# Software for industrial consumers electrical energy tariff optimal selection

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***Abstract:*** *This paper briefly presents some electrical energy management techniques and proposes a software product dedicated for automatic choose of the optimal tariff structure for industrial consumers. The optimal choose of electrical energy invoicing model proves to be an efficient way to bring quality and economies in any companies administration. Advanced description of the proposed software is also presented.*

***Keywords:*** *energy management, savings, tariff, industrial consumer, software.*

## I. INTRODUCTION

Energy management applied to industrial consumers has the main objective to provide a reasonable and efficient raw material and energy consumption, in order to maximize the benefits and to minimize the energetic costs, raising organizations competitivity. [1]

As secondary objectives of energy management can be mentioned: assuring and keeping the quality of electrical energy; permanent use and development of an energy consumption monitoring system and specific optimization strategies; optimal communication between departments, regarding specific energetic problems and liability of energy administration; raising economies by making investments in performant equipments and technologies.

The main instrument of the energetic analysis of any industrial consumer is the management of energy. Based on identification of quantity and quality of energy losses, energy-balance allows us to evaluate the power absorption efficiency, the specific consumption, and also allows us to establish the causes that lead to these losses. The final result of any energy balance should consist in a program of measures that need to be taken in order to save energy resources and to preserve energy. Still, energetic audit highlights important information regarding advancement in time of the technological processes, load-curves registered by consumer, and the way that these curves can be flattened and inframed in optimal tariff structures, from the commercial point of view of energy billing. [2]

The objective of this paper is to propose for utilization a software product, which can evaluate the electrical energy consumption of industrial costumers, in order to choose the optimal tariff structure. This self-acting choosing method can be considered an energetic efficiency method in both economical and technical perspective, naming the flattening of load-curves, further functioning in gap load intervals and framing in the limits of contracted power. It was shown that choosing the optimal tariff structure is a short-time applicable method, with minimum costs and raising economies form 10 % to 30 % of the total electrical energy costs.

It was found out, that an important number of industrial costumers do not have knowledge about the invoicing politics applied by energy providers or do not have the competent staff for making this type of decisions.

## II. TARIFF STRUCTURES

On world scale, it is considered that in conceiving tariff structures it has to be kept an eye on the following:

- efficient use of human and material resources (orientation of consumer towards a rational consumption);
- correctness and equitableness (every consumer has to pay a proportional price towards the quantity and quality of the services he receives);
- securing the financial necessity of the industrial compartment;
- easy to understand, easy to apply;
- consideration of economical and social objectives (which leads to existence of some preferential tariffs for certain economical branches, of strategic importance, or for some social categories).

Nowadays, the main electrical energy providers in Romania, under the regulation of A.N.R.E. (National Authority of Energy Regulations) uses in order to commercialize electrical energy the following tariff structures:

- The binomial differential **A33** tariff structure, on time intervals and utilization periods of the maximum power, represents the most complex active electrical energy consumption invoicing model. It assumes invoicing the consumed energy in peak hours, gap hours and normal hours, and the maximum absorbed power in load peak and normal hours. This invoicing model has three variants for small, medium and long utilization of the maximum absorbed power. To use this tariff structure, industrial consumers must have an electronic energy counter.

- The differential binomial **A** tariff structure represents one of the complex active electrical energy consumption invoicing forms. This tariff structure assumes invoicing the consumed energy and the maximum absorbed power in load peak and normal hours. In this case industrial consumers must have at least a two dial energy counter with commutation clock and maximum absorbed power indicator.
- The simple binomial **C** tariff structure is applied to consumers, who ask a specific quantity of power, which must be permanently assured by the electrical energy provider. The minimal measuring instrument needed in this case is an energy counter with maximum absorbed power indicator.
- The differential monomial **B** tariff structure invoice only the consumed electrical energy in load peak hours and normal hours. For this invoicing model industrial consumers need a two dial energy counter with commutation clock.
- The E1 tariff structure is the complex form of the day-night invoicing model. This monomial tariff structure makes difference between day and night hours, and between working days and weekend. The minimal measuring instrument for this invoicing model is a two dial energy counter with commutation clock.
- The E2 tariff structure is the simple form of the monomial day-night invoicing model. In this case it is made a difference only between the day and night hours of invoicing consumed electrical energy.
- The monomial **D** tariff structure is the most simple electrical energy invoicing model. In this case is needed an energy counter with only one dial.

In table 1 are presented the equations used to calculate the price paid for the seven shown tariff structures. And in table 2 are presented the variables used in these equations:

| Tariff | Equation |
|---|---|
| **A33** | If *PV>PR:* $F = EV \cdot pEV + ER \cdot pER + EG \cdot pEG + PV \cdot pPV \cdot \frac{NZ}{365}$ If *PR>PV:* $F = EV \cdot pEV + ER \cdot pER + EG \cdot pEG + PV \cdot pPV \cdot \frac{NZ}{365} + (PR - PV) \cdot pPV \cdot \frac{NZ}{365}$ |
| **A** | If *PV>PR:* $F = EV \cdot pEV + ER \cdot pER + PV \cdot pPV \cdot \frac{NZ}{365}$ If *PR>PV:* $F = EV \cdot pEV + ER \cdot pER + PV \cdot pPV \cdot \frac{NZ}{365} + (PR - PV) \cdot pPV \cdot \frac{NZ}{365}$ |
| **B** | $F = EV \cdot pEV + ER \cdot pER$ |
| **C** | $F = E \cdot pE + \max(P_{MaxContr}, P_{MaxMas}) \cdot pP \cdot \frac{NZ}{365}$ |
| **D** | $F = E \cdot pE$ |
| **E1** | $F = EZ \cdot pEZ + EN \cdot pEN$ |
| **E2** | $F = EZ \cdot pEZ + EN \cdot pEN$ |

**Table 1.** Equation used to calculate the seven tariff structures.

| Symbol | Name of Variable | Symbol | Name of Variable |
|---|---|---|---|
| *EV* | Energy consumed in peak hours | *pEV* | Price of energy consumed in peak hours |
| *EG* | Energy consumed in gap hours | *pEG* | Price of energy consumed in gap hours |
| *ER* | Energy consumed in normal hours | *pER* | Price of energy consumed in normal hours |
| *EZ* | Energy consumed in day hours | *pEZ* | Price of energy consumed in day hours |
| *EN* | Energy consumed in night hours | *pEN* | Price of energy consumed in nigh hours |
| *PV* | Maximum power absorbed in peak hours | *pPV* | Price of power absorbed in peak hours |
| *PR* | Maximum power absorbed in normal hours | *pPR* | Price of power absorbed in normal hours |
| $P_{MaxContr}$ | Contracted maximum power | $P_{MaxMas}$ | Measured maximum power |
| *pP* | Yearly power price | *NZ* | Invoicing period length (in days) |

**Table 2.** Variables used in defining equations

### III. SOFTWARE DESCRIPTION

Next in this paper we propose a software product for choosing the optimal tariff structure for industrial consumers, which indicates the results, with great precision, in financial terms. This software may be extremely useful for energy consumption management systems.

The "*Tarifare*" software was created in the Delphi programming language, and has arrived to the third version. In the current version the software can work in two operating modes: the *billing* mode and the *load-curves* mode, and has a Romanian menu only.

In the *billing* operating mode the software is cable to automatically choose the optimal electrical energy invoicing model according to the energy consumption and the energy provider of industrial consumers. While in the *load-curves* operating mode the software can draw the load-curve of industrial consumers on one day or longer time intervals.

When the software is launched in execution the user is asked to upload through a dialog box the consumption files, which will be used by the program in its calculations. The consumption files must be Excel files with a specific format. Data in this Excel files have to be structured in three columns. The first column represents the date when energy consumption was recorded. In the second column it has to be kept the time when the recording was made. And the third column represents the average power absorbed in a 15 minutes time interval. This file format was chosen according to energy consumption recording methods applied by energy providers and because in most cases the modern measuring instruments have the possibility to export recorded data in Excel files.

In both operating modes users dispose of the following options: "*Încărcare fişiere*", "Determinare Rezultate", "*Salvare Rezultate*", "*Printare Rezultate*" and the possibility to switch between the two operating modes. By the "*Încărcare fişiere*" utility users can anytime upload consumption files in the software.

If the *billing* operating mode it is used then when users select the "Determinare Rezultate" option, through the dialog box presented in figure 1, they can pick out the available invoicing models, the voltage level from where the industrial consumer is supplied, and the energy provider after whose prices will be identified the optimal tariff structure.


**Figure 1.** Dialog Box for Invoicing Models Selection

The obtained results are shown in the main window as figure 2 presents:

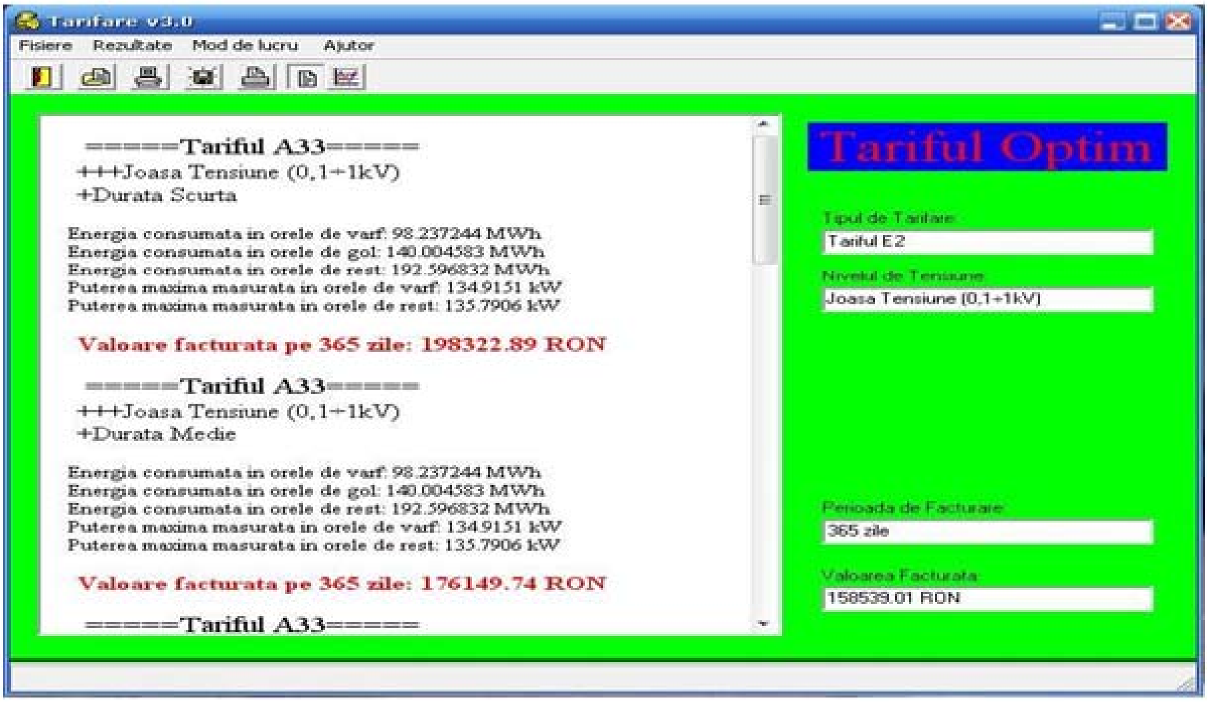


**Figure 2.** Main Window with *billing* operation mode results.

The "*Salvare Rezultate*" and "*Printare Rezultat"* options in the *billing* operating mode give users the possibility to save the obtained results form the text editor (left side block of the main window) to a word document file on the hard drive or to print it.

In case that the *load-curves* operating mode is selected then when users choose the "Determinare Rezultate*"* option, through the dialog box presented in figure 3, they can pick out what type of load-curves they want to be drawn : a 24 hours long load-curve or longer time interval load-curve.


**Figure 3.** Load-Curves Selection Dialog Box.

The software can simultaneously draw up to four load-curves. Also users can give the names whit which these curves will appear in the drawn graphic. If users want to view a 24 hours long load-curve then they have to select the day for which they want to see the load-curve. But if users want to view load-curves on longer time intervals they have to select de start day and the ending day of these time intervals.

Figure 4 presents the main window of "*Tarifare*" software in *load-curves* operating mode with the obtained load-curves.

The "*Salvare Rezultate*" and "*Printare Rezultat"* options in the *load-curves* operating mode give users the possibility to save the drawn load-results to a bitmap file on the hard drive or to print it. In these cases the graphics background will be set to white.

To facilitate an easy update of the time intervals which describes the tariff structures and the prices applied by electrical energy providers, this kind of data is stored in external Excel file on the hard drive. These Excel file are well organized to be easy to understand and modify by users if occurs some changes in the time intervals that describes the invoicing models or in the prices applied by providers.


**Figure 4.** Main Window with *Load-Curves* operating mode results.

| Tip Tarifare | Nivel Tensiune | Putere Zona de Varf | Putere Rest Ore | Energie Zona de Varf | Energie Zona de Gol | Energie Rest Ore |
|---|---|---|---|---|---|---|
| Durata Scurta | Joasa Tensiune (0,1-1kV) | 162,2112 | 70,6014 | 0,7104 | 0,2818 | 0,3608 |
| | Medie Tensiune (1-110kV) | 140,7270 | 61,1586 | 0,5412 | 0,2142 | 0,2705 |
| | Inalta Tensiune (110kV) | 137,3598 | 59,6580 | 0,4849 | 0,1917 | 0,2481 |
| | Inalta Tensiune (220kV) | 114,7410 | 49,9224 | 0,4396 | 0,1691 | 0,2255 |
| Durata Medie | Joasa Tensiune (0,1-1kV) | 405,7476 | 176,4852 | 0,4961 | 0,1917 | 0,2481 |
| | Medie Tensiune (1-110kV) | 351,6528 | 152,8782 | 0,4060 | 0,1578 | 0,2030 |
| | Inalta Tensiune (110kV) | 343,1250 | 149,2548 | 0,3721 | 0,1465 | 0,1917 |
| | Inalta Tensiune (220kV) | 286,8708 | 124,7694 | 0,3495 | 0,1354 | 0,1691 |
| Durata Lunga | Joasa Tensiune (0,1-1kV) | 614,0382 | 266,9238 | 0,4510 | 0,1691 | 0,2255 |
| | Medie Tensiune (1-110kV) | 605,8764 | 263,4468 | 0,3495 | 0,1354 | 0,1691 |
| | Inalta Tensiune (110kV) | 671,0976 | 291,7386 | 0,3045 | 0,1240 | 0,1578 |
| | Inalta Tensiune (220kV) | 605,0712 | 263,0442 | 0,2818 | 0,1128 | 0,1354 |

**Table 3.** The Structure of the Excel file with the energy prices applied for the A33 invoicing model.

Table 3 presents the structure of the Excel file which keeps the data about the prices applied to the A33 tariff structure by "S.C. CEZ VÂNZĂRI S.A.", electrical energy provider for the *Valea Jiului* region.

## I. CONCLUSIONS

❖ We consider this software can be useful and easily adopted to existent or new electrical energy consumption monitoring system in any industrial consumers energy management procedure.

❖ Our contribution consists in creating the "*Tarifare"* Delphi software for automatic choose of the optimal tariff structure for electrical energy invoicing of any industrial consumer based on data taken from measuring, recording and monitoring systems of the consumed energy quantity.

❖ We aim this product for a large scale use of the software by the industrial consumers.

❖ The software was tested on several consumers from the wooden industry, form the porcelain industry and construction sector. Its efficiency was fully proven by the economies that had been brought up.

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