# 5. POLICY AND MEASURES

## 5.1. BACKGROUND - EXISTING POLICY AND MEASURES

The climate had become a global issue when Croatia was experiencing the most difficult years in its history, the brutal war, followed by the period of political isolation, and all this accompanied by the well known problems of the countries in transition. It is only understandable that under such circumstances the global environmental issues had relatively smaller importance while the politics was facing existential problems, increased unemployment, falling standard of living, reconstruction of the war-stricken areas, and establishment of a democratic and politically stable system. The last political changes of 2000 contributed to a significant improvement in the Croatian international position and resulted in memberships in WTO, Partnership for Peace, and the beginning of the EU accession negotiations.

However, generally speaking, the policy and measures that have been implemented and a number of *ad hoc* decisions resulted in very low greenhouse gases emission, which has been considerably lower than that in developed countries and countries in transition. Some decisions, such as abandoning of the coal-fired thermal power plant projects and orientation towards natural gas based development of the energy sector, have almost exclusively been guided by the climate change and environmental issues.

Below, the basic policy and the measures having direct or indirect effect on the climate issues are described.

### 5.1.1. GENERAL AND ECONOMIC POLICY

The basic orientation of the Croatian economic policy is its transformation towards the market economy, reconstruction of the territory destroyed in war, privatization, integration with the international economic trends, structural adjustment in specific economic sectors and tertiary industry, increase in production and employment.

The Government's 2000-2004 Program (February 2000) sets up *"growth and development of economy, particularly increase in production and export, and accelerated opening of new jobs"* as its priority.

As regards the environmental protection, the arrangements underlying sustainable economic development focus on harmonization of the Croatian legislation with the EU criteria, and enhancing of all sorts of mechanisms for nature conservation and environmental protection. The principles of partnership and equality of all the participants in the decision-making process will be fostered when it comes to the investments crucial for the economy and environment. The prospective is that the environmental protection measures will be paid from the charges for pollution. The objective is an increase in funds earmarked for the environmental protection, and setting up a separate fund primarily intended for granting of soft loans and encouraging the environmentally sound facilities, projects and plants within the shortest possible period of time.

Late in 2000, the Draft Economic Strategy for the Republic of Croatia was finished, which is currently under adaptation. Since this document determines the economic development orientation it is of particular importance for planning of policy and measures for the greenhouse gases emission reduction.

It should be noted that the analyses and scenarios from this National Communication are based on the macroeconomic projections from 1995. The development has been slower than planned, so the 1995 projections can be shifted a couple of years into the future. Once the above mentioned economic strategy is adopted, the sector strategies development will start. The reevaluated projections will be presented in the Second National Climate Change Report.

### 5.1.2. ENERGY POLICY

Energy and Industry Sector of the Ministry of Economy is in charge of the energy policy. According to the objectives of the Government of the Republic of Croatia, the basic strategic task in the energy sector is to ensure quality and reliable energy supply of consumers, and provisions for consumers to choose a higher quality and cheaper energy source. The only condition precedent to achieve this is a more intensive presence in the international energy market. The Government's Program objective is achieving higher energy efficiency, diversification of energy resources, encouraging the use of renewable energy, realistic (market-based) pricing of electricity and development of energy market and entrepreneurship, and the environmental protection.

Reorganization of the energy sector will be based on five recently promulgated laws: Energy Act, Electricity Market Act, Gas Market Act, Oil and Oil Derivatives Market Act and Act on Regulation of Energy Sector Activities (Official Gazette 68/2001).

#### Draft Energy Development Strategy

The basic long-term planning document is the Draft Energy Development Strategy (EIHP et al, 1998). Although this comprehensive document has not yet passed thought the discussion and adoption stages, it has been used in the previous years as the basis for all planning analyses, and in this National Communication. The Draft baselines have been incorporated in the Economic Development Strategy for the Republic of Croatia, which is expected to be adopted in 2002.

The Draft Energy Development Strategy considers two possible scenarios of the energy sector development. The ultimate options include the baseline ("business-as-usual") scenario with moderate initiatives of the state, and the strongly "environmental scenario" with high involvement of the state in encouraging achievement of the set up objectives. These scenarios are described in more detail in Section 6.

#### National Energy Action Programs

In 1997, the Croatian Government has brought a Decision on Initiation of the National Energy Action Plan within the PROHES (*Croatian Energy Sector Development and Organization*) Program. This project has been initiated in order to build the energy management system that would specifically promote cleaner technologies, gas introduction, energy efficiency, renewable energy resources and environmental protection.

Realization of these projects is based on the programs, each of which covers a specific energy management field. These programs are planned to underlie organized and systematic care of energy efficiency and exploitation of the renewable energy resources.

The National Energy Action Plans include:

- **Gas Introduction Program for the Republic of Croatia:** PLINCRO
- **Energy Efficiency Programs:**
  - $KUEN_{zgrada}$ - building energy efficiency

- MIEE - industrial energy efficiency networks
- KOGEN - cogeneration
- $KUEN_{cts}$ - district heating systems energy efficiency
- TRANSCRO - transport energy efficiency

- **Renewable Energy Resources Programs:**

  - BIOEN - energy from biomass and waste
  - SUNEN - use of solar energy
  - ENWIND - use of wind energy
  - GEOEN - use of geothermal energy
  - MAHE - small hydro projects

Energy-related issues of the Croatian islands shall be resolved through a separate islands energy program - CROTOK.

The objectives and strategy for implementation of the renewable energy resources programs depends on specific characteristics of each renewable resource and the program of its use, and their common characteristic is considerable increase in share of renewable resources by the year 2030, which corresponds with the general trends in EU countries.

**PLINCRO** program has been initiated in order to increase gas share in the energy consumption, provide for expansion of the gas network in the areas where it has already existed, and for its introduction into the uncovered areas. In addition to the development of the new gas supply import routes, construction of the gas transmission mains and distribution networks would enable more pro-active participation of Croatia in the European and world gas network and consequently make use of the advantages offered by the global trade system.

The primary objective of the introduction of the building energy-efficiency program **$KUEN_{zgrada}$** is reduction of energy demand through design, construction and use of new buildings and housing estates, and through retrofitting of the existing buildings, providing for favorable microclimate parameters for the premises in the building, and reduction of the environmental impacts.

The energy-efficiency improvement strategy for consumers in industrial, services and public sector is encouraged by setting up of an organized structure within the **MIEE** program. As regards energy efficiency, the primary interest of industrial sector, and the strategic objectives of the community are reduction of operating costs, avoiding of high investment into the energy sector and lesser dependence on energy supply, optimization of technological processes and environmental impacts mitigation.

The primary objective of the **KOGEN** program is to encourage construction and exploitation of cogeneration plants in all the facilities that have realistic process and economic prerequisites for implementation of the program. The program is primarily based on establishing of a favorable legal, financial, technical/technological framework for construction of the cogeneration facilities.

As regards **KUEN**$_{cts}$ program for district heating systems, it is imperative to encourage development and advancement of the district heating systems and improve efficiency of the existing systems in the Croatian cities an towns, particularly there where the heat consumption density or concurrent demand for heat and power are high.

The **TRANCRO** program is aimed at permanent care for energy efficiency and environmental protection in transportation sector. The program encompasses long-term forecast of energy consumption increase in the transportation sector in the Republic of Croatia and determination of its environmental impact, along with the model analysis of economically viable measures that could result in energy efficient and environmentally sound development of the transportation system.

The **BIOEN** program is focused on energy generation from biomass and waste and it indicates that such production could cover minimum 15 percent of total primary energy demand by the year 2020. The objective is to be realized by initiation of the demonstration projects, creation of market and conditions for increased use of biomass energy, by attracting industry and businesses, education, and stimulation of research and international collaboration.

The **SUNEN** program has shown that combination of solar energy and LPG and/or natural gas is technically and environmentally acceptable concept for the Croatian Adriatic coast. Also, hybrids including solar energy, wind energy and LPG could contribute to both setting up of the energy infrastructure on the islands and initiation of development of the traditional island activities through harnessing of local resources in compliance with the strategic baselines for development of the Croatian islands.

The **ENWIND** program will ensure a number of conditions necessary for cost-efficient harnessing of wind in power generation, by using the wind turbines of new generation. The wind energy, an environmentally sound and accessible local resource, is a completely undeveloped energy resource that might contribute to satisfying the energy demand in Croatia..

Exploitation of geothermal energy demands that certain conditions for its increased use in the existing facilities be fulfilled. An organized approach, such as envisaged by the **GEOEN** program, asks for adequate and comprehensive marketing campaign that would attract interest of private businesses and local community in the use of geothermal energy and result in increased energy efficiency of the overall energy sector.

The basic objective of the **MAHE** program is construction of small hydro power plants and removal of any hurdles to the program implementation, along with providing all necessary for increased construction of such facilities in the Republic of Croatia. These power plants are planned as IPP projects, so it is necessary to ensure transparent and simple legislation for the private investors, particularly when it comes to their design and construction, and to provide soft loans for such investments.

**Power Generation Sector Policy**

Hrvatska Elektroprivreda - HEP (the Croatian Power Company) is a public limited company for power generation, transmission and distribution. It covers about 90 percent of power demand from its own generation and from import.

HEP's development policy has had the best positive effect on reduction of greenhouse gases emission in Croatia during the past period. The HEP's development policy has traditionally been oriented towards electricity generation in hydroelectric power plants and use of natural gas in cogeneration facilities. Presently, the cogeneration share in Croatia is 15 percent, and further development of new capacities in the cities is based on gas-fired cogeneration plants. This is the reason why specific emission from the power generation sector is about 250-380 kg $CO_2$/kWh of supplied power, and HEP's contribution to the total emission in Croatia is 12 to 18 percent, which is significantly lower than the usual contribution of power industry in other countries. It is interesting that the power generation sector emission is lower than that of the agricultural sector.

HEP's development planning by employing the method of strategic environmental impact studies has been used for a number of years. Full attention is paid to any commitments under the Convention and Kyoto Protocol. Concurrently with development of this National Communication, HEP has been working on a comprehensive study that analyzes possibilities for reduction of greenhouse gas emission. The teams, information and know-how engaged in the HEP's study have been used in this Communication (EKONERG, 2001).

An important concrete step was made by Hrvatska Elektroprivreda already in 1994, when the conditions have been provided for the power purchase from small independent power producers, IPPs (power plant capacity less than 5 MW). Electricity from the small hydroelectric power plants and cogeneration plants is purchased at 70 percent and from the wind power plants is at 90 percent of the average power system price. The power purchase and correction to grid of these power plants is based on the Power Purchase Agreements. The guidelines are available for potential small IPPs and partners interested in small hydroelectric power plants, cogeneration plants and wind plants projects. Hrvatska Elektroprivreda is currently preparing to introduce the demand-side management (DSM) system by setting up a network of Energy Service Companies (ESCO), along with the Renewable Resources Project to be financed by the GEF and the World Bank.

The power sector structural adjustment will be conducted so that all EU market development processes are taken into consideration and the Croatian processes harmonized with them, and that all the requirements ensuing from political, economic and energy-related objectives of the Republic of Croatia are met.

The first step in HEP's structural adjustment is unbundling of its core business (power generation, transmission and distribution) from the non-core activities (heat and gas distribution, various supporting services). The core business will be organized within the HEP Group (private and state ownership), and it will provide for reliable and stable functioning of the power system. The non-core activities shall be carried out through newly incorporated companies, fully or partly owned by HEP. Organization of the market and partial privatization of the HEP Group (in power generation segment) would further enable opening of the market for the demand-side, in compliance with the EU standards, and more intensive participation on the energy markets in the region.

### 5.1.3. ENVIRONMENTAL POLICY

The Ministry of Environmental Protection and Physical Planning is in charge of the environmental policy with the exception of the water resources issues that are the authority of the State Water Directorate. The environmental legislation includes laws, decrees and rules. The laws proposed by the Government and the Ministry are passed by the Croatian Parliament and subject to prior discussion at the Committee for Environmental Protection and Physical Planning of the Croatian Parliament. The Government brings the decrees on technical standards, and the Ministry brings the rules.

Within the Ministry, the climate issues come under the responsibility of Climate and Ozone Layer Protection Section within the Atmosphere Protection Department.

The *Environmental Act* elaborates general environmental issues and it is an umbrella document for a number of other sector bylaws. The Act stipulates development of strategy and regular reporting on the environmental protection performance. The First Environmental Status Report was prepared in 1998. Currently, the *Environmental Strategy with the National Environmental Action Plan (NEAP)* is under adoption. The analyses and goals from this National Communication have also been incorporated in the Environmental Strategy and in NEAP.

As far as air is concerned, the most important legislation includes the Low on Air Protection, Decree on air pollutants emission limits for Stationary Sources, Decree on Substances that Deplete the Ozone Layer, Waste Management Act, Rules on Waste Management Requirements, Rules on Environmental Impact Assessment, Law on Air Protection., The Decree on emission stipulates limit values for emission pursuant to the BAT technologies from the Protocol on Long-Range Transboundary Air Pollution (UNECE) and the measures, ranging from primary to secondary, depending on the type and capacity of a facility. For small furnaces, maximum heat losses are stipulated, and all furnaces must measure emission, that provides indirect determination of their energy efficiency. The same Decree recommends recovery of heat from thermal waste treatment facilities.

An important instrument for implementation of the environmental policy in Croatia is the mandatory Environmental Impact Assessment for different projects. The regulation that governs development of the Environmental Impact Study reflects the USA regulations. It has been in effect since 1986, when only a few countries in Europe had such a regulation. The impact assessment procedure applies to all industrial facilities, power generation facilities over 50 MW, power plants with unconventional energy sources, hydroelectric power plants, landfills and thermal waste treatment facilities. The assessment procedure includes public consultations, while the decision on project acceptability is brought on the basis of the conclusions of an independent expert committee appointed by the Government based on the proposal of the Ministry of Environmental Protection and Physical Planning. The large projects, such as thermal power plants or industrial facilities are commonly considered for $CO_2$ emissions, having in mind the present and potential international commitments. The last version of the Rules from 1999 explicitly demands a cost-benefit analysis and consideration of the environmental issues in the line with the Croatian international commitments.

The state of the environment in Croatia is rather favourable, and the major problems are those related to the waste disposal, water and sea pollution, and air quality in the vicinity of some industrial sources[1]. A comprehensive overview of the environmental policy implementation is given in the *Environmental Performance Review* prepared by the UNECE experts (UNECE, 2000).

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[1] A significant portion of the Croatian economic revenue is earned in tourism and agriculture, which partly affects general public awareness of environmental issues for economic reasons. Further, natural, geographic and clearly environmental diversity is recognized as a national capital, thus a synonymous cluster used for Croatia - "Our Beautiful". Such a genuine attitude could be considered as one of the reasons that industrialization in the period of communism did not rendermajor environmental pollution issues in Croatia.

The environmental protection priorities are currently under discussion within the process of the NEAP adoption (www.mzopu.hr). Here some infrastructure investments could be highlighted, e.g. rehabilitation of refineries aimed for fuel quality improvement, construction of municipal wastewater treatment plants in inland and coastal region, implementation of the BAT technologies for emission abatement, enhancement of domestic industry participation in energy efficiency equipment production, use of renewable resources and cleaner production.

### 5.1.4. FOREST MANAGEMENT POLICY

The forests cover 36.4 percent of Croatia and have significant environmental, social and economic value. The Ministry of Agriculture and Forestry is in charge of the forest management policy which is impemented by the public company Hrvatske Šume (*Croatian Forests*) pursuant to the Forests Act and appurtenant bylaws. The Forest Management Scheme is brought every ten years to determine forest management implementation orientation. The basic principle is the *sustainable management* that ensures continuous reforestation and permanent increase in timber-growing stock and conservation of the biodiversity. The forest management policy baselines are described in Section 3.

### 5.1.5. SOME ENVIRONMENTALLY FAVORABLE DECISIONS

Here, should be highlight some important individual decisions that directly affected greenhouse gases emission, such as, phasing out of some major energy consumers e.g. Bakar Coke Mill, ferrous alloys factory in Šibenik, blast furnaces in Sisak Steel Mill, orientation towards maximum use of the hydro potentials, large share of cogeneration plants in power generation, orientation to energy non-intensive industries, natural gas network expansion (27 percent of households is supplied with gas), shutting down of the only domestic coal mine for environmental reasons, suspension of construction of new coal-fired thermal power plant, sustainable forest management, construction of a PWR nuclear power plant of western type. Burning of coal in new heating plants has been banned in the City of Zagreb for over fifteen years and this policy, aimed at air pollution control, has also been enforced in some other cities and towns by individual decisions or within the Environmental Impact Studies (coal share is less than 1 percent of consumption in household and services sector).

### 5.1.6. AVAILABLE TECHNOLOGIES AND TRADITION OF ENERGY SECTOR PLANNING

Croatia has relatively good technical conditions for introduction of "climate-friendly" technologies. In addition to the available human resources and large capacities within the renown mechanical and energy engineering companies, there are a number of small businesses that could convert their production programs and adopt new technologies.

Development of solar technologies in Croatia started twenty years ago, so fifteen years ago Croatia had about 40,000 $m^2$ of solar collectors. Complete technology for the hydroelectric power plants is available from the Croatian internationally recognized manufacturer of this equipment. Croatia has its own technology for gas and oil exploration, it conducts research in this field in other countries, and uses technologies for $CO_2$ capture from natural gas. The period of war and economic recession during the last ten years has caused decrease of solar collectors manufacturing capacities and, and threatened manufacture of equipment for hydroelectric power plants because of market lose. Metal industry and boiler manufacturers are able to re-oriented to production of equipment for using renewable resources. There is significant experience with design and building of “solar houses” with passive and active systems.

Energy planing tools in Croatia have been developing for several decades. Models national energy planning, urban energy supply and power sector has been developed based on principle of strategic environmental impact studies. These models have been used for national planning, and some of them have been used as an integral methodology in other republics of the former Yugoslavia. Already over twenty years ago, the Croatian Ministry of Science developed the national energy conservation programs. Emission monitoring and energy performance in combustion plants over 1 MW was conducted in some cities on regular basis already twenty years ago. The Ministry of Economy encouraged energy efficiency in public institutions through specialized non-governmental organizations.

## 5.2. PLANNED CLIMATE CHANGE MITIGATION POLICY

### 5.2.1. BACKGROUND AND OBJECTIVES

**Croatia has so far been meeting its commitments under the Convention since its greenhouse gases emission is below the 1990 level**.

The basic long-term Croatian objective regarding the climate issue set up within the framework of this National Communication is:

***Climate change mitigation pursuant to the general principles of the Convention and assumed commitments, along the course that enables sustainable economic development of the country***

When speaking about mitigation it relates to the measures for reducing GHG emission by sources and increasing removals by sinks, and the measures for adaptation to the climate changes because of their possible detrimental impact on the human health, ecosystems, material and cultural goods and economy. The general principles from the above objective are orignated from the Article 3 of the Convention, and they are commented in Sections 3-11.

The objective is set up as a long-term objective that cannot be fulfilled in a couple of years. Therefore the socio-economic effects of the commitments might on a short run exceed the long-term benefits.

At the moment, Croatia has no quantitatively defined objective for the greenhouse gases emission reduction. During the preparation of this National Communication the possibilities and consequences of fulfilling the commitments under the Convention and Kyoto Protocol have been analyzed for the first time. Therefore, the actions presented here below are the first framework of the climate change mitigation action plan or rather a background for preparation of such a plan. For that reason part of the text was written in form or instructions rather than as description of the current status.

The Kyoto protocol defines the emission reduction of 5 percent in relation to base year for Croatia. In the light of general principles of Convention (Article 3 of Convention), established Kyoto target is not justifiable in the case of Croatia. Unfortunately, during the Kyoto negotiations Croatia didn't have available data on emissions and GHG reduction potentials, consequently not being in position to negotiate on targets appropriate to its circumstances and capabilities.

### 5.2.2. NATIONAL CLIMATE CHANGE MITIGATION ACTION PLAN

The National Action Plan will set up a framework for systematic addressing of climate change issue, pursuant to the defined objectives. The Plan will be an institutional and organizational framework for partnership of all the stakeholders, governmental institutions, public institutions, local authorities and services, scientific community, private businesses, non-governmental organizations and the general population, which will contribute to the climate change mitigation. The climate issue needs to be resolved on a global level and through the international collaboration, it is specifically inter-sectorial in nature, and one that asks for a framework that will stimulate synergetic effects of all the participants.

The Croatian National Climate Action Plan will consists of two parts: (a) Capacity Building Program and (a) Implementation Program.

#### (a) Capacity Building Program (KLIMAkap)

This Program will establish institutional, legal, organizational and scientific capacities, enhance human resources and arise general public awareness on the issues related to the climate change mitigation. This program needs to be dynamic and maximally tailored to the requirements of the Implementation Program by creation of different legal, incentive and economic tools. The objective is building of a system that will be permanently sustainable and self-supporting, in addition to its being economically effective.

The main features of the Capacity Building Program include:

**Emission inventory**

- building the national emission inventory system, including register of sources and technologies
- improvement of methods and procedures for enhancing quality of emission inventory

**Support to building, maintenance and evaluation of policy and measures**

- designing and building a system for collecting information necessary for planning of the policy and measures
- setting up the systems for projects/programs planning, reporting, monitoring and evaluation
- development and implementation of methods for emission abatement analyses, emission projections and scenarios development,
- development of strategies, programs and plans on different levels
- drafting of legislation, and economic and other incentives
- assessment of capacity building needs (technology, experience and knowledge)
- removal of barriers to efficient program implementation
- studies supporting project preparation
- building of project financing mechanisms and their monitoring
- collaboration with similar programs on the national and local levels
- development and promoting of approaches, methods and knowledge for sustainable development planning
- building of incentive and other measures for implementation of demonstration and pilot projects and programs
- development of and support to the demonstration and pilot projects and programs
- setting up the system for implementation of the mechanisms for joint implementation (JI), clean development mechanism (CDM) and emission trading (ET)
- international collaboration on climate issues
- networking of institutions and programs

**Support for impact and adaptation analysis**

- development and implementation of methods for assessment of impact, sensitivity and vulnerability to climate change
- development of methods and measures for adaptation to climate changes

**Observation, systematic monitoring and research**

- joining the Global Climate Observing System (GCOS)
- research on climate change, new technologies and solutions

**Education and public awareness arising**

- access to information
- education and public awareness arising
- other activities supporting the setting up of the system for implementation of policy and measures and reporting pursuant to the Convention.

### (b) Implementation Program (KLIMApro)

The Implementation Program (KLIMApro) will encompass preparation and implementation of projects, and all necessary implementation support such as regulations, manuals, facilitative services, incentives, and supervision and control of the project implementation. The Implementation Program should simplify preparation, organization of the project implementation and accelerate transfer of activities from the state and public institutions onto the private sector, businesses and civil sector.

The Program will encompass the following measures:

- use of renewable energy resources
- energy efficiency measures
- technical and other measures in the transportation sector
- fuel conversion into low-carbon energy forms
- increase removals by sink
- measures for emission reduction and sink increase in agriculture
- measures for waste management emission reduction
- measures in industry and cleaner production
- international projects based on joint implementation (JI) and clean development mechanisms (CDM) pursuant to Kyoto provisions
- integrated sustainable development projects
- other projects contributing to the climate change mitigation

Some of the KLIMApro activities overlap with the KLIMAkap program since it was not possible and there is no need to define strict boundaries. Preparation of the demonstration projects, regulations, manuals, public promotional campaigns are those areas where the boundaries need to be flexible. The KLIMApro program uses these activities directly for implementation, while all other activities on the level of the overall system or interaction with other sectors need to be incorporated in the KLIMAkap program.

#### 5.2.2.1. Institutional Framework

The planned Program organizational chart is given in Figure 5-1.

- Ministry of Environmental Protection and Physical Planning is responsible for the overall program implementation. The Ministry creates strategy, coordinates and supervises the program implementation, provides administrative and technical support. Operatively, the Program is the responsibility of the Ozone Layer Protection Section, Atmosphere Protection Department. After the Environmental Protection Agency has been established, some of operational and technical activities will be taken over by the Agency.

- National Climate Change Commission is an advisory body for supervision and evaluation of the program implementation results, assessment and decision-making on crucial strategic issues and support to exchange of information, cross-connecting of institutions and stakeholders. The Commission has 17 members, representatives of the Ministry, Croatian Power Board, INA Oil Industry, Croatian Chamber of Economy, academy of sciences, State Hydrometeorological Bureau and two representatives of the NGOs. The National Committee chairman is the representative of the Ministry of Environmental Protection and Physical Planning (minimum Assistant Minister).

- The Ministry maintains the Program Website on its web domain.

- The Executive Coordinating Committee is the body running the Program implementation, consisting of the leading experts in the field and a representative of the Ministry of Environmental Protection and Physical Planning, Ministry of Economy, Ministry of Transportation, Marine Affairs and Communications, Ministry of Agriculture and Forestry and Ministry of Finances each. The Executive Coordinating Committee is accountable to the Ministry of Environmental Protection and Physical Planning and through it to the National Climate Change Commission.

- Scientific and Technical Advising Committee for the Program assists in resolving technical and methodological issues related to the Program. Upon request of the Ministry of Environmental Protection and Physical Planning, the National Climate Change Commission or the Executive

Coordinating Committee, the Council renders its opinions on individual issues arising during the project preparation, implementation and control. The Council gathers prominent experts, some of which may be members of other Program bodies.

- Task Groups consist of representatives of stakeholders in individual sectors. The coordinators and members of these Task Groups under the KLIMAkap Program are appointed by the Ministry of Environmental Protection and Physical Planning in agreement with the Executive Committee. The coordinators and members of the KLIMApro Program are appointed by a ministry in charge of coordination with the Ministry of Environmental Protection and Physical Planning. The Ministry of Economy is in charge of energy efficiency, renewable energy sources and industry, the Ministry of Transportation, Maritime Affairs and Communications is in charge of transport, agriculture and forestry fall under the Ministry of Agriculture and Forestry, while waste management and joint projects come within the competence of the Ministry of Environmental Protection and Physical Planning. Coordinators of specific Task Groups are also members of the Program Task Groups.

- Projects and subprograms are individual terms of reference of defined duration, the scopes of which cover the climate change issues. They may be within the authority of individual ministries, public companies, local administrations, science, private companies, NGOs and others. The Project managers or their representatives are the members of the Task Groups. **Each project or program financed, or formally supported by the state, public companies, local self-government and international grants and loans is considered a part of the climate program and should be collaborative as stipulated by the Operational Instructions.**

- Links to other programs and projects are made on all hierarchical levels of the program, which means on the levels of projects, Task Groups or Executive Committee or the National Climate Change Commission. So, the national energy programs, scientific programs and educational programs will have their representatives in corresponding bodies of the KLIMA.

The structure set up in this way enables maximum exploitation of the human and technical resources, it networks the existing institutions with minimum demand for full-time staff in state institutions, and therefore makes it adaptable to the necessary changes.

Furthermore, the structure provides for short paths for transfer of know-how and activities from the public into the private sector and on the civil sector, which is an imperative if any program wants to achieve efficient implementation and partnership.

The structure of the planned program is easily tailored to changes, and therefore sustainable since it connects and integrates synergistically the capacities of different sectors and actors. Once the_Environmental Protection Agency (NEAP priority) is established, some sectors that express their need for permanent human resources and carry out the routine jobs will be transferred into the Agency. The_Agency shall also take over the operational coordination of the Program. Since the complete activity is interdisciplinary and involves numerous actors, most of the tasks will be rendered by different institutions, experts and representatives outside the state administration bodies.

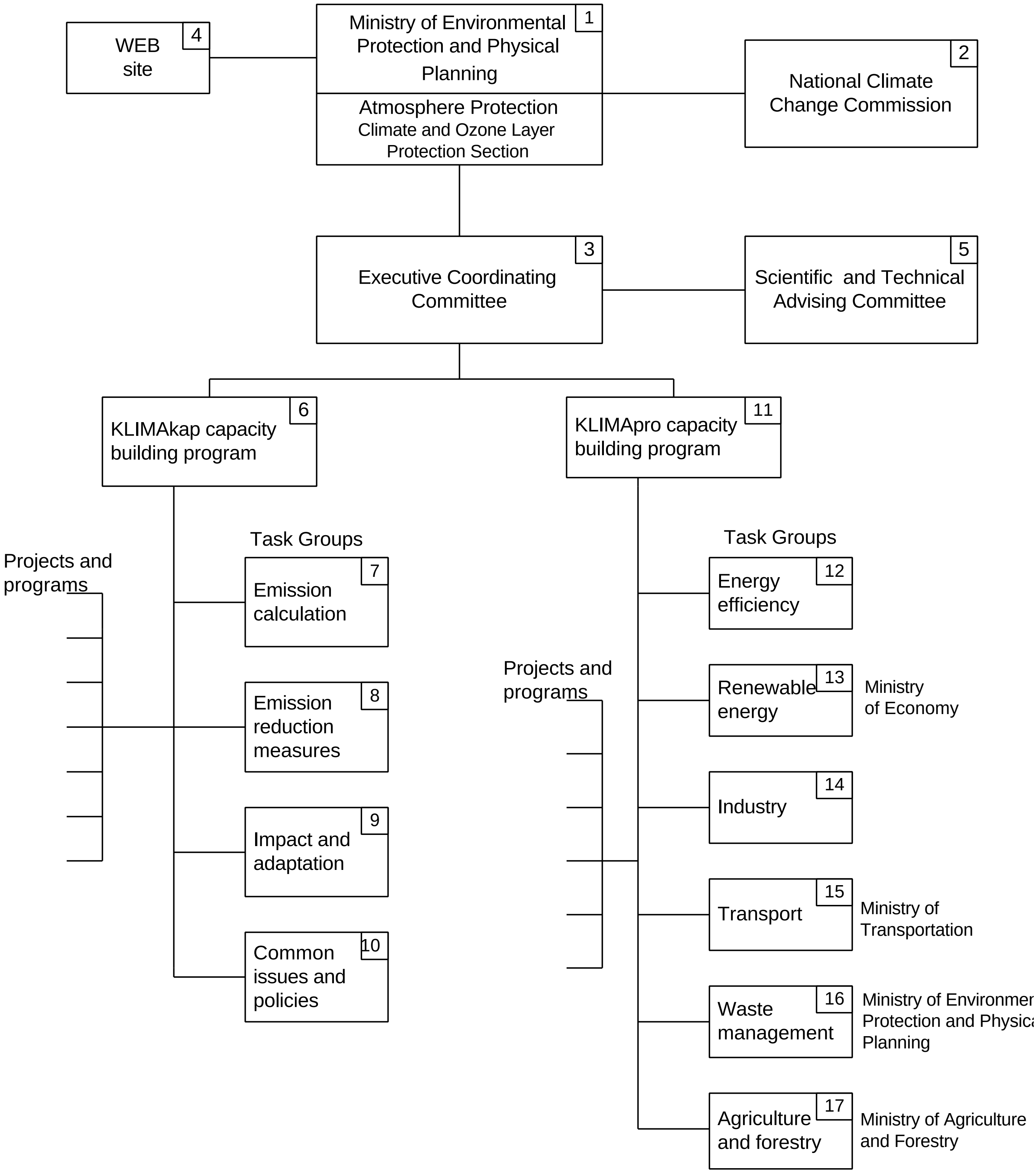


*Figure 5-1: Proposal of KLIMA – National Climate Change Mitigation Program*

Such Program structure is tailored to different funding sources and implementation actors. The Capacity Building Programs are mostly financed from the national funds, grants and international funds, or through technical assistance. Only a minor part of the KLIMApro projects would be financed from national and international funds, the major part funded from the so-called incentive and commercial loans. The major KLIMAkap implementation actors will be the administrative bodies supported by the scientific and technical institutions, while the KLIMApro is carried out by design engineering companies, businesses and NGOs. On some projects, where the capacity building components emerge on the level of the project, they need to be coordinated with the overall climate program, and those parts that are within the general capacity building should be connected with the KLIMAkap.

It should be noted that the proposed institutional and organizational framework is modern and original to a certain degree. It corresponds with the new strategic objectives and criteria for building of national capacities within the Convention and GEF capacity building funding mechanisms that are in preparation (*UNDP/GEF Building Capacities Assessment Report*). In this form, the Program has a number of desirable characteristics that need to be underscored once again - flexibility to changes, institutional networking, outsourcing, leaving initiative to the sectors in their domain, vertical and horizontal integration of activities, building on existing resources, openness to different financing modes, stimulation of synergy of all the involved actors. **The Program does not establish formal links among the actors. It engages the actors on resolving the climate issues, which is the basic condition for its successful implementation.** This is a framework oriented towards those who should implement it self-sufficiently to their best capacities, while strategically guided and assisted by the state administration.

The Fig. 5-1 is chart of activities/actors, which is already mostly functional, and the tasks are being successfully carried out. Boxes 2, 4, 7, 8, 9 and 10 are operational, and they have been developed within this National Communication. Boxes 12, 13 and 15 need to be established by grouping from the already existing energy programs. Boxes 3, 5, 6, 11, 14, 16 and 18 need to be set up since they still do not exist.

#### 5.2.2.2. Program Implementation Risk Areas

The Program implementation risks are numerous, since there are numerous barriers to be removed. The risks are mainly related to the funds, attitudes and knowledge, and to a smaller degree to the technical conditions. Croatia will face difficulties in realization of objectives set up., particularly in defining the programs, without international financial support. In the initial stage, special attention should be paid to the education and arising of public awareness.

Since the proposed Program is mostly based on outsourcing from the state administration bodies, the rights and duties of individual actors need to be carefully regulated, and care should be taken of maintaining the generated capacities, values and knowledge.

For the Program to be permanently sustainable, its financial aspect must be based on the market principles to the maximum degree, with minimum use of incentive financing. General environment, including the pace at which the Croatian economy and energy sector will adopt market principles, and willingness of the Croatian commercial banks to share risks, shall determine the level of success of the climate Program.

Here below some of existing barriers are listed, which are identified and systematically analyzed in preparations of the national project for *Removing Barriers for Implementation of Energy Efficiency in Households and Services Sectors* (UNDP-GEF). These include lack of regulations for fostering of measures and self-initiative, low prices of energy sources, lack of knowledge and accessibility of technology, insufficient information on costs, lack of knowledge about market and financing mechanisms and implementation of measures, lack of interest of the banking sector, poor information accessibility and low interest at the local level, insufficient knowledge about the potentials (e.g. wind and biomass), nontransparent ownership relations in services sector (hotels), lack of technical standardization and verification for new technologies lack of trust between the public sector and NGOs.

The modes of structural adjustment, liberalization and privatization of the energy sector will largely affect the use of renewable energy resources and energy efficiency. Thus, it will be necessary to permanently develop new stimulation mechanisms adjustable to the changes leading to decentralization of systems and of the free energy market.

#### 5.2.2.3. Performance Indicators

The Program implementation indicators need to be defined from the onset. The basic performance indicators include:

- quantity of GHG emission reduction and removal by sinks
- investments into climate change mitigation projects
- number of projects
- number of new jobs created through the measures implementation
- local/foreign financial component ratio in the projects
- transfered and newly developed technologies
- conservation of energy and other resources achieved by the measures implementation
- positive side effects of implementation measures (reduction of local pollution, improvement in international cooperation, and the like)
- interest of media and professional community on climate issues
- public awareness of the climate issues
- other measure-specific indicators.

The performance monitoring and evaluation asks for databases, while some indicators such as the media interest and public awareness ask for determination of the initial status. The first systematic step should be determination of the national sustainability indicators in compliance with the global and regional approach to this issue.

#### 5.2.2.4. Funding

The costs of planned establishment of the capacity building program (KLIMAkap) are estimated to USD 1.5-3 million in the next three years. During that period, it will be necessary to complete a system that will provide for the implementation of measures. The costs mainly include engagement of experts, either in the state administration bodies or outside them.

In planning the measures, the evaluation has been made of additional marginal costs and the so-called national emission reduction curve was constructed. The determined costs are the difference between the costs of the technical solutions with the measures and those without the measures (base line). The technical solutions without undertaking the measures are based on implementation of the "business-as-usual" scenario.

The emission reduction costs indicate that the most profitable is the energy efficiency measure applied to household and services sectors and the option that includes selection of the "gas scenario" for expansion of power capacities. Cost estimates shows that for 20 percent emission reduction in relation to reference scenario, which assumes implementation of nearly all adopted measures, needs 120 mil. $ in the year 2010. Presently, there is no cost estimate for energy from biomass, the cost of which might range from highly cost-effective solutions to the comparatively expensive options. For these costs to be determined, additional detailed analyses need to be made in which all other environmental and socio-economic effects will be accounted for.

A four basic funding sources are planned for use: national budget, fund based on greenhouse gases emission charges, commercial bank loans and international bilateral financial and technical assistance.

The KLIMAkap implementation program should be funded from the national budget, emission charges and international grants, particularly from the financing programs under the Convention (GEF). The major part of this Program could be implemented through bilateral technical assistance. The GEF support within a new program, the Capacity Building Initiative, is expected for the initial stage of the capacity building.

The KLIMApro Program is planned to be financed from the greenhouse gases emission charges. The incentives should cover the difference in costs between the "climate-friendly" and base line technology. The implementation projects should be a combination of funding from the incentives and different forms of soft commercial loans, although it is possible to use only commercial loans only. In the initial stage of the measure implementation, the assistance from GEF and other international funds could be expected for the demonstration projects and programs aimed at creating a positive environment. A good example of the latter are the projects: Removing Barriers to Energy Efficiency which has been approved for co-financing (UNDP-GEF), the Energy Efficiency Program based on implementation of the ESCO program at the HEP (WB-GEF), and the Croatian Project for Renewable Energy Resources (WB-GEF).

#### 5.2.2.5. Priority Steps

The policy priority steps include:

- **setting up a stable funding mechanism based on emission charges (within the Environmental Protection Fund)**
- **setting up the Program based on an adequate political decision.**

The capacity building for implementation of the climate program asks for the following actions to be undertaken during the next 1-2 years:

- assessment of capacity building needs
- implementation strategy with operative plan
- standards and technical legislation, regulations
- development of a national emission inventory system and register of emission
- project cycle database
- defining base lines and guidelines for joint implementation (JI) and emission trading (ET)
- support to development of sector plans and programs pursuant to National Climate Action Program objectives
- detailed evaluation of potentials and mapping of biomass, wind and small hydro capacities
- development of the background studies necessary for preparation of design documentation and programs (feasibility studies, socio-economic analyses, generic environmental impact studies, preliminary studies)
- identification of projects, their prioritization and preparation for implementation alternatives
- realization of international collaboration
- public promotion program implementation (2 years)
- preparation of the Local Agenda 21 for Croatia
- building capacities for policy and measures planning (professional education, technical excursions, planning models, climate impact models, climate scenarios, observation system)
- sea level rise impact effect analysis
- support to the design documentation development
- starting to work on Second National Communication

The applications is planned to be submitted for the funds from GEF and other potential donors for setting up of the climate Program. The capacity building must not cause lagging behind the implementation, thus the maximum support is necessary for already started activities while concurrently searching for new projects. The study research should specifically focus on the biomass projects on which the available information is insufficient.

To encourage implementation, the demonstration projects and programs and pilot projects should be used, which asks for creation of incentives to support the National Energy Action Plans and other measures in industry, forestry and agriculture. The operational plan for implementation of the Climate Program shall detail the implementation method. The support is given to urgent realization of the projects in preparation or those nearing realization, such as the projects planned to be co-financed by GEF, Project for Removing Barriers for Implementation of Energy Efficiency in Households and Services Sectors, Renewable Energy Resources Project and Energy Efficiency Project.

The priority in implementation is given to the measures with the lowest costs, while respecting the criteria specified in Section 5.2.1.

#### 5.2.2.6. Kyoto Protocol Mechanisms of International Collaboration

The Kyoto Protocol provides the possibility for the countries to meet their commitments by implementing "domestic" measures and, additionally, by applying the joint implementation (JI) mechanism, clean development mechanism (CDM) or emission trading (ET). The JI and ET are mechanisms applicable between the countries, which are the parties to Annex I, while CDM is the mechanism applicable to countries to parties not included to the Annex I to the Convention. The parties may use JI and ET only if they set up an internationally verified national emission inventory system as defined under the Kyoto Protocol.

The Croatia's Kyoto mechanism implementation strategy depends on how the base year issue will be resolved for Croatia.

At this moment, when the baseline year for Croatia has still not been determined, Croatia should be very careful with possible JI arrangements. The emission reduction costs need to be taken into consideration, and they indicate that the cost of the most of the measures is more than 10 USD/t$CO_2$eq. Possible JI projects should be connected with the measures that have other positive and currently favoured effects, such as waste management, forestry measures, industrial measures that contribute to the production increase and introduction of new technologies, agricultural measures, and the bioenergy projects.

So far, the JI projects should be used to encourage implementation of the measures, to cover different types of measures and demonstration projects on which valuable experience could be gained. However, no significant exchange of the ERUs has been permitted. Thus, it is necessary to adopt new knowledge shortly and prepare technical documentation to support the decision-making process. It is of particular importance to determine the baselines for determination of the ERUs is reccomended. The project preparation, verification and implementation procedure needs to involve domestic professional capacities to the maximum extent. It should be born in mind that a wrongly determined ERU credit will "become due" in 2008, since that is the year in which the assigned (sold) emission is added to the Croatian quota, so the "blown up" ERU today might damage the integrity of the planned "domestic" measures.

Considering the implementation of the CDM, Croatia might be interested in investment in the countries, which are not parties to the Annex I.

Croatia's position is that the major portion of the emission reduction could be achieved with the domestic measures, and the ratio between the domestic and Kyoto mechanism measures is still the matter of negotiations under the Kyoto process.

One of the priorities is determination of the baselines and stipulation of rules for approval, evaluation, verification and monitoring of JI projects.

The emission trading marcet should be monitored for strategic reasons, particularly regarding creation of the common EU electricity market. So, it is useful that HEP has already got involved in international pilot programs, such as EWP program of EURELECTRIC and Climate Program of REC/WRI.

#### 5.2.2.7. Implementation Instruments

There is no such an approach that could be considered best for implementation of the measures, since it mostly depends on the national situation. Thus, the international community now refers to the "good practice" instead of the "best policy", since the good practice integrates a number of different instruments for the policy implementation. The instruments can be economic, fiscal, legislative, voluntary and based on information, education and research.

The Croatian priority is reorganization of the energy sector that asks for removal of the market imperfection in prices of individual energy sources, both on the primary energy and on the demand side.

When selecting measures, special care should be paid not to disturb the market relations and competitive capacity. Therefore, the general principle should be that of the "polluter pays", based on the emission and external costs.

In building the policy for implementation of the measures in Croatia, priority should be given to the instruments shown in Table 5-1, which is an open list in which the activities are not presented in order of their valuation.

*Table 5-1: Major instruments for implementation of the greenhouse gases emission reduction measures*

| | Instrument | Sector | Implementation |
|---|---|---|---|
| I1 | Setting up actual energy market | energy | energy sector reform |
| I2 | $CO_2$ emission charges | energy | payment for carbon content in fossil fuel |
| I3 | Charges on greenhouse gases emission, products and raw material causing greenhouse gases emission | industry | charges on emission, quantity of goods and raw material |
| I4 | Incentives for renewable energy | energy | soft loans, competitive capacity incentives, import and tax relieves |
| I5 | Incentives for energy efficiency measures | industry | soft loans, import and tax relieves |
| I6 | Eco-labeling and sales of "green" energy from renewable sources | energy | "green energy" certification |
| I7 | Clean production initiatives and Environmental Management System introduction | energy industry | soft loans, import and tax relieves, product price incentives |
| I8 | Setting up target limit values per sectors and sources | energy, industry, waste management, agriculture, forestry | burden sharing based on measures economic efficiency and cost-benefit analysis, considering initial status regulating share of renewable energy in power generation |
| I9 | Setting up local greenhouse gases market | all | defining basic concepts, trading regulations and emission inventories |
| I10 | Defining conditions for JI projects and international trade | energy, industry, waste management agriculture, forestry | defining basic concepts, trading regulations and emission inventories |
| I11 | Voluntary agreements | power generation industry, agriculture | building partnership in setting up objectives and implementation measures |
| I12 | Promotion of sustainable integrated planning on all levels–Agenda 21 principles implementation | all sectors, local administration | Introducing Strategic Environmental Impact Study development obligation, national and local Agenda 21 program |
| I13 | Education, information, promotion | all sectors | Education and public promotion program Access to information on technologies, measures, possibilities of banking sector involvement |
| I14 | Encouraging demonstration and pilot projects and programs | all sectors | Removing barriers, grants, co-financing |
| I15 | Encouraging research and development of new technologies | all sectors | Grants, co-financing, support to technology transfer |
| I16 | Encouraging domestic production of "climate-friendly" technologies | all sectors | Grants, loans, information, cross-linking of actors |

|  | Instrument | Sector | Implementation |
|---|---|---|---|
| I17 | Regulating conditions for waste thermal treatment and landfilling | waste management | Regulation and instructions on waste-to-energy projects |
| I18 | Defining sustainable development of agriculture | agriculture | Strategy and Implementation Program development |
| I19 | Control over organic and mineral fertilizers application | agriculture | regulations |
| I20 | Encouraging reforestation and sustainable projects in energy and forestry sectors | forestry | projects co-financing, demonstration projects and programs |

The first measure is introduction of realistic pricing and competitiveness in the energy market. The energy sector reform is in progress, and it will be implemented on the basis of six recently passed laws (Section 6.1.2). The Croatian Power Company is concurrently undertaking its structural adjustment towards unbundling of production, transmission and distribution of electricity.

The mechanism that needs to be urgently introduced is the $CO_2$ emission charge. The most practical approach is taxation of fossil fuel in proportion with its carbon content. At the same time, development of $CO_2$ emission-trading system should be initiated along with defining the rules for JI arranged between the local and international partners. The funds raised through the charges should be used for capacity building, incentives, and encouragement of the demonstration "good practice" projects and programs, granting of soft loans and co-financing of the projects.

A condition underlying successful implementation of the climate program is stipulation of objectives as per sectors and incorporation of those objectives and implementation mechanisms into the sector strategies, plans and legislation. It is necessary to develop a method for transfer of commitments to individual industries and emission sources.

Education, informing and public awareness arising need to be continuous, with maximum participation of NGOs, and the priorities are given in Section 10.

To establish a favourable environment for implementation of the measures, it is important to increase the interest of the banking sector to invest into the climate change mitigation projects. This will only be possible if the long-term objectives and state incentives are transparent and the energy market stability ensured.

Some measures which might be direct barriers to the project implementation should be removed urgently in the preparation stage, even if *ad hoc* solutions are to be used for of demonstration and pilot projects and programs, in order to gain valuable experience for the full implementation projects.

#### 5.2.2.8. Involvement of Local Communities into the Program Implementation - Local Agenda 21

The Framework Convention on Climate Change is related to the general sustainability principles as defined in the Agenda 21, the document on development and environment adopted in 1992 in Rio de Janeiro. Since many problems and solutions originate from local activities, participation and collaboration of the local communities is one of the crucial factors in fulfilling the objectives. Local bodies of a city administration build and maintain the economic and social infrastructure, along with the environmental protection infrastructure. This being the administrative level closest to the population, local communities have the vital role in education, mobilization and solution finding when it comes to fostering of the sustainable development.

Since the basic objective of Climate Change mitigation program is to achieve specific objectives of emission reduction, pursuant to the sustainable development principle, a logical priority step is setting up of an directed program for implementation of the Local Agenda 21 principles as defined under the Section 28 of the Agenda

21. The Local Agenda 21 program should offer a vision of sustainable development of the local communities and aim at achieving understanding and application of the global context on individual decisions. The objectives may be achieved only if there is a coordinated partnership on local, regional, national and international level.

Some cities and actors in Croatia have already got involved in Local Agenda 21 initiatives on the European or global level. An establishment is proposed of the Croatian Local Agenda 21 program that would be a focal point integrating interests of numerous cities and local communities. There are numerous successful examples worldwide that confirm benefits, the support may be sought form the relevant United Nations programs, the United Nations Development Program (UNDP) and the United Nations Environmental Program (UNEP), and other international programs and associations.

### 5.2.3 Measures as per Sectors

**General on Available Measures**

Below, the objectives and measures for emission reduction as per sectors are described. This objectives need to be included the sector strategies and programs, therefore each sector or entity the program encompasses, should develop its own strategy and program for operational implementation. It should be noted that the indicated emission reductions are the target values, sometimes even the maximum achievable values, while in some cases the realistic potentials are presented. Without focusing on target figures at the moment, each sector or entity contributing to the greenhouse gases emission should show it is making a progress, which means they should initiate preparation and implementation of the projects.

The measures described below have been prepared on the basis of aggregate analysis of individual sectors, and further analyses should be based on “bottom up” approach.

The basic criterion used in selecting priority actions and measures and adequate instruments for their implementation is economic efficiency of a measure. This means that generally the priority is given to a measure that incurs lower cost per avoided emission unit. In addition to the cost efficiency criterion, a number of other factors, equally or even more important than the economic, may need to be taken into consideration. The Table 5-2 is an overview of the valuated significance of individual criterions, according to the results obtained during the workshop for Program preparation and confirmed in public consultations.

*Table 5-2. Valuation of measure selection criteria, grades 1-5 (1- negligible, 5-very important)*

| | Criterion | Average |
|---|---|---|
| 1 | Cost-benefit ratio for national economy<br>- GDP increase<br>- employment rate increase<br>- import/export balance<br>- increase in technical capacities of domestic production | 4.8 |
| 2 | Greenhouse gases reduction efficiency compared to investment | 4.2 |
| 3 | Compliance with national development plans | 4.2 |
| 4 | Information availability<br>- on technologies<br>- on program implementation costs | 4.2 |
| 5 | Implementation potential under Croatian conditions | 4.0 |
| 6 | Co-ordination with other environmental objectives<br>- reduction of other detrimental matter emission<br>- reduction of other environmental impacts | 3.5 |
| 7 | Arises public awareness of respect for quality of life and environmental benefits | 3.3 |
| 8 | Socio-economic impacts | 3.3 |
| 9 | Permanent sustainability of option | 3.3 |

**Table 5-2 indicates that the criterion under 1, the accompanying economic benefit, has been attributed more importance than the cost of avoided emissions. The employment issue is particularly prominent at the moment. It should be fully incorporated in planning of policy and implementation of measures.**

The next sections will give a more detailed elaboration of measures as per sectors, their potentials will be expressed same as the potentials, costs and instruments available for their implementation.

### 5.2.3.1. Energy Sector - $CO_2$ Emission Reduction

#### 5.2.3.1.1. Power Generation Sector

The measures in the power generation sector have been taken from the Analysis of Possible Greenhouse Gases Emission Reduction at Hrvatska Elektroprivreda (EKONERG, 2001). Since this study has been developed concurrently with preparation of the National Communication, and is not completely finished, its results need to be taken as preliminary. The total analysed potential in power generation is shown in Fig. 5-2.

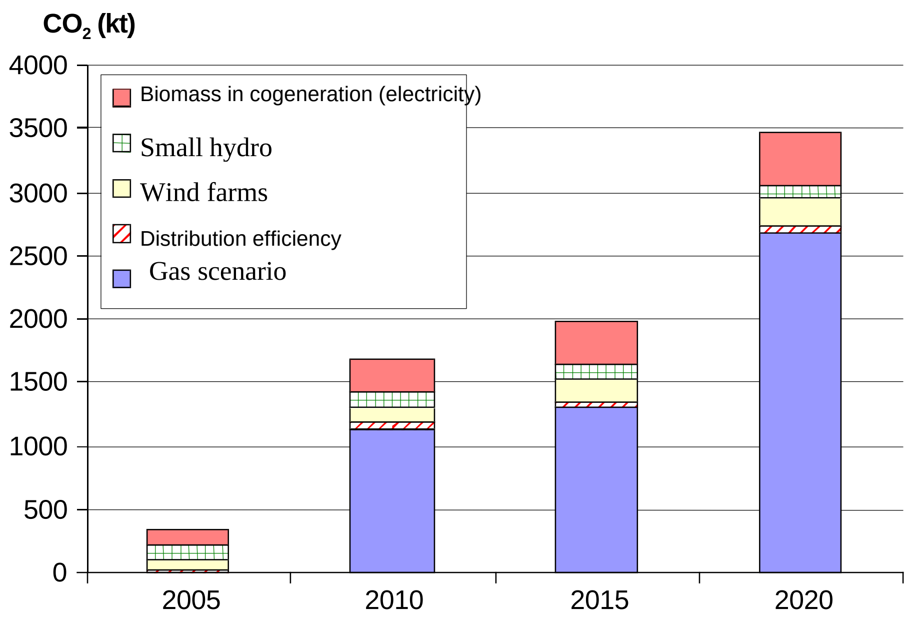


*Fig. 5-2.: Potential greenhouse gases emission reduction in power generation sector*

***(a) Gas scenario for the power system development***

For the purpose of the analysis of reduction of greenhouse gases emission from the power generation sector, two scenarios are observed. In the first, the baseline scenario, the development of power system is based on the need to diversify the analysed energy forms used in power generation, which involves a significant share of coal along with already high share of liquid fuels and natural gas. The presumption for the second scenario was a construction of the natural gas-fired instead of the coal-fired thermal power plants (TPPs). The hydro-electric power plants construction rate would remain the same for both scenarios. It should be noted that the shown construction rate for the hydroelectric power plants (HPPs) is to be regarded as optimistic.

*Baseline scenario - S1*

This scenario examines the development of the power system by the lowest-cost method, taking into account the reliability of energy sources supply. It presumes the inclusion of various criteria, not always simple to quantify, such as: world gas and coal reserves, price stability, transport facilities for providing adequate quantities of energy sources, storage facilities for energy sources, how realistic is the gas introduction scheme implementation, etc. Those criteria could at certain rate give coal an edge over the gas, all in the period 2005-2010. These are only some of the problems, which together with conventional namely technical and economic ones must be taken into account in power system development planning.

Hence, this scenario envisages putting into operation the two coal-fired thermal power plants with capacity of 500 MW in years 2010 and 2020. Other plants, which should meet the power demand, would be the combined-cycle gas-turbine thermal power plants (1,700 MW) and the hydroelectric power plants (378 MW).

Total installed capacities under the baseline scenario-S1, expressed in $MW_e$, for the years 2000, 2010, and 2020 are shown in Table 5-3.

*Table 5-3: Total installed capacities ($MW_e$) under baseline scenario*

| | 2001 | 2005 | 2010 | 2015 | 2020 |
|---|---|---|---|---|---|
| HPPs | 2061 | 2101 | 2184 | 2376 | 2439 |
| TPPs – liquid fuel | 952 | 952 | 927 | 355 | 0 |
| TPPs – natural gas | 377 | 677 | 977 | 1442 | 1942 |
| TPPs – coal | 315 | 315 | 815 | 815 | 1210 |
| Nuclear power plants | 332 | 332 | 332 | 332 | 332 |
| Total | 4052 | 4392 | 5250 | 5335 | 5938 |

*"Gas" scenario - S2*

This scenario presumes construction of natural gas-fired instead of coal-fired thermal power plants. By the year 2020, a total of 2,300 MW in new combined-cycle gas-turbine thermal power plants is expected to be available. Same as in the baseline scenario, this scenario envisages intensified construction of the hydroelectric power plants.

A possible problem in implementation of this scenario is supply of sufficient gas quantities. About 1,345 million $m^3$ of natural gas will be necessary already in 2010, and 2,660 million $m^3$ in 2020.

The emission avoided by implementation of the gas scenario is the result of changes in the fossil fuel structure (Table 5-4).

*Table 5-4: Change in fossil fuel consumption structure under gas scenario, PJ*

| | 2010 | 2015 | 2020 |
|---|---|---|---|
| Natural gas | 18.9 | 21.1 | 42.7 |
| Liquid fuel | 1.7 | 0.5 | 0.0 |
| Coal | -23.9 | -25.8 | -51.9 |

The emission reduction calculation has considered only the direct emission of greenhouse gases, i.e. the emission from burning of the fuel in power generation rather than entire cycle (emission from the fuel production, transportation and storage, emission from the manufacture of materials used in power plant construction and the like).

### *(b) Power Generation, Transmission and Distribution Efficiency Increase*

Increase in efficiency of fuel energy conversion into useful electrical energy can be achieved by a series of technical measures implemented in thermal power plants, on boilers, turbines and auxiliaries. Increase in efficiency is usually connected with upgrading of the existing facilities, extension of operating life and refurbishment of the complete facility. Since the efficiency of the existing thermal power plants is rather satisfactory, and considering their age and planned phasing-out by the year 2015, along with the comparatively high costs of additional activities, this measure has not been evaluated as attractive for the $CO_2$ emission reduction.

The losses from the power transmission network have been maintained during the last ten years at 3 to 3.7 percent of the total power output. Considering the configuration, spatial distribution of the generation facilities, the war-inflicted damages and outdated equipment, the losses could be taken as satisfactory. Reduction of the losses is a continuous task of the HEP, and it will be fostered regardless of the climate plan requirements. Additionally, it would have no economic justification compared to another measures.

The technical losses from the distribution network are evaluated at 5 to 5.5 percent. Hence, by exercising good practice, the loses could be reduced to approximately 1 percent. These measures demand high additional investment, for reduction of losses from the existing network, which is usually not cost-effective.

### *(c) Energy Conservation by the Demand-Side Management (DSM)*

These measures are described in the sections on energy consumption in services and household sectors.

### *(d) Low-Carbon Fuel Use*

The most important of all the measures is the earlier described "gas" scenario. Other measures include substitution of the liquid and solid fuel with natural gas in the existing thermal power plants. Technically highly feasible measure is use of gas in thermal power plants using dual fuel (gas/fuel oil). Switching (from coal to gas) of other power plants, namely Rijeka and Plomin TPPs, demands construction of the gas mains. The major problem in implementation of these measures is supply of sufficient gas quantities, since not even the very optimistic projections of the domestic production and import envisage quantities sufficient for implementation of these measures. Considering the available quantities, it would be economically viable to use the gas in modern combined-cycle facilities with 50 percent higher efficiency. Thus, these measures that result in about 1,250 kt $CO_2$ in 2010, are not shown in the table of measures (Table 5-4).

### *(e) Wind Energy Use*

The research conducted so far has singled out 29 sites for the wind energy harnessing at the Adriatic. The feasibility of the potential use depends on the size of the wind plants and their consolidation (wind farms). The unit capacities of 250, 500 and 750 MW enable the output ranging from 380 to 800 GWh/year, with total installed capacity of 195 to 380 MW. If the complete capacities were used, 1.5 to 3.2 percent of the power demand in 2020 could be covered.

The potential for use of the seaborne wind is estimated to another 170 to 250 GWh/year, which is 0.7 to 1.0 percent of the power demand in 2020.

In the emission reduction estimate, it is optimistically assumed that 50 percent of the coastal zone potential will be harnessed in 2010. It must be noted that the potentials are based on very limited data, since no detailed mapping of the Adriatic was made for harnessing of the wind potential, which is one of the research priorities. Further, the environmental impact studies point to the impact on birds and aesthetic pollution for which some of the technically feasible sites are questionable for use.

The cost estimates show that the emission reduction by implementation of this measure is relatively more expensive than implementation of most other measures, so its launching would demand considerable incentives.

### *(f) Intensified Construction of Hydroelectric Power Plants*

Total potential of the waterpower in Croatia is estimated to approximately 20 TWh a year. Technically feasible is approximately 12 TWh, and 6.2 TWh is already used. Opening of possibilities for harnessing of the unused water potential of the border rivers will depend on coordination of the Croatian interests with those of the neighboring countries. Part of the available potential may remain unused because of the environmental and other problems, so the realistic long-term estimate is that about 3.0 TWh a year may be harnessed in new hydroelectric power plants.

The baseline scenario envisages construction of the hydroelectric power plants with total capacity of 378 MW, i.e. startup of one facility every third year. It should be born in mind that this reduces the emission compared to the scenario combining the "coal/gas" thermal power plants (1:1, for new plants) by 11.00 kt $CO_2$ in 2010, and as much as 22.00 kt $CO_2$ in 2020.

Additionally, the construction of small hydro-electric plants was considered. There are records of 699 possible stretches for waterpower harnessing in small hydro plants on 63 streams in Croatia. Approximate total potential installed capacity could be 177 MW, and the power generation potential is about 570 GWh. If the stretches at small gradients are excluded, it is realistically assumed that about 350 technically feasible stretches are available. This number will further reduce because of the local town-planning and environmental requirements. If only 200 stretches were used, and about 160 GWh of power generated, the $CO_2$ emission would be reduced by 117 kt in 2010.

### *(g) Waste- and Biomass-Derived Power*

Biomass is a renewable energy source, because use of biomass as a fuel does not produce the greenhouse gases emission if the entire cycle is taken into consideration: wood stock increment, burning of the biomass and assimilation of $CO_2$. The wood carbon content is about 50 percent, and it is released during burning as $CO_2$, which is again fixed in biomass.

The biomass can be of wooden, non-wooden or animal origin. The biomass needs to be pretreated for its use in power generation, which includes the biomass collecting, preparation for transport and utilization.

Here, the estimate is given of possible utilization of the biomass generated as a byproduct and waste in forestry and agriculture. The presented figures do not encompass the energy farms (farms of the fast-growing trees, energy grass, algae and sugar-beet).

It should be underscored that the biomass use evaluation in determination of the theoretical potential, is technically feasible, but its economically justified use is highly uncertain. The biomass use has significant socio-economic and environmental consequences, which should be accounted for in the potential assessment. High uncertainties are already encountered in determining the existing quantities of fuelwood, since the official data do not correspond with the "field" data. The information on energy supply in particular Croatian regions point to a much higher use of fuelwood than the official records from the forestry management show. Today, the agricultural waste use is not practiced. This should be born in mind when considering the data given below, and it indicates the need for urgent research into this issue and its clarification.

Here, only the summary values are given from the HEP's study (EKONERG, 2001), which assessed the biomass on the basis of the results obtained by the national energy program BIOEN and other studies.

During the period 1990-1995, 12 to 16 PJ of fuelwood was used, which is about 6 to 7 percent of the total primary energy in Croatia (14 PJ in 1999). It is assumed that the 17 PJ value could be reached by the year

2020, and 20 PJ by 2020. This is the fire biomass in the form of stacked wood for energy, faggot wood and cutting and wood processing waste.

The usable potential in agriculture, in the form of animal husbandry biogas, could be 2 to 4 PJ, and corn remains could amount to 12 to 22 PJ. The differences arise from different agriculture development scenarios, where the higher figures correspond with the scenario of the "economically efficient" agriculture and gradual increase in plant production and animal breeding.

Total usable biomass potential from forestry and agriculture is 35 PJ for the baseline scenario, 41 PJ assuming the most probable scenario of the agriculture development, and 46 PJ for the efficient agriculture scenario.

This potential may be used in households, small boiler houses, industrial boiler plants or cogeneration plants. The optimum proportion of harnessing and probable implementation schedule need to be determined. Here, it is assumed that 50 percent of possible additional potential in forestry and 30 percent in agriculture will be in use by the year 2010, and 100 percent in forestry and 70 percent in agriculture by the year 2020. It is also assumed that 40 percent of additional potential will be used for cogeneration. The biomass-fired cogeneration plants should contribute to reduction of the $CO_2$ emission from power generation in the amount of equal to the generated power, and the reduction in the energy consumption sectors (mainly households) equal to the generated heat quantity.

***(e) Nuclear Power Plants Construction***

The nuclear option, namely construction of two 660 MW power plants by the year 2020 was considered within the analyses carried out for the Draft Energy Strategy for the Republic of Croatia in 1998. In the light of the European policy, short deadlines for implementation of this option, and negative public attitude, confirmed through the public consultations on this Communication, the nuclear option is for the time being considered unattractive for the first commitment period from 2008 to 2012. Considering the fact that currently construction of 1000 MW units is considered optimum, the issue is arising of incorporating of such a large unit into the power system so small as the Croatian is. At a certain point, Croatia was very serious about continuation of nuclear power plants constriction after completion of the 730 MW Krško Nuclear Power Plant owned jointly by the Republic of Croatia and the Republic of Slovenia.

## 5.2.3.1.2. Industry

The total potential of the analyzed measures related to the fuel consumption in industry is shown in Figure 5-3.

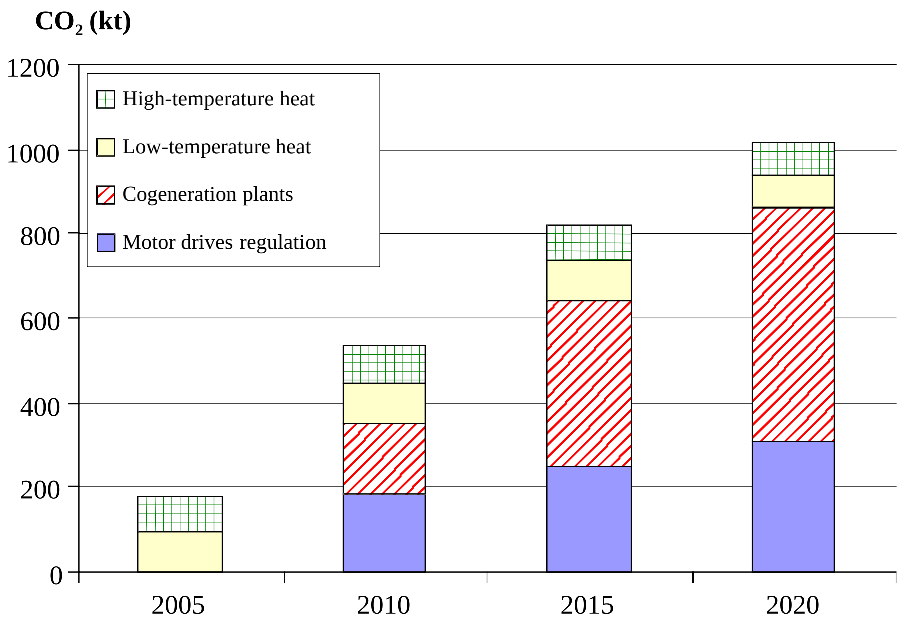


*Figure 5-3: Potential for greenhouse gases emission reduction in industry*

### *(a) High-Temperature Heat Generation Efficiency Increase*

High-temperature heat is mostly used in building material industry, paper industry, non-metal and chemical industry. This measure assumes introduction of new and more efficient technologies, and it is best visible as the improvement of conversion of fossil fuels to useful heat. The baseline scenario envisages a gradual replacement of the old with new and/or newer technologies, while the *mitigation scenario* sees the technology replacement rate as more intensive. In that way, the overall degree of conversion of fossil energy forms into the high-temperature heat in the *mitigation scenario* is about fifteen years ahead of the conversion degree in the baseline scenario.

The difference between presumed efficiencies causes different consumption of final fossil fuels, whether the measure is implemented or not. The potential for fossil fuels consumption reduction is not very significant and ranges from 1.4 percent of total electricity consumption in industry in 2010 to 0.4 percent in 2030.

### *(b) Low-Temperature Heat Generation Efficiency Increase*

Almost equal share of low-temperature and high-temperature heat is characteristic for the Croatian industry. The low-temperature heat is mostly used in non-metal, chemical and food processing industry, which, therefore offers more room for introduction and intensive use of process efficient plants, like in case of the high-temperature heat. Unlike the rate at which new technologies for direct fossil fuels combustion are introduced, introduction of the low-temperature technology will be somewhat slower. So, the *mitigation scenario* envisages five to ten years of intensified introduction of new and high efficiency technologies. The expected savings might be from around 2.1 percent in 2005 up to 0.4 percent in 2030. This is because at the end of the observed period and in the *baseline scenario*, the conversion efficiency gets closer to the desirable level set in the *mitigation scenario.*

### *(c) Industrial Cogeneration Plants*

Given the fact that cogeneration capacities are more efficient because of the combined generation of heat and power, the industries, particularly those that use more low-temperature heat, have noteworthy potential for construction of small cogeneration facilities and saving of a certain amount of fossil fuels because of increase in efficiency.

In order to estimate the contribution of a cogeneration plant, it should be compared with other thermal power plants under the condition that the heat and power generation is the same. The use of the industrial cogeneration plants will be instrumental in reducing heat and power generation in separate processes, i.e. generation of heat in boiler plants and of electricity in thermal power plants. The calculation presumes that the cogeneration plants and the boiler plants use natural gas as fuel, and that the thermal power plants use mixed fossil fuels with the mix structure that changes for different years. In that way, this measure includes the fuel substitution effects, i.e. the natural gas fired in cogeneration substituted the fuel oil and coal burned in the boiler plants and thermal power plants.

***(d) Industrial Electric Motors Efficiency Improvement***

One of the most-well known measures which can be instrumental in boosting the electricity efficiency is regulating of the motor drives in industry because in Croatian industry, similarly to the industries all over the world, about 90 percent of electricity for non-heat purposes is used for motor drives. The estimate is that possible savings are up to 7.5 percent of electricity, so that figure is set up as an objective in the *mitigation scenario*. In that way it would be possible to conserve energy and save from 254 GWh in 2010 up to 487 GWh in 2020.

***(e) Biomass Use in Industry***

Use of biomass in industrial facilities, both in cogenerations and the heat generating facilities, carries a large potential for emission reduction. This Communication analyzes the total biomass potential that is further simplified by its division into the power generation sector potential when the cogeneration plants are considered, and the household sector for the facilities generation only heat. Thus, the reduction potential of the industrial facilities is not presented separately.

## 5.2.3.1.3. Transport

Total potential of the analyzed measures for the transport sector is shown in Figure 5-4.

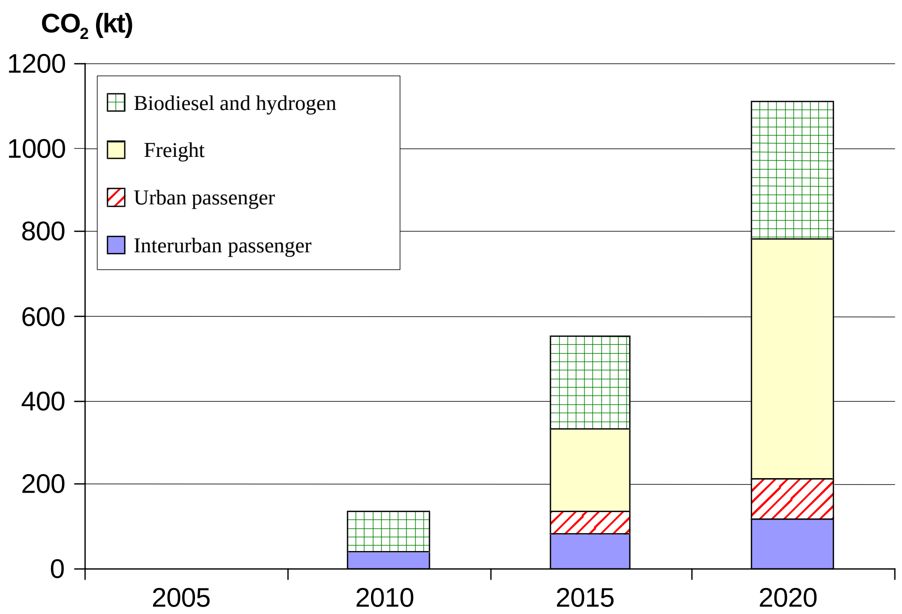


*Figure 5-4: Potential for greenhouse gases emission reduction in transport*

***(a) Interurban Passenger Traffic***

The greenhouse gases emission reduction potential in the inter-city traffic is considerable, as will be shown, and it is the result of the changes in passenger-kilometer structure. It should first be noted that the population mobility is equal in both scenarios. So, in this planning period the passenger-kilometer structure changes in a way that the share of the passenger cars is decreasing while the buses and trains, i.e. mass public transport would increase its share. By 2010, these changes would not be so visible, while up to 2030 the share of passenger cars in interurban passenger-kilometers would drop from 85 to 65.8 percent, and the buses share would rise from 7.8 to 15.4 percent. Equally, the participation of railway traffic would increase from 4.6 to 13 percent by 2030.

***(b) Urban Public Transport***

The structure of the urban public transport would experience a change similar to the interurban passenger traffic structure. It means that the passenger cars share would decrease and urban public transport share increase. More significant changes are expected only after the year 2010, and until 2030 we can expect the fall in the passenger cars share from 46 to 30 percent. At the same time, it means equal growth of the urban public transport.

***(c) Freight Transport***

Similar to the passenger transport, we expect to see more substantial changes in freight transport beyond the year 2010. The share of lorry traffic is relatively falling and the share of railway traffic is rising. The structure of railway traffic will be subject to some changes. After 2010, the electric-driven railway traffic will increase its share while the diesel-driven traffic will decline. Hence, until 2030, we should expect the decreasing of lorries share from 36.3 percent in the baseline scenario, down to 26 percent in the *mitigation scenario*, and the proportional increase of the railway traffic share. Further, until 2030 we should expect the rise in electric-drive portion from 80 to 85 percent, and the diesel-engine portion decline.

***(d) Biodiesel and Hydrogen***

Introduction of biodiesel and hydrogen is covered by the BIOEN and TRANSCRO national energy program. Gradual supplementation of motor fuels with biodiesel and hydrogen is expected beyond 2005 according to both the *mitigation* and baseline scenario. The *mitigation scenario* envisages faster rate for introduction of these fuels in the motor fuels market, so the increase in use of 0.8 PJ and 0.6 PJ for biodiesel and hydrogen, respectively, is expected in the year 2010 in comparison with the baseline scenario, and total increase by 4.6 PJ is expected by the year 2020. Increased use of these fuels decreases the demand for motor oil and diesel fuel, and results in $CO_2$ emission reduction (about 330 kt in 2020).

#### 5.2.3.1.4. Services Sector

Total potential of the analyzed measures for the services sector is shown in Figure 5-5.

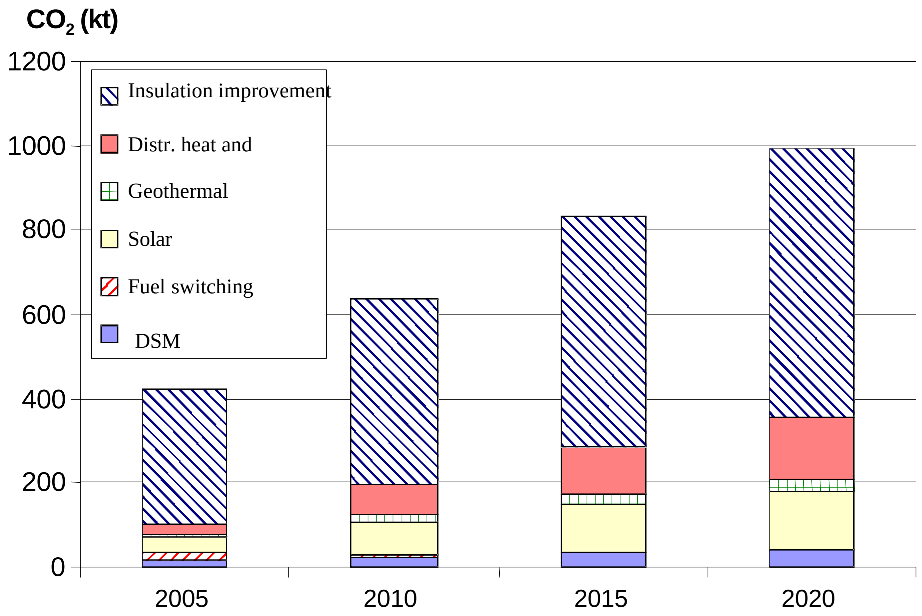


*Figure 5-5: Potential for greenhouse gases emission reduction in services*

### *(a) Fuel Switching*

Greenhouse gases emissions can be considerably reduced by a simply performed fuel switching from liquid fuel to natural gas. In the baseline scenario the services use 5.026 PJ of liquid fuels and this amount is slowly falling towards the end of the analyzed period. The liquid fuel share in meeting the energy demand in the services sector is 20 percent. The declining rate of fuel consumption towards the end of the planning period is almost negligible and primarily depends on available quantities of some other energy forms, which could be used as substitutes. At the moment, a very intensive gas introduction campaign is ongoing in those Croatian regions where natural gas was not available before. Meanwhile there is also an intensive upgrading of the existing gas networks. The liquid fuel burners replacement is an additional costs and there is no possibility for return on investment into the existing burners *(sunk cost)*. Nevertheless, this measure is foreseen only in that section of services sector where major works are not required and where the investments in new devices will not be necessary. Also, this measure is envisaged for those parts of the sector where it will not be possible to build in cogeneration systems either centralized or de-centralized ones, or another devices using the renewable energy (sun, geothermal energy, etc). It means that this measure is envisaged only for the exiting service sector coverage where the connection to natural gas system is feasible.

### *(b) Higher Share of District Heating and Small Cogeneration*

Energy conservation is best achieved in the cogeneration plants, generating both heat and power. The district heating systems participate in meeting the total useful heat demand in the services sector with around 12.4 percent. In the baseline scenario the quantity of thermal energy from the district heating systems remains constant throughout the planning period. Small cogeneration systems envisaged in the baseline scenario grow by an average annual rate of 8.9 percent to reach 2 PJ in 2030. In the *mitigation scenario*, the heat generated in the district heating systems grows at the same pace as the small cogeneration output. The potential for higher use of cogeneration plants is envisaged mostly in hospitals, state and other administration buildings, hotels and commercial molls.

### *(c) Solar Energy*

The solar energy use potential is the most significant in the coastal counties, and especially favorable conditions for its use are in the services sector of this Croatian region.

The *baseline* scenario envisages that about 3 PJ of thermal energy will be obtained from solar energy in 2030, while the *mitigation scenario* plans about 5.5 PJ of solar energy in the same year.

### *(d) Geothermal Energy*

Croatia has a centuries-long tradition of using geothermal energy from natural sources for medical purposes. The thermal gradient of the Croatian geothermal sources is much higher than the European average and the overall geothermal energy potential of discovered sources is 812 $MW_{th}$. Besides many spas where the geothermal energy is manly used for baths, there are two locations where geothermal energy surfacing from deeper wells has its energy-related use. In future we should expect the use of geothermal potentials mostly in hospitals and some hotels located in the vicinity of wells. The potential of wells gives total of 0.7 PJ of heat energy in the *mitigation scenario* in 2030, which indicates that the overall geothermal potential is not relevant.

### *(e) Thermal Insulation Improvement*

The total floor area of premises in the services sector is estimated to around 25 million $m^2$. Until 2030, it is estimated that the floor area will be doubled. Here, it should be kept in mind that the specific heat consumption by $m^2$ in newly built floor area is much lower than in the existing premises. It means that the improvements of thermal insulation in the services sector relate to the already existing floor areas. The *baseline* scenario envisages the thermal insulation improvement in the existing premises by about 15 percent in relation to the initial status by the end of the planning period. The *mitigation* scenario foresees an additional improvement of about 10 percent until the end of the planning period.

Comparatively high marginal costs of this measure are the result of high investment costs compared to the achieved energy savings.

### *(f) DSM Measures in Non-Heat Electricity Use*

In addition to being heat-intensive, the services sector is equally highly intensive user of non-heat electricity. Given the sector's intensive development we can count on potential reduction in non-heat electricity use, primarily with introduction of low-energy bulbs, substitution of the existing freezers and refrigerators with more efficient ones, introduction of better motor drive regulation and air-conditioning and finally, introduction of the information technology for demand-side management in complex buildings (hospitals, hotels, banks). The overall savings potential is estimated to around 24 GWh in the beginning and to around 50 GWh at the end of the planning period.

## 5.2.3.1.5. Presidential Sector

Total potential of the analyzed measures for the residential sector is shown in Figure 5-6.

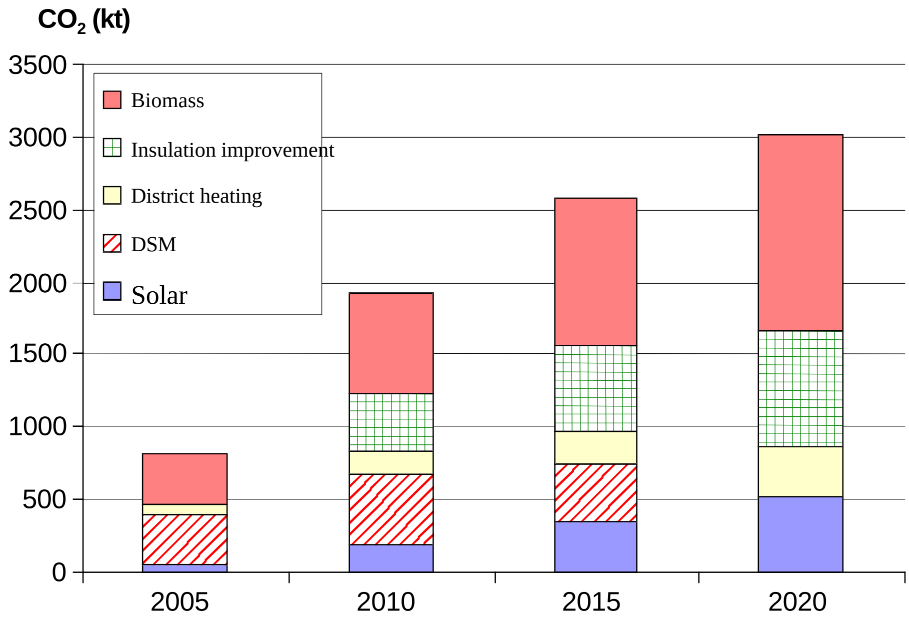


*Figure 5-6: Potential for greenhouse gases emission reduction in residential sector*

### *(a) Thermal Insulation Improvement*

In order to assess the potential of reducing greenhouse gases emission by improved insulation in households in Croatia, we should start from the fact that the housing stock of Croatia is rather old. Out of 1.6 million apartments 26 percent is over 50 years old, while almost 30 percent is 30 to 50 years old. On the other hand, it should be kept in mind that less than half of floor area in these apartments has quality heating. In the future, it can be expected that floor area in old apartments with quality heating will increase so, knowing that about 60 percent of useful heat used by households is consumed for space heating, it can be estimated how much useful heat will be consumed in the next thirty years. Based on various studies, the potential for insulation improvements in old apartments is estimated, given the assumption that new apartments will be built using the latest technologies with modern and efficient insulation, so the insulation improvement refers only to old housing stock.

The analysis of thermal energy demand has shown that by 2030 the heat required for apartment heating will grow almost twofold compared to 2000. Having in mind the possibility of 30 percent insulation improvement, total useful heat would by 2030 decrease by about 15 PJ in comparison with the scenario that does not include insulation improvement. However, the *baseline* scenario envisages the insulation improvement of 10 percent. So, the additional improvement in the *mitigation scenario* refers to the additional 20 percent of insulation improvement, which makes the total useful thermal energy for space heating lower by about 10 PJ in relation to the baseline scenario.

Total reduction of final energy forms use by this measure is about 8.6 percent of the total consumption of final energy forms by households. The potential reduction of greenhouse gases emission is rather good and amounts to 400 to 800 kt, pending on the year observed.

### *(b) District Heating Share Increase*

Similar to services, the household sector has good conditions for connecting to the district heating systems to meet the apartment space heating and hot water preparation demand. Due to a better efficiency compared to the conventional combustion systems, a more intensive development of the district heating systems will improve the overall efficiency of the energy system enabling savings of the final energy forms, especially the fossil fuels. A more intensive use of the district heating systems enables saving of about 6.3 percent of the overall final energy from the baseline scenario

### *(c) Solar Energy Use*

The solar energy potential in the seven coastal counties is very high. The biggest potential of solar energy application lays in water and space heating. This *mitigation scenario* gives estimates, based on the so far carried studies, of savings in final fossil energy forms as well as of electricity, achieved primarily by the solar energy use for water and space heating.

### *(d) DSM Measures in Households (Low-Energy Bulbs and Refrigerators)*

As in the services, a significant portion of total electricity consumption in households goes to the no-heat purposes. In order to encourage and calculate the potential of electricity savings by DSM measures, the model of introducing low-energy bulbs and refrigerators in the households has been worked out. The potential of electricity consumption trimming ranges from 93 GWh at the beginning of the observed period to almost 600 GWh at its end. In case of low-energy bulbs introduction the marginal costs proved to be exceptionally favorable, as is the case in the services sector, while the marginal cost of energy saving refrigerators is also favorable but is not negative.

### *(e) Energy Efficient Buildings*

Croatia has long experience in design and construction of buildings in which the passive and active energy conservation measures are implemented. Such construction integrates numerous measures and it is, as a rule, cheaper than when individual measures are separately introduced (insulation of buildings, solar energy, heat pumps and the like). Additional possibilities and costs of such building practice need to be determined.

## <u>5.2.3.1.6. Energy Sector Measures Summary</u>

A summary of measures in energy sector is presented in Table 5-5, and in Figs. 5-7 and 5-8. Among the presented possibilities, the highest insecurity is related with the biomass utilization. Since this is a considerable potential, it is a priority to determine actual possibilities for biomass exploitation in the power generation and all other sectors with direct energy consumption. The biomass projects should be linked with the forestry and agricultural projects and implementation of sustainable energy solutions where use of biomass from forestry and agriculture is possible.

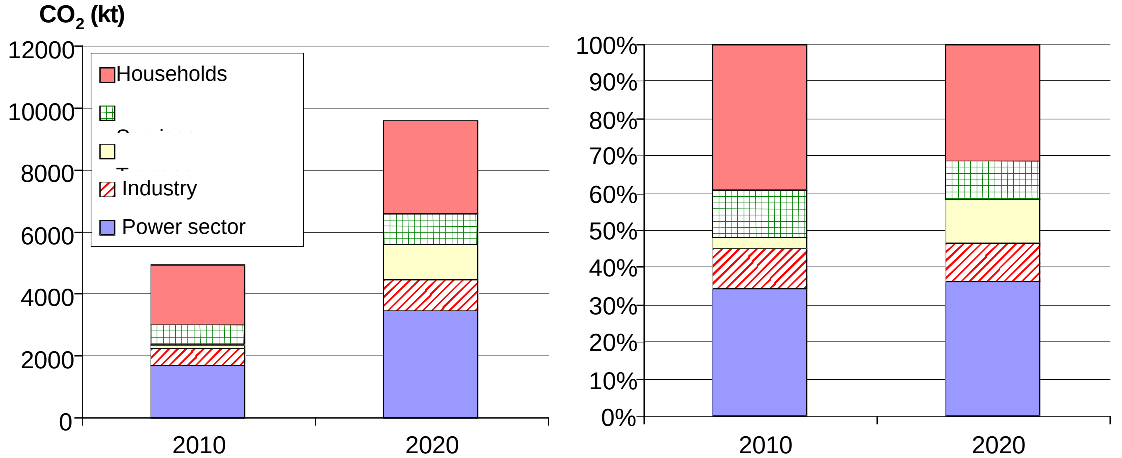


*Figure 5-7: Share of energy sectors in $CO_2$ emission reduction potential in energy sector*

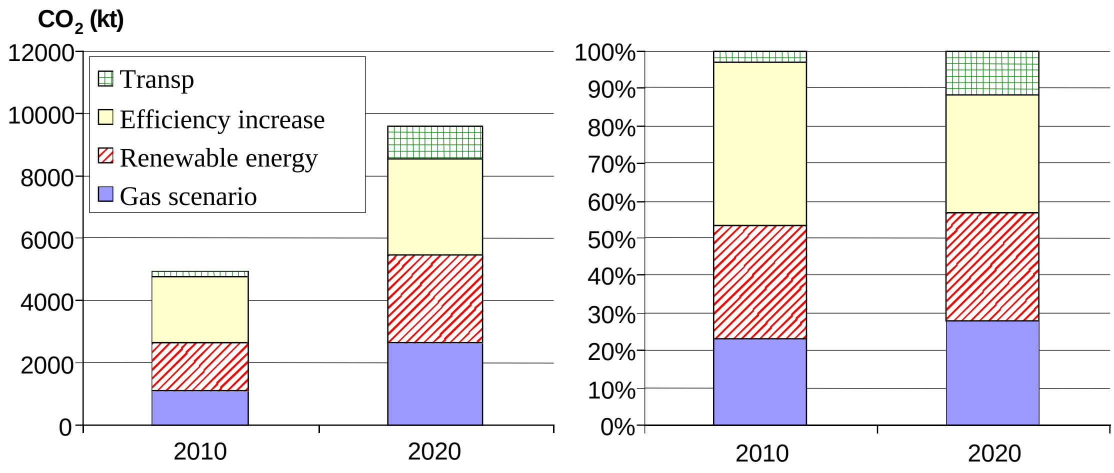


*Figure 5-8: Share of individual groups of measures in potential for reduction of $CO_2$ emission from energy sector*

The curve of marginal costs of the emission reduction in energy sector is shown in Figure 5-9. The marginal costs are calculated as the difference between the equivalent annual costs of the reference solution (or scenario) and the mitigation scenario. Thus, for example, the wind power plants pricing considers the difference between the power generation cost and the average power generation cost from the thermal power plants park in the baseline scenario. The calculations used the discount rate of 8 percent, and the methodology from the Economics of Greenhouse Gas Limitations - Methodological Guidelines (UNEP, 1998).

The expenses should be taken as given for orientation only, since the calculations have not been based on actual data of the projects implemented in Croatia.

*Table 5-5: Overview of $CO_2$ (kt) emission reduction in power sector for 2010 and 2020*

| Energy sector measures | Possible policy instruments | $CO_2$ (kt) | |
|---|---|---|---|
| | | 2010 | 2020 |
| *Power generation* | | | |
| Gas scenario | - $CO_2$ emission charge<br>- emission quotas regulation<br>- technical guidelines and standards<br>- renewable energy incentives<br>- eco-labeling<br>- voluntary agreements<br>- construction-related administrative procedure simplification<br>- public promotion | 1135.5 | 2666.9 |
| Savings in power transmission and distribution | | 47.4 | 56.3 |
| Wind power plants | | 126.6 | 219.0 |
| Small HPPs | | 117.4 | 101.6 |
| Biomass use in cogeneration (for power generation) | | 251.8 | 431.4 |
| **Industry** | | | |
| Motor drive regulation | - $CO_2$ emission charge<br>- realistic fuel prices parity<br>- measures introduction incentives<br>- voluntary agreements<br>- regulating emission quotas per sectors | 186.3 | 309.1 |
| Cogeneration contribution | | 163.4 | 549.7 |
| Low-temp heat generation efficiency increase | | 97.7 | 81.4 |
| High-temp heat generation efficiency increase | | 87.3 | 75.9 |
| **Transport** | | | |
| Interurban passenger transport measures | - $CO_2$ emission charge<br>- traffic planning and regulation<br>- incentives for public traffic improvements<br>- biodiesel production subsidies<br>- Local Agenda 21<br>- public promotion | 39.4 | 117.4 |
| Urban passenger transport measures | | 0.0 | 96.5 |
| Freight transport measures | | 0.0 | 569.6 |
| Increase in biodiesel and hydrogen use | | 99.2 | 326.0 |
| **Services** | | | |
| Electricity savings for non-heat purposes (DSM) | - ESCO companies incorporation incentives<br>- realistic power prices<br>- public promotion | 25.1 | 42.9 |
| Fuel switching (natural gas – liquid fuel) | - emission charge $CO_2$<br>- gas introduction incentives | 2.3 | 0.0 |
| Solar energy use increase | - technology introduction incentives<br>- information accessibility and public promotion<br>- domestic industry capacity building | 79.1 | 137.7 |
| Geothermal energy use increase | | 17.1 | 28.2 |
| District heating and cogeneration use increase | - fuel prices parity<br>- emission charge $CO_2$<br>- grid interconnecting regulations<br>- investment encouragement | 70.3 | 147.5 |
| Thermal insulation improvement | - financial incentives<br>- regulations and standards | 441.6 | 637.2 |
| **Residential** | | | |
| Solar energy use increase | - technology introduction incentives<br>- information accessibility and public promotion<br>- domestic industry capacity building | 196.4 | 527.6 |
| Electricity savings for non-heat purposes (DSM) | - ESCO companies incorporation incentives<br>- realistic power prices<br>- public promotion | 482.2 | 0.0 |
| District heating use increase | - energy planning<br>- realistic price parity | 146.6 | 332.8 |
| Thermal insulation improvement | - financial incentives<br>- regulations and standards | 401.9 | 803.2 |
| Heat-from-biomass (cogeneration + boiler plants) | - emission charge $CO_2$<br>- renewable energy subsidies | 698.6 | 1353.6 |
| **Total potential** | | **4913.2** | **9611.5** |

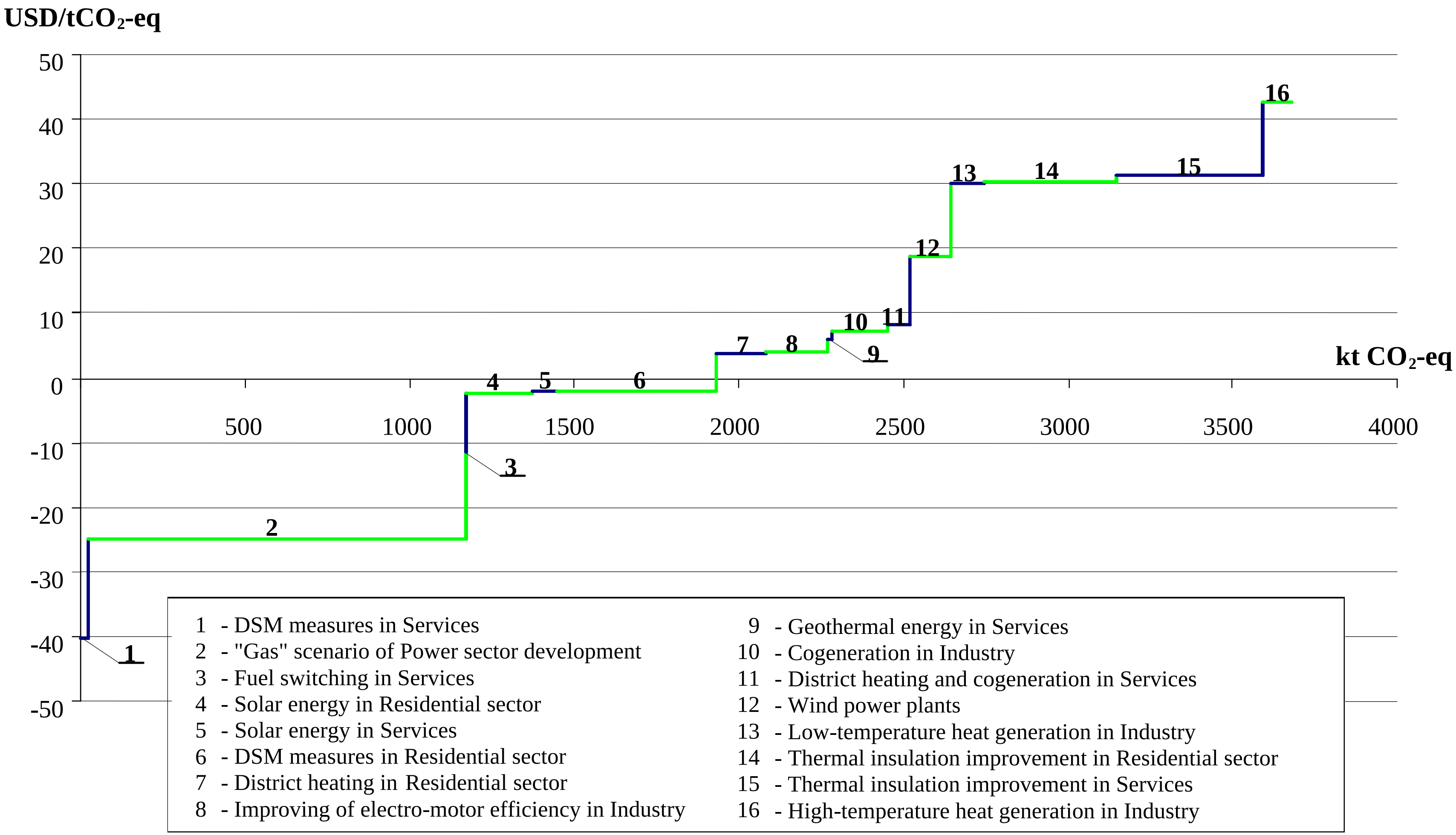


*Figure 5-9: Curve of marginal costs of emission reduction in energy sector*

#### 5.2.3.2. Industrial Processes

During the period 1990-1995, the share of industrial processes in total greenhouse emission in the Republic of Croatia was 11 percent. On average, 82 percent of the total emission from this sector is from manufacture of the nitric acid, ammonium and cement. Until 1991, when the Sisak Steel Mill and Šibenik Aluminum Industry were closed down, share of these processes in the emission has been more than 92 percent.

**Possible Emission Reduction Measures**

**Ammonia Production**

For development of the baseline scenario for ammonia production, it was assumed that the production would recover its full capacity of 1,350,000 tonnes by the year 2010. This means that the consumption of mineral fertilisers in Croatia in the observed future period shall recover to the average level from the period 1986-1988, i.e. 650,000-700,000 tonnes, and the rest will be placed on foreign markets. It has been assumed that the structure of the final product will be 23 percent of urea, 25 percent of KAN and 52 percent of NPK fertiliser.

According to the present level of the technology development, there are no measures that would enable reduction of the $CO_2$ emission from ammonia production.

**Nitric Acid ($HNO_3$) Production**

The nitric acid production directly depends on production of individual types of mineral fertilizers. It is estimated that the production could reach 305,000 to 345,000 tonnes by the year 2010.

The $N_2O$ emission reduction measure undertaken in the nitric acid production consists of use of non-selective catalytic reduction (NSCR) which uses $N_2$ to reduce $N_2O$. The marginal cost of implementation of this measure can be evaluated to 1 USD/t $CO_2$eq, which makes this measure very attractive. First, the detailed emission measurements need to be carried out in the plant, since the standard IPCC factors are used in calculation.

**Cement Production**

Generally, there are **two types of measures** for $CO_2$ emission reduction in cement industry:

1. Energy-related mitigation measures, encompassing:

   - changes in the production process type (switching from "wet" and "semi-wet" to "dry" and "semi-dry")
   - increase in the process energy efficiency (reduction in heat and power consumption per the produced unit)
   - switching to fuel with lower carbon content (switching from coal and petrol coke to natural gas or fuel oil)
   - use of fossil waste as alternative fuel (car tires, plastics, waste oil and solvents and the like)

2. Process-related measures (non-energy related mitigation measures), encompassing:

   - reduction of the clinker content in cement (increase of other ingredients/additives)
   - removal of $CO_2$ from the process flue gases

The feasibility analysis for individual emission reduction measures demands familiarity with the current conditions prevailing in the cement industry. There are four cement plants in Croatia - three producing clinker in "dry" process, and one using purchased (imported) clinker. The heat consumption rate in clinker production, as the process energy efficiency indicator, was between 3.26 and 4.48 GJ/t during the period 1990-1999. In clinker production, all types of fuel are used, however the fuel oil and natural gas predominate. It should be noted that all cement producers want to switch to coal and petrol coke as the basic fuel in clinker production, primarily because of their lower price. Waste as alternative fuel is used on a smaller scale in one of the cement plants. The clinker percentage in cement ranged from 68 to 88 percent during the period 1990-1999.

All the cement producers in Croatia use the "dry" procedure for clinker production, which is the most fuel effective. However, the heat consumption rate in clinker production does not compare with the best available practice results, which range between 2.9 and 3.2 GJ/t. The planned switching to coal and petrol coke as fuels with higher carbon content is not favourable from the greenhouse gases emission aspect, although it should be underscored that coal and petrol coke currently make about 81 percent of the total fuel consumption in the European cement industry.

Thus, the applicable greenhouse gases emission measures could include:

(a) Increase in energy efficiency of the clinker production process
(b) Switching to fuel with lower carbon content
(c) Decrease of the clinker percentage in cement
(d) Use of fossil waste as alternative fuel

The **increase in energy efficiency** of the clinker production process by decrease of energy consumption per ton of product is a measure incorporated in the baseline scenario because the increased process efficiency is primarily aimed at increase of the product competitive capacity in the market, rather than exclusively at the greenhouse gases emission. Removal of $CO_2$ from the flue gases, as the emission reduction measure, is still in the research stage, and it is not certain whether it will prove feasible for the cement industry.

Currently, Croatia has no instruments that would regulate the greenhouse gases emission either specifically from the cement production or from industry in general. **Switching to fuels with lower carbon content** is exclusively related to the fuel prices in the market. This measure envisages gradual switching to the fuel with lower carbon content, i.e. substitution of the current consumption of coal, petrol coke and fuel oil with natural gas in all the cement plants. It should be noted that this switching reduces only the emission from the energy-related segment of the clinker production, while the non-energy-related emission remains the same. This measure could result in emission reduction of up to 265 kt $CO_2$. The price of switching depends mainly on the fuel price difference and less on the investment into new equipment.

At the moment, the only **process-related measure** that can be applied to the $CO_2$ reduction is production of cement with lower clinker percentage, which reduces total production of clinker. The projections, which would take this measure into consideration, are unsafe since the cement industry products range primarily depends on the market demand. The percentage of clinker in the cement differs for different cement plants, and it ranges from 68 to 88 percent. Approximate data can be given that reduction of clinker by 1 percent results in reduction of $CO_2$ emission from the process by 5.2 kg $CO_2$ per ton of cement.

The measure (d), which is very attractive from the environmental standpoint, has not been considered for the time being since there is no sufficient data on the quantity of waste that could be cost-effectively turned into power in the cement industry.

#### 5.2.3.3. Waste Management

**Possible methane emission reduction measures and scenarios**

In addition to the measures from the baseline scenarios (**waste avoiding and recycling**), other possible measures for reduction of methane ($CH_4$) emission from the waste management sector correspond with the current technology development level in the developed countries and include various **thermal treatment procedures based on the waste-to-energy processes**, which bring double benefit as regards the greenhouses gases emission reduction:

- The greenhouse gases, carbon dioxide and vapor are the products of the thermal waste treatment. Their global heating potential is considerably lower than that of methane.
- The energy derived from waste reduces the quantity of fossil fuel necessary for generation of that energy, and consequently the carbon dioxide emission from combustion.

The main thermal treatment procedures used for municipal and similar waste include:

- **Incineration** of waste in waste-to-energy plants in which both heat and power are generated (cogeneration). Considering the number of constructed and planned facilities, this is the most widespread thermal municipal waste treatment technology. The waste-to-energy plants are often called the "waste incinerators" which thermally treat waste without energy generation; they are today generally not used for the municipal waste treatment.
- **Co-firing** of the waste-derived fuel and fossil fuels in large industrial furnaces, such as rotary kilns for production of clinker or the boiler furnaces of the coal-fired thermal power plants. This is an attractive solution because of relatively low costs but the conflict of interest and process-related problems have prevented its wider implementation so far. In Croatia, this process is mainly used for thermal treatment of the process waste. An example is the Koromacno Cement Plant, which co-fires the used car tires and waste oil.
- **Pyrolysis** of the municipal waste is a procedure under development, with only a few demonstration plants in developed countries, and it should find no application in the developing countries in due time.

As can be concluded from the above, the best option for Croatia in the near future is the use of the waste-to-energy plants as tested technology for thermal treatment of municipal and similar waste for larger cities and regions.

The described methane reduction measures have been used as the basis for development of **three reduction scenarios** for the methane emission from the waste management sector, as shown in Table 5-6.

*Table 5-6: Methane emission reduction scenarios*

| Scenario | Thermal treatment share (%) | |
|---|---|---|
| | 2010 | 2020 |
| S4 - “mini-thermal” | 20 | 40 |
| S5 - “midi-thermal” | 35 | 70 |
| S6 - “maxi-thermal” | 50 | 100 |

All three scenarios for the methane emission reduction in the waste management sector include, in addition to the thermal treatment, intensive implementation of measures of waste avoiding and recycling of separately collected waste, including the aerobic and anaerobic composting of separately collected biowaste. For the described scenarios of the methane emission reduction, with the presumed share of the waste thermal treatment from Table 5-6, the quantities of landfilled untreated and thermally treated waste are calculated, and the methane emission reduction expressed in equivalent quantities of carbon dioxide ($eqCO_2$), as shown in Table 5-7.

*Table 5-7: Methane emission reduction by thermal waste treatment*

| *Scenario /Year* | ***S4*** | | ***S5*** | | ***S6*** | |
|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2010 | 2020 | 2010 | 2020 |
| Disposed untreated waste (1000 t) and flaring | 1,200 | 1,000 | 1,000 | 500 | 750 | 0 |
| Thermally treated waste (1000 t) | 310 | 670 | 510 | 1,170 | 760 | 1,670 |
| Total (1000 t) | 1,510 | 1,670 | 1,510 | 1,670 | 1,510 | 1,670 |
| Methane emission reduction (1000 t eq$CO_2$) | 280 | 441 | 490 | 772 | 700 | 1,103 |

Table 5-7 shows the methane emission reduction in comparison to the baseline scenario. Each of the solutions assumes that the methane released from waste is flared, while the portion that is intended for power generation is used in a cogeneration plant, which reduces the fossil fuel consumption (fuel mixture for the power generation sector in the baseline scenario).

The major emission reduction is achieved under the "maxi-thermal" scenario S6, under which all generated waste would be thermally treated by the year 2020. Theoretically, this means that the landfill gas (methane) emission would be completely eliminated by 2020, which is less realistic than other emission reduction scenarios. The cost estimate for these measures shows that the costs of the emission reduction scenarios S4, S5 and S6 range from 11 to 18 USD/t $CO_2$, considering only reduction of the methane emission from the landfills. If the resulting reduction of the fossil fuel emission caused by use of waste is also considered, the cost of 7 to 11 USD/t $CO_2$ puts this solution among very attractive measures since it also resolves other environmental problems.

#### 5.2.3.4. Agriculture

In agriculture, the following measures have been considered:

(a) Energy-from-agricultural biomass
(b) Improvement in application of organic and mineral fertilizers aimed at nitrous oxide ($N_2O$) emission reduction
(c) Reduction in methane ($CH_4$) emission by decreased fermentation
(d) Anaerobic fermentation related to decomposition of organic manure and biogas generation
(e) Carbon storage in agricultural soil.

These measures are briefly described below, and the effects of the measures are summarized in Section 6. The measure under (e), carbon storage in agricultural soil is very efficient but it is still not considered in the international analyses, so it will not be presented here although the preliminary assessments have already been made.

**(a) Energy-from-agricultural biomass**

Use of biomass from agriculture in energy generation is described in the section covering the energy sector.

**(b) Improvement in application of the organic and mineral fertilizers aimed at nitrous oxide ($N_2O$) emission reduction**

**Organic agriculture**

To conserve the soil fertility, care must be taken of the organic matter exchange in soil. The organic fertilization is beyond replacement when it comes to the soil fertility maintenance, and not only because of the nutrient content. The soil fertility in high-input plant production is due, among other factors, to the correct application of organic and mineral fertilizers. Orientation towards organic agriculture, which demands exclusively organic fertilization, consequently demands an adequate level of animal breeding.

Application of the organic fertilizers may have positive economic effects (reduced production costs) although the yield will be somewhat lower. However, it is true that the application of organic fertilizers must ensure sufficient quantity of biogenic elements if the yield of the grown cultures is to be achieved.

The organic agriculture usually understands lower energy consumption and lower emission of carbon dioxide and nitrous oxide compared to the conventional agriculture. This is a consequence of reduced or completely phased out application of agrochemicals, storing of the organic matter in soil, wider crop rotation, and sometimes even smaller tillage depth. According to IPCC, the organic agriculture uses by 10-15 percent less energy than the conventional agriculture.

The organic agriculture promotion in Croatia should be scientifically based. Today, the organic agriculture is often based exclusively on ruling out the application of agrochemicals, while problems remain with use of organic fertilizers, inadequate tillage, crop rotation, and doubtful plant growing practices.

**Emission from mineral fertilizers application**

The mineral fertilization in Croatia is on average lagging far behind that in the developed European countries. It has further decreased during the last decade for well-known reasons. The approach based on the demand for sustainable agriculture is certainly good, however the sustainable soil management indicators have still not been determined in Croatia. Reduction of nitrogen fertilization is not a way to reduce nitrous oxide emission from application of the mineral fertilizers in Croatia. A Good Agricultural Practice Code must be prepared and the farmers educated on adequate use of the fertilizers.

The Good Agricultural Practice Code understands high efficiency and rational use of mineral fertilizers. The Code defines the methods for preparation of the nitrogen fertilization plans. Knowledge of specific needs of individual crops, estimate of the soil nitrogen content, and the methods of application might contribute to considerable decrease in losses, and therefore reduction in nitric oxide emission.

### (c) Reduction in methane ($CH_4$) emission from animal production

The simplest method of reducing methane emission from the animal production (fermentation during digestion and manure fermentation) is reduction in total cattle stock, particularly the ruminants. However, this solution is unacceptable for Croatia since the self-sufficiency of all the animal products, with exception of the poultry meat, is significantly less than 100 percent (e.g. 72 percent for beef, 85 percent for pork, 37 percent for mutton, 70 percent for milk and diary products). Since Croatia is considerably lagging behind the developed countries considering its (per capita) consumption of the animal products, the increase in the standard of living will certainly result in increased consumption. Furthermore, increase in demand during the tourist season (about 150,00 temporary inhabitant’s) results in increase in demand for food production by 10 percent over the self-sufficiency. Thus, in addition to increase in production intensity per production unit (genetic and management improvements), the number of domestic animals will grow in the future (Section 6).

**Feed Improvement through Mechanical and Chemical Treatment of Cattle Feed**

These treatments primarily include feedstuff with high lignin content (straw, corn stalks), that is generally not used as the domestic animal feed in Croatia. Straw and corn stalks are used as feed for low-productivity animals (ruminants and horses) or only in some phases of the production process (offspring, dry period). The straw can be chemically treated or mechanically shredded, which increases its digestibility and reduces the methane emission during the digestion. These practices are less significant for Croatia since the straw is used as bedding material rather than for the domestic animal feed. Croatia has ample natural resources (about 1.5 million ha of pastures) that are not used, although they are suitable for grazing of cows, sheep and goats.

Thus, the agricultural development strategy envisages use of these resources for the milk and meat production.

**<u>Feed Improvement through Organic and Inorganic Feed Additives</u>**

The feed additives that increase the growth and activity of rumen bacteria shall increase the bacteria digestion and reduce emission of methane per production unit. The microbial growth in the rumen is limited primarily by the concentration of the ammonia, available energy, phosphor, sulfur and other minerals. To increase the microbial growth in rumen and digestivity of feed, and to ensure better supply of the ruminants with proteins, urea and molasses can be added to the feed. They increase production and reduce methane emission. Use of feed with high percentage of bypass proteins (cotton, flax, soya, and sunflower) is the practice. In Croatia, sunflower and soya grits are added in the amount of 20-40 percent.

**a)** **Use of hormones** The growth hormone (bST), anabolic steroids and other preparations, such as clenbutherol and cimaterol, are used worldwide to increase production efficiency of the domestic animals. Use of these preparations is forbidden in Croatia.

**b)** **Reproduction efficiency increase** Improvement in reproduction efficiency of the domestic animals can result in reduction of methane emission since the number of animals necessary for offspring production is reduced ~~s~~. The techniques used in Croatia to that end include artificial insemination, estrus synchronization and embryo transfer.

**c)** **Rumen flora modification** Research into the rumen flora modification for more efficient decomposition of the cellulose and reduction in methane generation are topical in the world (McAllister et al., 1996). No research of this type has so far been conducted in Croatia.

**d) Manure Management and Procedures**

Over 80 percent of all domestic animals in Croatia are kept on small family farms. The animals are mainly fed on feed produced on those farms, and the manure is used for improvement in farm soil fertility. Therefore, most of the manure remains in the cycle, but for the part lost during storage, transportation and disposal in the form of animal product. These small farms do not attract interest of the public when the environmental issues are discussed. Although the family farms generate over 80 percent of manure, they do not cause significant pollution since the manure is, as a rule, used on the farmland. On the other hand, these farms are characterized for low production, so if the pollution index is expressed as quantity of waste per production unit, than these farms can also be referred to as the environmental polluters.

Most of the large farms have built lagoons, with capacities sufficient for 6-7 months of storage. Only two farms separate the solid from liquid phase. These lagoons are mainly located on the large diary farms, and on beeflings and hog breeding farms. The diary farms have sufficient land so the produced manure is used for fertilization. Croatia has only 20 such large diary farms and their waste management procedures are rather good closed-cycle, so they do not pose any environmental issue. The situation is similar at the large beefling farms. Since Croatia has about 1,500,000 ha of pastures which are not used, the agricultural development strategy proposes that they be primarily used in meat production (beef and mutton). Thus, we should expect more intensive introduction of meat animal sorts in Croatia (today, only several hundred cows are of meet sort). The management of the future meat animal farms envisages sustainable use of pastures and organic production in some locations (Lika, Gorski Kotar). Although manure has a comparatively small share in the methane emission, good management can considerably reduce emission of the detrimental gases. This particularly applies to the manure from large hog breeding and poultry farms, that have good manure handling and storage practices but insufficient land for its optimum use. These farms could be fitted, with small investment, with the anaerobic fermentation facilities for production of biogas.

### 5.2.3.5. Forestry

**Measures for Increase of Carbon Sequestration with Forest Biomass**

Under the conditions prevailing in the Croatian forestry, regarding the habitat and structural conditions in the forests, the forest management and forestry policy, the increase in carbon stock in the existing forests could be achieved by undertaking the following measures:

- **(a) Reforestation of productive bare forestland**
- **(b) Increase in forestland surface to be cared by thinning**
- **(c) Including of complete second age class forests (all the forests 20-40 years of age) into the thinning**
- **(d) Planting pioneer wood species (Aleppo pine, Austrian pine) on the degraded forests (garique and osier-beds)**
- **(e) Improvement in wood utilization efficiency and increase in harvesting**

The Croatian forestry sector attitude towards the forest protection and conservation is highly developed. The forests protected under the law cover 544,197 ha or 26 percent of the total forest surface area (Matic, 1999). Private forests in Croatia that cover 19 percent of the total forest surface area, are in poor condition, primarily because of the fragmented properties (0.7 ha per owner) and low timber-growing stock per hectare (82 $m^3$/ha). Improvement and increase in quality of these forests is not feasible under the present economic conditions and ownership conditions. This means that any increase in carbon, stocked in these forests, is not realistic at the moment.

**(a) Reforestation of productive bare forestland**

To increase the surface under forests, reforestation needs to be undertaken as a measure for expansion of the forests biological production-capacity. Croatia disposes of 331,000 ha of bare fertile forestland. About 30 percent of that land surface could be used for establishment of energy forests with 5-year rotation and expected increment of 12-15 $m^3$/ha, which gives an annual increment of 1.3 million $m^3$ on the surface of 100,000 ha. The remaining 231,000 ha of free surface would be used to plant the pioneer coniferous and deciduous wood species (pine, birch-tree, black alder, poplar-tree, willow, European ash, and the like). The expected increment of the cultures grown in this way is on average 8-10 $m^3$/ha, or 2.1million $m^3$ of annual increment on the entire surface. The reforestation could be carried out by 2020.

**(b) Increase in forestland surface to be cared by thinning**

Increase in forestland surface to be cared by thinning assumes that the present 1.7million $m^3$ of the timber-growing stock obtained from the previous yield or by thinning in the next period should give 2.2million $m^3$, which is currently the main yield. In this way, the quality would be improved, same as the biodiversity, stability and productivity of the thinned woods, and that would considerably increase the carbon stocked in the existing forests.

**(c) Including of complete second age class into the thinning**

Including of the complete second age class into the thinning would result in care by thinning on the surface of approximately 225,000 ha in the forest stand with the timber-growing stock of 20 million $m^3$ and increment of 1.8 million $m^3$. The thinning would include about 0.4 million $m^3$ a year. This would result in increase of carbon stocked in the forests, in the trees, underbrush and in forest soil.

**(d) Planting pioneer wood species on the degraded forest surfaces**

Planting of pioneer wood species (Aleppo pine, Austrian pine) on the degraded forest surfaces (garique and osier-beds) would result in increase of surfaces under high wood by 20,000 ha. Until 2020, this would result in growing stock increase by 1.5 million $m^3$ and corresponding increase in carbon stocked in these woods.

**(e) Improvement in wood utilization efficiency and increase in harvesting**

When speaking about the increase in wood utilization efficiency and harvesting, it should be noted that presently 60 to 70 percent of the forest stand mature for cutting and 50 percent of the biomass from the young forests is utilized. Further, the present stacked fuelwood production is 0.85 million $m^3$. It is forecasted that until 2020, the stacked wood production will increase to 1.2 million $m^3$. The demand for fuelwood is on increase, and it may be grown in short-rotation forests. Further, utilization of brushwood (under 7 cm in diameter on the thinner end) from the regular felling must be increased. Out of the total wood biomass, 20 to 25 percent remains in wood as brushwood with leaves or needles and tips (Sever et al., 1996). The quantity changes in dependence on the wood species, age and height. In mature beech stand about 14 percent of brushwood is expected as compared to the trunkwood, in oak stand 7 percent and in firtree 18 percent. In younger forest stands and smaller size trees, share of the brushwood is considerably higher. Taking that the average brushwood share is 20 percent compared to the trunkwood about 0.88 million $m^3$ of brushwood should be expected to remain on felling area during the period until 2020, and it might be included in production (Sever et al., 1996).

Another possibility for increase in share of fuelwood is utilization of the felling and primary wood processing waste. On average, felling, working and skidding waste could be accounted for with somewhat more than 20 percent of each timber stand and wood species. The expected wood waste from primary wood processing (sawmills) is 30 percent of waste from wood worked and transported from the forest to the wood working sites. The waste from the wood utilization is 1.1million $m^3$ and further 0.6million $m^3$ of fuelwood comes from the mechanical woodworking.

Increased efficiency of the wood utilization and more intensive harvesting practices could render 1.2 million $m^3$ of stacked fuelwood, 0.88million $m^3$ of brushwood in forests, 1,100,000 $m^3$ of felling and working waste, and 0.6million $m^3$ of primary wood processing waste (sawmills) by the year 2020. Total calculated quantity of the biomass as fuel is 3.78 million $m^3$.

Switching from fossil fuel to wood depends on the fuelwood production in the forests. According to the current data, 25 percent of annual felling in the state forests in Croatia is stacked fuelwood, 12 percent is stacked industry wood. The average consumption of fuelwood in Croatia is 0.18 $m^3$ per capita.

According to the FAO estimates, the average fuelwood consumption in undeveloped countries is 0.45 $m^3$ per capita, and in developed countries only 0.13 $m^3$ (Sever et al., 1996). According to the estimates, the Croatian consumption is 0.30 to 0.35 $m^3$ of fuelwood per capita, thus the actual production of fuelwood would be 1.45 to 1.67 million $m^3$. The differences are covered from the private forests, which render wood of poorer quality and have higher percentage of the fuelwood than of the timber.

It is assumed that by the year 2020 the realized annual felling would be 4.4 million $m^3$ of trunkwood. Out of this quantity, 60 percent will be round timber, and about 40 percent stacked wood. It is expected that 1.2 million $m^3$ will be fuelwood and 0.5 million $m^3$ industry wood.

The produced fuelwood, along with the biomass from different wood felling and working stages, will be a significant substitute for the fossil fuels.

The emission reduction resulting from the wood biomass use for energy generation is shown in Table 5-5, Power Sector section.