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IMPACT OF ENERGY EXCHANGES ON THE FUNCTIONING OF THE ENERGY MARKET IN THE EUROPEAN UNION

ABSTRACT

of a dissertation for acquiring the educational and scientific degree "Doctor" in a scientific specialty

"World Economy and International Economic Relations"

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The author is a PhD student in a part-time form of study at the Department of International Economic Relations at the Academy of Economics "D. A. Tsenov", Svishtov.

The dissertation is in the volume of 145 standard pages. Structurally, it consists of an introduction, an exposition in three chapters, a conclusion, and a list of references - a total of 83 sources. In support of the above, 11 tables and 18 figures are included. The appendices are 2 in number in a volume of 6 pages.

Content of the abstract

I. GENERAL CHARACTERISTICS OF THE DISSERTATION

1. Relevance of the research

The integrated European energy market is the most cost-effective way to ensure secure and affordable energy for EU households and businesses. Through common rules for trading on energy exchanges and reliable cross-border infrastructure, energy can be produced in one EU country and delivered to another, thus creating price competition and consumers being able to choose their supplier. Today's electricity market is fundamentally different from the market five years ago. The share of electricity produced from renewable energy sources (RES) is expected to increase from 25% now to 50% in 2030, according to the EU's energy strategy and to make the EU a world leader in renewable energy.

The transition to a decarbonized energy sector creates new challenges and opportunities, and innovation is a key element of a successful transition. The energy landscape is changing and technologies and new business models are evolving rapidly.

Energy companies and investors need stability to be able to invest in innovation and infrastructure. A reliable market is able to ensure this stability, provided that it is supported by a solid regulatory framework and provides sufficient space for entrepreneurship. Market prices take on the role of a transparent guiding signal to guide and stimulate innovation and investment. The success of market liberalization has shown that competition and market access ultimately lead to justified prices for consumers.

Energy exchanges are a key component of energy markets and are needed to meet today's challenges and create new opportunities. Exchanges and independent market operators shall ensure and facilitate neutral market access. They are the binding force of the increasingly diverse and diverse market landscape. They ensure price transparency, stimulate innovation, investment and competition.

The topic for the dissertation was chosen because it follows the relevance of economic relations for the development of international trade in energy and electricity. The problem is slightly developed in the Bulgarian specialized literature, and the preparation of theoretical and empirical part will help to build a vision related to the research topic.

2. Object and subject of the research

The object of the study is the EU energy market and in particular the wholesale electricity market in the context of the European energy policy.

The subject of the study is the impact of energy exchanges on the functioning of the electricity market as a whole in the EU.

3. Research thesis

The main thesis of the dissertation is that energy exchanges are at the center of the liberalized and single European energy market, as the most effective way known so far for trading of electricity and energy. Exchange trading provides transparency in pricing, liquidity, easy market access for multiple participants, competition and security of supply.

4. Aim and tasks of the dissertation

The main *research aim* of this dissertation is to analyze the impact of energy exchanges on the functioning of the energy market in the European Union in relation to electricity trading in the light of European energy policy.

To achieve this goal, several research tasks are set in the following areas:

- To analyze the European energy policy both in chronological order and in terms of building a legal and regulatory framework;
- To determine the main prerequisites for the formation of the European energy policy;
- To study the current challenges facing the European energy policy;

- To analyze the importance of the electricity market in the EU in terms of production, energy mix of Member States, structure and dynamics of consumption;
- To study the leading models for reforming the electricity market and the liberalization of the European energy sector;
- To analyze the impact of energy exchanges on the functioning of the electricity market and to indicate the main factors;
- Propose an index based on the above factors to measure the impact of energy exchanges on the EU electricity market.

5. Research methodology

In methodological terms, the research is based on the methods of scientific logic - observation, induction and deduction; descriptive method; analysis and synthesis; modeling and graphical presentation of the considered phenomena and processes.

6. Restrictive conditions of the study

The topic of the European energy market is multifaceted because it touches on a wide range of related issues, revealing many more interconnections, such as those between electricity generation and energy production; between the extraction of electricity from fossil and renewable sources; between the improvement of electricity generation technologies and the development of energy policy. For this reason, the study examines the European energy market, in the context of energy exchanges, and due to the wide scope of the topic, we set this restrictive condition, focusing only on the electricity market.

II. STRUCTURE AND CONTENT OF THE DISSERTATION

Structurally, the dissertation consists of an introduction (3 pages), a presentation presented in three chapters (120 pages), a conclusion (2 pages), a list of references (6 pages) and appendices (6 pages).

The structure of the development is structured as follows:

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III. SYNTHESIZED PRESENTATION OF THE DISSERTATION

Introduction

The introductory part presents the general statement of the research topic, outlining the framework for scientific analysis, the degree of development of the problems and reveals the relevance of the development. The object, the subject and the research thesis of the dissertation are successively defined, the aim of the study is formulated, specific tasks for implementation are set and the methodology and the restrictive conditions of the research are indicated.

Chapter One

CONCEPTUAL STRUCTURE AND ESSENCE OF THE EUROPEAN ENERGY POLICY

The first paragraph begins with a definition of energy policy as Noah Jacobs' description that "energy policy is the way an entity (often a government) has decided to deal with energy development issues, including the production, distribution and consumption of energy" (Jacobs, 2009). Jacobs expands with the understanding that in order for this policy as a whole to be effective, it must be implemented at a more global level, namely at the level of the European Union. In addition, the main issues to be addressed related to EU energy policy are addressed, defining the general principles and objectives of this policy. These objectives are subsequently synthesized by the Energy Union into five main ones, namely ensuring security of supply, promoting energy efficiency, decarbonizing the economy, promoting renewable energy, promoting research and competitiveness.

As a result of the considerations set out in the first paragraph, we can conclude that the European Energy Union is a natural continuation of the evolution of EU energy policy. It is based on the general principles and objectives of this policy. The Energy Union

clearly defines the main goal of ensuring the functioning of the internal energy market and determines the interconnection of networks, and energy exchanges are becoming not only an integral part of this market, but also a guarantee of openness and transparency of market relations in electricity trade.

The described general principles of the European energy policy, affecting the EU member states, do not appear spontaneously, but are part of the evolution of the project for a common energy policy, accompanying the process of common integration. That is why an essential part of the study of the European energy market is the tracking of its evolutionary development.

The *second paragraph* continues with a follow-up to the development of European energy policy from 1951 to the present day. The first steps in building energy policy in Europe include the signing of the Treaties establishing the European Coal and Steel Community (ECSC) in 1951 and the European Atomic Energy Community (EURATOM) in 1957. These are two of the three main EU treaty. In 1957, the European Economic Community (EEC) was established, which set in motion a number of integration policies.

The 1960s are characterized by a focus on the national level. The impetus for international energy cooperation was triggered by the oil crises of 1973/74. As a result, in 1974 a Council Resolution on a new Community energy policy strategy was adopted (Official Journal C, 1975), which soon afterwards it was extended to the energy targets for 1985. The Council not only emphasizes the added value of close coordination between Member States to tackle energy issues, but also adopts guidelines on energy supply, the promotion of nuclear energy, hydrocarbons and solid fuels in the Community, as well as more efficient use of energy.

In the coming years, the issue of environmental protection is becoming more and more relevant in Europe, but this is still not reflected in European legislation and climate change is still not at the top of the agenda. The first evaluation report of the Intergovernmental Panel on Climate Change (IPCC), published in 1990, the subsequent IPCC reports, the Earth Summit in Rio de Janeiro in 1992 and the adoption of the Kyoto Protocol in 1997 have put climate change and energy issues at the top of the global agenda, creating an environment for setting more ambitious goals.

It was not until March 2007 that EU Heads of State and Government approved the first action plan in the field of energy. Following a series of discussions in previous years, the European Commission's Energy Policy for Europe strategy sets the stage for a more integrated European energy policy, which has gained considerable momentum since then. The Action Plan outlines the three main challenges facing European energy policy that form the core of the common energy policy to date: sustainability, security of supply and competitiveness. To achieve these objectives, the Commission has also set quantifiable targets, including the well-known "20/20/20" targets, which have defined European energy policy in recent years. These targets relate to three 20% targets to be achieved by 2020:

• Reduction of EU greenhouse gas emissions by at least 20% below 1990 levels (to be increased to 30% in case other industrialized countries and economically more advanced developing countries also make an adequate contribution)

• 20% of energy consumption in the EU comes from renewable resources and

• 20% reduction in primary energy consumption compared to forecasts

Following some major changes in legislation in 2007, several strategic documents currently set out energy development at EU level, the most important of which are: Energy 2020. Competitiveness, Sustainable and Secure Energy Strategy and the 2050 Energy Roadmap, most recently published at the end of 2011, Energy 2020 emphasizes the urgent need to act not only to restructure the EU energy market and to achieve climate goals, but also remain competitive in the future.

As the implementation of the 2020 targets approaches, a new set of targets has been drawn up in 2014 through the so-called 'Climate and Energy Framework', to be achieved by 2030 (European Council, 2014). By 2030, greenhouse gas emissions must be reduced by at least 40%; the share of renewable energy in energy consumption should increase by at least 27% and energy efficiency should increase by at least 27%. In 2018, the target for renewable energy sources was set in EU legislation and increased to 32%, and the target for energy efficiency - up to 32.5%.

The 2050 Energy Roadmap is also a strategic document, but as the name suggests, for a longer period of time, as the pattern of energy production and use in 2050 has already been defined. The 2050 Roadmap is a response to the long-term investment cycles of

energy infrastructure and aims to provide guidance beyond 2020. By 2050, the EU is committed to reducing greenhouse gas emissions to 80-95% below 1990 levels. The 2050 map outlines the way to achieve these decarburization targets and ensure the key energy security and competitiveness targets.

EU energy policy, unlike other policies, is conceptual in nature, as it does not yet have a coherent framework and organization. It should be pointed out that until recently it was not officially recognized as a full-fledged policy of the integration community. Therefore, when we talk about EU energy policy, we mean the joint efforts of Member States to achieve coordinated action in the field of energy and a less streamlined structure that has gone through all stages of political governance, including defining on the agenda, formulation of goals, regulations, system for making decisions and their actual implementation.

Following the analysis of the evolution of European energy policy, we come to the following conclusions:

- European energy policy is evolving in parallel and as a result of the transformation of the energy market.
- Electricity supply is not only a strategic task for the economic development of individual economies in the EU. In the 21st century, the ways of sustainable energy supply come to the fore, which is related not only to the environmental challenges related to climate change, but also to the need to provide electricity at reasonable prices for both industry and household consumption.
- It should not be forgotten that the pursuit of energy allocation is at the root of many international conflicts, historically speaking. European energy policy aims to achieve fairness in electricity trade, taking into account the development needs of both developing and industrialized countries.

The *third paragraph* concerns the legal framework of European energy policy. As part of the EU's integration system, European energy policy is based on a specific legal framework. With the creation of the basic normative acts, beginning with the Treaty establishing the European Atomic Energy Community (1957), the common framework of energy policy continues to be built at the moment, creating new normative acts in

the form of directives, regulations and recommendations. The main actors in this work are the European Commission, the European Parliament and the European Council, together with the 27 Member States and local energy companies. The legal framework of European energy policy is evolving and improving in line with specific changes in the market environment and current challenges in the energy industry.

The fourth paragraph of the first chapter defines the current challenges facing European energy policy. In February 2015, the European Union's energy and climate policy took the form of an energy union strategy. It is the result of the maturing of the common energy market and is a long-term trend. This process forms a quadrangle of objectives related to energy and climate, competitive internal market, security of supply and sustainability, and the achievement of these objectives is associated with addressing some of the serious challenges described in Table 1 below.

Table 1

Challenges for European energy policy

Aims	**Challenges**
In the field of energy and climate	The EU as a bloc will be able to meet its own ambitions in 2020, but not all Member States are performing satisfactorily; Only half of EU emissions reductions are due to climate policies; Fundamental changes in current production and consumption patterns are needed to meet the medium-term (2030) and long-term goals (2050);
Common energy market	Low efficiency of the EU institutions to promote competition in European energy markets; Lack of significant competition, especially in the natural gas market;
Energy security	Threats of cyber-attacks on energy infrastructure;
Sustainability	Uneven distribution of social costs;

Source: compiled by the author

The described current challenges to the European energy policy are diverse. Some of them can be seen as external influences, under the influence of which the nature of European energy policy is changing. This is the general trend towards sustainable

development, which is being implemented in the EU as a reflection of the philosophy of economic progress through the protection of the environment and natural resources. Another part, such as energy security, is inextricably linked to the aspirations of EU member states to improve prosperity by ensuring independence and security in key sectors of the economy. The third part of the challenges facing European energy policy is related to compliance with commitments under multilateral agreements, such as those outlining measures to combat climate change as a result of industrial greenhouse gas pollution. The described current challenges to the European energy policy are an illustration of how the unity of the interests of the EU countries is achieved in the course of building the common principles and goals of the energy policy of the EU and the Energy Union.

In conclusion of the first chapter, we should summarize the following: in order to clarify the nature of the energy market within the EU, it was necessary to analyze European energy policy, including its general principles and objectives, as well as its evolution, as they form a theoretical foundation for studying the functioning of the market itself. In addition, the disclosure of current challenges to European energy policy is becoming an important prerequisite for disclosing the framework in which the analysis of the European energy market will be developed in order to highlight the specifics and importance of energy exchanges.

The conclusions that emerge as a result of the analysis in the first chapter show that:

- Historically, EU energy policy has moved from a fragmented phase to a period of gradual synchronization between Member States, undergoing significant change. EU countries are realizing their historic mission - to serve as a model for the energy transition through green innovation to limit global warming.
- Modern electricity generation is at the crossroads between climate goals, national interests and supranational regulation. In addition, technological dynamics and innovation in the energy sector and heterogeneous geopolitical conflicts also have an impact on the process of updating EU energy policy. We are witnessing not only a shift from fossil fuels to renewable energy sources, but also to new ownership models and the growing decentralization and democratization of energy supply and distribution.

Chapter Two

ELECTRICITY MARKET IN THE EU

The second chapter deals with the topic of the electricity market, starting with the basic definition of this market and the regions that make it up according to the classification of the European Network of Transmission Operators. The market is also seen as a set of reforms led by the European Commission.

The use of electricity for household and other everyday applications is one of the most important revolutions of modern times (Harris, 2006). In our daily lives we enjoy constant access to electricity, and the lack of electricity would make the life of modern man unthinkable. This makes electricity extremely important as a commodity and creates peculiarities in the way the electricity sector is organized in terms of production, transport, transmission and retail.

To build a real characteristic of the market we do not consider the life cycle of electricity, which gives us an idea of how it works. To achieve this, we follow the description proposed by (Harris, 2006), as the burden of such a description lies on the economy, and not on engineering sciences, politics or other fields. The life cycle of electricity leads to some main stages, certain additional activities and consequences described in fig. 1:

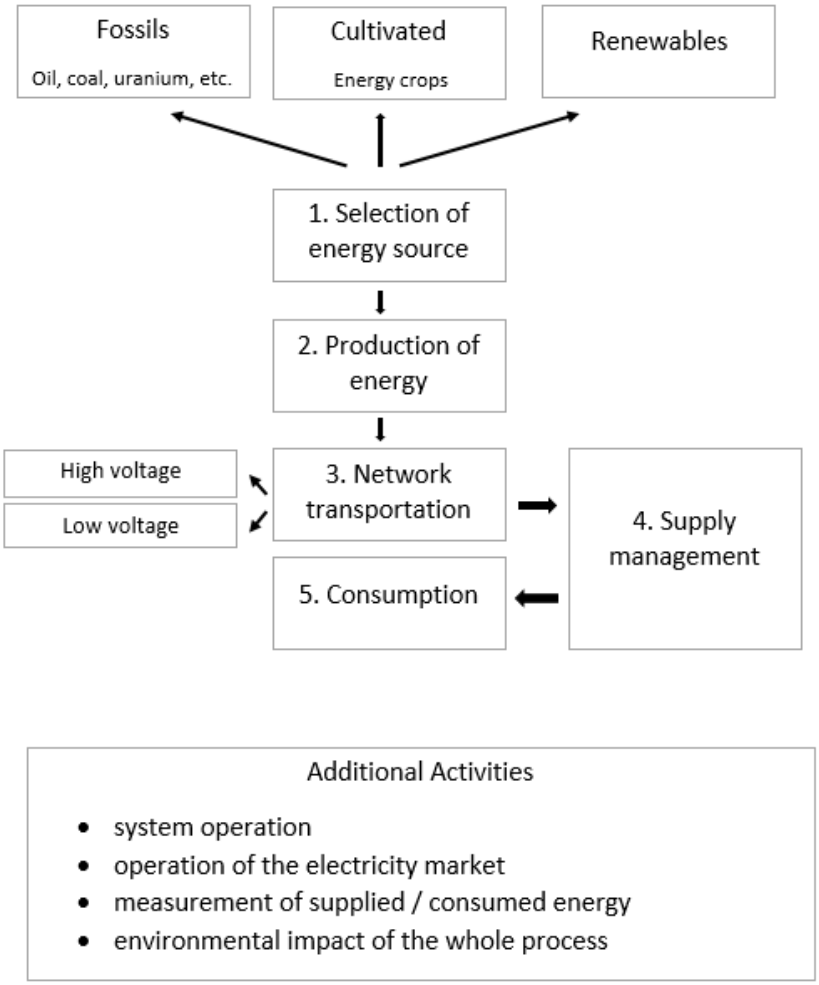

Figure 1. Life cycle of electrical energy

Source: Developed by the author

The cycle begins with the choice of energy source, and energy sources can be of several types: fossil (oil, coal, uranium), cultivated (e.g. energy crops) and renewables (wind, water, sunlight). The second step is electricity generation, where coordination between generation and demand is essential to avoid problems with grid load, power losses and voltage stability. Once electricity is generated, the next step is its transport, including transmission and distribution. After transport, the next step is supply management, and here we can include the management of the system, as supply and demand must be coordinated, i.e. perfectly and continuously combined, in just a few seconds.

The *first paragraph* of the second chapter concludes that on the one hand the European energy market can be considered as a sum of the national markets of the EU member

states where against the background of the growing internal exchange of electricity stand out countries that are net importers and net exporters respectively. On the other hand, the functioning of the energy market is realized under the influence of reforms undertaken by the European Commission. The most important steps towards the creation of a free electricity market are: choice of energy source; electricity production; network system for electricity transmission; supply management; consumption management.

The *second paragraph* addresses the issue of the importance of the electricity market within the EU. Almost all aspects of modern life depend to a greater or lesser extent on electricity.

Primary energy production in the EU-27 amounted to 641 million tons of oil equivalent (toe) in 2017, while world production reached 13.65 billion toe. In 2017, the share of G20 members in total primary energy production in the world was 71.7%, while the share of the EU-27 was 4.6% (see Figure 2).

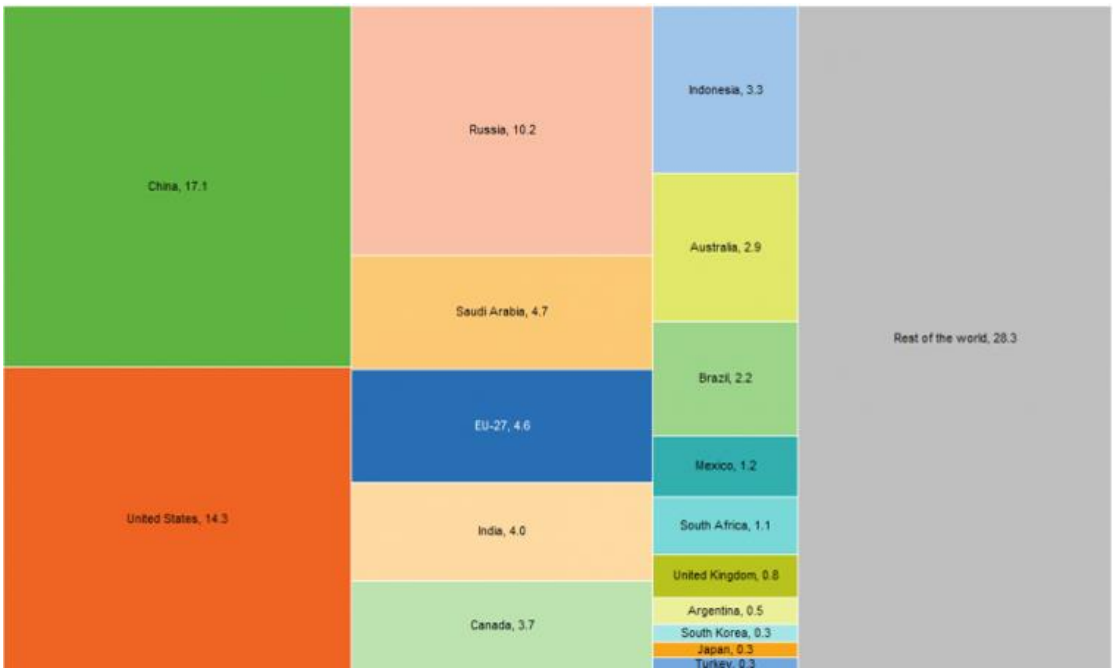

Figure 2. World primary energy production, in % by leading countries, 2017

Source: Eurostat

Electricity is a strategic sector and we need to understand this in the same sense in which it is used by the military, which is why it is a highly regulated sector (Nieto & Sola, 2003).

In the first subparagraph of Chapter Two, based on the facts and analysis, it is concluded that electricity generation should not be considered as an independent and neutral activity, but as a complex system of technologically diverse but relatively separate activities (Figure 1). As an economic branch, the production of electricity is considered in two main aspects. The first aspect allows us to emphasize the fact that in addition to electricity generation, it includes transmission, distribution and sales activities. The second aspect is related to looking at electricity generation in the context of the energy sector in general and in particular as generation that is highly dependent on primary energy sources provided by the energy sector.

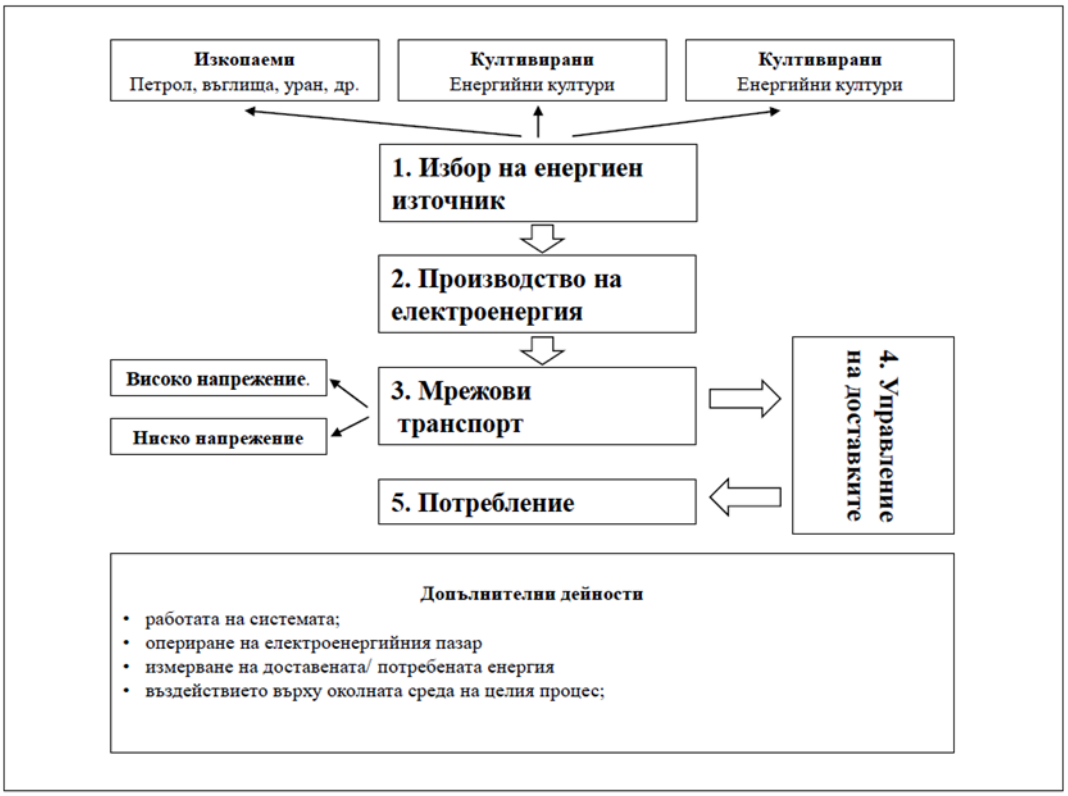

Figure 1. Life cycle of electrical energy
Source: Developed by the author

Based on the above, it is clear that the operation of the electricity market includes trading on energy exchanges, as well as capacity trading between producers and the system operator, and last but not least the coordination of all agents. It should be mentioned that in more mature and unrelated markets, electricity is traded repeatedly on its way from production to consumption.

In the second subparagraph, a market analysis of the energy mix in the EU is made on the basis of energy production and consumption of seven selected EU countries, including Bulgaria. Although Bulgaria is a net exporter of electricity, in general the country produces only about 61.5% of the energy it consumes as its main source of energy production, coal is still - 48.57%, followed by nuclear energy – 34.36% and RES - 16.6%.

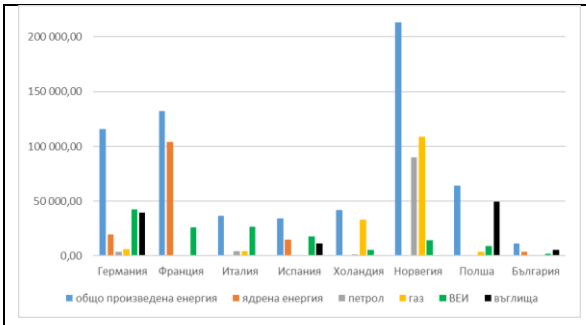

Figure 2. Energy production in selected European countries in ktoe
Source: Eurostat

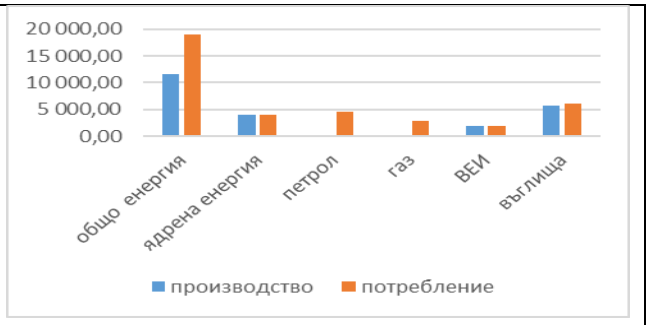

Figure 3. Bulgaria - energy production and consumption in ktoe
Source: Eurostat

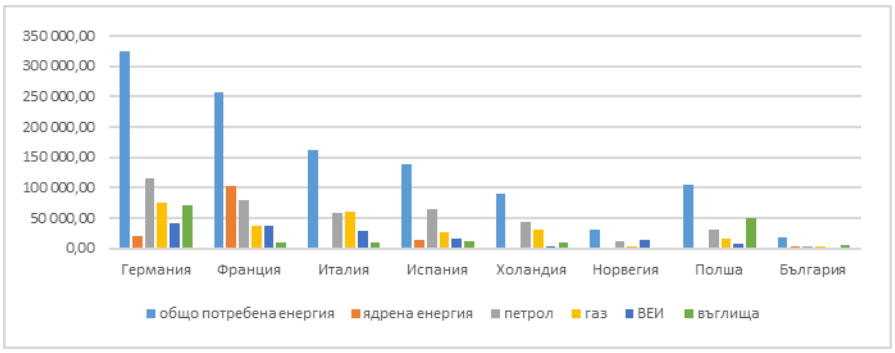

Figure 4. Energy consumption in selected European countries in ktoe
Source: Eurostat

The data show that the EU energy industry is a complex system and electricity generation is currently based on different energy sources. However, it appears that for most countries, coal is still the main source, followed by nuclear energy and renewable energy.

The *third subparagraph* of the second chapter discusses the structure and dynamics of electricity consumption in developed economies. For this purpose, two of the world's leading economies are taken as an example - the United States as the largest economy in the world and Germany as the largest and strongest economy in Europe. The original idea was to include the EU as a superpower, but due to the longer period we are studying - from 1949 to the present, as well as the accession of a large number of new member

states in the last two decades, and last but not least the exit of Britain from the EU, made us limit the example to the United States and Germany.

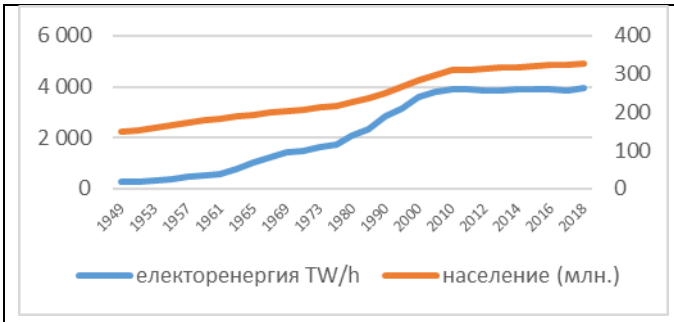

Figure 5. Population and total electricity consumption in the United States (1949 - 2018)

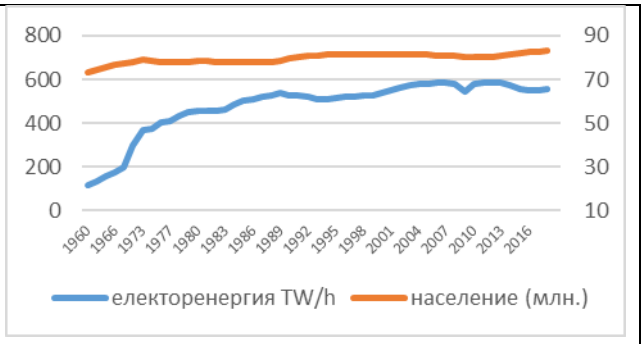

Figure 6. Population and total electricity consumption - Germany (1960 - 2018)
Source: World Bank; IEA

Over the last ten years, there has been a clear trend to reduce electricity consumption per capita and total consumption in the United States and Germany. On the one hand, scientific and development activities play a positive role here, which is expressed in the creation of more and more energy-efficient appliances with far lower electricity consumption compared to the corresponding equivalents from 20 years ago, for example. It should be noted that it is quite possible to observe a reversal of this trend in the medium term. An application for this gives the increasingly popular electric cars, as well as reducing their prices. 20 million new cars are expected to be sold in 2025, 28 million in 2030. In the longer term, by 2040, more than 30% of the world's moving cars are projected to be electric, with over 57% of the new cars sold will also be electric, and in 2040 56 million new cars will be sold (BNEF, 2019).

As a result of the analysis and the presented statistical material in the second paragraph we come to the conclusion that there are general trends in the production and consumption of electricity in developed economies. The energy sector is developing so fast and on such a scale, incl. with regard to new technologies and renewable energy sources, that the EU as a whole needs to rethink energy policy in order to remain competitive. The liberalization of the electricity sector would greatly contribute to this.

Table 2.

Models for reforming the electricity sector

Model	**Short description of the model**	**Pros and Cons**
Stephen Littlechild's Textbook Model	1. Privatization as a catalyst for efficiency; 2. Vertically divided into competitive activities; 3. Horizontal restructuring 4. Establishment of an independent system operator 5. Creation of energy markets; 6. New rules for access to the electricity transmission network; 7. Division of tariffs and rules for retail trade; 8. Clarification of the conditions for delivery to the end customers; 9. Establishment of independent regulatory agencies; 10. Establishment of transitional mechanisms;	1. The model does not allow deviation from the 10 main points; 2. The implementation of the "Textbook Model" would lead to the creation of an efficient electricity market; 3. The model is theoretical, as there is currently no example of a country in which it has been fully implemented, but rather the consequences of not applying it to a greater or lesser extent.
Model of Jamasb and Pollitt	1. Restructuring; 2. Competition and markets; 3. Regulation; 4. Property;	1. The model outlines a framework / plan and gives guidelines, allowing deviations; 2. Privatization should not be done at any cost, and privatization does not always lead to cost optimization and improvements;
Hunt's model	1. Open access to the network; 2. Restructuring of the sector through spin-offs and mergers or the creation of new companies; 3. Deregulation	1. The model is basic and oversimplified. 2. Full deregulation can lead to undesirable consequences, as the energy sector is too large and significant to be left to market forces alone.

The *third paragraph* consists of two sub-paragraphs, the first sub-paragraph examining modern models of reforming the electricity sector. The overriding task of electricity market reforms, especially in the EU Member States, is to build a more transparent, competitive and liberalized electricity market that provides reliable price signals to stimulate the necessary investment in renewable energy and new technologies, to bring

us closer to the environmental targets of 2030 and 2050. The overall goal is to increase efficiency, reduce costs and improve service quality. With regard to reform standards, two main models can be identified - the first described by (Littlechild, 2006), known as the Textbook Model for Restructuring and Competition, and the second described by (Jamasb & Pollitt, 2005). In addition to the two main models, we can include Hunt's model, which is relatively more basic and simple. All three models have advantages and disadvantages, which are listed in Table 2.

In summary, we can say that the goal of the reform in all three models discussed above is to create new governance arrangements that provide long-term benefits for consumers. These benefits must be realized by creating competitive wholesale and retail markets to improve efficiency and at the same time meet customer preferences, by stimulating the regulation of privatized transmission and distribution networks to improve their efficiency and facilitate competition. in them and, I add, by reducing the role of government and political influence in general.

In the *second subparagraph*, we look at the process of liberalization of the European electricity sector. Despite the fact that most EU Member States (EU) have liberalized their electricity market, one of the ultimate goals of EU energy policy has not yet been achieved. Eising (1999) talks about the existence of two identical modern processes - liberalization of energy markets and European integration. European integration is the point where economics and political science intersect and define concerns about the consequences that such a process could have on different areas for citizens or consumers (Pollack, 2010) (Baldwin & Wyplosz, 2009).

The *fourth paragraph* is dedicated to investments in the electricity sector and the price of electricity for end users. The electricity industry is capital intensive and the financial resources used for the development of this industry are both local and international. The main components that are included in the electricity bill are considered: the costs of production and supply of electricity, taxes and levies and network costs imposed on consumers. The main factors that form the price of electricity are analyzed.

The study concludes so far: although EU countries are achieving almost complete liberalization of their energy markets, the single internal energy market is not yet complete. Its final construction requires the removal of many barriers and trade barriers, the convergence of tax and pricing policies and measures with regard to norms and

standards, as well as common environmental and safety regulations. The aim of energy policy is to ensure a functioning market with fair access and a high degree of consumer protection, as well as adequate levels of interconnection and production capacity. This can be achieved through medium-term investment, enhanced cooperation between Member States' regulatory authorities and transmission system operators. An important aspect of the reforms and policy adaptations is the unbundling of ownership of the transmission infrastructure in the electricity sector, as this is one of the most effective tools for promoting the investment process in infrastructure in a non-discriminatory way, thus ensuring fair conditions for access to the network.

Chapter Three

ENERGY EXCHANGES AS PART OF THE EUROPEAN ENERGY MARKET

The *third chapter* is crucial because it directly addresses the topic of the dissertation and reflects the most significant contributions of this work, namely conducting an in-depth analysis of the factors influencing energy exchanges on the energy market and building an index based on these factors, to measure this impact.

The *first paragraph* examines the structure of the wholesale electricity market by defining and presenting the two main types of market - organized (exchange) and OTC (over-the-counter) market, together with their differences. The trade in electricity is analyzed in terms of time ranges, specifying the main segments of energy exchanges - "day ahead" and "intraday". The energy market in Bulgaria, its model of functioning, as well as the main participants are also considered.

Electricity is a commodity where no compromises are allowed in terms of accessibility and security of supply due to the specifics of transportation, production and storage, as well as due to its huge social and economic importance. In addition, it is possible to trade electricity in all time ranges, moreover, it is even mandatory. For this reason, it is not possible to say which trading time range is important. In essence, both long-term contracts lasting months and years and day-ahead and intraday trading are important. This statement is necessitated by the fact that the share of renewable energy sources in

the energy mix of the EU countries is constantly growing. We should not miss the fact that it is necessary to balance the market in real time.

The *second paragraph* presents the leading energy exchanges in Europe EPEX Spot and Nord Pool, as well as the Bulgarian Independent Energy Exchange. A comparative analysis of the advantages of stock exchange trading is made, defining the role of energy exchanges in the EU. The paragraph specifies that energy exchanges are playing an increasingly important role in the new structure of the electricity industry. This is particularly noticeable in the European wholesale market, which has so far been dominated by bilateral trade. All power exchanges share the same objectives, namely to facilitate trade in electricity, promote competition and ensure transparency. In conclusion, it must be concluded that each electricity exchange aims to develop liquidity and reliability of its price index. The development and strengthening of the importance of electricity exchanges as a classic example of highly efficient and highly competitive markets is key to the successful liberalization of the electricity sector, as well as to building a single energy market in the EU.

The *third paragraph* sets out the factors influencing energy exchanges on the functioning of the EU energy market. Two main factors are defined - the first in terms of cross-border trade in electricity within the EU in the light of the European single market and the creation of market associations, and the second in terms of economically measurable impacts. We are also structuring a third factor in terms of some additional impacts, including improving the quality of services, environmental impact and impact on innovation in the sector. These factors are presented schematically in Figure 7 and are described in the next three subsections.

The *first subparagraph* of the third paragraph examines the impact factor related to cross-border energy trade in the context of the single energy market in Europe and the topic of market mergers. Market groupings aim to link control and market areas in order to harmonize different electricity exchange systems and in particular to reduce price differences. In this way, the electricity market can to some extent be aligned with the physical reality of electricity flows, as neighboring electricity networks are physically connected and electricity always passes the shortest route from producer to consumer beyond market boundaries.

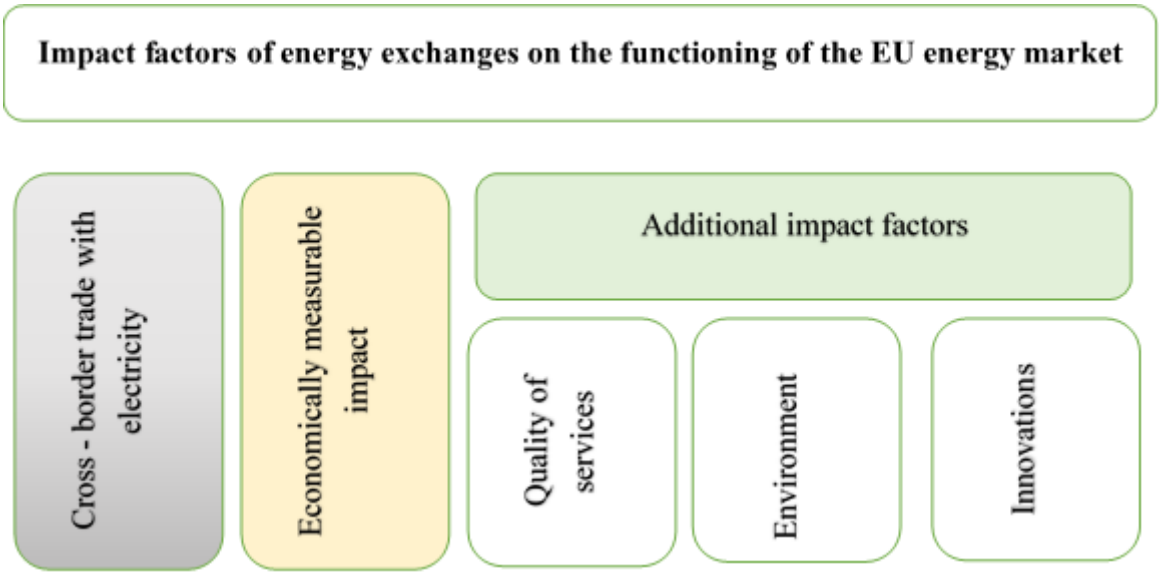

Figure 7. Impact factors of electricity exchanges on the functioning of the EU electricity market

Source: Developed by the author

The main steps related to building a single energy market are also considered, starting in 2006, when the first transnational merger took place: Belgium, France and the Netherlands merge their market segments "day ahead" in order to make optimal use of cross-border electricity capacity and increasing market liquidity, referring to EU Regulation № 1228 of 2003 and EC Directive 2006/108 / EC of 2006. It can be said that by the beginning of 2020 the EU electricity markets are of about 90% connected, and in the short term 100% unification will be achieved.

The same subparagraph also deals with the PCR mechanism, which is maintained by the Nominated Electricity Market Operators (NEPs), which are mainly energy exchanges. Emphasis is also placed on the single day-ahead European single markets (SDAC) and intraday markets (SDICs). The aim of these market segments is to increase the overall efficiency of trade by promoting effective competition, increasing liquidity and enabling more efficient use of energy resources across Europe.

Just as transmission system operators have a key role to play in ensuring better service quality, energy exchanges also contribute to ensuring continuity in electricity supply. In this context, it is considered that the development of the single day-ahead and intra-day stock markets plays an important role in ensuring the continuity of energy supply, because in times of shortage in one trading area, electricity can be purchased from another. .

The *second subparagraph* deals with the factor related to economically measurable impacts. Electricity prices can be monitored, but production costs cannot. The amount of costs can only be determined indirectly by examining the return on equity in terms of prices. If the return remains constant, then costs and prices will move together, if returns fall but prices remain the same, then costs must increase - although the cost of capital may fall - and vice versa. We would expect liberalization to reduce the overall return on capital in the electricity sector, but it is possible for companies to increase their profits through practices such as price discrimination of individual customers, as well as negotiating lower prices for energy sources for electricity generation. with your suppliers.

The *third subparagraph* deals with additional impact factors, which include the environmental impact, the innovation impact and the service quality impact.

Paragraph four *corresponds to one of the main tasks in the dissertation, namely to propose an index based on the impact factors from the previous paragraph. These are three factors as follows*:

- cross-border trade in electricity and market associations
- economically measurable impacts
- and additional impact factors, including service quality, environment and innovation

The index includes three components that participate with equal weights and represent the three main factors above, in the form of coefficients. The main task we set ourselves here is to find appropriate measures of these factors and to create the appropriate coefficients associated with them.

The proposed index measures the impact of energy exchanges on the EU electricity market and can also serve as a benchmark for the development of the EU electricity market as a whole, based on the presumption that the higher the impact of electricity exchanges, the higher the electricity market itself is more mature, transparent and efficient. The name of the index is EXIEM, which is an abbreviation of Energy eXchange Impact on Electricity Markets. In its basic version, the EXIEM index can be expressed by the following formula:

$$(1) \qquad EXIEM = K_1 x K_2 x K_3$$

Where K1, K2 and K3 are the coefficients related to the respective impact factors. These coefficients will be calculated according to the methodology as follows:

K_1 – market connectivity ratio, which reflects the ratio of the number of connected countries in the European single market "within a day" to the number of EU Member States, according to the formula below:

(2) $$K_1 = {}^{n}/_{EC_n}$$

Where:

n is the number of connected countries

EC_n is the number of EU Member States

Coefficient K_2 – **market volatility coefficient**, it reflects the economically measurable impact and is linked to the change in prices of the integrated energy market in the EU. The coefficient represents the standard deviation of the daily values of the ELIX index for the last 12 months. The coefficient K_2 is calculated by the formula below:

(3) $$K_2 = 1 - \sqrt{\frac{\sum(x_t - \bar{x})}{n-1}}$$

Where,

x_t is the value of the daily change of the ELIX index for day t

$\bar{x}$ is the average value of the daily change of the ELIX index for the last 12 months

n – the number of changes in the value of the index for the period

Coefficient K3 - **reflects the additional impact factors**, including service quality, environment and innovation. It is linked to challenges related to the achievement of the EU's energy and climate goals, and in particular the goals of the share of energy from renewable energy sources (RES) by 2020, 2030 and 2050. The coefficient will represent the fulfillment of the set goals and will be calculated by the formula:

(4) $$К_з = {ВЕИ_b}/{ВЕИ_t}$$

Where:

$ВЕИ_b$ is the share of energy from renewable energy sources (RES) in a given year

$ВЕИ_t$ is the share of energy from renewable energy sources (RES) in a given year according to EU targets

The value of the EXIEM index by 2019 shows that the impact of energy exchanges on the EU electricity market is still unsatisfactory, and we can talk about a high impact with values of the index above 0.9. However, the potential for the index to rise in the coming years is good, with expectations in the medium term for the single European market "within the day" to include all 27 EU countries, which means that the coefficient K1 will become 1. The greatest risk is the coefficient K2, which at this stage shows strong volatility, as it most strongly affects the EXIEM index. In order for this ratio to be in the order of 0.9, the standard deviation of intraday market prices must fall to 10% (0,1), or in general this market must reach maturity and good forecasting due to the development of stock exchange trading on the one hand and on the other hand the development of technologies for energy production from renewable sources. In the long run, the K3 coefficient can also pose a threat to reaching high values of the EXIEM index, as the targets for increasing the share of energy from renewable energy sources (RES) after 2030 become really quite challenging, with the share of RES expected in 2050 to increase to 85%.

CONCLUSION

Over the last two decades, the European energy sector has faced fundamental changes and continues to do so at an ever-increasing pace. Beginning with the liberalization of the energy market in the 1990s, there have been significant changes in the energy mix, corporate sentiment and the legislative and regulatory framework of the energy industry. The liberalization of the energy market has become one of the EU's great successes, and this leads to the belief that following market-oriented solutions is the most direct way to meet the EU's climate and energy goals, which are enshrined in its common policy.

Having well-functioning, liquid and transparent energy markets is crucial to meeting today's and tomorrow's climate change challenges, on the one hand, and the need to remain competitive, on the other. The efficient functioning of wholesale electricity markets facilitates innovation and the development of new business opportunities and is essential for achieving successful energy adaptation to today's challenges for energy systems.

The complex energy sector, with its ever-increasing number of different actors, should work towards harmonizing interests in order to: supply energy to European citizens and European businesses in a reliable, accessible and climate-friendly way. Exchanges are intermediaries in this complex environment by organizing liquid and efficient wholesale markets. Through the received price signals, the exchanges as an organized market react faster and more reliably. Price signals, which the stock exchange sends to the business in turn, represent the most effective means for managing investment decisions and for ensuring the most rational use of resources.

The study examines the development of European energy policy as one of the most important modern EU policies, making a chronological review, analysis of the legal framework and defining the challenges facing this policy. On this basis, the place of the electricity market in the EU is highlighted and its significance in the context of electricity generation, the creation of an adequate EU energy mix, as well as the structure and dynamics of consumption is examined. Based on this logical sequence for the study of interconnected phenomena, it becomes possible to outline the modern forms of liberalization of the energy market in the EU.

IV. REPORT ON THE CONTRIBUTIVE MOMENTS IN THE DISSERTATION WORK

The main scientific contributions derived from the dissertation research can be presented as follows:

1. The research on the essence of the EU policy in the field of energy is systematized and analyzed, which allows the construction of a multifaceted theoretical foundation for clarification of the general principles and objectives of the common policy.
2. Based on a retrospective analysis of the development of European energy policy in the period 1951 - 2019, the conceptual framework of the EU electricity market is built, contributing to the analysis of the interaction between the evolution of European energy policy and changes in the EU electricity market which presents the current challenges to energy policy.
3. Revealing the importance of the EU electricity market reveals its essential characteristics, including the specifics of the energy mix in the Member States and the way the market works. On this basis, the models for reforming the electricity sector in order to liberalize the electricity sector in the EU are outlined.
4. A factor analysis is conducted to determine the structure of the wholesale electricity market in the EU, based on which the impact of energy exchanges on its functioning is highlighted. A classification of the types of energy exchanges is made in Europe, which allows the construction of an index measuring the impact of energy exchanges on the functioning of the energy market in the EU - EXIEM.

V. LIST OF PUBLICATIONS RELATED TO THE DISSERTATION

Articles:

1. Иванов, И. Инвестиране чрез структуриран депозит в компании от сектора на възобновяемите енергоизточници // Сборник с научни разработки „Проблеми на регионалната интеграция и международния бизнес“– Свищов: АИ Ценов, 2016, с. 61-71. ISBN: 978-954-23-1172-0

2. Иванов, И. Алтернативни инвестиции в зелена енергия // Годишен алманах „Научни изследвания на докторанти“– Свищов: АИ Ценов, 11, 2016, с. 705-714. ISSN: 1313-6542

3. Иванов, И. Иновативни енергийни технологии – глобални пазарни проекции // Годишен алманах „Научни изследвания на докторанти“– Свищов: АИ Ценов, 13, 2017, с. 491-502. ISSN: 1313-6542

4. Иванов, И. Ролята на възобновяемите енергоизточници като двигател на съвременната енергийна революция // Годишен алманах „Научни изследвания на докторанти“– Свищов: АИ Ценов, 14, 2018, с. 423-433. ISSN: 1313-6542

Reports:

1. Иванов, И. Използване на пазарния механизъм като инструмент в борбата за намаляване на въглеродните емисии // „Интеграционни процеси в глобалната икономика“- сборник с доклади, Свищов: АИ Ценов, 2018, с.139-144. ISBN: - 978-954-23-1666-4

2. Иванов, И. Въздействието на енергийните борси върху функционирането на енергийния пазар // “Глобални и регионални измерения на международните икономически отношения“– сборник доклади, Свищов: АИ Ценов, 2020, с. 83-88. ISBN 978-954-23-1816-3

VI. DECLARATION OF ORIGINALITY AND RELIABILITY

from Ivan Vasilev Ivanov

In connection with the procedure for obtaining the educational and scientific degree "Doctor" in the scientific specialty "World Economy and International Economic Relations", I declare that:

1. The results and contributions to the dissertation on "The impact of energy exchanges on the functioning of the energy market in the European Union" are original and are not borrowed from research and publications in which the author has no participation.

2. The information presented by the author in the form of copies of documents and publications, personally compiled reports, etc. corresponds to the objective truth.

3. The results obtained, described and / or published by other authors are duly and in detail cited in the bibliography.

05.04.2021 Declarant: ……....

Svishtov /Ivan Ivanov/