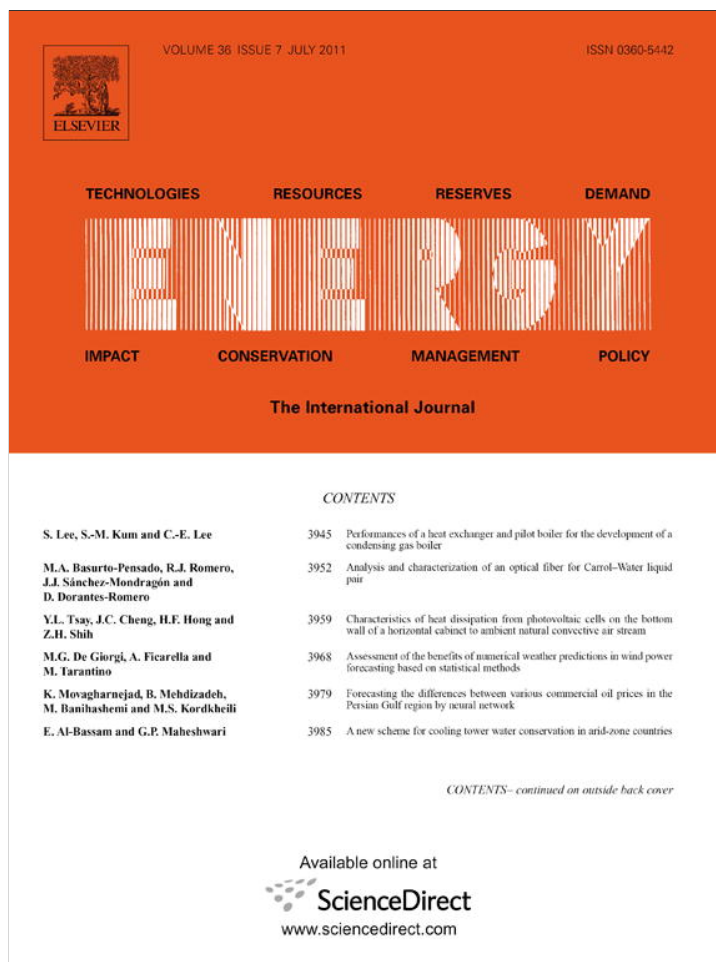


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Recommendations for implementation of energy strategy of the Republic of Croatia

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ABSTRACT

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 adoption of the Energy Strategy Implementation Program with associated measures is still in process. The goal of the Strategy was to create sustainable energy system that will make a balanced contribution to the security of energy supply, competitiveness and environmental protection in Croatia. In this paper an overview of the energy production, final energy consumption and planned development of energy infrastructure is given. The intention of the paper was to research and stress out the abilities and opportunities of Croatian energy system and to give recommendations for Energy Strategy implementation and practical realization of planned energy infrastructure projects for improvement of security of energy supply and competitiveness of energy system of the Republic of Croatia.

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1. Introduction

Until 2009 the relevant energy strategy in Croatia was the one from 2002 which considered energy sector development in Croatia on the basis of three energy scenarios – the “business-as-usual” scenario (the scenario without any measures towards energy efficiency improvement and environmental standards adoption), the scenario with moderate measures (the “most likely” scenario) and the scenario with additional measures (so called environmental scenario). The Strategy Implementation Program was adopted in 2004. At the end of 2009 Croatia adopted new energy strategy. Compared to the previous one the new Strategy considers only two possible energy sector development scenarios – the Business-as-usual scenario (BAU) and the Sustainable scenario (scenario based on additional measures towards energy efficiency improvement). The creation of the scenarios was based on global climate change and other environmental issues concerning meeting international environmental commitments and standards along with a creation of conditions for an open energy market activities with an effective market regulation. 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.

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Croatia has signed Energy Charter Treaty in 1994, ratified it in 1997 and in 1998 the Government has ratified the Protocol on Energy Efficiency and Related Environmental Aspects - PEEREA. PEEREA requires creation of energy efficiency strategies and policy aims, establishment of appropriate regulatory frameworks, development of specific programmes for the promotion of efficient energy use and development of programmes for reduction of adverse environmental effects from energy sector.

In 1996 Croatia ratified the UNFCCC, while Kyoto Protocol was ratified in 27 April 2007. Croatia is now obliged to reduce its emissions 5% in relation to the base year over the commitment period 2008–2012 and energy efficiency measures are expected to play crucial role in fulfilment of these obligations.

At the moment the Republic of Croatia is at the end of the negotiation process for joining the European Union (EU). By signing and ratifying the Stabilization and Association Agreement, Croatia is committed to opening and development of national energy market and its integration into internal energy market of the EU. It is expected that by the end of 2011 all of the negotiation chapters will be closed resulting with Croatia's full membership in the EU by the end of 2013. Before that Croatia has to harmonise its national legislation with so called Third Package (EU third internal energy market package) and to reform national energy sector in order to improve its competitiveness, safety of energy supply and ensure its sustainability. The harmonisation has to be done by March 3rd (same as other EU member countries). The Third Package sets out

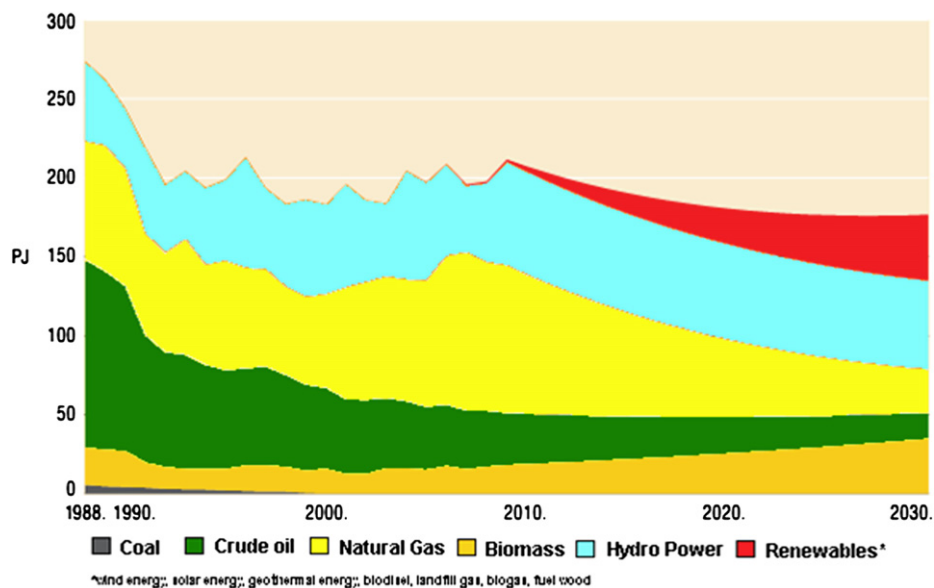


Fig. 1. Primary energy production in Croatia [9].

common goals, methodologies and mechanisms for improvement of internal energy sector of the EU. Furthermore, with new Energy Strategy Croatia has to ensure prerequisites for rapid start of investments into the energy sector.

Competitive market secures sufficient security of energy supply as one of fundamental goals of the Strategy. Market price and market position of energy entities is a powerful incentive to the market development. Liberalization of gas and electricity market in Croatia as EU acceding country was necessary in order to make easier adjustments to business conditions in a single market. In cases of natural monopolies, there is a necessity to regulate the price of service and the goal of such regulation is to protect the interests of consumers by defining a required quality of service with necessary costs. At the same time such regulation enables, through final tariffs, efficient service providers to do business while making profits adequate to investment risks.

The gas market liberalisation in the Republic of Croatia resulted in certain changes concerning the structure of the natural gas price for end consumers. Basic gas price elements include natural gas supply price and natural gas transmission and distribution tariffs defined by the Croatian Energy Regulatory Agency (CERA). In 2006 CERA has published documents that define methodologies and criteria for tariff values determination, so for the first time tariff systems were unbundled.

As an energy dependent economy, Croatia can alleviate the justified risk of further increase in the price of energy only by building an energy system which would be price-flexible. The Strategy clearly requires gradual liberalization of prices which were up to now regulated in an administrative manner. Actual prices of all energy products stimulate economic processes by which the social welfare is achieved in the optimum way, as well as the consumption elasticity. The impact of further, rapid liberalization of energy product's prices shall mostly impact the increase in prices of outputs of all sectors. In order to prevent possible unwanted social consequences, the Government should determine a minimum standard that has to be available even to citizens out of social category.

At the time of writing this paper the adoption of the Energy Strategy Implementation Program with associated measures is still in process. The new Strategy Implementation Program should 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. At the same time, the Strategy should be carried 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 main goal of this paper was to research possible and adequate measures for Croatian Energy Strategy implementation and possibilities for the development of different energy projects in the Republic of Croatia. In this paper an overview of the new Energy Strategy of the Republic of Croatia is given with an overview of the energy production and final consumption along with the planned

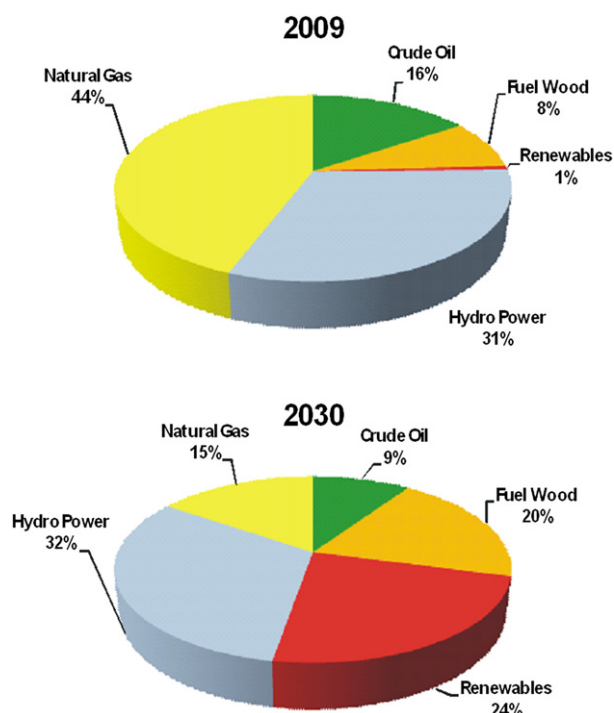


Fig. 2. Shares in primary energy production in 2009 and 2030 [9].

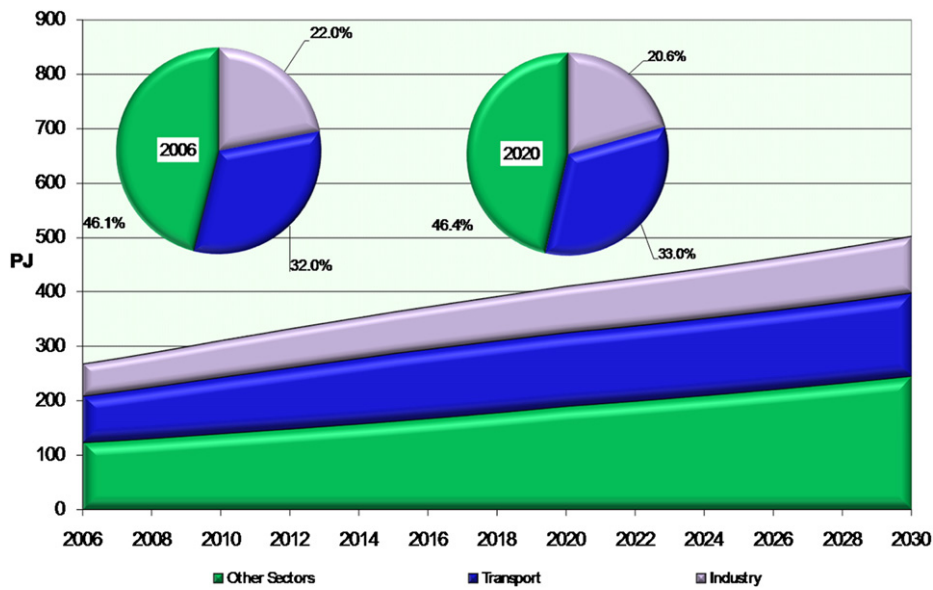


Fig. 3. Business as usual projections of final energy consumption in Croatia until 2030 [12].

development of energy infrastructure. Also some of accessible literatures in refer to different recommendations based on existing energy data have been analyzed [1,2]. The main principles of the Strategy, basic energy objectives and security of energy supply in Croatia were also discussed. The 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 sustainability of energy sector as a main challenge of energy development [3–5].

Furthermore, challenges and opportunities of Croatian energy sector development are given with an analysis of global geopolitical relations and security of energy supply. The challenges, but at the same time the opportunities, arise from the global climate change and other environmental issues, energy geo-strategic position of Croatia, approximation with the existing EU Energy Policy and present and future cooperation with neighboring countries and countries in

Southeast Europe [6–8]. Also, the vision of Croatian energy sector development, along with the future perspective of energy demand with strategic goals, priority activities and technological, economical and environmental strategy effects were presented in this paper.

2. Primary energy production in Croatia

In last six years the fastest growth in primary energy production was recorded in energy production from renewables. An increase was also recorded in natural gas production (3.9%/y) and fuel wood production (2.2%/y). Annual decrease of crude oil production was by 4.9%. The primary energy productions for 1988 as well as production forecasts to 2030 are shown in Fig. 1. As it can be seen from the figure it is expected that in future fossil fuels production will continue to decrease while the production from renewable energy sources will increase. In Fig. 2 the shares in primary energy production in 2009 and 2030 are shown [9].

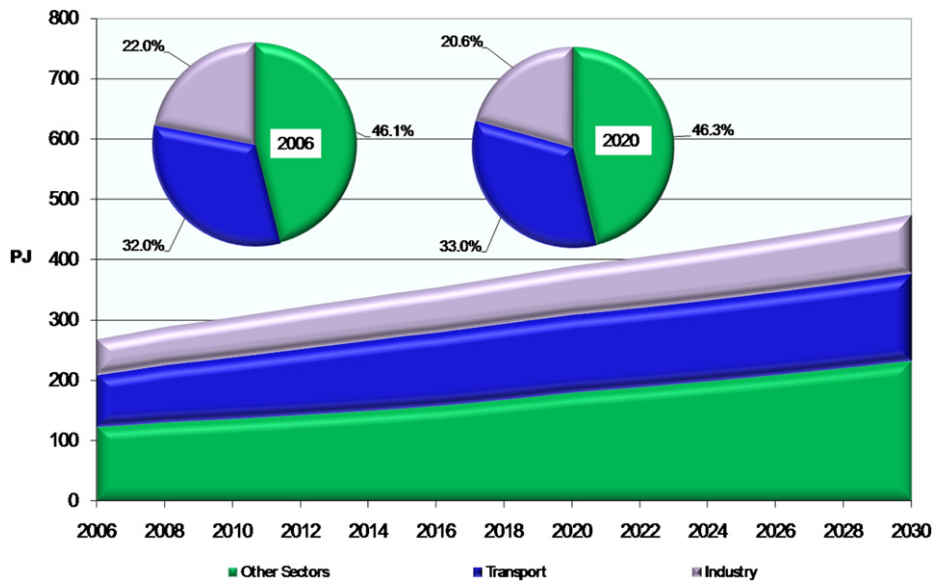


Fig. 4. Sustainable scenario projections of final energy consumption in Croatia until 2030 [12].

2.1. Final energy consumption in Croatia

Croatia is currently characterized with an increasing dependence on energy import since, at this moment, 50% of energy demand is imported. In primary energy supply in Croatia the share of oil was at level of 50% and natural gas at 25% [9]. In primary energy supply there is still a significant share of domestic oil and natural gas production, but the domestic hydrocarbon production records a constant decrease.

In the Strategy two main projections of energy consumption were given. Energy consumption is projected on sector and sub-sector level by using analogy methods (approximation of the Republic of Croatia to EU15 countries) and other econometric methods [10]. The new Energy Strategy is based on detailed analysis of final energy consumption projection in Croatia. Regarding demographic trends, it is projected that the population will remain constant (on 2007 level) taking into account the expected decrease of domestic population and increase of number of foreign inhabitants. The data used in the analysis are from the ODYSSEE database [11]. ODYSSEE MURE is a project coordinated by ADEME and supported under the Intelligent Energy Europe Programme of the European Commission. This project gathers representatives such as energy Agencies from the 27 EU Member States plus Norway and Croatia and it aims at monitoring energy efficiency trends and policy measures in Europe.

The final energy consumption in BAU scenario is based on an assumption that the consumption growth is purely determined by market trends and consumer's habits, without governmental intervention and with implementation of new advanced technologies. Final energy consumption represents the energy submitted to end users in industry, transport and other sectors (commercial and public services, agriculture, residential and non-specified) (Fig. 3).

Sustainable development scenario is a scenario used to achieve goals of the Energy Strategy. It is a result of energy policy measures proposed in the Strategy such as increase of energy efficiency in final energy consumption, increase of share of renewables, changes in use of energy in regards to the BAU scenario (Fig4).

The Energy Strategy objectives 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 1.

3. Development of Croatian energy sectors and infrastructure projects

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

Table 1
Increase in energy efficiency in Croatia by adoption of energy efficiency measures [2].

PJ	2006	2015	2020	Growth rate 2006–2020, %	2030
Consumption according to business as usual scenario	267.89	362.75	409.60	3.1	500.83
Consumption after implementation of energy efficiency measures	267.8	345.18	386.84	2.7	470.60
Reduction in final energy consumption	0.00	17.57	22.76	/	30.2

3.1. Power sector development

In period from 2000 to 2006 the power sector was characterized by the annual growth rate of final electricity consumption of 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 is predicted to reach present average electricity consumption in EU27 [12] (fig. 5).

Regarding power sector, the strategy of new electricity-generating capacities construction is based on maintenance of 35% share of electricity generation in total electricity consumption from renewable energy sources and large hydropower plants until 2020. It is expected that new 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 2400 MW of thermal power plants should be built along with at least 300 MW of back-pressure cogeneration units, at least 1200 MW natural gas-fired power plants capacity and at least 1200 MW of coal-fired power plants capacity are expected to be built by 2020 [12]. 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 3×10^6 tons in electricity generation. These amounts are expected to be covered by import. The advantage of Croatia, regarding coal supply, is the possibility of favorable import of good quality coal, which as an energy source, is still characterized with a security of supply, competitiveness and relative price stability [12–15].

3.2. Renewable energy sources sector development

Concerning renewable energy sources (RES), the target share in gross final energy consumption in 2020 is 20%. 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 [12,15].

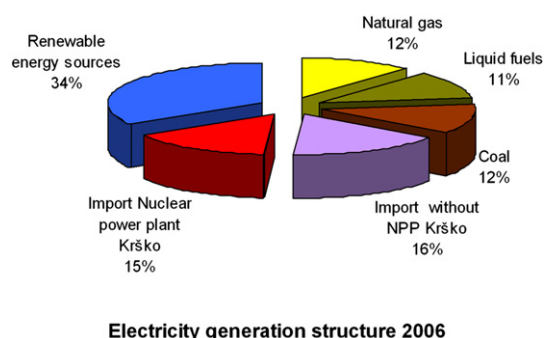


Fig. 5. Electricity generation structure in Croatia in 2006 [12].

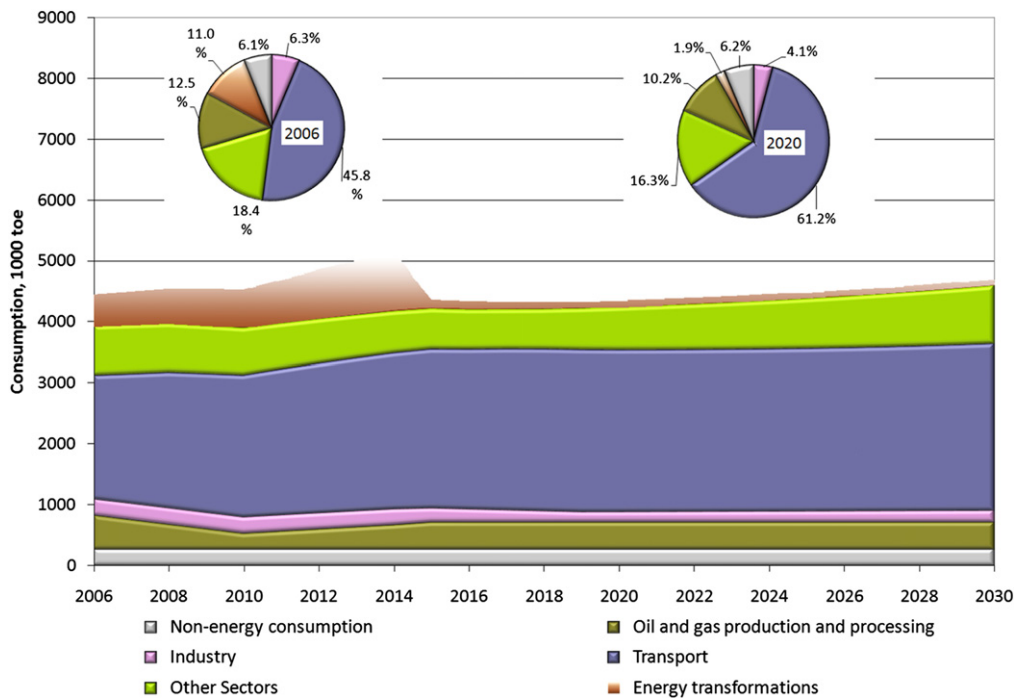


Fig. 6. Projections of liquid fuels consumption in Croatia until 2020 [12].

3.3. Oil sector development

Liquid fuels in Croatia currently represent the main energy source. The share of liquid fuels in total energy consumption is around 50% and the estimated average growth of liquid fuels consumption in the final energy consumption until 2020 is 1.2% per year with total liquid fuels consumption in 2020 around 4.3×10^6 tons [16] (Fig. 6).

Croatian domestic oil production of around 2×10^6 tons in 2010 is predicted to be reduced to only 500 000 tons in 2020 (Fig. 7), 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 [16].

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. 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 will 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

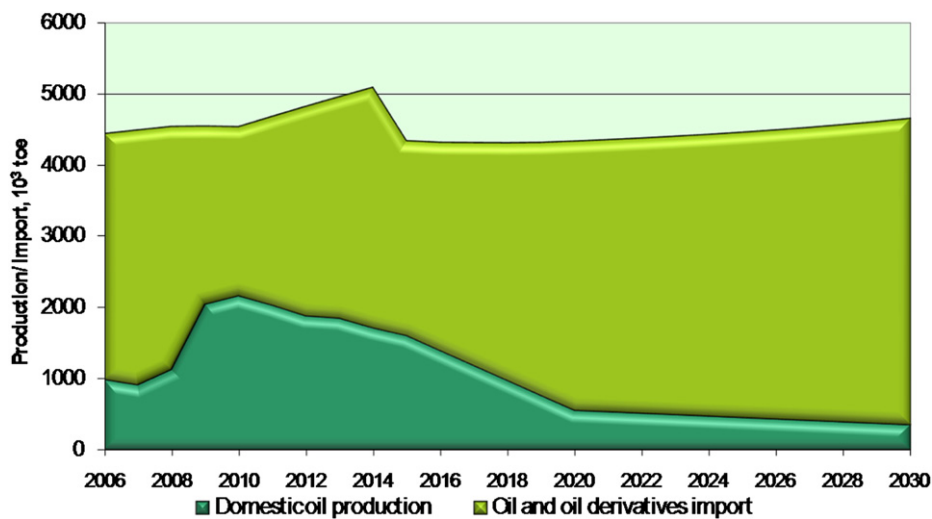


Fig. 7. Crude oil production in Croatia [12].

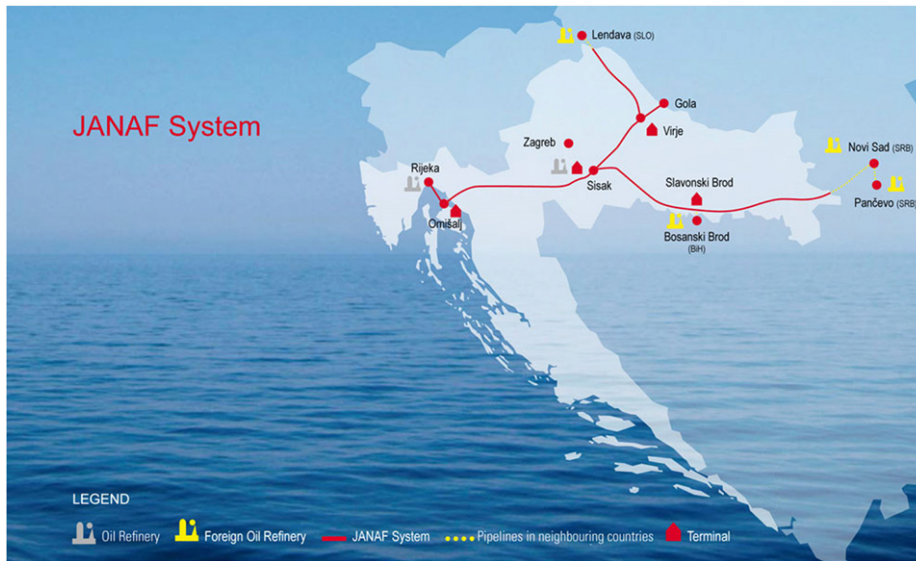


Fig. 8. Present Croatian oil transport system [17].

economic benefits of the project 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 [16] (Fig. 9).

The second project for increasing supply security in Croatia is reconsideration of the former Druzhba Adria project. First of all, it is necessary to analyze costs and benefits of this project from the environmental protection point of view. Druzhba Adria project stands for oil transport from Russia to Omišalj tanker port (Island Krk) through the existing oil pipeline system (Fig. 8), which is technically integrated and could provide supply of the Urinj refinery by Russian oil (Fig. 10).

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.



Fig. 9. PEOP - Pan-European oil pipeline project [18].



Fig. 10. The Družbna Adria Project [18].

3.4. Natural gas sector development

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%. In final energy consumption the share of natural gas is around 16% (Fig. 11). Over the next two decades (until 2020) constant growth of natural gas share in final energy consumption is expected to be 4.2%. Future natural gas consumption in Croatia will certainly 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 $2.6 \times 10^9 \text{ m}^3$ in 2010 will be reduced to $1.8 \times 10^9 \text{ m}^3$ in 2020 [19–22] (Fig. 12).

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 $6.5 \times 10^9 \text{ m}^3$ 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 an

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 [23].

The final capacity of the LNG terminal is planned to be $15 \times 10^9 \text{ m}^3$ 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 [24,25].

In 2007 Albania, Montenegro and Croatia signed an agreement on realization of pipeline construction of total capacity of $5 \times 10^9 \text{ m}^3$ 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 [12,24] (Figs. 13 and 14).

4. Recommendations for energy strategy implementation

In order to fulfil the Strategy goals different types of measures (legislative, regulatory, operational, administrative, informational, financial, energy efficiency and energy planning measures, environmental measures but also educational, informational, advisory and promotional measures etc) for sub-sectors within energy sector should be introduced along with 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 element of energy system, are carried out. 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. Based on an analysis of the Strategy goals in Table 2 some of the measures are proposed along with its predicted effects.

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

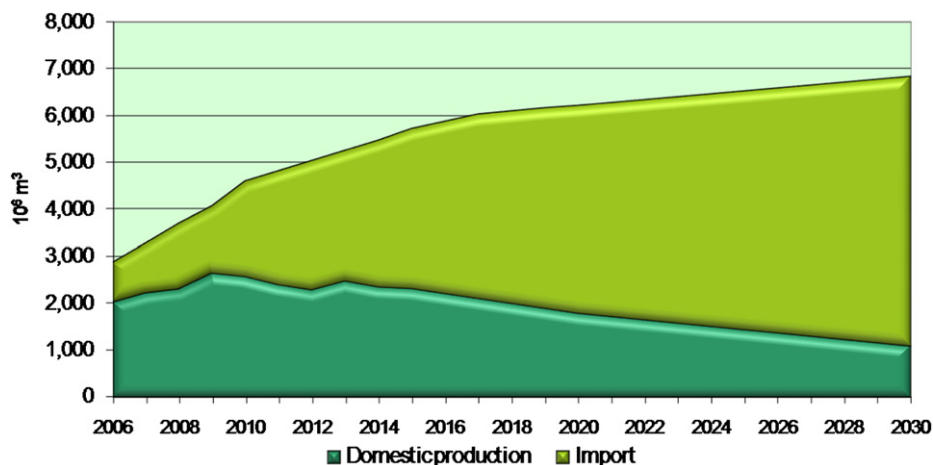


Fig. 11. Natural gas production in Croatia until 2030 [12].

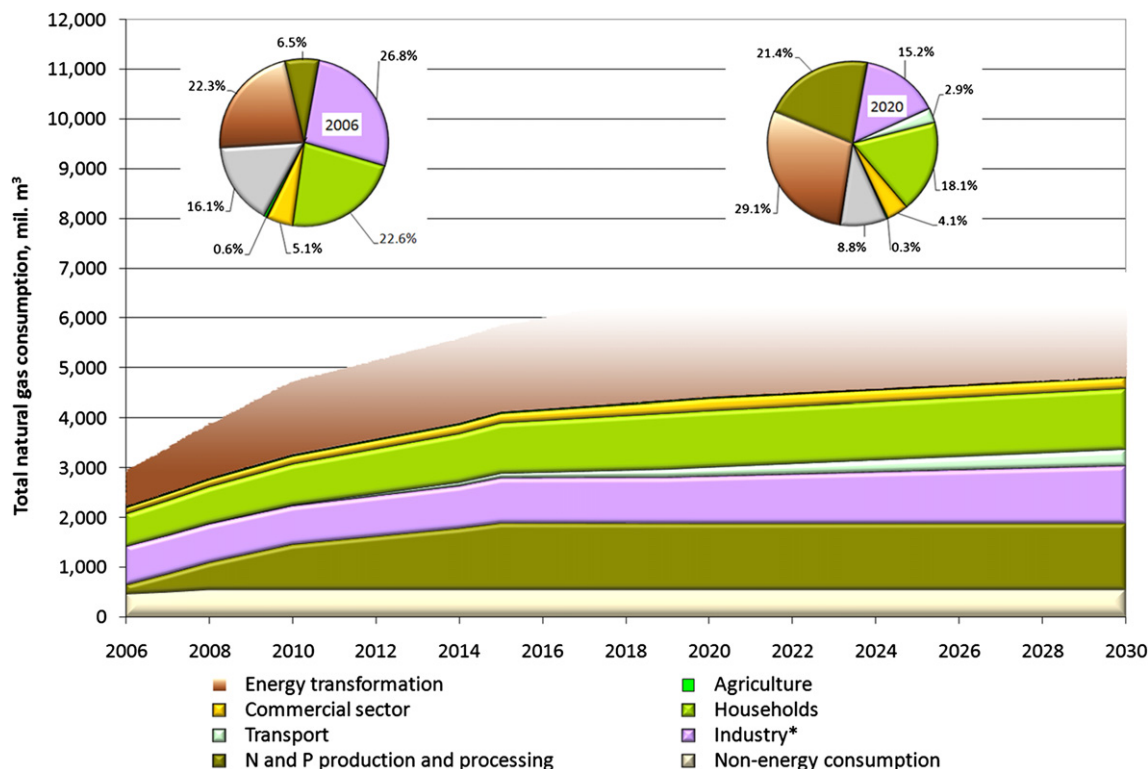


Fig. 12. The projections of natural gas consumption in Croatia until 2020 [12].

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 all 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-fulfillment 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 Strategy Implementation Program from 2004 [26]. 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. Comparative analysis of Central and Southeastern European countries' energy sectors and strategic guidelines

In next few figures and tables (Figs. 15–18, Tables 3 and 4) the contemporary state of energy sectors of Hungary, Poland, Czech Republic, Slovakia, Bulgaria, Romania and Croatia are given. The countries are chosen based on macroeconomic and geographical factors.

Hungary has been hit the hardest by the global financial crisis. It has stabilized by now, but this prolonged large investments that would increase the public debt significantly in energy sector.

Hungary is one of the analyzed countries with largest energy dependence from which rises the need for diversifying energy sources. Hungarian natural gas energy system is heavily reliant on Russian imports. Hungary has significant potential gas reserves but there are no good strategic measures for increasing of its exploration. Its energy strategy has been primarily focused on the Nabucco vs. South Stream dispute. The dispute between proposed gas projects is oriented to Hungarian further dependence on Russian gas. Also building an LNG terminal in Croatia is considered as a project of very high priority.

There has been public discourse about expanding nuclear power plant but this was put in back after financial crisis breakthrough.

Since Hungary's natural endowments don't offer many opportunities for renewable energy and also due to lack of investments in RES projects Hungary is lagging behind in fulfilling the set RES target.

Among analyzed countries Poland has the lowest energy dependence. Besides the measures for decreasing the reliance on Russian natural gas, there is a lot of discussion about the continuous reliance on coal (95% of electricity generation is from coal with rich coal resources), but most likely Poland's energy security in the near future will still be dominated by coal. Therefore Poland introduced measures for CO₂ emissions reductions by utilizing environmental friendly technologies. Also there is increasing exploration of natural gas reserves.

Energy policy is directed to privatization of the energy sector and privatization process will also affect the energy sector financing in future. Despite the increase of public debt Poland has retained ability to attract capital due to credible economic policy and the size of its market. When considering foreign investments there is fear from Russian capital entering Polish energy sector.



Fig. 13. Natural gas transport system in Croatia [12].

RES targets and CO₂ emission levels by 2020 have been adopted as a part of the official energy policy. Poland is relatively close to its RES target. Among renewable energy sources wind energy is considered as most promising one.

Czech Republic is not excessively reliant on foreign energy sources. The main issues about energy strategy in Czech Republic were articulated during first half of 2009 (Czech EU presidency). Energy security was second in the list of priorities, but after Russia – Ukraine gas dispute, energy security became the key issue. The Czech government introduced six point action plan:

- Diversification of energy suppliers, sources and supply routes-Northern Corridor, Southern Stream, Nabucco.
- Better inter-connections (Southern gas corridor, LNG, inter-connections in the Baltics, North–South, Mediterranean Energy Ring, North Sea offshore grid).

- Regular assessment of energy supply and demand for reduction of risks to the security of supply.
- Enhanced external dimension of the EU energy policy (high-level political engagement with supplier and transit countries-importance of Croatia as a transit country).
- Crisis mechanisms for oil and gas suppliers.
- Increased energy efficiency.

Among analyzed countries Czech Republic has good strategic direction toward RES targets and also it has fiscal room to invest in alternative sources.

Energy strategy of Slovakia was presented at the end of 2007. The main directions are based on EU principles of competitiveness, security of supply and sustainability.

Slovakia introduced measures for securing gas supply, functioning of liberalized gas market, crisis management and mechanism of emergency stocks.

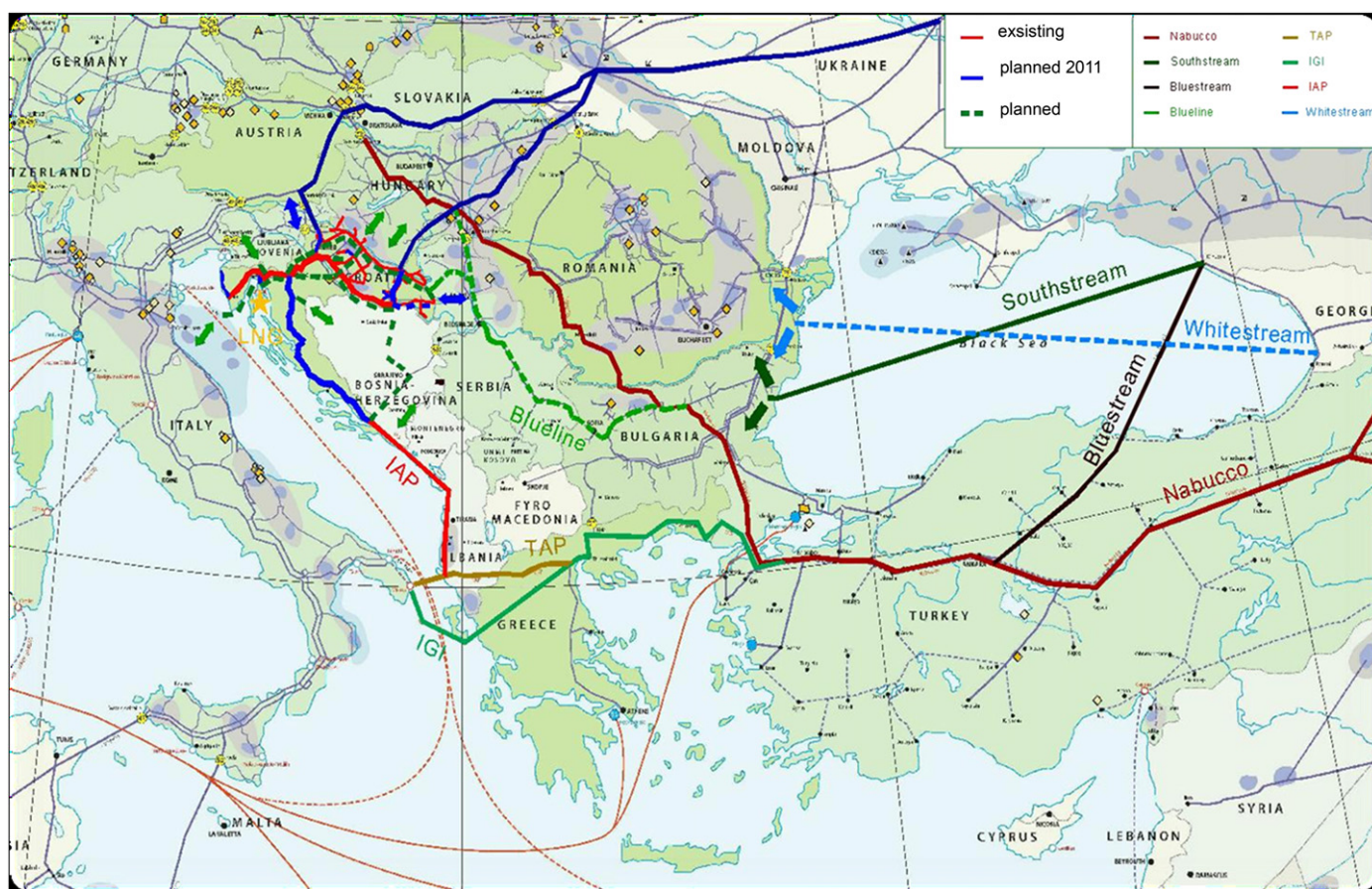


Fig. 14. Planned projects for the development of natural gas transport system in region [23].

Like previously mentioned countries, Slovakia has also strong energy reliance on Russian imports. The main gas pipeline projects in Europe are set as challengers to Slovakia's dominant transit role for Russian gas to Western Europe. Compared to analyzed countries diversification of gas supply in other countries is actually disadvantage for Slovakia.

Slovakia restored nuclear power unit which was condemned by EU, but Slovakia considers it necessary in time of crisis and Slovakian energy strategy considers nuclear energy essential as a long term energy solution (a few nuclear power projects) and also one of the only options for achieving the ambitious targets in CO₂ emission reduction, but there is minimal mention about concrete financial sources for proposed nuclear projects.

Slovakian energy strategy very little deals with renewable energy (only hydro). Strategic measure resulted with country's necessity for fiscal wherewithal to tackle the issues and meet its RES commitment.

Compared to other countries in the region Romania is not excessively reliant on foreign energy sources due to its oil and natural gas reserves. It also has significant hydroelectric generation.

Romania declared energy security as its second most important issue, right after the sustainability of economic growth. In order to decrease dependence on a single gas provider some energy supply diversification measures are taken. Romania is strong supporter of the Nabucco pipeline but does not distance itself fully from the South Stream project. Its energy strategy also considers nuclear energy as a long term solution for growing demand.

Measures for lowering energy dependency are at the moment stopped because of difficulties in attracting capital for major energy projects. EBRD, private investors and large European energy companies are considered as possible future investors.

Romania has strong attitude for reducing CO₂ emission but without clear policies and strategies to fulfil this commitment. Romania has rich hydro endowments and biomass, solar and wind potential, but there are no strategic programs in this regard.

Bulgaria is the country which was hit the hardest by 2009 gas crisis. Bulgaria has difficult situation in whole economy and in energy sector particularly. It is very much dependent on imported energy sources and it has no infrastructure to tackle loss of natural gas supply. It is entirely dependent on a single source in its gas supplies.

Bulgaria's energy policy is based on ambition to increase the country electricity production and diversify its sources of energy. Strategic measures include building of natural gas strategic reserves and furthermore interconnection with the neighbouring gas networks. In Bulgaria there are three projects under consideration (Beleno Nuclear Plant, Burgas–Alexandroupolis oil pipeline, Nabucco and South Stream). Oil pipeline is considered environmentally unfriendly. Gas pipeline projects are not viewed as competitors. There is lack of financial resources for nuclear power plant so the measures are introduced to attract private investors. Bulgarian government was not willing to finance alone the construction of a planned nuclear power plant. There is some progress regarding the strategic gas reserves (EU financing).

Bulgarian strategic measures resulted in balanced budget, but limited fiscal room for new investments. European investments (EBRD and EU) are viewed the key for large energy project funding.

There is no mention of renewable energy and no measures to achieve targets in RES and CO₂ emission reduction.

In Table 5 the analysis of strategy policy measures proposed in selected European countries is given.

Table 2

Proposed measures for achieving increase in energy efficiency in Croatia.

*1. Energy efficiency***Legislations and regulations for improvement of energy efficiency**

- ✓ Law enforcement for achieving National Energy Efficiency Action Plan objectives,
- ✓ Further development of energy services, energy efficiency and quality assurance.

Harmonization of building legislation and regulation for full incorporation of EU provisions on the energy performance of buildings

- ✓ Adoption and implementation of all sub-laws based on Physical Planning and Building Act.
- ✓ Reduction of energy consumption by setting up minimal requirements for energy performance of buildings.
- ✓ Continuous conduction of awareness rising campaigns.

Preparation of second National Energy Efficiency Action Plan

- ✓ Adoption of enhanced measures and activities that will comply with the requirements of the EU directive on energy end-use efficiency and energy services.

National campaign for raising the public awareness and establishing network of information centers

- ✓ Giving citizens free advice about options for improvement of energy efficiency in their homes.

Financial incentives for the implementation of energy efficiency measures through the Environmental Protection and Energy Efficiency Fund

- ✓ Application of innovative financing (third-party financing, public-private partnership).

*2. Renewable energy sources***Adoption of Renewable Energy Sources Act**

- ✓ Permanent adjustment of legislation with obligations of EU legislative framework related to renewable energy sources.

Adoption of Renewable Energy Sources Action Plan

- ✓ Increasing consumption from renewable energy sources in power sector, transport and heat and cooling energy production.
- ✓ Decreasing adverse environmental impact of energy sectors.
- ✓ Fulfillments of international obligations in renewable energy sources promotion and reduction of greenhouse gases emissions.
- ✓ Further development of sectors inter-connections and coordination of activities between government administrations for energy, environmental protection and physical planning, agriculture, forestry and financing.

Adoption of Biofuels Act amendments and National Biofuels Action Plan for stimulation of biofuels production and usage in transport

- ✓ Achieving sustainable development objectives in transport sector which will reduce greenhouse gases emissions and improve security of supply.

Introduction of registry of biofuel producers and users

- ✓ Increasing number of registered subjects.

*3. Power sector***Adjustment of energy legislation with Third EU Energy Package**

- ✓ Liberalization and increase of energy market competitiveness.

Initiation of Croatian Nuclear Program (CRONEP)

- ✓ Demystification of nuclear energy and encouragement of public debates regarding security of nuclear energy and its environmental impact.
- ✓ Preparation activities for decision making on building a nuclear power plant.
- ✓ Establishing of nuclear program legislation and regulation framework.

Establishing favorable legislative – regulatory framework for efficient open electricity market and attracting investments in power sector

- ✓ Implementation of economically cost-effective measures for effective use of electricity.
- ✓ Constructing various, regionally competitive power plants to meet growing domestic electricity demand while replacing existing deteriorated ones.
- ✓ Use of renewable energy sources in electricity generation and distributed production promotion.
- ✓ Development of transmission network for securing electricity supply and Croatian integration to common electricity market of the EU and Energy Community.
- ✓ Revitalization, modernization and development of electricity distribution network.

Revision of energy pricing

- ✓ Energy price liberalization and increase of competitiveness on electricity market.

*4. Oil and natural gas sector***Natural Gas Market Act amendments adoption**

- ✓ Adjustment of natural gas market legislation with Third EU Energy Package.
- ✓ Natural gas market development (competitiveness and security of supply).

Oil and Oil Products Acts amendments adoption

- ✓ Introduction of compulsory and increase of operation oil stocks for case of energy security threats.

Adjustment of energy subjects to Natural Gas Market Act and Third EU Energy Package

- ✓ Increase of business capability and market competitiveness of energy subjects.

Monitoring of LNG terminal planning and construction

- ✓ Information about construction dynamics in respect to natural gas supply diversification and security of supply.

Participation in international oil and natural gas pipeline projects for diversification of supply directions and improvement of oil and security of natural gas supply

- ✓ Background for projects final investment decisions.

Planning of new supply directions and expending of Croatian natural gas transport system.

- ✓ Ensuring natural gas transport system construction and expending dynamic.

Research study on new underground natural gas storage

- ✓ Background for project final investment decisions.

Surveillance over oil and natural gas exploration and production concession gaining process

- ✓ Securing desirable dynamic of oil and natural gas exploration and production.

Supervision of oil refinery modernization

- ✓ Information about modernization activities.

Research incentive for enhanced oil recovery (EOR) projects and CO₂ sequestration

- ✓ Increase of oil recovery and fulfillment of international obligations regarding reduction of greenhouse gas emissions.

Construction of infrastructure for reverse oil pipeline transport.

- ✓ Increase of security of oil supply.

*5. General sector measures***Establishing legislative and regulatory framework towards international integration and among energy sectors**

- ✓ Decentralization of energy policy.

Creating favorable national conditions for energy sector development

- ✓ Ensuring investments in energy sector and improving energy planning.

Revision of physical planning

- ✓ Integration of energy sector facilities in the physical plans
- ✓ Better administrative procedure for construction of energy facilities.

Integration of energy efficiency into Croatian education program at different educational levels

- ✓ Increasing knowledge about energy and its efficient use.

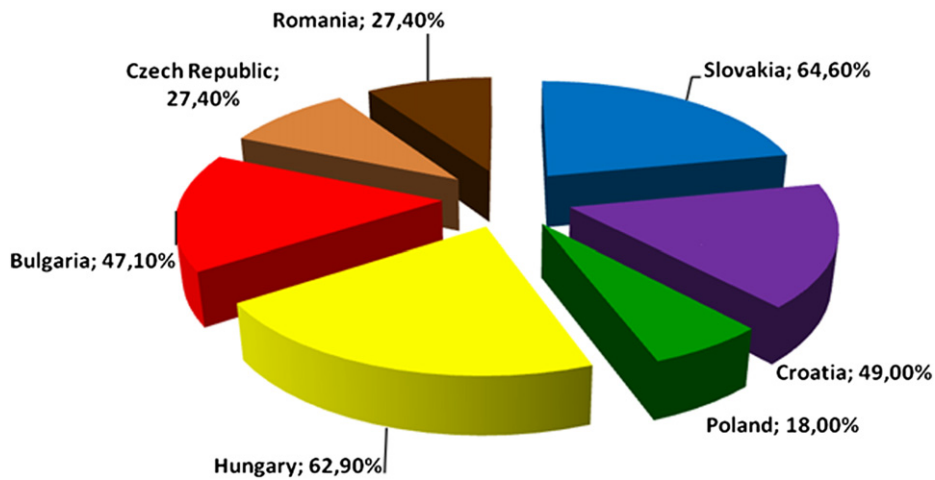
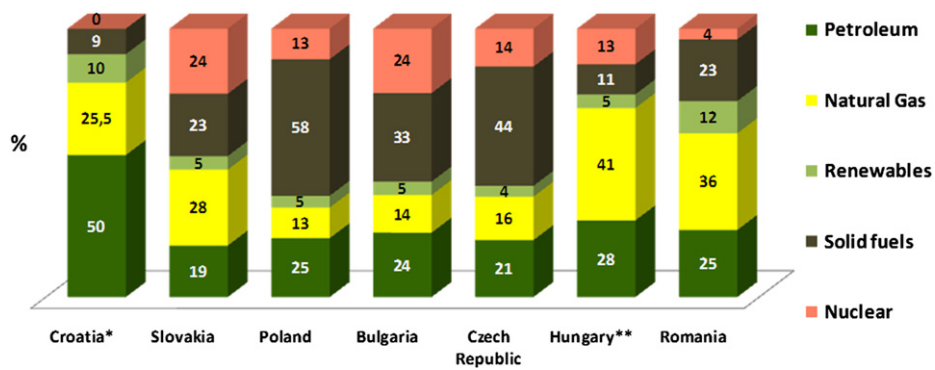


Fig. 15. Share of imported energy sources in total energy consumption 2009 [12,28,29].



* Croatia imports additional 5,5 % of its energy consumption as electricity
 ** Hungary imports additional 2,23 % of its energy consumption as electricity

Fig. 16. Share of different sources in gross energy consumption 2009 [12,28,29].

Energy strategies in analyzed countries need to strike a sustainable balance among aspirations for energy independence, meeting EU obligations and being affordable. Significant pressure is put on countries to achieve their RES targets. Continuing economic growth requires competitively priced energy. Since energy assets are relatively old in the region, new investments are necessary. The energy strategies of selected

countries have to solve very complicated situation including investment into new infrastructure capacities for improving countries' competitive position, while increasing the share of non-competitive renewable sources and improving energy independence despite the lack of sufficient financial resources. The analyzed strategies consider two options for achieving strategic goals of energy sector.

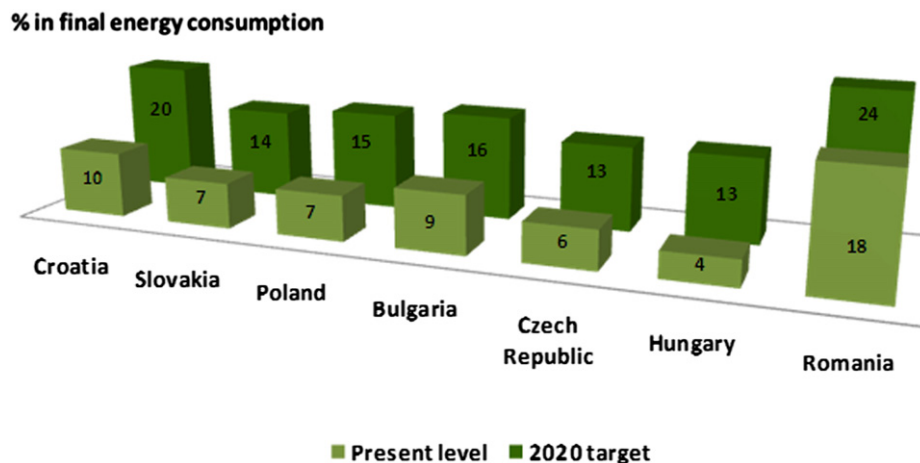


Fig. 17. RES targets by 2020 [12,28,29].

Table 5
Analysis of strategy policy measures proposed in selected European countries [12,28,29].

	Croatia	Hungary	Slovakia	Czech Republic	Poland	Bulgaria	Romania
Energy independence	Relatively heavily dependent (50%)	Very heavily dependent (63%)	Very heavily dependent (65%)	Relatively low dependent (27%)	Low dependent (18%)	Relatively heavily dependent (47%)	Relatively dependent (27%)
Economic potential	All countries are reliant on energy imports Czech Republic, Poland, Romania have relatively large domestic energy reserves and therefore their energy independence is relatively high Strategy measures include easing dependence on one supplier – the key driver of energy policy Very small All countries have relatively small economic potential for funding large scale energy projects Strategy measures include attracting foreign investment capital for energy projects Dependence on foreign natural gas supply is around 40% and oil above 80%	Very small Dependence on foreign natural gas supply is around 80% above 80%	Relatively good Relatively good Dependence on foreign natural gas and oil supply is around or above 80%	Small Substantial hydrocarbon resources, especially coal	Small Dependence on foreign natural gas and oil supply is around 80% or above 80%	Small Dependence on foreign natural gas and oil supply is around 35%	Small Dependence on foreign natural gas and oil supply is around 35%
Conventional energy sources							
Energy efficiency	Analysed countries are poor in energy sources and none of them is self sufficient in terms of energy resources Strategy measures include further exploration and development of domestic reserves Analysed countries are very energy inefficient						
Power sector	Proposed strategy measures suggested that investments into energy efficiency would be the most cost-effective way of lowering energy expenses but slow progress have been made Centralized urban heating – completely dependent on natural gas						
Oil & natural gas sector	Strategic measures for decentralization of urban heating and diversification of energy sources LNG terminal South Stream, Nabucco, LNG terminal in Croatia	South Stream, Nabucco, LNG terminal in Croatia	Diversification of transit routes of other countries imposes challenges for Slovakia current transit status	Gazelle, Nabucco LNG terminal, several interconnectors	LNG terminal, several interconnectors	South Stream, Nabucco and LNG terminal. Burgas-Alexandroupolis oil pipeline	Nabucco, South Stream
Economic aspects of energy strategy	The lack of alternative transit routes in case of natural gas Strategic measures include different projects for new pipelines connections and diversification of natural gas supply. (The Southern Gas Corridor, Nabucco, North Stream, LNG terminals, inter-connections in the Baltics, the Mediterranean Energy Ring and North Sea Offshore Grid)						
Financial measures and risk	Level of central heating price gives burden on the state budgets Strategic measures for additional energy investment for the fast amortizing energy asset base need to provide supply for the new demand						
Geopolitical issues	Strategic measures for redefinition of energy investment strategies because of the limitations on funding new projects due to scarce and expensive capital Countries under the influence of energy import from Russia but geopolitically very important position because of energy flows						
Environmental protection policy	Commitment to achieve targets for combating climate changes and enforcement of EU directives (Setting targets for the RES and CO ₂ emission reduction by 2020) Strategic measures for achieving set targets						
Progress made in achieving res targets	Actual level of RES targets 10% and 2020 target is 20% of final energy consumption.	Actual level of RES targets 4% and 2020 target is 13% of final energy consumption.	Actual level of RES targets 7% and 2020 target is 14% of final energy consumption.	Actual level of RES targets 6% and 2020 target is 13% of final energy consumption.	Actual level of RES targets 7% and 2020 target is 15% of final energy consumption.	Actual level of RES targets 9% and 2020 target is 16% of final energy consumption.	Actual level of RES targets 18% and 2020 target is 24% of final energy consumption.
	Most countries have made proportionate progress in achieving RES targets on time Romania has the highest target but also very good potential (hydro and biomass) to fulfill set targets Hungary has the lowest target in EU but with no significant renewable energy potential (only biomass and geothermal) is the farthest from its target Different strategy measures were proposed but some countries like Slovakia and Bulgaria do not consider use of renewable energy at the moment Croatia has a good potential in different renewable energy (wind, small hydro, solar, biomass) but also it will need significant investments in renewable energy sector to achieve targets						

The first one includes development of domestic energy sector by implementing one or a few capital intensive measures as simple energy solutions, but either too expensive or too environmentally unfriendly. The second one includes less capital intensive solutions with necessity of implementing several measures to make significant progress in energy sector development. In assessing the first options there are three main measures category. The first one is building new nuclear power plants, which enhances energy independence, but on the other hand is advantageous from CO₂ point of view, upfront investment cost of building a nuclear plant is enormous and not to mention the negative public opinion impact as a result of latest nuclear catastrophe in Japan. The next category of measures includes realization of the Nabucco pipeline project and realization of new LNG terminals (Poland, Croatia and Romania), which would significantly decrease energy dependence in region and also increase share of natural gas in the energy mix. The implementation of these measures represents significant political and financial sourcing obstacle and also there is misgiving in high cost of natural gas in future. Building new coal-fired power plants represents the third category of measures since coal is abundant in the region and relatively cheap energy source. The main drawback for this measure is that coal represents the most environmental unfriendly energy source and commitments to environmental protection imply decrease of coal consumption. Some of proposed measures are not feasible for some countries, while others might be possible in limited scope only with necessity of having alternatives.

The second energy option explores some more incremental measures with no ultimate energy solution but helping to develop energy sector. The most straightforward measures, possible in most countries, include further integration of energy markets, exploration of domestic hydrocarbon reserves, exploitation of local energy synergies and improvement of overall energy efficiency. The flexibility of energy system can be achieved by interconnecting energy infrastructure. The further exploration, development and production of domestic hydrocarbon reserves, especially natural gas can reduce countries' dependence on energy imports. Also natural gas provides competitively priced energy at no significant environmental cost and without any additional investment needs in energy transformation. Furthermore, local energy systems based primarily on biomass, geothermal, hydro and solar energy can significantly increase energy independence and also address environmental concerns. Since regional energy efficiency is very low there is a huge potential for introducing low cost energy savings measures.

6. Conclusion

The recent economical and geopolitical events dramatically impacted the dynamics of energy policy implementation in Central and South-eastern Europe region. Therefore, the issues in the energy sectors of analyzed countries have become more pressing.

The global economic and financial crises significantly decreased the amount of western liquid capital. Crisis also exposed the region's vulnerabilities and increased investment risks. Analyzed countries don't have significant economic potential for funding large scale energy projects. Therefore funding became a key obstacle to energy investments. So, the policy main problem became how to finance major energy projects proposed in strategies.

On the other hand, current economic depression influenced governments resulting with renewable energy initiatives taken even more seriously. The renewable energy sector has a great potential for industrial growth. The developed EU countries push towards green economy therefore EU RES targets became more important. Almost 80 billion EUR in investments is needed for achieving RES targets in the analyzed countries including Croatia. Comparing with conventional energy sources renewables are not

competitive and there will be challenging to attract required capital for project investments. But, EU is likely to put more pressure on but also provide more help for members countries lagging in meeting RES quota set for 2020. Therefore Croatia, as not yet a member country but in the process of joining EU, does not have the same level of resources for achieving RES targets and therefore will have to put more effort in.

Natural gas transport disputes between Russia and Ukraine exposed energy vulnerability to disruption, led to restrictions on natural gas consumption and resulted with the issue of energy dependence as a top priority in most analyzed countries' energy policy including Croatia.

Beside common goals including reduction of greenhouse gas emissions for 20% in 2020 in relation to 1990, 20% of renewable energy sources share in gross final energy consumption in 2020, 10% of renewable energy sources share in all types of transport in relation to the final energy consumption in land transport, decrease of final energy consumption of 9% in a period until 2016 using the energy efficiency measures; Croatia is setting up a national goal to maintain the share of electricity generation out of renewable energy sources, including large hydropower plants, at level of 35% in total electricity consumption in a period until 2020. Croatia will require significant increase in energy consumption regardless of energy efficiency increase.

Implementation of previously proposed measures will significantly influence the gross domestic product (GDP). Due to changes in energy sector along with necessary investments an average annual growth rate of GDP is expected to be at least 1 percent. Previous experiences show that energy sector investments have a large impact, in positive sense, on a majority of macroeconomic variables.

In conclusion it can be stressed that the Energy Strategy 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), oil and gas industry (30%) and heating systems (10%) [27]. There isn't enough capital accumulation for necessary energy sector investments, so Croatia will require the funds from international capital market. However, the basic condition for foreign investments is the achievement of electricity and natural gas market prices and legal framework protecting the foreign investments which can bring more investors and ensure competitiveness.

The new Energy Strategy has answered to the European Union demands and offered solutions 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 of the Republic of Croatia.

The strategic measures for Croatia proposed in this paper are, at the moment, the best possible solution for achieving planned goals of Croatia as a country in a process of joining EU. Only by implementation of the proposed measures it is possible to achieve set goals as energy sources and supply diversification with ensuring sufficient energy for predicted increase of energy consumption.

The most challenging issue that arises from achieving the goals will most certainly be lack of financial sources due to contemporary economic situation in Croatia but also on the global scale. Therefore Croatia is facing a difficult task of attracting foreign investors. On the other hand, withdrawal of financial sources from EU pre-accession funds could be a possible solution form implementation of proposed measures for set energy goals.

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