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## **ENVIRONMENTAL PROTECTION IN ACTUAL CIRCUMSTANCES OF EPS RECOVERY**

*Milan Gavrilović*

*Electric Power Industry of Serbia, Belgrade, Yugoslavia*

### **ABSTRACT**

The paper presents a brief summary of the state of environmental protection in the vicinity of Electric Power Industry of Serbia (EPS) power facilities, both when economy of FRY was at an acceptable level and the current situation resulting from a drastic decline of economic power of country and EPS itself, from unfavourable political development from the past period, from the sanctions imposed by UN Security Council, from a prolonged isolation from modern courses worldwide as well as from bombing of facilities during NATO aggression against Yugoslavia. The paper is focused on the analysis of the possibilities of taking certain activities aimed at environmental protection under expected realistic circumstances of EPS recovery and its further development, in accordance with the overall economic recovery and development of the country, and to estimate the price of all environmental protection measures which, would otherwise have been realised in the course of the past period if sanctions of UN Security Council have not been imposed on FR Yugoslavia.

Key words: electric power industry, power plants, environment, management

### **Introductory remarks**

Adverse political and economic development have marked quite a long period in the recent past of the country. This development had a negative impact on the entire EPS which was particularly emphasized in the area of environmental protection.

With the imposing of sanctions against FRY, by the UN Security Council, the economic conditions of the country had been drastically declined. An additionally adverse effect was generated by the aggression of NATO forces against FRY and bombing of EPS's facilities.

Under conditions of impossibility to provide necessary resources for maintenance and normal power plant operation, resources intended for environmental protection were minimized and numerous previously undertaken protection activities were stopped.

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## **The status of environmental protection in EPS before imposing of sanctions**

Until the 80's, environmental protection measures had been applied ,as in the case of developed electric power industries worldwide, with certain delay, never longer than ten years.

### *In coal mines*

As early as the 70's,an obligation was introduced to design, in parallel with the project of opening of new mine, also a project of land reclamation of barren disposal and surfaces damaged by mining. Intensive works on land reclamation implementation started during the same years. At first, land reclamation was performed by planting forest without special technical preparation of damaged ground. The land reclamation process was significantly improved later on and was carried out in two phases, each of them consisting of two subphases. The first phase represented technical preparation of ground, such as levelling, performance of amelioration works and repair works in orther to achieve the desired results. Biological land reclamation, as the second phase, was carried out in several subphases. At first, vegetable crops were planted on technically prepared surfaces,which enriched the ground with material which make it fertile,so that cultivation of crops, planting of orchards and vineyards and similar would be possible in a long-term period.

The remaining areas of abandoned mine pits were filled with water and, after making certain efforts, were turned into pleasant water surfaces for pleasure.

By 1991, over 1800 ha had been reclaimed in the aforesaid manner.Already in 80's, extensive measures of environmental protection of coal mines, in conection with minimization of disturbances of underground waters regime in the environment, reduction of emission of pollutants and noise by selection of equipment, other technical sollutions and application of special measures.

### *In thermal power plants*

All our thermal power plants are equiped with electrostatic precipitators for reduction of ash emission, as well as with tall stacks in order to achieve favourable conditions for dispersion of pollutants into environmental atmosphere.At the time of purchasing these electrostatic precipitators, they represented a modern, advanced sollution.All the plants also included neutralization pits for protection against waste waters.

The initial sollutions of ash transport to ash pits by cable, were replaced, due to exessive air and ground pollution during transport and discharge, by more favourable ones.The most frequently applied sollution of ash transport and disposal was the hydraulic means, whereby for transport of one quantity of ash was used a quantity of ten times more water.

The operating part of hydraulic ash pit was partly kept under water and remaining part was sprinkled with water, in order to prevent the ash from being blown by wind. Canals for diverting the drained and overflowed waters from ash pits were dug and deep wells supplied with pumps were constructed in order to prevent the overflowing of polluted water

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from ash pits which had been penetrating the underground and which could pollute the underground waters and thus cause overwetting of surrounding grounds.

Reserve ash pit parts were temporarily planted with various vegetable crops in order to prevent the wind from blowing the ash away, and the deserted pits were reclaimed by means of growing forest crops.

Thermal power plants constructed in that period represented contemporary solutions, implemented in practice, with corresponding thermal energy efficiency.

The Electric Power Industry of Serbia tried to follow the current thermal power development trends, so that intensive and extensive work was done in order to introduce combined heat and electric energy generation, which even today represent modern and practically proven highly energy efficient solutions. There had been essential development in the heating system project in Belgrade, Pristina, several cities of Voivodina, etc.

Energy efficiency clearly belongs to the group of most appropriate measures of environmental protection, which is selected in reduction of demand of primary raw materials and emission of pollutants.

### *In hydro power plants*

Almost all the environmental protection problems are simultaneously problems of hydro power plants operation and maintenance. It may be said that already the hydro projects have taken into account the solution of the environmental protection problems, but primarily as problems which may have an impact on the operation, maintenance and properties of hydro power plants as energy plants in general. Accordingly, the project had foreseen the solution of the question of reducing the problems of steep banks and detritus into reservoirs, protection of the banks, measures for preventing landslide initialization, limitation or prohibition of certain activities (for example construction of weekend cottages and tourist facilities and similar), in certain areas in the vicinity of reservoirs, limited use of water from reservoirs (speed of change of water level in reservoir and downstream), watercourse etc.

Unfortunately, due to impossibility to provide sufficient amount of financial resources in due time as well as the existing desire and need to start the commissioning of the plant as soon as possible, the said environmental protection problems were not solved in due time, before putting the plants in operation, because of the resolution thereof having been planned for a later period. The result was that they were solved too slowly, many of which have not been solved yet, although the consequences thereof are already present.

Some environmental protection problems of hydro power plants (HPP) have not been considered at all. The appraisal of the zero status has virtually not been done for any HPP, nor have preparations been made for grounds which were subsequently flooded when forming reservoirs, nor was organic material removed. Very little attention was paid to studying the change of water and sedimentation quality in the reservoir, as well as its effect on livings in the part of catchment where the impact of HPP exists.

## **The present status of the environment**

With the sanctions being imposed on FRY, the position of EPS very soon became considerable aggravated. The resources intended for environmental protection were drastically reduced and became almost symbolical.

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### *In coal mines*

Back in 1992 there were no resources for land reclamation of new barren disposals. Resources necessary for maintenance of already reclaimed land were obtained with great difficulty. Lack of resources weakened the personnel and organizational structure. Currently over 1000 ha barren disposals of "Kolubara" and "Kostolac" open cast mines and over 1200 ha of barren disposals of the "Kosovo" open pit mines may be reclaimed if required resources were obtained. Unfortunately, work on development of new land reclamation technologies is not being completed.

### *In thermal power plants*

The previously purchased electrostatic precipitators in TPP units with a total capacity of around 1800 MW, were planned for rehabilitation or replacement in the past ten-year period. Due to impossibility to purchase spare parts and insufficient maintenance, the status of all electrostatic precipitators is unfavourable and their efficiency levels are significantly reduced to the project values, which, being such, do not meet the advanced requirements.

The status of neutralization pits is unfavourable, as they have not been maintained.

Ash and slag pits are probably in the most critical state, in terms of unfavourable impact on the environment. The basic problem lies in the application of the hydraulic system of ash transport. The required large working surfaces (around 70 to 200 ha) and large quantities of water, make unsolvable problems of air and water protection, especially underground waters. These systems have been replaced worldwide by new technological solutions in the past fifteen years.

The worst situation is that of the ash pit of TPP "Kostolac", where there is frequently excessive air and ground pollution and there is permanent danger of accidents caused by collapse of dams, which could have tragical consequences on the environment and human lives.

Both "N. Tesla" TPP's ash pits are also in a very unfavourable state. On several occasions, there was excessive pollution of neighbouring villages by ash dispersion caused by strong winds. A particular disadvantage of inadequate solution and maintenance of ash pits of TPP "N. Tesla" are also extremely unfavourable ash pit sites as they are upstream and near potable water sources for Belgrade area, so that at least their correct maintenance is essential, for which it is impossible to provide required financial resources under present circumstances.

The current average life of TPP's is above 20 years. Significant capacities have already been in operation longer than their projected operating life. Inadequate maintenance represents a particular problem.

Constructed at a time when less attention was dedicated to operational efficiency, aging and inadequate maintenance had resulted in such TPP efficiency rates which were lower than the contemporary ones.

Unfavourable economic conditions prevented the implementation of planned heating system projects by using TPP's with combined thermal and electrical energy generation (CHP).

All the aforesaid has resulted in increased demand of fuel, and therefore in increased emission of pollutants and discharge of waste water.

Under conditions of isolation, due to sanctions and difficult economic conditions, an effort was nevertheless made to develop new technology of ash transport and disposal which have

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considerably better characteristics regarding impact on environment. By means of local forces, developed technology of ash transport was applied at TPP "Kosovo" B. Problems of air and water pollution in vicinity of ash pit were thus completely solved, with multiple reduction of electricity consumption. The problem of waste water (except the oil polluted one) was solved in parallel, as they were used for ash transport .

### *In hydro power plants*

The present state of environmental and near bank land protection has been considerably aggravated, compared to the previous period. The basic reason for that was lack of financial resources, so that many measures, previously foreseen by projects, were not implemented and the existing protection measures were not adequately maintained. There were, clearly, no resources for taking more significant new measures.

Operational conditions of HPP's, which could, often not be harmonized with regulated permitted regimes also considerably contributed to aggravated environmental conditions. It occurred that, due to lack of resources for timely overhauling of TPP's units ,lack of energy in early autumn months had to be compensated, on account of sudden occurrences of cold weath, by excessive commitment of HPP's. Rapid changes of water flow and sudden changes of level started up many existing and potential landslides, brought about increased erosion of banks, outlet of water from reservoirs with reduced oxigen content, causing fish mass death etc.

The difficult economic situation of our entire economy prevents industrial and municipal utilities from purifying their waste waters before discharge them into catchment watercourses of our HPP's. That causes unpermitted levels of water pollution.

Uncontrolled civil construction and usage of space for touristic and recreational purposes in the direct vicinity of reservoirs, should also be added to the aforesaid.

### **How to solve the problems of environmental protection in EPS, under current and future conditions**

In the past period marked by great economic difficulties and isolation of our country, great changes in the development of new technologies in electric power and environmental protection measures, as well as regulations connected to environmental protection have taken place worldwide. The strategic approach to futher energy development, particularly electric power energy, has changed. The accent is on development of renewable resources, which are,as a rule, much more favourable from the standpoint of environmental protection, and there are plans to restrict and maybe even very soon to stop the usage of fossil fuels for energy purposes, at least in developed countries.

The other trend of development and long-term solution of the energy problem is to increase energy efficiency in generation ,and especial in consumption, where there is incomparably greater potential both in rationalization and conservation of all forms of energy.

There is a marked fast development of international regulations in conection to environmental protection and sustainable development where requirements are becoming more and more rigorous.

The intention of the federal Government and the government of the Republic of Serbia were to promote environmental protection. For that reason, ministries for environmental

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protection were established at both levels and they immediately started work on preparation of corresponding regulations, in accordance with advanced international standard especially in accordance with the regulations of the EU. Unfortunately, due to sanctions which resulted in development a very unfavourable economic situation, the previously set goals had to be abandoned. In the last ten years, the Republic of Serbia, nevertheless established a considerable number of regulations of significance for environmental protection in the energy sector. All of them were significantly harmonized with international regulations.

In strategic planning of work on environmental protection, it is therefore, necessary to bear in mind both local and international regulations. One should also bear in mind the fact that there had been a delay of several years in EPS's application of advanced environmental protection measures, so that there had virtually been a complete standstill in terms of application of new protection measures in the last tentative ten-year period, resulting in insufficient maintenance of old non-rehabilitated facilities and reduction of efficiency of generating facilities, due to their age and left out maintenance. Electric power companies which were in a similar state ten years ago, and which then took all measures of protection, invested financial resources of the order of several billion German marks. This means that in the following period one should count on very significant investments, which will greatly exceed EPS's capabilities, on hard work and a need to acquire considerable know-how, and significant assistance from the international community, if one wishes to make up for the long-standing delay, which had taken place primarily as a consequence of many years of imposed sanctions, and partly as a consequence of bombing of EPS's facilities by NATO forces.

### *In coal mines*

The most significant problem with coal mines is to compensate a multi-annual delay in land reclamation, for which purpose, in order to apply the current land reclamation technology, it would be necessary to invest around 20,000 DEM per ha, and for compensation of left out activities around 40,000,000 DEM. It is necessary to make efforts in order to start, as soon as possible, with practice of complete land reclamation by preserving the humus layer when digging out overburden. The new technology requires certain investments for purchase of required equipment in the value of approximately 35,000,000 DEM.

More radical changes in the approach to design work and operation of pits are essential due to other problems concerning environmental protection in mining. One should take into account the necessary of ash disposal and other waste disposal (e.g. waste slurry from FGD plants) into exhaust part of coal mines. In selecting the equipment and solutions for coal and overburden transport, one must take into account minimization of emission of pollutants and noise and dust dispersion. Whenever possible, measures for reducing disturbance of underground waters regime must be applied and project must consider of minimizing harmful effects on the environment and human beings in that area.

The majority of the aforementioned problems would have been solved in the past period had there been available required resources which were estimated at approximately 30,000,000 DEM.

### *In thermal power plants*

The most critical problems of environmental protection of EPS's TPP's are in relation to ash pits and electrostatic precipitators. It is necessary to intensify efforts in order to complete research work on development of new technology of ash transport and disposal in

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the case of ash from the Kolubara and Kostolac coal basins, particularly regarding the economic justification of adding lime for the purpose of strengthening the disposed mass which would completely solve the problems of air and water pollution. Clearly, the problems of ash disposal into exhaust part of coal mines must be solved, as this is a much more favourable solution than to dispose of ash on the surface of the ground. For implementation of all required works an amount of approximately 140,000,000 DEM is required.

At older TPP units of total capacity of around 2000 MW, it is necessary to rehabilitate and replace electrostatic precipitators, while for all the older units reconstruction and modernization is necessary for purpose of improvement of rate of efficiency of ash removal. For these works it is necessary to invest approximately 80,000,000 DEM.

The problem of waste water purification have not been solved at any TPP of EPS, excluding CHP "Novi Sad" and "Zrenjanin", and oily waste water represent a particular problem.

The problem of reduction of emission of  $\text{NO}_x$  at EPS's TPP's, where lignite is used as fuel, may be successfully solved by application of primary measures (modification of the combustion process). For that reason, boilers capable of solving these problems should be rehabilitated, the very process of rehabilitation is the most favourable time to reduce emission of  $\text{NO}_x$  by means of changes in the combustion process (by replacement of burners, reallocation of fuel and air for combustion).

Because of its high price and operational and maintenance costs the decision to install flue gas desulphurization plants (FGD) at existing TPP's units, even during rehabilitation, requires more careful consideration and cooperation with competent government authorities, donors of financial resources, taking into account commitments of the country towards international organizations. There is no doubt that FGD plants must be installed at new TPP's, including CHP "Kolubara" B.

### *In hydro power plants*

A special professional team was set up at EPS, which is responsible for solving the problem of environmental and near bank land protection in the vicinity of HPP's. This team has reviewed all the critical problems to be solved urgently, as well as problems to be solved in the medium-term period. The most important thing to do would, by all means, be to complete all works foreseen by projects and programmes, during their construction, particularly works relating to prevention of filling reservoirs with sediments (by planting trees, construction sluices-dams with river basin watercourses and similar) and to protection of the near bank land area.

Greater attention must be paid to systematic monitoring of water and sediment quality, the effect of these changes on human being, the impact of the HPP on the environment, upstream and downstream, particularly under changeable working conditions and outflow of waters with poor oxygen content and similar.

The characteristics of HPP's in respect to the problem of environmental protection, is intensive interface with the environment. Nothing essential can be achieved in the field of environmental protection if uncontrolled outflows of pollutants into catchment watercourses and reservoirs from industrial, communal and other economic plans is not prevented simultaneously. Cooperation with competent government authorities is, therefore, necessary in order to minimize these outflows and to implement them by means of projects defining restriction of certain activities near the power plants.

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The total value of works which should have been done in the past period, according to projects and plans, is estimated at 180,000,000 DEM.

### **The consequences of bombing of EPS's facilities during NATO aggression against FRY**

During the aggression of NATO forces against FRY several hundreds of the EPS's facilities were bombed. During each act of bombing there were detrimental impacts of smaller or larger intensity on the environment. According to the impact intensity, nine cases of bombing and damage of EPS's facilities may be distinguished, as follows: Substations Bor 3, Novi Sad 3, Nis 2, Belgrade 3,5,8 and 9 and switchyards of TPP's "Kolubara" A and "Nikola Tesla" A, whereby there had been an outflow into the environment of approximately 300 to 400 t of transformer oil and approximately 200 kilos of PCB oil, as well as incomplete combustion of approximately 300 to 4000 t of transformer oil.

It is very difficult to give exact cost estimates of losses caused during the bombing, particularly in view of the fact that most of the consequences will be taking place in a longer forthcoming period. On the basis of rough analyses the value of the total expected damages has been estimated at approximately 40,000,000 DEM.

### **Conclusions**

Due to the aggravated economic situation in the country, sanctions and bombing of EPS's facilities during NATO aggression against FRY, there has been a multi-annual delay in implementation of modern environmental protection measures on EPS's facilities. Simultaneously, the existing protection measures, due to aging, obsolescence and lack of maintenance have lost their efficiency.

Regarding long-term negative impacts, delayed construction of new and rehabilitated old energy facilities will have a dominant significance, thereby having an essential impact on reduction of emission and discharges of pollutants into the environment.

This multi-annual delay requires increased and more intensive financial investments, which greatly exceed EPS's capabilities, a good organization, professional capability and capable staff and good material situation.