THE SMALL HYDRO POWER PLANTS – NEW DEAL OF THE SERBIAN ENERGETIC

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***Abstract*--The influence of organized investment in small hydro power plant building on the development of deregulating electric market in Serbia is presented in this paper. The results of analysis of energetic, economic and ecological benefits that can be derived from the process are also presented. In the process of initiation, preparation and forming of such approach participants were Ministry of Mining and Energy of Republic of Serbia, Electric Power Industry of Serbia, Energy Efficiency Agency of Republic of Serbia and Energy Regional Euro Efficiency Center Kragujevac. They prepared comprehensive pre-study entitled "The Master Plan for Small Hydro Power Plants Building in Serbia". The aims of that pre-study were to:**

- **preliminary investigate the influence of organized investment in small hydro power plants building on the development of deregulating electric market in Serbia;**
- **simulate energetic, economic and ecological possibilities of different variants of such approach for the next fifteen years;**
- **establish the optimal scenario for organized building of small power plants.**

All necessary political and administrative decisions related to the future development of Serbian national energetic sector are made and Electric Industry of Serbia had been already restructured. In this work, it has been attempted to identify methods for optimal management of the small power plants building in this new and for Serbian surrounding yet unsatisfactory clear economic conditions.

Besides the results of simulation of potential energetic, economic and ecological benefits from the Master plan realization, basic characteristics of original simulated mathematical model and developed software for determination of these characteristics are shown in this work.

***Index Terms*--Costs, CO_x, electric power, ecological advantages, master plan, economic advantages, small hydro power plant, mathematical modeling, NO_x, optimization, ash, income, profit, reduction of the emission, scenario, simulation, power, SO_x, tempo of the building, expense, water flow**

I. INTRODUCTION

Since the first big oil crises during the 1970-s, there were few campaigns related to the problem of utilization of small water flows in Serbia. The campaigns were initiated by the government and they were ended as media events. The only exception is one such campaign in the 1980-s, when the Cadastral with about 800 location for the building of small hydro power plants (SHPP). Today, this result serves to all persons that try to admonish that at the Serbian territory unused energy resources with 500 – 600 MW of power exists so the views of state planners must be direct toward it.

For the first time the Energy Law instituted SHPP as future reality in Serbian Electric Energy System (EES) and stated true energy significance of small water flows. Benefits of SHPP use in the Law present challenge to business people and capital but in order to achieve organized exploitation of this renewable energy potential the relevant state agencies must support a series of directed steps.

Therewith, it should be mentioned that present and future investors in energy of small water flows are interested in:

- precise locations for SHPP building;
- the amount of energy that can be produced at every location;
- building costs of every concrete SHPP;
- payback time of the investment;
- estimation of the profit that can be earned during the time of SHPP exploitation.

This does not complete the list of potential equations that interested investors and businessmen can ask. They will be interested in:

- geo-morphological characteristics of the site;
- hydrological characteristics of water flows;
- the ownership of the land where small hydraulic accumulation and SHPP can be built;
- methodology, terms and conditions for obtaining the concessions from the competent state agencies;
- the position of the nods of distributive electro-energetic network where SHPP can be connected;
- technical and other conditions and terms for connection of SHPP to the network;
- possibilities of physical approach to the locations for the building of SHPP, etc.

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In order to stimulate the building of SHPP investors must have prepared catalogues of potential constructional organizations, SHPP manufactures and services for their maintenance.

All mentioned data that should be at disposal to potential investors of SHPP building showed that in process of their collection and systematisation relevant state agencies should be engaged. If the state did not involve timely and pertinently in these activities the building of SHPP will be elemental which can lead to the creation of destabilizing subsystem of EES. In this case, the subsystem will be a disturbance on deregulated market of electric power.

Evaluating existing Cadastral of potential SHPP locations it can be concluded that the data from the Cadastral do not satisfy investor needs so there is a necessity for its reinvestigation, complement and modernization.

Regional Euro Energy Efficiency Center Kragujevac (REEECK) in cooperation with Serbian Energy Efficiency Agency (SEEA), created pre-study "The Main Plan for the Building of Small Hydro Power Plants in Serbia" (MP) evaluating current situation in field of so called "small energetic" "Ref. [1]".

It was foreseen by the pre-study that SEEA coordinate the complete task. With the strategic support of Ministry of Mining and Energy, EES and partner organizations and experts from Serbia and abroad, SEEA should help that MP will be realized in the next 15 years.

The first phase comprises updating and evaluation of existing data from more then 800 locations for SHPP building investigated twenty years ago. The result of the phase will be:

- The limited number of deeper studied current locations and prospective building of SHPP at these locations in the future;
- The database visualized at geodetic electronic map of Serbia and set as a portal on web site of SEEA. The database will be accessible to potential investors through the internet with adequate reimbursement.

The second phase will be dedicated to questions of investing and building of SHPP at specific number of locations that have higher priority according to their investable characteristics. Those locations are abstracted from the total number of locations from the first phase.

The third phase comprises follow up of research of new locations for SHPP building out of already 800 detected. According to up to date research, water flows in the Serbia have significant potential for building of SHPP in the range of power literary classified as mini and micro power plants. Naturally, the phase comprises updating the web database created during the first phase.

The fourth phase is continuation of the second and third phase. It is related to building of SHPP according to priority list established during the first and third phase. The complete system with 1900 SHPP installed will be created at the end of the phase.

Different scenarios of MP realization were studied in the pre-study "Ref. [1]". Using the appropriate software created for the purpose, series of interesting facts that enable creating the scenario with optimal relation between the tempo of SHPP building and the most significant ecological, energetic and economic consequences of MP realization were obtained.

II. Relationship between MP and started process of deregulation of electric energy market in Serbia

Following two facts were concerned during the work on the pre-study "Ref. [1]":

- adequate political and administrative decisions were made in Serbia and preparations for market deregulation are undergoing;
- Electric Power Industry of Serbia (EPS) mastered relevant methods and tools and it started to reconstruct.

In the pre-study "Ref. [1]" it was considered that the range of current and future activities is not completely and/or adequately presented to public. It was also considered that Serbian electro energetic system would be soon confronted with following necessities to:

- complete and reconstitute its new corporative structure;
- improve its business performances in competitive conditions at the market;
- establish the optimal concept of control of Serbian electro energetic assets in the fields of maintenance of equipment and energy objects and reinvestment of assets in new plants with bigger number of investors due to conditions imposed by deregulated market of electric energy.

It should be emphasized that relevant government agencies and private investors will strongly insist on development of new assets in a form of SHPP for the exploitation of national hydro energy resources, as important way for achieving better economic results, for strengthening the market balance and especially for reducing the emissive of fuel gasses because the biggest part of actual environmental pollution is related to electric energy production in thermal power plants.

By initiation of GP modeling, activities on promotion of using all others renewable sources of energy will be launched, and Serbia will be directed toward EU targets, defining within demand for significantly increasing of participation of green energy sources in total energy to be produced until 2010.

With conducting the main targets of MP, within establishing of integral information system related to available locations for SHPP as well as with stakeholders (citizens, media, political and economic factors) awareness arising, in relatively short period, positively effects (economic, energy and environmental) will be viewed by all factors from production to consumption of electricity. The main benefit of MP on community and economy is in making preconditions for:

- efficiently and environmentally sound using of hydro energy from Serbian small water resources;
- environmental and resources protection as well as increasing of participation of renewable sources of energy;

- decreasing the consumption of domestic and imported non-renewable energy resources;
- increasing of domestic economy level, opening new production lines and new employments.

When one emphasizes the social benefit of the GP realization, it should be point to one of Serbian most priority targets defining with demand to follow and to harmonize standards and legislation in area of environmental protection and energy efficiency with EU adopted practice. The key instrument of EU environmental protection and energy efficiency politics is free access to information concerning environmental issues. With this directive, all national administrations in EU are obliged to provide information to each person or organization, with no interest about reason for that request. Having previous in mind, analysis, data management and information about natural resources and environment, as well as establishment, development and maintenance appropriate data base about available location for building small hydropower plants is in compliance with EU demand. Development of Internet portal devoted to available locations for building SHPP may be observed, not only from energy stand point, but as a contribution to development of national environmental information system, that is precondition for accessing to European Environment Information and Observation Network (EIONET) as a collaborative network of the European Environment Agency. Therefore, realization of GP will be one of initial step in process of accessing of Serbia in one such complex system like EIONET, that is sophisticated way to perform European integration in area of environmental protection and energy efficiency.

III. Basic schemes of simulation model

REEECK developed and tested contemporary and original software in order to estimate adequacy and profitability of MP conduct. The software enables easy variation of all input data. As output result, it gives a big number of important data that can be very useful for analyzing and establishing the optimal scenario of MP realization.

Due to limiting space and purpose of the paper, the number of output quantities is reduced in a way that enables simple way of understanding possibilities of MP realization. The possibilities are related to ecological (due to reduced lignite consumption) and financial benefits. For obtaining the more objective picture of benefits that comes with MP realization, performances of its realization that can be achieved in every possible scenario, even in the case the ecological benefits of reduced lignite consumption are excluded from the calculation as well as incomes from side activities (tourism, agriculture, etc), are calculated but not presented in the paper.

III.1. Input data

Analysis of energetic, economic and ecological justification of MB was based on following presumptions:

- number of locations for SHPP buildings in the first and the second phase is 800;
- average installed electric power of SHPP that will be built on the locations in the first and the second phase is 610 kW;
- number of locations for SHPP buildings in the third phase is 1100;
- average installed electric power of SHPP that will be built on the locations in the third phase is 70 kW;
- average prices for SHPP building are: 1700, 1900, 2100 [EUR/kW of installed electric power];
- prices of electric energy produced at SHPP are 0.04, 0.05 and 0.06 [EUR/kWh] in 2004; it was presumed that the price of electricity will rise by 2 % in every two years;
- economic lifetime of SHPP is 20 years;
- real interest rate is 4.5 %;
- loan repayment periods were: 4, 6, 8, 10 and 12 years;
- electricity produced in SHPP reduce the consumption of "Kolubara" lignite with following characteristics: C=23.28%, H=2.28%, O=9.82%, N=0.62%, S=0.26%, A=10.96%, W=52.80% and H_d=7,771[kJ/kg];
- during combustion in boiler with air factor λ=1.3 combustion products have following composition and characteristics: $(CO_2)_s$=14.48%, $(CO_2)_w$=11.14%, $(H_2O)_w$=23.5%, $(O_2)_w$=3.79%, V_{RS}=3.006[m^3/kg]; V_{RV} =3.918[m^3/kg]; V_L=3.065[m^3/kg];
- average efficiency of domestic thermal power plants is $\eta_{TE} = 0{,}28$;
- this equivalence is valid:

$$1\,[MWh\ \ produced\ \ electricity] \equiv$$
$$\equiv 1.654\,[tons\ \ of\ \ equivalent\ \ domestic\ \ lignite]$$

- in order to provide adequate environmental protection, during electricity production with domestic lignite in thermal power plant following quantities must be isolated from combustion products:
    - 0.385 [kgCO_x/kWh of produced electricity];
    - 0.0102 [kgNO_x/kWh of produced electricity];
    - 0.0043 [kgSO_x/kWh of produced electricity] and
    - 0.1813 [kg ashes/kWh of produced electricity].

Following data are also adopted:

- price of CO_x reduction from exhaust gasses is 8.5 [EUR/tons CO_x];
- price of NO_x reduction from exhaust gasses is 19.3 [EUR/tons NO_x];
- price of SO_x reduction from exhaust gasses is 13.5 [EUR/tons SO_x];
- price of ashes reduction from exhaust gasses is 12.3 [EUR/tons ashes].

III.2. Standard "simulation" scenarios

Using the developed software, the realization of MP could be simulated as:

Simulation scenario {(a-b-c-d)-e-f-k-i-j} , (1)

where the marks are explained in the Table I.

III.3. Basic mathematical expressions used in simulation software

For creating the mathematical model of possible MP scenarios, certain presumptions were used. They can be described with mathematical formulae presented in this subchapter.

The growth of produced electric energy in newly built SHPP will be realized according the next mathematical relation:

$$P_{eg} = c + \mathrm{a} \cdot (T_g - 2004)^{\mathrm{b}} \ , \qquad (2)$$

TABLE I.

(a-b-c-d)	*e*	*f*	*k*	*i*	*j*
MP phases which realization is simulated. Next combinations can be realized: 1-2-3-4; 1-2-4 i 3-4	SHPP building costs [EUR/kWh] .	Loan repayment time [year]. Every even number from the group (4,…12) could be chosen as a loan repayment time.	Percentage of total available power determined in phases *a*, *b* and *c* that can be used in phase *d* up to set based year. As a base year, any number from the group (2006,..,2016) could be chosen.	Amount in [%] of total produced electric energy in SHPP that defines the incomes from side activities.	Price of electric energy produced in SHPP established for the base year 2004.

where:

P_{eg} $[kW]$ - total power of SHPP that will be built in current year of fifteen years of realization of the fourth MP phase. With alternative scenarios it is foreseen that by the end of the year 2012. SHPP with total power of 10% or 20% or 30% or 40% or 50% or 60% or 70% or 80% or 90% or 95% of total preliminary estimated power 565,000 kW will be set and started on locations with highest priority;

T_g $[year]$ - current year of MP realization;

a, *b*, *c* - coefficients mathematically determined in every simulation process.

Economic benefits of produced electricity were obtained according to:

$$\begin{aligned} D_{elek} &= D_{elekP} + C_{T_g} \cdot A_{elek} \ , \\ A_{elek} &= 24 \cdot [(\eta_{T_P} \cdot P_{eP} + \eta_{T_g} \cdot P_{eg}) \cdot \\ &\quad \cdot (T_g - T_{(g-2)})] \cdot n_{rdg} \end{aligned} \qquad (3)$$

where:

D_{elek} $[EUR]$ - income from the produced electric energy at the end of current two-year period of the fourth phase;

D_{elekP} $[EUR]$ - income from the produced electric energy before the beginning of current two-year period of the fourth phase

A_{elek} $[kWh]$ - amount of electric energy produced by all SHPP during the current two-year period of the fourth phase;

C_{T_g} $[EUR/kWh]$ - average price of electric energy during the current two-year period of the fourth phase (for the based year 2004 the price is 0.05 [EUR/kWh]);

η_{T_P} $[-]$ - degree of SHPP operative readiness during the current two-year period of the fourth phase (they were built before the phase) (adopted value is 0.98);

P_{eP} $[kW]$ - electric power of SHPP that were built before the beginning of the current two-year period of the fourth phase;

η_{T_g} $[-]$ - degree of SHPP construction and operative readiness during the current two-year period of the fourth phase (they were built during the phase) (adopted value is 0.5);

T_g $[year]$ - end of the current two-year period of the fourth phase;

$T_{(g-2)}$ $[year]$ - beginning of the current two-year period of the fourth phase;

n_{rdg} $[-]$ - number of annually working days of SHPP during the current two-year period of the fourth phase (adopted value is 295);

$24\,[h]$ - number of daily working hours of SHPP during the current two-year period of the fourth phase;

Income from environmental savings can be calculated as:

$$\begin{aligned} D_{ekolos} &= D_{CO_x} + D_{SO_x} + D_{NO_x} + D_{pepeo} = \\ &= (k_{CO_x} + k_{SO_x} + k_{NO_x} + k_{pepeo}) \cdot A_{eleku} \ , \end{aligned} \qquad (4)$$

where:

D_{ekolos} $[EUR]$ - *costs of elimination of all adverse products* that could be generated by combustion of equivalent domestic lignite when producing the same amount of electric energy as SHPP, during the current two-year period of the fourth phase and from the initiation of MP till the beginning of the current two-year period;

D_{CO_x} $[EUR]$ - *costs of elimination of* CO_x (CO_2 and CO) from fuel gasses that could be generated by combustion of equivalent domestic lignite when producing the same amount of electric energy as SHPP, during the current two-year period of the fourth phase and from the initiation of MP till the beginning of the current two-year period;

$D_{SO_x}\left[EUR\right]$ - *costs of elimination of SO_x* (SO_2 and SO) from fuel gasses that could be generated by combustion of equivalent domestic lignite when producing the same amount of electric energy as SHPP, during the current two-year period of the fourth phase and from the initiation of MP till the beginning of the current two-year period;

$D_{NO_x}\left[EUR\right]$ - *costs of elimination of NO_x* from fuel gasses that could be generated by combustion of equivalent domestic lignite when producing the same amount of electric energy as SHPP, during the current two-year period of the fourth phase and from the initiation of MP till the beginning of the current two-year period;

$D_{pepeo}\left[EUR\right]$ - *costs of elimination of ashes* from fuel gasses that could be generated by combustion of equivalent domestic lignite when producing the same amount of electric energy as SHPP, during the current two-year period of the fourth phase and from the initiation of MP till the beginning of the current two-year period;

$A_{eleku}\left[kWh\right]$ - produced electric energy from the initiation of MP till the end of the current two-year period of the fourth phase;

$k_{CO_x} = 3{,}273\cdot 10^{-3}[EUR/kWh\ prod.\ el.en.]$ - unit price of CO_x removal from fuel gases generated by combustion of equivalent domestic lignite;

$k_{SO_x} = 5{,}805\cdot 10^{-4}[EUR/kWh\ prod.\ el.en.]$ - unit price of SO_x removal from fuel gases generated by combustion of equivalent domestic lignite.

$k_{NO_x} = 1{,}969\cdot 10^{-4}[EUR/kWh\ prod.\ el.en.]$ - unit price of NO_x removal from fuel gases generated by combustion of equivalent domestic lignite;

$k_{ash} = 2{,}230\cdot 10^{-3}[EUR/kWh\ prod.\ el.en.]$ - unit price of ashes removal from fuel gases generated by combustion of equivalent domestic lignite;

$k_{PD}\ [-]$ - income coefficient from side activities.

Crediting of SHPP construction was simulated in accordance with domestic bank policies. It is possible to select loan period and analyze it effects on profit.

IV. LAY OUT OF ENERGETIC AND ECONOMIC RESULTS OF MP MATHEMATIC SIMULATION

At fig. 1. to 14. the results of MP simulation are shown. They were obtained according the following simulation scenario:

Simulation scenario {(1-2-3-4)-1900[EUR]-4[years]-(10%-95%)-20%-0,05[EUR]}, (5)

where arguments ***{(1-2-3-4)-1900[EUR]-4[years]-(10%-95%)-20%-0,05[EUR]}*** in equation (5) corresponds to arguments ***{(a-b-c-d), e, f, k, i, j}*** from equation (1).

V. CONCLUSION

Firstly, from the structural point of view, MP is demanding challenge considering activities that should be done and consequences it will have on future development of Serbian electro energetic system. MP is significant because it engages experts with different education and enables international cooperation. Secondly, the part of MP preparation costs could be covered with international donations. Thirdly, MP will enable the estimation of problem that EES will face during the continuing process of transition and electric energy market deregulation. So, it can serve as a range for preparation of relevant state agencies, EPS and EES to adequately and qualitatively react on transitional challenges. Fourthly, successful MP realization will open the door for domestic and foreign private investors in EES through the SHPP building and concessions for the building.

It should be emphasized that MP will help in:

- bringing adequate laws in this activities that should simplify and short procedures for obtaining licences for building and use of SHPP;
- preventing unsystematic SHPP building and "polluting" electro distributive network (distortion of electric parameters in the network) that can be created with massive, dilettante building and plugging of SHPP to electro distributive system as well as their inadequate maintenance during exploitation;
- securing that SHPP be a reliable source of electric energy at the whole territory of Serbia in case of eventual climate and other emergencies;
- efficient and ecological use of energy potential of so called small water flows in Serbia;
- environmental and conventional energy recourses protection;
- increasing the concurrency of Serbian economy, opening new production lines and increasing employment;
- directing Serbia toward projected EU targets, defined within demand for significantly increasing of participation of green energy sources in total energy to be produced until 2010.

VI. LITERATURE

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[5] M. Babić: **Smoll hydro power plants potentials and perspectives, 1st International Energy Fair,** Belgrade, October 04 – 07, 2005

VII. Biographies

Milun Babić was born on September 16, 1950 in Sjenica, Serbia. Lives in Kragujevac and Belgrade and works as a full professor at Energy and Process Engineering Department, Faculty of Mechanical Engineering, University of Kragujevac.

Fields of interest: turbomachines, applied fluid mechanic, process engeneering, hydraulics and pneumatics, energy efficiency, renewable energy sources, eco-technologies, computer simulations.

Milan Despotović was born in Kragujevac, Yugoslavia, on August 11, 1968. He graduated at the Faculty of Mechanical Engineering, University of Kragujevac in 1990. At the same university, he got M.Sc. degree in Mechanical Engineering in June 1994, and Ph.D. degree in Mechanical Engineering in June 2002.

Fields of interest: Computer Simulations, Applied Fluid Mechanics, Computational Fluid Dynamics, CFD Applications, Energy & Computer Aided Energy Engineering.

Nebojša Jovičić was born on March 2, 1963 in Kragujevac, Serbia. Lives in Kragujevac and works as an assistant professor at Energy and Process Engineering Department, Faculty of Mechanical Engineering, University of Kragujevac.

Fields of interest: Applied hydraulics and pneumatics, process engineering, energy management, renewable and alternative energy sources, eco-technologies

Dobrica Milovanović was born on December 30, 1954 in Desimirovac, Serbia. Lives in Kragujevac and works as an full professor at Energy and Process Engineering Department, Faculty of Mechanical Engineering, University of Kragujevac.

Fields of interest: Applied hydraulics and pneumatics, process engineering, energy management, renewable and alternative energy sources, eco-technologies

Nenad Pavlović was born in 1959 in Lazarevac, Serbia. Graduated at the Mechanical Faculty of the Belgrade University. He defended his master's thesis at the same faculty. Now he is director of Serbian Energy Efficiency Agency.

Fields of interest: energy efficiency, renewable energy sources, complex energy generation, district heating systems, power-related technologies, monitoring and diagnostics, clean coal combustion technologies, revitalization of thermal power plants.

Vanja Šušteršič was born in Kragujevac, Yugoslavia, on 15.05.1967. He graduated at the Faculty of Mechanical Engineering, University of Kragujevac in 1985. At the same university, he got M.Sc. degree in Mechanical Engineering in 1995, and Ph.D. degree in Mechanical Engineering in 2004.

Fields of interest: applied hydraulics and pneumatics, energy efficiency in industry, renewable energy sources, eco-technologies, computer simulations.

Dušan Gordić was born in Prijepolje, Serbia on October 26, 1970. PhD in Mechanical Engineering from the University of Kragujevac in 2002. Assistant professor in areas of fluid power & control and energy and environment at the Faculty of Mechanical Engineering in Kragujevac.

Fields of interest: applied hydraulics and pneumatics, energy efficiency in industry, renewable energy sources, eco-technologies, computer simulations.

Scenario of SHPP building based on different percentage (k = 10%, 20%,…,95%) of total power that can be generated by SHPP at Serbian territory until the year 2012.

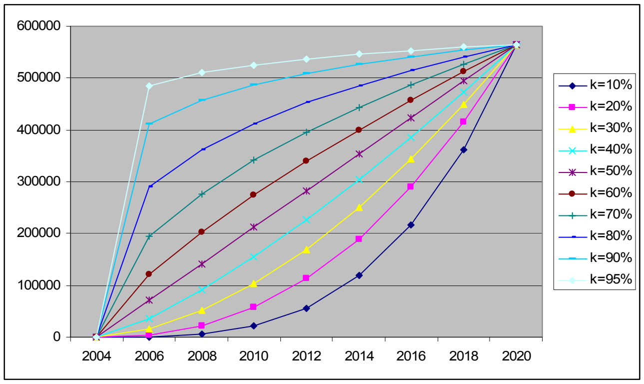

Fig. 1. Tempo of SHPP building during MP (Power P_{eg} [kW] of built SHPP during current period])

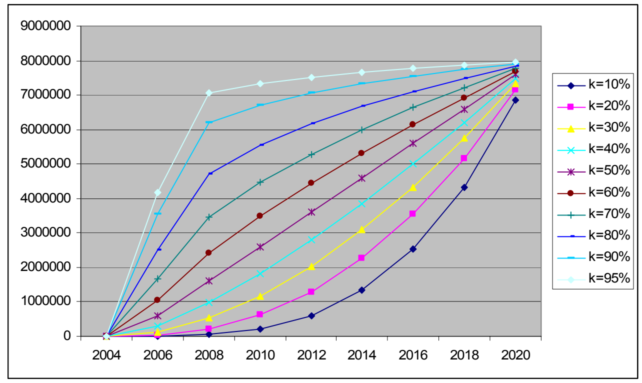

Fig. 2. Electric energy A_{eleku} [MWh] produced by SHPP during MP

Scenario of SHPP building based on different percentage (k = 10%, 20%,…,95%) of total power that can be generated by SHPP at Serbian territory until the year 2012.

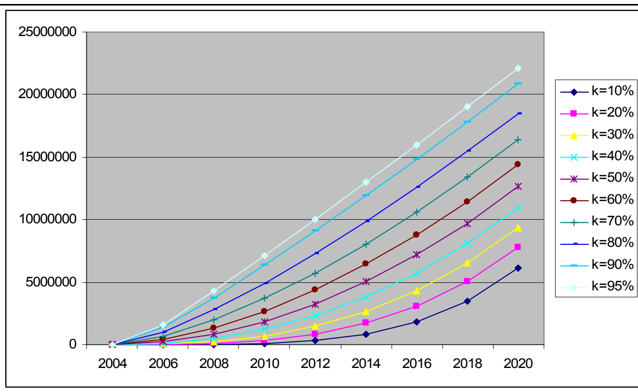

Fig. 3. Reduced CO_x from the begging of MP in [tons]

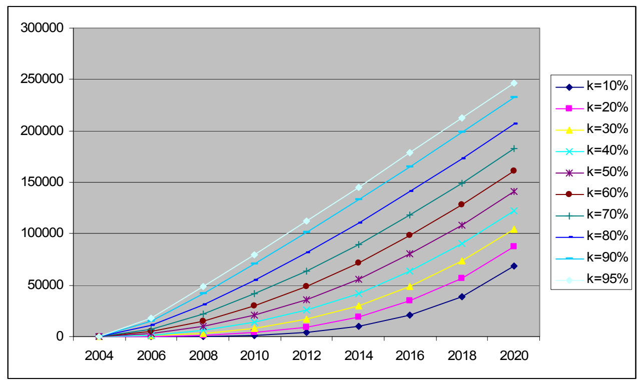

Fig. 4. Reduced SO_x from the begging of MP in [tons]

Scenario of SHPP building based on different percentage (k = 10%, 20%,…,95%) of total power that can be generated by SHPP at Serbian territory until the year 2012.

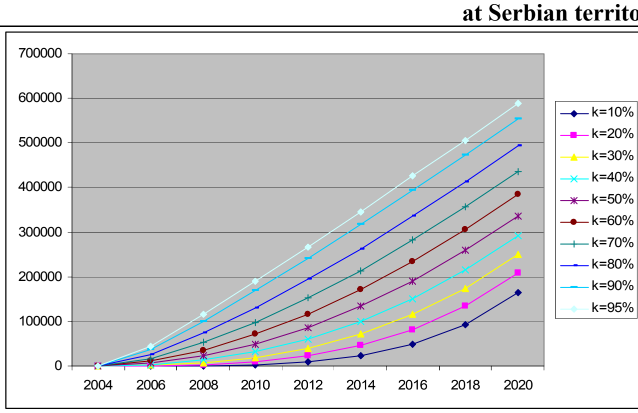

Fig. 5. Reduced NO_x from the begging of MP in [tons]

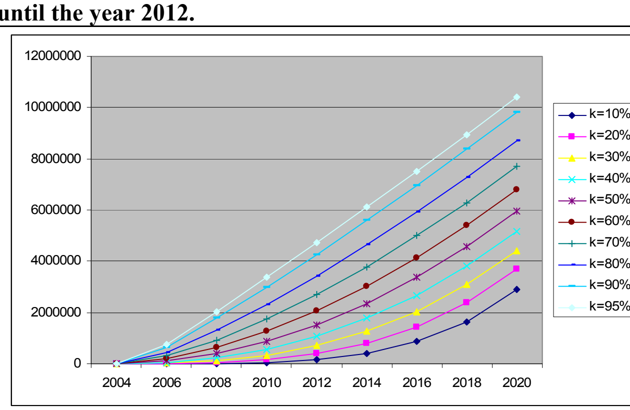

Fig. 6. Reduced ashes from the begging of MP in [tons]]

Scenario of SHPP building based on different percentage (k = 10%, 20%,…,95%) of total power that can be generated by SHPP at Serbian territory until the year 2012.

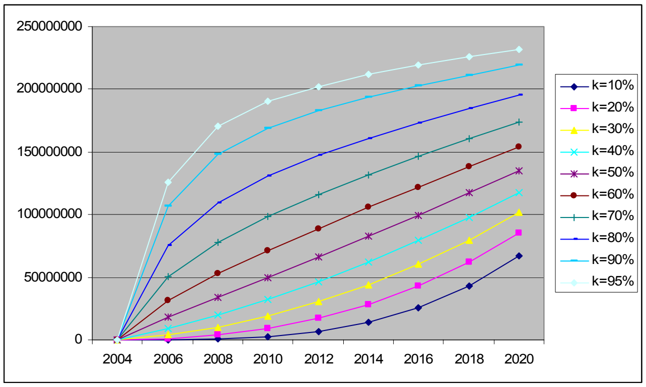

Fig. 7. The average annual income from produced electric energy D_{elek} [EUR/god] during MP

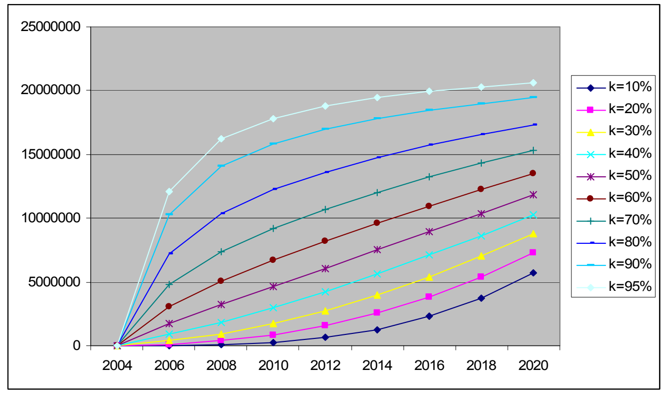

Fig. 8. The average annual cost reduction due to lignite substitution D_{ekolos} [EUR/god] during MP

Scenario of SHPP building based on different percentage (k = 10%, 20%,…,95%) of total power that can be generated by SHPP at Serbian territory until the year 2012.

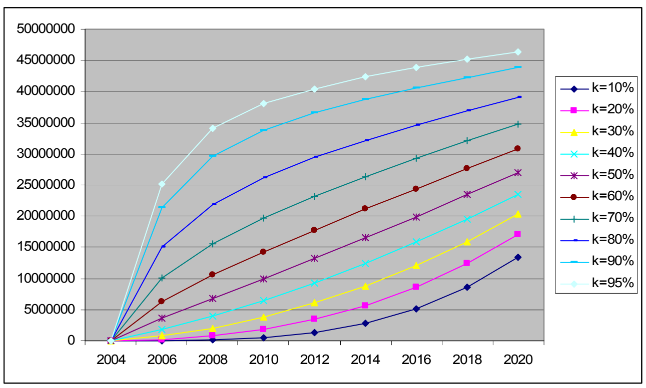

Fig. 9. The average annual incomes from side activities that will be developed simultaneously during MP D_{PD} [EUR/god]

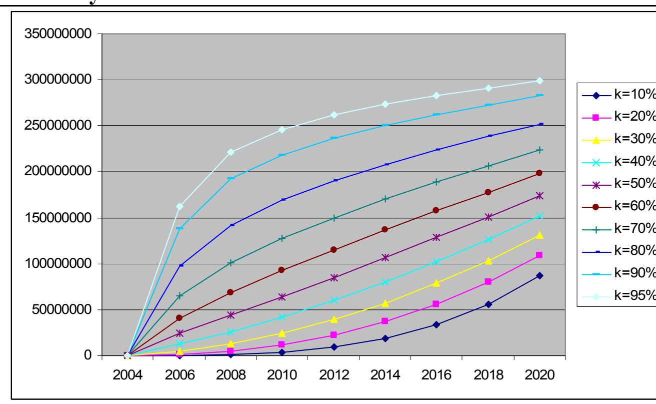

Fig. 10. Total average annual earnings during MP [EUR/year]

Scenario of SHPP building based on different percentage (k = 10%, 20%,…,95%) of total power that can be generated by SHPP at Serbian territory until the year 2012.

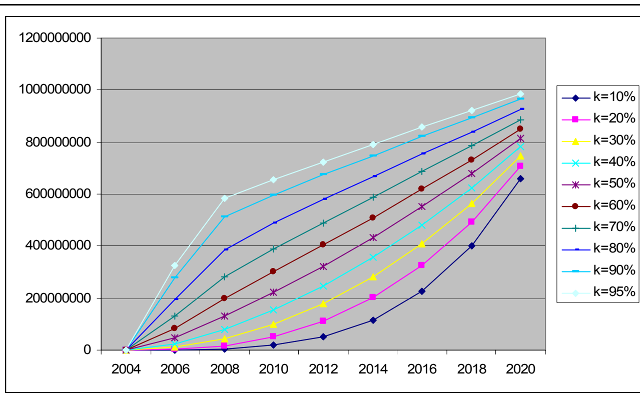

Fig. 11. Incomes during MP (produced electricity + ecological benefits + side activities) in [EUR]

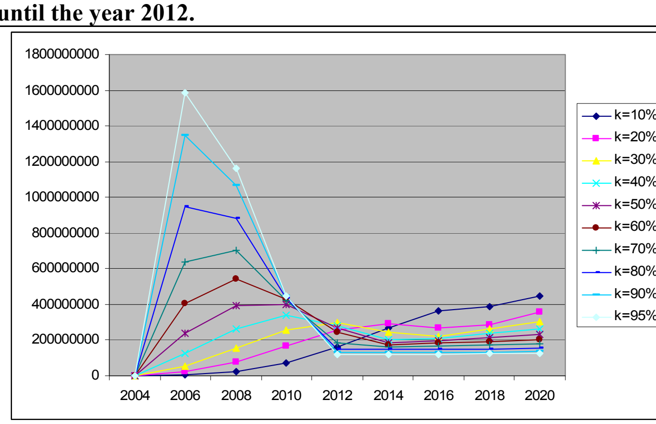

Fig. 12. Costs during MP (SHPP building costs +SHPP maintenance costs + SHPP maintenance worker salaries) [EUR]

Scenario of SHPP building based on different percentage (k = 10%, 20%,…,95%) of total power that can be generated by SHPP at Serbian territory until the year 2012.	
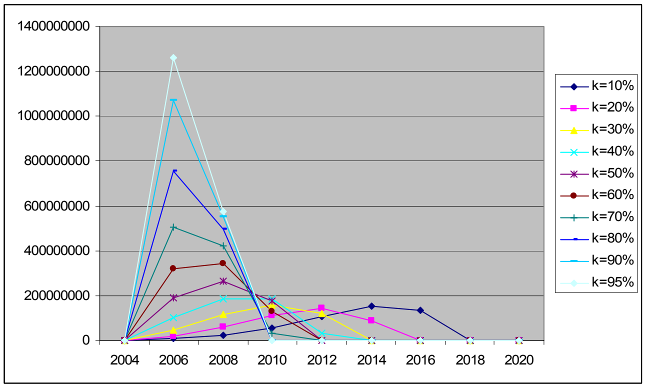	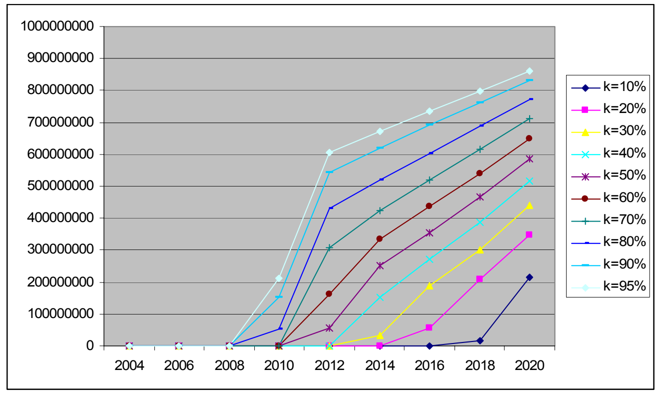
Fig. 13. Loans for MP realization [EUR]	**Fig. 14**. Profit (difference between incomes and costs plus loan disbursement) during MP [EUR]