

THE BUCHAREST UNIVERSITY OF ECONOMIC STUDIES

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SUMMARY OF THE DOCTORAL THESIS

entitled

**Research on the role of Power Purchase Agreements in the transition to green energy
and achieving climate neutrality**

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1. THESIS

The thesis includes 274 pages with a total of 7 chapters. The study used 238 source directories. During the dissertation the author, together with PhD supervisor Prof. Univ. Dr. Dr. Adrian Dumitru Tanțau, published several scientific publications.

This included 1 publication by an ISI proceeding Journal and 3 publications by an international non-ISI Journal, as well as 6 international conferences.

ABSTRACT

Research on the role of Power Purchase Agreements in the transition to green energy and achieving climate neutrality

This PhD thesis addresses one of the most important legal instruments that can help combat climate change, namely Power Purchase Agreements. As decarbonisation is essential for the global transition to electricity, these contracts are a direct legal link that can be formed between the power producer and the power buyer.

This type of contract plays an important role in stimulating the creation and development of more renewable energy projects, such as wind, solar or hydro, by providing secure and long-term revenues for producers, while customers benefit from long-term price predictability.

The reform of the electricity market, including the promotion of long-term bilateral power purchase contracts, is desired by the European Union, which, by amending Regulation 2019/943 on the internal electricity market, wishes to support the development of investments in renewable energy through the use of these contracts.

The implementation and development of the signing of these contracts are evaluated in this research, with taking into consideration both the economic, legal and social impacts, as well as the effects on the environment.

The analysis addresses the risks to which the parties are subject once these contracts are signed, the key factors that influence the development of these contractual relationships, with consideration of concrete cases where PPA market is a developed one, as well as examining these contracts with other legal financial instruments that have the same purpose and aim, namely Contracts for Difference.

The present PhD thesis analyses key topical issues and brings a new approach, in which research methods have been approached in an original way, in order to outline new perspectives on the topic under investigation.

Keywords: Power Purchase Agreements, Green energy, Climate neutrality.

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2. SYNTHESIS OF THE MAIN PARTS OF THE THESIS

The main objective of the present research is to evaluate the level of development of Power Purchase Agreements and to determine the role of Power Purchase Agreements (PPAs) in the transition to green energy and achieving climate neutrality.

The current PhD thesis has the following subobjectives: The assessment of Power Purchase Agreements (PPAs) on the road to green energy and achieving climate neutrality targets. (Chapter 2) The role of Contracts for Difference (CfDs) for achieving climate neutrality. (Chapter 3) The assessment of risks in a Power Purchase Agreement, combating and reducing them. (Chapter 4) Identification and evaluation of the main drivers and barriers that influence Power Purchase

Agreements. (Chapter 5) Determining measures taken by more developed states. (Chapter 6)
Finding appropriate solutions to encourage the signing of PPAs. (Chapter 6)

The content of the chapters is as follows:

Chapter 1 *Introduction* presents the problem background, the thesis' goal, the research questions, the research strategies and the methods and data used. This chapter forms the basis for the thesis' scientific process. Science is understood in this thesis as the entirety of insights and experiences which pertain to a subject area and are situated in a mutual context of reasons and rationales. The thesis' purpose is to explore Power Purchase Agreements (PPAs) in the transition to green energy and achieving climate neutrality.

In order to achieve this, a comparison was first made between this instrument and other financial mechanisms that have been created for the same purpose, namely Contracts for Difference, so as to find out whether and to what extent the applicability of the PPA is affected by the existence and conclusion of other financial contracts.

Further on, it was considered necessary to analyse the risks to which the conclusion of PPAs is subject, and the fifth chapter will deal with finding, highlighting and analysing the most important factors influencing the conclusion/disbursement of this type of contract, whether positive or negative.

Last but not least, the research aimed at carrying out a case study which involved the analysis of Power Purchase Agreement markets, i.e. the renewable energy electricity markets of two of the most developed countries in Europe: Spain and Norway.

To this end, chapter 1 describes main goals as well as sub goals of this thesis. From these goals, research questions are derived. The main research question of this thesis is:

Which is the main role of Power Purchase Agreements (PPAs) in the transition to green energy and achieving climate neutrality?

In order to be able to answer the research question(s) of this thesis, a set of instruments and methods are needed. These instruments and methods are also described in the first chapter.

Chapter 2 is entitled *The theoretical framework of Power Purchase Agreements (PPAs) on the road to green energy and achieving climate neutrality targets* and analyses the PPA in its entirety, starting with the literature review where this contract is analysed (section 2.1), continuing with the observation and analysis of the regulation of this contract both at the European Union level, in order to understand the measures taken and initiated by the EU bloc, and at the national level, so as to find out what is the stage of development and implementation of this contract in Romania. (Section 2.2)

In this way was stated that the aim of European Union was to transform EU into a rich, cost-efficient, modern and competitive society, by reducing greenhouse gas emissions by 2050 and decoupling economic growth from the use of natural resources. In order to reach its purpose, European Union wants to reduce net greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels.

In the document called *Guidance to Member States on good practices to speed up permit-granting procedures for renewable energy projects and on facilitating Power Purchase Agreements*, issued in 2022, the European Commission speaks about the barriers these agreements face at the national, regional and local levels of Member states.

EU stated the obligation for Member States to regulate these contracts at national level, by setting their obligations and the required targets. Regulation of PPAs continues with Directive (EU) 2023/2413 of the European Parliament and of the Council (“RED III”), which had the purpose to amend and update the current Renewable Energy Directive, and which brings to the fore important issues to be considered by Member States. The new Directive entered into force on 31st October 2023, and Member States (including Ireland) have the obligation to transpose it into national law by 21st May 2025.

Regarding the legal framework of PPAs at national level, it was stated that PPAs in Romania have been banned by the Energy and Natural Gas Law, being reintroduced by Government Emergency Ordinance no. 143/2021 which was issued precisely as a result of the amendments made by the European Commission through Regulation No. 943/2019, in the present moment, in Romania, 3 PPAs having been signed so far.

Section 2.3 analysis the importance of allowing the issuance of GOs in order to conclude and maintain the validity of a PPA. Within this PhD thesis it has been stated that the guarantees of origin represent the clear proof that the acquired energy is generated from renewable energy sources and signify a key pathway to achieve decarbonisation targets. In addition, it has been showed that, in Romania, guarantees of origin are not tradable because Romania is not an Association of Issuing Bodies (AIB) member, which means that their market value is zero. In order for GOs to be traded internationally, it is important for Romania to be a member of the AIB and to properly fulfill all its obligations.

Sections 2.4 and 2.5 analysis the classifications of PPAs, their respective benefits and advantages. Nowadays, the two most common forms of PPA are physical and virtual PPAs, the latter being the most widely used. A physical PPA represents the possibility of a producer to deliver physically the agreed volume of energy to the buyer, at the agreed price.

A virtual PPA – is a more complex form of PPA, in which the energy is sold in the spot market, and the difference between the sport price and the PPA price is established by the buyer and the seller.

The buyer gets the electricity from its supplier and at the end the two parties set up the difference between the agreed PPA price and the market price. In the situation in which the PPA price is lower than the one set in the market, the buyer gets the difference from the producer, otherwise, the producer is the one who gets the difference from the offtaker.

The future trends of PPAs are tilled in 3 categories some of them knowing a slightly movement (cross-border PPA, hybrid PPA), while the other (24/7 PPA) is currently in developing.

Cross-border PPA represents a bilateral contract signed between a renewable energy producer in one country and a corporate energy offtaker in another country.

Hybrid PPAs take advantage of storage, in this situation mainly being necessary two contracts: a) a normal renewable energy PPA for the generation asset and b) a separate contract for the storage asset. These two assets work independently and are two different contracts, which are linked though technical and financial advantages of being on the same site. (Hybrid PPA option I – Renewable PPA & Storage Capacity agreement (CSA)/ Optimisation agreement)

A new approach is given by "24/7" renewable PPAs, which is a trend that aims to provide green energy 24/7. It represents a greater and greener way to the energy transition, having the following benefits:

Firstly, stronger environmental credentials, achieved through hourly correlation, give greater credibility to environmental statements than an annual approach. Secondly, this more granular approach results in greater use of renewables, as demand actually drives the use of green energy 24/7, i.e. a 100% renewable grid, which increases the impact of additionality of the agreement. What's worth mentioning is that a more granular correlation of PPA renewable energy volumes with demand rises the efficiency of PPA hedging by reducing the buyer's exposure to the wholesale market for deficit and surplus volumes. Therefore, a 24/7 procurement can be a very efficient approach to renewable energy supply (Kandpal, Backe and Crespo del Granado, 2024).

Regarding the advantages and benefits (section 2.5) within this PhD thesis it was highlighted that Power Purchase Agreement is an useful tool which offers producers the chance to have a stable income, by the fact that a certain amount of energy is sold to the buyer, at a price and for a period agreed by the parties.

Securing the price and the volume of production represents one of the most important roles for a PPA and can be made through different methods such as: *reduction of the uncertainty that characterizes the price and the amount of electricity supplied on one way and by giving a valuable model for both the producer and the buyer* (Huneke et al. 2018; Lei & Sandborn, 2018; Gabrielli, Aboutalebi, Sansavini, 2022b; Tang & Zhang, 2019).

Last but not least, section 2.6 is about the significance of green energy and climate neutrality as long as both achieving climate neutrality and promoting green energy are defining for fulfilling the role of PPA, and were also the subject of a question in the questionnaire proposed for analysis. In this regard, question no. 5 from questionnaire considers the reason why PPAs are necessary, two of the answer options being the achievement of climate neutrality and the promotion of renewable energy sources. It should be mentioned that these options were chosen by a percentage of 10.1% of respondents, respectively 42.6% which proves that PPAs are a tool that by itself helps meet these objectives.

In addition, it was stated that becoming "climate neutral" means minimising greenhouse gas emissions as much as possible, as well as offsetting any remaining emissions, which is how a

balance of net zero emissions can be achieved. A net balance of zero emissions occurs when the amount of greenhouse gases released into the atmosphere is neutralized (European Council, 2023).

Regarding the meaning of green energy concept, this is thought to be the energy that is produced by a certain method and from certain sources that do not harm the environment (National Grid, 2023). TWI (2024) refers to green energy as any type of energy that is produced from natural resources, such as sunlight, wind or water, while Just Energy (2019) specifies that green energy offers the greatest environmental benefit and represents energy produced by solar, wind, geothermal, biogas, low-impact hydro and certain eligible biomass sources.

Chapter 3 - *The concept of Contracts for Difference (CfDs) and their impact on the signing of PPAs* - builds on the concept of Contracts for Difference by comparing PPAs with another financial instrument designed to help transition to green energy and achieving climate neutrality. To this end, it is important to verify whether and to what extent the entering into and maintaining of contractual relationships under a PPA are affected by the entering into contractual relationships under other financial instruments such as CfDs.

Contracts for difference (CfD) are defined in section 3.1 as being a mechanism to stimulate investment in energy generation assets with a high initial cost by ensuring stable prices for a long period, being used to protect consumers against high electricity prices. The term contract for difference (CfD) originates from financial practice, CfD being a derivative financial contract.

At the same time, regarding the incentive paid under the contract it is defined as the difference between the "strike" price and the "reference" price. The exercise price represents the sale price of electricity, which expresses the additional cost that could be reached in the generation with low carbon emissions, and the reference price represents the average market price of electricity. The parties must determine the strike price before determining the difference.

Regulatory legal framework of Contracts for Difference (CfDs) at national level expressed at section 3.2 shows that the Romanian Government supports the development of energy production from renewable energy sources, through low carbon technologies, in which sense Government Decision no. 318/2024 was adopted on the approval of the general framework for the implementation and operation of the support mechanism through Contracts for Difference for low carbon technologies.

This mechanism provides non-reimbursable financing in the form of either a state aid or ad hoc state aid for low carbon electricity generation capacities, the technologies concerned being those using energy from renewable energy sources such as onshore wind resources, offshore wind resources, solar photovoltaic resources, hydro resources, nuclear resources, hydrogen, energy storage (Article 2 Point 44 Government Decision (GD) no. 318/2024).

The third section states the objectives and methodology considered in research, while the last section, section 3.4, presents a comparison between the two instruments which states for the beginning that in general, long-term PPAs and CfDs are distinct financial instruments, each with a specific purpose, while PPAs offer revenue security and direct relationships with buyers, CfDs focus on price stabilisation and risk mitigation. At the same time, Innova (2023) states that developers have the right to choose between different markets when making an investment decision for a given project, CfD and PPA being two main options to support project financing in green energy.

Price is another criteria that makes a difference between these 2 contracts in a PPA the price being paid irrespective of the electricity price on the spot market, while CfD need to monitor market price variations and calculate payments accordingly.

From the strike price and the reference price point of view of CfDs there is an assemblance with virtual PPA, which is a more complex form of PPA, in which the energy is sold in the spot market, and the difference between the sport price and the PPA price is established by the buyer and the seller.

Parties are different in these two contracts, in a CfD also the state could be a part, not only the buyer and the producer, as in a PPA. In both cases, these contracts minimise the market risks associated with price fluctuations by reducing investment uncertainty for developers.

Even if at the moment it is not possible to establish a very clear relationship between these two contracts, one thing is certain, namely that their influence on the promotion of renewable energy is a beneficial and significant one, which will leave its mark and impact on innovation and development of this energy sector.

The 4th chapter - *Modeling risks, bearing and sharing risks in a PPA, combating and reducing them*- presents the risks faced by PPAs, risks that play a vital role within this contract,

this being the reason why they must be analysed and understood before the parties get involved in the contract.

While section 4.1 speaks about the concept of risk, section 4.2 is about different types of risks for Power Purchase Agreements and states the main risks that may have a particular impact on the signing of PPAs, as they emerged from the questionnaire and are as follows: force majeure, contractual changes, price including negative prices, level of market. The analysis is done both at the European/National level and is an attempt that was made in order to validate the hypotheses associated with the risks of factors from Romania.

The research methodology used in this chapter (section 4.3) consists in Comparative analysis between the risks assumed by the parties involved in a PPA, Questionnaire, Experts interviews, Spearman's correlation matrix, IBM SPSS Statistics for Windows, MS Excel, while the research question which is offered an answer is *Is PPA an useful and efficient tool to mitigate the risks regarding the volatility of energy market?*

For obtaining the results more variables were taken into account, such as for example force majeure, the attitude; experience; period; price payment; form of guarantee; regulation of negative prices, on which basis 7 hypothesis were formed among which I can mention the correlation between the level of knowledge and experience, respectively between attitude and risk-taking in a PPA, both being confirmed, but there were also cases where the hypotheses were rejected, such as the situation of the sellers where it was assumed that experience influences the attitude towards the conclusion of PPAs, and the result was negative.

Based on the hypotheses applied on the variables it was concluded that the variables influencing risk taking are force majeure, price negative prices, contractual changes, level of PPA market and price, section 4.4 presenting the main risks:

Regarding the changes brought to the contract it was showed that they are very important and affect the form and validity of the PPA, both buyer and seller considering that economic modifications play a very important role, and they certainly affect both the conclusion and the execution of the contract.

Tax and legislative changes rank 2nd and 3rd in respondents' preferences, with the percentages allocated being fairly close.

In this situation, there is a fourth option "Other", which although has a very small percentage of only 2% for respondents acting as a buyer and 1% for respondents acting as a seller, attention is drawn to the fact that there are additional external causes that may affect the shape of the PPA, an example given by respondents being political changes.

All the above demonstrate that these changes modify the substance of the contract, especially in terms of the possibility of fulfilling the parties' obligations, and the obligation to supply the energy and pay the price.

Regarding the establishment of price, it was stated that the price is an essential element and there are many ways in which it can be determined: fixed, variable or established under Contracts for difference.

Analysing the results, it was showed that contracts for difference are preferred by almost half of the respondents (43% in the case of buyers and 51% in the case of sellers), with only 10% of respondents wanting a variable price.

Also negative prices are among the risks which affect PPAs, the research presenting the need for negative price regulation, with high percentages of both parties wanting the negative price regulation in the PPA. Although the percentage is slightly higher in the sellers' category, 86% of them considering this to be the case, compared to that of buyers, where a percentage of 73% is observed, it can easily be seen that respondents are aware of the imminence of such prices which basically represent a signal to either increase demand or reduce supply.

Regarding the level of market, the results showed that the level of development of PPAs in Romania is very low, 82% of the respondents who have the status of sellers, respectively 75% of the respondents who have the status of buyers, having this opinion. Moreover, if the percentage of those who consider the market is not developed (7% in the case of sellers, respectively 17% in the case of buyers) is added, it can be seen that almost unanimously it is talked about a very low level of the PPA market in Romania. This situation draws attention to the urgency of taking the necessary measures regarding the impetuous obligation of the state to proceed with the promotion and development of this mechanism on the territory of our country.

In chapter 5 entitled *Main drivers and barriers that influence Power Purchase Agreements*, section 5.1 offers a general overview about the meaning of driver and barrier, while section 5.2

offers the definition and presentation of Drivers/Barriers that help the promotion and development of Power Purchase Agreements. In this regard, this section defines the meaning of the need to promote PPAs, state's implication, transition towards green energy and payment timing methods, **experience** revealed to be drivers, but also the meaning of PPA market, level of knowledge, risk assumption, force majeure, percentage of revenue proved to be barriers.

The main objective of this research revealed in section 5.3 is to find out, analyse and understand the factors that influence PPA on the way to green energy, regardless they promote this agreement or prevent the entry into this type of contractual relationships.

This chapter has the main purpose of analysing and better understanding the drivers and the barriers that influence the attitude of the respondents towards the possibility of signing a PPA and answers to the question *Are there factors that influence PPAs on the road of achieving climate neutrality and if so, which are they and what is their impact?*

The research methodology (section 5.3) consists in Comparative analysis between the risks assumed by the parties involved in a PPA, Questionnaire, Experts' interviews, Correlation matrix, IBM SPSS Statistics for Windows, MS Excel.

Section 5.4 shows Research results – effects and consequences of the drivers/barriers on signing PPAs and states that for each category, some factors, such as, for example, the need to promote PPA, transition towards green energy, price establishment, financing methods, state's implication (drivers), type of resource that requires more attention, negative prices, PPA market, state's implication (barriers) were assumed to become barriers/drivers as the case may be and on the basis of the variables, multiple linear regression was again performed with attitude towards the completion of the PPAs as the dependent variable.

A special case was the one of the experience, which although at the beginning was considered to be a driver, after the analysis was done, it seemed to be more like a barrier rather than a driver, because lack of experience or insufficient experience give people a lack of confidence in such a mechanism, as seen in the table.

At the same time, the impact of each driver/barrier on signing PPA was identified. Thus, it was highlighted that the most influenced driver is the need to promote PPAs with a percentage of

37.23%, situation which, when analysed in relation to the fact that the true purpose of the PPA lies in the fact that PPA is a promoter of energy from renewable energy sources.

Transition towards green energy occupy the second place in the share of each driver's impact on the attitude towards the conclusion of the PPA (23.53%) followed closely by Payment timing methods (23.40%), which lead to the clear conclusion that both of them contribute significantly to the development and promotion of PPAs.

Last driver with a percentage 15.81% is state's implication, which as can be seen is thought by respondents as beneficial, the involvement of the state, even if it implies taking several measures and it requires a sustained effort in order to see improvements, appears, at least for the time being, to be encouraging in terms of entering into contractual relationships within a PPA.

Regarding the impact of the factors proven to be barriers, the assumption of risks in a force majeure event has the greatest impact with a percentage of 34.4%.

In second place, with a percentage of 23.9% is the level of knowledge, and in third place is the analysis of risk-taking in a PPA (buyer or seller) (12.8%).

From the analysis of the previous results it can be seen that risks, regardless of whether it is talking about risk-taking in general or in particular in the case of a force majeure event are clearly barriers to the entry into a PPA.

The level of knowledge represents an important barrier as lack of knowledge may prevent a PPA from being signed. At the same time, an insufficient knowledge of the correct implementation of PPAs may also prevent the normal functioning of these contractual relationships, which proves what an important role the public awareness of the PPAs has on the signing of these agreements.

Chapter 6 *Comparative study regarding the Power Purchase Agreements market, implicitly renewable market at Spain and Norway's level* presents in the first section The concept of neutrality climate target both in Norway and Spain and shows regarding Norway that it was decided that in Norway electricity is generated almost exclusively from renewable energy sources, in the year 2020, 90% of the electricity being produced in hydroelectric plants (Norway has over 1000 storage reservoirs that correspond to 70% of annual Norwegian electricity consumption) (Climate Action Tracker, 2022), while regarding Spain it states that the renewable energy industry is very important for attracting investors in this field, in 2019, Red Eléctrica de España - the sole transmission agent

and operator of the national electricity system in Spain - receiving applications worth 125,200 MW, which meant more than the capacity expected for Spain until 2030, according to the forecasts of the Spanish Government (*48,550 MW of installed capacity for wind projects and 38,404 MW for photovoltaic plants, according to the National Energy and Climate Plan 2021–2030*).

Section 6.2 states the General presentation of the Norwegian and Spanish PPA market and presents that large electro-intensive industries represent an important segment for corporate renewable PPAs, with large aluminum smelters in Norway sourcing electricity through hydropower purchase agreements, and recently signing long-term wind power PPAs.

The second country studied - Spain - is one of the most attractive countries when it comes to PPAs, because between 2018-2021, it contracted more than 24% of the total PPA capacity in Europe, so that in 2022 it represented only one third of contracted capacity (Van Halm, 2022). At the same time, according to European Commission, (2022), as of 2020, Spain is the largest and most important market for PPAs in the EU, with 23% of total contracted capacity, while associated high value financial transactions accounted for almost 1% of the country's GDP.

In 2023, Spain closed deals for more than 3.2 GW of disclosed capacity, having 1.8 GW - almost 80% of the contracted volumes in MW - achieved through transactions concluded by the aluminum company whose wish was to reopen the San Ciprián smelter (Pexapark, 2023a).

The main objective of this chapter was stated in section 6.3 and concerned the analysis of the development and evolution of the renewable energy market and most importantly PPA market in two European countries Norway and Spain, considering the measures taken by each country, and the importance of the renewable energy market, while the research methodology used in this chapter consisted in a comparative analysis and an analysis using Ms Excel, and answered the question *What measures must be taken in order to promote and develop PPAs?*

Section 6.4 is about the presentation of the Guarantee schemes implemented by Norway and Spain, and showed that Responsible for the implementation of this mechanism are Eksfin in Norway, respectively CESCE in Spain, and the conditions to be fulfilled by buyers to benefit from this mechanism are to have at least 1 GW/year consumption in two of the last three years, and the consumption to be at least equal to half of their energy during off-peak hours (Spain), whereas the conditions to be fulfilled by the offtakers in Norway are to be registered in Norway, to be active in the field of wood, wood products, wood processing, metal production, chemical production and the

annual consumption to be more than 10 GWh and the PPA volume to be more than 35 GWh. The tenor for the Spanish guarantee scheme is required to be more than 5 years and cover more than 10% of the buyers demand, while in case of the Norwegian guarantee scheme the tenor is established between 7 – 25 years.

Regarding the guarantee scheme it must be mentioned that CESCE could indemnify up to 80% of the contract termination value to the seller, while Eksfin disturbs the difference between the PPA – and the annual mean spot market price, up to a maximum of 80% of the remaining payments under the PPA or up to 80% of any loss that occurs.

At the same time, it is stated in section 6.5 that both Spain and Norway allow the purchase of electricity either from a production facility or from supplier, and at the same time allow to sell electricity directly to an end user. In Spain for example according to the Electricity Sector Act (Act 24/2023) PPAs can take more forms: physical PPAs, financial PPAs, collar PPAs, direct (self-consumption) PPAs. In this regard, Royal Decree 244/2019 has eased the process for Direct PPAs by lowering the taxes and incentives and facilitating the process.

In addition, it was proved that the level of development of the PPA market in Spain is the highest among the marketing models for Renewable Energies, this country offering excellent conditions both in terms of bankability and potential. Although the market volume does not seem to take advantage from conditions as favorable as the other elements, it can be noticed from the analysis made in this chapter that the level of development and investment in the renewable energy segment is obvious and encouraging, the trend being the creation of more energy parks, especially wind and solar.

The profitability of the PPA market in Spain also results from the active involvement of the state, which has created various support mechanisms/schemes to attract companies to invest in the development of the renewable market. Basically, in addition to natural resources, the support provided by the state has helped to achieve such a developed level of the PPA market in Spain, which has propelled it to first place in Europe in the number of PPAs signed in Europe and fourth place in the world, with the podium being occupied by the USA, Brazil and Australia (Energy Monitor, 2023).

The last section, 6.6, is about the Proposal of solutions to promote and develop PPA at national level in Romania and shows that one of the proposals presented within this PhD thesis is

represented by the **development/creation of a guarantee scheme along the lines of the Norwegian and Spanish models, which would facilitate the use of such instruments by companies.**

Such an institution would provide financial guarantees to support not only industrial companies, but also small and medium-sized enterprises wishing to obtain financing for the development of their green energy investment projects, as well as ensuring the sustainability of the business.

Basically, this institution would now step in and partially take over the credit risk, making financing more affordable.

Another proposal presented is that the National Credit Guarantee Fund for Small and Medium-sized Enterprises **FNGCIMM should take over the tasks of this governmental institution.** As it is already known FNGCIMM implements government programs aimed at economic recovery, development of the business environment, as well as job creation and support, operating as a joint stock company, with the sole shareholder being the Romanian State, under the supervision of the National Bank of Romania.

Also, similarly to the Norwegian and Spanish institutions, FNGCIMM SA - IFN offers a guarantee of maximum 80% of the loan amount, but not exceeding the amount of 2.5 million euro/beneficiary (which is not the case for the other two institutions) and is issued at the request of the partner financing institutions, for approved financing, based on the analysis of the documents submitted by the financier.

The third proposal is about **attracting large companies with previous experience in concluding such financial contracts on the European or international market and which could bring their know-how to Romania.** In this sense, the CfD mechanism, which, although perhaps in a first phase could lead to a certain slowdown in the signing of such agreements, in turn could be a promoter in attracting such companies in Romania, which could help the development of the renewable market and which depending on their interest could be oriented even to PPAs, in case the signing of a CfD would no longer suit their intentions.

Also, membership within AIB is another facility that helps attract investments and people interested in investing in the Romanian energy market. As it is shown in the second chapter, sub-

chapter 5, guarantees of origin, which represent proof that the energy was produced from renewable energy sources, are currently tradable only in Romania, and their value is 0, which make some investors hesitant. Besides the fact that without them, buyers of PPAs cannot prove that they have purchased energy from renewable energy sources, GOs must be transferable between EU Member States. Once these guarantees of origin become internationally tradable, this would attract more investors. But the ability to transfer GOs within the EU can be possible only if these documents are certified by a European body, precisely the Association of Issuing Bodies (AIB).

In chapter 7 *Conclusions, main contributions of the research project and perspectives for the future*, conclusions are drawn to answer the research questions. A summary presents all findings in condensed form. In the section 7.2, the thesis is reflected upon and main contributions are presented, while section 7.3 deals with the prospects for future research.

This PhD thesis aims to provide a more structured and substantive knowledge about these financial contracts, how they can be promoted and developed, what their better and more efficient implementation entails, what obstacles need to be overcome, taking into consideration the risks that such instruments assume, in order to reach a unanimous solution to make them a reality.

It is therefore important that all these aspects to be taken into consideration and all the barriers that stay against the development of all these financial instruments to be eliminated, respectively to be minimized as much as possible all the associated risks. It is necessary also to be fair market signals because in their absence the signing of PPAs proves to be much more difficult, as long as there are no future perspectives. There is a waiting from the consumers the energy prices to decrease, with the implementation of different governmental schemes, which corroborated with the fear regarding the entering in long term contractual relationships, conducts to a reluctance from the consumers perspective.

In this purpose, the results obtained through this PhD thesis highlight and address important factual aspects which are faced by the economic-political and legal society, especially what renewable energy market and PPA market involve. By means of this PhD analysis a connection between the current energy market reality and the circumstances and opinions in the scientific literature is created, with consideration of the circumscribed international guidelines, but also specific cases and clear measures implemented in order to promote and develop the renewable

energy market and PPA market. By acting like this, the present PhD thesis definitely offers a clear contribution to the research field.

Another aspect that highlights the important contribution of this PhD thesis is proven by the analysis of the factors that have both a positive and negative influence upon the signing of PPAs, and divide them into two categories such as drivers and barriers. The results prove that the factors impacting on PPAs are in higher number barriers, which means that, despite the fact that state involvement is a driver, the state as the decision-making body that has the most power and influence must intervene and take the necessary measures. In the absence of support from the state, the level of knowledge, the level of the PPA market and the experience will decrease significantly, as these factors have proven to be barriers. This is why unclear policies can make signing PPAs more challenging, the low level of PPA signing being a direct consequence of lack of knowledge and experience.

The analysis of the risks, respectively the assumption of risks by the parties is another contribution that this paper brings in, this aspect being of an important matter to consider, as long as one of the counterparties may fail to fulfil its obligation under a long-term agreement. The risks are various, the ones analysed in this thesis being the main risks that resulted from the questionnaire.

The main contributions of this PhD thesis to research are summarized below.

1) Assessment of the framework conditions for PPA as a tool to promote renewable energy and achieve climate neutrality. One contribution of this PhD thesis to research is the evaluation of these framework conditions in order to find out to what extent the European Union offers a framework for establishing a common PPA market that meets the expectations of the new sustainability-oriented context. This evaluation of the framework conditions for a PPA market represents an own contribution because it highlights different measures that can be taken into account in order to improve this market.

2) Improving existing literature and research, i.e. analysing the latest developments of the PPA concept. In this regard, it was stated that the new 24/7 PPA and hybrid PPA concepts are a clear proof of the willingness to evolve, constantly making improvements to this efficient legal mechanism, which offers long-term price and volume security for renewable energy. The existing

research was further developed and a link between the existing literature and the current situation in the level of PPA market was made. Thus, this PhD thesis creates a bridge between theory and practice and this represents a major contribution to research.

3) Analysis and understanding the role that 24/7 PPAs and hybrid PPAs are playing in the development of renewable energy. Another contribution of this PhD thesis is focused on the analysis and understanding of the new PPAs concepts such as 24/7 PPAs and hybrid PPAs. In this regard is highlighted that due to the link between production and consumption in real time, 24/7 solutions offer the highest form of credibility on the market, while with a classic renewable PPA, fluctuating sources such as solar and wind can cover only part of a consumer's consumption profile per hour.

4) Identifying the benefits and advantages that PPA entails. In a desire to provide a better understanding of the concept of PPAs, this PhD thesis provides clear and precise information on the benefits and advantages that these contracts entail and which are impetuously needed to be brought to the attention of the general public.

5) Analysis of the importance of allowing the issuance of GOs to conclude and maintain the validity of a PPA. Within this PhD thesis it has been stated that the guarantees of origin represent the clear proof that the acquired energy is generated from renewable energy sources and signify a key pathway to achieve decarbonisation targets. The fact that Romania currently does not hold an AIB membership represents a major problem, and this thesis examines the importance that this document plays for the further development and promotion of PPAs.

This PhD thesis therefore makes an important contribution to research and shows that being an AIB membership will help see more cross boarder PPAs and also see really growing interest from corporate offtakers in the coming future.

6) The role of the EU in the promotion and development of PPAs and the investigation of the measures taken by it. This research paper also examines the role of European Union in promoting and developing PPAs and investigates the measures proposed by EU. The European Union has shown great interest in the development of renewable energy and therefore come up with different solutions in this regard. Now the current energy policy of the European Union intends to promote different financial instruments in order to meet the objective of reducing gas

emissions, one of which being PPAs. In this context, EU involvement and its regulations are analysed in this PhD thesis and this represents another contribution of this research.

7) Evaluation of Contracts for Difference as a financial instrument and their impact on the signing of PPAs. This PhD thesis makes a major contribution to research by analysing the CfD as a complementary instrument for the promotion of PPAs in Romania. To this end, this research paper analyses the impact that the CfD scheme has on the development of PPA market.

The CfD scheme will be very interesting from the developers' point of view, the main force attracting developers to enter the market and it can be seen some players with previous PPA experience in European jurisdictions coming to Romania and bringing this experience with them.

8) The assessment of the most important risks that impact on signing PPAs. The assessment of the risks that impact on the signing of PPAs represent also another main contribution brought by this thesis. The need to take these measures is more relevant as the legislative changes proved to be more often taken into account by the respondents when they refer to the risks that appear when signing PPAs.

The assessment of the results provided by the statistics shows that although PPAs are open to regulation and no longer banned, unfortunately the parties are not able to find a common point of long-term risk assessment, with the limited development of the PPA market and contractual changes making any decision difficult.

From the point of view of the price, this PhD thesis shows that while buyers agree to sign this contract at a fixed price, the sellers prefer CfD prices, what 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.

9) Identification of drivers and barriers that help or prevent signing of PPAs. One of the main contributions of this PhD thesis is the identification of the drivers and barriers that help or prevent the signing of PPAs. The key factors analysed in this research resulted from the answers given by the interviewed persons throughout questionnaire, and this finding can be explained by the fact that the PPA in Romania is at a very early stage and more resources need to be allocated to its promotion and development.

Another contribution brought by this thesis is that it revealed from the answers very well outlined by questionnaire, that although the existence of PPA is desired, its role and need are not well explained and therefore misunderstood by market participants so that a better communication is needed so that market participants, from regulator to beneficiary to understand the need, the utility and the mechanism behind them.

Therefore, as a main conclusion of one of the contributions made by this PhD thesis is that special attention should automatically be paid to these barriers in order to eliminate them, and if not completely eliminated, at least to mitigate the effects they have on the signing of PPAs, while further develop the factors that have proven to be drivers for the promotion and signing of PPAs.

10) Analysis of the measures taken by Norway and Spain to promote renewable energy and the development of PPAs and evaluation of the results achieved. The research investigates Power Purchase Guarantee Schemes created by the Norwegian and Spanish Government in order to facilitate and encourage the signing of this type of contracts.

In this context, the conditions created by the two states are analysed, with a special focus on legal measures taken by these countries. Accordingly, this PhD thesis describes also the results, strengthening the path towards an accessible development of PPA market.

Thus, by offering a clear and detailed presentation of the conditions and measures taken by Norway and Spain at national level so as to develop the PPA market and to encourage entry in such contractual relations, this PhD thesis adds value to the research done so far and helps create a favorable framework for the promotion of PPAs.

11) Identification of solutions to create an enabling environment for the development of PPAs. This paper identifies the specificities of the renewable energy sector, with a special focus on the strategic role of PPAs. Over time, the situation of PPAs proved to be unfavorable and the PPA market was not functional in Romania.

Only after the entry into force of GEO 143/2021 on 31 December 2021 will wholesale market participants be allowed to enter into directly negotiated bilateral transactions. Thus, in 2022, the first PPA was signed for two more to be signed in 2023.

One solution in order to see more maturity and growth in this area is to encourage more international corporations to use the Romanian footprint, to be an attractive option for the international corporation, cfd scheme could be such a solution.

Another solution would be to allow the financial transaction of Guarantees of Origin, thus being a member of AIB (Association of Issuing Bodies). This membership will help see more cross boarder PPAs and also see really growing interest from corporate off-takers in the coming future.

A possible third solution identified by this PhD is the creation of a possible Guarantee Scheme such the ones developed by the Norwegian and Spanish states, where the state gets involved and is the main guarantor having the principle aim of facilitating the use of PPAs by industrial companies.

Not lately, another solution would be that FNGCIMM to take over the tasks of this new institution and, considering its previous experience, to try to develop and encourage the entry into contractual relationships within a PPA.

12) Applying research methods in an original way to provide new insights and a better understanding of PPAs. The present PhD thesis has been carried out by combining several research methods, which have been used in an efficient way, creating new perspectives on the subject under analysis. Thus, qualitative research methods have been harmoniously combined with quantitative research methods providing a clear picture of the level of PPP contracting in Romania.

13) Assessment of the current situation in Romania regarding the signing of PPAs. This research focuses on showing that the key way that Romanian PPA market is able to see more maturity and growth is to encourage more international corporations with previous PPA experience to use the Romania footprint to sign PPAs. The recommendations and research findings are very important for the further development of Romanian PPA market and can also be taken into consideration in further research projects.