PROPOSES TO DEFINE THE COMPETITIVENESS INDICATORS IN POWER ENGINEERING

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REZUMAT. Lucrarea este structurată în patru părţi. În prima parte se justifică utilitatea subiectului, prin prisma conceptelor majore care marchează lumea globalizată, respectiv, competitivitate şi dezvoltare durabilă, dar şi prin prisma importanţei energiei pentru civilizaţia modernă. În susţinerea oportunităţii demersului se face referire la teoriile şi modelele destinate evaluării competitivităţii economice. Partea a doua este dedicată propunerii şi justificării setului de indicatori de competitivitate energetică grupată de cinci piloni: securitatea energetică, eficienţa energetică, impactul de mediu al proceselor energetice, gradul de valorificare al resurselor energetice regenerabile şi capacitatea instituţională. Sunt definiţi un număr de 45 indicatori, arondaţi celor 5 piloni prezentându-se, totodată, modelul de evaluare al acestora. Indicatorii de competitivitate energetică se pretează a fi evaluaţi la nivelul naţiunilor, regiunilor, la nivelul continental, respectiv, la nivelul UE. Partea a treia conţine un exemplu de aplicare a modelului de evaluare a indicatorilor, calculându-se valorile acelor indicatori pentru care s-au identificat datele primare, oficiale, la nivelul României şi al UE, iar în ultima parte se prezintă concluziile analizelor efectuate.

Cuvinte cheie: competitivitate, indicatori, energie.

ABSTRACT. This article has four parts. In the first part, the utility of the subject is justified, through the light of major concepts that mark the globalized world, competitiveness and sustainable development, respectively, but also through the prism of the importance of energy for modern civilization. To sustain the opportunity approach, there are references on theories and models used in assessment of economical competitiveness. The second part of the paper is dedicate to a set of competitiveness indicators proposed and justified, grouped in five pillars: energy safety, energy efficiency, environmental impact of energy processes, harnessing degree of renewable energy resources and institutional capacity. For the five pillars, there are defined 45 indicators and their assessment model. The energy competitiveness indicators assessed to nations, regions, continent, respectively, to EU. The third part contains an example of application of the assessed indicators, computing the values of those indicators for which the primary, official data were identify for Romania and for EU, and in the last part, there are presented the conclusions of the analysis.

Keywords: competitiveness, indicators, energy.

1. INTRODUCTION

Nowadays when the dominant process is the globalization, and the main concern is to assure a sustainable development of the resources, a key vector is the energy.

It is estimated that, in 2030 the total energy demand will be with 30 % higher as in 2010 [1,2], the primary energy sources weight (PES) remain in category of exhaustible energy resources (EER), (Fig. 1).

In accordance with the new energy policy of the EU [3], the energy is an essential vector and in equal measure, it is a challenge to stop the climate changes. Generally, EU27 depends on EER import, which mobilized the Union to promote a common energy policy, based on energy security, sustainable development and competitiveness, as main pillars having renewable energy resources (RER) and energy efficiency.

The concept of competitiveness appears in a period of smooth and continuous development of economic activities [4, 5] and has developed together with the increasing globalization, in recently context of challenges of the economy based on knowledge.

There were elaborate definitions of competitiveness and models of reference. The competitiveness is a key target of contemporaneous socio – economic strategies, integrated in the concept of sustainable development, with multiple faces and interpretations [6], for nations and companies, aiming first the economic consequences of some inputs [5,6,7].

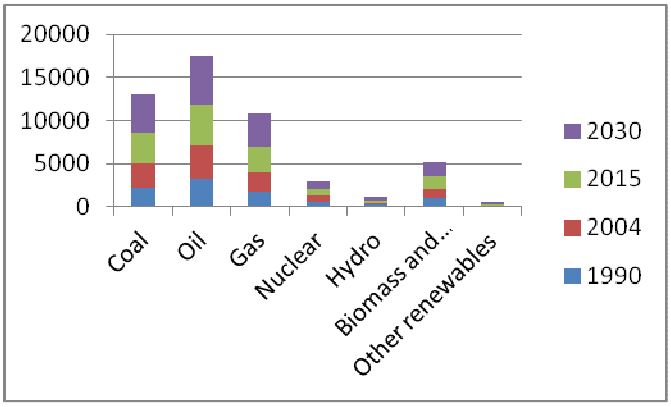

Fig. 1. Evolution of world energy demand

At present, from multiple theories of competitiveness [7], at international level, reference for nations' competitiveness assessment are those that are developed and applied by World Economic Forum (WEF), The Global Competitiveness Report (GCR) [8], International Institute for Management Development (IMP), World Competitiveness Year Book [9], World Bank - Doing Business, OECD – New Economy Report, European Commission – European Competitiveness Report. WEF and IMD yearly reports published about nation's competitiveness. For example, in the report published by WEF for 2010 / 2011, [8], is given result of 139 states analyze, structured in two directions of development.

To evaluate and characterize the level of competitiveness, according WEF – GCR, we start from 111 primary indicators structured on 12 pillars, and based on these there are calculated the aggregate indicators, and finally, the global indicator of competitiveness (GCI). It was analysed the competitiveness of Romania presented in [10], and compared with EU25, assessed by recommended indicators by WEF.

For sustainable development, also, were founded specifically indicators, most representatives in EU are the indicators assessed by Eurostat, structured in three levels [11].

2. NATIONAL ENERGY COMPETITIVENESS INDICATORS

A part of primary indicators applied to characterize the economic competitiveness, respectively, for characterize the level of sustainable development strategies make direct or indirect references about energy problems.

The energy is a main problem for competitiveness and sustainable development, there are elaborated national and European strategies [1,2,3] for short, medium and long terms, adapted to general developing strategies, to proven reserves by PES and predictions of factors evolution that influence the energy consume [12, 13]. The main objectives and scopes regarding energy policy are incorporate in strategies of sustainable development. For example, the Strategy of Sustainable Development of EU [14], incorporate in the 7 key challenges - climate changes, sustainable transport, resource conservation and management – references and details about objectives and scopes with energy nature.

There is extensive literature having as object the problem of energy, management of energy, founding and designing the politics of energy. From this category we give only few titles [15,16,17,18] and we make a remark about the treaty applied by prof. Vasile Nitu, [15], the first article where the base of energy policy were published, identified by the author after a careful and profound assessment of energy phenomenon evolution.

The speciality treaty and the articles, strategies and synthesis accessed by the authors of this article, didn't contain references to indicators that characterize and evaluate the energy competitiveness. Starting from the following reasons:

- Demonstrated advantages using indicators to characterize the economic and sustainable development competitiveness;
- Major importance of the energy for economic competitiveness and in realizing the sustainable development demands.

Next, we propose to use some indicators to characterize the energy competitiveness, structured on the applied strategies and policies in domain. The indicators are suitable to characterize the national, regional (group of countries) and European energy competitiveness. A propose in (Fig.2) is presented regarding the mode to configure the energy competitiveness on five pillars, in table 1, are enumerated the proposed indicators with reference on pillars.

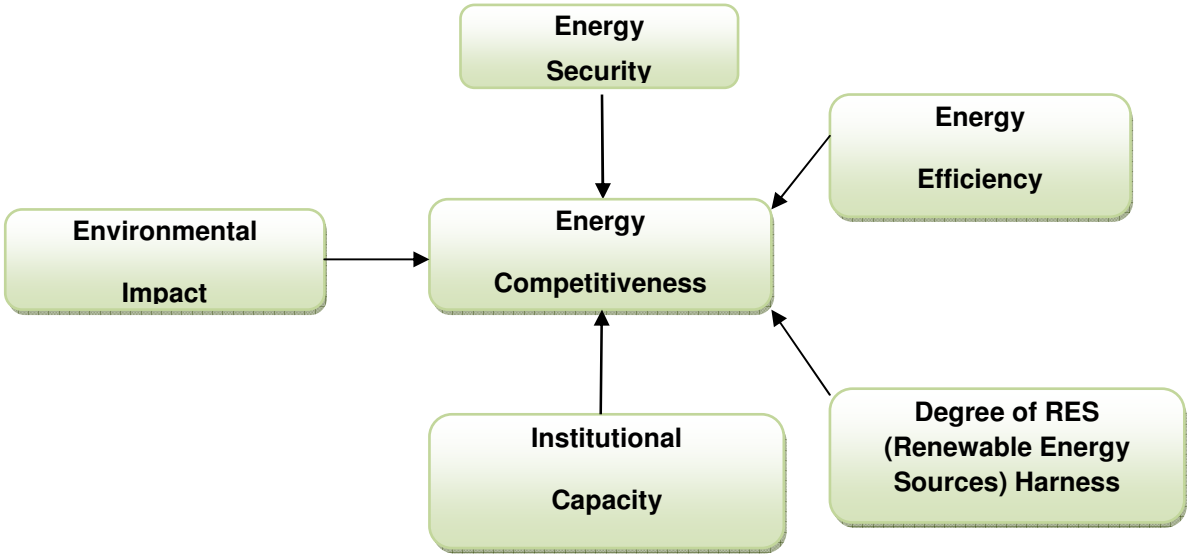

Fig.2. Pillars of energy competitiveness

Table 1

Indicators of energy competitiveness

Pillar	Indicator
1	**2**
1. Energy Security	1.1. Specific reserves of EER [tep / loc.]
	1.2. Specific potential of RES [tep / loc.]
	1.3. Momentarily availability of proper energy resources [u.r.]
	1.4. Operating safety of energy systems [u.r.]
	1.5. Availability of electric energy to consumers [u.r.]
	1.6. Level of indigenous property to national energy resources [u.r.]
	1.7. Degree of connection of National Energy Systems (NES) to European and International Energy Systems (ES) using infrastructures of type ”Connecting Europe” and ”Smart Grid”
	1.8. Capacity of processing, storage and transport of NES [u.r.]
	1.9. Proper security of Nuclear Electric Plants (NEP) [u.r.]
	1.10. Level of national mixture of energy resources, beside optimized energy mix [u.r.], [12]
	1.11. Relative level of engagement to increase the energy safety [M€ / loc.]
2. Energy efficiency	2.1. Primary energy intensity [tep / M €]
	2.2. Final energy intensity [tep / M €]
	2.3. Relative level of engaged investments to increase the energy [M€ / loc.]
3. Environmental impact	3.1. Relative level of CO_2 emissions in energy processes [Mt / tep consumed]
	3.2. Relative level of other Green House Gases (GHG) gases [No_x, SO_2, CO]
	3.3. Relative level for solid particles with negative environment impact
	3.4. Environment impact provoked by NEP [local radioactivity, management of nuclear, natural and burnt fuel, hydrological impact]
	3.5. Utilization degree of domestic and industrial waste to produce electric and thermal energy [u.r.]
	3.6. Relative degree of engaged investments to reduce negative impacts on environment [M€ / loc.]
4. Degree of harness of RES	4.1. Weight of RES in final gross energy consumption [u.r.]
	4.2. Weight of obtained Electric Energy (EE) from RER in total EE consume [u.r.]
	4.3. Weight of biocombustibles from total consumption [u.r.]
	4.4. Degree of harness of solar energy (thermal and photovoltaics) [u.r.]
	4.5. Degree of harness of wind energy [u.r.]
	4.6. Degree of harness of water energy [u.r.]

1	2
	4.7. Degree of harness of biomass energy [u.r.]
	4.8. Degree of harness of geothermal energy [u.r.]
	4.9. Degree of harness of hydrogen as energy vector [u.r.]
	4.10. Relative level of engaged investments to RES harness [M€ / loc.]
5. Institutional capacity	5.1. Degree of competitiveness of national legislation having impact on energy domain with the European one
	5.2. Stability of national energy strategy
	5.3. Level of competitiveness of National Energy Strategy with European Strategy of sustainable development
	5.4. Level of competitiveness of National Energy Strategy with national strategy of sustainable development
	5.5. Capacity of training, research, development, innovation for energy domain
	5.6. Including degree of environmental costs in price of energy [u.r.]
	5.7. Opening / liberalization degree of the energy market [u.r.]
	5.8. Level of arrears of state companies in domain of energy
	5.9. Implementation degree of the scheme commerce of GHG certificates [u.r.]
	5.10. Implementation degree of white certificates transactions leverage to stimulate investments of energy efficiency increase
	5.11. Attractiveness (generated by internal regulations) of private investments to increase the energy efficiency and RES harness
	5.12. Degree of population training to economize the energy, environmental protection and local utilization of RES
	5.13. Degree of implementation of European Standards of internal fabricants, importers and users of energy equipment
	5.14. Degree of application of national regulations viewing the energy audit and the energy management [u.r.]
	5.15. Level of transparency in transactional processes of energy produces

In the table 1, there are three indicators represented: (I_{cs})

- Indicators of specific quantities [1.1; 1.2; 1.11; 2.1; 2.2; 2.3; 3.1; 3.2; 3.3; 3.6; 4.10], for which numerical values are obtained with specified unit;
- Relative quantity indicators [I_{cr}] [1.3; 1.4; 1.5; 1.6; 1.8; 1.9; 3.5; 4.1÷ 4.9; 5.6; 5.7; 5.9; 5.14], for which there are obtained relative numerical values between [0; 1];
- Indicators that requires a quality appreciation (fuzzy) - I_f - [1.7; 1.10; 3.4; 5.1; 5.2; 5.3; 5.4; 5.5; 5.8; 5.10; 5.11; 5.12; 5.13; 5.15], first characterized by linguistic rating: unsatisfactory (0), approximately unsatisfactory (1), a bit satisfactory (2), satisfactory (3), good (4), approximately very good (5), very good (6).

The majority of indicators from "numerical" category (I_{cs}, I_{cr}), the calculation mode is obviously, resulting from the name or it is specified clearly in the literature [15,19,20,21]. Reference will be made only to those indicators from table 1, that are not included in the category above mentioned, so:

a. The values if indicators from [1.6; 3.5; 4.1 ÷ 4.8; 5.6; 5.7; 5.9; 5.14] are calculated with relations:

$$I_{cr.a}^{i,j} = \frac{V_R^{i,j}}{V_M^{i,j}} \quad (1)$$

$V_R^{i,j}, V_M^{i,j}$ – real (R) and maximal (M) value of amount that refers on indicator.

As example, $V_R^{1.6}$ is the value of energy resources and in the national energy system owned by the state, - at the moment of analyze -, and $V_M^{1.6}$, is the maximum value of the two goods.

b. At position 1.8 the value of indicator is calculated taking into account its structure on three components:

$$I_{cr}^{1.8} = \frac{1}{3}\left(\frac{C_{RP}}{C_{NP}} + \frac{C_{RD}}{C_{ND}} + \frac{C_{RT}}{C_{NT}}\right) \quad (2)$$

where:

(C_{RP}, C_{RD}, C_{RT}) – real capacity of processing (P), depositing (D) and transport (T);

(C_{NP}, C_{ND}, C_{NT}) – demand capacity of processing (P), depositing (D) and transport (T);

Processing includes even the producing of EE from other energy forms.

c. The value of indicator in position 4.9 is calculated with relation:

$$I_{Cr}^{4.9} = \frac{W_H}{W_{RES}} \quad (3)$$

(W_H, W_{RES}) – quantity of the produced energy from hydrogen and respectively, from RES in the year of analyse.

The values of „I_f" indicators will be established basing on the characterized linguistic level, placed between [0; 6]. To realize the correlation between the three categories of indicators will proceed to the norm of indicators from the category of (I_{cs}, I_{cr}) "numeric". So, for each ($I_{CS}^{i,j}$, $I_{cr}^{i,j}$) indicator will be construct the variation range of the values [19,21], based on real values of "n" states to the assessment process of competitiveness:

$$x_1 = x_{min} \leq x_2 \leq \ldots \leq x_k \ldots \leq x_{max} = x_n \quad (4)$$

The "minimum" and "maximum" level in the variation range isn't direct connected to the numerical value and always reflects the performance level referring to each indicator.

The "normalized" value corresponding to (x_k) level by linear interpolation formula is calculated:

$$x_k^N = \frac{6\,(x_k - x_{min})}{x_{max} - x_{min}} \quad (5)$$

Basing on the obtained results, distributed for each indicator in interval of [0, 6], can be proceed in function with the followed aim, so:

- Making a hierarchy of the studied "n" states by any primary indicator value and characterizing the competitiveness energy level referring on the respective indicator;

Calculus for each state of energy competitiveness indicator relative to "i" pillar, so:

$$I_{CE}^{i} = \sum_{j=1}^{m} \frac{I_{i,j}^{N}}{m} \quad (6)$$

$I_{i,j}^{N}$ – nominalised value of the indicator, computed with relation (5) or assigned basing on fuzzy level

m – number of indicators' from „i" pillar

By the obtained values it is made the hierarchy of the participant states in terms of energy competitiveness relative to „i" pillar.

The calculus for each state of the global energy competitiveness indicator is:

$$I_{CE}^{G} = \frac{1}{5} \sum_{i=1}^{5} I_{CE}^{i} \quad (7)$$

On the base of the obtained results, the hierarchy of the participant states under aspect of global energy competitiveness can be elaborate.

For any level, it can calculate the average values of indicators at level of a state group (for example, UE27, UE15, and so on and it can compare the states and reference groups.

3. APPLICATIONS

Basing on the published data in [2,22], an assessment was making referring on Romania to values of some indicators presented above. In table 2 are given the obtained values.

Table 2

Obtained values for some indicators of energy competitiveness

No.crt.	Name of indicator	Value			
		Romania		EU27	
		2008	2009	2008	2009
0	1	2	3	4	5
1.	1.3 Momentarily availability of proper energy resources [u.r.]	0.723	0.797	0.453	0.461
2.	2.1 Primary energy intensity [tep / M €]		405	167	165
3.	3.1 Relative level of CO_2 emissions in energy processes [Mt / tep consumed]	1.2	0.99	0.89	0.82
4.	3.2 Relative level of other GHG gases [No_x, SO_2, CO] [Mt / tep consumed]	0.0045	0.0038	0.0079	0.0076
5.	3.5 Utilization degree of domestic and industrial waste to produce electric and thermal energy [u.r.]	0.007	-	0.031	-
6.	4.1 Weight of RES in final gross energy consumption [u.r.]	0.204	-	0.103	-
7.	4.2 Weight of obtained EE from RES of the total EE consume [u.r.]	-	0.279	-	0.182

Table 2

Continued

0	1	2	3	4	5
8.	4.3 Weight of biocumbustible from total consumption [u.r.]	-	0.0333	-	0.0394
9.	4.5 Degree of harness of wind energy [u.r.]	-	0.0062	-	-
10.	I_{CE}^{3} (partially, 3.1 and 3.2)	0.602	0.4969	0.449	0.4138
11.	I_{CE}^{4} (partially, 4.2 and 4.3)	-	0.156	-	0.1107

Table 2

We conclude that, regarding pillars 1 and 2, from primary data only some indicators can be calculate. Referring on pillars 3 and 4, primary data allows three, respectively 4 indicators, partial values of energy competitiveness indicators will be calculate relative to pillars three and four.

With indicator values only for EU27 and Romania, calculate the average values with units of measurement (U.M.) of indicators, normalizing isn't necessary in this limit case. As follows, about pillar 3 it is calculate the medium value between 3.1 and 3.2 with the same unit [Mt / Mtep]. The obtained values are in table two presented on positions 10. Referring on pillar 4, all values given in table 2 (4.1, 4.2, 4.3, 4.5) are in u.r. So, at position 11 the value is even in [u.r.].

4. CONCLUSIONS

In the light of importance of energy resources for global and national sustainable development of the society, taking into account the use of some indicators to characterize the competitiveness of economy, it is important to establish a set of indicators to characterize the strategy of energy and the reality regarding the use of these.

Based on actual characterizing elements of the strategy of energy, but even the need of a more accurate characterize of reality and perspective in domain of energy, the authors of the paper propose to use 45 indicators for energy competitiveness, grouped in 5 pillars, so: energy safety (11), energy efficiency (3), impact with the environment (6), degree of harness of RES (10), institutional capacity (15).

Regarding the mode of evaluation of the proposed indicators, they are in three categories grouped: specific quantitative, relative quantitative and qualitative. After the assessment of the indicators' value, by category and meaning, to make appreciation of energy competitiveness level rated to each pillar as well as of global level of energy competitiveness, first, will be defined the "normalized" values of indicators' using linear interpolation model, then follows the "normalized" values of the indicators on pillars and global national, regional or EU.

The contain of the actual statistical databases on Romanian and EU27 energy sector, allows to calculate the values only for a little part of the proposed indicators in this paper, respectively 20% (9 from 45). From the obtained values - given in table 2 – we observe the following:

- Romania is more competitiveness as EU27 viewing the availability of energy resources (1.3) and the RES weight of energy consume (4.1 and 4.2);
- Romanian's competitiveness is more under EU27 competitiveness viewing energy efficiency (2.1) and environmental impact (3.1 and 3 – partial).

The authors consider as a first step toward definition and structure of certain indicators of energy competitiveness and are waiting proposes to supplementing and reconsideration.

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