THE PROFITABLENESS OF THE ENVIRONMENTAL PROTECTION IN A THERMAL POWER SYSTEM BY SETTING THE OPTIMUM LEVEL OF THE ENVIRONMENTAL TAXES AND CHARGES

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Abstract. In the power system, the approach to the internalization supposes the integration in the energy cost of the value of the damage caused to the environment by the production, transport, distribution and consumption of energy. The internalization of the externalities is translated by the payment of taxes or fines by those who cause damage to the environment and to human health in such a way that private costs may reach the level of social costs. In the present paper there has been determined the optimum level of the taxes and fines that have to be required in order to reach the social optimum, as by means of the profitableness of a thermo-power system one understands the capacity of the thermo-power system to obtain profit, that is to be lucrative, not to record losses that could lead it to bankruptcy. There has been made an application in the Matlab-Simulink programming language and with its help imposing the taxes on the pollutants emissions there can be determined the value of the supplementary taxes in case the legal limit values are exceeded or by imposing these supplementary taxes there is determined the value of the taxes on the applied pollutant emissions in the case of the legal limit values.

Keywords: profitableness, taxes, emissions, thermal power system.

1. INTRODUCTION

As the thermal power systems own, all over the world, an important quota of the emissions that generate negative effects on the human health, agriculture, on materials and ecosystems, in the specialised literature [6], [7], [8], [9] there has been termed the phrase “externalities/external cost” of electricity. These can be described as being costs imposed on society and the environment, that are not accounted for at the producer or consumer of electricity, thus not being included in the production cost, respectively in the market cost of electricity.

Pigou has introduced the term “internalization of externalities” [10], [11]. The internalization method proposed by Pigou is to cover (compensate) the difference social cost – private cost by making the one who causes the damage pay a tax.

The taxation or the penalization is manifested by the pollutant-emitting companies making payments. By means of these taxes, those who pollute are motivated to reduce the production of pollutants because their own costs will be increased by including these social costs due to pollution.

The essential problem in practicing this type of control of externalities is that the level of taxes has to be rigorously determined. If it is too low, the companies do not consider it important and easily accept the penalties because they produce a sufficiently large quantity of the final product that compensates this tax. If it is too high, there is the risk of the forced diminution of the production thus ending in reshaping.
2. THE ANALYSED THERMAL ENERGY SYSTEM

The analysed thermal energy system is a (STE) thermal power plant from Romania which was designed to work on solid fuel (lignite) having natural gas as flame support.

The operation parameters of the thermal power plant are:
- power = 50 MW;
- load factor = 81.4 %;
- level of boiler load = 51.3 %;
- average steam flow rate \( D_0 \) = 210 t/h;
- nominal steam flow rate \( D_{\text{nominal}} \) = 420 t/h;
- nominal pressure of steam = 137 bar;
- nominal temperature of steam = 540ºC;
- nominal temperature of the feeding water at its entrance in the economizer = 230ºC.

In table I the characteristics of the used fuel are presented.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>M.U.</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Heating Value, LHV</td>
<td>kJ/kg</td>
<td>7502</td>
</tr>
<tr>
<td>C % (wt)</td>
<td>19.09</td>
<td></td>
</tr>
<tr>
<td>H % (wt)</td>
<td>2.57</td>
<td></td>
</tr>
<tr>
<td>S % (wt)</td>
<td>0.71</td>
<td></td>
</tr>
<tr>
<td>O % (wt)</td>
<td>13.77</td>
<td></td>
</tr>
<tr>
<td>N % (wt)</td>
<td>0.63</td>
<td></td>
</tr>
<tr>
<td>Wt % (wt)</td>
<td>52.74</td>
<td></td>
</tr>
<tr>
<td>A % (wt)</td>
<td>10.49</td>
<td></td>
</tr>
</tbody>
</table>

3. THE POLLUTANT EMISSIONS OF THE SYSTEM

In order to be able to calculate the taxes that have to be paid by STE for the evacuated pollutants, there is determined the total quantity of the evacuated pollutants throughout a year based on the relations in the CORINAIR methodology from "The methodology of operative evaluation of the \( \text{SO}_2 \), \( \text{NO}_x \), dusts and \( \text{CO}_2 \) emissions from thermal and thermal power stations" drawn up by the Department of Environmental Protection from the Strategy and Economic Development Division – CONEL [12], [13], [14].

In table II there are presented the pollutants emissions calculated in comparison to the limit concentration according to the laws in force (LMV) [15].

Analysing the data from table 2 one can conclude that:
- the \( \text{SO}_2 \) emission is approximately 5.5 higher than the accepted limit value, which requires the use of a desulphuration technology;
- the \( \text{NO}_x \) emission is approximately equal to the accepted limit value, thus being situated within the present legal standards, which does not currently require to employ a secondary technology for the \( \text{NO}_x \) reduction. In case the legislative regulations regarding the nitric oxide emissions become more severe there will be required to adopt some secondary measures combined with the preexisting primary measures to clear the emissions;
- the solid particles emission is under the accepted limit value because the thermo-power system is equipped with an electrostatic precipitator. In case the legislative regulations regarding the particle emissions will become more severe it will be compulsory to increase the size of the yield of the dedusting installation.

4. THE TAXES AND FINES IMPOSED ON THE THERMAL POWER SYSTEM BY THE CURRENT LEGISLATION

In table III there are calculated the taxes that STE has to pay (in accordance with OUG 196/2005 – The Fund for the Environment [20]) for the pollutants evacuated into the atmosphere.

When STE implements the procedure lime spray drying for \( \text{SO}_2 \) removal (LSD) for which there have been considered: the desulphurisation efficiency \( \eta = 90\% \); the molar ratio \( \text{R}(\text{CaO}/\text{SO}_2) = 0.95 \) and \( \text{CaOi} = 93\% \), the overall annual pollutants emissions into the atmosphere and the taxes that STE has to pay are presented in table IV.

In figure 1 there are presented the annual taxes paid by STE for the pollutants emissions into the atmosphere.

In the case studied there are recorded instances of outrunning of the legal maximum value (LMV) for the \( \text{SO}_2 \) emission and because of that STE will...
pay fines for these. The amount of these fines is stipulated by the OUG 195/2005 regarding the environmental protection [16], [17] as being of 100,000 RON (33333 $). Taking into consideration that STE receives at least two fines per year due to polluting the environment with SO$_2$, in this case the cost of the production of electricity will be increased by 0.00019 $/kWh. If STE equips itself with an installation for the SO$_2$ emission reduction the production cost of electricity will be increased by 0.0004675 $/kWh.

\[ \text{Total tax } = \text{ Tax } \times \text{ Emission} \]

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Emission</th>
<th>Tax</th>
<th>Total tax</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO$_2$</td>
<td>826129</td>
<td>0.0129</td>
<td>10657</td>
</tr>
<tr>
<td>NO$_x$</td>
<td>866820</td>
<td>0.0129</td>
<td>11182</td>
</tr>
<tr>
<td>PM</td>
<td>124581</td>
<td>0.00645</td>
<td>712</td>
</tr>
</tbody>
</table>

From the things previously presented we can conclude that the price of electricity produced by a thermo-power system does not always reflect its costs for society, as the prices do not entirely take into account the impact that the production and consumption of electricity has on human health and on the environment. The government has the possibility to fix small taxes for reasonable values of the pollutant emissions (lower than the maximum legally accepted values) and of higher taxes for the outrunning of these values. Thus, in the case of steeper fines, the producer will be tempted to choose the solution of improving the quality of the raw materials or to invest in depollution equipments.

### 5. TAXES FOR POLLUTANT EMISSIONS USED IN ROMANIA AND SOME COUNTRIES FROM THE EUROPEAN UNION

In tables VI and VII there are presented by comparison the taxes for the emissions of air pollutants both in Romania and in other EU countries.

**Table VI**

Taxes for SO$_2$, NO$_x$ and PM emissions in Romania

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Tax €/t</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO$_2$</td>
<td>9.675</td>
</tr>
<tr>
<td>NO$_x$</td>
<td>9.675</td>
</tr>
<tr>
<td>PM</td>
<td>4.83</td>
</tr>
</tbody>
</table>

**Table VII**

Taxes for SO$_2$, NO$_x$ and PM emissions in some countries from the EU [18], [19]

<table>
<thead>
<tr>
<th>Country</th>
<th>SO$_2$</th>
<th>NO$_x$</th>
<th>PM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denmark (DK)</td>
<td>1342</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poland (PL)</td>
<td>123</td>
<td>98</td>
<td></td>
</tr>
<tr>
<td>Estonia (EE)</td>
<td>4.24</td>
<td>-</td>
<td>4.24</td>
</tr>
<tr>
<td>Slovakia (SK)</td>
<td>46.12</td>
<td>34.59</td>
<td>115.3</td>
</tr>
<tr>
<td>Czech Republic (CZ)</td>
<td>29.38</td>
<td>23.5</td>
<td>88.13</td>
</tr>
<tr>
<td>France (FR)</td>
<td>-</td>
<td>45.7</td>
<td></td>
</tr>
<tr>
<td>Italy (IT)</td>
<td>53.2</td>
<td>104.8</td>
<td>-</td>
</tr>
<tr>
<td>Lithuania (LT)</td>
<td>62.8</td>
<td>107.7</td>
<td>53.7</td>
</tr>
</tbody>
</table>

It can be noticed that Romania has the lowest taxes for the air pollutants emissions. The national budgetary expenses for the environmental protection, of about 0.2% of the GDP (gross domestic product), are among the lowest in Europe (Hungary 0.66% out of the GDP, Poland 0.45% of the GDP, etc.). Romania presently has budgetary incomes from environmental taxes of below 0.1% of the GDP, whereas in the central and east-European countries these reach 3.4% of the GDP in Slovenia, 2.7% of the GDP in
the Czech Republic or in Hungary, 2.5% of the GDP in Latvia, 2.2% of the GDP in Lithuania etc. [14].

In figure 2 there is presented the level of the taxes for the SO² emissions in some of the EU countries. There can be noticed that the maximum level of the taxes on the SO² emissions is of 1342 €/t in Denmark whereas the minimum level of the taxes is of 4.24 €/t in Estonia. The average value of these taxes is of about 238 €/t, and in case the two extremes (Estonia and Denmark) are excluded the average value is of 63 €/t according to figure 2.

In figure 3 there is presented the level of the taxes for the NOₓ emissions in some of the EU countries. One can notice that the average value of the taxes for the NOₓ emission is of 70 €/t.

In order to stimulate the investments in pollution diminution technologies, the level of the taxes has to increase from the present level to up to at least the average EU level. This means an increase of 6.5 times for the tax for the SO² emissions, of approximately 8 times for the tax for the NOₓ emissions and of about 14 times for the tax for the PM emissions. At the same time, if there is recorded LMV outrunning, the quantities of pollutants will be taxed supplementary, the values of these fines or taxes being 10 times higher compared to the tax value in the case of complying with the LMV.

6. THE PRESENTATION OF THE CALCULATION PROGRAMME THAT HAS BEEN MADE

To determine the optimum level of the taxes for which the investment in the desulphurisation equipment would become profitable from an economic point of view there has been made an application in the Matlab – Simulink language programming with whose help starting from the pollutants emissions for the analysed STE and imposing the taxes on the pollutants emissions there can be determined the value of the taxes paid supplementary in case of outrunning the LMV or imposing these supplementary taxes there can be determined the value of the taxes for the pollutants emissions in case they are within the LMV range.
In figure 5 there is presented the logical chart of the calculation programme implemented in Matlab regarding the determination of the annual taxes paid by STE for the SO$_2$, NO$_x$, and PM emissions.

From the chart we may notice that STE can be found in the following situations:
- in case there is no outrunning of the LMV for the analysed pollutants, STE will pay the tax stipulated in the present legislation corresponding to the quantity of emitted pollutants.
- in case there is outrunning of the LMV for some pollutants, STE will pay the tax stipulated in the present legislation corresponding to the quantity of emitted pollutants that are within the LMV and supplementary it will pay taxes for the pollutants that outrun LMV.

In figure 6 there is presented the block draft of the calculation programme with a view to determining the optimum level of the taxes and the fines that have to be required so as STE, as a result of implementing the pollution diminution technologies, may become lucrative from an economic point of view as well as from an environmental protection one.

With the help of the calculation programme there has been determined the level of the tax for the pollutants emissions that are within the LMV imposing a level of taxes for the emissions that outrun the LMV 10 times. As a result of the calculations there has resulted an optimum level of the tax for the SO$_2$ emission that is within the LMV of 85 $/ton, a lower value than the average value of the taxes for the SO$_2$ emission in the EU (the average value being of 90 $/ton).

7. CONCLUSIONS

In order to stimulate the investments in pollution reduction technologies, the taxes for the pollutants emissions have to increase from the present level which is the lowest in the EU to at least the average one in the EU. This implies an increase of 6.5 times of the taxes for the SO$_2$ emissions, of approximately 8 times for the NOx emissions and of approximately 14 times for the particulate matter emissions.

With the help of the calculation programme there has been determined the level of the tax for the pollutants emissions that fall within the legal VLE imposing a penalising tax level for the emissions that outrun 10 the VLE.

As a result of the calculations there has resulted an optimum level of the tax for the SO$_2$ emission which is within the LMV of 85 $/ton, a lower value than the average value of the taxes for the SO$_2$ emission from the EU (the average value being of 90 $/ton).
Simona Lizica PARASCHIV, Spiru PARASCHIV, Ion V. ION

Fig. 6. The block draft of the calculation programme.

REFERENCES

[1] Ion V. Ion, Ion C. Ionita, Daniela Negoiţă, Spiru Paraschiv – „The profitableness of hibrid solar vehicles (HSV)“, International Workshop on Hybrid and Solar Vehicles, 5-6 noiembrie, 2006 – University of Salerno, Italy
[3] Ionita C.I s.a., ”Expressing Numerically the Local Total Pollution by Using General Environmental Quality Grade (GEQG)“ METIME 2009, UGAL, Galati.
[16] ***Ordonanta de Urgenta nr. 195 din 22 decembrie 2005 privind protectia mediului

134 TERMOTEHNICA 2/2011