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COST-BENEFIT ANALYSIS OF INVESTMENT IN UNDERWATER CABLE BETWEEN MONTENEGRO AND ITALY

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NATAŠA VUJAČIĆ

AUTHORSHIP STATEMENT

The undersigned Nataša Vujačić, a student at the University of Ljubljana, Faculty of Economics, (hereafter: FELU), author of this written final work of studies with the title Cost-benefit analysis of investment in underwater cable between Montenegro and Italy, prepared under supervision of Professor Jelena Zorić, PhD.

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LIST OF ABBREVIATIONS

AC – Alternating current

BIH – Bosnia and Herzegovina

CAPEX – Capital expenditures

CBA – Cost-benefit analysis

CGES – Crnogorski elektroprenosni system

COTEE – Montenegrin market operator

DC – Direct current

EC – European Commission

EENS – Expected Energy not Supplied

ENTSO-E – European Network of Transmission System Operators

EPCG – Elektroprivreda Crne Gore

ERA – The Energy Regulatory Agency of Montenegro

EU – European Union

GME – Gestore dei Mercati Energetici

GTC – Grid transfer capability

GWh – Gigawatt hour

HUPX – Hungarian electricity exchange

HVDC – High Voltage Direct Current

IEM – Internal Energy Market

IPEX – Italian Power Exchange

IRR – Internal rate of return

KPI – Key performance indicators

kV – Kilovolt

kWh – Kilowatt hour

LOLE – Loss of Load Expectancy

MCP – Market clearing price

MSE – Ministry of Productive Activities

MWh – Megawatt hour

NPV – Net Present Value

NTC – Net transferred capacity

nTRA – Negotiated third-party access

OPEX – Operational expenditures

OTC – Over the counter

PCI – Project of common interest

PINT – Put In One at the Time

PV – Power voltage

QV – Quality voltage

RES – Renewable energy sources

rTRA – Regulated third-party access

TOOT – Take Out One at the Time

TSO – Transmission System Operator

TWh – Terawatt hour

TYNDP – Ten Year National Development Plan

VOLL – Value of lost load

INTRODUCTION

The power sector has been treated as a natural monopoly for decades. State companies had strong market power which lead to inefficiency. Electricity was produced and consumed in the same operative area. This sector was strictly regulated, but technical progress lead to market liberalization and deregulation of the sector's activities. The opening of the electricity market in the European Union (hereafter: EU) (in the last two decades of the 20th century) and South-East Europe (hereafter: SEE) (in the first decade of the 21st century) lead to introduction of competition and the development of cross-border trade in electricity. This trade takes place between companies, but also at the national or even regional levels. As a result of the increased trading, some borders between SEE countries were congested due to the scarce interconnection capacities, since the most of the power systems in those countries were built in the second half of the 20th century expecting only to meet needs of the national consumption and projected social development. Generally speaking, they are outdated and poorly maintained. Interconnection is recognized as a bottleneck for almost all of the electric power systems (Filipović & Tanić, 2010). With the opening of international trade in this industry, the need arose to interconnect those countries with the rest of the Europe and consequently, to build interconnectors between them. The ultimate goal is the creation of the Energy Union, which would gather all European markets into a single market area.

The thesis will be focused on energy flows between the Balkan and the Apennine Peninsulas. The two regions are connected by overhead lines with Slovenia to the north and with Greece to the south (TERNA, 2016). Italy, which opened its electricity market in 1999 (TERNA, 2017a), is a large importer of electricity (around 17 percent of the yearly demand is imported) (TERNA, 2016), while at this moment Bosnia and Herzegovina (BIH), Romania and Bulgaria have notable surplus in the power export. One part of the energy comes from hydropower stations suitable for cheap, band electricity generation (KPMG, 2010; POYRY, 2016; Edwards, 2010). With an appropriate development of production capacities, Albania, Kosovo and Serbia could also become exporters. Without any doubt the most untapped potential of Montenegro, which opened its market to competition in 2009 (POYRY, 2016), is that of hydro power, solar energy and wind energy. On the other side, the Italian grid operator TERNA is highly motivated in asset building projects. Lately, they have been focused on bringing clean energy to Italy to attain 20-20-20 targets set by the European Commission (hereafter: EC) (EC, 2010). That is the exact type of electricity the Balkan Peninsula can offer.

All the above mentioned resulted in the Italian TERNA and the Montenegrin Transmission System Operator (hereafter: CGES) entering in a joint project of construction of an underwater, single circuit cable between Montenegro and Italy (CGES, 2016). The realization of this idea slowly started in 2007 when Italy and Montenegro signed an intergovernmental agreement (TERNA, 2014). It was finalized by the signing of a construction contract for the underwater cable, two converter stations and a new transmission line in Montenegro in 2010 (Ministarstvo ekonomije, 2011; TERNA, 2014). It will operate at the voltage level of 500 kV and it will have a total length of 455 km (CGES, 2016). The value of investment together with the supporting infrastructure was initially estimated at about 850 million EUR, but at this moment it seems that the project will cost more than one billion EUR. The agreed share of TERNA in the investment is 80%, while CGES's share amounts to 20% (Ministry of Sustainable Development and Tourism, 2011). The purpose of this cable is to gather major electricity surpluses in the Balkans and to make them available to Italian suppliers and consumers. Naturally, it will significantly change market conditions under which future trades will be made. Construction of the cable and the supporting infrastructure begun in 2016 (CGES, 2016) and the cable is expected to be operational by the end of 2019. The cable will become an "energy bridge", which will serve for an efficient energy redistribution. The underwater cable which connects Italy and Montenegro is usually called "MONITA" by the Italian public (Ponte elettrico con il Montenegro, al via i lavori in spiaggia, 2015). It has been recognized as a project of common interest (PCI) which will bring together two distinctive markets. It is one step closer toward the Energy Union.

The purpose of this thesis is to examine economic justification of the connection of power systems of Montenegro and Italy through the underwater cable between Lastva and Pescara with the maximum power capacity of 1200 MW (ENTSO-E, 2016b). Benefits to be brought to the society of the two examined countries by the implementation of the new project will be compared to the costs. Besides that, this work will study impacts of the investment on the market integration. Without any doubt, Montenegro, whose market is significantly inferior to the Italian one, will be heavily impacted by the underwater cable. On the other hand, this project is just one among the grid investments of the Italian TERNA, but is highly placed on the company's list of priorities (TERNA, 2016). The project will also have an influence on the rest of the Balkan countries. As a matter of fact, this project depends on other interconnectors projects in this area. They are all inseparably tied to each other, since Montenegrin current electricity capacities cannot satisfy potential Italian needs for the import. The role of Montenegro is rather envisaged as a platform for transmission. The influence on both markets will be studied as well as the influence on cross-border electricity flows.

As a research method, the Cost-benefit analysis (hereafter: CBA) will be used. The CBA is a valuable tool for the decision making. It will answer the question if this "power bridge" is viable. The CBA will be used in the project assessment, comparing the contribution of the project by various indicators. The CBA provides the measurement of project costs and benefits of the investment. The project includes capital and operational costs. Benefits considered in this analysis are defined by the European Network of Transmission System Operators (hereafter: ENTSO-E). Only monetized indicators will be used for Net Present Value (hereafter: NPV) calculations.

The work is conceived as a graduated process starting from market liberalization when vertically integrated power systems were unbundled to the creation of the new electricity market of cross-border trading of power. This created a fertile soil for international projects of electricity transmission from areas with lower generation costs towards areas with the lack of electricity supply and higher wholesale and retail prices. The first chapter gives a short overview of electricity market reforms Europe wide. The process of the restructuring of the energy sector, in terms of deregulation and liberalization, became a global issue. In the developed countries this process is almost completed while in the developing countries it is in different stages. The final goal of this process is to increase the sector’s efficiency in electricity generation, transmission and supply and to establish the Energy Union. A short overview of the Montenegrin and the Italian markets will be provided as well. They are both in different development stages with many particularities. In the second part it will be explained how the energy market works today. The third chapter deals with the theoretical framework for the CBA, presenting benefit indicators and the cost structure of the transmission investment project. In the fourth chapter, the CBA will be applied to evaluate the project's viability. My intention is to compare benefits of two scenarios: one with the underwater cable and one without it. A short overview of the project's main characteristics will be provided. In the same part of the work I will calculate the project's net present value and the payback period for different scenarios. The change in the project's profitability will be presented through the change in socio-economic welfare, operational cost and losses. The fifth part will present impacts on the market for both Italy and Montenegro. Projects of this size usually go beyond their economic impacts and have an influence on other similar investments. This part of the work will present possible positive impacts and negative repercussions of the project for both countries and the rest of the Balkan region. It will be explained how the price of electricity and capacity rights will be determined for wholesale trading and what they will be influenced by. The two countries are not only different by the size of their markets, but also by levels of development, generation and consumption. Even though TERNA is the biggest investor, it is clear that significantly smaller Montenegrin market will be heavily influenced by this underwater cable, since it has already been recognized as one of the most important projects for its economy. On the other side, the Italian TERNA is asset-building oriented with a strong ambition to import energy to compensate for the lack of generation units at the south of the country.

1 REFORMS OF THE ELECTRICITY SECTOR

Electricity is an irreplaceable source of energy in any life area. This means that electricity indirectly and directly determines prices of services and products as well as the standard of living. By increasing the efficiency of power sector operations it was expected that electricity price would be influenced significantly. It was the aspiration to initiate reforms of this industry throughout the world. Since this work is focused on European countries, it will only discuss implemented reforms in that area. Usually, the argument to support deregulation is the inefficiency of regulation due to poor incentives for suppliers and regulators. Also, competition maintains prices close to the limit of marginal costs and minimizes costs simultaneously. Regulation could maintain only one or the other but never both of them at the same time. Electricity incurs significant costs in all industries and global competition aims towards the reduction of input costs (Joskow, 2008). International companies started emphasizing price comparison on international level, which motivated states to reduce costs. Privately owned companies could also respond much faster to economic and technological changes in industry (Rothwell & Gomez, 2003).

The power sector has been treated as a natural monopoly for decades. Vertically integrated companies used to be the sole supplier of electricity to all customers within their operative territory (Chick & Vivi Nelle, 2007). They were developed under specific conditions in countries that brought significant differences among developed capacities and structure. It influenced prices, ownership structure and organization. It doesn’t surprise that the differences in the sector’s development were huge between the countries of Western Europe and the Eastern Europe countries which were still in the process of transition. Monopolies dominated this sector assuming that they could offer a lower price than competitive markets. Basic assumption was that due to the presence of economics of scale power plants efficiency could only be obtained with vast production (Filipović & Tanić, 2010). From early 1990s, the process of moving this industry toward competition had been started. The idea of deregulated market was mostly triggered by the technical progress. All four economic activities; namely production, transmission, distribution and supply used to be bundled. All customers had one supplier, either the local or the state one. Economically efficient behaviour was promoted by regulatory body which was the one to determine prices of electricity. Production costs were covered by customers through regulated tariffs set by regulators. It resulted in little incentive for reduction of expenditures and investment with proper risk assessment. Through restructuring, vertically integrated, state owned enterprises were functionally and legally unbundled (Eberlein, 2008).

The fundamental goal of undertaken reforms was to increase the efficiency of the sector, primarily for the purpose of raising competitiveness of the economy and creating a single market for the entire Europe. It is expected to ensure cost-effective supply to final customers, protection of competition at the national level and neutral operators

(Newbery, Strbac, & Viehoff 2015). Liberalization of the market should bring price reduction of this commodity within the country, but also should help to reduce the difference in prices between countries. This process is also intended to improve the level of provided service and cut down the need for construction and maintenance of backup capacities. Deregulated market is expected to eliminate market power by offering sufficient number of suppliers which would prevent companies or group of companies in setting prices higher than production costs. Creators of reforms in this sector aspired to avoid cross financial support among different types of customers through more transparent tariffs. Finally, the aim of reforms was to achieve technically reliable and efficient power industry empowered by new production technologies that had reduced size of power generators (Rothwell & Gomez, 2003).

Single company which performed all of the sector's activities also controlled all of the sector's investments. It resulted in "market power" which is defined as an ability of a firm or a group of firms to set the prices much above production costs. Deregulation of the market was expected to create the market with enough generators to remove it. However, regulation must be used in areas where competition is not achievable, which are usually natural monopolies. In the examined sector it refers to transmission and distribution. Due to economies of scale, the largest companies can charge the lowest prices (Eberlein, 2008; Jacottet, 2012). Electric utilities, after deregulation had to split regulated from unregulated activities and contest against other companies which were free (to some extent) to enter the market. Each market participant had a chance to maximize profit under the decentralized process. Under the competition, return on investment in a new utility is not guaranteed any more. Cost could not be passed on to customers by the set of tariffs. That is how also risk management became an inseparable part of electricity business (Rothwell & Gomez, 2003; Meeus, Purchala, & Belmans, 2005).

1.1 Liberalization and restructuring of electricity sector

Liberalization was a gradual process. For the European market it started as a top-down process (Meeus, et.al., 2005). That means that the sector restructuring was designed for countries in a way which was consistent to the ideological and development path of the whole area. In order to implement this idea the first Directive 96/92/EC was introduced. It aimed to liberalize purchase of electricity by eligible consumers and to set the basic rules for creating internal electricity market. This directive established competitive framework which intended to promote sector's operational efficiency and guarantee quality and stable supply while achieving minimum costs (Conejo, Carrión, Morales, & Carrion, 2010). The Directive imposed the unbundling of national monopolies and allowed the completion in generation by issuing of authorization for the construction of new power plants (Hrovatin & Zorić, 2011; and Jakovac, 2011). It was a guideline for all countries in the reform process in all of the sector's activities. It also ensured the grid access to suppliers and generators by introduction of three models: negotiated third-party access (hereafter: nTRA), regulated third-party access (hereafter: rTRA) and single-buyer model (Hrovatin & Zorić, 2011; Meeus, et.al., 2005). Later on it was replaced by the Directive 2003/54/EC which was a step closer in creating the internal electricity market. Three different regimes were reduced only to rTRA (Meeus, et.al., 2005). It required establishing of an independent regulatory body and environmental protection. Electricity consumers (residental and non-residental) got the right to choose electricity supplier without national constraints. The goal of this Directive was to remove deficiencies of the previous Directive in the segments of regulation, network access and complete unbundling (Jakovac, 2011) and bring greater price convergence (Meeus, et.al., 2005). Six years later it was updated by the 2009/72/EC Directive. It fosters completion even more but also sets security of supply as the most important factor for development of the unified European market. This Directive provides effective regulation and independent national regulatory bodies (Jakovac, 2011; and Bockers, et. al., 2013). EU wanted to unify the market and introduce common policies in order to achieve its initial goal of economic and social progress by eliminating barriers and creating a uniform Energy Market (Meeus, et al., 2005). The only way to achieve it was through the cross border electricity transfers which would increase efficiency and maximize profits in this sector. In practice, Directives were implemented on the restructuring of vertically integrated monopolies into competitive companies. Countries opened their markets for other companies to enter which brought new investments coming from foreign and domestic investors.

Deregulation introduced competition to both wholesale and retail market. Wholesale refers to the sale of electricity to large customers and suppliers by power plants. Wholesale market reform was conducted with anticipation of cost reduction in generation. Several types of innovations would bring wiser investment, less expensive construction and maintenance of new capacities. On regulated markets, demand for electricity was assumed to be inelastic. New generation utilities were constructed based on that assumption. Competition brought great price instability induced by product seasonality in both demand and supply. It resulted that cost reduction became the most important task in the open market. Consequently, prices must stay at the level of the lowest cost. Retail refers to the sale of electricity to final consumers by registered suppliers. The aim of deregulation in this area was to provide reliable service and effective prices to consumer. Retail consumers got the opportunity to choose their supplier. It demonstrated price sensitivity in decision making. Even today it differs significantly from country to country. As indicator of market maturity are considered quantity of the total electricity consumed and the number of effectively unregulated customers. (Rothwell & Gomez, 2003; and Chick & Vivi Nelle 2007).

In practice the first step towards electricity trading was named pool. The pool is a mechanism through which competition on wholesale market was introduced while it was controlled by a system operator. All generators of the specific area had to participate in the pool. Generators had to announce their generating sets which would be available for the next day, provide guaranteed electricity prices and if necessary some special technical conditions on which their utilities would be run. Meanwhile, suppliers would submit estimates of the demand at each of the grid points from which they would take power for the next day. From the gathered data, the system operator would establish merit-order (Conejo, et al., 2010). Generation units with the lowest marginal costs would be the first activated and gradually, marginal cost of every next activated utility would be higher and higher until, if necessary, even the most expensive one would be activated. Continuous welfare economic problem was pricing electricity at marginal cost for the sake of economic efficiency while also providing sufficient revenue to cover the total costs inside the sector and providing enough incentives for investments in the future. This issue was overcome by paying a capacity charge for every unit of generated energy, whether or not it was called upon. Together with system marginal price it created the unified pool purchasing price (Chick & Vivi Nelle, 2007; and Edwards, 2010).

As we will see later in the example of two countries, the implementation of Directives was not a straightforward process. Fundamental issues for almost all countries were complexity of the system, local market influence and demand side shortages in terms of correct metering of actual consumption. As always, developing countries entered the process of reforms later than developed countries. Power systems of Southeast Europe countries were mainly built in the second half of 20th century. They were expected to meet needs of national consumption and projected social development. It resulted in electricity prices lower than real average cost. Development of the system had to be supported by state interventions in many different forms (subsidies, state guarantees for loans, etc.). It doesn’t surprise that these systems faced stagnation with seldom investments and insufficient maintenance. These countries did not have the same starting point as the developed European countries; they were inferior in technology, organization and other aspects important to the power sector development. It brought many problems, obstacles and slow implementation of the reforms. Once these countries partially carried out the reforms, cross border trading increased but some borders were congested due to the scarce interconnection capacities. Interconnection is recognized as a bottleneck for almost all of the power systems.

Following the relevant EU Directives energy sectors of Italy and Montenegro were restructured. It enabled market opening for both countries. The Italian market was partially opened in 90s while the Montenegrin market was officially open in 2009. All countries neighbouring Montenegro and Italy also opened their markets which allowed greater profitability of the studied underwater cable on integrated markets of two peninsulas. It is a very important detail since only that wide market area on both ends of the cable ensures return on investment and profitability of this cost intensive project.

1.2 Reform's outcomes

Neither the Directives nor other rules had special requirements regarding the ownership structure of companies in the restructuring process. They only allowed other participants to enter to the market to compete with national champions. Partial privatization seems logical from the perspective of new investments and decrease of market power (Hrovatin & Zorić, 2011). As stated earlier, European countries differ significantly in organization and ownership of power sector. Some of them, among which is Italy, also nationalized their monopolies in generation and transmission of electricity. Some other countries operate this industry in the form of regional enterprises. The third group has fully privatized production utilities or mixed ownership (public and private). Montenegro is at the similar stage of reforms as other Southeast European countries. They have a nationalized transmission system and partially privatized generation capacities.

Reforms of the sector through liberalization and privatization in some countries were expected to integrate market and equalize prices among European countries. Outcomes of reforms have to be used as much as possible in order to improve market functioning. At this moment integrated market is not attainable. Many countries are still in different stages of reforms. While positive effects of the Internal Energy Market (IEM) cannot be denied, some countries still oppose market integration (France for example). Mostly these counties do not want to depreciate their high export price. Other countries, such as Italy (it will be presented in one of the following segments) are highly motivated to integrate with as many as possible areas in order to decrease import costs. Those countries advocate integration not just among European countries, but also with other surrounding areas. If all European market areas would be integrated, as it was planned by the EC, the EU would be formed. Only this level of integration would be ready to face the upcoming market challenges. And yet, delays in market integration have been very vast. The idea of full openness and competition inside the EU had been opposed by most of the countries. In practice reforms faced many difficulties. Every country in this process primarily wanted to protect its own economic interest as much as possible. They tried to protect small and big producers and customers as well. It is believed that importing energy from the neighbouring countries with dramatically lower prices in generation would devastate national generation companies. On the other side it would increase prices to customers in exporting countries. In this process new international oligopolies were born: large power companies that extended business in profitable areas while closed them where losses were recorded. Currently, the EU market is divided among several companies with the majority of the market share even though intensions were to include also small players. This means that the European electricity market is horizontally concentrated (Chick & Vivi Nelle, 2007; and Burkard, 2008).

The process of restructuring was very complex and it is still a burning issue in many European countries. Transformation of energy sector reshaped the structure of the

European energy market. It influences its integrity, transparency and security but the most noticeable change was enabling trading of energy among different European neighbouring countries. Areas with the energy surplus sell electricity to the areas with energy deficit. Cross border trading increased the security of supply since now countries do not depend on their own generation but rather can effectively use cheaper sources of energy to satisfy their demand (Dahl, 2008). Market reforms resulted in increased market liquidity since transfers of energy are not anymore restricted to a single area. It was a motive for developing the idea of a unified European market which would have the purpose of achieving better allocation of capacities, better efficiency of congestion management, increased market transparency and finally convergence of the product prices among the areas (Harasheh, 2016; and Bockers, 2013).

1.3 Future challenges

In the past two decades energy market transformed significantly. Reforms were triggered by the technological progress and the idea of a more efficient use of energy. Through the EC Directives guidelines for deregulation were given. Ever since this market was introduced with international trade it faced many new challenges. Positive effects of the European integrated market are indisputable but they also create winners and losers. The future period is expected to be equally or even more turbulent. In the period of the economic crisis public took liberalization policies to a new eminence, particularly in SEE countries. The two dominant economic models, Neo-Keynesian and Neo-liberal raised the relevance in finding new balance between regulation and market. The new European economy model aims at bringing together growth and innovation, inclusiveness and competitiveness, probably by harmonizing regulatory frameworks and continued integration of IEM. It requires additional structural reforms, revival of liberalization and privatization policies in the whole Europe, but most of all in SEE countries (Arcidiacono, 2014). There is also a significant need for additional infrastructure projects especially in interconnection capacity. Grid needs to be reinforced in order to meet upcoming challenges of market integration. Market integration is usually interrupted by slow implementation processes, lack of interconnection capacities and insufficient capacity allocation procedures. Even though, much on this segment was already done by expending, adapting and reinforcing national market, further investments are required to reach optimal level of market integration. With the market opening, cross-border trading has been constantly increasing which is not followed by the proportional grid development. The greatest challenge faced by the energy sector is stimulation of those investments. Investments in infrastructure reinforcements are lagging mainly due to the insufficient access to finance, regulatory frameworks and the need to increase private funding. As a matter of fact, there is an approximation that only five percent of the overall financing needs into the infrastructure investments are covered by the European energy funding. New investments are needed in order to integrate large solar and wind capacities into the network but also to cope with other forms of volatile electricity production. It is equally important to set an adequate target level for interconnection capacity which would enable the functioning of the Energy Union since it is not possible to set the same target for every member state (Jaccottet, 2012; and EP, 2016).

When it comes to renewable energy sources (hereafter: RES) concerning issues they can be divided into two groups, both requiring upgrade of IEM towards even greater market integration (Szulecki, Fisher, Gullberg, & Sartor, 2016):

- Technical challenges,
- Structural challenges.

Technical challenges are referred to the integration of expected RES in the main system. Their massive expansion across Europe is expected and encouraged. RES generation must be placed close to the resources. That does not always coincide with national borders. Each country's renewable potential is different. Major harmonization between different systems requires also expansion of cross-border transmission capacity. There is a reasonable need for a wider coordination of interconnectors. In the future large investments in interconnector between many countries will also require new regulation in order to smoothly connect RES to the main grid. Structural challenge is how to further develop IEM into the Energy Union as a final step towards a completely integrated market. Energy Union is imagined as a tool for pooling all resources and diversifying them at the same time. By combining infrastructure, it will strengthen market share of RES. This union will unite barraging power and reduce dependency of many vulnerable areas. It is framed as climate and industrial policy for electricity, gas and liquefied petroleum gas. It aims to free movement of energy and enable affordable energy to consumers. Member states will shift from fossil fuels economy based on centralized and supply side approach. The shape and the scope of the Energy Union are not yet finalized but they will be grounded on decarbonisation of energy mix, investments in research and development, innovation and security of supply in order to achieve full unification of the energy market (Szulecki et al., 2016).

Cross-border energy flows can be only economically optimised if sufficient transmission and interconnection capacity are functioning well and if markets are integrated which allows for sharing reserve capacities among transmission system operators (hereafter: TSO). Currently, those capacities among the most of the European countries are rather limited which results in congestion. One of the solutions for above mentioned issues in the market is financing Projects of Common Interests (hereafter: PCI), introduced by the EC. They have priority in receiving financial support and they benefit from improved regulatory conditions, expedite permit granting. One of such projects is the studied project, MONITA, which proves its importance for the strengthening of the Energy Union. Furthermore, challenges are expected to be resolved with harmonization of national energy policies and market rules which will allow to realise economies of scale and to better value competitive advantages at the European level (EP, 2016).

1.4 Italian electricity market

Italian Market is the fourth biggest market in Europe with the total volume of 289 TWh in 2016 (GME, 2017). This market is divided into six geographical zones (Busnello, 2014). The greatest challenge it faces is insufficient generation units on the country's south. Transmitting energy from Germany (through Austria and Switzerland) and France through the North brings high cost and network losses. In order to keep loads at the required level, the Italian market is import dependent. In 2015, country’s net import was 43 TWh (GME, 2016). In the periods of high demand congestion often occurs which brings to a drastic increase in wholesale prices. The country's elongated shape is currently an issue but it also represents the biggest opportunity for the sector's development. The Italian energy sector has recognised the interconnection of the Apennine Peninsula to the Balkans, North Africa and main islands to the heart of Europe as the main priority. It would help linking RES capacities with the country's north. It is important to notice the price difference on all three markets. Energy would be transmitted from the areas with lower prices to the area with one of the highest electricity prices in Europe. Table 1 gives some crucial information about this market generation, prices and trade balance in year 2016.

Table 1: Italian market data for 2016 year

Indicator	
Yearly demand	310,252 GWh
Yearly generation	275,649 GWh
- share of hydro	15.40%
- share of coal	61.50%
- share of nuclear	0%
- share of wind	6.30%
- share of photovoltaic	8.20%
- share of biomass	6.60%
Import	43,181 GWh
Export	6,154 GWh
Yearly average retail price (without taxes and fees)	23.40 EUR/MWh
Yearly average national single market price	42.78 EUR/MWh

Source: Adapted from TERNA (2016); GME (2017); EUROSTAT (2017).

Long before Montenegro, Italy finalized its national power system reform known as Bersani Decree (in 1990s). Italy's aim is to participate in the creation of a single electricity market. It is ensured by cost-effective supply to final customers and open demand-side market. Marketplace is created to promote competition in generation and wholesale and it is known as the Italian Power Exchange (hereafter: IPEX). It is the main instrument for the exercise of the free market through requirements provided by the law no. 79/1999. It promotes both competition in production and resale of electricity, and protection of the end users by ensuring maximum transparency. Electricity Market Operator (hereafter: GME) ensures customer protection through coordination of the unified market. Market Operator must consider network constraints to transfer energy which may result in congestion. System marginal price is set throughout Italy if there is no congestion. When it occurs, market must be divided into zones with different marginal prices. Market Operator must set “unified national price” for purchasers on the power exchange. It is calculated as weighted average of various zones marginal prices. Zones are modelled based on probability of lines congestions connecting the lines (Harasheh, 2016).

The Italian electricity sector is divided into liberalized activities and activities operated under concession. Liberalised activities are:

- Generation of electricity,
- Wholesale is liberalized, but the Ministry of Productive Activities (hereafter: MSE) sets the framework for regulation on security and cost-effectiveness of the system, while TERNA (Transmission System Operator) identifies conditions and terms for electricity imports based on reports of the total capacities available on interconnectors,
- Retail recognizes all users as eligible to choose freely any wholesaler, distributor or producer from the country or abroad.

Regulated activities (operated under concession) include:

- Transmission, grid development and dispatching are still under state's control. TERNA, state utility, owns and operates the national power transmission grid.
- Distribution is operated after the MSE's authorisation approval.

Italian retail prices are not regulated, but they are influenced with intervention in price setting mechanisms in order to protect vulnerable consumers. This makes it rather similar to Montenegro’s market which is generally perceived as less developed. Under the “Acquirente Unico” (single buyer) model, electricity foreseen for retail is procured by the single buyer and later on resold to standard consumers at prices which reflect single buyer’s recognized costs (Harasheh, 2016). This model reduces ability of retailers to look for better offers. It is expected that from 2018 the tariff regime will be removed which will make Italian market completely opened. Major step towards integrated and free market is made also by the market coupling. Net transferred capacity (NTC) with Slovenia and Austria are increased in comparison to periods before 2014. Finally, it resulted in price convergence. Therefore, the main task of this market is further connection to other markets. It will allow uninterrupted and stable deliveries of electricity to households as well as to major consumers. Congestion income have already been influenced by market coupling, but much stronger influence will be attained only if Italy increase import from the countries that have significantly lower generation cost than Austria, Switzerland or Slovenia (ACER, 2016).

1.5 Montenegrin electricity market

One of the core stones of the Montenegrin economic development is improvement of the energy sector. The Energy Development Strategy until 2030 sets three priorities to this sector (Montenegro Ministry of Economy, 2015):

- security of energy supply,
- development of a competitive market,
- sustainable energy development.

Elektroprivreda Crne Gore (hereanfter EPCG), state only electricity utility, was slowly reorganised into four functional units: Energy Management, Generation, Distribution and Supply. Also, Montenegro's Transmission System Operator (CGES) was first legally separated in 2009. In the same year EPCG was partially privatized by the Italian utility A2A which bought 44 percent of it while the Montenegrin government still holds 56 percent of the company. The Government also retained 55 percent of ownership over CGES, TERNA holds 22 percent and the Serbian EMS has 10 percent of it (POYRY, 2016).

The sector's development requires liberalized, open energy market where pricing policy is based on market principles and new participants can freely enter the market. It would eventually create non-monopolistic and competitive market which is in accordance with the European energy market goal. In Montenegro, this process started in 2009, the crucial year for the energy sector when the electricity market was opened for all non-household customers. Studied project would accelerate this process since gathered Balkan's energy will be transferred towards the Apennine Peninsula (with significant price difference). Before market liberalization, this cross-border transfers were impossible. Even partial market opening brought opportunity for pooling.

The Energy Regulatory Agency of Montenegro (ERA) is the regulatory body established by the Montenegrin Government which ensures the implementation of the Energy Law, issue of necessary licences, setting the electricity prices, etc. It regulates prices of the sector’s activities where competition is not feasible (transmission and distribution). Until January 1, 2015 it was also regulating electricity prices for final customers since there was not enough competition on the market before that (Energy Community, 2017; Vijesti, 2015). Market operator COTEE was established in 2011. It is responsible for participants' registrations, financial settlements, calculation of imbalances and production-related activities (POYRY, 2016).

As presented in Table 2, this market is significantly smaller than the Italian one. Most of the 2016 demand was met from the domestic generation, mainly from hydropower generation units, while the rest was generated from the coal fired units. Montenegro has, on average, 2000 to 2.500 sunshine hours per year. This high solar potential is not utilised enough. Neither is great hydro potential. It is estimated that hydro energy potential is 9,8 TWh/year while only around 2 TWh was used in 2015. When it comes to wind energy potential, further research is scheduled although some initial sites are currently developed (Mozura and Krnovo). Since renewables are recognized as the greatest potential for sector development, the government initiated feed-in tariff program to support renewable technologies (POYRY, 2016). The plan is to increase the production through new mini hydro power plants, exploration of coal reserves and construction of new hydro power plants. It is expected that in the future more wind and solar sources could be used. It is very important to the sector infrastructure but it is even more important to invest in the transmission system. Montenegro's geographical position has a big role as a regional hub to exchange energy on the Balkans, collect it and transfer it further to Italy where electricity prices are significantly higher than in this area.

Table 2: Montenegrin market data for 2016

Indicator	
Yearly demand	3,440 GWh
Yearly generation	3,023 GWh
- share of hydro	59 %
- share of coal	40 %
- share of wind and photovoltaic	1 %
Import	1,096 MWh
Export	877 MWh
Yearly average retail price	9.70 EUR/MWh

Source: Adapted from EPCG (2017).

Electricity prices in Montenegro for end consumers are much higher in comparison with the neighbouring countries. According to the Energy Law, electricity prices are not regulated by the Agency from the beginning of 2017. However, there is no organized power exchange for the Montenegrin market yet, even an initiative has been set up recently. Nevertheless, ERA, which defines tariffs for vulnerable customers, must carry out its function as independently as possible without any interventions by the Government. Montenegro's energy market is rather small and underdeveloped. It needs an urgent restructuring and revitalization of the existing sector units, as well as the construction of the new ones. To encourage cross-border trading it is crucial for the country to connect its transmission system with neighbouring countries with 400 kV interconnectors. One of the strategic projects is also the analysed High Voltage Direct Current (HVDC) underwater cable. Its construction would be purposeless if Montenegro doesn't reinforce 400 kV transmission lines towards Serbia and Bosnia and Herzegovina. Further on in the work, influences of these new interconnectors will be also presented, since the underwater cable cannot be completely functional without them. All of the existing generation, transmission and distribution units need reconstruction, modernization and rehabilitation. New ones must be also constructed. This process will eventually reduce losses and negative environmental impacts. Market development must be followed by the strengthening of the legislative, financial and institutional framework which would encourage private sector investments. Currently, all of the generation units are owned by EPCG. This utility still has the market monopoly. The question that remains unresolved is whether the Government's majority ownership in transmission, generation and distribution is the main setback for the market development.

2 ELECTRICITY MARKET

This part of the work will present the main characteristics of the electricity market. It is important to get familiar with some basic market postulates. This market is fragmented and most of the people see only small part of it but it is also important to understand how it fits together as a whole. The complexity of this market is due to the inability to store the product. That makes the electricity a good sui generis. Consequently, the result is that the market is highly volatile since the supply and the demand must be matched all the time. Generally, markets are defined with respect to three dimensions (Bockers, 2013):

- Geography - if there is no physical connection among two areas, then these markets do not belong together except if they are indirectly connected through another region.
- Product characteristics - electricity is a precondition to use other goods. There is no direct substitute for electricity. It is an almost perfectly homogenous product.
- Time - electricity requires time delineation to the time dimension. Generation and consumption must be balanced at all time.

For the electricity market, the most important principle in terms of market characterization is the same for all three dimensions, as the central question is (Bockers, 2013): “Is there a critical elasticity of demand, so that a sufficient number of consumers could switch to a particular location, product or time of purchase in order to avoid any potential abuse of market power?”

This market can be divided from different perspectives. The most basic one according to Edwards (2010) is:

- wholesale, where market participants trade electricity for further resale;
- retail, where electricity is sold for the purpose of consumption.

Market can be also divided based on types of trades (Edwards, 2010):

- psychical trades that require delivery of the commodity,
- financial trades include many different financial instruments without any electricity delivery required.

Furthermore, wholesale market is divided into spot and forward. Forward market is auctioning of either physical or financial product, so-called derivative products for deliveries at specified future period. The most important feature of this market is trading for future, usually distant at today's prices (Conejo, et.al., 2010). Spot market is a day-ahead market as trading finishes one day before the actual electricity delivery (Weron, 2006a). Since electricity cannot be stored it might happen that they are not tightly connected but it is impossible to explain all of the financial market features if the physical market is not understood. In a competitive environment, spot market ensures that generation is equal to consumption. It results in regulatory bodies and operators monitoring its continuous functioning. Prices and quantities are determined for one day-ahead and they are often supplemented with intraday when market participants correct their positions before psychical deliveries. This is the most effective way to decrease risk of market imbalance but it does not eliminate it completely. Balancing market is operated for short periods of time prior to delivery. It is used by TSOs for pricing deviations in demand and supply from spot to forwards contracts. Balancing market ensures uninterrupted physical deliveries and it keeps the system balanced (Weron, 2006a).

Price and quantity determination depend on supply and demand for a given period of time. Supply stack is ranking of generation units. Power plants are activated one by one in merit cost order from the lowest to the highest until the consumer demand is met. Lower is the marginal cost (the cost of the power plant which was last activated), lower is the plant flexibility and some constant amount of quantity has to be produced all the time. These are usually used for base loads while more flexible plants are used for peak loads, but they produce electricity at higher cost. On the other side, average demand is marked by high seasonality. Variability in demand depends on season, day of week and time of day and it can be easily predicted by weather conditions. Residential trends and economic growth are taken into account only for a very long demand forecasting. Load, which is synonymous for demand is used for short-term generation scheduling and for new infrastructure and power plants projects. It is crucial to know when and where energy will be required. So-called spatial load forecasting estimates expected and maximum amount of electricity that should be used (Edwards, 2010).

Open, deregulated market recognizes two ways for energy products to be traded: over the counter (OTC) and on exchange. OTC trade is a direct contractual agreement between two parties with all trade details agreed. The exchange works as the intermediary where both sides enter into agreement with exchange instead of direct transaction. The exchange aims to ease short-term transactions by pooling many market participants in one spot. Essential difference between them lies in counterparty risk. For OTC transactions, companies with a weaker credit score need to ensure their credit quality otherwise many potential partners would rather choose not to work with them. With exchanges this risk does not exist, since most of the trades are anonymous and counterparties do not need to know each other's financial details. That makes trading easier but the drawback is a limited choice for contracts. Unlike the OTC, exchange trades must be standardized. All agreements made on exchange or over the counter must be submitted to the Market Operator which collects the information about settled transactions and forwards it to the TSO. TSO takes care of the power system security, psychical deliveries to all customers and real-time balancing on the market if imbalance occurs (Edwards, 2010). The exchange aims to match the supply and demand for electricity by determining the publically announced market clearing price (MCP) (Edwards, 2010). When auctions take place, bids (offers for selling or purchasing of electricity) are submitted. Market participants (producers, transmitters, traders, qualified customers) bid the minimum selling or the maximum purchasing price they are ready to accept. Intersection point of demand and supply curves defines the price for every hour. Further on in the work, we will see that the marginal price is not the only way of setting the clearing price since regulatory bodies can intervene as well (Weron, 2014b).

Quantities for matched bids must be approved by the Market Operator. Transmission rights are constrained and power lines might become overloaded in periods of high demand of electricity, so-called demand peak. This phenomenon is known as congestion. If there is no congestion, MCP is the price for the whole system. If congestion occurs, balancing of the market must be conducted by adjusting traded quantities. To resolve the price issue in this case, the exchange applies one of the two options (Weron, 2006a):

- Locational marginal price is the sum of generation marginal price and transmission congestion cost. Nodal pricing values electricity based on place of generation and delivery.
- Zonal market clearing price is the same for one specific portion of the grid, but may differ from one zone/area to another.

Capacity remuneration mechanism is payment to electricity generators for generation unit reservation in order to secure the system stability in case of demand peaks. These payments ensure economically viable generation reserve. From the moment the liberalization process allowed international trade of electricity, these rights were spread to interconnectors as well. Cross border capacity rights help efficient cross country transmission of energy. It is imagined that energy should be traded without any borders and boundaries as long as it is economically justified. The cooperation between the European states increases the sector's efficiency if spare capacities are pooled, but Europe wide capacity mechanism is not possible due to limited interconnection capacities which reduces electricity that can flow across borders. Cross border capacity rights are traded the same way that electricity is traded. It requires coordinated allocation and calculation mechanism. A coordination between bidding areas is crucial since electricity follows laws of physics and cannot be restricted by the trade agreements. In the case of examined underwater cable, when BIH will be exporting to Italy, electricity will flow thorough Montenegro. This transaction will also have an impact on the remaining interconnection capacity at the Montenegrin and Italian border. One of the most important impacts that the studied project will have on the Montenegrin economy is the allocation of cross border capacity rights. It will make Montenegro a hub for energy transmission collecting the fee for offered service.

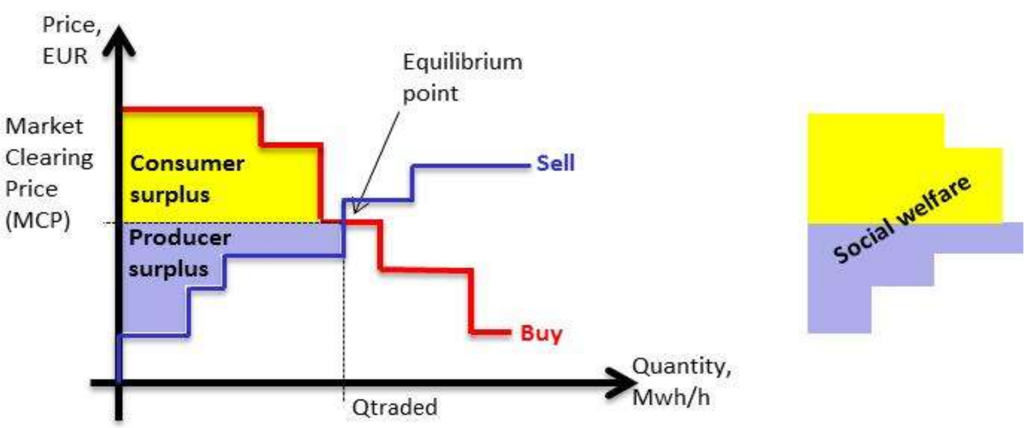
For the international trading, cross border capacity rights are auctioned either implicitly or explicitly. If the auction is implicit than the market operator collects the bids (offers) from several regions and calculates the regional price taking into account regional lines limitations. In explicit auctions, necessary number of transmission rights must be acquired by the market participant before trading beyond the borders. These rights are usually allocated either in annual, monthly or daily auctions for each flow direction separately. The easiest way to understand their purpose is to imagine capacity rights as a temporary rent on transmission lines or interconnectors. If the demand exceeds line capacity than such capacity rights would be above zero (Zachmann, 2007). Implicit allocation of available transfer capacities increases market liquidity and decreases price volatility. Implicit allocations additionally help in reducing market power (Meeus, et.al., 2005).

2.1 Integrated electricity market (IEM)

One of the three most important outcomes of discussed reforms is the integration of the European market. IEM brings together electricity markets across Europe by coupling interconnectors. Initial step in creating such market was made with the first Electricity Directive 96/92/EC. IEM is expected to support competition and to boost the utilization of networks and generation capacities. IEM efficiently gathers and allocates energy in contracting ahead, day-ahead, intraday and balancing trading. The European united market aims to share reserve capacity and allow efficient cross-border trading. "Hypothetical" scenarios of the future European Power System until 2030 estimates that positive benefits would be increased by wind generation, while sharing reserves could accomplish operational expenses saving of approximately 3 billion EUR/year Europe wide and reduction of up to 40 percent or less reserve capacity requirements. Many studies proved positive, undeniable outcomes, yet they are not straightforward since all of them have to compare the situation before and after when many different factors could change. These changes could even include complete pattern of generation, cross-border flows which would consequently influence price differences across interconnectors. Indirect benefits arising from market integration are not easy to measure since they are consisted of pressure to innovate, to reduce costs, increase market liquidity etc. In the long run, economics of constructing interconnectors could improve and encourage additional investments and allow even more efficient allocation of generation unit through Europe in order to exploit the gains from boosted trade (EP, 2016; Meeus, et al., 2005; Bockers, 2013; and Newbery, et al., 2015).

Figure 1 shows that utilization of cross-border capacities achieves social welfare which represents the difference between the aggregated amount of money which customers are ready to pay and the aggregated amount of money which suppliers are ready to accept taking into account adjustments for all market zones which participate in trading in all of the delivery hours. Besides that, congestion revenue is gained between two integrated markets, and it results from quantity of exchanged electricity between areas and clearing price between same areas.

Figure 1: Social welfare in the case of clearing at single market area (no congestion)



Source: Vlaisavljevic & Vujasinovic (n.d., p. 2, Picture 1).

Integrated power exchanges offer cross-border capacity available until the highest physical limit. If the quantity of offered capacities is sufficient to meet electricity demand, prices in the import and prices in the export area would be equalized and there would be no longer any differences between countries involved in trade. This means that if there is no market congestion, price convergence would be achieved. Market reforms created a greater market integration which resulted with price convergence. Price convergence is a reduction of international electricity price level over the time. If its existence is recognized on the market it implies that unified market idea is achieved. As expected, it creates winners and losers since producer and consumer surpluses are exchanged inside of the same market area (Iychettira, Hakvoort, Linares, & de Jeu 2016). The decrease in price definitely results in a net welfare gain but each country measures only its own benefits and benefits realized for its consumers. Price convergence is a dynamic amplification for the improvement towards a single European price of electricity (Zachmann, 2008).

2.2 Market coupling

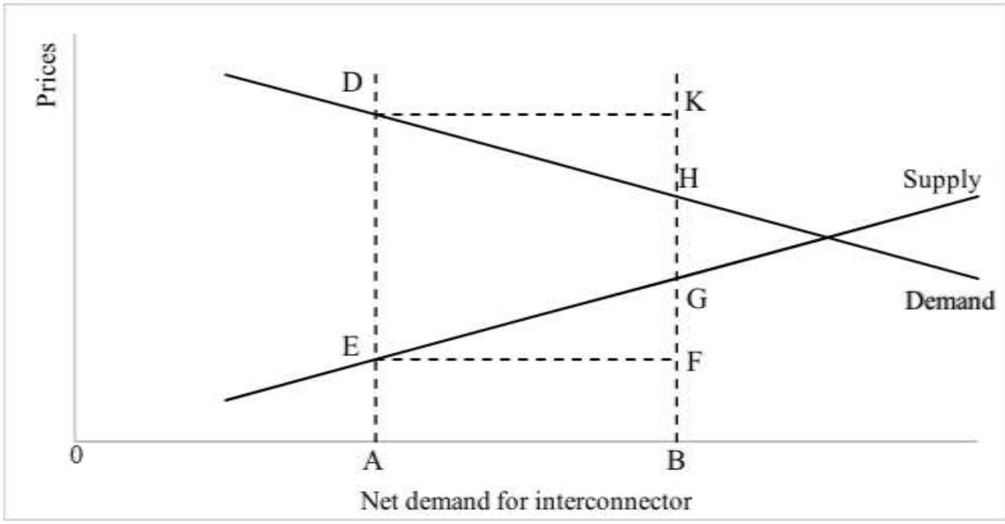
On the real market, firms which are dominant on one market face competitors which are perceived as dominant in their respective market area. Real electricity market faces some level of market power due to the model of oligopolistic interdependence (Busnello, 2014). Market coupling is a tool used for optimizing economic efficiency of interconnected energy markets which depend on power capacities. Market coupling is the subclass of the implicit auction concept. It coordinates and merges (day-ahead) trading of the electricity and purchase of transmission capacity rights into a single activity. Transmission capacity rights are traded on auctions by system operators and market participants that have rights to trade energy (Bockers, 2013). Before coupling cross border capacities had to be booked prior to the delivery and traders were expected to predict the price differences between interconnectors. That means that transmission auction are based on the forecast of electricity prices for the expected delivery period. For that reason, the amount of booked cross border capacity rights is not necessarily equal to the electricity units finally sold. Capacity rights could be also bought in the “wrong direction” (Newbery, et al., 2015). These two problems could be solved by implicit auctions. They combine energy and transmission trades. To implement this concept in an optimal way, auction offices have to be organized. Auction office gathers information on the availability of capacities from various transmission system operators and then optimizes the respective auction on the markets purchasing or selling electricity. That results in a single auction which leads to reduction of transactions costs. The lowest sale orders and the highest purchase orders would be executed while taking into account available capacities. It is assumed that the power would be always used more efficiently in the integrated market. In practice that means that the energy would flow from the lower price area to the higher price area which leads to the balancing of prices on the lower level on average than before (Bockers, 2013 and Vlaisavljevic & Vujasinovic, n/d). The most important contribution of market coupling to the creation of the uniform European market is an increased number of competitors which implies constraining the exercise of that power and lowering the probability of anticompetitive behaviour. Integration of markets may guarantee welfare maximizing equilibrium only in case of perfect competition (PCR, 2016).

Physical integration of markets may increase the efficient utilization of power utilities to satisfy demand and support competition. Beckers et. al (2013) show that market integration shares peak hours demand more efficiently. They find that almost one half of the nearby countries have non-simultaneous peak demands which implies that capacity needed to supply them together could be reduced. Lower the share of hours, in which two connected market areas have coinciding high peak-phases, more market coupling occurs reducing the wholesale prices, as two generation units are not necessarily fully used at the same time. This means that the same demand could be covered with fewer installed generation capacities if the two market areas are correlated. This is a clear indicator of how big the impacts of cross-border trading can be. It also signalizes effects on price and security of supply.

The gains of interconnected transmission systems at the day-ahead level are explained in Figure 2. This figure shows configuration of the interconnector before and after market coupling. Point A represents the net demand volume for power before coupling of interconnectors. Net supply for power is in direction EG while net demand for power is DH. Interconnector's full utilization to volume B is achieved by market coupling. This figure shows that the market coupling narrows the power price difference and increases the volume of the interconnectors' trade. Market coupling benefit is denoted by DHGE trapezium. Figure 3 shows the interconnector coupling with electricity flows in the wrong direction. In this case it would be efficient to export energy amount 0C but instead the amount 0A is imported. Because electricity is imported achieved benefit is DEH area which equals ED price difference times AC volume, while potential benefit in case that price stay the same could be DEGF area. Estimating benefits of interconnector coupling is not that simple since comparing scenarios before and after may include also change of many other factors and impact of other indirect benefits (Newbery et. al., 2015).

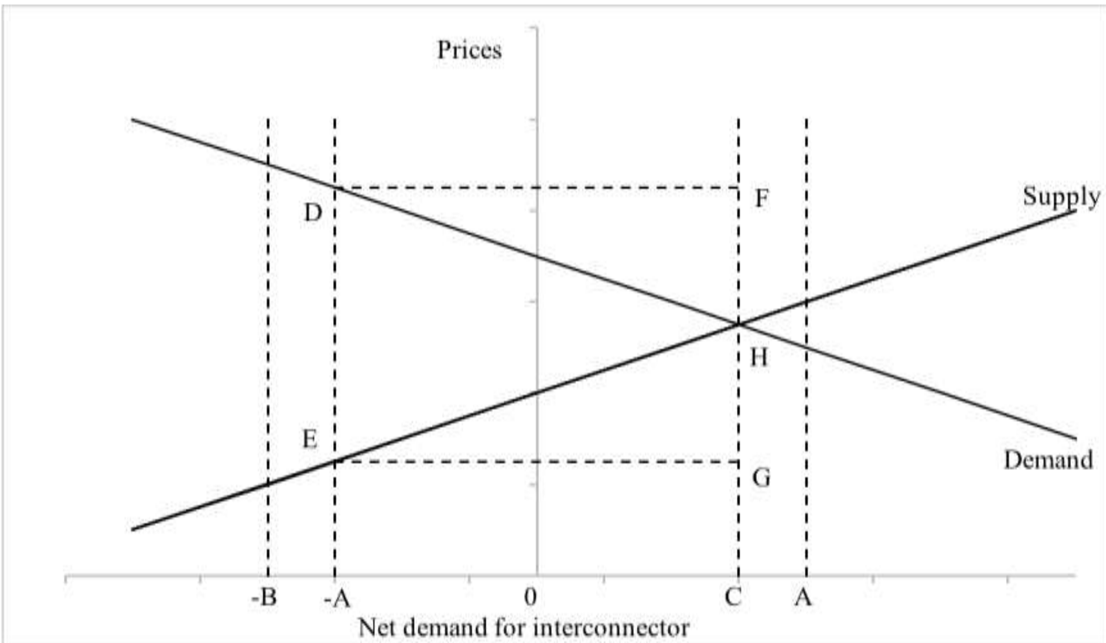
Newbery in his work from 2015 estimated that potential gains from day-ahead trades when using market coupling between European countries are between 310 and 630 million of EUR per year. Intraday trading under the same assumptions could gain up to 40 million EUR per year, while balancing benefits could be almost doubled. If all short-term and long-term benefits would be included, potential total benefit could even reach 2.3 percent of the total value of wholesale demand. Compared to the current benefits it represents an increase of more than 100 percent in value of interconnectors. It would make even more profitable investments in interconnectors. Previously marginal investments would become attractive. In general, market integration brings more benefits and exceeds the costs of the market design changes (Newbery et. al., 2015).

Figure 2: Benefits of market coupling assuming no adverse flows



Source: Newbery, Strbac, & Viehoff, (2015, p. 6, Figure 1a).

Figure 3: Benefits of market coupling with flow originally against price differential



Source: Newbery, Strbac, & Viehoff, (2015, p. 6, Figure 1b).

3 COST-BENEFIT ANALYSIS

Cost-benefit analysis (CBA) is a tool for applied decision making. It measures welfare brought to society by implementation of a new project. Expressed through monetary units, it combines heterogeneous items in a homogeneous flow. It is interested in achieved social value which comes from outputs of the examined project comparing the value of goods sacrificed for the benefit of the project. It is a challenging task, since the welfare cannot be directly measured. This is the reason why money is used for the analysis. Cost-benefit analysis compares benefits and costs before implementation of the project. CBA seeks to determine the potential of the project to contribute to the social welfare. The purpose is to find whether there is any additional surplus or value to increase the social welfare (Shaffer, 2010).

CBA process was defined by Prest and Turvey in 1965 as maximization of present value of all benefits decreased for the value of all costs, subject to specified constraints. CBA should answer four mutually related questions (Prest & Turvey, 1965):

- Which costs and which benefits should be included?
- How are benefits and costs evaluated?
- What discount rate would be used for discounting future benefits and cost in order to obtain present value?
- What are relevant constraints?

CBA has features of social CBA if it affects all individuals in a society, if the distributional effects are included with the efficiency effects, and if it emphasized that market prices are not an ideal indicator of individual willingness to pay. In that case, the market price is adjusted for effects to the market that are either not recorded or recorded imperfectly (de Rus, 2010).

Effects of the project can only be compared in two different scenarios: one with the project and another without it. So-called base scenario must be relevant in order to make a comparison with the project. Cost-benefit analysis has to create a scenario without the project. It could be a very difficult task, since the time period of the exercise may be very long and many variables will change, some of them in a predictable and some other in rather unpredictable ways. The scenario with the project execution has to be examined as well. Future changes have to be forecasted while they are unobservable. Economic appraisal of a project has to be founded on already defined objective. That objective could be achieved through alternatives. Their analysis is essential in order to avoid wrong conclusions. It is not enough to have positive benefits; they need to be greater than the benefits in the best available alternative. Cost-benefit analysis looks for an answer whether the investment is the best way to solve the problem. The project and relevant alternatives have to be set in a wider picture and cannot be narrowly defined since their existence is impossible without complementary actions. Opposite to it, neither the project can be defined too broadly. So, the project has to be defined and limited. After that it is necessary to identify benefits and costs obtained from its implementation. Some of them will have direct effect on the examined project while others will have significant effect on other markets. Benefits and costs occur in different periods of time. They need to be homogenized by discounting with discount rate greater than zero (Layard & Glaister, 1994).

It is assumed that individuals have stronger preferences for the present than for the future. When a product utility depends on consumption in successive periods, it is assumed that individuals give more weight to consumption closer to present, so that utility function has positive marginal rate of time preference which discounts the value of consumption according to its location in time. The question which arises from it is which discount rate to use in the project evaluation. Many projects with applicable cost and benefit ratio are completely dependent on this rate. The problem of interest calculation in CBA is how to evaluate output(s) and inputs occurring at different periods of time and most likely affecting different individuals (de Rus, 2010).

In practice discount rate differs significantly among the European countries as they can be driven by National Regulatory Authority, but in the case of projects of common interest it is important to use a single discount rate for all Europe in order to convert future financial benefits and expenses into their present value. It is the only way to make a meaningful comparison and evaluation. This is why the common pan-European discounting approach was suggested by EC and ACER and later accepted by ENTSO-E to be used for PCI and Ten Year National Development Plan (hereafter: TYNDP) project assessment. The real discount rate of four percent is used for all socio-economic benefit projects Europe wide (ENTSO-E, 2016b).

3.1 Performing CBA

CBA draws on the principles of welfare economics and public finance which provide the theoretical foundations for a general framework within which costs and benefits are identified and assessed from the society’s perspective. The analyst must identify all relevant costs and benefits and measure their values under alternative policy and economic environments. To conduct a reliable evaluation, an analyst needs to be equipped with all necessary analytical tools and economic concepts that will lead to the end (de Rus, 2010).

In a competitive market, economy resources are allocated based on information generated by the price mechanism. As prices vary, consumers respond by changing the quantities of the goods and services they demand and producers adjust output, supplying the market with a quantity of the output that maximizes profit.

The change in social welfare and decision criteria for the project assessment are measured by approaching the model of individuals’ utility maximization. Individuals who have their preferences always try to maximise utility under two constraints: available resources and technology (Edwards, 2010). CBA measures the change in that individual’s utility in order to access whether the project could bring improvement for an aggregate utility. People are forced to choose between different uses while technology limits the quality, variety, and quantity of goods due to the resources scarcity. This means that preferences limit individual's utility for a given endowment of recourses and technology (de Rus, 2010).

3.1.1 Net Present Value (NPV)

Net Present Value (NPV) summarizes flows of cost and benefits in different periods of time . If the NPV and redistributive effects are positive, the project will result in higher social welfare. NPV does not answer the question whether the project should be accepted or rejected. Even with NPV greater than zero, some individuals might be worse off while some others might be better off. A more precise argument is that the positive NPV has a potential to make more individuals better off. Social welfare is an increasing function in every individual's welfare. Total costs and total benefits affecting the project have to be calculated for all periods starting with t = 0 (beginning of the project) to the last period t = T. NPV is calculated using formula (1) (de Rus, 2010):

$$\mathrm{NPV} = \sum_{t=0}^{T} \frac{1}{(1+i^t)^t}\,(Benefits_t\text{-}Costs_t) \tag{1}$$

The NPV is obtained by discounting the net benefits for each period of predicted lifespan. The factor used in CBA is exponential discounting. It gives exponentially decreasing weight to the future costs and benefits. In the following discount factor formula (2) is a social discount rate (de Rus, 2010):

$$\delta^t = \frac{1}{(1+i)^t} \tag{2}$$

Discount factor will be less than one if social discount rate is greater than zero and if the time period is greater than zero. Present value of benefits and costs will be reduced eventually until one occurring far apart will become irrelevant. Profitability of the project depends directly on this factor and later discount factor for the project will be presented. Usually investments have only cost in the initial years while benefits and operational costs occur in the period of operating (Rothwell & Gomez, 2003).

Internal rate of return (hereafter: IRR) is used as a second indicator of project acceptance. It is the highest discount rate at which a project is on the margin of profitability. IRR gives the value of social discount rate which makes NPV equal to zero. If IRR is greater that the discount rate, the project is acceptable and if it is lower than the discount rate, the project could be rejected (Layard, et.al., 1994). After this calculation, risk analysis must determine the sensitivity of the NPV to changes in key variables. It provides information about the likelihood of the feasible results. CBA uses expected NPV since values that enter this calculation are also expected.

3.1.2 Risk analysis

It is not possible to live without risk since future is uncertain and it varies in outcome associated with a given action. The return on both public and private investments is affected by uncertainty and risk. Their calculations impel the analyst to recognize and quantify sources of potential risk at all stages in CBA. It helps in better understanding of the problem and more reliable selection of projects. It is very important to identify and quantify risky events but it is equally important not to put too much stress on unlikely events. Risk analysis is very important for projects with great socio-economic impact and/or when a project has high probability of shocks. Risk analysis is equally important in designing phases of the project. The decision maker might be faced with different project variances and alternative project proposals that would result in NPV change. This comparison could help reducing the costs exposed to unpredictable effects (Staehr, 2006).

It is assumed that individuals do not prefer risk and uncertainty and they do not value the assets with the uncertain returns at their expected values. The value of assets also depends on individual's initial assets holding and utility function. For these reasons, investors do not focus on maximizing the present value of expected returns but rather on maximizing the present value of returns properly adjusted for risk. The main issue arising from it is whether it is suitable to discount also public investments in the same way as private ones. If the government undertakes the investment project which is risk free than both cost and benefits would be measured in terms of willingness to pay for the expected outcome. Nevertheless, when a project brings some uncertainty then the outcome at less than the expected value of the net benefits needs to overstate the willingness to pay by an amount equal to the cost of risk bearing. Cost of this risk depends on the type of individuals that share cost and benefits from that project (Staehr, 2006).

Total cost of risk bearing associated with the investment is divided among all taxpayers who finance government expenditures. Furthermore, that cost must be subtracted from the value of the expected net benefit to get corrected value of net benefit. As it was already said, the government undertakes assumed investment and it spreads risk among all taxpayers which results in a negligible cost of risk bearing. Consequently, a public investment with an expected return which is lower than the private one may be still superior to its private alternative. In the context of the analysed project in this work it is crucial to notice that the same rule also applies for the large corporations as well. When the number of shareholders is high, then the total cost of the investment risk becomes negligible again. The same applies also if the wealth or income of the stockholders is large enough comparing to the size of the investment. This problem could be solved by discounting each period of predicted lifespan (Layard, et. al., 1994).

There is no single method of risk analysis that fits all cases of CBA. Out of several different analyses, in this work sensitivity analysis will be briefly described as it will be used in the project assessment. It examines the sensitivity of the expected NPV when variables in the calculation are changed.

3.1.3 Sensitivity analysis

Sensitivity analysis consists in testing how a change in one variable would affect the expected NPV. Effects of sudden changes in existing variables can be analysed. It does not explicitly refer to normative question of project acceptance (de Rus, 2010). Its biggest advantage is the ability to take into account risks as well as immeasurable uncertainly, to a certain extent. The starting point for this analysis is the basic scenario where all variables have their expected value. The second step is to change one of the variables and examine its change in conditional NPV or socio-economic welfare. This exercise can be taken for any or for all variables entering CBA. It is important to distinguish between two types of variables. The first are within the control of the decision-maker while others are outside of its control. For the first group sensitivity analysis is used as a basis to make changes, for the second group the analysis shows how risk affects the project. Finally, this test will reveal how sensitive is NPV to given changes in the considered variable(s). Sensitivity analysis is used as a descriptive exercise which does not have any normative implications (Staehr, 2006).

3.2 Cost-benefit analysis for electricity network project evaluation

So far, all the general rules and assumptions for a CBA were given. The basic idea was presented, but every project evaluation is specific. It depends on the type of the good that will be traded, market conditions under which the project will be developed, the group of individuals to be affected, etc. For evaluation of the project on the electricity market ENTSO-E created the guideline for CBA application. It is focused only on transmission network projects, as it is the case of the analysed underwater cable. Chosen guidelines define benefits, costs but also project feasibility. More independent electricity flows around Europe are the result of market liberalization and the rapid development and system integration of RES. Therefore, the network system must be designed beyond national TSO boundaries, moving towards a regional and European solution.

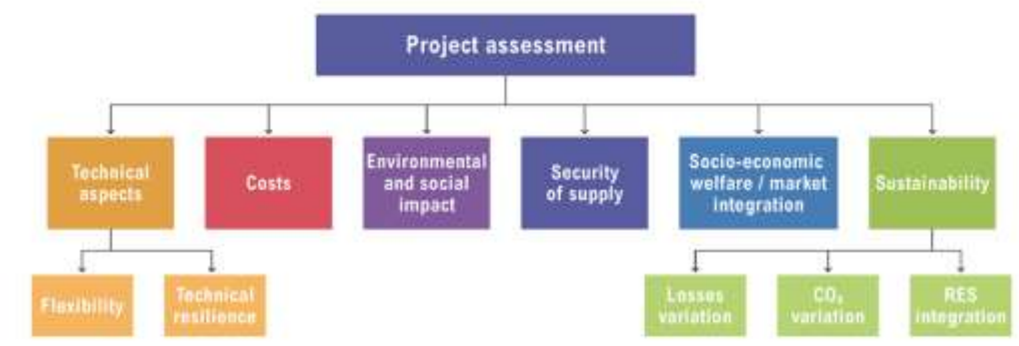
All transmission projects emerge from European policies on sustainability, market integration and security of supply. CBA must be conducted under such criteria to identify project candidates and calculate cost and benefit indicators. CBA evaluates projects in the context of their TYNDP towards the European society. The first phase of CBA in the transmission system project is defining planning scenarios which represent the plausible picture of the future development for long periods of time. They have to be built form several time horizons with interaction of key economic parameters such as CO_2 prices, economic growth, etc. Scenarios are defined by a generation portfolio, exchange patterns and demand forecast. This methodology recognizes two types of studies that complement each other (ENTSO-E, 2015b):

- Market studies are used for optimization of generation dispatch and supply-demand balance with the aim of minimizing power system operational costs. Those studies use a simplified grid model of single branch between two bidding areas. They highlight the network bottlenecks, as well as produce results in terms of wholesale electricity price forecast, production costs and social welfare.
- Network studies are used for detailed load flow network calculations under the given generation or load constraints. Market studies are also used as an input for network studies that will help in identifying the most representative planning cases.

Planning cases represent point in time particular situation that may occur within the framework of scenario in terms of demand, generation, grid development and their variations. The idea is to create multiple cases depending on variation in chosen, uncertain variable.

Every project evaluation is characterized by (Figure 4): technical aspects, operational aspects, socio-economic influence to the environment, security of supply, market integration and socio-economic welfare, and sustainability (consisted of RES integration, CO_2 emission variation and variation in losses). Benefit categories will be discussed in the next chapter followed by the explanation of costs.

Figure 4: Main categories of the project assessment methodology



Source: ENTSO-E. (2015, p. 25, Figure 10).

There are two possible ways for project assessment (ENTSO-E, 2015b):

- Take Out One at the Time (hereafter: TOOT) which examines load flows with and without network reinforcement by excluding grid elements one by one from the forecasted network structure. It is used for benefit estimation for each investment without considering other investment. It is used in TYNDP level since it considers the whole future evaluation of network and system environment. It evaluates the new project within the entire forecasted network. If some of the benefits are evaluated as poor it still does not mean that the project would be rejected. This method will be implemented in the evaluation of Lastva-Pescara project evaluation since it is mostly used in similar transmission plan developments such as TYNDP.

- Put In One at the Time (hereafter: PINT) examines every new network reinforcement evaluating one-by-one network flows with and without the examined grid reinforcement.

The idea behind this methodology is to bring the projects that are of the best interest for the whole European power system. This is why the bottom-up approach will be used. Geographical scope of this analysis must be regional and include also neighbouring countries. In order to meaningfully use appraised costs and benefits in the project and compare them with other similar projects, single discount rate is used all over Europe for NPV calculations. It is a rate of four percent for 40 years lifespan and a residual value of zero (ENTSO-E, 2015b).

4 ANALYSIS OF THE PROJECT

The previously explained liberalization of energy market enabled the connection of two South European peninsulas. Italy, with its constant need to import huge energy quantities, pays a high price for it. Montenegro, still weakly interconnected with the surrounding countries, is focused on strengthening its grid and generation units. Underwater cable will be used to transmit energy from the Balkan region to Italy. The analysis which will be conducted in the following part of the work will test economic justification of the project and cross-border flows between these two areas. Through the CBA, NPV and IRR will be evaluated. Discount rate of four percent will be used. After that sensitivity analysis will be conducted. It will show changes of NPV in different scenarios. For assessing this value, ENTSO-E CBA methodology (ENTSO-E, 2015b) will be used. As suggested, all seven benefits will be presented. Not all of them could be monetized. The data for these calculations are computed from ENTSO-E TYNDP 2016 evaluation (ENTSO-E, 2016b). They will be used as inputs for project evaluation together with capital and operational expenditures of the project. Project benefits are assessed by comparing two scenarios:

- Scenario 0 (base scenario) without underwater cable from Montenegro to Italy,
- Scenario 1 when underwater cable is already operational.

The difference in value in these two scenarios is the actual estimated value of each benefit. These values are input data for NPV calculation.

4.1 Underwater cable Lastva – Pescara

While sources of energy are localized, consumption tends to spread across the territory resulting in growing integration and need for transferring it over long distances. One of the available solutions for bulk electricity transmission which encompass wide and deep water bodies is using underwater power cables. They connect countries separated by small and medium width water bodies. More than 70 percent of them are in European seas (EC, 2015). One of them is also the studied cable which connects Montenegro and Italy. The cable has already been laid down in the Adriatic Sea. The construction of cable started in November 2016 (CGES, 2016). It is planned to be finished by the end of 2018. This is a High Voltage Direct Current (hereafter: HVDC) cable. This means that high voltage power systems are used. Cable current type is direct current (hereafter: DC). This means that electric charge flows will have the same direction (Ardelean & Minnebo, 2015). The cable is a single current one. Energy will travel from Lastva, Montenegro shore to Villanova, Province of Pescara in Italy. This type of cable reduces losses to minimum otherwise it would be uneconomical and impractical. Total cable's length is 420 km, 390 km of undersea cable and 30 km of underground cable. Cable is double and it consists of two 500 MW cables (600 MW in full utilization). Project's full utilization is 1200 MW and it is expected to be achieved after the network reinforcements inside of Montenegro and between Montenegro and neighbouring countries. Bosnia and Herzegovina and Serbia are recognized as priorities. They have very ambitious plans of generation capacities development which would significantly increase their export potential. Energy could be also transited from Hungary, Bulgaria and Romania through Serbia and Montenegro to Italy. Connection of those systems with Montenegro could bring great benefits in terms of export, safe and uninterrupted energy flows. But in northern part of Montenegro there are no 400 kV overhead lines with Serbia or with Bosnia and Herzegovina. Their construction is necessary and should not be delayed (POYRY, 2016). As stated earlier, on the Italian side insufficient generation capacities are the biggest market shortage. By connecting to the Balkan market Italian supply will be stabilized.

The idea to connect the highly import-dependent Italian market (especially the country's central and south area) resulted in the joint project of the Italian Operator TERNA and CGES. Total project investment is estimated to be over one billion EUR. There were several options how the interconnector might be financed. The Italian TSO's agreed share in the investment is 80 percent, while the Montenegrin Operator invests 20 percent (Ministry of Sustainable Development and Tourism, 2011). This means that the new underwater line will be managed in the "regulated" regime. It will be a part of the national transmission grid. The whole project consists of the underwater cable, two converter stations and new transmission line in Montenegro. Additional transmission lines are not required in Italy since it is estimated that the grid could bear upcoming energy flows from the Balkan area. As stated earlier, Montenegro does not have enough energy for export towards Italy. That energy will be transmitted to Montenegro through

BiH, Serbia, Romania and Bulgaria. That brought the need for strengthening the grid from the country's north to south, where the first end of the underwater cable is positioned. Building of the new transmission line (400 kV) from Pljevlja to Tivat has already started. That part of the project is fully financed by CGES. Once when energy reaches the Montenegrin coast through this line it will have to be transformed from alternating current (hereafter: AC) to direct current (DC). This energy is rather transmitted on long distances due to significantly smaller losses. Energy will be converted at 400 kV converter station on Lastva. This station is directly connected to the cable which will transmit energy to Villanova where the second 400 kV converter station is placed. Energy will be there "returned" from DC to AC and further on connected to the central Italian part of the grid. This part of the project is solely financed by TERNA. Even though, underwater carries the biggest weight in technical and financial sense, also other three parts are highly important for smooth and profitable operation of the cable. In the next part of the work, calculations will be done for the project as a whole, consisting of four parts.

4.2 Benefit categories

Benefits from constructing the new interconnector according to ENTSO-E guidelines are presented here. In order to analyse benefit indicators, transmission network development plans have to be taken into account. As common indicators for European countries, they can be found in the Ten Year Network Development Plan (hereafter: TYNDP) published by ENTSO-E. When a new project is analysed, it is not enough to compare the development plans for countries that will be connected by new interconnector but also for surrounding countries. They will influence the energy flows as well. Currently, the long-term perspective is to monetize as many as possible benefit indicators for any project in the transmission system. This idea was developed for the first time in TYNDP of 2014. Before that only socio-economic welfare could be monetized (ENTSO-E, 2014). Energy sector tendency is focused on monetizing all of the benefits, even though some project values cannot be turned into cash flows at the moment.

4.2.1 Project security of supply

Almost every economic process depends on reliable and safe electricity supply. Efforts to maintain and increase the level of security of supply must be balanced against electricity outages (if less than required amount of electricity is available) and blackouts (if there is no electricity at all). Every new transmission project is expected to bring improvement to the security of supply. This improvement is measured as a difference between the cases with and without the project with the defined indicator which could be either (ENTSO-E, 2015):

- Loss of Load Expectancy (hereafter: LOLE) measures hours of electricity not supplied during the year,
- Expected Energy not Supplied (hereafter: EENS) measures MWh of electricity not supplied during the year.

The basic monetary unit used to express undelivered energy is value of lost load (hereafter: VOLL). It calculates value added from one additional MWh produced which roughly determines the predictable value added due to electricity blackout or outage (Schroder, 2015). It is not unified and it varies largely among countries. It depends on regional and sector characteristics inside of one economy. Also, it is based on the role of energy as a good inside the analysed country. It is economic indicator of security of supply and it is defined as expense of outage due to the loss of economic activity due to kWh that was not supplied. It can be expressed in monetary units to kWh or in relation to time (ENTSO-E, 2016b).

Failures of the system occur rarely but may result in hazardous events. The main grid level operates according to “N-1” criterion which means that the system can withstand the loss of a single principal component without any interruption in supply (Kjolle, Utne, & Gjerde 2012). Opposite to it, outage in local networks causes delivery problems since they operate as radials. Risk analyses in this area are used for identifying of vulnerabilities, emergency readiness and risk reducing measures. Reliability in energy sector depends also on other sectors and infrastructure. Their high interconnectivity results in cascading effect in case of outage. Analyses of causes and consequences must be investigated in order to provide the basis for risk assessment. Further on, those risk analyses will identify chains of events that lead to system interruptions. System failures are caused by: breakdown of a single or more generation units, sudden and unexpected increase in loads, malfunction in some of the system elements, operating mistakes, transmission system collapse, switching, etc. Schroder (2015) cites two main trends that increase the risk of failures:

- liberalization and privatization (they are almost fully implemented),
- expansion of renewable energy production capacities.

Factors that influence outage could be divided into three groups as suggested by Table 3 Technical factors define conditions which constrain the electricity interruption and which are crucial for black out. The load-side factors describe the effects that cause damage to customers affected by the outage. The third group, social factors describe the consequences, which are difficult to evaluate objectively (Schroeder & Kuckshinrichs, 2015).

Table 3: Factors that influence outage

Technical factors	**Load-side factors**	**Social factors**
Duration	Type of customer	Cultural and social preferences
Region	Number of customers affected and level of dependences on electricity	
Frequency	Degree to which process steps can be substituted	
Time	Existence of standby power supply	
Dimension		
Advance warning		
Security supply level		

Source: Schroeder & Kuckshinrichs, (2015. p. 2, Table 1).

Beside these factors, it is necessary to consider also time frames of outage. There are three phases:

- preparation for outage (if it was predicted or expected),
- duration of outage,
- time to restart the generation, transmission or distribution processes.

Further on in the work, in order to calculate EENS in both scenarios, reliability index will be used by the formula (3):

$$EENS = \sum_{xEX} F(x)P(x) \tag{3}$$

where:
$F(x)$ is lost load, and
$P(x)$ is probability of unexpected event.
Energy not supplied is also calculated for both scenarios and differences in topology scenarios are presented by the formula (4):

$$\Delta EENS_i = EENS_i\text{-}\Delta EENS_o \tag{4}$$

where:
$EENS_i$ is undelivered energy in the scenario 1, and
$EENS_o$ is undelivered energy in the base scenario.

Table 4: Methodology used to calculate security of supply

Parameter	Source of calculation	Basic unit of measure	Monetary measure	Level of coherence
LOLE	Market studies	Hours or MWh	VOLL	National
EENS	Network studies	MWh	VOLL	National

Source: ENTSO-E, (2015. p. 35).

For the purpose of the project evaluation, security of supply indicator is assessed in the line with methodology given in Table 4 for targeted years (2020 and 2030). The performed analysis shows that security of supply will be stable for both countries (and region as well) in the observed periods. Construction of underwater cable will not influence it and therefore, evaluation of project impacts is not applicable. EENS for both scenarios is zero. Results are presented in Table 5.

Table 5: Estimated benefits from change in security of supply

Benefit category	Year 2020	Year 2030
Security of supply	No change	No change

Source: ENTSO-E, (2016a. p. 41).

4.2.2 Project variation in losses

Transmission losses are calculated by performing the AC load flow network analysis. The project can have three different effects on losses (Tol, 2007):

- It can increase losses in transmission grid due to higher long distance electricity transits (negative effect),
- It can reduce losses in transmission grid by creating better network configuration (positive effect),
- It can have negligible effect on losses (zero effect).

Variation in losses is calculated for both Italy and Montenegro together (see Table 6). They are assessed according to the quantity of lost electricity (GWh).

Table 6: Methodology used to calculate variation in losses

Parameter	Source of calculation	Basic unit of measure	Monetary measure	Level of coherence of monetary measure
Losses	Network studies	MWh	€/year (market-based)	European

Source: ENTSO-E, (2015. p. 42).

Table 7 presents negative effects from the increase of energy flows between South Eastern Europe and Italy. They are assessed both in quantity units (GWh) and monetary units (EUR).

It is calculated that increased energy transits through SEE caused by directly connecting Montenegro and Italy (and producing export energy corridors form Bulgaria-Romania-Serbia in the North-East and Bosnia and Herzegovina in the North-West towards Montenegro and the cable) will increase power system losses at the level of 325 GWh in 2020 and 400 GWh in 2030. The cost of producing additional energy for coverage of obtained higher power system losses is at the level of 14 million EUR in 2020 and 21 million EUR in 2030. Estimated price of loss per MWh in 2020 is 43,08 EUR and in 2030 is 52,5 EUR. The reason for an increase of the price of losses could be the result of expected increase of CO_2 taxes.

Table 7: Estimated benefits from variation in power system losses

Benefit category	**Year 2020**	**Year 2030**
Variation (increase) in losses (GWh/year)	325	400
Benefit from variation in losses (million EUR/year)	-14	-21

Source: ENTSO-E, (2016a. p. 41).

4.2.3 Project RES integration

Integration of the planned and existing renewable energy sources (hereafter: RES) is relieved by (ENTSO-E, 2015):

- Connection of RES to the main system,
- Increase of Grid Transfer Capability (GTC) between the areas with a surplus in generation from RES to other area in order to influence RES penetration into the system.

It is crucial to understand the difference between RES integration in the system and the project that would influence load flows of the system (EC, 2015). Both types of projects could result in the same project valuation but they do not use the same units (see Table 8). Direct integration uses as basic unit of measure MW (RES) while the GTC-based indicator uses MWh since it reduces congestion in the main system. Direct integration is calculated from network analyses and it is calculated for projects when RES should be integrated in the system. Both indicators are used to evaluate the project (used method has to be reported).

Table 8: Methodology used in calculation of RES penetration and integration

Parameter	Source of Calculation	Basic unit of measure	Monetary measure	Level of coherence of monetary measure
Connected RES	Market or network studies	MW	None	European
Avoided RES spillage	Market or network studies	MWh	Included in generation costs savings	European

Source: ENTSO-E, (2015. p. 41).

Table 9: Estimated benefits from RES integration

Benefit category	Year 2020	Year 2030
RES Integration (GWh/yr)	50	<10

Source: ENTSO-E, (2016a. p. 41).

This project is expected to have modest influence on RES integration. Table 9 shows that in 2020 additional 50 GWh of energy from RES can be evacuated to the grid due to the project commissioning. The quantity significantly drops in 2030 to below 10 GWh. Nevertheless, those results are expected since the focus of investment is to facilitate market coupling and a higher level of cross-border trade between two areas while usually production of RES is localized, and the problem of evacuation is dealt with smaller and local grid reinforcements.

4.2.4 Project socio-economic welfare

Socio-economic welfare was for a long time the only CBA benefit easily monetized (see Table 10). It is the most representative indicator of project utility. New interconnector brings together two bidding areas which allow the area with lower prices of generated energy to export it to a higher priced area. It will increase GTC and reduce total costs of energy supply. Socio-economic welfare is calculated using one of these two approaches. Both approaches give the same total transmission capability for the Europe (ENTSO-E, 2015):

- Generation approach measures the change in generation cost and market competiveness with the new interconnector.
- Total surplus approach is calculated as the sum of customer and generator surplus and congestion rent. With reduction of bottlenecks generation dispatch is optimized and it produces an increase of market surplus.

Table 10: Methodology used to calculate socio-economic welfare

Parameter	**Source of Calculation**	**Basic unit of measurement**	**Monetary measure**	**Level of coherence of monetary measure**
Reduced generation costs/additional overall welfare	Market or network studies	EUR	EUR	European
Internal dispatch costs	Network studies	EUR	EUR	National

Source: ENTSO-E, (2015. p. 40).

The achieved benefit is appraised for every hour of the year and then it is aggregated through market analyses. Analyses are conducted for source and sink area. The already explained "N-1" for security of supply must be also met in order to achieve socio-economic welfare. GTC must be compared in both scenarios (one with and one without the new interconnector) as suggested in formula (5) (ENTSO-E, 2015):

$$\Delta GTC = GTC_{project\ in} - GTC_{project\ out} \qquad (5)$$

Finally, socio-economic welfare is calculated for every hour separately according to the formula (6) (ENTSO-E, 2015):

$$Benefit = Total\ surplus_{project\ in} - Total\ surplus_{project\ out} \qquad (6)$$

The results of project evaluation analysis show that the project produces notable GTC increase of transmission capacity for 1200 MW (see Table 11). Since in the base scenario there is no connection between Montenegro and Italy ΔGTC and NTC are equal in the scenario 1 where the cable is built and operational. To calculate this transmission capability, the generation approach was used as requested by ENTSO-E with socio-economic welfare representing the savings in generation fuel and operational costs and maintenance costs. It is expected that the cable will help the most efficient use of generation capacities in Eastern countries. Even though it is rather small, it also helps RES integration to the system and reduces congestion. It is also very important to emphasize that this transmission capability does not disrupt "N-1" criterion explained earlier.

Table 11: GTC contribution

Δ GTC	Year 2020	Year 2030
ME-IT (MW)	1200	1200
IT-ME (MW)	1200	1200

Source: ENTSO-E, (2016a. p. 40).

The project enables a significant increase in socio-economic welfare by enabling the export of cheaper energy from SEE region towards Italy on account of more expensive Italian generation portfolio. The price difference between the two regions will decrease with project commissioning, benefiting the consumer surplus and the price decrease in Italy, and producer surplus and the price increase in Montenegro and the rest of SEE region. Overall stable benefits in range of 130-140 million of EUR per year are observed in both 2020 and 2030 (Table 12). The project could also enable savings since investments in generation capacity could be decreased. This aspect was not considered in the CBA methodology.

Table 12: Estimated benefits from change in socio-economic welfare

Benefit category	Year 2020	Year 2030
Socio-economic welfare (million EUR/year)	130	140

Source: ENTSO-E, (2016a. p. 41).

4.2.5 Project variation in CO_2 emissions

When network congestion is reduced or even eliminated, generation units with lower CO_2 emissions can generate more energy ignoring the conventional energy sources. Taking into consideration distinctiveness of CO_2 emissions for each and every generation unit and annual generation of CO_2 gases, CO_2 annual value could be calculated. It could be also monetized in socio-economic welfare by using dispatching generation and unit-commitment when standard CO_2 taxes are taken into account. If CO_2 emission is based on projected prices of CO_2 taxes in the observed period it could be used to calculate price of losses per MWh in one of the following ways (ENTSO-E, 2015):

- derive CO_2 change,
- consider CO_2 prices in socio-economic welfare,
- adopt long-term cost price of CO_2.

In this work multiple quantities with price differences in order to get CO_2 differences and mentioned cost are considered under calculation of socio-economic welfare. For the purpose of the project evaluation, CO_2 emission is assessed in the line with methodology given in Table 13 for targeted years.

Table 13: Methodology used in CO_2 emission

Parameter	Source of Calculation	Basic unit of measurement	Monetary measure	Level of coherence
CO_2	Market and network analysis (substation effect)	Tons	CO_2 price derived from generation costs	European

Source: ENTSO-E, (2015. p. 43).

With project enabling higher market integration and increase of cross border trading, more efficient generation portfolio dispatch will be observed. Older and less efficient fossil-fuelled generation units will become less market attractive, and therefore they will operate less under market conditions with the examined project (higher potential for cross border trade). Especially it could be important for Montenegro, which plans to construct new generation units, presented in the second chapter of this work. With higher output from clean energy units (hydro, wind, solar) or more efficient fossil-fuelled units on account of less efficient fossil-fuelled units, overall CO_2 emission will decrease in relative terms comparing it to demand in those years (see Table 14).

Table 14: Estimated benefits from change in CO_2 emissions

Benefit category	Year 2020	Year 2030
CO_2 emission (kT/year)	1400	2800

Source: ENTSO-E, (2016a. p. 41).

4.2.6 Project technical resilience and system safety margin

Technical resilience task is to prove that the new planned project contributes to operational safety for the transmission system in times of unpredicted or extreme conditions. Besides, it should prove that the analysed project would not contribute to uncertainty, insecurity or instability in relation to the final development and functioning of the future transmission system. It should instead prove positive effect on efficiency and ensure security of supply. The following criteria in network analysis are broken down (ENTSO-E, 2015):

- construction of analysed needs potential to hold up all required operational conditionals,

- steady state,
- voltage collapse criteria.

All of the above mentioned criteria are evaluated only qualitatively. Conducted analyses for this benefit indicators are (ENTSO-E, 2016c):

- security "N-1";
- security "N-1-1", analysis for transmission systems maintains;
- voltage stability analyses when power voltage (hereafter: PV) and quality voltage (hereafter: QV) curves are given as function of active power-voltage and reactive power-voltage.

Voltage stability is defined as the ability of a power system to maintain stable voltage value in all system points during the struggle, taking into consideration initial system conditions. If transmission's power is increased, voltage is decreased in some points of the system. The limit of the lowest voltage is defined as a value in point where voltage reaches its minimum. If pushed over this limit, unstable deliveries might result from the system breakdown. PV analysis is conducted when power variations from the source area towards the transit area (sink area) are observed. In this analysis, 1200 MW power increased is assumed. Montenegro's transmission system is taken as the source area while Italy is the sink area. QV analysis is used for setting reacting power that is required to inject in one specific point in order to keep the voltage, of that point, inside allowed limits. It will not be used in work of project analysis. If technical resilience is taken in consideration when planning new transmission system project, then significant contribution is achieved for extreme scenarios and security analyses. Considering technical resilience when planning a new project increases significantly system safety in extreme scenarios and security analysis. The mentioned factor allows better ability of the project in analysing and withstanding uncertainties in system functioning in future. It influences efficiency and security of supply Europe wide. Technical resilience is calculated by aggregating several key performance indicators. TOOT should be conducted and it covers ranking of projects based on these key indicators (ENTSO-E, 2016c).

- + is given if the project meets one of the indicators,
- ++ is given if the project meets all of the indicators.

Key performance indicators (hereafter: KPI) (ENTSO-E, 2016a):

- Ability to comply with all cases analyzed using probabilistic, multi-scenario approach,
- Ability to comply with all cases analyzed taking out some of the foreseen reinforcements,
- Ability to facilitate sharing of balancing services on wider geographical areas, including between synchronous areas.

The project has a moderate impact on power system technical resilience (see Table 15). The impact on all three KPI is presented below. This benefit is not monetized and it will not be used in the economic analysis.

Table 15: Estimated benefit from change in technical resilience

Benefit category	Year 2020	Year 2030
Technical resilience	+	+

Source: ENTSO-E, (2016a. p. 41).

4.2.7 Project flexibility

Project flexibility refers to changes that could influence the considered investment taking into the account "N-1" criterion for grid planning. These analyses ensure the project's full usefulness though other regional transmission projects could be implemented as well. The only obstacles could be either unsure development of transmission improvement or if cross-border transfers differ from the planned (ENTSO-E, 2015).

ENTSO-E TYNDP takes into account many additional interconnectors that are geographically close to the project discussed in this work. It was a trigger to conduct the so-called "N-1" security criterion that considers the ability of Lastva-Pescara project to resist insecurities from additional transmission reinforcements in the form of new interconnectors.

Table 16: Estimated benefits associated with project flexibility

Benefit category	Year 2020	Year 2030
Flexibility	+	+

Source: ENTSO-E, (2016a. p. 41).

Underwater cable has a moderate flexibility to potential delays of other transmission projects in the neighbouring countries (Table 16). The most important project cluster that supports the SEE and Italy corridor is at the same time also the grid reinforcement between Serbia-Montenegro-BIH. Currently, there are no 400 kV connections between the Northern Montenegro and Serbia and BIH. Connection between those two systems is imperative for Montenegro in order to provide uninterrupted transits of electricity towards Italy. Both BIH and Serbia have ambitious plans for generation capacities development. Also, some energy will be gathered from Romania, Hungary and Bulgaria and through Serbia transmitted to Montenegro and then to Italy. Network strengthening consists of two new interconnectors. Both will have voltage of 400 kV. One will be the overhead line Pljevlja 2 - Bajina Basta (Montenegro-Serbia). The other one will be the overhead line Pljevlja2 - Visegrad (Montenegro-BIH). Both projects also include the construction of 400 kV high-voltage filed in SS 400/220/110 kV Pljevlja 2. It is expected that Pljevlja 2 - Bajina Basta will be finished by the end of 2019 which is one year before the completion of Pljevlja 2 - Visegrad. These two projects could be studied as one single project since they represent an obligation under the Construction Contract for the Project implementation of the underwater cable. These two network reinforcements are crucial for underwater cable flexibility (Ministry of Economy, 2015).

4.3 Project costs

From ENTSO-E TYNDP, capital and operational expenditures are assessed. Capital expenditures (hereafter: CAPEX) consist of construction of 1200MW HVDC underwater cable, two converter stations on both ends of the cable and the transmission line 400 kV which will connect the Montenegrin South with the North. Italian grid reinforcements are not taken into account since there will be no reinforcements directly connected to cable construction. Operational expenditures (hereafter: OPEX) are annual interconnector's cost of grid maintenance, losses and operations, which as amount 2.5 percent of capital costs. In Table 17, the data appraised from ENTSO-E TYNDP (2015) are presented.

TERNA finances underwater cable and the Italian side converter station. It is an agreed share in costs of 80 percent or almost one billion of EUR. Montenegro finances twenty percent of the project which includes construction of the Montenegrin side converter station and the transmission line.

Table 17: 2015 ENTSO-E costs estimation

Type of costs	Amounts
CAPEX (million of EUR-2015)	1,246
OPEX (million of EUR/year)	31

Source: ENTSO-E, (2016a. p. 40).

4.4 Project evaluation

In Table 18, input data for project's evaluation are presented. Inputs were assessed from ENTSO-E TYNDP. Out of seven benefits only two of them are monetized: socio-economic welfare and variation in losses. Socio-economic welfare is also expressed through the GTC increase. Variation in losses is the value of energy which will be lost in the power system on the way to Italy. Capital expenditures were computed for the base year 2015. Annual costs of maintenance were estimated at 31 million EUR. Project implementation started in 2016. It is expected that the cable will be operational in 2019. By that time, all of its units will be constructed but also supporting projects will be completed. It is very important to note that the project's estimated socio-economic welfare is positive after one year of operating. The assumed lifespan is 40 years. It will be used in all calculations.

Table 18: Scenario specific CBA indicators

	Category	2020	2030
Benefits	GTC increase	1200 MW	1200 MW
	Security of supply (MWh/year)	No change	No change
	Socio-economic welfare(million EUR/year)	130	140
	RES integration (GWh/year)	50	<10
	Variation in losses (GWh/year)	325	400
	Variation in losses (million EUR /year)	-14	-21
	CO_2 Emissions (kT/year)	1400	2800
	Technical resilience	+	+
	Flexibility	+	+
Costs	CAPEX (million EUR)	-1246	-1246
	OPEX (million EUR/year)	-31	-31

Source: ENTSO-E, (2016a. p. 41).

Benefits are acquired for two years (2020 and 2030). The data for 2020 will be used for the first ten years when conducting evaluations. For the next thirty years, the data for 2030 (until year 2058) will be used. As suggested before, a four percent discount rate will be used for all evaluations. This discount rate is proposed by EC and ACER (ENTSO-E, 2016a). A further analysis will be developed with reference to the profitability appraisal model examining monetized benefits and costs of the infrastructure as a stand-alone venture. Evaluated benefits and costs are compared to assess the net cash flows. The project viability is calculated using all of these data and assumptions.

The project evaluation was used to appraise future net cash flows of the project. As we can see, there are three types of expenditures and one type of gains. Their difference is the assumed annual net cash inflow. The estimated NPV of the project under the base scenario in 2017 is 268 million EUR, indicating that the project is feasible (Tables 19 and 20). As alternative methods for project evaluation IRR, B/C ratio and payback period were calculated as well. They can be used for comparison with NPV approach but they can also supplement one another. Benefit to cost ratio is profitability index. It is calculated as a ratio between project's discounted costs and benefits. It gives an instant evaluation of the project. If higher than one, the project is rated as viable. It suggests that future benefits will top future costs. The studied underwater cable has B/C ratio 1.25. It is correlated to IRR. As explained earlier, if internal rate of return is higher than the discount rate, the project is estimated as feasible. This project's IRR is 5.18 percent while the discount rate is 4 percent. Investment decisions are also influenced by the payback period. Though very simple evaluation it is used as a signal for return on investment. This project will need 15 years for it, according to the collected data. This period is within the average for this type of capital investments.

So far, the project has all positive and optimistic results. All evaluations confirmed that the project is economically justified. But it is crucial to conduct a risk analysis to see how a chosen variable change would influence these evaluations. Sensitivity analysis is used to show how a change in one or more variables affects the expected NPV. They can be affected by numerous factors that cannot be examined in this work. The previously presented evaluation is the base scenario for these analyses. As presented in Table 19, three more scenarios are examined.

Table 19: Scenario analysis

(Million EUR)	**Base scenario**		**Scenario 2**		**Scenario 3**		**Scenario 4**	
Year	2020	2030	2020	2030	2020	2030	2020	2030
OPEX	-31	-31	-31	-31	-31	-31	-31	-31
Variation in losses	-14	-21	-14	-18	-14	-7	-14	4
Socio-economic welfare	130	140	130	150	130	140	130	60

Source: ENTSO-E, (2016a. p. 40).

In all scenarios it is assumed that OPEX will not change. Also, in all scenarios the data calculated for 2020 will stay the same. Sensitivity analysis is conducted on changes for variation in losses and socio-economic welfare in 2030. Many factors could influence these changes but they will not be examined. In the second scenario, variation in losses is reduced by 15 percent while the socio-economic welfare is increased by 10 million EUR, in comparison to the base scenario, for the same year. In the third scenario, variation in losses is assumed to be three times reduced while the socio-economic welfare is as in the base scenario. In the fourth scenario, variation in losses generates profits while the socio-economic welfare is extremely low. So, variation in losses is expected to be decreased in the distant future which means that losses on electricity are expected to be declined as well. On the other side, socio-economic welfare can decrease, increase or stay at the level of the base scenario.

In the second scenario where both variables have positive impact on the project, NPV is significantly increased while the payback period is decreased only for one year. In the third scenario, we see that the decrease of losses has a very strong influence on all evaluations even if OPEX and the socio-economic welfare stay at the same level. In this scenario, NPV would be almost doubled. B/C ratio in both scenarios changes very little probably due to a great capital intensiveness of the project. The fourth scenario assumes drastically lowered socio-economic welfare and cash inflows form variation in losses. Here we can see how volatile this project is. With the same costs, capital and operational expenditures, and with positive change in losses of electricity, a decrease in benefits would make this project unfeasible. NPV is negative, B/C ratio is lower than 1, while IRR is 2.41 percent. In this scenario, investment payback period would be more than 20 years (see Table 20).

Table 20: Project evaluation

Scenario	NPV 2017 (million EUR)	IRR (%)	Payback period (year)	Discounted payback period (year)	B/C ratio
Base scenario	268.32	5.18	15.00	21.96	1.25
Scenario 2	422.82	5.61	14.09	20.44	1.33
Scenario 3	433.02	5.65	14.05	20.24	1.34
Scenario 4	-270.78	2.41	20.74	N/A	0.93

Source: Own calculation

The project evaluation and sensitivity analysis showed that the project is economically justified yet very vulnerable to potential changes. Sensitivity analysis proved that both moderate and extreme shifts would significantly influence the project.

5 THE IMPACT OF INVESTMENT ON ELECTRICITY MARKETS IN THE TWO REGIONS

As earlier said, this project exceeds the borders of the SEE peninsulas. It has a strategic significance at the European level. It is recognized as a step further towards the single electricity market. Europe strives to generation and consumption decrease. These two goals are planned to be achieved with the help of energy efficiency programs and the use of clean energy sources (Notenboom & Boot 2016). This energy transition process was met by the most of the Balkan countries with obsolete and negligent energy systems. These systems on the other side have a great hydro and RES potential to generate clean energy at lower costs (IRENA, 2013a). Taking into account that Italy is connected to the Balkan Peninsula only through Slovenia and Greece, this underwater cable will have a great role in further market integration and creation of the European Energy Union (TERNA, 2016). There it exceeds its financial benefits and becomes cost valid. It will be used for ensuring secure, sustainable electricity at accessible prices for European citizens. For these reasons, the underwater cable got the status of PCI. It brought to Montenegro 25 percent of credit financing from EC for their part of project financing (CGES, 2016).

The Montenegrin and the Italian impacts will be scathed separately since both countries entered the project with different ambitions. This substantial energy investment will create long-term and short-term effects for both of them as well as for the surrounding countries. This power bridge will integrate the entire region. Mutual benefit reflects in an increase of security of supply and contributes to the system flexibility which arises from the speed of response if outage occurs (CGES, 2016). Calculations in the previous chapter estimated the project as feasible yet very sensitive to changes. With a four percent discount rate, it resulted in positive NPV. Sensitivity analysis proved that the project needs around 15 years to return the investment for every scenario. The new interconnector will bring together two energy markets and consequently both of them will be influenced by the cross-border trading. If the project is to be assessed only by the NPV, it is a question whether it would be accepted. From the calculations it become clear that the discount rate increase of only one percentage point would crush positive results of the project. Furthermore, the discounted payback period suggested that the project needs more than 20 years to return the investment for the base scenario and two different scenarios while in the last scenario the investment becomes irrevocable. It proves its volatility and the sensitivity analysis set this project in a group of very vulnerable projects. Even a small market shock would affect it radically.

Two markets are connected with new HVDC cable, which will be the capital-intensive power transmission facility, and it will bring severe integrative effects on both peninsulas. It should be noted that the opening of this connection will link two very interesting consumer areas. On one side, there is the SEE area with many unexploited energy potentials, mostly in renewable energy sources. On the other side there is the Italian market as one of the biggest European consuming areas, which faces a lack of generation units and importing around 13 percent of its yearly demand (Herbert Smith Freehills, 2015). Energy from one area to another will be transmitted only when Italy faces an increase in demand and the Balkans face a surplus in electricity while the price difference is positive. Few years ago electricity wholesale price difference between two discussed areas was much bigger than today (for example in the last quarter of 2011, the Italian average price was 78.0 EUR/MWh while the Romanian average was 59.4 EUR/MWh, in the same quarter of 2016, the Italian average was 52.8 EUR/MWh and the Romanian was 39.1 EUR/MWh) (EC, 2012; and EC, 2017).

Prices of all products on energy markets in the SEE region are mainly influenced by prices on the Hungarian electricity exchange (hereafter: HUPX) which is the most liquid exchange in this part of Europe. Furthermore, HUPX prices are influenced by German prices which has the lowest electricity prices and is the biggest electricity market in Europe, and by Italian prices which are the highest electricity prices. For every hour when the whole area has energy surplus, the price will be set based on German prices. If the area faces energy deficit, the price would be affected by Italian prices for the hours of deficit. Once the cable becomes operational, prices of electricity in the Balkan area will be increased since 1200 MW (maximum cable capacity) increase in Italian demand when the supply stays the same results in the lack of energy for export, ceteris paribus. On the Italian side of the cable the effect will be the opposite.

An increase in supply for 1200 MW when the demand stays the same will decrease in wholesale prices, ceteris paribus. It will result in price convergence when two markets' price spreads would be reduced. As we can see from the project estimations of the yearly average prices for the near future, the Hungarian market is also responding to the new cable by reducing the price spread between Italy and Hungary. In Table 21 we can notice that if the cable becomes operational in 2019 only one year after that Hungarian-Italian spread will be 2.7 EUR/MWh. HUPX prices will also influence the price of electricity exported to Italy since some of the energy must be brought from Hungary. This energy will be able to flow freely from Hungary though Serbia and Montenegro to Italy since sufficient interconnectors between those countries result in seldom congestions.

Table 21: Price projection

(Estimated price EUR/MWh)	**2018 year**	**2019 year**	**2020 year**
Italian average price	43.85	42.60	41.95
Hungarian average price	40.40	38.80	39.25
Spread	3.45	3.80	2.70

Source: Adapted from HUPX, (2017); GME, (2017).

5.1 Impacts on Montenegrin market

Several years ago, the construction of the cable was impossible since the Montenegrin market only just entered the process of market reconstruction and cross-border trading was impossible. Two years from now, when the cable becomes operational, the trading of electricity and cross-border capacity rights will be fully liberalized in all SEE countries, which will be additionally facilitated by newly opened regional exchanges. For the Montenegrin market, this project has multidimensional impacts. It is inferior comparing to Italy in terms of network development, market openness and new investment projects. This investment has a very important role for the Montenegrin economy in financial, social and energy terms. Montenegro's CGES entered into the project of underwater cable construction expecting the revenues from energy transmission and the access to European development funding (Ministry of Sustainable Development and Tourism, 2011). The project will set this country on the Europe energy map since it will be the hub for energy transmission. As consequence, other sectors will be also influenced positively. A change is expected within the energy sector. Underwater cable has already stimulated Montenegrin network enforcements and restructuring which will have positive impact on the country's security of supply (CGES, 2016). The same effects it has on country's borders where new interconnectors (they are explained in the Chapter four) are already conceived. Indirectly, the cable will accelerate market opening due to the increased trading between the Balkan countries, Hungary and Italy. Currently, Montenegro does not have enough energy for export but most of the other surrounding countries do and they are especially rich in electricity generated from hydropower which is cheaper and convenient for band deliveries (Ministry of Sustainable Development and Tourism, 2011). On the Montenegrin side, the HVDC underwater cable is a trigger for many possible new investments in the sector. The boost of investments in new generation units in the country is certain. All of these changes will eventually, if all the other parameters remain as planned, result in a boost of construction business, trade of concessions and consequently an increase of workforce (Ministry of Sustainable Development and Tourism, 2011). This project is an impulse for the sector's development. As the consequence of an increased trading towards Italy, new generation units will be also very important for the future sector's development if prices remain within the similar price range as they are now. The increase of export prices would stimulate investments in generation units in Montenegro. Maximum power transmission capacity of the examined underwater cable is 1200 MW which is a significant novelty for the whole energy sector of Montenegro, taking into account the size of the sector. Eventually it will also bring energy surplus to the market.

Companies operating in Montenegro will directly generate revenues from capacity trading. Cross-border capacity rights trading will be performed through explicit auctions. This is an opportunity for option purchase of capacity and less risk on revenues when the price difference between the Balkan region and Italy is positive and the price of capacity lower than the price spread. Transactions will be performed only when positive revenues are expected. The price of the capacity will be equal or lower than the spread price between Hungarian and Italian prices. If we take the price estimation from Table 21, this capacity price should be lower than 2,7 EUR per MWh to generate revenues from export towards Italy. CGES will generate revenues also from service fees for every MW of traded electricity. They will also gain revenues every time the price of capacity is lower from the importing countries (Serbia and BIH) than towards Italy. The price of capacity will be higher than zero in case of congestion but if there is no congestion, the price of capacity will be equal to zero. It is important to notice that not only electricity prices will be increased but also capacity rights in surrounding countries. It is expected that the price will be increased on Montenegrin borders with BIH and Serbia but also Hungary and Serbia, BIH and Serbia and Romania and Serbia. This cable will relieve interconnectors on the Slovenian-Italian border and consequently equalize the capacity price with the price spread between Hungary and Italy. Indirectly, through the market opening, new foreign capital will enter the country. Foreign companies will boost the wholesale trading and investments in new generation units (CGES, 2016).

The greatest concern regarding the cable is retail price shock Montenegrin consumers may experience. If prices remain within the same price range as they are now for the next few years and taking into account that Montenegro started from the 1st of January 2015 (Energy Community, 2017; Vijesti, 2015) free pricing, band of two markets retail prices for Italy and Montenegro would be slowly evened out. It is a natural market process, but it would also have very negative consequences for economically weaker Montenegrin citizens. Price convergence will influence a price decrease at the Italian end of the cable but it would also increase prices at the other end.

5.2 Impacts on Italian market

TERNA, the project's biggest investor, entered into this project with the aim to decrease electricity costs which would consequently result in the reduction of retail prices (TERNA, 2015). TERNA recognizes this project as one of the two most important projects in the domain of the company's regulated activities (TERNA, 2017a). This new interconnector was recognized as a public interest project and yet its main goal is to gain profit. TERNA's revenues come from the reimbursement of operational expenses and the payment of the capital invested. This means that the company is always primarily motivated on asset building but every new investment needs to be approved by the AEEG on the basis of a particular recognized asset base. MONITA is recognized as beneficial for the market development while also satisfying profit maximization goal (TERNA, 2017b). The idea is to transmit electricity from Romania, Hungary, Bulgaria and BIH through Serbia and Montenegro to Pescara. It will bring to fewer imports from France and Germany through Switzerland and Austria and reduce losses on transmission lines which occur when energy is transmitted from the country's north. The cable will encourage the trading of electricity and trading of cross-border capacities. It will guarantee new energy source for retail which will be available when shortages inside the country occur (TERNA, 2016) and decrease congestion from the country's South to South-Center (TERNA, 2017b). This means that the new cable will eliminate power bottlenecks in this area (IRENA, 2013b). Taking into account the size of the Italian market, as the fourth biggest in Europe, only Pescara Provence will be directly affected by the new underwater cable lined on the Adriatic Sea bottom. Further we move from this area, benefits for the market become smaller and eventually they become negligible. Benefits for the market will spread in a half concentric cycles. On this end of the cable there will be no need for network enforcements and new transmission lines. Neither it will influence other construction projects. TERNA invested in this project convinced that the price difference is sustainable and that it would benefit from trading and importing cheaper electricity into this country's area. Besides, the underwater cable is in line with the company's Strategic Plan which focuses on creating strong infrastructure of interconnectors with surrounding countries and expanding interconnections to reduce local congestions (TERNA, 2017b).

The Montenegrin network is extremely exposed to the influence of surrounding countries. This market is highly sensitive and vulnerable to generation patterns of power plants in the neighboring countries. In order to secure the supply to Italy from the Balkan area, Italian company TERNA also entered into the project of financing construction of three dams on the middle watercourse of the river Drina in BIH. In Serbia, TERNA signed an agreement to set up a joint venture for construction of hydro power plants on the river Ibar (di Florio, 2015). Both projects faced problems since irregularities were found, but it shows and confirms the intention of TERNA to finance in the Balkan territory (da Chieti & di Florio, 2015). These two projects are the aftermath of the examined underwater cable. It proves a strong influence it will have on the whole Balkan area and not just Montenegro.

The project was also greatly criticized in Italy. Criticisms mostly come from the belief that the contract with the Montenegrin CGES was not transparent enough and that many significant details were left unknown. One of them is the project significance to the Italian market. Though it is clear that entrance to a new, cheaper market is without any doubt positive, comparing it to the project's capital and operational costs brings skepticism. TERNA confirmed in all of its reports that the project would not have any negative environmental effects, but the Italian public claims otherwise (Agostinelli, 2015; and Codegoni, 2015). They were concerned about the Pescara's shore and the Adriatic Sea's possible contamination. As this work confirmed Italian public questions project feasibility on the long run. They believe this project is pushed by EC ambitious 20/20/20 plans. In order to have Italy fulfill all of the set requirements, TERNA had to reach sources of clean energy as soon as possible (Codegoni, 2015). Even if imported energy is not produced from the RES, it is still generated far away from Italy which suits TERNA, but consumers oppose. The idea to reach set goals as quickly as possible may be done at a high price for consumers. As earlier said, the company is driven by asset building and especially entering into ambitious projects such as this one. This is why some of the project opponents do not believe in its viability. Market integration is not considered by any of them and yet it will have a strong influence on the success of the underwater cable. This success will depend on many other factors but predominantly on rebuilding and reinforcements of the Balkans power systems, and what is the most important, on the Montenegrin grid and generation capacities.

There is no doubt that the underwater cable will be an "energy bridge" between the two peninsulas if energy transfers are "big" enough to cover its costs. With a smaller price difference and a price convergence as an inevitable result of two markets joining together positive effects for both countries (Italy and Montenegro) will be significantly lower than planned.

CONCLUSION

The idea to construct the underwater cable between the Balkan and the Apennine Peninsula was triggered by market liberalization of the energy sectors of SEE countries which came almost a decade later than in other European countries. The opportunity for cross-border trading between these two areas is particularly interesting since they have a significant difference in electricity prices. Also, Italy is one of the greatest electricity consumers while the Balkan countries have a lot of potential in generating cheap energy convenient for band deliveries. Montenegro is expected to be the hub for electricity transmission towards Italy which requires significant network reinforcements inside the country but also new interconnectors with the surrounding countries. It is planned that two new interconnectors will be built on BIH and Serbia borders. They are crucial for undisturbed electricity transitions to Montenegro and further to Italy. On the other side, the Italian network will not need any additional reinforcement to support the cable.

For estimation of economic viability of investment in underwater cable between Montenegro and Italy (MONITA), a CBA analysis was conducted. Several benefits suggested by ENTSO-E were examined. They suggest an improvement in security of supply in both countries in the future. Underwater cable will not influence it. Increased trading is expected to generate additional 14 million EUR (325 GWh per year) of losses in 2020. RES integration will be modest, but mainly due to the fact that this type of electricity generation requires local consumption. Underwater cable will increase Grid Transfer Capability (GTC) transmission capacity for 1200 MW and increase socio economic welfare for 140 million EUR in the first year of the cable operation. MONITA will have a moderate impact on both technical resilience and flexibility. The project is capital intensive. Its estimated investment cost is over a billion EUR while operating expenditures is estimated to 30 million EUR per year. Results are compared for four different scenarios in the first year after the project becomes operational and 10 years later. Conducted sensitivity analysis showed strong variations in NPV values. It suggests that the project is highly volatile to market changes. It is the greatest concern regarding the project viability on the long run. Besides, the price convergence might as well cause retail price shock on the Montenegrin market and increase prices for capacity rights on Montenegrin borders.

It is expected that electricity prices in Italy will be decreased thanks to the import of cheaper electricity. It will also decrease congestions in the South-Central region of the country. The cable will eliminate bottlenecks in this area. It helps TERNA in creating strong infrastructure with an easy access to energy in the future. The Montenegrin market will be affected much strongly by the underwater cable. While MONITA is one of the great TERNA's projects, for CGES this is the most important investment in the energy sector. It will bring Montenegro to the energy map of Europe and it will boost investments in energy infrastructure across the country.

Without any doubt, the project is a step closer towards the Energy Union of Europe which is set as the highest goal and the greatest challenge in the energy market in this part of the world. Electricity market is very volatile and the price of all energy market products varies a lot during the seasons and among seasons as well. It constantly changes and improves. On the long run, there are many possibilities to improve the profitability of the Lastva-Pescara cable and use it as much as possible to the benefit of both peninsulas.

In this moment is seems as project is not profitable, but it is justified since it will have many positive effects on the market and especially on the SEE area. It will be used for ensuring a secure, sustainable electricity at accessible prices for European citizens. It is expected to foster investments in generation and increase in use of hydro, thermo or RES potential. For these reasons, the underwater cable got the status of a PCI. It brought to Montenegro 25 percent of credit financing from EC for their part of the project financing (CGES 2016).

REFERENCE LIST

1. Agency for the Cooperation of Energy Regulators (ACER). (2015). *ACER Market Monitoring Report 2015*. Ljubljana: ACER.
2. Agostinelli, M. (2015. June 9). Montenegro, il carbone di A2A: importeremo energia inquinante? *Il Fatto Quotidiano*. Retrived June 28, 2017, from http://www.ilfattoquotidiano.it/2015/06/09/montenegro-il-carbone-di-a2a-importeremo-energia-inquinante/1759839/
3. Arcidiacono, D. (2014). Convergence and Mediterranean capitalism: Some empirical evidences on the liberalization of the Italian Economic System. *European Scientific Journal, 10*(10), 224-236.
4. Ardelean, M., & Minnebo, P. (2015). *HVDC Submarine Power Cables in the World*. Brussels: Joint Research Center, European Commission.
5. Burkard, E. (2008). The Making of the European Energy Market: The Interplay of governance and Government. *Journal of Public Policy*, *28*(1), 73-93.
6. Busnello, L. (2014). *Evolution of the Italian power sector after its liberalization* (Master's Thesis). Padova: University of Padova.
7. Crnogorski Elektroprenosni Sistem (CGES). (2016). *Commencement of works on installation of submarine cable Montenegro-Italy*. Retrieved February 23, 2017, from http://www.cges.me.
8. Chick, M., & Vivi Nelle, H. (2007). Nationalization and Privatization Ownership, markets and the Scope for Introducing competition into the electricity Supply Industry. *Sciences Po University Press, 5* (1), 277-293.
9. da Chieti, & di Florio. A. (2015. April 15). Mega-elettrodotti, progettida cancellare e cantieri da fermare. *Pop Off*. Retrieved on June 25, 2017, from http://popoffquotidiano.it/2015/04/15/mega-elettrodotti-progetti-da-cancellare-e-cantieri-da-fermare/
10. Codegoni, A. (2015. March 12). Linea Abruzzo-Montenegro: una TAV ellettrica? *Qual Energia*. Retrived June 28, 2017, from http://www.qualenergia.it/articoli/20150312-linea-abruzzo-montenegro-abbiamo-una-nuova-tav-elettrica
11. Conejo, A. J., Carrión, M., Morales, J. M., & Carrion, M. (2010). *Decision making under uncertainty in electricity markets*. New York: Springer-Verlag New York.
12. Dahl, C.D. (2008). *Međunarodna Tržišta Energije, Cijene, Politike i Profiti*. Zagreb: Kigen.
13. de Rus. G. (2010). *Introduction to Cost-Benefit Analysis: Looking for Reasonable Shortcuts.* Cheltenham: Edward Elgar Publishing Limited.
14. Eberlein, B. (2008). The Making of the European Energy market: The Interplay of Governance and Government. *Journal of Public Policy, 28*(1), 73-92.
15. European Commission (EC). (2010). *Europe 2020, A European strategy for smart, sustainable and inclusive growth*. Brussels: European Commission.

16. European Commission (EC). (2012). *Quarterly Report on European Electricity Markets. Market Observatory for Energy, October 2011-December 2011, 4*(2). Brussels: European Commission.
17. European Commission (EC). (2015). *Energy Economic Developments, Investment perspectives in electricity markets*. Institutional Paper. Brussels: European Commission.
18. European Commission (EC). (2017). *Quarterly Report on European Electricity Markets. Market Observatory for Energy; fourth quarter 2015 and fisrst quarter 2016 9*(1). Brussels: European Commission.
19. Edwards, D.W. (2010). *Energy Trading and Investing*. New York: McGraw Hill.
20. Electricity Coordinating Center (EKC) and DMS Group. (2014). *Market Coupling Simulator for South East Europe*, Final Report. Vienna: Energy Community.
21. Elektroprivreda Crne Gore (EPCG). Retrived July 10, 2017 from http://www.epcg.com.
22. Energy Community. 2017. Retrieved on July 1, 2017, from https://www.energy-community.org/implementation/Montenegro/EL.html
23. European Network of Transmission System Operators for Electricity (ENTSO-E). (2014). *Ten Year Development Plan 2014*. Brussels: ENTSO.
24. European Network of Transmission System Operators for Electricity (ENTSO-E). (2015). *Guideline for CBA of Grid Development Project*. Brussels: ENTSO.
25. European Network of Transmission System Operators for Electricity (ENTSO-E). (2016a). *Project sheets 2016*. Brussels: ENTSO
26. European Network of Transmission System Operators for Electricity (ENTSO-E). (2016b). *Ten Year Development Plan 2016*. Brussels: ENTSO.
27. European Network of Transmission System Operators for Electricity (ENTSO-E). (2016c). *Ten Year Development Plan 2016-Project Sheets*. Brussels: ENTSO.
28. European Parliament (EP). (2016a). *Energy Union: Key Decisions for the Realization of a Fully Integrated Energy Market.* Brussels: European Union.
29. European Parliament (EP). (2016b). *Understanding Electricity Markets in the EU.* Brussels: European Union.
30. EUROSTAT. Retrieved on July 10, 2017 from http://ec.europa.eu/eurostat
31. Gestore Mercati Energetici (GME). Retrieved on April 10, 2017, from http://www.mercatoelettrico.org/En/Statistiche/ME/DatiSintesi.aspx
32. Gestore Mercati Energetici (GME). (2016). *Annual Report 2015*. Rome: GME.
33. Filipović, S., & Tanić, G. (2010). *Izazovi na tržištu elektirične energije*. Beograd: Ekonomski institut.
34. di Florio, A. (2015. March). In lotta contro gli elettrodotti. *I Siciliani Giovani*. Retrieved on June 25, 2017, from http://www.isiciliani.it/in-lotta-contro-gli-elettrodotti/#.WU_d9bFh3q
35. Harasheh, M., (2016). Forecasting the Italian Day-Ahead Electricity Price Using Bootstrap Aggregation Method. *European Scientific Journal, 12* (28), 1857-7881.

36. Herbert Smith Freehills. (2016). *A Survey of Current Issues in the European Energy Sector, The Euroepan Energy Handbook 2015.* Herbert Smith Freehills LLP.
37. Hrovatin. N., & Zorić. J. (2011), *Reforme elektrogospodarstva v EU in Sloveniji*. Ljubljana: Ekonomska fakulteta, Univerza v Ljubljani.
38. Ponte elettrico con il Montenegro, al via i lavori in spiaggia (2015, January 15). *Il Centro.* Retrived July 5, 2017 from http://www.ilcentro.it/pescara/ponte-elettrico-con-il-montenegro-al-via-i-lavori-in-spiaggia-1.1565398?utm_medium=migrazione
39. IRENA. (2013a). *Renewable Energy Action Plans and Regulations to Harmonise with EU Directives*. Masdar city: IRENA.
40. IRENA. (2013b). *Priorities, Strategies and issues For developing Transmission Grids*. Masdar city: IRENA.
41. Iychettira, K., Hakvoort, R., Linares, P., & de Jeu, R. (2016). Towards a comprehensive policy for electricity from renewable energy: Designing for social welfare. *Applied Energy*, *187*, 228-242.
42. Jacottet. A. (2012). *Cross border electricity interconnections for well-functioning EU Internal Electricity Market*. University of Oxford, The Oxford Institute for energy studies.
43. Jakovac, P. (2011), *Electricity Directives and Evolution of the EU Internal Electricity Market.* Rijeka: Faculty of Economics, University of Rijeka.
44. Joskow. P. L. (2008). Lessons Learned from Electricity Market Liberalization. *Energy Journal, Special Issue.*
45. Kjolle. G. H., Utne. I. B., & Gjerde. O. (2012). Risk analysis of critical infrastructures emphasizing electricity supply and interdependencies. *Reliability Engineering & System Safety, 105*, 80-89.
46. KPMG, (2010). *Central and Eastern European Hydro Power Outlook*. Budapest: KPMG Tanacsado.
47. Layard. R., & Glaister. S. (1994). *Cost-Benefit analysis.* Cambridge: University of Cambridge.
48. Meeus. L., Purchala. K., & Belmans. R. (2005). Development of Internal Electricity Market in Europe. *The Electricity Journal, 18* (6), 25-35.
49. Montenegro Ministry of Economy. (2015). *Energy development Strategy of Montenegro by 2030.* Podgorica: Montenegro Ministry of Economy.
50. Newbery, D., Strbac, G., & Viehoff, I. (2015). *The benefits of integrating European electricity markets*. Cambridge: University of Cambridge.
51. Notenboom. J., & Boot. P. (2016). *An Essay on the Colourful Scene of Europe's Energy Transition*. The Hague: PBL Netherlands Environmental Assessment Agency.
52. POYRY Management Consulting. (2016). *Wholesale electricity price projections for Montenegro*. Vienna: ILEX Energy Report.
53. Price Coupling of Regions. (2016). *Euphenia Public Description- PCR Market Coupling Algorithm*.

54. Prest. A.R., & Turvey. R. (1965). Cost-benefit Analysis: A Survey. *The Economic Journal, 75* (300), 683-735.
55. Ropke. L. (2012). *The development of renewable energies and supply security: a trade-off analysis*. IFO Working Papers.
56. Rothwell, G., & Gomez. T. (2003). *Electricity Economics, Regulation and Deregulation*. Wiley-Interscience.
57. Schroeder. T., & Kuckshinrichs. W. (2015). Value of Lost Load: An Efficient Economic Indicator for Power Supply Security? A Literature Review. *Frontiers in Energy Research, 3*(55), 1-12.
58. Shaffer. M. (2010). *Multiple Account Benefit-Cost Analysis: A Practical Guide for the Systematic E valuation of Project and Policy Alternative.* Toronto: University of Toronto.
59. Staehr. K. (2006). *Risk and Uncertainty in Cost Benefit Analysis*. Copenhagen: Institute for Miljøvurdering.
60. Szulecki. K., Fisher, S., Gullberg A. T., & Sartor, O. (2016). Shaping "Energy Union": between national positions and governance innovation in EU energy and climate policy. *Taylor & Fransis Online, 16* (5), 548-567.
61. TERNA SpA., & TERNA Group. (2015). *Annual report 2014. Rome*: TERNA.
62. TERNA SpA., & TERNA Group. (2016). *Annual report 2015. Rome*: TERNA.
63. TERNA SpA., & TERNA Group. (2017a). *Annual report 2016. Rome*: TERNA.
64. TERNA SpA., & TERNA Group. (2017b). *Piano di Sviluppo 2017.* Rome: TERNA.
65. The Government of Montenegro, Ministry of Sustainable Development and Tourism. (2011). *Detail Spatial Plan*. Podgorica: RZUP.
66. Tol. R. S. J. (2007). *The value of lost load*. ESRI Working Paper, 214. Dublin.
67. Vijesti. Retrieved on June 28, 2017, from: http://www.vijesti.me/vijesti/domacinstva-od-danas-imati-pravo-da-biraju-snabdjevaca-strujom-812580
68. Vlaisavljevic, D., & Vujasinovic, Z. (n/d) *Evolutivni razvoj i praktična primena metode Spajanja tržišta*. Podgorica: CIGRE.
69. Weron, R. (2006). *Modeling and Forecasting Electricity Loads and Prices*, A Statistical Approach. West Sussex: John Wiley & Sons, Ltd.
70. Weron, R. (2014). Electricity price forecasting. A review of the state-of-the-art with a look into the future. *International Journal of Forecasting, 30* (4), 1030-1081.
71. Zachmann. G. (2008). Electricity wholesale market prices in Europe: Convergence? *Energy Economics*, *30*, 1659-1