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Energy Sector Note

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Energy and Extractives, Poverty and Equity Global Practices
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Croatia

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by

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Disclaimers

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Summary and Key Messages

Croatia joined the European Union (EU) in 2013, and the energy sector has been undergoing liberalization, deregulation, and unbundling of state-owned energy utilities. Croatia has welcomed a number of new public and private energy companies. The Croatian Power Exchange was established in 2014 and commenced operation in 2016 as a platform for electricity trade.

<u>Main Challenges</u>

Croatia's energy intensity (EI) is high and could be substantially improved. Croatia has more than a decade of experiences in energy efficiency (EE) actions and financing. However, Croatia's EI remains 55 percent higher than EU average. Building on its EE experience and institutions, Croatia can leap forward and achieve a more ambitious EE and EI targets by scrutinizing sub-sectoral EE and EI targets as envisaged under Croatia's 4^{th} EE Action Plan (residential, buildings, service and industrial, transport sectors).

Energy efficiency financing through traditional financial institutions remains limited. Croatia has more than a decade of experience in the Energy Services Company (ESCO) model, with a good range of services on offers. Considering the learning curve of the model in Croatia, ESCO in this context refers to the integration of all energy services in all project phases, through a single contract with guarantees on energy savings, and effective multi-faceted risk management. However, the gap in Croatia's ESCO model continues to be scaling up through traditional financial institutions. Confirming and addressing the constraints of ESCOs at a micro-level could help substantially expand EE financing options and optimize their performance.

The next phase of renewable energy projects needs support. Croatia has committed to decarbonizing its energy sector through expanding renewable energy and reducing carbon emission of fossil fuels. Adding more renewables—particularly wind and solar—could help reduce Croatia's energy intensity by displacing less efficient fuels such as coal, natural gas and biomass (in households). Thanks to existing hydropower plants and recent addition of wind and solar power generation, Croatia has already exceeded the EU renewable energy target of 20 percent in final energy consumption by 2020. However, intermittent wind and solar capacity accounted for just 11 percent (539 MW) of installed grid-connected power generation capacity in Croatia (2016), meaning there is a substantial room to increase (e.g. toward 20 percent) without disrupting the power grid. The key question is "what's next for renewables in Croatia"? Potential hydropower projects are faced with environmental and social concerns. Although the total cost of wind and solar power have declined, they are still higher than wholesale electricity prices in Croatia. The feed-in-tariff system to promote renewables was discontinued in 2015, while its successor renewable energy capacity auction is not yet operational, which halted development of new generation of renewable power projects. Finally, more traction could be had in Croatia by energy generation systems utilizing renewable sources such as distributed generation and mini-grid systems. Croatia, with its remote island regions, far away from power, heat and gas networks, could benefit from developing such renewables based energy generation systems.

Croatian businesses could be more competitive and active in the global EE and RE business. A number of firms within the energy technology sector have a long tradition in production of energy equipment. Most of the companies are SMEs, whose activities are linked to the larger Croatian firms and foreign multinationals. However, constraints such as outdated technologies, weak links between scientific research and industry, and low budgetary allocations for research and development, are impeding growth. For Croatian firms to effectively partake in the global energy technologies value chain, they could be more active in: i) developing efficient research and development ecosystem for EE, RE, and effectively utilizing available funding options; ii) developing integrated solutions that enable participation in the global renewable energy value chains; and iii) expanding ESCO model to the transport sector.

Declining natural gas reserve and production. Natural gas is the second largest primary energy source for Croatia at 26 percent. By 2016, gas proven reserve totaled 13.2 billion cubic meters (bcm) and production totaled 1.65 bcm. With no foreseen increase in gas reserve, gas production is expected to reduce toward 0.6 bcm per year in a few years. Therefore, import of natural gas to make up for declining domestic supply is needed. Moreover, natural gas will help Croatia transition away from importing coal and cut Croatia's greenhouse gas emission faster.

Ensuring energy security under a competitive and open electricity market is one of the overarching strategic goals for Croatia. Enhancing electric connectivity with neighbors and increasing liquidity of the Croatian Power Exchange are key enablers of this strategy. Displacing imported coal with gains in energy efficiency, renewable energy, and natural gas imports will help Croatia to enhance it energy security further.

The existing social support mechanisms for energy consumption could be improved and minimize the fiscal cost. Electricity and gas prices in Croatia have not increased substantially following the unbundling of the electricity and gas sector in 2013. These were possible partly due to stagnate energy demand in Croatia in recent years, excess electricity supply capacity in Croatia and in the region, as well as relatively stable European gas prices since the unbundling. To address concerns of energy affordability, the Croatian authorities have put in place social support mechanisms to lessen the burden of energy consumption for low-income households. While these mechanisms are crucial, further refinement to better target the support for the poor will help improve the mechanism's effectiveness and minimize the fiscal cost.

Opportunities for Development

The on-going update of the Croatia National Energy Strategy and the drafting of the National Development Strategy ("NDS") provide an invaluable opportunity to align energy and national development objectives and actions in the coming years. Based on our review of energy issues facing Croatia, we wish to highlight the following priority issues for follow up analytical work and actions:

On **energy efficiency and energy intensity**, first, follow up work on increasing efficiency particularly in the household sector, and through district heating. Second, follow up work on expanding multi-mode transport options, and raising the share of energy savings from the transport sector in the 4th National Energy Efficiency Action Plan. These two areas are somewhat lagging in terms of energy efficiency, and they could help substantially reduce Croatia's energy intensity level.

On **energy market and security**, a follow up work to adjust the way electricity is traded in Croatia is needed to increase liquidity of the Croatia Power Exchange, in addition to market coupling with Slovenia (which is underway). On the supply side, actions to reduce coal imports, expand renewable generation, and the need to inform and consult the public about environmental and social aspects of LNG import can be a follow up. Five years after Croatia's joining the EU and the on-going liberalization of the energy sector, a review of operational, financial and investment efficiency of the current energy state-owned companies could provide invaluable insight of their strength, weaknesses, and competitiveness in the coming years.

On **energy poverty and affordability**, a follow up work to support low-income households to access cleaner energy, connect to electric, gas and heat network, and improve household energy efficiency is a priority. A design of pro-poor network access fees and household energy efficiency, including through building owners, will be beneficial.

Policy Recommendations

- **Energy Efficiency**:

    - Croatia has prepared the Low Carbon Strategy and is updating the Energy Strategy. Together these will lead to the formulation of the National Energy and Climate Change Action Plan (NECCAP). As an EU member country, Croatia is obliged to complete NECCAP by the end of 2018. In addition, the National Development Strategy should be leveraged to tackle issues which cut across the energy sector such as the tourism-dominated energy demand and supply solutions, eco-friendly renewable energy, electric vehicles and smart electricity grid applications.
    - There is a clear and urgent need for rehabilitation of buildings constructed before 1990, especially publicly owned buildings in the city of Zagreb and privately-owned hotels located mainly on the Adriatic coast.
    - In addition, Croatia must focus on EE/EI in transport.
    - Measures to promote energy efficiency in poor households are still needed. This entails working with vulnerable homeowners to ensure that efficiency is improved.
    - On the supply side, Croatia must move ahead with adding state of the art combined-cycle gas turbines and increasing efficiency of district heating.

- **Energy Market and Energy Security:**
  - Since joining the European Union (EU) in 2013, Croatia has implemented a number of EU directives aimed at opening its electricity sector to competition and integration into a single EU electricity market. However, competition in Croatia's electricity market is still very limited. Market reforms are needed to improve the investment climate and create incentives for new entrants.
  - Croatia must develop a system to replace the feed-in-tariffs.
  - More traction could be had in Croatia by energy generation systems utilizing renewable sources such as distributed generation and mini-grid systems.
  - Enhancing electric connectivity with neighbors and increasing liquidity of the Croatian Power Exchange are key enablers of this strategy.
  - A follow up work to adjust the way electricity is traded in Croatia is needed to increase liquidity of the Croatia Power Exchange, in addition to market coupling with Slovenia (which is underway). On the supply side, actions to reduce coal imports, expand renewable generation, and the need to inform and consult the public about environmental and social aspects of LNG import.
- **Affordability:**
  - To address concerns of energy affordability, the Croatian authorities have put in place social support mechanisms and energy allowance to lessen the burden of energy consumption for low-income households. While these mechanisms are crucial, further refinement to better target the support for the poor will help improve the mechanism's effectiveness and minimize the fiscal cost. For instance, a blanket VAT reduction for all electricity consumption, while lessening the burden of electricity bills for the poor, should be reconsidered as this VAT reduction tends to overwhelmingly benefit the non-poor. In addition, measures to promote energy efficiency in poor households are still needed.

A. Energy Intensity[1] and Efficiency in Croatia

This section reviews energy intensity (EI) and energy efficiency (EE) status in Croatia.

There are multiple policy documents on EE in Croatia, championed by ministries and specialized agencies. A draft of the 4th EE Action Plan (2017–2019) has been submitted to the European Commission, and is the main policy document outlining the strategic direction for Croatian EE, which is built upon the 3rd EE Action Plan. Some programs are supported by the ministries such as Ministry of Construction & Spatial Planning, and agencies such as the Environmental and Energy Efficiency Fund, among which are:

a) the Promotion of Energy Efficiency and the Use of Renewable Energy Sources

b) the Program of Energy Renovation of Commercial Non-residential buildings 2014-2020

c) the Green Business Project launched by the Ministry of Tourism which is a platform for recognizing hotels as "green" energy efficient destinations

d) the 2018 National Reform Program and proposal of strategy for spatial development of the Republic of Croatia adopted in October 2017

In terms of final energy consumption per the International Energy Agency classification, the residential sector is the largest energy consumer in Croatia at 34 percent of final energy, followed by transport at 29 percent, industry at 15.5 percent, and commercial/services sector at 11 percent.

Available data shows Croatia's energy intensity to be higher than the EU28 average. Furthermore, the primary energy intensity of Croatia from 2005-2015 is decreasing slower than EU28 on average. A comparison with Central and Eastern Europe Countries shows Croatia to be doing better than some of its peers in the CEE region, however, there is room for Croatia to improve its energy intensity further.

Figure A1: Energy Intensity EU28 and Select Countries

Countries	Relative energy intensity (GDP in PPS, EU28 =100)	Gross inland consumption per capita (TOE) 2014
EU 28	100	3.2
Croatia	155	1.9
Austria	87	3.8
Czech Republic	212	3.9
Slovenia	151	3.2
Hungary	176	2.3

Source: European Environment Agency

[1] Energy intensity is the ratio between the gross inland consumption of energy and a country's gross domestic product (GDP). This indicator is essential for measuring progress under the Europe 2020 strategy for smart, sustainable and inclusive growth. If an economy becomes more efficient (not necessarily due to efficiency improvement, composition change in GDP can lead to drop in this ratio) in its use of energy relative to the GDP, then the ratio should drop. Source: Eurostat, 2017.

Improvements are being made across the EU on reduction of energy intensity, due to advancements in energy efficiency initiatives and integration of renewables. "Between 2005 and 2014, gross inland energy consumption in EU-28 decreased by 1.4 percent per year, while GDP increased by 0.8 percent per year. As a consequence, energy intensity in the EU-28 decreased by an average of 2.2 percent per year during this period."[2]

The following subsections assess energy consuming sectors in Croatia in more refined classification, ranked from the largest to smallest share of consumption, namely: the residential sector, the building and construction, the tourism sector, the transport sector, and the industrial sector. Overlaps that exist within the consuming sectors, for instance in the Residential and Buildings, or the Residential and Tourism will be explained in the subsequent text.

Demand Side (DS)

DS1. Residential sector

Biomass as the leading fuel. In the residential sector, biomass (e.g. firewood) accounted for almost half of final energy use (47 percent of energy content), followed by electricity 22 percent, natural gas 19 percent, and oil 6 percent. Almost half of the residential sector uses firewood for heating[3]. The large share of biomass in the residential sector suggests that many households are still using biomass and that low efficiency biomass requires more energy input, which escalates EI.

More cooling needs than other EU countries within similar geographical location. The table below shows the share of final energy consumption in the residential sector by type of end-use in 2016 (percentage of energy unit). Croatia is spending more energy on cooling than other EU countries and this trend is likely to continue given the country's geographical location and climate.

Figure A2: Share of Final Energy Consumption in Residential Sector (2016)

	Space heating	Cooling	Water heating	Cooking	Lighting & appliances	Other end uses
EU 28	**64.6**	**0.3**	**14.5**	**5.5**	**13.8**	**1.3**
Croatia	70.2	1.5	9.2	6.2	12.8	0.0
Italy	67.7	0.4	11.7	6.3	12.6	1.3
Bulgaria	54.0	0.4	17.4	8.5	19.6	0.1
Slovenia	65.0	0.4	15.6	4.0	15.0	0.0
Romania	63.9	0.3	13.3	9.2	13.3	0.0

Source: Eurostat 2018

Large opportunities to improve EE in Croatian households. Better building insulation, managing and operating energy management systems with the help of smart meters and intelligent appliances could help improve energy demands in Croatia. (Please see the section on buildings below for more details on EE improvements on buildings.) Statistics from the national energy efficiency portal states that there are currently 1.42 million occupied dwellings and houses in

[2] Energy intensity 2016 – European Environment Agency
[3] Biomass-Based Heating in the Western Balkans – A Roadmap for Sustainable Development, World Bank, 2017.

Croatia, of which 54 percent are standalone houses and 46 percent are multi-dwelling units. Since the majority of residential buildings are older than 20 years, the potential for reducing energy requirement in old, uninsulated standalone houses could be achieved. For example, if an uninsulated house[4], is insulated with 10 centimeters of material on the walls, 20 cm in the roof and 8 cm on the floor of the unheated basement, the energy requirement for heating could be reduced by more than half the current level.

Low income households often have higher electricity bills than the middle class[5] and the average Croatian consumer is sensitive to price. Some reasons for higher electricity bills in low income households include a lack of insulation in the homes, the use of more expensive sources of energy such as electricity for heating, the inability to afford energy-saving appliances, the lack of access to relevant information on energy efficient behaviors, etc.[6] In addition, low consumption households almost always pay a higher per unit price compared to medium-consumption households because of the high fixed component of the electricity price (which must be paid irrespective of the amount of electricity consumed). With an average net salary of around € 840 monthly, a number of households have limited capacity to shoulder EE investments in their homes, in addition to living costs.

Targeted communications about energy efficiency would address information asymmetry, particularly in detached areas like islands and villages along the coastline that deal with seasonal influx of tourists. Access to cheaper energy would not automatically imply a reduction or optimization of consumption. Bridging the knowledge gap could help ease the transition towards lower energy consumption in the residential sector.

DS2. Building and construction sector

The building sector, including residential buildings, is the largest energy consumer and as such has the highest potential for impactful energy savings. The building sector refers to commercial and residential buildings and the specific activities in building management systems that support high energy efficiency such as insulation, temperature control, water management systems, ventilation systems, etc. The Ministry of Construction and Physical Planning is the competent body in charge of this sector. The building and construction sector in Croatia was severely impacted by the economic crisis between 2008 and 2014, but has since resumed new investments.

[4] A typical area of about 140 square meters in Zagreb, whose annual heating costs are around € 2,400 for fuel oil, or € 1,030 for gas.
[5] Study on Energy Efficiency for low income households, 2016 – European Parliament, DG for internal policies
[6] Author's analysis of the work of the Croatian Society for Sustainable Development Design (DOOR) who advocates for among others, the reduction of energy poverty in local society; and from articles such as: http://www.hr.undp.org/content/croatia/en/home/ourwork/environmentandenergy/successstories/EnergyAdvisors.html

Investment spending in Croatia is primarily on tangible assets such as machinery and equipment, land, business buildings and infrastructure. According to the Construction and Utility Services department of the Croatian Chamber of Commerce in Zagreb, 80 percent of the total number of permits issued in 2016 were for buildings and 20 percent for civil engineering works. Additionally, 67.9 percent of the issued permits were for new constructions and 32.1 percent for reconstructions. The graph shows the average portion of ultra-modern machinery and equipment in firms to be below the EU average (39% versus 45%).

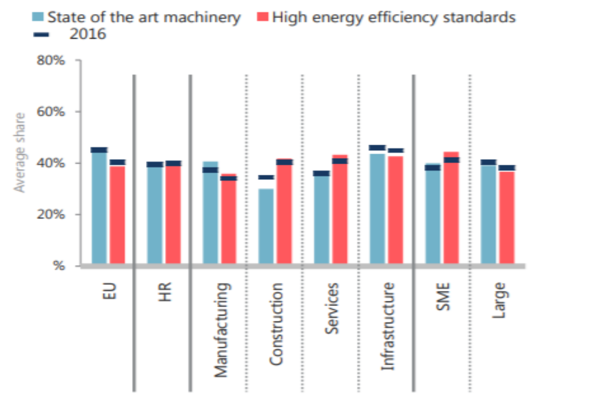


Fig. A3 – Source: EIB Group Survey on Investment and Investment Finance Country Overview: Croatia, 2017

Croatian building standards are in accordance with EU codes and there are several action plans that deal with energy efficiency in buildings. The 2017 – 2019 Energy Efficiency Action Plan has been submitted to the European Commission.

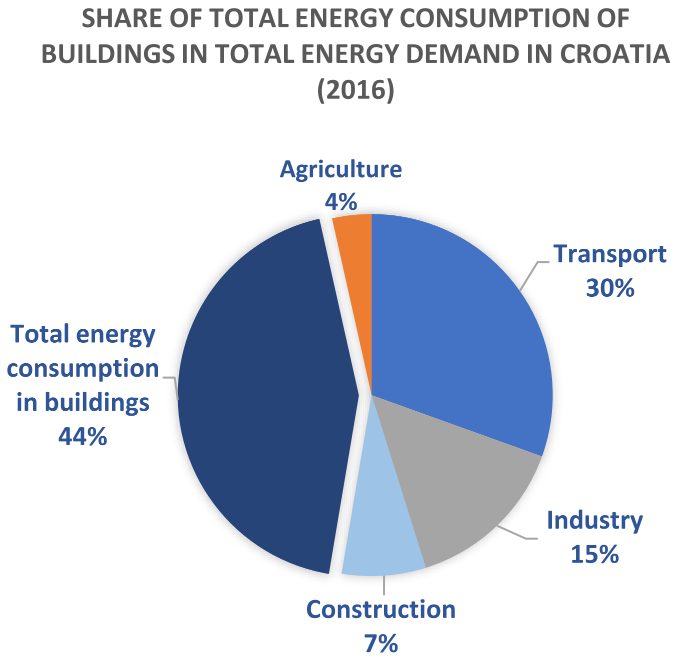


Figure A4: Source: EIHP

The energy performance of buildings directive of the European Commission requires all new buildings to be nearly zero-energy by the end of 2020. The European Commission definition is that: "nearly zero-energy buildings (NZEBs) have very high energy performance. The low amount of energy that these buildings require comes mostly from renewable sources." Various initiatives in Croatia are engaged in activities that would help fulfil those objectives.

The **Environmental Protection and Energy Efficiency Fund** (FZOEU), is the implementing and co-funding body of the 4th EE Action Plan in Croatia. Instruments are generally in the form of grants, subsidies and no-interest loans for activities such as the renovation of buildings, replacement of the heating and cooling systems, incorporation of renewable energy systems (RES), etc. Within the proposed financial plan of 2018, FZOEU has a detailed fund allocation outline for 2019 and 2020.

Since new buildings are expected to be in compliance with the energy efficiency standards, the focus should be on old buildings and heating and cooling systems updates. Such measures should identify, on the basis of the established optimal economic and energy model for building renovation, effective measures for cost-effective deep renovation of the residential and non-residential buildings. It is also necessary to develop a program for alleviating the constraints and integrating small solar systems in the production of electricity and heating/cooling systems in buildings, given the increasing demand.

An example of the use of new financial instruments for energy efficiency is the **BUILD2LC** (Boosting Low Carbon Innovative Building Rehabilitation in European Regions) project of Interreg Europe, which constituted 8 partner countries including Croatia. BUILD2LC cited the ZagEE (Zagreb Energy Efficient city) as an example of the right use of innovative financing schemes in achieving energy efficiency targets in buildings. ZagEE project, coordinated by the City of Zagreb, was from April 2013 – April 2017, and was within the Intelligent Energy Europe (IEE) program for Mobilising Local Energy Investments – Project Development Assistance (MLEI–PDA). It cost EUR 1.8 million and involved the total refurbishment of buildings owned by the city of Zagreb, public lighting, installation of renewable energy devices and application of innovative technical and financing schemes. The project achieved an average energy saving of 49 percent in buildings and 72 percent in public lighting, which translates to an annual energy saving of 33,526 MWh.

Croatia is in line with Europe wide activities in Zagreb for example, but more could be done to mobilize the smaller cities and regions that are lagging.

DS3. Tourism sector

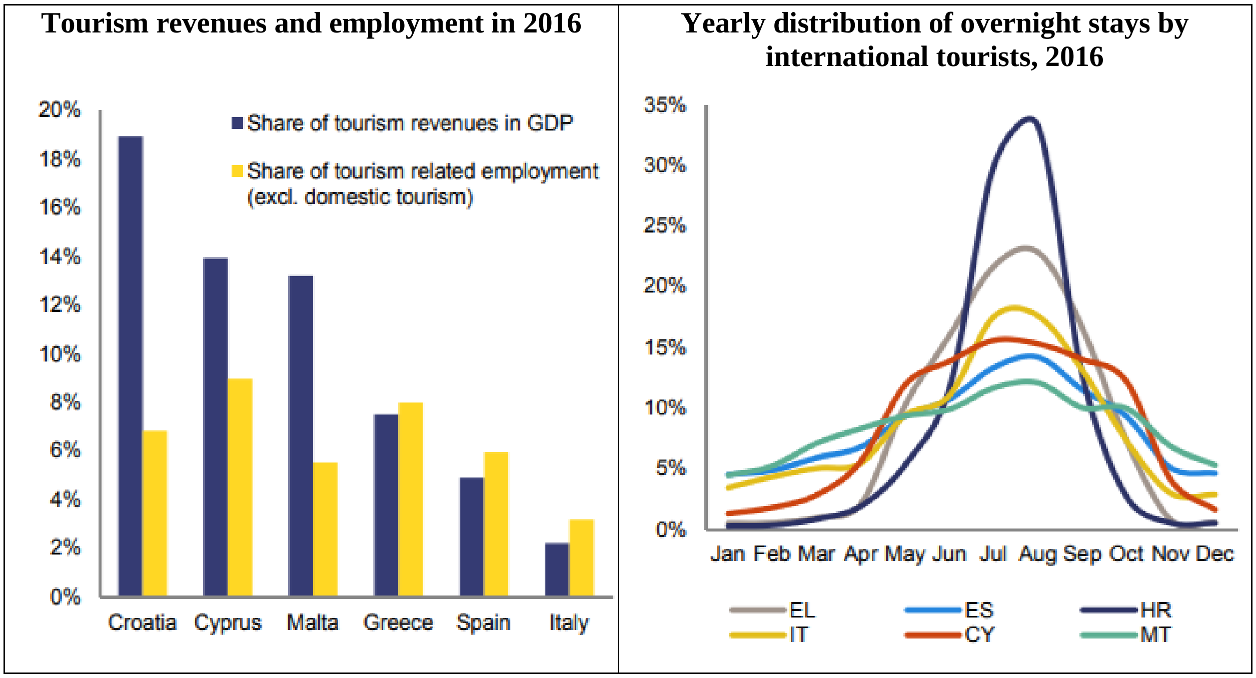
Croatia's tourism sector is quickly expanding the number of accommodation offerings by private households, predominantly in the coastal regions in the summer months. Accommodation type is skewed towards relatively cheap, poorly insulated structures and the average tourist spending is below the recorded figures of EU peers.[7]

At 19.6 percent of GDP, the tourism sector is a major driver of Croatian economy and a contributor to the high energy intensity figures. Data from the Croatian National Bank (HNB) shows that foreign visitors' tourism revenues amounted to EUR 9.5 billion in 2017, representing a growth of 10 percent compared to 2016 (EUR 8.6 billion), which was a record-breaking year. The reported positive financial figures are driven by high volumes, which poses a specific challenge, given Croatia's small size and geographical layout. A comparison of the tourism industry of Croatia and

[7] Orsini, Kristian; Ostojić, Vukašin, Croatia's Tourism Industry: Beyond Sun and Sea, 2018 – European Economy, Economic Brief 036

EU peers in the areas of the employment figures, and annual intensity of overnight stays are reflected in the figure below.

Figure A5: Tourism Sector Characteristics



Source: Croatia's Tourism Industry: Beyond Sun and Sea, 2018

A total of 16.5 million tourists visited Croatia in 2017, about four times the population, for a recorded 90 million overnight stays.

Tourism density and energy efficiency

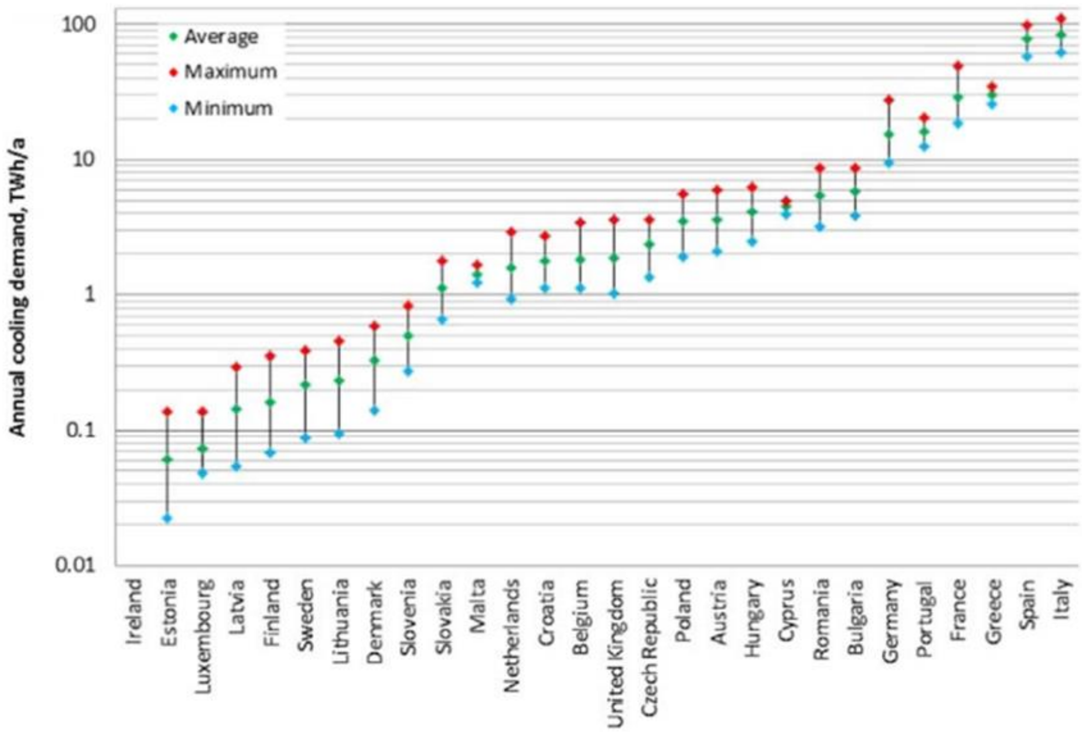
For only a second year in history, in 2016, Croatia saw its domestic consumption peak in the summer months, when tourists visiting the coastal areas are increasingly relying on air conditioning. Croatia's summer tourism is booming, attracting many visitors from other EU member states, where air conditioning use is more common.[8] That, combined with Croatia's own domestic demand for cooling, is changing the dynamics of electricity consumption in the country. Some estimate that Croatia's current demand for cooling stands at 1 TWh, but may double, resulting in a need for additional 260 MW of installed capacity (or imports).[9] The chart below shows that Croatia's estimated average cooling demand potential may approach that of the United

[8] While the direct link between tourism and an increase in electricity consumption is difficult to establish, HERA, Croatia's electricity regulator, states in its last annual report that according to HOPS, the transmission system operator, "the reason for this is an exceptionally mild winter and a good tourist season (increased use of air conditioning units)." https://www.hera.hr/en/docs/HERA_Annual_Report_2016.pdf

[9] https://ac.els-cdn.com/S030142151630653X/1-s2.0-S030142151630653X-main.pdf?_tid=d7b999cf-796a-4d09-bf91-fc004e5f4e9e&acdnat=1528315033_2b9f9bd56c2d3ce34d6fbd68bea2e2ec

Kingdom (a much larger, but more northern country) and neighboring South East European countries like Bulgaria and Romania.

Figure A6: Annual Cooling Demand



This pattern of increased use of energy for cooling is following a worldwide trend. The International Panel on Climate Change (IPCC) estimates that the demand for residential space cooling will rise from 300 TWh in 2000 to 4000 in 2050, about 75% of which is due to increasing income in emerging market countries and 25% is due to climate change.[10] Similarly, the EU Heating and Cooling Strategy also foresees a strong increase in residential cooling consumption, i.e. from about 35 TWh in 2015 to 137 TWh in 2050 for the reference scenario and 78 TWh the energy efficiency scenario in 2050.

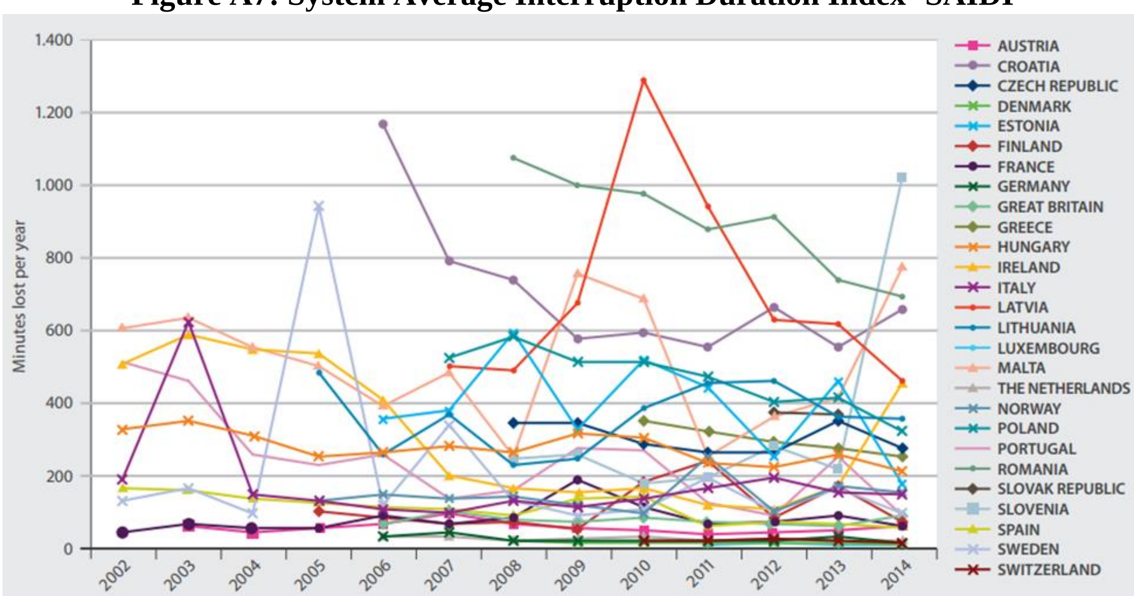
In a hot and dry summer year, Croatia may need alternative ways to meet its growing demand. Even though Croatia's current installed generation capacity exceeds its summer peak demand by a factor of 1.67, in dry (poor hydrology) years, Croatia relies on imports to cover its demand. While this strategy has its pros (such as flexibility to procure energy only when needed), it also has its cons (such as exposure to potentially high import prices). Therefore, Croatia may need to consider alternatives, such as ensuring an appropriate solar electricity generation in the areas with the highest summer demand since it has the characteristic to coincide with usage of electric air-conditioning units. Solar electric systems can contribute to the reduction of primary energy consumption.[11] Another option could be to reduce energy consumption in buildings and to implement demand response measures. Demand Response delivers these benefits by providing

[10] https://www.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-Chap10_FINAL.pdf
[11] https://www.sciencedirect.com/science/article/pii/S0038092X15002674

consumers – residential, commercial or industrial – with control signals and/or financial incentives to adjust their consumption at strategic times. However, implementation of demand response measures may be hampered by the prohibitive cost of metering infrastructure, and lack of peak-time pricing tariffs. Some efforts to improve buildings' energy efficiency are already under way, such as the Energy Performance of Buildings Directive (EPBD). The EPBD requires that all new buildings will consumer near zero energy by the end of 2020 and renovation of new buildings follow certain rules in order to improve energy efficiency. A third option is to promote district cooling grids in urban areas, since such grids require less electricity, and can be used to balance electrical load, as they facilitate the introduction of low carbon heating and cooling. District cooling is currently seen as a prominent part of future European energy system and is addressed in a number of European energy legislative documents such as Energy Efficiency Directive.

In order to improve the quality of supply to commercial and residential customers, Croatia will need to refocus its attention on improving its distribution network. According to HERA, the average annual number of interruptions per consumer (System Average Interruption Frequency Index - SAIFI) and the average total annual duration of interruptions per consumer (System Average Interruption Duration Index -SAIDI), have both been falling, indicating an improvement. In 2016, SAIFI was 3.5 supply interruptions per consumer in the HEP-ODS network, of which 43% were planned interruptions. SAIDI was 412 minutes per consumer, of which 54% were planned interruptions. However, these numbers still exceed those in almost every European country, as seen in the chart produced by the Council of European Energy Regulators (CEER) below, showing SAIDI AND SAIFI statistics for the last available year, 2014.[12]

Figure A7: System Average Interruption Duration Index -SAIDI



Source: Council of European Energy Regulators

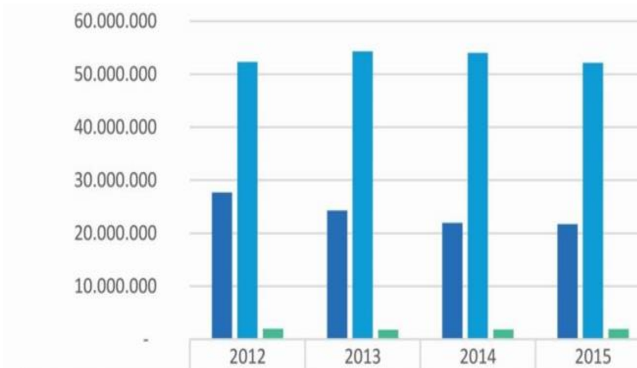
[12] https://www.ceer.eu/documents/104400/-/-/d064733a-9614-e320-a068-2086ed27be7f

DS4. Transport sector

To improve EE and reduce energy intensity, Croatia could implement multi-mode transport and developing the maritime subsector. The Croatian transport sector contributes about 8 percent to the GDP. Its three main branches of transportation: air, land and water, differ significantly in utilization. Transportation by land is further divided into road and rail. The road sector is highly developed, unlike the rail sector. There has also been notable infrastructure investments in air passenger transport, aimed at increasing the capacities to meet the demands of the tourist season. Cargo transport by air, remains a very small part of the transportation of goods. Where river transportation is concerned, plans are underway to revitalize the underutilized subsector.

Figure A9: Transport Sector Characteristics

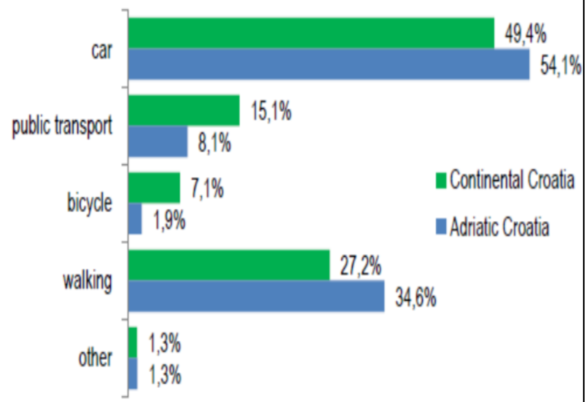
Historical data on the number of transported passengers show the predominance of road transport in Croatia.



	2012	2013	2014	2015
Railway Passengers	27.669.000	24.265.000	21.926.000	21.683.000
Road Passengers	52.293.000	54.292.000	54.000.000	52.126.000
Air Passengers	1.961.000	1.812.000	1.860.000	1.919.000

Source: Strategy of transport development in the Republic of Croatia, 2017 – 2031

Structure of mobility by different means of transport shows the general preference for the different mobility options.

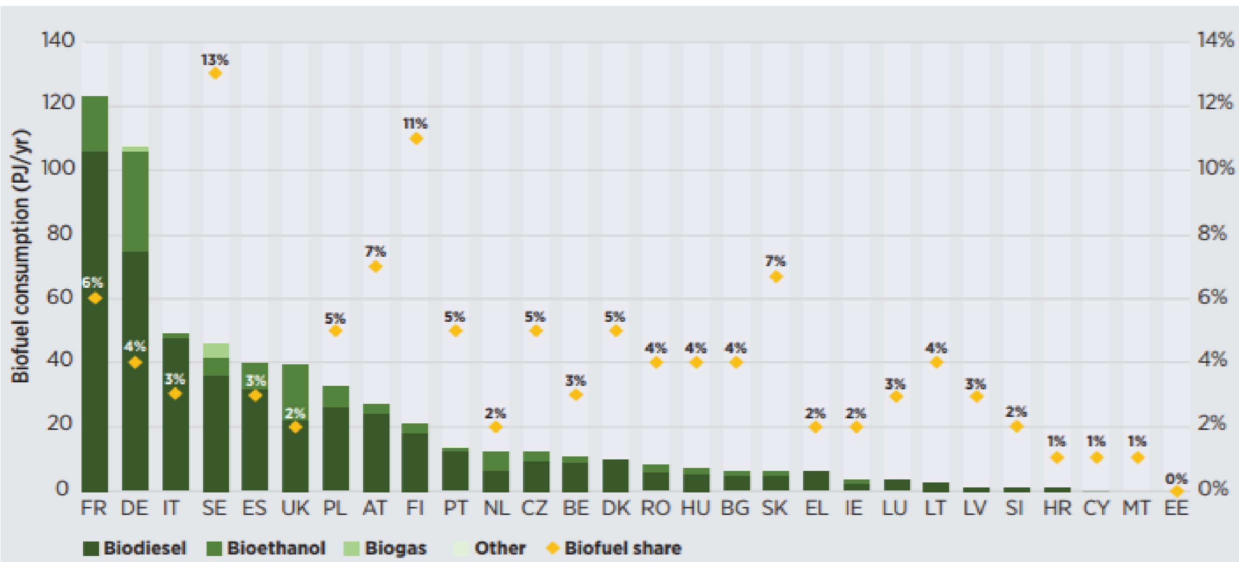


To achieve the target of reducing the environmental/climate change impact of traffic systems, there is a need to incorporate more renewable energy in transportation. The climate pact and efforts to reduce greenhouse emissions is driving the development of more energy efficient mobility solutions. These include fuels from renewable sources and electric vehicles. The transport sector accounts for approximately 30 percent of Croatia's total energy consumption, of which the road transport account for almost 90 percent.

Most of the country-specific initiatives are outlined in the transport development strategy of the republic of Croatia (2017 – 2030). Defining the guidelines regarding how those goals would be achieved, including an analysis of the environmental impact of the country's road dependence could help ensure that the set goals are attained. Some transport sector development activities are also outlined in the updated National Energy Efficiency Action Plan (2017 – 2019). There are among others, concrete measures such as "fostering integrated and intelligent transport and development of alternative fuels infrastructure on a local and regional level", which encompasses actions for energy savings and sectorial optimizations.

In the EU, the transport sector has the lowest penetration of renewable energy. The main source of renewables is liquid biofuels, of which biodiesel has the largest market share (80 percent) followed by bioethanol (19 percent). Biogas, used mainly in Sweden and Germany, accounts for 1 percent of the EU market. The proposal for a new Renewable Energy Directive (European Commission, 2016c) envisions a gradual phase-out of the unsustainable food and feed-based biofuels from 7 percent to 3.8 percent in 2030, with a corresponding gradual increase in the minimum share of advanced biofuels (not food based), from at least 0.5 percent in 2021 to at least 3.6 percent in 2030.[13] The figure below shows the biofuel consumption across EU Member States, as well as the biofuel share by market in 2015.

Figure A10: Biofuel Consumption



Source: Renewable Energy Prospects for the European Union, 2018

Croatia needs to accelerate sector reforms to facilitate electric vehicle deployment. Croatia relies on imported energy and on electricity generated from imported coal and natural gas. Transition to large scale electric vehicle adoption could have an impact on electricity demand and necessitate new infrastructure investments. Some explorative projects are underway in the country, for example, HEP is currently developing an eMobility project, while a pre-feasibility study has recently been commissioned by the two major highway companies HAC and ARZ, to assess investment levels and energy savings. Croatia-based electric car manufacturer, Rimac, recently caught the attention of Chinese and European investors with its newly unveiled electric hypercar that can reach 60 miles per hour in 1.85 seconds and has a range of up to 400 miles before it needs to be recharged. The factory outside Zagreb is currently gearing up to produce four cars per month. However, priced at $2.1 million, it is unlikely to become a mainstream electric vehicle any time

[13] Renewable Energy Prospects for the European Union, 2018

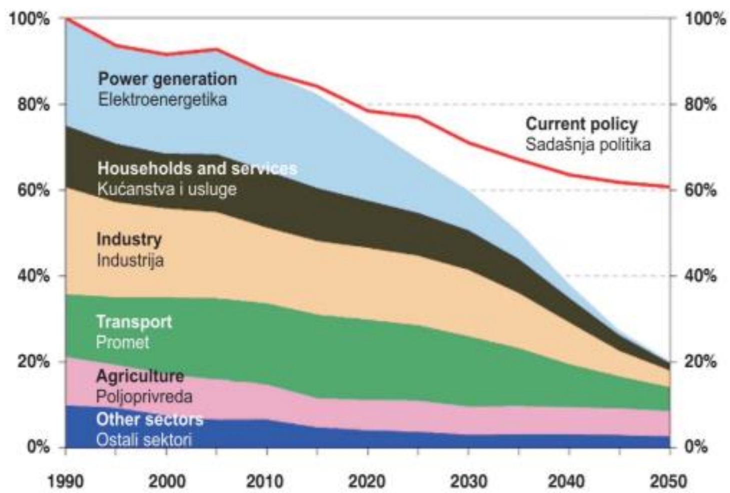
soon, leaving it as an option only to the super-wealthy.[14] Thus, Croatia will need to undertake significant additional sector reforms and investments to achieve its targets of implementing the current and future EU directives regarding the energy efficiency of internal combustion engines, and to pave the way toward wider use of electric vehicles.

DS5. Industrial sector

Croatia's industrial sector has dramatically decreased its energy use and is expected to continue this trend. In 2016, the electricity consumption in the industrial sector was unchanged compared to the previous year, while the natural gas consumption increased by 4.45 percent. Use of coal dropped by 40 percent. There was an overall decrease in consumption within distinct industrial sectors: 72.3 percent drop in the steel industry, occurring equally in electricity and natural gas, 10.2 percent drop in textile, clothing and leather industry, mostly in electricity, and 3.7 percent in the non-metallic minerals industry.[15]

A targeted intervention for energy-intensive industries such as paper, transport parts/components, food/beverages, etc., would help optimize the energy use and reduce the overall intensity.

Figure A11: Expected reduction of greenhouse gas emissions in the EU by 2050



Source: Possible development of the Croatian energy sector by 2050 in the view of carbon dioxide emission reductions, G. Granic et. al.

The white book on low carbon development strategy in Croatia reveals goals, such as a reduction of GHG emissions by 38 – 44% by 2030 and 52 – 77% by 2050, in comparison to the 1990 as base year. Decarbonization of the power system, among other measures, is supposed to contribute significantly to this reduction. On-shore wind energy is expected to increase until 2030 from the current 435 MW to 1520 – 2000 MW. However the biggest boom is anticipated from solar PV, leading to an increase from the currently installed 51 MW to 1140 – 1860 MW in 2030, and based on net metering and self-consumption models.

Source: White Book, Low carbon Development Strategy 2017

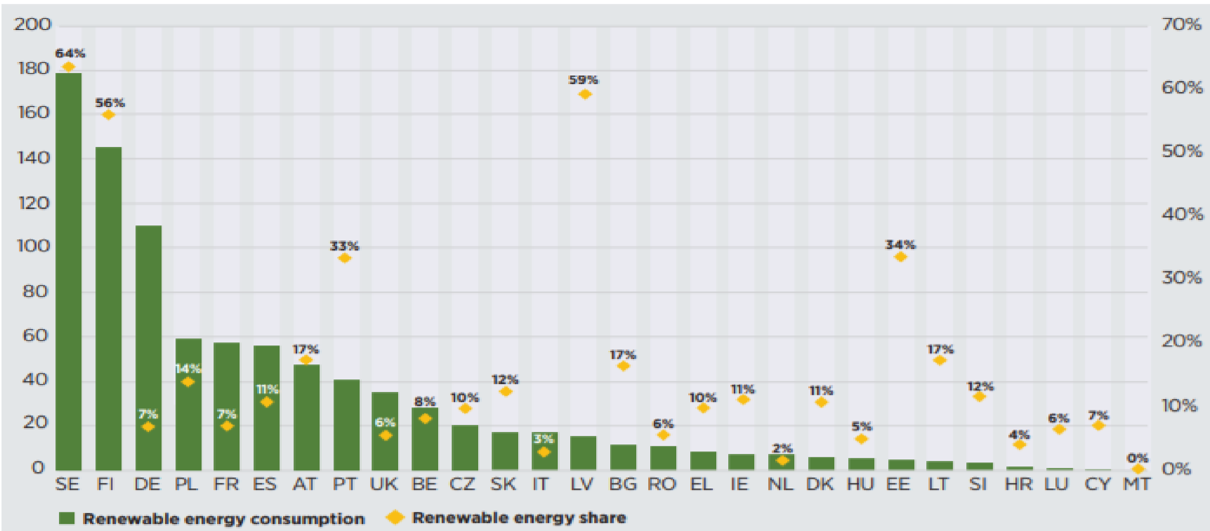
[14] https://www.barrons.com/articles/croatian-based-car-manufacturer-rimac-unveils-2-1-million-electric-hypercar-1522868026

[15] Energy in Croatia 2016

Energy Efficiency in Industries

This sector indicates unexploited energy efficiency potential, lower consumption and increased productivity, which could be achieved by incorporating renewable energy sources and electricity based process technologies. As a stimulus, the government approved a national program for the Promotion of Energy Efficiency and the Use of Renewable Energy Sources in Enterprises in September 2017, with the aim of encouraging investments in energy efficient manufacturing and decreasing fossil fuel dependence by incorporating renewable energy sources. The figure below shows the total renewable energy consumption (expressed in Peta Joules) and renewable share in the industrial sector of EU Member States in 2015.

Figure A12: Renewable Energy Consumption (Peta Joules) and Industrial Sector Share



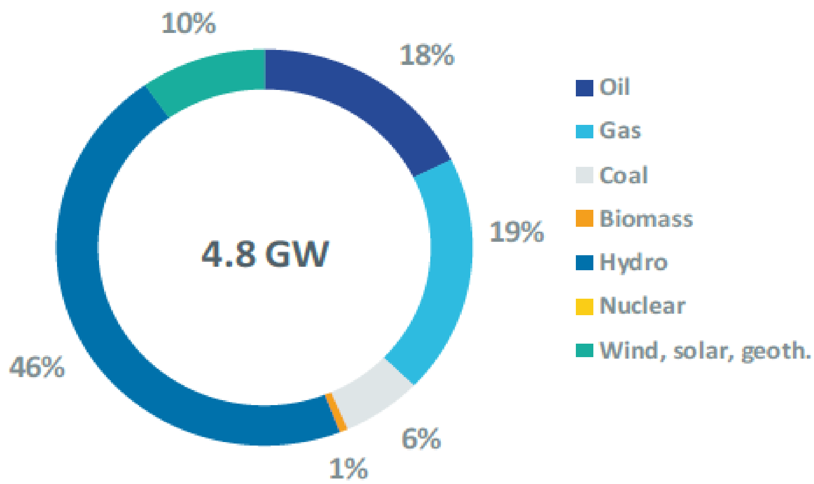
Source: Renewable Energy Prospects for the European Union, 2018

Supply Side (SS)

SS1. Thermal Electricity and Heat Generation Efficiency

There are opportunities to raise thermal electricity and heat generation efficiency toward 50 percent. Croatia thermal power plants account for almost half of Croatia's 4,762 MW installed power/heat generation capacity:

Figure A13: Installed Electric Capacity by Source (%)



In recent years, the use of oil for power generation has been phased out, replaced mostly by natural gas, wind and solar. By 2016, the average efficiency of thermal power plants in Croatia was 32.5 percent and has substantial room for further improvement. In particular, the new/planned combined-cycle gas turbines (CCGT) power/heat plants (e.g. 150 MW EL-TO Zagreb, 446 MW Osijek plant) have the potential to raise efficiency toward 50 percent together with the benefit of lower CO_2 emission relative to oil and coal power generation.

The energy authorities should reconsider the plan to expand coal power/heat generation in Croatia. There are currently two coal units operating on imported coal (297 MW Plomin A & B), with a plan for them to be replaced by a new 570 MW Plomin C. With the addition of highly efficient gas-fired power plants, increasing capacity of wind and solar, and expansion of electric connectivity through power market coupling, Croatia is in a solid position to expedite phasing out of coal.

Figure A14: Croatia's Installed Thermal Energy Capacity and Efficiency

	2013	2014	2015	2016
Installed thermal capacity	1,800 MW	1,800 MW	2,100 MW	2,100 MW
Efficiency of thermal power plants	34.6%	32.2%	33%	32.5%

Source: Enerdata, 2017

SS2. District Heating Efficiency

Efficiency improvement in district heating is an unfinished agenda item. Improvement in district heating (DH) is required to reduce heat and water losses, improve pipe insulation, upgrade valves, replace heat exchangers, replace boilers and burners, and modernize substations (IFC DH study, 2015). Water loss in several DH systems is very high. Water treatment equipment is not dimensioned sufficiently, which accelerates problems with corrosion. Outside the city of Zagreb, there is potential to expand DH to year-round operation (systems only operate during winter months).

Interconnection of existing DH systems is an option in several cities (e.g. Zagreb, Rijeka). Interconnection will reduce staffing costs and the need for peak- and reserve load capacity.

Most heat plants operate on natural gas. The first level of heat losses—from heat generators transmitted to different type of consumers—is around 6 percent in recent years (see table below). There are additional losses within each DH system: for instance, a World Bank 2010 report[16] indicates a heat loss of 9.45 percent for Zagreb DH and 6.8 percent for Osijek DH. A 2015 report commissioned by IFC indicates 22 percent heat loss for Karlovac and 26 percent in Rijeka.

There are opportunities to utilize biomass, (including wood chips or straw), waste heat from industry, waste-to-energy incineration, and geothermal in DH.

Figure A15: Heat Supply and Losses

					peta Joule (1 x 10^{15})	
	2011	**2012**	**2013**	**2014**	**2015**	**2016**
Gross heat supplied to network (PJ)	28.288	26.473	25.256	23.302	25.364	25.632
Heat losses in transmission to users (PJ)	1.510	1.389	1.364	1.415	1.588	1.487
Losses %	*5,3%*	*5,2%*	*5,4%*	*6,1%*	*6,3%*	*5,8%*
Net heat supplied to network, of which	26.778	25.084	23.892	21.887	23.776	24.145
energy sector %	*23%*	*23%*	*22%*	*23%*	*29%*	*24%*
industrial sectors %	*45%*	*45%*	*43%*	*46%*	*40%*	*44%*
households %	*25%*	*25%*	*27%*	*24%*	*24%*	*23%*
services sector %	*7%*	*6%*	*7%*	*6%*	*6%*	*7%*
others %	*0%*	*1%*	*1%*	*1%*	*1%*	*1%*

Source: Energy in Croatia 2016

SS3. Electricity and Natural Gas Transmission & Distribution Efficiency

Croatia has successfully reduced losses on its transmission and distribution systems, cost-benefit tradeoff is key for further improvement. Croatia has succeeded in reducing electricity

[16] Implementation Completion and Results Report, Croatia District Heating Project, December 2010.

distribution and transmission losses from 14.4 percent in 2000 to around 10 percent by 2016 (1,807 million kWh)[17], although improvement since 2010 has been less than 1 percent. Going forward, Croatia will need to consider cost- and benefit tradeoff, as further loss reductions are likely to require substantial capital investment. Indicatively, each one percent reduction would generate cost savings valued at not less than €18 million *annually* at the prevailing electricity tariffs in Croatia.

Figure A16: Electricity Supply and Losses

	2011	2012	2013	2014	2015	2016
Electricity supplied to grid (mil. kWh)	18,528	18,186	17,922	17,507	18,190	18,350
T&D losses (mil. kWh)	1,831	1,887	1,944	1,764	1,802	1,807
T&D losses, %	9.9%	10.4%	10.8%	10.1%	9.9%	9.8%

Source: Energy in Croatia 2016

According to the EU Energy Efficiency Directive (EED) and Croatia's Energy Efficiency Action Plan, every year HOPS submits a ten-year plan for the development of the transmission network, which includes investments, in accordance with the Plan's financial framework, to HERA for approval. In this Plan, HOPS must define the amount of annual energy savings as a percentage of the average total electricity supplied during the previous three years. HERA monitors the implementation of the Plan and gives its approval to HOPS for the ten-year plan for purchasing energy to cover losses in the transmission network for the following year. The achieved level of losses in the transmission network of Croatia for 2015 was 2.3 % of transmitted electricity. Similarly, HEP-ODS submits a Ten-year plan for the development of the distribution network, which includes investments resulting in a reduction of losses of electricity, in accordance with the Plan's financial framework, to HERA for approval. In this Plan, HEP-ODS must define the amount of annual energy savings as a percentage of the average total electricity supplied during the previous three years. HERA monitors the implementation of the Plan and gives its approval to HEP-ODS for the ten-year plan for purchasing energy to cover losses in the distribution network for the following year. The achieved level of losses in the distribution network of Croatia for 2015 was 8.1 % of purchased electricity. In 2016, HERA commissioned a study entitled "Assessment of the potential for increasing energy efficiency of electricity infrastructure", which was completed in 2016 and is used for monitoring losses in the transmission and distribution networks.[18]

Typically, natural gas losses in transmission and distribution are much lower than electricity losses. Natural gas losses in the transmission and distribution system are related to the concepts of Lost and Unaccounted for Gas (LAUF), which includes all components of loss, such as gas used by the transmission and distribution operators, adjusted for meter errors, billing cycle issues, and other considerations as well as leakage, venting, theft, etc. Overall, natural gas losses in Croatia are low and in line with the industry norms.

[17] Transmission losses ~ 2.2 %, distribution losses ~ 8.1 %. Sources: HOP, Enerdata, Energy in Croatia 2016.
[18] https://ec.europa.eu/energy/sites/ener/files/documents/1_EN_autre_document_travail_service_part1_v6_0.pdf

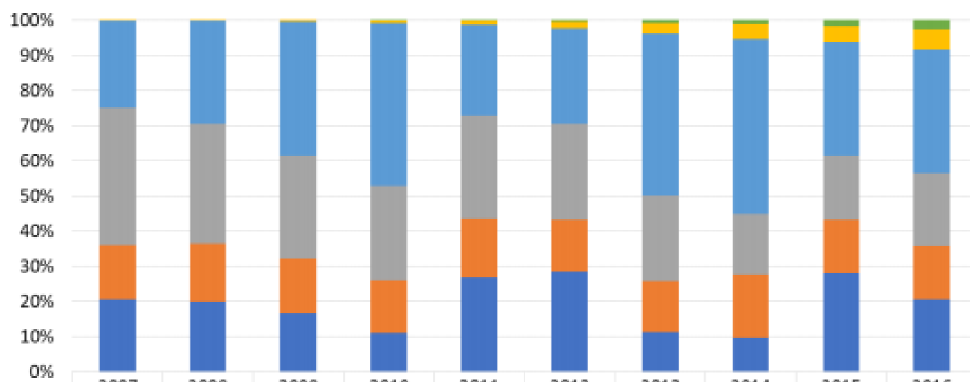
B. Energy Security Under a Competitive and Open Electricity and Gas Markets

B1. Overview

Croatia's size and location make connectivity with the neighboring countries a priority. Croatia is one of Europe's smallest countries, located near the geographic center of Europe. In 2016, Croatia's domestic electricity consumption was 17.7 terawatt hours (TWh).[19] This was about 10 percent less than it was before the crisis of 2008-2009 and only half a percent higher than in 2015. Croatia's moderate electricity consumption growth trends are influenced by the changes in its overall economy, as it is moving away from energy-intensive cement, chemical and metals industries (usually supplied at high voltages), to tourism, paper and printing and food industries (supplied at medium and low voltages).

Croatia gets over half of its electricity from domestic hydro power, which at 2,112 MW accounts for close to half of its installed capacity of 4,762 MW. Croatia is dependent on imported fuel to power its eight gas- and coal-fired power/heat generation plants. In addition to domestic hydro, coal and gas-fired power stations, HEP Generation owns a 50% stake in the 696 MW Krško nuclear power plant in Slovenia, near the Croatian border. Shares of individual sources of electricity from 2007 to 2016 are shown in Figure B.1 below.

Figure B.1. Shares of individual sources of electricity (in GWh)



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Other RES	0	0	5	16	33	85	132	194	298	454
Wind	35	40	45	138	201	329	517	730	794	1,002
Water	4,357	5,277	6,765	8,305	4,578	4,772	8,054	8,356	5,715	6,250
Fossil fuels	6,877	6,101	5,207	4,825	5,184	4,791	4,228	2,912	3,192	3,625
Krško NPP	2,714	2,986	2,730	2,690	2,953	2,622	2,518	3,030	2,685	2,715
Net import (without Krško NPP)	3,647	3,591	2,952	1,986	4,752	5,002	1,973	1,642	4,948	3,628

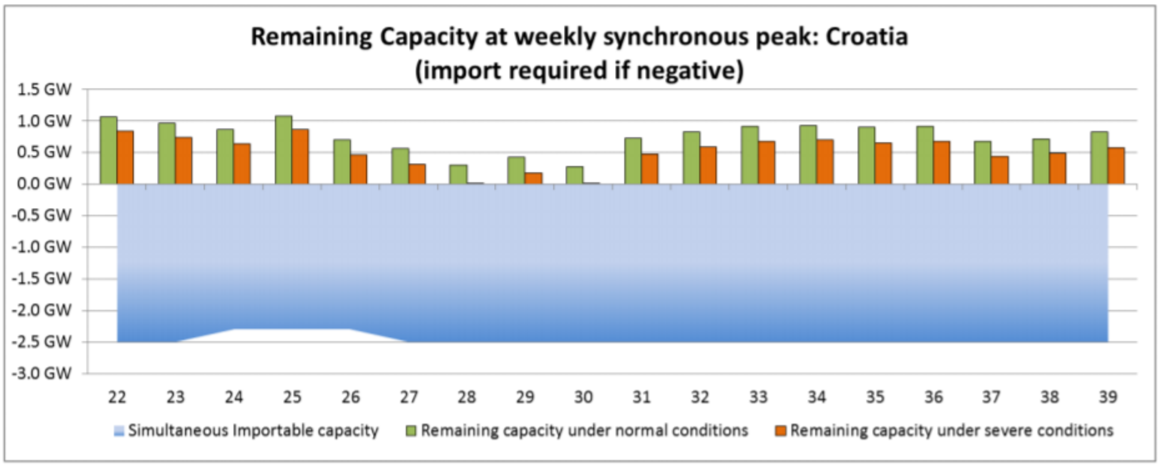
Croatia is a net importer of electricity (+2.4 TWh in 2016).

[19] In comparison, Italy's consumption in the same year was around 285 GWh.

In 2016, imports reached 12 TWh and came from Bosnia Herzegovina (38%), Hungary (30%), Slovenia (21%) and Serbia (11%), while power exports (6 TWh) went mainly to Slovenia (74%) and Bosnia Herzegovina (19%).

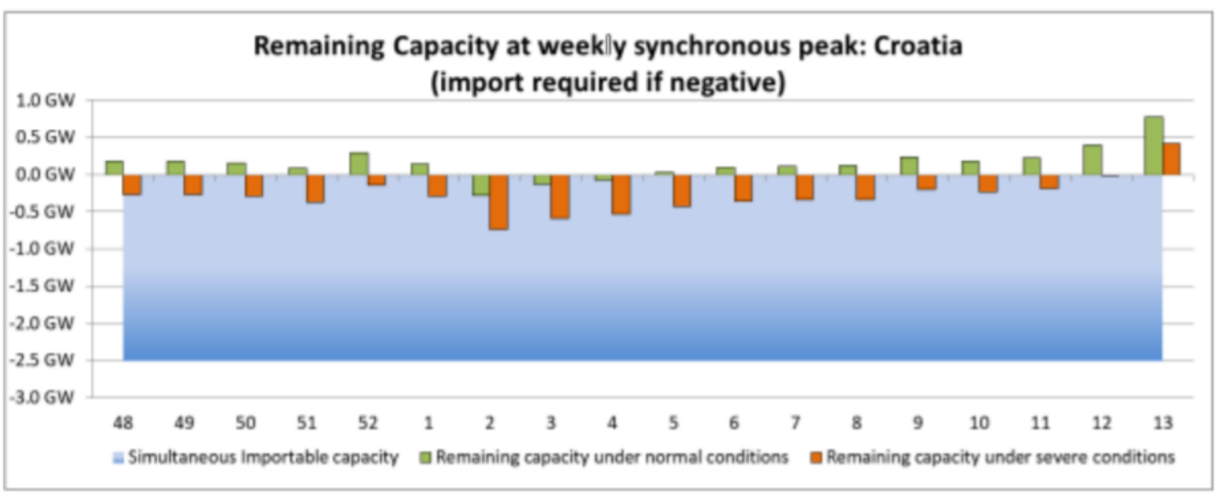
During peak demand, Croatia imports up to 40 percent of electricity. Figures B.2 and B.3 below demonstrate Croatia's ability to meet summer and winter peak demand and demand for electricity imports.

Figure B2. Croatia's Ability to Meet Summer Peak Demand



Source: ENTSO-E Summer Outlook 2017[20]

Figure B3. Croatia's Ability to Meet Winter Peak Demand



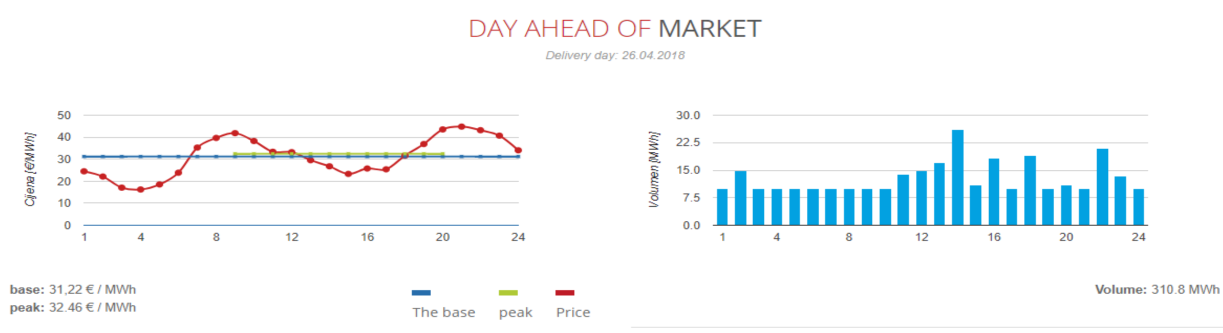
Source: ENTSO-E Winter Outlook 2017-18[21]

[20] https://docstore.entsoe.eu/Documents/Publications/SDC/Summer_Outlook_2017.pdf
[21] https://docstore.entsoe.eu/Documents/Publications/SDC/Winter_Outlook_2017-18.pdf

In 2016, Croatia made significant progress in its efforts to open its electricity sector to competition. Since joining the European Union (EU) in 2013, Croatia has implemented a number of EU directives aimed at opening its electricity sector to competition and integration into a single EU electricity market. The state-owned Croatian Power Utility (HEP) is unbundled into separate legal entities responsible for operating the network infrastructure and those responsible for running the market:

1. The Croatian Transmission System Operator (HOPS) –responsible for the reliable transmission of power from generation plants to the local distribution network by way of a high voltage electrical grid. HOPS is legally and functionally separate from the HEP generation and supply activities, which ensures non-discriminatory access to its transmission facilities by other suppliers.
2. The Croatian Distribution Operator (HEP-DSO) – responsible for operating the distribution electricity network.
3. HEP Supply – responsible for serving over 86 percent of the retail customers, with the remainder of the customers being served by new entrants competitive supplies, primarily German’s RWE and Slovenia’s Gen-I.[22]
4. HROTE –buys electricity from eligible renewable energy and combined heat and power producers under the feed-in tariff incentive system and trades it on the electricity market. Using the funds collected from taxes, levies and by selling electricity, HROTE also pays a preferential price for electricity to the RES in accordance with actual production. Government of Croatia is currently considering integrating HROTE with HEP.
5. The Croatian Power Exchange (CROPEX) is responsible for running the day-ahead electricity market where energy is bought and sold in hourly blocks for the next day and the intra-day electricity market which allows participants to buy or sell electricity closer to real time, and secure the balance between the supply and the demand caused by unexpected events. Below is an example of trading activity on CROPEX.

Figure B4. Trading on Croatia’s Day Ahead Market



Source: https://www.cropex.hr/hr/

[22] Croatian Energy Regulatory Agency (HERA), 2016 annual report. https://www.hera.hr/hr/docs/HERA_izvjesce_2016.pdf Commercial customers who choose a market supplier (offering non-tariff based rates) typically pay lower rates than the tariff rates under the regulated public supply system, but they may be more exposed to price fluctuations in market rates.

Competition in Croatia's electricity market is still very limited. **Market reforms are needed to improve the investment climate and create incentives for new entrants**. HEP Generation is the largest electricity generation company with an 85 percent market share.[23] At the wholesale level, the market is largely based on bilateral contracts, in which producers (power generators) and customers (retail electricity supply companies, and large customers) directly negotiate and agree on the price of electricity.

Since opening in February of 2016, CROPEX registered 11 members, including Germany's RWE, which commands 7 percent of the Croatian market.[24] Some industry observers note that only 2 percent of electricity (100GWh) is currently traded on the market, which is not unusual for a small national electricity market, dominated by an incumbent state utility.[25] A more liquid market, with more buyers and sellers would provide better economic signals for both existing, new generators and prosumers to sell their surpluses, and would allow traders to take advantage of the differences in the hydro inflow regimes across the market, divergence in weather conditions, non-coincidence of load patterns. A liquid, transparent and competitive market results in customers having access to more economic sources of generation. Similarly, a liquid market allows generators to be more efficient and to produce electricity at a time or in a location when it is most economic.

The cross-border transmission and linking of power markets among Croatia, Slovenia, Italy and Austria is progressing. In 2018, Croatia's first stated priority is to increase market liquidity by coupling its market with the neighboring Slovenia's electricity exchange (BSP South Pool). Market coupling enables implicit allocation of transmission capacity which leads to more optimal trading.[26] Since BSP South Pool has already coupled its day-ahead market with Italy and Austria, CROPEX will be coupled with the electricity exchanges of those countries as well, allowing all four countries to trade electricity in a more efficient way. In March 2017, CROPEX and HOPS officially became members of the regional project of Italian Borders Working Table (IBWT) to open up the possibility of linking the Croatian electricity market, the European market as part of the Multi-Regional Coupling (MRC), which currently includes 19 countries covering 85 percent

[23] Croatian Transmission System Operator Ltd. Annual Report for 2016. Page 38. http://www.hep.hr/UserDocsImages//dokumenti/Godisnje_izvjesce_EN//2016Annual.pdf
[24] German energy group RWE seeks bigger market share in Croatia. Reuters, February 23, 2018, https://uk.reuters.com/article/uk-croatia-energy-rwe/german-energy-group-rwe-seeks-bigger-market-share-in-croatia-idUKKCN1G71NR
[25] Electricity Market Design in Croatia within the European Electricity Market—Recommendations for Further Development, Mateo Beus, Ivan Pavić, Ivona Štritof, Tomislav Capuder, Hrvoje Pandžić, Energies 2018, 11(2), 346. http://www.mdpi.com/1996-1073/11/2/346
[26] In explicit procurement, transmission is allocated before energy is traded, which can lead to suboptimal results when the lack of available transmission capacity creates a bottleneck. In contrast, when implicit allocation mechanisms are in place, available transmission capacities and energy bids are simultaneously updated on a continuous basis. This leads to increased liquidity of the market, since excess supply in one country can be more easily sold to a country with excess demand. In addition, implicit allocation facilitates the operational tasks of intraday cross-border scheduling. Consequently, market efficiency is increased, maximizing both consumer and producer surplus.

of European electricity consumption.[27] In addition, Croatia is considering linking its market with Bosnia Herzegovina's.

The share of incentivized renewable and highly efficient co-generation was equal up to 10 percent of total electricity consumption in Croatia during some hours of the year. Such high penetration of intermittent resources on the system creates some challenges for the system operators. Electricity is a special type of commodity in that generation and consumption must be in balance every minute of every hour because electricity cannot be stored in sufficient quantities for future consumption.

Wind and solar generators are non-dispatchable, meaning that they are not under the control of the operator: they only generate electricity when the wind blows or the sun shines. Under Croatia's laws, wind and solar generators receive priority dispatch and are exempt from curtailment. This means that in a situation when a wind generator produces more electricity than was anticipated due to strong wind conditions, resulting in over-generation on the system, wind producers will not be curtailed. In most well-functioning systems, these balancing services are covered by the generators who cause the overgeneration or shortfall. The Croatian Energy Regulatory Agency's (HERA) identifies this as one of the challenges that must be addressed in order to reduce the financial burden on the electricity end-users and to provide an incentive to the intermittent resources to better manage their production by, for instance, using more advanced forecasting systems or installing on-site electric storage.

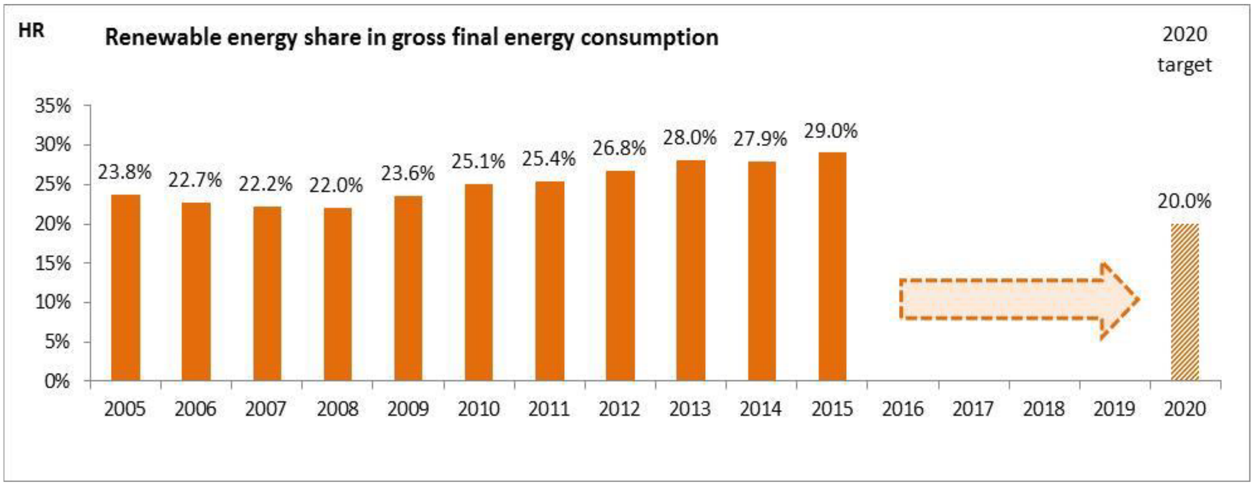
It is also important to point out that CROPEX only allows market participants to sell or buy electricity in hourly blocks. More advanced electricity markets allow for more granular, 15-minute bids, more favored by intermittent generators such as wind or solar, which may be unable to deliver energy for a full hour. If CROPEX were to allow generators to bid in 15-minute blocks, it would significantly decrease the need to balance the system in real-time and would lower the barriers to participation of renewable resources and thus increase competition and market liquidity.

B2. Electricity from Renewables in Croatia

Croatia has committed to decarbonizing its energy sector through expanding renewable energy and reducing carbon emission of fossil fuels. Adding more renewables—particularly wind and solar—could help reduce Croatia's energy intensity by displacing less efficient fuels such as coal, natural gas and biomass (in households). Thanks to existing hydropower plants and recent addition of wind and solar power generation, Croatia has exceeded the EU renewable energy target of 20 percent in final energy consumption. However, intermittent wind and solar capacity accounted for just 11 percent (539 MW) of installed grid-connected power generation capacity in Croatia (2016).

[27] The sixteen transmission system operators of the Central Western Europe and Central Eastern Europe capacity calculation regions (CCRs) signed a memorandum of understanding (MoU) on 3 March 2016 to develop a common day-ahead flow-based capacity calculation methodology and merge the two regions into one. https://preview.entsoe.eu/about/market/

Figure B5: Croatia Renewable Energy Share in Final Energy Consumption



Source: Energy Union Factsheet Croatia, 2017

The table below shows the mix of renewable power generation capacities in Croatia.

Figure B6: Croatia Installed Capacity of Renewable Power Plants

Type of Plant	Installed capacity (MW)
Hydropower plants	2,198.7
Wind power plants	483.1
Solar power plants	55.8
Thermal Power plants (biomass)	26.0
Thermal Power Plants (biogas)	35.9
Small Hydro power plants	6.6
Total	**2,806.1**

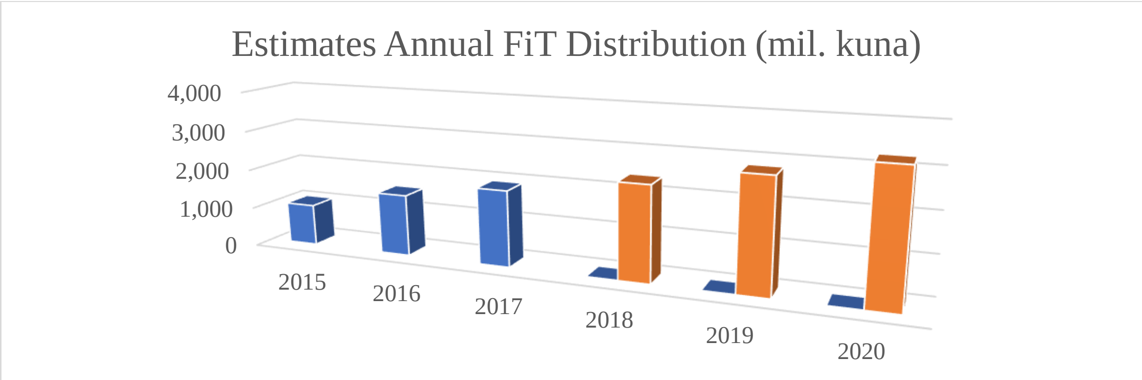
Source: Energy in Croatia 2016

To promote renewable power generation, a feed-in tariff (FIT) system for new projects was put in place until end of 2015. Until 2015 renewable electricity generation was supported through a FIT system, which were allocated via tenders. Such measures have cost implications on consumers as the scheme is funded by a fee that is charged on each kWh purchased by the final consumers.

The chart below shows the annual expenditures of the FIT paid by HROTE to qualified RE projects and subsequently the cost of RE, which is passed through to final consumers.[28]

[28] Data source: HROTE, forecast by project team.

Figure B7: Cost of Feed-in Tariff for Renewable Energy



	2015	2016	2017	2018	2019	2020
Values	1,039	1,547	1,913	0.00	0.00	0.00
Forecast				2,368	2,811	3,254

Costs of the FIT, including forecasts on the expense of its continuation are outlined in the table below.[29]

Figure B8: Value of FIT for Renewable Electricity

Year	FiT costs as % of GDP	FiT obligations (in million HRK)
2015	0.3	1,039
2016	0.4	1,547
2017	0.5	1,913
2018	0.6	2,368
2019	0.7	2,811
2020	0.8	3,254

In place of FIT, effective January 2016 a "Premium tariff" ("tržišna premija") system came into effect. This premium is designed to be applied on the market determined electricity tariff (i.e. through Cropex). However, this new system is not yet operational. As of July 2018, the Implementation Acts are under public consultation and the new renewable law is still being considered.

Croatia should consider accelerating adoption of the renewable energy auctions. The Act on Renewable Energy and High-efficiency Cogeneration came into force on 1 January 2016 (replacing FIT), prescribing the general guidelines for conducting auctions for RES support in Croatia. However, bylaws describing the implementation of the auctions are yet to be adopted. The draft would have introduced a competitive element in the state support offered to renewable energy producers. The proposed design also appears focused on better integrating renewables into

[29] Data Source: Project team calculation of data from Ministry of Finance and the energy market operator, HROTE

the energy market and will require renewables to assume balancing responsibilities as defined by the new law.

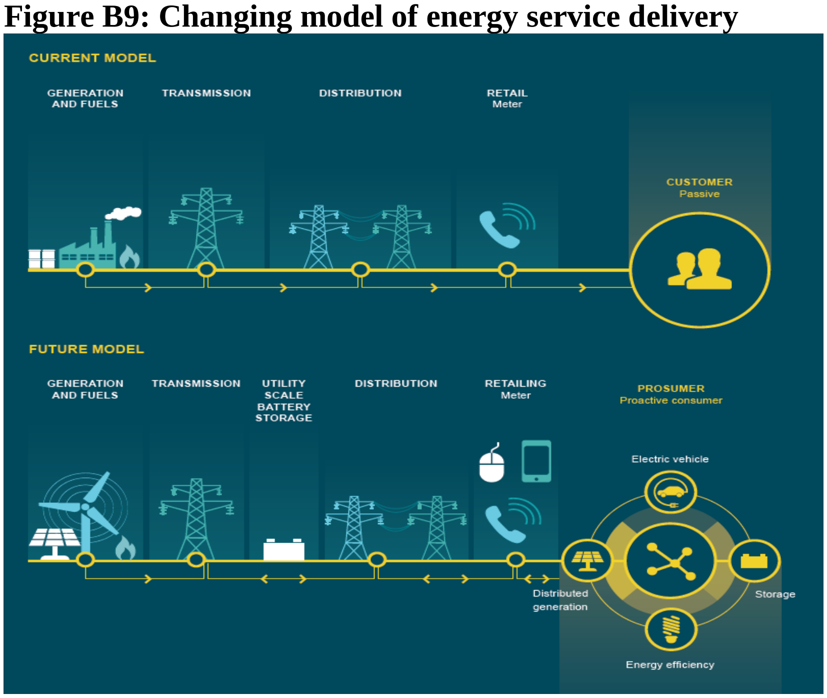
Distributed Generation and Mini Grids

The increasing viability and prevalence of renewable energy sources has resulted in a shift towards distributed generation globally, which is a model where energy is produced much closer to the end user. Some parts of Croatia such as islands, could benefit from mini-grids.

Distributed generation, as defined by the European Parliament document on Industry, Research and Energy is made of relatively small-scale generation capacities connected to the distribution network.[30] Factors such as the desire for energy security, climate impact reduction and technological advancement, are drivers of a prevailing trend toward localized community energy reflected in RES incorporation and distributed generation. This trend has led to the spread of decentralized energy systems, and mini-grids that are adept at integrating various types of RES and that can operate in "island" mode independently from the main grid.[31]

Mini-grids are not yet operational in Croatia. However, several pilots are in various stages of development, for instance the 3Smart project led by HEP Group, that commenced from 1st January 2017, scheduled to end by 30th June 2019, which aims to test the management of a minigrid (Solar & battery systems) with integrated heating/cooling systems in buildings and districts.

Figure B9: Changing model of energy service delivery



New business and investment opportunities are emerging closer to the consumer.

The traditional **"scale-driven, centralized, standardized service delivery model"** will be disrupted and substituted for one that is **"digital, distributed, personalized, customized, and technology driven"…**

Source: Azuela, Stanley, World Bank 2017

[30]http://www.europarl.europa.eu/document/activities/cont/201106/20110629ATT22897/20110629ATT22897EN.pdf
[31] Yap, Justin; Trpkov, Stephanie, 2017. *Croatia, Global Value Chains Assessment*, energy technologies, systems and equipment STPA.

B3. Natural gas in Croatia

In Croatia, natural gas is the second largest primary energy source following oil[32]. Natural gas is used mostly for electricity and heat generation, and for household heating and cooking. Gas use in industry and transport is relatively small. While the share of renewables has been increasing, the demand for natural gas is estimated to increase in the coming decade as the use of coal gradually declines, and more customers shift to cleaner energy source.

By 2016, gas proven reserve totaled 13.2 billion cubic meters (bcm) and production totaled 1.65 bcm. The sole gas storage facility is located in Sisak-Moslavina County, with a designed capacity to store 0.55 bcm of gas.

Figure B10: Croatia Gas Supply and Demand 2011 vs 2016

	2011	**2016**
Production in Croatia	2.47 bcm	1.65 bcm
Import	0.88 bcm	1.26 bcm
Export	(0.26) bcm	(0.39) bcm
Gas-to-electricity/heat/energy	1.21 bcm *(38% of supply)*	0.99 bcm *(38% of supply)*
Household	0.67 bcm *(21%)*	0.56 bcm *(21%)*
Industry	0.33 bcm *(11%)*	0.20 bcm *(8%)*
Services	0.17 bcm *(5%)*	0.22 bcm *(8%)*
Agriculture	0.02 bcm *(1%)*	0.03 bcm *(1%)*
Transport	0.8 million cm	4.4 million cm

Source: Energy in Croatia 2016

With no foreseen increase in gas reserve, Croatia's gas production is expected to dip toward 0.6 bcm per year in a few years. Therefore, Croatia is planning to increase gas import to meet domestic demand and expand international gas transit. The Krk Island LNG project is a candidate project to replace declining domestic production and enable increased international gas transit. Another international gas supply candidate is the Ionian Adriatic Pipeline (IAP), which would bring Caspian Sea gas to Croatia via the Trans Adriatic Pipeline in Albania and passing through Montenegro. Natural gas will help Croatia transition away from importing coal and cut Croatia's greenhouse gas emission faster.

B4. State-owned Enterprises in the Energy Sector

In the energy sector, fully state-owned SOEs such as HEP Group and Plinacro are financially self-funding, including through borrowings and bond issuance, and do not require direct government budgetary allocation. However, they benefit either directly or indirectly from their parastatal status, which benefits their credit standing or ratings.

[32] Primary energy supply totaled 8.4 million tons of oil equivalent (2015), led by oil (40%), gas (27%), biomass/fuel (17%), coal (8%), hydro (7%), geothermal/wind/solar (1%). Source: IEA.

HEP Group's capital expenditures amounted to about 0.7 percent of Croatia's GDP in each of 2015, 2016 and 2017, while dividend payments were about 0.2 percent of GDP in 2016 and 2017[33]. The return on equity was 5 to 8 percent of annual net profits in these same years.

INA Group's (45% owned by Croatian government) capital expenditures were about 0.4 percent of GDP in each of 2015, 2016 and 2017, while dividend payments were about 0.04 percent of GDP in 2015 and 2017 (no dividend paid in 2016). INA turned a profit in 2017 with return of equity of 11 percent following a loss in 2015.

Going forward, should state-owned SOEs continue to reinvest a majority of their internally generated funding surplus in their businesses? Would it be more economic for the country if these SOEs remit more dividend back to the government for other needs. These SOEs could perhaps tap more private capital for their future. Or the government could divest its equity stakes in financially viable SOEs and use the proceed for other needs. These are questions that could benefit from further review beyond this Energy Sector Note.

Figure B11: HEP Group and INA Group Select Financial Information

		2017	2016	2015
HEP Group Consolidated →	Total fixed assets, million HRK	32,538	32,124	31,546
	Total equity	25,996	25,484	24,025
	Total borrowings	9,274	9,434	10,615
	Net profit	1,307	2,066	1,982
	ROA (long term), %	4%	6%	6%
	ROE, %	5%	8%	8%
From cashflow statement	HEP GROUP: Net Investments	2017	2016	2015
	In million HRK	2,432	2,589	2,528
	% nominal GDP	0.7%	0.7%	0.7%
	% total fixed assets	7.5%	8.1%	8.0%
		2017	2016	2015
INA Group →	Total fixed assets, million HRK	12,599	13,144	13,306
	Total Equity	11,526	10,597	10,585
	Total borrowings	3,380	3,653	3,855
	Net profit	1,222	95	-1418
	ROA (long term), %	10%	1%	-11%
	ROE, %	11%	1%	-13%
From cashflow statement	INA Group: Net Investments	2017	2016	2015
	In million HRK	1,300	1,498	1,508
	% nominal GDP	0.4%	0.4%	0.4%
	% total fixed assets	10.3%	11.4%	12.0%

Source: Financial statements of the companies

[33] Dividend payout ratio of 29 percent (2016) and 61 percent (2017) of net profit, respectively.

C. Financing and Investment in Energy Efficiency and Renewable Energy

Croatia has more than a decade of experience in the Energy Services Company (ESCO) model, with a good range of services on offers. However, the two main gaps in Croatia's ESCO model are in: a) the lingering negative connotation of the model where regular loans that did not guarantee energy savings or absorbed risks were called ESCO; and b) leveraging available EU funding options and scaling up through traditional financial institutions.

C1. Energy Services Companies Model

There is a mature energy services market in Croatia. Although energy efficiency financing fundamentals are in place, but increasing scale has been elusive. Energy service companies develop, implement and sometimes finance, energy efficiency projects which are then compensated from energy savings. Croatia has over a decade of experience with the ESCO model. HEP ESCO under the aegis of the national utility company HEP, was the first ESCO established in Croatia in 2003[34] to provide financing support to improve energy efficiency in public buildings (schools, hospitals, offices), public lighting, residential sector, commercial and the industrial sectors. Between 2003 and 2009, HEP was the sole market provider of ESCO. There are at present about 10 active ESCOs operating in Croatia.

For illustrative purposes, some of the 10 ESCO companies actively operating in Croatia are:

These ESCOs operates in the public and private sectors. They offer a wide array of energy solutions that include construction of buildings such as schools, offices, hospitals, hotels, etc., public projects that include lighting and industrial/energy supply systems such as district heating and cogeneration. Some of their services also include project risk management.

The Joint Research Center[35] of the European Commission had estimated the value of the Croatian market for energy services at EUR 50 million in 2016. There was a market potential of EUR 250 million in street lighting and EUR 1.25 billion in public buildings, which is considerable relative to GDP. (Croatia's 2016 GDP € 47.4 billion). There was still a need for credit enhancement/guarantees to stimulate EE financing. The availability of energy performance guarantee by ESCO is limited.

Back in 2010, the World Bank had observed initial success of a credit enhancement mechanism through the Croatian Development Bank (HBOR). Three banks entered into guarantee arrangements with HBOR, while two other banks developed credit lines for EE and renewables investments[36]. However, the credit guarantee facility failed to attract demand and mitigate the

[34] Supported by the World Bank-funded Energy Efficiency Project, approved in 2008
[35] Energy Service Companies in the EU, 2017 (ISBN 978-92-79-71475-7, ISSN 1831-9424, doi:10.2760/12258)
[36] Implementation Completion and Results Report (ICR00001557), Energy Efficiency Project, December 2010.

collateral requirements imposed by local financiers. Going forward, it will be beneficial to take account of these lessons in adjusting credit enhancement/guarantee for the Croatian market.

Despite the presence of ESCOs, surveys and perceptions continue to indicate limited available financing for EE. Mainstream financial institutions are generally not active in EE financing. Concrete action plan to expand EE financing in collaboration with mainstream financial institutions and utilities remains necessary going forward. **As electricity and gas supply in Croatia has been liberalized with more supply companies gaining market share, the window to expand EE financing in collaboration with these companies and their financial institutions should be explored**.

C2. Research and development ecosystem for RE, EE, and available funding options

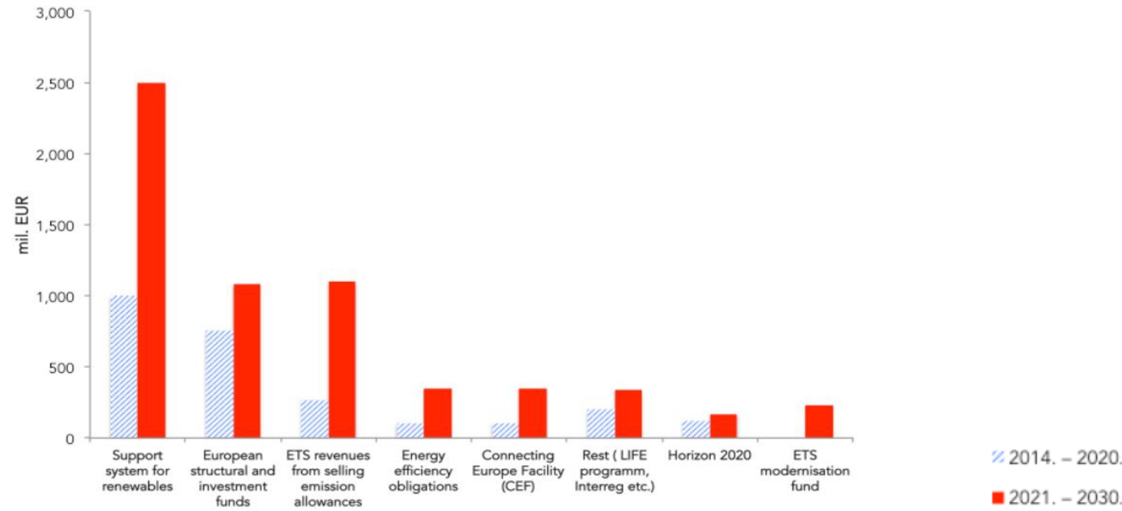
Croatia has an extensive network of institutions related to R&D, yet there are many opportunities to improve the relevance of funded topics and connect them with Croatian industrial needs.[37] While a major challenge for start-ups and young companies remain bridging the so-called valley of death, there is no shortage of funding options that would support the development of new energy technology solutions in the various sectors. Though the funding opportunities are better in Croatia now than before, there is a lack of ready projects. For instance, the European Fund for Strategic investments (EFSI) has so far invested EUR 220 million in Croatia, equal to is 0.5 percent of GDP. Furthermore, the fund implementation for Croatia has been prolonged to 2020 from the previous deadline of 2018. The value of EFSI for the EU has increased from EUR 315 to EUR 500 billion. Among the new 13 EU Member States, Croatia is in the middle by EFSI investment ratio to GDP, indicating room for improvement in the absorption rate of funds.

New EFSI instruments are currently in preparation by the Croatian Development Bank (HBOR) for higher- risk projects that also encompasses Energy Efficiency. The instruments would include a Venture Capital Fund of EUR 35 million, an Equity Fund, and a new Smart Islands initiative for clean transport, renewable energy, zero waste, sustainable tourism.

Other potentially available funds for financing Croatian Low Carbon Development Strategy are outlined in the figure below:

[37] Aprahamian, Arabela; Correa, Paulo Guilherme. 2015. *Smart Specialization in Croatia : Inputs from Trade, Innovation, and Productivity Analysis*. *Directions in Development--Countries and Regions;*. Washington, DC: World Bank.

Figure C1: Estimated Funding Sources for EE and RE



Source: Financing the Croatian low carbon development strategy, 2017[38]

Besides EFSI, other financial instruments to help improve energy efficiency, include grants and loans from national and European sources. These financial instruments serve to recognize the high costs of energy efficiency which are too large to be met by grants alone, but the benefits are too significant for the opportunities to be missed. With the available options and programs, access to finance should no longer be a binding constraint for Croatian entities seeking to invest in RE and EE.

C3. Croatian Business and Global Renewable Energy Value Chain

Analysis of the position of Croatia in global Renewable Energy value chains revealed that Croatia is active in most critical parts of the value chain. However, market failures — including incentives, coordination, information, capacity, competition, risk aversion, and governance failures — are prohibiting systematic upgrading to higher-value market segments.

Gaps exist in several areas, but the most urgent are related to the three pillars of distributed energy systems, which are renewable energy technology, monitoring and control systems, and energy storage (including batteries, pumped hydropower, flywheels, fuel cells, inverters, molten salt, solar methane, and condensers). The national utility HEP has received EU funding to work on grid optimisation and smart metering at several Croatian sites, but there seems to have been little commercialization at the national level.[39]

[38] https://www.starfishenergy.org/single-post/2017/08/28/financing-the-Croatian-low-carbon-development-strategy

[39] Yap, Justin; Trpkov, Stephanie, 2017. *Croatia, Global Value Chains Assessment*, energy technologies, systems and equipment STPA.

C4. ESCO model in the transport sector

ESCO in the transport sector is still being explored elsewhere and does not yet exist in Croatia, although there is an effort by EBRD who is supporting a study by Croatia Highway Company (HAC). The application of the financing model for energy efficiency, is being explored for the industrial and transport sector. Transport oriented energy service companies are referred to as T-ESCOs. Current strategies to reduce transport emissions rely on efficiency maximizing technologies and systems for public transportation networks and individual vehicles. Adoption of such energy efficient technologies for fleet or vehicle replacement are slow because of financial constraints, necessitating innovative financing mechanisms.[40]

The T-ESCO model could be an avenue for policy makers to secure private sector expertise to help with the transition to electrification and ICT integration, with a known framework for evaluating risks and outcome. A good T-ESCO strategy could help foster an environment conducive to the adoption of energy efficient technologies in the sector, effectively supporting the goal of reducing greenhouse gas emissions.

[40] Vermont Energy Investment Corporation; http://blogs.worldwatch.org/t-escos-applying-traditional-energy-financing-strategies-to-public-transport/

D. Energy Affordability in Croatia

D1. Croatia Context for Energy Affordability

The deregulation of Croatia's energy markets raised concerns about energy affordability. With the passing of the new Energy Act and the Act on Regulation of Energy Activities, Croatia deregulated its energy market in line with the European Union's Third Energy Package.[41] Deregulation of energy markets raised concerns on energy affordability, and made evident the lack of well-designed measures which could offer protection for the vulnerable.

The 2016 World Bank report[42] highlighted that poor households in Croatia, like other EU countries, tend to devote a higher share of their budgets to securing their energy needs. Consequently, the report highlighted a need for policies to alleviate the burden on the poor, along with interventions focusing on energy efficiency.

Interventions to support vulnerable households available are not straightforward since Croatian households rely on a broad array of energy sources, such as biomass, electricity, natural gas, and district heating. Moreover, the energy sources used vary considerably by income groups. Additionally, there are access problems; for example, district heating is not available throughout the country, and wood is extensively used in rural and urban areas.

An additional concern is households' inability to pay bills on time. According to the EU-SILC,[43] in 2013 (last year for which the data was available), close to 30 percent of households reported being in arrears in their utility bills. According to the latest data available, by 2016 the percentage of households who report being in arrears on their utility bills has dropped to 25 percent. The development, although commendable, still leaves many in a precarious situation since households commonly state that they would like to avoid the risk of their utilities being disconnected. *This is particularly salient during the winter season when households report giving priority to paying their utility over many of their other needs*.

Energy efficiency upgrades are also a potential source for improvement in energy savings and affordability. Despite its potential, efficiency improvements such as insulation is out of reach for many of the poorer households in the country. Most households are left to rely on time-of-use meters, where different rates are applied to electricity use during different times of the day. This leads to many households to rely on non-peak hour tariffs to satisfy their needs. *Non-peak hours are at night, after 10pm, and this can have negative effects on the quality of life for members who stay at home during the day, which commonly are the women who oversee household chores*.

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[41] The Third Energy Package aims to make the EU energy market more effective and to create a single EU gas and electricity market, with the aim to keep prices as low as possible and increase the standards of service and the security of supply.

[42] World Bank (2016), Ensuring Energy Affordability in Croatia.

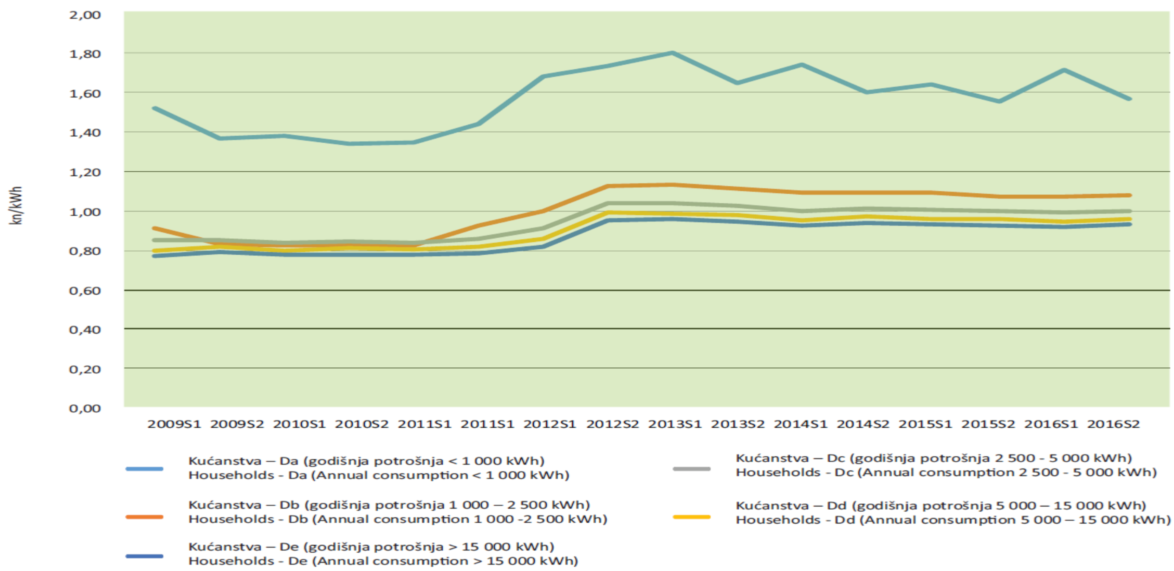
[43] The nationally representative SILC survey has been run in Croatia since 2010, and provides all the information to calculate the relative income poverty, material deprivation and labor market attachment indicators needed to measure the share of population at-risk-of poverty and social exclusion (AROPE), which is the headline poverty figure at the European level and for individual EU Member States.

D2. Electricity and Gas Prices in Croatia

Following the electricity sector's unbundling and market entry of new electricity supply companies in Croatia[44], electricity prices have stayed relatively stable. The relatively stable electricity prices help shield poor households from negative impact of price increases in Croatia. Moreover, supply from renewable generation —most likely will reduce upward pressure on electricity prices in Croatia in the next few years.

The natural gas sector in Croatia is also liberalized. By 2016 the top five gas distribution companies supply about 65 percent of the overall gas demand. However, residential gas prices remain regulated (HEP acts as a single buyer of gas for households), but are scheduled for full price liberalization starting 2018. Residential customers directly supplied with natural gas account for about 21 percent of total gas supply in Croatia[45]. Therefore, the impact of any large increase in gas price for poor households will need to be closely monitored.

Figure D1: Electricity and Gas Prices in Croatia



Slika | Figure 5.4.1. Ostvarene prosječne prodajne cijene električne energije (kn/kWh, s uključenim svim porezima i naknadama) za kupce kategorije kućanstvo prema Eurostat kategorijama u razdoblju od 2009. do 2016. godine | Average electricity selling prices (HRK/kWh, all taxes and levies included) for household customers by Eurostat categories from 2009 to 2016

Tablica | Table 4.5.1. Prosječna prodajna cijena prirodnog plina od 2000. do 2016. godine (u kn/m³, s PDV-om) | Average selling price of natural gas from 2000 to 2016 (in HRK/m³, VAT included)

Vrsta potrošača Customer category		2000.	2005.	2010.	2011.	2012.	2013.	2014.	2015.	2016.
Kućanstva Households	kn/m³	1,45	2,04	2,83	2,88	3,66	3,80	3,86	3,85	3,25
	kn/kWh	0,1565	0,2203	0,3056	0,3113	0,3952	0,4103	0,4168	0,4157	0,3509
Usluge Services	kn/m³	1,45	2,06	3,43	4,12	4,86	4,52	5,04	4,17	3,52
	kn/kWh	0,1565	0,2224	0,3704	0,4454	0,5248	0,4881	0,5442	0,4503	0,3801
Industrija Industry	kn/m³	1,38	2,05	3,60	3,99	4,47	4,35	4,05	3,70	2,92
	kn/kWh	0,1495	0,2214	0,3887	0,4309	0,4827	0,4697	0,4373	0,3995	0,3153

Izvor: | Source: EIHP

[44] By 2016 there were 15 electricity supply licensees.

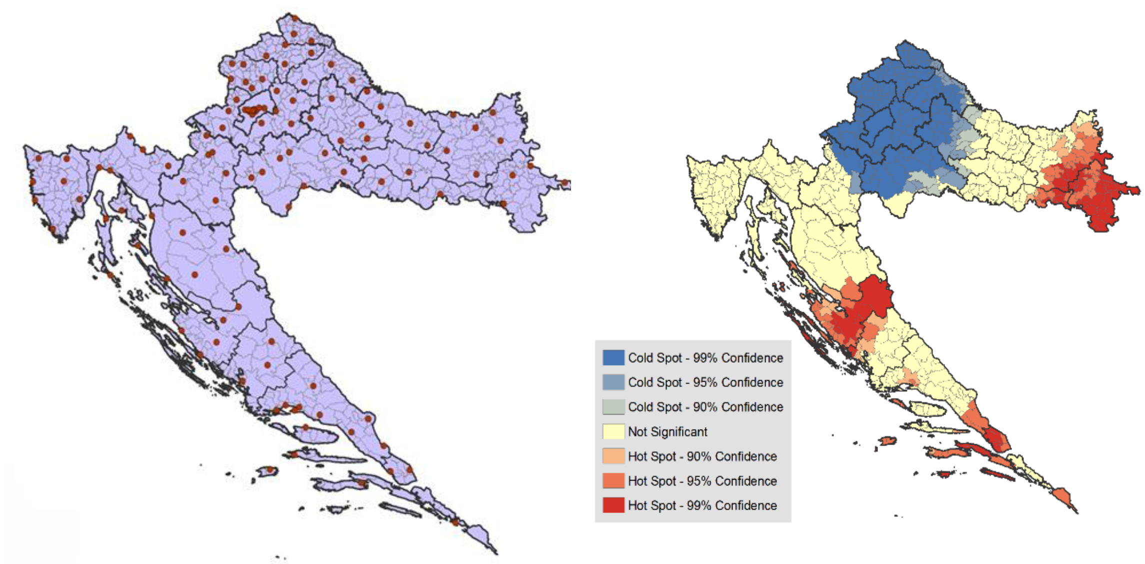
[45] In 2016, residential gas supply totaled 560 million cubic meters out of total gas supply of 2,611 million cubic meter. Source: Energy in Croatia 2016 Report.

D3. Addressing Energy Affordability in Croatia

Since the publication of the World Banks's Croatia Policy Note on energy affordability of 2016, energy affordability concerns have been addressed in Croatia. Two major policy interventions have taken effect since 2015. The first is the introduction of an energy allowance which is tied to the Guaranteed Minimum Benefit[46] for households who qualify by satisfying the program's requirements. The second, directly addresses price concerns; these have been addressed through a reduction in value added tax on electricity.

A program which is explicitly intended for the poorest in Croatia takes the form of a subsistence benefit, the Guaranteed Minimum Benefit (GMB) which is administrated by the Ministry of Demography, Family, Youth and Social Policy (MDFYSP). The GMB is a means tested program, is intended for households with an income below the household's basic needs threshold, and is dependent upon the household's characteristics and composition. Potential beneficiaries are expected to apply through social welfare centers in their place of residence. There are centers across the country, and thus the travel burden on most individuals is not high (Figure D2, left).[47] Hotspot analysis (Figure D2, right), reveals that the travel distance for individuals is lowest around Zagreb, while in some of the poorest areas of the country (see Figure D3) there are social welfare center blind zones.[48]

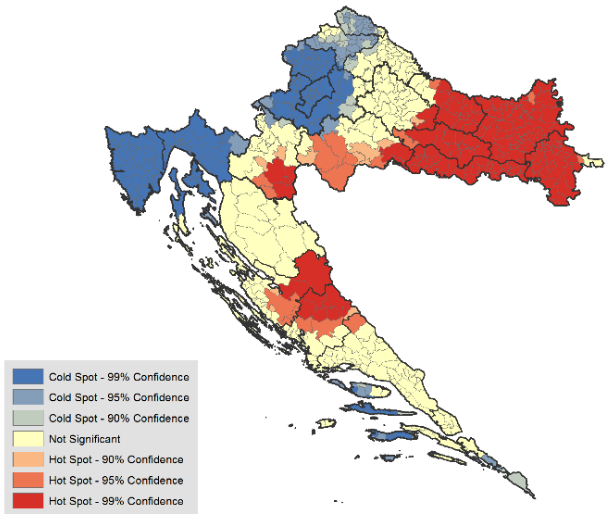
Figure D2: Location of Social Welfare Centers and travel distance Hotspots



Source: WB & MDFYSP, 2017

[46] The potential beneficiary's income needs to be below a certain threshold to qualify for the benefit.
[47] WB and MDFYSP (2017), Assessment of Social Benefit Effectiveness.
[48] These are neighborhoods where travel distance to a social welfare center is significantly higher than the national average.

Figure D3: Income poverty Hot-spots



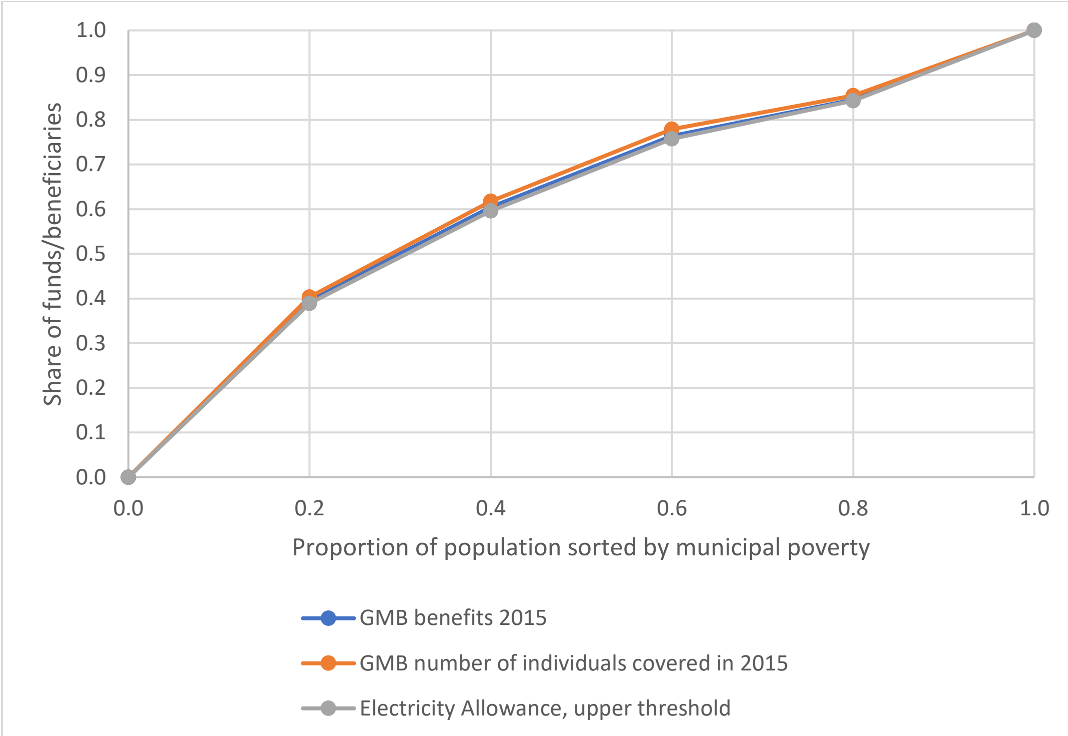
Source: CBS, 2016

All beneficiaries of the Guaranteed Minimum Benefit[49] are also entitled to the benefit for energy buyers at risk introduced in October 2015, which may cover at most 200 HRK (or about 200 kWh of electricity in May 2018) of the beneficiary's energy bill. The bill is paid directly to the electricity provider with no money being transferred to beneficiaries. An additional, in cash or in kind, allowance exists in the form of fire wood for beneficiaries of the GMB. This assistance is intended for those who use wood as a source of heating, and consists in a once a year payment of 3 m^3 of firewood, or in cash payment to cover its cost.

While household level analysis of the guaranteed minimum benefit is not readily available,[50] municipal level analysis suggests that the guaranteed minimum benefit is spatially progressive, implying that the funds go to the population residing in the poorest areas of the country (Figure 3). Roughly 60 percent of the funds got to 40 percent of the population who reside in the poorest municipalities in the country. Data on actual energy allowance distributed is not readily available,[51] but since the allowance is available to all GMB recipient households it is safe to assume that the program will also be spatially progressive. This is because most beneficiaries are found in the poorest municipalities where 40 percent of the population lives.

[49] Beneficiaries of the Personal Disability Allowance are also by default beneficiaries of the Energy Allowance.
[50] Given the program's size, roughly 49 thousand recipient households in 2016, it is not accurately captured in household surveys.
[51] Households who are recipients of the Guaranteed Minimum Benefit or the Personal Disability Allowance receive a voucher of 200 HRK per month, the money is paid directly without the money being received by the beneficiary. Therefore, the actual value of the transfer may be considerably less than 200 HRK.

Figure D4: Spatial Concentration of GMB and Energy Allowance



Source: WB & MDFYSP, 2017

Non-targeted support such as value added tax reduction for electricity should be reconsidered. As of 2017 Croatia introduced a value added tax (VAT) reduction on electricity; where common goods carry a VAT of 25 percent, electricity now carries a VAT of 13 percent. The average price per Kilowatt-hour in Croatia in the second half of 2016 was close to 1 HRK, by the first semester of 2017 the average price had fallen to 0.89 HRK.[52] The share of taxes and levies paid by household consumers in Croatia, after the decrease in VAT, is 15.5 percent. The decrease in VAT is expected to be a life line to poorer households, since these tend to devote a higher share of their expenditures towards electricity than those who are better off. *However, the poor are not the sole beneficiaries of this, since everyone is eligible, (both households with big families and the better off tend to consume more electricity), most of the foregone revenue is likely not going to the poor.*

The VAT reduction on electricity is expected to lessen the burden of energy expenditures on Croatian households. According to figures presented by the Croatian Bureau of statistics,[53] roughly 5 percent of total household expenditures in Croatia during 2014 were devoted to electricity[54].

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[52] Eurostat http://ec.europa.eu/eurostat/web/energy/data/database. Defined as medium-size consumers with an annual consumption within the range of 2 500 kWh and 5 000 kWh

[53] Results of Household Budget Survey, 2014 – Croatian Bureau of Statistics

[54] The latest household budget survey for Croatia is from 2014. The Survey of Income and Living Conditions (SILC), is conducted on an annual basis, however the survey does not collect information on household expenditures and consequently more recent data for budget shares is not readily available.

Nevertheless, vulnerable households devote a considerably higher share to their energy needs. In households with no employed individuals, roughly 13.6 percent of household expenditures is devoted to energy. As a result, the price reduction due to the VAT reduction, while likely to lessen the electricity budget of many households is still likely insufficient for most.

Despite the introduction of an energy allowance and VAT reduction, many households are still expected to suffer from energy poverty. Looking forward, many areas of improvement remain, particularly on energy efficient interventions. Nevertheless, low-income households will require considerable assistance in order to improve their energy efficiency. However, funds for this are available. In Croatia, between 2014 and 2020, 50 million Euros are available for energy efficient interventions. This amount is unlikely to be sufficient, and thus other measures are likely needed.

A measure which is expected to considerably improve energy efficiency is a measure which will facilitate improving energy efficiency among energy vulnerable households through the improvement of household conditions. The measure is outlined in the Fourth National Energy Efficiency Action Plan of the Republic of Croatia,[55] and entails replacement of old household appliances, windows, as well as improvement of heating systems, and increasing insulation. This to some extent also requires intervention with building owners some of whom are themselves vulnerable customers, particularly for low-income households. The program shall rely on timely monitoring indicators from the Croatian Bureau of Statistics that will allow for the identification of energy poverty at the national level. The program expects to reach close to 330 households in Croatia per year between 2017 and 2026.

Additional energy efficiency interventions expected to lessen the burden of electricity costs among consumers is targeted at multifamily homes constructed before 1987. The focus is on renovating these buildings for these to comply with low energy standards. The plan will be co-financed through European Funds for Regional Development. The plan is expected to mostly benefit building owners, but there is expectation that savings will be passed on to occupants thereby lessening their energy bills.

[55] https://ec.europa.eu/energy/sites/ener/files/hr_neeap_2017_en.pdf

Annex 1 -- Croatia Energy Sector in Numbers

Croatia is a net importer of energy, with energy imports valued at around 5 percent of GDP in 2016. The residential sector is the largest energy consumer at 34% of final energy, followed by transport at 29%, industry at 15.5%, and commercial/services sector at 11%.

In 2016 almost half of net primary energy supply (PES) was imported, led by oil and gas (76% of imported primary energy). Imported coal accounted for almost 8% of PES. Biomass, including fire wood, remained substantial in Croatia at 15% of PES. Hydropower accounted for 7% of PES, with no new major capacity under construction. Solar and wind energy in Croatia has increased considerably in recent years, although their contribution to the overall PES remains small, at less than 2%.

Primary Energy

- Primary energy supply totaled 8.4 million tons of oil equivalent (mtoe, 2015 and 2016), led by oil (37%), gas (26%), biofuels (15.5%), coal (8%), hydro (7%), net electricity import (5.6%), and geothermal/wind/solar (1.3%). During 2011–2016, total primary energy supply decreased 0.6 percent per year on average.
- Around 7.5 mtoe of primary energy supplied were imported, mostly crude oil/oil products 4.6 mtoe, electricity 1.1 mtoe, gas 1 mtoe, and coal 0.7 mtoe.
- Primary energy export totaled 3.4 mtoe, mostly oil products 2.1 mtoe, electricity 0.6 mtoe, natural gas 0.3 mtoe, and biofuels 0.3 mtoe.

Electricity and Gas

- 2016 electricity supply totaled 17.7 terrawatt-hours, comprising 55.16% hydropower, 32% thermal, 9% wind and 4% other renewables. Croatia is a net importer of electricity.
- 2016 gas production totaled 1.65 billion cubic meters (bcm), gas import totaled 1.26 bcm, and export totaled 0.39 bcm. Gas demand comprised 1 bcm for electricity/heat generation, 0.56 bcm for households, 0.2 bcm for industry, 0.22 bcm for service sector, 0.03 bcm for agriculture, and a very small 4.4 million cubic meter for transport sector.
- The power grid is connected with neighboring countries (Slovenia, Hungary, Serbia, Bosnia Herzegovina) mostly at 400 kV.
- Croatia's gas reserve and production have gradually declined in the past ten years. By 2016, gas proven reserve totaled 13.2 billion cubic meters (bcm) and production totaled 1.65 bcm. Gas production is expected to reduce toward 0.6 bcm per year in a few years.
- The gas grid is connected with Slovenia and Hungary for imports.
- Prospects for additional natural gas imports: LNG at Krk Island, Ionian Adriatic Pipeline (IAP).

Energy and the Economy

- By 2016 the final energy consumption totaled 7 mtoe. Residential sector was the largest at 2.4 mtoe (34%), followed by transport 2 mtoe (30%), industry 1.1 mtoe (15.5%), and commercial/services sector 0.8 mtoe (11%)
- In the residential sector, biomass (e.g. firewood) accounted for almost half of final energy use (47% of energy content), followed by electricity 22%, natural gas 19%, and oil 6%. The large share of biomass in the residential sector suggests that many households are still using biomass and that low efficiency biomass requires more energy input, which escalates energy intensity.
- In the transport sector, road transport accounted for 95% of energy use, with very little rail and water transport.
- In the industrial sector, the four largest energy users were in non-metallic mineral (e.g. cement), chemical/petrochemical, food/tobacco, and construction, respectively.
- Croatia's total merchandise imports reached USD 21.8 billion in 2016, of which USD 2.7 billion were energy commodities/products (oil USD 1.6 billion , electricity 0.67 billion, gas 0.28 billion, coal 93.7 million).
- Merchandise exports reached USD 13.6 billion, of which USD 1.3 billion was energy (oil products 0.76 billion, electricity 0.42 billion, gas 0.11 billion).
- Croatia's nominal GDP amounted to USD 50.4 billion (2016), with a per capita GDP of $ 12,090.

4.3. Energetska bilanca prirodnog plina

4.3 Energy Balances of Natural Gas

Tablica | Table 4.3.1. Prirodni plin | Natural gas

		2011.	2012.	2013.	2014.	2015.	2016.	2016/15.	2011-16.
		10⁶ m³						%	
Proizvodnja	Production	2471,4	2013,1	1856,1	1747,0	1780,5	1 647,2	-7,5	-7,8
Uvoz	Import	876,1	1357,7	1270,4	1132,6	1050,1	1 264,7	20,4	7,6
Izvoz	Export	258,6	256,8	376,1	433,9	367,4	389,4	6,0	8,5
Saldo skladišta	Stock change	76,1	-142,3	59,5	-2,1	56,0	88,9		
Ukupna potrošnja	Energy supplied	3165,0	2971,7	2809,9	2443,6	2519,2	2 611,4	3,7	-3,8
Potrošnja za pogon	Energy sector own use	183,6	47,3	140,5	120,2	129,0	123,2	-4,5	-7,7
-proizvodnja nafte i plina	-oil and gas extraction	96,6	39,4	46,5	44,3	80,9	55,2	-27,3	-10,6
-rafinerije	-oil refineries	70,6	4,9	85,3	72,6	48,1	54,6	13,5	-5,0
-degazolinaža	-NGL plant	16,4	3,0	8,7	3,3	0,0	13,4	168,0	-4,0
Energet. transformacije	Total transformation sector	1212,0	1328,5	1136,1	875,8	881,6	991,3	12,4	-3,9
-termoelektrane	-thermo power plants	27,0	14,0	2,7	0,6	52,5	66,1	25,9	19,6
-javne toplane	-public cogeneration plants	652,1	673,9	580,4	352,1	343,7	407,9	18,7	-9,0
-javne kotlovnice	-public heating plants	76,0	76,6	85,9	71,6	72,4	71,0	-1,9	-1,4
-industrijske toplane	-industrial cogenerat. plants	302,5	292,9	328,2	307,3	257,5	276,8	7,5	-1,8
-industrijske kotlovnice	-industrial heating plants	67,2	57,2	53,7	52,8	54,6	59,0	8,1	-2,6
-rafinerije	- petroleum refineries	76,0	207,5	83,1	86,6	88,4	103,4	17,0	6,4
-gradske plinare	- gas works	3,9	2,9	2,1	1,1	0,3	0,0	-100,0	
-degazolinaža	-NGL-plant	7,3	3,5	0,0	3,7	12,2	7,1	-41,8	-0,6
Neenergetska potrošnja	Non energy use	510,3	489,6	487,5	500,7	495,6	456,0	-8,0	-2,2
Gubici	Losses	60,0	52,9	40,7	29,0	31,7	33,4	5,4	-11,1
Neposredna potrošnja	Final energy consumption	1199,1	1053,4	1005,1	917,9	981,3	1 007,5	2,7	-3,4
Industrija	Industry	333,1	239,5	214,9	208,4	211,1	196,9	-6,7	-10,0
-željeza i čelika	-iron and steel	29,8	14,0	14,3	14,6	16,5	12,0	-27,3	-16,6
-obojenih metala	-non-ferrous metals	1,2	1,1	0,9	1,1	2,6	2,6	0,0	16,7
-stakla i nem. minerala	-non-metallic minerals	51,1	44,4	46,5	44,9	38,7	44,7	15,5	-2,6
-kemijska	-chemical	55,1	10,4	9,6	9,7	11,5	7,3	-36,5	-33,3
-građevnog materijala	-construction materials	67,6	54,1	39,3	36,3	40,7	38,4	-5,7	-10,7
-papira	-pulp and paper	7,8	7,0	6,6	5,7	6,7	6,2	-7,5	-4,5
-prehrambena	-food production	68,1	62,4	60,3	61,5	57,3	50,9	-11,2	-5,7
-ostala	-not elsewhere specified	52,4	46,1	37,4	34,6	37,1	34,8	-6,2	-7,9
Promet	Transport	0,8	1,0	1,9	3,9	4,0	4,4	10,0	40,6
-cestovni	-road	0,2	0,2	0,2	0,2	0,2	0,1	-50,0	-12,9
-javni gradski	-public city	0,6	0,8	1,7	3,7	3,8	4,3	13,2	48,3
-ostali	-non-specified	0,0	0,0	0,0	0,0	0,0	0,0		
Opća potrošnja	Other sectors	865,2	812,9	788,3	705,6	766,2	806,2	5,2	-1,4
-kućanstva	-households	670,2	630,2	601,3	524,1	540,0	560,5	3,8	-3,5
-usluge	-services	173,5	162,0	166,0	159,8	204,8	217,9	6,4	4,7
-poljoprivreda	-agriculture	21,5	20,7	21,0	21,7	21,4	27,8	29,9	5,3

Izvor | Source: EIHP