

MINISTRY OF ECONOMY, LABOUR AND ENTREPRENEURSHIP
AND UNITED NATIONS DEVELOPMENT PROGRAMME (UNDP)

UPDATE/UPGRADE OF THE ENERGY
STRATEGY AND OF THE
IMPLEMENTATION PROGRAMME OF
THE REPUBLIC OF CROATIA

GREEN PAPER, DRAFT

OCTOBER 2008

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1. INTRODUCTION

1.1. Purpose and Goals of the Updated Strategy

Croatia is approaching times when it has to make difficult and far-reaching decisions regarding its energy sector development. These decisions shall have a long-term impact on the Croatian economy, environment and society as a whole. The Strategy is aimed at showing current situation in the Croatian energy system and consequences of possible development options, as well as at establishing a transparent, decisive; add comprehensive national energy policy on the basis of extensive public consultation process followed by a political decision.

The purpose of the Croatian Energy Strategy update and upgrade is to define the development of Croatian energy sector by 2020.

The goal of the Strategy is to build, under the conditions of uncertainty in the global energy market and scarce local energy resources, a sustainable energy system that makes a balanced contribution to security of energy supply, competitiveness, and environmental protection and provides for security and availability of energy supply to the Croatian citizens and business sector.

Pursuant to Article 80 of the Constitution of the Republic of Croatia and Article 5, Section 3 of the Energy Act (Official Gazette 68/2001), the Croatian Parliament adopted the Energy Strategy of the Republic of Croatia (Official Gazette, 38/2002) – hereinafter referred to as 2002 Strategy - at its session held on 19 March 2002. According to the Energy Act, the Energy Strategy is a fundamental document aimed at setting up the energy policy and planning of the Croatian energy sector development adopted for a period of 10 years. The 2002 Strategy covered the period until 2030.

Since the 2002 Strategy was adopted, significant changes have happened at both international and national level. These changes affected the energy situation in Croatia and the basic facts for reconsideration of the Croatian energy sector future. Events that marked the previous period and which will have an impact on the development of energy sector in Croatia (requiring the update and upgrade of the national energy strategy) are as follows:

- *Croatia has become a candidate country for full membership in the European Union (EU),*
- *The Energy Community Treaty has been signed and ratified,*
- *Croatia ratified Kyoto Protocol along with the United Nations Framework Convention on Climate Change,*
- *Increase in the price of energy and instability of global energy market.*

1.2. The Approach to the Energy Strategy Updating – Basic Principles

The Croatian Energy Strategy has three basic energy objectives:

- *Security of energy supply,*
- *Competitive energy system,*

▪ **Sustainable energy sector development**

These objectives are elaborated in this Strategy, respecting specific situation in Croatia and its national interests. **Consequently, the Strategy is based on the following fundamental principles:**

- (1) ENERGY STRATEGY ADDRESSES THE GOVERNMENT'S ROLE IN ENERGY SECTOR**, namely it defines government's responsibilities in securing and exploitation of energy sources, competitiveness and the environmental protection. The government is to actively build security of energy supply as a component contributing to the Croatian economic growth. The main instruments of the government energy policy include regulation of the energy sector, consumer protection, promoting energy efficiency, internalization of external costs into the price of energy, planning in energy sector and taking timely actions to encourage investments (private investments in particular).
- (2) THE CROATIAN ENERGY SYSTEM IS REGARDED AS AN OPEN SYSTEM** integrated with the energy system of EU and regional energy system of Southeast Europe. The objective is to develop energy market and increase competitiveness, to attract foreign investments into market-oriented activities and energy sector, to harmonize development of future strategic energy projects (transit infrastructure in particular), and to establish economic cooperation with neighbouring countries.
- (3) ENERGY SECTOR IN CROATIA SHALL BE BASED ON MARKET PRINCIPLES.** The government shall intervene into market processes only when the stakeholders are affected by disturbed security of supply, quality of the environment, and monopoly.
- (4) ENERGY SECTOR IS ENTREPRENEURIAL, INFRASTRUCTURAL, AND EXPORT-ORIENTED ACTIVITY.** This Strategy changes the existing paradigm according to which the energy industry is only an infrastructural sector, and views it as an entrepreneurial activity open for private, especially foreign investments and an activity that would be a foundation for economic growth and development of Croatia in the future.
- (5) CROATIAN LEGISLATIVE, REGULATORY AND INSTITUTIONAL FRAMEWORK HAS TO BE CONTINUOUSLY HARMONIZED WITH EU ACQUIS COMMUNAUTAIRE** by transposing its spirit while having in mind specific Croatian conditions and interests.
- (6) INCREASE IN ENERGY EFFICIENCY** in all segments of the energy sector, especially in the final energy demand and primary energy production sectors (in power generation facilities design and operation stages), is considered as *an additional source of energy and as a basic permanent, long-term principle applying to the functioning and development of the energy system.*
- (7) CROATIA SHALL AIM AT ENERGY SECTOR DIVERSIFICATION** without preset restrictions on use of technologies and energy options available and accepted in the EU (renewable sources, natural gas, coal, and nuclear energy). *The Croatian energy sector development shall be based on energy-related, economic and environmental assessment of all available energy options.*
- (8) USING SPECIFIC CROATIAN GEOGRAPHIC POSITION** as an extraordinary potential for the Croatian energy sector development. *Croatia is potentially a transit country with excellent potential sites for construction of power generation plants.* In this regard, coordination

between the Energy Strategy, Physical Planning Strategy, and Physical Planning Program and land use plans is of utmost importance.

(9) IT IS NECESSARY TO LEVEL THE ENERGY SUPPLY CONDITIONS ON THE CROATIAN TERRITORY

with regard to the quality of supply and availability of different types of energy, especially of natural gas, but also of liquefied petroleum gas on the islands and in remote areas when natural gas supply is not economically viable.

(10) ENERGY STRATEGY SHOULD INTEGRATE THE ENVIRONMENTAL GOALS AND MEASURES WITH THE NATIONAL POLICIES TO MITIGATE CLIMATE CHANGE¹.

Croatia should be internationally active in creating policies and measures to mitigate climate change, and should fulfil the related commitments in an effective manner. Other problems related to the environmental impact should be solved at the local level using adequate technical concepts for power generation facilities and building energy structure that would enable sustainable development. By ratifying the Aarhus Convention (on 7 December 2006), Croatia adopted public right of access to information, public participation in decision-making, and access to justice in environmental matters.

1.3. Structure and Time Framework of the Energy Strategy

The Energy Strategy of the Republic of Croatia mostly focuses on the period until 2020. This is a long enough period to achieve the defined goals which concurs with the period covered by all adopted EU energy strategies. This facilitates comparison between national goals and EU goals. Beyond 2020, the Strategy offers only a “glimpse into future”. This period evades certain forecasts, therefore just some development guidelines are offered. Implementation of the Strategy will be elaborated in the Implementation Program.

Structure of the Strategy and its main elements are presented in Figure 1-1.

¹ According to the Integrated Energy and Climate Change Legislative Package, EC, January 2008.

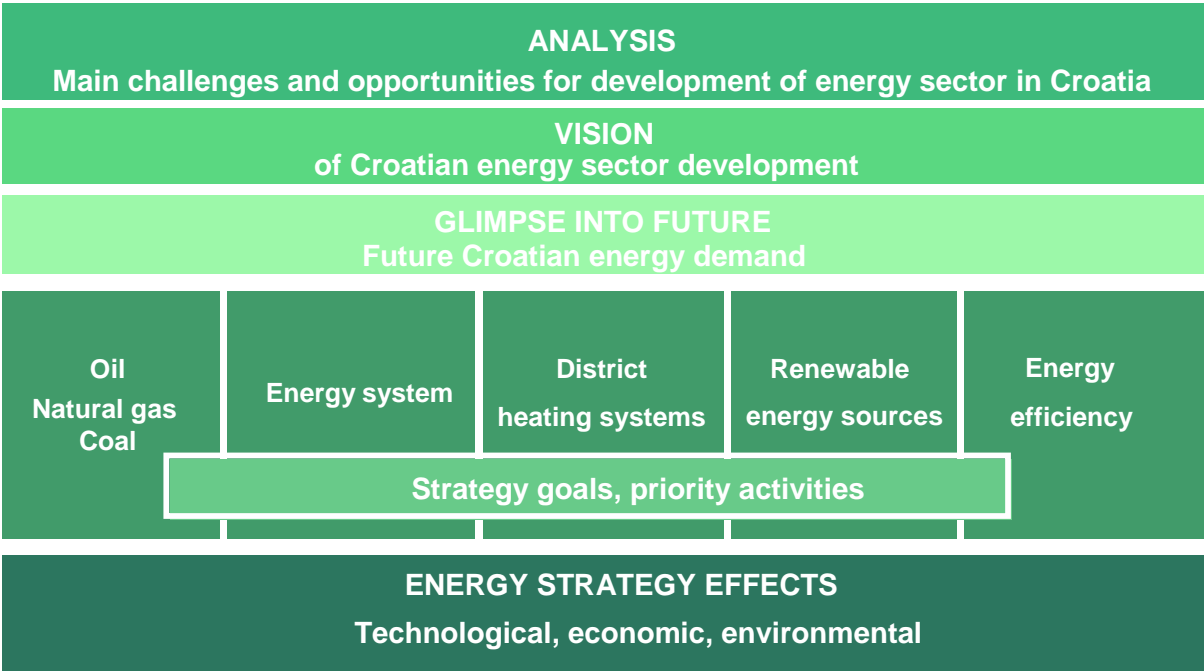


Figure: 1-1 Main elements of the Energy Strategy of the Republic of Croatia

2. CHALLENGES AND OPPORTUNITIES FOR THE CROATIAN ENERGY SECTOR DEVELOPMENT

2.1. Global Geo-political Context and Security of Energy Supply

Croatia, like other European countries, is becoming ever more dependant on energy imports. Croatia is currently importing about 50% of its energy demand. Of the imports made, more than 80% is oil².

According to the reports prepared by the International Energy Agency (IEA), oil and natural gas reserves are sufficient to meet the demand in the period covered by this Strategy (year 2030). However, these sources are concentrated on several locations in the world: 62% of world's oil reserves are located in a politically unstable Middle East, while 56% of natural gas reserves are located in just three countries (Russia, Iran and Qatar). Third fossil fuel, coal, is uniformly distributed in the world, reserves are huge, so the coal is probably going to remain a backbone of power systems in most countries of the developed world (in EU27, about 30% of electricity is generated in coal-fired thermal power plants).

In today's balance of primary energy supply in Croatia, oil and oil products are represented with 50% and natural gas with 25,6%. Consumption of these fuels shall grow in the future, while local oil and natural gas production is going to decrease due to exhaustion of deposits (beyond 2010). Croatia is therefore facing many challenges to the security of energy supply:

- *Oil deposits are concentrated in politically unstable regions of the world;*
- *Wars, terrorism, accidents and natural disasters can disturb oil and natural gas supply, prevent new investments and increase the price of oil and natural gas;*
- *Share of locally produced oil and natural gas covering the demand shall decrease, while the dependence on imports shall increase. Share of imports in covering overall energy demand is going to increase as well!*

Croatia, therefore, must strive towards alleviating its dependence on energy imports by building a flexible energy structure which will prove competitive and robust under uncertain conditions. This would be achieved by using own resources and potentials, effective use of energy, diversification of types of energy and technologies, diversification of supply routes and energy sources, and use of renewable energy sources.

2.2. Climate Change and Other Environmental Issues

Climate change and greenhouse gas emissions have become a priority development issue. The main challenge is a long-term development of *economy with decreased emission of carbon dioxide*. General trend is a more effective use of energy, use of renewable energy sources, more efficient transport system with greater use of CO₂ neutral fuels and internalization of external costs of environmental pollution by establishing a price of carbon dioxide emission (which gives a clear signal

² According to annual energy review „Energy in Croatia 2006“, MELE, 2007.

to the business sector that the environmental pollution risks must be accounted for when making plans and investments).

Consequently, Croatia is facing difficult tasks which will have major impact on the economy. These challenges are development opportunities at the same time, with a special emphasis on the following:

- *Meeting the Kyoto Protocol commitments;*
- *International environmental commitments beyond 2012;*
- *Integration into the European Union emission trading scheme and burden-sharing agreement between EU member states;*
- *Competitiveness in the region;*
- *Pressure from fast-growing sectors;*
- *Development and application of technology for carbon dioxide capture and storage;*
- *nuclear energy use;*
- *NIMBY³ syndrome;*

MEETING THE KYOTO PROTOCOL COMMITMENTS. Decrease in emissions by 5% in the period 2008-2012 is considered a short-term objective for the implementation of which a series of measures and instruments had been adopted based on EU *acquis communautaire*. Current legislative framework in Croatia encourages electricity generation from renewable energy sources and cogeneration, energy efficiency in building construction; the Environmental Protection and Energy Efficiency Fund has been established, regional energy centres are in the process of being established; charges for CO₂, SO₂ and NO_x emissions have been established on the basis of the polluter pays principle; measures are taken transport sector to arise awareness of drivers about the characteristics of vehicles with regard to carbon dioxide emissions, and indicative target for introducing biofuels into transport have been prescribed. Preparations are taking place to establish an emission trading mechanism which would involve participation of all large emission sources from the energy sector, in line with the European Union emission trade scheme (EU ETS), which would become operational in 2010.

INTERNATIONAL ENVIRONMENTAL COMMITMENTS BEYOND 2012. Parties to the United Nations Framework Convention on Climate Change continue with negotiations on obligations beyond 2012 which should result in a new international agreement. Three tools are to be used to accomplish the goals: measures taken in different sectors of economy, especially energy industry; carbon dioxide sequestration by forests, and application and/or upgrade of Kyoto flexible mechanisms. Members to the Annex I, including Croatia, are expected to achieve GHG emission reduction of 25-40% in 2020 in relation to 1990. In negotiations, Croatia advocates the principle of shared but distributed responsibility in alignment with Croatian economic capacities and development needs. In the course of negotiations and establishing individual goals, potentials and socio-economic aspects of fulfilment of individual goals shall be analyzed.

³ NIMBY is an acronym for *Not-in-my-backyard*.

INTEGRATION INTO THE EUROPEAN UNION EMISSION TRADING SCHEME AND THE BURDEN-SHARING AGREEMENT BETWEEN EU MEMBER STATES

European Union is entering negotiations with a proposed emission reduction of 20% by 2020 and 30% emission reduction in case of developing countries (Brazil, India, and China). EU shall distribute goal to two groups: one group made of large emission sources (ETS sector), and the other group made of all other sectors and activities. The distribution of commitments is based on the principle of solidarity between EU members, i.e. it depends on the economic strength, development perspectives and measures already taken.

The goal which is to be achieved by large emission sources in power generation included in the emission trading scheme is to decrease the emissions by 21% until 2020 in comparison with 2005, based on a single European allocation plan and obligation to purchase overall quotas per auctioning model which can be equally participated by existing and new participants. This removes barriers for the entry of new and more effective technologies regardless of their location and national borders, which was the case until now (however, the investors have to be aware of the risk related to the price of emission units in the case of increased demand). In other sectors, decrease in emissions by 10% by 2020 is envisaged, but in the countries in which GDP per capita is below EU average, increase in emissions up to 20% is allowed. It is clear that Croatia would be in a significantly more favourable position had it been a full-fledged member of the EU. Instead, Croatia has to independently negotiate within the UN Convention on Climate Change.

In the process of negotiations with the European Union, Croatia should fight for a decision to be made which would enable Croatia to join European system of burden-sharing and inclusion into the European Union emission trading scheme, which would make it easier to achieve energy development goals.

COMPETITIVENESS IN THE REGION. Croatia is the only country in Southeast Europe that has made a commitment to reduce greenhouse gas emissions. The countries in the region have signed the Energy Community Treaty in order to develop a common regional energy market which places, market-wise, in a less favourable position in the power sector and in other energy-intensive sectors. In the long run, these countries are expected to assume commitments under the UN Convention on Climate Change, which would then remove the above-mentioned threat.

PRESSURE FROM FAST-GROWING SECTORS. These sectors include energy-intensive activities like power generation industry, oil processing and production of mineral products (cement, lime, glass). They will shall be included in the emission trading mechanism and burdened with the price of carbon dioxide, and any emission in excess of allowed quotas will have to be purchased on the market. On the other hand, due to increased mobility and extreme inelasticity of prices, there is large increase in emissions from road transport despite the increase in the efficiency of new vehicles. Attempts shall be made to reduce emissions from this sector through development of sustainable transport, technological development and application of CO₂ neutral fuels (biofuels and hydrogen in the long run).

DEVELOPMENT AND APPLICATION OF TECHNOLOGY FOR CARBON DIOXIDE CAPTURE AND STORAGE (CCS) is a long-term measure for emission decrease, especially emissions from coal-fired power generation facilities. In Croatia, a technology has been developed and applied for capture,

transportation and injection of carbon dioxide for increase in oil extraction rates (so called EOR⁴). The CCS is expected to become commercially viable in some ten years.

NUCLEAR ENERGY USE. Of all the observed measures, this is the measure with the greatest potential in decreasing the greenhouse gas emissions, however, all aspects of the environmental impact, especially with regard to decommissioning and radioactive waste disposal should be considered.

PUBLIC RESISTANCE TO CONSTRUCTION OF POWER GENERATION FACILITIES (NIMBY SYNDROME). The problem of choosing a location and building new power generation facilities is also linked to the acceptability of these facilities to the local community. Timely and open communication with the public, especially with the so called stakeholders and local community, and consistency in following the principle which enables public to participate in the decision-making on the environmental protection issues is a democratic principle of the utmost importance (pursuant to the provisions of the Croatian Act on the Right of Access to Information and the Environmental Protection Act, which incorporate the provisions of the Aarhus Convention).

2.3. Geopolitical Position and Spatial Advantages of Croatia

Geographic position of Croatia is its strength and opportunity for sustainable energy sector development:

- Geopolitical position of potentially transit country for oil, natural gas (including liquefied natural gas) and electricity,
- Physical advantages of maritime country and country with good sites for construction of power generation facilities (underground gas storages, hydropower plants, wind parks and other renewable energy sources, oil and liquefied natural gas terminals, thermal power plants firing imported hard coal, nuclear power plant, LL and IL radioactive waste repository).

Croatia will mainly be supplied with oil and natural gas from domestic production from the remaining reserves, Northern Africa, Middle East, Russian Federation, and Caspian region. Energy sector development should be based on development of energy markets, but also on geopolitical planning and negotiations on participation in strategic projects that could bring Croatia increased security of supply and direct economic benefits (transit fees).

*With regard to oil and natural gas supply, international political activity and proactive economic policy shall be directed towards using the geopolitical position of Croatia and establishing Croatia as **European energy hub**.*

Political activity is therefore important in order to complete already initiated strategic projects:

- **Pan-European Oil Pipeline – PEOP and Družba-Adria**
- **Interstate connecting gas pipeline of the Croatian and Hungarian transmission system**
- **Liquefied natural gas terminal (LNG Terminal)**
- **Ionian-Adriatic gas pipeline**
- **Electricity transit**

⁴ EOR – Enhanced Oil Recovery

2.4. European Union Energy Policy – Towards Common Energy Market

European Union has adopted a common energy and climate change mitigation strategy, which would make Europe a "low carbon" economy with low greenhouse gas emissions, i.e. a global leader in the fight against climate changes. Goals of this single policy are as follows:

- *20% decrease in greenhouse gas emissions by 2020 in comparison to 1990, or 30% decrease in the case that developing countries should accept commitments in alignment with their economic capacities;*
- *20% of renewable energy sources in final energy consumption (increased by losses caused by energy transmission and distribution, own use in electricity and heat production) by 2020;*
- *10% biofuels in comparison to gasoline and diesel fuel consumption by 2020;*
- *With the application of energy efficiency measures, EU shall decrease the final energy consumption by 9% in the period 2008-2016.*
- *EU has proclaimed the goal of decreasing the energy consumption by 20% until 2020 (but has not elaborated such goal);*

Croatia, as future EU member state, is a part of such common European policy and is harmonizing its own goals with such policy. Fundamental "platform" for accomplishing these goals is a completely open and competitive European energy market. In that sense, EU is preparing so called third package of energy-related legislation.

Croatia will continue to harmonize its legislative and regulatory framework with EU acquis communautaire and create conditions for functioning of open energy market, based on transparent, stable and non-discriminatory rules and effective market regulation.

To achieve this, Croatia shall:

- *Complete and then continuously harmonize its regulations with EU Acquis communautaire that regulates activities of electricity, natural gas, oil and oil products market,*
- *Fulfil the commitments on use of renewable sources, energy efficiency and restraining greenhouse gases emissions,*
- *Increase the security of supply and thus enable the functioning of the market and free natural gas pricing on the market by increasing the technical possibilities for the imports of natural gas,*
- *Strengthen independence and the role of energy activities regulator*
- *Strengthen the integration into European associations of electricity transmission systems operators and application of common standards for increase in security of supply, both in Croatia and in EU.*

2.5. Cooperation in Southeast Europe and with neighbouring countries

With an Energy Community Treaty, countries of Southeast Europe have adopted a common binding strategy **for creating regional electricity and natural gas market** based on common interests and solidarity and for the purpose of its final integration into single European market. With regard to the region, the specific tasks of the Energy Community are as follows:

- *To advance security of supply by creating a single regulatory space, which will secure stable conditions for investments into energy sector, especially into building connections with Caspian, North African and Middle East regions in order to secure supply routes of the natural gas;*
- *To improve state of the environmental in the region and to advance energy use efficiency;*
- *To encourage use of renewable energy sources;*
- *To develop market competition in the energy sector.*

All signatories of the Energy Community Treaty, including Croatia, made a commitment to adopt and apply EU *acquis communautaire* in the area of energy (electricity and natural gas), environmental protection, renewable energy sources and protection of market competition (fair trading).

Social issues related to energy supply are an important aspect of the Energy Community. Memorandum of Understanding on Social Issues obliges members of the Energy Community to include social dimension into their energy policy. In the process of liberalization, tariff systems and ways to determine prices of energy are changing significantly. In case these changes should not be accompanied by an adequate social policy measures, these could have a negative impact on the standard of living in the countries of the region.

Croatia is a part of Southeast Europe and a member of Energy Community. Croatia has good conditions to become an important actor in the regional energy market, thus Croatia shall position itself as:

- *Transit country for oil and natural gas supply routes;*
- *Energy hub for supplying Europe with liquefied natural gas;*
- *Country with strong electricity transmission capacities;*
- *Exporter of electricity;*
- *Leader in encouraging energy efficiency in the region.*

3. VISION: SUSTAINABLE AND SECURE ENERGY SUPPLY

Our vision

Croatia shall have a reliable and sustainable energy sector, development of which shall be based on using all energy options in order to meet own energy demand and to create added value for Croatian citizens, in alignment with principles of environmental, economic and social responsibility.

Guidelines for Accomplishing the Vision

The Strategy offers guidelines for the implementation of activities that should provide for reliable, flexible⁵ and sustainable energy system through:

- **Strategic leadership**

In order to achieve a continued development of an energy system, timely and efficient investments are needed. In that sense, the Government of the Republic of Croatia plays a key role in creating a stimulating environment for investments into energy structure, especially into new production capacities, and in decreasing the risks for investors by its activities and transparent, unambiguous and firm strategic energy policy framework. Strategic framework of the Government's energy policy is as follows:

- *Openness to all energy options, without banning or giving preferential treatment to any energy technologies;*
- *Creating a stimulating legislative and regulatory framework for new investments into energy sector, accelerating administrative procedures for obtaining permits and timely harmonization of physical planning documents;*
- *Taking advantage of favourable geopolitical position of Croatia for its position as European energy hub;*
- *Active participation in regional initiatives for enhancing the security of supply through bilateral agreements and joint investments;*
- *Encouraging legal and physical persons for efficient energy and renewable energy sources use.*

⁵ Flexibility of the systems includes its capacity for timely and correct responses to changed external conditions and new challenges.

- **Using the market to achieve secure and affordable energy supply**

The main principle of the Strategy is to accomplish a completely open, independently regulated and competitive energy market in Croatia as a part of single regional and European energy market. There are several elementary starting points for achieving of this goal:

- *Independent regulation of the energy sector*
- *Government's role in securing market functioning*
- *Securing mandatory oil and natural gas reserves*
- *Using energy transit possibilities.*

The first starting point is an *independent regulation of energy sector*. Energy sector should function on obvious principles with strong and independent regulatory body, which is among other things, responsible for adopting the tariff systems methodology and tariff rates. Creating strong and independent national regulatory agencies is one of the main priorities of the EU energy policy.

The prices of energy should be determined by open market. However, the market can only function when supply is sufficient. *The Government should secure market functioning and maintain necessary level of security of energy supply by planning and timely undertaking of activities.* In the case of natural gas, in the period until LNG terminal is built, this means especially offering of necessary support to extending of current agreement for supply of natural gas from Russia, securing local production of natural gas using concession agreements, and construction of underground storage of natural gas.

Oil will remain a dominant energy source and the growth of natural gas consumption is expected in alignment with existing plans for development of transport system and consumption. Therefore, it is necessary to *secure mandatory oil and natural gas reserves and new supply routes.*

In the area of electricity, natural gas and oil, it is necessary to *take advantage of the transmission potentials and to direct development towards creating conditions for energy transit*, which would generate revenues and contribute to GDP through network and port fees.

- **Restraining the increase in greenhouse gases from the energy sector**

In order to achieve its Kyoto and post-Kyoto goals, Croatia has to *join European Union emission trading scheme (EU ETS)*. Such market mechanism shall contribute towards transformation of the whole economy, not just energy sector, towards the environmentally acceptable technological solutions. The prices of emission units shall have a significant impact on decision-making in the area of investments in the energy sector. Special efforts should be made in the transport sector in order to increase the share of environmentally favourable energy sources for running vehicles: biofuels, compressed natural gas and electricity.

- **More effective use of energy**

Croatia is using energy in a less effective manner than most countries of Western Europe. It uses about 20% more primary energy per GDP unit than on the average in EU-15. Such situation allows significant enhancements for which, besides the market prices of the energy, it is also important to define incentive measures for all final energy consumption sectors.

Croatia has also set clear goals of its energy efficiency policy – *decrease in final energy consumption by 9% in the period 2008-2016, in relation to average final energy consumption for the period 2001-2005* (which is in alignment with EU policy goals).

It is also necessary to stimulate the changes in the structure of energy use. The Strategy sets as a goal for *electricity used for heating and domestic hot water to be replaced by other energy sources*: solar energy, biomass, natural gas and liquefied petroleum gas (in the areas remote from natural gas network). This goal does not refer to the use of electricity for heating and domestic hot water from heat pumps.

Energy savings can also be observed as a new source of energy; therefore, cost-effective measures should be used to stimulate energy efficiency as a means for enhancing the security of supply.

- ***Maximum increase in the share of renewable energy sources with acceptable social costs for stimulating their utilization***

Croatia is a country with good natural potentials and possibilities for the use of renewable energy sources. Renewable energy sources are local energy sources and their utilization is primarily the means of enhancing the security of energy supply and also a manner for accomplishing the environmental protection goals.

Croatia has set the following strategic goals related to the use of renewable energy sources:

- *Mandatory target of 20% share of renewable sources in the final energy consumption by 2020 according to the Directive on the promotion of the use of energy from renewable sources published in January 2008 in the framework of the EU objectives defined in the Climate Action and Renewable Energy Package (CAREP) for 2020*
- *Mandatory target of 10% share of biofuels by 2020 in the consumption of gasoline and diesel fuel according to the Directive on the Promotion of the use of biofuels and other renewable fuels for transport*
- *35% share of electricity generation from renewable sources, including large hydropower plants by 2020, in the overall electricity generation*

- ***Stimulating research, development and application of environmentally sustainable energy technologies***

Energy and transport technologies are developing quickly in the world. Although this development takes place mainly in developed countries, Croatia has to secure its own capacity to apply such technologies as soon as they are economically sound. Therefore, it is necessary ***to increase investments into education and scientific and research projects and to systematically encourage international cooperation in the area of sustainable energy technologies***. Along with research and development, it is also necessary to support the application of new technologies by building demonstration sites and research laboratories/institutes. Research, among other things, should focus on developing of local industry and services, which should be directed towards high-tech solutions that bring larger added values. Therefore, there is a need of strong links between energy policy, industrial policy and higher education and science policy.

Croatia's energy development should be based on best available technologies. This will be done by strengthening highly educated professionals. The development of energy sector requires specialists of different profiles trained and qualified to work with new technologies, which would be used in

Croatian energy sector. Therefore, energy sector professional programs should be developed as soon as possible and life-long learning programs related to different aspects of energy system should be secured.

4. ENERGY EFFICIENCY

4.1. Development Guidelines and National Goals

Improving energy efficiency in all segments of the energy system is a guideline as well as an objective of this Strategy.

Energy efficiency is an integral part of the development guidelines in all sectors of the energy system. However, special attention should be paid to efficient energy use in final energy consumption, where it can deliver best results. Measures of energy efficiency reduce increase in energy consumption, thus reducing the need to produce the respective quantity of energy the need to build new capacities and import energy, and improving the safety of supply.

*The key element of the Strategy is the presumption that **efficient use of energy represents a new source of energy**. The goal of the Strategy is to reduce the energy consumption by implementing cost-effective measures of energy efficiency.*

The strategy of energy efficiency in Croatia is defined by the *Energy Efficiency Program*. The Program defines activities in the period between 2008 and 2016 and sets the goal for Croatia to save energy in the absolute quantity of 19.77 PJ through the implementation of measures in industry, transport, households and services⁶. The amount has been defined based on the average final energy consumption in the 2001-2005 period (219.72 PJ) and under the assumption that savings equivalent to 9% of the five-year average can be achieved in the ninth year.

When defining the goals until 2020 and further until 2030, it was assumed that most energy will be saved by 2016 through considerable efforts and national energy policy. Quick results in energy conservation are especially expected in the initial period when the potential of the low-cost measures is used, among other raising public awareness about the need for efficient energy management. In the period beyond 2016, the establishment of a fully functional energy efficiency market is expected. It will enable the energy efficiency increase trend to be continued, due to higher public awareness and efficient energy use technologies, however with decrease in intensity compared to the pre-2016 period.

Attaining the goals of more efficient energy use is far more complex than fulfilling the goals on the energy production side. Energy efficiency requires a strong involvement on the government side, in order to assure conditions for better implementation of energy efficiency measures in all sectors of final energy consumption. The activities that will be undertaken in that respect are as follows:

- **Enable the development of energy markets and market-driven energy pricing** – the price gives citizens the first and main signal about the need of efficient use of energy and change of their habits. Subsidizing the cost of energy and using it as an element of social policy encourages inefficient use of energy, upsets the relations in energy production, provides wrong signals regarding prices and misdirects investments;

⁶ The Croatian Energy Efficiency Program is based on the European Commission Directive 2006/32/EC on energy efficiency and energy services; Croatia needs to meet its provisions as part of the EU accession negotiations.

- **Create a legislative and regulatory framework aimed at encouraging energy efficiency** – it is necessary to legally define minimal criteria of energy efficiency for appliances/equipment and buildings, enable buyers to choose based on transparent information on energy-related characteristics of devices and buildings by mandating certification, define the public sector's obligations in implementing energy audits and cost-effective measures of energy efficiency, and mandate energy producers' obligation to promote energy efficiency;
- **Create an institutional framework for the implementation of the energy efficiency policy on national level** – the energy efficiency requires a good coordination of various state administration bodies, institutions and companies involved in the implementation of the energy efficiency policy, and Croatia lacks an institution capable of providing coordination of such activities. Apart from coordination, it is necessary to analyze, verify and document savings that are achieved. In order to coordinate these activities, document and verify the improvement in the area of energy efficiency, the Government will establish an Energy Efficiency Agency, based on best practices from numerous European countries.
- **Implement continuous campaigns aimed at the general public and specific target groups** – insufficient awareness and knowledge about the opportunities to cut down energy consumption and benefits it brings, represent a major obstacle in developing energy efficiency in Croatia;
- **Assure financial support for the implementation of energy efficiency measures and provide incentives to innovative ways of financing** – legal and physical persons should be given financial support for the implementation of projects and measures of energy efficiency through the Environmental Protection and Energy Efficiency Fund and public procurement policies aimed at encouraging energy efficiency, by developing energy services (ESCO), third-party funding and public-private partnerships.

4.2. Goals and Activities in the period 2008-2020 with a view to 2030

The summary of priority activities that need to be implemented in different sectors of final energy consumption is elaborated in the Energy Efficiency Master Plan for Croatia, which is described in this document. The implementation of measures defined for the three-year period is set in the National Energy Efficiency Action Plan that is adopted by the Government of the Republic of Croatia.

4.2.1. Industry

The industrial sector's share in the overall final energy consumption is slightly above 20%. It is estimated that industrial capacities that account for less than 50% of consumption will be involved in the emission unit trading scheme⁷. This mechanism should significantly improve the industrial sector's energy efficiency. The nineties brought a significant decline in energy consumption in the sector, due to the transition process (privatization and structural changes). Nevertheless, a slow, yet

⁷ The Energy Efficiency Program does not include energy efficiency measures in industries that will be included in the emission trading scheme (EU ETS). The expected energy saving in industrial sector is therefore significantly lower. Should the saving in these industries achieved by their participation in the EU ETS be included, the expected energy savings would double.

steady growth of energy consumption has been recorded in the recent years. The energy efficiency package for the industrial sector includes:

- **Creation of a functional network of industrial energy efficiency (MIEE??)** – the NIEE Program will provide industrial companies with support in implementing energy audit and establishing energy management systems, conducting comparative analysis (*benchmarking*) of their energy-related characteristics and characteristics of other companies in the same industry and implementing selected energy efficiency programs. Educational and training programs will also be launched for employees in the respective industry;
- **Establishing an energy audit scheme for the industry** – mandatory energy audit will be established for energy-intensive industries; a scheme of voluntary energy audits financially assisted by the Environmental Protection and Energy Efficiency Fund will be established for other industries. It is necessary to define a system of auditor certification and standardize procedures of energy audit and reporting;
- **Voluntary contracting with respective industries** – introducing CO₂ emission tax in Croatia provides the opportunity for voluntary contracting with industries that will assume obligation to improve their energy efficiency, while in return obtaining the opportunity to reduce the charge they are paying. Under such contracts, the companies commit themselves to implement a range of energy efficiency measures and establish a structure for energy management. Voluntary contracts should initially be implemented on a pilot-project basis, and systematically start in 2010;
- **Supporting cogeneration (combined heat and power generation) in industry** – current system of supports through guaranteed purchase prices for electricity generated in such plants should be analyzed, especially in case of highly efficient cogeneration, since *interest for their construction under current conditions is insufficient*.
- **Improving the CO₂ emission taxation system** – individual CO₂ emission tax in the 2007-2009 period is relatively low and it is not expected to directly affect the CO₂ emission level or improve energy efficiency. The system of emission taxation should be improved with regard to the marginal cost of measure implementation and establishment of the emission trading system with the goal of providing industries with incentives for the implementation of energy efficiency measures.
- **Creating conditions for Croatia's participation in the European Emission Trading Scheme**

4.2.2. Transport

The transport sector represents about 30% of the total final energy consumption, with a very high growth rate (more than 5% annually over the past five years). With over 90%, road transport accounts for the largest share of energy consumption in this sector. Given the rise in number of cars, longer average distances covered by car and fewer individuals travelling in each of the vehicles, this trend is expected to continue in the future. Road transport is therefore the focal point of energy efficiency policy in the transport sector.

From the energy efficiency point of view, the transport sector is the one in which desired results will be hardest to achieve. This is so because of its dependence on liquid fuels (oil products), as well as because of mobility that is so characteristic for the modern way of living and globalised economy. A package of energy efficiency measures will be adopted in order to reduce the energy consumption in transport, including:

- **Setting higher standards for new vehicles** – the European Union adopts new standards for allowable CO₂ emissions for light vehicles (the goal is set at 120 g CO₂/km by 2012), and decrease in emission will result in higher energy efficiency of vehicles. Croatia will follow and quickly adopt technical standards for vehicles that have already been adopted by the EU and thus assure that only the most efficient products reach the Croatian market;
- **Implementation of awareness raising campaigns on energy efficient behaviour in transport** – the campaign should promote efficient driving, as well as alternative means of transportation (public transportation, bicycles, carpooling etc.);
- **Planning and implementing more efficient transport systems** – the following shall be improved: transport planning in cities, including building the infrastructure for alternative means of transport, improving public transport, "park and drive" options, introducing efficient vehicles and alternative fuel in public transport (vehicle identification), mandating energy audit in public transport companies and obligatory cost-effective energy efficiency measures, implementation of parallel analysis of Croatian and European transport companies, introducing congestion fees in cities, etc.;
- **Facilitate a more energy efficient and cleaner operating transportation fleet** (vehicles with emissions below 120 g CO₂/km, electric vehicles, hybrid vehicles) for legal and physical persons through investment subsidies and by providing free parking, right to use yellow lanes etc.

4.2.3. Households

Households are the largest individual energy consumers in Croatia (29% of total final energy consumption) and the largest users of electricity (43% of total final energy consumption⁸). Energy efficiency policy in the sector of households is based on raising public awareness about possible savings and incentives to plan and build residential buildings in harmony with the principles of energy efficiency. This energy efficiency package includes:

- **Adoption and implementation of all by-laws** based on the Physical Planning and Building Act, fully incorporating the provisions of the EU Directive 2002/91/EC on energy characteristics of buildings. That will enable reduction of energy consumption rates by setting up minimal requirements for energy characteristics of buildings¹⁰, and improve public awareness about energy efficiency by implementing obligatory building certification. The objective should be to achieve low-energy buildings and energy systems with the level of energy efficiency higher than the legally prescribed ones.
- **Continuous implementation of awareness raising campaigns and establishing a network of information centres** throughout Croatia, in which citizens will be given free advice about the options for improvement of energy efficiency in their homes;
- **Labelling energy characteristics of appliances** (household appliances etc.) and adopting minimal standards for appliances, in order to encourage the most energy-efficient solutions;
- **Individual energy metering** where it has not been the case so far (particularly for heat supplied from CHS), using intelligent automatic meters combined with controllable devices, and sending

⁸ According to data from the Annual energy overview "Energy in Croatia in 2006", Ministry of the Economy, Labor and Entrepreneurship, 2007

energy users informative bills from which they would be able to deduce their efficiency in energy use;

- *Financial incentives to physical persons for implementation of energy efficiency measures* through the Environmental Protection and Energy Efficiency Fund and fiscal policy.

4.2.4. Services

The service sector participates in the total final energy consumption with over 10%. Electricity is the dominant transformed energy form with the share of over 60%, followed by liquid fuels and natural gas. The use of electricity for heating in the coastal region should be replaced with natural gas (after the distribution network is developed) and renewable energy sources, especially solar heating systems. Tourist facilities are particularly appropriate for this purpose, as their hot water demand coincides with the highest insolation period. Also, fuel oil should gradually be replaced with other fuels, such as natural gas or liquefied petroleum gas (where there is no natural gas network), and especially by renewable energy sources.

Total primary energy supply intensity, electricity demand intensity, and electricity demand per employee in service sector are increasing constantly⁹, which indicates inefficient energy use in this sector, along with the highest annual increase in energy demand compared to any other sector. In the short run, the energy efficiency policy measures have to focus on the public sector. The public sector is expected to provide an example and encourage taking of measures in commercial service and other sectors. It is necessary to focus on measures with low implementation costs, such as encouraging changes in the employees' behaviour through educational and awareness raising campaigns.

Additionally, Energy Management System (EMS), supported by monitoring and analysis tools, should be introduced into the public sector buildings and the public sector's obligations in improving energy efficiency and reporting should be defined.

The energy efficiency measures package includes:

- *Creation and implementation of building regulations* that will enable reduction of energy consumption rate per floor area by stipulating minimal requirements for thermal insulation and minimal energy requirements for buildings¹⁰ (it is necessary to meet the standards of low-energy buildings, particularly in new or reconstructed buildings owned by national, regional or local governments);
- *Regular control of boilers and ventilation systems in buildings* which would improve the maintenance of the respective systems and assure their better performance;
- *Continuous awareness raising campaigns targeting at employees* in public administration;
- *Implementation of the program "Systematic Energy Management (SEM) in Cities and Counties"*, that mandates cities and counties to improve energy efficiency in their buildings;

⁹ According to data from the Annual energy overview "Energy in Croatia in 2006", Ministry of Economy, Labour and Entrepreneurship, 2007

¹⁰ Building legislation in Croatia must be fully harmonized with the provisions of the European Commission Directive 2002/91/EC on energy characteristics of buildings.

- *Implementation of the national program “Put your House in order”,* which mandates the Government of the Republic of Croatia to reduce energy demand and improve energy efficiency in their buildings;
- *Introduction of systematic energy management in commercial buildings* in line with the program “SEM in Cities and Counties”;
- *Continuation of financial incentives for the implementation of energy efficiency measures* through the Environmental Protection and Energy Efficiency Fund;
- *Introducing “green” public procurement,* by incorporating energy efficiency and environmental protection criteria in public procurement procedures, and adopting project evaluation based on cost analysis for the project lifetime instead of on the investment costs only, which will enable the transformation of the market and its orientation towards more efficient products and projects.

4.3. Future Trends

In order to improve energy efficiency, Government’s policies need to provide strong support within its legislative and financial framework, which will enable a stronger influx of energy-efficient products, technologies and practices into the Croatian market.

However, this requires more than mere implementation of energy efficiency measures – it is important to evaluate their implementation and measure the resulting savings. The system of measurement and verification of energy savings is a special challenge for the Croatian energy efficiency strategy. It is *necessary to establish a uniform system of collecting data (energy-related data and data that influence energy consumption) for calculating and monitoring energy efficiency indicators in line with the methodology accepted by the EU (ODYSSEE methodology)*. In this respect, it is important to harmonize the Croatian energy-related and other statistics with the Eurostat methodology. Beside this approach, which provides insight into the macroeconomic and sectoral level, it is important to define the measuring, verification and reporting systems for energy savings that have been achieved in by projects (the so-called bottom-up approach). Furthermore, the results of the energy efficiency policy need to be continuously monitored and evaluated, and the policy needs to be adapted based on achievements and changes on the market. Cost-efficiency of the government-supported projects and programs has to be evaluated on annual basis.

The Program provides comprehensive technical input which is used for adoption of the Energy Efficiency Action Plan and Efficient Use of Energy Act (that is expected to be adopted in 2009). By adopting these documents and goals they set up, Croatia assumes the obligation to reduce its final energy consumption by means of energy efficiency measures harmonized with the goals defined in guidelines and strategic energy policy of the EU (Directive 2006/32/EC).

5. BUSSINES-AS-USUAL PROJECTION (SCENARIO) OF THE FINAL ENERGY CONSUMPTION BY 2020 (WITH A VIEW TO 2030)

The *business-as-usual* projection of final energy consumption the development of consumption in line with market trends and consumers' habits, without government interventions, provided new, sophisticated products that reach the market are used.

Energy consumption is assessed for various sectors and subsectors of the so called Other Sectors which includes households, services, agriculture and construction using analogy modes (Croatia's approach to EU-15 member states) and other econometric methods¹¹. As for demographic trends, it is anticipated that the population of Croatia would remain on the 2007 level, which includes the expected decrease in domicile population and increase in immigration.

5.1.1. *Business-as-Usual* Projection of Final Energy Consumption by Sectors

The final energy consumption projection is estimated for the following sectors: Industry, Transport and Other Sectors. The analyses were conducted by subsectors: for the Industry Sector – by type of industrial branches; for Transport Sector – by means of transportation (road, air transport, inland navigation, railways); and Other Sectors – by the following subsectors: households, services, agriculture and construction.

The starting point for the Industry Sector is that Croatia needs strong industrial growth. Although growth rates in Industry Sector are not expected to follow the growth in Services, growth in some industries is considered as the Croatian economy lever. The assessment of final energy consumption in Industry is based on the assumption that the Industry Sector will not be based on energy-intensive industries, but rather that the market mechanisms will direct the development in a balanced manner towards energy-moderate industries and industries in which Croatia does not lack resources.

As for the Transport Sector, the energy consumption is expected to grow faster than in other sectors. The projections are based on the assumption that the Croatian Transport Sector energy consumption rate for 2020 would be equal to the EU15 consumption in 2005, and that its growth beyond 2020 would follow an average growth trend of EU15 in the previous period (2000–2005). In this respect, transport of passengers and goods is analyzed separately. Faster growth of railways and inland transport is expected because of an overall growth of transport of goods. Air transport is expected to be the fastest growing mean of transportation. The listed means of transportation currently have low shares in the total energy consumption, and their growth therefore will not have major impact on the structure of energy forms used in transport.

¹¹ More detailed analyses are in the document „PROJECTIONS OF FINAL ENERGY CONSUMPTION IN THE REPUBLIC OF CROATIA“, available on the web of the Strategy of energy development of the Republic of Croatia, <http://www.energetska-strategija.hr/>.

Each subsector of the Other Sectors (households, services, agriculture and construction) has been analyzed separately, as the households and services subsectors combined account for about 40% of the total final energy consumption.

Households use energy for heating, domestic hot water, cooking and where electricity cannot be replaced with another source of energy (or it is not common), such as lighting, electrical household appliances, etc.. Most energy is used for heating. Stagnation of energy consumption per residential unit is expected at the 2006 level (the effect of larger heated areas will be annulled by lower heat losses). Due to increase in natural gas supply, the share of electricity and liquid fuels will decrease. A 3% rise is expected in energy for domestic hot water, due to the rise in standard of living. In case of lighting, the basic assumption is that the rise in the efficiency of lighting fixtures would annul the effects of larger average household floor area, and that the consumption of energy would grow at the same rate as the total number of households – at 1% annually. Electricity consumption for household appliances will grow due to citizens' better standard of living. Energy consumption rates for cooking in households will decrease as the standard of living rises following the European trends.

Structure of Croatia' domestic product with considerable share of service sector (60%) makes it different from most other countries of Eastern Europe. With the growth of production sector, high rates of gross domestic product growth are expected for services. With the planned long-term GDP growth rate of 5%, faster growth of GDP in services is expected, as well as better energy efficiency in that sector (i.e. there is a relatively good potential for improvements). Croatia's service sector energy intensity was 2177 kJ/EUR¹² in 2006, while the EU15 intensity was 712 kJ/EUR of added value. The increase in added value in the service sector is estimated at an average of 7% annually in the period until 2020, and at 6% in the period between 2020 and 2030. Energy efficiency will fall at an average annual rate of -3.4% by 2030. Energy forms are expected to change in the service sector. The share of electricity will get higher due to cooling and air-conditioning, and the share of natural gas for cooling will rise as number of areas in Croatia covered by the gas network increases. Higher electricity consumption and lower oil products consumption (fuel oil and liquefied petroleum gas) are expected, and their replacement with natural gas (although the share of liquefied petroleum gas will rise on islands and in parts of Croatia not included in the natural gas network).

Of all Other Sector subsectors, construction has had the fastest consumption growth in the period between 2000 and 2006. The average growth rate was 10.3%. Although the construction sector is expected to grow at a slower rate in the future, it is anticipated that energy consumption rate will rise continually in this industry. Croatia is facing considerable investments into its energy infrastructure, waste management, wastewater treatment, industry, construction of residential buildings, tourist facilities and other service sector facilities. As estimated, the energy consumption rate will continue to grow in construction industry by 2010, and it will keep growing at a slower rate beyond 2020 (around 6% annually). It is estimated it would slow to 5% annually beyond 2020. Average growth rate by 2030 is 6.3%.

The share of agriculture in the overall final energy consumption in Croatia is 3.8%. Growth in the energy consumption in agriculture is not expected to follow the rates in other sectors, and the share of agriculture in final energy consumption is expected to decline. With the annual added value

¹² Source: ODYSSEE database and the Annual energy report „Energy in Croatia 2006“

growth in agriculture of 2.97%¹³ and with energy intensity decrease, annual energy consumption growth will be 1.9%.

Based on previous analyses, final energy consumption is projected in the business-as-usual scenario and listed in Table 5-1 and Figure 5-1 (the figure also provides the structure by sector for respective years).

Table 5-1 Business-as-usual projection of final energy consumption by sector and subsector

PJ	2006	2010	2020	Committed increase rate from 2006 to 2020 [%]	2030	Committed increase rate from 2020 to 2030 [%]
Industry	58.86	67.11	84.43	2.6	103.09	2.0
Transport	85.63	103.65	135.22	3.3	152.59	1.2
Other sectors	123.40	139.85	189.95	3.1	245.16	2.6
Households	77.66	83.69	99.47	1.8	115.72	1.5
Services	28.09	34.50	57.60	5.3	81.51	3.5
Construction	7.39	10.59	19.52	7.2	31.79	5.0
Agriculture	10.27	11.07	13.37	1.9	16.13	1.9
Total	267.89	310.60	409.60	3.1	500.83	2.0

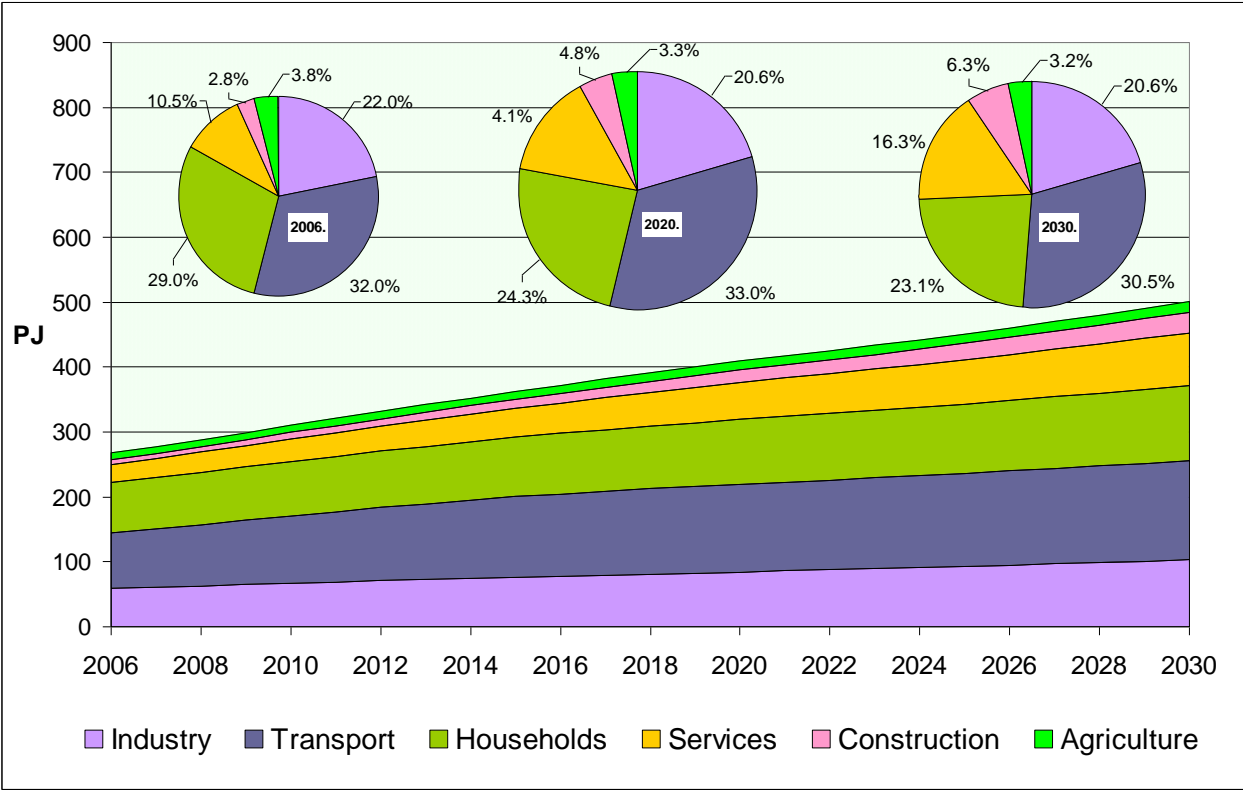


Figure 5-1 Business-as-usual projection of final energy consumption by sector and subsector

¹³ According to data by the Economics Institute, Zagreb

5.1.2. Business-as-Usual Projection of Final Energy Consumption by Energy Form

The *business-as-usual* projection of final energy consumption in 2020 and 2030 was created based on sectoral analyses and categorized by energy forms. It is shown in Table 5.2 and Figure 5.2 (the figure also contains the structure for respective years).

Table 5-2 Business-as-usual projection of final energy consumption by fuel and transformed energy form

PJ	2006	2010	2020	Committed increase rate from 2006 to 2020 [%]	2030	Committed increase rate from 2020 to 2030 [%]
Coal and coke	11.42	13.82	14.91	1.9	16.49	1.0
RDF*	0.23	1.20	1.62	15.0	1.97	2.0
Firewood	13.12	10.65	4.51	-7.3	2.83	-4.5
Gaseous fuels	41.98	52.07	79.68	4.7	101.68	2.5
Liquid fuels	124.57	143.34	177.16	2.5	200.86	1.3
Electricity	54.01	63.66	97.08	4.3	132.74	3.2
Steam and hot water	22.56	24.48	29.73	2.0	35.84	1.9
Biofuels	0.0	1.40	4.91	22.5	8.41	5.5
Total	267.89	310.60	409.60	3.1	500.83	2.0

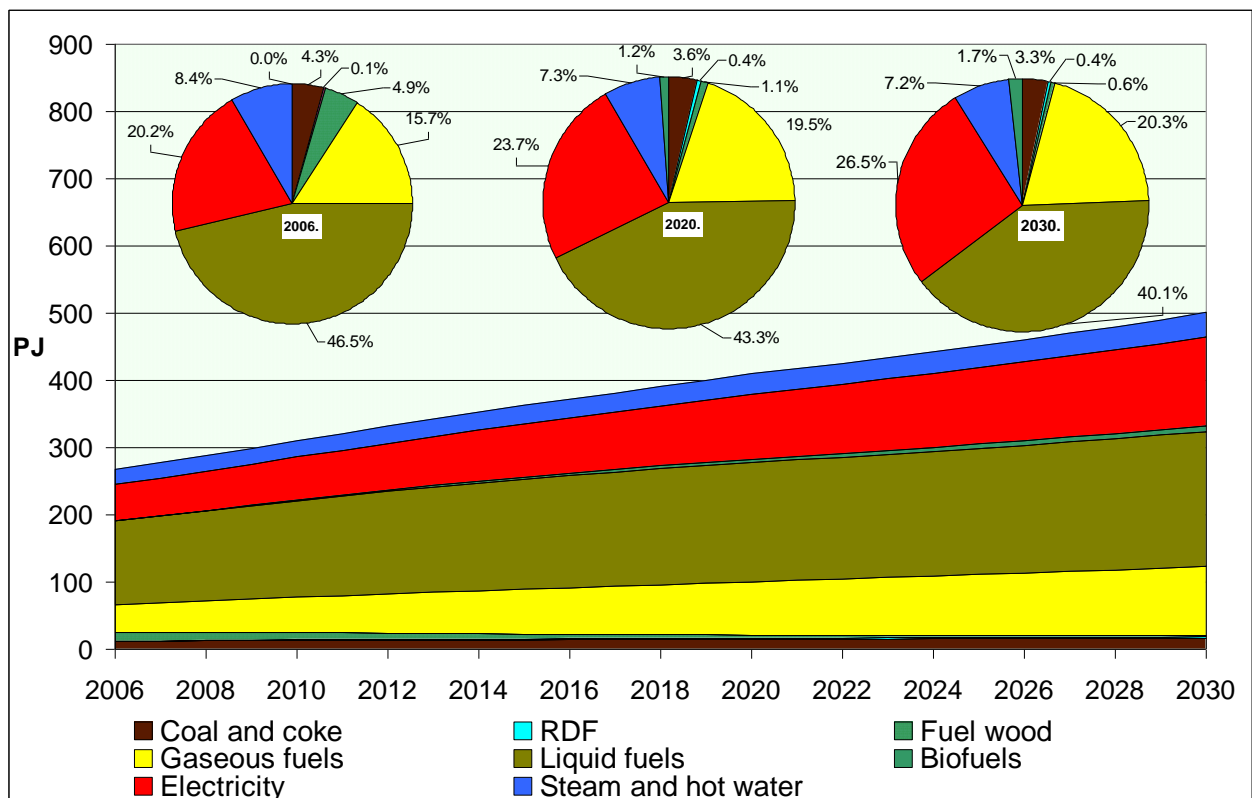


Figure 5-2 Business-as-usual projection of final energy consumption by fuel and transformed energy form

As it can be seen, the *business-as-usual* projection does not anticipate any major changes in the structure of fuels used in final energy consumption by 2020. Major reductions are expected in fuel

wood (from 5% in 2006 to 1% in 2020) and liquid fuels (from 47% to 43%). The share of coal will change to a lesser extent, since the use of coal in cement industry will not decrease.

5.2. Sustainable Development Scenario for Final Energy Consumption until 2020 (with a view 2030)

Sustainable development scenario for final energy consumption is a scenario used to achieve goals of this energy Strategy. It ensues from the energy policy measures proposed in this Strategy (implemented as government intervention unlike the business-as-usual scenario for final energy consumption). The sustainable development scenario is, therefore, a desired derivative of the *business-as-usual* projection of the final energy consumption, following the implementation of respective measures:

- increase in energy efficiency in final energy consumption
- increase in shares of renewable energy sources and other encouraged structural changes of the business-as-usual projection of used forms of energy
- use of distributed energy sources.

5.2.1. Increase in Energy Efficiency

The goal of this Strategy and the backbone of its sustainable development scenario is increasing energy efficiency, which should result in reducing final energy consumption by 19.77 PJ in 2016¹⁴, 22.76 PJ in 2020 and 30.23 PJ in 2030. Table 5-3 and Figure 5-3 compare the *business-as-usual* final energy consumption projection and the final energy consumption after the implementation of energy efficiency measures.

Table 5-3 Comparison of final energy consumption according to the *business-as-usual* projection with the final energy consumption after the implementation of energy efficiency measures

PJ	2006	2010	2020	Committed increase rate from 2006 to 2020, %	2030	Committed increase rate from 2020 to 2030, %
Consumption according to Business as usual scenario	267.89	310.60	409.60	3.1	500.83	2.0
Consumption after implementation of energy efficiency measures	267.89	304.01	386.84	2.7	470.60	2.0
Reduction in final energy consumption	0.00	6.59	22.76	/	30.23	/

In order to enable more detailed analysis of the proposed measure efficiency, the national goal is broken down by final consumption sectors. The national goal breakdown by sector is based on:

- share of respective sectors in the final energy consumption,
- potential for consumption efficiency improvements and

¹⁴ Total energy savings are defined by the Energy Efficiency Program of the Republic of Croatia.

- possible level of energy efficiency policy interventions in the sector.

Households and Transport have the largest share in the final energy consumption, yet the goal is not defined only based on the respective share, but also on estimates of the effects of proposed measures for energy efficiency improvement. The implementation of energy efficiency measures is the easiest in the Services sector. The implementation of measures in that sector has the largest additional benefits in other sectors.

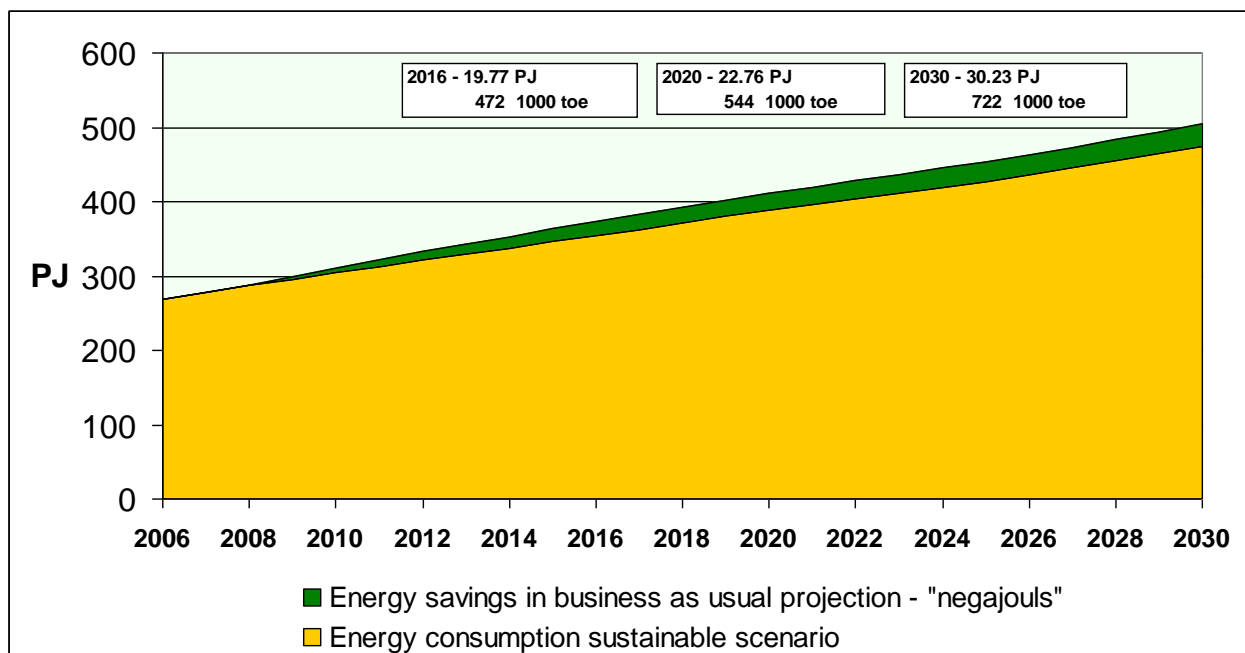


Figure 5-3 Comparison of final energy consumption according to the *business-as-usual* projection with the final energy consumption after the implementation of energy efficiency measures

Furthermore, it is expected that the Industry and Services sectors will undertake more energy efficiency measures, due to their commercial interest. The effect is expected to be the weakest in Transport sector, due to low demand flexibility in relation with the fuel price (higher fuel prices, especially in short term, do not have influence on habit changes). The consumption reduction goal by 2016 is set at 19.77 PJ, as defined in Section 4 (Industry 17%, Transport 30%, Households 34% and Services 19%). Specific energy efficiency measures are not planned for the Construction and Agriculture sectors, as their shares in the total energy consumption are low (market conditions are therefore sufficient motive for energy efficiency).

5.2.2. Increase in Use of Renewable Energy Sources and Encouraged Change in Energy Mix Structure in Relation To *Business-as-usual* Projection

Equally important, beside energy efficiency measures, the sustainable scenario takes in consideration the increased use of renewable energy sources in final energy consumption. This is particularly the case with the use of solar heating systems used for domestic hot water and use of biomass for heating (pellets and briquettes). Solar thermal heating systems will replace electricity in households,

and, to a smaller extent, natural gas and liquefied petroleum gas (LPG) used for domestic hot water production. In Services sector, it will replace electricity, liquid fuels and natural gas (in line with estimates in Section 9.2.6., total use of solar thermal energy for heating will equal 0.5 PJ in 2010, 4.96 PJ in 2020 and 12.21 PJ in 2030).

Solar photovoltaic cells for production of electricity will in most cases be installed by the end consumer, and this energy form conversion will be balanced as energy consumption reduction in the final energy consumption sustainable scenario (in line with the estimates in Section 9.2.6., 0.3 PJ of electricity would be produced in 2020 and 1.66 PJ in 2030).

Use of pellets and briquettes in households (9.5 PJ in 2020 and 13.6 PJ in 2030) will substitute for use of traditional fuel wood, as well as the use of liquid fuels for heating in households and services. The Strategy is aimed at reducing the use of liquid fuels in households and services. Natural gas is a competitive substitute for liquid fuels, and the government will provide incentives for the replacement of liquid fuels by renewable energy sources. Liquid fuels will continue to be used in households, notably the liquefied petroleum gas, as well as fuel oil for peak shaving of natural gas supply loads (i.e. by balancing the natural gas supply system).

Additionally, the scenario includes an increase in biofuels consumption in transport. In line with the EU policy, the legislative framework *will provide incentives for the placement of biofuels on the market*, and will use promotion campaigns to stimulate its use. By 2020 the share of biofuels in transport will be 10% share of the total consumption of gasoline and diesel fuels for the respective year as defined by mandatory target.

Affordable price of liquefied petroleum gas (LPG) makes it a popular fuel. As LPG does not enable efficiency of energy use and reduction of CO₂ emissions, its use will not be encouraged.

However, due to its positive characteristics, *use of compressed natural gas (CNG) will be stimulated* in transport. It is used on truck highways (so called “Blue Highways”) and city buses, as well as cars. The study “Natural gas use strategy in transport in Croatia until 2020” (EIHP, 2007), sponsored by the Ministry of the Sea, Transport and Infrastructure anticipates the compressed natural gas share in Croatia will be 3% in 2015 and 6% in 2020. These ambitious strategic targets are also the orientation of this Strategy. It is important to note the use of compressed natural gas in transport provides the opportunity for the use of *compressed biomethane which will be particularly supported*, as it facilitates the obligation to use biofuels in transport.

The policy of incentives should not make CNG push biofuels out of use (because of the obligations regarding the use of biofuels Croatia has as a future EU member).

The use of biogas will be stimulated in the agriculture sector (along the existing incentives for electricity generation, this use will be stimulated in heat production).

It is important to point out these measures are aimed at substituting fuel and reducing the emissions of pollutants, without reducing the total energy consumption in transport.

5.2.3. Distributed Energy Resources (DER) Use

The application of distributed energy resources is described in Section 7. This energy conversion takes place at the side of the end consumer; they are therefore balanced in the final consumption sustainable scenario, additionally changing the *business-as-usual* projection of final consumption. In

order to improve the efficiency of energy conversion and reducing CO₂ emissions, the use of micro and small cogenerations and heat pumps will be stimulated.

Cogeneration units (CHP) are used for heating, cooling and electricity generation. They reduce electricity consumption in the sustainable scenario and increase the consumption of natural gas. It is estimated 100 MW of micro and small cogeneration units would be installed by 2020; they would be capable of producing 500 GWh of electricity and 165 000 000 m³ of natural gas (total primary supply of natural gas annually increases by 86 000 000 m³).

It is estimated that by 2020, 18% of the total surface in households and services will use heat pumps for heating and cooling (based on the *business-as-usual* projection assumption that compression cooling devices will be used for cooling and heat will be produced directly). Out of that, 70% of heat pumps will be natural gas absorption heat pumps. Due to the enhanced energy conversion efficiency (i.e. use of renewable, interior energy of surrounding air, soil or water) the use of heat pumps will reduce the final energy consumption in the sustainable scenario by 133 000 000 m³, the electricity consumption will increase by 198 GWh and the use of renewable energy of surrounding air, soil or water will amount 4.87 PJ.

5.2.4. Sustainable Final Energy Consumption Scenario

Based on the analyses described in Section 4 and the *business-as-usual* projection of final energy consumption, the sustainable scenario of final energy consumption has been created. It is described in Table 5-4 and Figure 5-4.

Table 5-4 Sustainable scenario of final energy consumption by sector and subsector

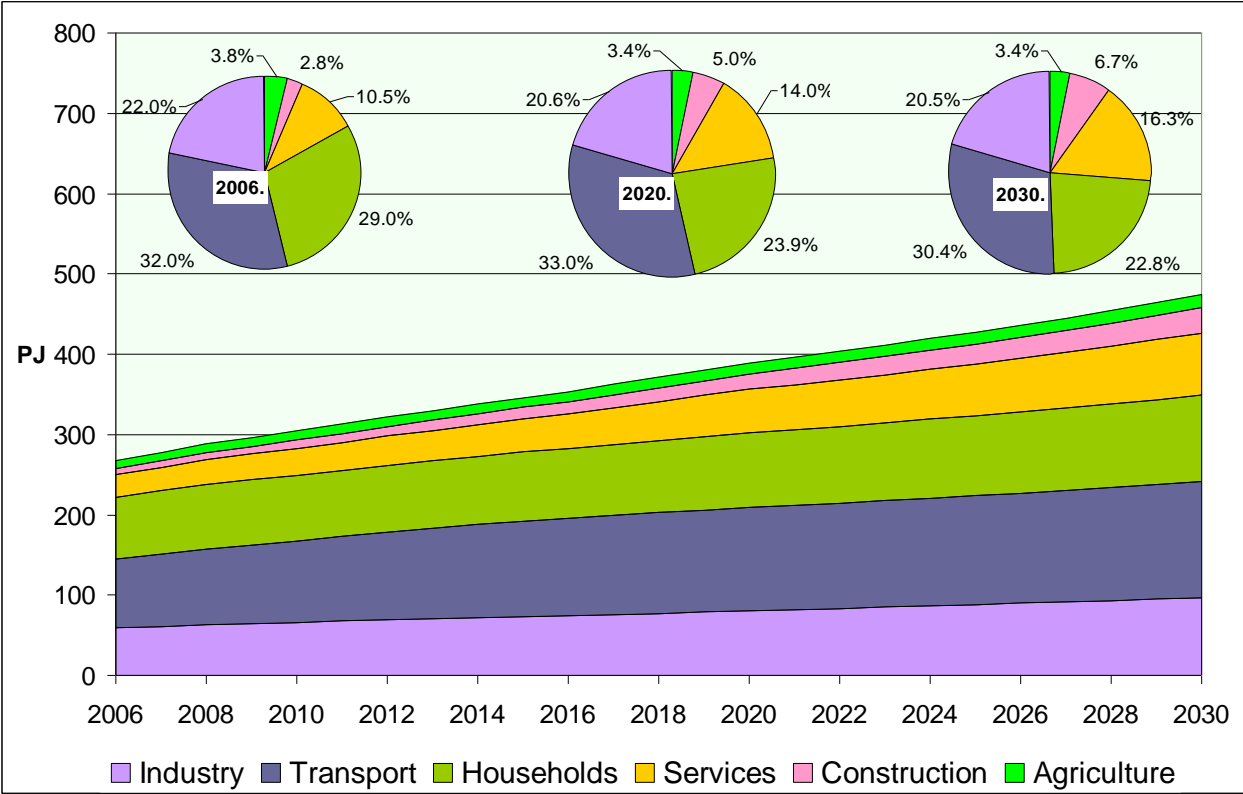


Figure 5-4 Sustainable scenario of final energy consumption by sector and subsector

The sustainable scenario of final energy consumption by transformed energy forms is based on sectoral analyses and analyses of fuel substitution. Figure 5-5 and Table 5-5 show the projections of consumption of various fuels and transformed energy forms in final production and estimated growth rates until 2020 with a view to 2030.

The sustainable scenario estimates structural changes by 2020, especially in liquid fuels, that will drop in share from current 47% to 39%. This reduction will result from measures, primarily from the increased use of biofuels in transport and replacement of liquid fuels in households and services by renewable energy sources and natural gas. In 2020 the share of renewable energy sources will be equal to the share in 2006 (around 5%), but it will have a significantly different structure (replacing traditional fuel wood by pellets and briquettes). Biomass will have the largest share, followed by solar energy. Biofuels, not used yet in 2006, will account for almost 3% of final energy consumption in 2020.

Table 5 - 5 Sustainable scenario of final energy consumption by fuel and transformed energy forms

PJ	2006	2010	2020	Committed increase rate from 2006 to 2020, %	2030	Committed increase rate from 2020 to 2030, %
Industry	58.86	65.99	80.32	2.2	97.11	1.9
Transport	85.36	101.67	128.54	2.9	144.04	1.1
Other sectors	123.40	136.68	180.32	2.7	232.93	2.6
<i>Households</i>	77.66	81.62	93.05	1.3	107.93	1.5
<i>Services</i>	28.09	33.40	54.39	4.8	77.08	3.5
<i>Construction</i>	7.39	10.59	19.52	7.2	31.79	5.0
<i>Agriculture</i>	10.27	11.07	13.37	1.9	16.13	1.9
Industry	267.89	304.34	389.18	2.7	474.08	2.0

* RDF + alternative fuels

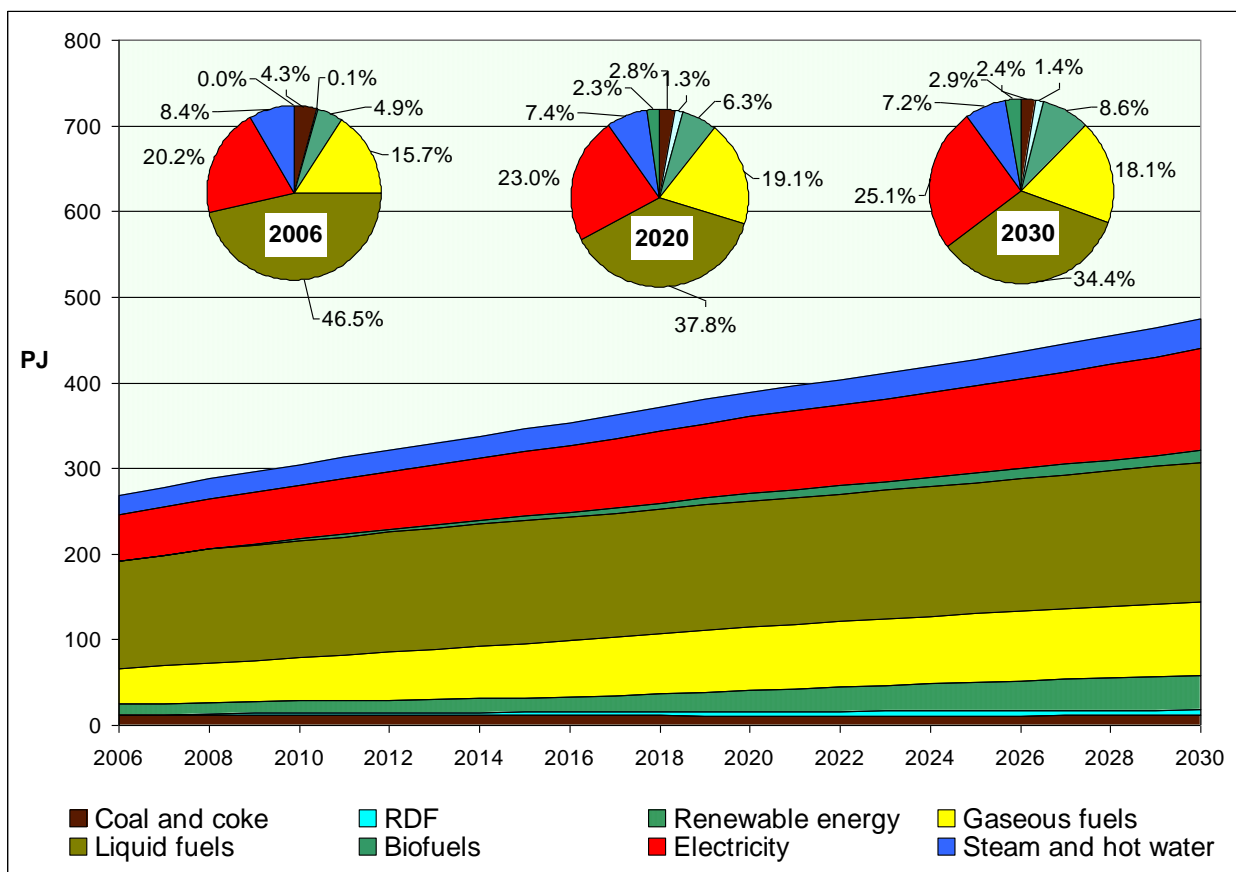


Figure 5-5 Sustainable scenario of final energy consumption by fuel and transformed energy forms

The share of electricity will increase due to the expected social standard growth and its use for purposes where it is hard or impossible to replace it. The increase of natural gas share is lower than presented in the *business-as-usual* scenario, due to the penetration of renewable energy sources. In line with the principles and goals of the Strategy, sustainable scenario of final energy consumption remains the foundation of all further analyses, particularly for the development of the power system and fulfilling the consumption for oil and natural gas.

6. ENERGY SECTOR

6.1. Future Electricity Demand

In the period from 2000 to 2006 the annual growth rate of final electricity demand was 4.1% which was higher than for any other energy form. This growth in final electricity demand is expected in the following period; particularly in households and services subsectors. Energy efficiency measures as well as replacing electricity as the energy source for heating with other energy sources, particularly natural gas and renewable energy sources can be worthwhile to cushion this rapid growth in electricity demand in Croatia. This is a fundamental determinant and objective of the Strategy and therefore, all further analysis is being conducted based on this presumption.

In Section 5 the *business-as-usual* projections of final energy consumption were given as well as some targeted, sustainable development scenarios for final energy consumption until 2030. Table 6-1 presents a comparison of the business-as-usual projection and sustainable scenario of the final electricity demand.

Table 6-1 Final electricity demand according to the *business-as-usual* projection and sustainable scenarios and total electricity consumption in a scenario of sustainable consumption

Year	2006	2010	2020	Growth rate of energy demand 2006-2020 in %	2030	Growth rate of energy demand 2020-2030 in %
Final energy consumption according to business as usual projections [TWh]	15.00	17.68	27.00	4.3	36.87	3.2
Final energy consumption according to sustainable scenario [TWh]	15.00	17.38	24.86	3.7	33.04	2.9
Total electricity consumption according to sustainable scenario [TWh]	18.05	20.57	29.24	3.5	38.66	2.8

Table 6-1 also presents total electricity consumption in a scenario of sustainable consumption. That consumption is relevant to determine demand of electricity generation and is equal to the sum of: final electricity demand, final electricity demand in industry on and oil and gas refining, transmission losses and distribution losses and energy sector own use. The structure of total electricity consumption is presented in Figure 6-1.

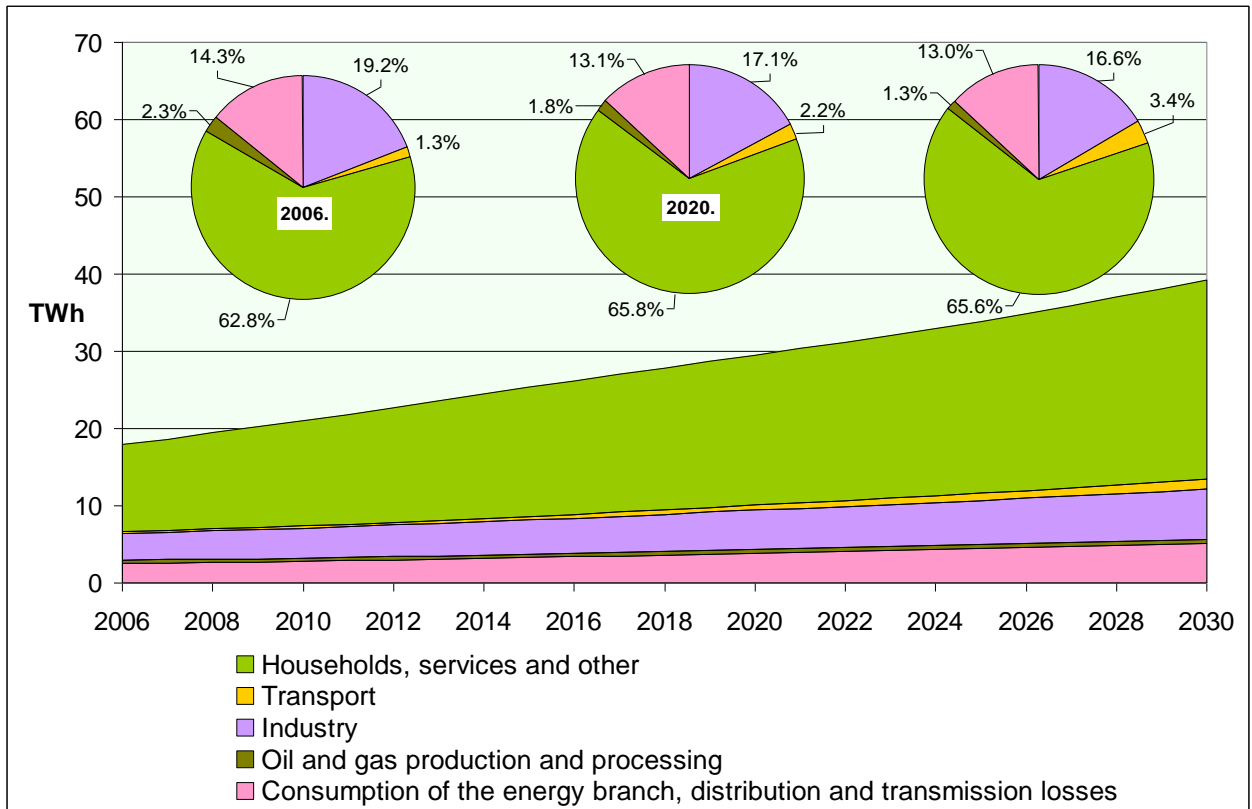


Figure 6-1 Structure of total electricity consumption until 2030

6.2. Development Guidelines

Based on the SWOT analysis conducted (the detailed SWOT analysis is presented in the supporting document of the Strategy), priorities are determined for future activities, i.e. development guidelines for the power sector:

- *Establishing a favourable legislative – regulatory framework for efficient functioning of an open electricity market and attracting investments;*
- *Electricity generation as an economic sector that contributes to the national GDP through increasing investments and exports;*
- *Constructing new production capacities to satisfy growing domestic electricity demand and replacing existing deteriorated plants;*
- *Developing transmission networks that will position Croatia as a transition country regarding electricity;*
- *Modernizing distribution networks;*
- *Use of renewable energy sources in the electricity generation and encourage distributed production;*
- *Stimulate electricity end-use efficiency.*

6.3. Goals and Actions until 2020 (with a view to 2030)

The fundamental objective of the Energy Strategy with regard to the energy sector is security of energy supply at competitive prices determined on the open market.

Long-term electricity security of supply requires:

- *The construction of necessary electricity-generating capacities to satisfy growing consumption and to take heed of the principle of diversification of energy sources and their economic and environmental sustainability;*
- *Securing sufficient quantities of fuel to maintain power plants keeping in mind any insecurities relating to the use of renewable energy sources (particularly hydropower and wind energy);*
- *The construction, modernization and maintenance of transmission and distribution networks; and*
- *A maximum utilization of economically feasible measures of energy efficiency and consumption management.*

6.3.1. The required New Electricity-Generating Capacities to Meet Electricity Demand

6.3.1.1. Necessary thermal power plant capacities required until 2020

Electricity-generating capacities that need to be constructed were analyzed on the basis of forecasts of total electricity consumption, peak loads in the system and quantities required for reserves in the system¹⁵. Based on the expected electricity consumption, the load factor and expected peak loads in 2020 amounts to 4767 MW. Sufficient available reserves need to exist in the power system of installed capacities so total installed capacities must be larger than the expected peak load. Necessary reserves in the system are determined on the basis of system features and the structure of production units in the system. The outcome therefore is that in 2020 it will amount to 30% of the expected peak load and so the required capacity amounts to 6200 MW.

The need for investments into the electricity system in Croatia is significant because apart from growing consumption it is necessary to replace deteriorated production units. Table 6-2 presents the expected decommission of existing power generation facilities.

Table 6-2 Forecasted decommission of existing power generation facilities

Facility unit	Nominal power on generator, MW	Foreseeable year for entry into operation
EL-TO Zagreb Cogeneration Plant unit A	12.5 (9)	2011
TPP Sisak unit A	210 (198)	2013
TPP Plomin unit A	105 (93)	2015
TE-TO Osijek Cogeneration plant PTA A	25 (23.5)	2017
TE-TO Osijek Cogeneration plant PTA B	25 (23.5)	2017
KTE Jertovec KB A (Combined-Cycle Power Plant)	42.5 (37)	2018

¹⁵ Detailed analysis of all parameters required to determine demand for new electricity-generating capacities are presented in the following expert supporting document, “**Development Scenario of the Croatian Power Sector**”.

Facility unit	Nominal power on generator, MW	Foreseeable year for entry into operation
KTE Jertovec KB B (Combined-Cycle Power Plant)	42.5 (37)	2018
TE-TO Zagreb Cogeneration plant unit C	110	2019
TE-TO Osijek Cogeneration plant unit A	45 (42)	2019
TE Sisak Cogeneration plant unit B	210 (198)	2019
EL-TO Zagreb Cogeneration plant unitB	32 (26)	2019
TPP Rijeka	320 (303)	2020
EL-TO Zagreb Cogeneration plant PTA A	25.6	2025
EL-TO Zagreb Cogeneration plant PTA B	25.6	2025
TE-TO Zagreb Cogeneration plant unit K	210	2030
TOTAL	1179.5 (1100.0)	2020
TOTAL	1440.7 (1361.2)	2030

Figure 6-2 presents a decrease in existing installed capacities in relation to the previously determined requirements of installed capacities to satisfy the demand.

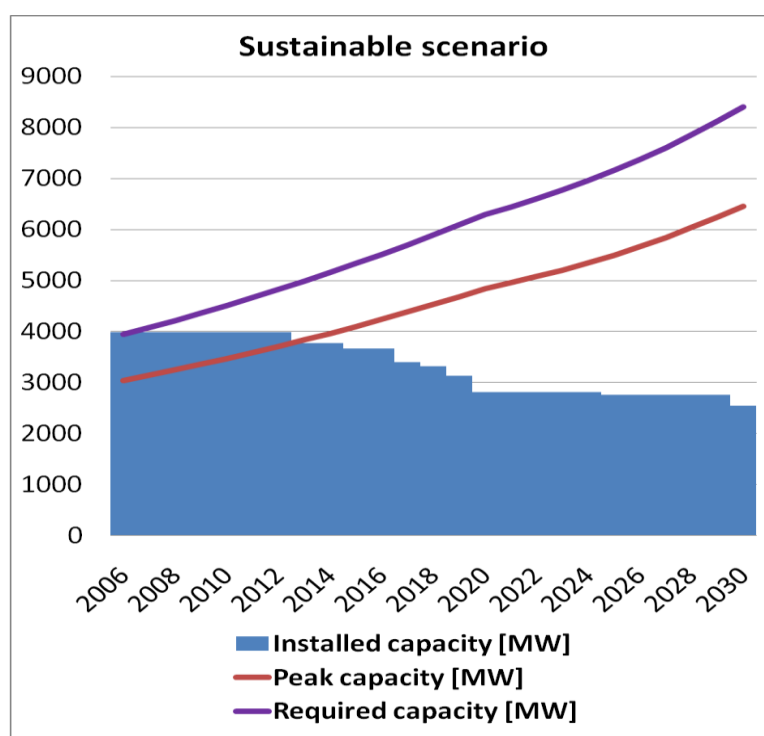


Figure 6-2 Decommission of existing power generation facilities and required installation capacities to satisfy the demand

The curve of installed electricity-generating capacities and the curve of required capacities indicate the need for additional generation capacities (Figure 6-3).

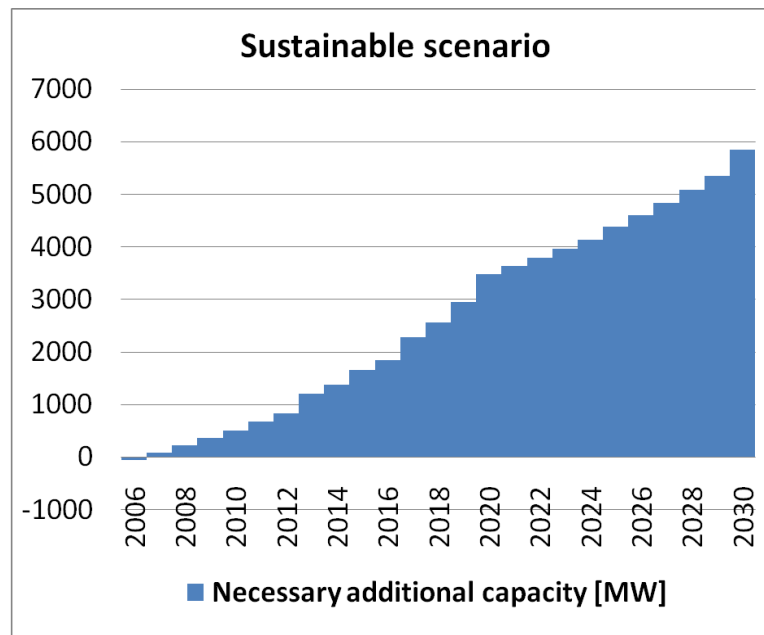


Figure 6-3 Required additional electricity-generating capacities

Several scenarios of development opportunities to construct new power generation facilities were analyzed on the basis of the input data presented. In order to facilitate a better understanding of the scenarios these have been labelled according to colour: **blue, green and white**. Each scenario has **common presumptions as follows:**

- **New electricity-generating capacities in hydropower plants in 2020 will amount to 300 MW** (that amount does not account for small hydropower plants because they are balanced with renewable energy sources). Greater utilization of hydropower plants is planned to cover peak loads – greater utilization of power. In addition to the construction of new hydropower plants, increased capacities will be enabled with the rehabilitation of existing plants.
- **A further production of 4000 GWh is expected by 2020 from renewable energy sources** (1545 MW new electricity-generating capacity). It is assumed that between 2011 and 2020 capacities of renewable energy sources (RES) will increase linearly.
- **In 2009 Unit L (100 MW) will come into operation at the TE-TO Zagreb Cogeneration Plant and in 2012 a new unit at TPP Sisak (250 MW) will be in operation.** These plants are natural gas-fired and their construction is currently underway.
- **By 2020 a further 300 MW will be installed in cogeneration units** (without 100 MW micro and small cogeneration units that are balanced under sustainable scenario of final energy consumption (natural gas-fired cogeneration units).

Specific differences of each of these scenarios are in their features and the going into operation date of new plants:

<ul style="list-style-type: none"> ▪ BLUE SCENARIO (2 TPPs firing natural gas, 2 TPPs firing coal) <ul style="list-style-type: none"> - 2013 start up of a natural gas-fired power plant with electricity-generating capacity of 400 MW - 2015 start up of a coal-fired power plant with electricity-generating capacity of 600 MW - 2019 start up of a coal-fired power plant with electricity-generating capacity of 600 MW - 2020 start up of a natural gas-fired power plant with electricity-generating capacity of 400 MW
<ul style="list-style-type: none"> ▪ GREEN SCENARIO (2 TPPs on natural gas, 1 NUCLEAR) <ul style="list-style-type: none"> - 2013 start up of a natural gas- fired power plant with electricity-generating capacity of 400 MW - 2015 start up of a natural gas-fired power plant with electricity-generating capacity of 400 MW - 2020 start up of a nuclear power plant with electricity-generating capacity of 1000 MW
<ul style="list-style-type: none"> ▪ WHITE SCENARIO (1 TPP on natural gas, 1 TPP on coal, 1 NUCLEAR) <ul style="list-style-type: none"> - 2013 start up of a natural gas-fired power plant with electricity-generating capacity 400 MW - 2015 start up of a coal-fired power plant with electricity-generating capacity of 600 MW - 2020 start up of a nuclear power plant with electricity-generating capacity of 1000 MW

These scenarios were analyzed and their features compared in relation to the fundamental energy development objectives: security of energy supply, competitiveness and sustainability. Each scenario was analyzed on the basis of previously defined criteria and a summary of the analysis is presented in Table 6-2.

Table 6-2 Comparative analysis of possible development scenarios of the Power sector in 2020

EVALUATION CRITERIA	BLUE SCENARIO	GREEN SCENARIO	WHITE SCENARIO
Possibility of electricity export	1	3 (due to NUCL)	5 (due to NUCL)
Power system reserves availability	5 (from 0.21 to 0.33)	1 (from 0.11 to 0.27)	3 (from 0.16 to 0.33)
Variety of fuels for conversion to electricity	3 (22% HPP, 13% RES, 19% gas, 37% coal, 9% NPP)	1 (22% HPP, 13% RES, 24% gas, 5% coal, 36% NPP)	5 (22% HPP, 14% RES, 14% gas, 14% coal, 36% NPP)
Import cost of energy sources	1	3	5
Impact to GDP growth (investment, import, export)	1 (least investment; greatest cost of importing energy sources; least possibility of exporting electricity)	3 (medium investment, medium cost of importing energy sources; medium opportunities to export electricity)	5 (highest investment; lowest cost of importing energy sources; best opportunities to export electricity)
CO ₂ Emission	1 (10.2 Mt)	5 (3.4 Mt)	3 (4.4 Mt)
Price of electricity In addition to the price of CO ₂ emission per unit 20 EUR/t (price of oil at \$84/bbl)	3 (440 HRK/MWh)	1 (449 HRK/MWh)	5 (369 HRK/MWh)
Price sensitivity of electricity due to price change of CO ₂ emission units	1 (to 584 HRK/MWh; change of 33%)	3 (to 521 HRJ/MWh; change of 16%)	5 (to 471 HRK/MWh; change of 28%)
Price sensitivity of electricity	1	3	5

EVALUATION CRITERIA	BLUE SCENARIO	GREEN SCENARIO	WHITE SCENARIO
due to change in fuel prices (price of CO ₂ emission units 40 EUR/t)	(change of 42% when oil prices change from \$84 to \$140/b)	(change of 41% when oil prices change from \$84 to \$140/b)	(change of 41% when crude oil prices change from \$84 to \$140/b)

1 – least satisfies the criteria; 3-satisfies well the criteria; 5-best satisfies the criteria

Figures 6-5 & 6-6 present the structure of electricity generated in each of the respective scenarios.

Based on the analysis conducted this draft of the Green Paper of Update/Upgrade of the Energy Strategy of the Republic of Croatia recommends that the Government creates conditions which will ensure investments in development of the Croatian power system following the White Scenario.

Characteristics of the White Scenario are presented below.

Table 6-3 Forecasted start up dates of new power generation facilities by 2020 according to the White Scenario

Facility/Unit/Part of plant	Nominal power on generator, MW	Foreseeable year for entry into operation
TE-TO Zagreb unit L	100	2009
TPP Sisak unit C	250	2012
TPP GAS 1	400	2013
TPP COAL 1	600	2015
NUCL 1	1000	2020
(CHP) COGENERATION	Progressive yearly increasing by 30 MW, additional total 300 MW	2011-2020
HPP other	Progressive yearly increasing by 50 MW, total 300 MW (0,75 TWh new energy from HPP)	2015 – 2020
Renewable	1545 MW Ren with production of 4000 GWh in 2020	2011 – 2020
Total GAS	1050	
Total COAL	600	
Total NUCL	1000	
HPP + REN	1845	

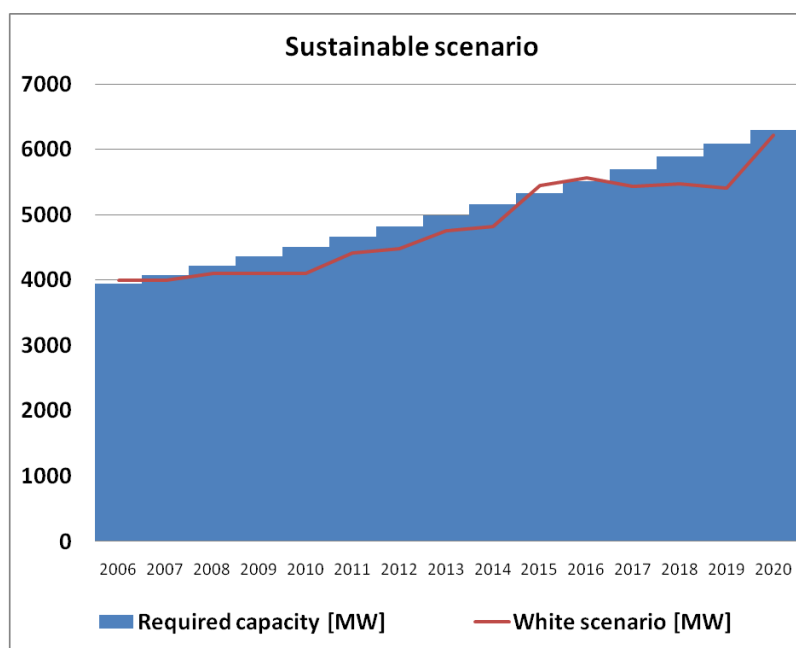


Figure 6-4 Total capacities required and planned capacities according to the White Scenario

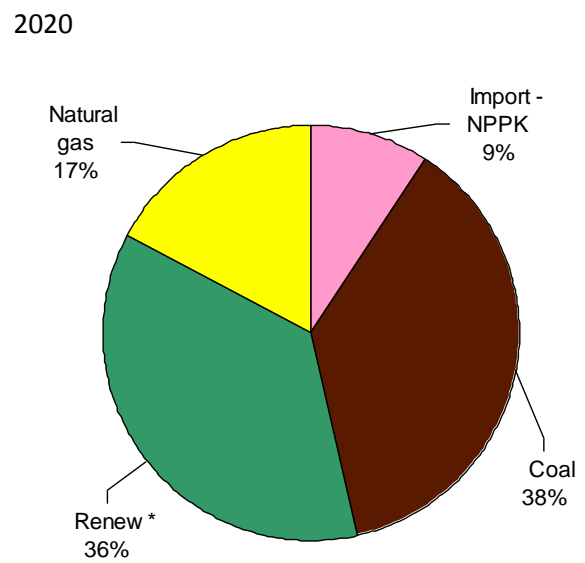
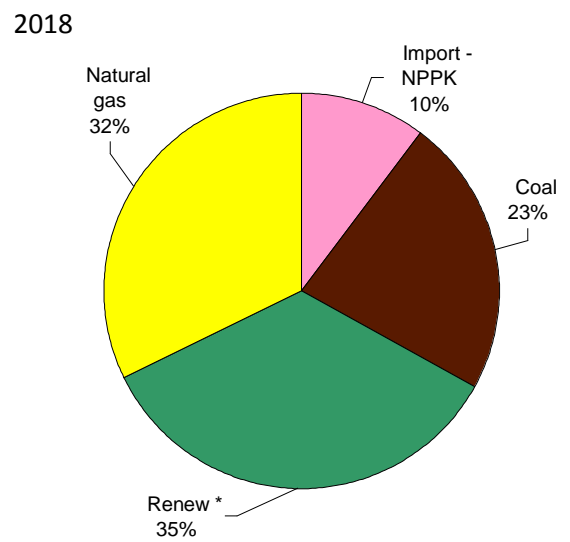
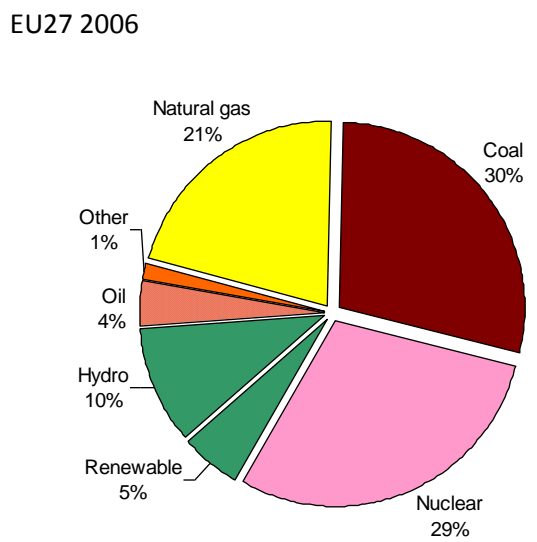
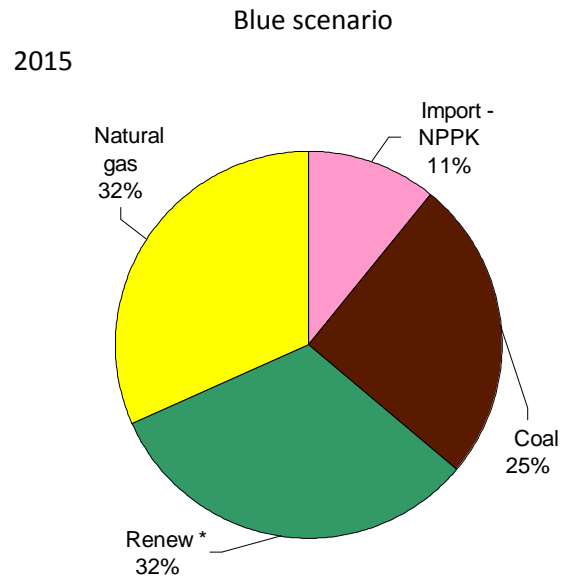
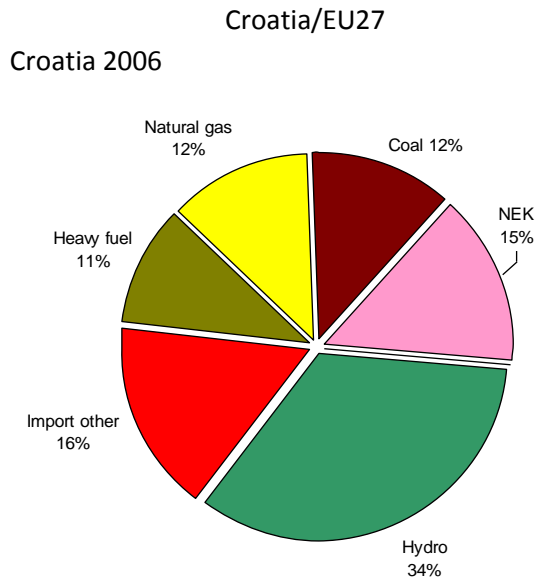


Figure 6-5 the structure of electricity generation according to the Blue Scenario

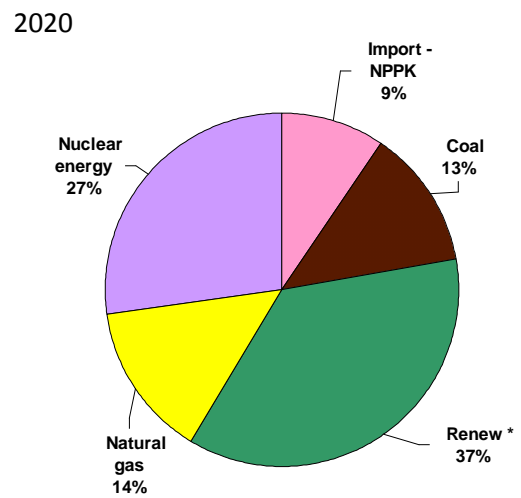
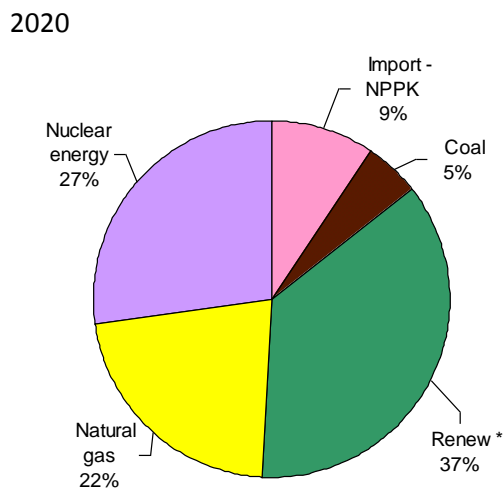
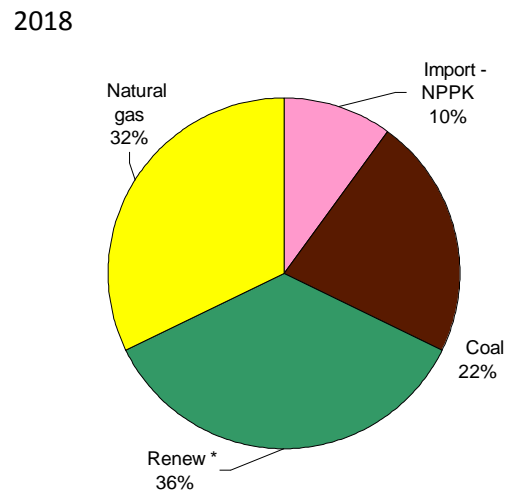
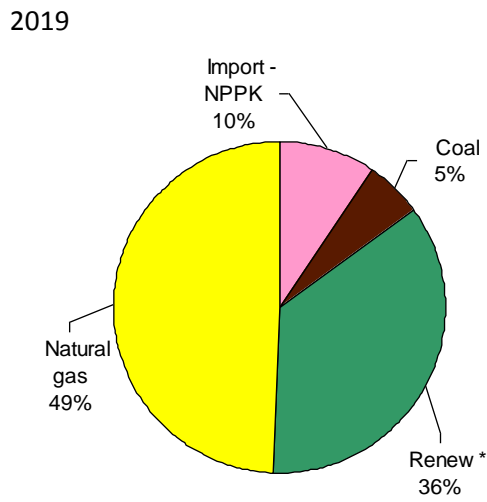
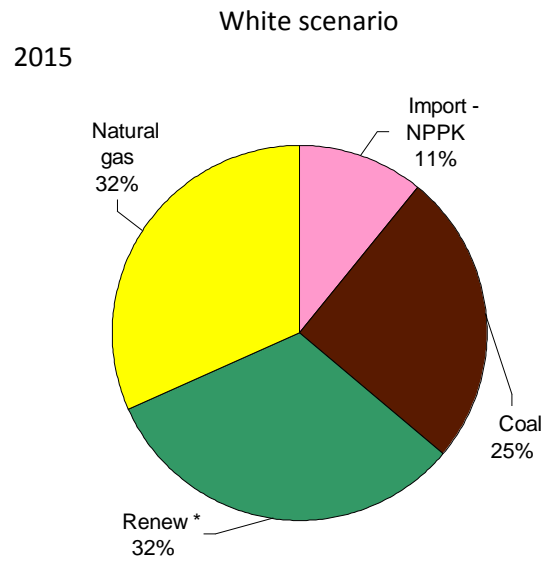
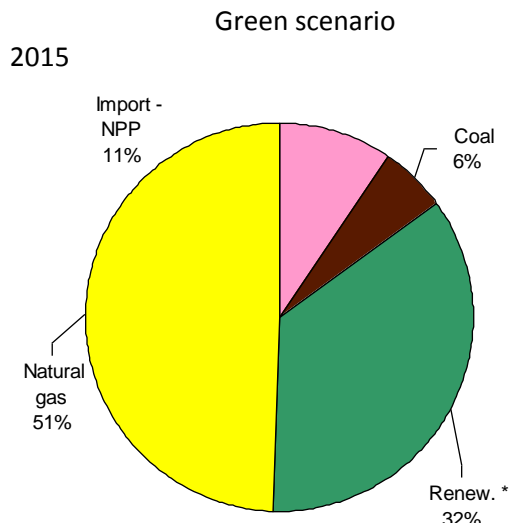


Figure 6-6 the structure of electricity generation according to the Green and White Scenario

The structure of electricity generated by energy forms used for that production according to the White Scenario of development of the power system is presented in Figure 6-7, while the structure by energy forms for the production of electricity is presented in Figure 6-8.

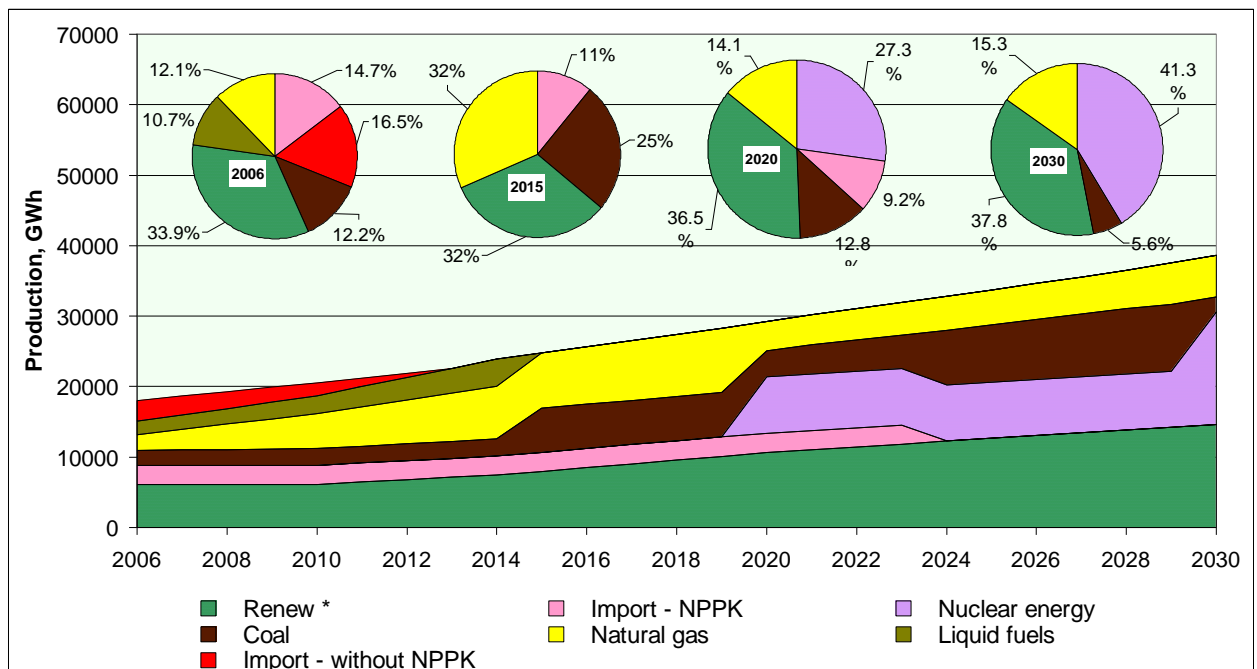


Figure 6-7 The structure of electricity generation (White Scenario)

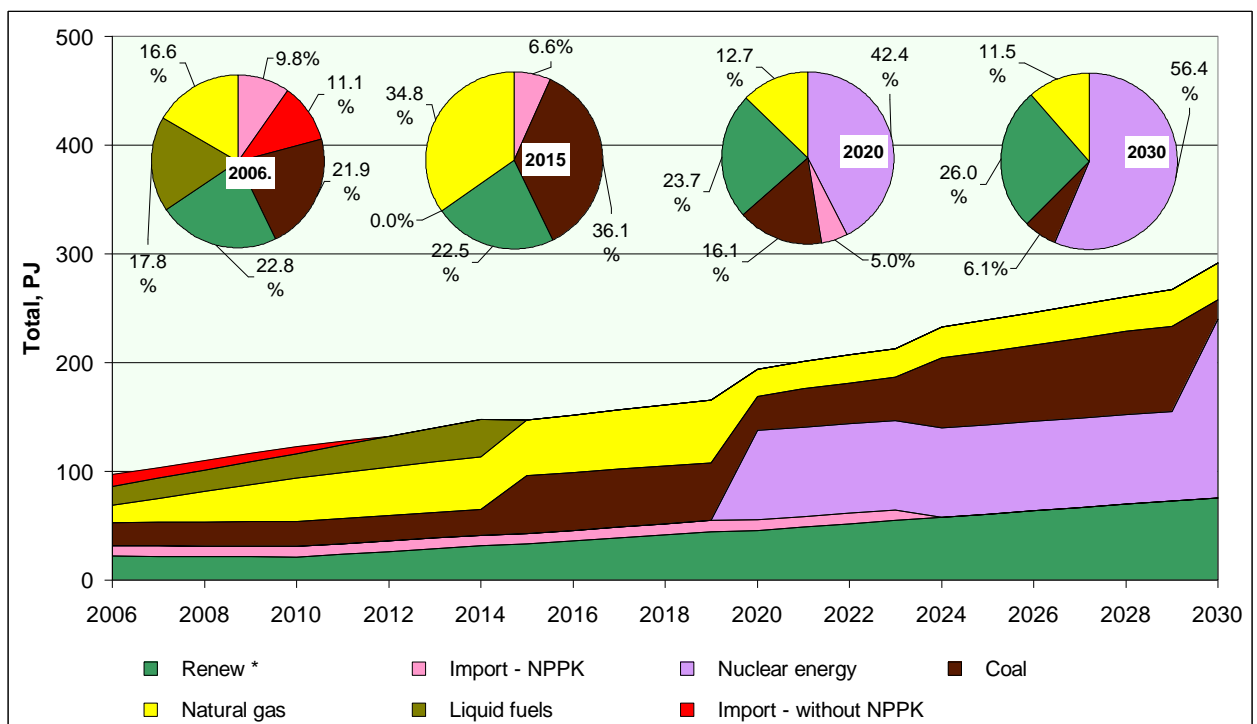


Figure 6-8 The structure of the energy forms used for electricity generation (White scenario)

6.3.1.2. A view to 2030

An estimate of new capacities required in the Power System until 2030 is based on an estimation of growth in electricity demand according to sustainable scenario and with defined years of decommission of existing plants. The increased consumption foreseen, future need for electricity-generating capacities and decrease in existing electricity-generating capacities until 2030 are presented in Figure 6-2, while capacities that need to be constructed are presented in Figure 6-3.

The proposed scenario of power system development foresees and analyses the start up of new plants by 2020. However, considering the growth of consumption beyond that year it is necessary to offer guidelines for construction of new plants by 2030. Even beyond 2020 it is necessary to increase the use of renewable energy sources and to maintain variety in the structure of the power system generation units. This is a precondition for a competitive system on the regional electricity market and for energy security supply. Potential investors will be interested in constructing only power generation plants that can satisfy these two preconditions. In that regard, for the period **beyond year 2020 it is recommended that the Government creates conditions for private investors according the following proposed development of the power system:**

- Installed electricity-generating capacities in thermal power plants using RES will increase and in 2030 these will be doubled in comparison to 2020 (about 3000 MW and electricity generation of 8000 GWh)
- New thermal coal-fired power plants will go into operation in 2024 (*urgent reservation of land for a second location for coal-fired thermal power plantl is a fundamental determinant of this Strategy*)
- A new nuclear power plant going into operation in 2030;
- Installed electricity-generating capacities in cogeneration plants will continue to increase and in 2030 will amount to 600 MW;
- Further growth in capacities are not foreseen in hydropower plants beyond year 2020

It is important to notice that the proposed development of the energy sector ensures a variety of energy forms and applied technologies for conversion into electricity (Figures 6-7 and 6-8).

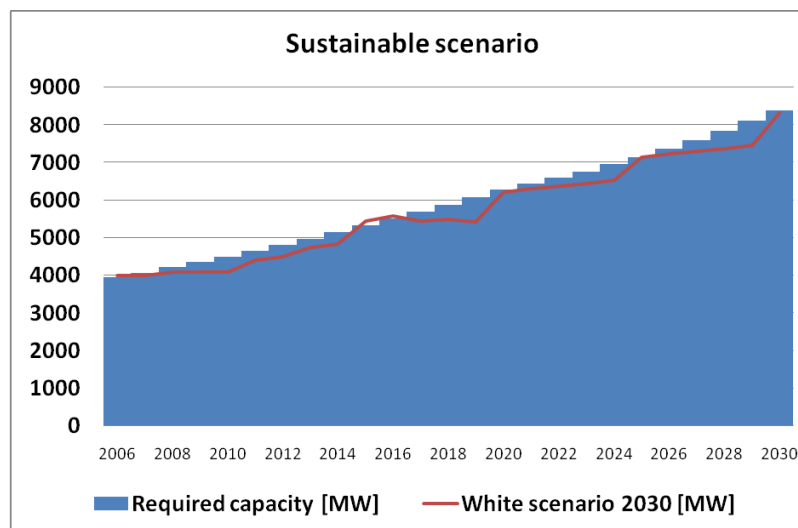


Figure 6-9 Total requirements and planned capacities according to the White Scenario by 2030

6.3.2. Transmission Lines and Distribution Network Development

Development guidelines for transmission networks

The Croatian electricity network is part of the UCTE – Union for the Co-ordination of Transmission of Electricity, a European continental system to coordinate the transmission of electricity. Due to mutual connections and mutual effects to planning the state of the network in the future it will be necessary to take into concern the state of other national systems. This relates in particular to the 400 kV network in Central and Southeast Europe. Transmission of electricity in Croatia is regulated electricity activity combined with power system management. The company responsible for the transmission of electricity - HEP – is the operator of the transmission system and is responsible for management, development planning and maintenance of the transmission network as well as being obliged to secure long-term operability of the transmission network in order to satisfy a variety of requirements of users of electricity transmission networks.

The existing 400 kV network in Croatia has sufficient capacity to transmit significantly greater power without any operational problems or limitations until the end of the period covered by this Strategy which goes in favour of accepting new generation units (regardless of the place of connectivity) as well as favouring trading electricity.

Even though there has been significant progress over the past few years with regard to reconstruction and revitalizing the existing network at all voltage levels investments will continue to be significant until the end of the period covered by the Strategy.

Planned increases in electricity demand will not require significant investments into the 400 and 200 kV networks until the end of the period covered by the Strategy. Greater investment into development the 400 kV and 200 kV networks will be required to connect new generation facilities to ensure optimal (secure) power to certain regions and to increase transit of electricity through Croatia.

If the facilities with high power are connected to the 400 kV networks which may cause congestion then the increase in transmission capacities can be solved with the construction of new transmission lines within the corridor in keeping with physical-planning documents.

Increased consumption needs to power large infrastructural systems (highways, gas and oil transport systems, electrification of the railway), and the acceptance of generation units with less power (particularly those in the RES segment and cogeneration production) will require reconstruction and renewal of existing 110 kV networks and the construction of new 110 kV lines and plants. With regard to accepting all foreseen intermittent sources from the RES segment, it is vital to foresee investments to achieve the necessary regulatory abilities of the system on the whole, particularly to adapt production units to regulatory requirements.

Significant investment must be accounted for in order to apply latest information-communication technology in remote control systems (coordinated supervision and administration, security and metering) the power system which comprehends continual modernization of the NDC (National Dispatch Centre) and network centres in keeping with obligations and requirements to operate parallel to the European system.

To be able to secure sufficient flexibility in developing Croatian transmission networks in conditions of an open European and regional electricity market to satisfy requirements by users it is necessary for physical planning documents to contain corridors and location sites for transmission facilities according

to their use for the demand of the current or another voltage level which ensures rational utilization of space and lessens the environmental impact.

Development directives for the distribution network

With the reconstruction of the energy sector, activities of traditional distribution companies have been completely disunited business wise and have divided into market orientated activities – supply of electricity and regulatory directives – managing the network or the distribution of electricity. It is expected that the fundamental activity of electricity supply (purchasing electricity on the market and selling it to buyers) will be expanded with additional services and their emergence significantly depends on the development of the distribution network.

The company responsible for distribution of electricity – HEP – Operator of the Distribution System is responsible for management, development planning, construction and maintenance of distribution networks from metering sites and connection nodes in transmission networks to each metering location for each user in the distribution network. It is the Operator's duty to secure undisturbed access to the distribution network for all users and to ensure access to information that is necessary for them to use the network efficiently. Users of the distribution network can be either buyers (consumers) of electricity, producers of electricity and at the same time buyers and producers of electricity. Production of electricity in the distribution network is distributed production and most often represents a privileged category of producers due to their use of cogeneration plants and renewable energy sources.

The distribution network in Croatia is characterized with huge differences between individual distribution regions – by the number of users, the quantity and nature of electricity consumption, physical dispersion and level of construction and the technological level of equipping plants and networks. It is worth emphasizing the need for increased renewal of certain sections of the distribution network in order to improve the quality of supply.

Changes that must be made to the distribution network are determined by three conditions:

- Functional changes of voltage levels in the distribution network;
- Structural changes in the network to increase acceptance of distributed production; and
- Technological development and adapting to European technological platforms relating to distribution networks (*Smart Networks*).

The development of distribution networks therefore needs to be directed towards:

- Gradual transition to two-level transformation;
- Installation of metering apparatus with the possibility of two-way communication at metering locations of users of distribution networks;
- Construction of simple distribution facilities and apparatus at all voltage levels of the distribution network where this can be justified;
- Construction of typical distribution facilities (especially transformer stations); and
- Automation of plants and networks and significant application of information-communication technology.

6.3.3. Renewable Energy Sources and Waste-to-energy

The Strategy foresees significant use of renewable energy sources to produce electricity which is in complete harmony with its fundamental determinants. The set objective comprehends a total of 1545

MW electricity-generating capacity in renewable energy sources in 2020, not taking into account large hydropower plants. ***The objectives for individual sources of renewable energy by 2020 are as follows:***

- **1200 MW electricity-generating capacities in wind parks** (2000 MW by 2030),
- **140 MW electricity-generating capacities in biomass power plants** (420 MW by 2030),
- **40 MW electricity-generating capacities in waste-to-energy plants** (60 MW by 2030),
- **20 MW electricity-generating capacities in geothermal power plants** (30 MW by 2030),
- **45 MW electricity-generating capacities in solar power plants** (250 MW by 2030),
- **100 MW electricity-generating capacities in small hydropower plants**(140 MW by 2030)

Apart from constructing the above new power plants increased power is planned in **existing hydropower plants with a total of 300 MW by 2020**. Existing hydropower plants will remain in the system.

It is very preferable to build pumped storage hydropower plants for the power system in the planned energy structure which will increase its competitive ability on the electricity market.

Electricity generated from all renewable sources (including all large hydropower plants) in 2020 will amount to around 10.7 TWh, or around 35% of total electricity generated. New renewable sources to produce electricity account for 4.1 TWh or around 13%.

Greater share of renewable energy sources in the power system requires of course new management methods due to their intermittent nature in order not to threaten the security of supply and to ensure sufficient reserves in the system to cover loads in those cases when these power plants are unable to operate. Wind parks will have a particularly important influence in the future for the system's operation. In that regard, it is important to develop and apply tools to foresee electricity generation by wind parks.

The growing use of renewable sources also comprehends small production units located in the vicinity of electricity consumers that will be connected to the distribution network. In that regard it is necessary to enable the acceptance of distributed resources and to create the technical conditions for active distribution networks to operate.

The Croatian electricity network is part of the UCTE, a European continental system to coordinate electricity transmission. Due to mutual ties and mutual effects on any plans for the network, in future it will be necessary to take into concern the state of other national systems. This relates in particular to the 400 kV network in Central and Southeast Europe. Transmission of electricity in Croatia is regulated electricity activity combined with managing the power system. The company responsible for the transmission of electricity - HEP – is the transmission system operator and is responsible for management, development planning and maintenance of the transmission network as well as being obliged to secure long-term operability of the transmission network in order to satisfy a variety of requirements of users of electricity transmission networks.

The existing 400 kV network in Croatia has sufficient capacity to transmit significantly greater power without any operational problems or limitations until the end of the period dealt with in this Strategy which goes in favour of accepting new production units (regardless of the place of connectivity) as well as favouring trading electricity.

Even though there has been significant progress over the past few years with regard to reconstruction and revitalization of the existing network at all voltage levels, investments will continue to be significant until the end of the period covered by the Strategy.

Planned increase in electricity demand will not require significant investments into the 400 and 200 kV networks until the end of the period covered by the Strategy. Greater investment into developing the 400 kV and 200 kV networks will be required to connect new production facilities to ensure optimal (secure) power to certain regions and to increase transit of electricity through Croatia.

If facilities with high power are connected to the 400 kV networks which may cause congestion then the increase in transmission capacities can be solved with the construction of new transmission lines within the corridor in line with physical-plans. Increased consumption, needs to power large infrastructural systems (highways, gas and oil transport systems, electrification of the railway), and the connection of production units with less power (particularly those in the RES segment and cogeneration production) will require reconstruction and renewal of existing 110 kV networks and the construction of new 110 kV lines and plants. With regard to connect all foreseen intermittent sources from the RES segment, it is vital to foresee investments to achieve the necessary regulatory abilities of the system on the whole, particularly to adapt production units to regulatory requirements.

Significant investment must be accounted for in order to apply the latest information-communication technology in remote control systems (coordinated supervision and administration, security and metering) the power system which comprehends continuous modernization of the NDC (National Dispatch Centre) and network centres in keeping with obligations and requirements to operate parallel to the European system in order to permanently ensure a balance in production and consumption of electricity as the foundation of securing supplies in a realistic time frame.

To be able to secure sufficient flexibility in developing Croatian transmission networks in conditions of an open European and regional electricity market to satisfy requirements of users it is necessary for physical planning documents to contain corridors and location sites for transmission facilities according to their use for the needs of the current or another voltage level which ensures rational utilization of space and decreases effects environmental impact.

6.3.4. Cleaner Coal, and Carbon Capture and Storage of Fossil Fuels

Security of Energy Supply

The main advantage of coal is security of supply. Supply security results from the fact that there are still enormous coal reserves with greater availability in comparison to oil and natural gas reserves and can be found in more politically stable countries (mostly OECD countries).

Competitiveness

The second advantage of coal is its relative price stability. Even though the price of coal reacts to changes in oil prices, this reaction is restrained.

Environmental impact

Regarding the environmental impact of thermal power plants in particular emissions into the air, water and soil, noise levels of thermal power plants, the problem of waste and the visual effect to the landscape and generally the aesthetic features of power plants and how they fit into their surroundings are being considered. Modern thermal coal-fired power plants have small air emissions

of other pollutants into the atmosphere - SO₂, NO_x and particles. The problem regarding coal dust and combustion by-products being released (so-called fugitive emissions) is resolved by containing the entire system in an enclosed surrounding and this also resolves any negative visual or aesthetic problems too. Technology used today in construction of enclosed storage areas, silos and transport infrastructures has advanced so much that this will not significantly affect investment into such power plants. With regard to combustion by-products, the construction and operation of coal-fired power plants (slag and fly ash) and gypsum (as a by-product of flue gas desulfurization), the demand in Croatia in the cement industry is sufficient enough and even in the White Scenario, this waste would be completely taken care off which would be benefit for both sides. Slag can also be used in road construction, for filling and levelling terrains etc. while ash and slag and gypsum for that matter may be permanently removed to landfill (in keeping with regulations that regulate that type of technological waste [even though in Croatia this would not be necessary]).

Off-loading from ships to ships has also been improved as far as environmental impacts are concerned. Off-loading is continuous with installed apparatus and modern techniques to eliminate dust dispersion – even in conditions of strong winds – the mentioned apparatus solves this kind of problem.

The public has the right to be informed about the situation of energy in the country and the environmental impact of certain technologies. The energy sector and government have ignored this question therefore, during the process of implementation of this Strategy, the special attention will be given to public right to information!

A significant problem relating to environmental impact of the coal power plants is the emission of carbon dioxide.

Considering the CO₂ emission the increased efficiency of energy transformation is at the moment the only way to achieve CO₂ emission reduction. Environmental protection requirements have always dominantly affected the development of coal-fired thermal power plants and even now technology that will reduce or completely eliminate carbon dioxide emissions is being intensively developed.

New qualities of the concept of classic coal-fired thermal plants have been realized with a series of technological improvements. The main features of all these projects are: due to technological developments to thermal plants and in particular developments in materials that enable the application of supra-critical and ultra-critical parameters of steam, thermal plants achieve a high degree of efficiency (43 – 46 %).

With regard to completely eliminating carbon dioxide emissions it is estimated that technology to capture carbon dioxide from flue gasses and storage into underground storage tanks (exhausted oil and gas basins) will be available commercially in about ten years time and so the construction of new coal-fired thermal power plants should foresee sufficient storage capacities for CO₂ storage. Through its mechanisms the European trading scheme ensures that emission of CO₂ are restrained following the set objectives and so when investment decisions are brought about construction generally the price of fuel should include the expected price of emission units. In that way a balance is made between energy supply security, competitiveness of the energy system and anthropogenic influences on green house gasses in the atmosphere.

6.3.5. Nuclear Energy

This Draft of the Green Paper recommends the construction of a nuclear power plant of about 1000 MW by 2020. With that the Energy Strategy, in keeping with the latest European recommendations, introduces an equal evaluation of all available options (natural gas, coal, nuclear power, hydropower and other renewable energy sources). Advanced nuclear technology is available on the market for use in new third generation nuclear power plants.

The greatest problem today is climate change on the one hand and security of supply on the other. Nuclear power contributes to resolving both these problems. Nuclear power falls into the category of low-carbon technology for electricity generation. Secondly, nuclear energy contributes to security of supply because it increases the variety of energy sources. It is justifiable to claim that the introduction of the nuclear option expands the energy mix because it introduces a new primary energy source – nuclear fuel. Furthermore, uranium minerals can be obtained in more than fifteen countries in the world that are politically independent of each other while nuclear fuel is obtained from the most developed, politically stable countries pursuant to long-term agreements. Additionally, the production price of electricity generated in nuclear plants is not as sensitive to price changes in the primary source – nuclear fuel.

Equally important, it is necessary to point out the following features of using nuclear power:

- Electricity generated in nuclear power plants is one of the cheapest low-carbon technologies in production;
- Reliability of electricity generated in nuclear power plants is very high, for example, in modern nuclear plants, the factor of the said load is above 90%;
- Operational security of modern nuclear plants with the application of all-encompassing and an efficient regulatory framework is exceptionally high.

The introduction of nuclear technology in the power system in Croatia by 2020 represents a demanding and comprehensive task and its success depends largely on the role of the Croatian Government. By accepting this Strategy the Croatian Government will take on the following obligations:

- *Upgrading the regulatory framework in the Republic of Croatia that regulates the entire procedure to select a location, construction and operation of nuclear plants;*
- *Establish administrative capacities relating to the construction and operation of nuclear plants;*
- *Physical planning, research and selection of a location for the nuclear plant;*
- *Fortifying scientific research capacities as a basis for the successful monitoring of construction and operation of the nuclear plant;*
- *Education of highly qualified experts;*
- *Selection of a solution to low and medium radio-active waste disposal;*
- *Preparation of a strategy for highly radio-active and exhausted nuclear fuel management.*

Figure 6-10 presents two basic phases in the process of construction a nuclear plant. The first, political phase, an important share of activities depends on decisions required by the Government and Parliament and based on experience in European countries; this may take between 4 to 6 years. In the second, the technological phase, a greater part of the activities are conducted by the investor and for current nuclear technology, this may take between 5 to 6 years.

It is obvious that the introduction of the nuclear option is a complicated and long process with a series of concurrent and subsequent activities which partially include the Croatian public. That is why the Croatian Government should immediately upon adopting the Strategy embark on preparing a detailed implementation plan of activities to introduce the nuclear option.

6.4. Future Trends

Achieving electricity supply security must rest on market mechanisms and therefore, setting these conditions is one of the basic presumptions of this Strategy.

The greatest future challenge in the power system naturally is CO₂ emission reduction and the price of emission units on the international market of which Croatia will certainly be part of. The analyses conducted to prepare this Strategy were implemented as such that they accounted to the price of emission units. Indications are that low-carbon technology to produce electricity (renewable sources and nuclear power) are insensitive to increases to emission unit prices and so increased emission unit prices to produce electricity from these sources become more competitive.

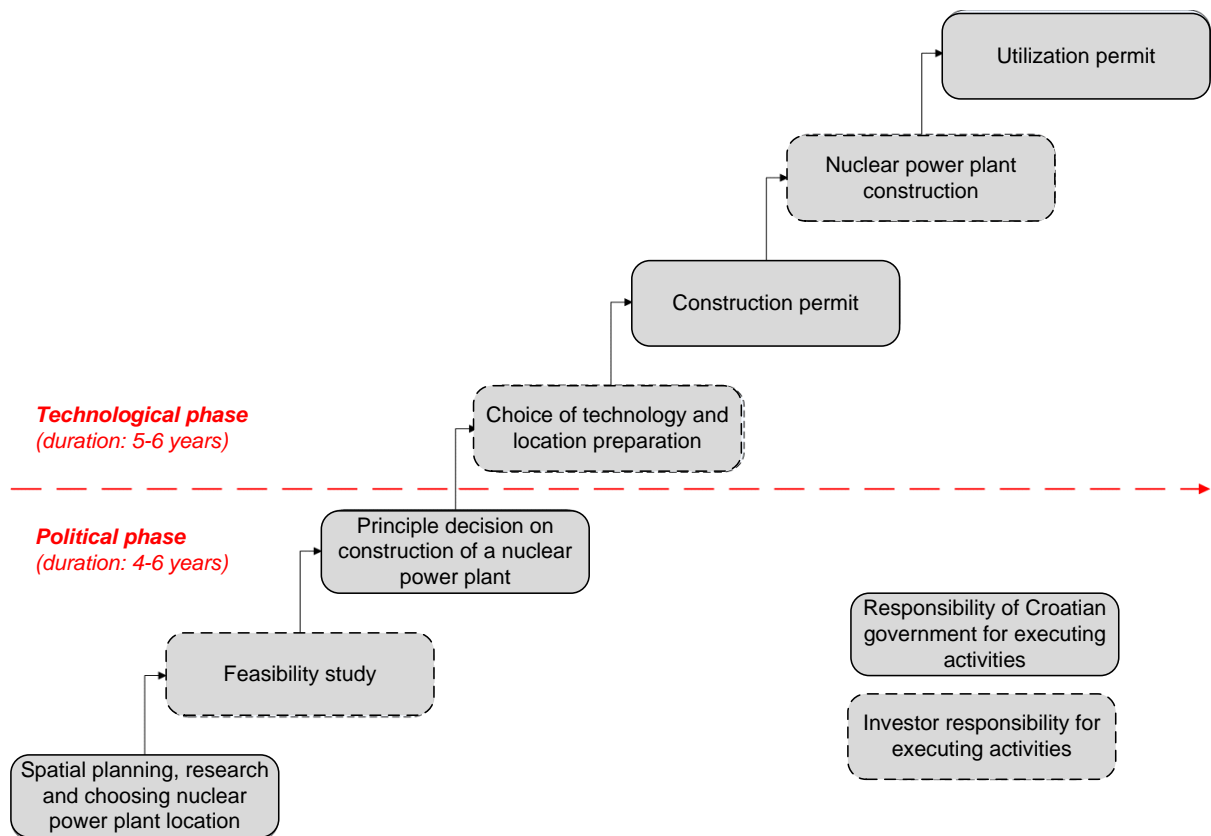


Figure 6-10 Basic phases and activities in construction of nuclear power plant

7. DISTRICT HEATING SYSTEM AND DISTRIBUTED ENERGY GENERATION

7.1. Future Heat Demand in District Heating Systems

The total installed heating power of production units in the District Heating System (DHS) in Croatia amounts to around 1.8 GJ/s. A large share of production capacities is outdated technology and so there is a significant possibility to increase its energy efficiency.

In 2006, these systems delivered 11.872 PJ of heating energy to users (internal engine steam and boiling water). Out of that 8.888 PJ were delivered from public thermal power plants (where heat is produced in steam generators and also in cogeneration generation units for heat and electricity generation), and 2.984 PJ from district heating plants. The total length of heating networks amount to around 460 km. Due to their age and technological deterioration the majority of the heating network, losses in distributing heating energy are high and amount to around 12% in the distribution of boiling water and 15% with water steam (average losses in modern district hot water grid amount to around 5%, and with water steam at around 10%).

In 2006, the households and services sector used around 7.575 PJ heating energy (6.120 PJ households and 1.455 PJ services) for heating and hot water production. Around 10% of the total number of households in Croatia is connected to the DHS and the total number of users is around 151,000. The fraction of DHS in the total final consumption of energy for heating and domestic hot water in households and services is 12%

According to the *business-as-usual* scenario a relatively low growth rate is foreseen in the consumption of heating energy in households (1.1% in the period from 2006 to 2020, and in fact to 2030), and just a little higher in services (1.4% for the same period). Projections in the *business-as-usual* scenario are positioned from the current practice of unplanned, *ad hoc* approach to energy development in Croatian cities and poor management of most small DHS's which is the reason for their development being ceased.

In the sustainable scenario somewhat greater growth rate of connections of surface consumers in the DHS's (2.1% per annum) is assumed as a result of systematic planning of energy development in Croatian cities and settlements and the application of state-of-the-art technological solutions and methods to manage DHS's. The advantages of complimentary development systems of supply of natural gas and district heating supply (which is more favourable in areas with a greater heating density and larger facilities) enables: a reduction in the total costs of heating and domestic hot water production and contribute to the annual balance in the supply of natural gas at the level of an urban centre; the use of biomass, municipal solid waste, geothermal energy and other replaceable energy forms and the application of cogeneration plants. However, the sustainable scenario assumes an increased energy efficiency amongst consumers connected to the DHS (1% per annum in the entire period until 2030) and therefore the growth rate in households according to the sustainable scenario will remain the same as it was in the *business-as-usual* scenario and for services the rate will decrease. With these assumptions, the following consumption of heat in households and services is expected in the period observed (Table 7-1):

Table 7-1 Consumption of heat in households and services

Year	2006	2010	2015	2020	2030
Households PJ	6.120	6.293	6.663	7.067	7.958
Services PJ	1.455	1.581	1.646	1.731	1.931
Total PJ	7.575	7.874	8.309	8.798	9.889

A growth in consumption of heat from existing DHS's (Zagreb, Osijek) is not expected in industry in comparison to the current level due to restructuring and displacement of industry to areas with lower costs. It is however, expected that industrial consumers (and support service industry) in new industrial zones led by private initiatives and mutual benefit from supply from a unified system of heat will establish new DHS's) particularly if this proves to be useful to implement cogeneration units in the basic fraction of the superposition load diagram). Methodologically it is permitted to observe heat together with heat from industrial heating plants, industrial cogeneration plants and heating energy to supply industry from the existing district heating system.

7.2. Development Guidelines for District Heating Systems (DHS)

Determining development guidelines for the DHS's (including systems for energy conversion to internal steam energy and hot water used in industry) is also based on SWOT analyses (presented in the attachment to the Strategy). The following development guidelines are defined for the DHS's:

- *Improving the legislative framework for the efficient functioning of the heating sector;*
- *Necessity to introduce planned energy supply to settlements from the position of the lowest cost in the observed period;*
- *Necessity to technologically modernize the DHS and incentives for development and application of domestic equipment and services (for production units and for the heating network);*
- *Utilization of renewable energy sources to produce heat and incentives for distributed production;*
- *Incentives for efficient use of heat; and*
- *Application of up to date information technologies to maintain and manage assets.*

7.3. Goals and actions for DHS

7.3.1. District Heating Systems in Households and Services

According to the Act on Production, Distribution and Supply of Heat (OG, 42/05) the Government and county administrative bodies, that is, the Zagreb Central Administrative Body responsible for energy, participates in preparing documents for physical planning that are adopted by representative bodies in local and regional self-government units. In order to facilitate planning and decision making in local self-government units, particularly those responsible for the energy sector and DHS's, the Ministry of the Economy, Labour and Entrepreneurship has started the preparation of the "Methodology, Planning, Implementation and Management of District Heating Systems in the Republic of Croatia". Preparation of

the Methodology is in accordance with Croatian Government decision to initiate activities to prepare strategy for the Heat Sector in the Republic of Croatia.

The main objective of the Methodology is to define technical, economic and legal framework to increase energy efficiency and optimizing development of DHS's in urban centres. Special emphasis is given to systems in smaller towns and the production of heat from renewable energy sources. It is foreseen that the said expert instrument will apply to all counties in northern Croatia, Lika-Senj County and Primorje-Gorski Kotar County (regional self-government units) as well as the cities of Karlovac, Čakovec, Varaždin, Koprivnica, Bjelovar, Virovitica, Slavonski Brod, Vinkovci, Vukovar, Rijeka and Split (local self-government units). Elaboration and application in counties refers primarily to legislative, property-juridical affairs and physical planning issues while cities and their facilities for heat supply fall under the entire scope of the guidelines.

The realization of the project of the Methodology of Planning, Implementation and Managing District Heating Systems in the Republic of Croatia is planned over the next three years (2007 – 2009). Its application will improve management and technical – technological features of the DHS to modern level of an efficient energy management system in accordance with the demand of individual consumers. Having this in mind the following measures will be undertaken:

- The Ministry of the Economy, Labour and Entrepreneurship will finish the preparation of the three-year project, District Heating Strategy of the Republic of Croatia". This strategy will explain in detail the vital activities for sustainable development of the DHS;
- The energy efficiency of existing DHS's will be improved with an advanced management system, the introduction of the latest information measuring solutions, supervision, maintenance and property management, technical and technological modernization of production units, heating networks, handover/takeover stations and apparatus for consumers. Aspirations will be directed so that consumers where installations in buildings that do not allow heat metering of heat consumption for each flat, decide to introduce heat cost allocator which is required with higher prices of energy sources and regarding requirements of environmental protection.
- Compulsory energy planning will be advanced and coherently implemented at the local self-government level. Regarding the supply in the sector of households and services the DHS's will develop as a complimentary system to natural gas supply in urban centres with complex energy supply while the location of each will be determined on energy supply plans (with a comparison of total costs for energy supply, environmental protection, need for diversification of energy sources in urban centres with complex energy supply and other relevant factors). Since distribution for DHS's and of natural gas is regulated activity, the recognized investments into the distribution network must be rational and expenditures must be justified and supported by plans for complimentary development of these systems.
- Heat demand and heat required for hot water production in multi-residential facilities larger than 1000 m², should be produced from house furnaces or from the District Heating System (which according to current legislation obliges the construction of a single separator and the installation of heating substation and heating metering for each housing unit ensuring total management of consumption by the individual consumer). Furthermore, the aim is to satisfy cooling demand in future constructions that will be supplied from a district cooling system (at

the building level or several district units). These solutions should enable the application of an efficient trigeneration plants (CHCP) - combined heating, cooling and power generation or the application of natural gas fired absorption chillers (which will reduce the summer peak load in the power system).

- With production units in district heating systems, incentives will be made for the use of renewable energy sources (biomass, municipal solid waste, solar energy) as well as a diversification of energy sources used.
- With production units in natural gas fired district heating systems, the use of replacement fuel will be ensured during periods of peak consumption in the natural gas supply system (residual oil, liquefied petroleum gas and other energy sources depending on the costs to cover peak loads). These measures may be normatively regulated even though the more favourable price of natural gas on a regulated market for consumers with the possibility of stopping delivery should be sufficient motive for this behaviour.
- In production units in the district heating system, construction of cogeneration units will be stimulated, if this proves to be economically viable regarding the external costs.

For the projected increased consumption of heat in the DHS for households and services, it is foreseen that energy forms presented in Table 7-2 will be used. With reference to this Strategy, it is not vital to plan development of production capacities of the heating network in the DHS as this is a free investment decision to be made by the concessionaire and local self-government based on previously adopted objectives and determinants. What needs to be emphasized is that supply to households and services from the DHS's offers the possibility to construct cogeneration units and heat storage tanks that could advance the economic efficiency in heating and the entire energy system.

7.3.2. Cogeneration for Industry

Development of natural gas supply and technological development of gas turbines and gas engines will vitally reduce specific investments to raise energy efficiency of heating cogeneration units for heat and electricity generation. Due to the higher degree of efficiency of these solutions compared to separate production of heat in steam generators (rarer in warm water and oil fired boiler), and electricity from condensation plants it is worth motivating the construction of these solutions. Achieved energy savings due to their construction will lower energy dependence, contribute to relieving climate change, adds dynamics to private investment into the energy sector, and raises electricity supply security and, most often, reduces losses in electricity transmission and distribution.

EC Directive 2004/8/EC and adopted national regulations define these solutions, the conditions relating to their construction and incentives. Croatian industry has good conditions to apply these solutions (large number of hours per annum for heat demand), however, the fact is that there is no interest to construct them. It is vital therefore to re-question the incentives system for cogeneration units (particularly those that are defined as highly-efficient) observed in the context of national objectives as an import dependent country and its obligations regarding CO₂ emission (where the energy efficiency in transformation has a vital influence). True incentives to build cogeneration units will be to develop the electricity market as this will direct market competitors to compare prices of electricity generated in cogeneration units in comparison to electricity generation in thermal power plants (particularly with high prices of natural gas).

Based on a detailed insight into the energy system in Croatian industry (each individual plant), it was determined that there is a possibility to construct a large number of cogeneration units which would be competitive in their price of electricity generated with the most modern natural gas-fired thermal power plants (total electricity-generating capacity of around 600MW). It is estimated that by 2020, due to improved incentives and growing interest of private investors, a total of 300 MW cogeneration units could be built with various power levels (the majority of that power relates to industrial cogeneration units but also includes estimates for cogeneration units in the DHS). By 2030, additional 300 MW could be built.

Table 7-2 Structure of energy forms and generating capacities to produce steam and hot water

Energy and production facilities structure for steam and hot water production	2006	2010	2020	2030	2006	2010	2020	2030	2006-2020	2006-2030
	PJ	PJ	PJ	PJ	%	%	%	%	%	%
Total	28.46	30.26	32.52	41.03	100.0	100.0	100.0	100.0	1.0	1.5
Coal	1.03	0.92	0.00	0.00	3.6	3.0	0.0	0.0	-	-
Liquid fuels	8.90	7.85	4.85	4.33	31.3	25.9	14.9	10.6	-4.2	-3.0
Natural gas	16.45	18.32	19.12	20.88	57.8	60.5	58.8	50.9	1.1	1.0
Renewable energy	2.08	3.18	8.55	15.82	7.3	10.5	26.3	38.6	10.62	8.82
Public heating plants	9.99	10.07	10.62	11.75	35.1	33.3	32.7	28.6	0.4	0.7
Industrial heating plants	10.07	11.05	11.92	18.21	35.4	36.5	36.7	44.4	1.2	2.5
Public cogeneration plants	3.73	3.82	4.03	4.46	13.1	12.6	12.4	10.9	0.6	0.7
Industrial cogeneration plants	4.67	5.33	5.95	6.62	16.4	17.6	18.3	16.1	1.7	1.5

7.4. Distributed Heat and Electricity Generation

Distributed energy resources (DER) include systems to produce and store energy located in the vicinity of the end users. The definition encompasses renewable energy sources, electricity generation and/or heat production and heat pumps. If we exclude renewable sources (RES are described in Section 9), the majority of technological solutions for DER use natural gas (or LPG) but also electricity in heat pumps (in the future it is expected to use hydrogen). DER's are usually featured with less power (up to a few MW's), they can operate on islands but are most often connected to electricity distribution networks and less frequently to heating networks (heating or cooling).

This Strategy gives guidelines in development of DER so that their role in energy supply will be of a complimentary nature to large energy systems. *The construction of DER's will be stimulated* in energy intensive commercial buildings in the service sector (shopping centres, hospitals, university buildings, large business buildings, hotels, sport facilities), and larger residential buildings (at the level of the house energy source or settlements with a high heating density), but may also apply to smaller residential buildings down to the level of individual houses when this is viable from a sustainable development position. This directive is positioned from the fact that the power system and natural gas supply system is the fundamental national energy system that offers energy supply security and price competitiveness due to their economic size. The position of these systems facilitate a series of solutions for energy conversion that in themselves would not be able to offer a quality energy supply however, supported by these large systems, they can contribute to relieving the problem of CO₂ emissions, lowering the country's energy dependence (due to lower losses in electricity distribution and transmission and a greater degree of efficiency in comparison to divided production of electricity and heat) as well as supply security due to the greater diversity of energy sources to the system.

Massive application and technological development of these systems can, in a period of high energy prices and increased allowances for CO₂ emissions, be a competitive energy supply from conventional energy systems due to their economic features (some of them are competitive in price even now). Because investments into these technologies are mostly of a private nature, their application stimulates a favourable climate of entrepreneurship and facilitates development of energy services.

It is estimated that by 2020, 100 MW micro and small cogeneration units will be built (up to 1MW), while by 2030 a further 50 MW will be built. Cogeneration units will be used for heating, cooling and electricity generation.

Heat pumps are used in low-temperature heating and as such are not applicable to the existing heating system. With higher energy prices and Government incentives they are becoming competitive and therefore the low-temperature heating is expected to grow. It is estimated that by 2020, 18% of the total surfaces in households, services and other sector will use heat pumps for heating and cooling. 70% of heat pumps will be absorption natural gas fired heat pumps. Furthermore, by application of heat pumps renewable internal energy from the surrounding air, earth and water amounting to 4.87 PJ per annum will be used (this stands for energy produced with an equivalent of 116 thousand tones of oil).

8. OIL, NATURAL GAS AND COAL

8.1. Future Oil, Natural gas and Coal Demand until 2020 (with a view to 2030)

The development strategy for the oil and natural gas sector is based on the *sustainable scenario* of final energy consumption. As the sustainable scenario is positioned from the point of improving the efficiency of energy use and greater penetration of renewable energy in the Croatian energy structure, we can ascertain that the success of implementing the Strategy can be measured by realized consumption of natural gas, oil and coal in relation to the projections made in the sustainable scenario.

8.1.1. Oil

Consumption of liquid fuels (oil products) is the main energy source in the Republic of Croatia and this will remain so in the period encompassed by this Strategy. The sustainable scenario of final energy consumption foresees a decrease in the share of liquid fuel in the total energy consumption from the current 47% to 38% in 2020 (and 34% in 2030). However, despite all measures of energy efficiency and the replacement of liquid fuel an increase in the consumption of liquid fuel is foreseen in final consumption from 1.2% per annum until 2020 and on that basis the foreseen total consumption of oil products is presented in Table 8-1 and Figure 8-1.

Under liquid fuel in final consumption all oil products and condensates are being considered, while oil is defined as crude oil for refining into oil products. Furthermore, some presumptions about the decreased consumption of residual oil have been taken into consideration which can be considered as certain considering the development decision adopted and the relatively brief time horizon of the assessment.

The following are additional presumptions made to estimate future consumption:

- Losses in oil refining in domestic refineries will decrease following technological reconstruction of the refineries in the period from 2010 – 2020;
- Consumption of oil products in refineries will decrease beyond 2010, following the reconstruction of refineries;
- Beyond 2011 decreased consumption of oil products and by 2020 the consumption of oil products will not be used anymore for energy transformation in oil production and refining;
- The need to secure an additional 100 thousand tonnes of oil per annum for the purpose of building up compulsory oil and oil products stocks to meet the obligation of minimum oil stocks of 90 days average daily consumption by 2012.

Presumptions upon which estimates were made of the future oil products demand in Croatia in the period between 2020 and 2030 are:

- The average growth rate of final consumption of liquid fuel is foreseen at a rate of 1.0%;
- With regard to expected growing geopolitical tension regarding frequent instability on the global oil market beyond 2020 and possible disorder in oil supplies as well as the continuing fall in domestic oil production in the period between 2020 and 2030, compulsory oil product stocks will be maintained and further developed in the Republic of Croatia.

Based on these presumptions, long-term demand of domestic consumers for oil products were estimated and are shown in Table 8-1 and Figure 8-1. The consumption of residual oil is balanced with the following presumptions: thermal power plants (and public cogeneration plants) will until the start up of thermal power plants on coal (2015) contract a maximum of 1.5 billion m³ of natural gas per annum and electricity will not be imported into Croatia. In case of thermal power plants taking the risk of contracting larger annual quantities of gas or in case that electricity is being imported, the consumption of residual oil in thermal power plants will be less than shown in Table 8-1 and Figure 8-1.

Table 8-1 Projection of the oil products consumption in Croatia until 2020 (with a view to 2030)

Consumption of oil derivatives	2006	2010	2014	2020	2030	2006	2010	2014	2020	2030	2006-	2006-
	1000 toe	1000 toe	1000 toe	1000 toe	1000 toe	%	%	%	%	%	2020	2030
Industry	277.23	262.40	268.48	181.76	201.74	6.2	5.8	5.3	4.2	4.3	-3.0	-1.3
Transport	2024.37	2325.71	2573.32	2650.03	2732.12	45.1	51.7	50.6	61.1	58.0	1.9	1.3
Other sectors	811.53	776.90	690.98	717.52	1008.09	18.1	17.3	13.6	16.5	21.4	-0.9	0.9
Oil and gas production and processing	617.10	261.49	397.28	440.89	440.89	13.8	5.8	7.8	10.2	9.4	-2.4	-1.4
Energy transformations	487.35	602.53	886.56	75.93	53.63	10.9	13.4	17.4	1.8	1.1	-12.4	-8.8
Non-energy consumption	270.11	270.11	270.11	270.11	270.11	6.0	6.0	5.3	6.2	5.7	0.0	0.0
Total	4487.69	4499.14	5086.73	4336.24	4706.57	100.0	100.0	100.0	100.0	100.0	-0.2	0.2
Total, PJ	187.89	188.37	212.97	181.55	197.05							

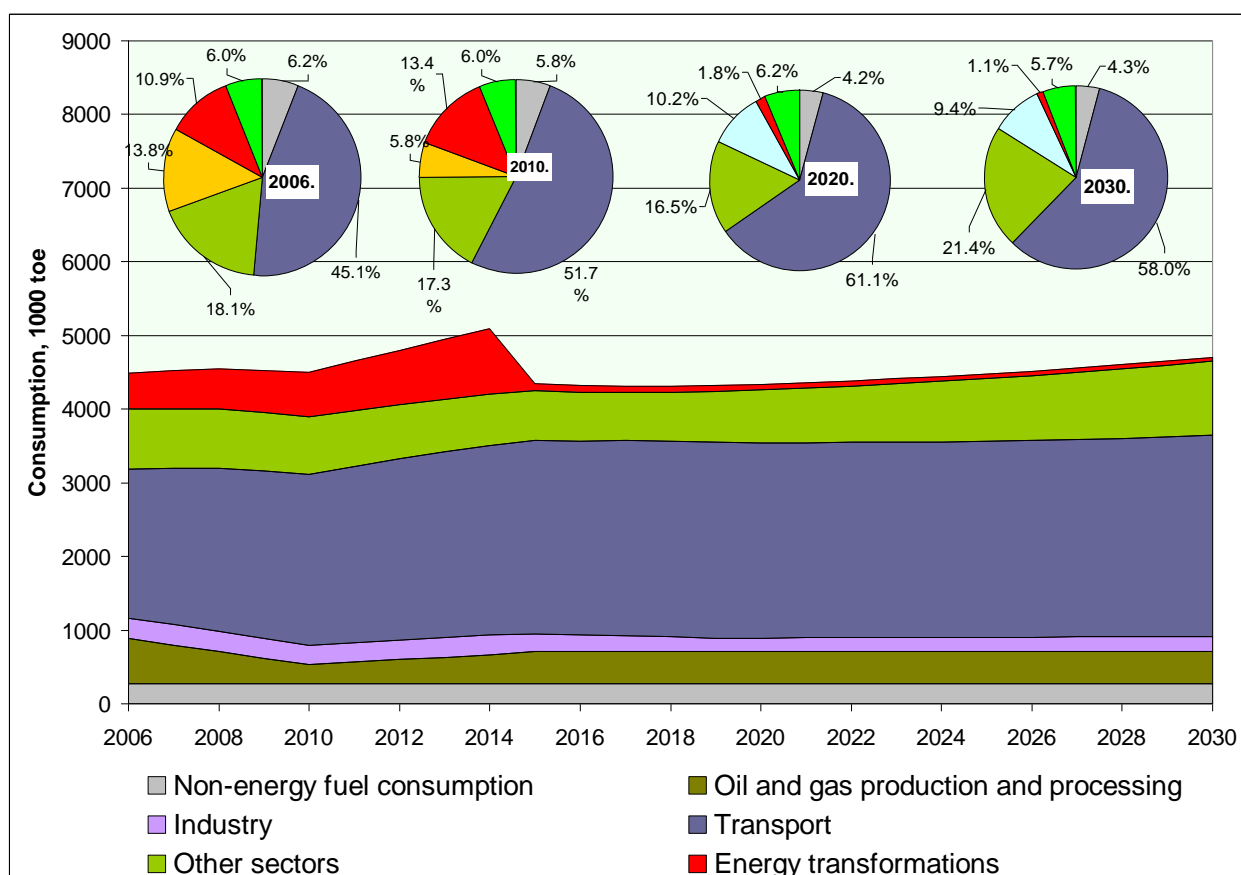


Figure 8-1 Projection of oil products consumption in Croatia

8.1.2. Natural gas

The share of natural gas in total energy consumption in Croatia is one quarter and around 16% in final consumption. Consumption over the past twenty years is marked with a constant growth with the exception of the war year in the nineties. According to the sustainable scenario, final energy

consumption foresees a growth in natural gas consumption in final consumption with a rate of 4.2% by 2020. Forecasts of total consumption of natural gas in Croatia are shown in Table 8-2 and Figure 8-2.

Until 2015 and the start up of coal-fired thermal power plants (White Scenario), demand of the power system will be covered in thermal plants which if possible will in addition to natural gas partially use residual oil (with low sulphur content) or electricity will be imported. Beyond 2015, residual oil will not be used any more (except as reserve fuel) and so, until the nuclear power plant is started up, consumption of natural gas in thermal plants and public cogeneration plants will be increased by around 1.7 billion m³. After that year, electricity generation in natural gas fired thermal power plants will decrease and therefore, consumption of natural gas will also decrease unless these electricity-generating capacities will be used to export electricity.

Table 8-2 Projection of total consumption of natural gas in Croatia

Gas consumption	2006	2010	2015	2019	2020	2030	2006	2015	2020	2030	2006-2020	2006-2030
	mil. m ³	mil. m ³	mil. m ³	mil. m ³	mil. m ³	mil. m ³	%	%	%	%	%	%
Industry *	770.6	749.9	909.8	946.4	969.9	1,166.6	26.8	15.9	18.4	19.7	1.7	1.7
Transport	0.0	15.9	87.5	162.6	181.9	325.5	0.0	1.5	3.4	5.5	27.6	16.3
Other sectors	816.6	1,019.5	1,241.8	1,385.2	1,405.7	1,467.5	28.4	21.7	26.6	24.8	4.0	2.5
Non-energy fuel consumption	462.9	710.4	1,009.7	1,005.7	1,004.7	1,004.7	16.1	17.6	19.0	17.0	5.7	3.3
Oil and gas production and processing	186.5	750.5	877.8	875.2	874.5	874.5	6.5	15.3	16.6	14.8	11.7	6.7
Electricity **	372.9	1,061.7	1,333.7	1,520.2	567.7	822.8	13.0	23.3	10.8	13.9	3.0	3.4
Electricity - open EES	372.9	1,061.7	1,333.7	1,520.2	1,501.0	1,513.9	13.0	23.3	28.4	25.6	10.5	6.0
Steam and hot water ***	268.4	279.8	273.0	270.9	274.5	256.7	9.3	4.8	5.2	4.3	0.2	-0.2
Energy transformations	641.2	1,341.6	1,606.7	1,791.1	842.2	1,079.5	22.3	28.0	16.0	18.2	2.0	2.2
Energy transformations - open EES	641.2	1,341.6	1,606.7	1,791.1	1,775.5	1,770.6					7.5	4.3
Total	2,877.8	4,587.6	5,733.3	6,166.1	5,279.0	5,918.2	100.0	100.0	100.0	100.0	4.4	3.0
Total - open EES	2,877.8	4,587.6	5,733.3	6,166.1	6,212.2	6,609.3					5.7	3.5

* final energy consumption, own electricity and heat & hot water production

** Total natural gas losses included

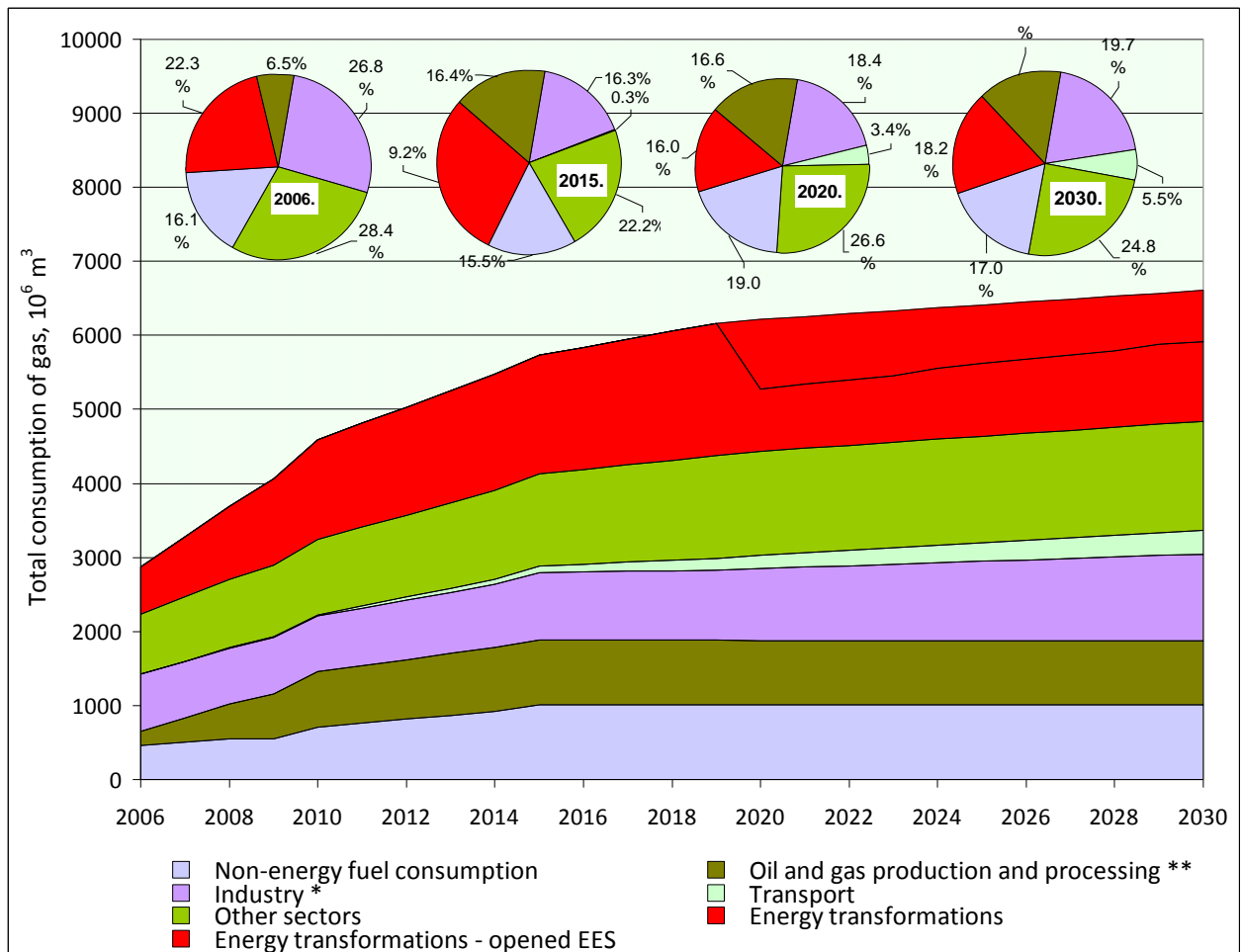


Figure 8-2 Projection of total natural gas consumption in Croatia

These observations have to be recognized as a process of better understanding the features of the system because they relate to a closed power system. In the following ten years the European and regional natural gas and electricity market will develop into a single energy market where power plants will mutually compete according to their competitive abilities and therefore consumption of natural gas in the energy sector will depend on the structure of production capacities in the region (including those constructed in Croatia). They will depend on whether they will use regional potential to construct coal fired thermal power plants; construction in regions planned for nuclear power plants and whether the dynamics of construction of production capacities in the region satisfy electricity demands in the region.

8.1.3. Coal

Croatia does not have any domestic coal reserves that it can utilize commercially. Croatia has the sea and therefore “all the coal mines in the world” are accessible to it. Imported coal is used today in cement industry and the Plomin thermal power plant, but is insignificant in households, services and other sector consumption and other industry. What is significant is that the complete domestic cement industry over the past few years has moved from using residual oil and natural gas to coal and therefore securing market competitiveness.

Based on forecasts in the sustainable scenario of final consumption of coal and development of the power system according to the White Scenario, Table 8-3 shows forecasts of total coal consumption in Croatia to 2020 (with a view to 2030).

Table 8-3 Projection of total coal consumption in Croatia until 2030

Structure of coal consumption	2006	2010	2015	2020	2030	2006	2010	2015	2020	2030	2006-2020	2006-2030
	1000 tce	1000 tce	1000 tce	1000 tce	1000 tce	%	%	%	%	%	%	%
Toatl	1159.47	1230.20	2209.98	1444.09	999.19	100.0	100.0	100.0	100.0	100.0	1.6	-0.6
Industry *	427.05	445.36	391.88	374.95	389.66	36.8	36.2	17.7	26.0	39.0	-0.9	-0.4
Other sectors	19.45	6.85	4.36	1.88	0.00	1.7	0.6	0.2	0.1	0.0	-15.4	-
Electricity **	712.97	777.99	1813.73	1067.26	609.53	61.5	63.2	82.1	73.9	61.0	2.9	-0.7

Net calorific value of coal equivalent 29,3 MJ/kg

8.2. Development Guidelines for Oil and Natural Gas Sector

Defined opportunities of exploitation of oil and natural gas with regard to natural energy resources in Croatia and developments in the oil and gas economy is one of the key elements to realize general objectives in the energy development strategy. A SWOT analysis was conducted for this purpose of the consumption sector, production and refining of oil and natural gas in Croatia (the results are shown in the attachments to the Strategy) and based on these, priorities are determined for action, i.e. development directives for the oil and natural gas sector:

- *Motivating maximum use of remaining domestic oil reserves, condensates and natural gas;*
- *Motivating more efficient consumption of oil, oil products and natural gas (including by-products) that could slow down the growth rate of consumption of these energy sources, and diminish dependence on imports and improve supply security;*
- *Accelerated modernization of domestic refineries;*
- *Conditions in concession contracts should ensure exploration dynamics of our own oil and natural gas findings and the use of new technical and technological solutions to advance exploitation, increase exhausting and increase gained oil and natural gas reserves;*
- *Securing new supply directions for oil and natural gas by participating in international projects;*
- *Constructing storage capacities and securing compulsory oil and natural gas stocks;*
- *Further development of gas transportation and distribution networks; and*
- *Creating a favourable legislative-regulatory framework for the efficient functioning of an open natural gas and oil market.*

8.3. Goals and Actions in Oil and Natural Gas Development until 2020 (with a view to 2030)

The objectives of the Energy Strategy for the oil and natural gas sector are as follows:

- *To secure regular supply on the domestic energy market of required quantities of oil and natural gas, prior to and after the modernization of Croatian refineries, by diversifying supply directions, constructing an LNG terminal and concluding long-term inter-state agreements for deliveries of natural gas from the Russian Federation and neo-methane and continual oil transit to supply Croatian refineries;*
- *Increasing security of supply of the domestic oil market, oil products and natural gas in conditions of global and regional instability, growing geopolitical tensions and possible*

disturbances to the global energy market by forming operation and compulsory stocks of oil and oil products and compulsory natural gas reserves in Croatia;

- *Being included in the energy market in Southeast Europe and acting on integrating the energy structure in Croatia as part of the energy infrastructure in the immediate and wider international surrounding;*
- *Ensuring openness of the oil and natural gas market with the aim of increasing supply security and market competitiveness in keeping with international obligations to organize the domestic energy market, organizing network and other regulations on the energy market and their adaptation to international energy markets;*
- *Enabling the construction of a terminal for Liquefied Natural Gas (LNG), its adaptation to the domestic energy infrastructure and including domestic oil pipelines and gas pipeline into the oil and gas pipeline infrastructure in Southeast Europe;*
- *Improve the quality of oil products that are sold on the Croatian market to match European quality standards;*
- *Adjusting the energy infrastructure with current security and environmental protection requirements;*
- *Enabling technological development of energy activities in the oil and gas sector and in particular gas by developing new natural gas transport systems – LNG and Compressed Natural Gas (CNG); and*
- *Ensure organizational presumptions, plans and measures to develop compulsory oil and gas stocks in Croatia for the purpose of the security of supply and creating the material presumptions to react to possible disturbances on the energy market.*

The following activities will be implemented:

- Motivate technological development of technological exploitation of remaining and all the more valuable domestic hydrocarbon reserves – oil, condensates and natural gas – motivating measures for use of enhanced oil recovery technology (EOR);
- Completing the technological reconstruction of domestic refineries – facilitating import of technology and equipment to reconstruct refineries by stimulating the participation of domestic designers, engineering organizations, the building sector and domestic production equipment;
- Stimulate offshore exploration of the central and southern Adriatic through concessions for hydrocarbon exploration and in cases of positive findings to oblige concessionaires to rapidly activate production of defined hydrocarbon reserves and secure natural gas supply and possibly oil on the domestic market;
- Diversifying supply directions for oil and natural gas and developing strategic infrastructure to import and refine oil and integrating it into the surrounding European energy infrastructure.
- Foreclosing contracts for oil transit for Croatian refineries if the oil is supplied from the Russian Federation via the pipeline from Byelorussia, the Ukraine, Slovakia and Hungary; and
- Planning and realizing the development of compulsory oil stocks as well as creating compulsory gas reserves beyond 2010 and raising these reserves to a level that satisfies at least 90 day requirements for oil and satisfying 7 daily requirements for natural gas in meteorologically

unfavourable winter months until 2012 and planning further expansion of compulsory oil stocks and gas reserves in strategic reserves beyond 2020 until 2030.

8.3.1. Oil

8.3.1.1. Exploitation of domestic oil reserves

With projection of oil and condensate production for the period until 2020, future oil and condensate production on domestic exploitation fields was taken into account. In addition, oil production using the Enhanced Oil Recovery (EOR) method was also taken into consideration to increase oil extractions as well as production of oil that is qualified for use with new techniques and technology.

Table 8-4 & 8-5 and Figure 8-3 present estimates of oil reserves and production in Croatia for the period to 2020 (with a view to 2030).

Table 8-4 Estimated domestic oil and condensate reserves at the end of 2007

Year	Unit	Prooved	Prooved + possible	Prooved + possible+ feasible
Oil	10 ³ m ³	10 113	12 906	12 906
Condensate	10 ³ m ³	2 497	2 649	2 674
Total (Oil+ Condensate)	10 ³ m ³	12 610	15 555	15 581

Table 8-5 Projection of oil production until 2030

Year		2006	2010	2015	2020	2030
Oil+ Condensate	10 ³ t	977	2137	1586	550	350
	PJ	41	91	67	23	15

From the estimates shown it is evident that a growth in domestic oil production may be expected around 2010 due to the application of EOR methods to exploit oil, i.e. the injection of carbon dioxide separated in the Molve Central Heating Station with the aim of increasing production in the Žutica, Ivanić and Šandrovac fields. In the period to 2020, it is foreseen that the so-called tertiary method of oil exploitation will be applied, i.e. injecting polymers with further expansion of the EOR method which should lead to a certain slow down decrease of production in domestic basins, that is, oil yielding fields. However, production estimates have not accounted for this additional production because the estimates were made on the basis of confirmed or probable reserves shown in Table 8-4. A complete view indicates that this production will be fewer than 10% of the demand for the entire period (2020 – 2030), that is, 5% in 2030; however with regard to the expected high price of oil that production will be of great value.

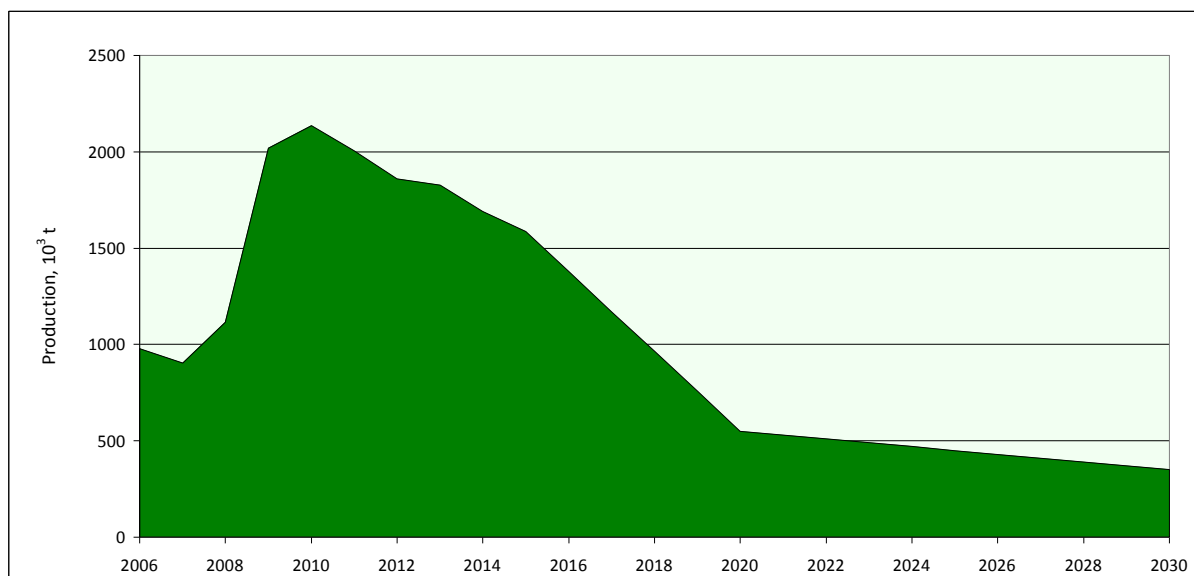


Figure 8-3 Estimate of oil production in the period to 2030

Domestic oil production will decrease and consequently decrease the share in covering the energy demand in Croatia which renders the energy system more sensitive to supplies of primary energy resources. Due to geopolitical sensitivity of the energy market and the high price of oil on the world market it is necessary to foresee special measures to motivate technological development of technological exploitation of remaining increasingly valuable oil reserves. Incentive measures will be elaborated within the Strategy Implementation Programme.

8.3.1.2. Securing new supply directions

Considering the growing dependence of energy activities as well as Croatia's economy on the whole on imported oil and natural gas the aim of this Strategy is to diversify supply directions and for Croatia and its energy companies to participate in international projects to import energy.

Securing new supply directions to import oil includes:

- **Reconsidering the Družba – Adria Project** (oil would be transported from Russia to Omišalj through the existing oil pipeline system which is technically integrated and can already supply oil from Hungary to Sisak and from 2009 will facilitate reversibility of the JANAF pipeline to Omišalj);
- **Croatia participating in the planning and construction of the Pan-European Oil Pipeline (PEOP) and other oil pipeline projects**

All benefits of this project are being observed: increased supply security for European refineries including Croatia by supplying oil from *new directions (Black Sea) via land*, unloading the Adriatic and Mediterranean tanker transport by several dozen million tonnes of oil per annum, 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 oil pipeline, etc.

Croatia and JANAF will participate in **other oil pipeline projects that are** considered important for the EU and Croatia in keeping with the objectives of energy and economic policies of the country.

Independently of the realization of the said projects it is vital that JANAF's pipeline system is brought into a functional state facilitating oil supply to Urinj refinery from the pipeline from Hungary. In that regard, it is of great importance to retain the technical-technological and commercial possibility to transport oil from Omišalj towards Sisak.

8.3.1.3. Creating compulsory and operation stocks

Compulsory stocks of oil and oil products are created for the purpose of oil and oil products supply in case of threats to the energy security of the country as a consequence of extraordinary disturbances in supply.

Compulsory stocks should include petrol, diesel fuel, kerosene, gas oil and residual oil with dynamics and in quantities determined by valid regulations that are entirely harmonized with EU legislation. Finally, compulsory oil and oil products stocks should meet the obligation of minimum oil stocks of 90 days of average daily consumption – not later than 31 July 2012. Regarding stocks forming it is important to keep a maximum possible share of compulsory stocks in crude oil.

Additional storage capacities will be constructed for the purpose of forming compulsory stocks which will be distributed around Croatia, depending on the level of regional consumption. When choosing the location to form compulsory stocks it is vital to primarily use locations that are already used as warehousing facilities for oil and oil products and are located in the centre of consumption and can facilitate the storage and distribution of goods via various transport means.

The project to create compulsory stocks will at the same time develop storage installations for commercial warehousing with the aim to lower costs of creating and maintaining compulsory stocks as well as continuing to open the market and inspiring competitiveness.

Apart from creating compulsory stocks it is vital to develop a system of operation oil and oil products stocks. Operation stocks are formed for the purpose of ensuring stability and safety of technological processes in refining oil and oil products, producing heat and electricity for the market and consumers requiring special security and quality supply. Operation stocks of oil and oil products shall be created in keeping with the provisions of valid legislation.

8.3.2. Natural gas

With regard to natural gas, the fundamental question is security supply and the desired level of market competitiveness as a condition for an orderly functioning market. On a liberal market, market mechanisms create supply security. The decision for new production of natural gas or to import it lies in the hands of private investors who act on the basis of price signals and estimated market demand. Compared to supply, the distribution and transport system and storage capacities are a natural monopoly and as such a regulated activity (if the offer of storage capacities were to be larger than the needs of the Croatian market, approach to the warehouse would succumb to negotiation). The clear division of responsibility between market subjects and the system operator is vital to obtain optimal system security. Special responsibility lies on the transport system operator concerning strategic development interests of the heating system in order to secure supplies for domestic consumers as well as being responsible for utilizing the regional position of the country and the possibility of developing its transport system in the interest of the national economy and satisfying internationally accepted obligations.

In order to facilitate creating and organizing the Croatian gas market, bylaws shall be adopted to the Gas Market Act.

8.3.2.1. Exploiting domestic natural gas reserves

Production forecasts for natural gas to 2020 account for future gas production on existing domestic exploitation fields in Panon and the northern Adriatic. Furthermore, gas production following additional investment into existing fields was accounted as well as the gas production qualified as possible with the use of new techniques and technology. Increased production by 2010 will result from developing and activating some other additional field in the northern Adriatic as well as measures to activate production from reserves at small fields in Panon. It is estimated that beyond 2010 gas production in Croatia will decrease due to depleting of the reservoirs.

Natural gas production forecasts for the period between 2020 to 2030 account for future gas production on existing domestic exploitation fields in Panon and the northern Adriatic. It is estimated that beyond 2020 depleting of the reservoirs will lead to further decrease of natural gas production. Extending activities to deep gas exploration, activating all small basins and starting up gas production from so-called single bores with the use of compressed gas techniques and transporting compressed gas to the market in tanks may moderate that decrease in production.

Figure 8-4 and Tables 8-5 and 8-6 present estimated natural gas reserves in Croatia for the period to 2030.

Table 8-6 estimated natural gas production in the period to 2030

Year	Unit	Proved	Proved + possible	Proved + possible+ feasible
Gas dissolved in oil	10 ³ m ³	1 667	3 091	3 091
Free gas - land	10 ³ m ³	14 999	17 367	17 665
Free gas - Adriatic	10 ³ m ³	13 907	19 053	20 052
Total natural gas	10 ³ m ³	30 537	36 511	40 808

Source: MELE; INA-Oil industry, Yearly report for 2007., www.ina.hr

Domestic natural gas production shows total domestic production which in 2006 amounted to around 700 million cubic meters of gas and was exported according to concession agreement for offshore gas fields in the northern Adriatic. Exports will decrease proportionally and in 2010 will amount to around 400 million cubic meters and continue decreasing pursuant to the joint investment agreement in gas production in the northern Adriatic.

Table 8-7 estimated domestic natural gas production in the period to 2030

Year		2006	2010	2015	2020	2030
Natural gas	10 ³ t	2864	2581	2324	1800	1100
	PJ	99	90	81	62	38

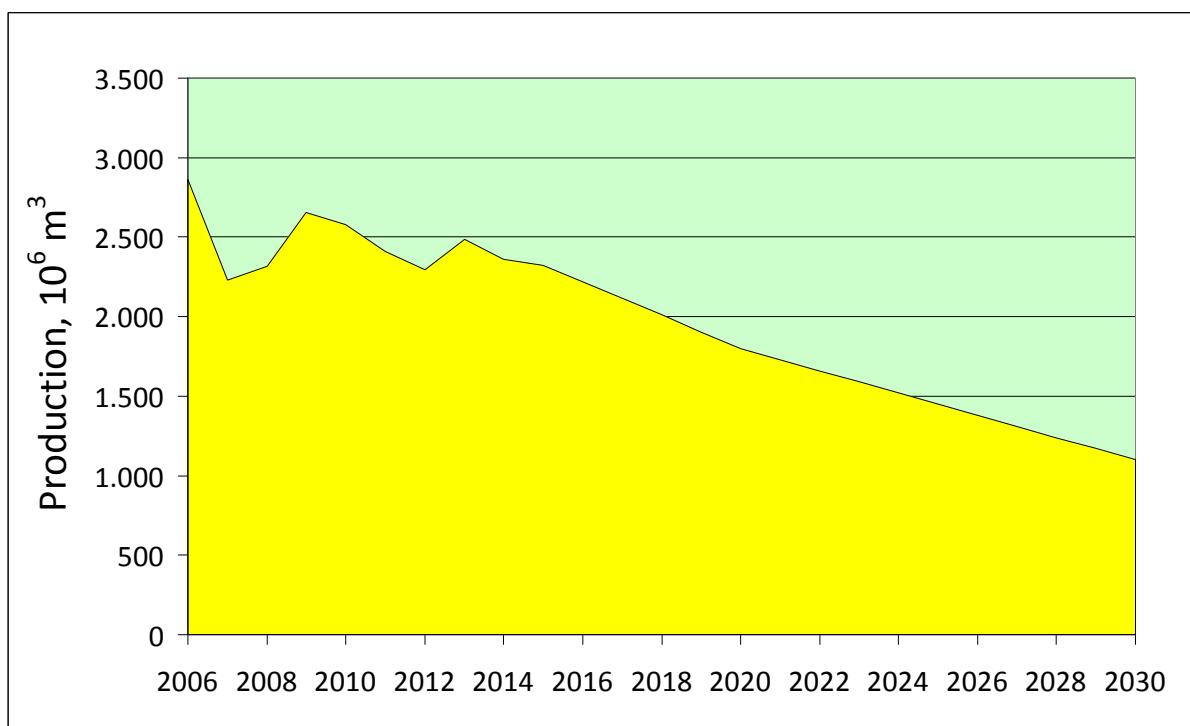


Figure 8-4 Estimated domestic gas production in the period to 2030

8.3.2.2. Securing new supply directions and construction of the Croatian gas transport system

Development of natural gas demand in Croatia and being included in the energy infrastructure of the immediate and wider European surrounding requires securing new import directions of natural gas and the completion of construction of Croatia's gas transport system:

- Inter-state connecting gas pipelines with the Hungarian system to natural gas transport;
- Constructing a Liquefied Natural Gas (LNG) terminal, constructing associated transit gas pipeline and connecting it with the GASCRO transport system;
- Completing the construction of the major 75 bar gas pipeline system in eastern Slavonia towards Dalmatia and construction of the transport system in all regions where this is economically viable in relation to the supply of LPG; and
- Realizing the Adriatic – Ionian direction to import natural gas.

8.3.2.3. Need to construct storage capacities

Croatia has one natural gas storage capacity in Okoli with a total estimated capacity of 550 million m³, and a maximum injection capacity of 3.8 million m³/day and a maximum exhaustion capacity of 5 million m³/day. Considering the expected growth in natural gas consumption, large seasonal imbalance in the hourly consumption of natural gas in other sectors consumption and in smaller extent variable natural gas consumption in industry, *it is vital to construct additional underground capacities for natural gas.* Figure 8-5 shows a standardized diagram of the annual consumption of natural gas in Croatia (five-year average, 2003 – 2007) without non-energy consumption, consumption in thermal power plants and public cogeneration plants and without consumption for oil and natural gas production and refining). From the diagram we can conclude that it is necessary to store around 25% in seasonal storage of the

total consumption of natural gas to satisfy the demand of the observed consumers. Despite future supply to the coast (minor seasonal variability in consumption) and change in the consumption structure (use of natural gas for cooling), this is the share that should be taken into account also in the future.

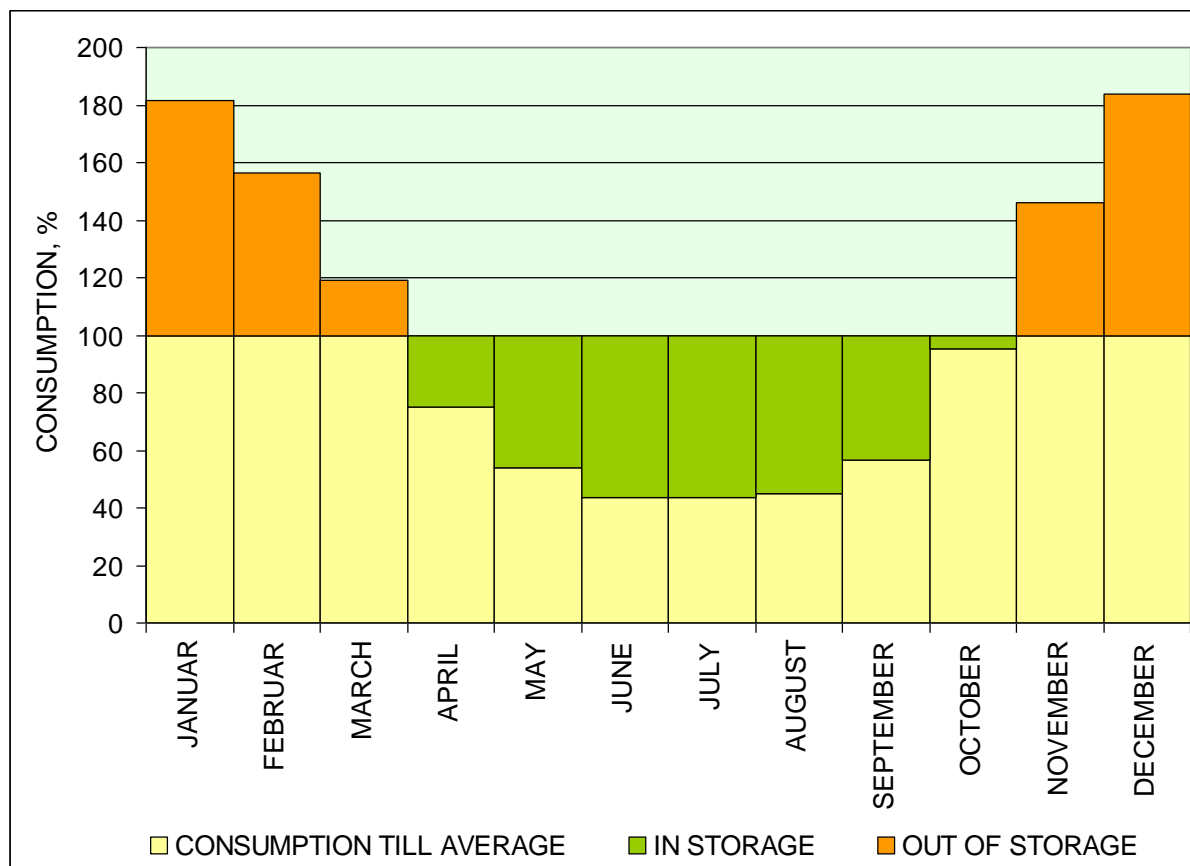


Figure 8-5 Standardized annual consumption of natural gas in Croatia

EU Directives and Croatian legislation do not foresee compulsory natural gas stocks (even though some EU countries prescribe them). Today, Croatia covers around 60% of its demand by domestic production while in 2020 it will depend on around 60% of imported gas. Security of supply of natural gas will be vitally increased with the construction of an LNG terminal and its larger storage capacities. It is estimated that compulsory stocks of natural gas would be sufficient at a seven-day average consumption level during meteorologically unfavourable winter months for the group of consumers defined in the preceding paragraph which amounts to around 5% of the annual consumption. It appears that in 2020, the forecasted level of consumption amongst the group of consumers of natural gas observed it would be vital to secure storage at a level of 30% of the annual consumption or 790 million m³, of which around 660 million m³ would be used for seasonal storage.

What needs to be especially pointed out is that apart from energy, it is necessary to ensure the required capacities of extraction of natural gas (mass flow or hourly supply) during peak hour consumption of the natural gas system. This feature of storage capacity is as equally important as seasonal capacities! Extraction capacities need to be determined while forecasting new storage capacities based on forecasted consumption characteristics – structure of consumer groups and their diagram of consumption, possibilities and techno-economic characteristics of potential consumers with contracts for interrupted natural gas supply as well as other features of the system. It is understandable that the market, and legislative conditions (tariff policies) will optimize and balance out seasonal variability in the gas system as well as other measures if during the peak consumption period of natural gas these prove

to be economically more viable in the system than the use of underground natural gas storage capacities (interruptible consumers with the possibility of using replacement fuel, plants shutdown due to more favourable prices of natural gas, etc.).

Based on the knowledge of the characteristics of exploitation of natural gas and oil resources, it is expected that Croatian geological features will facilitate the construction of significantly larger storage capacities than will be required to satisfy domestic consumption of natural gas. This is Croatia's advantage compared to its neighbours and therefore it can commercialize this advantage with the construction of storage capacities of regional significance. *Tariff policies and the amount of tariffs should facilitate investment returns for investors constructing storage capacities with a profit that adequately covers also possible investment risks* (in the part required for the Croatian market). Additional capacities will be a matter of contractual approach and therefore these investments will not only secure supply for Croatian consumers but will also bring significant revenue to investors for exporting services, warehousing and other related commercial activities.

For the purpose of the security of natural gas supply and valorisation of our natural advantages, the government should ensure management rights over storage capacities.

8.4. Future Trends

Based on the presented estimates, we can see that in the period 2020 – 2030 the share of domestic production in fulfilling the demand for oil and natural gas will continue to decrease and that dependence on import will increase (Figure 8-6). Consequently, beyond 2020 it will be particularly important to include our energy infrastructure into the energy infrastructure of the immediate and wider surroundings.

Consequently, we can conclude that the vision of oil and gas consumption to 2030 is burdened with uncertainty and above all, uncertainty concerning the ability to foresee oil price trends. Various sources offer different forecasts of future, long-term tendencies in oil prices but we can certainly expect that the price of natural gas and oil will be firmly tied to linear law.

In the vision of development until 2030 we can count on uncertainty on global energy markets, occasional instability and crises which will naturally affect already sensitive energy markets in smaller countries like Croatia, particularly in regard to oil import and oil and natural gas prices. This is a vital fact that has determined the guidelines of this Strategy and to which has been given special attention in the objectives and measures of this Strategy and in particular to stimulate development of domestic production from remaining oil and gas resources, secure our own production and market supplies from abroad, secure new supply directions for oil and gas as well as the need for government concern for strategic development of oil and gas reserves and to secure necessary storage capacities.

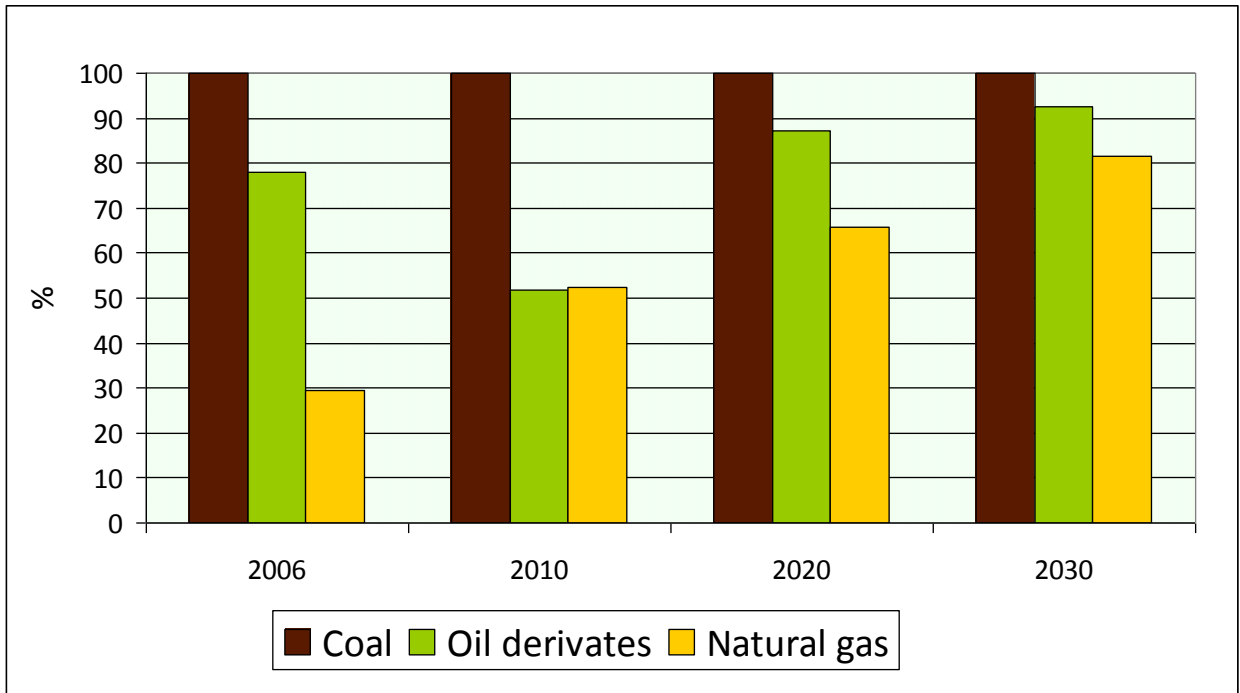


Figure 8-6 Croatia's dependence on energy imports

9. RENEWABLE ENERGY SOURCES

9.1. Development Guidelines and National Goals

Use of renewable energy sources (RES)

With its Energy Strategy Croatia is determined to use RES in keeping with the principles of sustainable development. Table 9-1 and Figure 9-1 show the RES structure in Croatia foreseen in the Strategy to 2020, with a view to 2030.

Table 9-1 Forecast of the renewable energy sources structure to 2020 (with a view to 2030)

		2010	2020	2030
Biomass	[PJ]	18.14	36.27	68.72
Biofuel	[PJ]	2.50	9.55	14.35
Wind energy	[PJ]	1.02	9.50	15.84
Hydro power – small HPPs	[PJ]	0.40	0.97	1.55
Hydro power – Large HPPs	[PJ]	21.06	23.76	23.76
Geothermal energy	[PJ]	0.15	5.51	8.54
Solar energy	[PJ]	0.51	5.27	13.87
TOTAL	[PJ]	43.78	88.42	146.63
	[t _{oe}]	1 042 000	2 105 000	3 491 000

9.2. Goals and Actions until 2020 (with a view to 2030)

9.2.1. Solid Biomass

Potential

The assessment of the biomass potential is referred to the use of wood biomass and biomass from agriculture as well as the possibility of firewood cultivation¹⁶ and is based on data available from Croatian Forests including wood waste in the wood industry. Additionally, wood biomass from wood harvesting during maintenance of waterways and power facilities (waterways, protected transmission corridors and electricity distribution lines) as well as protected road corridors and finally possible agricultural residue are also being included in the assessment of the biomass potential. Wastes from the residues of crops can only be partially used (not more than 30%), because residue must be returned to agricultural fields to ensure a balance in minerals. Agricultural residue is complex and includes residue from orchard and vineyard pruning as well as olive pips, sunflower seed shells, straw, etc.

¹⁶ Analysis of biomass potential is described in detail in a document prepared for this Strategy which is available on the following Web site: www.energetska-Strategy.hr.

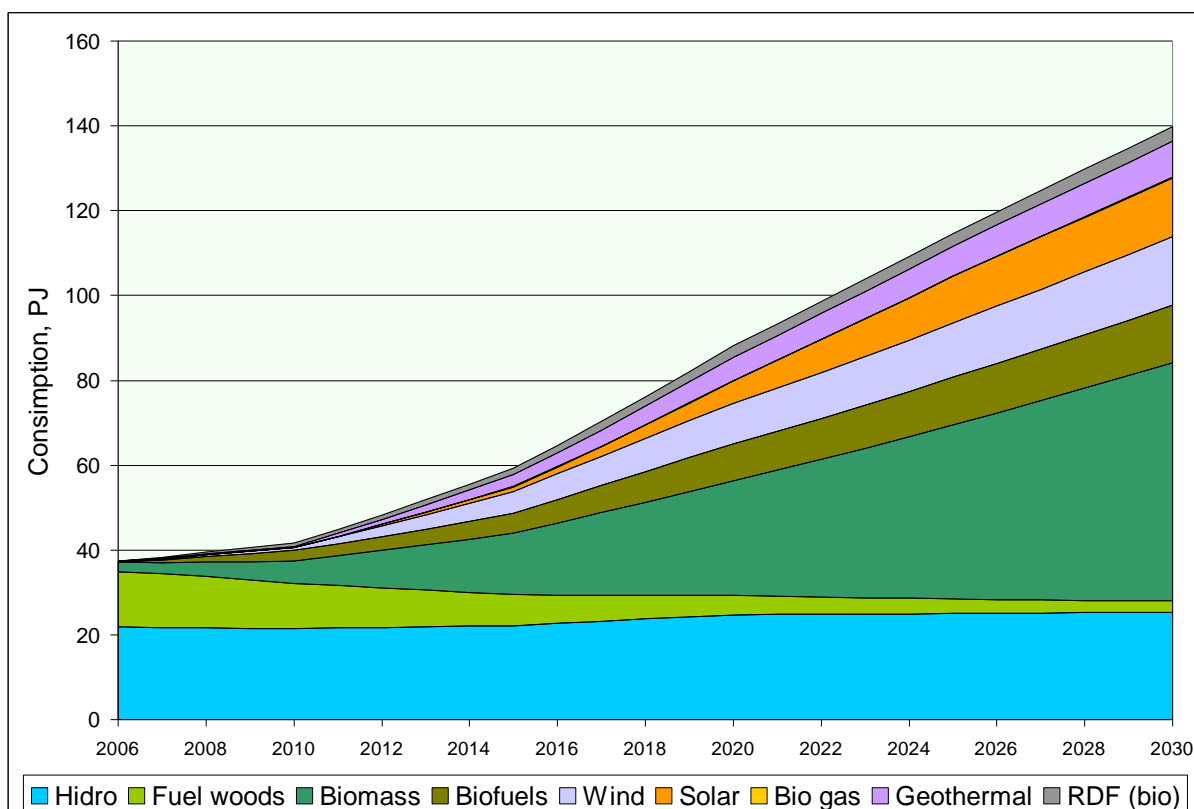


Figure 9-1 Structure of renewable energy source to 2020 (with a view to 2030)

Table 9-2 shows the total estimated potential of wood biomass and biomass obtained from agriculture.

The table shows biomass that could be produced in energy forests, that is, biomass especially cultivated for the purpose to use wood for energy purposes. It is possible to fell 6 – 8 thousand m³ of wooden biomass per hectare every 3 – 4 years. Energy forests could be cultivated on degraded forest land. It is estimated that there is around 600 – 800 thousand hectares of available land for this purpose in Croatia and so the annual production of biomass could be 1.0 to 1.2 million m³.

Table 9-2 Total estimated potential of wood biomass from forestry, industry and agriculture

No.	Sort of biomass	Volume	Density	Mass	Net calorific value	Energy
		m ³ / year	kg/m ³	t/year.	kWh/kg	PJ
1	Cord wood	1,889,551	730	1,379,372	4.90	24.33
2	Wood residue	700,928	700	490,650	4.90	8.65
3	Abbaino	207,306	550	114,018	4.90	2.01
4	Wood industry residue	1,389,000	730	1,013,970	4.90	17.89
5	Water management, Roads and HEP	400,000	680	272,000	4.90	4.80
6	Agro residue	2,888,000	450	1,299,600	4.90	22.93
7	Total	7,474,785	-	4,569,610	-	80.62
8	Energy forests	1,000,000	730	730,000	4.90	12.88
9	Total	8,474,785	-	5,299,610	-	93.49

Objectives

Even with the most favourable incentive measures it cannot be expected that all theoretically available biomass will be exploited. A share of biomass will be used to produce second generation biofuels. **This Strategy has set its objective that by 2030 of the total available biomass potential described above in Croatia, 72% will be exploited for energy purposes and that the use of biomass will as of today, continue to grow.** As the application of any new technology requires a period of “a running start”, before any major thrust is made on the market it is assumed that by 2010, 22% of potential biomass will be exploited and 32% in 2015 and up to 40% by 2020 (without accounting for energy forests).

It is possible to use available biomass with various techniques to transform it into electricity and/or internal energy (heat) or to refine it for commercially acceptable forms of energy (pellets, briquettes and wood coal). Table 9-3 shows the structure of biomass according to the technology used in primary conversion.

Table 9-3 Structure of applying biomass according to the technology use in primary conversion

No.	Technologies for usage/biomass transformation	Input		Output				
		Mass	Energy	Masa	Energy	Electricity	Power	Heat
		t/year	PJ	t / year	PJ	GWh	MW	PJ
2010								
1	Pellets production	41,126	0.73	38,248	0.69	0.00	0.0	0.00
2	Briquettes production	10,282	0.18	9,562	0.17	0.00	0.0	0.00
3	Firewood	616,056	10.87	603,735	10.65	0.00	0.0	0.00
4	Charcoal production (non-energy feedstock)	102,816	1.81	31,873	-	0.00	0.0	0.00
5	Pellets production + cogeneration (heat and electricity)	77,600	1.37	60,528	1.09	11.18	2.2	0.00
6	Industrial cogeneration (heat and electricity)	0	0.00	0	0.00	0.00	0.0	0.00
7	Cogeneration in public heating plants	0	0.00	0	0.00	0.00	0.0	0.00
8	Bio THP	0	0.00	0	0.00	0.00	0.0	0.00
9	Heat production in industrial heating plants	180,281	3.18	0	0.00	0.00	0.0	2.62
10	Total	1,028,162	18.14	743,946	12.60	11.18	2.2	2.62
2020								
11	Pellets production	274,194	4.84	255,000	4.59	0.00	0.0	0.00
12	Briquettes production	63,351	1.12	58,917	1.06	0.00	0.0	0.00
13	Firewood	260,884	4.60	255,667	4.51	0.00	0.0	0.00
14	Charcoal production (non-energy feedstock)	205,632	3.63	63,746	-	0.00	0.0	0.00
15	Pellets production + cogeneration (heat and electricity)	274,217	4.84	213,889	3.85	39.51	7.9	0.00
16	Industrial cogeneration (heat and electricity)	205,632	3.63	0	0.00	134.67	26.9	2.45
17	Cogeneration in public heating plants	246,759	4.35	0	0.00	289.06	55.6	1.85
18	Bio THP	205,632	3.63	0	0.00	256.94	48.9	0.00
19	Heat production in industrial heating plants	320,023	5.65	0	0.00	0.00	0.0	4.66
20	Total	2,056,325	36.27	847,218	14.01	720.17	139.4	8.96
2030								
21	Pellets production	362,485	6.39	337,111	6.07	0.00	0.0	0.00
22	Briquettes production	130,292	2.30	121,172	2.18	0.00	0.0	0.00
23	Firewood	148,302	2.62	65,971	2.56	0.00	0.0	0.00
24	Charcoal production (non-energy feedstock)	381,193	6.72	118,170	-	0.00	0.0	0.00
25	Pellets production + cogeneration (heat and electricity)	381,193	8.20	297,330	5.35	61.02	11.1	0.00
26	Industrial cogeneration (heat and electricity)	457,431	8.07	0	0.00	299.57	54.5	5.46
27	Cogeneration in public heating plants	571,789	10.09	0	0.00	669.80	115.5	4.29
28	Bio THP	1,143,578	20.17	0	0.00	1428.92	238.2	0.00
29	Heat production in industrial heating plants	235,665	4.16	0	0.00	0.00	0.0	3.43
30	Total	3,811,927	68.72	939,754	16.16	2459.31	419.2	13.18

It is expected that with the existing incentive measures, but also the removal of existing institutional barriers, the total **electricity-generating capacity to be produced in several biomass fired power plants could be around 140 MW**, preferably cogeneration plants (and in that regard, existing legislation will be

upgraded). Beyond 2020 it is necessary to balance energy available from energy forests and in 2030 the installed electricity-generating capacity in biomass fired power plants could be 420 MW.

Activities

The objectives are defined with the presumptions that can be included into incentive measures in government, industrial, agricultural and energy policies in the following period:

- **Motivate development of the Croatian wood processing industry** by creating favourable conditions for private investment into this sector with the aim of reducing exports of trunks from Croatia and instead exporting products of a higher degree of manufacturing;
- **Develop forestry and facilitate all forest residues to be utilized** as is the case in EU countries. Without proper organization in the forestry industry, forest residue will only partially be utilized and will rot at the detriment of forests themselves and the surrounding environment (CH₄ emissions);
- **Motivate forest cultivation and energy forest cultivation** on degraded forest land; and
- **Motivating biomass fired cogeneration plants for heat and electricity generation.**

9.2.2. Biofuels

Potential

Here, biofuels will be referred as biodiesel and bioethanol. Biodiesel is obtained from the oleaginous plants while ethanol is obtained from plants rich in sugar and carbon. The most important sources for biodiesel production are: rapeseed, sunflower, soya, palm oil, waste edible oil, beef tallow and lard, etc. To continue, an analysis of production potential of bioethanol from corn, wheat and barley as well as biodiesel from rapeseed oil, soy oil and waste edible oil will be described.

Certain agricultural reserves exist in Croatia that could be used to produce biofuels. In order to determine the quantity of these reserves, data about average areas, yield and production was analyzed for five agricultural crops that have been traditionally cultivated in Croatia.

An analysis of the current situation taking into account the existing low average yields for the particular crops. With the average yield of corn of 5.50 t/ha, wheat at 4.04 t/ha, barley at 3.24 t/ha, rapeseed at 2.23 t/ha and soy at 2.27 t/ha, the conclusion is that in the existing production conditions, there aren't any reserves to produce biofuels from corn, wheat, barley, oil rape and Soya.

An analysis was then made of variables that could improve yields, increase areas to be cultivated with the said crops and a combination of these measures.

Table 9-4 shows possible production of biofuels in Croatia dependent on the size of cultivated areas and the yields realized on these areas.

Table 9-4 Possible production of biofuels in Croatia from corn, wheat, barley, rapeseed and soy

	Variant 1	Variant 2	Variant 3	Variant 4
Biodiesel [t]	3 682	9 225	21 901	32 353
Bioethanol [t]	110 518	13 302	249 327	307 878
Total [t]	114 200	22 527	271 228	340 231
Total [PJ]	3.09	0.69	7.47	9.41

It is necessary to stress that this potential was calculated with the condition of satisfying food demands in Croatia, creating compulsory grain reserves and respecting cultivating timetables in order to avoid negative affects to the soil.

The important source used to produce biofuels, biodiesel, is also waste edible oil. Research has shown that the average person in Croatia produces about 2 litres of waste edible fuel per annum. The analysis of potential accounted for cities with a population of more than 20,000 residents which accounts for around 2.2 million people. The estimated potential from waste edible oil amounts to 4.4 million litre which can annually produce around 3,800 tonnes of biodiesel.

Objectives

Croatia’s strategic direction defined in the Strategy is to develop the renewable energy sector which comprehends the rational use of renewable energy sources. Seeing that all the production models to produce biofuels were estimated respecting the principle of primary use of agricultural land to produce food and the sustainable exploitation of the soil (sowing timetable), **the objective that the Strategy has adopted is to realize an annual domestic production of biofuels from crops amounting to 340,231 tonnes and an additional 3,800 tonnes obtained from waste edible oil by 2020.** Furthermore, it is estimated that incentive measures through government agricultural and energy policies can be implemented in full extent by 2015. Beyond 2020 increased production of biofuels will depend on demand for that energy form and it is expected that this will continually grow due to a “growing awareness” of citizens, government incentives and/or the high price of oil products. Table 9-5 and Figure 9-2 show the dynamics of the growing production of biofuels in Croatia to 2030.

Table 9-5 Dynamics of the growing production of biofuels in Croatia to 2030

	2010	2020	2030
Production of biofuels [t]	90,060	344,031	380,055
Production of biofuels [PJ]	2.5	8.91	10.55

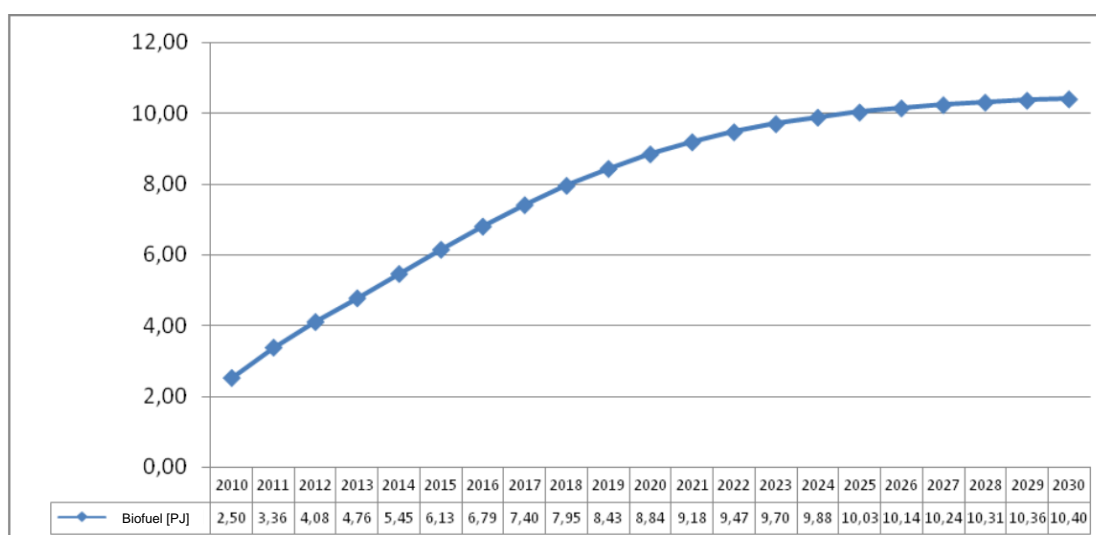


Figure 9-2 Dynamics of the growing production of biofuels in Croatia to 2030

Furthermore, it is necessary to consider the implementation for **second generation biofuels production.** It is necessary to secure conditions in Croatia to apply this as soon as possible. Consideration should be

made due to the fact that it is not possible to exploit all the available biomass resources. Namely, of the total biomass produced on agricultural fields, 40% must be returned to the soil, 30% is used for fodder and on farms and the remaining 30% may be used to produce biofuels. Waste biomass produced on the agricultural land for the five crops observed has a significant energy value. The energy value of the available agricultural waste for biofuel production amounts to 23.4 PJ. The quantity of biofuels that can be obtained from that depends on the efficiency of the technology applied to produce second generation biofuels.

Activities

In order to achieve the defined objective, it is necessary to increase the production of the observed agricultural crops as follows:

- Increasing cultivated areas; and
- Intensifying production on current and new agricultural land.

Taking into consideration that Croatia has a significantly larger area of arable land than is cultivated today, it can be expected that part of this arable land can be utilized to produce corn, wheat, barley and rapeseed for this purpose. Nevertheless, it needs to be said that the best quality arable land has been left for food production and the agricultural land planned for crops with the purpose of biofuel production will require significant investments (clearing scrub, cleaning water canals, clearing roads, etc.). Measures that the government needs to take are to motivate land owners to activate these areas by including them in direct subsidies and offering higher prices for crops. The current high price of crop seeds can itself stimulate sowing on greater areas however; this could affect the sowing of oleaginous plants, sugar rape, etc. The current law on agricultural land facilitates these policies; however provisions concerning "land taxation" on uncultivated land are not implemented. It is therefore necessary to implement currently existing legislative provisions.

Considering the above and in addition to relevant policies in import/export prices, in 2-3 years we could expect increased production and by 2015 and no later than 2020, Croatia could certainly produce sufficient quantities of biofuel crops to satisfy the need to produce the estimated quantities of biofuels required.

In order to achieve the set objective it is vital to increase investments into agricultural products and above all for: further mergers of agricultural farms and to exploit productive areas primarily through change of ownership or through leasing private agricultural land. It is necessary to stimulate turnover on agricultural land. Modest agricultural areas owned by the government should be put into full use through concessions. This is a precondition to create commercial ventures that will be responsible to implement measures to maintain and repair fertile soil and in that way create conditions for long-term and stable production.

Significant resources must be tied to compulsory stocks of vital products in order to regulate prices on the domestic market which is one of the government's functions.

Equipping with modern mechanization should be facilitated under favourable conditions with expert assistance from agencies and advisory bodies, faculties, etc.

Current activities to facilitate the introduction of irrigation would also contribute to accelerating increased agricultural production.

It is also necessary to be aware of the fact that rural areas have a large number of unemployed workers – farmers who should be treated just like any other unemployed citizen in Croatia and this requires a change in the philosophy regarding villages and rural regions in general.

Finally, it is necessary to follow future trends in Europe and the world regarding the cultivation of biofuels and to facilitate the acceptance of available and efficient technology to produce second generation biofuels including hydrogen in transport.

9.2.3. Wind power

Potential

Estimated¹⁷ onshore potential of wind parks is presumed with the energy consumption projections while the electricity-generating capacity of wind power plants is calculated dividing projected energy by an average of 2,200 operation hours per annum (WP load factor is equal to 0.25).

- The natural potential of onshore Wind parks (WPS) in Croatia (56,542 km²) is estimated at 120 TWh electricity per annum, which is the equivalent to 54.5 GW installed electricity-generating capacity in wind parks;
- Technically, onshore potential of WP in Croatia is estimated to nearly 10 TWh of electricity generated which is equivalent to 4.54 GW of installed electricity-generating capacity in WP;
- The presumed economic potential of onshore wind energy in central and southern Dalmatia is estimated at 0.36 – 0.79 TWh/annum with generating units of 250-750 kW¹⁸. Unofficial estimates with larger units are around 1.5 to 4 TWh where the larger amount accounts for possible trading with electricity balanced out with surrounding power systems.

Estimated sea potential of wind parks⁶ is:

- The natural offshore potential of WPS (territorial waters and internal waters of Adriatic Sea: 61,067 km²) is estimated at around 150 TWh electricity per annum;
- Technically, offshore potential in WPS in Croatia are estimated at nearly 12 TWh of electricity per year. That is 12 times less than the average in Italy (150 TWh/annum) and around eight times less than that estimated for Greece (100 TWh/annum) which has 4 to 6 times more sea than Croatia with relatively similar meteorological conditions.
- Economically, offshore potential of WPS in Croatia was calculated in 1998 for two locations - Vis and Lastovo at around 0.5 TWh/annum⁷. Unofficial estimates in 2001 for a larger number of locations for modern wind turbines are estimated at around 2 TWh/annum, with an estimated trade of electricity to balance surrounding power systems up to 5 TWh/annum.

There is currently no wind energy resources atlas for Croatia. At the end of July 2004, the first metering system was set up to measure wind potential and a metering campaign was launched to collect data to create a wind atlas for Croatia. In the meantime, research at individual locations is being conducted by potential investors themselves.

¹⁷ Potočnik, L., Lay, V.; „Obnovljivi izvori energije i zaštita okoliša u Hrvatskoj“, Ministry of Environmental Protection and Physical Planning, Zagreb, 2002

¹⁸ Nacionalni energetske programi – ENWIND – Nove spoznaje i provedba, Energetski institut Hrvoje Požar, Zagreb, 2001.

Objectives

By 2020 Croatia should with estimated 1,200 MW of installed electricity-generating capacity per installed electricity-generating capacity in wind parks for each 1,000 population head achieve Spain's current level of (348 kW/1000 per population head).

By 2030, Croatia should have 450 kW of installed electricity-generating capacity in WPS per 1,000 population head which is a total of 2,000 MW of installed electricity-generating capacity. It is assumed that energy balances will be achieved by trading on the open market with neighbouring power systems.

Total numbers for the years observed are shown in Table 9-6, while the growth dynamics is shown in Figure 9-3. Calculations presume that WPS will have an average of 2,200 working hours per year.

Table 9-6 Growth dynamics of installed capacities to produce electricity in wind parks to 2020 (with a view to 2030)

	2010	2020	2030
Installed power[MW]	129	1200	2000
Electricity production [TWh]	0.28	2.64	4.40
Electricity production [PJ]	1.02	9.50	15.84

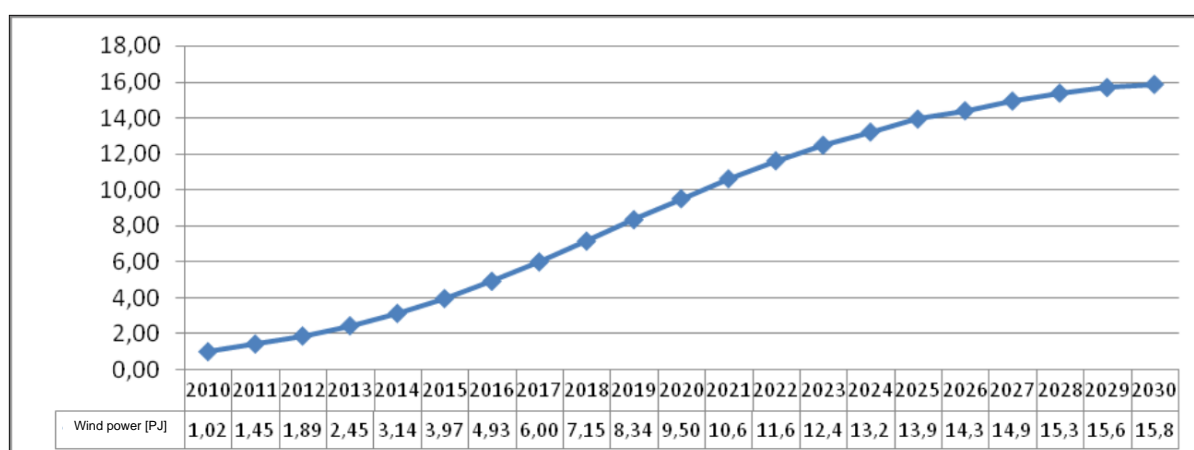


Figure 9-3 Growth dynamics of electricity generated in wind farms until 2020

Activities

Wind parks are the most important RES to produce electricity in Croatia (not counting potential in existing large hydropower plants). There is great interest shown by investors which is greatly facilitated by favourable legislation and guaranteed sales prices (*feed-in tariffs*). Nevertheless, additional activities in this area could include the following:

- **Facilitating and accelerating administrative procedures** to obtain the necessary permits to construct wind farms;
- **Updating physical plans**, and
- **Creating a wind energy resources atlas.**

9.2.4. Hydropower (small hydropower plants – SHPPs)

Potential

Technically exploitable water potential resources in Croatia are estimated at 12.45 TWh/annum. Of that potential approximately 6.13 TWh/annum or 49.2% is currently used in hydropower plants. Based on experience in other countries with similar topographic and morphological features the 10% we can count on of the total potential refers to the potential of small water courses (around 1 TWh/annum).

Research of the potential of small water courses in Croatia was conducted through a cadastre for small water courses “Katastar malih vodnih snaga” (KMVS), which encompassed 130 water courses indicating the possible energy that could be exploited. The total gross potential of the water courses inspected was around 1,310 GWh per annum. Of that, around 1,180 GWh falls off on water courses at the defined exploitation sites and 130 GWh on water courses without defined exploitation sites. It is important to stress that locations inspected were for possible small hydropower plants (SHPPs) with electricity-generating capacity up to 5 MW¹⁹.

Technically exploitable potential at 699 locations inspected on 63 water courses amounted to around 570 GWh, while the installed **electricity-generating capacity** on a little less than 50% of these locations was estimated at less than 100 kW. Based on the KMVS, a cadastre for small hydropower plants “Katastar malih hidroelektrana” (KMHE) was prepared which signals out 67 potential exploitation locations for SHPPs along the following water courses: Boljunčica, Bijela, Bregana, Brzaja, Butišnica, Čabranka, Čučkov jarak, Jadova, Jadro, Krupa, Kupčina, Kupica, Ljuta, Orjlava, Ovrlja, Ruda Velika, Rumin Veliki, Slapnica, Vitunjčica, Voćinka and Žrnovnica. The investigation determined an annual possible production from these 67 locations at around 100 GWh. However, further analysis of the feasibility of construction as well as conditions to adapt the small hydropower plants into the local surroundings, protection of cultural-historical heritage and environmental protection significantly reduced the number of potential locations which left a total of only 6 water courses with a possible 18 exploitable locations.

The electricity-generating capacity of all 18 SHPPs was a little less than 2 MW, while the estimated average annual electricity generation amounted to 8.3 GWh.

However, it is necessary to investigate a further 622 locations which surely offer the possibility for additional potential with regard to SHPPs.

In order to estimate the total potential in SHPPs it is necessary to estimate the potential power of SHPPs with 5 – 10 MW of electricity-generating capacity. According to available data²⁰ the construction of these SHPPs is foreseen with a total electricity-generating capacity of around 125 MW. Based on the use of existing SHPPs and HPPs that amounts to 0.34 of the total production of these SHPPs, it is safe to make a conservative estimate of around 300 GWh per annum. As further investigation is necessary to satisfy limiting factors and we can expect that this figure will be significantly reduced.

¹⁹ “Hrvoje Požar” Energy Institute: 'Program izgradnje malih hidroelektrana – prethodni rezultati i buduće aktivnosti', Zagreb, April 1998.

²⁰ Elektroprojekt: 'Hidroelektrane u Hrvatskoj', Croatia Electricity, February 2000.



Figure 9-4 Potential locations of SHPPs

Figure 9-5 shows the estimated potential of exploitation of energy water courses in small hydropower plants.

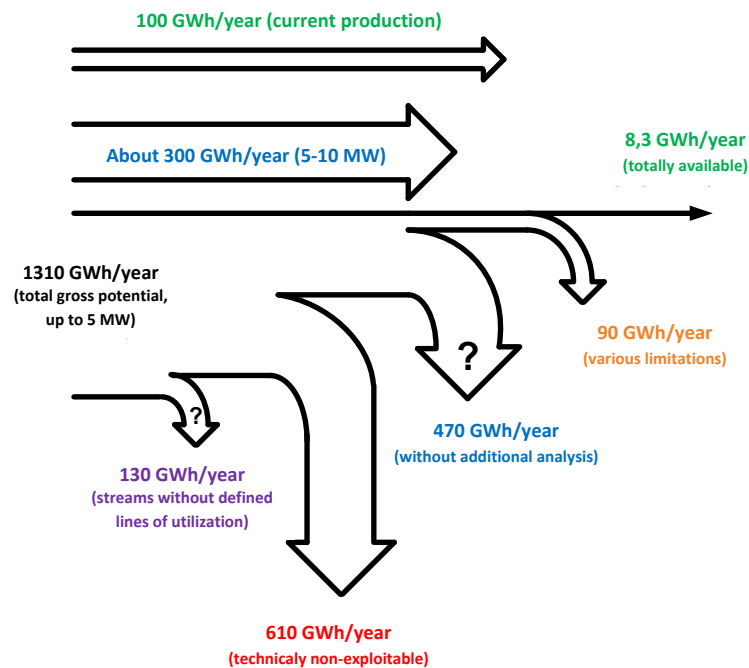


Figure 9-5 Balance of potential in SHPPs

Objectives

It is realistic to expect within a relatively short period (by 2015) that production from small hydropower plants will be increased by about 10 GHz at virtually all the sites that were investigated and so the expected average production from Shops is estimated at around 110 GHz. Based on 67 water courses that are noted on the Cadastre (KMHE) with a technical exploitable potential of around 100 GHz, which after meeting certain criteria was reduced to less than 10 GHz, we can estimate that 10% of the technically exploitable potential is the expected lower limit of use of technically exploitable potential after satisfying all the criteria (feasibility, environmental conditions, cultural-natural heritage, border courses).

The remaining technically exploitable potential in small hydropower plants is less than 5 MW and amounts to 500 GHz, while the power of larger plants of 5 MW is around 300 MHz per annum, therefore a total of 800 GHz per annum.

Future electricity generation from small hydropower plants will depend on the factor of technically exploitable potential. There are three different cases:

- With the presumption that the factor of technically exploitable potential is equal to the presumed lower limit of 10%, additional production from new Shops is estimated at around 80 GHz. The total production of Shops is estimated at around 190 GHz in 2020;
- With the presumption that the factor of technically exploitable potential is around 20%, additional production from new Shops is estimated at around 160 GHz. The total production of Shops is estimated at around 270 GHz in 2020. That increase is supported by the fact that amongst the newly investigated sites there will not be as many that run along border regions which is a realistic assumption. This scenario is included in the Strategy;
- With the presumption that the factor of technically exploitable potential is around 40%, additional production from new Shops is estimated at around 320 GHz. The total production of Shops is estimated at around 430 GHz in 2020. This increase assumes that newly investigated sites will not be within protected regions and a greater interest of investors is presumed virtually for all the Shops with electricity-generating capacity of up to 5 MW.

As such, in keeping with the foreseen development scenario for Rees's with a forecasted production of 4,500 GHz of electricity, the share of production by Shops will be around 2 – 7%.

The Strategy sets the objective of 270 GHz of electricity generated in small hydropower plants in 2020, or 430 GHz in 2030.

With regard to the development of the use of energy from small water courses beyond 2020, if a total production of 430 GHz was to be achieved by 2020, that value would be retained in the following period due to the exploitability of available potential. If that increase is not achieved then measures should be taken to realize this object by 2030.

Table 9-7 and Figure 9-6 show the forecasts growth in exploitation of energy from small water courses in small hydropower plants to 2030.

Activities

In order to utilize all available potential of small water courses in Croatia it is necessary in the following period to implement certain activities:

- Motivate the inspection of remaining water courses to determine the exact location and potential to construct SHPPs;
- Facilitate administrative procedures to obtain the necessary permits to construct small hydropower plants (particularly for small plants under 5 MW);
- Harmonize energy legislation and other laws relating to water management (granting concessions).

Table 9-7 Growth in the exploitation of energy from small water courses in SHPPs in Croatia to 2030

	2010	2020	2030
Electricity production [GWh]	110	270	430
Electricity production [PJ]	0.40	0.97	1.55

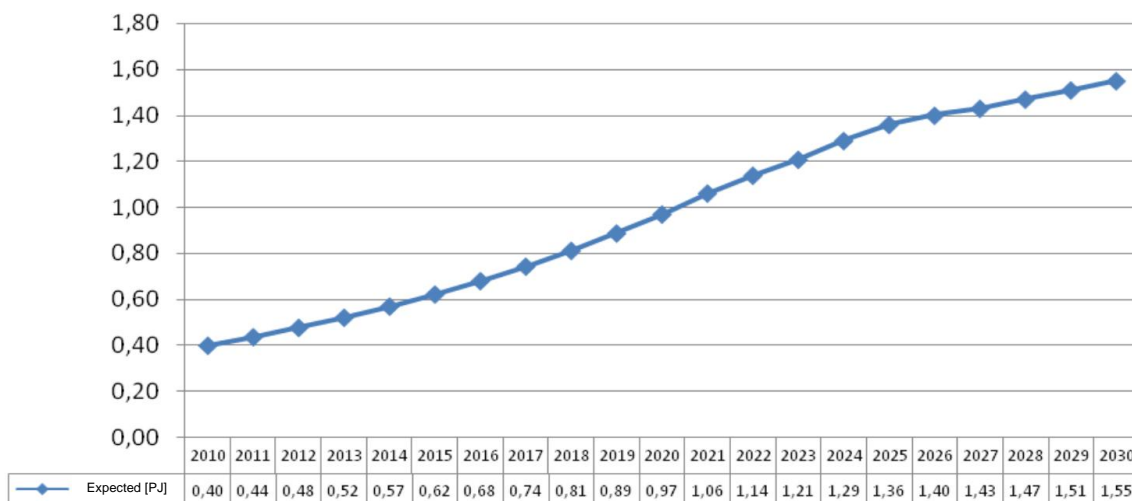


Figure 9-6 Growth in the exploitation of energy from small water courses in SHPPs in Croatia to 2030

9.2.5. Geothermal energy

Potential

Geothermal energy is energy contained in the Earth’s interior which is extracted via internal water energy or steam to the surface and exploited for energy purposes. In Croatia there is a long tradition of exploiting geothermal energy from natural resources for medical purposes and hot baths. Geothermal energy is the foundation of economic success of numerous mineral springs in Croatia. Geothermal waters in mineral springs are created by natural flows. Today in addition to natural springs, geothermal waters are exploited from shallow bores.

Exploration of oil and gas and techniques and technology to obtain geothermal energy from deep bores is well developed in Croatia. The purpose of initial exploration was to process data obtained in exploration bores with the aim of finding oil and gas reserves. This entailed certain exploration bores to be drilled in order to confirm the data obtained. Of the numerous locations explored only the following need to be mentioned, Bizovac near Valpovo, then the region between Koprivnica, Ludbreg and Legrad and the south-western outskirts of Zagreb.

Total geothermal energy potential from drilled bores in Croatia is estimated at 203MJ/s (using heat at water temperature up to 50°C) or 320MJ/s (at water temperature of 25°C). In case of complete utilization of the basin that potential is 840MJ/s (or 1170MJ/s).

Medium temperature potential (at water temperature between 120 - 170°C) in already drilled bores amount to 169MJ/s (with the use of heat at water temperature of 50°C) or 218MJ/s (with the use of heat at water temperature of 25°C). In case of complete utilization of the basin that potential is 756MJ/s or 989MJ/s.

The possible capacity of thermal power plants to transform internal energy of the hot water into electricity at a medium temperature in already drilled bores amounts to 11 MW, and with complete utilization of the basin, 48 MW.

Low temperature potential (water at 65 - 96°C) in already drilled bores amounts to 26MJ/s (with the use of heat at water temperature of 50°C) or 48MJ/s (with the use of heat at water temperature 25°C). In case of complete utilization of the basin that potential is 74MJ/s or 130MJ/s. Geothermal energy from these basins can be used for heating, hot water and for recreation facilities.

Potential springs at extremely low temperatures (up to 65°C) in already drilled bores amounts to 9MJ/s (with the use of heat at water temperature of 50°C) or 53MJ/s (with the use of heat at water temperature of 25°C). This group of springs belongs to geothermal springs that are used for medical and recreational purposes as are a large number of mineral spring baths and recreation facilities. These include springs in Daruvar (Daruvarske Toplice), Ivanić Grad (Naftalan Hospital), Krapinske Toplice, Lipik (Lipičke toplice), Livade (Istarske toplice), Samobor (Šmidhen SRC), Stubičke Toplice, Sveta Jana (Sveta Jana RC), Topusko (toplice Topusko), Tuhelj (Tuheljske toplice), Varaždinske Toplice, Velika (Toplice RC), Zagreb (INA-Consulting), Zelina (Zelina RC) and Zlatar (Sutinske toplice).

Objectives

The main objectives of this Strategy with regard to the exploitation of geothermal energy are:

- **Exploitation of medium temperature basins** to develop business area where geothermal power plant would be the central business facility
- **Constructing a pilot project geothermal power plant and business area by 2011** where the coordinating role would be the responsibility of the local self-government with the support of regional and national government
- **Constructing a total of 3 geothermal power plants with business area by 2020**
- **Tripling the use of internal geothermal water energy for heating by 2020**

Activities

The exploitation of geothermal energy in Croatia in future will be tied to complete exploitation of existing geothermal bores that were drilled on the main part to obtain oil and gas with economically feasible boring techniques. Today, Croatia exploits 0.14 PJ of geothermal waters for energy purposes (heating and hot water) and 0.42 PJ for recreational purposes (pools and other similar recreational facilities, which will not be balanced here).

Projects are currently being prepared regarding electricity generated using geothermal energy at the Lunjkovec-Kutnjak and Velika Ciglena bores. These are multi-purpose projects with a fundamental objective to develop business zones where the thermal power plant will be in a situation to stimulate electricity prices and as such be in a position to offer business in the zone at favourable price for waste heat and in that way attract potential investors (greenhouses for horticulture, tourist-recreational facilities, and fisheries).

In addition to electricity generation, geothermal energy will continue to be used for its traditional purpose (tourism and recreational purposes), but also for heating, hot water, agricultural production, industrial manufacturing, fish farms, drying cement beams, etc.

Table 9-8 shows a forecast of the use of geothermal energy in Croatia. The table shows heat consumption without consumption for recreational purposes.

Table 9-8 Forecasted use of geothermal energy in Croatia

Structure of geothermal energy consumption	2006	2010	2015	2020	2030	2006	2010	2020	2030	2006-2020	2006-2030
	PJ	PJ	PJ	PJ	PJ	%	%	%	%	%	%
Total	0.14	0.15	2.77	5.51	8.54	100.0	100.0	100.0	100.0	30.3	22.5
Electricity	0.00	0.00	2.49	4.98	7.47	0.0	0.0	90.3	87.5	-	-
Other sectors	0.14	0.15	0.28	0.53	1.07	100.0	100.0	9.7	12.5	10.3	10.4

9.2.6. Solar Energy

Potential

Estimates of the potential of solar energy, on the most part along the Croatian coastline were conducted by the National Energy Programme - SUNEN²¹ in 1998 for Croatia on the whole with a Solar Handbook²² written in 2007.

The natural potential of solar energy in continental regions of Croatia, with an average insolation of 3.6 kWh/m², amounts to around 74,300 TWh/annum (267.500 PJ/annum.), which is over 800 times more than the consumption of primary energy in Croatia in 2000.

Technical potential of solar energy on 1% of the continental part of Croatia is estimated at 830 TWh/annum (3.000 PJ/annum) or close to 10 times of the daily consumption of primary energy in Croatia. With the presumption that 60% of that energy is used for heating and 40 % for electricity generation, we can conclude the following:

- The technical potential to produce heat from solar collectors and the use of passive solar energy (solar architecture) amounts to 175 TWh/annum. (630 PJ/annum);
- The technical potential to electricity generation from photovoltaic (PV) systems and solar thermal power plants amounts to around 33 TWh/annum.

The economic potential of solar energy in Croatia is estimated as follows²³:

- Heat produced from solar energy amounting to around 50 % of total low temperature heat in 2000 in Croatia, or nearly 12 TWh/annum. (43.2 PJ/annum.), the production of heat from solar collectors and passive use of solar energy (solar architecture). That makes up for about 7% of the technical potential of solar energy for heating in Croatia.
- Electricity generated from solar energy in photovoltaic systems and solar thermal power plants could become economically viable around 2020. With the use of a little less than 1% of the technical potential, the economic potential to produce solar electricity would amount to around 0.3 TWh/annum, which is the equivalent of around 200 MW of electricity-generating capacity.

The scope of radiation in Croatia is shown in Figure 9-7, with data for specific regions in Croatia and Europe shown in Table 9-9.

²¹ National Energy Programme (NEP) – prethodni rezultati i buduće aktivnosti, Energetski institut Hrvoje Požar, Zagreb, April 1998.

²² „Sunčevo zračenje na području Republike Hrvatske-Priručnik za energetske primjene Sunčevog zračenja“, Energetski institut Hrvoje Požar, Zagreb, 2007.

²³ Potočnik, V., Lay, V.; "Obnovljivi izvori energije i zaštita okoliša u Hrvatskoj", Croatian Ministry of Environment Protection and Physical Planning, Zagreb, 2002.

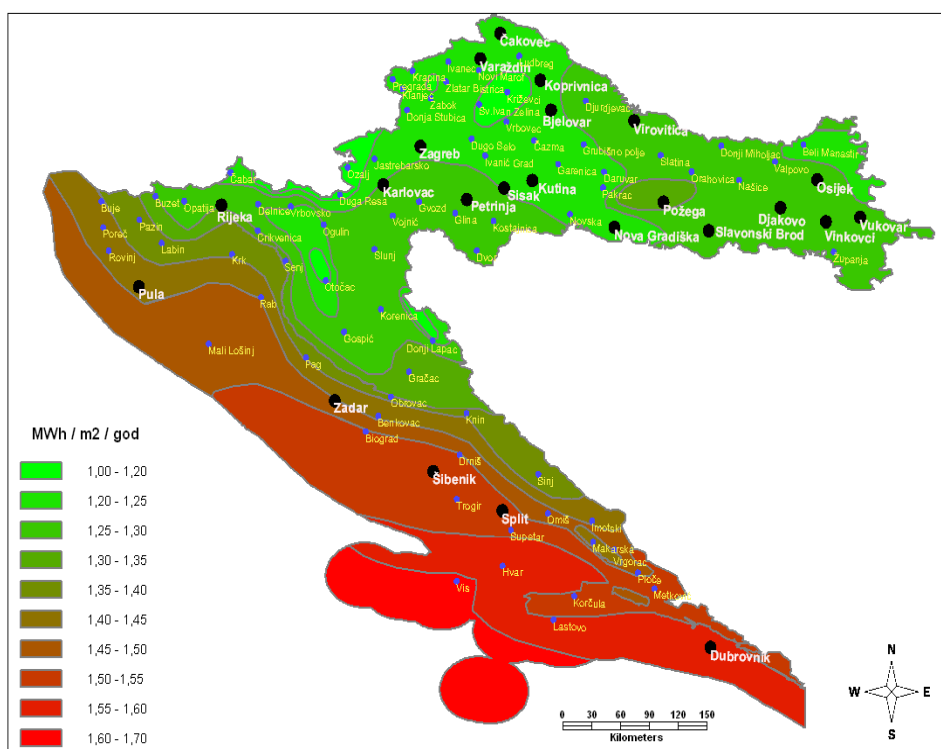


Figure 9-7 Insolation in Croatia²⁴

While investigating the potential of solar energy in Croatia consideration was given to the fact that apart from covering peak loads the daily path of the Sun coincides favourably. Peak hours during the tourist season in Croatia coincides with insolation as shown in Figure 9-8 compared to Spain (ES) and Greece (GR), where solar energy has already been exploited in their tourist activities.

Table 9-9 Comparison of radiated solar energy on an optimal position of measuring surface in various parts of Croatia and Europe²⁵

Location	Yearly average of emitted energy (kWh/m ² d)
Croatia, south Adriatic coast	5.0 – 5.2
Croatia, north Adriatic coast	4.2 – 4.6
Croatia, continental part	3.4 – 4.2
Central Europe	3.2 – 3.3
North Europe	2.8 – 3.0
South Europe	4.4 – 5.6

²⁴ According to data presented in the Handbook - „Sunčevi toplinski sustavi za kampove“, Društvo za oblikovanje održivog razvitaka, Zagreb, 2007, and „7th report EurObserv'ER: State of Renewable Energies in Europe“, Barometer prepared by Observ'ER in the scope of “EurObserv'ER” Project which groups together Observ'ER, Eurec Agency, Erec, Eufores, Institut Jozef Stefan, with the participation of IEO/EC BREC, 2008.

²⁵ Handbook - „Sunčevi toplinski sustavi za kampove“, Društvo za oblikovanje održivog razvitaka, Zagreb, 2007.



Figure 9-8 Tourist nights in 2005

Objectives

Two objectives regarding the use of solar energy have been set:

- The situation regarding solar heating systems in Croatia by 2020 must be equal to the level in Germany and Greece en par to the population ratio (objective of 0.225 m² per capita);
- The situation in Croatia regarding photovoltaic systems by 2020 must be equal to the situation in Spain today (11.71 W per head), and Germany by 2030 (over 45 W per capita).

It is presumed that the growth rate in exploiting solar heat collectors will be around 47% per annum by 2010 and beyond 2020, it is expected that this growth rate will slow down to around 10% per annum.

It is presumed that the growth rate in exploiting photovoltaic systems will be around 68% per annum to 2020 and by 2030 this rate should be around 20% per annum. The total estimates in controlled years are shown in Table 9-10, and the dynamics of growth is shown in Figure 9-9. Estimates accounted for the average insolation in Croatia equal to 1.37 MWh/m²/annum. It is estimated that solar hot water preparation accounts for 1.5 m² of solar collectors per capita of those who use these systems and 1.825 hours of peak power in photovoltaic systems per annum (maximum radiation at an average of 5 hours per day all year round).

Table 9-10 Growth in exploitation of solar energy in Croatia by 2030

	2010	2020	2030
Solar energy – hot water production [PJ]	0.5	4.96	12.21
Inhabitants using solar hot water system (1,5 m ² collector / inhabitant)	67,691	660,000	1,653,017
Average m ² per 1000 inhabitants	23.8	225.00	563.53
Solar Energy – PV [PJ]	0.01	0.3	1.66
Electricity-generating capacity [MW]	1.52	45.66	252.66
Average W per inhabitant	0.34	10.38	57.42
Solar energy – Total [PJ]	0.51	5.27	13.87

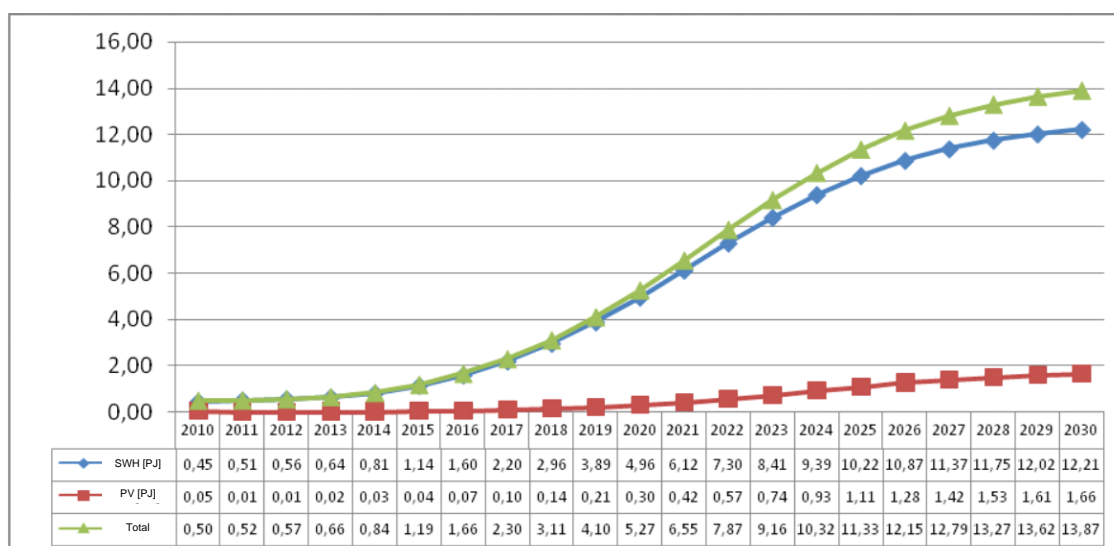


Figure 9-9 Dynamics of growth in exploitation of solar energy in Croatia to 2030

Passive use of solar energy in Croatia, particularly in coastal regions, mostly in tourist catering and accommodation sector will mean huge energy savings in heating. It is estimated that savings could be as high as 50 - 75 per cent compared to current consumption. By 2030, all hotel, catering and accommodation units, and in particular those to be built along the coast beyond 2010 will be required to use modern technology primarily high energy efficiency passive solar systems while at the same time all available active solar systems will be used for heating, air-conditioning and lighting. The total energy demand of all new buildings will not be allowed to be over 80 kWh/m², which is about two times less than is the case today.

Activities

In the first phase of implementation of this Strategy, activities need to be directed towards stimulating the use of solar heat systems. It is imperative that solar collectors are constructed to obtain heat energy (low temperature heating and hot water use) in all new construction both inland and along the coast.

Croatia is geographically positioned allowing high energy efficiency in solar energy. Installations with two circular knots should not be ignored which facilitate very hot water that can be used for low temperature heating via thermal regulators. As such, not one system is excluded and installation should be made possible for individual housing units and collective buildings. The objective need not be 100% coverage of heating for hot water production but rather to contribute to hot water production which reduces the demand for electricity or other energy sources for this purpose.

Long-term incentives to use solar heating systems and photovoltaic systems will have a positive effect to developing domestic industry and so this segment should be included in government incentive policies.

Time plan for growing solar energy use is divided into 3 phases:

- By 2010:
 - Motivating solar heating systems through tax relieves and/or subventions, introducing construction regulations and planning incentive programmes for the installation of solar thermal systems in households, services and industry;
 - Promoting solar energy as a modern way for hot water production and residential heating (raising awareness);
 - Redefining attitudes towards photovoltaic systems and expanding the quota of stimulation for 1MW cumulative power to a higher value;
 - Primary orientation to solar heating systems due to advanced technology, low input costs and relatively quick investment return period while a secondary orientation would be to introduce photovoltaic systems; and
 - Removing all existing administrative barriers and amending relevant legislation in this regard.
- 2010 – 2020:
 - Achieving the set indicators – 300,000 residents with at least 1.5 m² solar collectors installed to satisfy their own heating requirements;
 - Achieving the set indicators – 11.71 W/per head of installed **electricity-generating capacity** in photovoltaic systems.
- 2020 – 2030:
 - Accomplishing 15% of buildings with some form of solar source participating in their own energy balance;
 - Accomplishing 50% of newly constructed buildings with some form of solar energy source satisfying their own energy balance;
 - Achieving more than 45 W/per head of photovoltaic power;
 - Reaching fourth place in Europe with regard to MW of solar thermal systems per capita.

9.3. Future Trends

The strong trend in exploiting RES must continue even beyond 2020. In the following ten years it is expected that new technologies will be introduced that this Strategy has not considered because these are still in the research phase and estimates of their future use are still uncertain, particularly with reference to hydrogen.

However, with regard to strong development technology to exploit RES, Croatia must secure long-term investments into research, development and application. New technology and solutions will naturally include technologies to obtain and exploit hydrogen, exploiting RES for air-conditioning and absorption apparatus, further development technology in distribution production, development of “smart grids”, methods to foresee production from RES and managing electricity systems largely produced from RES.

It is without a doubt that today already, Croatia must follow global development trends in this field so that it can be in a position to apply the best available technology as soon as they become economically viable.

10. TOTAL PRIMARY ENERGY SUPPLY OF CROATIA

Total energy consumption is all energy forms input into the energy system reduced by exported energy. Forecasts of total energy consumption for Croatia to 2020 is shown in Table 10-1 and Figure 10-1, with the presumption of achieving a sustainable scenario of consumption and the selected development scenario of the power system (White Scenario) and following the presumption of satisfying energy requirements for Croatian consumers only. The postulate of this Strategy is Croatia's economic openness and fitting it in to the EU market the previously described presumption is simplified with a purpose to present a simpler analysis of the main trends in total energy consumption. This analysis is a base for energy policy determination and directions for companies in which energy objects they should invest. Developed energy market and competition between energy facilities will not be limited by country borders and therefore the market mechanisms will direct energy flows optimizing the regional energy system. Due to Croatian future technical and commercial opportunities to export electricity and oil products it is expected that the total energy consumption will be greater than shown in the table (due to losses in transformation), however should its production capacities not be in a position to compete even at the domestic market, consumption could be lower than presented.

Table 10.1 - Forecasted total energy consumption

Energy consumption	2006	2010	2015	2020	2030	2006	2010	2015	2020	2030	2006-2020	2006-2030
	PJ	PJ	PJ	PJ	PJ	%	%	%	%	%	%	%
Nuclear energy	0.00	0.00	0.00	82.16	164.32	0.0	0.0	0.0	13.8	21.8	-	-
Import of electricity - NPPK	9.52	9.71	9.71	9.71	0.00	2.5	2.2	1.9	1.6	0.0	0.1	-
Import of electricity - without NPPK	10.72	6.67	0.00	0.00	0.00	2.8	1.5	0.0	0.0	0.0	-	-
Coal and coke	33.67	36.35	64.75	42.31	29.28	8.9	8.2	12.5	7.1	3.9	1.6	-0.6
RDF *	0.23	2.67	4.76	8.06	10.49	0.1	0.6	0.9	1.4	1.4	29.0	17.3
Renewable energy	37.34	38.15	54.52	79.06	132.20	9.8	8.6	10.5	13.3	17.6	5.5	5.4
Liquid fuels	187.89	188.37	181.86	181.55	197.05	49.5	42.4	35.0	30.5	26.2	-0.2	0.2
Natural gas	99.98	159.37	199.17	183.39	205.60	26.4	35.9	38.3	30.8	27.3	4.4	3.0
Biogas	0.00	2.59	4.67	8.91	13.53	0.0	0.6	0.9	1.5	1.8	13.2	8.6
Total	379.34	443.88	519.45	595.16	752.47	100.0	100.0	100.0	100.0	100.0	3.3	2.9

With regard to total energy consumption, by implementing this Strategy, Croatia would achieve:

- Slowing down the growth of the total consumption of oil products (average growth rate by 2020 will amount to – 0.2%)
- The structure of primary energy in total energy consumption will be more varied (due to the high growth rate in exploiting renewable energy sources and nuclear power)
- Share of oil and natural gas (fossil fuels with a firm price relationship) will be reduced from 75% in 2006 to 60% in 2020
- Share of domestic energy sources in total consumption will grow by 8% (from 35% in 2006 to 43% in 2020)

The share of domestic energy sources will grow due to the growth in renewable energy sources and nuclear power with a significant domestic production of oil and natural gas (in 2020, domestic oil production will cover 13% of liquid fuel consumption, while domestic natural gas production will cover 34% of natural gas consumption – Figure 8-6). Electricity generation in a nuclear power plant is defined

by the European Commission as a domestic energy source with a low level of fuel price dependency. The share of domestic energy sources in total consumption is shown in Figure 10 – 2.

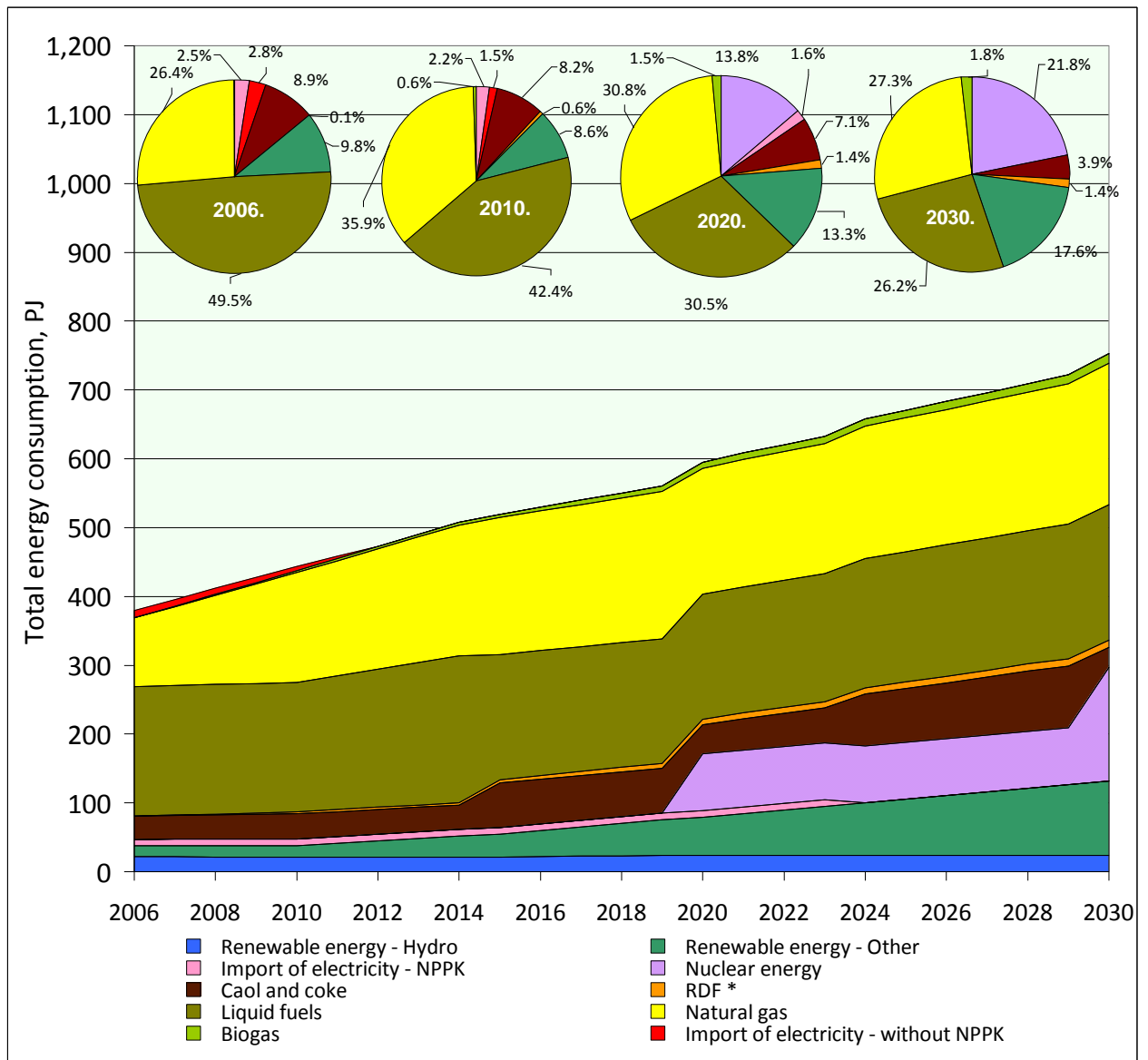


Figure 10-1 Forecasted energy consumption in Croatia

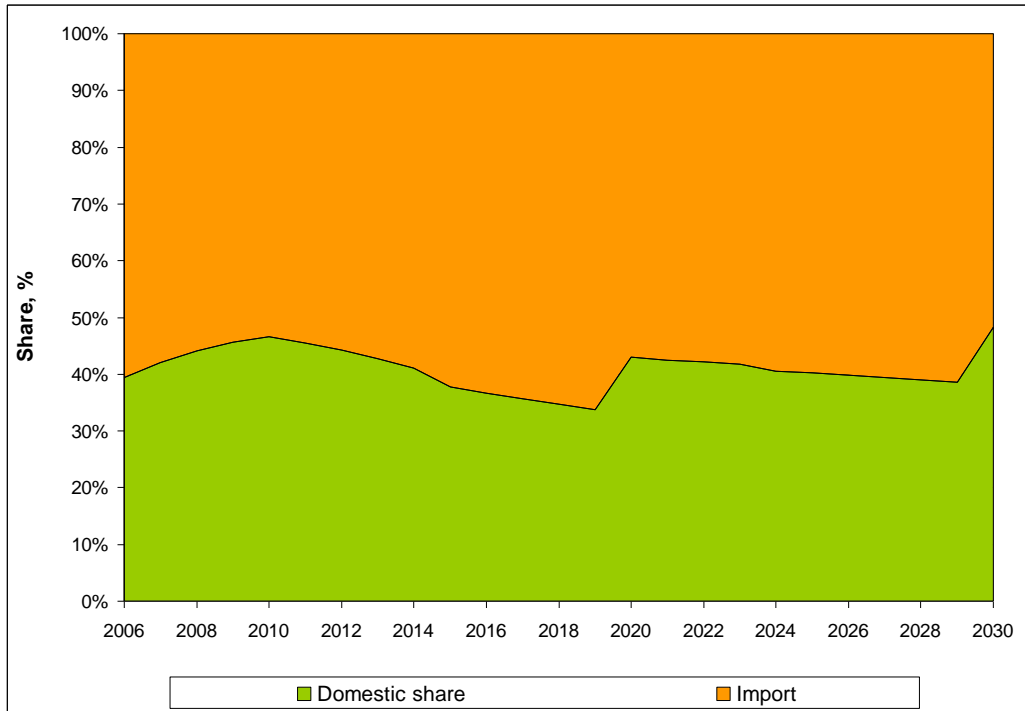


Figure 10-2 Share of domestic energy sources

As the consumption of liquid fuel in transport is not very flexible compared to energy policy measures, possible achievements with the implementation of this Strategy are more visible if the structure of total energy consumption is observed without the transport sector (Figure 10-3). A balanced structure of energy forms will be the fundamental indicator of primary energy to supply other sectors and industry in the period to come (just 50% of energy will be from fossil fuels).

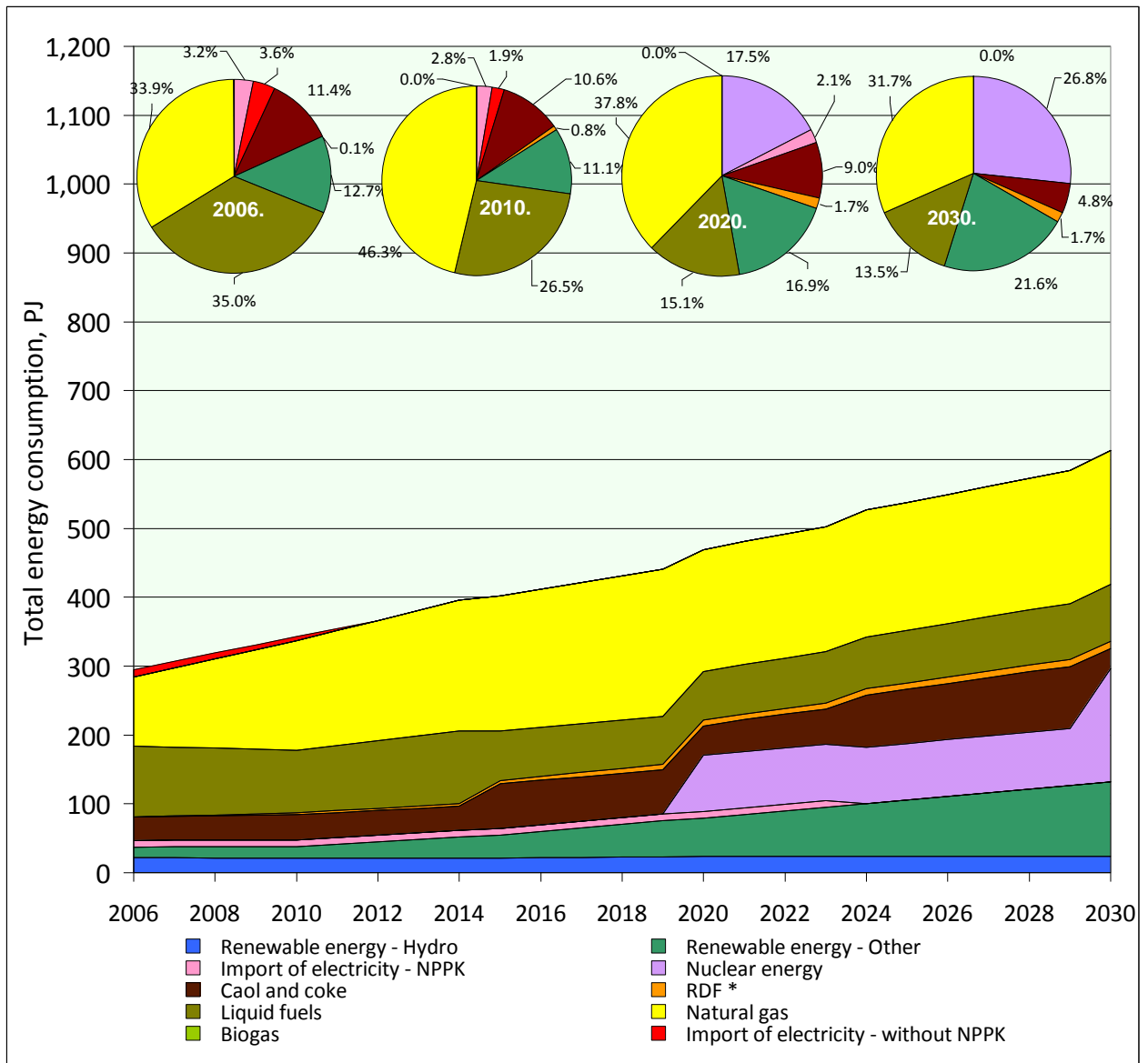


Figure 10-3 Forecast of total energy consumption without the transport sector

According to recommendations in the new EU Directive on Renewable Energy²⁶, Croatia is required to achieve a share of renewable energy in final energy consumption of 19.0%. If development recommended in this Strategy is achieved, Croatia will satisfy this demanding obligation because the total share of RES will be 20.3%!

²⁶ Proposal for a directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources, COM (2008) 19 final

We can conclude that this Strategy offers guidelines for energy sector development in Croatia which will be sustainable, competitive and will ensure security of energy supply. The energy system will be efficient and services and domestic energy efficiency technology will stimulate economic growth. Use of renewable energy sources in greatest possible reasonable amount (wind, solar energy, water energy, geothermal energy, biomass and biofuels). The energy system will be diversified with regard to the technologies applied, energy forms, supply directions and energy sources. Croatia's energy system will be completely integrated into the regional energy system. It will be open and attractive to private investors, energy trading and energy flows. Due to Croatia's geographic and human potential the energy sector will be an important, export directed factor for economic prosperity.

11. SUPPORT TO ENERGY POLICY – CROSS-CUTTING ISSUES

11.1. Establishing a Legislative and Regulatory Framework

11.1.1. Towards Integration into EU Institutional Framework

As part of the accession negotiations for the EU membership, Croatia is adopting its *acquis communautaire* in the energy sector as well. The aim of creating and implementing legislative and institutional framework based on the *acquis communautaire* is to regulate and liberalize the energy sector of Croatia in order to ensure the free energy market and improve competitiveness, security of energy supply and environmental protection.

EU Acquis communautaire regarding energy sector is included in the EU Directives and international agreements, signed by Croatia with the Union, and emphasis should be placed on the Treaty establishing the Energy Community, of October 2005 (came into force on 1st July 2007). As one of the signatories of the Treaty (nine countries of Southeast Europe and EU signed the Treaty) Croatia committed to adopting electricity Directives and Natural gas Directives into its legislative system. The commitment refers to the Directive 2003/54/EC concerning common rules for the internal market in electricity and the Regulation 1228/2003/EC on conditions for access to the network for cross-border exchanges in electricity as well as the Directive 2003/55/EC concerning common rules for the internal market in natural gas. Subsequently, the commitment included the Gas Regulation 1775/2005/EC (must be implemented by 31 December 2008) and the Directive 2004/67 EC concerning measures to safeguard security of electricity and natural gas supply (must be implemented by 31 December 2008). As signatory countries failed to meet all their contractual obligations by the start date (mid 2007), the Treaty was twice extended for the period of six months, and the closing date for the implementation of all individual obligations from the Treaty is 31 December 2017.

Croatia has also committed to adopting and applying EU legal regulations concerning environmental protection, renewable energy resources and market competition. In the field of environmental protection Croatia has applied the Directive 85/337/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment, amended by the Directive 97/11/EC and the Directive 2003/35/EC providing for public participation in relation to the drawing up of certain plans and programmes, and amendments to the Directive 85/337/EEC and the Directive 96/61/EC concerning integrated pollution prevention and control (IPPC Directive). By the end of the year 2011, Croatia will have applied the Directive 1999/32/EC (amending the Directive 93/12/EEC) and relating to a reduction in the sulphur content of certain liquid fuels, and by the year 2017 it will have applied the Directive 2001/80/EC on the limitation of emissions of certain pollutants into the air from large combustion plants. Furthermore, Croatia has implemented article 4, paragraph 2 of the Directive 79/409 on the conservation of wild birds.

Croatia has ratified the Kyoto Protocol, although the Treaty establishing the Energy Community does not provide the obligation of ratifying the Kyoto protocol (whilst accession to the EU does) and is about to start negotiations on the obligations in the post-Kyoto period.

In compliance with assumed obligations, Croatia shall strictly implement the assumed legal regulations and adjust its legislation to the requirements and recommendation of the European commission, bearing in mind its own specificity and the need to ensure economic and social development.

The legal framework regulating the energy sector in Croatia consists today, in addition to the energy sector development strategy (as fundamental document laying down the energy sector policy), of the Energy Act (Official Gazette, 68/01, 177/04 and 76/07), the Act on Regulation of Energy-Related Activities (Official Gazette 177/04 and 76/07), the Gas Market Act (Official Gazette, 40/07), the Electricity Market Act (Official Gazette 177/04 and 76/07), The Act on the Production, Distribution and Supply of Thermal Energy (Official Gazette, 42/05), The Oil and Oil Product Market Act (Official Gazette 57/06), The Act on the Environmental Protection and Energy Efficiency Fund (Official Gazette, 107/03) as well as many implementing bylaws which have been enacted or shall be enacted based on the provisions of these Acts. The Act on Energy Efficiency and the Bio fuels Act are to be enacted. International agreements ratified in accordance with the Constitution of the Republic of Croatia also represent part of the internal legal order (the Energy Charter Treaty, The Energy Charter Protocol on Energy Efficiency and Related Environmental Aspects, the Treaty establishing the energy community, the Convention on Nuclear safety).

11.1.2. Electricity

With respect to electricity, the legal framework has been completely finished. However, some shortcomings have been noticed, which have delayed the application, so they will be eliminated by amendments to incomplete provisions (bearing in mind the intentions of the passed provisions). It is specifically emphasized the need to provide clear principles and criteria to be applied in the procedures of issuing licenses to build facilities for electricity generation, that is, the methods of the implementation. The mentioned shortcomings impede the clear picture of investor's position in the project planning stage and present a limitation to the investors. In that respect, the competent ministry, i.e. the government of the Republic of Croatia, shall determine and proscribe a clear manner of implementing the adopted criteria and principles which are to be applied in the procedures of issuing construction permits by the competent ministry, as it is provided by article 9 of the Electricity market Act.

11.1.3. Natural gas

In the field of gas, the basic Act is the Gas Market Act (Official Gazette, 40/07) regulating the rules and measures for carrying out energy-related activities in the natural gas sector including LNG, rights and obligations of the participants on the gas market, separation of system operators' activities, third-party access to the gas system and opening the natural gas market.

It is necessary to adopt certain bylaws which are to complete the implementation of the EU *acquis communautaire* and offer possibilities for the gas market to function: General terms of natural gas supply, Regulation on security of natural gas supply, The Ordinance on gas market organization, network rules for transportation system, network rules for distribution system, Rules on the use of gas storage system, Rules on the use of LNG terminal, Ordinance on the fee for access to gas supply network and on the increase to access power, Ordinance on submitting data on investment projects.

11.1.4. Heat Production

In addition to basic energy acts, sector of thermal power plant is normatively regulated by the Act on production, distribution and thermal energy supply (Official gazette, 42/05) and bylaws.

For the purpose of completing the normative framework in the field of thermal energy sector, it is necessary to adopt the following acts:

Ordinance on the technical requirements for power plants for the thermal energy production, Ordinance on the conditions required to acquire the status of eligible thermal energy producer, Ordinance on the manner of distribution and cost calculation for the supplied thermal energy, Regulation on the parameters for determining the share of the eligible thermal energy producer, Ordinance on the fee for the access to distribution network.

11.1.5. Oil and Oil products

The Act on oil and oil products market lays down a normative framework for conducting oil products production activities, transporting oil by oil pipelines, transporting oil products by product pipelines, oil products wholesale, oil products retail sale, oil and oil products storage and trading, brokerage and representation on the oil and oil products market.

As a part of amendments, i.e., enacting of a new Mining Act, and part of adoption of EU acquis communautaire, the following issues shall be regulated: relations and procedures for granting future concessions for hydrocarbon research (oil, gas condensates and natural gas), as well as appropriate bylaws providing procedures for issuing license to exploit hydrocarbons and legalize new increased fees for hydrocarbon exploitation from domestic reservoirs.

In that segment, a special section of the Mining Act and bylaws shall ensure appropriate definition, evaluation and transfer to government ownership of geological-mining documents regarding hydrocarbon reservoirs and containing data which belong to the expert-technical framework for defining of mineral resources, which are public good and state ownership under the Constitution of the Republic of Croatia.

Subsequently, during the implementation of this Strategy, legal framework shall be amended so as to enable additional construction of systems of required oil and oil products reserves as well as a development of the strategic oil reserves systems in the period beyond the year 2020, and as part of the visions of the energy development by 2030.

11.1.6. Renewable Energy Sources, Energy Efficiency and Cogeneration

The basic legal framework for the field of renewable energy resources, energy efficiency and cogeneration in Croatia is contained in the Energy Act, Electricity Market Act, The Act on Environmental Protection and Energy Efficiency Fund and bylaws which represent implementing acts of these Acts.

Obligations based on the Directive 2006/32/EC on energy end-use efficiency and energy services are only partially adopted in the Croatian legislation in the cited Acts. In order to fully apply the Directive in question, a new act shall be enacted, the Act on Energy use Efficiency and a number of implementing acts. Establishment of the certification systems of energy performance of buildings (obligation under the Physical planning and Construction Act (Official gazette 76/07) shall contribute to energy efficiency, and only few bylaws need to be enacted.

The Croatian legislative framework regarding cogeneration and renewable energy resources is in compliance with the *acquis communautaire*. Financial incentives have been ensured through feed-in tariffs determined by the tariff system for electricity production from renewable energy resources and cogeneration (Official gazette, 33/07). Financial resources for that purpose are ensured through a special fee to be paid by electricity consumers, which has been determined by the Regulation on incentive fees for promoting electricity production from renewable resources and cogeneration (Official Gazette, 33/07 and 133/07). National goals for electricity generation from renewable energy resources and cogeneration have been laid down in the Regulation on a minimal share of subsidized electricity production from renewable energy resources and cogeneration (Official gazette 33/07). Criteria for the highly efficient cogeneration are laid down in the Ordinance on acquiring the status of eligible electricity producer (in accordance with the Directive 2004/8/EC and Commission Decision 2007/74/EC establishing harmonized efficiency reference values for separate production of electricity and heat in application of Directive 2004/8/EC).

Obligation to implement the Directive 2003/30/EC on the promotion of the use of biofuels requires the Bio fuels Act to be enacted (it shall be adopted by the end of 2008).

11.1.7. Regulation and Croatian Energy Regulatory Agency (HERA)

Normative framework regarding the Croatian Energy Regulatory Agency (HERA) has been established. It consists of the Energy Act, the Act on regulation on energy-related activities (as fundamental act regulating the establishment and implementation of the regulatory system for energy-related activities) and acts on energy-generating product market as well as the ordinance on issuing licenses for performance of energy-related activities, ordinance on the period for which the license to perform energy-related activities is issued, Ordinance on the data to be submitted by energy entities to the Croatian Energy Regulatory Council, existing methodologies and tariffs systems as well as internal acts of HERA.

11.2. Creating Favourable National Conditions for Energy Sector Development

11.2.1. Ensuring Investments in Energy Sector

Based on the projection of future energy demand and the need to replace the existing energy infrastructure as well as on challenges to be faced by the energy sector in future, this Strategy has shown that the energy sector in Croatia requires significant investments. The public sector shall not be able to finance these investments with its own resources (as this is not its purpose), so there exists the ***necessity to promote private, domestic and foreign investments in the energy sector.*** To that end, state institutions are facing great demands to create, coordinate and improve conditions which should ***attract domestic and foreign capital with a purpose to take part in the realization of the required investments in the energy sector.***

For investments in the energy sector as a special type of investment, favourable conditions can be created only through a combination of general favourable economic conditions and specific conditions resulting from the importance of energy for the economy and population and which have to support the goals defined by this energy strategy.

Favourable general economic conditions mean macroeconomic stability, efficient state administration, competitive level of tax burden, legal safety, adequate human resources, well-developed economic

infrastructure, protection of market competition, presence of financial investment incentives, presence of specialized state institutions for investment promotion, etc. However, so as to encourage investments in the energy sector, and given the high levels of required investments, long-term nature of investments and sensitivity of investment outcomes to volatile trends of world energy prices, it is necessary to create additional conditions so as to make these investments more attractive and channel them in a desired direction.

As far as specific conditions for this type of investment are concerned, of crucial importance are timely planning and preparation of required investments based on an analysis of existing trends and a projection of future market trends, as well as clear communication of the plans to a wider public, all stakeholders and especially to interested investors. A strategic framework of future energy development, defined in this Strategy, tested in a public consultation process and backed by the firm and unchangeable political commitment of the government and the Parliament, **provides basic information** on priority investments in the infrastructure of regulated activities and necessary market and private investments. A strategy implementation programme shall **ensure that obstacles to private investment** in energy sector are **eliminated** so as to achieve strategy goals based on the guidelines on how to create clear, unambiguous and **stable legal framework** which shall favour such types of investment and **reduce level of uncertainty facing private investors**. Success in reaching strategy goals shall be monitored based on annual reports on implementation of the strategy implementation programme and on reports to the Parliament by the government on implementation of the strategy implementation programme in the period from 2009-2012.

When it comes to big, investment heavy production facilities with a long-term return on investment period, private investors will be encouraged not only by favourable legal framework but also by **efficient state administration** whose task is to create favourable investing atmosphere, raise public awareness on the need to invest and assist directly investor so as to put into practice faster and with less risk, their investment ideas.

To this end, cooperation between state institutions and local and regional authorities is necessary. Even though market research is investor's obligation, the state, based on planning systems, will provide potential investor with information on investment needs and possibilities. In addition, special care shall be given to required investments in energy producing facilities, when it comes to physical planning.

When it comes to regulated activities, investment risks are smaller due to lesser impact of world and regional market uncertainty on business conditions of these activities on internal markets. With respect to **regulated activities**, good planning as information source and the role of regulators are of great importance, since wrong information and investment decisions made on the base of which, can put at risk **security of energy supply** (if they are belated) or unnecessarily increase energy supply costs and reduce **energy system competitiveness** (if an investment is unrealistic or unjustified, and costs are socialized, distributed on all system users). Of great importance are investments in infrastructure for transit of oil, natural gas and electricity, which take advantage of geographical position of Croatia and investment decisions have to be considered bearing in mind positive effects on balance of payments and direct profit for the state.

Investments in renewable energy resources and technologies that increase energy efficiency contribute to greenhouse gas emission mitigation, increasing a country's energy autonomy and having a robust energy system. Based on a large number and variety of investments, technology availability and possibilities for a development of domestic products and services in that field, their potential to **make**

activities of small and medium-sized entrepreneurs more dynamic can be the basis for a new development that cannot be fully realized nowadays.

The existing legal solutions and incentives to economic growth concerning these activities will continue to be examined and improved with a purpose to create special conditions and special assistance of institutions and regional and local self-government (through organization, education and information, financial incentives, easier access to funding sources, encouragement of technology and product development and placement of technological findings made in scientific and research project of the academic community at the disposal of private sector).

The Croatian tax system does not provide any special tax relief in relation to energy efficiency and use of renewable energy resources even though many EU member states tax relief partially replaces incentive system. The advantage of tax relief is that it is equal for all investors and it contributes to better functioning of market mechanisms. However, they should be designed with great care, therefore, before introducing such initiatives, it is necessary to carefully examine consequences for the economy system.

11.2.2. Integration of Energy Sector Facilities in the Physical plans

Achieving this Strategy requires amendments to documents regarding physical planning which are in force! According to the current regulations (the Environmental Protection Act, the Physical Planning and Construction Act and related documents) it is not possible to start not even preparatory activities for a certain project (procedure) if that project is not adequately planned in the physical planning documents. Article 6 of the Regulation on the assessment of the effects of certain plans and programmes on the environment (Official Gazette, 64/2008) provides that the *Application/request for the assessment of certain plan or programmes on the environment* has to include, among other things, "data on conformity of the plan with the current documents regarding physical planning, which is to be proved by an appropriate certificate, confirmation and similar, issued by the competent body under the law regulating physical planning." Annex VI of the same document determines the content of the *Application for issuing guidelines on contents of the study on environmental impact* in which it is also required that the project is planned in accordance with current documents regarding physical planning.

Physical Planning Strategy of the Republic of Croatia

Physical planning strategy of the Republic of Croatia is a key document regarding physical planning (adopted on 27 of June 1997 in the House of Representatives of the Croatian Parliament). Regarding energy field, the basic guideline of the strategy is as follows:

- Keep all existing locations of energy generating facilities as a basis for expansion and development of energy sector (oil and gas field exploitation with related oil and gas pipelines, refineries, Adriatic Oil Pipeline, Hydropower plants and Thermal power Plant, power-transmission lines and transformer stations, etc.)
- Upgrade and (or) expand existing energy and transfer systems (upgrading/expanding does not present significant spatial requirements),
- Keep all so-far explored and potential locations for possible new power plants for which further investigation is required,
- Keep existing locations and ensure new locations and corridors of power plants connecting Croatia with neighbouring countries,

- Apply consistently the Selection criteria for the location of thermal power plant and nuclear facilities in Croatia (regulation of the government of the Republic of Croatia),
- Explore, from economical and environmental point of view, possibilities and advisability of expanding the gas distribution network in Croatia (based on new projects of gasification: Adria LNG, gasification of Lila and Dalmatia and other.),
- Encourage and guide the usage of additional energy sources at the county and municipal level,
- Ensure adequate compensation to local communities on whose territory the facilities are being constructed,
- Present a possibility to participate in the development of energy-related activities for business entities with different ownership structure, and define the need for certain legal regulations which would regulate relations between energy sector participants,
- Apply the most relevant environmental protection criteria with respect to construction of energy and power transmission systems.

Physical Planning Programme of the Republic of Croatia

The Physical Planning Programme of the Republic of Croatia (PPP) represents the main implementing document regarding physical planning in Croatia (adopted by the Croatian Parliament on 7 of May 1999). Physical planning documents of lower level (county, city and municipal physical plans) are required to comply with the PPP, and the PPP should contain at least those projects (buildings) defined in the Energy Development Strategy, for which the Ministry for Environmental protection, Physical Planning and Construction issues a location or construction permit (under the regulation on determining projects for which the Ministry for Environmental protection, Physical Planning and Construction issues a location or construction permit), and others would be regulated in the county (or city and municipal) physical planning documents.

It can be said that the PPP has additionally limited possibilities of power plant construction in relation to the Physical Planning strategy and in relation to results of previous research. Unlike the Strategy, the PPP as implementing document ***puts an end to coal-based thermal power plants and nuclear power plants***. By excluding, already processed and mostly in detail examined, locations from the basic physical planning document they have been excluded from physical plans at county level as well, therefore, many of the suggested ***locations have already become or will become impossible to use for the designed purpose*** because other users have in the meantime occupied the land or will occupy area of some location.

Conditions for implementation of the Energy Strategy of the Republic of Croatia with respect to physical planning

Conditions for implementation of this Energy Strategy with respect to physical planning are these up-to-date activities:

1. ***Examination and improvement of documents regarding location selection for power plants, including examination and rating of previously suggested preferential locations and possible new locations. It is necessary to define locations for these types of power plants: imported coal-fired thermal power plant (it is necessary to determine a new location for the construction of a coal-fired thermal power plant on the Adriatic coast, regardless of when it is to be constructed), gas-fired thermal power plant with and without co production, nuclear power plant, Repository for Low-and Intermediate Level Radioactive Waste, LPG terminals,***

renewable resources of electricity-generating capacity higher than 20 MW, all other energy sources of thermal power greater than 50 MJ/s, new gas and oil pipelines corridors.

2. *Adjustment and application of the Physical Planning Programme of the Republic of Croatia in the field of energy-related activities according to the guidelines of the Energy Strategy and to the research results cited in 1.*
3. *Adjustment of all county documents regarding physical planning with the Physical Planning Programme of the Republic of Croatia.*

11.3. Central Government's role at Regional and Local Self-government level in Energy Sector

In order to achieve the vision of a sustainable energy supply the main ***role of the Government is to adopt, implement and monitor the energy policy***, as a part of overall economic policy, as well as to ***improve institutional and legal framework and ensure its implementation***. The Government should intervene in the market processes only when the participant are affected by transactions (the so-called external effects) With respect to energy system, the main external effects are in relation to security of supply, environmental quality and monopoly protection, in which case the role of the Government is necessary. The main instruments to be applied in the implementation of energy policy are energy sector regulation, measures promoting energy efficiency, customer protection, inclusion of the costs of external effects in the energy price, planning in the energy sector and, in connection with that, timely intervention in order to encourage investments (especially private) in the energy sector.

An important role of central government is to continuously increase levels of energy efficiency and promote projects which improve energy efficiency. Central government shall promote energy efficiency projects and by doing so, positively affect their wide presence in the entire economy. Sufficient incentives for the private sector to adopt more quickly the principles of energy efficiency will be ensured by government sector being more ready to invest in energy efficiency projects with the purpose to prove their financial profitability.

Central government enables greater energy efficiency based on a transparent public procurement system for the energy efficiency projects. The simplest way to achieve that is by drawing up elaborate examples of standard agreements for specific procurement types, making detailed instructions for savings estimates in different energy efficiency projects, providing measuring systems and regularly monitoring achieved savings. Central government actively promotes products (services) which are more energy efficient by improving the concept of costs estimates for equipment, devices and services in the field of energy efficiency. Adoption of a new concept of costs estimates takes into account overall costs of product life cycle, including lower costs of energy consumption. This means that the existing system is abandoned, according to which, a supplier offering the lowest costs should be selected, and it also means that it is possible to avoid a frequent situation where a purchase of more energy efficient product (service) is not competitive since the initial costs for their acquisition are greater than for products (services) which are less energy efficient. Application of the new concept requires detailed expert data on products, which will ensure their comparison.

Decentralization of energy policy separates roles and tasks of the central government, regional and local self-government. Regional and local self-government participate actively in energy related field in

legally defined cases (production and supply of thermal energy, public lighting, gas distribution, decision-making on location and construction of new energy-related facilities and other energy-related infrastructure). In the process, they encounter various problems, among which lack of institutional framework and adequate knowledge (of competent experts) should be singled out.

The previous Energy Strategy of the Republic of Croatia (from 2002) provided for **establishment of energy offices within bodies of local and regional self-government**, which has not been achieved. Implementation Programme of this Strategy will eliminate this oversight. The project of Systematic Energy Management in Towns (Ministry of the Economy, Labour and Entrepreneurship/ UNDP) has shown the necessity to set up offices for energy-related activities (a few of them were set up, although with limited task of managing energy use in the facilities owned by the local administration). Basic tasks of the offices for energy-related activities include efficient energy management, incentives to use renewable energy resources, coordination of interests and projects of regional and local self-government and energy-related facilities, energy planning and balancing, promotional and advisory activities. This kind of organization will strengthen local capacities so as to prepare, implement and monitor energy efficiency projects by improving human resources (raising awareness on importance of energy savings and environmental protection among decision-makers on local development), networking and connecting municipalities and towns, proactive approach to resolving energy-related problems with special emphasis on participation of all interested parties, as well as improving technical capacities for project implementation and monitoring (measurement of energy savings, on which the use of potential financial mechanisms and solutions to energy efficiency incentives could be based).

In order to systematically **improve energy efficiency**, regional and local self-government play an important role in establishing **Assets Register** for the assets they own, improving **asset management**, introducing modern information systems for assets maintenance and energy efficiency increase, in ensuring energy reviews in order to determine in which facilities, owned by local administration, and in which manner, it would be possible to achieve highest savings, and in developing measuring systems in order to ensure monitoring of implemented measures in the field of energy efficiency, as well as in developing networks of local units so as to exchange information on positive experiences in relation to energy efficiency projects.

Different initiative includes regional and local authorities in finding solutions to energy-related problems in the EU. The Intelligent Energy-Europe Programme encourages an establishment and activities of regional and local energy agencies. Special attention is given to the support to local authorities in all energy-related activities and planning, provision of technical assistance in starting and developing projects, informing and educating the public, promoting energy efficiency and concept of sustainability, establishing communication with European networks and intuitions and other. To that end, we will also encourage establishment of energy-related agencies as expert support to energy offices (which have administrative and organizational role). Their very important role will be to develop and support initiatives to participate in national and EU funds regarding energy as well as to develop entrepreneurship and inform about possible use of different financial mechanisms for the implementation of energy projects.

So as to ensure successful complementary activities of government, regional and local self-government in the energy field, administrative employees will be able to attend professional education, develop communication and marketing skills and project management skills.

11.4. Improving Energy-related Planning

Investment decisions in the energy sector have long-term consequences on competition, security of supply and environmental impact, so that planning is inherent to energy sector. In addition, market participants define planning as data processing with the aim of creating new understandings necessary to make investment decisions. For the Government, planning represents a basis for creating and improving energy policy with the aim of balanced and sustainable development. Planning in the energy sector, under the Energy Act, is the responsibility of the Croatian government which, based on the Energy strategy, recommends long-term basis of energy policy, and based on article 9 adopts long-term and annual energy balances.

The Energy Act obliges regional and local self-government to draft development documents in which they plan for needs and energy supply manner, but that obligation is only sporadically complied with. Main reason for that is absence of institutional framework and planning coordination at the government, regional and local level in order to determine relations and obligations in the planning processes.

Obstacles to planning at regional and local level should be eliminated; as a result, the dynamic of implementing this provision shall be determined in the Strategy Implementation Programmes. The task of the Ministry of the Economy, Labour and Entrepreneurship is to elaborate certain levels of methodological standards of planning, which will facilitate communication between units of local and regional self-government and the Ministry of the Economy, Labour and Entrepreneurship, and other participants in the energy planning (energy-related subjects, associations, population and others). Methodological standards are a good prerequisite for integration of energy sector planning into other strategies and development plans (physical plans, economic plans). Planning continuity contributes to the energy planning improvement, so that planning should be understood as successive process of periodical assessment, improvement and adjustment of the previous plan. Care about the continuity of the planning process, at the regional and local level, should be the responsibility of energy offices, which have enough human and technical resources to be central points of regional energy policy implementation.

The key problem regarding planning is energy statistics! Although the Ministry of the Economy, Labour and Entrepreneurship, in its annual report 'Energy in Croatia', presents in a systematic manner balance of the previous energy consumption at the state level, making these balances is painstaking since the issue of energy statistics is not adequately regulated. There is no common data base, cooperation between subjects – data sources when it comes to submitting data, and very often data is not available. At the regional and local level self-government, data on energy consumption and energy resources are not registered.

It is therefore necessary to establish a system of creating a unique data base for the energy sector!

This will ensure collection of all energy-related data in accordance with positive Acts and Directives of the European Commission, single data base management including quality assurance, their storage and availability definition. Single data base will be used to make energy balances, plan, develop strategy, and different analyses and reports, and distribute collected data in accordance with legal powers, as well as report to the European Commission and international and national institutions to which the Ministry of the Economy, Labour and Entrepreneurship and the government are obliged to report. Of great importance, in that respect, are the monitoring of implementation of energy efficiency programme and register of renewable energy resources projects, cogeneration and eligible energy producers. The

Strategy Implementation Programme will determine the dynamic of establishing single data base for the energy sector.

12. IMPACT OF ENERGY POLICY MEASURES

12.1. Environmental Impact

Energy sector has a significant environmental impact, regardless whether this is a local, regional or global impact. Emissions of polluting substances and greenhouse gases into atmosphere present a dominant impact in comparison with other strains to the environment (impact on water and soil, noise, strain on space, landscape, biological diversity). With the increase in efficiency in energy production and consumption, with the application of renewable sources of energy, application of contemporary technologies for the removal of polluting substances (SO₂, NO_x and particles), increased fuel quality, and progress in the use of by-products and waste, strains to the environment per unit of used energy become smaller.

Table 12-1 presents main impacts and instruments that regulate impact issues.

Table 12-1 Impact of energy industry on environment

Level	Impact	Instrument
Global	Climate change	Implementation of obligations from UN Framework Convention on Climate Change (UNFCCC), Kyoto Protocol and future obligations in the post-Kyoto period
Regional	Eutrophication Acidification Damages due to ground-level ozone	Implementation of obligations from Convention on Long-range Transboundary Air Pollution (CLRTAP) and accompanying protocols EU Directive on national ceiling for certain atmospheric pollutants (2001/81/EC) ESPO Convention
Local	Impact on quality of air, water and soil Noise Space occupation Impact on landscape Biological diversity	Regulations on requirements for quality of products and devices, ceilings of emissions, techniques for decreasing emissions and regulations on quality of environment Regulations on energy efficiency and renewable sources of energy Strategic environmental assessment/ environmental impact assessment Unified environment protection conditions ("environment permit") Physical planning documentation, Nature Protection Act and regulations for its implementation

Figures 12-1 and 12-2 present projections of SO₂ and NO_x emissions from the energy sector, as well as projections of overall emissions and their comparisons with internationally accepted ceilings.

With regard to SO₂ emissions, there will be a significant decrease in emission, mainly due to use of low-sulphur fuels and smaller overall consumption of liquid fuels in electricity production. NO_x emission shall grow due to increased volume of road transport, so that the application of catalysts and new rigid emission standards will not be sufficient to decrease the emission. According to new regulations, large energy facilities have to use highly effective de-sulphuring devices and devices for treating nitric oxides. Emission of SO₂ and NO_x shall be below obligations originating from the Protocol on prevention of acidification, eutrophication and ground-level ozone (Gothenburg Protocol of the LRTAP Convention).

Decrease in the use of liquid fuels in large beds shall decrease the burden caused by small floating particles in city agglomerations which currently have second category air quality (Zagreb, Sisak and Rijeka)²⁷.

Energy industry is also charged with fugitive emissions of non-methane volatile compounds (NMVOC), which appear in liquid fuels production, storing, transfusing, transporting and on petrol stations. Croatia has new regulations for this type of emissions and their application would decrease the emission of non-methane volatile compounds. When building and using hydropower plants and energy transport corridors, special attention should be paid to protecting biological diversity.

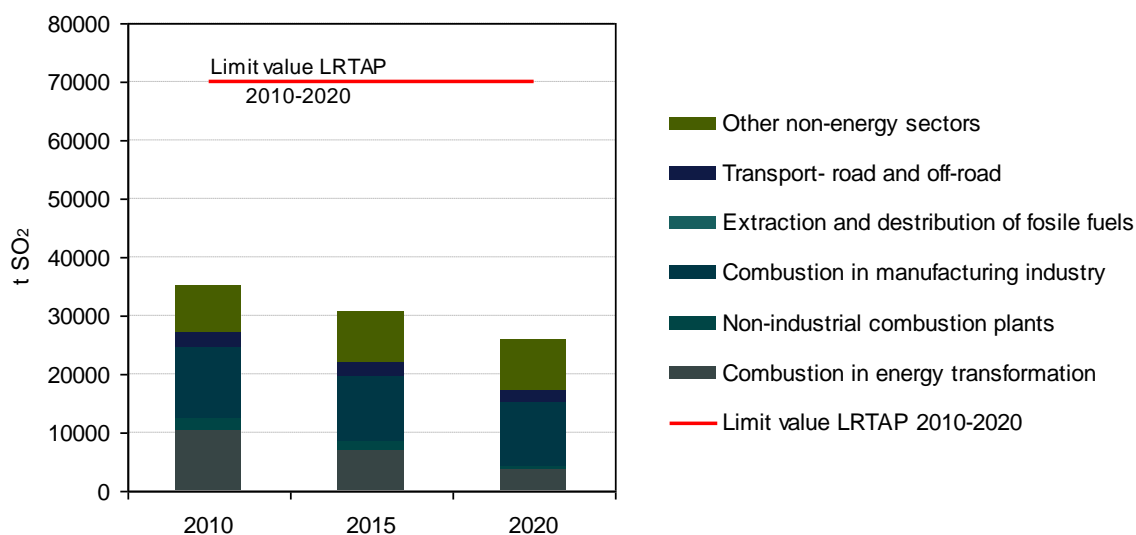


Figure 12-1 Projections of SO₂ emissions from the energy sector (White scenario)

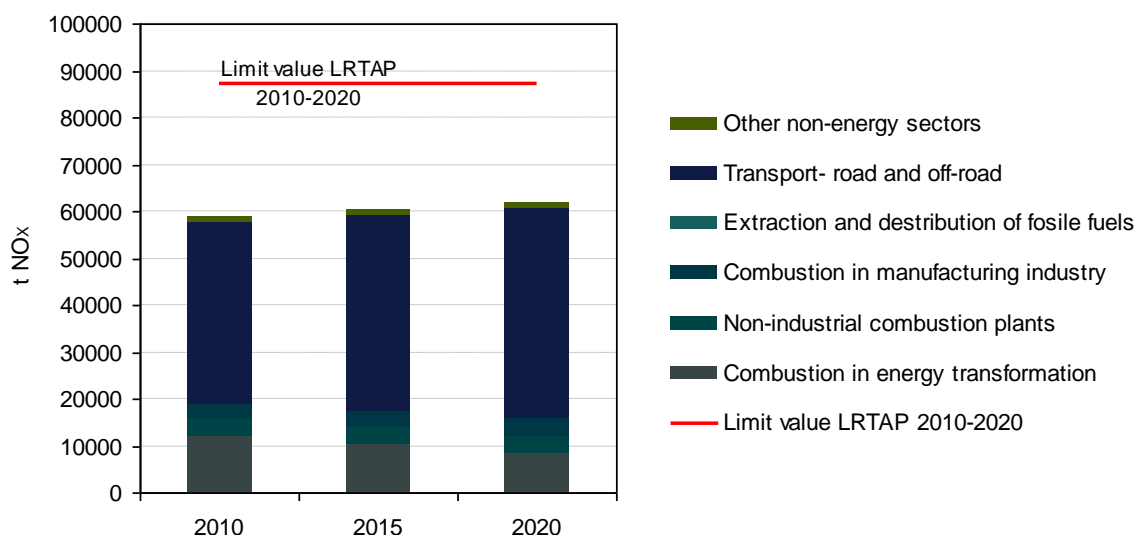


Figure 12-2 Projections of NO_x emissions from the energy sector (White scenario)

²⁷ Categorization per Plan for Protection and Air Quality Enhancement for 2008-2011 (OG 61/08)

12.2. Impact on Emissions of Carbon dioxide and Fulfilment of Obligations Related to Greenhouse Gas Emissions

On 27 April 2007, Croatia ratified Kyoto Protocol and thereby made a commitment to decrease the emission of greenhouse gases by 5% in the period 2008-2012 in comparison to level of emissions in the base year. Table 12-2 presents sources of emissions by sectors, showing that energy sector contributes to 75% of total emissions.

Table 12-2 Emissions and removal of greenhouse gases in Croatia, 1990-2006

Source	Emissions and removals of GHG (Gg CO ₂ -eq)									
	Base year	1990	1995	2000	2001	2002	2003	2004	2005	2006
Energy		22882	16400	18907	19953	21074	22580	22048	22411	22548
Industrial Processes		4609	2785	3400	3271	3148	3346	3659	3833	4004
Solvent and Other Product Use		80	80	69	75	99	108	135	155	182
Agriculture		4558	3191	3285	3485	3400	3348	3549	3560	3507
Waste		399	475	567	599	633	663	697	601	591
Total emission without removals	36027	32527	22930	26228	27383	28353	30045	30088	30561	30834
Removals (LULUCF)		-4185	-9154	-5281	-8214	-8206	-6276	-7900	-7726	-7490
Total emission		28342	13776	20947	19169	20148	23768	22189	22835	23344

Figures 12-3 and 12-4 show overall greenhouse gas emissions for three sustainable scenarios. Figure 12-3 points to the fact that according to all scenarios, greenhouse gas emissions in the period 2008-2012 would be 5% less than the emissions in the base year. Hence, all three scenarios meet the obligations from the Kyoto Protocol.

In the period beyond 2012, emissions would rise for all three scenarios, but at a slow pace. Increase in emissions in the period 2015-2020 is caused by the increase in the share of coal in electricity production, by entering into use in one thermal power plant in 2015 (blue and white scenario) and in the other one in 2019 (blue scenario). Beyond 2020, the use of CCS technology is envisaged in coal power plants, and for the existing ones, locations for underground storage of CO₂ should be provided for subsequent application of CCS technology.

Green and white scenarios in 2020 envisage lower emissions due to entering of a nuclear power plant into use. In 2020, emissions would drop to the level below the base year, so it would be approximately at the level of Kyoto target. These scenarios that use maximum measures point to the fact that it is not possible to achieve the goal of decrease by 25-45% in 2020, as it is being set in the negotiations at the global level for period beyond 2012 (post-Kyoto period).

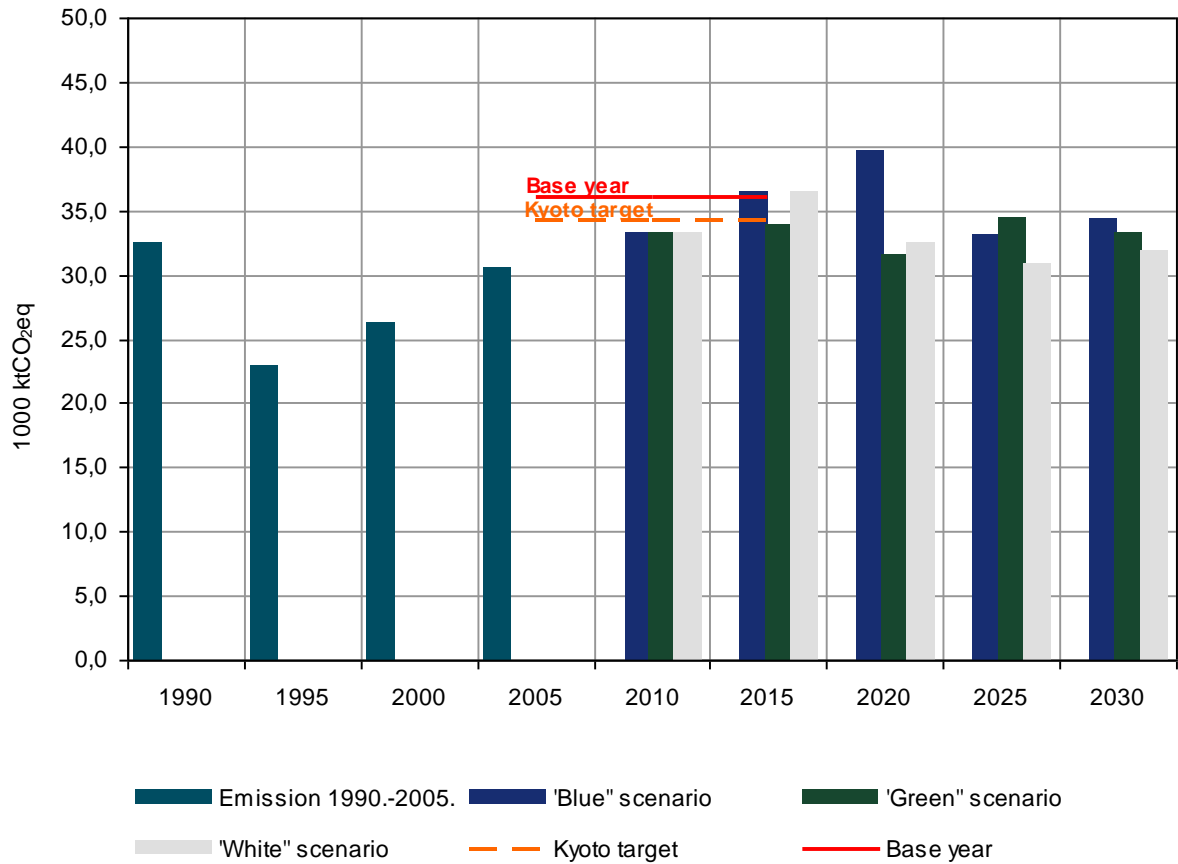


Figure 12-3 Total emission of greenhouse gases

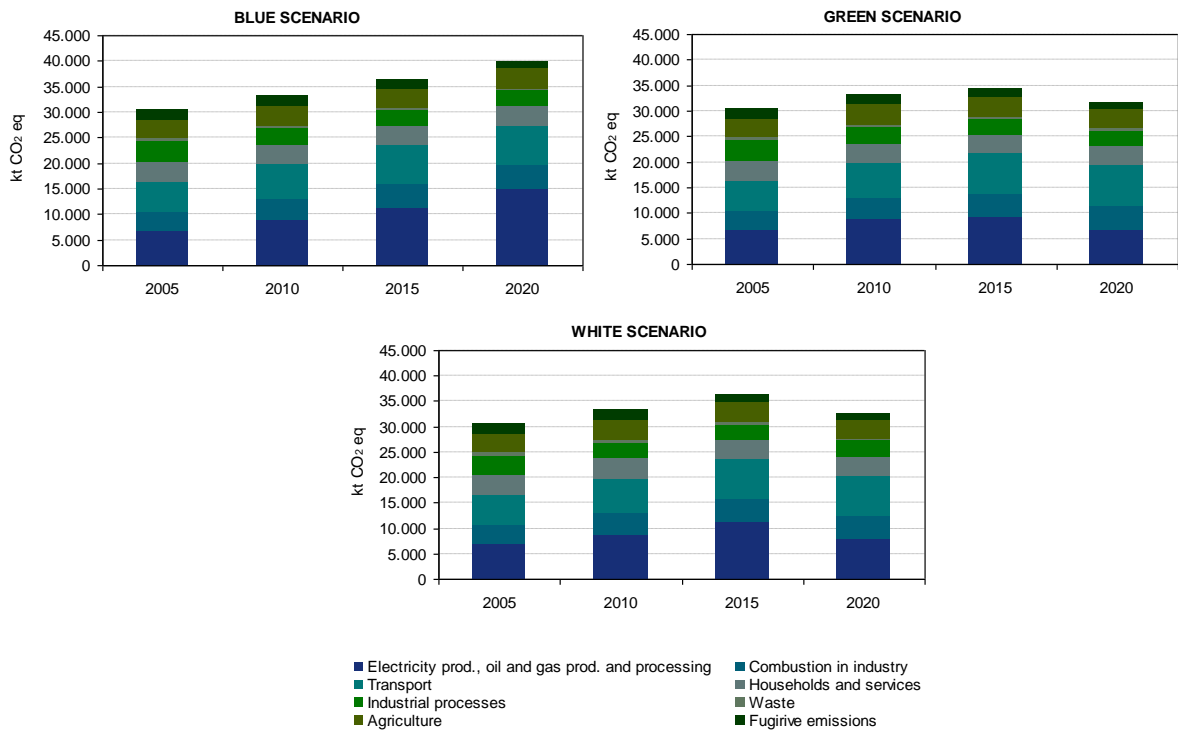


Figure 12-4 Total emission of greenhouse gases by sectors

It should be stressed that the above-mentioned is relevant under the precondition of the electricity import which would be gradually decreased, so that beyond 2015 it is at a minimum level. These figures do not envisage any electricity exports. In that case, emissions in the Green and White scenario, which meet preconditions for electricity exports, would in 2020 be higher for the exports made.

Total increase in emissions is mainly due to increase in the emissions in the so called ETS sector (figure 12-5). ETS sector comprises of public thermal power stations, refineries, all sources larger than 20 MW, cement industry and larger mineral products industry. If Croatia was in the EU, the increase in emissions in this sector would not be at the “care” of the state, instead, it would be the issue of the level of costs for emission allowance units (EAU).

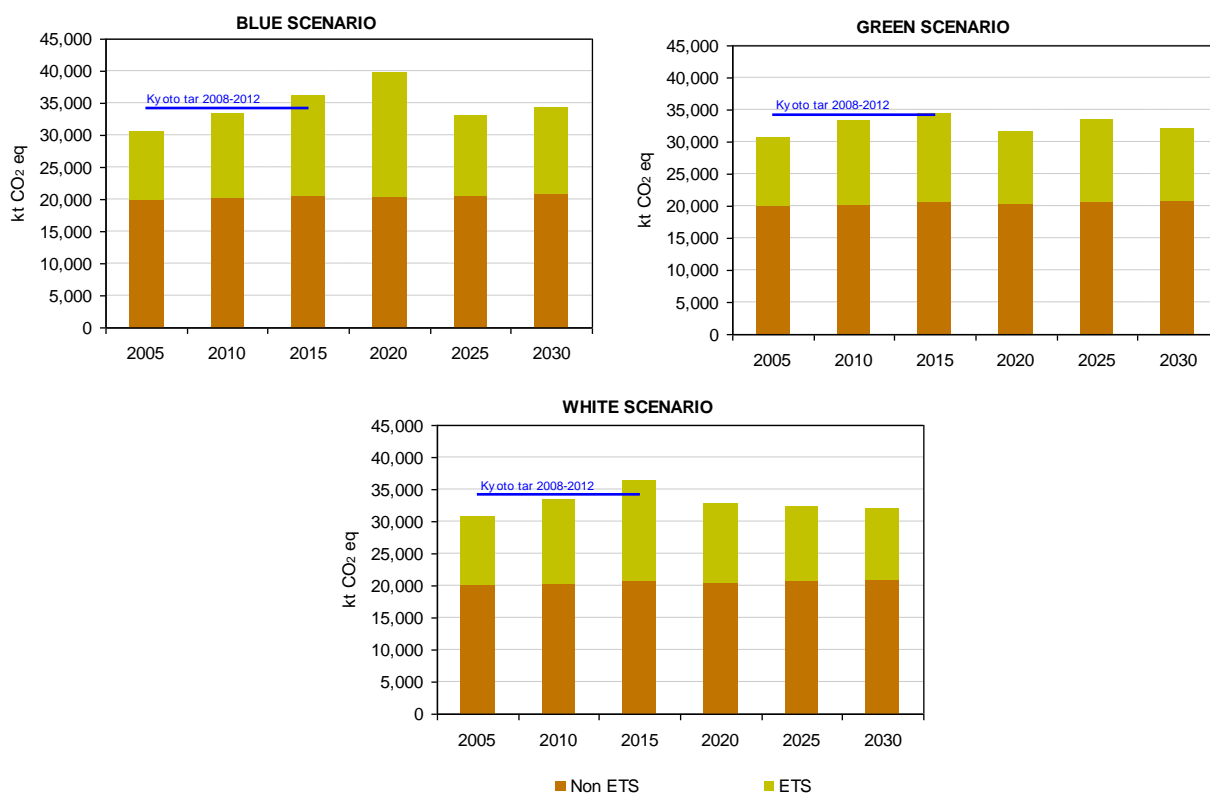


Figure 12-5 Total emission of greenhouse gases in ETS and non-ETS sector

The largest increase in the emissions is linked to the sector of power and thermal energy production (public power plants and public cogeneration plants). However, the specific emission of CO₂ per generated kWh of electricity and heat is decreased for Green and White scenario, so that in 2020 it could be significantly lower than current EU average. Under Blue scenario, the specific emission has a trend of mild growth, so that in 2020 and later it would be by some 10% higher than current EU average.

12.3. Impact on Security of Energy Supply

Security of energy supply is defined as a long-term availability of energy sources and ability for proper market functioning and as a desired level of competitiveness on the market (especially on the natural gas and electricity market).

At a liberalized market, market mechanisms create the security of supply. Decisions on the new electricity generation, natural gas or making imports are in the hands of private energy entities that act upon price signals and estimates of demand on the market. Opposite to the supply, distribution and transport systems and storing capacities present a natural monopoly and thus are regulated activities. Clear division of responsibilities between market entities and operators of systems of regulated activities is necessary for optimal maintenance of system's security. Particular responsibility rests on the operator of transmission and transport system, which, besides the care for strategic interests of system development in order to secure supply of local consumers, also is responsible for the use of country's regional position and for the development potentials of own transport system in the interest of national economy and for the fulfilment of international commitments.

12.4. Impact on Energy Market Development

Strategy points to further liberalization and development of energy market and to leaning on public sector cooperation with private, both local and foreign investors entering energy market under the same conditions. The market will continue to be strictly regulated, but the conditions for entering the market and doing business would be the same for everyone.

Competitive market only exists where there is a sufficient supply and a right number of competitors, in a situation where security of supply enables market functioning. In this case, prices of energy have to be determined on the market. Only such market structure in return secures sufficient security of energy supply as one of fundamental goals of this Strategy, as well as removal of a pressure to increase the price of energy, which secures that energy as an important input contributes to the competitiveness of Croatian economic entities at a global market.

Liberalization of gas and electricity market in Croatia as EU acceding country was necessary also in order to make easier adjustments to business conditions in a single market, which are something that local entities in the energy sector are also going to have to face in the future.

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 which reflects necessary costs, while at the same time protecting also the interests of activities in a manner that final tariffs enable efficient service providers to do business while making profits adequate to investment risks. These regulation goals presume adequate information on the regulated entities, so the development of information systems for property management is in the interest of both regulated entity and the regulator (which acts in the interest of public).

12.5. Impact on Energy Prices

Energy prices are the largest mystery that all world economies dependent on energy imports from just a few countries rich in their sources are facing. As an energy dependent economy, Croatia, like many of the European countries can alleviate the justified risk of further increase in the price of energy only by building an energy system which would be flexible enough to be less sensitive to increases in the price of oil (the main determinant of economic relations in the world's energy industry), in other words to be competitive both in case of moderate and high oil prices. This involves the increase in the security of supply of natural gas, electricity, oil and oil products, diversification of energy structure, increase in energy efficiency and removal of monopolies in the energy supply.

Energy Strategy proposes to build such energy system, so that strict implementation of Strategy and consistent application of principles on which it is based would contribute to restraining the impact on living standard and business operating costs that could be caused by further increase in the price of energy-generating products. However, on the other hand, the Strategy clearly requires gradual liberalization of prices which were up to now regulated in an administrative manner.

The impact of further, rapid liberalization of prices of energy-generating products shall mostly impact the increase in prices of outputs of all sectors: supply of electricity, gas and water, transport, storage and connections, hotels and restaurants, mining and extraction, and only then the producers in the processing industry.

In order to prevent unwanted social consequences, which are possible given the fact that the share of expenses for electricity, gas and other fuels in the structure of household consumption is about 8.4%, in the process of price liberalization in the area of energy, there will be a necessity to set a minimum standard that has to be available to all citizens and in alignment with it, there is a need for well directed state measures for providing subsidies to citizens which are “energy poor”. In relation to poverty in general and energy poverty, the following groups are particularly vulnerable: unemployed, senior citizens with no retirement or with low retirement income, persons with lower education, single parents, families with a lot children, citizens of rural areas. When designing price liberalization policy, these groups should be taken into special consideration within the frame of other national policies.

Such measures shall require careful preparations and setting up a database on citizens (a register), which is a precondition for effective social policy and which would enable that state support is only awarded to those citizens who really need it. This will contribute to decreasing the costs for implementing such measures and minimize ineffective waste of state funds. Introduction of unique tax number is an important step in creating preconditions for effective social policy.

Energy efficiency in Croatia is low. The consequence of existing lack of price pressure on energy efficiency due to protected prices of energy is a high energy consumption growth rate and related energy imports. Encouraging energy efficiency as an important integral part of Energy Strategy can only partly lead to significant savings in consumption of energy for households and economy and thus decrease the costs associated with energy consumption.

Securing balanced quality of supply and availability of energy forms in Croatia (natural gas and liquid petroleum gas) will have an additional influence on the decrease in share of costs associated with energy consumption in the total household and economic entities costs.

12.6. Impact on Economic Growth

Despite the increase in energy efficiency, Croatia’s economic growth shall require increased energy consumption. Increasing the supply of total energy is at the same time a precondition for economic growth, but also an additional contribution to the growth of economy.

Given Croatia’s geopolitical position and scarce primary energy, persistence is needed to stick to a concept of building a regional energy hub. Becoming an energy hub, with regard to scarce resources on one hand and securing the security of supply on the other hand, imposes the need to develop the energy sector towards diversifying energy-generating products, supply routes and more balanced regional distribution of energy facilities. However, the importance of energy sector in the forthcoming period in the region and in the EU, points to the facts that the position of a regional energy hub should

not only be looked from the aspect of energy-generating products supply, but also as Croatia's opportunity to enhance its international trade. The low level of competitiveness in the production of goods for international trade and specialization towards provision of services, provide an opportunity to strengthen and create the trade surplus through the export of services provided by such energy hub.

Since specialization of economy towards provision of services that lean on favourable geopolitical position is anticipated and there is a trend to less lean on industrial development, an accelerated development of the following sectors is expected: transport, civil engineering, business services, tourism and the growth of household sector consumption.

Development of transport is largely leaning on the supply of oil products which are hard to be replaced in the mid-term. Given limited oil production in Croatia and declining local reserves, envisaged storing capacities (Section 5) should be built, especially for oil products and contemporary refinery capacities in Croatia should be secured, which would decrease the risk from distortions at the global market. The risk associated with crude oil products supply is lower than the risk associated with oil products supply.

Business services are using better quality energy (electricity and gas) to greater extent. Indented territory of Croatia calls for more balanced distribution and strengthening the networks in relation to the environment. More even distribution of energy facilities in alignment with the concentration of consumption should be viewed in the context of regional development policy.

In further economic growth of Croatia, there is a significant room for the increase in energy efficiency, use of renewable sources of energy, distributed sources of energy and development of products and services in this area. The growth of private initiatives by numerous small and mid-size entrepreneurs, investors and consulting companies, transfer of foreign know-how and technologies and development of local production make this area especially important from the point of bringing dynamics into economic growth. In reference to projected consumption and supply of energy-generating products, in Croatia there is a need to stress both energy efficiency and the increase in supply in order to provide for better market functioning.

Given the dynamics of putting certain energy facilities out of use (especially in the electricity sector), increased growth of energy supply and insufficient investments into energy sector as a whole for a number of years due to unrealistically low prices of energy-generating products, it is obvious that Croatia, like many other countries in the world, is headed for an investment cycle in the energy sector. However, in order to strengthen incentives to investors, as well as to provide qualitative information to the market, especially to consumers on anticipated trends, a precondition for entering into a more significant investment cycle, much like a rational approach to energy efficiency issue, is to establish realistic, market-driven prices of energy-generating products for consumers. This is especially in reference to the price of electricity and natural gas, which are the backbone of Croatia's energy strategy, both in the sense of diversifying energy-generating products and using geo-strategic rent for the benefit of Croatia.

Existing knowledge and capacities of consulting, civil engineering, installation and partly production companies can be significantly advanced by involving them into the investment cycle, thus contributing to the increase in employment, growth of gross domestic product and strengthening their international competitiveness. Involving local producers is of special importance, given that the most of equipment needed to build investment facilities would be imported. Construction of energy facilities has a significant multiplication effect on overall economy of Croatia, particularly building sector that makes around 13% of total intermediary consumption and procurement of different types of equipment for the

energy facilities which makes about 17% of total intermediary consumption in the electricity, gas and water supply activity.

The growth of competitiveness of Croatia's processing industry is necessary for further enhancement of national competitiveness and international trade. Qualitative supply of energy-generating products, besides importance for activity of supplying electricity, gas and water, is of special importance for the following activities of processing industry in which energy, gas and water make a significant share in the intermediary consumption: mining and stone extraction, cellulose and paper production, production of other non-metal mineral products, extraction of crude materials that generate energy, production of metals and metal products, wood processing and production of chemicals and chemical products. In the case of afore-mentioned activities, costs of energy, gas and water supply make between 4.6 and 9.8% of total costs. These are the activities that present most of exporting activities by companies in Croatia.

Overall impacts of investments on energy sector will depend primarily on how energy facilities are financed, for these are large and complex investments. Due to level of Croatia's foreign debt, as well as increasing vulnerability due to negative shocks originating from the environment, when making each individual investment, preference should be given to funding that does not result in the growth of foreign debt and which contributes to sharing the risk between local and foreign investor or between public and private sector.

Each significant investment project, due to the complexity, long-lasting and the amount of investment should be prepared in a qualitative manner and necessary feasibility studies and analysis of social and economic, regional and environmental impacts should be conducted.