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# Possibilities for Implementation of Energy Strategy of the Republic of Croatia

***Daria KARASALIHOVIĆ SEDLAR,***
***Lidia HRNČEVIĆ* and *Igor DEKANIĆ***

Faculty of Mining Geology and Petroleum Engineering, University of Zagreb (Rudarsko-geološko-naftni falultet, Sveučilište u Zagrebu), Pierottijeva 4, HR-10000 Zagreb, **Republic of Croatia**

daria.karasalihovic

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Introduction to the Energy Strategy of the Republic of Croatia with an overview of the final energy consumption and planned development of energy infrastructure is given in this paper. The intention of the paper was to research and stress out the possibilities for Energy Strategy implementation and practical realization of planned energy infrastructure due to improvement of security of energy supply and competitiveness of the Croatian energy system.

**Mogućnosti implementacije Strategije energetskog razvitka Republike Hrvatske**

Izvornoznanstveni članak

Ovaj članak nas upoznaje sa Strategijom Energetskog razvitka Republike Hrvatske te je u njemu naveden prikaz neposredne potrošnje energije kao i planirani razvoj energetske infrastrukture. Namjera članka je bila istražiti i ukazati na mogućnosti za implementaciju Strategije energetskog razvitka kao i praktična realizacija planirane energetske infrastrukture sa svrhom povećanja sigurnosti opskrbe energijom te povećanja konkurentnosti energetskog sustava Republike Hrvatske.

## 1. Introduction

In this paper introduction to the Energy Strategy of the Republic of Croatia is given with an overview of the final energy consumption in Croatia along with the planned development of energy infrastructure. Along with main principles of strategy, basic energy objectives and security of energy supply in Croatia are also discussed. The main goal was to research possibilities for Energy Strategy implementation and development of different energy projects.

The Energy Strategy of the Republic of Croatia was adopted by the Croatian Parliament in 2009 for the period until 2020 in order to harmonize national energy goals with goals and time framework of strategic documents of the European Union. The goal of the Strategy is a creation of sustainable energy system that makes a balanced contribution to the security of energy supply, competitiveness and environmental protection providing security and availability of energy supply to Croatian citizens and economy.

Three basic energy objectives of the Strategy include security of energy supply, competitive energy system and sustainable energy sector development. This implies improvement of energy supply, fulfillment of competitiveness due to diverse energy structure of electricity generation and high share of domestic natural gas production and achievement of sustainable energy sector which represents the main challenge of energy development.

Furthermore, challenges and opportunities of Croatian energy sector development are given under global geopolitical context and security of energy supply. This includes climate change and other environmental issues, energy geo-strategic position of Croatia, EU Energy Policy and cooperation in Southeast Europe and with neighboring countries. Also, the vision of Croatian energy sector development, along with the future perspective of energy demand with strategic goals and priority activities and technological, economical and environmental strategy effects were presented in this paper.

## 2. Final energy consumption in Croatia

Currently Croatia is characterized with an increasing dependence on energy import since, at this moment, 50 % of energy demand is imported. In primary energy supply oil has 50 % share and natural gas 25 %. [1] There is still a significant share of domestic oil and natural gas production, but the domestic hydrocarbon production records a constant decrease. The climate change and other environmental issues concerning meeting international environmental commitments and standards along with a creation of conditions for open energy market activities with an effective market regulation also represent the main framework of the Strategy. The Strategy is also focused on taking advantage of geo-strategic position and opportunities of the Republic of Croatia and intensifying transit position for oil, natural gas and electricity which could establish Croatia as regional energy hub.

In the Energy Strategy two main projections of energy consumption were given. The first one is a business as usual (BAU) projection of final energy consumption and the second one is a sustainable scenario of final energy consumption. Sustainable scenario assumes that there will be an increase in energy efficiency and in shares of renewable energy sources in final energy consumption along with other encouraged structural changes of the BAU projections of used energy forms with increased use of distributed energy sources.

Objectives of Energy Strategy also include increase in energy efficiency in final energy consumption. It is expected that planned, and in future adopted, energy efficiency measures will result with the increase in energy efficiency shown in Table 3.

## 3. Croatian Energy Sectors and Infrastructure Development Projects

In the Strategy each energy sector is thoroughly analyzed. Hereafter the main issues as reserves of energy sources, production and consumption in particular energy sector will be given along with the planned infrastructure.

**Table 1.** Business as usual projections of final energy consumption in Croatia until 2030 [2]

**Tablica 1.** Temeljna projekcija neposredne potrošnje energije u Hrvatskoj do 2030. godine [2]

| PJ | 2006 | 2015 | 2020 | Growth rate / Stopa rasta 2006-2020, % | 2030 |
|---|---|---|---|---|---|
| Industry / Industrija | 58.86 | 75.82 | 84.43 | 2.6 | 103.90 |
| Transport / Promet | 85.63 | 124.51 | 135.22 | 3.3 | 152.59 |
| Other Sectors / Opća potrošnja | 123.40 | 162.42 | 189.95 | 3.1 | 245.16 |
| Total / Ukupno | 267.89 | 362.75 | 409.60 | 3.1 | 508.83 |

**Table 2.** Sustainable scenario projections of final energy consumption in Croatia until 2030 [2]

**Tablica 2.** Održivi scenarij neposredne potrošnje energije u Hrvatskoj do 2030. godine [2]

| PJ | 2006 | 2015 | 2020 | Growth rate / Stopa rasta 2006-2020, % | 2030 |
|---|---|---|---|---|---|
| Industry / Industrija | 58.86 | 75.82 | 80.32 | 2.2 | 97.11 |
| Transport / Promet | 85.63 | 119.24 | 128.54 | 2.9 | 144.04 |
| Other Sectors / Opća potrošnja | 123.40 | 153.94 | 180.32 | 2.7 | 232.993 |
| Total final energy consumption / Neposredna potrošnja energije | 267.89 | 346.01 | 389.18 | 2.7 | 474.08. |
| Gross final energy consumption / Ukupna potrošnja energije | 278.40 | 358.97 | 404.30 | 2.7 | 492.50 |

**Table 3.** Increase in energy efficiency in Croatia by adoption of energy efficiency measures [2]

**Tablica 3.** Povećanje energetske učinkovitosti u Hrvatskoj primjenom propisanih mjera [2]

| PJ | 2006 | 2015 | 2020 | Growth rate / Stopa rasta 2006-2020, % | 2030 |
|---|---|---|---|---|---|
| Consumption according to Business as usual scenario / Potrošnja prema temeljnoj projekciji | 267.89 | 362.75 | 409.60 | 3.1 | 500.83 |
| Consumption after implementation of energy efficiency measures / Potrošnja nakon primjene mjera energetske učinkovitosti | 267.8 | 345.18 | 386.84 | 2.7 | 470.60 |
| Reduction in final energy consumption / Smanjenje neposredne potrošnje energije | 0.00 | 17.57 | 22.76 | / | 30.2 |

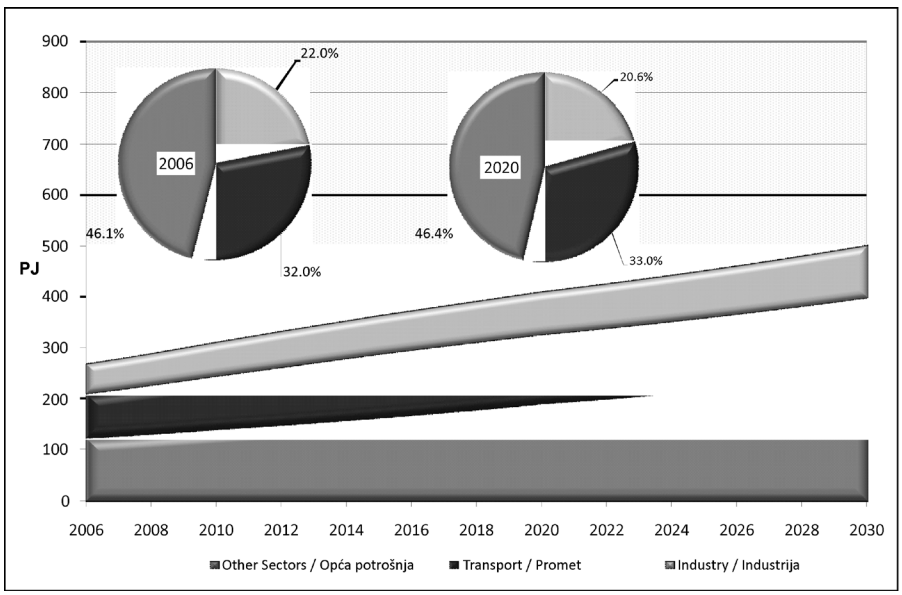


**Figure 1.** Business as usual projections of final energy consumption in Croatia until 2030 [2]

**Slika 1.** Temeljna projekcija neposredne potrošnje energije u Hrvatskoj do 2030. godine [2]

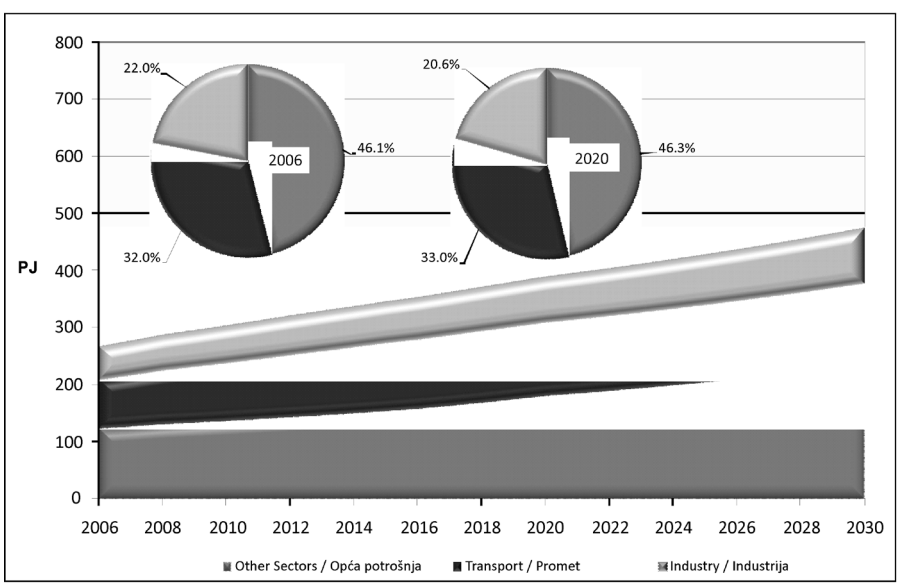


**Figure 2.** Sustainable scenario projections of final energy consumption in Croatia until 2030 [2]

**Slika 2.** Održivi scenarij neposredne potrošnje energije u Hrvatskoj do 2030. godine [2]

### 3.1. Power sector

In the power sector, in period from 2000 to 2006, the annual growth rate of final electricity consumption was 4.1 %. The projected average annual growth of final electricity consumption by 2020 is 3.7 %. By the same year (2020) the average electricity consumption per capita in Croatia will reach present average electricity consumption in EU27. [2]

As regards power sector, strategy of new electricity-generating capacities construction is based on maintenance of 35 % share of electricity generation in total electricity consumption until 2020 from renewable energy sources and large hydropower plants. It is expected that new

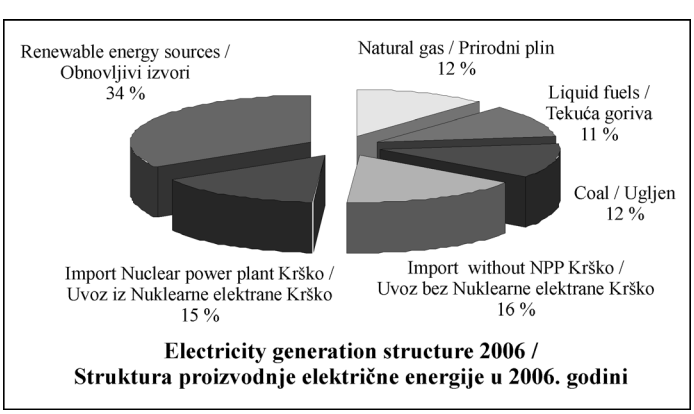


**Figure 3.** Electricity generation structure in Croatia in 2006 [1]

**Slika 3.** Struktura proizvodnje električne energije u Hrvatskoj u 2006. godini [1]

electricity-generating capacities in large hydropower plants in 2020 will amount around 300 MW starting from 2015 (HP Lešće). By 2020 1100 MW of thermal power plants total capacity will be shut down due to their deterioration. So, in order to fulfill the goal of 35 % share of electricity generation from renewable energy sources and large hydropower plants in total electricity consumption, total capacity of at least 2 400 MW of thermal power plants should be built along with at least 300 MW of back-pressure cogeneration units, at least 1 200 MW natural gas-fired power plants capacity and at least 1 200 MW of coal-fired power plants capacity are expected to be built by 2020 [2].

Since at present point Croatia is not ready to make decisions regarding building a nuclear power plant, because no preparation activities have yet been performed, starting with this Strategy Croatia initiates the Croatian nuclear program according to which decision making on building the nuclear power plant is expected by 2012 at the latest.

Furthermore, Croatia does not have any domestic coal reserves that it can utilize commercially but it is assumed that in 2020 around 375 thousand tons of the equivalent coal will be used in industry and around 3 ×106 tons in electricity generation. The advantage of Croatia, regarding coal supply, is the possibility of favorable import of good quality coal which is still characterized with security of supply, competitiveness and relative price stability [2].

*Renewable energy sources sector*

Concerning renewable energy sources (RES), the target share in gross final energy consumption in 2020 is 20% of the renewable energy sources. This prediction implies development of RES energy sector, especially utilization of biomass potential with planned biomass fired power plants of total 85 MW power, production of around 340 000 tons of bio fuels in 2020, governmental stimulation of wind power plants construction, construction of at least 100 MW of small hydropower plants, construction of 20 MW capacity in geothermal power and installation of 0.225 m2 of heat collectors per capita by 2020 [2].

### 3.2. Oil sector

Today in Croatia liquid fuels represent the main energy source. The share of liquid fuels in total energy consumption is around 50 % and the estimated average growth of the liquid fuels consumption in the final energy consumption until 2020 is 1.2 % per year with total liquid fuels consumption in 2020 around 4.3 ×106 tons. [3].

The domestic oil production of around 2 ×106 tons in 2010 is predicted to be reduced to only 500 000 tons in 2020 (Figure 5.), which stresses out the necessity of new oil supply directions assurance including Croatia's participation in planning and construction activities of the Pan-European Oil Pipeline (PEOP), reconsideration of the Druzhba Adria Project and creation of compulsory and operational oil stocks [3].

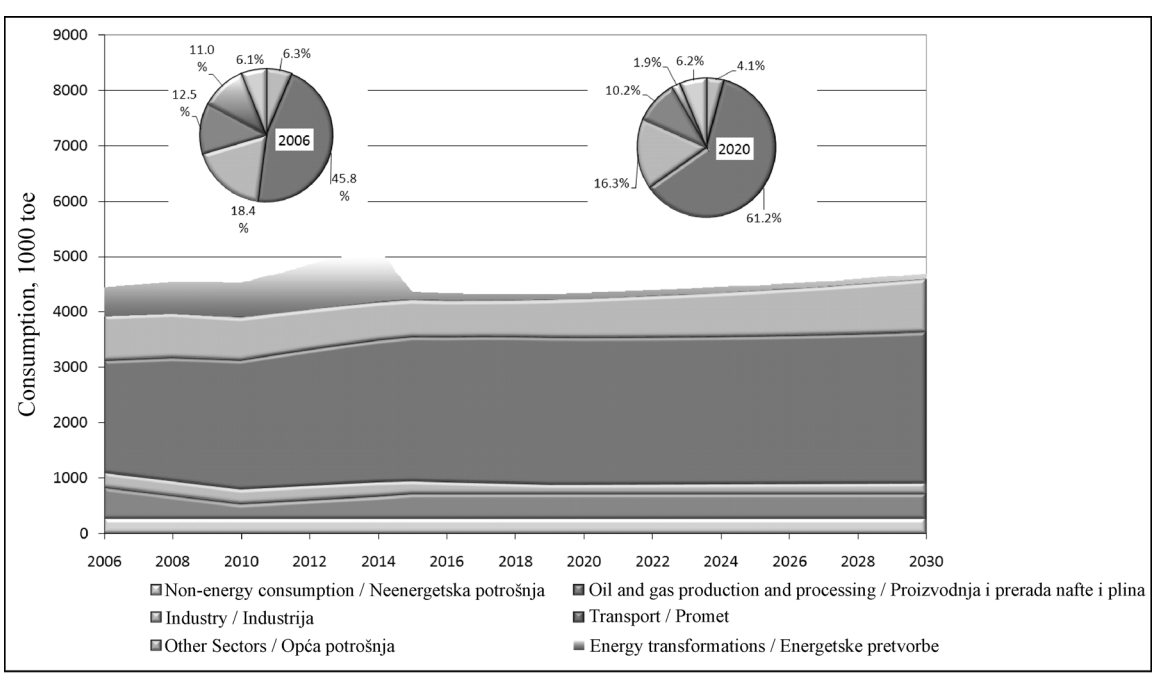


**Figure 4.** Projections of liquid fuels consumption in Croatia until 2020 [2]

**Slika 4.** Projekcije potrošnje tekućih goriva u Hrvatskoj do 2020. godine [2]

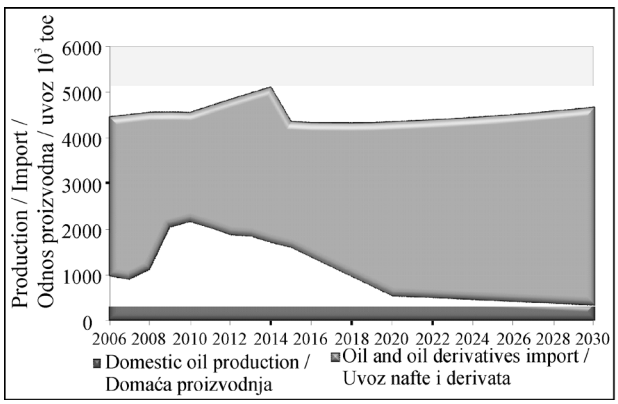


**Figure 5.** Crude oil production in Croatia [2]

**Slika 5.** Proizvodnja nafte u Hrvatskoj [2]

Realization of PEOP-Pan-European Oil Pipeline project, which started in 2007 including Croatia, Romania, Serbia, Slovenia, Italy and European Commission, which all signed the Declaration on this Pipeline, will partially secure diversification of oil supply in Croatia (Figure 7.). The pipeline route is planned from Romanian Black Sea port Constantza across Romania, Serbia, Croatia, Slovenia (underwater oil pipeline from Croatia to Italy is the alternative to direction through Slovenia), Italy, its connection to the oil pipeline TAL (Transalpine Pipeline which connects Italy, Austria and Germany) near Trieste, connection with the Italian oil pipeline network and further on to Genoa and Marseille. The main benefits of the PEOP project would be increased security of oil supply for European and Croatian refineries, new directions of oil supply via land and unloading of the Adriatic and Mediterranean tanker transport by several dozen million tons of oil per year. Furthermore, there are also direct economic benefits like increasing budget revenue for the local community and country, increasing revenue from transit tariffs and revenue for companies participating in the construction and operation of the pipeline [3].

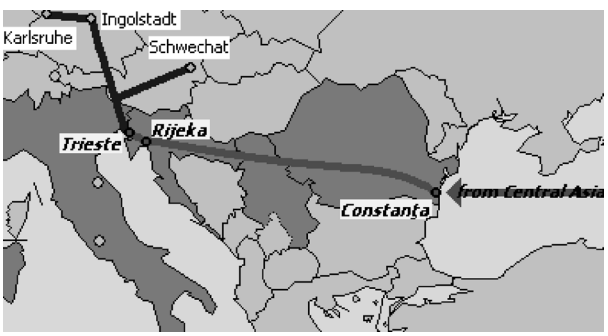


**Figure 7.** PEOP - Pan-European oil pipeline project [5]

**Slika 7.** PEOP – Projekt Pan-europskog naftovoda [5]

The second project for increasing supply security is reconsideration of the former Druzhba Adria project. First of all, it is necessary to analyze costs and benefits

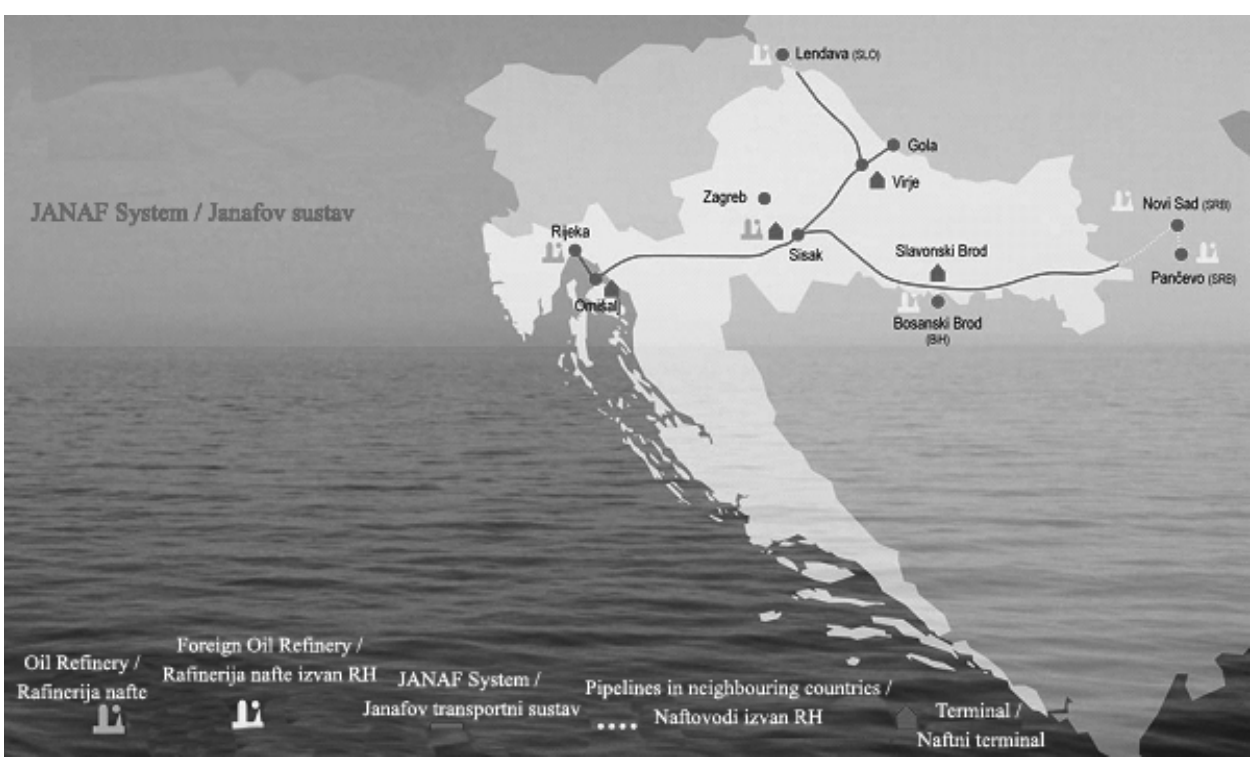


**Figure 6.** Present Croatian oil transport system [4]

**Slika 6.** Sustav transporta nafte u Hrvatskoj [4]

of this project from the environmental protection point of view. Druzhba Adria (Figure 8.) project stands for oil transport from Russia to Omišalj tanker port (Island Krk) through the existing oil pipeline system (Figure 6.), which is technically integrated and could provide supply of the Urinj refinery by Russian oil. In addition, in order to increase the security of oil supply in Croatia, especially in crises conditions, the Strategy recommends creation of compulsory and operational oil stocks. Compulsory oil and oil products stocks cover the supply needs in case of threats to the country's energy security as a consequence of extraordinary disturbances in supply. Additional storage capacities should be constructed for the purpose of forming the compulsory stocks, which will be strategically distributed across Croatia, due to the level of regional liquid fuels consumption. When choosing the location of the compulsory stock storages it is necessary to primarily consider and utilize the locations that are already in use as warehousing facilities for oil and oil products.


**Figure 8.** The Druzhba Adria Project [5]
**Slika 8.** Projekt Družba-Adria [5]

### 3.3 Natural gas sector

With regards to natural gas, the fundamental question that rises up is the security of supply and the desired level of market competitiveness. The present share of natural gas in total energy consumption in Croatia is 25% and around 16 % in final energy consumption (Figure 9). Constant growth of the natural gas consumption in final energy consumption over the next two decades (until 2020) is expected with the rate of 4.2 %. Future natural gas consumption in Croatia will depend on the structure and level of electricity generation as on domestic territory so in the region. Today Croatia covers around 60% of the total domestic natural gas consumption from domestic sources. According to the predictions the domestic natural gas production of around 2.6 ×109 m3 in 2010 will be reduced to 1.8 ×109 m3 in 2020. [6-9]

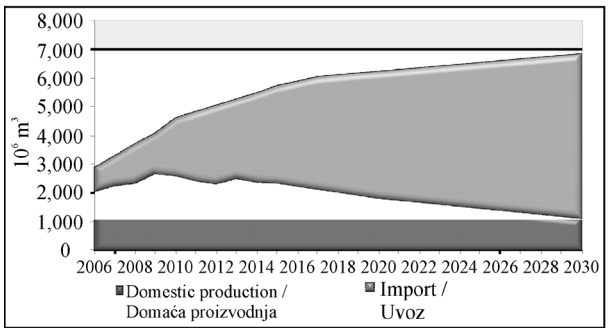


**Figure 9.** Natural gas production in Croatia until 2030 [2]
**Slika 9.** Proizvodnja prirodnog plina u Hrvatskoj do 2030. godine [2]

Securing new supply directions and construction of natural gas transport system is a prerequisite of natural gas sector development. Planned projects for achieving higher level of natural gas supply security include construction of the inter-state connection pipeline with the Hungarian natural gas transport system from Varosfeld gas pipeline hub to Slobodnica, which became a priority project for increasing security of natural gas supply and electricity production. The inter-state connection pipeline will start operating in the beginning of 2011, with the transit capacity of 6.5 × 109 m$^3$ of natural gas toward Slovenia, Austria and Italy. Beside this project, the additional projects, planned for the increase of supply security and supply direction diversification include construction of new underground natural gas storage Grubišno Polje, construction of a LNG (Liquefied Natural Gas) terminal in Omišalj on Island of Krk, the Adriatic–Ionian pipeline construction, construction of gas pipeline system in Dalmatia and Slavonia region and connection to the planned international natural gas pipelines such as Nabucco and the South Stream pipeline. [10]

The final capacity of the LNG terminal is planned to be 15 × 109 m3 of natural gas per year, which will ensure long term improvement of natural gas supply security in Croatia, diversification of natural gas supply directions but also an integration of Croatia into the unique European energy market. [11-12]

In 2007 Albania, Montenegro and Croatia signed an agreement on realization of pipeline construction of total capacity of 5 × 109 m3 per year (The Adriatic–Ionian pipeline). The pipeline route will start in the Albanian port Fier and will run to the Croatian port Ploče, connecting the Croatian natural gas transport system with the Trans-Adriatic Pipeline (TAP). This will represent a new natural gas supply and transit direction from the Caspian region and Iran to Europe. Furthermore it is planned to complete the construction of the 75 bar planned main gas pipeline system in Dalmatia and Slavonia region by the end of 2011. [2,10]

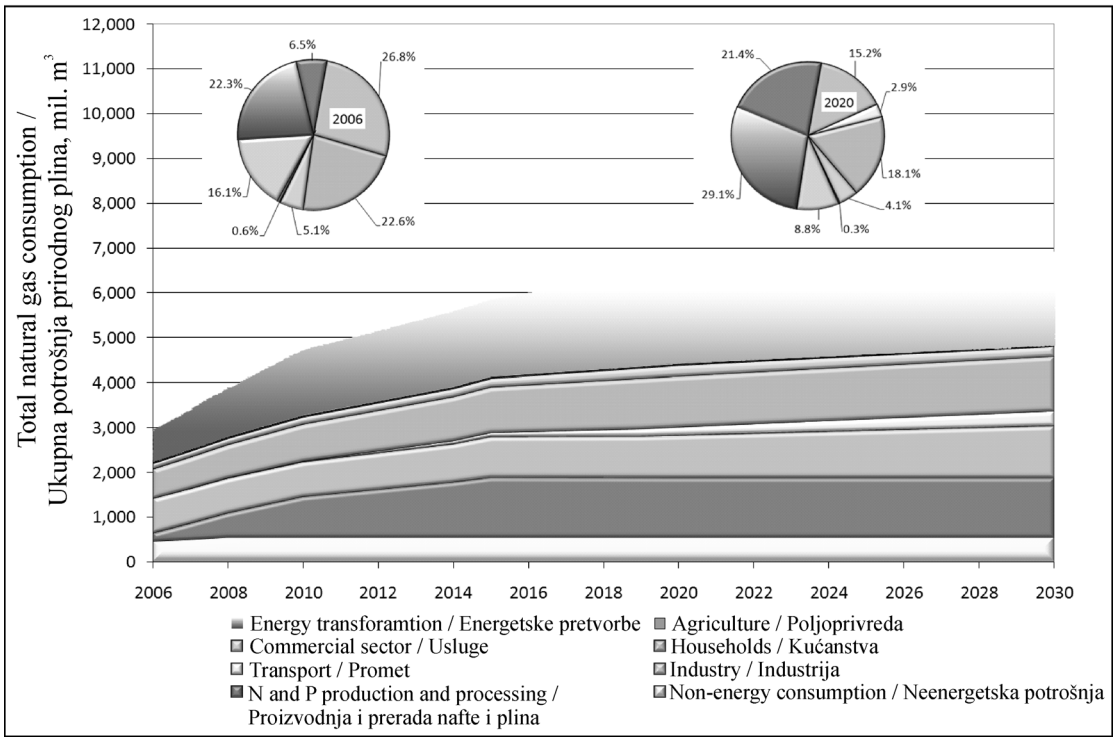


**Figure 10.** The projections of natural gas consumption in Croatia until 2020 [2]

**Slika 10.** Projekcije potrošnje prirodnog plina u Hrvatskoj do 2020. godine [2]

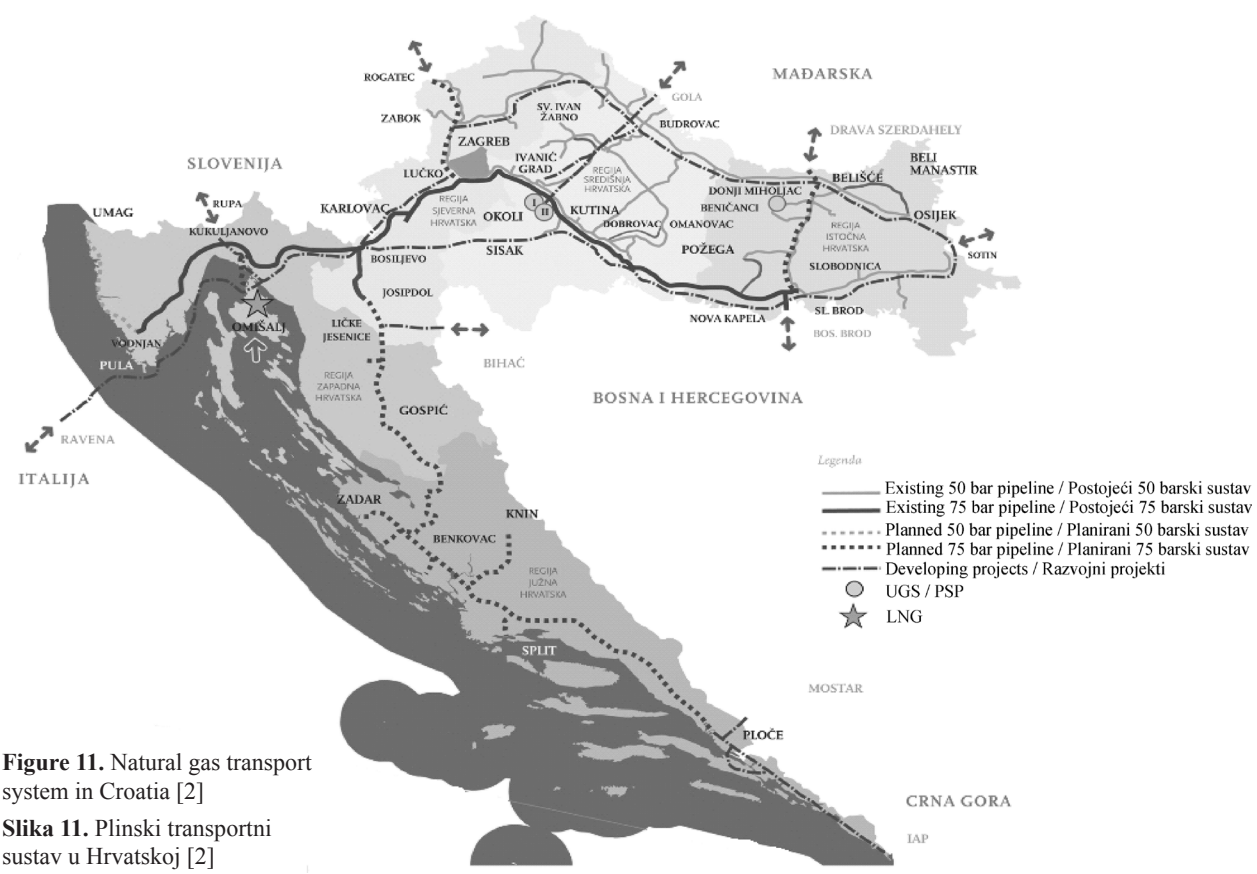


**Figure 11.** Natural gas transport system in Croatia [2]

**Slika 11.** Plinski transportni sustav u Hrvatskoj [2]

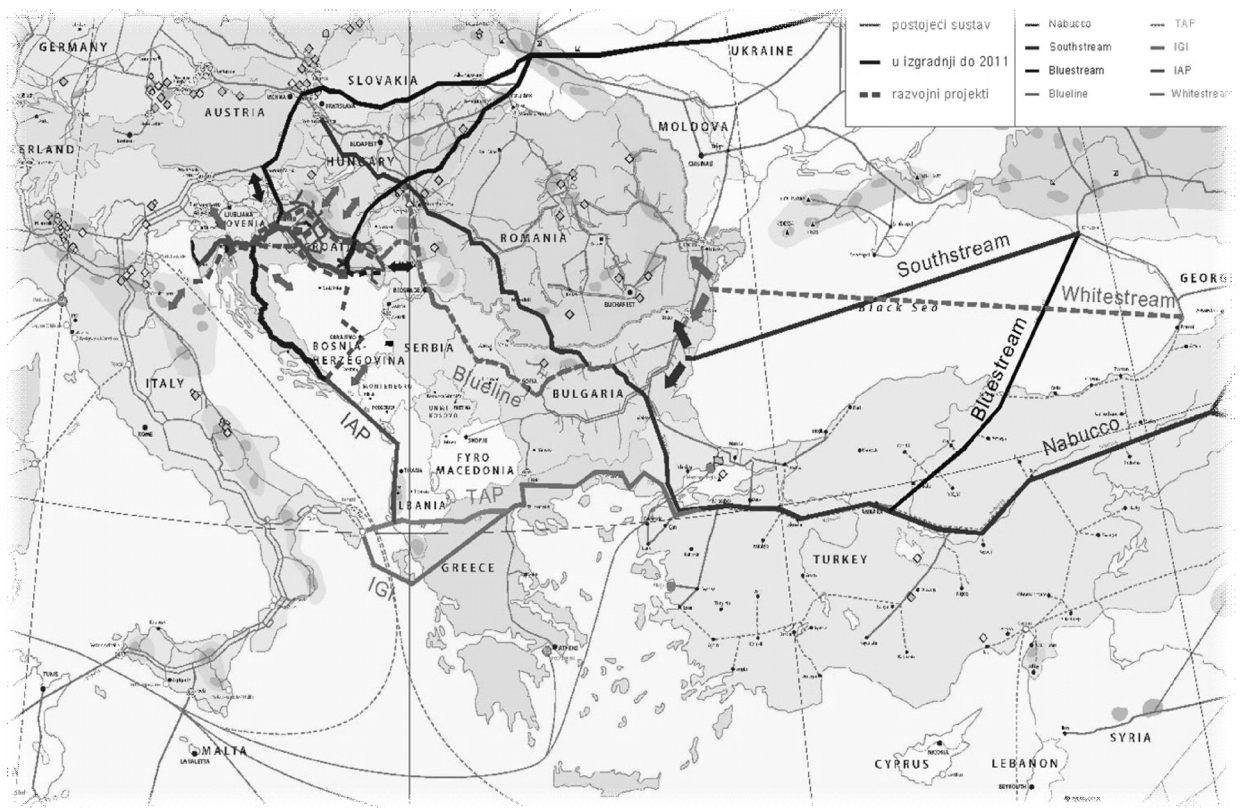


**Figure 12.** Planned projects for the development of natural gas transport system in region [10]
**Slika 12.** Planirani projekti razvoja plinskog transportnog sustava u regiji [10]

## 4. Energy Strategy Implementation

For the successful implementation of the Energy Strategy of the Republic of Croatia it is important to determine required measures and activity bearers for enforcement of particular measures as well as the realization dynamics of the adopted energy policy. In order to achieve sustainable development of overall energy sector, but also for the purpose of social and economic development of the Republic of Croatia, it is necessary that all planned activities, regulated by the Strategy within each particular part of energy system, are carried out. The implementation of the new Strategy must be carried out in the framework of European Union energy policy, which primary objectives are the security of energy supply, the competitiveness of energy sector and overall sustainable development, but also, at the same time, with the preservation of the national interests of the Republic of Croatia.

The target period for achieving the goals of the Energy Strategy is until 2020 with wider time scale up to 2030. The program for the Strategy implementation refers to the four years period after the adoption of the Strategy. Implementation of the Strategy lies upon state cooperation with national energy subjects, but also with all others entities like municipal government, nongovernmental organizations and international organizations for energy development planning.

By determination of the Strategy implementation principals the main instruments of planning, coordination and monitoring will be created. These principles certainly must include different groups of measures: like legislative, regulatory, organizational, financial, business restructuring measures, technical measures, energy efficiency and energy planning measures, environmental measures but also educational, informational, advisory and promotional measures.

The Strategy has three basic energy goals: security of energy supply, competitiveness of energy system and sustainability of energy development. For the purpose of achieving mentioned goals it is necessary to ensure energy sources diversification, promotion of efficient energy systems and renewable energy sources as well as encouraging efficient price policy and environmental protection.

By adjustment of Croatian energy legislation with the European Union directives i.e. Acquis Communautaires, it is necessary to ensure prerequisites for the Croatian joining the European Union, but also prerequisites for the

establishment and reinforcement of regional international energy market. As a member of that market Croatia could (should) take advantages of its geopolitical position in order to increase the competitiveness of national energy system. Furthermore, by active environmental protection, as a part of energy system development, which will be in detail developed in accompanying legislation, sustainability of energy system has to be ensured.

Moreover, after implementation of the Strategy there should be a revision of al conducted activities in order to insure the efficiency of Strategy implementation. Also it is necessary that the possible substitute implementation measures, in the case of non-fulfillments of planned activities, should be prescribed. There was a lack of quality assurance concerning previous Strategy of energy development in Croatia, adopted in 2002, and its accompanying Program of Strategy implementation from 2004. [13]. All measures for complete and quality implementation of Energy Strategy must be within suitable legislative and regulatory framework in order to ensure their consistent implementation, with the purpose of strategic energy goals realization.

## 5. Conclusion

For conclusion it can be stressed that the Energy Strategy of the Republic of Croatia assumes significant investments into energy sector in amount of around 15 billion € within the period from 2009-2020 (net present value). The largest investments are expected in power system around 60 % of total investments, then in oil and gas industry 30 % and 10 % in heating systems. The Strategy has answered to the European Union demands and offered solution for achieving the basic goals related to the security of energy supply, competitiveness of energy sector and sustainable development, but at the end, the global economic crisis will have the crucial effect on realization of previously mentioned planned investments in energy infrastructure. Also it must be emphasized that the Strategy implementation program should have been adopted immediately after adoption of the Strategy, but as time passes delay of the Strategy implementation could cause considerable problems in achieving mentioned strategic goals of energy sector.

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