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THE INFLUENCE OF THE ROMANIAN LEGISLATION SPECIFIC TAXES OVER THE ECONOMIC EFFICIENCY OF THE GAS AND STEAM COMBINED CYCLE COGENERATION PLANTS FOR SMALL AND MEDIUM POWER

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Abstract: *This paper presents the influence that it can have the tax rate used in the optimal sizing calculation of CCGMMP with TG/TA combined cycle, in the current conditions in Romania, over NPV and* $(\alpha_{cg}^{n})_{opt}$*. After some complex calculations there were submitted comparisons between the effects of the tax rate variation over the two sizes pursued, under the condition in which the values of the main parameters were either established by ANRE, either simultaneously modified towards the current conditions. Also, there were presented comparisons between the influences of the tax rate over NPV and* $(\alpha_{cg}^{n})_{opt}$*, under the conditions in which these CHP plants sell electricity for different types of contracts.*

Key words: *tax rate, gas and steam turbines combined cycle, cogeneration for small and medium power, cogeneration nominal coefficient, economic efficiency.*

1. Introduction

The taxation is often used in the optimal sizing calculations of the gas and steam turbines combined cycle cogeneration plants for small and medium power, especially when it want a correct estimation of the profit cogeneration plants, which will be implemented.

The study realized in this paper was to show the influence of the specific taxes of the Romanian legislation over the optimal cogeneration nominal coefficient and over the economic efficiency of CCGMMP with TG/TA combined cycle for different conditions:

- this cogeneration plant sells electricity through regulated contracts or through bilateral contracts;
- parameters which have stayed at the basis of calculation are either set by ANRE, either simultaneously change towards the actual conditions.

For this purpose it was developed an algorithm for sizing of CCGMMP with TG/TA combined cycle in current conditions in Romania, where the tax rate is a determining factor regarding of their implementation, because its payment significantly drops the net present value and thus it modifies the cogeneration optimal solution. The cogeneration plants

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sizing refers to establish capacity, type and number of cogeneration equipments and auxiliary installations necessary for the cogeneration plants to be able to deliver the desired amount of energy.

The paper covers the theory part presented in the Chapter 2 and the results and their interpretations pointed in the Chapter 3. The Chapter 4 shows the conclusions of the results from the Chapter 3.

2. Aspects Regarding to the Romanian Legislation Specific Taxes. The Calculation Manner of the Costs with These Taxes

The financial effort required to implement a CCGMMP with TG/TA combined cycle is determined by two factors: investment costs and annual costs. The annual costs of this CHP plant represent the amount of the fixed and variable annual costs with the fuel, with the operation and maintenance, the costs with different environmental taxes, the costs with returning the loan (if it was used a bank loan) and the costs with the fees and taxes for the specific area where the cogeneration solution will be implemented. The formula for calculating the annual cost is:

$$C_i = C_{fuel} + C_{m+o} + C_{CO_2} + C_{loan} + C_{f+t} \; [€/\text{year}], \quad (1)$$

where: C_{fuel} [€/year] - annual costs with the fuel (natural gas); C_{m+o} [€/year] - annual costs with the maintenance and operation; C_{CO_2} [€/year] - annual costs with the CO_2 tax; C_{loanl} [€/year] - annual costs for returning the bank loan; C_{f+t} [€/year] - annual costs with the fees and taxes.

At the implementation in Romania of the gas and steam turbines combined cycle cogeneration plants for small and medium power, a certain portion of the profit obtained from the sale of the produced energy is taxed according to the Romanian legislation. The tax rate, which is applied to the taxable profit (r_{tax}), is 16% according to the Romanian legislation [3].

The costs with the fees and taxes, witch are specific to the Romanian legislation, for a CCGMMP with TG/TA combined cycle, are determined as follows:

$$C_{f+t} = P_{taxable} \cdot r_{tax} \; [€/\text{year}], \quad (2)$$

where: $P_{taxable}$ [€/year] - annual taxable profit; r_{tax} [%] - tax rate.

The taxable profits represent the difference between the incomes earned and the expenses of these incomes, excluding the expenses which are not deductible [3]:

$$P_{taxable} = V_i - (C_{fuel} + C_{m+o} + C_{CO_2} + C_{interest}) - C_{AI} \; [€/\text{year}], \quad (3)$$

where: V_i [€/year] - annual income of the cogeneration plant; $C_{interest}$ [€/year] - annual cost with the loan interest; C_{AI} [€/year] - annual costs with the investment amortization.

In the case where:

- $P_{taxable} < 0$ it results that taxable profits will not be subject to the tax rate; from the tax point of view, it will be zero, because the project does not bring profit;
- $P_{taxable} = 0$ the project is unprofitable;
- $P_{taxable} > 0$ the project is viable and brings profit [2].

3. The Optimal Value of the Cogeneration Nominal Coefficient Determination

The optimum value of the nominal coefficient cogeneration $(\alpha_{cg}^{n})_{opt}$ can be determined in the optimization complex calculations, which must take into account all the effects of its adoption on the technical and economic performance of the CCGMMP with TG/TA combined cycle. The most relevant optimization criteria for determining the value of $(\alpha_{cg}^{n})_{opt}$ is the net present value (NPV). The economical optimal calculation value of the cogeneration nominal coefficient is determined in two ways:

- in real mode: in the sizing practice of the CCG equipments, because of a discrete and limited range of the nominal capacities of the equipments, practically it is impossible to obtain an exact recommended value of $(\alpha_{cg}{}^{n})_{opt}$. In this case, it can speak about an "economic optimal domain" in which is $(\alpha_{cg}{}^{n})_{opt}$ and not a single value of it, because the curve of the net present value is strongly flattened around $(\alpha_{cg}{}^{n})_{opt}$;
- in theoretical mode: in this case, it writes the mathematical form of the net present value equation obtained by expressing of all the components of NPV depending by the cogeneration nominal coefficient. Thus, the $(\alpha_{cg}{}^{n})_{opt}$ can be determined from the following equation:

$$\frac{\partial NPV}{\partial \alpha_{cg}^{n}} = 0, \qquad (4)$$

with meeting the follow condition:

$$\frac{\partial^2 NPV}{\partial (\alpha_{cg}^{n})^2} > 0. \qquad (5)$$

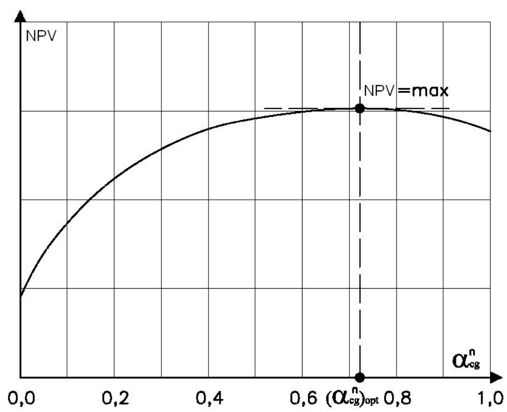


Fig. 1. *The optimal value of the cogeneration nominal coefficient determination* [1]

4. The Specific Taxes Influence Over the Optimum Cogeneration Nominal Coefficient and Over the Economic Efficiency of the Cogeneration Plants

The Romanian legislation specific taxes are applied as a tax rate on the profit realized by implementing of the cogeneration solution. This causes additional costs and, considering the relationship of calculating of these costs, it can say that any change to the tax rate of the profit leads to modification of NPV.

To prove this, there considered two variants V_1 and V_2, where the tax rate increased from $r_{tax}^{V1} = 16\%$ to $r_{tax}^{V2} = 30.6\%$.

For these two variants, in the Figure 2, NPV values were determined depending by the change of the nominal value of the cogeneration coefficient. The parameter values needed for calculations were changed compared to the current situation set by ANRE, under the conditions in which the CCGMMP with TG/TA combined cycle for a rated thermal input of 31.5 MW_t sell electricity through regulated contracts. In these cases it ascertains that:

- maximum value of NPV decreased by € 3.5 million from one variant to another, the difference between the NPV values for these two variants increased with increasing the nominal value of the cogeneration coefficient;
- the optimum value of the cogeneration nominal coefficient decreased from $(\alpha_{cg}^{n})_{V1}^{opt} = 0.80$ to $(\alpha_{cg}^{n})_{V2}^{opt} = 0.78$ (see Figure 2).

In the example calculation whose results are presented in the Figure 3, it shows how changes in tax rates modifies NPV^{max} and $(\alpha_{cg}{}^{n})_{opt}$ values, under the conditions in which the cogeneration plant sell electricity through regulated contracts and parameters values used in the calculations are set by ANRE. So, there were envisaged increases in the tax rate in the range [0%; 70%].

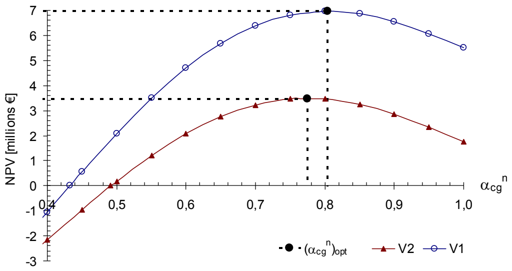
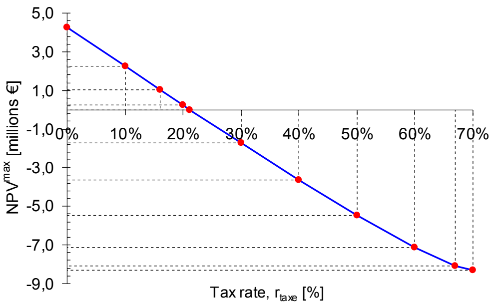
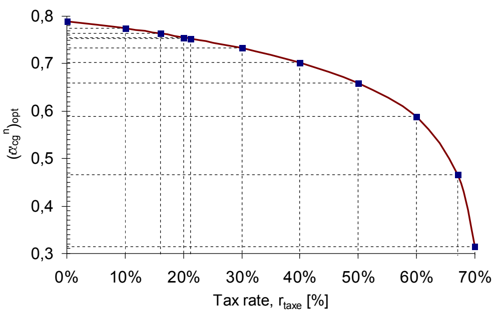


Fig. 2. *NPV variation depending by* α_{cg}^{n} *at increasing the tax rate to 91% from* V_1 *to* V_2



a) NPV^{max} *variation depending by* r_{tax}



b) $(\alpha_{cg}^{n})_{opt}$ *variation depending by* r_{tax}

Fig. 3. *The modification influence of* r_{tax} *over* NPV^{max} *determined at* $(\alpha_{cg}^{n})_{opt}$

It is found that NPV^{max} and $(\alpha_{cg}^{n})_{opt}$ values decrease with increasing the tax rate. For an increase the tax rate to 21.2%, CCGMMP with TG/TA combined cycle is at the breakeven point, where the maximum NPV is zero. For higher tax rate values more than 21.2%, the cogeneration plant is economically inefficient, the maximum NPV values are negative and decrease with the tax rate increases. The increase of the tax rate in the range [0; 70%], widely changes the cogeneration nominal coefficient in the range [0.32; 0.79].

Under the conditions in which cogeneration plant sells electricity only through bilateral contracts and the parameters values used in the calculations remain ones set by ANRE, the tax rate change influences NPV^{max} and $(\alpha_{cg}^{n})_{opt}$ as shown in the Figure 4.

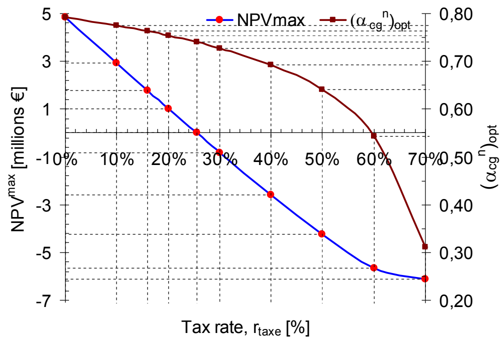


Fig. 4. NPV^{max} *and* $(\alpha_{cg}^{n})_{opt}$ *values determined at the tax rate modification*

In this case, cogeneration plant does not benefit by a bonus for selling electricity through regulated contracts produced in cogeneration, whereas $E_{cg}^{year,SEN} = 0$ kW_{el}/year.

In the Figure 4 it follows that with the increase of the tax rate in the range [0; 70]%:

- NPV^{max} values decrease and for a tax rate value of 25.5% the cogeneration plant is at the breakeven point, where $NPV^{max} = 0$;
- the optimal values of the cogeneration nominal coefficients decrease in the interval [0.31; 0.79], accordingly it modify the optimal sizing solution of the cogeneration plant.

Analyzing the two variants in which has changed the tax rate, under the conditions in which the cogeneration plant sells energy either through regulated contracts either through bilateral contracts, it is found that:

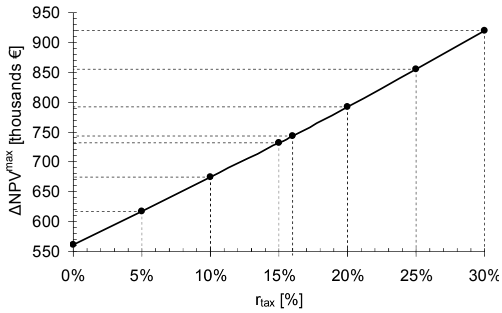


Fig. 5. *ΔNPV^{max} variation depending by the tax rate, r_{tax}*

• in the second case, the cogeneration plant is economically efficient for higher increases of the tax rate compared to the first case;

• the optimal values of the cogeneration nominal coefficients it is insignificant changed from one case to another;

• the difference between the NPV^{max} values for the two cases increase as the tax rate is increased, this thing is shown in the Figure 5, where it drew the graph [2]:

$$\Delta NPV^{\max} = f(r_{tax}),$$
$$\Delta NPV^{\max} = NPV_{cons}^{\max} - NPV_{SEN}^{\max}.$$

5. Conclusions

Following the technical-economic analysis that was done in the two cases where the tax rate changed (the cogeneration plat sells electricity trough regulated contracts or through bilateral contracts), it was found that:

- in the second case, cogeneration plat is effective for higher tax rates that do not exceed 25.5% compared to the first case, where cogeneration plat is effective for tax rates that do not exceed 21.1%;
- difference between the NPV^{max} values obtained in the two cases increases with increasing of the tax rate;
- in the both cases NPV^{max} and $(\alpha_{cg}^{n})_{opt}$ values decrease with increasing the tax rate.

The simultaneously modification of the parameters' main values, used in the sizing calculations of CCGMMP with TG/TA combined cycle, which have a major effect of changing the optimal values of the cogeneration nominal coefficients, does not alter the variation meaning of the NPV^{max} and $(\alpha_{cg}^{n})_{opt}$ values compared with the variant in which the values of these parameters remain ones established by ANRE.

In the table below it presented the behaviour of the cogeneration optimal nominal coefficient and of the economic efficiency of GCCMMP with TG/TA combined cycle at the modification of the tax rate for all the conditions presented in this article.

Table 1

r_{tax} influence over $(\alpha_{cg}^{n})_{opt}$ and NPV^{max} of CCGMMP with TG/TA combined cycle, no matter the considered conditions

The influence coefficient considered at the CHP plant implementation	**UM**	**Influence manner over:**	
		$(\alpha_{cg}^{n})_{opt}$	**technical economic efficiency (trough NPV)**
Tax rate	%	always decreases at the increasing of "r_{tax}"	

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Medium Power). Scientific Report no. 2, University “Politehnica” Bucharest, 2011, p. 190.

3. *** Guvernul României: *Codul Fiscal cu normele metodologice de aplicare* (*Fiscal Code with the implementing rules*). OG nr. 30/2011.

List of notations:

Notation	Description	UM
ANRE	National Authority for energy regulation	-
cons	Electrical consumer	-
SEN	National power system	-
$(\alpha_{cg}^{n})_{opt}$	Optimal cogeneration nominal coefficient	-
r_{tax}	Tax rate	%
C_{f+t}	Costs with the fees and taxes	[€/year]
$P_{taxable}$	Annual taxable profit	[€/year]
V_i	Annual income of the cogeneration plant	[€/year]
C_i	Annual costs of the cogeneration plant	[€/year]
C_{fuel}	Annual costs with the fuel (natural gas)	[€/year]
C_{m+o}	Annual costs with the maintenance and operation	[€/year]
C_{CO_2}	Annual costs with the CO_2 tax	[€/year]
C_{loan}	Annual costs for returning the bank loan	[€/year]
$C_{interest}$	Annual cost with the loan interest	[€/year]
C_{AI}	Annual costs with the investment amortization	[€/year]
NPV	Net present value	€
$E_{cg}^{year,SEN}$	Electricity produced in cogeneration and sold through regulated contracts	kW_{el}/year
CCG	Cogeneration plant	-
CCGMMP	Cogeneration plants for small and medium power	-
TG/TA	Gas turbine/steam turbine	-
CHP	Cogeneration	-