IMPLEMENTATION OF MULTI-OPTIONAL MODEL FOR REGULATING TARIFFS ON ELECTRIC POWER UNDER THE CONDITIONS OF INDEFINITE PARAMETERS

D. CHOMAKHIDZE, T. TSABADZE, S. BARATASHVILI, D. BERIKASHVILI

The article was prepared with the financial support of Georgian National Scientific Fund (Grant GNSF/ST08/7-475).

Any ideas expressed in this publication belong to the authors only and may not reflect the approaches of Georgian National Scientific Fund.

***Key words*:** model, algorithm, software, fuzzy sets, generation tariff.

Assence and improrrtance of the tariffs under market economy conditions are reviewed in the report [1]. In order to draft tariffication model, fuzzy set theory is proposed [2-5, 8].

Now, we will describe the way of realization of the model drafted in the report [1]. The drafted model has the following form:

$$T = \left(\sum_{i=1}^{k} x_i + \sum_{j=1}^{l} x_j^{'} \right) \Big/ x_1 \, . \qquad (1)$$

1. Working Up Appropriate Algorithms for the Realization of the Drafted Model

1.1. Theoretic Basics

Definition 1.1 [7]. Finite collection of fuzzy sets on the metric lattice $\{A_j\}$ is similar to the the finite collection of the fuzzy sets $\{B_j\}$, if each $x \in X$ $\boldsymbol{\rho(A_i^{'}, A_{i-1}^{'}) = k\rho(B_i^{'}, B_{i-1}^{'}); \quad i = \overline{2,m}; \quad j = \overline{1,m}; \quad m = 2,3,...}$, where $k>0$ is similarity coefficient; $\{A_j^{'}\}$, $\{B_j^{'}\}$ are respectively the regulations of $\{A_j\}$ and $\{B_j\}$.

The similarity of two fuzzy set finite collections are marked in a following way:
$\{A_j\} \overset{k}{\cong} \{B_j\} \Leftrightarrow \{B_j\} \overset{1/k}{\cong} \{A_j\}$ or simply $\{A_j\} \cong \{B_j\}$.

Example 1.1. Let's assume, that $\Psi(X) = \{\mu \mid \mu : X = \{x_1, x_2\} \to [0;1]\}$, isotonic evaluation $v(A) = \sum_{i=1}^{N} \mu_A(x_i) \;\; \boldsymbol{\Rightarrow \rho(A,B) = \sum_{i=1}^{N} |\mu_A(x_i) - \mu_B(x_i)|;}$ N =2; m=3 and two $\{A_j\}$ and $\{B_j\}$ are the regulations of the fuzzy set finite collections.

	$A_1^{'}$	$A_2^{'}$	$A_3^{'}$	$B_1^{'}$	$B_2^{'}$	$B_3^{'}$
x_1	0.2	0.3	0.45	0	0.2	0.5
x_2	0.7	0.7	0.9	0.3	0.3	0.7

Let's calculate relevant distances: 0.2 – 0 = 2 × (0.3 - 0.2), 0.5 - 0.2 = 2 × (0.45 - 0.3), 0.3 - 0.3 = 2 × (0.7 - 0.7), 0.7 – 0.3 = 2 × (0.9 – 0.7).

Eventually, we will get $\{\mathbf{B_j}\}\overset{2}{\cong}\{\mathbf{A_j}\} \Leftrightarrow \{\mathbf{A_j}\}\overset{0.5}{\cong}\{\mathbf{B_j}\}$.

The following important theorem is obtained. Index of coincidence is calculated with the follwoing formula [6]:

$$S\{A_j\} = (m - [(2m+1)/4]^{-1} \times \sum_{j=1}^{m} \rho(A^*, A_j))$$

Theorem 1.1 [7]. If $\{\mathbf{A_j}\}\overset{k}{\cong}\{\mathbf{B_j}\}$, than the index of coincindence of these two fuzzy set finite collections is associated with equality $\mathbf{S\{A_j\} = kS\{B_j\} + (1-k)S_{max}}$; $\mathbf{j = \overline{1,m}}$; $\mathbf{m = 2,3,...}$.

It is obvious, that $\{\mathbf{A_j}\}\overset{1}{\cong}\{\mathbf{B_j}\} \Rightarrow \mathbf{S\{A_j\} = S\{B_j\}}$; $\mathbf{j = \overline{1,m}}$; $\mathbf{m = 2,3...}$.

The following theorem is the main theoretic basis for fuzzy aggregation.

Theorem 1.2 [7]. For those two $\{A_j\}$ and $\{B_j\}$ fuzzy set finite collection on the fuzzy set metric lattice with continuous isotonic evaluation for which $S\{A_j\}$, $S\{B_j\} < S_{\max,}$ there is such fuzzy set finite collection $\{C_j\}$, that $\{C_j\} \cong \{B_j\}$ and $S\{C_j\} = S\{A_j\}$; $\mathbf{j = \overline{1,m}}$; m=2,3,…

For each fuzzy set finite collection on the fuzzy set metric lattice there is an infinite amount of limilar fuzzy set finite collections. This condition is appropriate for the given similarity coefficient too. Now, we will determine such conditions, when the given fuzzy set finite collection has the only similar collection.

Theorem 1.3 [7]. For those two $\{A_j\}$ and $\{B_j\}$ fuzzy set finite collection on the fuzzy set metric lattice with continuous isotonic evaluation for which $\{C_j\}\overset{k}{\cong}\{B_j\}$ and $S\{C_j\} > S\{B_j\}$, for each k there is just the only fuzzy set finite collection $\{A_j\}$, such that $\{A_j\}\overset{1}{\cong}\{C_j\}$ and $\mathbf{A_l = B_l^{'}}$; $\mathbf{j = \overline{1,m}}$; $\mathbf{l \in \{1,2,...,m\}}$; $\mathbf{m = 2,3...}$.

Let's consider fuzzy set finite collection $\{\overline{A}_j\}$ the membership function of which is a simple average of the repsective membership function under the conditions of the 1.3 theorem:

$$\mu_{\overline{A}_j}(x) = \{\frac{\sum_{l=1}^{m} \mu_{A_{lj}}(x)}{m}\}, \quad j = \overline{1,m}, \quad m = 2,3,..., \quad \forall x \in X. \tag{2}$$

The following proposal is observed:

Proposal 1.1 [7]. If under the conditions of 1.3 theorem, the fuzzy set finite collection $\{\overline{A}_j\}$ is given by (3.6) formula, then $\{\overline{A}_j\}\overset{1}{\cong}\{C_j\}$ and repectively, $\mathbf{S\{\overline{A}_j\} = S\{C_j\}}$; $\mathbf{j = \overline{1,m}}$; $\mathbf{m = 2,3,...}$; $\mathbf{\forall x \in X.}$

1.2. Description of Tarrif Calculation Algorithms

First of all, we will present the calculation algorithm for fuzzy parameters which is a common block in determining various tarrifs.

Let's assume that, $\Psi(X)=\{\mu\,|\,\mu:X\to[0;b]\subset\Re\}$ is a metric lattice under continous isotonic estimator $v(A)=\sum_{i=1}^{N}\mu_A(x_i)\Rightarrow\rho(A,B)=\sum_{i=1}^{N}|\,\mu_A(x_i)-\mu_B(x_i)\,|$, the universe X is a finite set $\{x_1,x_2,...,x_N\}$ and a group composed by *m* expert evaluates the membership degree of *A* concept against the given universe. As a result, we will get the fuzzy set finite collection $\{A_j\}$; $\mathbf{j=\overline{1,m};}$ m=2,3,…Then, the symbol [ ] means an integer part of a number.

Step 0: initialization: fuzzy set finitie collection $\{A_j\}$, its regulation $\{A_j^{'}\}$, $j=\overline{1,m}$, $m=2,3,\ldots$. Let's mark fuzzy aggregation result with $\mu(x_i)$ at x_i, $i=\overline{1,N}$ point.

Step 1: Let's calculate the representative of the fuzzy set finite collection $\{A_j\}$:

$$\mu_{A^*}=\begin{cases}(\mu_{A^{'}_{[m/2]}}+\mu_{A^{'}_{[(m+3)/2]}})/2 \quad if \quad \sum\limits_{j=1}^{[(m+1)/2]}\rho(A_j^{'},A^{'}_{[m/2]})=\sum\limits_{j=[m/2]+1}^{m}\rho(A_j^{'},A^{'}_{[(m+3)/2]}),\\ \mu_{A^{'}_{[m/2]}}+\dfrac{\sum\limits_{j=1}^{[(m+1)/2]}\rho(A_j^{'},A^{'}_{[m/2]})}{\sum\limits_{j=1}^{[(m+1)/2]}\rho(A_j^{'},A^{'}_{[m/2]})+\sum\limits_{j=[m/2]+1}^{m}\rho(A_j^{'},A^{'}_{[(m+3)/2]})}(\mu_{A^{'}_{[(m+3)/2]}}-\mu_{A^{'}_{[m/2]}}) \quad otherwise.\end{cases}$$

Step 2: Let's calculate the index of coincidence of the fuzzy set finite collection $\{A_j\}$ in every x_i, $i=\overline{1,N}$ element:

$$S\{A_j\}=\frac{1}{N}\left(N-\left[(2m+1)/4\right]^{-1}\times\sum_{j=1}^{m}\rho\left(A^*,A_j\right)\right).$$

Let's mark these values as $S(x_1),S(x_2),...,S(x_N)$ and respectively, $S_{\max}=1$.

Step 3: Let's select such S^* element of $\{S(x_i)\}$ which will be more or which will equal to all the elements except $S_{\max}$.

Step 4: Perform step 5 for $i=\overline{1,N}$

Step 5: Calculate $\Delta=S^*-S(x_i)$:

- If $\Delta<0$, then $\mu(x_i)=\mu_{A_j}(x_i)$
- If $\Delta=0$, then calculate with $\mu(x_i)$ formula:

$$\mu=\begin{cases}(\mu_{A^{'}_{[m/2]}}+\mu_{A^{'}_{[(m+3)/2]}})/2 \;\; if \;\; \sum\limits_{j=1}^{[(m+1)/2]}\rho(A_j^{'},A^{'}_{[m/2]})=\sum\limits_{j=[m/2]+1}^{m}\rho(A_j^{'},A^{'}_{[(m+3)/2]}),\\ \mu_{A^{'}_{[m/2]}}+\dfrac{\sum\limits_{j=1}^{[(m+1)/2]}\rho(A_j^{'},A^{'}_{[m/2]})}{\sum\limits_{j=1}^{[(m+1)/2]}\rho(A_j^{'},A^{'}_{[m/2]})+\sum\limits_{j=[m/2]+1}^{m}\rho(A_j^{'},A^{'}_{[(m+3)/2]})}(\mu_{A^{'}_{[(m+3)/2]}}-\mu_{A^{'}_{[m/2]}}) \;\; otherwise.\end{cases}$$

- If $\Delta > 0$, then calculate k_i from the following equation $S^* = k_i S(x_i) + (1-k_i)m$; and then calculate

$$c = \frac{\sum_{l=1}^{m}(\mu_{A_l^{'}}(x) - k\sum_{i=1}^{N}\mu_A(x_i))}{m}$$

and finally,

$$\mu_{A_j} = \begin{cases} c + k\dfrac{\mu_{A^{'}_{[m/2]}} + \mu_{A^{'}_{[(m+3)/2]}}}{2} \ \ if \ \ \sum_{j=1}^{[(m+1)/2]}\rho(A_j^{'}, A^{'}_{[m/2]}) = \sum_{j=[m/2]+1}^{m}\rho(A_j^{'}, A^{'}_{[(m+3)/2]}), \\ c + k(\mu_{A^{'}_{[m/2]}} + \dfrac{\rho(A^{'}_{[m/2]}, A^{'}_{[(m+3)/2]})\sum_{j=1}^{[(m+1)/2]}\rho(A_j^{'}, A^{'}_{[m/2]})}{\sum_{j=1}^{[(m+1)/2]}\rho(A_j^{'}, A^{'}_{[m/2]}) + \sum_{j=[m/2]+1}^{m}\rho(A_j^{'}, A^{'}_{[(m+3)/2]})}) \ \ otherwise. \end{cases}$$

Step 6: The result is $\{\mu(x_1), \mu(x_2),..., \mu(x_N)\}$.

Repair fund for all the tarrifs to be reviewed is determined in a following way (thousand GEL):

$$x_8 = \begin{cases} 0.05x_1, \ if \ \ x_8 > 0.05x_1, \\ x_8 \ \ otherwise \end{cases} . \qquad (3)$$

Now, we will present the formulas for estimating various tarrifs. x_i and x_j values are given in previous [1] report.

Generation Tarrif

Total electric power, (million kW/hr) transmitted through the high voltage network, is calculated in a followoing way:

$$x_{37} = x_{38}^{'} - x_{36}^{'};$$

Generation tarrif equals to (tetris/kW.hr)

$$T_{\text{gen}} = 0.1\times\left(x_8 + x_{17} + x_{18} + x_{23} + \sum_{j=32}^{34}x_j + x_6^{'} + x_7^{'} + \sum_{j=9}^{16}x_j^{'} + \sum_{j=19}^{22}x_j^{'} + x_{24}^{'} + x_{25}^{'} + x_{31}^{'} + x_{35}^{'}\right)\Big/ x_{37}, \qquad (4)$$

Transmission Tarrif

Repair fund is specified by (3).
Let's mark total demand of the transmission company on revenue by G_{gad}.

$$G_{\text{gad}} = x_8 + x_{17} + x_{18} + \sum_{j=32}^{34}x_j + x_6^{'} + x_7^{'} + \sum_{j=9}^{16}x_j^{'} + x_{19}^{'} + x_{21}^{'} + x_{22}^{'} + x_{25}^{'} + x_{31}^{'} + x_{35}^{'}.$$

Total electric power, (million kW/hr) transmitted through the high voltage network, is calculated in a followoing way:

$$x_{44} = x_{39}^{'} - x_{40}^{'} .$$

Average tarrif of the transmission network (GEL/kW. hr):

$$T_{\text{Sgad}} = 0.1 \times G_{\text{gad}} / x_{44} ; \quad (5)$$

35/110 kW voltage transmission network tarrif is determined (GEL/kW/hr) in a following way:

$$T_{35/100} = 0.04777 \times G_{\text{gad}} / x_{41}^{'} ; \quad (6)$$

6/10 kW voltage transmission network tarrif is determined (GEL/kW/hr) in a folllwing way:

$$T_{6/10} = 0.05223 \times G_{\text{gad}} / x_{42}^{'} . \quad (7)$$

Dispatching Tarrif

Repair fund is specified by (3).

Let's mark total demand of the transmission company on revenue by G_{gad}.

$$T_{\text{disp}} = 0.1 \times \left(x_8 + x_{17} + x_{18} + \sum_{j=32}^{34} x_j + x_6^{'} + x_7^{'} + \sum_{j=9}^{16} x_j^{'} + x_{19}^{'} + x_{21}^{'} + x_{22}^{'} + x_{24}^{'} + x_{25}^{'} + x_{31}^{'} + x_{35}^{'} \right) \div x_{46} . \quad (8)$$

Distribution Tarrif

Repair fund is specified by (3).

Let's mark total demand of the transmission company on revenue by G_{gad}.

$$G_{\text{gan}} = x_8 + x_{17} + x_{18} + \sum_{j=32}^{34} x_j + x_6^{'} + x_7^{'} + \sum_{j=9}^{16} x_j^{'} + x_{19}^{'} + x_{21}^{'} + x_{22}^{'} + x_{25}^{'} + x_{26}^{'} + x_{31}^{'} + x_{35}^{'} .$$

Total distributed electric power (million kW/hr) is calculated in a followoing way:

$$x_{44} = x_{39}^{'} - x_{40}^{'} ;$$

Average tarrif of the distribution network (GEL/kW.hr):

$$T_{\text{Sgan}} = 0.1 \times G_{\text{gan}} / x_{44} ; \quad (9)$$

35/110 kW voltage distribution network tariff is determined (GEL/kW.h) in a following way:

$$T_{35/110} = 0.0004 \times G_{\text{gan}} / x_{41}^{'} . \quad (10)$$

6/10 kW voltage distribution network tariff is determined (GEL/kW.h) in a following way:

$$T_{6/10} = 0.004 \times G_{\text{gan}} \Big/ x'_{42}\ ; \tag{11}$$

0.4 kW voltage distribution network tariff is determined (GEL/kW.h) in a following way:

$$T_{0.4} = 0.0956 \times G_{\text{gan}} \Big/ x'_{43}\ . \tag{12}$$

2. Working Up Computer Systems Based on Designed Algorithms

2.1. Brief Description of Software

Relevant software was designed based on the above described algorithms. It was written using the web-site programming languages HNML, CSS, JawaScript.

The softawe can be used (run) in any PC and operation system - WINDOWS 2000/XP/VISTA/7, LITNUX Based Systems, MAC without installing it.

In order to use the software it is necessary to install in the computer any of these browsers: Opera, Microsoft Internet Explorer, Mozila Fairfax, Google chrome, Safari or any other internet browser. The software capacity is 75,9 kilobites and the name is “terifi”. In order to run the software, it is enough just to double click its icon.

2.2. Description of Software Interface

We will present the description of the software interface scenario on the example of power generation unit.

The following tariff application presented by the licensee based on Engurhesi Limited application for determining 2005 tariff on power generation is reviewed.

Note: The below tariffs were approved by GNERC in 2005 and respectively, independent experts’ estimations cover the same period.

Georgian Engineering Academy
GRANT #GNSF/ST08/7-475 of Georgian National Scientific Fund

Multi-Optional Model for Regulating Tariffs on the Electric Power Under Indefinite Conditions

(Software)

Welcome to Software System for Calculating Tariffs on Electric Power

---

For what kind of unit you would like to calculate the electric power tariff?

1. Generation unit.
2. Transmission unit.
3. Dispatching unit.
4. Distribution unit.
5. Consumers unit (retail tariff).

Generation Unit

Unit name: **Engurhesi Limited**

Please fill up the following tariff application

	Parameter	Amount
1	Remaining cost of main operations funds as of January 1st 2010, thousand GEL	102298.00
2	Property tax interest, %	1
3	Profit tax interest, %	20
4	Depreciation (financial) interest, %	7,6
5	Interest on profit from the remaining funds, %	4,4
6	Depreciation amount, thousand GEL	7775.00
7	Profit amount from funds, thousand GEL	4491.00
8	Repair fund, thousand GEL	15308.90
9	Service provided by other companies (that are not included in the repair fund), thousand GEL	3117.00
10	Raw material and auxiliary materials, thousand GEL	2430.00
11	Salary fund, thousand GEL	4320.50
12	Insurance (compulsory, etc) costs, thousand GEL	8.00
13	Costs on safety measures, thousand GEL	130.00
14	Wear and tear of cheap and quickly wearing items, thousand GEL	55.00
15	Office arrangement costs, thousand GEL	180.00
16	Business trip costs, thousand GEL	245.00
17	Regulatory fee payable to GNERC, thousand GEL	139.00
18	Service fee payable to ECKO thousand GEL	229.00
19	Employee preparation costs, thousand GEL	85.00
20	Scientific-research, design and trial and construction work costs, thousand GEL	1684.00
21	Company security costs, thousand GEL	559.00
22	Credit interest, thousand GEL	0.00
23	Reimbursement of the amount paid by the Ministry of Finance, thousand GEL	0.00
24	Difference in currency rate, thousand GEL	2817.00
25	Other (contingency) costs, thousand GEL	2300.00
31	Profit tax, thousand GEL	898.00
32	Property tax, thousand GEL	1023.00
33	Land tax (of no industrial purpose), thousand GEL	0.00
34	Natural resource usage tax (water fee), thousand GEL	3.00
35	Customs duty, thousand GEL	1085.00
36	Private usage of electric power, million kW.h	8,20
37	Total energy transmitted to high voltage network (effective supply) million kW.h	2001,80
38	Full power generation, million kW.h	2010

Back **Forward**

Generation Unit

	Parameter	Amount
2	Property tax interest, %	1
3	Profit tax interest, %	20
4	Depreciation (financial) interest, %	7,6
5	Interest of profit on the remaining funds, %	4,4

Experts number | 4 | Forward

Estimation of Fuzzy Parameters by Independent Experts

	Parameter	Parameter meaning			
		1 Expert	2 Expert	3 Expert	4 Expert
6	Depreciation amount, thousand GEL	4091.92	4061.64	4091.92	4061.64
7	Profit amount from funds, thousand GEL	14321.72	14215.75	14321.72	14215.75
9	Service provided by other companies (that are not included in the repair fund), thousand GEL	1500	1650	1420	1470
10	Raw material and auxiliary materials, thousand GEL	2010	2430	2080	2170
11	Salary fund, thousand GEL	6320.5	6030.5	6000.5	6100.5
12	Insurance (compulsory, etc) costs, thousand GEL	8.00	7.9	7.8	7.85
13	Costs on safety measures, thousand GEL	107	104	103	102
14	Wear and tear of cheap and quickly wearing items, thousand GEL	51.5	55	50.5	50.5
15	Office arrangement costs, thousand GEL	108	118	120	104
16	Business trip costs, thousand GEL	225	245	235	215
19	Employee preparation costs, thousand GEL	83	85	80	81
20	Scientific-research, design and trial and construction work costs, thousand GEL	1004	1073	1006	1080
21	Company security costs, thousand GEL	505	558	509	519
22	Credit interest, thousand GEL	0	0	0	0
24	Difference in currency rate, thousand GEL	720	810	630	765
25	Other (contingency) costs, thousand GEL	281.15	305.60	274.15	292.45
31	Profit tax, thousand GEL	3582.18	3555.48	3582.72	3555.53
35	Customs duty, thousand GEL	1085	1085	1085	1085
36	Private usage of electric power, million kW.h	7.01	7.04	7	7.02
38	Full power generation, million kW.h	2900	2993.4	3046.45	3001.32

Back | **Forward**

Close

Tariff of Engurhesi Limited makes 1,411 tetri/kW.h

Thank you for using our software
(back)

Tariff requested under the application of Engurhesi Limited equals to:

$$T = 0.1 \times (48882,4 / 2001,8) = 2,44 \text{ tetri/kW.h}$$

GNERC made the changes to the tariff application presented by the licensee which are given in the below table:

	Parameter	Amount
1	Remaining cost of main operations funds as of January 1st 2010, thousand GEL	101541.10
2	Property tax interest, %	1
3	Profit tax interest, %	20
4	Depreciation (financial) interest, %	4
5	Interest on profit from the remaining funds, %	14
6	Depreciation amount, thousand GEL	4061.64
7	Profit amount from funds, thousand GEL	14215.80
8	Repair fund, thousand GEL	5077.10
9	Service provided by other companies (that are not included in the repair fund), thousand GEL	2310.00
10	Raw material and auxiliary materials, thousand GEL	2430.00
11	Salary fund, thousand GEL	8456.40
12	Insurance (compulsory, etc) costs, thousand GEL	8.00
13	Costs on safety measures, thousand GEL	130.00
14	Wear and tear of cheap and quickly wearing items, thousand GEL	55.00
15	Office arrangement costs, thousand GEL	180.00
16	Business trip costs, thousand GEL	245.00
17	Regulatory fee payable to GNERC, thousand GEL	141.80
18	Service fee payable to ECKO thousand GEL	120.50
19	Employee preparation costs, thousand GEL	85.00
20	Scientific-research, design and trial and construction work costs, thousand GEL	1073.00
21	Company security costs, thousand GEL	558.60
22	Credit interest, thousand GEL	0.00
23	Reimbursement of the amount paid by the Ministry of Finance, thousand GEL	-11662.5
24	Difference in currency rate, thousand GEL	0.00
25	Other (contingency) costs, thousand GEL	2300.00
31	Profit tax, thousand GEL	3553.94
32	Property tax, thousand GEL	1015.41
33	Land tax (of no industrial purpose), thousand GEL	0.00
34	Natural resource usage tax (water fee), thousand GEL	3.00
35	Customs duty, thousand GEL	1085.00

36	Private usage of electric power, million kW.h	7,04
37	Total energy transmitted to high voltage network (effective supply) million kW.h	2986,36
38	Full power generation, million kW.h	2993,4

Based on this table, tariff specified by GNERC equals to:

$\boldsymbol{T} = 0.1 \times (35442{,}69 / 2986{,}36) = 1{,}187$ tetri/kW.h

Below is the table summarizing the tariffs calculated by various entities:

Tarrif calculator	Tarrif, tetris/kW.hr
Engurhesi Limited	2,44
GNERC	1,187
Team implementing # GNSF/ST08/7-475	1,411

We believe, that the approach of the fuzzy set based theory provides more adequate results in calculating the tariffs.

R E F E R E N C E S

1. ცაბაძე თ., ჩომახიძე დ., შალამბერიძე ი. ელექტროენერგიის ტარიფების რეგულირების მრავალვარიანტული მოდელი განუზღვრელობის პირობებში//Energyonline. №1(2). 2010.
2. Gustave Nguene Nguene, Matthias Finger; A. fuzzy-based approach for strategic choices in electric energy supply. The case of a Swiss power provider on the eve of electricity market opening, Engineering Applications of Artificial Intelligence, v. 20, Issue I, (February 2007).p. 37-48.
3. Dubois D., Prade H. Possibility Theory, an Approach to Computerized Processing of Uncertainty. Plenum Press, New York. 1988.
4 . Zadeh L. A. Fuzzy sets, Information and Control. V. 8 (1965). pp. 338-353.
5.. Zadeh L.A. The concept of a linguistic variable and its application to approximate reasoning, Information Sciences. V. 8. (1975). pp. 199-249.
6. Tsabadze T. The coordination index of finite collection of fuzzy sets. Fuzzy Sets and Systems. 107 (1999). 177-185.
7. Tsabadze T. A method for fuzzy aggregation based on grouped expert evaluations. Fuzzy Sets and Systems. 157. (2006). 1346-1361.
.8. Tsabadze T. A new approach to the establishment of electricity tariffs based on fuzzy sets. Georgian Engineering News. 1 (2007). 113-119.

David CHOMAKHIDZE, Head of Legal Department
Tel./Fax: (995 32) 399863; Mob.: (995 77) 502999;
E-mail: david.chomakhidze@gnerc.org