Chapter 7

Spatial Aspects of Environmental Impact of Power Plants

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Additional information is available at the end of the chapter

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Abstract

Strategic Environmental Assessment (SEA) is one of the key instruments for implementing sustainable development strategies in planning in general, namely for analysing and assessing the spatial development concepts, in this case in the field of energy and planning of power plants. The SEA in energy sector planning has become a tool for considering the benefits and consequences of the proposed changes in space, also taking into account the capacity of space to sustain the implementation of the planned activities. This chapter examines the multi-criteria evaluation (MCE) method for carrying out an SEA for the power plants in Energy Sector Development Strategy of the Republic of Serbia (case study). The MCE method has found its use in the analysis and assessment of the energy sector spatial impacts on the environment and elements of sustainable development and, in this context, also considering the importance of impacts, spatial dispersion of impacts, their probability and frequency of occurrence, along with the elaboration of the obtained results in a specific, simple and unambiguous way. The chapter focuses on the consideration of aspects of environmental impact of all kinds of power plants, without taking into account the details regarding other aspects of energy sector development that are dealt with in the case study.

Keywords: strategic environmental assessment, power plants, multi-criteria evaluation

1. Introduction

The strategic environmental assessment (SEA) can be considered as the most important, the most general and the most comprehensive instrument for directing the strategic planning process towards the principles and objectives of environmental protection, as well as for making optimum decisions on future sustainable spatial development [1] can be considered one.

Since the very beginning of the last decade of the twentieth century until now, many authors [2–7] have written about the importance of the implementation of SEA in the process of making optimum decisions on sustainable spatial development and on the concept of development policy in different fields of social activities (energy, water resource management, infrastructure, tourism, etc.). The issue is therefore quite interesting, from both scientific and professional aspects, and is of great importance in creating any environmental policy.

The European Strategic Environmental Assessment Directive 2001/42/EC [8] prescribes the obligation to undertake SEA for plans, programmes and framework documents in different fields, thus also in the field of energy sector. By using the SEA, it is possible to consider the positive and negative implications of the proposed changes in the earliest stages of creating a development policy and accordingly direct the planning process in a way to increase positive impacts and minimize negative implications. The SEA process unavoidably implies the participation of the public in all stages of the planning process, thus emphasizing the contribution in decision-making, in this case in the field of the energy sector development [9–13]. Compared to other methods that contribute to decision-making, such as the traditional 'life cycle assessment' (LCA) [14–17] which is mainly used for the analysis of impacts in smaller territorial units, the SEA contributes to integrating the impacts at the strategic level of power plants planning (national, regional and, if necessary, international level). Given that the strategic level of planning requires a multi-dimensional consideration of phenomena and processes and that making appropriate decisions on spatial impacts and spatial development is a complex process, it is necessary to have an appropriate problem and methodological approach to making appropriate decisions on sustainability of offered concepts of development. This is particularly necessary in conceiving an energy sector policy, where the development tendencies can have significant implications for space and the environment. Multi-criteria analysis has been strongly advised by various authors with expertise in the energy sector [18, 19].

The chapter will present the possibility and importance of using the SEA for analysing spatial impact of power plants, regardless of whether it comes to fossil fuel power plants or power plants using renewable energy sources (RESs) because both can have strategically significant impacts (positive and negative) on the space where they are built. The chapter will examine the multi-criteria evaluation (MCE) method for carrying out an SEA for the case study–Energy Sector Development Strategy of the Republic of Serbia by 2025 with projections until 2030 [20] (herein after referred to as the 'Strategy').

2. Methodological framework

The concept of the SEA methodologies, unlike the diverse, precise and highly operable tools used in environmental engineering or other science-based areas, is rather fuzzy [21]. Some authors [22–24] believe that there is no uniform methodological approach to the SEA process because its use in very thematically different planning processes is not appropriate, but it is the most appropriate to use different methodological approaches or their combination that would be aligned with specific conditions in which the planning process is carried out [22, 25]. In accordance with the above-mentioned, it can be concluded that the SEA process should be based on an interdisciplinary approach and open to the use of different methodological approaches. Such flexibility in the approach to the SEA process leaves the possibility of finding the best solutions in accordance with specific approaches to the planning process. Generally speaking, the SEA techniques and methodologies derive from the traditional Environmental Impact Assessment (EIA) and policy appraisal/plan evaluation studies [25, 26], ensuring that methodologies would not become a barrier for institutional promotion of the SEA [27]. A variety of possible techniques for conducting the different steps of SEA have been further analysed and discussed by others [1, 25, 27–29]. In addition, Marsden [30] pointed out that, in terms of methodologies, the SEA process is dominantly based on the qualitative or semi-quantitative approach which to a great extent depends on the skills and knowledge of experts involved in the evaluation process. Such an approach also implies a certain degree of subjectivity that should be minimized by using different software packages (like geographic information system [GIS]) in combination with their adequate use experiences accumulated through comparative studies of past schemes and applications [21].

The procedural and methodological framework for SEA is shown in **Figure 1**. The SEA process begins with decision-making on undertaking the SEA, as well as on its scope and contents. This stage involves the defining of framework for investigations to be carried out in the SEA process along with the unavoidable participation of the public, relevant institutions and non-governmental organizations (NGOs). The next stage includes the analytical part of the SEA process implying the analysis of the state of the environment in the area under investigation using the GIS technologies [31–33]; analysis of the strategic concept of development (in this case in the energy sector); comparative analysis of the planning and strategic documents relating to the space that is subject of investigation and to the specific field of investigation; other investigations and analyses of importance for the specific field of investigation. The next stage included the setting of the SEA objectives, relevant indicators (**Table 1**) and evaluation criteria (**Tables 2** and **3**), followed by an impact assessment procedure in which the first stage included the evaluation of alternative scenarios and the selection of the most suitable alternative. Then, the process of multi-criteria evaluation (a semi-quantitative method) followed, representing the focal point of this chapter (presented in point 3 herein). The role of multi-criteria evaluation is to identify the influence of the activities planned in the space in which they are being undertaken (the prediction of spatial influences) according to the SEA objectives. When the impacts of the Strategy are identified in such a way, then it is possible to elaborate and present them in a simple and unambiguous way and in a way that is clear to all actors in the SEA process, namely the actors included in the decision-making process.

The specific SEA objectives (**Table 1**) were set in certain fields of environmental protection. The specific SEA objectives are the concrete, partially qualified statements in a form of guidelines and actions (measures, works and activities) for the implementation of these changes. The

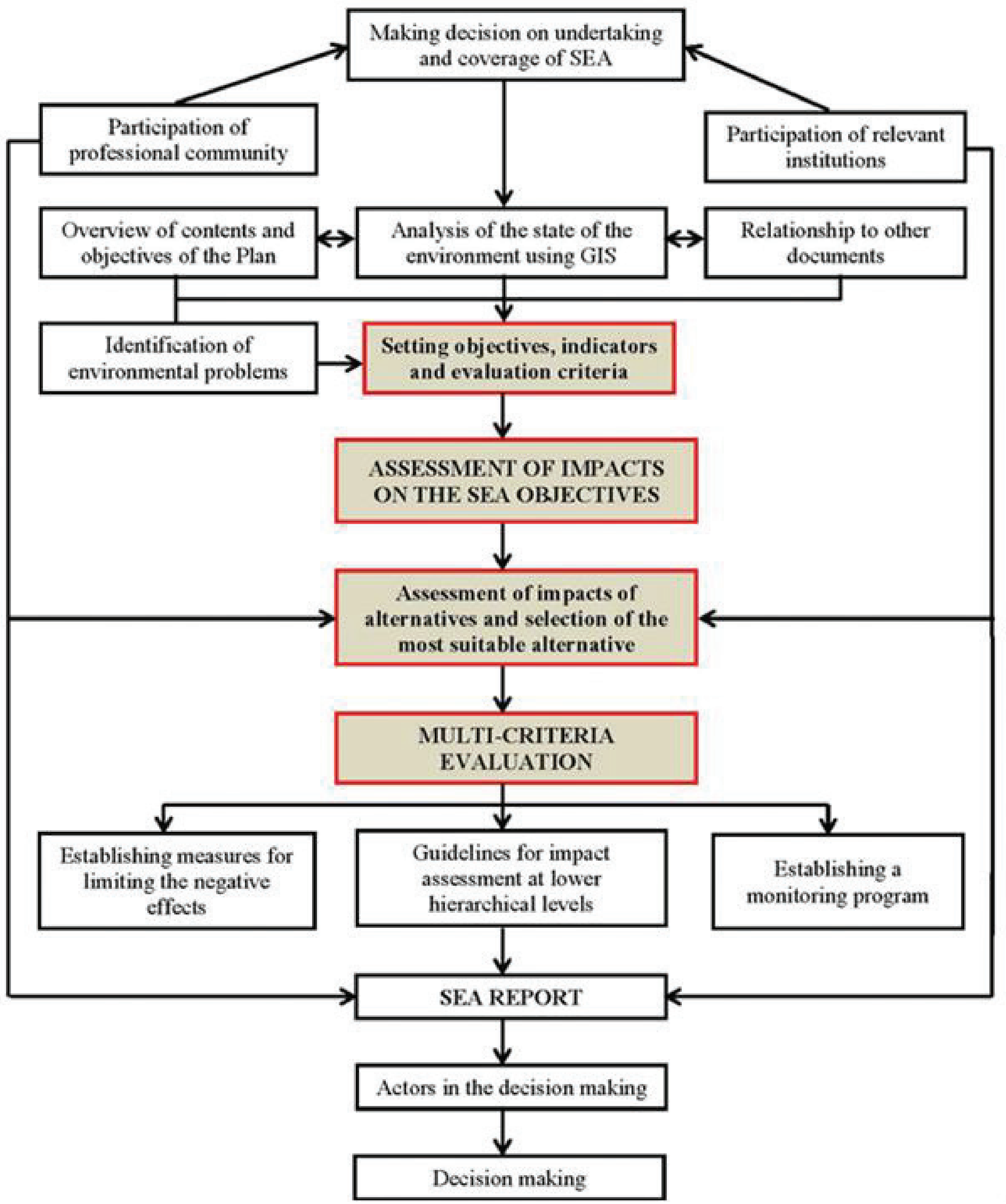

Figure 1. Procedure and methodological framework for the SEA [11].

specific SEA objectives are primarily a methodological measure through which the effects of power plants (and energy sector in general) on the environment are identified and checked. The multi-criteria evaluation of the planning solutions is carried out in relation to these objectives to obtain a clear idea about possible effects of the planning process and make optimum decisions on future sustainable spatial development accordingly.

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Specific SEA objectives	Indicators
AIR	
- Reducing air pollutant emissions to prescribed emission levels	- Particle emissions, and SO_2 and NOx emissions - Frequency of exceeding the daily limit values for soot, SO_2 and NO_2 - Changes in greenhouse gas emissions, primarily in CO_2 (%) - Increase of RES share in energy balance (%)
WATER	
- Reducing surface and groundwater pollution to the level that will not affect their quality - Mitigating negative effects of energy facilities on hydrological regimes	- BOC and COC in watercourses affected by energy facilities and activities - Temperature changes in watercourses - Changes in water regimes - Changes in water quality class (%) - Reused and recycled water as a result of energy sector activities (m^3)
SOIL	
- Protection of agricultural and forestry land - Reducing soil degradation and erosion	- Changes in forest cover (%) - Changes in agricultural land area (%) - Share of degraded areas as a result of activities in the field of energy (%) - Land area threatened by soil erosion processes (ha)
NATURAL VALUES	
Specific SEA objectives	**Indicators**
- Landscape protection - Protection of natural values and areas - Biodiversity conservation – avoid irreversible losses	- Share of re-cultivated areas in the overall area of degraded regions (%) - Number of energy facilities that may cause landscape changes - The area of all protected natural areas that may be affected - Number of endangered flora and fauna that may be affected
CULTURAL AND HISTORIC HERITAGE	
- Cultural properties protection	- Number and importance of protected immoveable cultural properties that may be affected
WASTE	
- Improving waste utilization, treatment and disposal	- Total annual amount of waste generated in energy sector (t) - % of total amount of waste subject to re-use, recycling and treatment
POPULATION HEALTH	
- Reducing negative effects of energy industry on human health	- Frequency of respiratory diseases (%) close to energy facilities - Frequency of diseases which can be associated with energy activities - Number of people affected by noise generated by energy facilities
SOCIAL DEVELOPMENT	
- Better quality of life - Preservation of population density in rural areas	- Improvement of energy efficiency in residential buildings (%) - Number of households displaced as a result of energy activities
INSTITUTIONAL DEVELOPMENT	
- Improve environmental protection and management and control services	- Number of measuring points in monitoring system
ECONOMIC DEVELOPMENT	
- Encouraging economic development - Promote local employment - Reducing dependency on sources of imported energy - Reducing transboundary negative environmental impacts	- % of employed in the energy sector with salary above the average salary - Reduction in number of unemployed as a result of growth in the energy sector employment (%) - Number of environmental protection programs for energy sector development - Number of IPPC energy facilities with transboundary impacts
NATURAL RESOURCES	
- Rational use of non RES and increasing the use of RES - Improving energy efficiency - Introducing cleaner technologies	- Final energy consumption per capita - Share of renewable energy sources in total energy use - Improvements in energy efficiency (% of reduction in energy use)

Table 1. SEA objectives and indicators for the Strategy [34].

The sustainable development indicators (**Table 1**) are needed to identify trends of moving towards or away from sustainability, as well as to set goals for improving general well-

Impact magnitude	Designation	Description
Critical	- 3	Significant environmental overload
Greater	- 2	Environmental disturbance of great extent
Smaller	- 1	Environmental disturbance of smaller extent
No impact	0	No direct and/or unclear environmental impact
Positive	+1	Smaller positive environmental changes
Favourable	+2	Favourable environmental changes
Very favourable	+3	Changes that significantly improve the quality of life
Impact significance	**Designation**	**Description**
International	I	Possible transboundary impact
National	N	Possible impact at the national level
Regional	R	Possible impact at the regional level
Local	L	Possible impact of local character
Probability	**Designation**	**Description**
100%	S	Impact will definitely occur
More than 50%	L	Likely impact
Less than 50%	P	Possible impact

Table 2. SEA evaluation criteria for the Strategy [34].

being. In 2008, the Republic of Serbia adopted the National Energy Sector Development Strategy [35] which contains principles and priorities in sustainable development, as well as 76 indicators for tracking the progress of Serbia towards sustainable development. These indicators have been selected from the set of UN indicators, but not all of indicators are used in Serbia. The indicators are specified in the Law on Spatial Plan of the Republic of Serbia [36]. The Regulation on the National List of Environmental Indicators [37] prescribes the list of environmental indicators, which have been used herein. The SEA indicators have been selected in accordance with the above-mentioned SEA objectives. This set of indicators is based on the 'cause-effect-response' concept. The indicators of cause denote human activities, processes and relationships affecting the environment, the indicators of effect denote the state of the environment, while the indicators of response define strategic options and other responses aimed at changing 'consequences' for the environment.

Based on an analysis of the possibility of primarily considering the spatial aspect, as well as the problematic aspect of potential impacts, three sets of criteria with a total of 14 individual criteria were defined. The criteria used in the MCE of the planning solutions were related to the magnitude (intensity) of the impact, the spatial dimension of the impact and the impact probability (**Table 2**).

The importance of identified impacts for achieving the SEA objectives is evaluated. The impacts of importance for the subject Strategy are those which have stronger or greater effects on the international (transboundary), national or regional level, according to the criteria shown in **Table 3**.

The methodological framework for the SEA presented in this chapter is centred on a plan-based approach to and the use of MCE method for the planned activities and strategic determinants in

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Level	Impact magnitude		Designation of significant impacts
International level: I	Strong positive impact	+3	I+3
	Greater positive impact	+2	I+2
	Strong negative impact	- 3	I-3
	Greater negative impact	- 2	I-2
National level: N	Strong positive impact	+3	N+3
	Greater positive impact	+2	N+2
	Strong negative impact	- 3	N-3
	Greater negative impact	- 2	N-2
Regional level: R	Strong positive impact	+3	R+3
	Greater positive impact	+2	R+2
	Strong negative impact	- 3	R-3
	Greater negative impact	- 2	R-2

Table 3. SEA criteria for evaluating strategically significant impacts of the Strategy [34].

relation to the capacity of space as a basis for the valorization of space earmarked for sustainable development [38].

The development of the MCE method is linked to the early 1970s of the twentieth century when many authors [39–41] began to develop such an approach. When first developed, the MCE was characterized by the methodological principle of multi-criteria decision-making (MCDM) with little or no participatory mechanisms included [42, 43]. The initial idea was to elicit clear preferences from a decision-maker and then solve a well-structured problem by means of mathematical algorithms (e.g. to design an engine by taking into account its power, weight and efficiency). Over time, this ambitious idea has been directed towards a more rational approach [44] and to a constructive or a creative approach [45], which has led to an approach based on the development of the multi-criteria decision aid (MCDA) that is characterized by placing in focus the process of decision-making on specific development processes, namely the raising of the level and quality of this process along with permanently including the public into all stages of creating the future development [46–48]. This approach has resulted in the emergence of the participatory multi-criteria evaluation (PMCE) [46, 49] and social multi-criteria evaluation (SMCE) [50]. Nowadays, the MCE method is often recommended as a convenient support in the decision-making process because of its capacity to point out in many ways multiple alternatives of development on the basis of assessing criteria related to the environment and socio-economic aspects of sustainable development [51–54].

The MCE method presented and elaborated in this chapter was originally defined in a scientific research project entitled 'Method for Strategic Environmental Assessment in Planning' (2005–2007). The method was later developed and upgraded through several domestic and international scientific projects, in which the Institute of Architecture and Urban & Spatial Planning of Serbia (IAUS) also participated. The results of the research and method development have found their applicability in the drawing up of a number of strategic documents at national and regional levels, in the fields of energy, water resource management, waste management, tourism and so on. An example of the application of the MCE method is shown in the text that follows.

3. Case study: MCE method in the SEA for the power plants in the Strategy

The results presented in this part of the chapter have been taken from the SEA for the Strategy [34] (case study), conducted by the authors of this chapter. The mentioned methodological approach was used in drawing up the mentioned document, while only the results that are in the context of the theme of this research and that were partially slightly modified to adapt them to the format of this chapter are elaborated herein.

3.1. Subject of the Strategy and SEA

The approach of integrated and continuous planning was used in creating the Strategy and carrying out the SEA with a focus on finding the measures for sustainability through integrating the realistic goals and the potentials in the field of energy, on the one hand, and the goals of and needs for environmental protection, quality of life of population and socio-economic development, on the other hand. The Strategy will be a framework for the development of the energy system of the Republic of Serbia with all possible (positive and negative) implications for the environmental quality. The purpose of carrying out the SEA for the Strategy is to consider possible negative effects on/trends of environmental quality, as well as to develop the guidelines for their reduction, namely bringing them within acceptable limits without creating the conflicts in space and taking into account the environmental capacity in the considered area.

The SEA is not focused only on the analysis of strategic commitments that can imply negative impacts and trends but also on the strategic commitments that can contribute to environmental protection and quality of life of population. In this context, the potential environmental impacts of planned activities were analysed in the SEA and were evaluated relative to the objectives and indicators.

The chapter of the Strategy related to the priorities of the energy sector development mentions the power plants as one of the keys and essential potentials for development, but also as a possible cause of significant problems in the environment. For this reason, the chapter emphasizes that there is the need to introduce the latest technologies in energy generation, both in the thermal power plants and in the field of renewable energy sources (RES) for which there are significant potentials, but they have not been sufficiently used in the Republic of Serbia.

Although other important strategic priorities in the field of energy are also dealt with in the Strategy, due to the fact that power plants have significant environmental impacts on the space in which they are built, the SEA gives special attention to this aspect, and exactly this aspect is elaborated further herein.

3.2. Evaluation of power plant impacts using the MCE method

The SEA for the Strategy singles out the total of 29 planned activities/strategic priorities that was included in the multi-criteria evaluation process. Nine out of 29 strategic priorities relate to the projects of power plants (**Table 4**). However, save for the locations defined by the document entitled 'Cadaster for Small Hydro Power Plants in Serbia' [55], the Strategy does not determine micro-locations for the majority of power plants (this particularly refers to the power plants using RES), so the evaluation could be based on predictions and on keeping pace with trends in space on the basis of micro-location determination and knowledge of general regularities and potential environmental impacts that certain types of power plants imply.

Table 4 shows the strategic priorities in the Strategy, which directly relate to the projects of power plants and which were also included in the multi-criteria evaluation presented further herein. In addition to these priorities, the Strategy also formulates priorities that directly relate to power plants because they are actually in their function. This includes, for example, the extension of coal open-pit-mining areas and opening of new coal open-pit mines which supply thermal power plants with coal. These strategic priorities were also elaborated in the SEA for the Strategy, but are not presented herein.

Each individual strategic priority in the Strategy relating to the projects of power plants (**Table 4**) was included in the multi-criteria evaluation process by forming matrices (**Table 5**) in which the mentioned priorities relating to power plants 'intersect' with the SEA objectives and indicators (**Table 1**). They were evaluated according to the adopted groups of criteria (**Table 2**).

The matrices were formed for the first two groups of criteria (impact magnitude and impact significance) because it is possible to identify the impacts of strategic importance already based on these two groups of criteria, namely the impacts where evaluation is within the values adopted and presented in **Table 3**.

The evaluation of strategic priorities was semi-quantitative, qualitative and aligned with the level of detail/generality that characterizes the strategic documents such as the Strategy. It was based on the planning approach through which the spatial (territorial) impacts were considered, as well as on possible conflicts in space that can occur in the interaction between the existing and the planned activities in a specific space without going into the technical and technological aspects of potential impacts that are not possible to be identified at this level of planning.

Each individual strategic priority was then also presented in the form of graph (**Figure 2**) and in a way comprehensible to the general public and decision-makers, this being in accordance with the Arhus Convention principles.

The evaluation of strategic priorities in the Strategy that relate to power plants, and which were elaborated in the SEA, is presented further herein.

A table was formed based on the adopted criteria for determining the strategically significant impacts (**Table 3**) and results of the multi-criteria evaluation presented in the form of matrices

Sector of the Strategy	Priority activities
Electric power system	Reconstruction and withdrawal of thermal power plants pursuant to Large Combustion Plants Directive
	Coal-fired power plants of capacity of 700MW by 2025 (350MW by 2020)
	"Bistrica" reversible HPP and/or "Djerdap 3" reversible HPP
	Construction of combined heat and PPs of capacity of approx. 450 MW by 2020
Renewable energy sources	Development of wind farms
	Development of hydroelectric power plants and small hydro power plants
	Development of biomass power plants
	Development of solar power plants
	Development of geothermal power plants

Table 4. Strategic priorities in the strategy included in the SEA relating to the projects of power plants [34].

(**Table 5**). The table identifies the strategic priorities that imply strategically significant impacts (positive and negative) on the environmental quality and elements of sustainable development, namely on the SEA goals, and determine the rank of impacts identified in such a way (**Table 6**).

ASSESSMENT OF IMPACT MAGNITUDE																					
Strategic priorities	SEA objectives																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Reconstruction and withdrawal of thermal power pursuant to the Large Combustion Plants Directive	+3	+3	0	+2	0	0	0	+1	0	+1	+1	+1	+1	0	+1	0	0	+1	-1	+1	+3
Coal-fired thermal of capacity of 700MW by 2025	0	0	0	-1	0	-2	0	-1	0	+1	0	+1	-1	0	+2	+2	+2	0	-1	0	+2
"Bistrica" reversible HPP and/or "Djerdap 3" reversible HPP	0	0	-3	-2	-1	-2	-1	-2	0	0	0	+1	-1	0	+2	+2	+3	-2	+3	0	+3
Development of combined heat and power plants using gas engines of capacity of approx. 450 MW by 2020	+1	0	0	0	0	-1	0	0	0	0	0	+1	0	0	+2	+1	0	0	+2	0	+1
Development of wind farms	+3	0	-2	-1	0	-1	-1	-2	0	+2	+1	+1	0	0	+1	+1	+1	-1	+3	0	+2
Development of HPPs and SHPPs	+3	0	-2	-1	0	-1	-1	-2	0	+2	+1	+1	0	0	+1	+1	+1	-1	+3	0	+2
Development of biomass power plants	-1	0	0	0	0	0	0	0	0	+1	+1	+1	0	0	+1	+1	+1	0	+3	0	+1
Development of solar power plants	+3	0	0	-1	-1	-1	0	0	0	0	+1	+1	0	0	+1	+1	+1	0	+3	0	+3
ASSESSMENT OF IMPACT SIGNIFICANCE																					
Strategic priorities	SEA objectives																				
Reconstruction and withdrawal of thermal power pursuant to the Large Combustion Plants Directive	R	R		L				L		L	R	L	L		L			I	L	R	R
Coal-fired thermal power plants of capacity of 700MW by 2025				L		L		L		L		R	L		N	L	N		N		R
"Bistrica" reversible hydropower plant and/or "Djerdap 3" reversible HPP			I	I	I	I	I	N				I	L		N	L	N	I	N		N
Development of combined heat and power plant using gas engines of capacity of approx. 450 MW by 2020	L					L						L			L	L			L		L
Development of wind farms	N		I	L		L	L	I		L	L	N			N	N	N	I	N		N
Development of HPPs and SHPPs	N		I	L		L	L	I		L	L	N			N	N	N	I	N		N
Development of biomass power plants	L									L	L	L			L	L	L		L		L
Development of solar power plants	L			L	L	L					L	L			L	L	L		L		L

*Criteria according to **Table 2**.

Table 5. Matrices of spatial impacts of power plants on the environment and sustainable development [34].

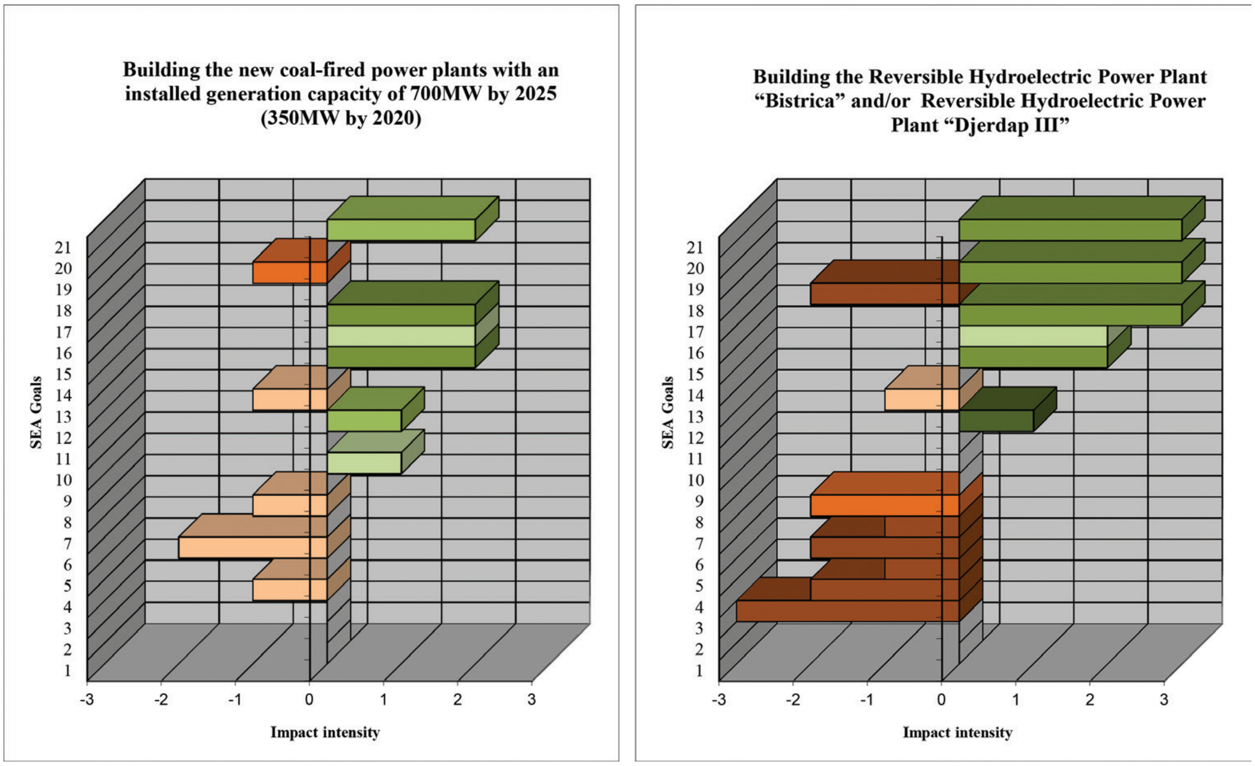

Figure 2. Examples of the presentation of obtained results in the form of graph [34].

3.3. Summary of significant strategic impacts

On the basis of the evaluation of impact significance shown in **Table 6**, it can be concluded that the Strategy produces significant number of strategically important, both positive and negative, environmental impacts. This is not at all surprising considering that the main idea of the Strategy was to create a concept of development of an energy sector which would rely in all of its segments on the principles of the prevention and active protection of the environment, its main factors, thus also on the improvement of human health by primarily permanently reducing the exposure to air pollution resulting from the operation of thermal power plants operating with inadequate technologies.

The identified negative impacts of the Strategy are the result of development in the energy sector which, in the Republic of Serbia like in other countries, dominantly relies on the existing energy potentials. The most important negative impacts are the result of thermal power plant operations, namely the result of the surface coal exploitation necessary for their operation. In this context, the impacts of the main environmental factors (air, water, soil and biodiversity), as well as impacts on landscape, stand out by their importance. The impacts on social factors as the result of extension of open-pit mines, due to which parts or even entire settlements are moved to completely new location, are of special importance.

Most of the mentioned impacts are not significantly spatially dispersed, but, nevertheless, they were assessed as being of strategic importance due to the assessed impact intensity, as shown in **Table 6**.

Strategic priorities	Identification and evaluation of significant impacts		Reasons explanation
	SEA objective	Rank	
ENERGY SYSTEM			
Reconstruction of thermal power plants pursuant to the Large Combustion Plants Directive	1	R+3 / S	It is expected that people's quality of life will be significantly improved at the regional level by reducing emissions of ambient air pollutants and reducing negative impacts on water quality. The introduction of cutting edge technologies in thermal power plants will contribute to this.
	2	R+3 / L	
	21	R+3 / S	
Development of new coal-fired thermal power plants of capacity of 700MW by 2025 (350MW by 2020)	15	N+3 / P	Significant positive effects are expected, which will spur economic growth and reduce dependence on energy imports by using new technologies in production processes.
	17	N+2 / S	
	21	R+2 / S	
Construction of the "Bistrica" reversible hydropower plant and/or "Djerdap 3" reversible hydropower plant	3	I-3 / S	There will definitely be negative transboundary impacts on hydrological regime of watercourses on which hydropower plant will be built, which may also cause the loss of forest and agricultural lands upstream of water intake (dam). Construction of the hydropower plant could have visual impact on landscape quality, but also impact on biodiversity. Positive impacts relate to spurring economic growth, reduction in dependence on energy imports, increase in the share of power produced from renewable energy, and introduction of clean technologies in electricity production.
	4	I-2 / L	
	6	I-2 / S	
	8	N-2 / P	
	15	N+2 / P	
	17	N+3 / S	
	18	I-2 / S	
	19	N+3 / S	
	21	N+3 / S	
RENEWABLE ENERGY SOURCES			
Increase in the share of power produced from renewable energy	1	N+3 / L	The expected positive effects will contribute to reducing harmful air pollution by increasing renewable energy use, i.e. by introducing clean technologies in electricity production processes. Certain projects can have negative effects on certain natural resources (effects of small hydropower plants on water resources) and biodiversity (effects of wind farms on ornithological fauna and chiropters).
	3	I-2 / L	
	8	I-2 / P	
	19	N+3 / S	
	21	N+2 / S	
Development of HPPs and SHPPs	1	R+3 / Lk	The expected positive effects will contribute to reducing harmful air pollution by increasing renewable energy use, i.e. by introducing clean technologies in electricity production processes. The negative impacts on the hydrological regime of watercourses on which they will be built are likely to happen. Hydroelectric power plants. These impacts will be particularly pronounced during the construction of HPPs with powerhouse at the toe of the dam and during the construction of SHPPs as a result of creating an artificial lake upstream from the dam, as well as in cases when several HPPs and SHPPs are planned on the same watercourse (cumulative and synergetic impacts). The positive impacts of national character that relate to the examples of clean technologies, renewable energy sources and reduced energy dependence by using significant hydro-energy potentials are certain to happen.
	3	I-2 / L	
	8	I-2 / P	
	19	N+3 / S	
	21	N+2 / S	
	3	R-2 / P	
	9	N-3 / P	
	17	N+2 / S	
	19	N-2 / P	
	21	N-2 / P	

Table 6. Identification and evaluation of strategically significant impacts with explanations [34].

Certain negative implications are also expected due to the construction of the 'Bistrica' HPP and/or construction of the 'Djerdap 3' reversible HPP, which would have negative effects on hydrological regime of watercourses on which their construction is planned, as well as on biodiversity and ichthyofauna, and will cause possible changes in the use of agricultural and forest lands.

By accepting the provisions of the Espoo Convention [56] and Kiev Protocol [57], the Republic of Serbia is obligated to notify the neighbouring countries on the projects that could have transboundary impacts. According to the Espoo Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention), the transboundary impacts are defined as all impacts (positive and negative) of a certain activity or a project that affect the environment under the jurisdiction of another country. The implementation of the Espoo Convention provisions implies that the relevant institutions of the neighbouring countries should provide information on the planned activities and their environmental impacts so that the affected country could participate in making optimum decisions on planning and future realization of such activities.

In addition to the projects defined by the Strategy that could have transboundary impacts, such as the RHPP 'Bistrica' and/or RHPP 'Djerdap 3' projects, the transboundary environmental impacts can also occur as the result of the realization of the following projects:

- Wind farms—possible transboundary impacts on the flying fauna (ornithological fauna and chiropters) on the border between Serbia and Romania (actually, all wind farm projects planned to be built in the north-eastern part of the Republic of Serbia);
- Small hydropower plants on transboundary watercourses (actually, the watercourses flowing from the territory of the Republic of Serbia into the territory of the neighbouring countries)—possible adverse impacts on benthonic organisms and ichthyofauna on boundaries with Montenegro, B&H and Romania;
- Coal-fired power plant projects—possible impacts on the air quality and international rivers.

Other planed activities that can imply the transboundary impacts of strategic importance have not been identified.

In addition to the adverse impacts, by using the MCE method in carrying out the SEA for the Strategy, a whole series of strategically significant positive impacts were also identified:

- Environmental quality: positive impacts on the quality of main environmental factors (air, water and soil) and reduction of greenhouse gas (GHG) emissions by increasing the use of RES and the use of clean technologies in thermal power plants in accordance with Directive 2001/80/EC on the limitation of emissions of certain pollutants into the air from large combustion plants and with the Directive 2010/75/EU on industrial emissions for new projects; withdrawal of all thermal power plants with generating capacity less than 300 MW; the implementation of a whole set of energy-efficiency measures will contribute to more rational energy use, that is, reducing the production of the required amount of energy for the same amount of required energy; the improvement of legal regulations in the area of energy and their harmonization with the EU regulations; the development of institutions for the implementation of improved legal regulations related to the environmental pollution reduction and main environmental factors;
- Socio-economic development: Improvement of the energy sector as a driver of economic growth and development, the market-oriented formation of energy prices and prices for energy-generating products; the development of domestic industry and commercial

scientific research sector for the transfer of leading edge technologies in the field of energy; strict implementation of energy-efficiency measures in final energy consumption; labour market mobility; as well as overall energy sector development, will represent a long-term contribution to sustainable economic development and rational use of non-renewable energy sources, that is, increasing the share of energy from RES.

4. Discussion and conclusions

The Strategy represents a strategic framework for implementing the policies and measures in the field of energy, also including the aspect of using the energy potentials by planning and building new power plants or by modernizing the existing ones. The possible implications for the environment as a result of the realization of such projects, as well as the significant public participation (NGO, population, expert groups, relevant institutions, investors and public companies in the field of energy) in the decision-making processes, undoubtedly indicate the need to consider this aspect in creating the policies in the field of energy, either at the national, regional or at the local level. The reason for the interest of the public in power plants, and energy sector in general, lies in the nature of their operation and possible significant spatial/territorial impacts. In this context, besides different studies on environmental protection carried out at the level of specific investment projects for individual power plants (e.g. EIA or LCA), it is of particular importance to carry out an environmental impact assessment at the strategic level of planning which should direct a strategic-planning document to the goals of sustainability and prevent potential conflicts in space in the earliest stage of creating an energy policy. The SEA is exactly the instrument that meets these specific requirements. This has been much written about in scientific literature, which is briefly summarized in the 'Introduction' section of this chapter.

The Energy Strategy [20] is a specific document due to the fact that it establishes a completely new and altered concept of energy sector development relative to the existing one that has been, at least in the Republic of Serbia, assessed as unsustainable and ecologically unacceptable. In addition, the Strategy gives a special attention to power plants (the existing and the planned ones) that are particularly significant for analysis from the aspect of environmental protection. This conditioned the specificity of the subject SEA within which it was necessary to make a symbiosis of all existing phenomena and the processes in space and predictions about potential impacts of power plants on the environment. This served for defining the SEA objectives and corresponding indicators, but also the criteria, based on which the strategic priorities related to power plants were assessed. By using the multi-criteria evaluation and semi-quantitative methods according to three groups of criteria, as well as by presenting the results using the matrices and graphs, the results were shown in a clear and unambiguous way for each of the strategic priorities. Different aspects of impacts (significance, spatial extent and probability) were encompassed. The results of the used MCE method were taken as a basis for defining the appropriate measures/guidelines for the environmental protection and monitoring which should be used in implementing the Strategy, namely in determining the micro-locations for new power plants and in preparing the investment projects. These measures/guidelines defined the SEA by each type of power plant, particularly taking into account new power plant projects and instructions for their realization in a way that provides the preventive protection of space and the environment, thus enabling all actors in the process of creating and adopting the Strategy to make conclusions on positive and negative implications of all identified impacts in a simple way, while the SEA in this process also serves as a regulatory and control tool for all future investments in the energy sector.

Unlike some SEA that are oriented towards identifying 'for and against' alternatives, in the SEA for the Strategy it was relatively simple to propose to actors to make decisions on which solution is the most suitable for the implementation of the Strategy because positive changes brought by its implementation are many times greater relative to the possible negative implications. This was affected by the methodological approach that is conceptually conceivable; clear way of presenting the obtained results which enables great public participation in critical stages of the SEA (identification of possible positive and negative impacts of the planning concepts); the use of semi-quantitative methods in assessing the impacts and defining the appropriate guidelines for the environmental protection and monitoring.

The specificity of the presented approach is reflected in the identification of the objectives and indicators of the SEA that is based on the analysis of a complex symbiosis of environmental quality, strategic frameworks defined in different strategic and planning documents and the Strategy. The objectives and indicators obtained through this procedure are a good basis for assessing the complex implications of the planned activities for the space and possible mutual interactions between different sectorial determinations regarding the elements of sustainable development. A clear presentation of obtained results of multi-criteria evaluation in the form of matrices, and particularly in the form of graphs, is particularly important in the SEA stages involving public participation. However, the use of semi-quantitative method of expert decision-making brings a certain dose of subjectivity, which can be tentatively regarded as a lack of such an approach. On the other hand, the use of different mathematical methods like ARAS (additive ratio assessment) [58] or AHP (analytical hierarchy process) [59] at the level of strategic planning and management is not necessary, and often impossible because of a lack of appropriate inputs. In this case, for example, there was no determination of micro-locations for the planned power plants that will use renewable energy sources, so the prediction of impacts could be only made based on the knowledge on energy potentials, for example, the energy to be obtained from renewable sources at the micro-location level, the state of the environment on these micro-locations and potential capacities (installed power) in these potentially suitable micro-locations. Such obtained results of the assessment of spatial/territorial impacts of strategic priorities represent exactly a good basis for establishing adequate guidelines and for the use of the above-mentioned mathematical methods at a lower level of impact assessment, namely in carrying out the EIA, which is actually also an obligation in carrying out the SEA. In this context, this lack should be understood tentatively, but should in no way be ignored in the process of carrying out the SEA and in making appropriate decisions.

The guidelines for environmental protection were established based on the results of multi-criteria evaluation of strategic priorities that relate to the planning, building or modernization of power plants. The guidelines were given for the most significant facilities/projects envisaged in the Strategy, namely for the energy facilities/projects which can be significant polluters by nature of their operation.

A special contribution of the SEA process was laid in the identification of possible transboundary impacts and in the establishment of the transborder cooperation with the neighbouring countries. In this context, the cooperation has been established with the Republic of Croatia, Romania and Republic of Bulgaria, which have showed their interest including themselves into the SEA process and in officially submitting their views regarding the identified possible transboundary impacts. Their views were adequately taken into account in the preparation of the SEA Final Report.

Performing the SEA for the needs of the Strategy resulted in making appropriate decisions in the process of establishing sustainable energy sector development, while the implementation of documentation in practice should contribute to the applicability of results and to the possible monitoring of SEA contribution in the process of planning both power plants and all other plans in the energy sector.

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