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Evaluation of the Sectoral Energy Development Intensity in the Euro Area Countries

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Abstract: National economic development largely depends on the development of the energy sector. Its condition is most commonly assessed based on the situation over the last year. An alternative approach, however, is to evaluate fluctuations in development that have occurred over a longer period. In this paper, both methodologies have been applied, in order to assess, based on the results, which of them is more accurate. The article hypothesizes that the second method is more accurate. To prove this empirically, values representing the energy development in various sectors (industrial, agricultural, transport, service and the other (miscellaneous) sectors) in various European countries over the 2009–2018 period were estimated. The development fluctuations that occurred during the period under consideration were evaluated according to two parameters—intensity and stability. The first parameter was taken to be the difference between the values representing energy development in a given sectors at the end and beginning of the period under consideration. The second parameter was taken as the aggregate change across consecutive time slots during which positive or negative fluctuations occurred. The value of energy development in a particular economic sector was estimated as the product of the latter coefficient and the development intensity indicator. Comparison of the results representing evaluation of energy development based on the methodology proposed, and the analysis of the situation in the last year for which data was available revealed that the results in both cases differed, with the values varying from 2% (for the transport sector) to 4.5% (for the agricultural sector). Taking into account the fact that the indicator representing energy development in particular economic sectors was estimated as a percentage of the total sectoral energy consumption, this difference was relatively significant (22.7 and 1.5% respectively). Thus, the findings suggest that application of the proposed methodology is relevant. The methodology provides a greater potential to adequately research issues related to national economic development.

Keywords: sectoral energy development; quantitative evaluation

1. Introduction

Sustainable development (SD) is one of the most pressing problems of human development, and one which is constantly being addressed. It has been under discussion since 1987. Today, the concept of SD has been legitimized as a fundamental long-term ideology within human development. The purpose of sustainable development is ensuring the wellbeing of present and future generations through the harmonised development of three major components—economic, social and environmental [1–5]. Only in this way can limited natural resources be used sparingly. On the other hand, as has been noted in numerous literature sources, meeting the needs of the world's ever-increasing population is possible primarily through economic development [6–8].

Since national economic development depends on the condition of a country's economic sectors, the analysis and assessment of the factors that reflect this are relevant. Today, energy development (ED) is likely to be the most significant reflective factor. It is no coincidence that the European Commission emphasizes the importance of the interaction between energy consumption and economic growth when projecting the steps of the European Union's development [9]. There are several studies on this issue which research the national energy sector as an independent phenomenon and note that economic development primarily depends on the condition of the energy sector [10,11]. This is a debatable approach when considering the role of particular economic sectors. The production processes that generate national gross domestic product (GDP), an indicator of national economic development, run in a number of economic sectors (industrial, agriculture, transport, services, etc.), and the rates of their economic development largely depend on energy development, which is also emphasised by the European Commission [12]. On the other hand, energy consumption in various economic sectors at a certain point in time, for instance, at the end of the reporting year, does not reflect either their economic development tendencies or the effects of national policies directed towards development of individual economic sectors, which is indicated by energy consumption rates that can significantly vary in size, nature and other characteristics in different years of the period under consideration. The first of these factors–size–reflects the development intensity, i.e., the quantitative side of development. On the other hand, economic development can be driven not only by positive, but also by negative fluctuations. Because they may vary in their duration, it is necessary to evaluate not only the intensity of development, but also its invariance, i.e., its stability. In this way, energy development in national economic sectors can be quantitatively evaluated based on the following model (Figure 1):

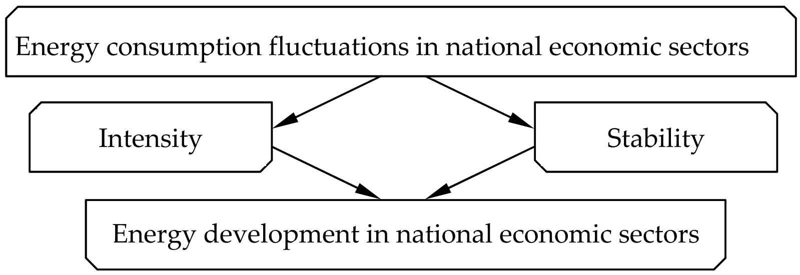

Figure 1. Model for quantitative evaluation of energy development in national economic sectors (source: compiled by the authors).

Figure 1 indicates that in order to quantitatively evaluate energy development in national economic sectors, the relevant energy consumption intensity and stability indicators need to be aggregated into a single quantity. Based on the above methodology, a scientifically substantiated analysis of energy development and its trends in the national economic sectors under consideration can be applied.

2. Literature Background

The relationship between energy development and economic growth has been explored since the 1960s [13]. Two major aspects of this analysis are the significance of the energy sector to national economic development, and the nature of the relationship between the variables. It is unanimously recognized that energy use is a key factor of both national economic growth as a whole and sectoral economic development [14]. Taking into account the role of the energy sector in national economic and social development, research on this issue in the context of sustainable development (SD) has already gained momentum [10,15]. Authoritative global organizations, such as the OECD (Organization for Economic Cooperation and Development), Eurostat (Statistical Office of the European Communities), and the International Energy Agency (IEA), have proposed a set of the balanced indicators for energy development. On this basis, the International Atomic Energy Agency (IAEA) has developed a system of indicators (YSED) that covers 16 factors, evaluating various aspects of sustainable energy development [15]. The system attributes the energy intensity indicator to the category of economic indicators.

Previous studies that focused on the relationship between energy development and economic growth [16–18] were based on two opposing attitudes. One set proposed that energy consumption largely depends on national economic development [13,19,20]. The other set brought energy consumption to the forefront, especially when analysing the development of individual economic sectors [21–23]. In general, most studies emphasize the impact of national economic development on energy production and consumption, rather than vice-versa [13]. In principle there is no contradiction, because national economic development raises energy demand, and the development of the energy sector, in its turn, forms favourable conditions for further national and sectoral economic development (Figure 2).

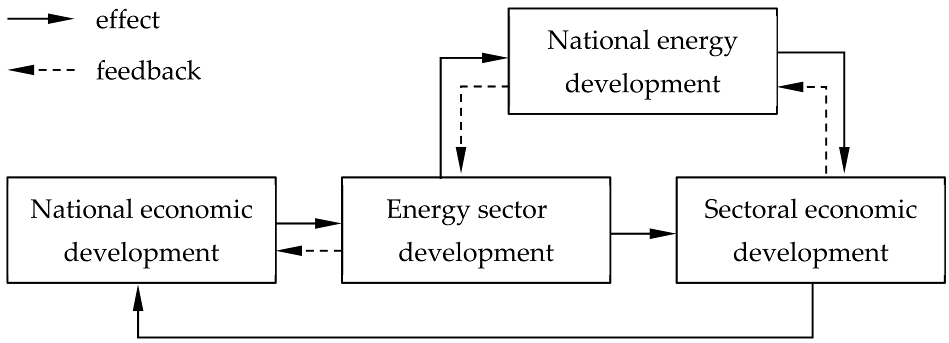

Figure 2. Principal model of the relationship between national economic development and energy sector development (source: compiled by the authors).

Figure 2 indicates that the assertion that energy sector development depends on national economic development may be fully valid at the national level, because in this case the energy sector is considered as an independent economic sector [11,24,25]. Nevertheless, at a lower–sectoral–level, it makes more sense to talk about the effects of energy on sectoral development. The countries with an underdeveloped energy sector (with limited national resources, etc.) or those with limited electricity import capacities can face the problem of energy scarcity, which may impede the development of promising economic sectors [26].

The development of any phenomenon is a process; a process refers to successive fluctuations in a causally related condition [27]. It follows that both the development intensity and the stability indicators must reflect such fluctuations over a period of time, rather than the condition in the year under consideration. Consequently, estimations of these indicators must be based on a certain time period. To date, there is no general agreement as to how long this period should be, or on what its length should depend. In this case, one can follow the logic that when the period over which development is assessed is longer, the accuracy of estimation also rises. One suggestion is to measure the extent of fluctuations via the ratio of the development values estimated for target and base periods [28]. In our case, the intensity of national sectoral development is represented by the value difference. This can be estimated by employing a number of methods. For instance, the primary energy intensity can be measured as energy use per unit of GDP [10,15]. The efficacy of this approach is, however, debatable, since it is essentially an indicator of energy efficiency [29]. In addition, it is limited to the graphical representation of energy intensity fluctuations estimated in this way and only partially represents the fluctuations in the process under consideration that have not been evaluated quantitatively. Without quantitative evaluation, the relationship between national and sectoral economic growth and energy development cannot be analysed comprehensively [30].

Quantitative evaluations of the stability of the process under consideration are rarely found in the scientific literature. Previous studies have mainly focused on the smoothness of development. They usually compare the lengths of the ideal and factual trajectories of the development process over the research period [31].

If a study is based on the last year's value only, it can be stated that it will provide an inaccurate depiction of the situation regarding energy development. The statistical data analysis shows that this indicator is comparatively random because it does not reflect the development context [32]. The present article hypothesizes that in order to adequately reflect the current situation, a study should cover a longer time period and consider both the intensity and nature of the fluctuations that occurred during this period. Previous literature sources do not provide any methodologies that would allow the quantitative evaluation of the impact of the above-mentioned determinants on energy development. The methodology proposed in this article is relevant both in a practical and scientific sense, because it facilitates more accurate research on the relationship between national economic development and energy development.

3. Research Methodology

Methods for the quantitative evaluation of sectoral energy development can be selected based on the development fluctuation over the period under consideration.

The methodology is illustrated by employing some typical cases which reflect the radically different nature of energy development during the period under consideration. The differences in both the extent of sectoral energy development and nature of the development, reflected in Table 1, are graphically depicted in Figures 3–7.

Table 1. Typical cases of fluctuations in sectoral energy development in target countries over the 2009–2018 period, percentage of total electric energy consumption (source: compiled by the authors with reference to Indicator for Sustainable..., 2002 [15]).

Country	Economic Sector	Year									
		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018 *
Slovakia	Industrial	28.8	28.2	29.7	32.1	30.2	33.8	33.6	32.6	21.6	33.2
Belgium	Agriculture	2.10	1.8	1.7	1.8	2.0	1.8	1.8	1.9	1.9	1.9
Lithuania	Transport	27.5	27.4	25.0	25.0	26.3	28.4	30.7	29.6	30.3	31.7
Latvia	Services	14.3	14.7	15.5	15.6	15.7	15.7	15.5	15.6	15.3	14.3
Greece	Other sectors	28.1	29.6	43.1	36.5	30.9	30.9	32.9	31.5	33.5	31.7

* the latest data announced.

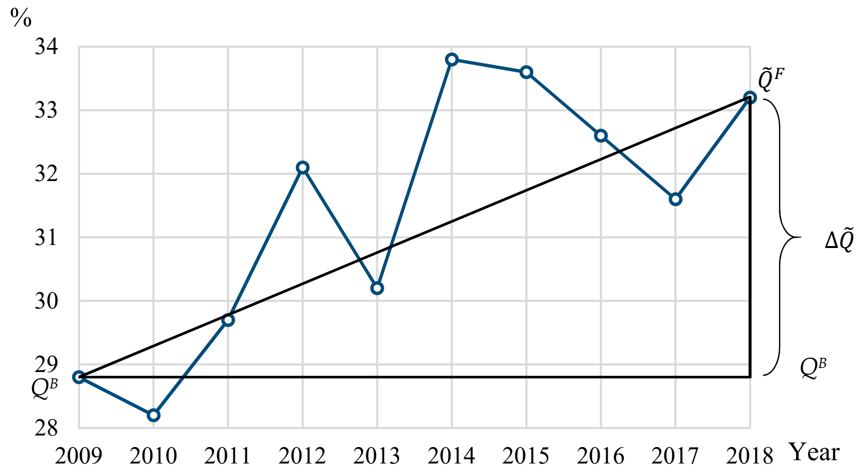

Figure 3. Energy development in the Slovak industrial sector over the 2009–2018 period (source: compiled by the authors).

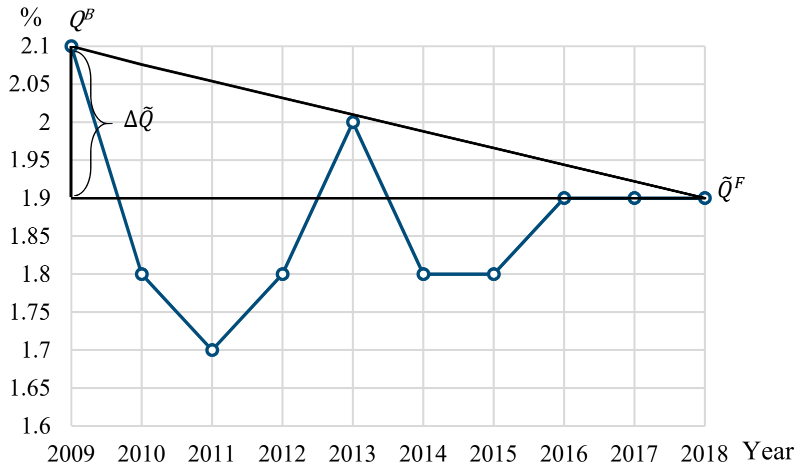

Figure 4. Energy development in the Belgian agricultural sector over the 2009–2018 period (source: compiled by the authors).

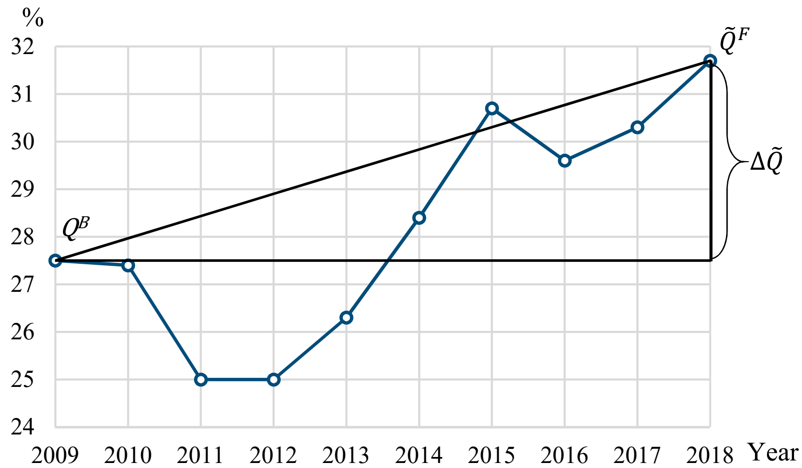

Figure 5. Energy development in the Lithuanian transport sector over the 2009–2018 period (source: compiled by the authors).

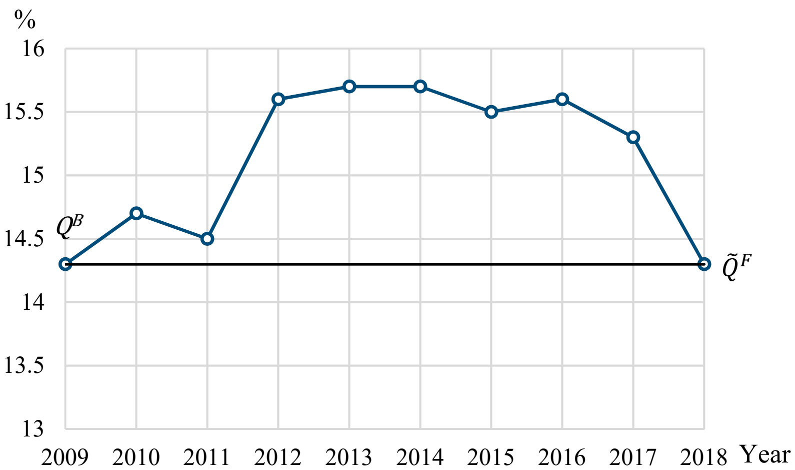

Figure 6. Energy development in the Latvian service sector over the 2009–2018 period (source: compiled by the authors).

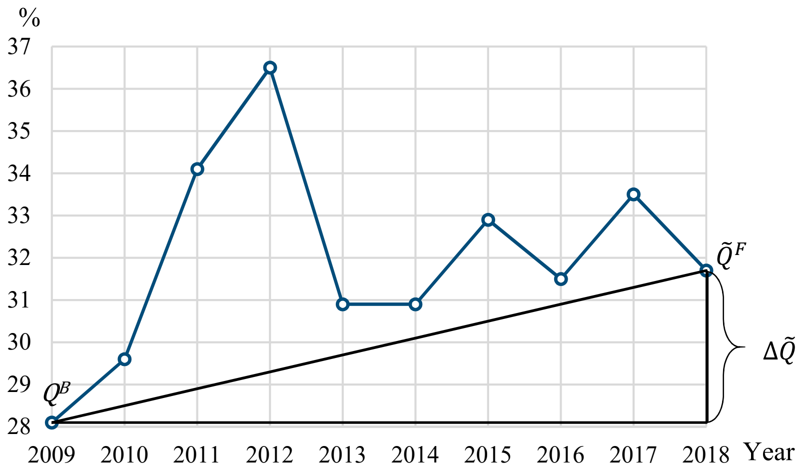

Figure 7. Energy development in other (miscellaneous) sectors in Greece over the 2009–2018 period (source: compiled by the authors).

Table 1 and Figures 3–7 highlight the following features of energy development in the economic sectors under consideration:

1. During any given period, in any of the countries, and in any of the economic sectors, the energy development is not smooth: in different sub-sections of time, development is characterised by either positive or negative fluctuations that affect its extent.
2. The number of time slots over the period in which positive or negative fluctuations occur may vary significantly.

Given this situation, the major purpose of this paper is to propose a methodology for the quantitative evaluation of both the intensity of energy development and the nature of its fluctuations.

3.1. Evaluation of the Intensity of Sectoral Energy Development

The intensity of sectoral energy development can be represented by the difference in the development values at the end and beginning of the period under consideration:

$$\Delta\tilde{Q}_{Tij} = \tilde{Q}^F_{Tij} - Q^B_{Tij} \tag{1}$$

where $\Delta\tilde{Q}_{Tij}$ is the extent of the fluctuations in the i^{th} sector energy development in the j^{th} country over period T; $\tilde{Q}^F_{Tij}$ isthe value of the i^{th} sector energy development in the j^{th} country at the end of period T; and Q^B_{Tij} is the value of the i^{th} sector energy development in the j^{th} country at the beginning of period T.

Formula (1) indicates that if $\tilde{Q}^F_{Tij} > Q^B_{Tij}$, then $\Delta\tilde{Q}_{Tij}$ will have a positive sign, and vice-versa. It affects the estimations of the transformed value, Q^F_{Tij}, of quantity $\tilde{Q}^F_{Tij}$. This value depends on the extent of positive and negative fluctuations. If the extent of positive fluctuations is greater than the extent of negative fluctuations, then $\Delta\tilde{Q}_{Tij}$ will have a positive sign; if the extent of positive fluctuations is less than the extent of negative fluctuations, it will have a negative sign. If $Q^B_{Tij} = \tilde{Q}^F_{Tij}$, the extent of either positive or negative fluctuations is the same.

3.2. Evaluation of the Sectoral Energy Development with Consideration of the Qualitative Fluctuations

To identify the reflective quantities, the extreme and intermediate development fluctuations will be considered (Figure 8):

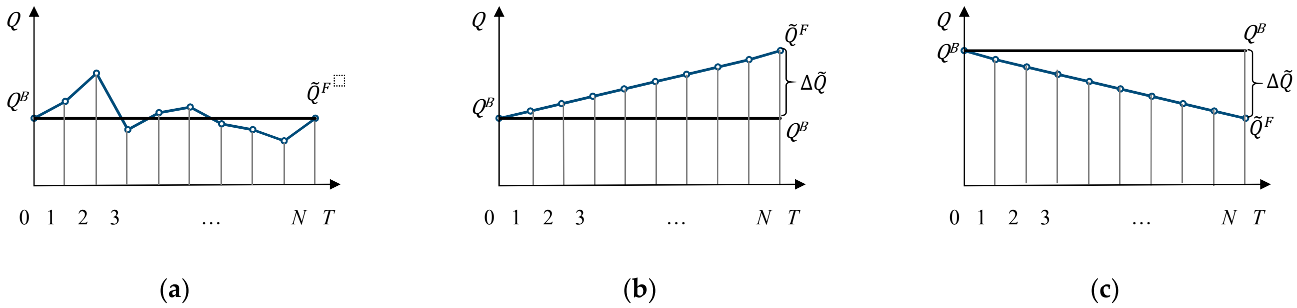

Figure 8. Exemplary cases of sectoral energy development: (**a**) is when positive and negative changes of economic sector energy development was regular during period T and its scale was similar; (**b**) only possive changes were observed (**c**) only negative changes (source: compiled by the authors).

Figure 8 indicates that in case (a), quantity $\Delta\widetilde{Q} = 0$; thus, $p^+ = p^-$ (Table 1). Based on Formula (1):

$$\widetilde{Q}^F_{Tij} = Q^B_{Tij} + \Delta\widetilde{Q}_{Tij} = Q^B_{Tij} \tag{2}$$

In this case, the extent of the development has not changed. Therefore:

$$Q^F_{Tij} = Q^B_{Tij} \tag{3}$$

where Q^F_{Tij} is the value of the i^{th} sector energy development in the j^{th} country at the end of period T with consideration of the fluctuations over the development period.

In case (b), quantity $\Delta\widetilde{Q} \neq 0$, but the development proceeds without any deviations, i.e., $q_i = \frac{\Delta Q_{Tij}}{N}$; here N is the number of time slots over period T ($N = T - 1$). Quantity $\Delta\widetilde{Q}$ remains unchanged. Thus, based on Formula (1):

$$Q^F_{Tij} = Q^B_{Tij} + \Delta\widetilde{Q}_{Tij} \tag{4}$$

In case (c), quantity $\Delta\widetilde{Q}_{Tij} \neq 0$; in addition, the period under consideration sees both positive and negative fluctuations that affect the extent of the development (quantity $\Delta\widetilde{Q}_{Tij}$):

$$\Delta Q_{Tij} = k^k_{Tij}\Delta\widetilde{Q}_{Tij} \tag{5}$$

where ΔQ_{Tij} is the extent of the i^{th} sector energy development in the j^{th} country over period T with consideration of the qualitative fluctuations.

Based on Formulas (4) and (5), quantity Q^F_{Tij} is estimated as follows:

$$Q^F_{Tij} = Q^B_{Tij} + \Delta Q_{Tij} = Q^B_{Tij} + k^k_{Tij}\Delta\widetilde{Q}_{Tij} \tag{6}$$

Thus, the current objective is to find coefficient k^k_{Tij}.

Qualitative fluctuations in the sectoral energy development can be evaluated based on a number of consecutive time slot groups during which positive or negative fluctuations occur. To that end, it is first necessary to estimate the relative weight of each time slot group in their total number:

$$\widetilde{\omega}_{Tijk} = \frac{R_{Tijk}}{N}, \tag{7}$$

where $\widetilde{\omega}_{Tijk}$ is the relative weight of the k^{th} group of sign-related time slots in the total number of groups in the i^{th} sector, j^{th} country, and R_{Tijk} is the number of sign-related time slots in a group.

The significance of a separate time-slot group to the sectoral energy development intensity may vary and depends on the number of time slots in this group. It can be evaluated by internally weighting quantity $\widetilde{\omega}_{Tijk}$:

$$\omega_{Tijk} = \omega_{Tijk} \quad (8)$$

where ω_{Tijk} is the relative weight of sign-related time slots in the i^{th} sector and j^{th} country with consideration of the significance of the time slot group.

Figure 8 indicates that the fewer opposite-sign fluctuations occur during period T, the higher the value of coefficient k^k will be. In the latter case, it is estimated as follows:

$$k^k_{Tijk} = 1 - \sum_{i=1}^{k} \omega_{Tijk} \quad (9)$$

where k is the number of time slot groups.

Further in the research, the values of coefficients k^k and Q^F can be estimated.

4. Research Results and Discussion

Based on the above methodology, sectoral energy development in target countries in Europe over the 2009–2018 period was evaluated. The values representing this development were extracted from the OECD database [33,34] (Table 2). Based on the target data and Formulas (1)–(7), the values of $\Delta\widetilde{Q}_{Tij}$, k^k_{Tij}, ΔQ_{Tij} and Q^F_{Tij} were estimated (Table 2).

Table 2. Sectoral energy development in various European countries over the 2009–2018 period, energy consumption as a percentage of the total energy consumption (source: [33]).

No.	Country	Economic Sectors									
		Industrial		Agriculture		Transport		Services		Other Sectors	
		Year									
		2009	2018	2009	2018	2009	2018	2009	2018	2009	2018
1	Austria	27.0	27.9	1.9	1.9	30.2	32.3	9.8	8.6	31.0	29.3
2	Belgium	25.5	26.9	2.1	1.9	22.7	21.6	11.5	11.1	38.2	38.5
3	Cyprus	15.0	14.6	2.3	2.8	43.1	43.0	13.6	15.3	26.0	24.3
4	Estonia	18.9	16.3	3.3	4.2	25.1	27.8	14.7	16.3	37.9	35.4
5	Finland	39.2	43.1	3.2	2.8	17.2	16.3	12.0	11.7	28.3	26.2
6	France	17.3	18.4	2.9	2.9	27.9	29.9	14.6	15.2	37.4	33.6
7	Germany	23.2	26.0	0.2	1.6	24.2	25.2	15.5	13.0	36.9	34.1
8	Greece	16.8	17.4	4.2	1.8	40.5	37.5	10.4	11.7	28.1	31.7
9	Iceland	18.2	22.9	2.6	2.2	36.3	35.7	13.6	12.9	29.4	26.3
10	Italy	22.1	20.5	2.4	2.6	29.9	29.9	12.9	14.2	32.6	32.9
11	Latvia	16.2	21.8	3.5	4.6	25.9	26.9	14.3	14.3	40.1	32.4
12	Lithuania	16.6	16.9	2.0	1.6	27.5	31.7	11.2	9.9	42.7	39.8
13	Luxembourg	18.2	16.7	0.8	0.6	56.0	55.8	10.2	12.6	14.8	14.2
14	Malta	13.9	10.9	1.3	1.4	45.5	44.8	19.0	23.5	20.3	19.6
15	The Netherlands	22.7	24.4	6.2	6.5	19.3	18.8	12.1	11.6	39.7	38.6
16	Portugal	27.6	28.2	2.2	2.8	34.2	35.8	10.8	12.1	25.3	21.0
17	Slovakia	28.8	33.2	1.2	1.2	21.3	24.6	17.9	11.7	30.8	29.4
18	Slovenia	24.2	27.2	1.3	1.4	34.2	38.6	9.8	8.4	30.6	24.5
19	Spain	22.8	23.3	2.6	3.2	37.9	37.4	10.3	12.5	26.4	23.6

Based on the data provided in Table 2, mean values representing the sectoral energy development over the 2009–2018 period, as well as the differences in quantities $\widetilde{Q}^F$ and Q^F, percent were estimated (Table 3).

Table 3. Comparison of the current and transformed values representing sectoral energy development in the targeted European countries over the 2009–2018 period (source: compiled by the authors).

Indicators	Economic Sectors				
	Industrial	Agriculture	Transport	Services	Other Sectors
Mean energy consumption as a% of total energy consumption	22.7	2.5	29.7	12.9	29.7
Difference in quantities $\widetilde{Q}^F$ and Q^F, percent	2.4	4.5	1.9	2.8	2.1
Comparison of quantities $\widetilde{Q}^F$ and Q^F, percent	+4.1	−4.2	−6.1	+0.3	−5.7

Table 4 reveals that the targeted European countries consume the most energy in their transport and other (miscellaneous) sectors, followed by the industrial, service and agriculture sectors. Over the ten-year period, energy consumption increased in the industrial (4.1 percent) and service (0.3 percent) sectors, but decreased in the agricultural (4.2 percent), transport (6.1 percent) and other (miscellaneous) (5.7 percent) sectors. Evaluation of the qualitative aspects of the sectoral energy development clarifies the result by 2–4.5 percent.

Table 4. Values representing the sectoral energy development in various European countries over the 2009−2018 period as a% of the total energy consumption (source: compiled by the authors on the ground, [33]).

No.	Country	Economic Sectors																			
		Industrial				Agriculture				Transport				Services				Other Sectors			
		$\Delta\tilde{Q}$	k^k	ΔQ	Q^F	$\Delta\tilde{Q}$	k^k	ΔQ	Q^F	$\Delta\tilde{Q}$	k^k	ΔQ	Q^F	$\Delta\tilde{Q}$	k^k	ΔQ	Q^F	$\Delta\tilde{Q}$	k^k	ΔQ	Q^F
1	Austria	+0.9	0.86	+0.8	27.8	0	0.52	0	1.9	+2.1	0.79	+1.6	31.8	−1.2	0.74	−0.9	8.9	−1.7	0.82	−1.4	29.6
2	Belgium	+1.4	0.86	+1.2	26.7	−0.2	0.82	−0.16	1.9	−1.1	0.84	−0.9	21.8	−0.4	0.87	−0.3	11.2	+0.3	0.78	+0.2	38.4
3	Cyprus	−0.4	0.77	−0.3	14.2	+0.5	0.74	+0.4	2.7	−0.1	0.77	−0.1	43.0	+1.7	0.75	+1.3	14.9	−1.7	0.84	−1.4	24.6
4	Estonia	−2.6	0.77	−2.0	16.9	+0.9	0.89	+0.8	4.1	+2.7	0.79	+2.1	27.2	+1.6	0.79	+1.3	16.0	−2.5	0.77	−1.9	36.0
5	Finland	+3.9	0.86	+3.4	42.6	−0.4	0.82	−0.3	2.9	−0.9	0.82	−0.7	16.5	−0.3	0.79	−0.2	11.8	−2.1	0.77	−1.6	26.7
6	France	+1.1	0.86	+0,9	18.4	0	0.84	0	2.9	+2.0	0.82	=1.6	29.5	+0.6	0.84	+0.5	15.1	−3.8	0.82	−3.1	43.3
7	Germany	+2.8	0.77	+2.2	25.4	+1.4	0.80	+1.1	1.3	+1.0	0.84	+0.8	25.0	−2.5	0.77	−1.9	13.6	−2.8	0.84	−2.4	34.5
8	Greece	+0.6	0.74	+0.4	17.2	−2.4	0.79	−1.9	2.3	−3.0	0.84	−2.5	38.0	+1.3	0.79	+1.0	11.4	+3.6	0.86	+3.1	31.2
9	Iceland	+4.7	0.83	+3.9	22.1	−0.4	0.67	−0.3	2.3	−0.6	0.84	−0.5	35.8	−0.7	0.69	−0.5	13.1	−3.1	0.84	−2.6	26.8
10	Italy	−1.6	0.77	−1.2	20.9	+0.2	0.79	+0.2	2.6	0	0.79	0	29.9	+1.3	0.77	+1.0	13.9	+0.3	0.86	+0.3	32.9
11	Latvia	+5.6	0.77	+4.3	20.5	+1.1	0.79	+0.9	4.4	+1.0	0.87	+0.9	26.8	0	0.84	0	14.3	−7.7	0.72	−5.5	34.6
12	Lithuania	+0.3	0.77	+0.2	16.9	−0.4	0.82	−0.3	1.7	+4.2	0.72	+3.0	30.5	−1.3	0.82	−1.1	10.1	−2.9	0.82	−2.4	40.3
13	Luxembourg	−1.5	0.72	−1.1	17.1	−0.2	0.82	−0.2	0.6	−0.2	0.82	−0.2	55.8	+2.4	0.72	+1.7	11.9	−0.6	0.79	−0.5	14.3
14	Malta	−3.0	0.77	+2.3	11.6	+0.1	0.79	+0.1	1.4	−0.5	0.87	−0.4	45.1	+4.5	0.67	+3.0	22.0	−0.7	0.77	−0.5	19.8
15	The Netherlands	+1.7	0.70	+1.2	23.9	+0.3	0.87	+0.3	6.5	+0.5	0.79	+1.3	20.6	−0.5	0.84	−0.4	11.7	−1.1	0.79	−0.9	38.8
16	Portugal	+0.6	0.86	+0.5	28.1	+0.6	0.76	+0.4	2.7	+1.6	0.82	+1.3	35.5	+1.3	0.82	+1.1	11.9	−4.3	0.72	−3.1	22.2
17	Slovakia	+4.4	0.79	+3.5	32.3	0	0.87	0	1.2	+3.3	0.82	+2.7	24.0	−6.2	0.87	−5.4	12.5	−1.4	-.86	−1.2	29.6
18	Slovenia	+3.0	0.77	+2.3	26.5	−0.1	0.84	−0.1	1.2	+4.4	0.79	+3.5	37.7	−1.4	0.82	−1.1	8.7	−6.6	0.74	−4.9	25.7
19	Spain	+0.5	0.74	+0.4	23.2	+0.6	0.84	+0.5	3.1	−0.5	0.59	−0.3	37.6	+2.2	0.77	+1.7	12.0	−2.8	0.60	−1.7	24.7

The obtained results offer a different perspective on the analysis of the development of socio-economic processes. It is a recent practice for international statistical institutions [34], etc. to provide information on the state of socioeconomic processes in annual values. If a sufficiently long period is covered, it is, of course, possible to evaluate the trends of the changes. On the other hand, this only provides a qualitative picture of the situation, as the trends are not quantified. For this reason, a country's rankings today are presented not on the basis of a particular period, but on the basis of its situation in recent years. This is not an adequate reflection of the situation: that can only be obtained by estimating changes over the whole period of time.

The development of any socioeconomic process is affected by various destabilizing factors and is therefore characterized by both negative and positive fluctuations. Merely comparing the situation at the beginning and the end of the period, without evaluating these fluctuations, gives only a rough picture. Assessing the nature and extent of the fluctuations is also important because they can affect other social processes in the country, such as unemployment, emigration, poverty, etc.

The proposed methodology is universal and allows one to analyse the socioeconomic processes at another, higher level.

5. Conclusions

Human life is inextricably linked to different levels of socioeconomic systems represented by families, enterprises, unions, states, etc. These systems are characterized by their sustainability. Sustainability, in its turn, is ensured by the development of these systems, i.e., by continuous positive fluctuations in their condition. Taken together, these fluctuations can be treated and evaluated as a socioeconomic process. Previous studies have mainly focused on analysing the condition of these systems, i.e., their static situation. In this paper, the fluctuations have been evaluated based on a graphical representation of the static estimates, i.e., on diagrams. This is qualitative evaluation. Nevertheless, without measures to quantitatively evaluate socioeconomic processes, the causes and consequences of the fluctuations cannot be analysed comprehensively.

The analysis of these real socioeconomic processes has shown that their development is reflected in two parameters—intensity and stability. The former reflects the quantitative aspects of development, the latter its qualitative side. The intensity can be quantified as the difference between the development values at the end and beginning of the period under consideration. On the other hand, an extremely high or low value for this difference does not reflect the real situation. For instance, significant positive or negative development fluctuations might occur over the last time slot of the period under review, which would distort the true picture, causing the fluctuations that occur over the entire period to be underestimated. Thus, the development intensity indicator needs to be adjusted by employing a coefficient that takes into consideration the nature of the fluctuations. This could be a measure that integrally reflects the number of time slots during which any positive or negative consecutive development fluctuations occurred.

The methodology proposed here for evaluating the sectoral energy development in Euro-area countries over the 2009–2018 period revealed that the analysed countries' transport and other (miscellaneous) sectors accounted for the largest share of energy consumption over the target period, followed by the industrial, service and agricultural sectors. The most significant development was observed in the industrial and service sectors, whereas in the other sectors development had slowed.

This evaluation of the sectoral energy development in various European countries over the 2009–2018 period, based on both the last year's values and the methodology proposed, revealed that the estimates vary from 2% (for the transport sector) to 4.5% (for the agricultural sector), and respectively account for 22.7% and 1.5% percent of energy consumption in these sectors. Considering the fact that energy consumption in separate sectors of the economy is between 2.5% and 30.0% of the total energy consumed, this error is quite significant. Thus, the results propose that for an adequate reflection of the current situation, the research should cover a sufficiently long period (in our case, 10 years) and consider the nature of the fluctuations that occurred during the target period. The differences in the results obtained by applying two methodologies make it possible to confirm the hypothesis raised at the beginning of this paper. The methodology proposed in this article provides the potential to adequately analyse one of today's most relevant issues–the relationship between economic development and energy development.

This methodology is universal. It can be applied to the quantitative evaluation of the development of any socioeconomic processes, and has broad potential for the scientific analysis of the impact of the development on various national socioeconomic processes. In addition, EU institutions could use this methodology to publish adequate data on the energy development of member states' various economic sectors.

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