PAGERPOWER

Case Study 20:

Lilbourne Wind Farm

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CONTENTS

1 INTRODUCTION

Hemex applied for planning permission to develop a wind farm at Lilbourne near Rugby in Northamptonshire. The 10 MW farm consists of 5 turbines that have been operational since 2014 – the wind farm being operated by Energiekontor.

The wind farm was objected to initially by Coventry Airport because the wind turbines were visible to its radar whilst lying beneath one of the airport's approach routes.

Pager Power advised the developer, negotiated with the airport and provided expert evidence for the public inquiry.

Figure 1: Coventry Airport Radar

2 BACKGROUND

There is a region of wind farm development generally to the south east of the M1/M6/A14 interchange near Rugby. The wind turbines typically have maximum tip heights of 125 metres above ground level.

Local topography and airspace structure means that all of these turbines are within radar line of sight of the primary surveillance radar at Coventry Airport as well as being beneath important airspace used by aircraft approaching the airport.

Figure 2: Wind Turbines at East Midlands Airport

3 THE CHALLENGE

The proposed wind farm had an objection due to its predicted technical impact on the radar at Coventry Airport. Whilst the wind farm developer knew that the proposed wind farm at Lilbourne would have no significant additional impact when compared with the approved neighbouring wind developments it was unlikely that planning permission would be awarded if Coventry Airport's objection was not addressed.

4 THE RESULT

On 6 July 2012 planning permission was granted for a 5 turbine wind development at Lilbourne.

Prior to this a commercial agreement regarding radar mitigation was agreed with Coventry Airport. There was no specific radar planning condition although there was an air safeguarding condition which is reproduced below:

> ***Air Safeguarding***
>
> *18. Within 30 days of the First Export Date, written confirmation to the Local planning Authority shall be provided confirming that the necessary aviation bodies such as the Ministry of Defence and the Civil Aviation Authority have been given written notice of the date of completion of construction, the height above ground level of the highest structure in the development and the position of each wind turbine in latitude and longitude.*

Radar and aviation was not a significant subject during the inquiry itself. An excerpt from the decision notice[1] is reproduced below:

> ***Decision***
>
> *4. The appeal is allowed insofar as it relates to a wind farm located north and south of Lilbourne Lodge, comprising 5 wind turbine generators (Turbines 3, 4, 5, 6 and 7) up to 125m high, access tracks, including access off public highways, a control and maintenance building, crane hard-standings, cable trenches, anemometer mast up to 80m high (for a period of 25 years) and a temporary construction compound. The appeal is dismissed insofar as it relates to Turbine 1 and associated infrastructure. Planning permission is therefore granted for a wind farm located north and south of Lilbourne Lodge, comprising 5 wind turbine generators (Turbines 3, 4, 5, 6 and 7) up to 125m high, access tracks, including access off public highways, a control and maintenance building, crane hard-standings, cable trenches, anemometer mast up to 80m high (for a period of 25 years) and a temporary construction compound at Lilbourne Fields, Lilbourne, Nr Rugby CV23 0SV in accordance with the terms of the application, Ref DA/2009/0731, dated 16 September 2009 so far as relevant to that part of the development hereby permitted and subject to the conditions in annexe 1.*

[1] APP/Y2810/A/11/2164759

5 THE EVIDENCE

The below proof of evidence was prepared for the public inquiry. The evidence was not heard because an agreement was reached with Coventry Airport.

Qualifications and Experience

1. My name is Mike Watson. I have an honours degree in Electronic, Computer and Communications Engineering and am a Chartered Engineer. I have worked as a commissioning engineer at Sizewell B nuclear power station and have worked as a software developer for Barclays Bank plc. I founded Pager Power Limited in 1997. Pager Power advises wind farm developers and undertakes studies for them. The company deals with aviation, radio communications and radar issues for wind farm developers and consultants. The company deals with onshore and offshore wind farms and occasionally with other building developments.

2. I am a member of the Renewable UK (formerly BWEA) aviation strategy group which meets regularly in London to discuss aviation and wind farm issues. The International Energy Agency (IEA) runs Topical Expert Meetings on wind farms, radar and radio. I was technical chairperson of the last meeting in Amsterdam. The NATO Research and Technology Organisation is considering the impact of wind turbines and radar. I attended the second meeting in Paris. Eurocontrol have issued guidelines on wind farms and radar. I have commented on these guidelines and participated in a workshop to finalise the guidelines.

3. I addressed the American Wind Energy Association conference in Dallas in May 2010 regarding my successful data fusion mitigation solution for the 140 turbine Whitelee wind farm in central Scotland. In 2010, I addressed the British Wind Energy Association [now Renewable UK] conference in Liverpool regarding Ministry of Defence threat radar.

4. Pager Power helped Scottish Power and BAA overcome issues associated with the 62 turbine Black Law wind farm and its potential impact on the radar at Edinburgh Airport in 2003. The company has acted for the majority of major UK wind farm developers on hundreds of wind farm proposals. The company has also worked on wind farm developments in Ireland, Belgium, Canada, Bulgaria, Seychelles, South Africa and Australia. We have a good relationship with wind developers and consultants in the USA, Netherlands, Sweden, Czech Republic and Romania.

5. In 2011 the company launched an advanced online assessment service for assessing the impact of wind turbines on aviation, radar and radio systems. This service uses an advanced terrain data processing algorithm to deliver accurate and conservative results for wind farm radar assessments.

6.

7. The company holds regular internal meetings of its five technical staff to discuss the latest developments in wind farm radar mitigation. I regularly meet with and have discussions with the suppliers of wind farm radar mitigation solutions.

8. I have a good relationship with the Civil Aviation Authority, the Ministry of Defence, National Air Traffic Services, BAA and many airport operators. I also have a good relationship with Eurocontrol and a number of overseas aviation and military bodies.

9. I am a qualified private pilot and have flown subject to air traffic control in the vicinity of wind farms in my own aircraft.

Scope

10. I have considered the impact of the proposed wind farm on the primary surveillance radar at Coventry airport. I have also considered the radar impact of the approved neighbouring Yelvertoft and Swinford wind farms.

Proposed Wind Farm

11. The proposed Lilbourne wind farm consists of six turbines each having maximum tip height of 125 metres and a hub height of 80 metres. The turbine coordinates are shown in the table below:

Turbine	Easting (OSGB 36)	Northing (OSGB 36)	Base Elevation (m)
T1	456674	277714	97.0
T3	457174	277589	97.5
T4	457573	277669	98.0
C1	457077	276255	99.0
C2	457485	276258	99.8
C3	457193	275905	99.0

Table 1 Proposed Lilbourne Wind Farm Turbine Coordinates

Consented Neighbouring Wind Farms

12. There are two consented neighbouring wind farms. Swinford, to the north, consists of eleven turbines and Yelvertoft, to the south, consists of eight turbines. These turbines also have maximum tip heights of 125 metres.

13. The coordinates of these turbines are shown in the tables below:

Turbine	Easting (OSGB 36)	Northing (OSGB 36)	Base Elevation (m)
1	456867	281409	146.0
2	457212	281544	149.9
3	457622	281643	148.5
4	458022	281933	150.7
5	457057	280994	140.0
6	457422	281184	141.2
7	458127	281509	136.3
8	458388	281504	141.0
9	457222	280674	142.6
10	457597	280764	135.1
11	458352	281269	137.1

Table 2 Swinford Wind Farm Turbine Coordinates

Turbine	Easting (OSGB 36)	Northing (OSGB 36)	Base Elevation (m)
1	457726	275887	100.0
2	458173	275979	104.2
3	457477	275585	102.8
4	457867	275533	106.6
5	458328	275707	108.4
6	457491	275263	114.6
7	457826	275204	119.7
8	458297	275362	112.0

Table 3 Yelvertoft Wind Farm Turbine Coordinates

Coventry Airport Primary Surveillance Radar

14. Coventry Airport is a licensed airport located to the south east of Coventry. The airport is operated by Coventry Airport Ltd. The airport has an asphalt runway aligned 05/23 (50˚/ 230˚magnetic heading) which is 2008m x 46m.

15. The airport operates a primary surveillance radar which is a civil airfield radar operating in the S-Band used for Air Traffic Control.

16. The radar location and height is shown in the table below:

Radar Type	Location (OSGB 36)	Antenna altitude (amsl)

Table 4 Coventry PSR location

Other Radar available to Coventry Airport

17. Air traffic controllers at Coventry also have access to Secondary Surveillance Radar SSR data from a NATS (formerly National Air Traffic Services) radar at Clee Hill in Shrophire.

18. This SSR radar will not be affected by any of the wind turbines at Lilbourne, Swinford or Yelvertoft.

Location Plan

19. The chart below shows the relative locations of the Coventry Airport PSR, the proposed Lilbourne wind farm and the consented Swinford and Yelvertoft wind farms.

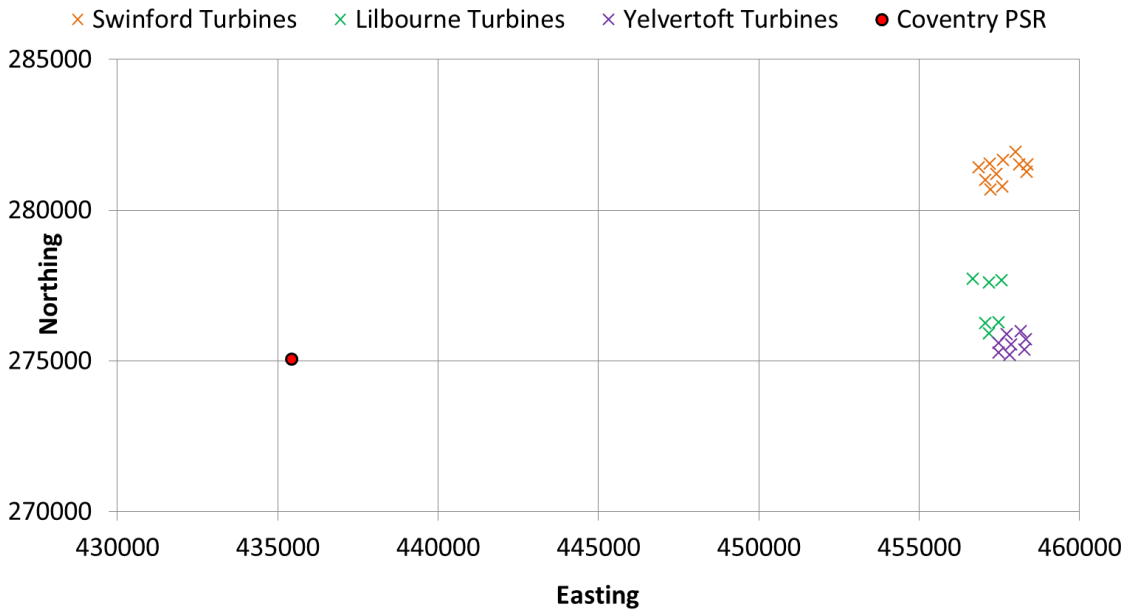

Figure 1 Chart showing relative location of radar and wind turbines

Published Guidance

20. Civil Aviation Publication 764 is entitled CAA Policy and Guidance on Wind Turbines and provides guidance on the wind farm radar interference issue.

21. There are many further sources of information on this topic including "Wind Energy and Aviation Interests – Interim Guidelines" published by the UK government in 2002; "Assessment of the Effects of Wind Turbines on Air Traffic Control Radars" published by the US department of commerce in 2008 and "Eurocontrol Guidelines on How to Assess the Potential Impact of Wind Turbines on Surveillance Sensors" published in 2010.

The Impact of Wind Turbines on Primary Surveillance Radar

22. Primary Surveillance radar are designed to detect aircraft and display them on radar screens. They work by transmitting a series of radio pulses which can be reflected from targets of interest. Non-moving targets are filtered out with the intention of solely displaying aircraft. This filtering is based on the Doppler effect and is known as Moving Target Detection [MTD].

23. Road traffic, birds, weather and other moving objects that are not aircraft are sometimes displayed on the radar. Such non-aircraft returns are referred to as clutter.

24. Wind turbines can cause clutter on radar screens because of their height and because the turbine blade ends move at high speed of around 80 knots, the cut off speed for MTI processing typically being around 40 knots.

Assessment of Wind Turbines and Primary Surveillance Radar

25. It is desirable to predict whether a proposed wind turbine will affect a particular radar installation. There are methodologies and computing tools that enable such predictions. Radar line of sight analysis is used to determine whether a particular wind turbine is visible to the radar. If the turbine is entirely below the line of sight it will not usually be detected. If it is entirely above the line of sight it will usually be detected.

26. The principles of line of sight analysis are shown in the diagram below:

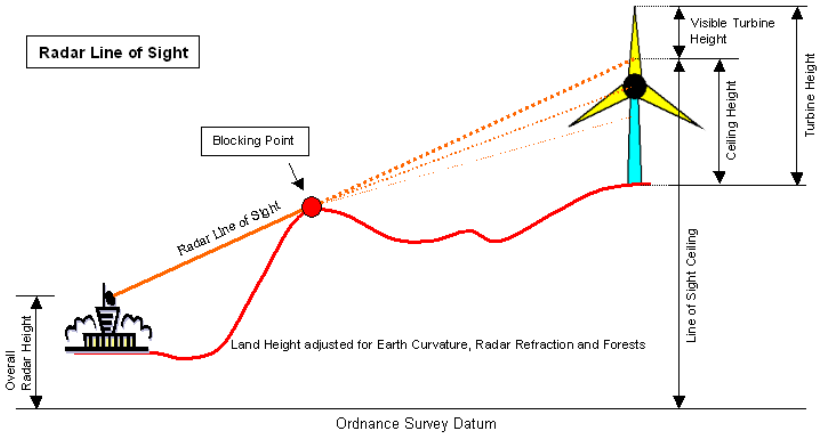

Figure 2 Diagram showing principles of line of sight analysis

27. Radar line of sight analysis usually takes terrain elevation (derived from a database of digital terrain data), Earth curvature and refraction into account.

28. Radar detectability calculations can also be undertaken. These take the characteristics of the radar into account as well as diffraction effects. Radar

detectability calculations are more complicated than radar line of sight calculations but can give more accurate results.

Coexistence of Wind Turbines and Radar

29. There are many examples of wind turbines and primary surveillance radar co-existing in the United Kingdom, and elsewhere in the world, in situations where the turbines have a predicted or actual technical effect on the radar.

30. In some cases the technical effects are deemed to be operationally acceptable and in some cases these effects are mitigated with some form of technical mitigation solution.

31. Two turbines have recently been erected at East Midlands Airport. These are just over one kilometres from the airport's primary surveillance radar which is a Marconi S511. Coventry also has a Marconi S511 radar.

Assessment

32. Two neighbouring wind farms at Swinford and Yelvertoft have been consented and are not subject to airport planning conditions.

33. The airport's letter of 20 December 2011 raises concerns regarding the operational impact of the Lilbourne wind farm resulting from its technical impact on the radar. The specific concerns raised were:

    a) There will be a significant impact on radar services because of the wind development's proximity to the 348 DTY radial and the wind farm's location in an area used for vectoring inbound IFR aircraft.

    b) There will be an inability to provide a full deconfliction service because there will be radar clutter within 5 nautical miles of aircraft awaiting clearance to undertake an instrument approach.

    c) Air traffic services to transiting aircraft would be significantly compromised due to radar returns from the Lilbourne wind turbines.

34. The proposed Lilbourne development is located between the consented Yelvertoft and Swinford wind developments and is on lower ground than either of them. It is considered likely that these developments will be built before the proposed Lilbourne development.

35. Radar line of sight analysis has been undertaken for each of the turbines at Swinford and Yelvertoft from the Coventry Airport primary surveillance radar.

36. The chart clearly shows that Swinford Turbine 1 is almost fully visible to the radar. It is therefore likely that the radar will be affected by this turbine if no technical mitigation is established.

37. Line of sight analysis has been undertaken for the remaining turbines at Swinford and Yelvertoft. Results for each turbine are shown in the tables below.

Turbine	Radar Line of Sight Visibility (metres)	Technical Impact
1	123.4	Radar likely to be affected
2	124.4	Radar likely to be affected
3	121.7	Radar likely to be affected
4	121.5	Radar likely to be affected
5	115.6	Radar likely to be affected
6	115.8	Radar likely to be affected
7	109.1	Radar likely to be affected
8	112.6	Radar likely to be affected
9	118.2	Radar likely to be affected
10	109.5	Radar likely to be affected
11	108.2	Radar likely to be affected

Table 5 Line of Sight Analysis Swinford and Coventry

Turbine	Radar Line of Sight Visibility (metres)	Technical Impact
1	92.2	Radar likely to be affected
2	95.2	Radar likely to be affected
3	96.9	Radar likely to be affected
4	100.2	Radar likely to be affected
5	99.3	Radar likely to be affected
6	109.9	Radar likely to be affected
7	113.1	Radar likely to be affected
8	106.3	Radar likely to be affected

Table 6 Line of Sight Analysis Yelvertoft and Coventry

38. The analysis clearly shows that each of the nineteen turbines planned at Swinford and Yelvertoft are likely to affect the Coventry PSR unless some form of technical mitigation is implemented.

39. The technical effects of these turbines at Yelvertoft and Swinford may well result in the following operational impacts at Coventry:

    a) There will be a significant impact on radar services because of the wind development's proximity to the 348 DTY radial and the wind farm's location in an area used for vectoring inbound IFR aircraft.

    b) There will be an inability to provide a full deconfliction service because there will be radar clutter within 5 nautical miles of aircraft awaiting clearance to undertake an instrument approach.

    c) Air traffic services to transiting aircraft would be significantly compromised due to radar returns from the Lilbourne wind turbines.

40. I have assessed the impact of the Lilbourne wind development on an environment in which the turbines at Yelvertoft and Swinford are already operating.

41. Radar line of sight analysis has been undertaken from the Coventry PSR to each of the Lilbourne wind turbines. Results are shown in the table below:

Turbine	Radar Line of Sight Visibility (metres)	Technical Impact
1	101.6	Radar likely to be affected
2	95.9	Radar likely to be affected
3	96.3	Radar likely to be affected
4	93.5	Radar likely to be affected
5	93.4	Radar likely to be affected
6	92.4	Radar likely to be affected

Table 7 Line of Sight Analysis Yelvertoft and Coventry

42. All six turbines are likely to affect the Coventry PSR unless a technical mitigation solution is implemented.
43. The technical impact is likely to be slightly smaller than the technical impact of either Swinford or Yelvertoft because:

    a) There are fewer turbines

    b) The turbines are less visible

    c) The turbines are on lower ground

44. I have assessed the net operational impact of the proposed Lilbourne scheme by comparing the likely operational impact of Yelvertoft and Swinford without Lilbourne with the likely operational impact of Yelvertoft, Lilbourne and Swinford.

45. Results for the comparison are shown in the following table:

Wind Farms	Impact on Radar Services – 348 DTY	Inability to provide full deconfliction service	Air Traffic Services to transiting aircraft
Yelvertoft and Swinford	Adverse Impact	Adverse Impact	Adverse Impact
Yelvertoft, Swinford and Lilbourne	Adverse Impact	Adverse Impact	Adverse Impact

Table 8 Comparison of operational impacts without radar technical mitigation

46. If the Lilbourne wind farm were to be built after the two consented wind developments it may cause additional clutter but it would not introduce a significant additional operational impact because it is situated between the other two developments; will have a smaller technical impact than either of them and there will already be a significant operational impact from the other two wind farms.

47. This net operational impact is insignificant because all three wind developments are close to the airport's approach routes and because Lilbourne is situated in between the two consented wind farms.

Wind Farm Radar Technical Mitigation

48. There are many ways of reducing or eliminating the technical effects of wind farms on radar. One possible method is to use an alternative radar source which can be a local in-fill radar or an existing radar. The diagram on the following page indicates how such a solution might work.

49. Such a solution requires an in-fill source of radar data. Sources that could be considered in this situation include:

    a) Existing Birmingham Airport Radar

    b) Local In-fill radar from Aveillant

    c) Local In-fill radar from c-speed

50. Other technical mitigation solutions that could be employed include:

a) Thruput Limited radar display processing upgrade

b) Migration of air traffic control services to Birmingham

c) Replacement of Coventry Airport PSR with a new advanced type tolerant to wind turbines (e.g Thales STAR 2000)

51. I have considered each of these possible mitigation solutions and asked myself the following questions.

52. If the solution were to be implemented to mitigate the effects of Swinford and Yelvertoft:

    a) Could it be extended to mitigate the effects of Lilbourne?

    b) Would it mitigate the effects of Lilbourne as well as it would mitigate the effects of Swinford and Yelvertoft?

    c) Would there be a requirement for additional equipment and infrastructure to extend the solution to mitigate Lilbourne?

53. The answers to these questions for each of the identified mitigation solutions are shown in the table below:

Solution	Could it be extended?	Would it work as well for Lilbourne?	Additional equipment for Lilbourne?
In-fill Birmingham	Yes	Yes	No
In-fill Aveillant	Yes	Yes	No – provided that the mitigation is initially designed to accommodate Lilbourne
In-fill C-Speed	Yes	Yes	No – provided that the mitigation is initially designed to accommodate Lilbourne
Thruput	Yes	Yes	No
Birmingham migration	Yes	Yes	No
New Coventry PSR	Yes	Yes	No

Table 9 Evaluation of extending mitigation solutions

54. Any solution to mitigate the impact of Yelvertoft and Swinford could be extended to mitigate the effects of Lilbourne.

Conclusions

55. The consented Yelvertoft and Swinford wind farms are likely to have a technical impact on the Coventry radar.

56. The proposed Lilbourne wind development is likely to have a smaller technical impact on the Coventry radar.

57. The two consented wind farms are likely to have a significant operational impact on Coventry airport.

58. The proposed Lilbourne wind farm will not increase this operational impact significantly because it lies between the two consented wind developments.

59. Any technical solution to mitigate the impacts of Yelvertoft and Swinford could be extended to mitigate the effects of Lilbourne. Extending such a solution is unlikely to require additional equipment or infrastructure.