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A quantitative-based evaluation of the environmental impact and sustainability of a proposed onshore wind farm in the United Kingdom

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ABSTRACT

In this paper, a quantitative-based evaluation of the environmental impact of a proposed wind farm is presented using the Rapid Impact Assessment Matrix (RIAM). The paper uses the revised Environmental Statement of the Grove Farm Wind Energy Project, which was rejected during the planning decision consent stage initially and upheld on appeal. The paper evaluates quantitatively the potential impact of an onshore wind farm at the construction and operation stages. Based on the RIAM evaluation conducted, the paper then goes on to apply a mathematical model to the results to determine the indicated potential level and nature of sustainability of the proposed wind farm. The results indicate that the Grove Farm project was deemed, as a whole, detrimental to the environment–human system, particularly in respect to impacts to visual amenity and cultural heritage. The application of the model to the RIAM indicated that in both the construction and operation stages, the project was considered as unsustainable. The results obtained raised legitimate questions as to the benefits of such projects as a major contributor to the UK's renewable and sustainable energy mix.

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1. Introduction

In numerous Environmental Impact Assessments (EIAs), the environmental impact and sustainability of onshore wind farms are often cited as being positive. In the case of the United Kingdom, this is based upon qualitative evaluations of the magnitude and significance of the various impacts caused (e.g. high, moderate, or low), and professional judgement evaluations in the determination of sustainability. This can make comparing and contrasting wind farm projects difficult to do. Therefore, an alternative approach to evaluate the environmental impacts and sustainability of a proposed wind energy project is required, which is consistent and rigorous. Based on previous research on the indicated level and nature of sustainability of renewable energy installations [1,2], this paper quantitatively evaluates the environmental impact and sustainability of a proposed onshore wind farm in the United Kingdom.

The Grove Farm Wind Energy Project was proposed by the University of Nottingham. The project consisted of 3 wind turbines generating between 2–3 MW on land which the University owned, known as Grove Farm, located next to the River Trent and Clifton Bridge [3–5]. The proposed turbines were designed to be 80 m high to the hub and 126 m high to the rotor tip [3]. An Environmental Impact Assessment (EIA) of the project was conducted by AECOM and produced in July 2011 [4]. A revised Environmental Statement was produced in January 2012 [5] in respect to points raised by the relevant local planning authorities. The project was rejected planning consent by Broxtowe Borough Council in October 2012 and by Nottingham City Council in February 2013. The decision of the councils was upheld by the Planning Inspectorate in November 2013.

The determination of the magnitude and significance of impacts within the Grove Farm EIA, as well as other EIAs conducted in the UK, are performed using a qualitative approach. The Institute of Environmental Management and Assessment (IEMA) states that: "*quantitative techniques tend to involve a prescriptive method being set out and followed, whereas qualitative techniques rely less upon a prescribed method instead relying heavily upon professional judgement*" [6]. Quantitative-based EIAs are extremely rare within the UK. This is despite the potential advantages to conduct further modelling, scenario analysis or model application.

Therefore, this paper intends to: 1) Conduct a quantitative-based EIA using the Rapid Impact Assessment Matrix (RIAM) method [7,8] based on the original results of the Grove Farm revised Environmental Statement [5]; *and* 2). Based on the obtained results of the RIAM, applies a revised mathematical model to evaluate the level and nature of sustainability derived from the original research of Phillips [9,10].

The paper's context is very relevant at the present time due to the considerable disquiet of local communities in the UK when an onshore wind farm is proposed. In particular, this prevalent in commutable rural areas where visual amenity and cultural heritage are greatly values assets. This is against the backdrop of the UK's attempts to reduce by 80% the 1990 level of anthropogenic greenhouse gases by the year 2050, as stated in the 2008 Climate Change Act [11], as well as the EU's target to have 20% of energy generated by renewable sources. Consequently, the paper intends to make a positive contribution to the debate and state of knowledge concerning the long-term impact and sustainability of onshore wind farm installations.

2. Methodology

2.1. The Rapid Impact Assessment Matrix

2.1.1. Overview

The Rapid Impact Assessment Matrix (RIAM) method is a semi-quantitative method that uses a standard definition of the important assessment criteria, and which consequently provides for an accurate and independent score for each condition [8].

Table 1
Assessment criteria of RIAM, based on Pastakia [7] and Pastakia and Jensen [8].

Criteria	Scale	Description
A1: Importance of condition	4	Important to national/International interests
	3	Important to regional/National interests
	2	Important to area immediately outside the local condition
	1	Important only to the local condition
	0	No important
A2: Magnitude of change/effect	+3	Major positive benefit
	+2	Significant improvement in status quo
	+1	Improvement in status quo
	0	No change/status quo
	−1	Negative change in status quo
	−2	Significant negative disbenefit or change
	−3	Major disbenefit or change
B1: Permanence	1	No change/not applicable
	2	Temporary
	3	Permanent
B2: Reversibility	1	No change/not applicable
	2	Reversibility
	3	Irreversibility
B3: Cumulative	1	No change/not applicable
	2	Non-cumulative/single
	3	Cumulative/synergistic