ENGINEERING MANAGEMENT OF ENERGY SYSTEMS

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Abstract: Engineering of energy management; Models of Engineering operational applied to efficient utilization of energy; Development durable decision of economics-engineering systems approach.

Key words: energy management, energy system, economics engineering

1. REENGINEERING OF ENERGY MANAGEMENT

As a method of the modern management, reengineering requires a new design of the systemic probiems in view of process innovation and human resources reshaping. The reengineering of the industrial management uses informatic tools which supervise the leading of industrial organisation so that the technical, economic and financial risks should be under entire control. The reengineering approaches the commercial organisation inclusively the companies as a reunion of processes which are subdued by entire innovation (technology resources, economics activities, management, decisions). The new designed industrial organisations are focused on customers' necessities in view of entire integration of the resources in order to built a new market based on integrated consumption. In this point of view, the organisation charts are designed as a matrix where the responsibilities are found at level of each employee. The reengineering allows to go from management focused on command - control to performance management concentrated on team leader that is based on abilities development in resources allotting and dysfunctional studies through current and forecast activities monitoring. The informatic supervision of entire technical - economics activities allow to eliminate the limitation in real process functioning.

The reengineering is used after covering the following: increasing the quality of human factor and training the team that will implement the reengineering in analysed company, establishing the activities at input and output and picking out the perturbation points, redesigning of the processes that are increasing the entropy, replacing old equipment by new ones, designing working places in ergonomics view, designing the quality of products which will be turned out in the new industrial organisation.

The revolutions in informatic and cognitive fields are considered as start points of reengineering. These revolutions allow going from the production based on improving of the physical proprieties to innovation of thinking process. As a result of this process, the level of products will be increased by value of new assimilated knowledge in new created installations. By this way, the quality of products and equipment could be doubled and the price could be cut down to 30%. After all. the customers' probiems can be settled without any risk in terms of benefit increasing.

The reengineering is applied entirely to design the new industrial objectives. This method can be used by companies which are monopoly of state, too. Applying this method of reshaping at the CONEL Corporation has brought new companies. Figures 1 + 4 outline the reshaping process at the CONEL Corporation. The new managerial structures will be viable if the benefit of the forecast level at the National Energetic System differs from nothing. Passing from current managerial structures of CONEL corporation to new ones (National Company of Electricity, Company of Nuclear Energy and so on) will allow tuning up the competitive market of energy and improving, customer's supplying with energy in terms of decreasing energetic tariffs.

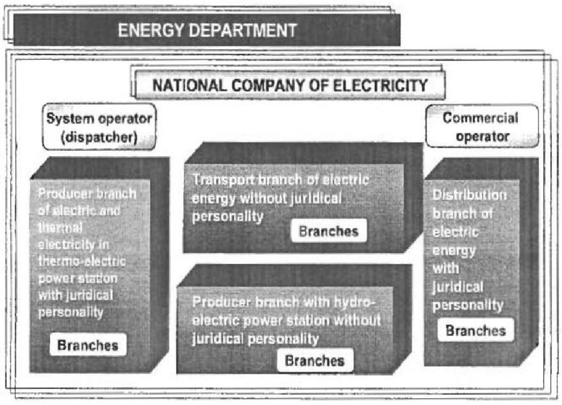

Fig.1. National Company of Electricity at establishment data

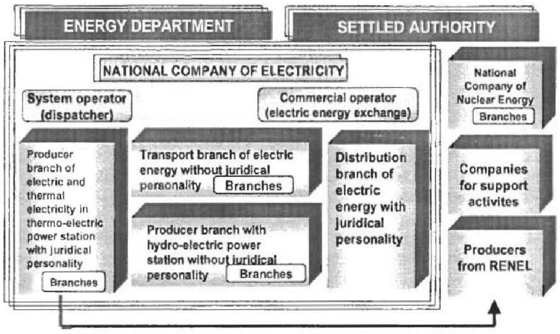

Fig.2. National Company of Electricity at the second faze of reshape

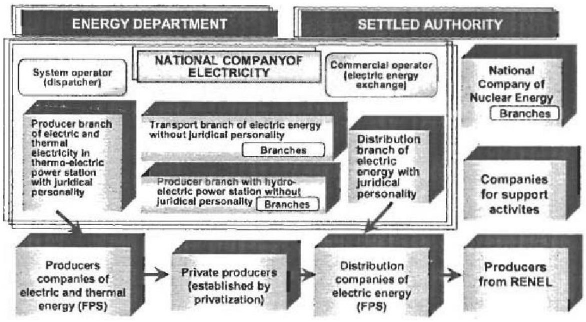

Fig.3. National Company of Electricity at the third faze of reshape

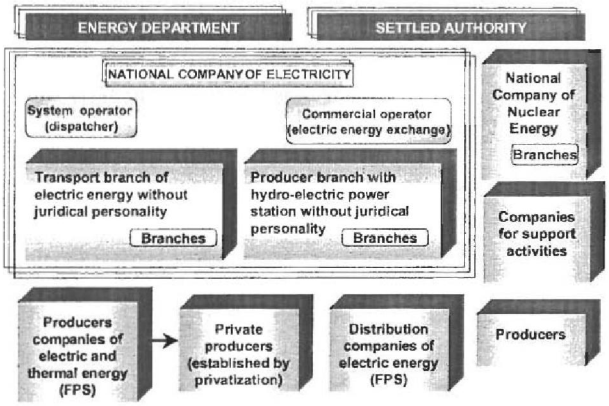

Fig. 4. National Company of Electricity at the end of reshaping process

2. MODELS OF OPERAȚIONAL ENERGETIC REENGINEERING

Models of reengineering energetic systems are based on mathematics relations. Operational research uses these relations accordingly to managerial functions and activities.

$$M_{OPR} = M_{DEV} + M_{COM} + M_{PRO} + M_{HR} + M_{ECA} + M_{DRC}$$
$$M_{dev} = E_{search} + E_{forecast} + E_{risk} + E_{catastrophe}$$
$$M_{COM} = E_{stock} + E_{expectation} + E_{marketing}$$
$$M_{PRO} = E_{renew} + E_{tribology} + E_{economic\ regime} + E_{quality}$$
$$M_{HR} = E_{emphatic} + E_{ergonomics - remuneration - productivity} + E_{dialogue\ human\ being - computer - process}$$
$$M_{ECA} = E_{ff} + E_{ts} + E_{b}$$
$$MD_{RC} = E_{dt} + E_{rdc} + E_{de}$$

where: M_{OPR} = the model of operational research based on following functions (development DEV; commercial COM; production PRO; human resources HR; economics activities ECA; decision and reverse connection DRC).

The models shared in functions include the efforts (E) on activities such as: search, forecast, risk, catastrophe, stock, expectation, marketing, renewing, tribology, economic regime, quality, emphatic, ergonomics (the relationship between human being -work - environment), standardising - remuneration - productivity, dialogue human being -computer - process: E_{ff} = the effort for gathering financial funds, E_{ts} = the effort for tariff settling down, E_{oe} = the effort for office equipment designing and implementation, E_{dt} = the effort for decision makers training, E_{rdc} = the effort made in order to achieve the direct and reverse connection between settled objectives and working system, E_{de} = the effort made in order to make up the decision.

This mathematics model constitutes the base for making up the costs and tariffs through cost- benefit centres which are implemented in National Energetic System.

3. DEVELOPMENT DURABLE DECISION OF THE ECONOMICS – ENGINEERING SYSTEMS

3.1. The pattern of decision models

a) Model based on economic - engineering efforts

$$M_{DE} = E_{search} + E_{forecast} + E_{risk} + E_{catastrofique} + E_{stock} + + E_{expectation} + E_{marketing} + E_{renew} + E_{tribotogy} + + E_{economic\ regime} + E_{emphatic} + E_{quallty} + E_{ergonomics} + + E_{standardising - remuneration - productivity\ dialogue\ human\ being - -computer\ process} + E_{gathering\ funds} + E_{tariffs\ working\ out} + + E_{office\ equipment} + E_{decision\ maker\ training} + E_{direct\ and\ reverse\ connection} + E_{decision\ making\ up} = \boldsymbol{minim.}$$

b) Model based on economic - engineering effects

$$M_{LP} = \max_{j}\left| i\sum \frac{p_{ij}p_j}{n_j} \right|; M_{WM} = \max_{i}\min_{j} p_{ij}$$
$$M_{HW} = \max_{i}\left(c_{opt}A_i + c_{pes}a_i\right);$$
$$Ai = \max_{j} p_{ij};\ a_i = \min_{j} p_{ij}$$
$$M_{DW} = \max_{i}\max_{j} p_{ij};$$
$$M_{sv} = \min_{i}\max_{j} r_{ij};\ rij = \left(p_{ij}^{max} - p_{ij}^{curent}\right)$$

where: M_{LP} = the model of Laplace decision; p_{ij} = the benefit placed at the intersection between the lines (j) and columns (i) from the matrix of benefits that could be achieved: p_j; n_j= the probability of achievement benefits (P_j) depending on the nature situations (n_j); c_{opt} C_{pes} = the optimistic and pessimistic coefficients; M_{HW} = the model of Hurwicz decision; M_{DM} = the model of maximum decision; M_{sv}= the model of Savage decision; r_{ij} = the regret that it have not been able to achieve the performance solution; p_{ij}^{max}, $p_{ij}^{current}$ = the maxim and current benefits.

Further on, there are some applications concerning to profitableness of innovations at the level of reshaped energetic installations.

3.2 Applications concerning to Systems' profitableness subdued to sustainable development

A. There are known:

Installed power: P_i = (10000 + 100 x 4) MW = 10400 MW;

Specific investment: i_{SP} = (1000000 + 1000 x 4) lei/KW;
Working time: t_f = (7000 + 50 x 4) hours/year = 7200 hours/year;
Price of intern energy: P_{ei} = 1400 lei/KWh;
Price of extern energy: P_{ee} = 100 \$/MWh x 30.000 x 10^{-3} = 3000 lei/KWh;

Rate of actualisation: $r_a = r_d + r_{inf} = 0.24$; r_a = 24%.

$$b_{tac} = \sum_{i=1}^{dv_j} (1 + r_a)^{-i} = 10;$$

$$C_{tan} = [(k_i x l_t) + (p_e x E_p)][lei / year]]$$

where: $k_i = (0.033 + 0.04)$, $l_{ti} = i_{SP}$ x P_i
The analysed branch is developing with a power of prognoses P_p:
P_p = 2800 MW; $I_{fulfilled} = 0.75\ I_t$; $I_{nonfulfilled} = 0.25\ I_t$; Q_{par}, = 3000 Gcal/year;
t_t = 900.000 lei/Gcal; $C_{opt} = C_{per} = 0.5$; g = 0.8; d_{vi} = (35 ÷ 25) years - installation time life;
$k_t^{ei} = k_d^{et} = 0.5$; P_{ij} = [lei incomes/lei invested].

There is known the pattern of energy cost:

Table 1

S_j	S_1	S_2	S_3	S_4	S_5
CTE CET	4	6	1	5	8
CME	3	7	8	9	10
CNE	5	3	2	8	4

The structure of energy cost in SE:

Table 2

	SEN	SEE	SEM	
C_{fuel}	72%	22%	30%	from C_{tan}
$C_{exploatation}$	15%	17%	30%	from C_{tan}
$C_{remunerations}$	7%	21%	8%	from C_{tan}
$C_{management}$	4%	33%	25%	from C_{tan}
C_{others}	2%	5%	7%	from C_{tan}

B. It is asked:

1. Incomes for the following systems of development energy:
   a) power stations with and without thermofication only for working stations;
   b) power stations with and without thermofication, as new energetic objectives.
2. The costs and electric tariffs in the following situations:
   a) The costs and tariffs in actual situations;
   b) The costs and tariffs in operational research.
3. Yearly and actualised expenses in operațional research on function of SE (commercial, development, production, human engineering, financial).

C. Solution

1. CET without thermofication:

$$V_{a1}tac = [b_{tac}(p_{ee} x E_{imported}) - p_{ei} x E_{p\ intern} - k_i x l_m] \Rightarrow$$
$$V_{a1}tac > 0 \Rightarrow V_{a1}tac = (P_{ee} x t_t x k_s - k_i x i_{sp} - P_{ei} x t_f) x P_i;$$

V_{a1} tac = (100 x 7200 x 1,5 - 0,04 x 100 x 4000 - 100 x 7200) x 10400 x 10^3;

V_{a1}tac = 33,26 x 10^{10} x lei/year ⇒ tac > 0 it is advantaugeos that the objective should be fulfuilled.

CET with termofication:

V_{a2}tac = (V_{ua}tac+t_t x Q_p x b_{tac}) = (3.326.336 x 10^3 + +35000 x 3000 x 10)

V_{a2}tac = 3336,8 x 10^8 = 33,36 x 10^{10} lei/year ⇒V_{a2} tac > 0 ⇒it is advantageous that the objective should be fulfilled

CTE with partial working:

$V_{b1} = [V_{ua} + k_i\ x\ I_{fulfilled}\ ki\ x\ I_{nonfulfilled};\ I_t = i_{sp}\ x\ P_i;$
$I_t = 1.004.000\ x\ 10{,}4\ x\ 10^6;$
$V_{b1} = 332.6\ x\ 10^{10} + 0{,}04\ x\ 1.004.000(0{,}27\text{-}0{,}75)\ x\ x10{,}4\ x\ 10^6;$

V_{b1} = 31,2 x 10^{10} lei/year ⇒ V_{b1} > 0 => it is advantageous that the objective should be fulfilled

CTE without partial working:
V_{b1} = (V_{a1} x t_{ac}); V_{b1} = 332,6 x 10^{10} lei/year.

CET with partial working:

V_{b2} = V_{a2} - (V_{a1} x b_{tac}) = 332,6 x 10^{10} lei/year.

AII incomes are different from zero, so it is advantageous that the settled objective should be fulfilied.

2. Costs and tariffs of the electric energy:

a) $C_{sp} = C_{tan} / E_p$: $t_{ee} = c_{sp} + tva + tdv + profit;$
$t_{ee} = 1{,}31\ x\ C_{sp} = 1{,}3\ x\ 0{,}5\ x\ (c_{tan}/E_p);$

but:

$C_{tan} = k_i\ x\ l_t + p_e\ x\ E_p;\ c_{tan} = (k_i\ x\ i_{sp}) + (p_e\ x\ xE_p);$

Replacing in formula will result t_{ee} = 790 [lei/KWh].

b) $c_{sp\ tac} = C_{tac}/(q_j x\ E_p x\ d_{vj});\ t_{ee} = c_{sp\ tac} + t_{polution} + r_{fe};$
$t_{ee} = 1{,}31\ x\ c_{sp\ tac}\ x\ 0{,}5$

$t_{ee} = 1{,}31\ x\ c_{sp\ tac}\ x\ 0{,}5 = 0{,}655\ x\ c_{tac}/(q_i\ x\ E_p\ x\ xd_{vi}) = 780\ [lei/KWh];$

3. Expenses on functions of SEN

Table 3

	SEN	SEE	SEM
C_{dev}	$0,04xc_{tac}=$ $=41,62x10^6$	$0,05xc_{tac}=$ $= 52,02x10^6$	$0,30xc_{tac}=$ $= 312,12x10^6$
C_{prod}	$0.15xc_{tac}=$ $=156,06x10^6$	$0,17xc_{tac}=$ $=176.87x10^6$	$0,15xc_{tac}=$ $= 156,06x10^6$
$C_{hum\text{-}cng}$	$0,07xc_{tac}=$ $=72,83x10^6$	$0,21xc_{tac}=$ $=218,48x10^6$	$0,08xc_{tac}=$ $=83,23x10^6$
$C_{fin\text{-}cont.}$	$0,02xc_{tac}=$ $=20,81x10^6$	$0.25xc_{tac}=$ $=260,10x10^6$	$0,07xc_{tac}=$ $=72,83x10^6$
$C_{com\text{-}dec.}$	$0,03xc_{tac}=$ $= 31.21x10^6$	$0,10xc_{tac}=$ $= 104,04x10^6$	$0,10xc_{tac}=$ $=104,04x10^6$
$C_{comm.}$	$0,70xc_{tac}x=$ $= 728,28x10^6$	$0,22xc_{tac}=$ $=228,89x10^6$	$0.30xc_{tac}=$ $=312,12x10^6$

It could be observed that the achievement of energetic objectives in our country are profitable on account of the net incomes are positive.

Also, in can be observed that whatever method we should use, we will obtain the same optimum solution (CNE). This situation confirms the internațional tendency and, also, shows that in România SEN will be developed economically through designing and construction of CNE.

BIBLIOGRAPHY

[1]. A. Carabulea, *Principles and Models of Energy systems Management,* Academy Press, Bucharest, 1996.

[2]. A. Carabulea, I. Felea, *Reengineering of the Human Resources,* Madrid, 1997.

[3]. A. Carabulea, R.Cirica *Reengineering of Technological systems,* Toronto, 1998.

[4]. I. D. Gheorghiu - Industrial Re-engineering of the Energy Risk ui operațional research philosophy - Politechnical Publishing House Bucharest – 2007.

[5]. D. Gligor etc. - Technical - experimental Study for using a new fuel renewable resource - ISPE – 2007.

[6]. A. Carabulea - Power Systems Management Polytechnical Publishing House Bucharest – 2006.

[7]. *** Feasibility Study of fuel structure renewal in Oradea power plant - ISPE – 2007.

[8]. *** European Union Studies of Renewable Energy Use in the Power Systems Central Office Forms - World Power Council (2000 - 2007).