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Key Barriers that Prevent the Development and Implementation of Power Purchase Agreement in the Transition Process to a Zero Carbon Economy

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Abstract

To comply with the promotion of green energy and to enable the transition to a zero carbon economy requires the development of increasingly easier tools which can help the achievement of new climate targets. A facile way to do this is to participate in bilateral power purchase agreements (PPAs) with renewable producers (REP).

Although a PPA can be drafted in a very flexible way, its main purpose is to offer the possibility to buy future green renewable energy from a seller at an agreed price. This is the reason why PPAs are financially attractive for the seller due to their price certainty, but they can also offer uncertainty for the buyer due to the uncertainty of the future green energy production. This situation complicates things when it comes to concluding such contracts, the above-mentioned uncertainty jeopardizing the objectives considered at the time of signing PPA, on one hand and, on the other hand, complicating the efficiency of the demand. To this are added legislative changes that may not always have a beneficial effect on the sustainability of PPAs.

For this research questionnaires and interviews with experts in the energy field are used, both carried out at the level of the Romanian energy market.

This article aims to investigate the main barriers that prevent the development of PPAs and make these contract more difficult or less attractive to be accessed, especially for buyers.

The results suggest that there is an interest shown by both buyers and sellers, even if the level of knowledge on such contracts is at an average level. It is also clear that the more people are familiar with the benefits of PPAs, the more their intention to conclude such contracts is higher, especially when we are talking about industrial consumers, where the benefits of using green energy have a higher impact on their expenditures.

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

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1. Introduction

Everywhere in the world, there is a huge need to reduce CO_2 emissions, this being the reason why beginning from a certain point is crucial (Sklepovič, 2022). From what we can see, more and more countries and institutions show an increasingly interest in the acceleration of their decarbonisation system by reducing the greenhouse gases (Iancu, 2021). At this moment, we can see that there is a huge need to make global, national, and local policy changes, as long as we all know that the global warming or climate change are very dangerous, this aspect being shown in many reports from World Wide Organisation and from the intensity of this phenomenon we can convince us alone.

Due to this fact, green and clean energy are very seriously taken into consideration, their development making the subject of many debates, and climate neutrality could easily be gained through renewables. The achievement of the European Union's goals and the reduction of CO2 emissions by 2050 are the objectives that must be fulfilled as quickly as possible (Soeiro, 2020).

Despite the high initial costs, technology and user, the benefits brought by renewables are many more and their results are far from encouraging, the creation of a green global economy that could fight against air pollution and climate change being primordial (Taghizadeh-Hesary, 2021). The legislative part is playing a huge role in the development and in the encouragement of the use of renewable energy, as well as in the transition to green energy acceleration, PPAs being one of the many aspects that we are talking about when it comes to legal aspects in the renewable energy field development.

PPAs are contracts concluded between an energy buyer and an energy seller, who buy and sell a certain amount of energy, energy that is or will be generated by a renewable asset. What is very important to understand is that both the investors and creditors from non-subsidized markets are able to invest in renewable energy projects.

Therefore, the possibility of creating energy from renewable sources, as well as the purpose of these PPAs to create a fair agreement and with as few risks as possible between the parties, are two aspects that need to be given more attention (Mendicino, 2019).

The purpose of this article is to study and examine the key barriers that prevent the development and implementation of a Power Purchase Agreement in the transition process to a zero-carbon economy.

So, while PPAs can help the transition to green energy in many ways, they face several barriers that prevent their implementation and development, and although the benefits and advantages brought by PPAs are very high, these barriers make people reluctant in getting involved in such a project. Among these barriers we mention level of knowledge, the attitude, state's implications, and the level of development of the market, the level of promotion, risks, and legal consequences.

This article has the following structure: The introduction presents Power Purchase Agreement Concept, the advantages and the disadvantages they assume. In Section 2, PPAs are defined with an analysis of the main scientific sources. In Section 3, the research methodology is presented, which consists of a workshop with energy experts and a questionnaire. Section 4 presents the main research results, and last but not least the final section shows the main conclusion. Bibliographic references complete this article.

2. Power Purchase Agreement in the Scientific Literature

When we talk about renewable energy, we talk about PPAs, which are one of the most important ways that help achieve climate neutrality, when it comes to legal proceedings. Their complexity is very well known, and many aspects should be taken into consideration when signing a PPA. The aforementioned complexity is given primarily by the long-term negotiations, this being the reason why the clauses should be accurate and very clear.

We have heard many times the question – When is the usage of Power Purchase Agreement necessary? – The answer is very simple: PPAs are useful when:

- The financing of the project can be unsecure, and there is a need to secure the amount of energy bought and the price offered;
- There is likely to exist an event that can provide energy at a lower price – in this case, PPAs provide the security to be safeguarded from such a situation;
- It might be that one or some of your most important buyers want to get most of the production. For example, when a government public service wants to buy the entire amount of energy produced by a power plant – in this moment the government must know the price that must be paid for that energy, as well as that it is the first that can buy that energy;
- The society will want the security of the income, and the buyer wants to have the certainty of the required quantity of energy.

Also, PPAs are highly attractive to renewable energy producers, especially because they offer a security of price for a forthcoming unsecure energy amount. Buyers are attended to sign PPAs due to the durability they offer. Anyway, for buyers, the insecurity of energy quantity produced by renewable energy producers can bring both economic and technological difficulty. (PWC, 2016; Yashar, 2021)

At the same time, we have to mention that both decreasing the risks for developers and fiscal parties and encouraging the use of renewables make from PPA a very profitable and attractive mechanism. Due to the simple fact that the mechanism is purchased directly from the seller, this contract appears to be more and more reliable. It seems that according to inverstors, banks are the most accurate when it comes to invest in green energy, being closely followed by financial instruments such as European Funds, state aid, and so on.

In the analysis of PPAs, we should take into consideration all types of renewable sources (solar, wind, hydro or maritime), because all these types offer these contracts special characteristics, this being the reason why geographical distribution is an

important aspect that should be taken into account when we want to get involved in such a project (Soeiro, 2020).

The investment in green energy also means a step forward in the development of green energy, and it draws the attention that many more societies can get involved in this project as long as the private system is not very interested in this aspect, according to Doval & Negulescu (2014) (Doval, 2014).

From the point of view of Taghizadeh-Hesary et al. (Taghizadeh-Hesary, 2021), one of the best ways to get funding for green energy development are PPAs, considering, at the same time, that the evolution of this field will increase significantly if the private sector will get more involved. Also, they consider that PPAs are the most competent instrument in the development of renewable energy as well as in the improvement of the relationship that exists between the seller and the buyer of green energy.

It happens also that the purchased energy limit is obtained, the offtake has the possibility not to pay anymore the required contractual price, and the excess of energy could be bought at a reduced price or not at all. This is the moment when the seller has the possibility (according to some PPAs) to sell the energy that is in excess into the spot market, where he can obtain lower or higher prices (Bruck, 2021).

PPAs have many advantages as well as disadvantages that we should talk about. Regarding those in the first category, we mention the security of the price for a long period, the chance to invest in electrical energy plants, the decrease of potential risk that may come together with the transaction of electrical power, and last, but not least, the price, which can be established in several forms, for example contracts for difference, fixed, or variable.

Regarding the disadvantages, we have to mention the complexity of the contracts due to the fact that they require a longer time to be completed, the variation of the price, which could result in negative prices for the contracting parties, the quantity of the produced energy may fluctuate, principally when we speak about wind/solar energy (Pexapark, 2021). In the event that the contracted amount of energy cannot be offered, then financial or physical compensations will be offered, being possible even to reach the situation of contracting a third person, an electricity trader, who can supply this energy instead of the producer.

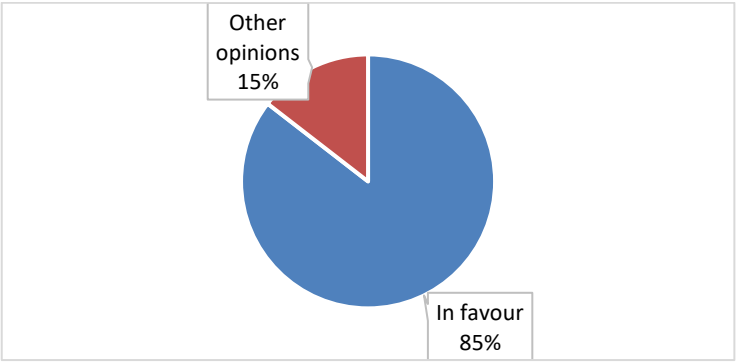
So signing PPAs jeopardized the durability of buyers' goals for a long time due to the insecurity of the energy and made their energy request harder in the near future. This is the reason why buyers want a prospective energy security from producers in order to make a viable plan that can offer a trustworthy and financial backup purchase, for example trading in day-ahead electricity markets (Delmarva Power & Light Company, 2008).

3. Research Questions

We begin the presentation by talking about the attitude of the survey participants toward PPAs (Figure 1) and, as far as we can see, only one person opposes, 2 persons are indifferent, 6 respondents prefer another type of contract through which to

purchase electricity, but not necessarily from renewable energy sources, while the remaining 53 respondents show a positive attitude and are in favor of signing PPAs.

Figure 1. The attitude towards PPAs



Source: Questionnaire Analysis.

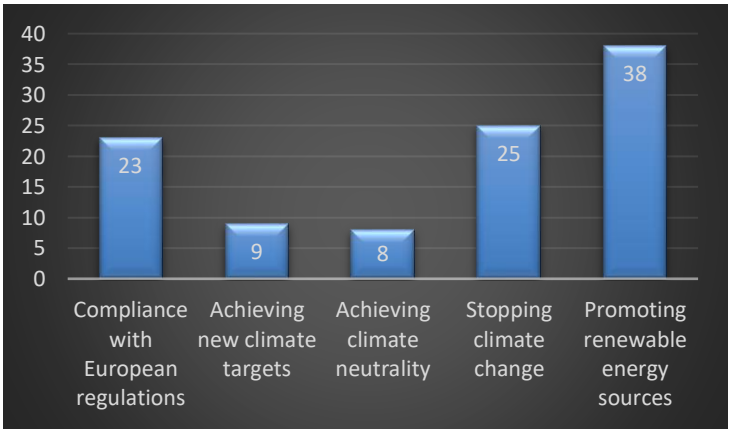
The distribution is interesting and shows us, on one hand, that PPA is needed and, on the other hand, that PPA is an important element for the energy transition for the development of the projects.

The starting point is that there is a positive attitude towards such a contract, which is seen as necessary for the development of new production capacity.

But now a question arises: why do people who completed the questionnaire have such a positive attitude towards PPAs?

The answer to this question should be linked to the answers to the question "Why do you consider it necessary to promote these PPAs?" (Figure 2).

Figure 2. The reasons why the promotion of PPA is required



Source: Questionnaire Analysis.

The variants to this question were as follows:

a. Compliance with regulations established at the European level;

b. Achieving new climate targets;

c. Achieving climate neutrality;
d. Stopping climate change;
e. Promoting renewable energy sources.

Analyzing the received answers, we can see that there were persons who chose answer a) - compliance with European regulations, from which we can conclude that the meaning and role of PPAs are not known, due to the fact that PPA is not a European Regulation, but a commercial agreement between parties.

This situation gives rise to the following discussion: although there is a positive attitude towards PPA, the mechanism is not fully understood, at least for those who responded, which shows that there is no understanding of the true role of PPA.

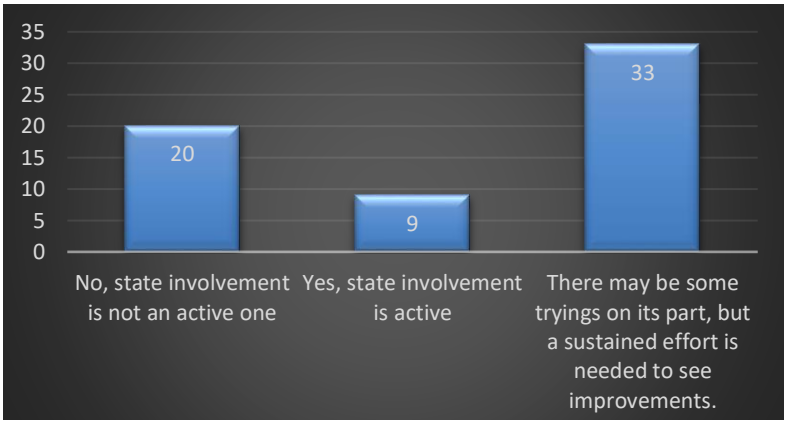
Because this type of contract is considered necessary to achieve climate neutrality, it shows that there is a misunderstanding of its true role, as well as the fact that PPA is a risk management tool for a developer.

If we proceed to a correlation of the answers from the question regarding the reason why PPAs promotion is necessary with the 4 answer options, it results that the positive attitude is built on a lack of understanding of the market mechanism.

Therefore, PPAs are necessary, and despite the fact that not many people have understood their real meaning, namely the promotion of renewable energy sources, coupled with the high degree of acceptance, we can say that the level of understanding of PPA mechanism is relatively low.

Another aspect that caught the attention of the panel of experts is the answers to the question regarding the involvement of the state in the development of PPAs (Figure 3).

Figure 3. State involvement



Source: Questionnaire Analysis.

The answer to this question should be correlated with the results given to the attitude question, from which we can observe that although there is a great acceptance of PPAs and the respondents are in their favor and consider them necessary, the state is still not considered active in PPAs' development.

Other questions that the focus group answered are “If this statistical answer is correct?” and “Why would the role of the state be relevant?"

The answer would be affirmative, the statistics are correct, and the role of the state is understood by experts as the role of the regulator. For example, regarding the Romanian market, unfortunately, in the period 2012-2020 such contracts were not allowed, the wholesale electricity transactions being limited only on centralized platforms and only on standard products. This situation forced the appearance of liquidity on the market, but at the same time, this measure, although beneficial for the formation of a market at the beginning, had a boomerang effect, as it destroyed the ability of market participants to negotiate non-standard contracts.

Another analysis is given by comparing the answers of the persons who consider that the state is involved / not involved in the development of the PPAs in relation to the general questions about the respondent. The results are also interesting and prove that the more connected people are in the energy market and the better they know these regulations, the more they appreciate that the involvement of the state is very small. Proof of this is the fact that only 9 respondents consider that the state is involved, respondents whose monthly consumption is between 0-50 MW, which proves that the state is an active element only for people with low energy consumption, the others, as we have shown before, not having such a good opinion of the involvement of the state.

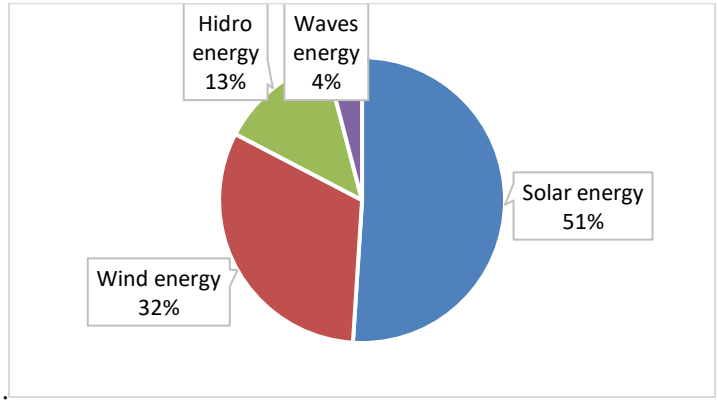
From what we can see, those who consider that the state, in the person of the regulator, does not do enough, so as to create favourable conditions for signing such contracts are those who in a way or another work in the energy field. There was no desire from the part of the authorized institutions to regulate such contracts, the change being made by the issuance and entry into force of Regulation no. 943/2019 of the European Union.

However, no matter what the regulator does, signing a PPA means the will of the parties and, respectively, the producer to be willing to sell electricity at the price that the buyer is willing to buy. Or a PPA by definition is a long-term nonstandard product contract. The state cannot intervene and force / set the price, in case the parties cannot find a price to accept together. Therefore, yes, it is necessary for the regulator to allow PPAs and to have an institutional framework that guarantees their functioning as a legal element, respectively, as a contract. Apart from that, regarding the operation of PPAs, there must be people who take risks, no matter whether we talk about the seller or the buyer.

In conclusion, the regulator should get involved, make PPAs known, and allow them, respectively, to create the institutional framework to run such contracts.

Another aspect discussed was based on the correlation between the attitude of the participants and the types of renewable sources energy considered at the signing of the PPAs (Figure 4).

Figure 4. Type of renewable resources used in signing the PPAs

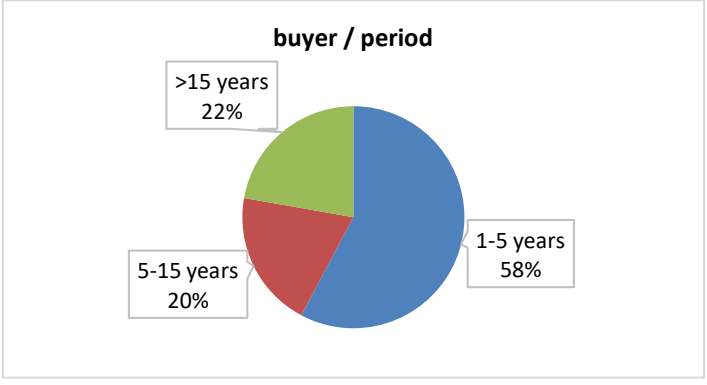


Source: Questionnaire Analysis.

The answers prove that the most used form of energy would be solar energy, which leads us to see that although the technology behind PPA is not relevant, the production profile, the imbalances and risks associated with such a contract are highly dependent on technology. Therefore, they will be reflected in the price of the PPA type contract. It is understood from this graphic that those who participated in the study are willing to purchase energy from solar production, because they feel that they can more easily determine the risks associated with production, in comparison to wind, which is less predictable, with larger deviations. Practically, in this way it is easier to understand solar production and to determine the risk assumed when contracting.

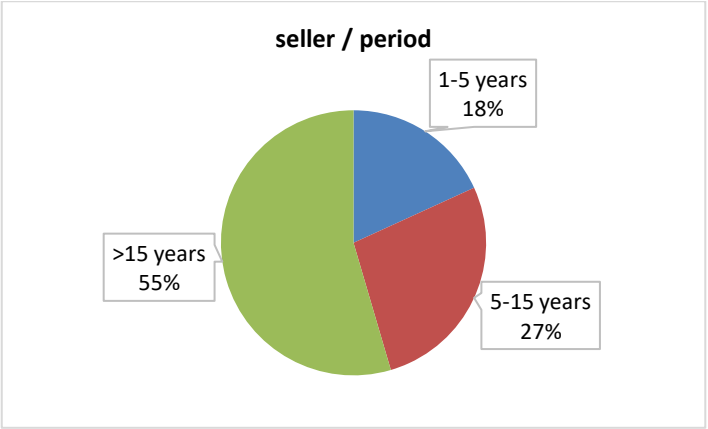
From the analysis of the questionnaire from the point of view of the period for which such a contract would be concluded, we can see that buyers are willing to close the contract and assume the price risk only for 1-5 years (Figure 5), while the sellers, in their majority, only discuss in the long run period (Figure 6).

Figure 5. Contractual period from the buyers' point of view



Source: Questionnaire Analysis.

Figure 6. Contractual period from the sellers' point of view

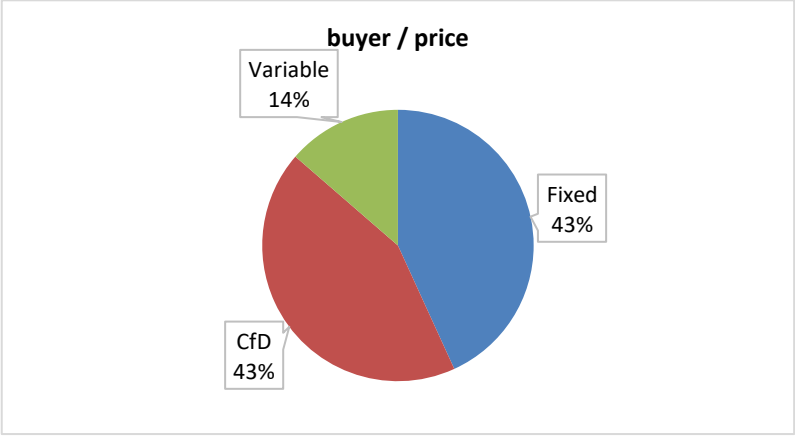


Source: Questionnaire Analysis.

Asked what would be the reason for these results, the experts answered that this is normal, precisely because PPAs involve assuming a long-term price risk and analyzing the difference in terms of time considered by the producer, who is the seller, and the buyer, who is the supplier, we identify another major problem in the sense that there is no payback in any renewable project between 1 and 5 years. The need of the energy seller, who is the producer, is to insure the price during the financing period, which is usually equal to the payback, what means that a contract should be concluded for 10 years or more.

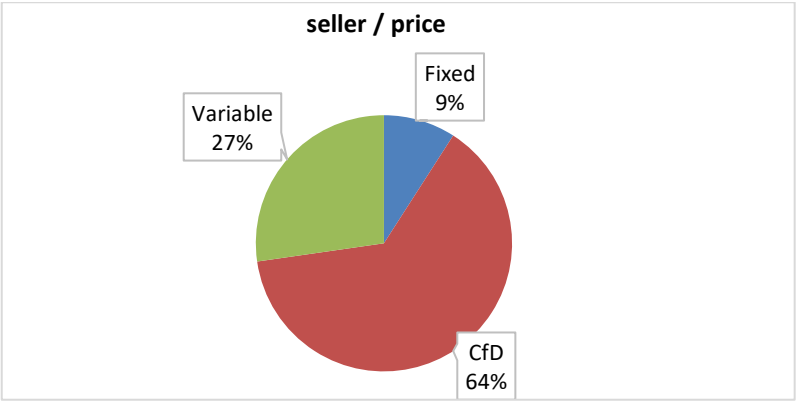
Regarding the price, from what we can see, the buyers preferences are equally divided between fix and CfD price (43% - Figure 7), while sellers prefer CfD (64%) and variable (27%) – Figure 8.

Figure 7. The price from the buyers' point of view



Source: Questionnaire Analysis.

Figure 8. The price from the sellers' point of view



Source: Questionnaire Analysis.

About CfD, we have to mention that they are named "contracts for difference" and refer to a contract that enables two parties to enter into an agreement to trade on financial instruments based on the price difference between the entry prices and closing prices. If the closing trade price is higher than the opening price, then the seller will pay the buyer the difference, which is the buyer's profit. The opposite is also true, meaning that if the current asset price is lower at the exit price than the value at the contract's opening, then the seller, rather than the buyer, will benefit from the difference.

This chart shows the different understanding that sellers have now - they are not looking for PPA signings to finance projects, but are looking for PPA signatures to limit their exposure to price variations, as such they want to capture PPA prices as high as possible, reason for which they resort to prices set in the form of CfD or variable prices, so that they can maximize their profit.

The buyers, however, know that they are taking the risks (Figure 7) and therefore they want a fixed price, so that they can limit the cost of the purchase, given that the risks are subsequent, once they have been assumed in the contract (Figure 8).

The second thesis would be that at the moment the sellers expect an ascending price trend and they are not willing to set the price, having the feeling that there is a high potential given by the energy transition, the replacement of capacities in Romania, and so on.

4. Research Methods

The main objective of this research is to study and examine the key barriers that prevent the development and implementation of the Power Purchase Agreement in the transition process to a zero carbon economy.

The research methodology used in this paper is based on two steps: in step 1 a panel of experts from energy field was invited to a workshop in order to formulate the first hypothesis regarding the key barriers that prevent the development and

implementation of Power Purchase Agreement as they appear to be from the questionnaire.

The participants were: energy trader, responsible for purchasing for a portfolio of the top 10 universal customer suppliers in Romania, developer of renewable projects, renewable electricity producer, average industrial consumer (category C3).

These experts were randomly selected from the list of respondents from the questionnaire, without knowing their answers, their role being to expose their opinion on PPAs' barriers based on the questionnaire results.

The formulation of questionnaires realised in step 2 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 several categories representing different fields of activity, such as energy experts and financial accounting experts, energy producers and industrial and small consumers, this research being made at the level of the Romanian energy market, namely Bucharest county. The survey involved 62 respondents (Table 1).

Table 1. Respondent Profile

Category	Level	Procentage
Respondent type	Industrial consumer	45.2%
	Small consumer	19.4%
	Producer	9.7%
	Energy Experts	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%

Source: Questionnaire Analysis.

The idea of this questionnaire was to find out and to analyse the level of PPAs in the Romanian energy market. So, in this questionnaire, the level of knowledge about

PPAs was analysed by different stakeholders: industrial and small energy consumers, energy producers, and last but not least energy, financial and accounting experts. In addition, were examined the attitude towards this contract and the point of view regarding the legally implementation of the PPAs, for example price, risks, parties or contractual period.

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

5. Findings

Results

Referring to Figure 1 regarding the attitude towards PPAs, we can see that 85% of the participants are in favour of these contracts while 15% have other opinion. This means that the respondents have a very positive attitude towards PPAs and they are in favour of signing them.

Figure 2 talks about the type of renewable resources used in signing PPAs. From what we can see, 51% of the interweed prefer solar energy, because it is easier to purchase this energy from solar production and the risks are easily to be determined, while the other half is split between wind energy (32%), hidro energy (13%) and waves energy (4,5%), which proves that people still show a slight reluctance to these energy sources.

The third figure is entitled – The reasons why the promotion of PPA is required - and shows that most of the respondents (38%) will choose to sign a PPA in order to promote renewable energy sources. Although the majority will choose a PPA due to the above mentioned reason, we can see that there is a missunderstanding of the true role of PPA as long as the next reason among the respondent's preferences is compliance with European regulations (23%) and stopping climate change (25%) – which do not represent the true role of PPA. From this point we can say that the level of understanding PPA mechanism is relatively low.

The next two figures speak about the contractual period from the point of view of the buyer and from the point of view of the seller. From what we can see, while the buyer prefer short term period 1-5 years (58%), the seller will definitely agree to sign a PPA for a long term period, this meaning more than 15 years (55%), the following variants of the periods being equaly split in the contractual parties preferences (buyer period: 5-15 years – 20%, more than 15years - 22%; seller period: 1-5 - 18% and 5-15 - 27%).

Figures 7 and 8 are about the price from both the buyer's and the seller's point of view. From what we can see, both sides are in favor of having the price established under the form of contracts for difference, even if in the case of the buyer the preferences regarding the establishment of the price in the form of CfDs are equal to the preferences regarding the fixed price. But from the perspective of creating new capacity, the only type of contract that banks or financiers would be willing to accept is a fixed-price PPA or a CfD that is built from a strike price (reference price) to cover the investment and accepted profit.

The last figure speaks about the state's involvement and shows that most of the respondents believe that there may be some trying on its part, but a sustained effort is needed to see improvements. So, although, many persons have a positive attitude towards PPAs, only 9% from them believe that the state is active in PPA's development. Therefore, urgent measures should be taken by the state in order to make PPAs count on increasing the use of energy from renewable energy sources.

6. Conclusions

This study has investigated the key barriers that prevent the development and implementation of the Power Purchase Agreement in the transition process to a zero carbon economy.

A first conclusion that can be drawn from these answers would be that the present situation very well outlined by statistics shows that in fact although the existence of PPA is desired, its role and need are not well explained and therefore misunderstood by market participants.

Another conclusion would be that this type of contract is necessary both for the producer of renewable energy, but also for any producer who wants to make an investment in a new production capacity and wants to limit his exposure to market risk, in the time that he gets finance, but this type of exposure will not be accepted by his financer. This is why banks or credit institutions that finance such investments, respectively, investment funds or even private investors will always want to have a mechanism for managing this risk.

Anyway, another proved aspect is that although the attitude and acceptance are not perceived in unison, the results are encouraging, but we must understand that a better communication is needed so that market participants, from regulator to beneficiary, understand the need, the utility and the mechanism behind them.

Another conclusion of our survey would be that although PPAs are open to regulation and no longer banned, unfortunately, the parties are not able to find a common point of risk assessment in the long-run period, taking into consideration that the sellers want more than 15 years, while the buyers prefer a short-term period from 1 to 5 years.

From the point of view of the price, we can see that while buyers agree to sign this contract at a fixed price, the sellers prefer CfD or variable prices, which is understandable. But from the perspective of creating new capacity, the only type of contract that banks or financiers would be willing to accept is a fixed-price PPA or a CfD that is built from a strike price (reference price) to cover the investment and accepted profit.

As a general conclusion, what the panel of experts concluded based on the results of the questionnaire analysis is that the barriers do not necessarily come from the lack of regulation, but also from the lack of fair pricing experience and the respondents' desire to participate, being necessary for the state to take several measures that will lead to the development and popularization of PPAs in Romania.

Furthermore, in terms of the barriers considered in this analysis, we can conclude that these are: lack of knowledge about what it really means to sign a PPA (although

there is a positive attitude, the lack of knowledge will make if not impossible, at least very difficult to implement this type of contract), the involvement of the state, which, unfortunately, is not an active one, the period for which this contract should be signed, since potential buyers prefer a short period (1-5 years) and the producers want a longer period (more than 15 years), the price in question, which can be either fixed or set in the form of a contract for difference, and last but not least, the type of renewable energy used, most of the respondents preferring solar energy because, they believe, it would be easier to insure the risks in relation to the amount of energy produced.

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