Chapter 7
Effects of Sustainable Energy Facilities on Landscape: A Case Study of Slovakia

Katarina Pavlickova, Anna Miklosovicova, and Monika Vyskupova

Abstract Sustainable energy, known as renewable energy, is the provision of energy that meets the needs of the present without compromising the ability of future generations. As sustainable energy sources, those most often regarded are hydroelectricity, solar energy, wind energy, geothermal energy, and biomass energy. The impacts of increased sustainable production and consumption are considerably less than the increased supply and the consumption of conventionally produced energy. However, we have to take into consideration also negative effects of new renewable production energy facilities, mainly on the landscape and its characteristics. Their localization could be considered as a factor that affects future settlements' development: this can be perceived not only as a facility reducing the amount of "green gas emissions" but also as a separate construction in the landscape.

The intent of this contribution is to mention specific aspects of environmental impact assessment of sustainable energy facilities with the emphasis on the role of landscape and landscape ecological evaluation in the Slovak Republic.

Keywords Cumulative effects • Ecological stability • Environmental impact assessment • Landscape • Slovakia • Sustainable energy

7.1 Introduction

Renewable energy implies energy sources that have no undesirable environmental consequences such as combustion of fossil fuels or generation of nuclear energy. Alternative energy sources are renewable and thought to be "free" energy sources

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K. Pavlickova (✉) • A. Miklosovicova • M. Vyskupova
Department of Landscape Ecology, Faculty of Natural Sciences, Comenius University in Bratislava, Mlynska dolina B-2, 842 15 Bratislava, The Slovak Republic
e-mail: pavlickova60@gmail.com; miklosovicova.anna@gmail.com; monikavyskupova@gmail.com

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because they all have lower carbon emissions compared to conventional energy sources: these include biomass, wind, solar (thermal, photovoltaic, and concentrated), geothermal, hydroelectric, and tidal energy sources (AES 2011).

After the Kyoto Protocol entered into force on February 16, 2005, investment in rational uses of energy, savings, and efficiency became the main premise to support the development of new energy. If energy consumption decreases, renewable sources could cover a significant part of the demand of energy, in particular, electricity; if consumption remains uselessly high because inefficient and less energy consuming (acting also on final uses), renewable energy would become a reality, a feasible method even in these sectors. With investments being equal (today all are in the sector of generation from fossil sources), if there was parallel research on how to reduce consumption and wastes considerably (at least 35 %) and on power plants from renewable sources, there would be also a reduction of gas emissions, without any negative influence on development (Iacomelli 2005).

Two slightly differentiated concepts can be identified in the discussion on energy transition. At first, all kinds of energy based on renewable resources found their way into the scientific debate and public discussion. With rising concern for a socially fair, environmentally friendly, and economically feasible future, the focus has shifted to include sustainable energy sources (van Etteger and Stremke 2007).

The growth of renewable sources of energy also stimulates employment in Europe, the creation of new technologies, and improved trade balance (EC 2011). The renewable sources are also considered as a basis for building new energy facilities (new energy power stations), which can be called “sustainable energy facilities” because of their global and regional impacts on the environment. But on the local level also, all these facilities can have their adverse impacts on the environment and especially influencing the landscape. For instance, the emplacement of high wind power stations into the country influences the scenery, and solar parks require spacious open ground.

The capacity for sustainable energy production is affected by geographic location and climate as well as geology and is therefore limited. This perception is based on ecological understanding. But according to Kozova and Pauditsova (2010), landscape suitability must be assessed not only in ecological terms but also in the terms of social and cultural carrying capacity. Environmental impact assessments from simple methods such as checklists to complex predictive models can also evaluate landscape suitability. This idea became a supporting topic for our authentic research. Its methods and knowledge are stated in this chapter, “Case Study from Slovakia” (sect. 7.5).

7.2 The Concept of Sustainable Energy Facilities Within the Slovak Republic

The Slovak Republic, as a member state of the European Union, has to follow European strategies, plans, and programs. In the frame of the Energy Sector, the "Green Paper: A European Strategy for Sustainable, Competitive and Secure Energy" (COM 2006) can be considered as a leading document. According to this document, renewable energy is already the third electricity generation source worldwide (after coal and gas) and has the potential to grow still further, with all the environmental and economic advantages that would follow. For renewable energy to fulfill its potential the policy framework needs to be supportive and in particular to stimulate increasing competitiveness of such energy sources while fully respecting the competition rules. Although some sources of low carbon indigenous energy are already viable, others, such as offshore wind, waves, and tidal energy need positive encouragement to be realized. The full potential of renewable energy will only be realized through a long-term commitment to develop and install renewable energy facilities.

How is the Slovak Republic prepared to use sustainable energy sources? In July 2004, the Government approved the document "Progress Report on the Development of Renewable Energy Sources, including the Identification of National Indicative Targets for the Use of Renewable Energy Sources." According to this document, based on Slovak natural and economic conditions, it is realistic to produce electricity from renewable energy sources at approximately 5.9 TWh in 2010. Then, in 2006, the "Energy Policy of the Slovak Republic" was approved by resolution of the Government of the Slovak Republic No. 29 from January 11, 2006. Under this policy, the obtainable ratio of all the renewable energy sources had to share in the overall electricity production at 19 % (5.9 TWh) in 2010, 24 % in 2020, and 27 % in 2030. Biomass is considered to be the most promising renewable source for heat and electricity production.

The energy policy was the starting point for the development of electro-energy, the thermal power industry, the gas industry, extraction, processing, and transit of oil, coal extraction, and the use of renewable energy sources. It defined three objectives:

1. Safeguarding, as effectively as possible, a secure and reliable supply of all forms of energy in desired volume and quality;
2. Decreasing the share of gross domestic energy consumption in gross domestic product—reducing the energy intensity;
3. Ensuring the volume of energy generation that would cover demand on a cost-effective principle.

To achieve the objectives of energy policy, 11 fundamental priorities were set in "Energy Policy of the Slovak Republic" (Ministry of Environment of the Slovak Republic 2006). To achieve point 8, "Increasing the share of renewable energy sources in the generation of electricity and heat with the aim of creating adequate

Table 7.1 Conservative scenario for the use of renewable energy sources (RES) in the Slovak Republic

Type of RES (total joules, TJ)	2010	2015	2020	2025	2030
Biomass	31,000	48,000	66,000	85,000	120,000
Solar energy	300	1,000	6,000	14,000	20,000
Geothermal energy	200	1,000	3,000	4,500	7,000
Hydroenergy	18,000	20,000	22,000	23,000	24,000
Wind energy	300	x	x	x	x
Energy waste	200	x	x	x	x
Total amount	50,000	73,000	100,000	130,000	175,000
Share of RES in total energy consumption (%)	6.4	9.0	12.0	16.0	21.0

x, no increase is expected; 1,000 TJ = 278 GWh (in electricity)
Source: Ministry of Environment of the Slovak Republic (2008)

Table 7.2 Optimistic scenario for the use of renewable energy sources (RES) in the Slovak Republic

Year	2010	2015	2020	2025	2030
Type of RES (TJ)					
Biomass	31,000	50,000	74,000	90,000	120,000
Solar energy	300	3,000	12,000	22,000	37,000
Geothermal energy	200	2,000	7,000	10,000	14,000
Hydroenergy	18,000	20,000	22,000	23,000	24,000
Wind energy	300	x	x	x	x
Energy waste	200	x	x	x	x
Total amount	50,000	78,000	120,000	150,000	200,000
Share of RES in total energy consumption (%)	6.4	9.5	14.0	18.0	24.0

x, no increase is expected; 1,000 TJ = 278 GWh (in electricity)
Source: Ministry of Environment of the Slovak Republic 2008

additional sources in order to cover domestic demand," many documents were established. As the most important, we mention here the "Strategy of Higher Usage of Renewable Sources of Energy" (Ministry of Environment of the Slovak Republic 2007) and the "Energy Security Strategy" (Ministry of Environment of the Slovak Republic 2008).

The future of using renewable energy sources in the Slovak Republic is illustrated in Tables 7.1 and 7.2, which represent the so-called "conservative" and "optimistic" approaches. To achieve both the proposed numbers the Slovak Republic had to build and still has to build new power stations based on renewable energy sources.

The evaluation of expected impacts on the environment and sustainable development, resulting from the new developed power stations, is governed in compliance with the relevant legislation. The environment is also affected by the development of related networks and systems. Therefore, the development and placement of new system should be located especially in areas where a sufficient system and network is already present. The development of new facilities and the modernization of existing energy facilities should be realized only under the rule of law, the implementation of recommendations and comments from the environment impact assessment process: Act No. 24/2006 Coll. on environmental impact assessment, Ministry of the Environment, and according to the decision of authorities.

7.3 Specific Feature of Environmental Impact Assessment in the Slovak Republic: The Role of Landscape

7.3.1 Environmental Impact Assessment/Strategic Impact Assessment of Sustainable Energy Facilities

Many projects concerning energetic constructions were carried out in the Slovak Republic. To maintain the typical landscape of our country and to conserve or improve the actual conditions of the environment there, it was necessary to engage some tools that can help to avoid these problems. As many others countries have done, Slovakia has adopted the structured approaches of Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA). These processes, as the base elements of sustainable development, have been helpful in creating energetic politics and strategies and in finding appropriate locations for many different projects, including renewable facilities.

Formally, the EIA and SEA are tools for obtaining and evaluating environmental information before its use in decision making in the development process. This information consists basically of predictions and the evaluation of social, economic, health, and environmental impacts and advice as to how best manage these changes if one alternative is selected and implemented (Abaza et al. 2004). An EIA focuses on proposed physical developments (constructions, facilities, and activities), and an SEA focuses on proposed documents such as new laws, policies, strategies, and plans.

The institution of impact assessment was first established in the Slovak Republic by Act No. 127/1994 Coll., which was effective from September 1, 1994. This law covered not only EIA, but also in a rather simple form, SEA. To harmonize the Slovak legislation with that of the EU, the law was later modified by the Act No. 391/2000 Coll. On February 1, 2006 the law was replaced by the new Act No. 24/2006 Coll. This law covers all requirements from the relevant EU directives and related international agreements. This act has been many times revised. In this current law, the processes of EIA, SEA, and transboundary assessment are equally represented. The individual steps of processes, the structure of documentation, and public participation are all specified.

	Wind energy	Solar energy	Biomass energy	Water energy	Geothermal energy
Act No. 127/1994 Coll.	0	0	0	2	2
Act No. 391/2000 Coll.	9	0	0	16	4
Act No. 24/2006 Coll.	65	12	3	16	9

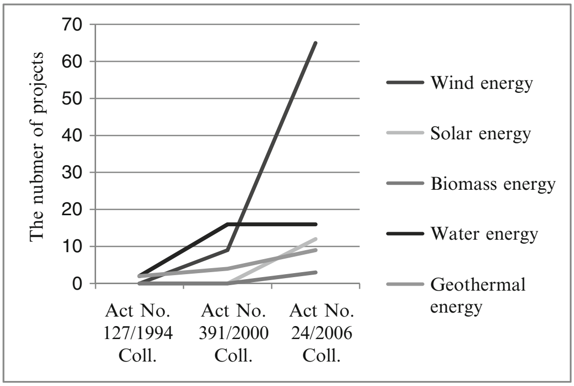

Fig. 7.1 Proposed projects of sustainable energy facilities assessed under environmental impact assessment (EIA) in the Slovak Republic in years 1994–2011

The main part of the EIA and SEA is the impact assessment. The actual law in Slovakia characterizes it as a comprehensive finding, description, and assessment of presumed impacts of the strategic documents and proposed activities on the environment, including comparison with the existing state of the environment in the given locality and in the area of presumed impacts. The assessment includes the preparation of environmental impact statements, consultations, and the final statement (Act No. 24/2006 Coll. in wording of later issued provisions).

Together, more than 5,900 constructions, facilities, and activities and more than 700 strategic documents were assessed during the force of the EIA and SEA legislation from 1994 (based on www.enviroportal.sk). Among them were four assessed documents related to energetics, specifically, the "Draft of Conception on Utilization the Hydroenergetic Potential of the Water Flows," the "Energy Security Strategy," the "Strategy of Final Part of Nuclear Energetics," and the "Strategy of Higher Usage of Renewable Sources of Energy." Also, the conceptions of the development of heat energetics in cities and towns have been evaluated. In focusing on renewable sources of energy under EIA, altogether 138 proposed projects of renewable facilities have been assessed (see Fig. 7.1).

The majority of these intentions were proposed to build up the wind power stations situated in wind parks, which were located not only in wide open spaces but also in built-up areas. Other projects suggested some wind parks in the same areas or nearby areas. Nevertheless, they usually have been assessed individually. A challenge for impact assessment is therefore to distinguish the limits of the study area and to determine all the connected projects to judge effects as well as possible.

7.3.2 Specific Feature of Environmental Impact Assessment: The Role of Landscape

The specific feature of EIA in the Slovak Republic is that great emphasis is put on the landscape, which coincides with the environment (see the definition of the landscape, following). The quality of the landscape is considered as equivalent to the quality of the environment. Interpretation of landscape in the assessment is fully compatible with the concept of sustainability, which is the basis of impact assessment. The process is based on three dimensions in terms of sustainable development: the environmental dimension, the social dimension, and the economic dimension.

Generally, the relationship of humans to the landscape is complicated. Mankind was born in the natural landscape and its biological and spiritual existence depends on it. The human population is an inseparable part of the landscape. Positioning of people in the landscape is determined by their physiological dependence on it (air, water, food, and all other landscape elements necessary for humans). Landscape also provides shelter to humans and is their home. It is an existential relationship. On the other hand, the landscape is the direct (primary production) or indirect (secondary production and the following production levels) object of human work. This relationship to the landscape is given by humans, creators of material things. The first relationship is of primary importance for humans and corresponds with the concept of sustainability. Failure to consider this connection as a criterion for decision making about the use of natural resources and the landscape has led the present society to the global environmental crisis. This is the reason why this specific approach, which relies on the concept of sustainability, is in the Slovak Republic a determining one in valuation of the landscape for any purpose (Drdos 2005).

As the landscape is the living environment of humans, the environmental impact assessment also considers humans (affected population) and their activities along with the landscape. Also, without knowledge regarding humans and their activities it is impossible to identify correctly anthropogenic phenomena and changes in the landscape.

The effect (impact) influences (Drdos 2005) the natural landscape components (natural effects); landscape (as geosystem and ecosystem), its structure and use (geosystemic effects); protected territories and elements of the territorial system of ecological stability (ecozoological effects); image of the landscape (visual effects); population (social effects); economy and its branches (economic effects); and material and immaterial components of culture (cultural effects). Such classification of impacts fully reflects the analytical procedures applied to the landscape-ecological studies.

7.4 The Most Important Impacts of Sustainable Energy Facilities

The most important impacts of sustainable energy facilities are based on the general knowledge of the authors, who utilized their practical experiences from the Slovak Republic.

7.4.1 Hydroelectric Power Plants

7.4.1.1 Negative Impacts

Hydroelectric water plants are relatively expensive and are associated with significant negative environmental and social impacts. These impacts significantly depend on the type of hydroelectric power plant: accumulation, derivative, flow, pumped, or combined type. The main negative impacts, listed below, are mainly associated with the following significant effects:

- Changes of water flow and water quality in a river modify living conditions for aquatic organisms, especially fish;
- Dam lakes separate fish populations living in the lower and upper parts of a water course and block migration routes;
- Construction of a dam causes changes in local climate and groundwater levels with high territorial radius;
- Changes of water flow may result in changes of sediment transfer; sedimentation in a reservoir can lead to erosion in the lower part of the water course;
- Construction of a water dam causes increased transfer of mud and sediment, thereby reducing water quality in the lower part of the water course;
- Construction of the water dam changes visual effects.

7.4.1.2 Positive Impacts

In addition to the fundamental socioeconomic impacts typical for energy constructions, it is possible to consider contribution to summer tourism, potential recreational space near water increasing water sports and fishing, as positive impacts of hydroelectric power plants and therefore resulting in significant increase of tourism in the chosen area. Flood protection and possible use of more environmentally friendly shipping can be also considered as a significant positive impact.

7.4.2 Wind Power Plants

7.4.2.1 Negative Impacts

It is necessary to point out the assumption that small turbines do not affect the surrounding environment. Larger turbines (with a tower height of 110–130 m) are considered as a problem with such parameters as noise, visual impact, collisions with birds and bats, and interference with the electromagnetic field. From the energy aspect it is a source dependent on weather conditions, power limited, and unstable.

7.4.2.2 Positive Impacts

Cheap power supply: Wind parks do not require a larger area and in terms of land use are shown to be most economical.

7.4.3 Solar Power Plants

7.4.3.1 Negative Impacts

Environmental impacts are linked to land occupation, change of landscape structure, and landscape character. Another disadvantage is the strong dependency of solar power plants for effectiveness on climatic conditions, especially the intensity of solar radiation and the number of sunny days per year.

7.4.3.2 Positive Impacts

The use of solar energy could be the cleanest way of energy use, and in contrast with other renewable sources, its impacts on the surrounding environment are lower. Direct use to produce heat is also another advantage of solar power plants.

7.4.4 Biomass Power Plants

7.4.4.1 Negative Impacts

Electricity production from biomass is similar to the thermal power plants with fossil fuel combustion (coal, gas). Therefore, correspondingly similar negative effects can be observed in biomass power plants in relationship to the emergent flue gas and solid and gaseous pollutants, as in the case of thermal power plants. The difference, in comparison with thermal power plants, is in significantly lower values of carbon dioxide (CO_2). According to other information, the greatest danger represents escape of PM10 and PM2.5, because filters cannot capture them and these particles are inhaled by humans. Impacts on the landscape usually have a visual character.

7.4.4.2 Positive Impacts

The technology of direct combustion of biomass is the most common way of its energy exploitation; methods of biomass modification to biofuels such as pyrolysis, gasification, aerobic putrefaction, and fermentation are also possible. Modern combustion facilities are able to burn almost any treated or untreated organic material. Given the impacts on the environment, burning of wood waste, agricultural production waste, and municipal waste especially has significance.

7.4.5 Geothermal Power Plants

7.4.5.1 Negative Impacts

There is a risk of possible release of toxic compounds from the bore (e.g., boric acid) or radioactive radon directly from the thermal water or steam. There are also other frequently identified impacts, especially on the landscape character, and common impacts on the landscape are usually visual.

7.4.5.2 Positive Impacts

A geothermal power plant is characterized by high performance in a permanent work regime and does not produce any technological waste or pollutants.

7.5 Case Study in Slovakia

In any EIA system, a definitive record of EIA reports undertaken should be maintained and made public (Wood 1995). We have chosen four of them as a basis for our research: Wind Park Svabovce I with two wind power stations, Wind Park Svabovce II with five wind power stations, Wind Park Horka pri Poprade with four wind power stations, and Wind Park Straze pod Tatrami with five wind power stations (Fig. 7.2).

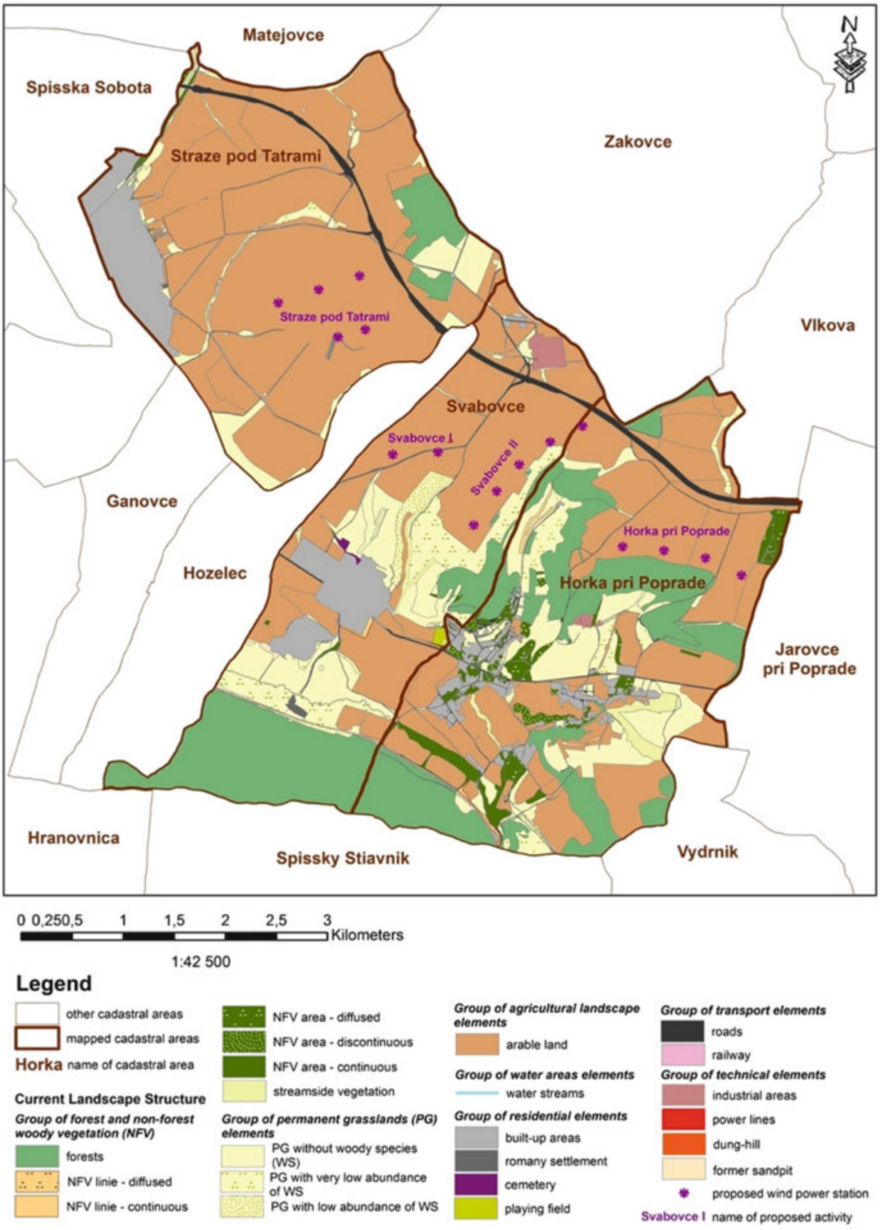

Fig. 7.2 Current landscape structure of all cadastral areas and the placement of proposed wind parks

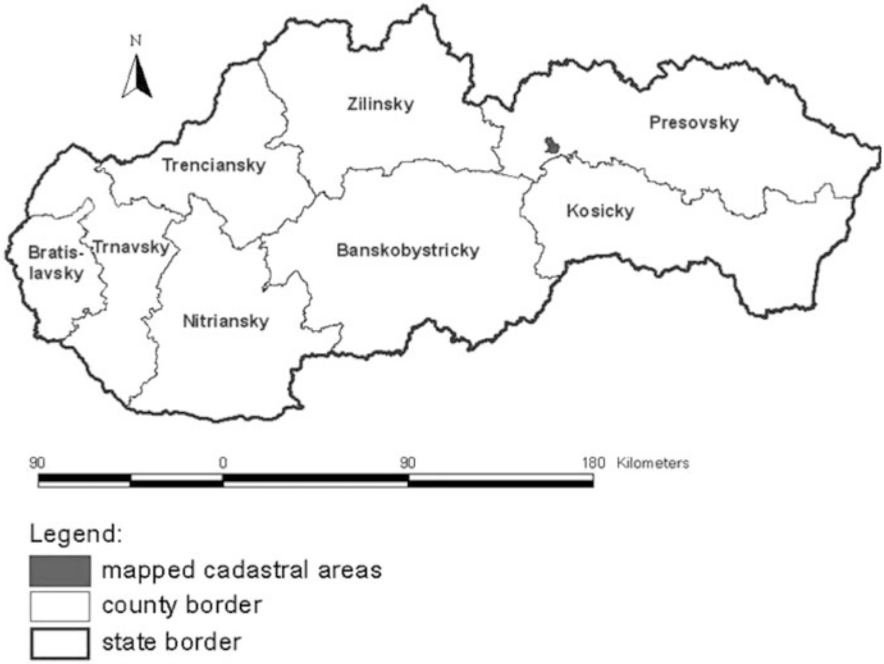

Fig. 7.3 Location of mapped cadastral areas within the Slovak Republic

All these parks are situated (Fig. 7.3) in the east part of the Slovak Republic (Presov region, Poprad district), covering an area of 3,061.33 ha. According to the geomorphological division of Slovakia (Mazur and Luknis 1980), cadastral areas belong to the unit Podtatranska kotlina Basin. These cadastral areas fall under the moderately cool subregion: basins with high altitude are cool. Average temperatures vary between 4 ° and −6 °C in January and from 14 ° to 17 °C in July. The total rainfall varies from 600 to 900 mm/year (Fasko and Stastny 2002). According to the phytogeographical division of Slovakia (Futak 1980), all cadastral areas belong to the subregion of Pannonian flora (*Pannonicum*), ward of West Carpathian flora (*Carpaticum occidentale*), and district Inner Carpathian Basin (*Intercarpaticum*). According to the zoogeographical division of Slovakia, the terrestrial biocycle, Svabovce, Horka pri Poprade, and Straze pod Tatrami cadastral areas belong to the West Carpathian District of Carpathian Mountain subprovince and Central European mountain province (Cepelak 1980). According to the zoogeographical division of Slovakia, the limnic biocycle (Hensel and Krno 2002), these cadastral areas belong to the Poprad area of Atlantic province.

Among the most common impacts on landscape evaluated are impacts on landscape structure, protected areas, landscape image (visual impact), and ecological stability. The proposed wind turbine plants were evaluated with a matrix method, using assessment of impact significance (in positive or negative sense) as follows:

- Without impacts (the proposed activity will not affect components of natural environment, population, and landscape in any way): value, 0;
- Insignificant impact (mainly impact with character of risk, coincidence, or with a negligible influence or contribution): value, 1;
- Small significant impact (impact with low influence from quantitative point of view, local impact, with low reception): value, 2;
- Significant impact (the impact on the wider environment, reception is high): value, 3;
- Very significant impact (reception is high to very high): value, 4.

Localization of proposed wind parks was incorporated to the map of current landscape structure by using the transposition methodology there through was reached illustration of their localization in cadastral areas. Impacts were different especially in their significance in which they are affecting landscape character. Actually, they were evaluated separately with the following results: Horka pri Poprade, 1; Svabovce I, 3; Svabovce II, 2; and Straze pod Tatrami, −1. But you should realize that all four wind parks are proposed in three neighboring cadastral areas, and this is why a joint map of landscape structure and proposed wind park localization was created for all three cadastral areas. We came to the logical conclusion that this impact is multiplied so that it is necessary to evaluate cumulative effects. The impact of all wind parks on the landscape character is insignificant, but the cumulative impact has a final value of 3, a significant impact.

In the conditions of the Slovak Republic, in Environmental Impact Assessment a specific evaluation methodology aimed at ecological landscape stability is used. By evaluation of impacts on ecological landscape stability, we came to the conclusion that it is necessary to evaluate it as one unit. Because this methodology is not commonly known, we describe it next.

7.5.1 Evaluation of Landscape Stability

To evaluate ecological landscape stability as the most frequent indicator in the assessment of environmental landscape quality, several methodological approaches were developed that are mostly based on defining the coefficient of ecological stability, the basic definition and mathematical expression of which were introduced by Michal (1982) in his work. The equation for calculation of this coefficient of ecological stability has undergone several revisions and modifications for different types of work.

The most frequently used term for characterization of landscape ecological quality is the term ecological stability. Ecologists have proposed several incompatible definitions of ecosystems and landscape ecological stability. The most available definitions for this chapter are found in articles by Michal (1982, 1992, 1994), Mician and Zatkalik (1986), Miklos (1992), Forman and Godron (1993), Voloscuk (2001), and Rehackova and Pauditsova (2007).

According to Michal (1982), the stability of any kind of system is not in its unchanging state, but in its ability to retain its own dynamic equilibrium. Ecological stability is the ability of ecological system to persist even under a disruptive influence and reproduce their essential features as well as in terms of outside distortions. This ability is expressed by minimal change in the case of destructive impact or spontaneous return to its initial state, respectively, the development of the original trajectory after eventual change. Landscape ecological stability preservation is the most general and comprehensive condition for preservation of the gene pool, biological diversity, equilibrium, flexibility, natural ecosystem behavior, and the natural productive ability of the landscape (Izakovicova et al. 2008).

7.5.2 The Coefficients of Ecological Stability

7.5.2.1 Coefficient of Ecological Stability 1

This coefficient of ecological stability 1 (Low 1984) is based on assignment of ecological significance coefficient from A to E to each secondary structure element. The highest value of ecological significance coefficient achieves areas of forests and water areas, which are hereby the most stable landscape elements, and the formula for the coefficient (CES) is as follows:

$$\mathrm{CES}_1 = \frac{1.5\mathrm{A} + \mathrm{B} + 0.5\mathrm{C}}{0.2\mathrm{D} + 0.8\mathrm{E}}$$

where A is areas with ecological stability (ES) degree 5 (forest, water areas); B is areas with ES degree 4 (bank overgrown, greenways); C is areas with ecological stability degree 3 (meadow, pastureland); D is areas with ecological stability degree 2 (arable land); and E represents areas with ecological stability degree 1 (built-up areas).

Attributes of the coefficient are interpreted thus:

$\mathrm{CES}_1 < 0.1$	Degraded landscape
$\mathrm{CES}_1 < 1$	Disrupted landscape
$\mathrm{CES}_1 = 1$	Balanced landscape
CES_1 1–10	Landscape with dominating natural elements
$\mathrm{CES}_1 > 10$	Natural or almost natural landscape

7.5.2.2 Coefficient of Ecological Stability 2

According to Rehackova and Pauditsova (2007) the CES_2 calculation considers the total area of particular landscape structure elements and the degree of their ecological stability (the ecological stability degree varies between 0 and 5). These degrees are assigning in accordance to Low (1984). In comparison with Low's work, there are amplified other landscape structure elements with their ecological stability degree. For the assessment of ecological stability coefficient is proposed the use of following formula, which considers acreage deal of landscape structure elements and the degree of their ecological stability in the assessment area:

$$\mathrm{CES}_2 = \sum_{i=1}^{n} \frac{P_i \times S_i}{p}$$

where P_i is the area of secondary landscape structure (SLS) elements; S_i is the ecological stability degree of land-use elements; p is the total area; and n is the number of SLS elements in territory.

Attributes of the coefficient CES_2 are interpreted thus:

1.00–1.49	Landscape with very low ecological stability
1.50–2.49	Landscape with low ecological stability
2.00–3.49	Landscape with medium ecological stability
3.00–4.49	Landscape with high ecological stability
4.00–5.00	Landscape with very high ecological stability

7.5.3 Landscape Ecological Stability in Horka pri Poprade, Svabovce, and Straze pod Tatrami Cadastral Areas

In the Slovak Republic is EIA documentation executed on the basis of landscape protection and landscape ecological stability preservation. Landscape ecological stability coefficients in cadastral areas were evaluated according two mentioned methodologies. At first, they were evaluated particularly and thereafter together as one unit. Particular results are as follows:

Horka pri Poprade:	$\mathrm{CES}_1 = 0.76$	$\mathrm{CES}_2 = 2.32$
Svabovce:	$\mathrm{CES}_1 = 0.51$	$\mathrm{CES}_2 = 1.68$
Straze pod Tatrami:	$\mathrm{CES}_1 = 0.08$	$\mathrm{CES}_2 = 1.17$

When evaluating landscape ecological stability, the choric aspect should be considered also; this means horizontal relationships between particular cadastre areas, because landscape evaluated only from the topical aspect represents landscape as a discontinuous system. Thereafter, particular cadastral areas with different degrees of ecological stability are evaluated as separate segments regardless of their horizontal relationships with adjacent cadastral areas. Especially, horizontal relationships affect in a high degree the value of landscape ecological stability.

Table 7.3 Representation of individual land structure elements and values of ecological stability coefficients in Horka pri Poprade, Svabovce, and Straze pod Tatrami Cadastral Areas

Component of land structure	Area (ha)	Area (%)	CES_1	CES_2
Built-up areas	87.21	2.85	E	0
Permanent grassland	478.52	15.63	D	2
Gardens areas	112.01	3.66	D	2
Arable land (large-area)	1,664.58	54.37	E	1
Industrial area	11.98	0.39	E	0
Nonforest vegetation (area)	74.71	2.44	B	2
Nonforest vegetation (line)	7.6	0.25	B	2
Forests	512.69	16.75	B	3
Roads	69.09	2.26	E	0
Railway	3.54	0.12	E	0
Nonforest vegetation by the river	21.2	0.69	B	3
Agricultural dung-pit	0.33	0.01	E	0
Former sandpit	1.6	0.03	E	0
Streams	11.44	0.37	A	4
Playing field	2.7	0.07	E	0
Romany settlement	2.1	0.07	E	0
Cemetery	1.38	0.04	E	1
Total	3,061.33	100.00	0.4	1.52

CES_1, degree of ecological stability; CES_2, degree of ecological stability

So, finally, the cadastre areas were evaluated together as one unit (Table 7.3): the first coefficient of ecological stability, which regards the total area of secondary landscape structure elements and also their ecological stability degree, reaches a value of 0.4, which means that this cadastral area is disrupted landscape type. When specific structure is deliberate, the coefficient of ecological stability reaches 1.52, which means that this cadastral area is classified as landscape with low ecological stability.

According to the degree of human extended intensity to the landscape and the ability of landscape to regenerate to the previous landscape condition (Ruzicka et al. 1978), this cadastral area represents a disrupted landscape, which rises from antirational landscape use and impairing of natural resources; hence, human economic activities are negatively affecting its natural conditions. Disturbance of biological equilibrium is evident, so there are impending changes in secondary landscape structure, but its regeneration may still be possible by natural-biological or technical means.

7.6 Cumulative Effects of Project Assessment

Many environmental problems faced today result from the accumulation of multiple small, often indirect effects rather than a few large obvious ones. Examples include loss of tranquility, heathland, and wetland, changes in landscapes, depletion of fish stocks, and global warming. These effects are very hard to manage on a project-by-project basis through EIA. The EIA comes too late, is too detailed, and is too focused on the short term. As such, despite the difficulties of doing so, SEA should make a special effort to consider cumulative, indirect, and long-term impacts (Therivel 2004).

For accumulation of effects from several projects, cumulative effects are used. According to Canter (1996), they are impacts on the environment that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time.

Cumulative effects may result from combined impacts from many, varied sources or repeated impacts from a single source. Cumulative impacts may be (Treweek 1999) additive (incremental), aggregated (synergistic), and associated (connected).

To evaluate cumulative impacts it is necessary to create a specific conceptual framework on which basis impacts will be identified and thereafter evaluated. Clark (1994) focused attention on the potential of cumulative effects assessment to serve as a predictive tool for gauging the sustainability of proposed development projects. According to this work, we propose the following steps for evaluating these effects:

1. Establish the geographic scope for the analysis and the time frame for the analysis
2. Describe the affected environment(this part includes evaluation of landscape character and ecological stability)
3. Identify other actions affecting the environment
4. Determine the environmental consequences of cumulative effect
5. Determine the magnitude and significance of cumulative effects

7.7 Conclusions

Our society and industry relies on large amounts of energy and the world is becoming increasingly dependent on fossil fuels (oil, gas, coal, etc.). The industrialized nations of Western Europe and North America, China, and India depend almost entirely on these fuels, and the developing nations are also increasing their use. It is understood that there is a direct link between the way we produce energy and damage caused by pollution. Finding cleaner and alternative ways of producing energy are now looked upon as being very important for the future of our planet.

On the basis of dozens of evaluated sustainable energy facilities (activities) assessed in the past 10 years as the specific aspects were determined: choice of locality—“brown fields” versus “green areas,” increased emphasis on cumulative impacts evaluation, clear suggestions are strengthening the proposed activities including their visualization and visibility evaluation.

To focus attention on the possibility of cumulative impacts is a way to call attention to disrupting the landscape where humans live. It is important to realize all the projects in harmony with landscape quality and respect its limits. To achieve this objective, it is necessary to accumulate knowledge about the environment from the beginning of the EIA process. A very appropriate way is to present its stability through the coefficients as we have shown in the case study in the Slovak Republic.

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