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Research Results
Резултати от научни изследвания

CHALLENGES TO INVESTMENTS IN SOLAR ENERGY IN THE EU IN ITS QUEST FOR ENERGY INDEPENDENCE

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Abstract. This paper discusses the current challenges to solar energy capacity building in the EU in attempting to achieve both, the sustainable development goals and bigger energy independence from third countries. One particular challenge concerns the risks to investors in solar energy industry, deriving from the fast-growing number of solar installations across the Member States while the existing electricity cross-border grid cannot meet the needs of the EU energy market. This leads to wasting green energy and negative prices that affect the return on investment, apart from existing bureaucratic obstacles and regulatory difficulties. The paper argues that this and other socio-economic and political uncertainties and flaws such as occupational issues and the lack of long-term EU and state policies supporting solar energy investments in some countries do hinder the energy transition. Therefore, it is necessary that investments in solar energy address all these challenges otherwise finding alternatives to energy dependence on Russia and achieving the 2030 Sustainable Development Goals will be jeopardized.

Keywords: solar industry; solar energy; renewable energy sources; energy transition; energy security; grid connectivity

JEL: P28, Q01, Q20, Q42

Introduction

The EU Member States' opposition to the military aggression of Russia in Ukraine has assumed the form of a significant withdrawal from the Russian gas and petroleum, apart from other economic sanctions and military support for Kiev. This has inevitably brought to the fore the topic of the EU energy security and the importance of renewable energy sources. The latter have not only been recognized as an alternative to fossil fuels, but they have been promoted around the globe as a means to address climate change and to further increase human well-being and economic growth. These days renewable energy sources are also regarded as a means to reduce the EU dependence on very few external actors and thus, as a tool to improve both energy and supply diversification security and eventually economic growth

(Carfora et al. 2022). In short, the development of renewable energy sources is a top priority at the EU level. Actually, this is noted in the European Commission proposal to increase its binding renewable energy target for 2030 to a minimum of 42.5% – that is, twice as much as the share of renewable energy within the Member States in 2021, equal to 21.8% (European Commission 2023). This was later reconfirmed in the Revised Renewable Energy Directive EU/2023/2413, which also indicates that in line with the so-called REPowerEU Plan, Member States are supposed to achieve a common renewable energy target of 45% (Official Journal of the European Union 2023).

Although most of the electricity generated from renewables comes from wind and hydro power, solar energy is the single fastest growing one. In the EU, the electricity generated through solar systems increased from 1% in 2008 to 15.1% in 2021 (Eurostat 2023). Solar energy is also considered key to achieving the transition to clean energy as well as to the REPowerEU plan aimed at reducing the EU's dependence on Russian fossil fuels and promoting the green transition, targeting to deploy some 600 GW solar photovoltaic capacity by 2030 (European Commission 2022). All this is associated with the implementation of the 2030 Sustainable Development Goals as well.

Nonetheless, current policies and economic realities indicate a number of challenges to building the necessary EU solar energy capacity to achieve energy independence from third countries. Among these are the lack of enough efforts in strengthening the existing cross-border connectivity and the modernization of the EU electric grid networks; the volatility of electricity prices; the likelihood that avoiding energy dependence on a particular third country simply lead to dependence from another one; the ecological impact in the long run; the lack of adequate regulations and other mechanisms at the national level; the increased recognition of nuclear energy to be a zero-emission clean energy; as well as some employment issues, just to name a few. All these can be interpreted as prerequisites for lower motivation among investors and countries, which if not properly addressed, will likely hinder the investments in solar energy industry with all respective political and economic consequences at both the national and the EU levels.

Therefore, in coping with the current challenges of solar energy industry, the EU and its Member States are expected to implement policies that take into account all the risks and necessary benefits for all parties involved, including investors, state and private grid companies, businesses and consumers. Otherwise, not only overcoming the dependence on Russia's energy sources would be jeopardized, but other negative aspects should also be expected to happen, for example a deception of private and public investors, social discontent, bankruptcies, etc.

1. Literature review

The energy produced from renewable sources has become strategically important to many countries around the world, as is associated with generating very lim-

ited or no harmful emission at all, as well as with enhancing energy security and environmental protection (Liu et al. 2016). As stated above, solar energy is seen as key to both the clean energy transition and reducing energy dependence on third countries. Among the main advantages of solar energy is its low price and thus, competitiveness in the EU, which led to an 82% decrease within the 2010 – 2020 period (European Commission n.d.a). It is also regarded as a freely available renewable source of energy for managing energy crisis in the long term, especially when there is a high demand for energy against the background of high prices of alternative and exhaustible energy sources (Kannan & Vakeesan 2016, p. 1093). Not surprisingly, solar energy and its place in achieving sustainable development globally has been a major political topic in recent years.

Yet, international organizations, political actors and scholars point out several main challenges to the use of solar energy as an alternative to thermal power plants and the EU's energy dependence on Russia. For example, one of these is the connectivity and modernization of electric grid networks, as the energy transition and security in the EU needs better cross-border electricity interconnections to secure improved energy supplies and the integration into the energy market of the constantly growing share of renewables (Commission Expert Group on electricity interconnection targets 2017). According to a report by the International Energy Agency, risks associated with grid connection currently seem to be the weak link on the way towards clean energy transition, as investment in grids has changed only insignificantly in recent years against the huge investments in renewable power projects (IEA 2023, p. 8). With regards to this, it should be noted that a 10-year Network development plan of the European network of transmission system operators was adopted in 2022. It represents a comprehensive vision for the future efficient development of the European transmission energy system, including a strategy for the connectivity and storage of electricity aimed at reaching energy balance and energy transition in a cost-effective and secure way.

Some scholars also highlight the possibility that putting an end to the energy dependence on Russia simply leads to the development of dependence on another third country, in this case China since most of the solar systems equipment is produced there. Therefore, it is argued that energy security and geopolitics should be regarded as interrelated, with the EU feeling the pressure of the much cheaper solar installation equipment and manufacturing costs in China, the Covid-19 pandemic and the war in Ukraine (Van Wieringen and Hüntemann 2022). In addition, investments in solar energy are crucial for China's efforts to pursue green development. Concerning this, within the first seven months of 2023 alone, China's major power companies invested in solar energy more than 22 billion U.S. dollars, representing an increase of 108.7 percent compared to the previous year (The State Council of the People's Republic of China 2023).

As any other market, the solar energy one requires certain regulations and other mechanisms to be put in place. Concerning this, Bórawski et al. (2019 p. 44) argue that these should be properly structured so that a market can be formed with the respective necessary production capacity, which will permit the price of solar electricity to go down in the long run. Simultaneously, Rabbi et al. (2022) argue that the most critical challenge is *'the determination of the people and government within every nation to effect swift transformation'*.

With regards to the above-mentioned, it should be noted, that another and often underestimated challenge at the national and regional levels, are the occupational safety and health (OSH) risks triggered by a faster growing solar energy installation industry. Generally, it is assumed that the global industrial and technological progress leads not only to changes, but to some risk associated consequences as well, some of which having the potential to lead to significant damages to both humans and economies (Zio 2018 in Jahanvand et al. 2023). According to some estimations, the current political and economic context suggests that achieving energy independence could lead to the creation of between 540 000 and more than 1 million full-time direct and non-direct jobs by 2026, or in the second case, a 126% increase compared to 2021 (SolarPower Europe 2022, p. 22). Still, there is a relatively limited literature addressing the OSH risks associated with the fast-growing solar energy installations across the EU. Duroha and Macht (2023) note some of highest and widespread construction-related occupational safety risks are associated with the solar energy systems building and yet, there are still gaps in data about incidents in this regard.

In fact, underestimating such risks further highlights other challenges of the solar energy production in the EU as an alternative to the dependence on energy produced and supplied by third parties. For instance, as such can be seen some economic, social and environmental factors that should be considered when it comes to the deployment of solar energy systems (Castillo et al. 2016). Makhonko et al. (2021), argue that the production of solar energy in a given country is closely related to environmental and legal challenges as well. Gulzar et al. (2020) point out that solar panel manufacturing involves the use of hazardous and very difficult to recycle materials, posing a great risk of being transmitted into the environment under the form of an industrial waste. Therefore, it is needed an adequate approach which takes into account economic aspects triggered by the search for energy interdependence as well as by environmentally related issues at home (Ibid.).

Looking at the solar energy technologies from an economic perspective, it should be said that although energy interdependence and sustainable development are all the more important today and represent a central point in the political agenda of many EU countries, investments in renewables cannot simply be taken for granted. Economic circumstances often have their say in various political initiatives, especially if they are of such scale. For example, some political debates such as

coal and nuclear generated energy, including the investors' perspective in terms of economic incentives for investments, are often neglected, as an overestimated optimistic point of view about the security of supply prevails (Eurelectric 2019, p. 4). What is more, some scholars (Stević et al. 2019, p. 498) note that in a possible *conflict between economic principles and principles of sustainable development* when it comes to electricity production technologies, the former will likely prevail given the importance of the economic effect of the choices we make as a civilization. Therefore, it is expected that the state interferes to manage that conflict, including through subsidies to guarantee certain profit margins and encourage at the same time investments in sustainable development technologies (Ibid. p. 498).

2. Methodology

This paper outlines the main challenges to investments in solar energy. For this purpose it compares the share of solar energy in the energy mix in the EU Member States against the background of the war in Ukraine and the recognition of nuclear energy as a renewable energy source. The study analyses trends and policies at both, the national and EU levels, affecting the solar energy sector. The paper uses publicly available information only, including from Eurostat and national statistical institutes.

Given the above-stated, the paper is trying to answer the following research question: How to encourage more investments in solar energy at the EU level if currently there are more risks than potential benefits for investors.

By addressing this question, the study is aimed at contributing to the existing academic knowledge about the challenges to solar energy investments and the path to sustainable development of the energy sector in the EU without being largely dependent on third countries.

This paper also aims to contribute to the existing theoretical economic models, and thus, help decision-makers in understanding better the challenges of the solar energy sector. For this purpose, the study's objective is twofold. On the one hand, it presents stylized facts about the solar energy sector in the EU, and, on the other hand, highlights the main challenges to the investments in this sector, and suggest some solutions on how they can be overcome.

This study has some limitations. Although relevant, solar energy impact on the environment, especially in terms of decommissioning of solar parks and other related issues, is not covered thoroughly, as data regarding it will be available in a few years and any predictions in that direction may be biased.

3. Results and discussion

For investments are often associated with taking certain risks, investing in the solar energy makes no exception. More often than not, it is about market risks, which have the potential to affect the whole sector. These are, for instance, geopolitical

events, changes in government, major economic shifts, regulations, dependence on external actors, just to name a few. All of them can easily disrupt the market and lead to challenges that may negatively affect investment in solar energy and hence, the EU efforts of putting an end to energy dependence from third countries and reaching its climate-related goals. Some of these challenges are analysed and discussed in detail below.

3.1. Investments in solar capabilities and some other economic aspects of solar energy

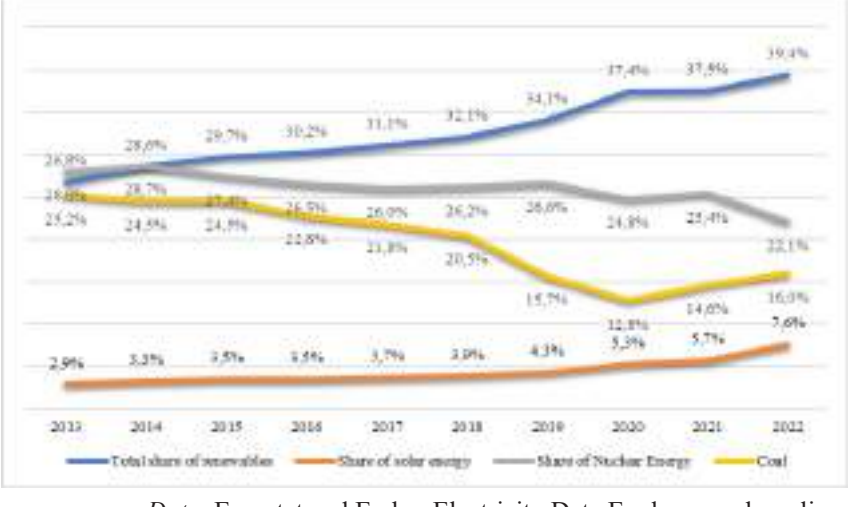
Solar energy technologies have particular socio-economic benefits. They have the potential to impact several sustainable development goals such as no poverty (SDG1), zero hunger (SDG2), good health and well-being (SDG3), quality education (SDG4), sanitation (SDG6) and clean energy (SDG7), while interactions between some of these goals are also possible (Adenle 2020, pp. 6 – 7). Achieving sustainable development goals alone, however, cannot justify large investments in solar energy. With economic measures being regularly used as tools to enforce geopolitical and strategic decisions around the world, the EU energy security in general, and solar energy specifically, are facing a major challenge. Therefore, when it comes to return on investments in solar energy technologies, other important factors should be taken into consideration as well.

Chang & Starcher (2019, pp. 1352 – 1353), for example, indicate that such factors are technical or geographical considerations such as whether the photovoltaic panels are properly installed, efficiency and transmission loss, weather conditions, some political and economic factors such as tax and other incentives, installation and maintenance costs, etc. From an economic perspective is important to know whether the investment is financially worthwhile, thus the initial installation costs and the energy production per year. This is so because a given solar photovoltaic installation may be considered economically feasible in case the overall earnings exceed the overall costs within a certain period of time, usually within the system lifetime, but in practice much sooner (Ibid.).

With regards to the above-mentioned, undoubtedly, one of the biggest challenges of investing in solar energy and generally, to the EU goal to achieve energy independence from Russia, is the still underdeveloped grid connection. With a significant solar energy capacity expected to be achieved by 2030, it becomes all the more important that the EU grid is able to "integrate" it all, and obviously within a relatively short time (SolarPower Europe n.d.). Having insufficient grid connectivity will very likely be seen by companies and other actors (including single states) on the energy market as a deterrent to invest in solar energy. As mentioned earlier, poor cross-border connectivity leads to volatility of electricity prices. In the course of 2023 this has been expressed in various cases in zero and even negative electricity prices on a daily basis, which in turn translates into potential revenue loss for renewables and high prices for solar energy storage batteries.

Therefore, other solutions should be suggested. For example, through a common European transmission energy network, it will be possible for the European South to sell solar generated electricity at affordable prices to the European North, and respectively, the European North to sell electricity produced by wind at affordable prices to the European South. In this way, it will be created kind of a European South-North-South Transmission renewable energy wave (EU-S-N-S-T-R-E-W) (Spassov 2023, p. 376). For example, in 2021 UK citizens paid more than £500 million in energy bills, as the country's national grid was not able to absorb all the power produced by wind farms (Jones 2023). The latter also led to a serious delay in issuing permits to renewable energy projects, which in the end of the day hinder the SDGs and the investment in renewables. Similar situations can be found in 2023 in different periods in North European countries such as Germany and the Netherlands where the massive use of solar panels caused cheap energy supply against the background of large investments in solar energy.

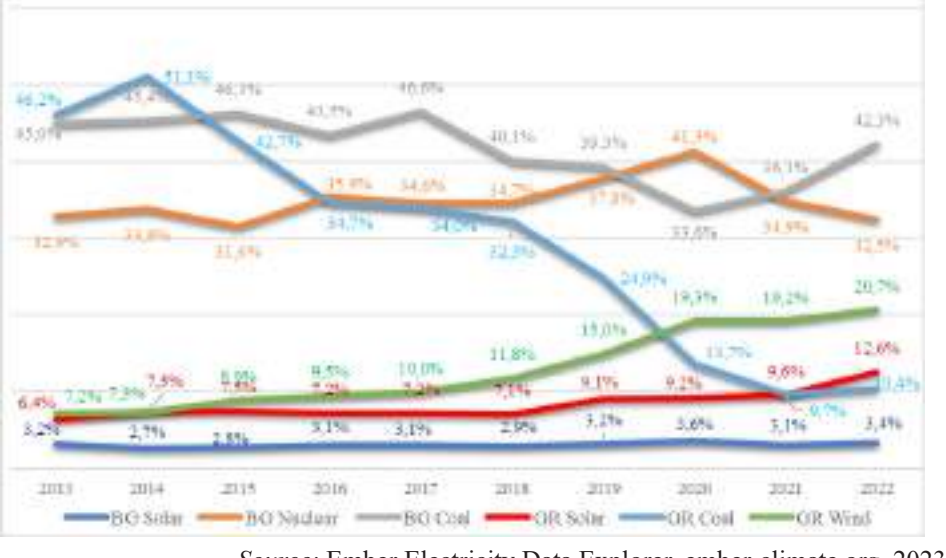
It is also important to note that there are some barriers (e.g. institutional or market-related) to investment in energy supply infrastructure, due to which some fundamental uncertainty remains over the financial resources necessary for the energy sector (Fachetta et al. 2021). For example, while investments in photovoltaic installations are increasing, they are still a long way from being significantly in volume, given the current expenditures on fossils. For instance, in 2021 alone, some $105 billion was invested globally in the coal supply chain (IEA 2023, p. 63). Even in the EU relying on coal generated electricity is still an important part of the energy mix (Fig. 1).



Data: Eurostat and Ember Electricity Data Explorer, ember-climate.org

Figure 1. Share of renewable energy sources in gross electricity consumption in the EU

As the data in Figure 1 reveal, solar energy and renewable energy in general are on the rise as shares of the total energy mix in the EU. However, coal is still seen as very important, reaching a share bigger than the one prior to the Covid-19 pandemic. Undoubtedly, the war in Ukraine and the sanctions against Russia that followed, have played a major role in that. Still, this shows that at least in the short term, in various countries coal energy might be seen to some extent as a deterrent to more investments in solar energy, especially given the political and socio-economic implications that the topic provokes. In fact, we can observe this, for example, in the case of two neighboring EU Member States, namely Bulgaria and Greece (fig. 2).



Source: Ember Electricity Data Explorer, ember-climate.org, 2023

Figure 2. Comparison between Bulgaria and Greece in terms of electricity generation by solar and coal (2013 – 2022)

Figure 2 shows that the two countries have been following a different path in terms of solar energy. While Greece has doubled the share of electricity generated by solar energy over the last ten years, Bulgaria pretty much has maintained approximately the same level throughout the same period. The same can also be said for coal, where after decreasing for several years, in 2022, Bulgaria reached a level close to that of 2013, and very similar to that of early 2000s. At the same time, Greece has succeeded in decreasing over four times the share of coal in the country's energy mix.

Evidently, in both above-mentioned cases a "balancer" is required in the energy

mix to make the desired transition to clean energy and ending the energy dependence on Russia smoother and less painful in socio-economic and political terms. In the case of Bulgaria, it may be argued that the balancer's role goes to nuclear energy, while in Greece it is the wind generated energy.

The example above also shows that although setting a common EU goal, government policies and business practices at the national level (including between single Member states) can go at a very different pace. Miloui et al. (2023, pp. 83 – 85) shed more light on this issue, stating that firstly, that generally compared to the public sector, the private one is using far more energy from renewable sources, although in Bulgaria this is not that visible due to inadequate government policies.

From a socio-economic point of view, another factor is also very important, namely the employment. The solar energy sector is supposed to trigger full-time employment numbers similar to those of the fossil fuel sector, otherwise public discontent may follow. This, in turn, may lead to actors using it for political reasons to oppose larger investments in solar energy at the expense of thousands of people losing their job in the fossil fuel sector.

Actually, major shifts in the economy can be seen from the perspective of employment, thus, the job creation in the solar industry is of great importance. According to some data, in 2021, there were some 466 000 full-time jobs in the EU solar energy sector, with 205 000 of these being direct jobs (SolarPower Europe 2022, p. 15). A year later, in 2022, these numbers increased reaching 648 000 full-time jobs, with 281 000 of them as direct jobs (SolarPower Europe 2023, p. 13).

An important aspect of the solar jobs is that most of them are associated to the deployment phase. For example, in 2021 they amounted to approximately 80% of all jobs in the sector (SolarPower Europe 2022), while in 2022 their share reached 84% with the growth of the solar energy sector (SolarPower Europe 2023). The difference here comes from the fact that the most intensive job related to solar energy installations is the construction itself, and once that is done, little physical human activity is necessary for their operation and maintenance. In other words, most of the solar energy jobs concerns the installation phase and due to this, they are predominantly temporary ones. While some changes are expected after 2030, as around that time many installed systems will have reached the end of their lifecycle, some uncertainties concerning long-term full-time employment are in place.

Against this background, most of the jobs in the fossil fuel industry are namely in the phases of (fuel) processing and operation and maintenance (Czako 2020, p. 7). Moreover, many of these jobs are in specific regions where they support thousands of families and thus, the local economy as well. Therefore, in such places a shift from conventional energy industries to greener ones understandably will require tailor-made state policies.

Also, it is interesting to note that most of the solar jobs in the EU in 2021, were in only seven Member States, with Poland creating almost 113 000 of them,

followed by Germany, Spain, Netherlands, Greece, France and Italy (SolarPower Europe 2022, p. 20). In short, this may be interpreted as another deterrent to more investments in solar energy in those Member States where other energy sources play an important role in employment, and thus, in political and socio-economic terms.

3.2. The role of nuclear energy for the EU's energy mix and enhancing its energy security

With the clear goal to significantly reduce greenhouses emissions and potentially achieve carbon neutrality by 2050, it becomes clear that nuclear energy will very likely play an important role. It is known that nuclear energy generates none or very little carbon footprint during its life cycle and can be considered much safer than other renewables such as solar and wind (Rehm 2023).

There have been some controversies in the EU regarding the use of nuclear energy, more precisely the nuclear safety and security. The war in Ukraine, however, has once again put the question of the nuclear energy's future on the table. This and the political commitments to shut down many thermal power plants (TPP) in a number of countries (e.g. Germany, Czech Republic, Bulgaria, Romania, Greece) have inevitably led to the question who will take the place of the TPP. As a result, nuclear energy was recognized as "transitional", entering the list of environmentally sustainable economic activities covered by the Taxonomy Delegated Act of the European Commission (European Parliament 2022). While this is important for the energy mix of almost half of the EU countries, it could also be interpreted as a prerequisite for lower motivation among them to invest more in solar energy and thus, refrain from strongly encouraging other related activities such as more investments in the EU power grid connectivity. In fact, table 1 below, sheds some light on this issue.

Table 1. Share of electricity produced per energy source in 2022 in the EU Member States hosting at least one nuclear power plant

Country	Renewables	Nuclear energy	Fossil fuels	Number of nuclear power reactors in 2022
Belgium	27%	46%	27%	5
Bulgaria	20%	34%	46%	2
Czechia	14%	37%	49%	6
Finland	54%	35%	11%	5
France	25%	62%	14%	56
Germany	44%	6%	50%	3
Hungary	21%	45%	34%	4

Netherlands	40%	3.3%	57%	1
Romania	45%	20%	35%	2
Slovakia	22%	60%	18%	5
Slovenia	31%	43%	26%	1
Spain	44%	20%	36%	7
Sweden	69%	29%	1.2%	6

Data: European Council & Council of the European Union, 2023; European Nuclear Society, 2023

Table 1 includes all Member States that produced nuclear energy in 2022. As can be seen, in many of them nuclear energy is the main source for electricity production, and in some cases accounts for more than half of the total electricity produced. With the exception of Sweden, those countries where nuclear energy accounts for roughly one third or less in the total energy mix, rely significantly on energy produced by fossil fuels. In addition, in the case of Sweden, only 1.4% of the total electricity generated came from solar technologies (Ember Electricity Data Explorer 2023).

As a whole, in 8 out of 10 Member States ranked as those relying less on renewable energy production, nuclear power plants produce between 34% and 62% of the total electricity produced. At the same time, the first five EU Member States as per share of electricity produced by renewables, namely Luxemburg, Denmark, Latvia, Lithuania and Austria, do not have nuclear power plants on their territory (European Council & Council of the European Union 2023).

Concerning this, it is interesting to further investigate the possible relationship between investments in solar energy technologies and working nuclear power plants within the EU. In fact, in 2022, only two of the top 10 countries with the most solar capacity per capita had on its territory operating nuclear power plants. What is more, although initial plans in both Belgium and Germany to close the respective nuclear power plants there, the war in Ukraine has prompted their national governments to reconsider nuclear energy production as an alternative to the energy dependence on Russia. In fact, in June 2023 Belgium secured the use of two nuclear reactors by another 10 years, which are responsible for the production of some 35% of Belgium's nuclear energy capacity (Strauss 2023). As for Germany, despite of the fact that the country stopped producing nuclear energy in April 2023, nowadays this matter is given thorough reconsideration as a tool to address climate change (e.g. Thurau 2024).

Furthermore, in Finland, where solar energy, understandably, currently takes almost a symbolic place in the energy mix, in April 2023, the Olkiluoto 3 reactor started producing energy. Having a capacity of 1.6 gigawatt, the construction of the reactor initiated in 2005 and was originally scheduled to be opened in 2009. It is now expected to significantly contribute to achieving the goal of carbon neutrality

and energy security of Finland, by covering about 14% of the country's electricity demand (Lehto 2023). The latter is assumed to lead to reducing electricity imports by some 60% (TVO, n.d.).

Last but not least, we have to take into account the development of small modular reactors, which are seen as another advanced and significant technology for the clear energy transition (European Commission 2023). These nuclear reactors are aimed to produce electricity within a short time while reducing capital costs and avoiding the dependence on large grid systems (World Nuclear Association 2023), and therefore, they will likely compete with solar energy technologies for investments.

In short, nuclear energy should be seen not only as a balancer in the energy mix of the EU, but as a supporting tool of the electricity produced by renewables in the Member States as well. Actually, some nuclear power plants already contribute to the electricity grids' stability by balancing the fluctuates of the electricity production demand (Krikorian/IAEA 2019). This is one more reason why the grid connectivity must be further developed and supported at the EU level.

3.3. Chinese solar raw materials as a challenge to the EU energy security

At a country level, the issue of putting an end to the EU energy dependence on Russia has been much debated. As many argue that solar energy is the way ahead, several aspects are to be taken into consideration. With 80% solar panels imported from China, we are facing a situation which will very likely lead to shift in energy dependence from third countries, namely from Russia to China (Van Wieringen and Hüntemann 2022).

Actually, the global photovoltaic market is constantly growing and even the recent supply chain challenges and the high prices of the modules have not had a significant impact on it. However, over the last 10 years, this market has been dominated by China. In 2022 alone, the country recorded a growth almost doubled the volume from 2021, representing 45% of the global installation in 2022. USA, India and Brazil occupy the following three positions, while only four EU Member States (Spain, Germany, Poland and Netherlands) made it to the top 10 photovoltaic markets with a total share of little more than 9% of the global market (IEA 2023, pp. 12 – 15).

Taking the above-stated into account, we can expect that in the near future the EU solar industry will continue to remarkably depend on China in terms of providing the raw materials necessary for the PV production and maintenance. Rabe et al. (2017, p. 694) note that the EU relies to a large extent on the Chinese supply of indium and gallium, and to a lesser extent of tellurium. This should not be surprising, as in the last ten years the global supply, demand and prices of solar installations have been impacted by Chinese government policies which permitted the country to develop a strategically important solar sector supporting a constantly evolving innovative supply chain (IEA 2022, p. 7). However, the '*latter has led not only*

to a crucial decrease in prices, but to some supply-demand imbalances in the PV supply chain', which in turn have led to higher prices of some core PV elements (Ibid., pp 16 – 18).

It is important to highlight that changes in the ownership of large solar cell manufacturers, which can happen more than once in a relatively short period of time, also can affect the EU solar industry by making it more dependant from third countries, including China.

It should not be underestimated that in the current political, economic and security context, energy and raw materials supply chains can be used for achieving political goals, and thus, can disrupt at some moment the EU solar (and not only) industry. All this suggests that the Member States can mainly push either for more EU-triggered protection or for a further reliance on alternative energy sources such as nuclear energy.

Against this background, the need for building a competitive solar photovoltaic supply chain in Europe comes to the fore. Some aspects such as reducing the cost of the battery and the introduction of alternative methods of solar energy storage should not be underestimated as well. For example, among these are – introduction of technologies for the production of green hydrogen (if there is an overproduction) and Pumped Storage Hydroelectric Power Plant, as well as the impact on ecology in the long term.

Conclusion

Although solar generated energy has registered a significant increase in the EU over the last few years, there are still a number of challenges to investment in the solar energy industry. Among these the main ones are the need for further development of the cross-border electricity grid network, long-term employment related matters, the importance of nuclear energy as well as the dependence on China for raw materials. This paper highlighted that all these challenges are interrelated and thus, they should not be addressed separately from one another.

Also, they all have the potential to impact decision-making, especially where shifts in energy industries will likely lead to negatively affecting the local employment. Investing in renewables and particularly in solar energy, does not have to come at the expense of creating social discontent. On the contrary, the society is supposed to become a driver for such investments and the government's role as a facilitator is more than evident.

Attempting to achieve the 2030 SDSs does not mean finding short-term solutions to issues that will very likely have long-term consequences within the EU, both in positive and negative aspects. Concerning this, further research is needed to properly assess the place of solar and nuclear generated electricity in the energy mix at the national and the EU levels.

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