental issues such as (high fossil fuel subsidies, high carbon emissions, and high energy demand). This current economic situation needs new methods, which should generate sustainable solutions that are mostly independent of the use of fossil fuels. However, there are many barriers to the development of renewable energy. Based on the literature the major barriers to renewable energy are economic, Policy and legal, and technical. A literature review was performed in this paper to determine the reasons for shifting from conventional energy to renewable energy and identifies the barriers to the development of renewable power generation.

**Keywords:** Renewable Energy, Fossil Fuels, Energy Subsidies, $CO_2$ Emissions, Capital Cost
**JEL Classification:** Q20, Q40, Q42

## 1. INTRODUCTION

In recent years, the world has been facing an energy crisis because of the increased demand for fossil fuels to meet the growing demand for energy. Studies have shown that the world is facing a challenge in providing adequate resources for energy generation. The shortage is expected to be particularly in oil and natural gas, which the world has relied on for 55% of the global energy consumption (WEC, 2016).

Perera (2018) argues that the burning of fuels is considered the main source of air pollution and greenhouse gases caused by human, which increased global warming. According to IEA (2018), global carbon emissions grew by 1.4% in 2017, reaching 32.5 Gt which is the highest increase in history. This high-level occurred despite the reduction, which happened in emission in the UK, Japan, Mexico, and the high reduction in the USA due to its increased dependence on renewable energy. The IEA report highlighted the three key factors that played a crucial role in increasing global carbon emissions to be increasing global economic growth by 3.7%, lower fossil fuel prices, and ineffective energy efficiency policies.

At the same time, fossil-fuel subsidies have been one of the reasons for the continued use of and slow shift from fossil fuels to renewable energy. According to IEA (2018), global fossil-fuel consumption subsidies reached US$ 260 billion in 2016. Electricity subsidies were US$ 107 billion, followed by oil subsidies accounted for 40% of total consumption subsidies (i.e., about $105 billion). Natural gas subsidies and coal subsidies were $50 billion and $2 billion respectively over the same year. G20 spent 4 times more on fuel subsidies than it spent on renewable energy between 2013 and 2015 (Doukas et al., 2017).

The expansion in using renewable energy technologies is facing barriers. Despite the significant decline in the costs in recent years, some studies argue that the costs are still one of the essential barriers to the development of renewable energy (Ali et al., 2017; Lyman, 2016; Tse and Oluwatola, 2015).

We aim to determine the reasons for shifting from conventional energy to renewable energy and identifies the barriers to the development of renewable energy. This paper reviewed numerous studies were concentrated in developed countries, some developing countries, and emerging countries, while there were a limited number of studies in the MENA region.

## 2. REASONS FOR SHIFTING FROM FOSSIL FUELS TO RENEWABLE ENERGY

### 2.1. High Fossil Fuel Subsidies

The economic theory suggests that subsidies of fossil fuel fail in achieving their aim and goal in supporting the most unfortunate of society. Subsidies of fuel proved to be poorly aimed because of high-income household, who are capable of affording a higher consumption level, catch most of the benefit. Anand et al. (2013) reports 10% of the wealthiest households in India consumed fossil-fuel subsidies 7 times greater than the poorest 10%. In Sudan, the poorest 20% of the population absorbs only 3% of fuel subsidies, while more than 50% goes to the richest 20% (IMF, 2014).

Bridle and Kitson (2014) emphasised that subsidies of fossil fuel have effects and repercussions on investment decisions making it a harder competition for energy efficiency and renewable energy. In spite of the fact that many countries have reduced fuel subsidies throughout time, fuel subsidies remain high in developing nations (Ahuja et al., 2009). IEA (2018) estimates that $260 billion was consumed by subsidies of fossil fuel worldwide in 2016, rather than $310 billion in 2015. IEA (2016) attributed this drop due to the fall in prices of oil and a subsidy reform process in dozens of countries as Egypt, Mexico and Indonesia. A study by Coady et al. (2016) found that Post-tax subsidies of fossil fuel went from $4.9 trillion worldwide in 2013 to $5.3 trillion in 2015, this equals 6.5% of GDP in both years. This study reveals that the top five subsidisers of energy are China, USA, Russia, the European Union, and India.

An early study by Saunders and Schneider (2000) found that fossil fuel subsidies paid by the government crowd out investment in more productive services such as health and education. In 2008, the Government of Indonesia spending on fuel subsidies is greater than it's spending on education, defence, health and social security (IISD, 2011). According to Whitley and Van Der Burg (2015), in 40 developing countries fossil fuel subsidies are equivalent between 25% and 30% of government revenues. Coady et al. (2016) estimate that pre-tax subsidies to fossil fuels were 0.7% of global Gross Domestic in 2011 and 2013. Doukas et al. (2017) argue that fuel subsidies can be viewed as an obstacle and hurdle to investment and trading of renewable energy technologies. The study shows that G20 governments allocated yearly an average of $71.8 billion of public finance for fossil-fuel projects from the year of 2013 to the year of 2015, which was 4 times more than it allotted for renewables.

### 2.2. High Energy Demand

Adams et al. (2016) estimate that total global energy consumption will witness a raise by 28% from the period of 2015 to 2040, raising from 575 quadrillion British thermal units (Btu) in 2015 to 663 quadrillion Btu by 2030 and reaching 736 quadrillions Btu by 2040. Due to rapid population increase and high economic growth, energy demand is increased mainly in Non-OECD countries. While comparing the energy consumption in both non-OECD countries and OECD countries from 2015 to 2040, a 41% rise is noticed in non - OECD countries in comparison to a much smaller rise, a 9% rise, in OECD countries. In developing countries, there is an expected and anticipated increase of energy use by 90% rather than a 17% increase in industrialized countries by the year 2040. Also, China's energy demand is predicted to be twice as much that of the United States.

It will be difficult and challenging to estimate the energy amount demanded globally by using fossil fuels solely, with the present increase in energy demand. Shafiee and Topal (2009) used three econometrics models to illustrate the relationship between fossil fuel reserves, their consumption and respective prices from the year of 1980 to the year of 2006. The study assumes that if world consumption rates of fossil fuels remains the same as the year 2006, resources will gradually ran out. Oil will be the first to run out approximately in 40 years, natural gas following in approximately 70 years and coal in approximately 200 years. It means that coal will last significantly longer than other types of fossil fuel, and oil will run out earlier than natural gas and coal. According to studies, Egypt encounters a difficulty and challenge in generating and attaining electricity from fossil fuels. In particular with oil and natural gas that alone equate to about 95% of Egypt's total energy mix in 2016 (EIA, 2018). According to RES4MED (2015), Egypt will encounter a challenge to accommodate the growing energy demand in time to come as a result of rapid utilization and rise of extraction costs for non-renewable resources.

### 2.3. High $CO_2$ Emissions

Based on a literature review, a major source of $CO_2$ emissions is fossil fuel energy. According to IRENA (2014), Burning fossil fuels releases about 80% of human-caused $CO_2$ emissions. This portion of emissions originates from coal by 44%, 36% from oil and 20% from natural gas. Fossil fuels burning marked to be the main source of US greenhouse gas emissions from human activities (Desai and Harvey, 2017). Rafindadi et al. (2014) used panel least square technique for the individual countries of Asia-Pacific over a period from 1975 to 2012, asserted that there is a significant relationship between air pollution, energy consumption, and water productivity. The study showed that fossil fuel energy consumption plays a great role and impact on the air pollution variation in the area.

China and India's emissions have risen dramatically since 1990 and developing nations now produce more greenhouse gases than developed nations. Much of that rise was due to the burning of coal. China is held responsible for nearly half of global coal trade (Helm, 2016). Goods and services exports from developing countries to developed countries are the primary cause of a growing share of $CO_2$ emissions from fossil fuel combustion (Edenhofer et al., 2014).

Multiple Studies have tried to assess and evaluate economic costs associated with fossil fuel-related $CO_2$ emissions. For example, Watson et al. (2017) found that air pollution from burning fossil

fuels currently costs the United States $240 billion a year, which marks 40% of the ongoing growth of the United States economy and 1.2% of the GDP. The study estimates that this number will grow within the next decade to $360 billion yearly, this is about 50% of the estimated growth of the economy. A recent study by Stefanski et al. (2017) examined the relationship between a country's emissions intensities and its GDP, by using the calibrated model for 170 countries during 1980-2010. The model found that over the last 30 years subsidy-like wedges have been a major cause of a quarter of global carbon emissions. The direct cost of fossil-fuel price-distortions reached US$ 983 billion in 2010 only that equates to 3.8% of total global GDP in the same year.

Griffin (2017) envisions a rise of global temperature by the end of the century if no change is made in the increase of energy coming from burning fossil fuels and we continue with the same rates of 1988 to 2017.

## 3. BARRIERS TO THE DEVELOPMENT OF RENEWABLE ENERGY

A number of barriers to the market deployment of renewables have been listed in the literature. Barriers discussed in this section are economic, Policy and legal, and technical.

### 3.1. Economic Barriers

#### *3.1.1. Cost of technologies*

Historically, high cost has been cited as one of the essential barriers to switching from the traditional energy sources to renewable energy sources. Dufey (2010) highlights that the expense per installed megawatt of renewable energy remains more expensive compared to traditional energy production which makes the use of the traditional energy more wide spread, even though the renewable energy has positive impacts and its great future prospects are recognised. Renewable energy projects requires a high investment, many aspects contribute to their high cost. Starting from the technology used cost, hiring experts and specialists for project development, to the cost of the studies themselves and ensuring the feasibility of project and resources needed. Chodkowska-Miszczuk (2014) states that the rising and high cost of renewable energy are considered an obstacle to the evolution of the renewable energy system compared to conventional electricity.

Timmons et al. (2014) found that renewable electricity costs are sensitive and responsive to interest rates as a result of high capital costs of nearly all renewable energy resources. They also found that higher interest rates make traditional energy more attractive when compared to renewable sources, while low- interest rates make renewables more attractive. The construction of large-scale renewable power plants is highly costly because of the high capital costs of renewable energy technologies (Ali et al., 2017). For instance, in Western Europe, the cost of wind plants are 4.6 more than the cost of gas plants and large-scale PV plants are 14.1 more than the cost of gas plants (Lyman, 2016).

According to Reddy and Painuly (2004), multiple consumers prefer to maintain low initial costs instead of reducing operating costs that pays back over a longer period of time, which makes it harder for them to deal with renewable energy technologies because of higher initial costs. High initial investment costs of the systems represent a huge barrier to the rapid growth of solar PV, even with government incentives (Tse and Oluwatola, 2015).

Recent studies argue that renewable energy has become cheaper than traditional energy. Wind costs decreased from $140/MW-h in 2009 to $47/MW-h in 2016 by 66% in just 7 years. The decrease in cost of utility-scale solar has been more dramatic, dropping 85% since 2009 to 2016 range of $46-$61/MW-h (Lazard, 2016). A review by U.S. Department of Energy (2015) reported that since 2010, the price of installed solar energy has fallen by as much as half. At that time, the average price per photovoltaic unit decreased from 2.08 dollars/W to 0.66 dollars/W. The report shows that cost for solar energy has dropped by about 40% compared to 2015, which makes it economically competitive with traditional energy sources across the United States.

Costs of renewable energy may be cheaper than fossil fuels in some cases and places (Pasqualetti, 2011). As stated by IDC (2012), the cost of wind energy is competing with traditional energy market prices in areas with the best wind resources. In some countries, with high solar radiation, higher electricity prices and subsidies, Solar PV is expected to reach grid parity.

#### *3.1.2. Access to finance*

Another essential barrier to renewable energy technologies is financing. A research survey by Reddy and Painuly (2004) found that 40% of wind energy developers indicated that financing was a major barrier to renewable energy technologies. IEE (2014) shows that high financing costs influence the competitive position of renewables, as renewable energy requires higher initial investment than traditional energy, although their operating costs are lower. Renewable energy developers and customers may face difficulty in obtaining low-cost financing, as may be available for conventional energy facilities. Nelson and Shrimali (2014) estimated that about 90% of total project costs of photovoltaic, and hydropower are comprised of initial capital cost, while the initial investment of gas projects represents just one-third of the total cost of the discount life.

IEE (2014) points out that financial institutions are generally unfamiliar with renewable energy technologies and likely to recognise them as risky, so that they may lend funds at higher rates. For example, Chile's financial markets face difficulties in dealing with renewable energies. This is because of the absence of understanding non-traditional sources, guarantee requirements, uncertainties about long-term profitability, and the availability of alternatives in the traditional sector with lower risk and higher profitability (Hatzfeldt, 2013). Also, renewable energy technology in Malaysia is suffering from a lack of appropriate support mechanisms and a high initial price. The study concluded that renewable energy technology is not economically viable in Malaysia (Yusoff and Kardooni, 2012).

Renewable energy projects need access to long-term financing, due to high capital costs and low operating costs. In the lack of such long-term financing, investment choices will be directed

toward traditional technologies that may be financially practical (Hussain, 2013). In recent years, private investment has become the largest source of financing for renewable energy projects in different countries after the government played this role. This is due to two factors the costs of renewable energy technologies have declined, and renewable energy policies have encouraged private sector investment by creating new market opportunities (Wüstenhagen and Menichetti, 2012).

#### *3.1.3. Price distortion*

Pelosse (2009) argues that the comparison between renewable energy and traditional energy prices is unfair because of the financial and political support, which traditional gained in the past and the benefits it still enjoys. Several studies argue that the market prices of fossil fuels don't indicate their actual costs. The study by Biebl (2015) deduced the price of fossil fuels to be low in the United States because of government subsidies. Without these subsidies, renewable energy producers would be in a better state to compete in the energy market.

Governments frequently choose to control the prices of electricity through subsidizing the price of fuel inputs to the power generation sector (Bridle and Kitson, 2014). According to Komor and Molnar (2015), PV can't compete against subsidised diesel. The study found that subsidised diesel-fueled generates 66% of rural India's electricity needs. These subsidies cause electricity to be priced lower in the rural poor, but cause difficulties in introducing renewable energy sources. (WEF, 2016) estimates that without subsidies, more than 30 countries have already achieved grid parity between networks, and about two-thirds of the world will achieve grid parity within a few years.

Studies have shown that ignoring environmental and health cost for conventional energy also create price distortion. Gboney (2008) points out that the existing pricing methodology for traditional generation sources in Ghana ignores the environmental externalities of fossil-fuelled power plants into the calculations. Kilonzo (2013) argues that renewable energy is costly in comparison to fossil fuels due to the pricing of fossil fuel not consisting of environmental externalities, such as health care costs. Wind and solar energy from new plants in Europe are cheaper than coal and nuclear power plants, given environmental and health risks (Alberici et al., 2014).

### 3.2. Non-economic Barriers

#### *3.2.1. Policy and legal barriers*

In many countries, governments focus more on the traditional energy sector than on renewable energy. They give limited policy reinforcement in the area of renewable energy, by allocating low government subsidies to renewable energy compared to traditional energy subsidies (Karekezi and Kithyoma, 2003). This includes the absence of national R&D programs and low domestic spending on R&D (Manuhwa, 2013). According to Elliott (2013), shifting policies and changing priorities was one of the main difficulties faced by the United States in supporting renewable energy. However, the IEA, 2018 remarked that the high reduction in pollution in USA is due to its increased dependence on renewable energy.

A recent survey carried out by IGCC (2017) revealed that the majority of Australian and New Zealand institutional investors weighed both policy uncertainty and lack of deals with appropriate risk-return objectives to be the main barriers to renewable energy investment. Stadler (2016) argues that investment in renewable energy in Australia is still slow with the potential for a large-scale shortage of generation certificates by 2018. This is due to policy uncertainty as a constant feature of Australia's renewable energy industry. One of the top major obstacles to increasing investment in wind and solar energy in the United States stems from uncertainty about programs and policies at the federal and state level that aim to stimulate growth in renewables (Luckow et al., 2015). Forecasts out the development of renewable energy is expected to slow down in the next 5 years if policy uncertainty continues.

The lack of a comprehensive legal and regulatory framework has been a main obstacle for investment in renewable energy technologies by independent power producers in Ghana (Gboney, 2008). Chang and Wang (2016) show that there are a number of regulations and laws regarding renewable energy and utilisation in China, which affects renewable energy development.

#### *3.2.2. Technical barriers*

Renewable Projects are confronted by technical and infrastructure barriers and challenges. Nasirov et al. (2015) highlights network integration to be a primary challenge for renewable energy due to wide variety of qualifications, requirements, specifications and standards that change from country to country. The study finds that RETs need a high level of the technical basis for their technological assessment. The absence of energy storage is becoming a main technical barrier to the electricity production from renewable energy resources.

REN21 (2017) argues that major barriers to renewable energy growth are not associated to cost but to the restraints of current infrastructure. Nasirov et al. (2015a) show that one of the top barriers to increased current and future renewable energy generation is the limited grid infrastructure in areas where renewable resources are most abundant. Uncertainties regarding the existing data and information are among the main difficulties in this category of barriers. In this context, the Chilean Government faces hurdles incentivising the development of new transmission lines, especially in remote regions where renewable energy projects are often located. The risks related to Renewable energy technology are high because technology is under development and risks are not known (Wüstenhagen and Menichetti, 2012).

An early study by the National Renewable Energy Laboratory has found the shortage and lack of skills and training as a primary obstacle to renewable energy development (ILO, 2011). UNIDO (2009) points out that the main barrier in developing countries in the area of installing renewable energy is the absence of skills in numerous countries and different skills capacity throughout the country. The study highlights the difference in the concentration of installation and maintenance as they are much higher in urban areas than countryside.

## 4. CONCLUSION

From the literature review, there are main reasons to shift from conventional energy to renewables. One of these reasons is that many countries are suffering from a gap between energy supply and the domestic energy demand for them. Several studies have shown that fossil fuel energy subsidies fail in meeting their intended objectives. In addition, the literature illustrated that the fossil fuels consumption is major source of carbon dioxide emissions. Fossil fuel energy is one of the main source of $CO_2$ emissions. This economic and environmental situation needs more feasible solutions that are self-sufficient and non-relying on the use of fossil fuels.

Barriers to renewable energy in the literature were classified into three categories economic, policy and legal, and technical. Although high cost has been cited in the literature as one of the major barriers to shifting to renewable energy sources, recent studies indicate that cost of renewable energy has decreased over the last decade. Some studies find that costs of renewable energy may be cheaper than fossil fuels in some cases and areas. In some countries, financial institutions are not quite acquainted with renewable energy and likely to recognise them as risky, and this is a main barrier to the deployment of renewable energy.

Within the literature, there are barriers other than economic that face renewable energy. In many countries, governments focus more on the traditional energy sector than on renewable energy. This leads to the lack of a comprehensive legal and regulatory framework that supports renewable energy. In addition, some authors found that major barriers to renewable energy generation are irrelevant to cost but to the limitations of current infrastructure, and the absence of skills and training.

## 5. ACKNOWLEDGMENTS

This work is supported by the Newton-Mosharafa fund which is offered by the Egyptian Government- ministry of higher education (cultural affairs missions sector) and the British Council.

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