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# AN OVERVIEW AND ANALYSIS OF ENERGY CHALLENGES IN THE REPUBLIC OF CROATIA

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## Abstract

*This paper examines the key energy challenges that Croatia faces, how those challenges are likely to evolve in the coming years, and some possible solutions to the issues presented. While there is a wide variety of issues that Croatia will need to address, this paper will address two of the most pressing: reliance on energy imports, and an inadequate power grid and energy infrastructure. After identifying current vulnerabilities that the country is facing, the analysis points out the trends and the ongoing challenges regarding the demand for energy in Croatia.*

*Finally, this paper concludes with the recommendation that Croatia pursue a multi-pronged approach to renewable energy generation, emphasizing decentralized production as the most time and cost effective strategy until the national power grid can be sufficiently upgraded and integrated to support more centralized approaches. Its geographic location, immanent admission to the EU and potential for diverse domestic sources of renewable energy combine to set the stage for a bright future for Croatia's economic development, as long as the Croatian authorities place a priority on a multi - pronged approach to energy sources on the one hand, while continuing to work to a unified energy infrastructure on the other.*

## 1. INTRODUCTION

Croatia is among the first Southeastern European (SEE) countries to enter the final stages of membership in the European Union, with full membership expected by the end of 2013, and many of the energy challenges and opportunities it faces are representative of the region (Sedlar, Hrnčević and Dekanić, "Recommendations" 2011). This paper examines the key energy challenges that Croatia faces, how those challenges are likely to evolve in the coming years, and some possible solutions to the issues presented. While there are multiple issues that Croatia will need to resolve, this paper will discuss two of the most pressing—reliance on energy imports, and an inadequate power grid and energy infrastructure. Finally, this paper concludes with the recommendation that Croatia pursue a multi-pronged approach to renewable energy generation, emphasizing decentralized production as the most time and cost effective strategy until the national power grid can be sufficiently upgraded and integrated to support more centralized approaches. While this method will still require significant foreign investment, it provides a clear way forward that utilizes the unique geographic potential found in Croatia.

## 2. CURRENT VULNERABILITIES

Croatia is currently reliant on external sources for oil and most of its natural gas needs, having no significant oil deposits and only modest natural gas deposits available. Electricity consumption is also increasing, and as the economy of neighboring countries grow, easily accessible supplies of surplus energy from those countries are decreasing (Schneider, Dui and Bogdan 2007). As of 2011, Croatia continues to be heavily dependent on energy imports, relying on imports for roughly 50 percent of its energy needs, and

it has only relatively small oil reserves to buffer against supply issues (Sedlar, Hrnčević and Dekanić, "Recommendations" 2011). This dependence on foreign imports opens up several possible vulnerabilities.

First, Croatia's limited domestic production capacity and low stock supplies mean that it is highly susceptible to price shocks and volatility in the international energy market. Though Croatia is one of the least energy intensive countries in the SEE region, the vulnerabilities of low domestic production and low stock supplies are compounded by the effects of the global economic downturn, as energy intensive industries (such as factories and hotels) have weaker demand for their outputs (Atsushi 2010). This means that when fuel prices suddenly rise in response to global supply shortages or other issues, Croatia is unable to compensate by increasing local production or releasing reserves to help mitigate the effects of the price shocks. Additionally, since it is located near the Middle East and other regions that are prone to experience political upheaval, supply routes into the country remain vulnerable to disruptions (Tatalović 2008). This results in part from concerns about terrorists who may attempt to disrupt supply lines leading to the EU, and it has become a growing factor influencing policy decisions concerning energy security.

Other major vulnerability is Croatia's lack of a high quality, unified energy infrastructure. This is in part due to previous regional instability that both damaged the existing infrastructure and slowed progress in development of new infrastructure (Schneider, Dui and Bogdan 2007). Developing this infrastructure will be a key part in allowing Croatia's economy to continue to grow as it becomes a full EU member, since new industry, new sources of domestic energy and full integration with regional and global energy markets are all reliant on a functional and secure national

infrastructure (Tatalovi 2008, Schneider, Dui and Bogdan 2007, Vailati 2009). Without a secure national infrastructure that can interface with neighboring countries, Croatia would be unable to fulfill its obligations to share energy reserves in time of crises, or easily receive reserves from countries, or properly take part in the regional energy market.

### 3. ONGOING CHALLENGES

Over the coming decade, trends indicate that the demand for energy in Croatia is only likely to increase. This seems especially probable given the predicted boost in Croatia's economy once it attains full EU member status (Lejour, Mervar and Verweij 2009, Sedlar, Hrnčević and Dekanić, "Recommendations" 2011). However, though the state-owned power utility, Hrvatska elektroprivreda d.d., plans to build new power plants in the coming years, with Croatia's ratification of the Kyoto Protocol in April 2007, the number of new fossil fuel fired power plants faces restrictions, increasing the importance of seeking local alternative energy supplies (Schneider, Dui and Bogdan 2007). Unless new sources of domestic energy are developed, this will leave Croatia even more vulnerable to global market volatility and to disruptions due to terrorism or regional conflicts. As new energy sources in the Caucasus and Central Asia are developed, supply will likely be routed through or near Croatia, having the benefit of increasing supply. An unwelcome side effect is that these supply routes would also increase regional tensions, unless a broader global or regional framework for energy development can be reached. This results from the power dynamics and potential revenues given the control over a part of the supply chain, as each country attempts to promote its own energy security agenda (Tatalovi 2008).

Croatia's current energy policy is focused only on the years leading up to

2020, in line with EU policy (Raguzin, Vešligaj and Jelavi 2010). Some of these environmental targets include increasing reliance on renewable energy sources from 7 percent in 2005 to 20 percent in 2020, reducing emissions by 5 percent over 1990 levels (though so far Croatia has fallen short on the greenhouse gas emission targets), and reducing final energy consumption by 9 percent (Raguzin, Vešligaj and Jelavi 2010, Garside 2011, Sedlar, Hrnčević and Dekanić, "Recommendations" 2011). In order to meet these milestones by 2020, Croatia will have to dramatically increase the amount of renewable energy it utilizes, while also seeking to significantly increase overall efficiency (Sedlar, Hrnčević and Dekanić, "Possibilities" 2010, Raguzin, Vešligaj and Jelavi 2010). These will be difficult goals to meet without extensive infrastructure development, in order to allow transmission of energy between viable sources within Croatia, and to ensure that there are proper redundancies built into the infrastructure to sustain disruptions due to disaster, whether natural or caused by humans—all of which requires a great deal of time and investment (Schneider, Dui and Bogdan 2007).

Croatia has abundant resources available in all of the major areas of renewable energy resource technology, and it has especially high availability in several key areas that will be discussed in the next section. However, in order to take full advantage of these resources, new support policies will have to be put in place (Raguzin, Vešligaj and Jelavi 2010). These policies are especially critical in the wake of the global economic crisis, which reduced the availability of liquid Western capital available for investment in Eastern energy projects. One factor that offsets this is that the crises also raised awareness of the importance of renewable energy sources, especially because of the potential of that sector for rapid growth.

As EU member countries are facing increasing pressure to meet environmental goals, lagging members have been receiving additional support to meet their goals. However, since Croatia will not become a full member until July 1, 2013 (assuming the remaining 8 of 27 members ratify the agreement backed by the European Commission), it has not yet had the benefit of additional resources to aid in developing its renewable energy sector (BBC 2013, Sedlar, Hrnčević and Dekanić, "Recommendations" 2011). If sufficient resources are invested in new energy sources, research by Sedlar et al. (2011) indicates that the result will be positive for the Croatian economy, with a boost to the average annual growth rate of the GDP of at least 1 percent. However, until the effects of the crises begin to fade, it may remain difficult for Croatia to find the necessary capital for these infrastructure and energy source developments.

#### 4. RECOMMENDATIONS

While some reasonable comparisons can be made for energy policy in SEE countries, a blanket approach to energy policy for developing countries across the globe is not appropriate because it fails to account for differences that are associated with geography (Bouzarovski 2009). Croatia is an interesting case study for energy security because some of its biggest challenges are also unique opportunities. On the one hand, proximity to unstable oil producing regions means that Croatia is vulnerable to local unrest, but on the other hand same proximity gives the opportunity to take advantage of energy pipelines and surpluses produced in the region. Another positive facet of its location is that one of the key issues in Croatia—foreign energy dependence—can be addressed in part by leveraging unique geographic characteristics of the region. Though the mountains, islands, and numerous rivers make building a unified

power grid more difficult, they also provide potential solutions to energy issues. For instance, opportunities exist for geothermal power, biomass utilization, biodiesel production, and cogeneration techniques (Guzović, Lončar and Ferdelji 2010, Čosić, Stanić and Duić 2011, Kulišić, et al. 2007, Lončar, Duić and Bogdan 2009). Hydrologic power is already an important sector in Croatia for energy production, but an extensive reliance on this source of energy can lead to vulnerability to drought, and in general, diversity of supply (a supply diversity) is necessary for energy stability when utilizing geographical energy sources (Atsushi 2010, 80). In addition to the following energy sources, there is also potential for increased use of solar and wind technologies, but more feasibility studies are needed in those areas (Sedlar, Hrnčević and Dekanić, "Recommendations" 2011).

Geothermal energy plants have recently gained momentum in Croatia, and concrete initiatives have been put into place to take advantage of the medium temperature geothermal sources present. Since the first commercial geothermal plant was built in 1914, the technology has matured to the point where it is in use in 24 countries. The availability of suitable geothermal sources in Croatia has been known since the 1970's, though all projects until recently were abandoned in the preliminary phase. Research by Guzović, Lončar and Ferdelji (2010) points to a number of suitable geothermal sites in Croatia, and furthers the work on the optimal ways to harness the available energy. Though the return on geothermal energy sources tends to be relatively low, compared to other sources of energy, the relative lack of local hydrocarbons in Croatia renders it a useful addition to other potential energy supplies (Sedlar, Hrnčević and Dekanić, "Recommendations" 2011).

This is especially true when linked with Croatia's mandate to cut emissions by 5 percent by 2020 compared to 1990 levels

as part of the EU accession process, as well as other environmental commitments (Garside 2011, Sedlar, Hrnčević and Dekanić, "Possibilities" 2010).

Production of energy using waste biomass has also been evaluated and it holds promise in Croatia. Based on Croatia's primary agricultural products and large forestry industry, the main viable biomass fuels that have sufficient available volumes for energy production are wheat straw, corn stover, and forestry residue (in that order). This technology has undergone increasing developments and improvements as countries strive to reduce greenhouse emissions, and in countries with high biomass availability like Croatia, it is projected that biomass utilization has finally reached a point of economic viability.

The next source of energy that can be exploited in Croatia is biodiesel. The transport sector is a particularly important sector of energy growth in Croatia, and biodiesel presents an opportunity to both increase local energy production and reduce the dependence on oil imports, while also working towards meeting its international environmental commitments. Biodiesel has been under consideration in Croatia since 1997 (Domac 1998), though other research carried out from a technical or investors' point of view up until 2001 suggested that biodiesel projects would not be competitive (Kulišić, et al. 2007). However, because of the increase of the oil cost between 2001 and 2006 (from \$28 to \$60 per barrel), the research by Kulišić, et al. (2007) suggests that it has become a viable fuel source that could have a net positive impact on the Croatian economy.

However, the same research suggests that in order to make biofuels competitive (at least initially), significant subsidies will be required, such as exemption from the special excise tax imposed upon petroleum products.

Cogeneration (combined heat and power production, or CHP) is another potential area for energy development in

Croatia. As many countries around the globe begin to work towards tough environmental goals, CHP has received increasing attention as a possible method to increase the efficiency of overall power outputs, despite the fact that in 2007 it accounted for only around 9 percent of global energy generation. In Croatia, some efforts have been made to implement cogeneration systems, and it supplied from 11 to 16 percent of the energy market and more than 70 percent of the heat required for district heating or industrial processes (Lončar, Duić and Bogdan 2009). As with the other potential alternative energy sources discussed, cogeneration will require a significant legislative effort, initially, in order to integrate cogeneration technology into the Croatian energy system. However, it remains a potentially valuable tool for increasing the efficiency of the energy sector (Lončar, Duić and Bogdan 2009).

Using this multi-pronged approach to increasing energy output and reducing dependence on energy imports will not relieve Croatia of the burden to continue towards developing a unified energy infrastructure. However, in the short term, it may be possible to leverage the diverse energy sources mentioned above in a decentralized way. As noted earlier, the varied geology of Croatia poses challenges for creating a unified power grid between mountainous, sparsely habited, or island areas. This, combined with areas that were devastated by war, depopulated, or simply underdeveloped means that many areas of the country have little to no access to adequate power supplies. However, the opportunities for energy generation using the geothermal, biomass, biodiesel production, and cogeneration techniques discussed above lend themselves to deployment in a decentralized, independent fashion across the country, based on localized viability for each technology. Research conducted by Schneider et al. (2007) suggests a variety of areas where decentralized production

could prove beneficial. Hotels, apartment houses, and entertainment centers, and other facilities that service the tourist industry are a prime example since they tend to be located in remote areas such as mountains and islands where connecting to the national power network is impossible or too expensive. Outside the tourist industry, various other energy intensive industries could benefit from decentralized power generation, with results coming much quicker than possible by waiting for an improved national power grid. These types of technologies do have a major downside though, in that some renewable sources (e.g. hydroelectric, solar, wind, etc.) tend to be intermittent and susceptible to environmental changes. This can however be offset to some degree by using new energy storage technologies, as noted by Schneider, Dui and Bogdan (2007). Overall, the decentralized approach holds much promise, as it would allow development to continue across the country without being constrained by the slow pace of implementation of a national energy infrastructure (Schneider, Dui and Bogdan 2007).

Ultimately, it will be necessary to develop a unified energy infrastructure that can fully interface with regional energy markets in order to meet efficiency and development goals (Atsushi 2010; Sedlar, Hrncevic and Dekanic 2010). These goals should prove easier to fund via international investors once Croatia becomes a full EU member. This is due to the fact that the perceived level of corruption tends to decrease after EU membership status is achieved, and foreign investors are more likely to trust institutions that are bound to EU member standards (Lejour, Mervar and Verweij 2009).

An important component of the development of a future centralized system is working towards compliance with EU rules governing stockpiles and distribution systems for oil reserves. In this area Croatia is in a good position compared to

most of the SEE countries due to the relatively small amount of investment required, which is about one percent of GDP compared to around ten percent for many countries in the region (Tosun 2012). As the global economic conditions improve, and resources become available through EU membership, Croatia may have a much easier time developing its alternative energy sector than many other SEE countries. Another important factor is that as cross-national transit lines for electricity and pipelines for hydrocarbons are implemented, Croatia's access to energy markets will increase, but also increases the likelihood for regional conflict (Tatalovi 2008, 131). However, this seems to be a price that must be paid in order to succeed in fully integrating with EU energy markets, and to increase energy security at home (Deitz, Stirton and Wright 2009; Tatalovi 2008).

## 5. CONCLUSION

While Croatia faces many challenges in the coming years, it has sufficient options for overcoming those challenges if appropriate policies are enacted. All of the current alternative energy technologies have viable applications in Croatia, though most will require at least modest policy support, for instance, exemption from the special excise tax that is currently applied to oil. These accommodations would not be overly burdensome to the Croatian energy sector, and these would have the long-term effects of increased energy security, decreased susceptibility to global price shocks, and (it) would be a step towards meeting the environmental targets (Raguzin, Vešligaj and Jelavi 2010). If energy sources are initially tapped in a decentralized way, the upfront costs are further reduced, allowing progress to continue on a national energy grid, with suitable regional interfaces, backup supplies, and transmission redundancy. This further step will be essential as energy markets continue to integrate and

become interdependent (Global Public Policy Institute 2009). In short, its geographic location, (its) immanent admission to the EU, and (its) potential for diverse domestic sources of renewable energy combine to set the stage for a bright future for Croatia's economic development, as long as the Croatian authorities place a priority on a multi-pronged approach to energy sources on the one hand, while continuing to work to a unified energy infrastructure on the other.

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## Biography

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