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The role of Power Purchase Agreements for the promotion of green energy and the transition to a zero carbon economy

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Abstract. *There are many debates regarding Power Purchase Agreements (PPAs), but there are only few studies that are analyzing the real role of PPA in promoting green energy and for the achievement of new climate targets. Although the demand for these types of contracts is increasing, the energy market at this moment is not very well developed and from this point of view there are just a few energy actors which actually succeed in closing such an agreement. The goal of this research is to identify and analyze the main factors which contribute to the development of PPA as a tool for promoting green energy and enable the transition to a zero carbon economy. For this research there are used questionnaires and interviews with experts from all of the parties involved in such a contract: producers, consumers, financial experts and energy experts. The article reduces the gap between the declaration of different stakeholders related to PPA and their involvement in the implementation and development of these contracts and estimates the main contributions of these contracts to the promotion of green energy and the transition to a zero net carbon economy. The results suggest that PPA play a major role in the renewable energy market and they will have a positive impact in what it means the consumption and transition to green energy and the achievement of climate neutrality.*

Keywords
Power Purchase Agreement, Renewable Energy, Green Energy, Zero Carbon Economy, Climate Neutrality

Introduction

Renewable energy is nowadays an important subject, many countries and institutions trying to accelerate their decarbonisation system by reducing CO_2 emissions. In this world, terms such as green energy or environment friendly are gaining ground, the trend being to get less polluted environment and create global, national and local policy changes (Iancu, 2021). It is well known that global warming or climate change are dangerous phenomena that are growing nowadays, therefore there is a need to take urgent measures and to act quickly. As long as the focus on global warming is increasing, certain measures should be taken into consideration, thus meaning pushing for green and clean energy. Renewables represent an economic and viable way that can lead to climate neutrality. These can play a major role by achieving the objectives established by the European Union and maintain an equal importance on emissions as well as on removals of greenhouse gasses to achieve zero net emissions by 2050 (Soeiro, Ferreira, 2020). Although renewables have high initial costs, the benefits which are brought together are significant and it is worth underlying that in spite of the costs, technology and type of user, these advantages will help to develop a green global economy which can combat air pollution and climate change (Taghizadeh-Hesary, et al., 2020). One solution to improve and encourage the use of renewable energy and at the same time to accelerate the transition to green energy is to take great measures

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also from the point of view of the legislative and legal part, this being the moment when PPAs enter into the market and PPAs are defined like contracts concluded between an energy buyer and an energy seller, who come together and decide to buy, respectively to sell a certain amount of energy. PPAs allow the investors and creditors from non-subsidized markets to allocate money in renewable energy projects. Actually, what is the most important fact of all is that this energy is or will be generated by a renewable asset, which plays an important role in fulfilling UE's commitment towards the environment, thus decarbonising and achieving climate neutrality.
Two important aspects that should be remembered are that the obtained energy will be generated by a renewable asset and that its aim is to create a "fair" and risk-controlled agreement between the parties (Mendicino et al., 2019; Busu et al., 2020).

The goal of this study is to identify and analyze the role of Power Purchase Agreement for the promotion of green energy and the transition to zero net carbon economy and to analyze its level in the Romanian energy market.

Power purchase agreement in the scientific literature

Power purchase agreement is a very important and, at the same time, a highly complex part of a renewable energy project. There are many aspects that should be taken into account when a PPA is signed, but the most important in closing such an agreement are the negotiations, this being the reason why for obtaining finance it is highly important to make these projects bankable. As a consequence, in order to obtain funding or to attract investors, the discussions of contractual clauses should be very clear and precise.

In addition, PPAs are a very good and efficient instrument because they reduce the risk for developers and financial parties and they can help encourage the use of renewables. Because the buyer gets the electricity directly from the seller, it is more reliable for all the parties involved in this contract. From the point of view of the investors, it seems that banks are the most suitable for taking a loan and investing in green energy. However, financial instruments like European funds and state aid can also support the investments in renewable energy and its development, together with the transition to climate neutrality.

Regarding the aspects that should be taken into consideration when such an agreement is written these are the quality of the parties and the period of time, the risks and the ways in which these should be shared, the legal consequences that appear when there is an impossibility of electricity supply, the price and its payment, with the including of the necessity to regulate the negative prices, the finance and the aspects that should be taken into account if you get involved in such a project, the contractual changes and last but not least the resilience and the cases when it interferes.

As we mentioned before all these provisions must be discussed and the PPA should be adapted to the type of renewable sources used, because there are various forms of PPAs, which are analyzed differently depending on renewable sources used (solar, wind, hydro or maritime). So the geographical distribution of the power resources in a country is a significant aspect that should be taken into consideration when signing a PPA (Soeiro and Ferreira, 2020).

For interest are also the opinions of Doval and Negulescu (2014) who considered that financing green energy is a major step in developing this type of energy as long as in the private sector there is not so much interest in acquiring energy from renewable resources.

In their article, Taghizadeh-Hesary et al sustained that PPAs are the most suitable way for enhancing green investment and they draw the attention once again upon the private system that should be more involved in taking part in reducing the pollution. That is the reason why, PPAs are

one of the most efficient mechanisms that can develop the creation of green energy and at the same time the most efficient mechanism that can improve the relation between a clean energy buyer and a clean energy supplier.

At the same time these agreements include long-term price security, opportunities to finance investments in power generation capacities, or the reduction of risks associated with electricity sales and purchases. When a specific physical supply of electricity with certain regional characteristics and guarantee of origin occurs, this opportunity can be used to make their brand more sustainable and greener. Another important advantage is the price, that could be fixed, established under the form of contracts for differences or even variables.

When we talk about the advantages, we must also discuss the disadvantages that can occur when signing a PPA. Although they are fewer in comparison with the benefits, the disadvantages must seriously be taken into consideration when the parties want to assume some or all of these contractual obligations. First of all, we have to admit that PPA is a very complex contract for whose subscription a long term negotiation is required. Secondly, this long term nature of the PPA means that there can exist a fluctuation of the price that can lead even to a negative price for one of the parties. At the same time, the electricity production itself can vary, especially when we are talking about wind and solar power (Busu et al., 2019; Pexapark, 2022). This is the reason why when the negotiated amount of energy cannot be supplied, the producer must offer financial or physical compensation, or even find external solutions, for example contracting with a third party such as an electricity trader.

Research methodology

The main objective of this research is to determine the real role of PPA for the promotion of green energy and for the achievement of new climate targets. The research methodology used in this paper is based on interviews with experts and questionnaires. The interviews with experts helped to find out from their experience the level of the PPAs development in the Romanian energy market and which are the most important aspects that require improvements and measures to be taken. The formulation of questionnaires had the main purpose to determine the role of PPAs for the achievement of new climate targets. It has to be mentioned that the respondents fall into different categories representing different fields of activity, such as energy experts and financial accounting experts, energy producers and industrial and small consumers. The survey involved 62 respondents.

The level of knowledge about PPAs, the level of promotion, the parties and the contractual period, the risks involved, the price, the contractual changes and general questions about the respondent were considered in this analysis as independent variables. The attitude to PPA is thought in this research as dependent variables, as described in the tables and figures discussed in the following.

The profile of the persons who answered the questionnaire is detailed in Table 1.

Table 1. Respondent Profile

Respondent type	Industrial consumer	45.2%
	Small consumer	19.4%
	Producer	9.7%
	Regulation	12.9%
	Financial Expert	12.9%
Level of knowledge	None	19.4%
	Beginner	21.0%
	Medium	27.4%
	Advanced	17.7%
	Proficiency	3.2%
Fiscal Value	< 60 000 €	24.2%
	60 000 € - 500 000 €	4.8%
	500 000 €- 1000 000 €	1.6%
	> 1000 000 €	3.2%
	Preferred not to answer	41.9%
Annual Energy Consumption	0-50MWh	40.3%
	50 – 100 MWh	16.1%
	100 – 500 MWh	19.4%
	> 500 MWh	6.5%

The idea of this questionnaire is to find out and to analyze the level of PPAs in the Romanian energy market and at the same time their role for the promotion of green energy and for the achievement of new climate targets. So, this research analyzed the level of knowledge about PPAs by different stakeholders: industrial and small energy consumers, energy producers and last but not least energy, financial and accounting experts. In addition, it examined the will of signing such a contract and the point of view regarding the legal implementation of the PPAs.

The legal aspects are also important to be taken into account, when someone agrees to be part of such a project. This is the reason why there is a need to find out the respondents opinion about the risks, because when it is talking about a contract, it definitely talks about situations when unforeseen things can happen. Therefore it is important to know who is taking the responsibility, who takes the risks or how they can be shared or resolved. A case of high importance is also the regulation of price, funding, contractual changes which may occur during the performance of the contract and which may change the form, but also the rights and obligations assumed through it and last but not least the regulation of cases in which the contract is terminated.

For the correlation analysis, linear regression was used, due to the fact that in a viable and precise way we can demonstrate the results of the questionnaire. The dependence of the identified factors was analyzed, these factors being the ones that influenced the use of PPAs in the energy field. The main variables used are the level of knowledge and the trust in PPAs, the level of promotion, the parties and the contractual period, the risks involved, the price and the funding, the contractual modification, dissolution and general questions about the respondent.

Results and discussion

The results regarding the level of knowledge and the confidence in PPAs are presented in figure 1.

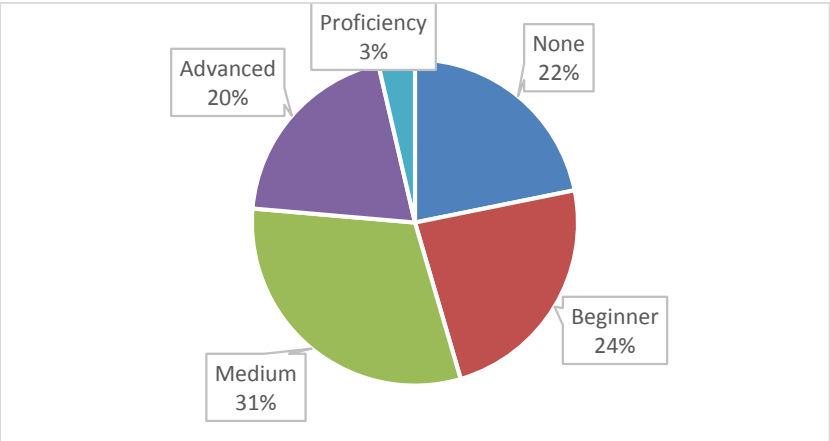


Figure 1. PPA market in Romania – the level of knowledge of PPAs

As it can be seen just only 3% of respondents have a high level of knowledge, the rest being split in half between medium/advanced (51%) and beginner/none persons who have any knowledge about PPAs (46%). This aspect definitely raises a question mark regarding the measures that were taken until now, in principle, and proves the need and urgency to adopt and implement new regulations in subsidiaries. A strong and well-developed legislative system will provide the necessary basis for establishing and implementing new solutions that will help achieve new climate goals and ensure the transition to green energy.

Regarding the attitude towards PPAs, it has been found out that 85% of the respondents are firmly in favor of signing such contracts, which is an encouraging step towards the development and improvement of these contractual instruments. In figure 2 a detailed representation of the subject's attitude can be found.

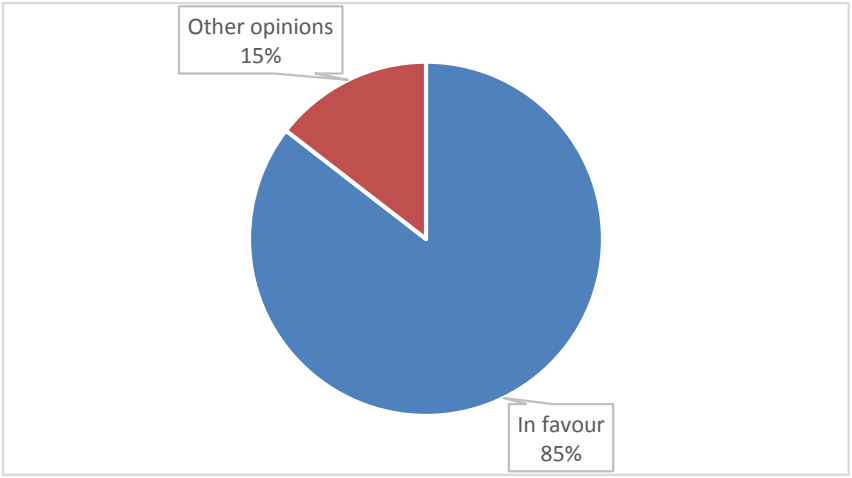


Figure 2. The attitude towards PPAs

In figure 3 is presented the situation whether PPAs will help the transition to green energy. From what it resulted, the most of the interviewees (64%) agree that PPAs will help the transition to green energy, but together with the help of other factors.

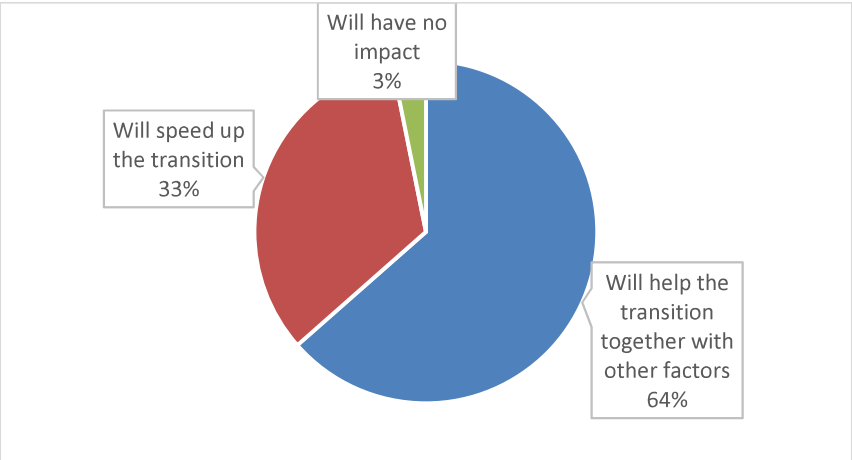


Figure 3. Whether PPA will help the transition to greeen energy

As far as the contractual period (figure 4) we can observe that most of the examined (51.6%) wish to sign these contracts for a short period, namely 1-5 years while a longer period is thought suitable for 25.5% of the respondents.

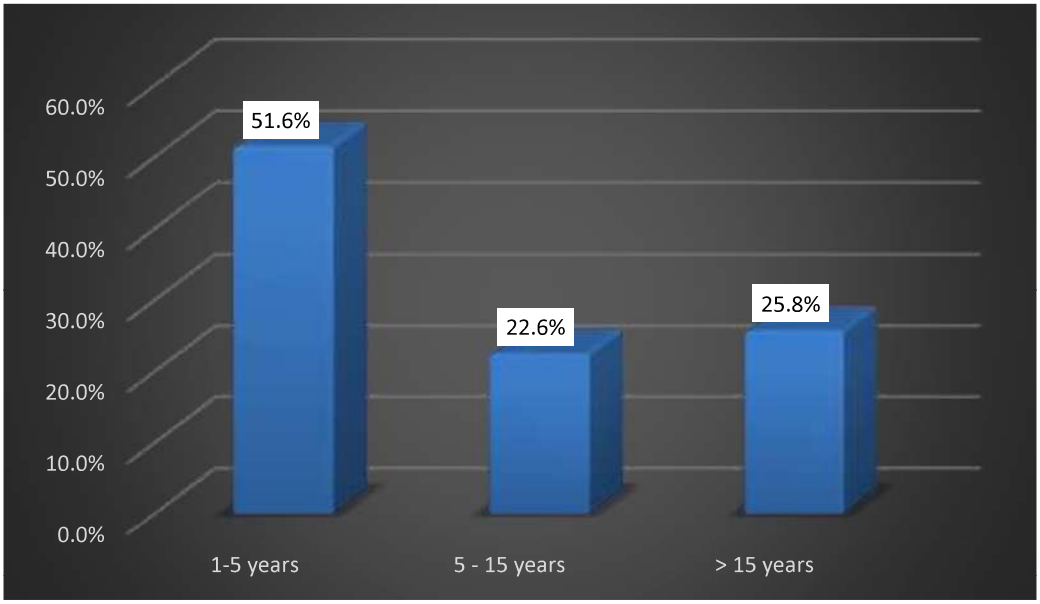


Figure 4. Contractual period

Furthermore, table 2 and figure 5 show that the higher the level of knowledge, the attitude towards the implementation and development of PPA is rising. Although the slope has a low value, there can be a correlation between knowledge and trust, therefore it is important to promote and encourage consumers to learn about the benefits of PPAs.

In table 3 is presented the correlation between the monthly energy consumption and the percentage of income spent on energy. It is very clear that the percentage is proportional to the energy consumption. What we can learn from this statistic is that the impact on the PPAs and reducing the price of energy by resorting and implementing this contract is more significant for the large consumers which spend a higher percentage of their revenue.

By improving and developing the technology used for creating green energy from renewable resources and by encouraging the people to take part in such a project and to sign PPAs, the price paid by the consumers will decrease. Another result of the regression is that the higher the interest of industrial consumers, the higher the demand for renewable energy will be, therefore a quick transition to green energy will take place.

Conclusions

This study has investigated the level of PPAs in the Romanian energy market and, at the same time, their role for the promotion of green energy and for the achievement of new climate targets. The level of knowledge about PPA is low, just a few respondents having a proficiency (3%) or advanced information (20%), but what is interesting and can help the development of this field is the fact that most of them are in favor of signing such contracts.

If we put the subjects opinions in order of importance, we can observe that 79% of the respondents consider that PPAs will help the transition to green energy, but their results depend also on other factors, for example states implications, environmental or geographic position.

As a conclusion, PPAs have a positive impact on reducing CO_2 emissions, on helping the transition to green energy and on achieving climate neutrality, helping at the same time the economy, in general, and the interest of consumers, in particular, by increasing their profit.

Therefore, good communication and information could help encourage the consumers not only to consider, but also to negotiate and finally to conclude such contracts.

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Appendix: Correlation tables

Table 2. Correlation between Level of Knowledge and Attitude against PPA

Regression Statistics	
Multiple R	0.05117954
R Square	0.002619345
Adjusted R Square	-0.014003666
Standard Error	0.580532635
Observations	62

ANOVA

	df	**SS**	**MS**	**F**	**Significance F**
Regression	1	0.053105113	0.053105113	0.157573456	0.69280897
Residual	60	20.22108844	0.337018141		
Total	61	20.27419355			

	Coefficients	**Standard Error**	**t Stat**	**P-value**	**Lower 95%**	**Upper 95%**	**Lower 95.0%**	**Upper 95.0%**
Intercept	3.72675737	0.176289576	21.13997584	1.71546E-29	3.374125715	4.079389024	3.374125715	4.079389024
X Variable 1	0.024943311	0.062836584	0.396955231	0.69280897	-0.100748571	0.150635192	-0.100748571	0.150635192

Figure 9.

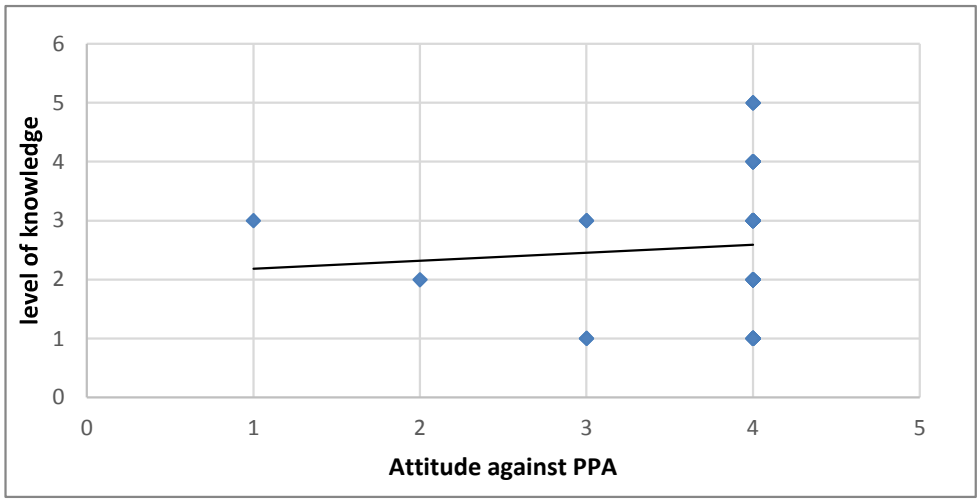


Figure 5. Correlation between level of knowledge and attitude against the PPA

Table 3. Correlation between Energy consumption and Percentage of Revenue

Regression Statistics	
Multiple R	0.306854
R Square	0.094159
Adjusted R Square	0.076398
Standard Error	0.943446
Observations	53

ANOVA

	df	SS	MS	F	Significance F
Regression	1	4.718621	4.718621	5.301285	0.025425
Residual	51	45.39459	0.89009		
Total	52	50.11321			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	1.220085	0.287633	4.241814	9.35E-05	0.642638	1.797533	0.642638	1.797533
X Variable 1	0.298433	0.129615	2.302452	0.025425	0.038219	0.558647	0.038219	0.558647