



A review of the environmental and human impacts from wind parks. A case study for the Prefecture of Lasithi, Crete

Dimitris Al. Katsaprakakis *

Wind Energy and Power Plants Synthesis Laboratory, Technological Educational Institute of Crete, Estavromenos, Heraklion 710 04, Crete, Greece

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ABSTRACT

A review of the wind parks' environmental and human impacts, based on extended research on the most recent relevant bibliography, is carried out in the present paper. The results of former studies are presented on:

- the impact on the aesthetic of the landscape
- the noise emissions
- the impact on birds and wildlife
- the shadow flicker from wind turbines
- the occupation of land
- the wind turbines electromagnetic interference.

In addition, the results of case studies for selected wind parks installed in the Prefecture of Lasithi in Crete, concerning their visual impacts and their noise emissions are presented. A statistical survey implemented in Crete concerning the public opinion on wind parks and wind energy is also presented.

The accomplished tasks indicated:

- There are no serious impacts caused by the installation or operation of wind parks. The wind parks' impacts may be eliminated with the optimum selection of the installation sites and the appropriate siting of the wind turbines.
- People in Crete exhibit a strongly positive attitude towards wind energy and wind parks, although they are not willing to pay a higher price for the electricity produced from wind parks.

A map with the optimum sites for wind parks installation in the Prefecture of Lasithi was constructed, taking into account all possible restrictions concerning the use of land, the environmental conservation and the impacts on human life. This map can constitute a flexible tool for the optimum site selection for a wind park installation, contributing to the elimination of environmental and human impacts of new wind parks, to the minimization of the required project's licensing time and to the limitation of possible negative public reactions.

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Contents

1. Introduction	2851
2. The environmental and human impacts of wind parks	2851
2.1. Visual impact	2851
2.2. Noise emissions	2852
2.3. Impacts on birds and wildlife	2853
2.4. Shadow flicker from wind turbines	2853

* Tel.: +30 2810 379220; fax: +30 2810 319478.

E-mail address: dkatsap@wel.gr

URL: <http://www.wel.gr/>.

2.5. Use of land	2854
2.6. Electromagnetic interference	2854
3. A case study for the Prefecture of Lasithi, Crete	2854
4. Visual impacts and noise emissions of the examined wind parks	2855
4.1. Visual impacts	2855
4.2. Noise emissions	2856
5. Public opinion on wind energy and wind parks in Crete	2858
6. The map of optimum wind parks installation sites in the Prefecture of Lasithi	2860
7. Conclusions	2861
Acknowledgements	2862
References	2862

1. Introduction

Wind power is considered as one of the cleanest energy sources, with mild impacts on the environment, on wildlife and on human life, as far as the production of electricity from modern wind turbines is concerned. The impacts on the aesthetic of the landscape, the noise emissions, the impacts on birds and wildlife, the occupation of land, the wind turbines' shadow flicker and the electromagnetic interference are mentioned in relevant former studies as the most serious environmental and human impacts of wind parks. The effect of the abovementioned impacts is always local, namely it is restricted in the vicinity of a wind park's site, unlike the impacts of conventional electricity production technologies (greenhouse gases emissions, nuclear waste), that exhibit a global attribute. The environmental impacts from the most common electricity production technologies are summarized in Table 1. From Table 1 it is obvious that the environmental and human impacts of wind parks are significantly less important compared to the respective impacts of conventional electricity production technologies (thermal or nuclear power plants).

Despite the abovementioned facts, under certain circumstances, the environmental and human impacts of a wind park can be important for the neighbouring area of its installation site. On this occasion, significant negative public reactions may appear during the wind park's licensing, installation or operation [1–4]. Such reactions can only be treated beforehand with the appropriate selection of the wind park's installation site, as well as with carefully planned dissemination policies [5–7].

The present article investigates environmental and human impacts of wind parks. The article aims to evaluate the impacts of wind parks and to investigate the prerequisites for a wind park's mild and secure operation. This aim is approached with the following tasks:

At a first stage, a review of the impacts of wind parks, based on extensive research on the most recent relevant bibliography is fulfilled. With this task, the global experience on the environmental and human impacts of wind parks, as provided by different teams of scientists (engineers, biologists, environmentalists), is gathered.

At a second stage, a case study is fulfilled for the Prefecture of Lasithi, in Crete. This study includes visual impacts evaluation and noise emissions calculation for selected wind parks installed in the Prefecture of Lasithi. The case study is integrated with a statistical survey implemented in Crete about the public opinion concerning wind parks and wind energy.

Finally, following the results of both the former relevant articles and the implemented case study in Crete, a map with the optimum sites for wind parks installation in the Prefecture of Lasithi is constructed, taking into account all possible restrictions concerning the use of land, the impact on human life and the environmental conservation. This map can constitute a flexible decision tool for the optimum site selection for a wind park installation, contributing both to the limitation of the environmental and human impacts of

the new wind parks, to the minimization of the required project's licensing time and to the elimination of possible negative public reactions.

2. The environmental and human impacts of wind parks

2.1. Visual impact

Visual impact of wind parks is based on the influence on a landscape's view, caused by the installation of huge technical constructions, especially in sites with a lack of any other human interference. The required network for the produced electricity transportation affects the landscape as well.

The wind turbines' size, in combination with their installation positions (usually at the top of hills or mountains) make them visible even from great distances. Consequently, the influence of wind parks on the landscape is indubitable. The question is whether this influence can be accepted or not. The answer is rather subjective, since it depends on the point of view with which one may face this issue [8]. Sometimes wind turbines may be considered as large and ugly constructions that convert natural landscapes to industrial areas, sometimes as useful and clever machines that produce clean and cheap energy and sometimes as one of the most promising solutions towards the limitation of the operation of the thermal and nuclear power plants, a fact that makes them invaluable and irreplaceable.

The evaluation of the visual impact of a wind park in a landscape is a difficult multi-parametric task [9–13]. Despite the subjective nature of this issue, there are some objective parameters that affect the visual acceptability of a wind park [14]. Generally, these parameters are:

- **The wind park's normal operation.** An important parameter for the acceptance of a wind park is its normal operation. When the wind turbines operate normally, they are considered to serve a purpose, so they are useful. In this case, they may be visually acceptable. On the contrary, when the majority of the wind turbines in a wind park are standing still while the wind blows, the observer's anticipation for the wind turbines' necessity and usefulness is broken. In this case, the impression of the landscape's spoliation without any benefits dominates.
- **The wind park's installation site.** The zone of visual impact of a wind park installed in a flat area in central Europe is less broad than the one of a wind park installed at the top of a hill in a small island in the Aegean Sea. On the other hand, the visual impact of a wind park on the landscape may be considered more intensive in narrow and closed landscapes (a valley in central Europe) rather than in open areas (a hill on a Greek island).
- **The natural aesthetics of the installation area.** The installation of a wind park in the neighbourhood of areas with remarkable natural beauty may cause significant negative reactions. On the

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