INCENTIVE MECHANISM FOR BIGGER USAGE OF RENEWABLE ENERGY SOURCES IN CROATIA

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Abstract: Ever since the industrial revolution the social development has been founded on cheaper fossil fuels, neglecting how energy transformations increasingly affect the environment. The consequence has been the atmosphere pollution and global warming. In the beginning of 2007 the European Commission sent the Communication "An Energy police for Europe" to the European Council and the European Parliament. That Communication is an important document in which the Commission considered many energy issues, with the goal of creating economy with high energy efficiency by 2050, with sustainable increase of production from renewable energy sources and development of energy technologies of the future. In the European Union today the electricity production from renewable energy sources ranks third and these sources have a great potential of growth, with clear advantages in the sense of environment protection. Today Croatia cannot produce enough electricity to cover its own needs, so it imports on average 30% of electricity per year. Taking into consideration potentially large possibilities of renewable energy sources, the Croatian approach to the development of the incentive mechanism for greater electricity production from the renewable energy sources is elaborated in the paper. It is estimated that Croatia could increase its electricity production from the renewable energy sources by 532 GWh in the course of the next two years, which would cost 16 million EUR (in order to cover higher costs of such production). Therefore an incentive mechanism needs to be developed and implemented that would ensure that the electricity price of one kWh produced from the renewable energy sources is as low as possible.
Keywords: Electricity production, Renewable energy sources (RES), Incentive mechanism, Electricity price.

1. INTRODUCTION

It can be safely assumed that the modern society will be going through the process of energetic transition in the next decades, based on principles of sustainable development. Renewable energy sources (further in the text: RES) will be an important part of that transition. Experts have been studying RES issues for years and many books and studies have been written. For example, The Lti-Research Group (1998) analyzed the complex problem of integration of RES into the European energy system. In the future, RES should: enable increased production of electricity at reasonable prices; partly substitute electricity production from conventional sources; ensure ecological electricity production; contribute to the security of supply combined with the permanent growth of consumption.

In Europe, a relatively energy efficient region, there is a question of balance among sustainable development, competitiveness, and security of supply. It is considered that RES can contribute to this balance. In this respect, the Directive 2001/77/EC is particularly important as it defines the necessity to increase the share of RES in the production of electricity from the 13.9% in the year 1997 to as much as 22.1% in the year 2010. The Directive regulates the distribution of obligations among state members, stresses the promotion of RES as a special priority "due to the safety and diversification of energy supply, environment protection, and economic cohesion", and establishes the obligation to issue guarantees for the origin of the RES. EU is already entering the new energy period. That period, as opposed to the current situation, will not be characterized by the high percentage of fossil fuels in the energy transformations as the foundation of development. The world oil crisis (with its ups and downs) had a significant influence on national economies of the EU member states. After the growth of prices of oil derivatives in the last two years, it is clear that the future energy issues should be redefined. In January 2007, in a publication called "An Energy police for Europe", the European Commission has introduced a new joint European energy policy. An important objective of that policy is to create a highly efficient energy policy of the European Union by 2050. This will be accomplished by establishing a unified energy market, followed by a significant growth of electricity production from RES and developing new technologies. The portions of petroleum and natural gas in the primary energy production should be greatly reduced as the result of taken measures (25% petroleum and natural gas, 75% RES expected in 2030). That would be a huge step toward the necessary greenfield option of the developed economy of tomorrow. It is now understood that the present, general approach to the energy issues is unsustainable and that massive usage of fossil fuels has a negative influence on the climate changes. That is why RES are accepted as a solution. Moreover, there are several different applications of RES, as shown in Table 1.

Table 1. RES by mode

RES	Wind energy	Hydropower	Solar energy	Biomass
Transport				+ (Biofuels)
Thermal			+ (Solar thermal)	+ (Biogas, Solid biomass)
Electricity	+	+	+ (Photovoltaic)	+ (Solid biomass, Landfill gas)

Certain forms of RES have a really good perspective. For example, biomass (the oldest form of energy utilized by people) has a huge potential and its portion in the primary energy production could reach 30% by 2050. It should be noticed that burning biomass in small thermal power plants can produce steam for heating (in households and industry) and electricity. Currently, 58% of the primary energy produced from RES (in the EU) is from wooden biomass. In addition, it is noticed a huge growth of wind turbines

electricity production and the number of wind turbines has increased all around the world. According to the American Wind Energy Association (AWEA) data, the USA had the biggest increase in the number of wind turbines, and has the total installed wind energy capacity of 11,600 MW (it is the second largest increment of capacity, after the natural gas). The State of Texas has become the leader in wind energy production in the USA and it is expected to double its total wind energy capacity by 2015 and to increase it four times by 2025. Several factors have contributed to these results, such as: reduced production costs; opening of the transmission networks for the electricity produced from wind turbines; federal tax relieves for wind energy.

However, considering the variety of RES technologies, all characteristics of a particular source should be taken into account when analyzing its cost effectiveness and efficiency. This subject has been already covered in several articles. For example, in a recent work, De Rosa (2005), considered fundamentals of RES.

Development of RES is important for many reasons and it is beneficial for the state and for the energy companies. State's interests in the increased RES usage are:

- diversification of energy sources and better security of supply,
- using local resources instead of importing,
- Kyoto protocol implementation and environmental protection (the most important strategic goal in the future),
- development of the domestic industry,
- regional economic development,
- job openings.

Goals of the energy companies are:

- controlling a significant market share,
- extra income,
- obtaining a competitive advantage,
- pleasing the customers.

Every state should establish its own market support mechanism for RES which would include:

- incentive system through the Renewable Energy Feed In Tariffs (REFIT),
- the inclusion of externalities through energy taxes, for example carbon dioxide emission taxes - such as Banovac & Pavlović specified in their work (2004),
- tax relieves for the customers that buy energy produced from RES,
- incentives for building the RES facilities,
- development of the consumers awareness by implementing Green pricing and Green certificates.

Sustainable development must be accompanied by the environment friendly energy production and mass usage of RES. Together with energy efficiency and security of supply this should be the main characteristic of the future development of the energy sector. However, it is important that the price ratio between the green energy and the energy from conventional facilities become more favorable than today. That would reduce the effects of incentives and grant competitiveness of the new RES projects.

2. RES, ENERGY EFFICIENCY AND ENVIRONMENT PROTECTION

Today, there are efforts to develop sustainable energy production, increase energy efficiency and reduce pollution and greenhouse gases emission. The objective of the energy efficiency program is to use less energy by optimizing the production process and maintaining the same level of quality. Therefore, term "energy saving" is being avoided because it is associated with life standard and development limitation. The goal of energy efficiency program is just the opposite – life standard and development stimulation with lower energy consumption.

The next important issue is the impact of energy transformations on the environment (carbon dioxide pollution above all) and global climate changes. The Climate Change Performance Index - CCPI is shown in Table 2. It shows the attitude of countries regarding the climate changes (Table 2 contains data from the biggest ten countries in the world, 2007 in relation to 2006, and portion of global carbon dioxide emissions). The Index includes several factors and therefore it gives a realistic valuation of measures taken by a certain country, like improving energy efficiency, subsidies for RES and emissions trading. Above all, RES are important because they help reduce the carbon dioxide emissions and improve energy sustainability.

Table 2. Important factors for the biggest ten countries - emitters of CO_2

Country	CCPI order (2007 / 2006)	Global carbon dioxide emissions share (%)	Primary energy sources supply share (%)	Global GDP share (%)	Global population share (%)
England	2 / 3	2.02	2.08	3.18	0.94
Germany	5 / 5	3.19	3.10	4.13	1.30
India	9 / 10	4.15	5.10	5.96	17.00
Japan	26 / 34	4.57	4.75	6.56	2.01
Italy	31 / 38	1.74	1.64	2.86	0.92
Russia	42 / 48	5.75	5.72	2.50	2.26
South Korea	48 / 49	1.74	1.90	1.76	0.76
Canada	51 / 46	2.07	2.40	1.81	0.50
USA	53 / 52	21.82	20.72	20.47	4.63
China	54 / 29	17.94	14.49	13.81	20.51
TOTAL	-	64.99	61.90	63.04	50.83

In 2005, the EU started European Emissions Trading Scheme - EU ETS, a program that involves more than 12,000 energy facilities, including power plants. This program determines the total amount of emissions allowed for each facility. These conditions can be met by emissions trading or by reducing emissions. In 2006, the value of all transactions under the EU ETS program was 18.1 billion €. On the emissions markets, a price is allocated to the ton of carbon dioxide equivalent (the emission right), which impacts variable costs of the electricity production in thermal power plants. Consequently, growth of the variable costs due to the emissions costs causes the electricity prices to grow. These market conditions influence the profit amounts. Therefore, power plants with lower carbon dioxide emissions have higher profits.

The next important thing to consider is the aspect of externalities' influence. For example, conventional thermal power plants have higher external costs than other power plants which use different technologies. The main reason is emissions of sulphur, nitric and carbon oxides (coal fueled power plants have the highest emissions, and natural gas fueled power plants have the lowest). Wind power plants have very low external costs. Actually, high external costs of conventional power plants have triggered the development of technologies that tend to reduce greenhouse gas emissions and have a more efficient burnout of fuel (mostly natural gas). The achieved economic and other results of the EU ETS program implementation show that it plays an important role in the growth of competitiveness of low-emission technologies, e.g. biomass.

The European Renewable Energy Council (EREC) has introduced a future scenario. According to this scenario, half of all consumed energy in the EU should be produced from RES by 2040. Table 3 shows a share of each renewable source in the total EU energy consumption (a prediction for 2010).

Table 3. RES in total energy consumption in the EU

RES	1995 Eurostat	2001 Eurostat	Goal for 2010	Average annual increase 1995-2001 (%)	Necessarily average annual increase 2001-2010 (%)
Wind	2.5 GW	17.2 GW	40 GW	37.9	9.8
Small hydro-power plants	87.1 GW	91.7 GW	100 GW	0.9	1.0
Solar PV	0.04 GWp	0.26 GWp	3 GWp	36.6	31.3
Biomass	44.8 Mtoe	56.5 Mtoe	135 Mtoe	3.6	10.3
Geothermal	2.72 Mtoe	3.43 Mtoe	5.2 Mtoe	3.9	4.7
Solar-thermal	6.5 Mlo	11.4 Mlo	100 Mlo	9.8	27.2

Data source: www.erec-rene

3. CROATIAN RES STRATEGY AND LEGISLATION

Today, Croatia cannot produce enough electricity to cover its own needs. Hence, Croatia imports about 30% of electricity per year. There are efforts to reduce energy dependency and the importance of the RES is increasing. In 1999, the Croatian Government has adopted proposal of strategy of energy development. The strategy includes new 300 MW of installed capacity from RES by 2010, when renewable sources will produce 5.8% of total energy (1,139 GWh).

Croatian legislative framework supports the RES production and anticipates subsidies for the renewable sources and a clearly positive attitude towards RES is published in the Energy Law (Official Gazette, issue no. 68/01 and 177/04). It is accentuated that RES usage is in Croatia's best interest. Thus, the Croatian RES legislative was harmonized with the EU standards in the first half of 2007. The following sub-Acts were adopted:

- Tariff system for generation of electricity from renewable energy sources and cogeneration,
- Executive order on compensations for generation of electricity from renewable energy sources and cogeneration,
- Executive order on minimal share of electricity generated from renewable energy sources and cogeneration which generation is stimulated,
- Regulation on usage of renewable energy sources and cogeneration,
- Regulation on gain the status of eligible producer of electricity,
- Executive order on biofuel quality.

However, despite the positive attitude toward RES, only hydro power is used to a larger extent, and only in hydro power plants. The total installed capacity in hydro power plants is 2,063 MW, which is 54% of total installed capacity. There are 21 large and 6 small hydro power plants in the Croatian electric-power system. The first commercial wind power plant was built on the island of Pag. It started operating in February 2005 (7 wind turbines with 6 MW of total installed capacity). The second wind power plant was built near Sibenik, with installed capacity of 12 MW. Other wind power plants are being built, with even more installed capacity. Regarding this, it was necessary to adopt the Executive order on minimal share of electricity generated from the renewable energy sources and cogeneration which generation is stimulated, because this act determines the minimal share of electricity produced from RES and cogeneration that every supplier is obliged to buy. A production of 1,100 to 1,200 GWh in 2010 would represent between 5.7 and 6.0% of total energy consumption. Therefore, the planned 5.8% of total

electricity produced from RES would be in compliance with the EU criterion (12.5% without large power plants).

Croatia should have over 300 MW of installed power in wind turbines and over 100 MW in other RES by 2011. For this reason, the specific subsidies in electricity price are important, as well as the subsidies for producers of equipment for production of electricity from alternative sources. Executive order on compensations for generation of electricity from renewable energy sources and cogeneration sets fees for stimulating RES application. The electricity supplier has to include these fees into the price of electricity in order to collect funds for settle the incremental costs for RES stimulation. Fees will total 0.12 c€/kWh in 2007 up to 0.47 c€/kWh in 2010 (without the VAT). An obligation to pay these fees has all electricity buyers, and Market operator disposes the collected funding. Furthermore, the Tariff system for generation of electricity from the renewable energy sources and cogeneration (further in the text: Tariff system) sets the eligible producer right on stimulant price for delivered electricity which it receives from the Market operator. The tariff system is based on reasonable business, maintenance, replacement, construction or reconstruction costs of the RES or cogeneration. The aim of the above mentioned regulations is setting a system of collecting funds and stimulations, which is based on price-based approach for the producers of energy. There is still left to issue the green certificates regulative, which acknowledges that the electricity is produced from RES, and which producers get for every unit of electricity transmitted to the grid (evidence of producing 1 MWh from RES), and to set the subject which will hand out the international-recognized certificates.

Beside the already mentioned the Executive order on bio-fuel quality, other resolutions on the percentage of bio-fuel in overall fuel quantity and in turnover on domestic market in 2007 (22,000 tons), as well as stimulant measures for oil-seed rape for producing bio-diesel are issued. This sets the base for a successful production and utilization of bio-fuel. A national goal of 5.75% of bio-fuel in total motor fuel consumption has identified (for the Croatian market by the year 2010).

4. CROATIAN APPROACH TOWARDS ESTABLISHING THE INCENTIVE MECHANISM FOR GREATER ELECTRICITY PRODUCTION FROM THE RES

Taking into consideration potentially large possibilities of RES, the incentive mechanism for greater electricity production from the RES is developed in Croatia. It is estimated that Croatia could increase its electricity production from the RES by 532 GWh in the course of the next two years, which would cost 16 million EUR (in order to cover higher costs of such production). It is important that an incentive mechanism should be developed and implemented for ensuring that the electricity price of one kWh produced from the RES is as low as possible.

4.1 EU Incentives for the RES usage

Unless the environment protection expenses are included in the production price, the RES are not competitive to the fossil fuels. Therefore it is necessary to introduce the incentive mechanisms. Nevertheless, any introduced incentive mechanism has to be economically efficient and must not reduce market competitiveness. The RES subsidy mechanism is based on the following principles:

1) electricity production from the RES,
2) installed RES power plant capacity,
3) fee for connecting to the grid,
4) transparency of influence of prescribed incentives on demand and supply of electricity produced from the RES.

The above mentioned RES support mechanism has to include: Green Certificate trading rules, RES produced electricity prices warranty, incentive taxation for RES electricity producers and national subsidy for finance invested in the RES facility construction.

The prime incentives for the RES electricity production are REFIT and Green Certificates, combined with the mandatory quotes. These measures may combine with the investment subsidies and fiscal measures, public tender system and grid connection fees. The amount of grid connection fee can be crucial for starting RES projects and regarding this, the incentive for connecting to transmission and distribution grid is also important for RES facilities. The REFIT tariffs have appeared to be efficient in states with big wind turbine capacity, such as Germany, Spain and Denmark. The amounts of the REFIT tariffs are paid-out to the electricity producers, while the minimum redemption price is regulated by the government based on specific methodology. The advantage of this type of incentive is guaranteed redemption price, which ensures longtime security to the future RES electricity producer, as well as to the potential investors. The disadvantage of the REFIT tariffs is that they discourage the electricity producers regarding competitiveness because the tariffs are set in advance. Thus, the difference between real production costs in RES facilities and the set electricity price (incremental costs) is paid by the customers through the increased bills. On the other hand, Sweden, Poland, Belgium and Great Britain have introduced Green Certificates with Quota Obligations as the market model for encouraging RES utilization. Green Certificates, issued by the subject independent from the producers and suppliers, do not include mandatory subsidies either from the state or from the buyers, but are based on government regulated mandatory quotes of the RES produced electricity for electricity suppliers. There is division in the Green Certificates system on market priced electricity and the Green Certificate of the produced green energy which producer sells to the suppliers. Therefore, the Green Certificates represents the value of the ecological benefit from produced green energy, by which the supplier satisfies the imposed RES electricity proportion. However, there could be a problem with buyers' willingness to buy high-priced green energy, which demands for highly developed ecological awareness of the buyers.

4.2 Croatia in Euro-integration processes and possibilities of implementing incentives for electricity production from RES

Croatia, as an EU member candidate, has adjusted the power sector reform concept according to EU rules. In the scope of harmonized Croatian energy legislation, the existing RES projects have a stabile regulative and incentives which will appreciate ecological and other values of their utilization. According to the EU policy, it is set that RES have to total 1,139 GWh or around 5.8% of the overall electricity consumption by 2010. Also, all RESs (including HPPs over 10 MW) have to participate with 6,750 GWh or 34.4% in overall electricity consumption by 2010. This equals a linear increase of 220 GWh a year. Regarding this, it is necessary to introduce an efficient RES support mechanism, as is shown in Fig. 1.

The incentive mechanism and the funding procedure are determined by the Tariff system for generation of electricity from the renewable energy sources and cogeneration. Producers have guaranteed prices and duration conditions that are set in advance. The incremental costs are divided among all electricity buyers, depending on their total consumption. In fact, green energy producers receive a fixed guaranteed tariff during a specific term, and additional costs (difference between real production costs in RES facilities and market electricity price) pay all electricity buyers. Regarding the Executive order on compensations for generation of electricity from the renewable energy sources and cogeneration (Official Gazette, issue no. 33/07), in Croatia all buyers pay a fee of 0.12 c€/kWh in the year 2007, which will increase to 0.47 c€/kWh by 2010. Calculation prices for each RES are based on the assumption that after 12 years each facility will pay off.

Tariff system determines that an eligible producer has a right to an incentive price. Fee for producing electricity from RES stimulation is set separately for each technology. The Market Operator, which concludes contracts on buying electricity with the eligible producers, manages the financial resources acquisition system and divides funds among eligible producers.

Tariff amounts for delivered green electricity, according to the Tariff system are shown in Table 4. That tariff amounts are corrected by the correction factor, dependent on the percentage of the domestic components in a RES project. Croatia encourages domestic industry to engage development and production programs of constructing wind turbines, bio power plants, solar collectors, etc., because that increases employment. Therefore, the Tariff system contains the correction factor value for share of the domestic component in a RES project, in a way that $k_o = 1$ when the percentage of domestic component is above 60%, $k_o = 0.93$ when the percentage is below 45%. Finally, if the percentage of domestic component is between 45 and 60%, the correction factor is calculated from the following equation:

$$k_o = \frac{7 \cdot p}{1500} + 0.72 \qquad (1)$$

where p is percentage of domestic component in a RES project identified by the Croatian Ministry of Economy.

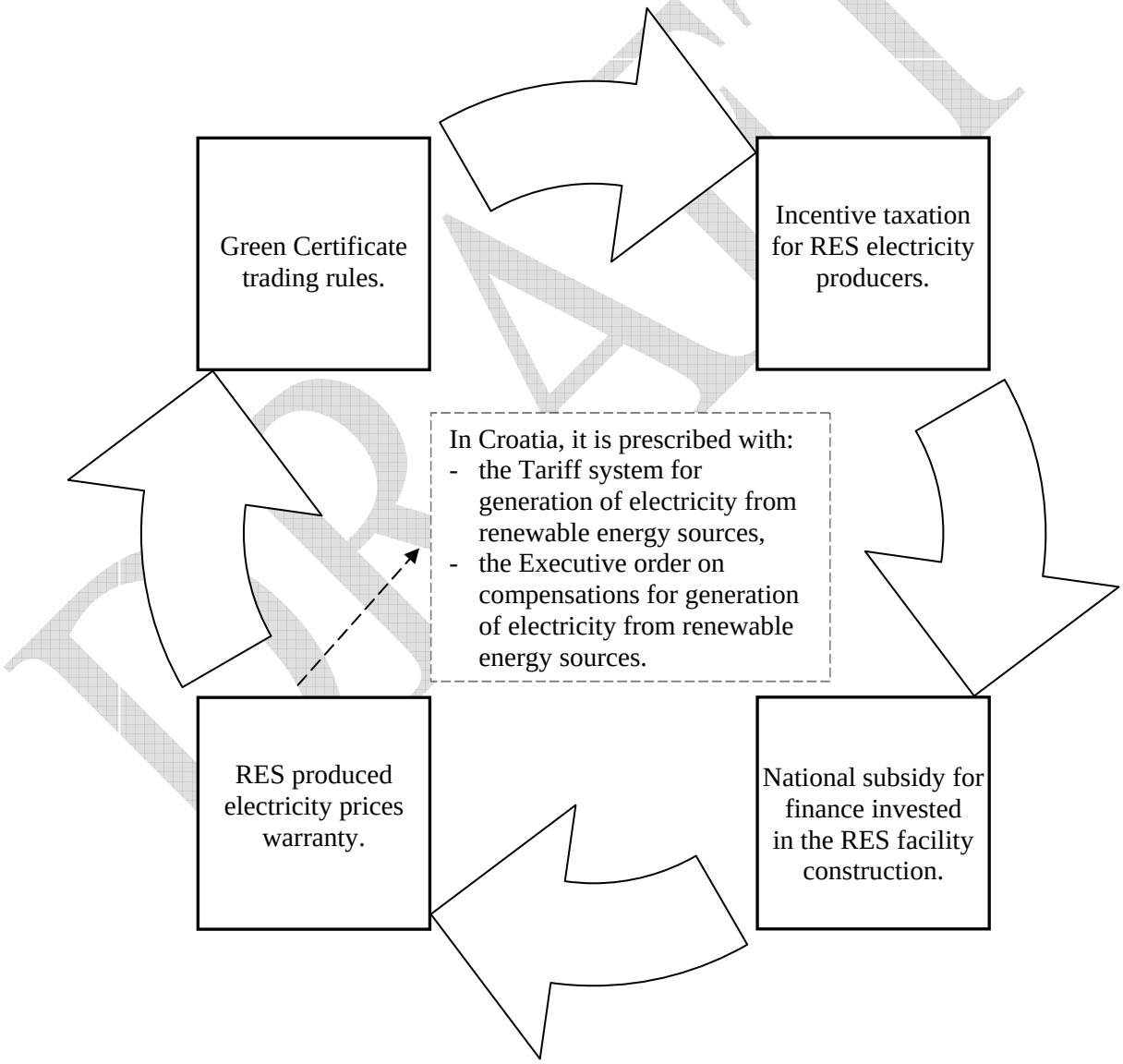

Figure 1- Scheme of RES Incentive Mechanism.

The stimulant price for the electricity produced by the RES facility, while the electricity redemption contract is valid (the duration of stimulant price is 12 years), is annually corrected with the Consumer price index:

$$C_{t(RES)} = C_{t-1(RES)} \cdot I_{t-1(RES)} \quad (2)$$

where $C_{t(RES)}$ is stimulant price for the current year, $C_{t-1(RES)}$ is stimulant price for the previous year, and $I_{t-1(RES)}$ is the Consumer price index for the previous year.

In a recent work (Raguzin et al., 2007), it is noticed that the investments in RES equipment in Croatia, between 2002 and 2006, were approximately 15,000,000.00 €. Since the investments were growing in that period, a multiple growth is expected in the next few years. It is important to emphasize that at growing RES utilization a stimulation system has to be upgraded, because when the RES proportion becomes significant, the described approach could lead to an electricity market distortion.

Table 4. Croatian tariff amounts for RES facilities

TYPE OF RES FACILITIES		Tariff amount c€/kWh*
A. Facilities up to 1 MW connected to the distribution grid		
Solar plants with installed capacity	up to including 10 kW	45.94
	more than 10 kW and up to including 30 kW	40.54
	more than 30 kW	28.38
Liquid bio-fuel power plants		4.86
Power plants on deponium gas and gas from the waste waters purification facilities		4.86
Power plants on other renewables (tide and ebb, sea waves, etc.)		8.11
Wind turbines		8.65
Geothermal power plants		17.03
Hydro power plants		9.32
Power plants on solid biomass	forestry and agriculture	16.22
	wood processing industry	12.84
Power plants on biogas from agricultural plantations and organic waste and agricultural and food processing industry waste		16.22
B. Facilities above 1 MW connected to the distribution or transmission grid		
Liquid bio-fuel power plants		4.86
Power plants on deponium gas and gas from the waste waters purification facilities		4.86
Power plants on other renewables (tide and ebb, sea waves, etc.)		6.76
Wind turbines		8.78
Geothermal power plants		17.03
Hydro power plants with installed capacity up to including 10 MW, with production in a year:	up to 5,000 MW h	9.32
	5,000 – 15,000 MWh	7.43
	more than 15,000 MWh	5.67
Power plants on solid biomass	forestry and agriculture	14.05
	wood processing industry	11.22

Power plants on biogas from agricultural plantations and organic waste and agricultural and food processing industry waste	14.05

* *Based on exchange rate 1 € = 7.40 kn*

5. CONCLUSION

Member states of the EU, even with great penetration of RES, reveal needs for new electricity production capacities. Obliged redemption prices of electricity produced from RES are implemented. Growing utilization of RES is enabled after introduction of the specific measures, e.g. guaranteed redemption prices, CO_2 fees, stimulations on RES utilization, etc. At the beginning of the year 2007, the EU recommended a platform for the new energy policy which should be based on creating a unified electricity market, energy efficiency, sustainable growth of RES electricity consumption, and development of new energy technologies. Therefore, the RES promotion should be continued, foremost by using the Renewable Energy Feed In Tariffs (REFIT).

Basically, Croatia has a great share of electricity produced from RES in its overall electricity production. For example, in 2006 hydro power plants produced 6.07 GWh of electricity, which makes 43% of overall electricity production. On the other hand, there were only two wind plants in Croatia with total installed capacity 17.2 MW, and other RES types are negligible. However, there are big plans for realization of various RES types, which are supported by adoption of the sub-Acts in the first half of 2007. Although the effects of introducing stimulant measures in Croatia will be appreciable barely in a few years, it is obvious that introducing stimulant measures in Croatia represents a big step towards the sustainable development, environment protection and security of supply. The adopted Tariff system for generation of electricity from the renewable energy sources and cogeneration is based on the Feed In Tariffs and guarantees a stimulant redemption price during the next 12 years to the producers. The Tariff system should stimulate broader RES utilization, moreover because Croatia, currently negotiating to become an EU member, should obtain a reference of 20% of electricity produced from RES until 2020. This will not be an easy task considering that Croatia is behind developed countries in that area, but the goal is set to increase the RES electricity production to 5.8% of overall electricity production in Croatia by the year 2010.

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