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# THE IMPACT OF RENEWABLE ENERGY DEVELOPMENT ON EMPLOYMENT IN ARABIAN GULF COUNTRIES

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**Abstract:**

Given the considerable potential of renewable energies, the transition towards their utilization is poised to provide a substantial influx of employment opportunities across several industries. Moreover, this shift is expected to serve as a fundamental catalyst for fostering sustainable development. Based on the reports published by the World Renewable Energy Organization, it is anticipated that the utilization of renewable energy resources within individual regions will significantly contribute to the overall augmentation of employment prospects across various sectors, encompassing production equipment, construction, administration, and services. Given the significance of this matter, the present study used the dynamic ordinary least squares (DOLS) approach for estimate purposes. In this study, we apply the Pooled Mean Group (PMG) approach proposed by pesaran et al. (1999) to examine the influence of renewable energy technology development on the employment rate in the Arabian gulf countries from 2010 to 2021.

The empirical findings suggest that the implementation of renewable energy initiatives in the Arabian gulf nations will have favorable outcomes in terms of employment, leading to a notable rise in job opportunities within these respective regions.

**Keywords:** Renewable energy, employment, developing countries, developed countries, dynamic ordinary least squares.

## 1.INTRODUCTION

Energy is widely recognized as the primary catalyst for industrial activities and serves as the fundamental foundation for the economic and social infrastructure of every given nation.

The expansion of planners' goals is closely associated with various issues, including the limitations of fossil energies, projected price increases, environmental concerns such as air pollution and global warming, population growth, and the potential insecurity in their supply due to political and economic crises. This statement highlights the imperative for policy makers to identify suitable strategies for addressing global energy challenges, with a particular emphasis on environmental crises. Additionally, it underscores the importance of researchers' efforts in advancing the development of renewable resources that are less detrimental to the environment, and have the capacity to supplant fossil fuels (Shehbazi et al., 2013 and Asadzadeh and Jalili, 2014).

Energy is widely recognized as the primary catalyst for industrial activities and serves as the fundamental foundation for the economic and social infrastructure of every given nation. In the past few decades, there has been a growing need for alternative sources of fossil energy due to climate changes and the negative long-term impacts of fossil energy use on the ecosystem and the global economy (Fitras et al., 2013). The increasing focus on renewable energies in various countries can be attributed to their significant significance and advantageous position in diversifying energy production sources and enhancing energy security (Karimi, 2018). Extensive evidence supports the notion that the transition to a green economy would yield a substantial influx of employment opportunities across various industries, serving as a crucial catalyst for the advancement of sustainable development. According to the study conducted by Terkoulias and Mirjades in 2011, it was found that... Presently, on a global scale, the employment opportunities generated by renewable energy technologies surpass those offered by fossil technologies. According to the most recent estimates conducted in 2017 by the International Renewable Energy Agency, approximately 10.3 million individuals are engaged in direct and indirect employment within the renewable industries.

Energy is widely recognized by ecologist economists as a pivotal growth driver and a primary catalyst for

**World Economics & Finance Bulletin (WEFB)**
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economic output endeavors. According to Stern (2000), the acquisition of products within an economy is contingent upon the expenditure of energy. Furthermore, labor and capital, which serve as intermediate components, necessitate the utilization of energy in order to effectively employ them.

Given the policymakers' prioritization of economic growth and development, it is imperative to address the challenges associated with fossil energy consumption. These challenges include the constraints posed by finite fossil fuel resources, escalating prices of these energy sources, the environmental repercussions and global warming resulting from their utilization, as well as the long-term detrimental effects and the vulnerability of their supply chains to political and economic conflicts. Consequently, planners and policymakers have consistently endeavored to identify viable solutions to these issues in recent times. Consequently, the imperative to transition towards primary energy sources with reduced environmental emissions has engendered a quandary within the realm of economic growth literature. Renewable energies, which possess considerable potential for satisfying energy demand and fostering economic growth and development, have garnered significant attention.

there has been a growing interest in exploring and utilizing renewable energy sources. This shift in focus may be attributed to the recognition of the detrimental impact of climate change and the realization that the reliance on fossil fuels is unsustainable in the long run. The research conducted by Faiffer and Mulder (2013) supports this claim, highlighting the increasing demand for alternative energy sources as a response to the negative consequences of climate change and the negative effects of fossil fuels on both the environment and the global economy. Numerous nations across the globe have implemented legislative measures aimed at promoting the utilization of renewable energy sources, aligning with the objectives outlined by the International Energy Agency and the Kyoto Treaty.

Extensive evidence supports the notion that the transition to a green economy has resulted in the emergence of numerous employment opportunities across various industries, playing a pivotal role in fostering sustainable development (Terkoulias and Mirjades, 2011). The study by the International Renewable Energy Agency (2019) indicates that the global renewable energy sector witnessed a notable growth in job creation in 2018. Specifically, it is said that the development of renewable energy resulted in the generation of over 11 million jobs, both directly and indirectly. This figure represents an increase compared to the previous year, 2017, during which around 10.3 million jobs were generated. Furthermore, it is noteworthy that solar power plants account for the biggest proportion, constituting one third of the overall employment generated by renewable energy sources.

Renewable energy sources also play a significant role in fostering economic development by generating domestic wealth through the establishment of renewable energy facilities and mitigating the outflow of currency by exporting electricity to neighboring nations. The utilization of these energy sources not only has a substantial impact on the conservation of fossil resources and the environment but also serves as a catalyst for economic growth and employment opportunities. As an illustration, the implementation of a solar energy facility has the potential to generate employment prospects in various sectors. These may include suppliers of mechanical equipment and raw materials, consultants and contractors responsible for assessing and evaluating potential sites, construction companies involved in infrastructure development and equipment installation, as well as environmental service providers, among others. The findings of a study conducted in the Netherlands indicate that the transition from non-renewable energy sources to renewable energy sources has a beneficial impact on the Dutch economy. It is projected that this transition will result in the generation of around 50,000 employment opportunities by the year 2030, contributing to approximately 1% of the country's Gross Domestic Product (GDP). includes Numerous scholarly investigations, exemplified by the research conducted by Bulavskaya and Reynès (2018) on the impact of renewable energy on economic growth and job generation in the Netherlands, have consistently yielded findings that support the notion that the adoption of renewable energy sources is associated with favorable outcomes for employment rates and overall economic prosperity.

It seems that the continuation of the policies adopted by the countries of the world in the field of renewable energy development will guarantee the increase in the number of employees in this sector, so that on this basis, India plans to produce solar electricity in the amount of 100 thousand megawatts and 515 thousand people will be employed in 2022 (Johnson, 2013).

The generation of employment opportunities in the renewable energy sector is influenced by a range of factors, such as governmental legislation, the diversification of supply chains, the adoption of new business models, organizational restructuring, and prevailing trends of industry consolidation. The

**World Economics & Finance Bulletin (WEFB)**
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Vol. 28, November, 2023
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renewable energy sector is experiencing a surge in employment opportunities, since there is a growing demand for individuals skilled in constructing wind farms, installing solar panels on various structures, and developing solar and geothermal power facilities. The annual growth rate of efficiency in industrial businesses involved in the production of equipment for energy production facilities exceeds 30%. According to Daman Keshide et al. (2018), these investments have a dual impact, since they not only contribute to the generation of employment opportunities but also serve as a means of mitigating the adverse effects of climate change. Indeed, it is worth noting that as the renewable energy sectors continue to expand and their economic magnitude grows, there will be a corresponding rise in automated procedures, leading to a reduction in the human workforce required for these operations (International Renewable Energy Agency, 2019).

Despite the absence of fossil fuels and their associated financial burden, along with the pressing issue of global warming, empirical evidence indicates that Iran possesses significant potential for harnessing renewable energy sources. However, it is worth noting that the use of these sources has not been adequately realized thus far (Elahi et al., 2014) .It is important to acknowledge that, as stipulated by the legislation pertaining to the reformation of energy consumption patterns, multiple governmental bodies such as the Ministry of Energy and the Ministry of Oil are obligated to provide assistance in promoting the widespread use of renewable energy sources.

## 2.RENEWABLE ENERGY SOURCES

Renewable energies encompass a collection of energy sources derived from natural processes and systems that possess the inherent ability to replenish themselves through time, ensuring their ongoing availability for human utilization. Renewable energy can be broadly defined as a collection of non-fossil fuel energy sources that possess certain key attributes, including the capacity for sustained extraction and utilization, renewable replenishment, and compatibility with the natural environment. Renewable energy encompasses the energy generated from various sources such as solar, geothermal, water, wind, biomass, and similar sources (Mousavi and Piri, 2014).

The renewable energy sector continues to be a very active area within the global economy. The renewable energy sector has experienced robust expansion, mostly driven by heightened competition within the wind energy and solar energy domains. According to the BP study published in 2018, The sector has become a significant catalyst for global economic growth due to advancements in technology, savings in costs, and the substantial influence of novel financing methods. Significantly, a worldwide consensus exists over the approach to address the peril of climate change by means of adopting clean energy technology on a global scale. The Paris Agreement, held in December 2015, provided countries with renewed motivation to endorse political measures that promote the advancement of renewable energy sources (US Department of Commerce, 2016).

In contrast, the Paris Agreement places significant emphasis on the historical responsibility of developed nations with regards to the prevailing global energy landscape. It asserts that developed countries bear the onus of supporting a larger proportion of endeavors aimed at achieving sustainable energy practices. Specifically, these nations are expected to possess the capacity to facilitate the expansion of the transition towards a low-carbon economy (Bulavskaya & Reynès, 2018). The development of renewable energies in countries offers various advantages, such as enhancing energy supply security, mitigating the depletion of fossil fuel resources while preserving them, mitigating global warming, fostering economic growth, creating business opportunities and new jobs, increasing per capita income, promoting social justice, safeguarding the environment, facilitating development in remote regions, and enhancing a nation's strategic position in energy diplomacy on the global stage (International Renewable Energy Agency report, 2019).

## 3.THE RELATIONSHIP BETWEEN RENEWABLE ENERGY AND THE ECONOMY.

Currently, there exists a strong interconnection between energy and the economy (Kaytakoğlu, 2016). Energy holds significant strategic value with regards to technological, legal, and economic dimensions, as well as in the context of international relations and environmental degradation. Energy has a significant impact on various macroeconomic phenomena, primarily through secondary consequences such as inflation and the appreciation of exchange rates. Moreover, the allocation of resources towards the energy sector is another noteworthy economic dimension of the matter, as highlighted by Zern and Akkosh (2018). Currently, there exists a disparity between the growth of global energy demand and the pace of population growth, with the former surpassing the latter. This trend persists alongside ongoing advancements in technology (Demirbash et al., 2009). According to Yanar and Karimoglu (2011), energy

**World Economics & Finance Bulletin (WEFB)**
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Vol. 28, November, 2023
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serves as the primary input in the production process, playing a crucial role in facilitating social and economic growth. Moreover, Karluk (2014) highlights the existence of a strong correlation between energy consumption and economic progress.

Neoclassical theorists claim that energy is regarded as an intermediary factor of production inside the production process. According to ecological economists, energy is considered the primary determinant of economic growth. According to the authors' perspective, energy is an indispensable component in every manufacturing process, thereby consistently influencing the production process (Daman Kashide et al., 2013). To attain sustainable development, it is imperative to incorporate renewable resources and allocate resources towards environmental preservation. Additionally, the accumulation of physical capital should be prioritized to counterbalance the depletion of natural resources and mitigate environmental degradation. In this context, it is crucial to incorporate non-renewable natural resources and energy within the production function (Ostadzad, 2012). According to the scholarly work authored by Brent and Wood (1975), energy is posited as a constituent factor of production within the overall production function, and is intricately interconnected with labor. According to certain neoclassical economists, such as Brent (1978) and Denison (1979), the impact of energy on economic growth is not direct, but rather mediated through its influence on labor and capital. The underlying premise of the conducted study posits that there exists a disparity in the effects of non-renewable energy and renewable energy on economic growth.

Numerous scholarly investigations have been conducted to explore the intricate interplay between renewable energy and economic growth, thereby delineating three distinct categories within the existing body of literature. One category of scholarly literature investigates the influence of renewable energy on the advancement of economic growth. The second category of research investigates the effects of renewable energy sources on environmental conditions, while the third category focuses on studies exploring the interplay between renewable energy, economic development, and environmental well-being. According to Saeidi and Omari (2020), renewable energy exhibits a beneficial impact on economic growth across all three categories of literature.

The advancement and proliferation of renewable energy sources contribute to the attainment of a nation's economic, social, and environmental development objectives, which are fundamental elements in the pursuit of sustainable development within any given country (Shenvai, 2016).

## 4.RENEWABLE ENERGY AND CREATING JOBS

In recent years, the growing number of renewable energy sources on a global scale has emerged as a significant catalyst for the generation of employment opportunities. The transition towards the production and utilization of renewable energy sources is anticipated to provide a substantial influx of employment opportunities across many industries. Moreover, this shift is expected to serve as a crucial catalyst for fostering sustainable development. The implementation of clean energy sources has the potential to generate a substantial number of domestic employment opportunities. It is noteworthy that the production processes associated with these energy sources necessitate building and installation activities, thereby ensuring the retention of a significant portion of these jobs within the country (Wei et al., 2010). The utilization of renewable energy sources (RES) within individual regions is anticipated to make a substantial impact on the overall augmentation of employment prospects across various sectors such as production equipment, construction, administration, and services (Terkelias & Mirjads, 2011).

Presently, there exists a discernible disparity in the rate of employment creation between the renewable energy industry and the fossil technology sector, with the former exhibiting a more pronounced growth trajectory. This phenomenon can be ascribed to a multitude of variables. For instance, the implementation of cost reduction measures and supportive policies across many nations has significantly accelerated the adoption of renewable energy sources and energy efficiency practices, resulting in a remarkable surge in job opportunities. Nevertheless, it appears that the aforementioned favorable advancements have been tempered as a result of inadequate investments, heightened mechanization, and alterations in policies, hence resulting in a decline in the rate of job growth within the renewable energy sector in key markets such as Brazil, Japan, Germany, and France (Rafiei and Sohrab, 2019).

Investments made by both the public and private sectors in green growth have been found to result in the generation of employment opportunities, commonly referred to as green jobs, across different sectors of the economy and in activities associated with environmental concerns (Lehr et al., 2012). Jobs in the renewable energy sector constitute a significant component of green employment. At a fundamental level,

**World Economics & Finance Bulletin (WEFB)**
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Vol. 28, November, 2023
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employment within the renewable energy industry can be categorized into two main sectors: construction and operation (Torklias and Mirjades, 2011).

Renewable energy has indeed contributed to the enhancement of macroeconomic productivity by generating employment opportunities and yielding various economic advantages. Consequently, augmenting the utilization of renewable energy sources has the potential to raise the income levels of both urban and rural families. In contrast, the utilization of renewable energy sources has facilitated the exportation of electricity to adjacent nations, thereby generating domestic prosperity through the establishment of renewable energy facilities. Additionally, this practice contributes to the influx of foreign currency, thereby bolstering the economic sector in question. The creation of jobs in the renewable energy sector is influenced by a multitude of factors along the supply chain. These factors play a crucial role in determining the location and nature of employment opportunities. The elements encompassed in this analysis comprise government regulations, supply chain diversity, company models, reorganization procedures, and industry consolidation. Moreover, the significance of worker productivity has been emphasized over an extended period of time (Renewable Energy Agency, 2019).

The analyses conducted by the International Renewable Energy Agency indicate that the expansion rate of renewable energy and energy efficiency development, in accordance with global objectives, results in a highly favorable increase in gross production. On a global scale, it is projected that the growth rate will rise to 0.8% by the year 2050, resulting in a corresponding increase in employment opportunities to encompass a workforce of around 28.8 million individuals.

According to the United States Energy Agency's (2018) estimates, there was a significant increase of approximately 18% in employment within the renewable energy sector during the period from 2015 to 2016. Based on the findings of this analysis, the predominant source of employment within the renewable energy industry pertains to solar energy, while in the energy efficiency sector, it mostly revolves around building-related activities encompassing construction, as well as renewable heat and cold technologies. According to the European Union Energy Organization's study (2018), it is indicated that the renewable energy and energy efficiency industry generates 16.7 jobs per one million dollars of investment, whereas the fuel sector yields a similar number of employment for the same level of expenditure. Approximately 60% of employment opportunities are derived from the fossil fuel industry. The findings of this study indicate that the employment opportunities generated by investments in the clean energy sector are thrice higher compared to those resulting from investments in the fossil fuel industry. Projections indicate that the workforce in the renewable energy industry is anticipated to expand to 23.6 million individuals by the year 2030, and further increase to 28.8 million by the year 2050.

The implementation of supportive policies pertaining to the utilization of renewable energy has had various implications on employment rates within the renewable energy sector. Additionally, the perpetuation of commercial policies has also exerted a substantial influence on employment within the equipment manufacturing industry across different nations.

As an illustration, China has strategically established manufacturing facilities or acquired the necessary infrastructure for photovoltaic electricity generation (solar energy) in many nations including Malaysia, Thailand, South Korea, India, Brazil, and the United States, with the aim of augmenting its commercial strategies and accessing broader markets. Additionally, Osburn (2015) asserts that there will be a movement of employment opportunities associated with the advancement of photovoltaic equipment to other nations. Hence, the advancement of photovoltaics represents a collective worldwide endeavor aimed at attaining sustainable energy, thereby yielding economic ramifications such as heightened job opportunities across various nations.

The renewable energy sector is seeing a growing demand for labor, as seen by the increasing employment opportunities in the construction of wind farms, installation of solar devices on rooftops, and establishment of solar and geothermal power plants. The yearly growth rate of efficiency in industrial businesses engaged in the development of equipment for renewable energy installations exceeds 30%. These investments play a crucial role in employment creation and mitigating the potential for unmanageable climate change (Damankeshide & Hasani, 2018).

Jobs in the field of renewable energy are divided into three categories: direct jobs, indirect jobs, and related jobs:

**1- Direct jobs:**

Typically, these employment opportunities are generated in correlation with the core operations of the renewable energy industries. This encompasses the jobs created within the construction, production, equipment distribution, installation, commissioning, and

**World Economics & Finance Bulletin (WEFB)**
**Available Online at:** https://www.scholarexpress.net
Vol. 28, November, 2023
**ISSN: 2749-3628,**

operation and maintenance sectors, which constitute integral components of the industry. The quantification of direct employment opportunities is a reasonably straightforward task, and there exists a discernible positive relationship between the total count of such jobs and the pace at which renewable technologies are expanding.

**2- Indirect jobs:**

The aforementioned occupations are associated with the secondary level of the renewable energy industry, specifically within the supply and service sectors. These employment opportunities encompass key industry suppliers, such as producers of copper and steel utilized in the construction of renewable equipment and systems. Additionally, they extend to many sectors, including as marketing and sales, administration in ministries, and activities established by institutions. The establishment of monitoring, consultancy, and research companies is recommended. While certain categories of indirect employment have emerged in tandem with the need for installed or domestic capacity, such as jobs in materials supply, other categories, such as support organizations, exhibit a weaker correlation with the renewable energy sector. Within the realm of performed research, a limited number of studies have undertaken the task of quantifying indirect employment opportunities. In this context, certain research acknowledge the presence of indirect effects, while others quantitatively assess these effects by employing a straightforward multiplication method.

**3- Related jobs:**

These are the employment opportunities that arise from economic activity stemming from the establishment of renewable industries. Dependent employment arises as a consequence of the economic endeavors undertaken by several stakeholders, including direct and indirect workers, stockholders, and governmental entities. These stakeholders generate profits that might subsequently invigorate other industries, so establishing a ripple effect within the renewable energy sector. Indeed, the associated occupations thrive through the utilization of economic revenue generated by renewable businesses. The conceptualization of affiliate enterprises can be achieved with relative ease. An illustration of the potential relationship between renewable energy workers patronizing a restaurant and the subsequent increase in labor demand inside said establishment may be observed. As an additional illustration, it can be posited that individuals residing in the vicinity of a photovoltaic manufacturing plant or in the vicinity of an establishment dedicated to solar thermal energy or photovoltaic technology deployment tend to exhibit heightened consumption of goods and services. Consequently, this heightened demand can potentially engender job creation within the relevant sectors responsible for supplying said goods and services.

## 5. METHODOLOGY AND DATA

The model related to investigating the impact of the development of renewable energy technology on the level of employment in the Arabian gulf countries is as follows:

$$EMP_{i,t} = f(RC_{i,t} + GDPP_{i,t} + W_{i,t} + TR_{i,t})$$

*i* indicates the country under study and *t* indicates the time.

$EMP_{i,t}$: Employment rate per capita in country *i* at time *t*.

For this variable, the data of the ratio of employment to the population of the countries has been used.

$RC_{i,t}$ the total installed capacity of renewable energy technology in country *i* at time t

The annual installed capacity of renewable energy means the annual installed capacity to produce electricity from various sources of renewable energy such as solar energy, hydroelectricity and biomass in each country. Data related to this variable have been collected from the World Renewable Energy Agency.

$GDPP_{i,t}$ : Gross domestic product of country *i* at time *t*

An increase in the level of production will lead to a higher level of employment, so it is expected that there will be a positive relationship between employment and production.

$W_{i,t}$: wages in country *i* at time *t*

The surrogate variable for wages is the statistics on workers whose jobs are defined as (wage jobs) who have employment contracts (written or oral) or tacit. Statistics related to this sector have been collected from the World Bank.

$TR_{i,t}$: Trade openness of country *i* at time *t*

Trade is the sum of exports and imports of goods and services measured as a share of gross domestic product.

It should be noticed that all the variables are entered into the model logarithmically.

In order to obtain the essential knowledge regarding the theoretical themes and the backdrop of the experimental experiments, library and internet sources have been utilised. On the other hand, one of the primary elements for estimating a pattern is access to trustworthy statistics and information. The data and statistics required for modeling in this research have been acquired from the sources of the World Bank (WB), international Renewable Energy agency.

**World Economics & Finance Bulletin (WEFB)**
**Available Online at:** https://www.scholarexpress.net
Vol. 28, November, 2023
**ISSN: 2749-3628,**

### 5.1. Unit Root Test

Panel unit root tests are performed in order to assess the degree of co-accumulation between the researched variables. These tests are provided as an alternate way to evaluate the causal link between variables in the framework of panel models. In truth, panel unit root tests are more common and used due to their ability to measure cross-sectional special effects and directly study heterogeneity and parameter values. In this research, numerous unit root tests such as Levin, Lin and Chu (LLC), Im, pesaran and Shin (IPS), Madala, Wu and Choi (MWC), Brightong and Hadri test to check the presence or absence of the unit root The unit root of the variables and their degree of co-accumulation have been used. The LLC test is one of the common panel unit root tests and is based on the generalized Dickey-Fuller (ADF) test and the assumption of panel homogeneity. The IPS unit root test is a larger variation of the LLC test, in which there is no need to assume panel homogeneity because this test is based on the assumption of heterogeneity of the autocorrelation coefficients of all panel components. In both IPS and LLC tests, it is assumed that cross-sectional independence exists between panel components (with the exception of the common time effect), while this assumption is very restrictive due to cross-sectional correlation and the relationship between countries, regions, and different sectors. Recently, attention has been made to cross-sectional independence on which IPS and LLC unit root tests rely, and current research try to quantify cross-sectional dependence in panel unit root tests and try to employ Brightong, MWC, and Hadri tests.

### 5.2.Panel cointegration test

The second stage of investigating the development of renewable energy technology on the employment rate is to determine the long-term relationship between these variables using the panel co-integration method. In this study, different co-integration methods of Pedroni and Kao have been used in order to investigate the presence or absence of co-integration relationship. One of the most famous panel cointegration methods is the Pedroni cointegration test. In this method, the heterogeneity between the individual components of the panel is considered, and therefore, it is more reliable than other existing methods. This test is almost similar to Im et al.'s test, with the difference that the Pedroni panel cointegration test takes into account different individual effects in cross-sectional interdependence

Pedroni has presented seven different statistics in order to examine the clustering of the panel. Among these seven statistics, four of them are based on integrated data, which is between groups, and the other three are between groups. In both types of these tests, the null hypothesis indicates the absence of co-accumulation. The difference between these two types of tests is in the design of the opposite hypothesis. For intergroup test, the opposite hypothesis is for all i's, while based on intergroup tests, the opposite hypothesis is for all i's. Limited sample distribution for these seven statistics was calculated by Pedroni using Pedroni simulation. In order to reject the hypothesis based on the absence of co-accumulation, the amount of estimated statistics should be smaller than the critical statistic calculated by Pedroni. The only limitation of the Pedroni panel cointegration test is that it is based on the hypothesis of the limitation of the common factor and does not calculate possible cross-sectional dependence (Ozterek, 2010). According to this hypothesis, the long-term parameters of the variables at the level are equal to the short-term parameters of the variables with a difference. The existence of this limitation can significantly reduce the power and stability of cointegration tests based on the residual. For this purpose, in this research, in addition to Pedroni's cointegration test, Kao (1999) and Westerland (2007) cointegration tests were used to estimate the long-term relationship between the impact of renewable energy technology development on employment in selected countries.

The Kao test is based on the Engel-Granger two-step method and considers the homogeneity of the panel components in performing the cointegration test. The null hypothesis in this test based on the lack of co-integration relationship is investigated using the ADF test

### 5.3.DOLS estimation

The DOLS estimator, in order to obtain an unbiased estimate of the long-term parameters and obtain the endogeneity correction of the variables used in the model, uses the parametric adjustment of the model errors by entering the past and future values of the first order difference of the explanatory variables. The estimated coefficient of DOLS estimation in this model is equal to:

$$\hat{\beta}^*_{DOLS} = \frac{1}{N}\sum_{i=1}^{N}\left[\left(\sum_{t=1}^{T} z_{i,t}z'_{i,t}\right)^{-1}\left(\sum_{t=1}^{T} z_{i,t}\tilde{y}_{i,t}\right)\right]$$

Finally, using the pooled mean group (PMG) method of Sons and colleagues (1999), the impact of the development of renewable energy technology on the employment rate in developing countries with renewable energy technology is investigated. The last step of investigating the effect of renewable energy

**World Economics & Finance Bulletin (WEFB)**
**Available Online at:** https://www.scholarexpress.net
Vol. 28, November, 2023
**ISSN: 2749-3628,**

development on employment in this part of the research is to estimate the short-term and long-term coefficients of the panel error correction model using the PMG method provided by Pesaran et al. (1999) and then investigating the causal relationship between the variables .

PMG is median estimation because it includes both pooling and averaging. One of the advantages of the PMG method compared to the OLS, DOLS and FMOLS methods is that in this method the short-term dynamic characteristics can be different from one period to another, while the long-term coefficients estimated in the OLS, DOLS and FMOLS models are The assumption of being the same is estimated in all stages. In other words, in the PMG method, the characteristics of different countries are considered in estimating the coefficients (Lee et al, 2008). If the variables of the model are co-integrated, the PMG estimator can be used to investigate the causal relationship between the variables.

## 6. RESULTS

### 6.1. Unit root test

In this section, the results of various unit root tests of Levin, Lin and Chu (LLC), Im, Pesaran and Shin (IPS), Wu and Choi (MWC) and also the Breitung unit root test are also in tables 1 are shown. As it can be seen, at the confidence level above 95% based on all the tests, except for the variable of trade openness ($I_0$), the rest of the variables of the model are ($I_1$).

**Table 1. unit root test**

| **hypothesis** | **Null hypothesis: existence of unit root Null hypothesis: No unit root** | | | | | |
|---|---|---|---|---|---|---|
| test / variable | | Levin, Lin and Chu (LLC) | Breitung t-stat | Im, Pesaran And Shin (IPS) W-stat | MW–ADF Fisher Chi-square | MW–PP Fisher Chi-square |
| EMP | statistics | -2.31 | 2.38 | 0.51 | 28.94 | 23.38 |
| | prob | 0.01 | 0.99 | 0.69 | 0.14 | 0.38 |
| D(emp) | statistics | -7.90 | -2.05 | -3.88 | -59.39 | 72.97 |
| | prob | 0.00 | 0.02 | 0.001 | 0.00 | 0.00 |
| REC | statistics | 2.41 | -0.0007 | 0.47 | 17.33 | 15.29 |
| | prob | 0.007 | 0.49 | 0.68 | 0.74 | 0.84 |
| D(REC) | statistics | -14.27 | -4.63 | -3.99 | 55.64 | 71.39 |
| | prob | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| TR | statistics | -2.35 | -3.63 | -2.006 | 36.60 | 50.65 |
| | prob | 0.009 | 0.001 | 0.02 | 0.02 | 0.0005 |
| GDP | statistics | -3.80 | 1.77 | 0.19 | 23.64 | 54.60 |
| | prob | 0.0001 | 0.96 | 0.36 | 0.36 | 0.001 |
| D(GDP) | statistics | -7.33 | 0.37 | -1.88 | 43.40 | 74.73 |
| | prob | 0.000 | 0.64 | 0.03 | 0.004 | 0.000 |
| WAGE | statistics | -2.46 | 1.01 | -0.23 | 24.27 | 15.15 |
| | prob | 0.006 | 0.84 | 0.40 | 0.33 | 0.85 |
| D(WAGE) | statistics | -5.55 | 1.01 | -3.39 | 46.23 | 44.08 |
| | prob | 0.000 | 0.84 | 0.0003 | 0.001 | 0.003 |

According to the results of the unit root tests and by making sure that most of the variables used in the model are Stationary from the first order, the existence of a long-term relationship between them is examined. There are various tests to examine the long-term relationship and co-integration relationship between variables in panel data, such as Pedroni's test (1999 and 2004) and Kao (1999).

### 6.2. panel co-integration tests

Table (2) shows the results of the Pedroni cointegration test. As can be seen in this table, four between-group tests and three within-group tests were conducted in

**World Economics & Finance Bulletin (WEFB)**
**Available Online at:** https://www.scholarexpress.net
Vol. 28, November, 2023
**ISSN: 2749-3628,**

order to determine the presence or absence of long-term relationship between research variables. Based on the obtained results, the null hypothesis that there is no co-integration of the panel in different studied countries is rejected. According to previous studies, Pedroni's panel cointegration test has a problem. This test requires that the long-term co-integration vector of the variables in the level is equal to the short-term adjustment process of the changes of the variables, and it also assumes the independence of the sections. The presence of such limitations reduces the validity of Pedroni's method to some extent (Yang Xuan and Dong Hu, Ouedrago, Ozterek et al. and Judd et al.).

In addition to the co-integration test of the Pedroni panel, the co-integration test of the Kao panel residuals was also performed to ensure the obtained results. Based on the results of these tests, the panel co-integration relationship between the investigated variables in the research model was confirmed. Therefore, it can be said that the research variables tend to a long-term relationship, which is estimated in the next step.

**Table 2- Pedroni co-integration Test results**

| **Intergroup panel statistics** | | | | |
|---|---|---|---|---|
| | Pedroni, 1999 | | Pedroni, 2004 (weighted statistics) | |
| test | statistic | prob | statistic | prob |
| Panel v-Statistic | -0.06 | 0.52 | -0.80 | 0.79 |
| Panel rho-Statistic | 2.01 | 0.97 | 2.76 | 0.99 |
| Panel PP-Statistic | -2.83 | 0.002 | -2.36 | 0.009 |
| Panel ADF-Statistic | -3.05 | 0.001 | -3.38 | 0.0004 |
| Intergroup statistics (individual statistics) | | | | |
| test | statistic | prob | | |
| Group rho-Statistic | 3.92 | 1.00 | | |
| Group PP-Statistic | -4.27 | 0.000 | | |
| Group ADF-Statistic | -4.04 | 0.000 | | |

**Table 3. kao co-integration test**

| **model** | **Generalized Dickey-Fuller statistic (ADF)** | **prob** |
|---|---|---|
| EMP,REC,GDP,,WAGE | -2.06 | 0.01 |

Considering the proof of the panel co-integration relationship between the investigated variables in both models, in the next step, the long-term coefficients of the variables are estimated.

### 6.3.Estimation of long-term relationship

Considering the proof of the panel co-integration relationship between the investigated variables in both models, at this stage of the research, the long-term coefficients between the variables are estimated. As stated in the methodology section, the DOLS method is used to estimate the long-term relationship between the variables in the model.

Tables 4 show the results of estimating the long-term relationship between employment and renewable energy installation capacity, gross domestic product and wages among Arabian gulf countries during the years 2010 to 2021.

| **Variable** | **coefficient** | **Std.Error** | **t-statistic** | **prob** |
|---|---|---|---|---|
| rec | 0.007 | 0.003 | 2.22 | 0.03 |
| wage | -0.371 | 0.105 | -3.53 | 0.0009 |
| Gdp | 0.162 | 0.04 | 3.71 | 0.0006 |
| tra | 0.05 | 0.02 | 2.06 | 0.04 |
| $R^2$ | 0.99 | | | |

| | |
|---|---|
| Adjusted $R^2$ | 0.99 |

As can be seen in the above tables, based on validation criteria such as R2 and R2 statistics, and also based on the probability obtained for each of the estimated coefficients of the models, the accuracy of the results obtained from the estimation for analysis And the comment is confirmed.

**World Economics & Finance Bulletin (WEFB)**
**Available Online at:** https://www.scholarexpress.net
Vol. 28, November, 2023
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As the results of this table show, in the estimated model, the effect of renewable energy installation capacity on employment is positive and statistically significant. Based on the results presented in the above table, a one percent increase in renewable energy installation capacity leads to a 0.007 percent increase in employment. Considering that the renewable energy industry is hiring more and more people day by day to build wind farms, install solar devices on roofs, and build solar and geothermal thermal power plants, it can be said that the capacity to install renewable energy and move towards production And using them more can have a significant contribution to the overall increase of job opportunities in several sectors, including production equipment, construction, administration and services. Therefore, as the results obtained from the estimation show, it can be said that the renewable energy installation capacity variable has a positive effect on employment in these countries and has created new jobs in these countries.

The point to be considered here is that the impact of renewable energy sources on the employment rate depends on the number of production steps that are carried out locally. Given that the design and development side of renewable energy deployments often occurs in developed economies, jobs related to these sectors are created in this group of countries, while in developing countries, only manufacturing jobs in lower levels (after design etc.) are created and therefore the positive effect of increasing the capacity of renewable energy on increasing employment in the Arabian gulf countries, which are developing countries, is less.

The estimated coefficient for GDP is positive and significant. A one percent increase in GDP causes a 0.16 percent increase in employment in the studied countries. Gross domestic product is one of the most important macro-economic variables and indicates the overall result of the country's economic activities. With the increase of the gross domestic product in the country, the amount of investment in various sectors will increase and therefore will lead to an increase in employment.

The estimated coefficient for the wage variable is negative and significant. So that a one percent increase in wages causes a 0.37 percent decrease in employment. A change in the real wage level will lead to a positive change in the direction of the real cost of labor for companies. As the real cost of labor increases, firms prefer to hire less labor or the change in the level of employment is less than before. Therefore, it is expected that there is an inverse relationship between the change in real wages and the employment of the labor force, and with the increase in wages, the employment will decrease.

Since the anticipated coefficient for the trade variable is significant and positive, an increase in trade of 1% will result in an increase in employment of 0.05%. It makes sense that there will be more jobs the more active a nation's overseas trade is.

### 6.4.PMG test

After estimating the long-term relationship between employment, renewable energy installation capacity, wages , trade and GDP, in this section, the short-term relationship between the variables of the model is examined and the causal relationship between the variables is determined.

| variable | Short term | | | |
|---|---|---|---|---|
| | coefficient | Std.Erorr | t-statistic | prob |
| D(LREC) | 1.35 | 0.62 | 2.17 | 0.0345 |
| D(LGDP) | 33.09 | 6.28 | 5.26 | 0.0000 |
| D(TRADE) | 8.66 | 1.86 | 4.63 | 0.0000 |
| D(LWAGE) | -61.63 | 8.44 | -7.29 | 0.0000 |
| C | 6.65 | 1.84 | 3.61 | 0.0007 |
| | | | | |
| COINTEQ01 | -0.41 | 0.13 | -3.09 | 0.032 |

The error correction component of this model is equal to 0.41, which is significant at a high confidence level and indicates the speed of adjustment towards long-term balance. This coefficient shows that 0.41% of the imbalances in the system must be removed in each period in the countries under review in order to reach a long-term balance. According to the significance of the error correction coefficient in this model, the long-term

**World Economics & Finance Bulletin (WEFB)**
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Vol. 28, November, 2023
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relationship between the variables can be confirmed. The significance of long-term dynamic relations in the equations, which is a component of error correction based on statistical significance, shows that the variables of the model can move to adjust the long-term balance and establish long-term balance in the system.

## 7. CONCLUSION AND SUGGESTION

In the current study, the effects of renewable energy installation capacity, gross domestic product, wages and trade on employment in Arabian gulf countries during the period of 2010 to 2021 have been investigated using panel data econometric models. In this research, in order to investigate the effect of renewable energy capacity, gross domestic product and other independent variables on employment, the advanced panel data method of Pedroni (1999 and 2004) and the panel error correction model (PECM) were used and the relationship between the installed capacity of renewable energy renewable and other effective factors studied on employment in the studied countries in the form of a multivariable panel model and the analysis of long-term and short-term coefficients have been examined in three stages. First, the study of the unit root test of the research variables and determination of their co-accumulation order was done, and in the next step, the existence or non-existence of long-term relationship between the variables of the model was investigated by using the panel co-accumulation tests. DOLS method is used to estimate the long-term relationship between variables in the model.

Then, using eviews software, the specified model was estimated and based on the estimated regression equations, the following results were obtained:

-The renewable energy installation capacity variable has a positive effect on employment in these countries and has created new jobs in these countries.

-The estimated coefficients for the variable of GDP are positive, which is statistically significant. The positivity of these coefficients indicates the existence of a positive relationship between employment and GDP in the studied countries.

-The estimated coefficients for trade indicate the positive and significant impact of this variable on employment

-The estimated coefficients for the wage variable are negative and statistically significant. The negativity of this coefficient indicates the inverse relationship between wages and labor force employment, and it states that employment will decrease as wages increase.

Based on the results of this research on the positive impact of employment on the development of renewable energy installation capacity, more and more countries need to pay attention to regular policies related to the development and application of renewable energy technology. Considering the limitations of non-renewable energy resources in countries and also the problems of using more of them, such as pollution, heating, environmental destruction, etc., it is obvious that the development of the use of renewable energy resources, in addition to creating employment in countries, can lead to to preserve the environment for future generations.

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