TRZISTE ELEKTRICNE ENERGIJE IZ OBNOVLJIVIH IZVORA

ELECTRICITY MARKET FROM RENEWABLE SOURCES

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Cilj ovog rada je prikazivanje istorijskog značaja obnovljivih izvora i budućeg širenja tržišta električne energije zasnovanog na ovoj vrsti proizvođača energije. U današnjem svetu, populacija Zemlje raste eksponencijalno, što znači da će nedostatak energije biti problem u narednom periodu. Problemi sa konvencionalnim fosilnim gorivima su dobro poznati, pa kao rezultat toga, države širom sveta nastoje da obezbede energiju iz obnovljivih izvora. Ovi tipovi resursa bili su poznati još iz praistorije i helenskog perioda, ali su danas dostigli svoj puni potencijal. Do sredine 1800-ih, drvo (biomasa) je bilo izvor gotovo svih svetskih energetskih potreba, a pretežno je korišćen za grejanje, kuvanje i osvetljenje. Od kraja 19. Veka do danas, tržište električne energije je bilo manje-više jednolično- fosilna goriva su se isticala kao dominantni energent. Danas je svet na prekretnici. Stručnjaci su izračunali da do 2040. godine iz vetra i sunca moramo proizvesti devet puta više energije od nivoa koji danas proizvodimo, udeo fosilnih goriva na tržištu mora biti smanjen za 80%, dok energija iz hidroelektrana mora biti povećana za 50%, ako mislimo da rešimo problem klimatskih promena. Ali, ta tranzicija mora da bude postepena i strpljiva-promena u tipovima proizvodnje će uticati na celokupnu električnu industriju-od proizvodnje, preko upravljanja, prenosa i distribucije.

Ključne reči: *klimatske promene; obnovljivi izvori energije; prirodne katastrofe; solarna energija; vetro energija; pametne mreže; monopol; deregulacija; feed-in tarife; superkondenzatori; baterije*

The goal of this paper is to present historical significance of renewable sources and future expansion of the electricity market based on this type of energy producers. In the modern world, Earth's population is growing exponentially, so this means that lack of energy will be a problem in future decades. Problems with conventional fossil fuels are well-known, and as a result, countries around the world tends to provide energy from renewable sources. These types of resources were known from the prehistoric and Hellenic period, but they have reached their full potential nowadays. Until the mid-1800s, wood (biomass) was the source of nearly all of the world's energy needs for heating, cooking, and light. From the late 1800's until today, electricity market was pretty unpolarized- fossil fuels were dominating. Today, the world is at a turning point. Experts have calculated that by 2040 wind and solar must deliver more than 9 times it delivers today, the fossil-fuels production needs to be lowered 80%, while hydro will increase by 50%, if the world has any hope of getting anywhere near the targets needed to address climate change. But, that transition needs to be slow and patient- the shift in generation types will affect the whole electric industry — generation, system operations, transmission and distribution. Since oil – more broadly liquid petroleum products – are primarily used to fuel the transport sector, the obvious starting point is to convert it to electricity generated from low carbon resources. And as everyone knows, China accounts for roughly half of the global coal consumption. Hence if China abandons coal, game is over. Wind and solar energy are leading sources of new electricity generation, driven by increasing demand and rapidly declining costs. Although wind and solar power are beating all other sources on cost in many regions, grid operators limit their deployment by failing to utilize them for reliability services such as ramping and frequency regulation. So, at this time, it's not really a question how electricity market would look like in the future, but how fast can it accept desperately needed changes and will it be fast enough to save our planet.

Key words: *Climate changes, Renewable energy sources, Disasters, Solar, Wind, Smart Grids, Monopol, Deregulation, Supercapacitors, Feed-in tariffs, Batteries*

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1 Importance of RES

In the modern world, Earth's population is growing exponentially, so this means that lack of energy will be a problem in future decades. With mounting concerns over climate change caused by fossil fuels, there has been growing reliance on renewable energy. The global renewable energy market is anticipated to grow significantly during the forecast period owing to increased emissions of greenhouse gases (GHGs), particularly CO2 due to utilization of fossil fuels for generation of energy. In addition, limited presence of fossil fuel on the earth as well its volatile prices fuels the renewable energy market. However, generation of energy from renewable sources requires huge investment. Many countries have responded by not only introducing renewable energy policy targets for the economy at large but imposing these on conventional energy companies. The hope has been to both reduce fossil fuel emissions and also benefit from renewable energy by offering lower prices to consumers. Furthermore, in the Middle East, fossil fuels are majorly used to generate energy owing to its cost effective nature as compared to other regions. On the contrary, continuous advancement in technologies and increased government funding in renewable energy sector to offer lucrative growth opportunities during the assessment period. The renewable energy market size is increasing due to rise in government regulations regarding climate change in the developed and developing economies.

Illustration of disasters caused by 'Harvy'

However, on the strong insistence of US President Donald Tramp, US abandoned the Paris Agreement on Climate Change of the United Nations on 1 June 2017, which will 2020 replace the previous Kyoto Protocol. Simply, the US, primarily under the pressure of an industrial lobby that massively uses fossil energy sources, is not in the interest of spending large resources on alternative and renewable energy sources. The discharge of large amounts of CO2 generated by combustion of fossil fuels primarily leads to the mentioned greenhouse effect. However, it is enough to mention only the last two hurricanes that hit the United States in late August and September 2017 and notice how much such a policy is wrong. First uragan, called "Harvey", hit the US state of Texas, in particular the city of Houston and Corpus Christi, on 26 and 27 August 2017. Houston was flooded, and nearly 300,000 residents were left without electricity. Soon after, another, even more powerful hurricane named "Irma" appeared, which, after the great devastation in the Caribbean, caused great damage to the federal states of the United States, Florida and Georgia. More than a dozen people were killed, the city of Miami was evacuated, and damage was measured in millions of dollars.

On the other hand, Europian Union proposed The Climate and Energy Package 2020. It is a set of binding legislation aimed at ensuring that the European Union achieves its ambitious climate and energy targets for 2020.Targets, known as "20-20-20," set three key targets for the EU by 2020:

1. Reducing GHG emissions by 20% compared to 1990 levels;

2. Increasing the share of energy consumption from renewable sources to 20%;
3. Increase energy efficiency by 20%.

Objectives 20-20-20 provide an integrated approach to climate and energy policies aimed at combating climate change, increasing the EU's energy security and strengthening its competitiveness. These goals were set by EU leaders in March 2007, when they committed themselves to making Europe a highly energy-efficient economy with low carbon emissions, and were adopted through the 2009 climate-energy package. The EU also offers to increase its emission reductions to 30% by 2020, if other key economies are also committed to taking the right part of efforts to reduce global emissions. The climate and energy package consists of four complementary legislative acts:

1. Reform of the Emission Trading System (EU ETS)
2. National target values for emissions that do not fall under the EU ETS
3. National targets for renewable energy sources
4. Capture and storage of carbon

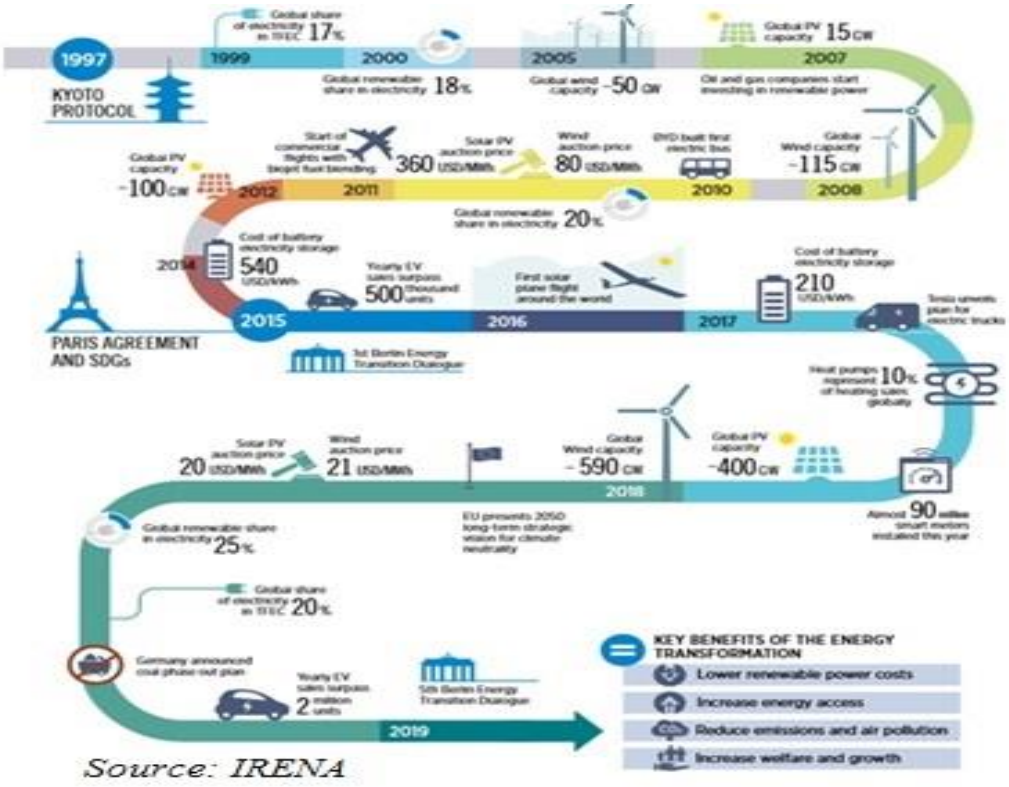
2 Transition

The transition to a 100% renewable energy system based on variable renewable energy raises technical but also institutional questions. The smart energy system concept integrates variable renewable energy by addressing the technical challenges through the integration of different energy sectors, but integration of variable renewable energy also entails a change in the cost structures, especially related to electricity. The effect of this change in cost structures on market prices is investigated. This is done through simulation of a 100% renewable energy system that utilises a large degree of cross-sector integration but maintaining the current electricity market structure. This is reflected in the use of wind energy as the primary renewable energy source. It is concluded that the current electricity market structure is not able to financially sustain the amounts of wind power necessary for the transition to a 100% renewable energy system. Meanwhile, the demand for renewables is rapidly growing. Solar and wind power now come closest to meeting three energy consumer priorities: reliability, affordability, and environmental responsibility.

Speaking of reliability, modern analysis show that renewables are reaching price and performance parity on the grid and at the socket. Second, solar and wind can cost-effectively help balance the grid. Third, new technologies are honing the competitive edge of wind and solar. Fourth, in global practice, the deployment of solar has flattened midday price peaks, while wind has lowered nighttime prices. Demand from energy consumers has mostly coalesced around three goals that the first three trends have enabled renewables to best fulfill. With varying degrees of emphasis on each goal, consumers are seeking the most reliable, affordable, and environmentally responsible energy sources. One of the most often cited obstacles to the deployment of solar and wind energy has been their intermittency. The situation is reversing: Wind and solar may soon cease to appear as problems to be solved, but rather as solutions to grid balancing. Indeed, renewables have not been as difficult or costly to integrate as anticipated. What’s more, they have demonstrated an ability to strengthen grid resilience and reliability and provide essential grid services. Most countries and regions are at renewable utilisation levels that require minimal adjustments to the grid: Renewables either barely register at the system level or require only small changes in operating practices and in the use of existing resources.

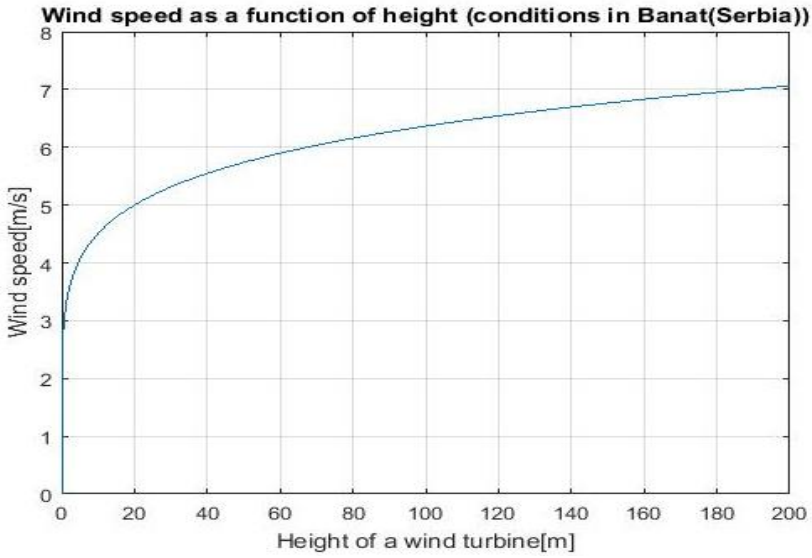
With the addition of storage, wind and solar become more dispatchable, eroding the long-held advantage of conventional energy sources. While the cost of renewables plus storage is higher, they can provide capacity and ancillary grid services that make them more valuable. Regulatory and market structures determine whether the additional value can be monetized. But even if the services cannot be sold, this combination is more valuable because operators can supply more of their own needs and potentially time shift the use of grid-supplied electricity to off-peak, cheaper hours.

In leading renewable markets such as Denmark, national, and local community interests are aligned on these goals. In others, such as the United States and Australia, where the national leadership is retreating on decarbonization efforts, cities, communities, and corporations have become the most relevant actors.



Historical development of RES market

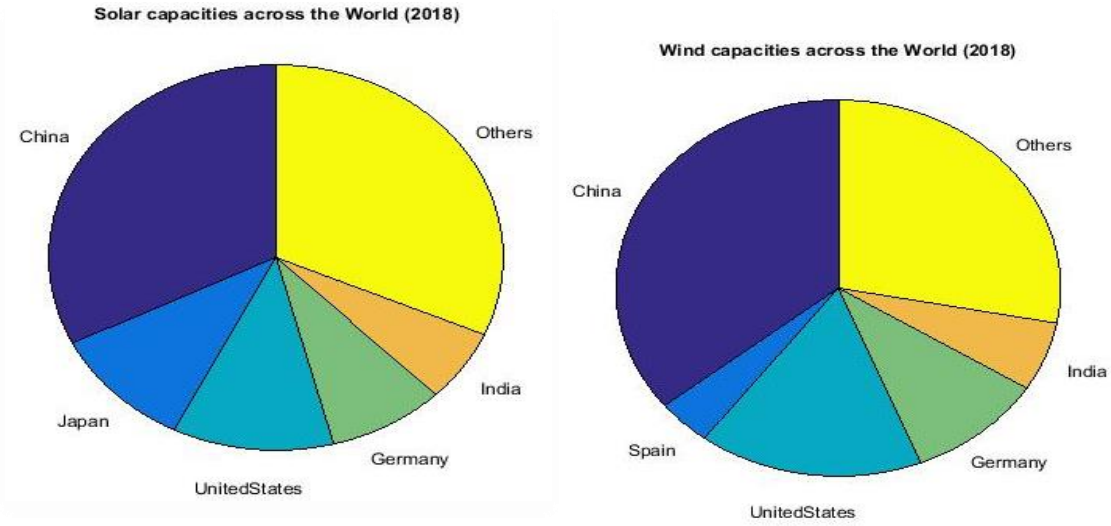
Renewables combined with storage are also reaching price parity as lithium-ion battery costs have fallen nearly 80 percent since 2010 and solar usage has increased. In addition, upgrading, or "repowering," wind turbines in the developed world is also pulling global average costs downward by raising capacity factors. In addition, developing world costs could fall as global developers and international organizations team up to facilitate project development. Such partnerships are helping resolve the resource dissonance created by the fact that Japan, Germany, and the United Kingdom have some of the poorest solar resources but are global solar leaders, while Africa and South America, respectively, have the greatest solar and wind resources, but these remain largely untapped. Automation is dramatically cutting time and costs for solar and wind production and operations. US solar companies automated its manufacturing plants last year and tripled the size of its panels at a cost that undercut its Chinese competitors by 30 percent by transforming production from a hundred-step, multiday process to one that takes just a few steps and hours.



Wind speed as a function of height

As for the wind, primar focus is on a increasing wind turbine height and diameter. Power extracted from the wind is a nonlinear function of velocity (it is propotional to the average wind speed at the axis of turbine to the power 3).Velocity, is on the other hand, nonlinear function of height (graph beyond).So, this challenge requires a whole aspect of planning foundation of a pillar, problems with safety, optimization of losses and etc. Today's wind turbines are placed on abnormal heights (aprox. 230m). Their diameter is fastly closing to the magic number of 200m. How far this process has gone would be best described with following news: biggest Danish wind turbine producer (Vestas) announced that they will by 2021 start to sell commercial 10MW wind turbine.

3 Today's RES



Key players in Solar and Wind

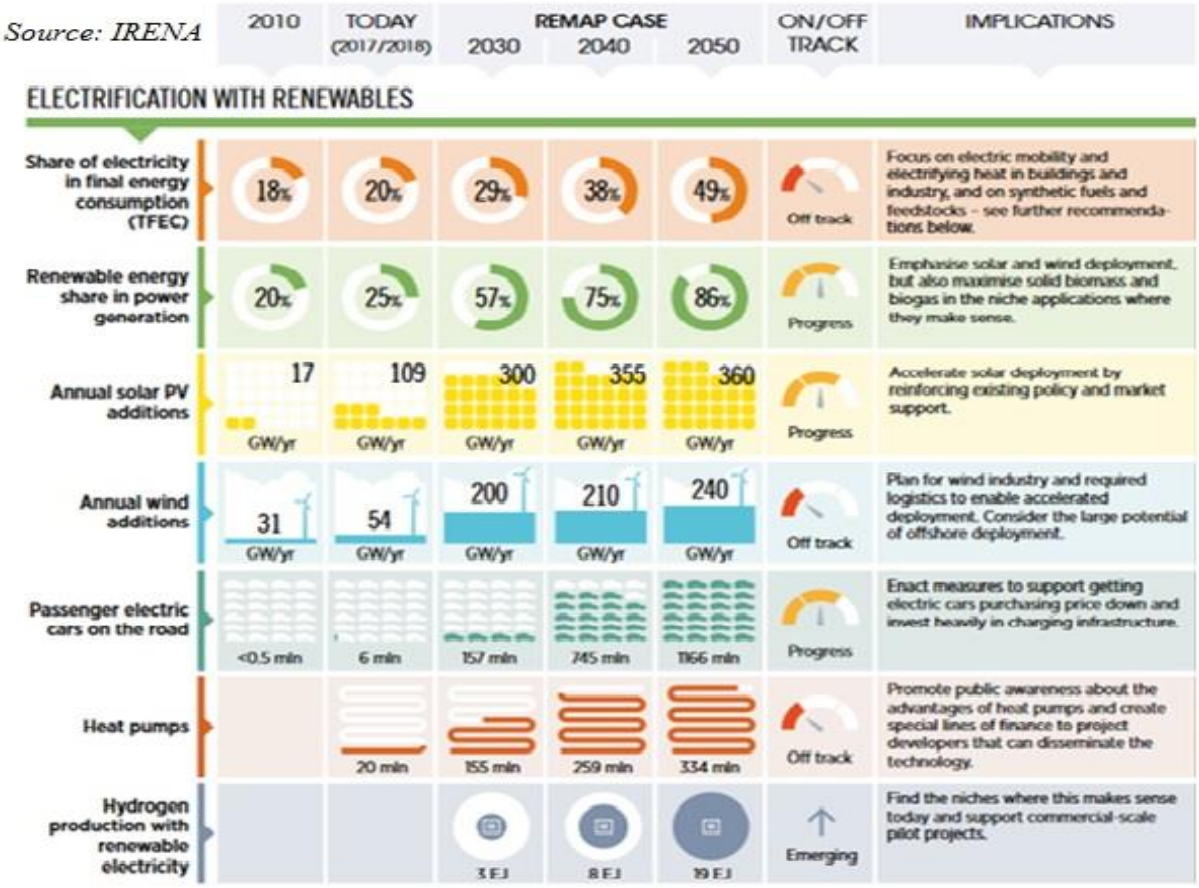
The renewable energy market today is segmented into type, end use, and region. Based on type, the market is divided into hydroelectric power, wind power, bioenergy, solar energy, and geothermal energy. Based on end use, the market is categorized into residential, commercial, industrial, and others. Based on region, it is analyzed across North America, Europe, Asia-Pacific, and LAMEA. Based on end use, the renewable energy market is classified into residential, commercial, industrial, and others. The industrial segment is expected to account for the highest market share. The best possible image of future electricity market is interconnected Danish and German grids, which are currently two of the world's most reliable. European data shows that unplanned outages form a minority of onshore and offshore wind outages, whereas most coal and gas plant outages are unplanned; onshore wind has fewer and shorter outages and recovers faster than any other generation source. In instances where extreme weather conditions have tested grid resilience, renewables compensated for fuel-based resource shortfalls.

4 Future RES

One of the most important concepts of future RES market is smart grids. A smart grid is an evolved grid system that manages electricity demand in a sustainable, reliable and economic manner, built on advanced infrastructure and tuned to facilitate the integration of all involved. In the world of the Smart Grid, consumers and utility companies alike have tools to manage, monitor and respond to energy issues. The flow of electricity from utility to consumer becomes a two-way conversation. Smart grids will provide more electricity to meet rising demand, increase reliability and quality of power supplies, increase energy efficiency, is able to integrate carbon free energy sources into power networks. One of the most important ways you can get involved with the Smart Grid is to take advantage of time-of-use programs. Smart meters and home energy management systems allow customers to program how and when their home uses energy. Throughout the day the demand for energy

changes. It's usually lowest in the middle of the night and highest from about noon to 9 p.m., but it can vary according to weather patterns and what's happening during that time.

The energy transition requires fewer overall subsidies. The focus of subsidies will need to change progressively, however – away from power and fossil fuels and into energy efficiency technologies and solutions needed to decarbonise the industry and transport sectors. The level of additional investments needed to set the world on a more climate-friendly path above current plans and polices is USD 15 trillion by 2050 – a significant sum, but one that decreased by over 40% compared to the previous analysis due in large part to rapidly falling renewable energy costs as well as opportunities to electrify transport and other end-uses. The deployment of new technologies will help further decrease costs and improve integration. This will enable a growing number of energy consumers to procure their preferred energy source and accelerate national energy transitions across the world.



Predictions for future look of a RES market

5 Negative Sides

On the other hand, pollution is still generated with renewable energy. Renewable energies are cleaner than most fossil fuels, but “cleaner” and “clean” are very different terms. A resource like biomass still burns waste products and puts pollution into the atmosphere. This includes carbon and methane, which are classified as greenhouse gases. The technologies and facilities that are used to build renewable energy resources require fossil fuels, as do the transportation and distribution networks. In many instances, renewable energy relies on fossil fuels, whereas fossil fuels do not rely on renewables. In additon, renewable plants are far apart so that there is less correlation among renewable supply, they create more miscoordination in supplies, increasing price volatility. Many forms of renewable energy require storage capabilities. With traditional power resources, a home or business is connected to a local distribution grid so that it can be accessed 24/7.

When using a renewable energy resource, back-up and storage resources must be included with the power generation opportunity. Sunlight doesn’t happen at night. Wind speeds are not always consistent. The storage capabilities that are required can push the cost of a new renewable energy system

beyond what the average person or community can afford. Also, renewables often require subsidies to make them affordable. In the United States, an emphasis on biofuels and renewable energies led to the creation of ethanol as a crude oil replacement. Despite taxpayer-funded subsidies in place for this corn-based fuel, only 430,000 barrels per day were produced in 2007. That was enough to replace 2% of the oil that was being consumed while corn prices skyrocketed because of the crops being funneled into this renewable fuel. Also, some forms of renewable energy require a massive amount of space.

6 Deregulation

In areas with developed electric grids, community energy provides shared ownership or access to wind and solar resources. Energy cooperatives are the most common structures and involve shared citizen ownership and operation of renewable resources. Germany is the global energy cooperative leader: Over two-fifths of renewable energy installed in the country last year was cooperative-owned, and Germany recently implemented new rules to level the playing field for energy cooperatives to participate in power auctions. Denmark also strongly supports energy cooperatives, requiring a 20 percent local community share in all wind projects. The energy cooperatives have contributed to strong citizen engagement and support for the deployment of renewables in these two countries. Spurred by a national competition, the Danish island of Samsø successfully transitioned from an entirely fossil fuel-dependent market to a 100 percent renewables-fueled one in under a decade with a community energy model.

In a regulated marketed, vertically-integrated utility own and control the whole stream of flow of power from generation all the way to your meter. In this model, clients are forced to pay a set cost set up by the service organization—no different alternatives. Single authority or few producers costs are controlled by single commission Costs passed to customers small incentive for efficiency In a deregulated marketed, utility corporations working in a deregulated electric market are still able to set their own costs, however should buy power during its generation stage before selling to end-clients. However, the main difference between regulated and deregulated electricity is found at the most micro level—the customers. Advantages of Deregulated Electricity Market Electricity price will reduce: It is a common understanding that the competitive prices are lesser than the monopolist prices. The producer will try to sell the power at its marginal cost, in a perfectly competitive environment. Choice for consumers: The consumer will have choice for its retailer. The retailers will compete not only on the price offered but also on the other facilities provided to the customers. These could include better plans, better reliability, better quality, etc. Customer-centric service: The retailers would provide better service than what the monopolist would do. Innovation: The regulatory process and lack of competition gave electric utilities no incentive to improve or to take risks on new ideas that might increase the customer value. Under deregulated environment, the electric utility will always try to innovate something for the betterment of service and in turn save costs and maximize the profit.

7 Electricity RES Market in Serbia

The Republic of Serbia has very significant potentials from renewable energy sources. This can be a strong support for energy stability in the future. Regarding the overall available potential in Serbia, it creates the opportunity to satisfy a quarter of current energy needs annually.

In 2009 Serbia introduced stimulative production tariffs for electricity from renewable energy sources. These tariffs consists of criteria for granting privileged producer status. After all checks, privileged producer signs a contract for 12 years with a guaranteed price for produced energy. The privileged production includes the following:

- Small hydropower plants up to 10 MW (30 MW)
- Biomass power plants up to 10 MW,
- Biogas and waste materials up to 10 MW,
- Power plants for wind power,
- Power plants on solar and geothermal energy

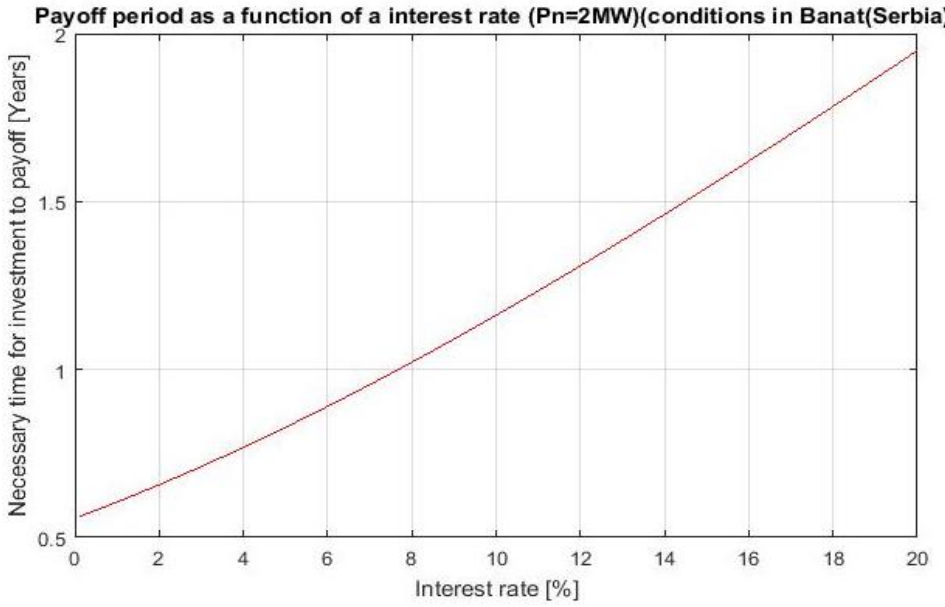
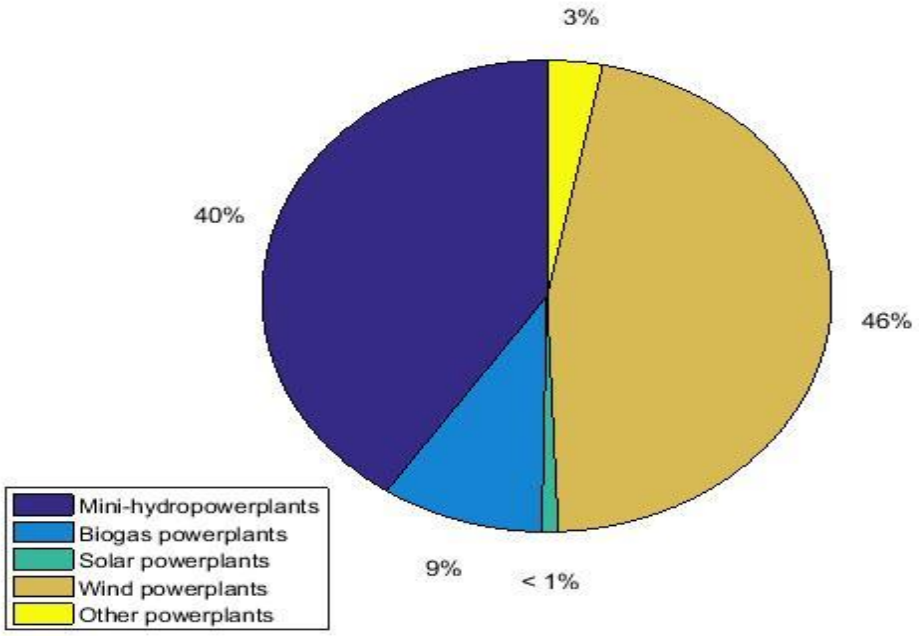


Illustration of a payoff period varying interest rate



Desired installed capacity until 2020 from a National Plan in 2013

On 6 December 2011, the Energy Community of South East Europe Energy Community accepted that the share of renewable energy is 21.2% of the total energy consumption in Serbia, that is, the basis for determining the obligation of Serbia to increase the share of renewable energy sources in consumption by 2020 On this basis, Serbia assumed an obligation to increase the share of renewable energy in total consumption by 2020 from the current 21.2 to 27%. Our major source of renewable energy is water. It is difficult to ever accept the fact that our hydroelectric plants are in fact ecological sources of energy and that in fact we are neglecting all possible ecological damage to biodiversity.

On the other hand, important problem of RES in Serbia is machinations with mini-hydro power plants. Introduction of feed-in tariffs in Serbia opened a lot space for various suspect investitors. In addition, these tariffs are assigned to private investitors for too long period (basicly for 10 years), so, general impression is barely positive. Solution should be found soon, otherwise, RES market in Serbia is in big threat to slip to be monopolistic. Construction of more than 800 mini-hydro power plants on mountain rivers is planned throughout Serbia. So far, about 90 SHPPs have been built in Serbia, but

majority is located in protected natural areas. Opponents indicate that they have a very negative impact on the ecosystem. If all SHPPs were made, only 2% of the needs in the energy balance of Serbia would be provided annually. To conclude, mini-hydro power plants should be built only if they satisfy various conditions in terms of their impact on eco-system, especially in protected natural areas.

8 Conclusion

The biggest problem in transition from fossil fuels to renewable sources is the transport sector. However, mass production of batteries for storage of electricity does not advance to the desired flow and it is necessary to find good enough alternatives. One of the possibilities is massive use of superconductors, as well as hydrogen as a fuel. Nowadays, there is a significant decline in investment prices in renewable sources, and these trends need a stronger support. It is necessary to find alternative ways of supporting investors in renewable sources, because feed-in-tariffs have proved to be not so reliable. In the upcoming period, the RES electricity market needs to be more reliable, efficient, digitalised and costeffective in order to make it more consumer-friendly.

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