Complex Evaluation Model of Corporate Energy Management

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SUMMARY

With the ever increasing energy problems at the doorstep alongside with political, economic, social and environmental challenges, conscious energy management has become of increasing importance in corporate resource management. Rising energy costs, stricter environmental and climate regulations as well as considerable changes in the energy market require companies to rationalise their energy consumption and cut energy costs. This study presents a complex evaluation model of corporate energy management, which can be used for identifying corporate challenges resulting from global energy crises and for seeking possible answers to them as well as enabling companies to evaluate their current energy management practices and identify the level of their energy consciousness. This model enables companies to rethink their energy management tasks and identify the most acute problems of their energy management practices.

Keywords: energy management, corporate resource management, evaluation model
Journal of Economic Literature (JEL) code: M19, M21, Q49, L69

INTRODUCTION

From an operation perspective, it is of major importance for a company to ensure the resources required for its smooth operation at the lowest possible cost impact. An effective organisation of corporate resource management is a fundamental factor in terms of competitiveness. As for resources, apart from raw materials, assets, human resources and other resources, the energy used also plays an increasing role. The importance of conscious energy management is growing, since market processes pose challenges to companies. The rising energy prices and strict environmental and climate-protection requirements require companies to rationalise their energy consumption and decrease energy costs. The fact that companies assign different priorities to these issues should not be neglected. The efforts companies make for energy rationalisation depend on company size, the sector it is categorised in, energy intensity of the activities, and the proportion of energy costs compared with operating costs. Based on the information reviewed, it would be wise for companies to review their priority list in terms of energy rationalisation measures, evaluate their current energy management practices and level of their energy consciousness, set further tasks regarding their energy management and identify problem areas in their current practices. The complex evaluation model elaborated in this paper can provide assistance to companies in this endeavour.

THEORETICAL FRAMEWORK OF THE TOPIC

Before the complex evaluation model of corporate energy management was constructed, the available technical literature was thoroughly reviewed. The available literature on the topic of energy management has increased over the past few years. A number of sources deal with setting tasks in energy management, motivation factors and barriers of its application, and energy-management tools from different aspects and in various depths. (See among others: National Productivity Council, 2002; Zsebik & Czinege, 2003; Zsebik et al., 2003; Goebel, 2007; Diófási & Diófási, 2009; Carbon Trust, 2010, 2011a,b; Hirzel et al., 2011; Bihari, 2012; Thorpe, 2013). There have been several empirical studies on evaluating energy efficiency of particular sectors of economy (Önut & Soner, 2007; Pardo Martínez, 2009; Gordićat al., 2010; Sivill, 2011; Madlool et al., 2013). Apart from the above-listed studies, a number of other sources provided background for developing the approach used in this paper. As for the applied methodology, self-assessment models widely used in

current practices (energy management matrix (EMM)[1], Energy Management Assessment (EMA)[2], Ecomapping[3], Ecostar methodology) and self-assessment questionnaires (Virtual Power Plant Programme, Gvozdenak & Morvay, 2008) were thoroughly reviewed.

This paper presents two self-assessment models which are most frequently applied: the Energy Management Matrix and the Energy Management Assessment. The Energy Management Matrix (Brescu, 1993) is a simple and easy-to-use self-assessment method of energy management. It analyses energy management performance in six areas. The ascending rows, on the scale from 0 to 4, represent the increasingly sophisticated, mature and formalised nature of energy management activities, which indicate increasingly good practices. The organisational profile received after the levels have been marked indicates the areas where additional efforts are required to further promote energy management efficiency. The advantage of this method lies in its simplicity.

The matrix enables companies to assess the operation of energy management functional areas without involving external experts. If this assessment is repeated after a certain period of time, progress can be measured. The priority areas are apparent; however, I think their number and contents could be expanded. The disadvantage of this model is that it is subjective, like any other method based on self assessment. However, the subjectivity is slightly decreased since relatively concrete requirements are assigned to each level and clear and accurate statements provide bases for choosing the right level. Yet I think that – apart from the lowest and the highest levels – the statements are a bit constrained at other levels and do not always show realistic 'stair steps'. The application of only this single matrix highly simplifies, even over simplifies the assessment. Thus, it is advisable to collect background information related to particular areas and perform in-depth studies, which makes the choice of levels better grounded. (To this end, there are propositions formulated in 'Energy Efficiency Guide for Industry in Asia' (www.energyefficiencyasia.org). Unfortunately, the guide fails to list the cases and areas where a weaker performance can be considered acceptable.)

The Energy Management Assessment (EMA) provides a more detailed appraisal of energy management performance than the Energy Management Matrix. The Carbon Trust Guide (2011a, b) serves as a basis for introducing the method. The method distinguishes twelve key areas across five area groups and analyses each key area according to several criteria (with variable numbers). Particular criteria are weighed in different ways. Each key area is assigned a maximal reachable score and an actual reached score. After all the key areas are assessed, a summary table is compiled illustrating actual scores, maximal scores, and performance in percentage. The achieved results are illustrated in a cobweb diagram. The areas which require further improvement can be identified from the diagram (Carbon Trust 2011a, b). The advantage of the EMA is that it analyses several key areas according to several criteria. Since the criteria have different weight, the relevance of particular criteria can be distinguished. The disadvantage of the EMA is that the determination of the evaluation criteria and variables of particular areas results in superficial evaluation. Thus, the content lying behind the evaluation of particular areas requires further consideration. The EMA is not suitable for comparing companies.

After the secondary research was conducted, a comprehensive summary of the motivations, toolbars and main barriers of corporate energy management were prepared (Kádárné Horváth in Szakály (szerk.) 2012), which provided a basis for identifying the main directions of further research and compiling questions for a corporate questionnaire and the elements of an empirical model. The reviewed research studies were considered to be guidelines when the model was created. However, none of them was really suitable for performing the role of a complex evaluation method. When the complex evaluating model was elaborated, the methodological framework of the EMA self-assessment method was particularly inspiring. Its framework was mostly followed but its content was considerably changed when the complex model of corporate energy management evaluation was created.

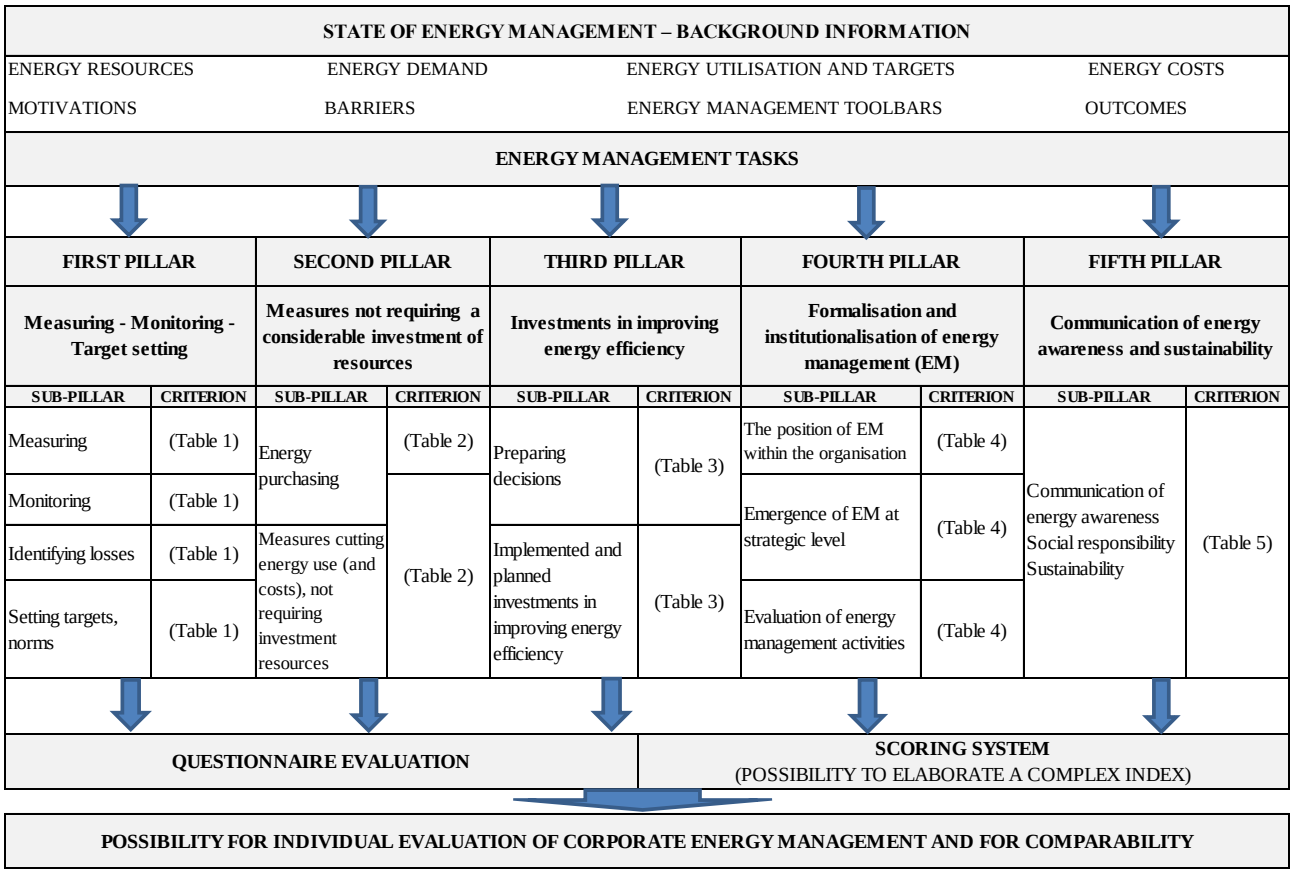
COMPLEX MODEL OF CORPORATE ENERGY MANAGEMENT EVALUATION

The starting point of the complex evaluation model was the most important task in corporate energy management, namely, to identify the corporate activities to be assessed. It was followed by grouping the identified tasks and establishing the pillars of the model. When the task groups making up the pillars of the model were determined, a principle of gradation was applied. On particular pillars, the energy management activities reflect tasks which require higher level and more corporate efforts and a more sophisticated and energy-conscious approach. The pillars (task groups) constitute main tasks of energy management (the sub-pillars) and main criteria for task evaluation. These criteria are assessed with a variable of different numbers.

The complexity of the model is experienced in several areas. First, the areas being evaluated cover almost all of the most important tasks, toolbars and motivating and

[1] *Copyright © Brescu 1993*
[2] *Carbon Trust 2011a,b*
[3] *Ecomapping © Heinz-Werner Engel, 1998*

hindering factors of energy management. Second, the model can be applied in several areas. Our aim was to construct a complex model with a double function which provides an informative evaluation of corporate energy management, mapping the areas for improvement and allows comparing companies. This double function can be fulfilled by the two evaluation tools applied in parallel in the model. The evaluation is performed on the basis of a detailed questionnaire in which there are questions related both to topics corresponding with the model elements and to background information in order to have a better insight into the issue. This method enables companies to identify the areas for improvement in their energy management, since companies have to think over what responses to give to the questions and utilise the opportunities provided by the individual evaluation of the responses. The scoring system developed on the basis of the model pillars makes individual assessment possible. This is the second tool for evaluation besides the questionnaire. Figure 1 shows the complex evaluation model.



Source: own elaboration

Figure 1 Complex evaluation model of corporate energy management

In the next part of the study the pillars of the model are introduced.

THE FIRST PILLAR: MEASURING – MONITORING – TARGET SETTING

The first pillar includes four tasks, which are measuring, monitoring, identifying energy losses, and setting norms and objectives (Table 1). They make up the first level of energy management tasks, where there is neither energy nor cost savings. However, these tasks are crucial from an efficient energy management perspective. Sustainable energy savings cannot be achieved without knowing where and with what purpose the energy is used, the amount of energy used, factors influencing it, where and at what points intervention is required, and what measures should be taken to achieve energy rationalisation. Major energy consumers, energy loss sources and the amount of lost energy are to be identified as well.

Without measuring, monitoring and controlling energy consumption, energy rationalisation measures cannot be accomplished. Identification of sources of energy losses and target setting are also important tasks. The assessment of the certain tasks should be carried out according to the following criteria:

- Measuring energy consumption. A company can estimate the amount of the energy used in several ways. One is to collect data from utility bills and suppliers' invoices. Another way is to read the utility meters. The latter provides more

accurate information. As for the measurements, the first evaluation criterion is to identify the presence of measurement conditions, namely, to map whether the company has enough utility meters and sub-meters and in what state of maintenance they are; and whether the company has energy supervision and information systems that are suitable for analysing and evaluating the collected data. The other evaluation criterion is to identify the levels where the accurate measurements of energy consumption are performed and to examine the frequency of these measurements.

- Monitoring. Monitoring and analysing the energy consumption and energy costs are of vital importance from an energy management perspective. As for evaluation criteria of activities, it is also critical to know at what levels the measurements are carried out and with what frequency they are performed. Apart from monitoring at the corporate level, performing monitoring at the site, category, plant, building, process, equipment and shift levels also provides useful information for analyses. Accurate measurement data and the data available on the utility bills, as well as different calculation methods, provide bases for information. Another important move is to analyse and monitor energy costs. Accurate and detailed analyses also allow reliable evaluation of activities. It is not sufficient to examine only the trends in energy usage and energy costs – the reasons lying behind these trends are also worth considering when energy consumption and energy costs are evaluated. This is because several factors have a considerable impact on energy consumption and energy costs. Thus, the identification of these factors and the analysis of each impact are essential. The savings resulting from energy rationalisation measures, should be distinguished from the savings that result from changes in the weather, in the production structure, in the organisational structure (organisational changes, changes in work schedules, outsourcing or insourcing activities), in the production volume, in costs, in purchasing strategies and in energy prices.
- Identifying energy losses. Energy losses can be experienced at several levels. Apart from shipping, distribution and transformation losses, there may be technological and overhead-nature losses (in technological process or in lighting, heating). It is of utmost importance whether companies identify the main sources of energy losses or quantify the losses in some way. The quantification of monetary losses makes companies sensitive to these losses and helps them overcome their vulnerability.
- Setting goals and norms. Taking into account the outcome of analyses, a company sets goals related to energy savings. The assessment of the suitability and elaboration precision of these goals may be another evaluation criterion. The goals should be clear, realistic, relevant to the specific features of the area under analysis, and measurable. An additional criterion of evaluation is the presence of concrete action plans including resource, cost and timescale analyses, a list of names of responsible persons with set deadlines, and evidence for goal implementation, feedbacks and regular reviews.

Table 1
Structure and evaluation criteria of the first pillar

THE FIRST PILLAR	
Measuring – Monitoring – Target setting	
SUB-PILLAR	EVALUATION CRITERIA
Measuring	Presence of measurement conditions
	Measurement levels, frequencies
Monitoring	Monitoring frequencies
	Precision, detailedness of analysis
Identifying energy losses	Identification of sources of energy losses
	Quantification of energy losses
Setting targets, defining norms	Conformance of targets
	Extent of objective elaboration

Source: own elaboration

THE SECOND PILLAR: MEASURES NOT REQUIRING A CONSIDERABLE INVESTMENT OF RESOURCES

Measures not requiring a considerable investment of resources constitute the second pillar of energy management tasks (Table 2).

Table 2
Structure and evaluation criteria of the first pillar

THE SECOND PILLAR	
Measures not requiring a considerable investment of resources	
SUB-PILLAR	EVALUATION CRITERIA
Energy purchasing	Bargaining power in the energy market
	Performing operative tasks
	Elaborating the energy purchasing strategy
Measures for reducing energy use without requiring a considerable investment of resources	Energy saving measures
	Energy efficiency measures

Source: own elaboration

The first task among the measures is energy purchase which is not accompanied by considerable additional costs. When the energy is purchased, there are no energy savings; however, considerable energy costs can be saved by adopting appropriate energy purchasing strategies. Apart from purchasing tasks, the second pillar encompasses company measures resulting in reducing energy use and not requiring a considerable investment of resources.

The assessment of the certain tasks should be carried out according to the following criteria:

- Energy purchasing. The role of energy purchasing in saving corporate energy costs has increased in the past few years, especially after the liberalisation process of energy markets. Different types of contracts have been concluded in the free market, which requires better preparedness and knowledge from energy management. Comparing tenders submitted by energy traders competing in the energy market is also a complicated process. Apart from the negotiated prices and the grid fees, there are several other contractual terms and conditions (tolerance bands, surcharges, penalties, currencies, exchange rates, payment deadlines and timeframes) that should be taken into account. It is by no means certain that the contract offering the lowest price is really that cheap. Energy can be purchased from different vendors and places in various ways (OTC markets, energy stock exchanges, energy tenders and grouped purchases). There are also several ways to rationalise energy costs while purchasing energy. Whilst evaluating the utilisation of the opportunities lying in purchasing energy, the company's bargaining power, the performance of such basic tasks as checking energy bills, and the presence of professional competences used for developing purchasing strategies are also worth considering.
- Measures reducing energy usage and not requiring a considerable investment of resources. Energy usage can be reduced in two ways: by introducing measures targeting energy savings and through increased energy efficiency. The fundamental difference between the two ways is that in the first case energy can be saved by placing consumers in a worse situation (providing heating at a lower temperature). In the latter case, energy consumption is reduced; however, the original degree of comfort remains. The available options arising from this should be examined. This idea involves such simple actions as turning off machinery and interrupting power, eliminating the standby mode, encouraging employees' conserving behaviour, setting appropriate lightning levels, or identifying and utilising natural lighting options.

THE THIRD PILLAR: INVESTMENTS IN IMPROVING ENERGY EFFICIENCY

The third pillar is a considerable jump in terms of corporate energy management. The tasks on this level have financial implications since decision making involves financial considerations. In order to implement investments, a financial basis is to be established. As for energy- efficient investments, two sub-tasks are worth giving priority (Table 3). First, it should be analysed how much caution and prudence was exercised when the decision about investing in energy project was made and processes were prepared. Second, it should be investigated whether the company has already performed any investment activities or planned investments aiming at improving energy efficiency.

Table 3
Structure and evaluation criteria of the third pillar

THE THIRD PILLAR	
Investments in improving energy efficiency	
SUB-PILLAR	EVALUATION CRITERIA
Preparing decisions on investments improving energy efficiency	Priority to energy investments
	Support of energy investments
	Decision-making methodology
	Ways of raising resources
Executed and planned energy efficiency investments	Energy investment in corporate processes
	Energy investment in building energetics
	Reduction of energy loss
	Incorporation of energy efficiency criteria into other investment processes

Source: own elaboration

The assessment of the certain tasks should be carried out according to the following criteria:

- Preparing decisions. It is essential to analyse priorities a company has given to energy investment projects from the perspective of implementing different energy investments and their support in a company. Its mapping is important because some companies lack solid justification of investment projects in energy and the conditions of their implementation. Another evaluation criteria can be to identify the applied decision-making methodology and to evaluate the calculations a company has made before deciding for or against investing in a project. It is also worth examining whether minimum criteria (for instance, the return on the investment) are set when evaluating a project and whether all investments in energy are given the same considerations or each investment project is evaluated according to seperate

criteria. The method of financing investment projects is also of great importance.

- ➢ Implemented and planned investments in improving energy efficiency. Mapping implemented and planned investments in improving energy efficiency is an important evaluation criterion. It is worth examining in what areas investments in energy efficiency were implemented and with what objectives, whether they targeted corporate main and support processes or building energetics or they were aimed at reducing losses. Another critical element is the presence of energy efficiency critera in other investment processes of a company (for instance, in purchasing office machines).

THE FOURTH PILLAR: FORMALISATION AND INSTITUTIONALISATION OF ENERGY MANAGEMENT

The fourth pillar analyses the level of formalisation and institutionalisation of energy management (Table 4). Formalisation and institutionalisation mean how energy management is addressed by a company, whether the company has an official framework for pursuing this activity and whether the functional area plays any role in corporate strategic visions. The fundamental tasks at this level are to identify the position of energy management within the organisation, to map its place at a strategic level and to evaluate corporate activities in energy management.

Table 4
Structure and evaluation criteria of the fourth pillar

THE FOURTH PILLAR	
Formalisation and institutionalisation of energy management	
SUB-PILLAR	EVALUATION CRITERIA
The position of energy management within the organisation	Emergence of energy management functional areas in the organisational structure
	The number of employees responsible for the energy management, their job duty areas and organisational position
	Harmonisation of competencies, powers of decision and responsibilities
Emergence of energy management at the strategic level	Emergence of energy management in the corporate strategy
	Energy strategy, energy policy
	Energy management system
Evaluation of energy management activities	Evaluation of outcomes of energy efficiency policy measures
	Identification of energy management tasks

Source: own elaboration

The assessment of the certain tasks should be carried out according to the following criteria:

- ➢ The position of energy management within the organisation. Energy management tasks can be positioned within the corporate hierarchy in a different way. Because of the character of energy management, it can be considered to be a border area between technical and economic areas, so its position in the organisation structure is not clearly defined. For this reason, the emergence of energy management functional areas in organisational structure is worth analysing. The focus should be laid on determining whether a company employs a person whose job duty areas are related solely to energy management; how many persons are responsible for performing energy management tasks; whether competencies, powers of decision and responsibilities are harmonised; whether the company has an Energy Management Department; whether the energy management tasks are present at middle and top management levels and the performance of this activity is indicated in the management's and other employees' payrolls; and whether energy efficiency is included in the performance evaluation as a criterion.
- ➢ Emergence of energy management at strategy level. Important evaluation criteria can be whether energy management issues are present in the corporate strategy within a formalised framework; whether the company has elaborated independent energy strategy and energy policy and whether they are in harmony with each other and with the corporate strategy; whether the company has implemented an energy management system certified by an international standard; and whether a regime of energy audits is introduced on a regular basis. The above-listed issues emerge at a more sophisticated level of a corporate energy management policy.
- ➢ Evaluation of energy management activities. It is worth examining whether a company performs a regular efficiency evaluation of energy management, strives to quantify the outcomes of energy efficiency policy measures, identifies the areas in energy management practices requiring improvement, and has professional competences to perform energy management tasks. The methods applied by the company when conducting the evaluation should also be examined.

THE FIFTH PILLAR: COMMUNICATION OF ENERGY AWARENESS AND SUSTAINABILITY

The fifth pillar is the most sophisticated level of performing energy management tasks (Table 5).

Table 5
Structure and evaluation criteria of the fifth pillar

THE FIFTH PILLAR	
Communication of energy awareness and sustainability	
SUB-PILLAR	EVALUATION CRITERA
Communication of energy awareness, emergence of sustainable energy management	Communication of energy awareness
	Participation in energy efficiency initiatives
	Further expansion of an energy-aware purchasing policy to materials, equipment and buildings
	Further expansion of energy-aware purchasing policy to the complete supply chain
	Emergence of energy efficiency criteria in product development
	Social and environmental responsibility
	Emergence of sustainable energy management

Source: own elaboration

The assessment of the certain tasks should be carried out according to the following criteria:

- Communication of energy awareness and emergence of sustainable energy management. Information about the following issues is to be collected at this level, namely whether the company communicates energy awareness inside and outside the company, is a participator or an active initiator of energy efficiency initiatives (for instance, the Virtual Power Plant Project), expands energy efficiency criteria to the whole purchasing process (including material, equipment and building purchases), expands energy aware purchasing concept to the complete supply chain, applies energy efficiency criteria in product development, undertakes social and environmental responsibility in corporate activities and includes sustainability and sustainable energy management in the corporate strategy.

OPERATION OF THE MODEL

As a result of the research work, a research questionnaire and the first draft of the scoring system have been created. Pre-testing has already been carried out. After pre-calculations are made a final version of the questionnaire will be developed.

According to the initial concept, the evaluation of the five pillars was performed along several sub-pillars on the basis of several (a variable number) evaluation criteria. Variables used for measuring particular elements were developed in every evaluation criterion. The set of variables used in the scoring system was compiled on the basis of the questions in the questionnaire. The questionnaire was made up of questions thematised by the elements of the introduced evaluation model. On the basis of the scoring system, an equal obtainable total score could be reached in each pillar. However, the sub-pillars making up the pillars were weighted differently, since sub-pillars were assigned a different maximal reachable score. The variables of the criteria selected to evaluate the sub-pillars were also weighted depending on how much relevance they have compared to each other. (The variables may include not only specific questions, closed questions, specific data and information but also scale-type questions, which involve some subjectivity.) There is a maximal reachable total score for each pillar and sub-pillar. After the evaluation is completed, the score reached by the company is established. As a quotient of the reached score and the maximal reachable total score, the percentage rate of the potential of a particular task group exploited by the company can be defined for each pillar.

The following concrete example presents the application of the model. As has already been mentioned above, the first draft of the research questionnaire and the scoring system built on it have been pilot tested. The responses given by 8 companies to the pilot questionnaire were evaluated and calculations related to eight companies were performed. On the basis of obtained results, the scoring system is currently under elaboration (clarification) and the circle of variables to be included in the scoring system is being worked on. Although only the results of the tentative calculations are available, they do not hinder the understanding of the theoretical operation of the model.

One of the concrete examples of test calculations illustrates the application and interpretation of the complex evaluation model. The information known about the company is as follows. The company's business activities belong to the sector of 'manufacture of wood and of products of wood and cork','manufacture of articles of straw and plaiting materials' and 'manufacture of furnitures'. As for the size, it is a small-sized company with five employees. It has been successfully operating as a family enterprise for 20 years. The business has been growing; its activities have expanded and changed. A new wood manufacturing company, a carpentry and wood machining plant, was founded to meet the increased consumer demand. The plant is involved in both trading and manufacturing activities and is a service provider, too. The plant has advanced machines (a wood drying machine, different types of circular saws, a milling machine, and a pressing machine) and technology, which enables the management to handle wood waste efficiently

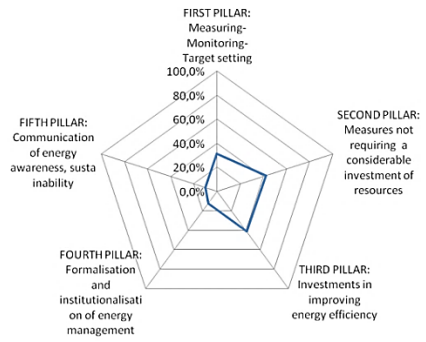
and use wood residues for further purposes. From an energy aspect, the purchasing of a biomass boiler was a major investment in enhancing the energy efficiency of the business. It is used for heating the workshop and burning wood waste and chips. The wood waste generated during production is made into useful briquettes, which are sold alongside with logs as a heating fuel. The company is thinking of further investments in modernising and expanding its machine park and plants to deploy solar panels with the objective of reducing and covering electricity demand. The return on these investments is estimated at 10-12 years. The management is not planning to hire an energy expert to perform energy management tasks. The company uses most of the purchased electricity for operating machines (60%), lighting (32%), and supporting processes (8%). They do not purchase any heating fuels for heating buildings or operating drying machines. The purchased biomass boiler, operating on logs and wood waste, is used for generating the required amount of heat. In addition, the company has two gas-powered forklifts. The proportion of energy costs in the revenue amounts only to 1.71% and together with fuel costs this figure accounts for 2.1%. The company is attempting to take an advantage of the liberalised electricity energy market and is planning to change its supplier. The management constantly strives to cut energy consumption. By rationalising the production processes, modernising lightning (using energy-efficient lamps), replacing old doors and windows and improving insulation, the company has saved a considerable amount of energy. The company lacked an explicit and written energy strategy and an energy management system. Their energy losses were assessed by an external expert. Nevertheless, the company adopted good energy management practices. On the basis of the new model and the results obtained from the tentative calculations, a summary table was elaborated (Table 6), which illustrates the points obtained, the maximal reachable score and the percentage performance.

Table 6
Summary table of the complex evaluation model (on a basis of a real company)

Evaluated areas	Reached scores	Maximal scores	Percent of points (%)
FIRST PILLAR: Measuring-Monitoring-Target setting	12.5	40	31.3
Measuring	0.25	8	3.1
Monitoring	6.75	16	42.2
Identifying losses	3.5	8	43.8
Setting targets, norms	2	8	25
SECOND PILLAR: Measures not requiring a considerable investment of resources	16.98	40	42.4
Energy purchasing	5.38	20	26.9
Measures cutting costs, not requiring investment resources	11.6	20	58
THIRD PILLAR: Investments in improving energy efficiency	16.48	40	41.2
Preparing decisions	1.48	10	14.8
Implemented and planned investments in improving energy efficiency	15	30	50
FOURTH PILLAR: Formalisation and institutionalisation of energy management	4.88	40	12.2
The position of energy management within the organisation	0.25	10	2.5
Emergence of energy management at strategy level	1	15	6.7
Evaluation of energy management activities	3.63	15	24.2
FIFTH PILLAR: Communication of energy awareness, sustainability	4	40	10
Energy awareness, communication, social responsibility, sustainability	4	40	10
Total:	**54.83**	**200**	**27.4**

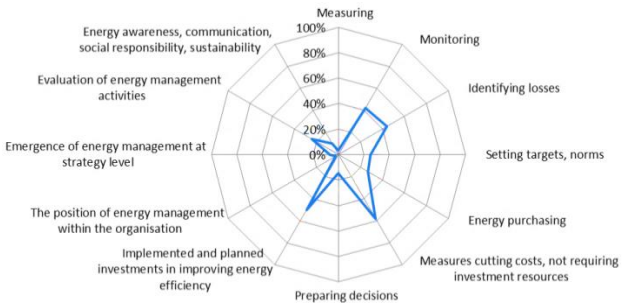
Source: own elaboration

The obtained results are shown in a cobweb plot (Figure 2 and Figure 3) where the areas which need improving can be easily identified.



Source: own elaboration

Figure 2 Implementation of pillars in the company



Source: own elaboration

Figure 3 Implementation of sub-pillars in the company

Although the obtained figures of the tentative calculations show that the company had some energy management areas where energy efficiency was low, it is

invalid to draw negative conclusions from the outcomes themselves. First, taking into consideration the sectoral and corporate characteristics, low and high values need to be determined. If the value is low, the company's specific features are to be considered and the reasons for low performance in specific areas should be identified. It should be noted that not every company needs to have high values in every area. It may happen that a lower value in one group of companies shows better performance than a slightly higher value in another company group. This depends on what an acceptable level in specific cases is considered to be. In the case of the company under evaluation, the circle of issues related to strategy, formalisation, communication of energy awareness and sustainability will not play a very important role. This expectation is justified by the outcome. Taking into account that the rate of energy costs was relatively low related to their revenues, it can be stated that a 50% and a 58% performance reached in the components of investments in improving energy efficiency and measures not requiring a considerable investment of resources, respectively, is quite good.

After giving a serious consideration to these criteria and identifying causes, areas for energy improvement can be determined. The presented model makes it possible to perform an energy management analysis for each company separately. However, the model cannot be considered suitable for comparing energy management practices of companies.

POSSIBILITIES FOR CREATING A COMPLEX EVALUATION INDICATOR

The complex evaluation model was constructed with the objective of performing specific and individual evaluations as well as comparing companies. There is a growing requirement for establishing comparability of countries and companies. In cases where the comparison is done not only for one factor, but considering complicated and complex correlations, factors influencing each other and requiring identification of complex impacts, comparison is considerably more difficult. As a compromise solution to individual cases, composite indices have widely been used in the past few years. Both at a macro level (see OECD 2008, Bartha et al. 2013 among others) and at a micro level (Sasvári, 2008) complex indices are applied (country and corporate competitiveness index, sustainability index and so on).

The comparison of corporate energy management practices and energy awareness is not possible along one single dimension. The analysis should be done according to several criteria. In addition, in order to create bases for comparison, it is important to recognise the distortions arising from unique features of sectors and companies. In this regard, an idea of constructing a composite indicator used for comparing energy management and energy awareness of companies may be raised which combines impacts of numerous factors that influence each other into a complex indicator.

Table 7

*Theoretical possibilities for taking into account unique features of sectors and companies**

		COMPANY GROUPS (based on sectoral energy intensity and/or company size, and/or rate of energy costs)							
		DIVERGENT WEIGHTING (decrease of weight rate of less relevant factors)		APPLICATION OF MULTIPLIERS (by multiplying scores of less relevant factors)		APPLICATION OF DIVERGENCE TOTAL SCORES (by deducting scores of less relevant factors)		APPLICATION OF DIVERGENCE THRESHOLD (defining good performance threshold)	
		GROUP 1*	GROUP 2**	GROUP 1*	GROUP 2**	GROUP 1*	GROUP 2**	GROUP 1*	GROUP 2**
1st PILLAR	Measuring-Monitoring- Target setting	20%	40%	1	1	40	40	75%	50%
2nd PILLAR	Measures not requiring a considerable investment of resources	20%	30%	1	1	40	40	90%	70%
3rd PILLAR	Investments in improving energy efficiency	20%	15%	1	1.3	40	25	70%	40%
4th PILLAR	Formalisation and institutionalisation of energy management	20%	10%	1	1.3	40	25	80%	25%
5th PILLAR	Communication of energy awareness and sustainability	20%	5%	1	1.4	40	20	70%	15%
	TOTAL:	100%	100%			200	150		

*Group 1: energy intensive sector/ large companies/high energy cost rate
** Group 2: not energy-intensive sector/ SMEs/low energy cost rate
*** Figures in Table 7 are used for demonstration purposes only and require further research

Source: own elaboration

The complex indicator can be made up of the weighted summary of the total scores reached on each pillar or a weighted summary of the percentage performance (it could be interpreted on sub-pillar levels as well). Identifying unique features of sectors and companies is more important when a comparison is done than when individual cases are analysed. The company size, what sector it is categorised in, how energy intensive its activities are, the proportion of its energy costs and the company's rank on the vertical value chain all make a considerable contribution to determining the energy management priority levels and the tasks which are less relevant to the energy management of a particular company. Numerous possible methods can be used for determining these issues, four of which are shown in Table 7. In each case, the starting point is that the criterion of grouping of companies should be chosen, by which the differences in the importance of energy management activities are reflected. Then companies are divided into groups. In each company group, the sub-pillars that play the most important role and the ones that are the least relevant to the company group are identified. Table 7 offers some theoretical possibilities for how to take into account less relevant factors. It is important to note that the weights and multipliers in the Table 7 are indicated for demonstration purposes only and require further research.

CONCLUSIONS

The complex evaluation model described in this paper offers a theoretical approach which provides possibilities for measuring the efficiency of corporate energy management after conducting an analysis based on several evaluation criteria listed in the sub-pillars and the scoring system that has been created. By applying this model, corporate areas requiring further energy improvement can also be identified. The set target of establishing specific individual evaluation possibilities has been met. Apart from individual evaluation, there is also a growing need for establishing the comparability of companies. In some cases when the comparison of corporate energy management practices and energy awareness is not possible along one single dimension, an idea of constructing a composite indicator is raised, which combines impacts of numerous factors that influence each other into a complex indicator. The constructing of the composite indicator could be based on the complex evaluation model shown in this article. The complex indicator can be made up of a weighted summary of the total scores for each pillar or a weighted summary of the percentage performance. Weighting is needed because of the prerequisite of comparison, which identifies distortions resulting from unique features of sectors and companies.

The reception of composite indicators and their application varies greatly among scholars in the academic community. Indicators are criticised for their limited applicability, subjectivity in their creation, and loss of information. Indicators used at a micro-level raise further problems, namely, they lack 'hard' information, statistical data, measurable information, or collections of factual data: these are outweighed by 'soft' variables. Although the raison d'être of criticism is indisputable, the bias can be decreased by adopting a prudent approach to creating the indicators. There are strict fundamental criteria for developing composite indicators (establishing a theoretical framework, choosing data selection methods, handling missing data, conducting a multivariable analysis, performing normalisation, weighting and aggregation, addressing robustness and sensitivity issues) and if they are followed, the validity and reliability of indicators can be considerably improved (OECD 2008). The widespread application of composite indicators highlights the fact that there is a need for developing complex indicators which help evaluate reality, which is typically affected by several factors, and such indicators can simplify multidimensional correlations into a single index.

In conclusion it can be said that the complex evaluation model presented in this paper is suitable for meeting two objectives, namely it offers an informative evaluation about corporate energy management and shows areas for further improvement. In addition, it makes comparison of companies possible. Furthermore, it serves as a basis for constructing a composite type of indicator. The concept underlines the importance of background information, separate analyses of specific areas, specific features of companies, and the parallel application of evaluation tools to reduce information loss as much as possible.

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