

Green Technologies – Assumption of Economic Recovery

Mario Šiljeg¹, Sandra Tucak Zorić², Aleksandra Anić Vučinić³, Sanja Kalambura⁴,
Vedrana Čemerin⁴ and Nives Jovičić⁴

¹ Energy Institute »Hrvoje Požar«, Zagreb, Croatia

² City of Zagreb, City Department of Energy, Environment and Sustainable Development, Zagreb, Croatia

³ University of Zagreb, Faculty of Geotechnical Engineering, Varaždin, Croatia

⁴ University of Applied Sciences Velika Gorica, Velika Gorica, Croatia

ABSTRACT

Green technologies include implementation of technological projects in the field of environmental protection through all associated components, such as: waters, soil, air or biodiversity. Hence, such projects potentially become a driving force of new economic momentum in the conditions of post-crisis recovery. In addition, the support of this segment by the institutions of the European Union, either in terms of organization through the establishment of rules and systems for monitoring and control of environmental protection measures, and most importantly in terms of finances, by supporting the development of infrastructure for environmental protection, is today an indisputable category. The aim of the research is to show the potential of green technologies in the initiation of economic activities based on content analysis of the collected literature, as well as to determine the correlation between green technologies and environmental protection and the measures for the reduction of the impact of energy sector on the greenhouse gas emissions.

Key words: *environmental protection, green technologies, greenhouse gas emissions*

Introduction

In early 2008, the world began to face an economic crisis at a global level, which has only very recently started to show signs of waning, or there appear to be indications of overcoming such unfavorable conditions. Entirely new and different economic relations have been created in this five-year period, characterized by a marked decline in consumption and exaggerated caution when making investment decisions. Likewise, the Republic of Croatia has faced a particularly strong crisis in the real sector somewhat later, in 2009. The result at the both national and global level is a distinct decline in economic activity. Consequently, the need to find new efficient measures and areas for rapid cessation of such, in the long run unsustainable situation, has become clear.

Green technologies include implementation of technological projects in the field of environmental protection through all associated components, such as: waters, soil, air or biodiversity. Hence, such projects potentially become a driving force of new economic momentum in the conditions of post-crisis recovery. In addition, the

support of this segment by the institutions of the European Union, either in terms of organization through the establishment of rules and systems for monitoring and control of environmental protection measures, and most importantly in terms of finances, by supporting the development of infrastructure for environmental protection, is today an indisputable category.

Material and Methods

The aim of the research is to show the potential of green technologies in the initiation of economic activities based on content analysis of the collected literature, as well as to determine the correlation between green technologies and environmental protection and the measures for the reduction of the impact of energy sector on the greenhouse gas emissions.

Based on the defined research aim, we set the following tasks:

- Determine the importance of using green technologies.
- Collect data on the impact of individual sectors on climate changes.
- Analyze the possibilities of implementing strategic projects to increase energy efficiency, mitigate pollution caused by traffic, as well as utilize renewable energy resources on the case study of Zagreb.
- Consider funding opportunities for green projects.
- In order to accomplish individual tasks and realize set research goals, the following research methods have been selected:
- Descriptive analysis method to analyze general concepts.
- Logical-scientific method to collect data, process it and draw conclusions.
- Induction and deduction method to draw conclusions and write the paper.

Green technologies and climate change

Until today, over one thousand cities worldwide adopted local action plans due to climate change, in which they defined goals to reduce greenhouse gas emissions¹.

Climate change is one of the most challenging problems facing the world in the 21st century².

The issue of climate change with potential risks it carries already threatens to become a source of a new financial crisis on a global scale in the near future, with consequences worse than the economic-financial crisis of 2008. Concentrations of greenhouse gases in the atmosphere, primarily CO₂, have reached a level which can be called the upper value of ecological sustainability, it is therefore necessary to consider the short and long-term measures to be adopted and implemented to reduce these impacts as much as possible³.

Using the example of the city of Zagreb, it is evident that the largest share (63%) of the total CO₂ emissions has the building sector, followed by the transport sector with 36%. Emissions of natural gas (635 kt CO₂) and electrical energy (560 kt CO₂) are the most prevalent in the building sector, while in the transport sector the largest amount of emissions is produced by the consumption of diesel (558 kt CO₂) and gasoline (417 kt CO₂). If the industry sector of the city of Zagreb, whose estimated CO₂ emission in 2008 amounts to 382910 t, is added to the building, transport and public lighting sectors, the total CO₂ emission in Zagreb amounts to 4.03 t per capita. Therefore, the city of Zagreb has the possibility, but also the obligation to become a leader in the country in directing its economic potential into sectors which will contribute to the significant growth of domestic and foreign investments, while opening a large number of jobs, which will likewise exert positive influence on the climate change mitigation. Those are primarily strategic projects of increasing energy efficiency, reducing pollution caused by traffic, as well as the exploitation of renewable energy resources such as geothermal energy, watercourse energy

of river Sava, biomass energy, and particularly significant energy from waste⁴.

In order to achieve these goals, it is important to focus attention on the realization of a number of prerequisites:

- Cooperation of city authorities with the scientific and university community for the purpose of developing and researching new technologies of using renewable energy sources and the evaluation of their potential.
- Connecting scientific and university community with the economic sector and intensive cooperation of those entities.
- Starting production of finished products, or their components depending on the complexity of the technological process.

Development of infrastructural projects – investment into the use of renewable energy sources, in a way that minimizes in objective possibilities the share of the import component in all phases of their realization, with the purpose of fulfilling conditions for the realization of the previous two prerequisites.

Potential of the city of Zagreb in the economic-financial sense is certainly not sufficient for such ambitious goals. Therefore, it is necessary to take advantage of the imminent accession of the Republic of Croatia to the European Union, as well as the possibilities of using European structural funds. The prerequisite is an intensive informational and educational campaign which would thoroughly inform all interested public, particularly entrepreneurial and professional public, on the possibilities.

Results

Renewable energy sources

In order to stop (reduce) climate change and its ever more evident consequences, it is necessary to very rapidly develop energy systems which use/produce energy from renewable sources⁵. This approach can easily be applied to cities.

The development of Zagreb energy system should be closely linked to environmental criteria, which should be evaluated as factors facilitating success, and not as additional implementation costs. The struggle against increasingly pronounced climate change at the global level likewise imposes gradual reduction in dependence on fossil fuels, coal and oil, as well as attributing greater importance to the use of renewable energy sources and the increase in energy efficiency. As a strategic guideline, the Republic of Croatia has adopted a plan of increasing energy efficiency by 20% until 2020 through the development of energy efficiency projects, as well as an increase in the share of RES in the total energy consumption by 20% by the same deadline.

In addition to natural potentials, and in order to accept such a path of development, the city of Zagreb should certainly take into account other factors in favor of such a determination, such as: instability of energy

prices, dependence on energy imports, supply insecurity and ultimately the fulfillment of international obligations (EU directives, Kyoto Protocol).

Technological-industrial potential of the city of Zagreb definitely classifies it as a potential Croatian leader in the production of systems of renewable energy sources, or such plants, whether concerning the construction of wind power plants, systems for the use of biomass, smaller hydroelectric power plants or solar systems in the production of heat and electricity. To realize this goal, it is necessary to enable transfer of developed and advanced technologies to companies and entrepreneurs, since independent development of new technologies is not realistically possible in the short run. A good solution is biogas produced from sludge from the purification of municipal wastewater (example Stockholm), which would represent significant cost savings for the city budget, in addition to all ecological benefits.

However, the necessary prerequisite is to provide incentive measures to investors through easier access to loans. There is an array of measures which could significantly help to realize this goal in the short term, and particularly worth mentioning are the subsidized interest rates on loans, and investments through investment funds.

Efficient consumption of electrical energy

Energy efficiency management in cities helps the local government to focus on energy projects which have a powerful impact on the environmental aspects and financial sustainability. Research has shown that there is a strong correlation between investments in the public lighting sector and the reduction in carbon dioxide emissions⁶.

Energy efficiency measures can be realized, inter alia, through the savings in electrical energy consumption. An intensive educational campaign can contribute to the larger use of energy efficient machines and appliances in the population. A very important issue is the lighting, where the City can encourage gradual exclusion from use of traditional mercury lamps and the introduction of energy-saving bulbs in the households through various models.

The city of Zagreb manages the system of electric and gas lighting which combines over 105 000 lighting fixtures (lamps) and more than 130 000 light sources (light bulbs). The share of public gas lighting in the total lighting is almost negligible.

Adjustment to the measures defined in the Act on the Protection from light pollution (OG RoC114/11)⁷, which regulate the introduction of more efficient and environmentally friendly system of lighting public areas, as well as the more efficient use of the resources of the Environmental Protection and Energy Efficiency Fund, in cooperation with HEP, it is possible to achieve significant energy efficiency in the city's public lighting system.

Building construction

Building sector of the city of Zagreb can be divided into three sub-sectors:

- Residential and public buildings, as well as enterprises owned by the City of Zagreb.
- Commercial and service activities' buildings not owned by the City of Zagreb.
- Residential buildings (excluding residential buildings owned by the City of Zagreb).

There are several aspects from which the possibilities of applying energy efficiency in the field of building construction can be assessed, such as the application of passive heating and cooling, ventilation, using daylight and the use of solar energy. Energy efficiency in the building construction likewise depends on the city's energy performance such as the building density, city texture and building layout. Energy efficient architectural-construction solution must start with the optimal selection of the building location and orientation. Wind rose for Zagreb shows dominant wind flows from the north and north-east, showing the need for adequate protection of buildings from dominant winds through the organization of settlement, while providing sufficient air flow around buildings to achieve the high quality of natural ventilation. With the protection from cold winds, it is necessary to enable the best possible quality of the penetration of solar energy through glass façade designs, and through the achievement of sufficient distance between buildings. Due to the climate features of Zagreb, for the penetration of solar energy are optimal southern building façades – eastern and western façades in principle cause uneven heat gains within buildings.

CO₂ emissions from the building sector of Zagreb include emissions from the consumption of electrical and thermal energy, as well as those from fuel combustion. The largest share in the total CO₂ emission constitutes the emission from natural gas with a share of 36.1%, followed by the indirect emission from the electricity consumption (31.8%), emission from the thermal energy consumption (26.5%), while the CO₂ emission from fuel oil and liquefied petroleum gas (LPG), is less than 6%. Considering the building sector, the largest share in total emissions is constituted by households (63.7%). Buildings with commercial and service purposes contribute with a share of 28.3%, while buildings and enterprises owned by the City contribute with 7.9% to the total emissions. The emission of CO₂-ekv from fuels has likewise been calculated, so it amounts to 1 762 kt CO₂-ekv for the building sector.

Thermal renovation of residential buildings

More than half of the residential buildings built before the 1970s in the city of Zagreb do not meet the minimum energy requirements for the conservation and energy efficiency.

The total number of households of the City of Zagreb amounts to over 280 000 in 2008, with a total surface area of over 18 million m². A little less than 1000 GWh of elec-

trical energy is spent in the residential area, which provides specific electricity consumption of approximately 46.62 kWh/m². Remediation of the current situation is becoming an increasingly attractive investment, since it is entirely profitable through an acceptable period of time, through reduced expenses for energy. Among several measures, the improvement of thermal insulation and the installation of efficient heating and cooling systems should be particularly emphasized. Through basic reconstruction of the building (by improving the thermal insulation properties of the outer shell of the building-insulating façades and roofs, as well as changing the windows and exterior doors), heat losses through exterior walls can be reduced by at least 50% and savings of more than 30% achieved. Mobilization of private owners of apartments and houses to invest into thermal remediation of buildings is possible with the securing of loans with subsidized interest, either by the City, or from the funds of the Environmental Protection and Energy Efficiency Fund.

Transport

The transport sector is a major consumer of energy, but also a source of greenhouse gas emission with a steady upward trend. Therefore, it plays a significant role in the challenges of the measures for the reduction of emissions which affect climate change⁸.

Transport sector of the City of Zagreb contains three sub-sectors:

- Vehicle fleet owned by the City of Zagreb.
- Public transportation in the City of Zagreb area.
- Private and commercial vehicles.

Road traffic accounts for 89% of the total energy use in transport, and public transportation of approximately 1.6%. Therefore, special importance should be given to the development and intensification of other forms of transport, primarily of goods, but also people. Besides environmental protection, the main goal should be rationalization of costs and reliability.

City traffic is the greatest source of air pollution in the city of Zagreb. Without significant interventions in the city transportation system, the traffic congestion is such that traffic control is not an effective measure. The introduction of environmentally friendly vehicles for public transport is a measure which can significantly contribute to the improvement of air quality, and in parallel with this, to the reduction in greenhouse gas emissions. Due to the limited possibilities of further development of environmentally most acceptable tram system, buses should use environmentally friendly fuels, particularly renewable energy sources. These include biofuels, i.

e. biodiesel mainly for buses with diesel engines, where the situation of the existing fleet can be improved with only minor modifications and the use of diesel and biodiesel fuel.

In the total fuel consumption for Zagreb transport sector, by far the largest share of energy consumption is generated by private and commercial vehicles. In accordance with this, the reduction in greenhouse gas emissions from transport sector is to a considerable extent based on the increase in the share of public transport, but also on the education and promotion of environmentally friendly modes of driving.

The total emission of CO₂ of the Zagreb transport sector amounts to approximately 1007 kt, of which more than 94% constitutes the sub-sector of private and commercial vehicles. The share of CO₂ emissions by vehicles owned and used by the City of Zagreb in the total CO₂ emission from Zagreb transport sector amounts to 2.8%.

Discussion and Conclusion

Sources of funding green projects

After determining the list of socially acceptable and justifiable projects, it is necessary to consider funding possibilities as necessary prerequisites for their implementation.

Those are primarily one's own sources of capital accumulation, as well as the regional and cohesion policy of the European Union, achieved through the EU funds. This category includes several possibilities, such as: European Regional Development Fund (investments intended to reduce the uneven development between regions), European Social Fund (fund for the unification of chances for social inclusion), Cohesion Fund (co-financing of the trans-European transportation network projects, environmental protection, energy sector and similar).

Projects in the environmental sector can have a strong contribution to the post-crisis social recovery, since they would enable the activation of the most significant developmental potentials of the Republic of Croatia, or the City of Zagreb at the micro level. An additional value is the creation of a large number of new jobs, reduction of the trade deficit and import dependence. Besides the ecological component, the reduction in greenhouse gas emissions, these projects increase the value of the total area and simultaneously the standard of living for the population. Projects from the field of energy and energy efficiency create the conditions for significant energy savings in the business sector and household sector.

REFERENCES

1. SETO KC, CHRISTENSEN P, Remote sensing science to inform urban climate change: mitigation strategies (Urban Climate, 2013). — 2. O'BRIEN KL, LEICHENKO RM, Glob Environ Change, 10 (2000) 221. — 3. CORFEE MORLOT J, HOHNE N, Glob Environ Change, 13 (2003)

277. — 4. Energy Development Strategy of Zagreb, (2011). — 5. TODOROVIĆ MS, Energy Build, 48 (2012) 180. — 6. RADULOVIĆ D, SKOK S, KIRINČIĆ V, Energy, 36 (2011) 1908. — 7. Protection from light pollution Act (NN RH 114/11) — 8. LI J, Energy policy, 39 (2011) 3503.

S. Kalambura

*University of Applied Sciences Velika Gorica, Zagrebačka cesta 5, 10410 Velika Gorica, Croatia
e-mail: sanja.kalambura@vvg.hr*

ZELENE TEHNOLOGIJE – PRETPOSTAVKA OPORAVKA GOSPODARSTVA

S A Ž E T A K

Zelene tehnologije poticaj su implementaciji razvojne politike i investicija prema relativno novijim sektorima kao što su: čistije tehnologije, energetska učinkovitost, zelena gradnja, obnovljiva energija, zeleni promet, vodno gospodarstvo, gospodarenje otpadom, održiva poljoprivreda i šumarstvo te održivi turizam. Zelene tehnologije omogućavaju tehnološki napredak, reindustrijalizaciju, i usmjeravanje poslovnog sektora i infrastrukture prema prirodnim kapacitetima, kako bi se postigao ubrzani napredak kojeg će pratiti učinkovito korištenje energije, smanjenje emisija stakleničkih plinova, manja produkcija otpada i nepotrebnih nusproizvoda. U radu je dan prikaz mjera koje doprinose dugoročnom razvoju Republike Hrvatske, koji treba biti naglašeno održiv i okolišno prihvatljiv, a temelji se na korištenju i učinkovitom gospodarenju prirodnim resursima.

