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Konrad Rojek*

THE RENEWABLE ENERGY LABOR MARKET INCLUDING COVID-19

Abstract

The aim of this paper is to present the changes taking place in the labour market in the renewable energy sector in the period before the COVID-19 pandemic and to show the opportunities and threats for this sector as a result of the changes taking place. Therefore, the factors shaping employment in the renewable energy sector, global employment in the sector and the role of the value chain in shaping the local labour market were analysed on the example of photovoltaics. Basic methods of descriptive statistics were used for this purpose. A SWOT analysis for the renewable energy market in the context of COVID-19 considerations was also carried out.

JEL classification: *J4, Q20*

Key words: *labour market, renewable energy sector, photovoltaics*

Paper type*: Theoretical research article*

Introduction

The benefits of renewable energy for the environment, such as lower carbon dioxide emissions and less air pollution, have been widely known for decades. However, many other positive socio-economic effects have only become more noticeable in recent decades as a result of the increasingly widespread implementation of this type of technology.

* **mgr inż. Konrad Rojek** – PhD candidate, Kazimierz Pułaski University of Technology and Humanities in Radom, Faculty of Economics and Finance, e-mail: k.rojek@uthrad.pl

Renewable energy[1] is a guarantee of maintaining the pillars of sustainable development (environmental, economic and even social). Except decreasing costs and continuous improvement of technology, the transition to renewable energy sources also creates numerous employment opportunities.

The impact of renewable energy technologies (RES) on job creation is one of the important arguments for RES support policies, found in European Union (EU), national, regional and local documents (Sidorczuk-Pietraszko, 2015, pp. 28). Renewable energy creates a significant (and growing) number of jobs every year in the world. The renewable energy sector employed a record number of 10.9 million people in the world in 2018.This fact is conditioned by increasing investments, decreasing costs, technological improvements and government policies supporting renewable energy sources.

In addition to striving for climate-related goals, many governments have recognized renewable energy as a stimulus for low-carbon economic growth. The supply chain has diversified, which has consequently contributed to the extension of the geographical coverage of the sector. More and more countries are taking an example from leading markets in this respect and combining the use of "green technologies" with wider socio-economic benefits. The anticipation that the renewable energy industry will replace the unsustainable fossil fuel industry is becoming more common.

Employment in the renewable energy sector increases every year. More and more countries produce, sell and install renewable energy technologies. Due to the accelerating pace of global energy transformation, the employment dimension in this sector ensures socio-economic stability and is another reason why countries commit to implementing renewable energy technologies.

The aim of this paper is to present the changes taking place in the labour market in the renewable energy sector in the period before the COVID-19 pandemic and to show the opportunities and threats for this sector as a result of the changes taking place. Therefore, the factors shaping employment in the renewable energy sector, global employment in the sector and the role of the value chain in shaping the local labour market were analysed on the example of photovoltaics. Basic methods of descriptive statistics were used for this purpose. A SWOT analysis for the renewable energy market in the context of COVID-19 considerations was also carried out.

[1] RES - renewable energy sources.

1. Review of research results on the impact of renewable energy technologies on employment

Research on the assessment of the effects of policies supporting renewable energy sources and the development of RES technologies on the labour market in general has been conducted in the European Union since the 1990s, among others within the projects The Potential Contribution of Renewable Energy Schemes to Employment Opportunities (ECOTEC Research & Consulting Ltd, 1995); Monitoring and Modelling Initiative on the Targets for Renewable Energy (ALTENER Programme, 2003) and The impact of renewables on employment and economic growth in the European Union (EmployRES, 2009). These analyses aimed to capture the overall effects of renewable energy support policies, including employment.

At the regional level, Moreno and Jesus López (2008, p. 11) estimated the employment impacts associated with the development of renewable energy sources in the Asturias region of Spain. For the period 2006-2010, three scenarios were analysed taking into account different levels of RES use, with more or less active policies to support RES.

Thornley, Rogers and Huang (2008, pp. 1922–1927) carried out a detailed technical, economic and environmental assessment for individual biomass energy technologies, including the labour demand at each stage of the process.

E. Sidorczuk-Pietraszko (2015, pp. 26-41) in her research presented the impact of RES technologies on local job creation. In this study, employment in renewable energy installations was determined, especially the relative measure of the impact on employment.

Golisz E., Maczynska J., Wozniak K. (2016, pp. 32-33) presented issues related to employment in the renewable energy sources sectors in Poland and in the European Union in the context of Directive 2009/28/EC. They identified opportunities for job creation in the RES sectors in Poland. They stated that development of RES markets creates opportunities for new professions resulting from both traditional and innovative activities. Moreover, they discussed the domestic market of RES equipment production in the context of new jobs.

In turn, P. Gradziuk (2017, pp. 92-98) examined the impact of renewable energy on the labour market. The study shows that the largest number of jobs in relation to the generated energy was created in the wind energy sector and in the solar energy sector, both solar and photovoltaic. The key factor influencing such a development of employment rates in these sectors was the fact that the amount of energy generated per unit of installed capacity was several times lower than in the case of other RES.

Systematic analyses of the renewable energy market are conducted by EurObserv'ER and IRENA, which prepare systematic reports for individual renewable energy subsectors. The data contained in these studies were used for the preparation of this article.

In general, the studies so far indicate that the amount of employment generated in the different phases of the life cycle of RES technologies varies, depending on the type of technology, and that the spatial distribution of these effects varies considerably. This depends decisively on the labour intensity of the individual life cycle phases.

2. Factors determining employment in the renewable energy sector

Employment in the renewable energy sector is conditioned by several basic factors. They shape the way new jobs are created and their location. These factors include government policies, supply chain diversification, trade patterns and trends in industry reorganization and consolidation. It should be noted that these factors generate an increase in labor productivity over time. As the renewable energy industry becomes more mature, it obtains economies of scale and increases its technological advancement, and thus the automation of its processes. The consequence of this automation is a lower employment rate.

Governmental activities such as auctions, tenders, guaranteed tariffs, subsidies, industrial policy and labor and trade policy are necessary due to the development and maturation of the renewable energy sector. In this way, government policies have a strong impact for employment.

Guaranteed tariffs were necessary to create many of today's markets, but if their rates are too high then they can become a budgetary burden. The growing role of tenders in recent years has resulted in lower project implementation costs, greater competitiveness with fossil fuels, and thus greater use of 'green technologies'. Competitiveness in tenders also involves some risk. This is because winning offers do not always have to result in positive results. Cost pressure may lead some companies to use cheaper and very often also low quality equipment. Cost pressure can also manifest itself in lower levels of employment, wages or skills training (IRENA, 2018a, p. 22-23; 2017a, p. 16).

Government policies on renewable energy sources need to be well-balanced. It seems necessary to balance actions between strong supporting elements and aggressive restrictions. Equipment manufacturers, project developers, and other industry players need to feel stabilized as part of their business activity. Therefore, all government regulations and strategies should be introduced well in advance so that the renewable energy sector has enough time to prepare for them.

Properly developed investment incentives support emerging industries. Preferential loans, business incubators and business development programs are also helpful. The creation of new jobs in the renewable energy sector is also supported by appropriate education and training policies. Their goal is to build a competent workforce (IRENA, 2017b, 2017c, 2018b).

An example of an effective industrial policy are well developed domestic supply chains and economies of scale that can be observed in the Chinese photovoltaic industry. Production clusters in the Yangtze River Delta play a key role. The extensive industrial infrastructure in this area, low energy prices and the presence of suppliers from sectors such as the glass industry allows solar energy companies to buy cheap raw materials. Strong support from central governments, provinces and municipalities also plays a very important role here. Many other countries can, in principle, imitate such policies in order to build viable national supply chains (Ball et al., 2017, pp. 28-30).

Domestic markets are important for creating jobs in the lower segments of the value chain. Well-developed domestic supply chains allow for a lower dependence on the import of equipment and components. On the other hand, export sales are also important for creating jobs in countries that serve as regional or global production centers. This is especially true of China and many European countries (EurObserv'ER, 2019, pp. 173-175).

Trade profiles of countries in the renewable energy sector differ significantly between its individual technologies. For example, China is the largest exporter of solar photovoltaics (Figure 1), however their wind energy companies mainly serve the domestic market. In turn, Europe is a net importer of photovoltaic devices, but the wind sector (especially in Denmark, Germany and Spain) is strongly export-oriented. In addition, European wind companies play a large role in global energy production. The USA is a small exporter of wind equipment and has a very small trade deficit in this sector, but is a large net importer of solar energy along with countries such as India and Turkey (Bloomberg New Energy Finance, 2019).

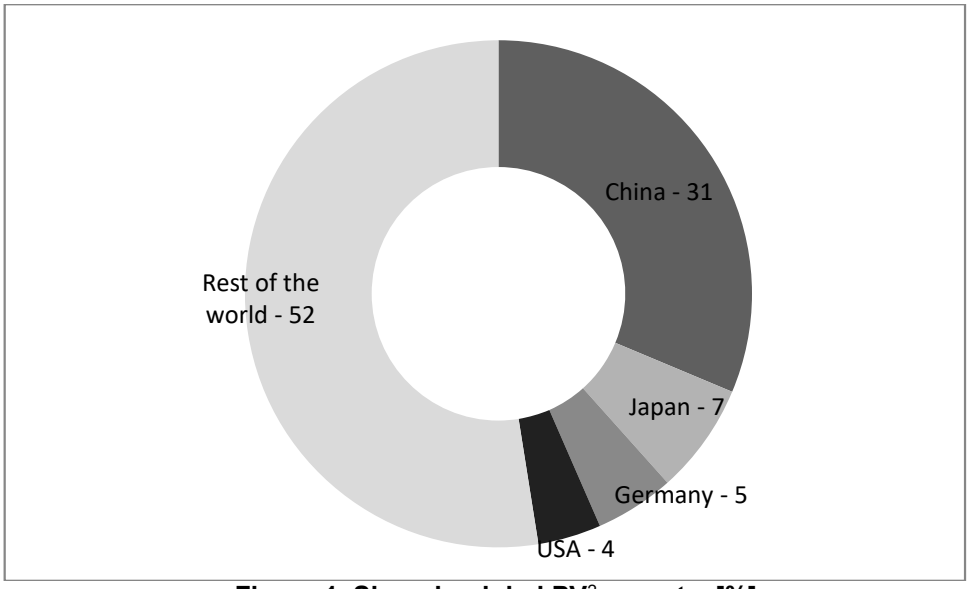


Figure 1. Share in global PV[2] exports [%]
Source: Own study based on: EurObserv'ER, *The State of Renewable Energies in Europe, 2018 Edition*, Paris 2019, p. 235.

In the case of biofuels, the USA accounted for nearly 30% of exports in 2016. They were ahead of European countries (including the Netherlands, France, Belgium, Hungary, Germany and the United Kingdom). In hydropower, China accounted for a quarter of global exports, while European companies (mainly from Germany, Austria and Italy) had a 46% market share. The US and India contribution was slightly below 5% (IRENA, 2019, p. 8).

Transformations in renewable energy supply chains are changing the geographical nature of the industry and its trading patterns. This phenomenon affects the labor market. Corporate strategies are globally recognized as a key driver of the industry. However, some countries are trying to play an active role in the industry through local/national markets.

For example, the solar industry has changed significantly since 2012. A large part of the production capacity has been transferred to Asia, which currently accounts for 92% and 85% of global cell and module capacities respectively[3]. In addition to China's dominant role, other Southeast Asian countries are also becoming significant exporters. The US, India and Europe are largely focused on imports (Roselund, 2019). In order to build or maintain a national production base, some importing countries have adopted different

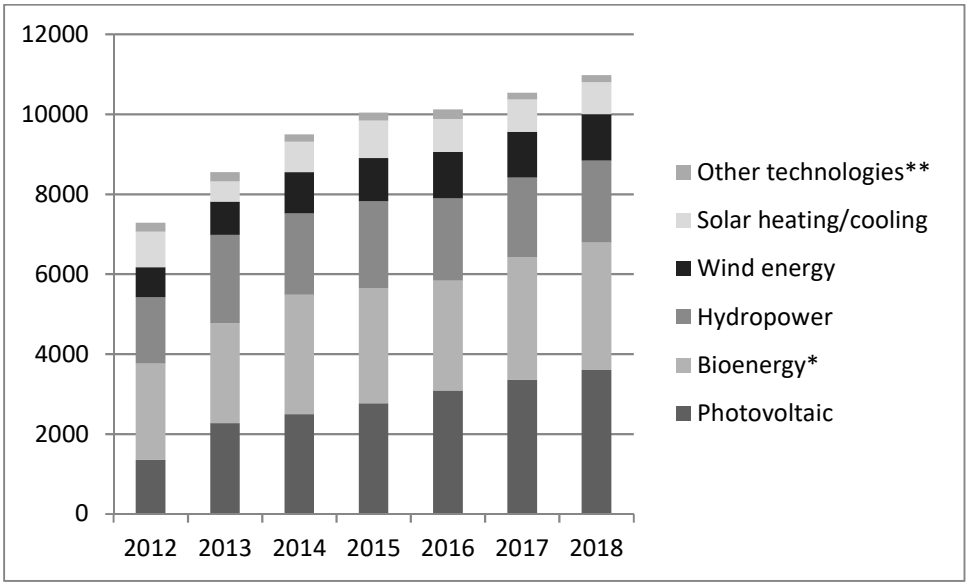
[2] PV – photovoltaics
[3] Including India.

import tariffs and compensatory charges. However, the effectiveness of such policies can also have a negative effect (Trendforce, 2019).

As a result of growing competitive pressure, industry consolidation is changing the face of the renewable energy sector. For example, Siemens and Gamesa have merged in wind energy. Mitsubishi Heavy Industries and Vestas formed an offshore joint venture (MHI Vestas). GE, in turn, bought Alsthom wind assets and acquired Danish LM Wind Power (IRENA 2019, p. 10).

3. Global employment in the renewable energy sector

Employment in renewable energy sources is constantly growing (Figure 2). In 2017, 10.5 million people were employed worldwide, while in 2018 this number increased to 10.9 million. As more and more countries produce, sell and install renewable energy technologies, the number of jobs in the renewable energy sector has risen to its highest levels so far. Global growth occurs despite the noticeable slower development in key renewable energy markets.



*Bioenergy - liquid biofuels, solid biomass and biogas

**Other technologies - geothermal energy, heat pumps, municipal and industrial waste, concentrated solar power (CSP), tidal energy

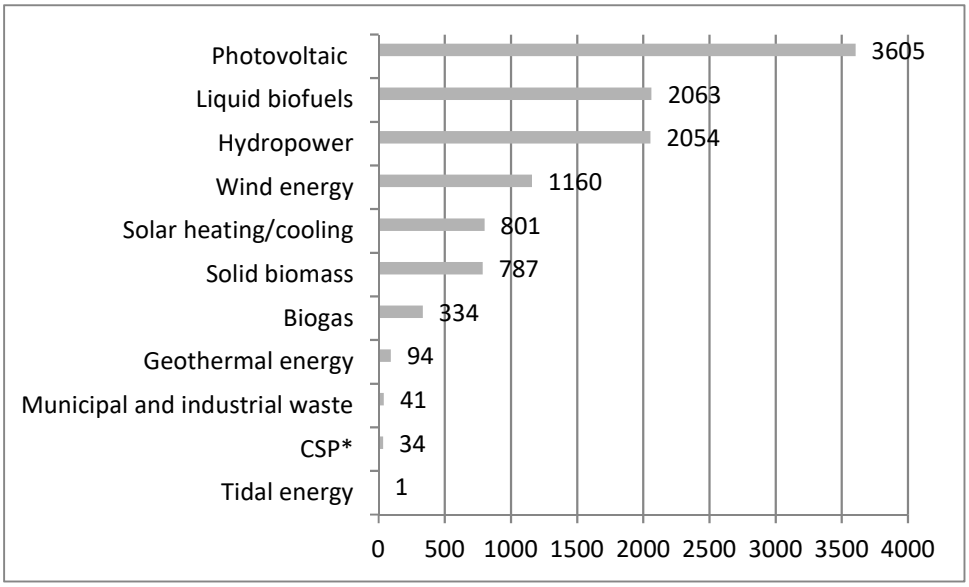
Figure 2. Employment in renewable energy sources by technology in the years 2012-2018 [thous.]

Source: Own study based on: Database International Renewable Energy Agency – www.irena.org [access 04.01.2020].

The solar industry maintains the highest position in the renewable energy industry with one-third of the total workforce of the entire sector. In 2018, employment in photovoltaics increased in India, Southeast Asia and Brazil. In contrast, China, the US, Japan and the European Union slowed down.

The growing production recorded in the biofuels sector contributed to an increase in employment in this industry by 6% to 2.1 million. Obviously, employment growth is recorded in countries where renewable energy is gaining popularity, but above all also in those whose supply chains are dominated by 'handwork'. Such countries include, for example, Brazil, Colombia and Southeast Asian countries. On the other hand, the USA or European Union countries have much more mechanized production processes and in this type of countries employment may slow down at some point in the development of the industry due to mechanization and automation.

Currently, employment in wind energy amounts to 1.2 million jobs (Figure 3). Land projects dominate, but the maritime segment is still gaining popularity and its development can be even more efficient and intensive when it begins to make full use of the knowledge and infrastructure of the offshore oil and gas sector.



*CSP – Concentrated Solar Power

Figure 3. Employment in renewable energy sources by technology in 2018 [thous.]

Source: Own study based on: Database International Renewable Energy Agency – www.irena.org [access 04.01.2020].

Hydropower has the next largest installed power from all renewable energy sources, but is currently growing slowly. The sector directly employs 2.1 million people, of whom three-quarters involved in operation and maintenance.

Employment in the renewable energy sector remains concentrated in several countries, including China, Brazil, the US, India and EU members. The share of all Asian countries in the market is recorded at 60% of the global total.

Renewable energy plays an increasingly important role in improving access to energy. Direct employment outside the network (off grid) in parts of Sub-Saharan Africa and South Asia has been estimated at 372 000 full time job (Figure 4).

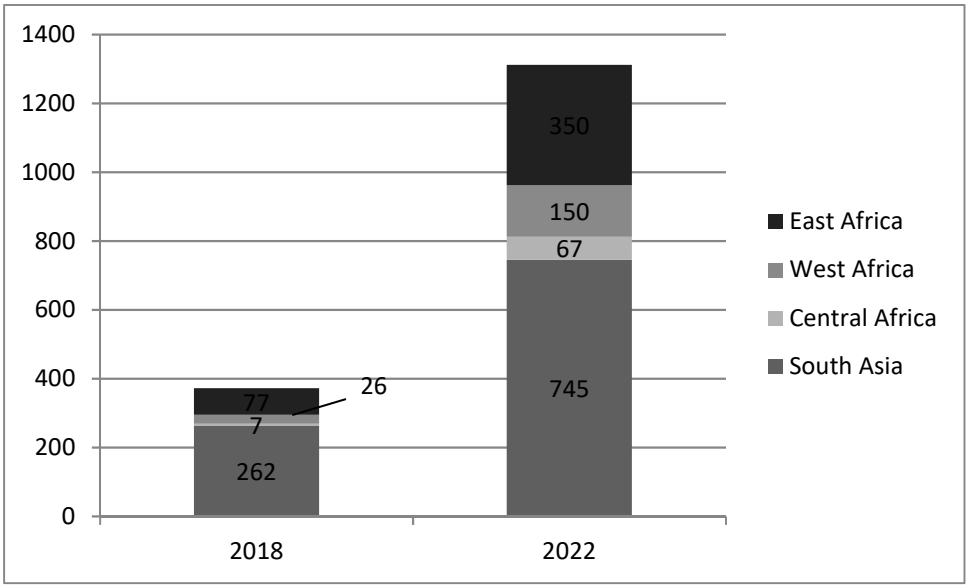


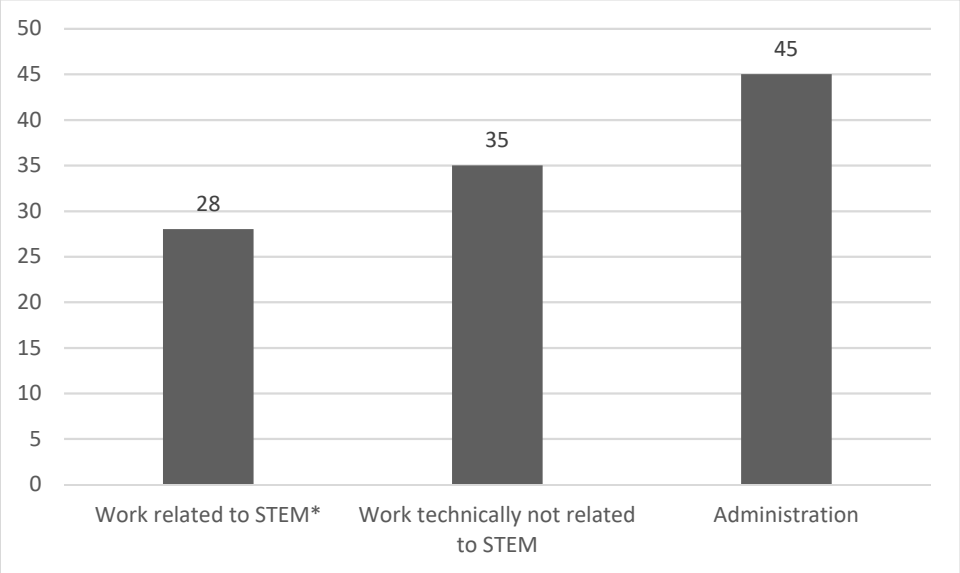
Figure 4. Direct employment outside the network (off grid) in parts of Sub-Saharan Africa and South Asia in 2018 and estimates for 2020 [thous.]
Source: Own study based on: Database International Renewable Energy Agency – www.irena.org [access 04.01.2020].

56% of these jobs are in rural areas (27% are filled by women) (GOGLA and Vivid Economics, 2018, pp. 2-4).

According to forecasts, in 2022 there will be a huge increase in off grid employment (these forecasts should be confronted with the current situation related to COVID-19). It will total about 250%.

Women currently account for 32% of the renewable energy workforce, which is much more than the average of 22% in the global oil and gas industry. The largest percentage of women work in administration (45%).

A significant proportion are employed as technical staff not associated with STEM[4]. In contrast, 28% of all STEM employees are women (Figure 5).



*STEM – Science, Technology, Engineering, Mathematics (Science, technology, engineering and mathematics as common fields of knowledge).

Figure 5. Percentage of women employed in the renewable energy sector [%]
Source: Own study based on: Database International Renewable Energy Agency – www.irena.org [access 04.01.2020].

An important mention is that as the global energy transformation gathers pace, leaders and decision makers strive to maximize social and economic benefits. In addition to decarbonisation and climate goals, countries must create jobs and boost economic development.

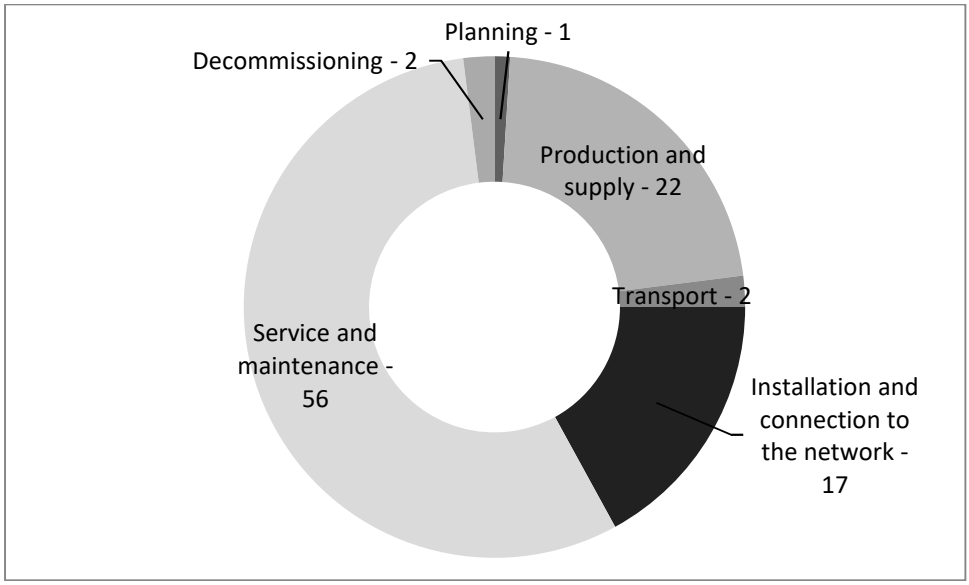
4. Value chain in the development of the local labor market on the example of photovoltaics

The process of implementing solar energy is characterized by continuous growth. In 2007, the installed capacity in this sector was less than 9 GW. However, in 2016 it was already over 290 GW. According to IRENA estimates, achieving energy transformation in the G20 countries would require cumulative investments in the solar sector of approximately USD 3630 billion USD by 2030 and 6610 billion USD by 2050. Such

[4] STEM – Science, Technology, Engineering, Mathematics (Science, technology, engineering and mathematics as common fields of knowledge).

investments can create value and bring economic benefits, including generating income and job creation (IRENA 2017d).

In PV implementing countries, the potential for generating income and creating jobs will depend on the extent to which industry in various segments of the value chain can employ people locally, can use existing economic activities or create new local economic initiatives. This part of the article focuses on the main segments of the photovoltaic value chain: project planning, production and supply, transport, installation and grid connection, operation and maintenance and liquidation. Figure 6 shows the distribution of human resources required throughout the entire value chain for the construction of a 50 MW solar plant (PV).



*The assumed duration of the project is 25 years with the assumption of increasing work efficiency by 3.8% per year.

Figure 6. The distribution of human resources required throughout the entire value chain for the construction of a 50 MW solar plant (PV) [%]

Source: Own study based on: International Renewable Energy Agency, *Renewable Energy Benefits: Leveraging Local Capacity for Solar PV*, Abu Dhabi 2017, p. 12.

56% of photovoltaic installation work is focused on operation and maintenance, and 17% on installation and connection to the network. The solar installation sector is growing rapidly in countries such as China and India, creating new jobs. A large percentage of human resources is also needed at the production and supply stages (22%). Therefore, there is also an increase in employment in this area.

The photovoltaic production process can be based primarily on local resources. This applies to both labor and construction materials. 70 tons of glass, 56 tons of steel and 19 tons of aluminum are needed for solar panels (production of 1 and installation of 1 MW). These materials are used for assembly structures and panels themselves. In turn, about 47 tons of concrete are needed for the foundations of the structure. Figure 7 illustrates the amount of materials needed to produce and install a 1 MW silicon-based solar photovoltaic installation.

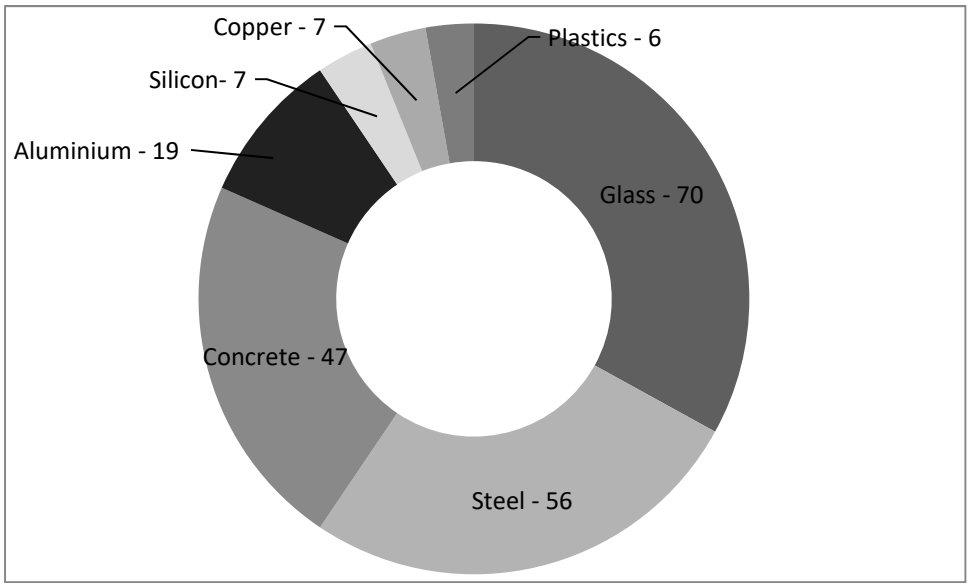


Figure 7. Materials needed to complete a 1 MW solar installation [tons]
Source: Own study based on: International Renewable Energy Agency, *Renewable Energy Benefits: Leveraging Local Capacity for Solar PV*, Abu Dhabi 2017, p. 14.

Other key materials such as silicon, copper and plastic make up a smaller proportion of the total mass of materials needed for a solar installation.

5. The impact of COVID-19 on the RES market

Due to the presentation in this article of the impact of COVID-19 on the renewable energy market on a global scale, the presented conclusions and forecasts are generalized. Therefore, it is not possible to attribute them all to one particular national market, because the development of renewable energy sources varies greatly from one country to another, which results in different reactions to the current market conditions.

Experts' opinion on the effects of coronavirus impact on the renewable energy market is diverse. Some see weaknesses and threats, while others

see opportunities. Table 1 presents the SWOT analysis for the renewable energy market in the context of conditions related to COVID-19.

According to New York Times forecasts, coronavirus is a bigger threat to fossil fuels than to the renewable energy sector. An example is the US market forecast. Renewable energy sources may reach 21% in the American energy mix in 2020, compared with 18% in 2019 and 10% in 2010. Experts believe that the US renewable energy sector, unlike the fossil fuel sector, will develop despite the recession caused by the COVID-19 crisis (CIRE 2020).

Table 1. SWOT analysis for the renewable energy market in the context of conditions related to COVID-19

Strengths	**Weaknesses**
- currently lower operating costs of RES producing plants than, for example, fossil fuel power plants; - an increase in the share of renewable energy sources in domestic energy mixes.	- dependence on advanced technologies; - sensitivity to a lack of replacement components (dependence on the Chinese market); - renewable energy market dependence to a large extent on government subsidies.
Opportunities	**Threats**
- the growing attractiveness of renewable energy sources for power plants and investors, due to lower operating costs; - natural gas and coal prices staying at a relatively constant level (despite drastic reductions in oil prices); - decrease in emissions CO_2; - traditional methods of coal mining and energy production are becoming risky for employees and their health.	- economic slowdown, which will affect parts of the RES industry, as well as the entire economy; - risk of inhibiting government incentives - lower investment capacity of prosumers; - postponed investments will mean that, for example, small companies selling and assembling panels may not survive this downtime; - decrease in energy consumption due to reduced production due to COVID-19 restrictions; - reduction of conventional energy prices; - reduction of CO_2 emission prices; - collapse of supply chains, e.g. solar panels and inverters from China.

Source: Own study

The New York Times reports that wind turbines and solar panels are currently producing cheaper electricity in many regions of the world (including California and Texas) than using natural gas or coal. This

obviously contributes to increasing the attractiveness of renewable energy sources for power plants and various types of investors. In addition, the phenomenon of the lack of a drastic fall in natural gas and coal prices is also favorable (despite a significant drop in oil prices) (Plumer, 2020).

Raymond James & Associates analysts believe that even lower electricity consumption, as a result of companies stopping their activities, can contribute to the development of renewable energy sources. They argue in this way that other enterprises that are able to operate, along with a progressive decline in their income, will tend to acquire larger amounts of electricity, including from wind or solar farms, which have lower operating costs than fossil fuel power plants (CIRE 2020).

Lower electricity consumption due to the coronavirus related situation has also been reported in Poland. The first symptoms of this phenomenon occurred in the second half of March, when for two weeks the demand for electricity dropped by 8.5%. The effect of this decline was, among others an increase in the share of renewable energy in the national energy mix. In the long term, of course, demand for energy will increase again. As the economy gradually returns to pre-pandemic levels, it will again have comparable electricity demand.

The economic slowdown caused by the fight against coronavirus will also contribute to the appearance of negative effects in parts of the renewable energy sector - as in the case of the entire economy. Enterprises that have operated successfully so far and employ new employees are now forced to reduce employment and postpone investment. Smaller companies dealing with, for example, selling and installing solar panels are characterized by the biggest sensitivity in this respect. The orders of these entities dropped dramatically due to the decisions of customers who, among others are afraid of "contact" with coronavirus and feel the financial consequences of economic downtime.

According to estimates, the trade association Solar Energy Industries Association, a large part of the RES sector employees (in the United States about 125 thousand.) may lose their jobs due to the pandemic coronavirus (in some cases at least temporarily). Solar Energy Industries Association also reduced the projected increase in new solar capacity in 2020. One-third more than the expected 19 GW. However, these forecasts are considered too pessimistic. Such opinion is, among others independent experts from Wood Mackenzie (CIRE 2020).

The difficulties of the renewable energy sector may also depend on the collapse of the supply chains of solar panels and their components from China. Therefore, in the case of already implemented investment projects, as well as those planned, there may be delays, and in some cases even their suspension. In addition, fewer (diseases and shortages

of foreigners) employee teams will be less efficient at work and more expensive.

Focusing on domestic supplies or imports from outside China can solve the problem of such supply chain disturbances. Substitutes for the Chinese market are often mentioned India, Vietnam or Southern Europe. An example of implementing such a business strategy is the German company building wind farms (Siemens Gamesa Renewable Energy). She announced that she would import the necessary components from India. The long-term goal of such action (except providing ad hoc business continuity) is to become independent of Chinese suppliers.

Negative effects may also occur on the prosumer market. This will be caused by both interruptions in the supply of components and a decrease in the efficiency of installation companies. In addition, the level of savings for individual clients and small enterprises that were to be allocated to own contributions to prosumer investments is reduced. Economic downtime and related financial difficulties forced these entities to gradually use their savings during the national quarantine. The financial difficulties of the market will also result in the fact that banks may be obliged to suspend borrowers' repayments. This process will deprive them of funds to make further investments. In addition, a significant proportion of consumers may lose or decrease their creditworthiness. The growing level of inflation will also be significant, which in some cases may even reach double digits.

One of the threats to the renewable energy market nowadays is also the possibility of stopping government incentives for prosumers. Transfer of funds to other areas of the economy will result in lowering individual investments in this energy sector. Therefore, the challenges faced by the renewable energy industry now need more than ever government stimulation.

Conclusions

Employment in the global renewable energy sector is increasing every year. In 2018, it amounted to 10.9 million people compared to 10.5 million in 2017. The highest concentration of employment in this industry is recorded in several countries, including China, Brazil, the USA, India and members of the European Union. The leaders are in this field primarily Asian countries. Their share is estimated at around 60% of the global sum.

Several basic factors are responsible for shaping the way and location of job creation in the renewable energy sector. These include national industrial strategies and policies, changes in the geographical shape of supply chains and trade patterns, and industry consolidation trends.

Among all renewable energy technologies, it is the solar sector that maintains the highest place in employment. It has with a third of its total

workforce. In 2018, employment in PV increased in India, Southeast Asia and Brazil. Countries like China, USA, Japan and EU Member States have experienced a slowdown in this respect. The growing number of jobs to date is on an increasingly large scale in the off grid sector. This fact is conditioned by the growing production of solar energy outside the network, which in turn translates into increasing access to energy and stimulating economic activity in previously isolated communities.

Growing employment has also been recorded in the biofuels sector. It increased by 6% compared to 2017 to the level of 2.1 million employees. The increase in the production of this type of energy contributed to this. The most intensive employment growth occurs in countries characterized by low industry automation. These are countries which are primarily based on "the work of human muscles". These countries include, for example, Brazil, Colombia and Southeast Asian countries. On the other hand, the USA and EU Member States have much more mechanized production processes and in this type of economies employment is slowed down at some point in development due to mechanization and automation.

Employment in wind energy is 1.2 million jobs. Above all, land projects dominate, but the maritime segment is increasingly used.

As for hydropower, it has the largest installed capacity of all renewable energy sources, but is currently developing slowly. The sector directly employs 2.1 million people, of which about 75% are involved in operation and maintenance.

The positive trend in the renewable employment sector may be shaken to a great extent by the crisis caused by the coronavirus epidemic. Negative effects appearing in the global economy, which is a "connected vessel system", must also affect the renewable energy industry.

Observing the development of the situation on the energy market, it can be concluded that any changes made or occurring automatically under the influence of coronavirus are more of a coincidence than the effect of consistent policy. In fact, we are not able to predict the long-term effects of this situation for the economy, and thus the consequences for the energy market. However, we know for certain that coronavirus is already affecting the energy market. Demand for electricity is reduced, which in turn leads to a reduction in its prices. At the beginning of the pandemic, demand for electricity decreased, which led to a temporary reduction in its price. In the longer term, however, we could see a significant increase in energy prices. Thus, the share of renewable energy sources in domestic energy production is growing. This fact causes a temporary reduction in greenhouse gas emissions.

Despite the increase in renewable energy sources in domestic energy mixes, the coronavirus pandemic is a major threat to this industry. Investments in this energy sector have been significantly slowed down.

Contributed to this, among others disruptions in supply chains, downtime in the construction industry as well as administrative obstacles and various restrictions imposed by the state administration. These are examples of just a few challenges that investors are currently facing. Therefore, it is the governments of individual countries (if they have already decided to take measures to stop the economy), more than ever must engage in saving the industry by offering increasingly attractive and effective programs to stimulate the economy.

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