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ЭКОНОМИЧЕСКИЕ АСПЕКТЫ ЭНЕРГОЭФФЕКТИВНОСТИ СТРАН ЕС

ECONOMIC ASPECTS OF THE ENERGY EFFICIENCY OF EU COUNTRIES

30 YEARS OF
JEAN MONNET
ACTIVITIES

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Экономические аспекты энергоэффективности стран ЕС

Economic aspects of energy efficiency in EU countries

Нижний Новгород 2020

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Представлены статьи участников международной конференции «Экономические аспекты энергоэффективности стран ЕС», организованной 9-10 июля 2018 г. в Нижегородском государственном техническом университете. В статьях анализируются достижения и разработки в области возобновляемых источников энергии и энергоэффективности экономики Европейского Союза.

Для представителей научных кругов, исследователей, специалистов в области энергоэффективности (ученых, производителей, компаний, агентствам т.д.), аспирантов, молодых специалистов, политиков и гражданского общества.

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The articles of the participants of the international conference “Economic aspects of energy efficiency in EU countries”, organized on July 9-10, 2018 at the Nizhny Novgorod State Technical University, are presented. The articles analyze achievements and developments in the field of renewable energy and energy efficiency of the European Union economy.

For representatives of academia, researchers, specialists in the field of energy efficiency (scientists, manufacturers, companies, agencies, etc.), graduate students, young professionals, politicians and civil society.

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IMPLEMENTATION OF ENERGY EFFICIENCY STRATEGIES IN EU COUNTRIES COMPARED TO SOUTHEAST AND EAST EUROPEAN COUNTRIES

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Keywords: Energy transition, energy efficiency, transition economy, cogeneration.

Abstract. After the oil crisis in the 70ties the growth of energy consumption that followed an enormous increase in the european post-war economy, industry and building stock, slowed down and the interest in energy efficiency programs enhanced across Europe.

The paper aims at overcoming the described challenges by highlighting the specific conditions of energy transition caused by the economic transition.

1.INTRODUCTION

Sustainable development could be defined as equitable distribution of limited resources and opportunities in the context of the economy, society and environment. Sustainable development aims at the well-being of everyone in the present and in the future, leaving the opportunity for significant differences in future needs of which we are not aware of. The sustainable energy system is defined through the terms of energy efficiency, reliability and impact on the environment. It could be defined as a system capable to produce enough energy and power for everyone at affordable prices and at the same time, energy and power produced are clean, safe and reliable [1].

A common practice is to generate energy at big, centralized facilities. One way to achieve security and reliability of energy supply is to encourage regional cooperation and utilization of local energy sources. Such an approach inevitably leads to a decentralized (distributed) energy system with smaller units for energy generation that have a few advantages compared to conventional centralized systems. A decentralized system is more flexible for the implementation of new technologies and political decisions. Hence this system usually works with different technologies for energy conversion that makes it efficient and eligible for working with different energy sources. A decentralized system is suitable for off grid and on grid operation. The local character of the system and utilization of local energy sources decreases the needs for fuel supply and fuel storage. Besides it reflects on the local community through local employment. Distributed energy system (Figure 1) represents a new approach to energy generation. Analysing literature it is obvious there is no distinct definition of such a system [1].

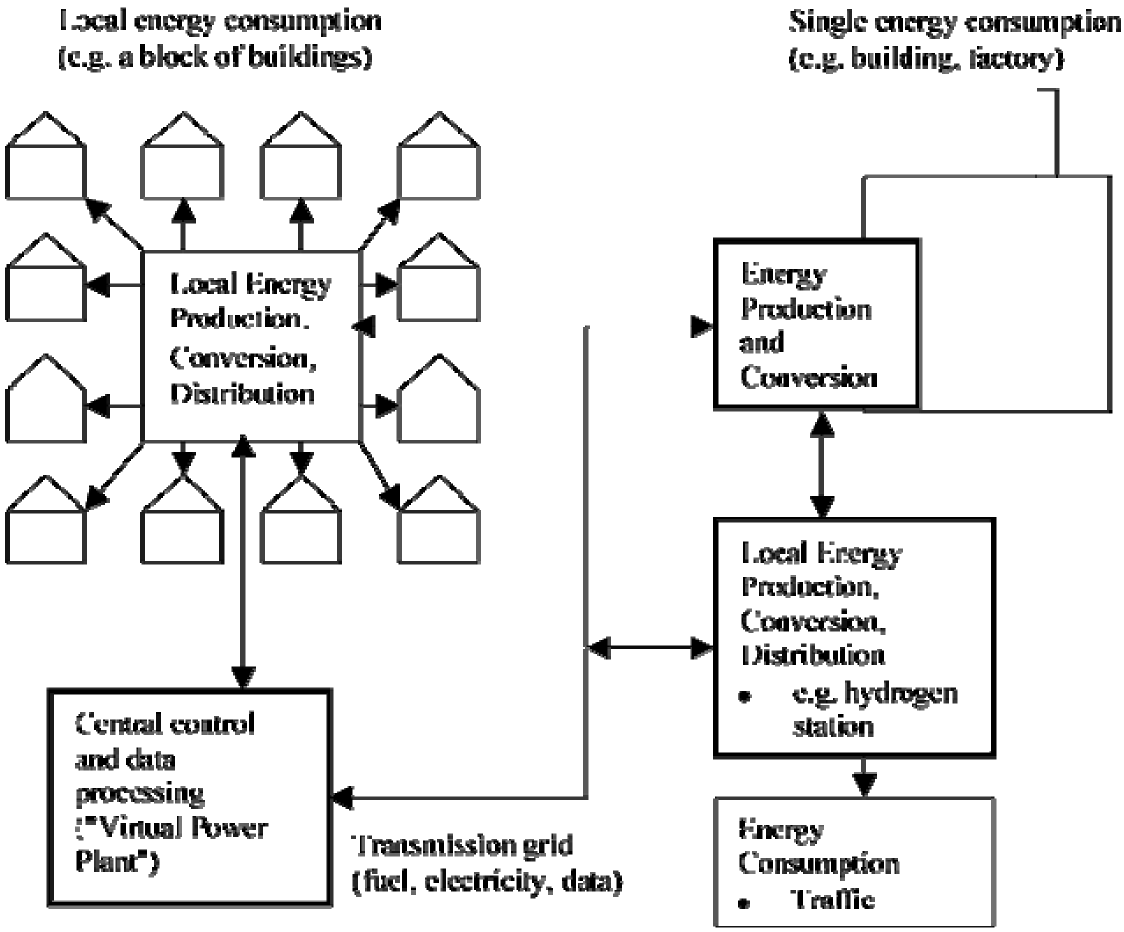

Figure 1. Schematic representation of the distributed energy system [1]

Considering the number of impact factors (facility size, purpose, location, degree of decentralization, ownership, technology, impact on environment, etc.) that should be taken into consideration when defining distributed energy system, for the purpose of this paper we will use the definition of parallel operation of decentralized and centralized system for energy generation [1], [2] . This definition will be probably used as a model of sustainable energy development in the near future.

Energy efficiency projects and investments represent a broad concept and their impact on sustainable development cannot be easily analysed. Such a survey would be time, money and people consuming, so for this report, one segment of the energy efficiency investment is analysed. That segment is cogeneration.

Responsible consumption and production are set as a global sustainable development goal [3]. Combined heat and power production (CHP or cogeneration) is the responsible production of energy in order to increase energy efficiency and reduce the impact on the environment that energy production has [4], [5], [6], [7], [8], [9]. For cogeneration application equally suitable are decentralized and centralized systems. The total energy efficiency of a CHP facility can reach as much as 85-90% which is significantly higher than the energy efficiency of the conventional facility for electricity generation (30-40%). Thus, primary energy consumption could be decreased as far as 30% compared to conventional energy generation. Furthermore, it means that there is up to 30% decrease in CO_2 emissions [10].

2.ENERGY POLICY AND COGENERATION IN THE EU

This section will give a brief overview of the development of the cogeneration in the developed countries of the EU. In particular, examples of good practices of the countries that have a successful implementation of the cogeneration in the district heating (DH) will be highlighted.

According to data from the International Energy Agency (IEA) only 10% of the total electricity produced in the world is produced from the cogeneration, and only a few countries successfully lifted the share of the produced energy from the cogeneration to 30 to 50%. What is common to all countries that successfully implement the cogeneration is the focused energy policy [8].

The leading states in the implementation of cogeneration in the EU are Denmark, Finland and the Netherlands, and from 2010 thanks to the use of natural gas and the tradition of using DH, the sharp growth is recorded by Lithuania, Latvia and Slovakia (Figure 2).

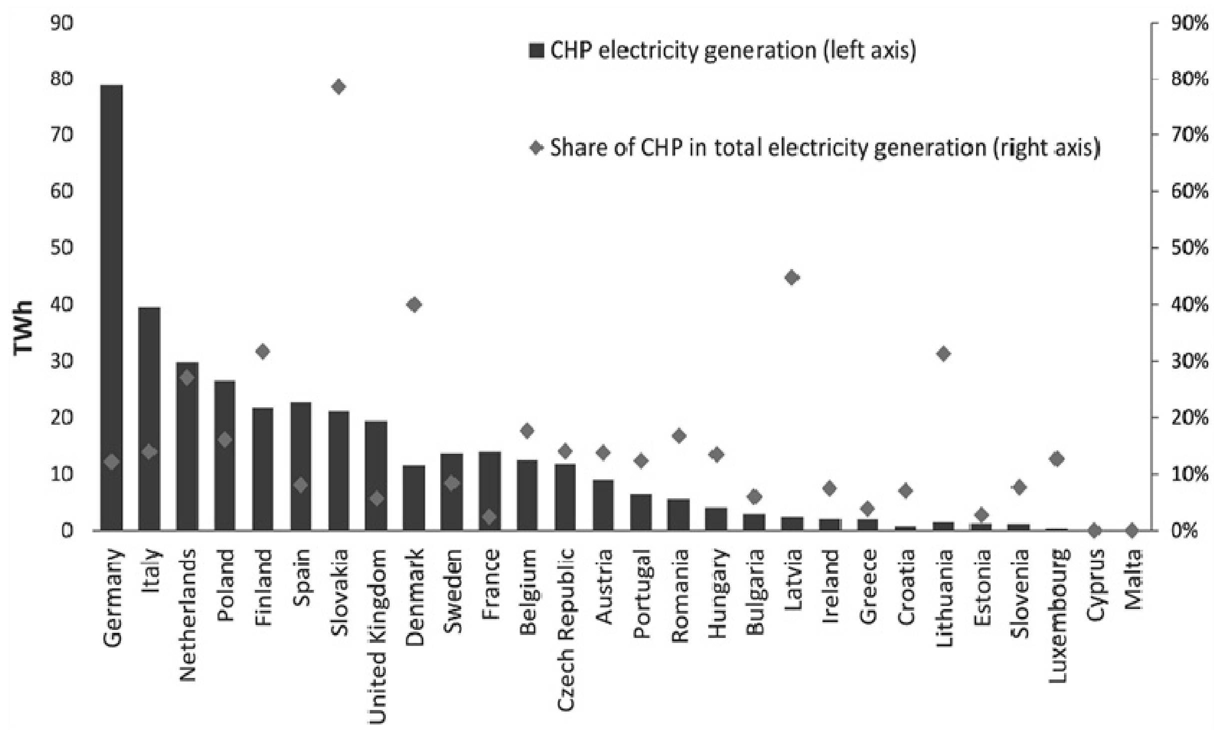

Figure 2. A share of electricity produced in the cogeneration plants in the European Union in 2017 [11]

In 2008 and 2013 the IEA has taken a series of research of energy profiles of different countries with special emphasis on cogeneration and DH in order to better familiarize with the examples of successful implementation of cogeneration and DH. The results of this survey were published in a report that showed that the key to success is the recognition of DH and cogeneration as key factors for achieving energy security and determination of the state to invest in it [8].

The survey revealed that the most successful countries in this area have defined clear objectives and formed the state agencies/departments that were committed to achieving these goals. The agencies initially identified the potential and barriers for the successful implementation of DH and cogeneration, and then in accordance with their authorities, they developed energy policies and tools for its implementation and solutions that would systematically remove the existing barriers.

The distinction of Finland, in relation to the other examples which will be analysed, is a sharp climate that was pushing the development and implementation of energy efficiency projects. Thanks to climate conditions in Finland, heating is used approximately nine months a year and during the winter months lighting is turned on most of the day. In these climate conditions and with limited energy sources, the use of DH and cogeneration has been imposed as a logical solution. The heating of buildings in Finland is accounted for about 20% of the total energy demand, with half of this demand provided through DH. Approximately half of the population is connected to DH and in larger cities and up to 80 % (in Helsinki over 93%). Keeping in mind that the population's density is only 16 per square kilometre, such a large use of DH is a success, which categories Finland among the largest beneficiaries of DH and cogeneration in the world. From 2000, Helsinki and other larger cities have started to use the district cooling [12]. Thanks to decades of development of DH and cogeneration, a significant new potential for cogeneration is not expected in Finland. However, the latest studies point to possible growth of almost 20% in the next 15 years. [13]

Another country that belongs to the world leaders in the use of cogeneration is the Netherlands. In 2006 the final energy consumption in the Netherlands was 711 TWh, of which almost 40% is used for heating and about 20% of that energy is produced through the cogeneration. Unlike Denmark and Finland, in the Netherlands the most important is industrial cogeneration (in the first place of chemical and paper industry), however, the cogeneration in DH which supplies over 250,000 inhabitants, small cogeneration in agriculture, public and service sectors should not be ignored. In the production of electricity, the cogeneration plays an even more significant role: as much as 29% of electricity is manufactured in the cogeneration plants [14].

The Netherlands has a long tradition of the use of the cogeneration and DH and is also a very good example for the impact of energy policies on the energy market and the interdependence of growth/fall of economic indicators and the extent of the implementation of cogeneration technologies. During the 90ties the steep development of the cogeneration and DH were significantly influenced by the incentives of the government and the stable energy market. After 10 years of a favourable climate for growth and development of cogeneration and DH, in 1998 new electricity law was introduced which made significant changes and practically abolished the privileged status of the producers of energy from the cogeneration. After several years of implementation of this law, it has become evident that the cogeneration has difficulty surviving in the liberalised market. This condition has been further intensified with the rise in natural gas prices and the low cost of imported electricity and electricity produced by thermo-power plants. In order to retain energy savings made during the 90ties and to revive the cogeneration, the Netherlands in 2001 reintroduced incentives. The strong development of the cogeneration during the 90ties was interrupted and did not reoccur.

According to a consortium of Dutch energy companies and R&D organisations dealing with micro cogeneration, it is envisaged that till 2030 in the Netherlands will be installed from two to four million micro-cogeneration units [15]. On the other hand, the Dutch Centre for Energy Research in its study states that the implementation of micro-cogeneration depends greatly on the implementation of energy policy under the name "Clean and efficient", aimed at reducing energy consumption in existing buildings. Depending on the success of this program, but also the use of solar panels and heat pumps, installation of 900,000 to 1.4 million micro-cogeneration units can be expected by 2020 [14].

The German energy market is the biggest in the EU. Electricity production is based on thermal power plants and nuclear power plants, but in recent years, Germany is making a big effort to diversify the energy used, thus becoming the world leader on the renewable energy sources (RES) market [16].

For the supply of inhabitants and entrepreneurs in the cities, DH and cogeneration have been applied broadly in Germany for more than 100 years. Thanks to energy policy, many cities are working to expand and modernise their DH networks.

Since many of the facilities in the service sector and public institutions have already been using DH, the small cogeneration has only recently started developing in hospitals and hotels. The new legal framework is expected to support the development of this segment of the energy market [16].

Germany set the goal to increase electricity produced from the cogeneration from 12.5% (in 2005) to 25% in 2020. And for that purpose, in 2008 provided legal support through the second law on cogeneration. Official monitoring from 2011 showed that the share of electricity produced from cogeneration grew to 15%. The electricity produced from the cogeneration is steadily increasing and according to data the share of electricity produced in the cogeneration in 2012 reached 17% [17], [18]. At that rate, without any additional effort, until 2020 the share of electricity produced from cogeneration will be 20%. This was the reason for further amendments to the law from 2012. These amendments further boosted incentives for small and micro-cogeneration, but also for the expansion of the DH networks, that now also provide district cooling. After monitoring in 2014, expectations are that with these additional measures the 25% goal for 2020 will be achieved.

Last but not the least important country to be analysed country is Denmark. Denmark is one of the countries with the most efficient energy consumption. This status Denmark has reached through energy policy, increased renewable energy sources (RES) distribution and technological development [19], [20]. An especially important part of Denmark's success is long term and continual energy policy carried out and implemented for more than 30 years. Special consideration has been put on district heating, cogeneration and renewable energy sources.

The status of energy self-sufficient country (Denmark is energy self-sufficient since 1997) Denmark has reached mainly due to oil and gas discovery in the North Sea and energy policy that was introduced in 1976 with the First Heat Supply Law. The Law has been implemented through 3 phases with planning and implementation responsibility distributed among state and local authorities.

The Law required municipalities to identify potential for DH in their jurisdiction, allowing the most effective layout for DH to be planned at the national level. Efforts were then made to introduce collective heating schemes in the most appropriate areas.

In the first phase local authorities prepared the report about their heat requirements, the heating methods used and the amounts of energy consumed. Local plans were aggregated to the county level to prepare regional heat supply strategies. In the next phase, local authorities prepared a report on their future heat supply needs. This directly led to the third phase: preparation of a national plan based on this information. The national plan focused to secure energy supply and to increase energy generation efficiency. This led to further development of cogeneration technology and market [21], [22].

Share of responsibility between state and local authorities from the planning phase largely contributed to the efficient implementation of the plan. Two major consequences of the law implementation are a ban on electric heating and the obligation to connect or to stay connected to DH. Together with the support to the law implementation, the state has supported research and development of new technologies arisen from the needs of wider application of cogeneration and RES.

Plans and goals that arise from the law's implementation are the most important factors in the early stages of market development. After that, financial incentives were introduced to ensure on-going economic viability. For cogeneration and DH systems the state has developed two main programs for financial incentives.

The first incentive has been realized through taxation on fuel for heating. Differential taxation on fuels for individual and for DH was used for the promotion of DH. This incentive strongly shifted heat-only production to cogeneration. Fuel taxation has not only encouraged cogeneration but has made biofuel competitive with fossil fuels since renewable fuels have been excluded from the tax.

The second financial incentives are feed-in tariffs for RES and cogeneration (CHP electricity production subsidy). Cogeneration facilities that use biomass and biogas as a fuel receive a premium feed-in tariff. It should be stressed that coal-fired cogeneration plants have not been abandoned but rather retrofitted and modernized.

Besides these two financial incentives, a rather important contribution to the energy policy's implementation and success has been made by an obligation to purchase electricity produced by local cogeneration plants. This ensured long-term planning and long-term revenues, encouraging investments in cogeneration and was particularly important for further development of technology and market thus decreasing initial investments.

The overall result of energy policy implementation is that in Denmark heat and electricity have been produced and distributed through decentralized systems (Figure 3).

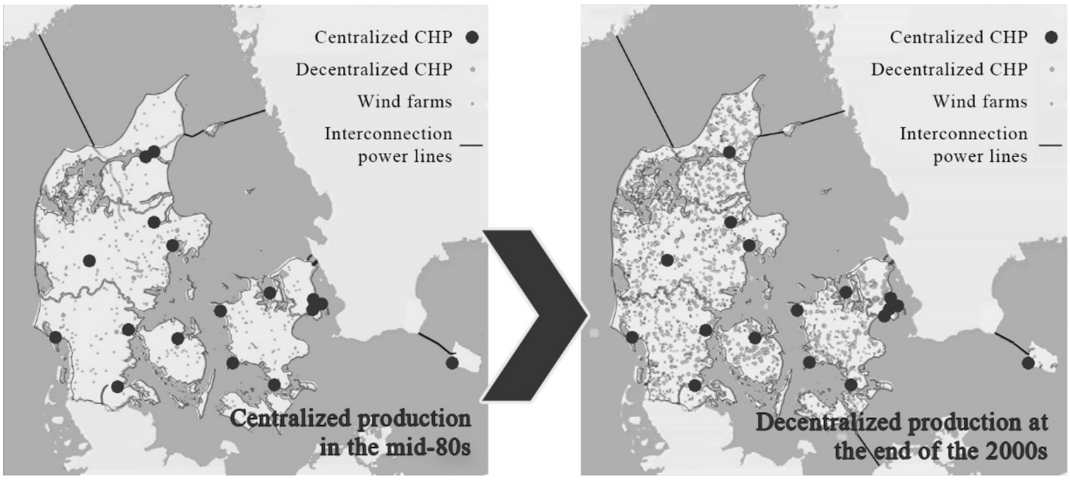

Figure 3. Energy production in Denmark [20]

3.ENERGY POLICY AND COGENERATION IN SOUTHEAST EUROPEAN COUNTRIES

Besides the countries that joined the European Union (Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, Slovenia, Romania, Bulgaria and Croatia), that are addressed as countries that have completed the transition process, there are still countries in East and Southeast Europe (countries of the former Soviet Union, Albania, Bosnia and Herzegovina, North Macedonia and Serbia) that keep struggling on their way to the market economy.

Looking from the perspective of the Human Development Index (HDI) almost the same line can be drawn dividing developed countries (HDI over 0.8) from developing countries with HDI below 0.8 (Figure 4). The HDI is a summary of factors that influence human development: a long and healthy life, being knowledgeable and have a decent standard of living. The HDI simplifies and captures only part of what human development requires, it does not reflect on all factors, such as inequalities, poverty, human security, empowerment, etc [23].

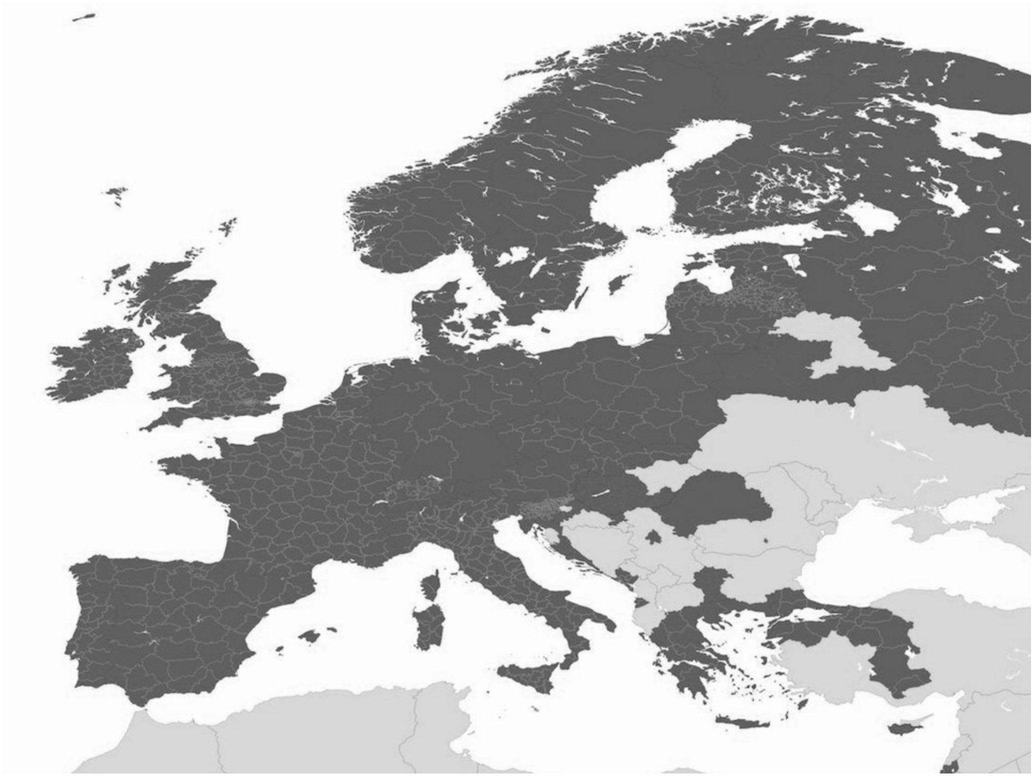

Figure 4. Regions with Human Development Index over 0.8 [24]

The HDI was created for assessing the development of a country, to put people and their capabilities under the spotlight, not economic growth alone. The HDI can also be used to question national policies, asking how two countries with the same level of gross national income (GNI) per capita can result in different human development outcomes. These differences can open questions about government policy priorities and the level of policy implementation.

For all the reasons mentioned, a transition from a planned economy to a market economy should not be overlooked. It has proven to be a hard process in which all the transition economies have experienced severe and, for many, long-lasting recessions. Most of the countries have gone through a slow process of building institutions for a market economy [25]. And yet, the transition is still not over even for the countries that have made the furthest advances.

When evaluating changes and reforms in the energy sector, it is crucial to understand how social and economic factors might have influenced the energy sector, perhaps even more strongly than specific reforms [26].

Throughout the transition process, the countries have faced many parallel challenges, from reforming their economic systems to creating an appropriate institutional framework for future growth. The paper aims to highlight the specific conditions of energy transition caused by economic transition. In that sense, the energy sector in Serbia is no exception, so we will use it as an illustration of challenges ahead of many similarly developed transitioning economies.

Case Study: Potential of Serbia

Serbia has been identified as a country with poor performance in sustainable development, environmental protection and energy efficiency like other transition economies.

The effort of the Republic of Serbia to harmonize its legislation with the global perspective is clearly visible. A Decree on the requirements for obtaining the status of the privileged electric power producer and the criteria for assessing fulfilment of these requirements ("Official Gazette of the RS" No.72/2009 of September 3rd, 2009) and Decree on incentive measures for electricity generation using renewable energy sources and combined heat and power (CHP) generation – Feed-in tariffs ("Official Gazette of the RS" No.99/2009 of December 1st, 2009) have defined possibilities for creation of decentralized energy system but not the obligations that would stimulate and aid its creation.

The first deficiency in sustainable energy development efforts of Serbia is the lack of a transparent national plan and coherent energy policy. The second major deficiency is a limitation on capacity size (less than 10MWe) of plants that qualify for incentives causing a significant constraint in technology selection. On the other hand, postponement of adopting Law on energy efficiency and postponement of founding the Energy Efficiency Fund has delayed the creation of programs necessary for the cost-effectiveness of small CHP facilities that have been addressed within Decree on incentive measures. High initial investment and decreased efficiency of small capacity cogeneration plants are major issues considering the cost-effectiveness of these plants that have to be addressed through some programs which will support the Decree on incentive measures. Beside feed-in tariffs, there are no other financial subsidies. Current Serbian energy policy is narrowly defined without possibility to evolve and change in time and that is the biggest stumbling stone of this policy. When reviewing Serbian legislative, it becomes clear that there is a lack of regulations concerning interconnection standards (regulating relations between electricity generating plants, distributors and end-users) especially in the spotlight of the ongoing liberalization of the Serbian electricity market.

4.ANALYSIS AND DISCUSSION

For the last fifty years, Denmark has devotedly built DH system and implemented CHP technology in DH plants. In the same period as Sweden, Serbia has developed its DH network (Figure 5) but have not worked to improve that system which now represents a significant and unused resource.

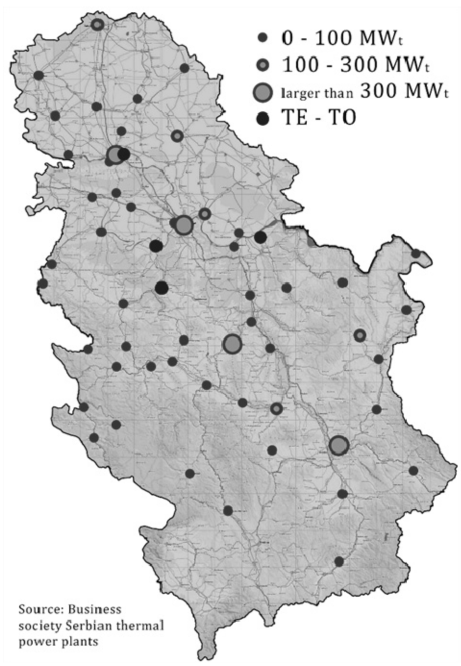

Figure 5. District heating and district heating within thermal power plants (TE-TO)

Total installed capacity in Serbia is around 6 GW. In cities with DH system, 38% of households use DH that is 23.4% of the total number of households in Serbia. More than 60% of heating energy is generated using NG fired boilers and a large number of small towns (25 towns out of 55 towns in Serbia that have DH) uses heavy fuel [27].

Serbian government doesn't have a visible strategy of renewing, capacities increasing and/or boiler conversion to natural gas. There is no systematic approach to cogeneration in DH systems. Power plants are one more unused energy resource of Serbia. The most of coal-fired power plants do not use waste heat (exemptions are power plant Nikola Tesla A, power plant Kostolac A and partially power plant Kolubara A, that use part of the waste heat for DH of neighbouring towns).

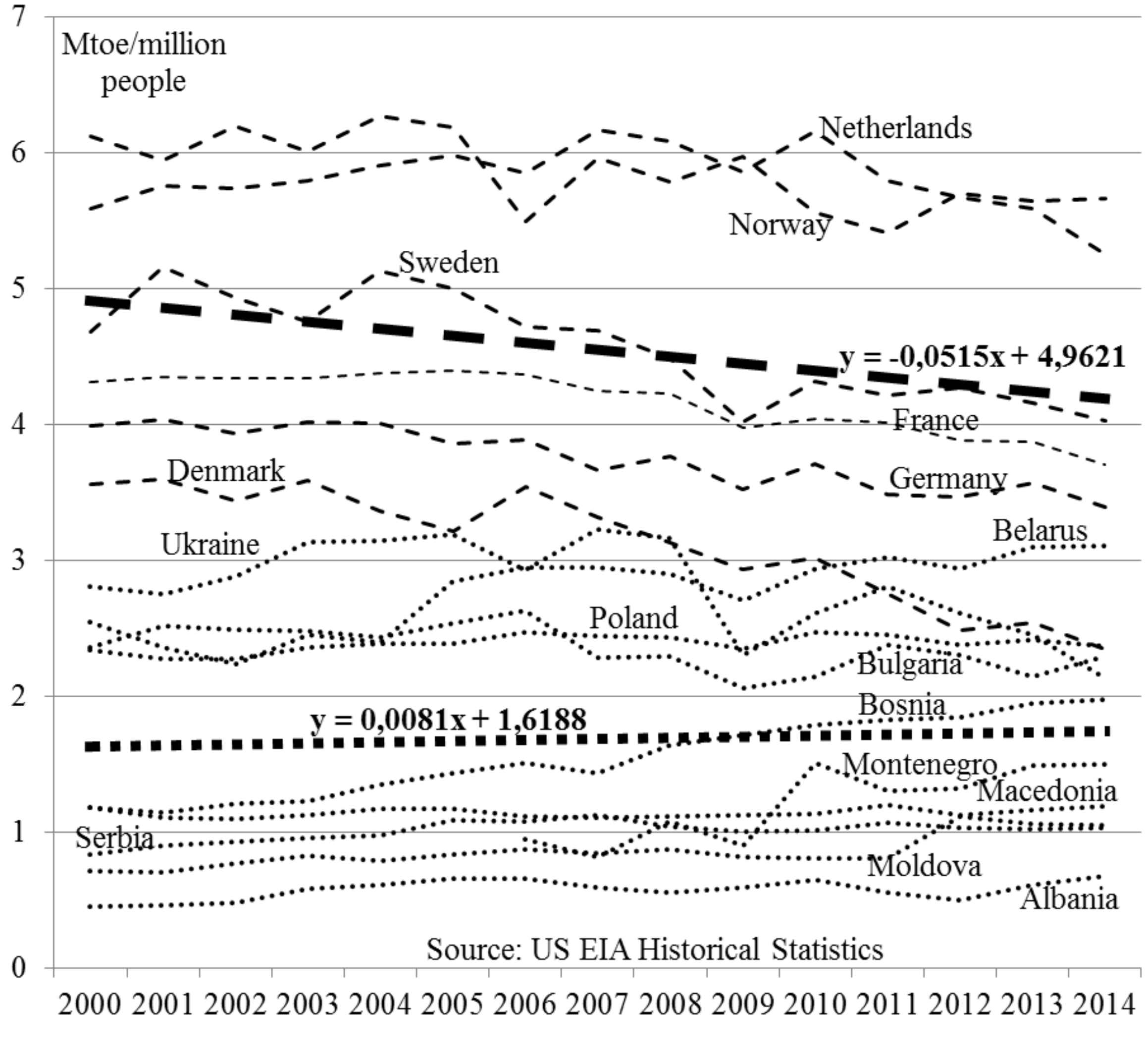

Figure 6. Trendlines of energy consumption of EU Countries and Southeast and Eastern Europe

Figure 6 shows energy consumption per capita trendlines of six highly developed European countries (marked with dashed lines and all showing slightly downward trends) and nine Southeast and Eastern Europe (or former eastern bloc) countries (marked with dotted lines and the majority of whom are showing upward-facing trends) for the last 15 years. Cumulative trendline for developed EU countries is shown as a dashed line with (relatively) strong downward trend, and commutative trendline for Southeast and Eastern European countries is shown as a dotted line with a slightly rising trend. European policies on energy use are clearly resulting in lower energy consumption but what with former eastern bloc countries? While on their way to become highly developed countries, they could use opportunity to learn from highly developed countries, redraw their policies and reverse abovementioned trends and that leads us to following question: Is it possible to reach and sustain HDI of 0.8 with average energy consumption of 1.6 toe/capita, and how are these issues interconnected? Looking just on examples of Belarus, Poland and Bulgaria on one hand and Denmark on other (Figure 6) opens space for discussion on these issues and possible steps to be taken by developing countries.

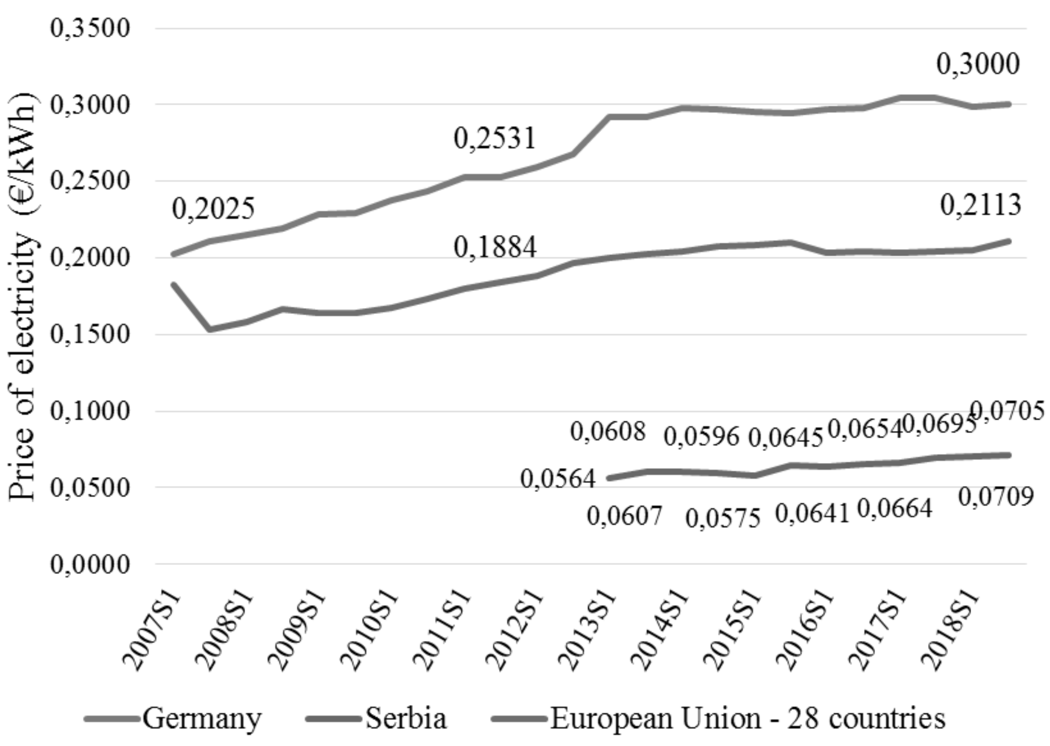

Figure 7. The price of electricity (€/kWh) (all taxes and levies included) in the semi-annual periods from 2007 till 2018 [11]

The second important question for developing countries is the electricity price. Transition economies have a specific attitude toward electricity supply and electricity price [25] resulting in the low electricity price compared to developed countries (figure 7). With such electricity price, payback periods are a few times higher than in developed countries what is a significant drawback in the implementation of energy efficiency projects.

CONCLUSION

District heating and cooling in urban, densely populated areas using existing technology are widely accepted as an efficient and cost-effective heat generation method, especially when power generation is included [19]. Most of the European countries that are still in transition and are categorized as developing countries have obsolete district heating networks built during the 70ties that represent a significant and unused resource. This could be an opportunity for smart retrofitting projects that would involve energy efficiency, cogeneration and possibly trigeneration. Though electricity price in developing countries has had a steady increase in the previous period it should be stressed that with a very optimistic and unfortunately unlikely scenario of 10% annual upraise and even with some more positive disruption in the trend it would take decades for developing countries to reach electricity price of developed countries. This leads to the conclusion that some mechanisms for financing energy efficiency projects have to be incorporated into government energy policies in order to throttle energy market.

REFERENCES

[1] K. Alanne, A. Saari. Distributed energy generation and sustainable development. 2006. Vol. 10, pp. 539-558.

[2] T.Ackermann, G. Andersson, L.Soder. Distributed generation: a definition. 2001. Vol. 57, pp. 195-204.

[3] United Nations. Transforming our world: the 2030 Agenda for Sustainable Development. s.l. : General Assembly, 2015. A/RES/70/1.
[4] CODE project report. Cogeneration Case Studies Handbook. s.l. : Cogeneration Observatory and Dissemination Europe, 2011.
[5] CODE project report. European summary report on CHP support schemes - A comparison of 27 national support mechanisms. s.l. : Cogeneration Observatory and Dissemination Europe, 2010. www.code-project.eu.
[6] CODE2 project report. Micro-CHP potential analysis European level report. s.l. : Cogeneration Observatory and Dissemination Europe, 2014.
[7] Government of Japan, Tokyo. Innovative Strategy for Energy and the Environment. s.l. : EEC (Energy and Environment Council), 2012.
[8] International Energy Agency. Cogeneration and District Energy. s.l. : IEA, 2009.
[9] Beith, Robert. Small and micro combined heat and power (CHP) systems. s.l. : Woodhead Publishing Limited, 2011. ISBN 978-1-84569-795-2.
[10] Živković, Dubravka. Development of methodology for evaluation of cogeneration projects in buildings (Razvoj metodologije za vrednovanje kogeneracionih projekata u zgradarstvu). doctoral thesis. s.l. : Faculty of Engineering University of Kragujevac, 2016.
[11] Eurostat. http://ec.europa.eu/. [Online] [Cited: June 15, 2019.]
[12] International Energy Agency. CHP/DHC Country Scorecard: Finland. s.l. : IEA, 2013.
[13] International Energy Agency. CHP/DHC Country Scorecard: Finland. s.l. : IEA, 2008.
[14] International Energy Agency. CHP/DHC Country Scorecard Netherlands. s.l. : IEA, 2008.
[15] Key variables in cost-driven decision on instaling micro-chp in households. Ton Monasso, Michiel Houwing, Ivo Bouwmans. 2010, International Journal of Distributed Resources, Vol. 6(1), pp. 19-39.
[16] International Energy Agency. CHP/DHC Country Scorecard: Germany. 2008.

[17] Goldbach, Adi. German policy and market update. s.l. : COGEN Europe Webinar, 20.09.2012.
[18] Kerr, Tom. Cogeneration and District Energy. s.l. : International Energy Agency, 2009.
[19] Kerr, Tom. CHP/DHC Country Scorecard: Denmark 2008. s.l. : International Energy Agency, 2008.
[20] Karl Sperling, Frede Hvelplund, Brian Vad Mathiesen. Centralisation and de-centralisation in strategic municipal energy planning in Denmark. Energy Policy. 2011. Vol. 39, pp. 1338-1351.
[21] Ole Odgaard, Maria Hagen Jørgensen. Heat supply in Denmark - Who What Where and Why. s.l. : The Danish Energy Authority, 2005.
[22] United Nations Development Programme. Human Development Report 2016. 2016. ISBN: 978-92-1-126413-5.
[23] Maps & Gabriel. [Online] [Cited: June 15, 2019.] https://mapsandgabriel.blogspot.com/.
[24] Smelser J. N., Baltes B. P. International Encyclopedia of the Social&Behavioral Sciences. s.l. : Elsevier, 2001.
[25] Carvalho A. Drivers of reported electricity service satisfaction in transition economies. Energy Policy. 2017. 107: 151-157
[26] Serbian business society of thermal power plants. Indicators of DH in thermal power plants, members of the business society "Thermal power plants of Serbia" for 2017/2018 (Pokazatelji daljinskog grejanja u toplanama članicama poslovnog udruženja "Toplane Srbije" za 2017/2018 godinu). 2019.