# PLANNING FOR CLIMATE CHANGE

## *Renewable Energy Opportunities for Blaby, Harborough, Hinckley and Bosworth, Melton, North West Leicestershire, Oadby and Wigston and Rutland*

*Final Report*

*May 2008*

*ITP/1017*

# Hinckley & Bosworth Borough Council
# Rutland County Council
# Blaby District Council
# Oadby and Wigston Borough Council
# North West Leicestershire District Council
# Harborough District Council
# Melton Borough Council

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Renewable Energy Opportunities

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# 1 INTRODUCTION

The Planning for Climate Change Project was initiated to provide evidence to underpin the preparation of future planning policy relating to climate change in the following local authority areas of Leicestershire and Rutland:

- Blaby District Council
- Harborough District Council
- Hinckley and Bosworth District Council
- Melton Borough Council
- North West District Council
- Oadby and Wigston Borough Council
- Council

There are three key parts to the project:

1) Climate Change Assessment of Core Strategy Strategic Options
2) Renewable Energy Opportunities – Quantification of the potential for renewable energy in each of the seven local authority areas
3) Energy Efficiency Recommendations for New Developments - An assessment of the extent that it may be technically and economically possible to expect new buildings to reduce their carbon dioxide emissions beyond the requirements of the Building Regulations.

An executive summary summarising the project as a whole is available in a separate document.

**This report contains the findings of the second part of the project – Renewable Energy Opportunities – Quantification of the potential for renewable energy in each of the seven local authority areas.**

This report presents the findings of the assessment of the potential for large wind, hydro, biomass, solar photovoltaics, solar water heating, ground source heat pumps and small wind.

For each area the potential for renewables has been estimated, and in the case of wind, biomass and hydro suitable sites have been mapped.

The potential for building integrated renewable energy has been quantified in terms of retro fit and new build opportunities.

This information has been used to provide recommendations for policies relating to;

- renewable energy for domestic premises;
- on-site renewable energy for residential and industrial developments
- large scale commercial renewable energy developments

## 2 WIND ENERGY

The UK is fortunate in having a substantial wind resource. The current wind energy market is almost entirely large grid-connected wind farms, due to the economies of scale and the current market incentive system, the Renewables Obligation. The Renewable Obligation requires electricity supply companies to procure an increasing proportion of their electricity from certified renewable sources, rising to 10% by 2010. The Government has also recently started to encourage small wind turbine installations through its Low Carbon Building Programme.

Wind power in the UK is a mature industry, with a complex supply chain, including planning, environmental impact assessment, meteorology, electrical engineering, electricity trading, transport and assembly.

Wind turbines operate most effectively in a strong and turbulent free wind. In the built environment of several of the councils considered in this study, the presence of buildings, trees and surrounding hills means that wind speed will be reduced. This is significant as the power in the wind is proportional to the cube of the wind speed, so a 20% increase in wind speed means a 70% increase in instantaneous power.

The large and small wind turbine market today is predominately taken up by horizontal axis wind turbines (HAWT) with three blades (Figure 1). Vertical axis wind turbines are also available but these are typically smaller turbines and are used to a lesser extent (Figure 2).

**Figure 1: Large Horizontal Axis Wind Turbine (500 kW, 54m tip height) Royd Moor, Penistone.**

**Figure 2: Vertical Axis Wind Turbine (1 kW) TASSA GmbH**

Small scale wind installations (less than 15kW) have received substantial interest in the past year with new products entering the market. These smaller turbines are both for the rural and urban environment and have specific installation issues over and above those of large wind turbines (Figure 3 & Figure 4).

**Figure 3: 6 kW turbine on a 9m mast (5.5 m diameter). Townfield Head Farm, Stannington**

**Figure 4: 1.5 kW building mounted wind turbine (2 m diameter)**

## 2.1 Consultation

Large wind turbines can interfere with normal operation of airports and airfields. IT Power contacted representatives from the East Midlands Airport and from the Cottesmore RAF station for their input regarding the presence of wind turbines in the proximity of the aforementioned airfields. The key contacts are listed below in Table 1.

**Table 1: Organisations contacted for consultation on wind**

| Name and position | Organisation | Information provided |
|---|---|---|
| Ian Nowakowski, Environment Department | East Midlands Airport<br>Castle Donington<br>Derby<br>DE74 2SA<br>Tel: 0871 919 9000 | Opinion and information was provided on the issues regarding wind farms and wind turbines in proximity to the East Midlands Airport.<br><br>Potential air traffic issue and communication masts are noted relative to each site where it is likely to be an issue and could well prevent development. Air traffic and communication mast considerations typically require site specific studies to be carried out. This is typically a requirement which should be fulfilled by a developer. |
| Neil Hatfield, Safeguarding Derpartment | Defence Estates Kingston Road<br>Sutton Coldfield<br>B75 7RL<br>0121 311 3696 | Opinion and information provided on the issues regarding wind farms and wind turbines in proximity to the Cottesmore RAF station.<br><br>Wind sites in proximity to the airfield have to be submitted for a technical analysis. It' is a case-by-case analysis, as there really isn't a minimum safety distance, depends heavily on topographical features. |

## 2.2 Resource assessment

The most effective method of establishing the potential wind resource prior to any detailed monitoring is to use ETSU NOABL (National Oceanic and Atmospheric Administration (NOAA) Boundary Layer) wind speed database developed by ETSU for the DTI (Department of Trade and Industry) in 1997. This provides an estimated wind speed for a 1 km square at 10 m, 25 m and 45 m above ground level. The database uses the Ordnance Survey grid system for Great Britain which was then plotted using GIS software an example of which is presented in Figure 5.

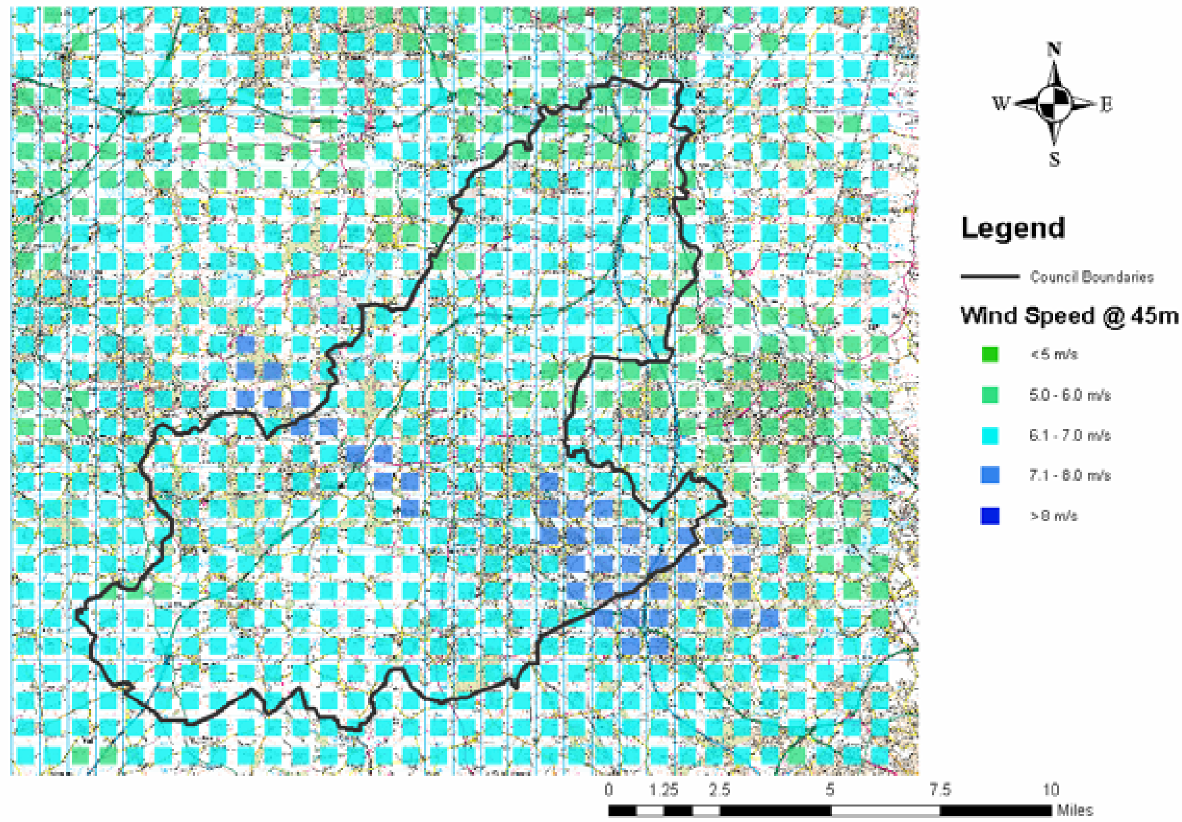


**Figure 5 - ETSU NOABL database wind speeds for Northwest District Council at 45m above ground level**

Currently in the UK an annual average wind speed of 6 metres per second (m/s) or more is generally required for a large project to be regarded as economically viable. Future changes in electricity prices and government incentives could have a considerable impact on the viability of a development.

The wind speed data in the ETSU NOABL database is the result of an air flow model that estimates the effect of topography on wind speed. There is no allowance for the effect of local thermally driven winds such as sea breezes or mountain/valley breezes or local roughness such as buildings and trees which can have a considerable effect on wind speeds. As a result the NOABL data should only be used as a guide and should be followed by on-site measurements for proper assessment, once a particular site is found to be initially feasible. However there is considerable potential for variation between NOABL and real wind speeds. A more conservative wind speed is worth adopting when estimating the amount of energy generated from small wind turbines. (see Annex 1)

## 2.3 Constraint identification and analysis

Generally the most limiting factor when identifying suitable sites for wind farm developments is whether there is sufficient wind. The space available for a wind farm development is also a limiting factor as once a buffer zone is applied around buildings there can be little land available. A buffer zone of at least 350 m between a large turbine and the nearest dwelling is recommended as at this distance the noise levels from a large turbine are generally regarded as acceptable 35-45 dB(A) [(1)]. For the purposes of this study a more conservative buffer distance of 400 m was applied to the address point data for the councils considered in this study and plotted using GIS software, the result of which can be seen in Figure 6 (North West Leicestershire District Council used as an example). This conservative distance was applied as such an approach is generally adopted by developers.

It must be noted that the address point data also contains businesses addresses, which may well tolerate slightly higher noise levels. In the identification of suitable sites, business and industrial areas were taken into consideration as well as areas located close to sources of high background noise such as the motorways.

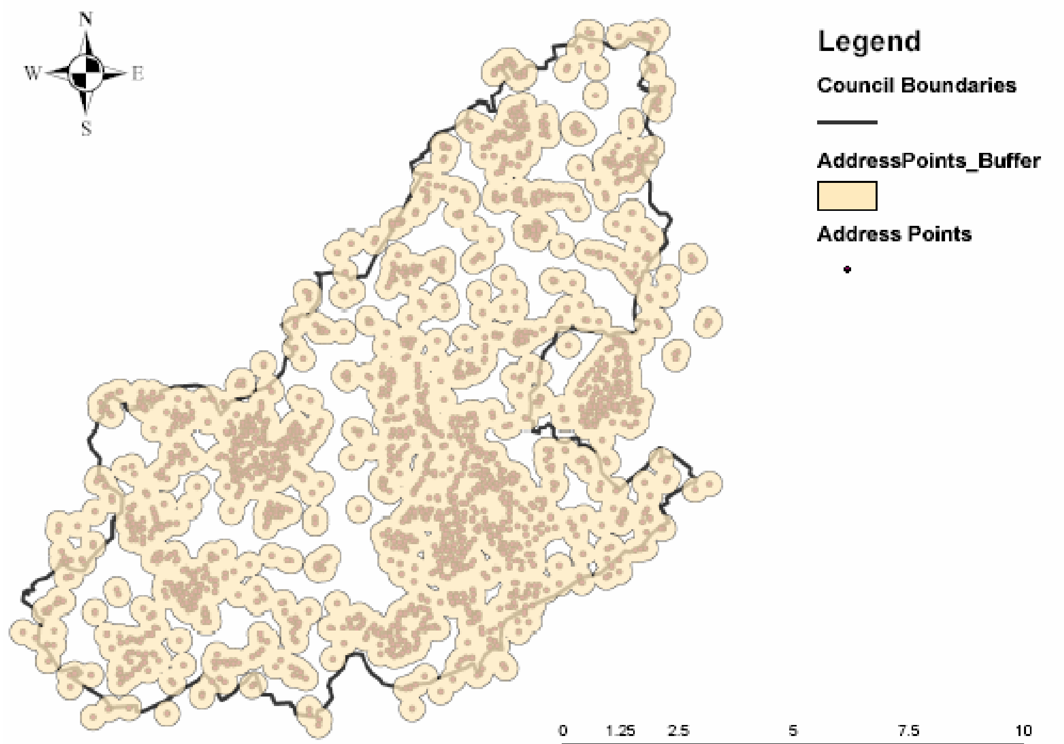


**Figure 6: Example of 400m buffer applied to address point data (North West Leicestershire District Council)**

The other constraints considered were:

- local topography
- sites of special scientific interest (SSSI's)

[1] ETSU, The assessment and rating of noise from wind farms, URN No: 96/1192, DTI September 1996

- common land
- World Heritage Sites
- topple distance to major arteries (for safety 150m (or turbine height) from major roads and railways is used)
- Air traffic and electromagnetic interference considerations
- 50 m buffer zone to footpaths (a wind farm is less likely to be approved if it blocks access to a public footpath)

**Local topography**

The lay of the land can have significant impact on the wind speed and flow. The prevailing wind in the UK is from the south west and so sites which were on the leeward side of a hill were discounted from the search. This is due to reduced wind speeds which occur on the leeward side.

**Sites of Special Scientific Interest (SSSI)**

These are sites which are important due to their flora, fauna or geology. In Planning Policy Statement 22 SSSI's are regarded as National Designations and the following policy applies:

> PPS22 states (page 13) "...planning permission for renewable energy projects should only be granted where it can be demonstrated that the objectives of designation of the area will not be compromised by the development, and any significant adverse effects on the qualities for which the area has been designated are clearly outweighed by the environmental, social and economic benefits."

Potential disruption on flora and fauna during construction of a wind farm along with the potential impact on fauna during a wind turbines operation most commonly ends in developments not being granted planning permission on SSSI's. As a result for the purposes of this study SSSI's have been discounted from the wind farm site search.

**Common Land**

Common Land can be considered for development however from a developer's perspective common land presents potential access issues and make obtaining agreement for development difficult. As a result Common Land is frequently discounted from a wind farm site search.

**World Heritage Sites**

World Heritage Sites are places of international importance for the conservation of mankind's cultural and natural heritage. In 2007, there were 851 of them, including 27 in the UK and overseas territories. Examples include the Great Wall of China, the Pyramids, the Great Barrier Reef, Venice and the Tower of London. World Heritage Sites are places that need to be preserved for future generations, as part of a common universal heritage. Buffer zones are usually applied around these sites as wind turbine developments would impact upon the visual amenity in the area. No sites were identified within the study area.

**Air traffic and communication masts**

Wind energy developments may cause adverse impacts on aircraft flight safety and radar use for air traffic control and aircraft instruments. Early consultation between developers and statutory authorities can help with siting and mitigation measures.

The movement of a wind turbine can interfere with radar as it may be interpreted as a moving object. This could cause it to be mistaken for an aircraft or reduce the ability to track aircraft by radar in the vicinity of a wind energy development.

Developers will need to consult with radar operators if a proposal falls within a 15km consultation zone, or the 30-32km advisory zone around both civil and military air traffic radar, respectively. New figures from the British Wind Energy Association (BWEA) show that the Ministry of Defence objected to 48% of pre-applications to build onshore wind turbines last year, up from 34% in 2002.

The British Wind Energy Association website combines a proforma to aid consultation with stakeholders. This form will include relevant wind turbine details, such as number of blades and wind turbine hub height and rotor diameter. Developers should use this: www.bwea.com/aviation.

For the purposes of this study, consideration was given to the East Midlands Airport (located in North West Leicestershire) and the Royal Air Force Cottesmore station (located in Rutland).

Coventry Airport was also taken into account, the 15km and 30 km buffer zones used are shown in Annex 2a. Other smaller airfields such as smaller commercial airports (Tollerton and Langar) and recreation airports (Saltby within Melton) were considered to a lesser extent.

More detailed advice can be found in the following resources:

***DTI AMS Feasibility Study, June 2005:***

www.dti.gov.uk/renewables/publications/pdf/windenergyaviation.pdf

***Wind farm impact on aviation radar interests DTI:***

www.dti.gov.uk/energy/page18050.html

***Wind energy and aviation interests: an interim guide, DTI:***

http://www.dti.gov.uk/files/file17828.pdf?pubpdfdload=02%2F1287

In total 24 possible sites were potential identified. The following sections provide a breakdown of the sites considered for each local authority. The sections include comments on each site regarding issues that could present a problem in their development. Annex 2 indicates the locations of the potential sites identified. For the purpose of this study it is assumed that the wind turbines (referred to as 'large wind turbines') that could potentially be installed would be 2 MW wind turbines.

It should be noted that the sites presented below were found to be suitable according to the above described desk based methodology. This provides a useful estimate of the potential for wind energy in each local authority. This report does not recommend excluding other sites identified by developers or land owners, nor does it guarantee that the sites lists will be suitable for development – further analysis and investigation will be required.

## 2.4 Hinckley & Bosworth Borough Council

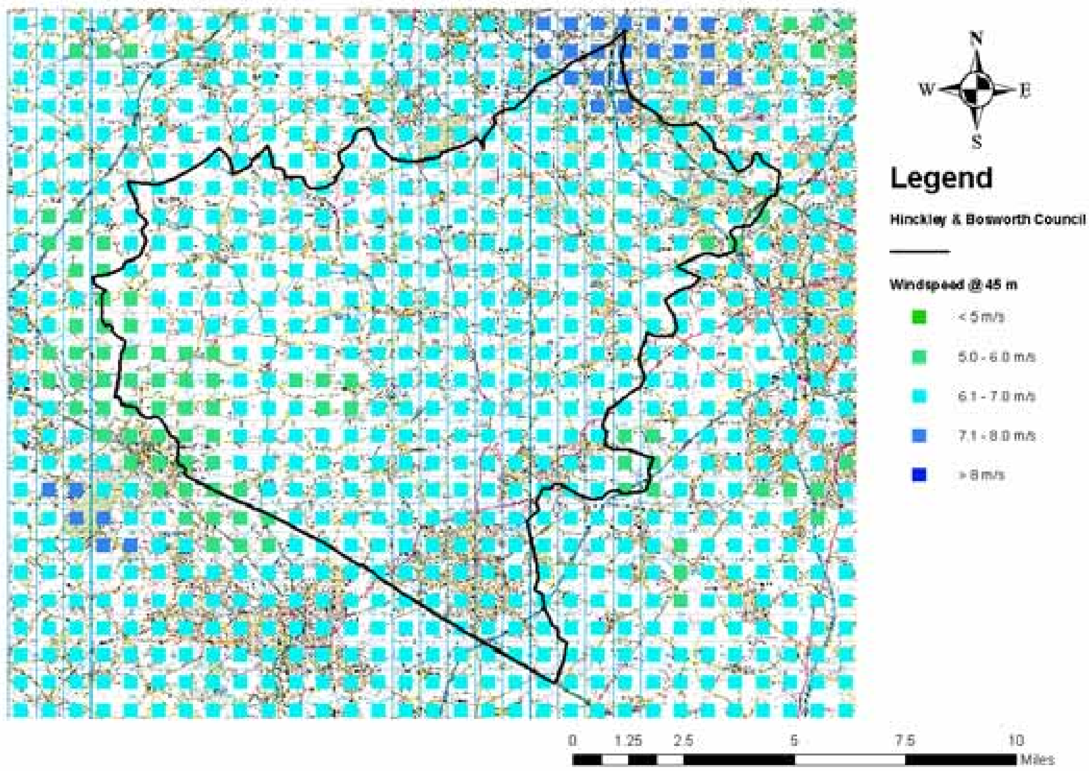


**Figure 7 - ETSU NOABL database wind speeds for Hinckley & Bosworth Borough Council at 45m above ground level**

With the exception of the area near Atherstone, Hinckley and Bosworth Borough Council also offers very good wind resource and 3 potential sites for large wind turbines were found and listed in Table 2.

**Table 2 - Sites considered for large wind turbines.**

| Ref | Name | Easting | Northing | NOABLE Wind speed @ 45m m/s | Potential | Capacity (MW) | Comment |
|---|---|---|---|---|---|---|---|
| W10 | Congerstone | 438442 | 305276 | 6.3 | Medium | 4 MW | Site near Congerstone potentially suitable for 2 wind turbines. Difficult access and the presence of wood on the west side to present an obstacle for the wind flow. |
| W11 | Twycross | 435129 | 304171 | 6.3 | High | 6 - 8 MW | Site located about 2 km from Twicross. Proximity to the A444 could facilitate access. Suitable for up to 4 wind turbines |
| W12 | Barton in the beans | 439842 | 307002 | 6.4 | High | 2- 4 MW | Small site, suitable for 1-2 large wind turbines. |

In total these sites would provide an estimated 35 040 MWh per year, sufficient for 7 455 homes.

## 2.5 Rutland County Council

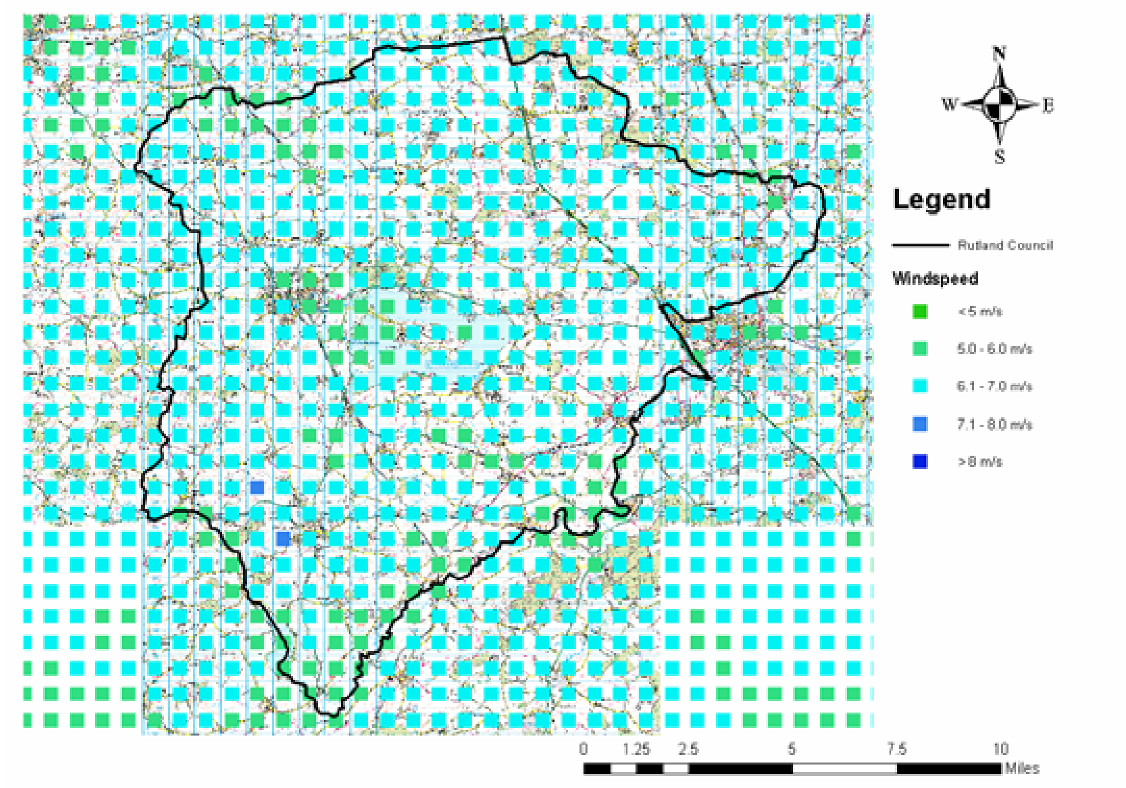


**Figure 8 - ETSU NOABL database wind speeds for Rutland County Council at 45m above ground level**

Cottesmore RAF station is located in northern Rutland County Council, near Market Overton. This created as restricting factor for potential wind farm sites in the surrounding area, as wind turbines could present air traffic issues. The most import issues are whether turbines present an obstacle for aircraft or whether they would be picked up on radar. Areas considered as Sites of Special Scientific Interest (SSSIs) were also taken into account, namely the Rutland Water area and the Eyebrook Reservoir.

The sites found are presented below in Table 3.

## Table 3 - Sites considered for large wind turbines in Rutland

| Ref | Name | Easting | Northing | NOABLE Wind speed @ 45m m/s | Potential | Capacity (MW) | Comment |
|---|---|---|---|---|---|---|---|
| W19 | Belton-in-Rutland | 480342 | 301623 | 6.1 | High | 4 - 6 MW | Near the western boundary of Rutland council, this site would be suitable for 2-3 wind turbines. |
| W20 | Wardley | 482695 | 301227 | 6.5 | Medium | 4 - 8 MW | Site located between Belton-in-Rutland and Wardley and suitable for 2-4 wind turbines. Footpaths could be an issue for planning and reduce the available area for wind turbines. |
| W21 | Prestley Hill | 488809 | 297505 | 5.9 | Medium | 8 – 10 MW | Site located between Lyddington and Seaton. Fairly large site for wind turbines, suitable for 4-5 wind turbines. |
| W22 | Ashwell | 484421 | 321624 | 6.1 | Low | 6 MW | Site near Langham, suitable for up to 3 wind turbines. Proximity to the RAF Cottesmore Airfield (around 6km) means would have to be subjected to technical analysis to assess possible interference with airfield operation. |

In total these sites would provide an estimated 52 560 MWh per year, sufficient for 11 183 homes.

## 2.6 Blaby District Council

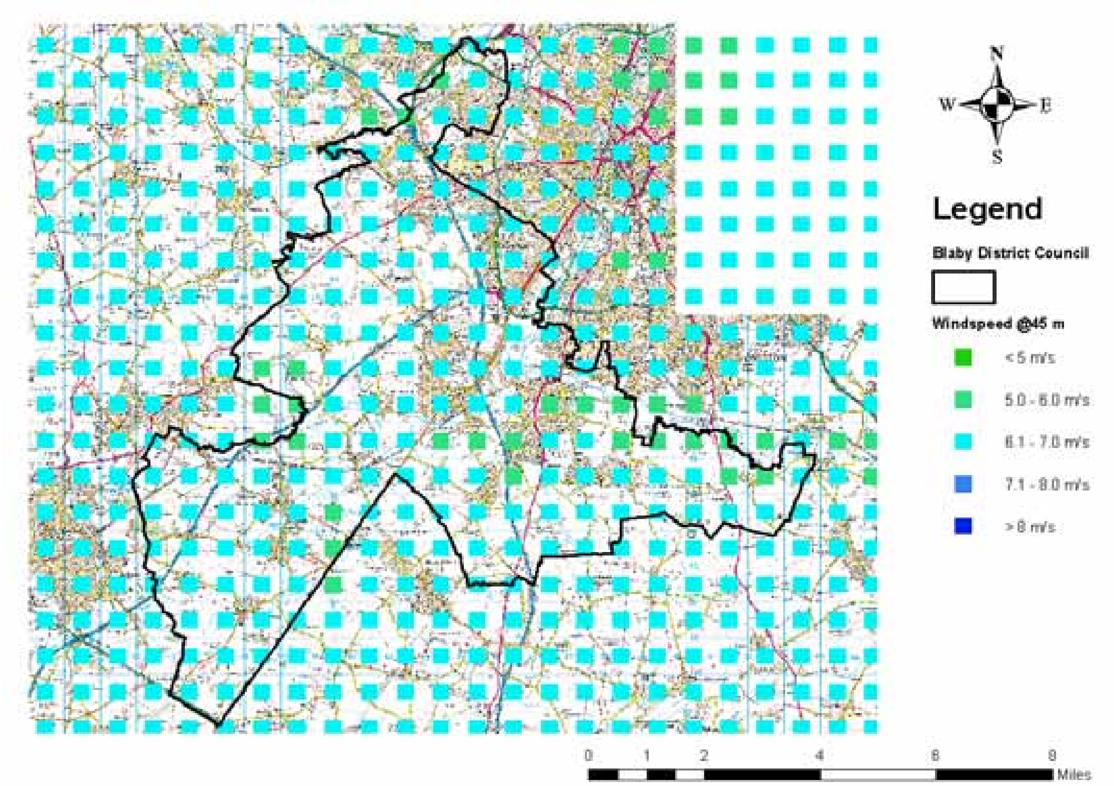


**Figure 9 - ETSU NOABL database wind speeds for Blaby District Council at 45m above ground level**

Blaby District has an average wind speed of 6-7m/s (at 45 m above ground level) across most of its area. This is considered to be a good resource for large scale wind turbine installations. However Blaby District has a high population density, partly due to its proximity to the City of Leicester. The high population density combined with a buffer zone of 400m around address points substantially limits the number of potential large scale wind sites in this District, with only one suitable site being found (Table 4).

**Table 4 - Site considered for large wind turbines.**

| Ref | Name | Easting | Northing | NOABLE Wind speed @ 45m m/s | Potential | Capacity (MW) | Comment |
|---|---|---|---|---|---|---|---|
| W1 | Enderby | 451639 | 300127 | 6.5 | High | 4 - 6 MW | Site approximately 2 km from Enderby. This site has an altitude of 100m and there are no topographical features which would shelter the site from the prevailing south westerly winds. Suitable for 2-3 large wind turbines. |

In total these sites would provide an estimated 13 140 MWh per year, sufficient for 2 796 homes.

## 2.7 Oadby and Wigston Borough Council

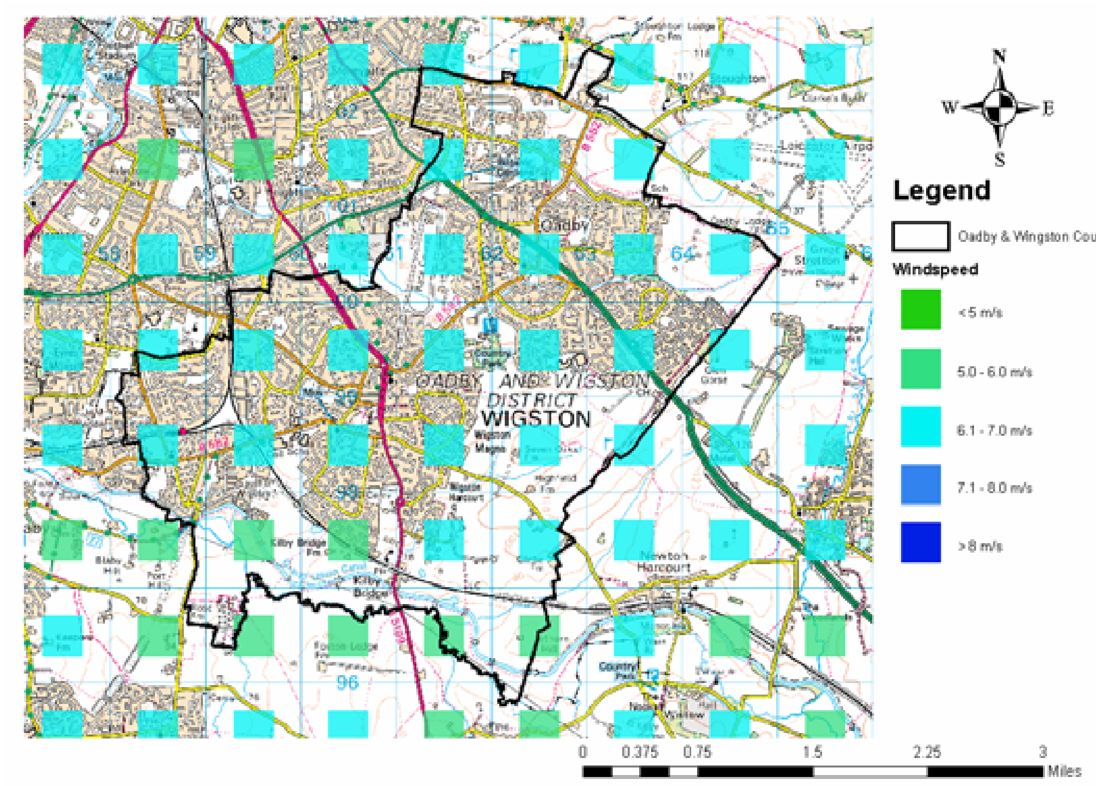


**Figure 10- ETSU NOABL database wind speeds for Oadby and Wigston Borough Council at 45m above ground level**

Oadby and Wigston Borough Council is relatively small in terms of area (approximately 23.52 Km2) and is it also has very high population density. As a result, the remaining available area for potential large wind turbines was very limited. Only one suitable site was found for this council, this is presented in Table 5.

**Table 5 - Sites considered for large wind turbines.**

| Ref | Name | Easting | Northing | NOABLE Wind speed @ 45m m/s | Potential | Capacity (MW) | Comment |
|---|---|---|---|---|---|---|---|
| W18 | Tythorn Hill | 462265 | 296395 | 6.0 | Medium | 2 - 4 MW | Site close to the Oadby & Wingston south boundary. Suitable for 1-2 large wind turbines, although access could be an issue due to the lack of major roads nearby and the proximity of the Grand Union canal. |

In total these sites would provide an estimated 8 760 MWh per year, sufficient for 1 864 homes.

## 2.8 North West Leicestershire District Council

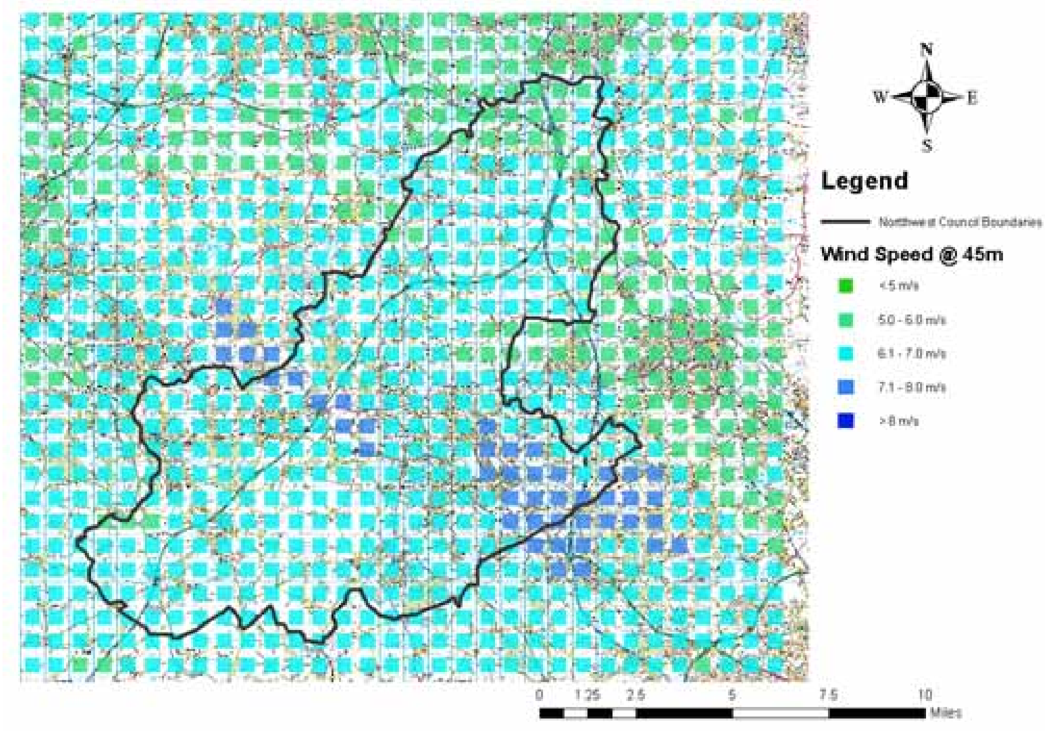


**Figure 11 - ETSU NOABL database wind speeds for North West Leicestershire District Council at 45m above ground level**

The East Midlands Airport is located in the North West Leicestershire District Council. This presents a significant obstacle for the siting of large wind turbines, which may interfere with the normal operation of radar systems and air traffic control. Therefore the identified potential sites were eliminated because of proximity to the airport.

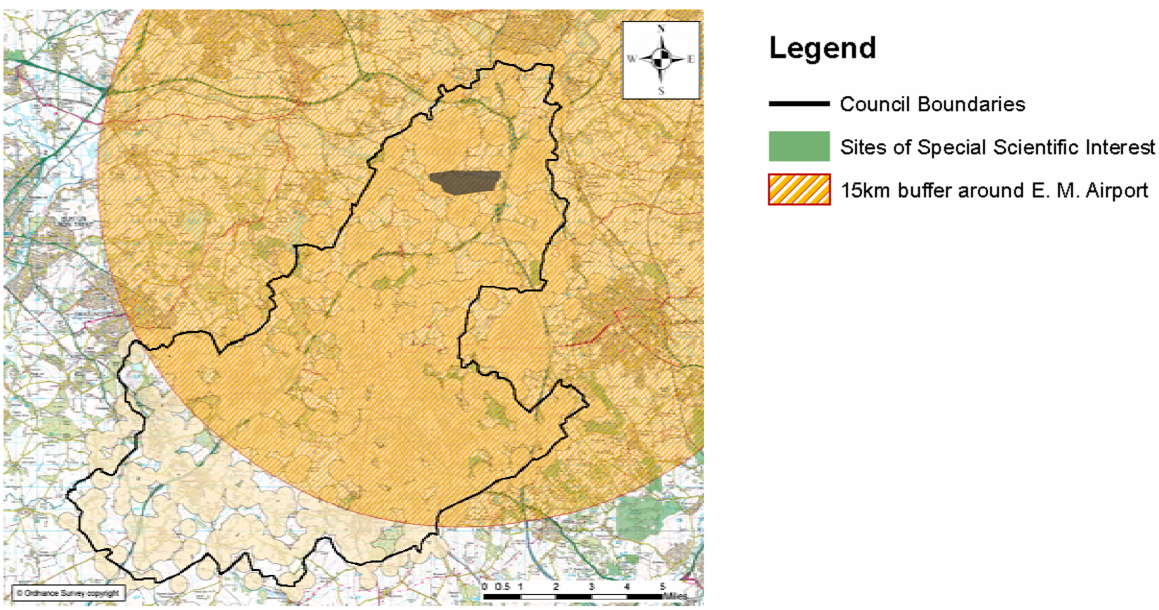


**Figure 12 - Location of the East Midlands Airport (North West Leicestershire District Council)**

**Table 6 - Sites considered for large wind turbines in North West Leicestershire, later eliminated because of proximity to the airport**

| Ref | Name | Easting | Northing | NOABLE Wind speed @ 45m m/s | Potential | Capacity (MW) | Comment |
|---|---|---|---|---|---|---|---|
| W23 | Appleby Parva | 431913 | 308114 | 6.5 | Low | 6-8 MW | Site south of Appleby Parva. Considerable available area which would be suitable for 3-4 large wind turbines. Falls within the 30km advisory zone around East Midlands Airport and lacks appropriate access. |
| W24 | Snarestone | 436136 | 308389 | 6.3 | Low | 4 - 6 MW | This site is also under the 30km advisory zone around East Midlands Airport. Difficult access and footpaths nearby also contribute for the low potential for this site. |

## 2.9 Harborough District Council

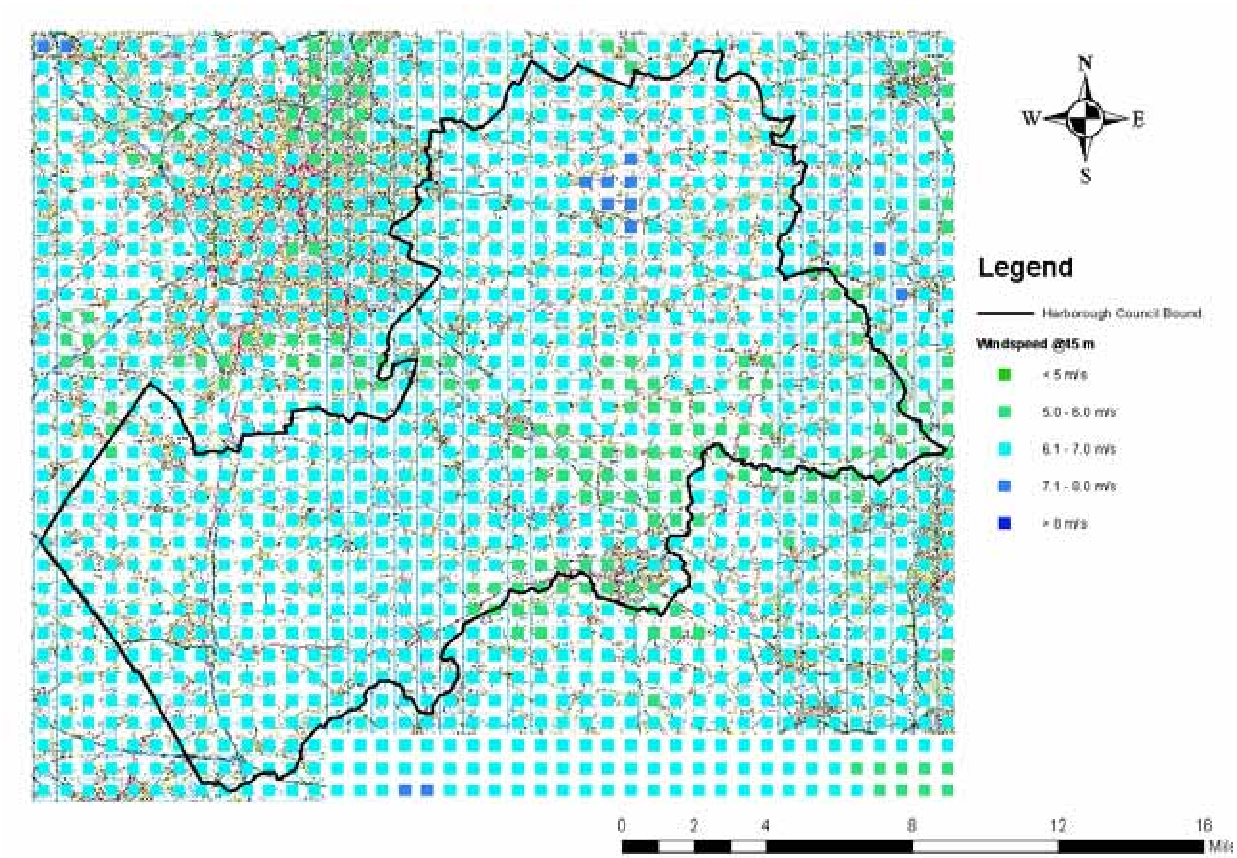


**Figure 13- ETSU NOABL database wind speeds for Harborough District Council at 45m above ground level**

Harborough District offers greatest potential for wind energy out of the 7 authorities. With average wind speeds of at least 6.0m/s in most of the district, there is a good wind resource as well as available area available for siting of larger wind turbines. 8 potential sites were identified which are listed below in Table 7.

**Table 7 -Sites considered for large wind turbines.**

| Ref | Name | Easting | Northing | NOABLE Wind speed @ 45m m/s | Potential | Capacity (MW) | Comment |
|---|---|---|---|---|---|---|---|
| W2 | Hovel Hill | 459192 | 282035 | 6.3 | Medium | 6 - 8 MW | This site, located around 2 km from South Kilworth, offers quite a large area large wind turbines. Site access could present a problem. Suitable for 3-4 turbines. Falls within the 30 km advisory zone around from Coventry Airport. |
| W3 | Theddingworth | 464317 | 285687 | 6.5 | Low | 4 - 6 MW | This site's relative proximity to Husbands Bosworth could present a problem. Grand Union canal could also make access more difficult. Suitable for 2-3 turbines. |
| W4 | Laughton | 466847 | 288736 | 6.7 | High | 2 MW | Small site could be considered for a large single turbine. |
| W5 | Foxton | 470392 | 290936 | 6.1 | Medium | 6 - 8 MW | Site located Foxton and the A6 road and suitable for 3-4 wind turbines. Footpaths could be an issue for planning and reduce the available area for wind turbines. |
| W6 | Saddington | 465049 | 290887 | 6.3 | Medium | 2 - 4 MW | Site suitable for 1-2 large wind turbines. Footpaths could present a problem for this site. |
| W7 | Thorpe Langton | 474887 | 293213 | 6.1 | Medium | 4 MW | Suitable site for 2 large wind turbines, spoiled by irregular topography features |
| W8 | Glooston | 474240 | 297049 | 6.3 | Low | 6 MW | Located around 1,5 km from Foxton. Suitable to up to 3 wind turbines. Layout for the turbines should take into account Stonton Wood, which could shelter the site from south west winds. |
| W9 | Hallaton | 476204 | 269599 | 6.2 | Medium | 2 - 4 MW | Suitable site for 2-3 wind turbines, marred only by possible access problems. |

In total these sites would provide an estimated 65 700 MWh per year, sufficient for 13 980 homes.

## 2.10 Melton Borough Council

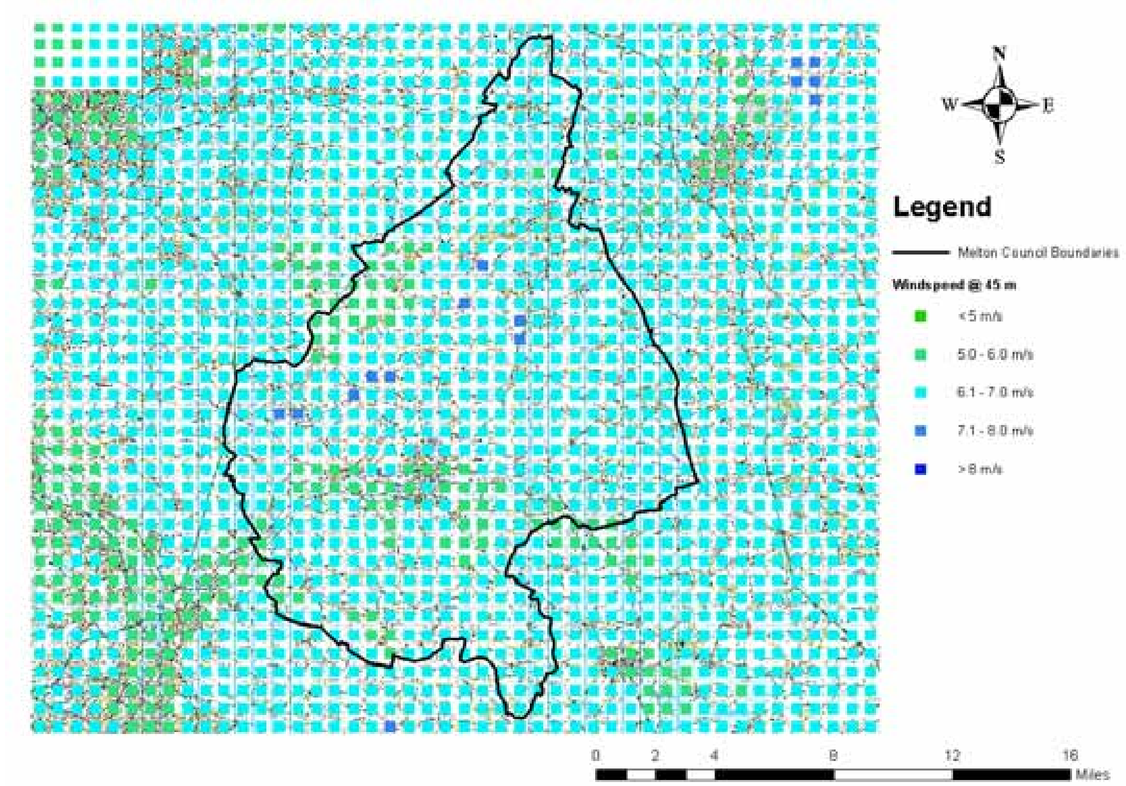


**Figure 14 - ETSU NOABL database wind speeds for Melton Borough Council at 45m above ground level**

Melton Borough Council offers very good potential for wind energy generation, looking solely from the perspective of wind speeds. However, proximity to the Cottesmore RAF station (in Rutland) poses as a limiting factor for potential wind turbines in the southern area of the council.

**Table 8 - Sites considered for large wind turbines.**

| Ref | Name | Easting | Northing | NOABLE Wind speed @ 45m m/s | Potential | Capacity (MW) | Comment |
|---|---|---|---|---|---|---|---|
| W13 | Nether Broughton | 469587 | 327295 | 5.9 | High | 6 - 8 MW | Site near Melton Council boundary, near Nether Broughton. Access could present a problem for this site. Suitable for 3-4 wind turbines. |
| W14 | Saltby (disused airfield) | 486562 | 326329 | 6.9 | Low | 4 MW | Disused airfield which could potentially be used as a site for 2 wind turbines. Within relative proximity to the RAF Cottesmore Airfield. |
| W15 | Garthorpe | 482599 | 321505 | 6.4 | Low | 8 - 10 MW | Large site near Garthorpe, suitable for up to 5 wind turbines. Proximity to the RAF Cottesmore Airfield means would have to be subjected to technical analysis to assess possible interference with airfield operation. |
| W16 | Burton Lazars | 479281 | 316556 | 6.1 | Low | 6 - 8 MW | Site located around 2 km from Burtons Lazars. Within relative |

| Ref | Name | Easting | Northing | NOABLE Wind speed @ 45m m/s | Potential | Capacity (MW) | Comment |
|---|---|---|---|---|---|---|---|
| | | | | | | | proximity to the RAF Cottesmore Airfield which could raise some technical issues. Suitable for 2-3 wind turbines. |
| W17 | Pickwell | 480271 | 311395 | 6.6 | Low | 6 - 8 MW | Site with irregular topography, further inspection needed. Also, Within relative proximity to the RAF Cottesmore Airfield which could raise some technical issues. If found suitable, 2-3 wind turbines could be installed. |

In total these sites would provide an estimated 65 700 MWh per year, sufficient for 13 979 homes.

# 3 HYDRO

## 3.1 Introduction

The seven local authority areas being considered in this study are predominantly low-lying with either flat or moderately undulating topography. Annual rainfall in the area is relatively low, varying between 700 and 900 mm, typical for the East Midlands. Potential evaporation is between 450 and 525 mm annually, which is higher than much of the UK and means that average flows in water courses are below the average for the country.

The scope for hydropower is therefore much less than in some other parts of the UK. Evaluation of the 7 Districts has shown some potential for small-scale hydropower (projects of 1-2 MW capacity and below) but only at a limited number of sites.

## 3.2 Small hydro

Although there is still no internationally agreed definition of 'small' hydro, the upper limit is usually taken as 1-2 MW in the UK. The projects of interest to this study are in this range and have specific technical characteristics that warrant their own definition:

- mini-hydro = schemes below 1 MW
- micro-hydro = between 5 kW and 100 kW
- pico-hydro = below 5 kW

The situation with the small hydropower sector in the UK is that projects are on a very different scale to the larger hydro projects (which total about 1,500 MW mostly from dam schemes in Scotland and Wales) - there are about 150 small hydro projects (between 80 kW and 10 MW) but only totalling about 200 MW capacity. England and Northern Ireland have the most small hydroelectric projects but their total contribution is only 0.05% of the UK's electricity supply.

Estimates vary on the remaining potential for small hydro power, from about 300 to 700 MW of plants less than 10 MW[2] with an additional 500 MW existing for low-head hydro schemes of heads less than 3 metres[3]. However, not more than a half of this total is thought to be economically exploitable and there still remain some constraints to developments due to environmental and social/planning issues.

But although the UK's potential for small hydro power is quite limited compared to other countries, if all the streams and rivers in the UK could be tapped for small hydro generation it would be possible to produce 10 000 GWh of energy per year - enough to meet over 3% of total electricity needs, a 60 fold increase on the present energy capture.[4]

Lately there has been renewed interest in small hydropower and a growing number of pico-, micro- and mini-hydro projects are being developed. This is being driven partly by UK government policies, such as the 2003 Energy White Paper and 2006 Micro-Generation Strategy, but mainly by the value of electricity sales from grid-connected hydro due to the price that the Renewable Obligation (RO) gives and the growing base-price of electricity.

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[2] http://www.small-hydro.com/index.cfm?Fuseaction=countries.country&Country_ID=79

[3] S. Batley, 1996

[4] http://www.ecocentre.org.uk/resources/hydro.htm

## 3.3 Assessment Procedure

The hydro assessment process used in this study included:

- Detailed investigation of Ordnance Survey maps (nos. 128, 129, 130, 140, 141).
- Review of all Leicestershire sites identified in the Salford University 1989 Study 'UK small hydro potential'.
- Prepare a list of the sites found to have initial potential from the Salford Study and investigation of maps (this is usually indicated by rivers either with; a weir, sluice, reservoir or previous study undertaken).
- Average flow sampling and head analysis for rivers of interest.
- Site visits to initial sites with potential of 5 kW capacity and above (in total, 30 site visits were made - see Table 1).
- Ranking of identified sites based on development potential, grid connection and site owner interest.
- Hydrological analysis for the highest ranked sites using EA gauging data.
- Identification of staff at the EA responsible for Water Resource Management and Development Control and discussion with them of sites that could be developed.
- Summarize the hydro generation that could be practically developed, listing total capacity (MW), annual generation (MWh) and outline of the schemes.

## 3.4 Overview of hydro potential

There is no existing hydropower developed in Leicestershire and the nearest significant scheme is a 1.676 MW hydro plant at Beeston Weir on the River Trent in Nottinghamshire (see the Figures below).

Generally, the very low potential for sites means that Leicestershire has traditionally not been a recommended area for modern hydropower development.

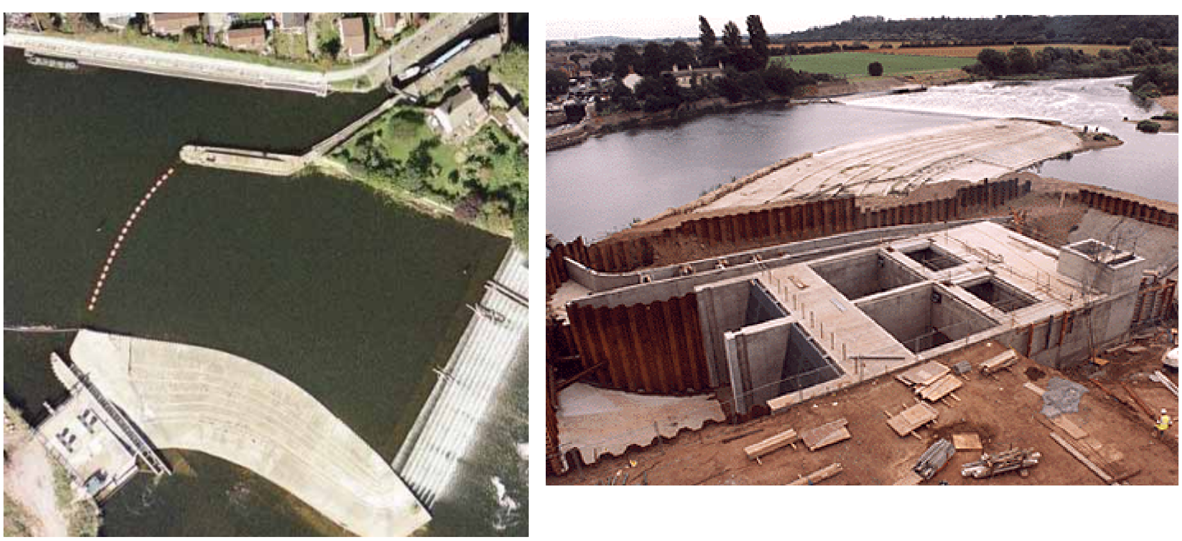

**Figure 15: Beeston Hydro Scheme installed and during construction (1999)**

According to a previous study[5], the technically feasible resource from all sites in the county with a head of more than 1.5 m is 5.5 GWh / year. For comparison, this is what the Beeston Weir project alone generates in a good year.

Also, this figure includes the Charnwood Borough which is not included in this study and was seen to have the best hydro resource of all the Leicestershire Districts (see Figures and Table below).

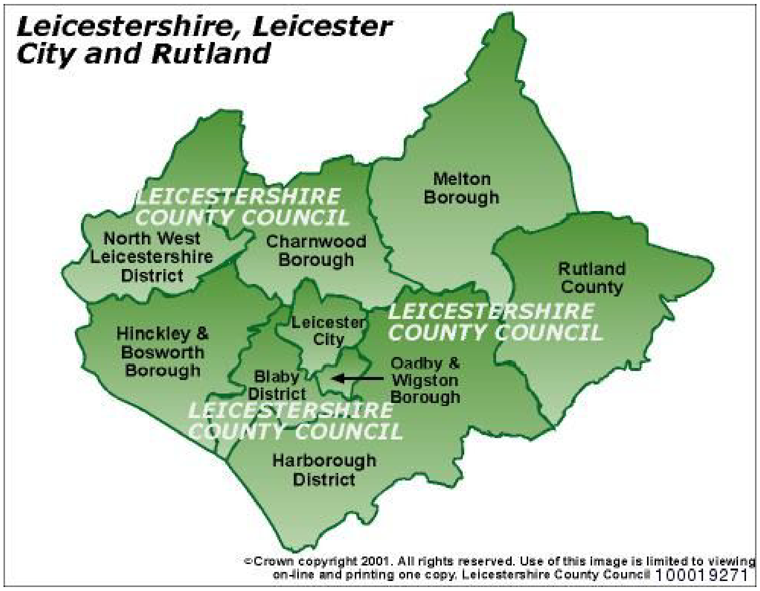


**Figure 16: District Map of Leicestershire**

The sites that have been identified in the whole of Leicestershire in the past are few, as listed below, and only 2 are in the study area:

**Table 9: Previously identified potential hydro sites in Leicestershire**

| Sites with minimum 1.5 m head | District |
|---|---|
| Barrow Lock, Soar | Charnwood |
| Sawley Locks / Weir, Trent | North West Leicestershire |
| Red Hill Farm, Soar | North West Leicestershire |
| Cotes Mill, Soar | Charnwood |
| Mountsorrel (3 sites), Soar | Charnwood |
| Pillings Lock, Soar | Charnwood |

[5] East Midlands Resource Study - Hydro module, Mark Allington ETSU, Draft 1995, ETSU SSH 4063; Small scale hydroelectric generation potential in the UK, 1989; Viewpoints on Sustainable Energy in the East Midlands, March 2001.

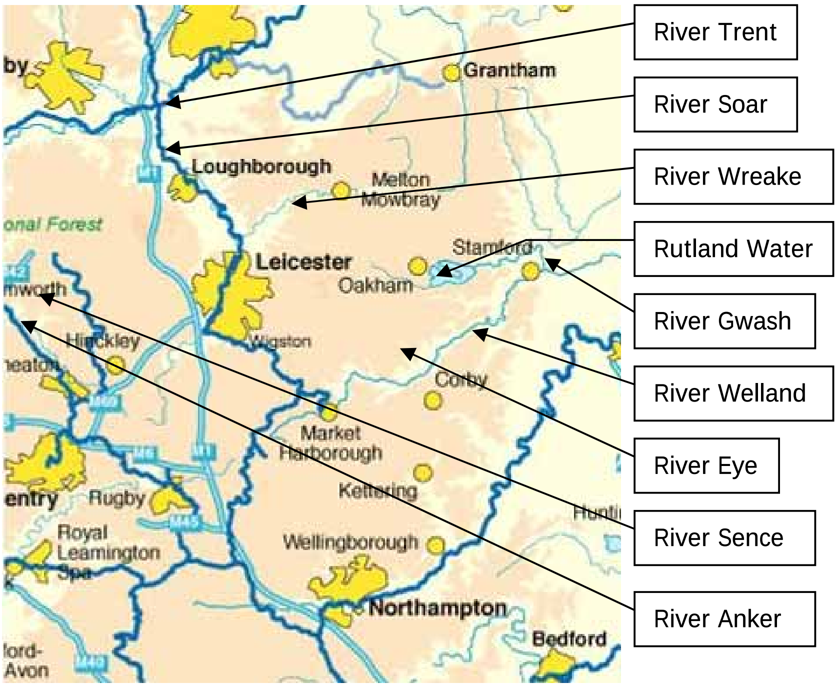


**Figure 17: Hydrological map of Leicestershire**

The dark blue line in the Figure above are navigable rivers or canals, and the latter in this area cannot generally be used as they either have no vertical differential along them or their flow is too low.

The lighter blue lines are the main rivers (smaller ones such as the Eye and Sence are not marked but their location is indicated with arrows).

## 3.5 Consultation

There are several organisations that would need to be involved in any hydro-electric projects proposed for the 7 districts, particularly for the regulatory or statutory consultation aspects of any development. Some of these have been contacted, as shown in the Table below.

**Table 10**: **Organisations contacted for small hydro developments**

| **Organization** | **Contact** | **Address / Phone No.** | **Notes** |
|---|---|---|---|
| Environment Agency – East Midlands Office | Margaret Neill – Water Resources Regulatory Officer | Nottingham Office – 0115 846 3646 | Consulted on ownership of weirs on the River Trent and River Soar |
| Environment Agency – Anglia Office | Dan McCauly – Development Control Officer | Bedford Office – 01480 483039 | Contact for consultation on developments near to a water course in the Anglian region, including hydropower |
| British Waterways | Richard Wylie – Engineer | Newark office – 01636 704481 | Consulted on use of locks and weirs along the River Trent and River Soar |
| British Waterways | Dave Parrett – Lockkeeper | Sawley Cut Lock – 07717 802543 | Consulted on actual drops across locks on the River Trent and River Soar |
| Anglian Water | Rutland Water Pumping Station | 08457 145145 | A new pumping station with standby generator plant is being planned below Rutland Water for new water supplies. Planning permission (FUL/2007/1041) has been granted but there do not seem to be any plans for energy recovery. |

## 3.6 Constraints analysis

There are eight main constraints on the selection of potential sites in the overall resource assessment carried out for the development small-scale hydroelectric generation:

1. Head – the power capacity of a potential hydro site depends crucially on the vertical drop of water at the site (creating water pressure). Although the water flow is also an important parameter, there is a minimum 'head' that is typically acceptable for the viable development of small hydro resources in the UK. The figure is about 1 metre of vertical drop. In reviewing the potential sites in Leicestershire, the most important constraint was to only look at sites with 1 m of head or above and to consider sites with 3 m and above as strong candidates.
2. Access – the second most important constraint is access to the potential hydro site. Although pico-hydro equipment can be small and even portable, in most small hydro power developments, there is a need for construction equipment to reach the site, especially for the civil works. Therefore a site should ideally have vehicular access.
3. Land availability – related to access, particularly for hydro sites in built-up areas, the availability of land for construction of the powerhouse is a crucial concern, as many potential (riverside) sites may not have any immediately available land for the plant.
4. Grid connection – as the current development of small hydro in the UK is primarily for connection to the grid, to either offset the site building's electrical demand and/or to sell the electricity generated, the site should have proximity to a grid connection point.
5. Flow – as basic flows are already known from published hydrological studies for the main waterways in the 7 Districts, initial resource assessment has only considered those rivers and streams (which display a low head potential) with mean flows of about 500 litres/sec (or 0.5 $m^3/s$), which would give at least a reasonable 'pico-hydro' level capacity (5-10 kW) at low heads. For higher head sites seen at some reservoirs, the flow rate can be less for the same potential installed capacity.
6. Environmental impacts – there are numerous potential environmental concerns for hydropower developments, and within built-up areas the important ones will be visual and noise impacts (particularly during construction), and concerns about impacts on fisheries and other aquatic animals, which would have to be answered to the Environment Agency and English Nature if a project was to seek development.
7. Climate Change - Climate Change is likely to increase the instances of high river flows and flood risks especially during winter months. Run of river hydro schemes where the head is due to a weir will see reduced generation output at periods of high flows as the head available will be reduced. Where power houses are at risk of flooding they should be made water-tight. In summer months there could well be reduced flow so reducing potential generation.
8. Listed structures - Certain weirs may be within the cartilage of listed buildings. This could well prevent, restrict or imposed certain requirements on a hydro development.

## 3.7 Resource Assessment

In addition to those already listed (in Table 10 above), the sites that were identified for initial study are shown in Table 11 below. There were no potential sites identified in Blaby District or Oadby & Wigson Borough while Leicester City and Charnwood District are not in the original area of study.

Because rivers are often natural boundaries, many of the larger sites on the Trent and Soar form the border between Derbyshire and Charnwood District, nevertheless they have been included, as some of the hydro plant infrastructure may lie within the Districts in question.

**Table 11: Summary of potential small hydro sites for initial consideration**

The sites visited were prioritised by their initially assessed potential and are shown shaded; photos from these sites are in Annex 1.

| District | # | Location | River/Stream | Head (m) | Weir? | Estimated Mean Flow ($m^3/s$) | Estimated Power (kW) | Grid Ref | Ownership | Potential | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Melton** | 1 | Brooksby | River Wreake | 1.2 | Yes | 1.6 | 15 | 669 164 | Private house | Low | |
| | 2 | Frisby | River Wreake | 0.9 | Yes | 1.6 | 11 | 686 178 | Private business | Low | |
| | 3 | Kirby Bellars | River Wreake | 1 | Old lock | Diverted river | 0 | 719 181 | Field? | Zero | |
| | 4 | Knipton Reservoir | River Devon | ? | Yes | Too small | 0 | 818 308 | Estate? | Zero | |
| | 5 | Melton Mowbray | River Wreake | Zero | No | 1.4 | 0 | 750 189 | In town | Zero | |
| | 6 | John o'Gaunt | River Wreake trib. | 1 | No | Too small | 0 | 735 094 | Road | Zero | No grid |
| **NW Leicester-shire** | 7 | Ratcliffe Power Station Weir (Cranfleet) | River Trent | 3.2 | Yes | 65 (NB. large power station abstraction) | 1,000 | 496 310 | Network Rail | Medium | Flood prone site |
| | 8 | Trentlock | Erewash Canal | 1.6 | No | Too small | 0 | 489 312 | Business premises | Zero | On border |
| | 9 | Red Hill Farm | River Soar | Low | Yes | 12.5 | 0 | 491 303 | British Waterways | Zero | Now a flood lock |
| | 10 | Sawley Cut Weir | River Trent | 1.7 | Yes | 53 | 625 | 467 310 | British Waterways | Medium/Low | |
| | 11 | Kings Mills | River Trent | 0.8 | Yes | 52 | 310 | 416 275 | Hotel | Low | Weir derelict |
| | 12 | Ratcliffe on Soar | River Soar | 1.5 | Yes | 12.5 | 150 | 493 288 | British Waterways | Medium | |
| | 13 | Kegworth Weir | River Soar | 3.8 | Yes | 12 | 300 | 490 268 | Private houses | High | |
| | 14 | Stanton Harold Weir | | ? | Yes | Too small | 0 | 380 215 | National Trust | Zero | |

| District | # | Location | River/Stream | Head (m) | Weir? | Estimated Mean Flow ($m^3/s$) | Estimated Power (kW) | Grid Ref | Ownership | Potential | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Hinckley & Bosworth** | 15 | Sibson Mill | River Sence | 1 | No | 1.1 | 0 | 345 025 | Private house | Zero | River diverted |
| | 16 | Sheepy Magna | River Sence | 1.2 | Yes | 1.1 | 10 | 328 015 | Private flats | Medium/Low | |
| | 17 | Alder Mill | River Anker | 1 | Yes | 3 | 16 | 307 994 | Private house | Low | No headrace |
| **Har-borough** | 18 | Claybrooke Magna | Upper River Soar | 4 | Mill | Small | Has waterwheel | 499 891 | Private Mill | Low | Existing waterwheel with milling |
| | 19 | Allexton Mill | Eye Brook | 1.2 | No | 0.3 | 3 | 819 005 | Private house | Low | |
| | 20 | Bosworth Mill Farm | canal from Welford Reservoir | 4-5 | No | Small | 4 | 630 824 | Private farm | Low | |
| | 21 | Mill Farm – Stonton Wyville | River Welland | ? | ? | Too small | 0 | 735 948 | Private? | Zero | River diverted |
| | 22 | Loddington Mill | Eye Brook | ? | ? | Too small | 0 | 780 015 | Private? | Zero | River diverted |
| **Rutland** | 24 | Eyebrook Reservoir | Eye Brook | 20 | Yes | 0.23 | 30 | 855 942 | Anglian Water | Low | Used water supply |
| | 25 | Caldecott Mill | Eye Brook | 1 | Yes | Too small | 0 | 867 935 | Garage business | Zero | |
| | 26 | Gretton Weir | River Welland | 2.5 | Yes | 1.9 | 37 | 888 948 | EA | Low | No grid |
| | 27 | Barrowden Mill | River Welland | 1.4 | Yes | 2.1 | 23 | 947 999 | ? | Low | Derelict site |
| | 28 | Duddington Mill | River Welland | 1.3 | Yes | 2.3 | 20 | 985 009 | Private Mill | Medium | |
| | 29 | Tinwell Mill | River Welland | 1.1 | Yes | 2.9 | 0 | 008 062 | Private house | Zero | Derelict headrace |

| District | # | Location | River/Stream | Head (m) | Weir? | Estimated Mean Flow ($m^3/s$) | Estimated Power (kW) | Grid Ref | Ownership | Potential | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30 | Ketton Mill | River Chater | ? | No | 0.5 | 0 | 983 043 | Private house | Zero | Derelict headrace |
| | 31 | Rutland Water Reservoir | River Gwash | 25 | Yes | 0.16 | 30 | 946 081 | Anglian Water | Medium/Low | Energy recovery |
| | 32 | Empingham Mill Farm | North Brook | Low | No | 0.24 | 0 | 960 084 | Private Mill | Zero | |
| | 33 | Horn Mill | North Brook | 2 | Yes | 0.22 | 3 | 953 105 | Private Mill | Low | Fishfarm |
| | 34 | Tolethorpe Mill | River Gwash | 1 | Yes | 0.75 | 5 | 022 104 | Private Mill | Low | |

The theoretical list of all sites with some potential (low, medium and high) shows a total capacity of **2,592 kW** with over half, or 1,625 kW of this total from just two sites on the River Trent at Cranfleet and Sawley Weirs (which may be marginal for development due to flood risk).

Due to various concerns with the "low" potential sites in the list, they are not recommended to be considered for development. One of these sites is already used for hydropower employing a waterwheel for milling (Claybrooke Mill) and more details on its operation is given in Annex 3.

Those seven (7) left on the list that have either a low to medium or high potential for development are discussed in detail here.

## 3.8 Hinckley & Bosworth Borough Council

### Sheepy Magna Mill – Medium / Low

The River Sence has a reasonable flow and has a tradition of milling, for example at Sibson's Mill and at this large Mill (see Annex 1). There are a potentially a usable set of sluices and other hydraulic structures are in place, and although the head is low, a modest amount of power can be generated. The issue will be on access now that the site has been landscaped for the flats in the Mill.

| | |
|---|---|
| River | Sence |
| Head | 1.2 m |
| Rated Flow | Because this is a small scheme, the mean flow at this point (1.1 $m^3/s$) may be taken as the scheme rated flow |
| Capacity | 10 kW |
| Estimated annual energy capture | 40 MWh (based on capacity factor of 45%) |
| Ownership | Private flats |
| Grid ref | 328 015 |
| Local Authority | Hinckley and Bosworth |


**Figure 18: Sheepy Magna Mill – River Sence**

## 3.9 Rutland County Council

### 1. Duddington Mill – Medium

This is a beautiful traditional mill with sluices and a spillway in good working order. The leat is long and the installation of a small hydro scheme would not disturb the deprived reach that passes to the south. The issue will be on installing a turbine large enough to take the rated flow of 2 $m^3$/s, and a more detailed investigation is required in agreement with the owner, to size the scheme appropriately.

| | |
|---|---|
| River | Welland |
| Head | 1.3 m |
| Rated Flow | Although the mean flow at this point is about 2.2 $m^3$/s, the scheme would be rated at 2 $m^3$/s due to the needs for the deprived reach and restrictions at site |
| Capacity | 20 kW |
| Estimated annual energy capture | 70 MWh (with capacity factor of 40%) |
| Ownership | Private house |
| Grid ref | 985 009 |
| Local Authority | Rutland |

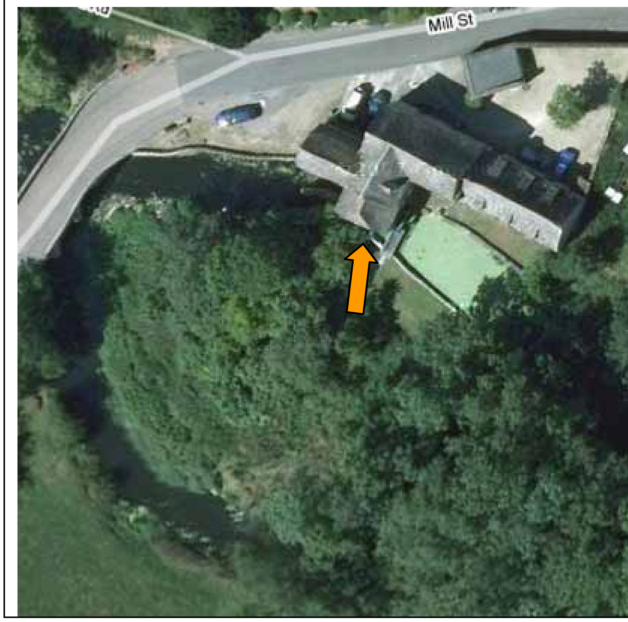

**Figure 19: Duddington Mill – River Welland**

## 2. Rutland Water Reservoir – Medium / Low

There is existing pumping station below the weir visible on the map, from where the River Gwash continues and a compensation flow of average 160 l/s is released into the river at this point. The plan of Anglian Water is to build a second pumping station with standby generators for the pumps' power needs and permission is being sought for that. Energy recovery from this compensation flow as it drops through the dam seems not to have been considered in the plans but at a 25 m head, useful amounts of energy could be generated.

| | |
|---|---|
| River | Gwash |
| Head | 25 m |
| Rated Flow | The mean flow at the Church Bridge point is about 160 l/s which is the compensation flow for the river Gwash so the scheme would be rated at 150 l/s |
| Capacity | 30 kW |
| Estimated annual energy capture | 223 MWh (this would have a high availability factor due to reserve flow being used, 85%) |
| Owner | Anglian Water |
| Grid ref | 946 081 |
| Local Authority | Rutland |

**Figure 20: Rutland Water Reservoir**

## 3.10 Blaby District Council

No potential hydro power sites were identified.

## 3.11 Oadby and Wigston Borough Council

No potential hydro power sites were identified.

## 3.12 North West Leicestershire District Council

### 1. Ratcliffe Power Station Weir (Cranfleet) – Medium

This is a very high flow site, as the River Soar joins the River Trent just above the weir. There is abstraction of water for a power station through a large tunnel to the south, but with a good head and large remaining flow, this scheme could be 1 MW. The site is prone to flooding but a similar approach as at Beeston Weir could be taken to developing the site, although the owner (Network Rail) would have to be convinced that the flooding risk to its rail lines would not increase. High voltage 33 kV lines exist to the north of the weir and there is access to both sides.

| | |
|---|---|
| River | Trent |
| Head | 3.2 m |
| Rated Flow | Although the mean flow at this point is about 65 $m^3/s$, the scheme would be rated at 40 $m^3/s$ due to a large abstraction just upstream at the 2,000 MW coal Power Station intake |
| Capacity | 1,000 kW (1 MW) |
| Estimated annual energy capture | 3,000 MWh (based on a capacity factor of 35% capacity factor, typical for Beeston Hydro Plant) |
| Ownership | Network Rail |
| Grid ref | 496 310 |
| Local Authority | North West Leicestershire |


**Figure 21: Ratcliffe Power Station Weir – River Trent**

### 2. Sawley Cut Weir – Medium / Low

Being located on the River Trent this is a high flow site with a usable head, this scheme could be at least 600 kW. As with the Cranfleet site flooding would have to be designed for and the owner (British Waterways) would have to be convinced that the flooding risk to local navigation would not increase. Grid connection and access would not be as simple as at Cranfleet and the eastern side of the weir appears to be the best route in.

| | |
|---|---|
| River | Trent |
| Head | 1.7 m |
| Rated Flow | Although the mean flow at this point is about 53 $m^3/s$, the scheme would be rated at 44 $m^3/s$ due to the needs for navigation through the Sawley Cut |
| Capacity | 625 kW (0.625 MW) |
| Estimated annual energy capture | 1,900 MWh (based on 35% capacity factor, typical for Beeston Hydro Plant) |
| Ownership | British Waterways |
| Grid ref | 467 310 |
| Local Authority | North West Leicestershire |


**Figure 22: Sawley Cut – River Trent**

### 3. Ratcliffe-on-Soar – Medium

Two weirs take the river around the Ratcliffe-on-Soar Marina and hydropower plant would best be sited on the northern-most weir where access and the grid connection could be made through the Marina. There would be less flooding concerns to the owner (British Waterways) than along the higher flow River Trent.

| | |
|---|---|
| River | Soar |
| Head | 1.5 m |
| Rated Flow | Although the mean flow at this point is about 12.5 $m^3/s$, the scheme would be rated at 12 $m^3/s$ due to the needs for the deprived reach and navigation through the Locks |
| Capacity | 150 kW |
| Estimated annual energy capture | 525 MWh (based on capacity factor of 40%) |
| Ownership | British Waterways |
| Grid ref | 493 288 |
| Local Authority | North West Leicestershire |

**Figure 23: Ratcliffe-on-Soar Weir – River Soar**

### 4. Kegworth Weir – High

This site appears to be the best for development because of the relatively high head and also a good flow. Access can be made from the north through a private housing estate called The Osiers and the grid is present in the area. The key aspect to developing this site will be fitting the plant in to the north side of the weir without compromising the private land adjacent.

| | |
|---|---|
| River | Soar |
| Head | 3.8 m |
| Rated Flow | Although the mean flow at this point is about 12.5 $m^3/s$, the scheme would be rated at 10 $m^3/s$ due to the needs for the deprived reach and navigation through the Locks |
| Capacity | 300 kW |
| Estimated annual energy capture | 1,000 MWh (based on capacity factor of 40%) |
| Ownership | British Waterways |
| Grid ref | 490 268 |
| Local Authority | North West Leicestershire |


**Figure 24: Kegworth Weir – River Soar**

## 3.13 Harborough District Council

No potential hydro sites were identified

## 3.14 Melton Borough Council

No potential hydro sites were identified

## 3.15 Summary

The analysis in this study for hydropower shows sites with a reasonable or good potential of **2,139 kW (~ 2.14 MW)**, through the development of 7 small hydro schemes, which is 82.5% of the total assessed potential in the 7 Districts. These are summarised in Table 12. To put this into perspective, this is the output from one large modern wind turbine, which indicates that the potential for hydropower in the 7 Districts is actually quite limited.

The total annual energy generation from these potential schemes is estimated as **6,758 MWh**, or the equivalent of the consumption of 1,400 average UK households, and displacing **3,100 tonnes** of $CO_2$.

**Table 12: Summary of Hydro potential**

| Ref | Local authority | Name | Grid Reference | Estimated power | Estimated annual output | Estimated potential for development |
|---|---|---|---|---|---|---|
| | North West Leicestershire | Ratcliffe Power Station Weir (Cranfleet) | 496 310 | 1000 kW | 3 000 MWh | Medium |
| | North West Leicestershire | Sawley Cut Weir – | 467 310 | 625 kW | 1 900 MWh | Medium/Low |
| | North West Leicestershire | Ratcliffe-on-Soar | 493 288 | 150 kW | 525 MWh | Medium |
| | N W Leicestershire | Kegworth Weir | 490 268 | 300 kW | 1,000 MWh | High |
| | Hinckley and Bosworth | Sheepy Magna Mill | 328 015 | 10 kW | 40 MWh | Medium/low |
| | Rutland | Duddington Mill | 985 009 | 20 kW | 70 MWh | Medium |
| | Rutland | Rutland Water Reservoir | 946 081 | 30 kW | 223 MWh | Medium/Low |

Of the original 40 sites initially considered (34 of which were of enough interest from the mapping exercise to tabulate and 30 of which were visited), the majority had to be rejected for various reasons, mostly technical (lack of flow or head) but also difficulties with grid connection, access or being an un-developable site (i.e. derelict or built over).

Some images of these sites and a record of those visited are shown in Annex 4. The locations of the sites found to be potentially feasible are mapped in Annex 5.

# 4 BIOMASS

Biomass is derived from plant material and animal wastes. It can be used to generate electricity and or heat. By using locally produced biomass fuel, biomass energy projects can produce a range of benefits. This section reports on the assessment of the potential for both large biomass power production and biomass heating.

## Large scale biomass power production

Generating electricity from biomass is usually done on a larger scale than biomass heating in order to obtain the economies of scale required for a turbine and generator or engine. New projects being built in the UK are in the size range 2 MWe[6] to 45 MWe, with the small plants producing both electricity and heat (known as combined heat and power or CHP). The three main technologies for biomass power production are:

- Direct combustion – biomass is burnt to raise steam and the steam is then used to drive a steam turbine which drives a generator.
- Gasification – partial combustion of the biomass material in a restricted supply of air, at high temperatures produces what is known as 'producer gas' this can then used in gas turbines and engines to produce electricity. This is a more complex process than using the direct combustion and steam cycle process. However, the advantage of gasification is that it can achieve much higher efficiencies.
- Pyrolysis – thermal decomposition of the biomass material, in the absence of oxygen produces a liquid fuel, known as bio-oil or pyrolysis oil. This can be used as a fuel for heating or power generation. Pyrolysis technology, in comparison with combustion and gasification, is in the early state of development and thus the development costs are still very high and not well established, but this also means that there is considerable scope for cost reduction.[7]

Direct combustion is the simplest, most common and most proven of the three technologies.

Anaerobic digestion of sewage sludge or other wet organic matter produces biogas. The major constituent of biogas is methane which can be used to produce heat and / or power. Anaerobic digestion of sewage sludge is commonly carried out as part of the processing of domestic and industrial waste and there are several digesters in Leicestershire (including sewage treatment works at Loughborough, Wanlip, Hinckley and Melton Mowbray). The energy produced is mainly used on site for other parts of the waste treatment process and little if any electricity is exported. Anaerobic digestion of animal slurry is less common and has been the subject of a recent scoping study initiated by Leicestershire County Council. The study sought to identify the potential for Anaerobic Digestion (AD) technology as a renewable energy source, primarily using animal manure as a feedstock.

There are three main issues affecting the use of large-scale power production in the seven local authority areas:

1) Biomass fuel resource available
2) Availability of a suitable site
3) National support for biomass technologies

## Biomass heating

[6] MWe refers to the peak rated electricity output.

[7] IEA Bioenergy http://www.aboutbioenergy.info/technologies_pyrolysis.html visited 06/07/2006.

Biomass heating can be implemented on a much smaller scale than biomass power production. A local fuel supply is very important. Suitable materials for heat applications include woody biomass from local forestry and forestry residues or energy crops such as willow coppice. Residues from saw mills and other wood processes can also be used.

The most common and convenient forms of woody biomass for energy are wood chips and wood pellets. These can both be used in automatic operating equipment.

Wood chips are small pieces of wood which have usually been seasoned to reduce their moisture content. Wood chips contain more moisture than wood pellets and they also have a lower bulk density. They therefore require a far larger store than wood pellets but are cheaper per unit of energy than pellets.

Wood pellets are harder and denser than wood chips. They are usually formed by compacting saw dust for example from saw mills using equipment similar to that used to make animal feed pellets. Small very regularly shaped particles facilitate automatic feeding of the burner. They are also less prone to clogging and fungus growth caused by high moisture levels than wood chips.

The quality of wood fuel is very important to ensure the reliable operation of a wood fuelled heating system. A consistent quality fuel supply is crucial to the success of a project.

### National biomass strategy

In 2004, the Government commissioned a year-long independent Biomass Task Force to identify the barriers to developing biomass heat and electricity and to recommend ways to overcome the problems. The Biomass Task Force Report was published in October 2005. In April 2006, the Government published its response to the Task Force's report. This response accepts that energy from crops, trees and waste can make a strong contribution to reducing greenhouse gas emissions and set out 12 key initiatives to make this happen.

The **Forestry Commission's Woodfuel Strategy** for England[8] was launched in March 2007. The aim of the Strategy is to bring an additional two million tonnes of wood into the market, annually, by 2020 saving 400,000 tonnes of carbon every year – the equivalent of 3.6 million barrels of crude oil and enough to supply 250,000 homes with energy. To achieve this target it focuses efforts on the potential wood resource available in the 60% of English woodlands that are currently under-managed. Using wood from well-managed woods provides a renewable source of fuel as well as giving woodland owners an incentive to manage their land productively, improving conditions for wildlife. The strategy does not rule out support to any development, but prioritises the development of local heat.

The Forestry Commission hosts the Biomass Energy Centre (BEC)[9]. The BEC aims to draw together information from existing sources into one easy to use service based around this website and an information enquiry service to UK individuals, companies, local authorities and other UK organizations.

The following sections consider the biomass resource in each authority area and then estimate the practical potential for biomass heating and electricity generation. The dry biomass resource is considered first, followed by the wet resource (animal slurry).

[8] http://www.forestry.gov.uk/england-woodfuel

[9] http://www.biomassenergycentre.org.uk

## 4.1 Consultation

To help assess the resources available in the area a number of organisations were contacted. The list of those consulted is included Table 13 in below.

**Table 13: Organisations contacted for consultation on biomass**

| Name and position | Organisation | Information provided |
|---|---|---|
| Will Rolls, Wood fuel Coordinator | Forestry Commission, East Midlands | Overview of regional activities, Natural England Study, wood fuel supply and demand studies for Pathfinder areas, promotional and training activities. |
| Liz Thomas, | National Forest / Leicestershire County Council | Woodland Economy Business Support (WEBS) |
| Andrew Shaw, Forester | Leicestershire County Council | Overview of County Council's activities in biomass |
| Tony Lockley, Team Leader Environmental Action | Leicestershire County Council | Further contacts within Leicestershire County Council |
| Nick Fellder, Parks | Leicestershire County Council | Biomass material available from parks and highways under County Council responsibility. |
| George Chase, Head of Waste and Amenities | Rutland County Council | Biomass material available from parks |
| Mich French, Park Management | Park Management, Melton Mowbray Town Estate | Biomass material available from parks |
| Sam Faire | Melton Borough Council | Biomass material available from parks |
| Dave Payne | Blaby District Council | Biomass material available from parks |
| Graham Norman, Head of Client Services | Oadby and Wigston District Council | Biomass material available from parks |
| Ground manager | Hinckley and Bosworth District Council | Biomass material available from parks |
| Clark Robinson | North West Leicestershire District Council | Biomass material available from parks |
| Hetal Patel | Leicestershire County Council | Anaerobic digestion initiatives in Leicestershire |
| Simon Greenhouse | National Forest Company | Overview of initiatives of National Forest Company. The National Forest Company sees woodfuel as very important in terms of encouraging good woodland management. |

## 4.2 Dry Biomass

The main forms of dry biomass available around Leicestershire and Rutland are:

- Woodland and forestry
- Waste from parks and highways
- Energy crops

The 2001 Viewpoints on Sustainable Energy in the East Midlands report[10] estimated the total accessible renewable energy resource from energy crops and forestry residues in Leicestershire at 37.1 MW or 287.0 GWh year, based on a total technical resource of 453.3 thousand tonnes (oven dry) per year. Based on current conditions the assumptions used to translate technical resource to accessible resource are possibly rather conservative.

The following sections explore firstly the existing regional initiatives to encourage the use of dry biomass before estimating the potential resource within each local authority area. Energy crops and woodland resources are considered separately.

### *4.2.1 Regional initiatives*

There are number of local and regional initiatives underway to promote the sustainable use of wood fuel for heating.

**The Bioenergy Group** is an informal partnership of organisations from the private, public and not-for-profit sectors within the East Midlands region which are collectively seeking ways to increase the use of locally grown biomass for the creation of heat and energy. The main focus of the group is currently on wood fuels, mainly woodchip and wood pellet; however the group will also aim to promote other forms of bioenergy in the future. Its membership is derived from fuel suppliers - forestry, agriculture and waste wood industries, Boiler suppliers, Potential users, business support and energy strategy agencies and academic institutions. The group is currently chaired by the Forestry Commission.

**The Forestry Commission** has recently commissioned a study on woodfuel supply and demand within three pathfinder areas: Sherwood Forest/ North Nottinghamshire and Derbyshire coal fields; The National Forest; and the North Northamptonshire growth zone. The study includes a survey of potential stakeholders within the supply chain and is due to be completed during April 2008. The findings will form the basis for further work to encourage the use of wood fuel for heating and will be used as part of The East Midlands delivery plan for the implementation of the Forestry Commission Woodfuel Strategy (mentioned above). Contact details for Will Rolls, Wood fuel co-ordinator for the Forestry Commission are provided within Annex 7.

The **National Forest Woodland Economy Business Support Programme (WEBS)** operates in Leicestershire and Derbyshire areas of The National Forest. Its main aim is to assist in creating and developing new and existing forest related businesses. The programme offers business development advice, grant funding, training and wood fuel heating feasibility studies.

There are a number of **existing wood heating installations in Leicestershire and Rutland**, primarily in County Council property, Schools and Country Parks. Leicestershire

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[10] Viewpoints on Sustainable Energy in the East Midlands: A study of current energy projects and future projects, Land Use Consultants and IT Power, 2001 http://www.emra.gov.uk/files/file677.pdf

County Council has seven schools running biomass boilers[11] however the County Council has no current plans for further biomass heating projects, the easy opportunities having already been addressed.

**Rural Energy Ltd**, based in Owston, is a local supplier of wood fuel and biomass heating equipment and has installed many of the existing installations in Leicestershire and Rutland. The company supplies and installs wood chip, wood pellet and log heating systems in the size range 10kW to 5MW. The company also supplies wood pellets in bulk or in bags and wood chips.

**East Midlands Wood Fuels** is a producer group established in 2006 to represent the interests of wood fuel growers and producers in the region. The Group consists of a mixture of woodland owners, contractors, professional bodies and manufacturers. The organisation sources local wood fuel by the co-ordination of services of individual members of the group to fulfil wood chip sales and supply contracts. It guarantees the quality and reliability of wood chip supplies and acts as principle contractor and indemnity provider for medium to large end users.

### *4.2.2 Energy crops*

There are three main options for energy crops (that is plants grown specifically for energy purposes):

- Short Rotation Coppice (SRC) consists of densely planted, high yielding varieties of willow or poplar and can be established on a wide variety of soil types from heavy clay to sand including reclaimed land from gravel extraction and colliery spoil. The rainfall in the East Midlands is ideal for willow SRC. The crop has a 3 year rotation, the plants last 20 - 30 years after establishment and produce 7 - 12 oven dry tonnes (odt) / ha / year. International studies show that 6 to 10 ha is the minimum commercially viable size for an SRC plantation.
- Miscanthus is an alternative energy crop to short rotation coppice. Miscanthus has an annual harvest, and so an annual income for the farmer, for the 15 year lifetime of the crop. Highest yields of miscanthus are possible south of a line drawn between the Bristol Channel and The Wash and production is optimum on soils with a pH value of between pH 5.5 and 7.5. Yields are expected to be between 9 and 13 tonnes/ha/yr.
- Co-product from arable crops (straws of various kinds) or dedicated annual energy crops. The physical and chemical properties of straw make it unsuitable for heating applications but suitable for large scale power production.

A large proportion of the total land area in Leicestershire and Rutland is agricultural (79%). In the seven areas considered by this study, all areas except Oadby and Wigston are over 60% agricultural land. **Table 14** shows the total farmed area for each local authority and the area in hectares dedicated to different land uses.

[11] 2007 Regional Biomass Active Demand Mapping Project commissioned by Natural England and carried out by David Wright & Henry Leivers

**Table 14: Agricultural land area, hectares[12]**

| | % total land used for agriculture | Land area, Hectares | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Total farmed area | Crops & bare fallow* | Grassland | Rough grazing | Woodland on farms | Set-aside* | Total Arable |
| **Blaby** | 64% | 8376 | 3705 | 3852 | 75 | 77 | n/a | 2325 |
| **Harborough** | 89% | 52536 | 22558 | 24979 | 512 | 1016 | 2724 | n/a |
| **Hinckley and Bosworth** | 78% | 23101 | 11337 | 9535 | 124 | 443 | 1260 | 7362 |
| **Melton** | 86% | 41258 | n/a | 16650 | 143 | 523 | 2662 | 12700 |
| **North West Leicestershire** | 64% | 17870 | n/a | 6349 | n/a | 676 | 993 | 6421 |
| **Oadby and Wigston** | 16% | 373 | n/a | 219+ | 0 | 0 | n/a | n/a |
| **Rutland** | 76% | 29880 | 17993 | 6765+ | n/a | 1281 | 2313 | n/a |

* Set Aside and Bare Fallow areas are subject to revision

Note: Where a cell is marked n/a, figures are not available due to some figures within the DEFRA data being suppressed to prevent disclosure of information about individual holdings.

+ Total grassland figures for Oadby and Wigston and for Rutland are not available. These figures refer to Permanent grass only.

**SRC:** The majority of the arable land, grassland, set-aside and fallow in the areas are likely to be technically well suited to growing energy crops. The Department for the Environment, Fisheries and Rural Affairs (DEFRA) has published a series of regional maps indicating the local suitability of land for energy crops[13]. The short rotation coppice map shows that the majority of Leicestershire and Rutland has a suitability of medium to high i.e. is expected to produce yields of over 8 oven dry tonnes (odt) per hectare per year. The majority of Harborough, Melton and Rutland is classified as high. However, a variety of factors will influence the willingness of farmers to convert land to biomass production.

The UK arable sector is highly efficient, volume concentrated and has well-developed supply chains. It is in a continuous cycle of efficiency improvement with the replacement of labour by better machines (the latest combine harvesters can achieve harvesting rates of 100 tonnes an hour), yield growth (1.5% per annum), precision agronomy (very targeted application of fertiliser and agrochemicals) and a better understanding of rotations. Rotation, that is not growing the same crop year on year on the same ground is a key management tool which if used effectively can radically reduce cost and improve yield. Furthermore, failure to rotate increases disease risk and can, under certain circumstances, permanently destroy soil fertility through severe disease infestation. The concept of suitable 'break crops' to follow wheat or oil seed rape is an important new issue for farmers as some traditional break crops (such as peas or beans) have limited markets and there is a continual search for new markets and new crops. **Rotation means that perennial crops such as short rotation coppice and miscanthus have limited application because they take land permanently out of production thereby severely limiting rotation potential**.

[12] June 2006 Agricultural and Horticultural Survey – England, DEFRA

[13] http://www.defra.gov.uk/farm/crops/industrial/energy/opportunities/index.htm

**Annual combustion energy crops:** Dedicated annual combustion energy crops could become attractive to arable farmers. A number of crops are vulnerable for replacement owing to their relatively low yields and therefore poor returns. These include field peas, beans and linseed. Species such as Triticale could enhance rotational benefits and could be harvested in a whole crop format. This would yield up to 18 tonnes per ha total biomass. Triticale is widely grown in Eastern Europe for energy purposes but no trials have yet been undertaken in the UK. Other unfashionable crops such as energy oats (previously grown as horse feed) are also a contender owing to their high yields and good rotational benefits. Trials would be necessary to assess the suitability of Triticale or other species to land in Leicestershire and Rutland.

**Straw:** Based on the areas within each Local Authority dedicated to cereals (as given by DEFRA statistics) and an average wheat yield of 8 tonnes per ha, of which 80% is recoverable straw. Table 15 below presents the potential for straw. A small quantity of straw is used for winter animal bedding. (This market normally consumes about 5 million tonnes for the UK as a whole). The practice of ploughing some straw back into the field as a soil conditioner is becoming less and less common. Modern practices favour removal of straw from the field as early as possible. The removal of set-aside and a buoyant market for cereals means that wheat and oil seed rape areas will continue to grow increasing the current levels of straw production. Changes to the CAP with the removal of production support will further reduce livestock stocking rates and possibly slightly reduce the demand for winter animal bedding. Demand for straw comes from the Ely dedicated biomass plant which consumes 200 000 tonnes of straw annually and if completed the proposed Sleaford Renewable Energy Plant in Lincolnshire will require an additional 240 000 tonnes[14] per annum. The new Sleaford plant is likely to obtain at least some of its requirement from the East Midlands including Leicestershire and Rutland.

Table 15 below shows estimates of the quantities of straw available as a by product from cereal farming, the future potential for dedicated annual energy crops and also for short rotation coppice.

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[14] Eco2 Ltd. and Axis, 2007. *Environmental Statement, Non-technical Summary.* http://www.sleafordrep.co.uk/info/ESVol3/Non-Technical%20Summary.pdf.

Table 15: Estimated potential for energy crops in Leicestershire and Rutland

| | Straw | | Potential Triticale / Annual energy crops | | Potential SRC | |
|---|---|---|---|---|---|---|
| | Tonnes (oven dry) | MWh | Tonnes (oven dry) | MWh | Tonnes (oven dry) | MWh |
| **Blaby** | 14880 | 57913 | 4185 | 12442 | 2545 | 13445 |
| **Harborough** | 92174+ | 358743 | 25924+ | 77074 | 13620 | 71941 |
| **Hinckley and Bosworth** | 47117 | 183379 | 13252 | 39398 | 6300 | 33277 |
| **Melton** | 81280 | 316342 | 22860 | 67964 | 13310 | 70303 |
| **North West Leicestershire** | 41094 | 159939 | 11558 | 34362 | 4965 | 26225 |
| **Oadby and Wigston** | - | | - | | - | - |
| **Rutland** | 73521+ | 286145 | 20678+ | 61476 | 11565 | 61086 |
| **Totals** | **350 067** | **1 362 461** | **98 456** | **292 716** | **52 305** | **276 277** |

*Assumes 6% set aside in Blaby (set aside figures for Blaby not given by DEFRA statistics)
+Area used for cereals not given for Harborough and Rutland therefore an estimation based on average % cereal areas

Oadby and Wigston's potential is constrained due to limited agricultural land.

**Assumptions**

- The potential for Triticale /annual energy crops is based on an available area of 10% of the total area currently given to cereals and an annual yield of 18 oven dry tonnes (odt) per hectare.
- The potential for SRC is based on an available land area of half of that designated as set-aside, and a yield of 10 odt per hectare.

### *4.2.3 Woodland and forestry*

The potential for dry biomass as a fuel for heating and power depends on the area of woodland and forest, its management and also competition for this resource from other users.

The quantity of biomass material available from woodland is estimated from the area of woodland within each authority area. A list of assumptions used is listed in Table 16.

**Table 16: Assumptions used for wood fuel**

| Assumption | Comments |
|---|---|
| • Only areas greater than 0.1 hectare are considered | - |
| • 20% open space within each woodland block | 20% represents a typical woodland. |
| • 20% of woodland would be available for wood fuel production | Generally 20-50% of total wood grown is suitable for wood fuel rather than higher value markets such as saw mills however there are competing markets for the material. |
| • Typical Yield classes are $10m^3$/ha/year for conifers, $4m^3$/ha/year for broadleaf and $7m^3$/ha/year for mixed woodland. | The yield class is the volume in cubic metres of timber that will grow per year on a given site. It depends on the type of tree and the management of the woodland. Typical values are used. |
| • Energy per cubic metre for air dried timber (35% MC): 3.6 GJ | - |

Using the above assumptions together with woodland data provided by the Forestry Commission, the potential woodfuel resource from woodland in the seven areas is estimated. The results are shown in Table 17. Maps showing the main woodland areas for each area are provided in Annex 8.

**Table 17: Potential biomass wood fuel resource from woodland**

| | Local Authority Area | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Hinckley and Bosworth** | **Rutland** | **Blaby** | **Oadby & Wigston** | **Harborough** | **Melton** | **NW Leics** |
| **Wood land area, hectares** | | | | | | | |
| Young trees | 321 | 164 | 18 | 7 | 105 | 93 | 476 |
| Shrub | 6 | 3 | 0 | 0 | 22 | 7 | 3 |
| Mixed | 131 | 354 | 27 | 0 | 193 | 240 | 143 |
| Coniferous | 36 | 192 | 1 | 2 | 36 | 67 | 109 |
| Broadleaved | 655 | 1115 | 120 | 1 | 1034 | 1089 | 758 |
| felled | 13 | 31 | 0 | 0 | 9 | 34 | 33 |
| Total area | 1162 | 1859 | 166 | 10 | 1400 | 1530 | 1524 |
| **Potential volume of biomass available now** | | | | | | | |
| Current annual volume, $m^3$ | 468 | 1063 | 82 | 3 | 702 | 804 | 615 |
| Energy content, MWh | 853 | 1259 | 103 | 11 | 828 | 916 | 1187 |
| Heating potential – number of homes | 49 | 112 | 9 | 0 | 74 | 85 | 65 |
| **Potential volume of biomass available as young trees mature** | | | | | | | |
| Future annual volume, $m^3$ | 853 | 1259 | 103 | 11 | 828 | 916 | 1187 |
| Energy content, MWh | 901 | 1330 | 109 | 12 | 875 | 968 | 1254 |
| Heating potential – number of homes | 90 | 133 | 11 | 1 | 88 | 97 | 125 |

### *4.2.4 Parks and highways management*

For each authority the officer responsible for parks maintenance was contacted to obtain information about tree clippings and other materials resulting from parks and street maintenance. The majority of this material is currently chipped and composted or where possible used directly as a mulch on flower beds. In some cases the work is contracted to an external company, and the contractor is responsible for disposal of the material. In all cases it was difficult for the authority to estimate the quantities produced on an annual basis however rough estimates were given and these are shown in Table 18. In addition to the amounts shown in the table, approximately 600 tonnes of tree waste is generated by Leicestershire County Council Highways Department (approx. 1580 MWh). This material is sent to a chip board manufacturer in Cheshire but could potentially be used locally. The contribution from parks to the total woody biomass resource is small.

#### *4.2.5 Constraints analysis*

**The constraints to large biomass power projects** are:

- Biomass resource: The total resource available depends on land availability in proximity to the project location (transport distance is important). In the short term however the available resource depends on the demand for biomass fuel and this often presents a chicken and egg scenario since farmers are unlikely to invest in the supply side until demand is certain and similarly potential users are unlikely to commit until the fuel supply is certain.
- Space available for the plant and fuel storage: This depends on the size of plant. Typically, a 1.5MW plant will require a site area of around 0.5 hectares and a 40MW plant may require 5 hectares.[15]
- Access for fuel deliveries: Regular fuel deliveries will be required. Typically a 2.5MW plant would require 25 deliveries (using a 38 tonne lorry) per week.
- Access to water for cooling: As in fossil fuel power stations water is required to cool and condense the exhaust gas from the turbine.
- Access for grid connection
- National support for biomass power production: In 2003 Bio-Energy Capital Grants worth a total of over £25 million were awarded for eight bio-power and CHP systems. Out of the eight projects only one is now operating and a further two are under construction. One plant in Winkleigh, Devon was refused planning permission and two are on indefinite hold. Two more are progressing.

**The constraints on the widespread use of biomass for heating** are as follows:

- Biomass resource: The total estimated woody biomass resource in the seven authority areas is estimated at 283 710 MWh. To give an idea of what this could heat, an average new home in the UK uses 10 MWh per year for heating and hot water so the available resource could provide for 28 370 homes.
- Access and space for storage
- Infrastructure for processing and storage - The number of biomass heating installations is constrained by the number of buildings with suitable access for deliveries of fuel and space for fuel storage.

  Ideally a wood chip store is designed so that the wood fuel can be simply tipped into it, rather than requiring special equipment to blow chips into the fuel store.

  In urban locations the number of possible locations for biomass heating may be restricted however many schools, leisure centres, community centres, offices, warehousing and sub urban locations are likely to be suitable.

  The availability of locally produced wood pellets would enable additional biomass heating installations which due to either their small or variable heat demand or space or access issues are unsuitable for wood chips.

  There is currently no local manufacture of wood pellets in the East Midlands. There are very few pellet facilities in the UK as a whole and some wood heating installations use wood pellets imported from the Baltic countries and Scandinavia. It is possible that a new facility may be developed near Rotherham in Yorkshire in the next few years.

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[15] PPS22 Companion Guide

- Funding available nationally and locally to assist with capital cost of equipment. Some funding for biomass heating installations is available through the Low Carbon Building Programme however this is limited to individual systems for homeowners and to systems of less that 50kW for the public sector. A new round of DEFRA funded capital grants offering up to 50% funded was launched on 8 April 2008. A total of £4 million is available and the maximum single award is £100,000 per installation. Further rounds are expected in Autumn 2008 and several rounds in 2009 and 2010.

#### *4.2.6 Results*

A summary of the potential renewable energy fuel from dry biomass sources is presented in Table 18. Rutland and North West Leicestershire have the greatest woodland and forest resource but Harborough and Melton as well as Rutland have significant potential for short rotation coppice and other energy crops. The potential resource from energy crops is much greater than that available from woodland.

The resource available from parks maintenance was difficult to estimate is small although not insignificant but may be difficult to utilise as a sole source due to its dispersed nature. It could be used with other dry biomass.

The resource available from energy crops (both Triticale and SRC) depends on farmers establishing such crops.

The largest part of the dry biomass resource is from straw. This constitutes over 60% of the total resource. The available resource presented in the table below assumes that one third of the total available straw is used in the straw power station in Ely and the planned facility in Lincolnshire. Even with this taken into account there is significant potential to consider a straw fired power station within one or more of the local authority areas.

**Table 18: Total dry biomass potential by local authority area**

| Resource potential, MWh | Local Authority Area | | | | | | |
|---|---|---|---|---|---|---|---|
| | Hinckley and Bosworth | Rutland | Blaby | Oadby & Wigston | Harborough | Melton | NW Leics |
| Woodland (including young trees) | 901 | 1 330 | 109 | 12 | 875 | 968 | 1 254 |
| Parks | 110 | 50 | 40 | Unknown | No information | 100 | 90 |
| Straw | 122 252 | 190 763 | 38 609 | 0 | 239 162 | 210 895 | 106 626 |
| Triticale or other annual energy crops | 39 398 | 61 476 | 12 442 | 0 | 77 074 | 67 964 | 34 362 |
| SRC | 33 277 | 61 086 | 13 445 | 0 | 71 941 | 70 303 | 26 225 |
| **Total woody biomass suitable for heating, MWh** | 34 287 | 62 467 | 13 594 | 12 | 72 816 | 71 372 | 27 569 |
| Heating potential (from woody biomass)-no. homes | 3 429 | 6 247 | 1 359 | 1 | 7 282 | 7 137 | 2 757 |
| **Total straw and annual energy crops, MWh** | 155 529 | 251 850 | 52 053 | 0 | 311 103 | 281 198 | 132 851 |
| Electricity generation potential from straw and Triticale, MW | 5 | 9 | 2 | 0 | 11 | 10 | 5 |

## 4.3 Wet Biomass

As mentioned above Leicestershire County Council commissioned a feasibility study and a consultation on Anaerobic Digestion. The study 'Biogas in Leicestershire, A Technical Feasibility Study for Leicestershire Anaerobic Digestion – A Renewable Energy Resource' was completed in May 2007.[16] The project is countywide and focused on hotspots of livestock production such as Melton. The study concluded that Leicestershire encompasses a considerable resource of animal manure, as well as considerable food waste resources and the potential to grow significant amounts of energy crops. All of these resources are ideal feedstocks for the AD process. The analysis of the various options for biogas plants concluded:

- On-farm options with up to 600 dairy cattle, or 14 000 pigs are not viable
- When food waste is added, the option with 14 000 pigs becomes viable but none of the other on-farm options do.
- A plant fed with a mixture of energy crops and slurry is unlikely to be viable without much enhancement of the grant \ income balance.
- The smallest size of plant that is viable is one of a size sufficient to process the slurry from 3000 cattle plus food waste. Larger plants are even better financially.

Leicestershire County Council is working to act as a catalyst to develop anaerobic Digestion Plants in Leicestershire. As a facilitator, the County Council will financially support up to three applications to develop site specific business cases. On the merits of the business cases, the County Council will provide financial support to potential cases for Environmental Impact Assessment (EIA). The council is also offering Anaerobic Digestion Business Plan Grants to support the development of site specific business cases for a parish scale centralised AD plant.

### *4.3.1 Constraints analysis*

The constraints to the use of anaerobic digestion are as follows:

- Availability of animal manure and other substrate. For animal manure this depends on the number of animals and whether they are kept indoors or outside. Food wastes may also be considered however the manure is an essential part of any process because it contains a wide range of bacteria necessary to foster the digestion process, but it is also considered the most likely feedstock because it is a waste product with little, or even negative, value and its disposal by traditional spreading methods brings problems with odours and ground contamination. The slurry produced by dairy cattle is a particularly suitable feedstock because these animals are typically kept indoors for up to 6 months per year and their manure must be collected and disposed of.
- Composition of feedstock–including type of animal manure (which affects biogas yield) and dry matter content (which affects the size of digester required).
- Location of feedstock
- Local heat demand
- Availability of finance

16 http://www.leics.gov.uk/index/community/community_services/environment_and_heritage/enable/ad.htm

- Market for digestate: The digestate (the treated liquid from anaerobic digestion plants) has the potential for use as a fertiliser and soil conditioner, which can provide an additional revenue stream for the operators of anaerobic digestion plants. At present, however, the use of digestate is subject to waste management controls. This a significant barrier to the growth of this technology. Currently the recycling to land of the digestate from AD plants is regulated by the Waste Management Licensing Regulations unless the feedstock consists only of farm animal manures and/or grown biomass such as maize, wheat and grass. The Renewable Energy Association drafted a Digestate Standard in 2006, the aim of which is to assist in the deregulation of digestate products by ensuring products are of a consistent and verifiable quality. In March 2008 the British Standards Institution published a draft Specification for Whole Digestate, Separated Liquor and Separated Fibre Derived from the Anaerobic Digestion of Source-Segregated Biodegradable Materials (PAS 110:2008).

The following table (Table 19) indicates the number of animals required to produce one tonne of organic waste and the corresponding biogas yield for each feedstock. These are likely to be subject to seasonal variation but represent annual averages.

**Table 19: Biogas production and energy output potential from one tonne of various fresh feedstocks[17]**

| Feedstock | No of animals to produce 1 tonne of organic waste per day | Dry matter content | Biogas yield (m3/tonne feedstock) | Energy value (MJ/m3 biogas) |
|---|---|---|---|---|
| Cattle slurry | 30 | 12 | 25 | 24 |
| Pig slurry | 275 | 9 | 26 | 23 |
| Laying hen litter | 8500 | 9,000 | 30 | 25 |
| Broiler manure | 12,000 | 60 | 50 | 22 |
| Food waste | - | 15 | 46 | 21-25 |

Table 20 below shows animal numbers and numbers of holdings for cattle, pigs and poultry. Information on poultry numbers was only available at the county council level and not at individual local authority level. Some data for cattle and pigs is missing for Oadby and Wigston, Rutland and Melton (pigs only).

**Table 20: Animal numbers for each local authority area[18]**

| | Dairy cattle | | Pigs | | Poultry | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Laying hens | | Table chicken | |
| | No. animals | No. holdings | No. animals | No. holdings | No. animals | No. holdings | No. animals | No. holdings |
| **Leicestershire Cc and Rutland** | 51020 | 564 | 57059 | 157 | 882070 | 484 | 599692 | 16 |
| **Blaby** | 4360 | 50 | 8628 | 16 | n/a | n/a | n/a | n/a |
| **Harborough** | 13820 | 158 | 6492 | 40 | n/a | n/a | n/a | n/a |

[17] Anaerobic Digestion of farm and food processing residues Good Practice Guidelines, British Biogen

[18] June 2006 Agricultural and Horticultural Survey – England, DEFRA and Office National Statistics

| | Dairy cattle | | Pigs | | Poultry | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Laying hens | | Table chicken | |
| | No. animals | No. holdings | No. animals | No. holdings | No. animals | No. holdings | No. animals | No. holdings |
| **Hinckley and Bosworth** | 10000 | 100 | 8071 | 24 | n/a | n/a | n/a | n/a |
| **Melton** | 12860 | 118 | n/a | n/a | n/a | n/a | n/a | n/a |
| **North West Leicestershire** | 4074 | 64 | 10456 | 18 | n/a | n/a | n/a | n/a |
| **Oadby and Wigston** | n/a* | n/a* | n/a* | n/a* | n/a | n/a | n/a | n/a |
| **Rutland** | 1416 | 22 | 2397 | 17 | n/a | n/a | n/a | n/a |

The total potential biogas and hence potential energy can be calculated from the number of animals and the biogas production by number of animals (Table 19). In practice however the practicable potential will be limited by the constraints described at the beginning of the section, most notably by the fact that a significant proportion of the available feedstock is produced by smaller dispersed farms.

As mentioned above the feasibility study commissioned by Leicestershire County Council[19] looked at the minimum size of anaerobic digestion plant which would be economically viable under current conditions. The study concluded that waste from a minimum of 3000 cattle (i.e. around 10 farms) plus food waste is needed to make a project viable and that around 12 such plants could be developed in Leicestershire.

There are relatively few examples of anaerobic digestion of farm slurries in the UK. One example is the 2.7MW plant in Holsworthy in North Devon. The plant digests a mixture of animal slurries from approximately 30 farms in addition to food waste. The Holsworthy project came about during the time of the Non Fossil Fuel Obligation (NFFO) –the predecessor to the current Renewables Obligation.

Since the Leicestershire feasibility study the Renewables Obligation has changed and electricity generated by Anaerobic digestion plants is now eligible for two ROCs per MWh rather than one.

It is difficult to make a precise estimation of the total potential for anaerobic digestion in Leicestershire and Rutland since there are many project specific factors (especially the demand for local heat) which determine the viability of a project. It would seem however to to assume that around 50% of the total animal slurry feedstock could be used for anaerobic digestion for energy use.

### *4.3.2 Resource assessment –results*

The total estimated potential for energy from animal manure in Leicestershire and Rutland is presented below in Table 12. It should be noted that the potentials for electricity, heat etc. are not additive and are presented only as examples as to how the resource could be used.

The majority of the resource comes from cattle, with the contribution from pigs and poultry being small. The total potential installed electricity capacity from cattle manure is estimated at just over 2MW.

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[19] 'Biogas in Leicestershire, A Technical Feasibility Study for Leicestershire Anaerobic Digestion – A Renewable Energy Resource'

**Table 21: Estimated biogas resource for Leicestershire and Rutland**

| | Numbers of animals | Available Biogas $m^3$/year | Potential Energy output, MWh | | | | Potential Installed Capacity, MW | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Electricity only | Heat only | Combined heat and power (CHP) | | Electricity only (MW) | Heat only | CHP | |
| | | | | | Electricity | Heat | | | Electricity | Heat |
| **Cattle** | 51 020 | 489 792 | 40.82 | 95.24 | 40.82 | 48.98 | 2.09 | 4.88 | 2.09 | 2.51 |
| **Pigs** | 57 059 | 54 880 | 4.57 | 10.67 | 4.57 | 5.49 | 0.23 | 0.55 | 0.23 | 0.28 |
| **Laying hen** | 882 070 | 32 429 | 2.70 | 6.31 | 2.70 | 3.24 | 0.14 | 0.32 | 0.14 | 0.17 |
| **Broiler manure** | 599 692 | 12 094 | 1.01 | 2.35 | 1.01 | 1.21 | 0.05 | 0.12 | 0.05 | 0.06 |

Results for the individual authority areas are shown in the following sections.

### *4.3.3 Hinckley & Bosworth Borough Council*

**Table 22: Estimated biogas resource for Hinckley and Bosworth**

| | Numbers of animals | Available Biogas $m^3$/year | Potential Energy output, MWh | | | | Potential Installed Capacity, MW | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Electricity only | Heat only | Combined Heat and Power (CHP) | | Electricity only | Heat only | CHP | |
| | | | | | Electricity | Heat | | | Electricity | Heat |
| **Cattle** | 10 000 | 1 520 833 | 3 042 | 7 098 | 3 042 | 3 650 | 0.43 | 1.00 | 0.43 | 0.51 |
| **Pigs** | 8 071 | 139 261 | 267 | 623 | 267 | 320 | 0.04 | 0.09 | 0.04 | 0.05 |

*These figures for potential installed capacity are provided in order to give an idea of what the biogas resource could provide. In practice an electricity only installation of this size would not be viable.

### *4.3.4 Rutland County Council*

**Table 23: Estimated biogas resource for Rutland**

| | Numbers of animals | Available Biogas $m^3$/year | Potential Energy output, MWh | | | | Potential Installed Capacity, MW | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Electricity only | Heat only | Combined Heat and Power (CHP) | | Electricity only | Heat only | CHP | |
| | | | | | Electricity | Heat | | | Electricity | Heat |
| **Cattle** | 1 416 | 215 350 | 431 | 1 005 | 431 | 517 | 0.06 | 0.14 | 0.06 | 0.07 |
| **Pigs** | 2 397 | 41 359 | 79 | 185 | 79 | 95 | 0.01 | 0.03 | 0.01 | 0.01 |

*These figures for potential installed capacity are provided in order to give an idea of what the biogas resource could provide. In practice an electricity only installation of this size would not be viable.

### *4.3.5 Blaby District Council*

**Table 24: Estimated biogas resource for Blaby**

| | Numbers of animals | Available Biogas $m^3$/year | Potential Energy output, MWh | | | | Potential Installed Capacity, MW | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Electricity only | Heat only | Combined Heat and Power (CHP) | | Electricity only (MW) | Heat only | CHP | |
| | | | | | Electricity | Heat | | | Electricity | Heat |
| **Cattle** | 4 360 | 663 083 | 1 326 | 3 095 | 1 326 | 1 592 | 0.19 | 0.43 | 0.19 | 0.22 |
| **Pigs** | 8 628 | 148 872 | 285 | 666 | 285 | 342 | 0.04 | 0.09 | 0.04 | 0.05 |

*These figures for potential installed capacity are provided in order to give an idea of what the biogas resource could provide. In practice an electricity only installation of this size would not be viable.

### *4.3.6 Oadby and Wigston Borough Council*

The estimated biogas resource in Oadby and Wigston is negligible.

### *4.3.7 North West Leicestershire District Council*

**Table 25: Estimated biogas resource for North West Leicestershire**

| | Numbers of animals | Available Biogas $m^3$/year | Potential Energy output, MWh | | | | Potential Installed Capacity, MW | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Electricity only | Heat only | Combined Heat and Power (CHP) | | Electricity only (MW) | Heat only | CHP | |
| | | | | | Electricity | Heat | | | Electricity | Heat |
| **Cattle** | 4 074 | 619 588 | 1 239 | 2 892 | 1 239 | 1 487 | 0.17 | 0.41 | 0.17 | 0.21 |
| **Pigs** | 10 456 | 180 414 | 346 | 807 | 346 | 415 | 0.05 | 0.11 | 0.05 | 0.06 |

*These figures for potential installed capacity are provided in order to give an idea of what the biogas resource could provide. In practice an electricity only installation of this size would not be viable.

### *4.3.8 Harborough District Council*

**Table 26: Estimated biogas resource for Harborough**

| | Numbers of animals | Available Biogas $m^3$/year | Potential Energy output, MWh | | | | Potential Installed Capacity, MW | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Electricity only | Heat only | Combined Heat and Power (CHP) | | Electricity only (MW) | Heat only | CHP | |
| | | | | | Electricity | Heat | | | Electricity | Heat |
| **Cattle** | 13 820 | 2 101 792 | 4 204 | 9 809 | 4 204 | 5 045 | 0.59 | 1.38 | 0.59 | 0.71 |
| **Pigs** | 6 492 | 112 017 | 215 | 501 | 215 | 258 | 0.03 | 0.07 | 0.03 | 0.04 |

*These figures for potential installed capacity are provided in order to give an idea of what the biogas resource could provide. In practice an electricity only installation of this size would not be viable.

#### *4.3.9 Melton Borough Council*

**Table 27: Estimated biogas resource for Melton**

| | Numbers of animals | Available Biogas m³/year | Potential Energy output, MWh | | | | Potential Installed Capacity, MW | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Electricity only | Heat only | Combined Heat and Power (CHP) | | Electricity only (MW) | Heat only | CHP | |
| | | | | | Electricity | Heat | | | Electricity | Heat |
| **Cattle** | 12 860 | 1 955 792 | 3 912 | 9 128 | 3 912 | 4 694 | 0.55 | 1.28 | 0.55 | 0.66 |
| **Pigs** | | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

## 4.4 Biomass -summary and recommendations

A summary of the estimated total potential for biomass in the seven local authority areas is given below. There is sufficient resource for a power generation plant and for a few dispersed biogas units.

**Table 28: Total estimated biomass potential**

| | Estimated resource, GWh equivalent fuel | Potential Energy output, MWh | | | | Potential Installed Capacity, MW | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Electricity only | Heat only | Combined Heat and Power (CHP) | | Electricity only (MW) | Heat only | CHP | |
| | | | | Electricity | Heat | | | Electricity | Heat |
| **Animal manure from Cattle and pigs** | 17 407 | 40 616 | 17 407 | 20 888 | 893 | 2 | 6 | 2 | 3 |
| **Woody biomass** | 85 115 | 198 601 | 85 115 | 102 138 | 4 365 | 12 | 28 | 12 | 14 |
| **Straw and annual energy crops (e.g. Triticale)** | 355 375 | 829 209 | 355 375 | 426 450 | 18 224 | 50 | 117 | 50 | 60 |
| **Total** | **1 526** | **457 897** | **1 068 427** | **457 897** | **549 477** | **64** | **150** | **64** | **77** |

Possible actions to assist in implementation of the identified total potential are identified:

- Provide assistance to research the potential for Triticale or other annual energy crops
- Consult farmers on the use of straw with the aim to create a willingness to supply so that a developer would be interested in going ahead.
- Ensure development control planners are familiar with what the use of biomass really entails –This may mean reviewing any training needs. If training is needed authorities should aim to benefit from national training programmes such as those funded by BERR.
- Identify possible site(s) for implementation for anaerobic digestion and biomass heating
- Build on results of this study by collating information on food waste and working with Leicestershire County Council to facilitate AD.

# 5 SMALL WIND

### *5.1.1 Small scale wind constraints*

The three main installation constraints for small ground mounted wind turbine installations are finding a site that i) does not present noise or shadow flicker issues to surrounding buildings ii) does not impact considerably on the local visual amenity iii) does not have the potential for vandalism.

Building-mounted turbines require buildings either to be specifically designed for the installation of a turbine, or if a turbine is to be installed on an existing building it is recommended that a structural survey is conducted. A structural survey can ensure the building has sufficient structure strength to withstand the forces and vibration from a turbine. Chimneys are often regarded as suitable fixing locations for building-integrated turbines, however typical brick-built chimneys are not designed to take the lateral forces that are likely to occur and fixing to chimneys should be discouraged. Gable ends of building are otherwise preferred, but this substantially reduces the number of potential installation sites. In addition to the structural element, noise, visual impact and shadow flicker from a building mounted turbine must also be taken into consideration.

Noise from small wind turbines is very much dependent on turbine as each turbine has a specific noise profile. Opinion as to whether a turbine is noisy is subjective and must be put in context with the background noise levels. The majority of noise arising from small turbines is due to blades moving through the air. The higher the tip speed of the blade the higher the vortices and noise. Small turbines are typically gearless and variable speed so noise increases as a result of increased wind speed. At high wind speeds the noise of a turbine is in part masked by the background noise of the wind. Mechanical noise also arises from the generator.

There is currently no specific guidance with regards to noise from small wind turbines. In light of this, the most appropriate step would be for to adopt the guidance set out for large scale wind turbines which suggests noise levels should not exceed 43 dB(A)[20]. Siting small turbines should take background noise into account as this masks noise arising from a small turbine, especially if located near to busy roads.

Visual influence of small turbines is again subjective. Individual turbines are less imposing than the cumulative impact of a number of turbines. Future developments could potentially see numerous turbines being installed and their visual appearance should be considered in relation to the surrounding environment.

It is worth mentioning that the purposes of this study locations for small wind turbine have not been included as there would be too many to identify and their development and contribution to the overall renewable energy would be substantially less than large scale wind system.

[20] The assessment and rating of noise from wind farms. ETSU –U-97

# 6 PHOTOVOLTAICS

A photovoltaic (PV) system converts light energy from the sun into electricity. PV systems have the advantages of being silent in operation, having a very low visual impact and well suited for use in urban areas, including housing.

The electrical energy produced by a PV system can either be used immediately at the point of generation - to power appliances within the home - or can be fed into the local grid. Any excess electricity generated can be sold to the local electricity company, although an agreement for this will need to be negotiated.

PV systems can be either integrated into the building structure becoming the weather-proof layer of a building or can be retrofitted onto top of the existing roof see Figure 25 to Figure 28.

**Figure 25: 5 x 1.75 kWp roof integrated PV arrays**

**Figure 26: 0.75 kWp non-integrated PV array**

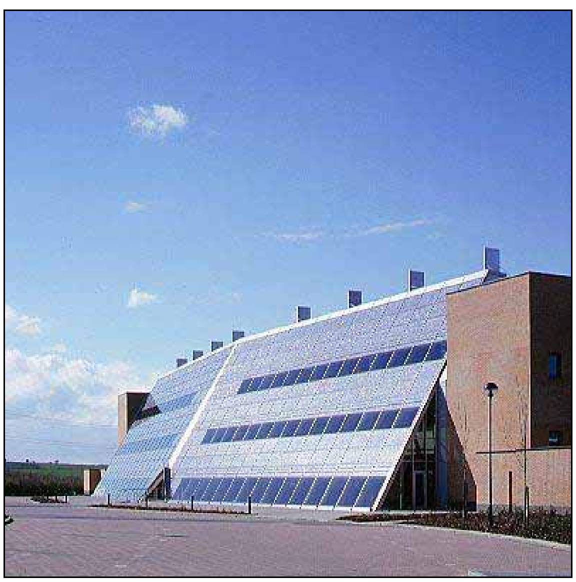


**Figure 27: 73 kWp array as a building façade**

**Figure 28: Internal appearance of the 73 kWp array**

Typically, a grid connected system would be installed. This comprises of a number of sub-systems as shown in Figure 29. These include:

- PV array
- DC system
- DC-AC Inverter
- AC system
- Monitoring

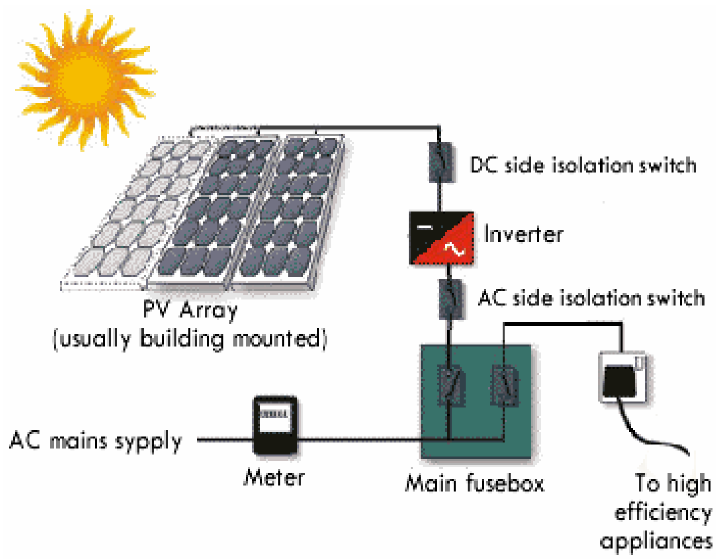



**Figure 29: Grid connected PV System**

## 6.1 Resource assessment

Contrary to popular belief, there is sufficient solar resource in the UK to generate electricity from photovoltaics with 941 kWh/m$^2$ of solar radiation. The ideal location for photovoltaic system in the Leicestershire region is a south facing roof angled at around 37 degrees to the horizontal. A 1 kWp system at the optimum angle of 37 degrees would theoretically generate 818 kWh per annum. The equivalent north facing array would see a 45% drop in power output see Figure 30.

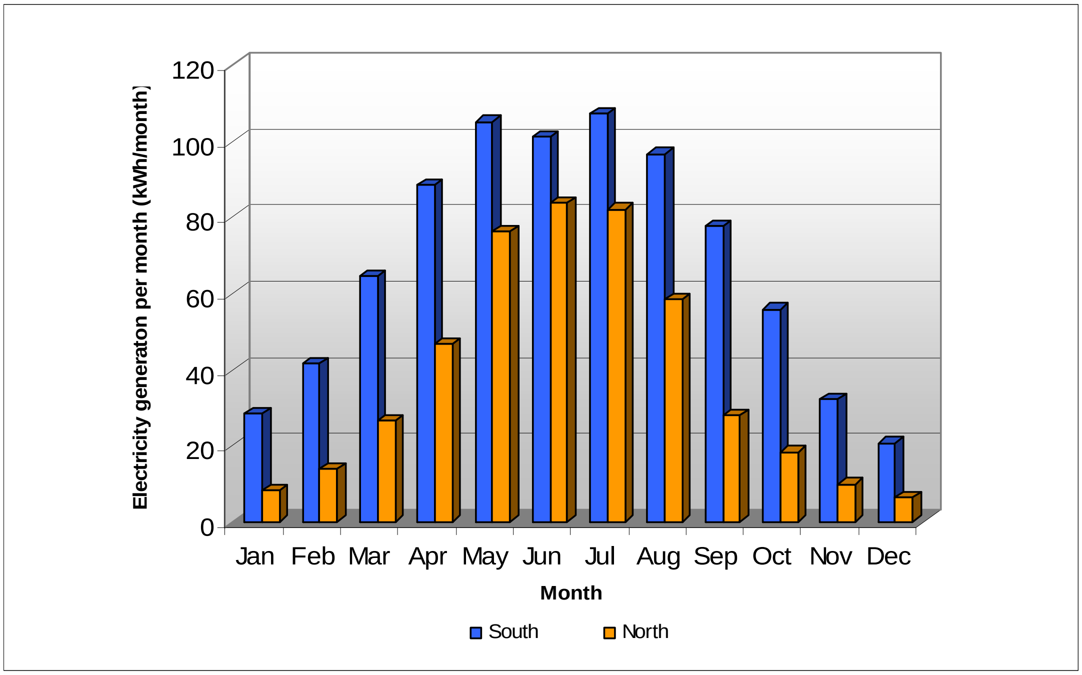



**Figure 30: A comparison of monthly energy output from a 1 kWp PV array at 37$^{o}$ to the horizontal at North and South orientation.**

In reality not all roofs are south facing and have an angle of 37 degrees. Typically roofs facing south west through to south east with a pitch of 20-60 degrees are also suitable for a PV array.

A typical rule of thumb used by the industry is that a 1 kWp[21] system will in optimal conditions i.e. at 30 degrees and south facing generate at least 750 kWh per annum. A typical domestic system would have a rated size of 2 kWp, occupying an area of approximated 16 $m^2$ (4 m x 4 m) and would generate 1,500 kWh per annum. Smaller systems are available and cost can be kept to a minimum when standard sizes are selected.

## 6.2 Constraints analysis

The main physical constraint in the installation of a photovoltaic system is whether there is sufficient shade free south west to south east facing roof area. Though photovoltaic systems can be installed on north facing roofs the amount of electricity that is generated is substantially reduced. As the aim of installing a PV system is to generate as much electricity as possible it is most appropriate to locate a PV system on a south west to south east roof at a pitch of 20-60 degrees. In addition photovoltaics can be installed as cladding on a building.

Relative to other renewable energy technologies PV can be relatively easily integrated into existing buildings as only requires the retrofitting of an array on the roof, the installation of inverters typically in the loft of a domestic property or in the plant room of a commercial building and then the connection to consumer unit.

[21] kWp refers to the rated output of a PV system at Standard Test Conditions (STC) of 1000 $Wm^2$ solar radiation, 25°C, Air Mass 1.5

The main prohibitive constraint of PV is the cost. Grants are currently available such as the government Low Carbon Buildings Programme which can assist in making them more attractive. Current electricity prices and typical grants of 50% of installation cost mean that systems currently do not provide an appropriate economic return.

Other constraining factors as to whether photovoltaics can be installed on a building include whether the building is in a special conservation area or is a listed building. The reflective nature of the glass module surface should also be considered when a PV system is being proposed as in some circumstances this may present a problem.

# 7 SOLAR WATER HEATING

Solar water heating systems use the thermal energy from the sun to heat hot water. Solar water heating systems typically consist of a collector, thermal store, pump and controls see Figure 31.

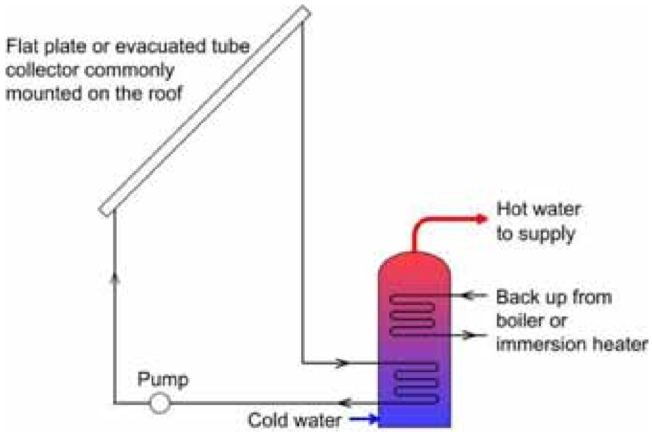



**Figure 31: Typical domestic solar water heating system**

Solar water heating systems are most suited to buildings which require large quantities of hot water such as domestic premises, hotels, swimming pools and industry. They are less suited to building with low hot water demand such as offices although that is not to say they cannot be installed.

A solar water heating panel can be either integrated or retro-fitted onto an existing building examples of which are given in Figure 32 & Figure 33.

**Figure 32: Evacuated tube collector**

**Figure 33: Integrated flat plate collector**

## 7.1 Resource assessment

There is sufficient solar thermal energy in Leicestershire to provide a significant proportion of a building's hot water requirement. Like photovoltaics, solar water heating systems are ideally suited to south west through to south east facing roofs with the most energy being gained from a south facing roof angled at 37 degrees. They perform best in direct sunlight rather than passive light conditions such as those experienced on a cloudy day. Solar thermal systems are not typically suited to providing space heating in the UK as require a substantial collector area and an exceptionally large thermal store capable of storing the heat energy for the winter months.

Solar water heating systems require a back up heater to lift the water temperature to the required temperature on days when there is insufficient solar thermal radiation. A typical rule of thumb is 1 $m^2$ of active collector area will offset the equivalent 400 kWh of electrical energy.

## 7.2 Constraints analysis

The main constraint for solar water heating is the number of appropriate non-shaded south facing roofs and number of appropriate buildings in which solar water heating systems can be installed. A typical solar domestic hot water system will have a collector area from 2.5 - 6 square metres, depending upon the number of occupants. The retro-fitting of solar water heating system on an existing building involves some disruption depending on the type of system installed. Either a dual coil cylinder or a secondary solar preheat cylinder would be installed. In recent years there has been a tendency to build houses with combination boilers and so do away with a hot water cylinder. This can make it difficult to install solar water heating systems as there may be insufficient space for the new solar store. In addition the solar store is typically larger than a typical domestic hot water cylinder.

As with photovoltaic systems, in conservation areas and on listed buildings, solar water heating collectors can be viewed as influencing the character of the area or building so planning may be an issue.

# 8 HEAT PUMPS

Heat pumps can either utilise the air as a heat source or the ground as a heat source. Both ground source and air heat pumps are discussed.

## 8.1 Ground source heat pumps

Ground Source Heat Pumps (GSHP) work by extracting heat from the ground, which maintains a fairly constant temperature throughout the year, and upgrading it to a more useful temperature to be used for heating. This can be then used to provide heating to a building. A ground source heat pump can also be used in reverse to provide cooling. Ground source heat pumps are best suited to larger buildings (for reasons of economy of scale) with good levels of thermal insulation. An area of land next to the building will be required to install ground source loops (vertical or horizontal).

As shown in Figure 34, a heat pump system consists of a ground heat exchanger, a heat pump and a distribution system. The ground heat exchanger is a sealed loop of pipe buried either vertically or horizontally in the ground. The refrigerant can be circulated directly through the ground heat exchanger or indirectly where a water/antifreeze solution circulates in the ground loop and energy is transferred from the heat pump refrigerant circuit via a heat exchanger (a closed loop system) [22].

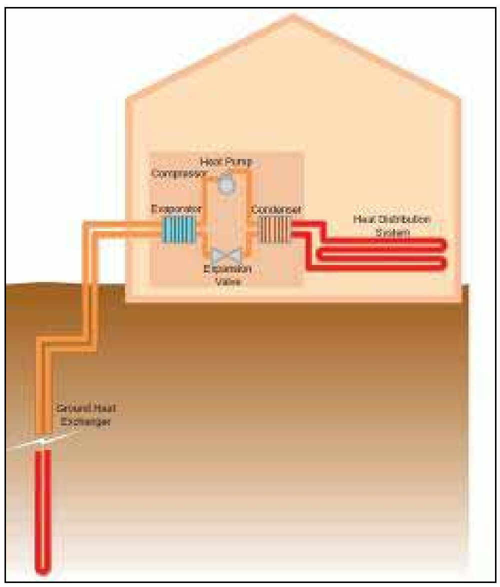



**Figure 34: Schematic of a closed loop ground source heat pump**

Heat pumps use electricity for their operation i.e. to pump the fluid around the pipes in the ground. The efficiency of the heat pump depends on the temperature of the supply temperature (determined by ground temperatures) and the temperature of the heating distribution system. GSHPs are particularly suitable for low temperature heating systems, such as underfloor heating, as this maximises the efficiency of the heat pump.

[22] Domestic Ground Source Heat Pumps: Design and Installation of closed-loop systems, Good Practice Guide 339, BRE, January 2003.

# 9 BUILDING INTEGRATED TECHNOLOGIES

As discussed in the above sections the total potential for building integrated renewable energy technologies (solar water heating, solar PV, small wind, ground source heat pumps and biomass heating) depends partly on the progressive tightening of building regulations as well as the existence of any local planning requirements to install renewables on new buildings.

The total potential for the building integrated renewables has been estimated based on the planned tightening of the building regulations (for further information see the accompanying report developed as part of the same project 'Energy Efficiency Recommendations for New Developments'.

The estimation uses the expected proportion of renewables to meet the building regulations together with the number of new developments expected in each local authority. Retrofits are based on a percentage of the number of existing homes and the floor area of existing non-domestic buildings (from GIS analysis).

Three scenarios were developed, the low scenario assumes building regulations compliance and little incentives for retro-fits, the medium scenario assumes local planning policy encourages higher levels of renewables and the high scenario assumes higher incentives for both new and retro fit applications.

The percentage of buildings installing microgeneration is difficult to predict accurately since the total potential for renewable energy on existing buildings is large but the realisation of the potential depends on local and national policies. Currently relatively little is being done to encourage retro-fitting of building integrated renewables. Table 29 shows the assumptions used for existing buildings for the three scenarios.

**Table 29: Percentage of existing buildings installing microgeneration**

| Scenario | [2008-2009] | [2010-2012] | [2013-2015] | After 2016 |
|---|---|---|---|---|
| Low | 0.1% | 0.2% | 2.5% | 5.0% |
| Medium | 1.0% | 2.5% | 5.0% | 10.0% |
| High | 2.5% | 5.0% | 10.0% | 25.0% |

**Table 30: Percentage of new buildings installing microgeneration**

| Scenario | [2008-2009] | [2010-2012] | [2013-2015] | After 2016 |
|---|---|---|---|---|
| Low | 2% | 10% | 50% | 100% |
| Medium | 4% | 25% | 50% | 100% |
| High | 15% | 50% | 100% | 100% |

The figures below present the results of the assessment for the three scenarios. It is clear that the building integrated technologies represent the greatest potential for renewable energy, apart from in Harborough, which of the seven authorities has the greatest potential for wind. Existing buildings represent between 20% and 74% of the estimated potential for building integrated renewables, depending on the type of building considered and the scenario.

**Table 31: Total potential for building integrated renewables (LOW SCENARIO)**

| | Biomass heating | GSHP | PV | SWH | Small wind | Total MW electric | Total MW thermal |
|---|---|---|---|---|---|---|---|
| Council | MW (thermal) | MW (thermal) | MW (electrical) | MW (thermal) | MW (electrical) | MW | MW |
| Blaby | 1 | 4 | 9 | 7 | 1.0 | 10 | 11 |
| Harborough | 1 | 4 | 10 | 6 | 1.2 | 11 | 12 |
| Hinckley & Bosworth | 1 | 5 | 10 | 7 | 1.3 | 12 | 13 |
| Oadby & Wigston | 0 | 1 | 2 | 2 | 0.3 | 3 | 3 |
| North West Leicestershire | 2 | 7 | 16 | 10 | 2.2 | 18 | 19 |
| Melton | 1 | 4 | 7 | 4 | 1.1 | 8 | 9 |
| Rutland | 1 | 2 | 4 | 3 | 0.6 | 5 | 5 |
| **Total** | **7** | **27** | **59** | **39** | **8** | **67** | **73** |

**Table 32: Total potential for building integrated renewables (MEDIUM SCENARIO)**

| | Biomass heating | GSHP | PV | SWH | Small wind | Total MW electric | Total MW thermal |
|---|---|---|---|---|---|---|---|
| Council | MW (thermal) | MW (thermal) | MW (electrical) | MW (thermal) | MW (electrical) | MW | MW |
| Blaby | 1 | 6 | 12 | 9 | 1.4 | 13 | 16 |
| Harborough | 2 | 8 | 15 | 9 | 2.1 | 17 | 19 |
| Hinckley & Bosworth | 2 | 7 | 13 | 9 | 1.6 | 15 | 18 |
| Oadby & Wigston | 0 | 3 | 4 | 3 | 0.5 | 4 | 6 |
| North West Leicestershire | 2 | 10 | 20 | 13 | 2.9 | 23 | 25 |
| Melton | 1 | 6 | 11 | 6 | 1.7 | 12 | 14 |
| Rutland | 1 | 4 | 6 | 4 | 1.4 | 8 | 8 |
| **Total** | **10** | **44** | **81** | **52** | **12** | **93** | **106** |

**Table 33: Total potential for building integrated renewables (HIGH SCENARIO)**

| | Biomass heating | GSHP | PV | SWH | Small wind | Total MW electric | Total MW thermal |
|---|---|---|---|---|---|---|---|
| Council | MW (thermal) | MW (thermal) | MW (electrical) | MW (thermal) | MW (electrical) | MW | MW |
| Blaby | 3 | 8 | 24 | 17 | 3.1 | 27 | 28 |
| Harborough | 4 | 20 | 31 | 17 | 4.9 | 36 | 41 |
| Hinckley & Bosworth | 3 | 18 | 29 | 19 | 3.9 | 32 | 40 |
| Oadby & Wigston | 1 | 6 | 8 | 6 | 1.1 | 10 | 13 |
| North West Leicestershire | 4 | 20 | 34 | 21 | 4.9 | 39 | 44 |
| Melton | 3 | 14 | 22 | 12 | 3.5 | 25 | 29 |
| Rutland | 2 | 8 | 13 | 7 | 2 | 14 | 17 |
| **Total** | **20** | **94** | **160** | **98** | **23** | **183** | **212** |

# 10 SUMMARIES OF OPPORTUNITIES

A summary of the renewable energy opportunities identified for large wind energy, hydro and biomass energy from anaerobic digestion and from straw and annual energy crops is provided in the following tables. As mentioned within the technology specific sections there are various factors which will affect the development of renewables. For this reason the final results are summarised according to three scenarios –low, medium and high. The high scenario is the most optimistic.

**Table 34: Total potential for large wind energy, hydro and biomass energy from anaerobic digestion (LOW SCENARIO)**

| | Wind | | Hydro | | Anerobic digestion of cattle and pig slurry | | Straw and annual energy crops (e.g. Triticale) | |
|---|---|---|---|---|---|---|---|---|
| **Council** | **MW** | **MWh/ year** | **MW** | **MWh/year** | **MW (electrical )** | **MWh/year** | **MW (electrical)** | **MWh/year** |
| **Blaby** | 0 | 0 | 0.0 | 0.0 | 0.2 | 1 209 | 1 | 34 994 |
| **Harborough** | 12 | 26 280 | 0.0 | 0.0 | 0.5 | 3 314 | 8 | 69 998 |
| **Hinckley & Bosworth** | 4 | 8 760 | 0.0 | 0.0 | 0.5 | 3 314 | 4 | 34 994 |
| **Oadby & Wigston** | 0 | 0 | 0.0 | 0.0 | 0.0 | 0 | 0 | 0 |
| **North West Leicestershir e** | 0 | 0 | 0.3 | 1.0 | 0.2 | 1 189 | 3 | 29 892 |
| **Melton** | 6 | 13 140 | 0.0 | 0.0 | 0.4 | 2 934 | 7 | 63 270 |
| **Rutland** | 4 | 8 760 | 0.0 | 0.0 | 0.1 | 383 | 6 | 56 666 |
| **Total** | **26** | **56 940** | **0.3** | **1** | **1.8** | **12 342** | **30** | **289 813** |

**Table 35: Total potential for large wind energy, hydro and biomass energy from anaerobic digestion (MEDIUM SCENARIO)**

| | Wind | | Hydro | | Anerobic digestion of cattle and pig slurry | | Straw and annual energy crops (e.g. Triticale) | |
|---|---|---|---|---|---|---|---|---|
| Council | MW | MWh/year | MW | MWh/year | MW (electrical) | MWh/year | MW (electrical) | MWh/year |
| Blaby | 4 | 8 760 | 0.0 | 0.0 | 0.2 | 1 450 | 2 | 41 993 |
| Harborough | 24 | 52 560 | 0.0 | 0.0 | 0.6 | 3 977 | 10 | 83 998 |
| Hinckley & Bosworth | 4 | 8 760 | 0.0 | 0.0 | 0.6 | 3 977 | 5 | 41 993 |
| Oadby & Wigston | 2 | 4 380 | 0.0 | 0.0 | 0.0 | 0 | 0 | 0 |
| North West Leicestershire | 0 | 0 | 1.5 | 4.5 | 0.2 | 1 427 | 4 | 35 870 |
| Melton | 12 | 26 280 | 0.0 | 0.0 | 0.5 | 3 521 | 9 | 75 923 |
| Rutland | 18 | 39 420 | 0.0 | 0.1 | 0.2 | 459 | 8 | 67 999 |
| **Total** | **64** | **140 160** | **1.5** | **4.6** | **2.2** | **14 810** | **37** | **347 776** |

**Table 36: Total potential for large wind energy, hydro and biomass energy from anaerobic digestion (HIGH SCENARIO)**

| | Wind | | Hydro | | Anerobic digestion of cattle and pig slurry | | Straw and annual energy crops (e.g. Triticale) | |
|---|---|---|---|---|---|---|---|---|
| Council | MW | MWh/year | MW | MWh/year | MW (electrical) | MWh/year | MW (electrical) | MWh/year |
| Blaby | 6 | 13 140 | 0.0 | 0 | 0.2 | 1 612 | 2 | 46 659 |
| Harborough | 30 | 65 700 | 0.0 | 0 | 0.6 | 4 419 | 11 | 93 331 |
| Hinckley & Bosworth | 16 | 35 040 | 0.0 | 1 | 0.6 | 4 419 | 5 | 46 659 |
| Oadby & Wigston | 4 | 8 760 | 0.0 | 0 | 0.0 | 0 | 0 | 0 |
| North West Leicestershire | 10 | 21 900 | 2.1 | 5 | 0.2 | 1 585 | 5 | 39 855 |
| Melton | 30 | 65 700 | 0.0 | 0 | 0.5 | 3 912 | 10 | 84 359 |
| Rutland | 24 | 52 560 | 0.1 | 0 | 0.2 | 510 | 9 | 75 555 |
| **Total** | **120** | **262 800** | **2.1** | **7** | **2.4** | **16 456** | **41** | **386 418** |

The following figures summarise the total renewable energy potential for both large scale and building integrated technologies.

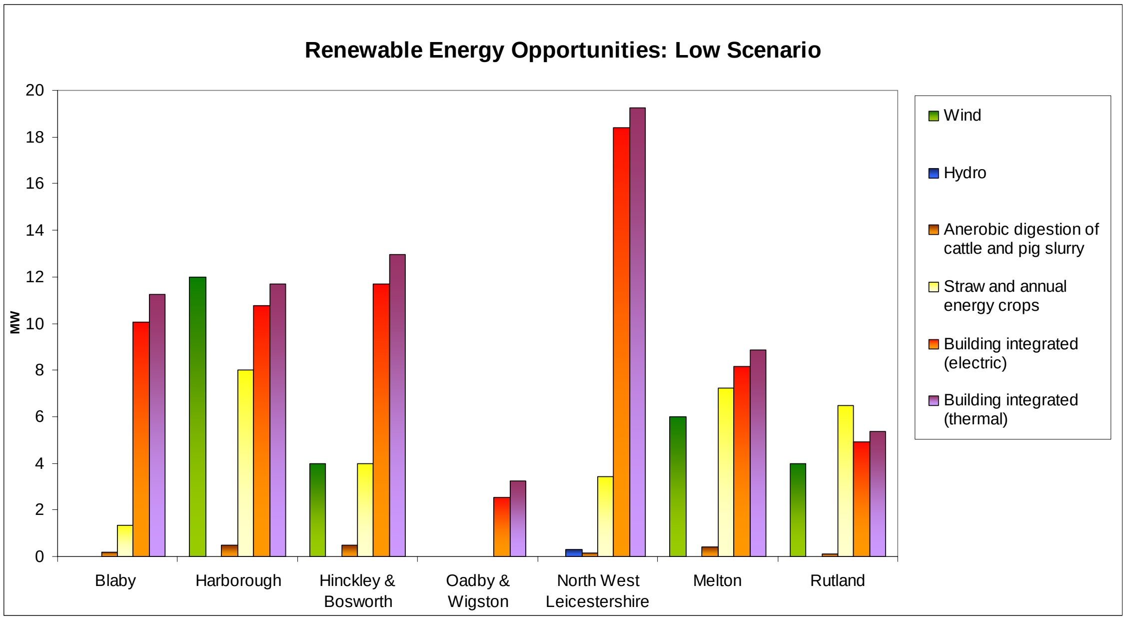



**Figure 35: Summary of opportunities for Renewable energy (Low Scenario)**

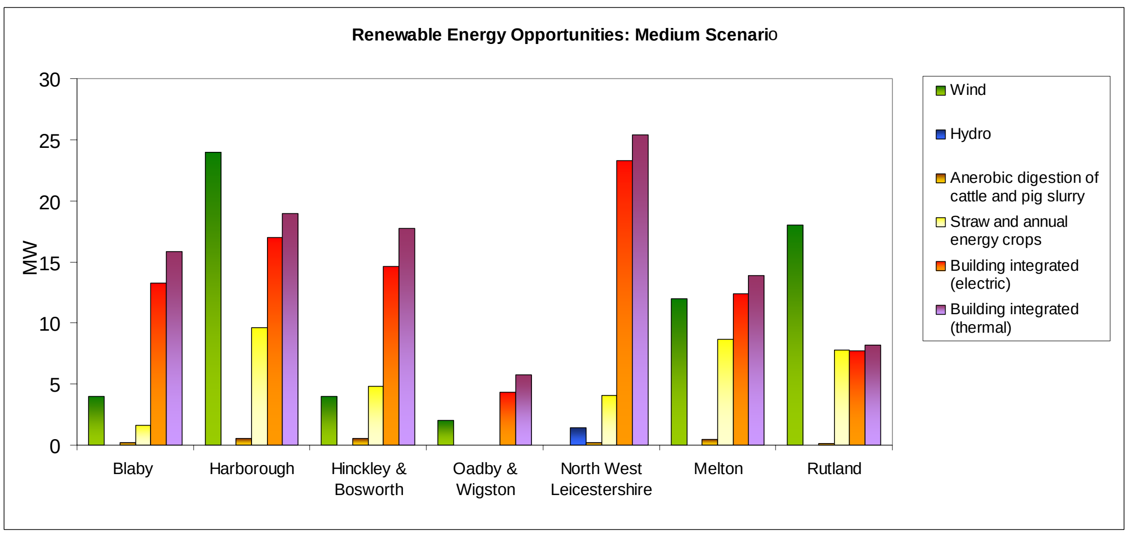



**Figure 36: Summary of opportunities for Renewable energy (Medium Scenario)**

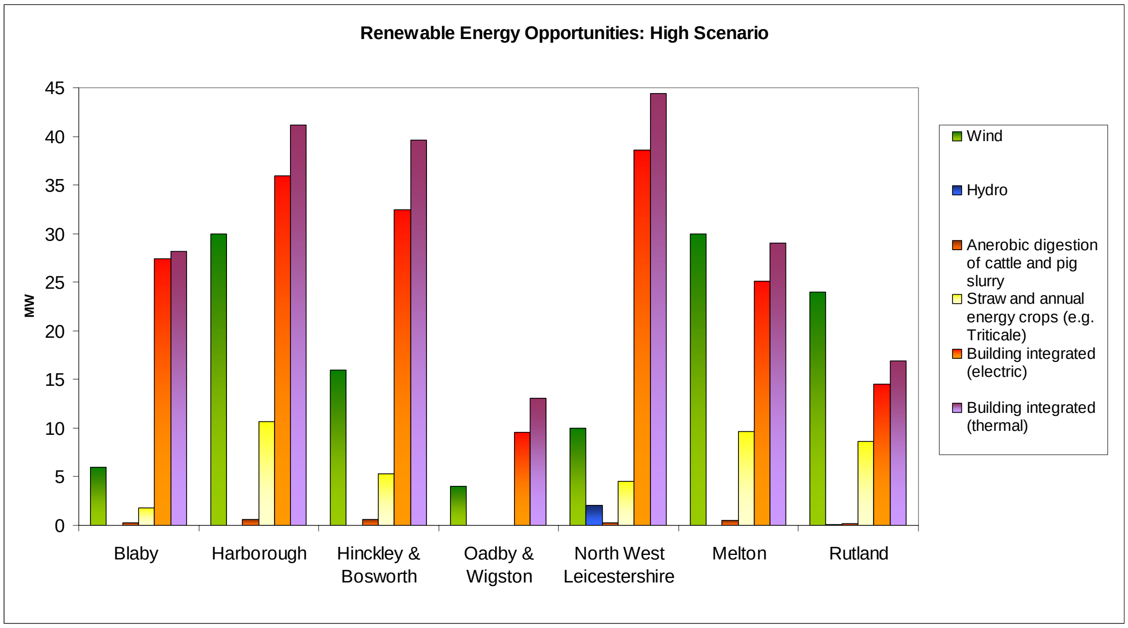



**Figure 37: Summary of opportunities for Renewable energy (High Scenario)**

## 11 RECOMMENDED TARGETS

IT Power recommends that the results for the medium scenario (presented in Table 37) be adopted as targets for renewable energy development by 2026.

**Table 37: Recommended targets for renewable energy development by 2026**

| Recommended Renewable Energy Targets | | | | | | |
|---|---|---|---|---|---|---|
| | Wind | Hydro | Anerobic digestion of cattle and pig slurry | Straw and annual energy crops | Building integrated renewables: solar PV and micro wind | Building integrated renewables: Biomass heating, solar water heating and GSHP |
| | MW | MW | MW | MW | MW electric | MW thermal |
| Blaby | 4 | 0 | 0 | 2 | 13 | 16 |
| Harborough | 24 | 0 | 1 | 10 | 17 | 19 |
| Hinckley & Bosworth | 4 | 0 | 1 | 5 | 15 | 18 |
| Oadby & Wigston | 2 | 0 | 0 | 0 | 4 | 6 |
| North West Leicestershire | 0 | 1 | 0 | 4 | 23 | 25 |
| Melton | 12 | 0 | 0 | 9 | 12 | 14 |
| Rutland | 18 | 0 | 0 | 8 | 8 | 8 |
| **Total** | **64** | **1** | **2** | **37** | **93** | **231** |

The following section recommends policy measures to realise the above proposed targets. In addition the authorities should consider adopting the above targets, developing an action plan for their realisation and a monitoring plan to assess progress towards the targets. Such an action plan should build on the stakeholder consultation make during this study and be developed in terms of:

1) Timeline for development and critical milestones
2) Stakeholder relationships
3) Financing and funding options – which may include Energy Service Company (ESCo) arrangements and Public private partnerships
4) Regulatory issues – including un-licensed supply, Private wire network arrangements, Relationship to national, regional and local planning policies
5) Maximising use of local skills and expertise

# 12 POLICY RECOMMENDATIONS

National, regional and local planning policies are crucial in realising the potential for renewables. National planning guidance includes[23]:

- Planning Policy Statement 1: Delivering Sustainable Development and its supplement on Climate Change
- Planning Policy Statement: Planning and Climate Change - Supplement to Planning Policy Statement 1

The recently published supplement to Planning Policy Statement 1 on Climate Change confirms that there will be situations where it could be appropriate for local planning authorities to expect higher levels of building sustainability than the standards set nationally through Building Regulations. The policy sets out that local requirements should be brought forward through development plan documents and focus on known opportunities. Local planning authorities are expected to demonstrate clearly the local circumstances that warrant and allow such local requirements.

The guidance states that planning authorities need to assess their area's potential for accommodating renewable and lowcarbon technologies. And also that substantial new developments will need to gain a significant proportion of their energy supply from renewable technologies. It also calls on developers and councils to consider the potential for connecting developments to neighbouring community heat and power schemes that can serve an entire local community.

The Planning for Climate Change project provides the authorities with information on the local opportunities for renewables.

In order to realise the potential identified there are three key areas for policy intervention:

1. Additional renewable energy or carbon reduction requirements for new developments
2. Encouraging strategic approach to energy supply for new developments
3. Encouraging appropriate large scale RE development

Actions to take within these three areas include:

- Criteria based policies within:
  - Local development framework
  - Community strategies
  - Economic development plans
  - Environmental strategies
  - Forestry frameworks
- Other wider actions – e.g. training and promotional activities
- Development of local expertise, building on existing successes such as the biomass heating installation company Rural Energy. This will ensure benefits from employment and income generation are maximised.
- Collaboration between authorities and with Leicestershire County Council (LCC), for example on the Anaerobic Digestion initiative currently being lead by LCC.

[23] A summary of national policies relating to sustainable energy is provided within Section 3 of the report 'Climate Change Assessment of Development Options' also developed as part of this Planning for Climate Change project.

## 12.1 Additional renewable energy or carbon reduction requirements for new developments

### *12.1.1 Existing local relevant sustainable energy policies*

There is increasing use of Merton type policies requiring 10% on site renewables for larger developments (10 dwellings or more). Most recently targets are being set beyond 10% at 15 or 20%.

**Merton Rule**

The London Borough of Merton and Croydon have been at the forefront of policy development and implementation. In October 2003 the London Borough of Merton adopted the Unitary Development Plan (UDP) policy PE 13 which is often referred to as the Merton Rule.

Policy PE13 reads: "The council will encourage the energy efficient design of buildings and their layout and orientation on site. All new non-residential development above a threshold of 1,000 sqm will be expected to incorporate renewable energy production equipment to provide at least 10 % of predicted energy requirements. The use of sustainable building materials and the re-use of materials will also be encourage, as will the use of recycled aggregates in the construction of buildings. This will be subject to the impact on the amenity of the local environment, taking into account existing character of the area."

**Croydon Unitary Development Plan (UDP) (Adopted July 2006) Chapter 8**

Croydon adopted similar policy to the Merton Rule which was incorporated into the Unitary Development Plan in 2006.

Policy EP16 reads: "The Council will encourage all developments to incorporate renewable energy, but will require proposals for non-residential developments exceeding 1 000 square metres gross floorspace, and new residential developments comprising 10 or more units, whether new build or conversion, to incorporate renewable energy production equipment to off-set at least 10 % of predicted carbon emissions, except where:

a) the technology would be inappropriate;

b) it would have an adverse visual or amenity impact that would clearly outweigh the benefits of the technology; and

c) renewable energy cannot be incorporated to achieve the full 10 %.

Where the 10% requirement cannot be achieved on major developments, a planning obligation will be sought to secure savings through the implementation of other local renewable energy schemes."

The simplicity of these policies has been instrumental in their application and is something which should be considered when formulating renewable energy policy.

There are four key rationales behind Merton's UDP renewable energy policy. These being:

1. It will act as a Global to Local initiative for helping the UK to meet its Kyoto commitments and domestic $CO_2$ reduction targets.
2. Provide a way of addressing fuel poverty, and making Merton businesses more competitive by lowering their monthly energy bills.
3. Act as mechanism for expanding the renewable and sustainable energy economy.

4. Provide a way of raising the profile of renewable energy and combating climate change in Merton, and stimulating the debate on establishing secure and sustainable energy sources for the future.

General questions which are often raised with regards the Merton Rule are discussed below.

**Can a 10% or higher renewable energy generation target on new developments be realistically achieved?**

Yes, although there will inevitably be some developments which are not able to encompass renewables or sufficient renewable generation to achieve 10% target. This may be due to orientation, available area of the plot or intended use. In these situations some leeway has been given to other technologies such as combined heat and power or a requirement for the developer to encompass other design features.

Other considerations could be the offsite generation. This could be in the form of providing funds for the installation of other community-based renewable energy generation schemes. This does present further issues such as which potential community system should be funded. Alternatively the purchasing of green electricity could be made a requirement on building occupants however ensuring compliance is unlikely to be feasible.

**Have other councils adopted the 10% rule?**

To date another 97 authorities have adopted the Merton Rule (either fully or within draft LDF/SPD) with over a 100 other authorities actively progressing adoption.

**What about higher than 10%?**

Merton expects that its policy will be extended to cover all development in Merton therefore it will include residential. Further to this, during consultation on the LDF it will be considered whether it is appropriate to increase the percentage of the policy up to a 20% requirement.

North Devon has set a target of 15 % $CO_2$ reduction from renewables and Kirklees Council have proposed that by 2011, 30 % of energy used in the council's new buildings is to come from renewable sources. In addition Kirklees have set an incremental target for non-residential developments above a threshold of 500 $m^2$ along with all residential developments (new build, renovation or conversion). Woking has set a requirement for 20% on-site renewables within its Preferred Option Core Strategy.

**Kirklees Policy EN2**

Proposals for major development submitted before 2011 will need to include an energy efficiency statement and incorporate renewable energy generating capacity to provide at least 10 % of the development's predicted energy needs; proposals submitted during 2011 to 2015 will need to incorporate 15 % and proposals submitted after 2015, 20 %

Kirklees have been highly active with significant number of renewable installations both on schools, council premises and social housing. Their targets are ambitious and there will inevitably be developments which will not be able to achieve the targets set. At the time of writing feedback on how developments that could not achieve the targets would be dealt with had not been obtained.

Ambitious targets such as those of Kirklees should not be dismissed as they encourage uptake of new technologies. Consideration must be put in place for buildings which cannot achieve the targets. Measures adopted for buildings which cannot achieve these targets must be a last resort and challenging in themselves to prevent developers trying to opt for the easier option. In reality each development has to be assessed individually and the onus put on the developer.

**What about sustainable energy and carbon reductions rather than just renewable energy?**

Some Merton Type policies lack in flexibility and may not lead to the implementation of the most cost effective methods in reducing carbon emissions, nor do they necessary address the need to consider energy supply strategically, prioritising community heating and combined heat and power, which is important to utilise biomass.

The London Plan's policies on sustainable energy consider renewable energy, energy efficiency and combined heat and power. The full policy wording can be viewed at http://www.london.gov.uk/thelondonplan/climate/

**London Plan Policy 4A.7 Renewable energy**

The London Plan Policy on Renewable Energy states: Mayor will and boroughs should in their DPDs adopt a presumption that developments will achieve a reduction in carbon dioxide emissions of 20% from onsite renewable energy generation (which can include sources of decentralised renewable energy) unless it can be demonstrated that such provision is not feasible. This will support the Mayor's Climate Change Mitigation and Energy Strategy and its objectives of increasing the proportion of energy used generated from renewable sources by:

- requiring the inclusion of renewable energy technology and design, including: biomass fuelled heating, cooling and electricity generating plant, biomass heating, combined heat, power and cooling, communal heating, cooling and power, renewable energy from waste, photovoltaics, solar water heating, wind, hydrogen fuel cells, and ground-coupled heating and cooling in new developments wherever feasible
- facilitating and encouraging the use of all forms of renewable energy where appropriate, and giving consideration to the impact of new development on existing renewable energy schemes.

Boroughs in their DPDs should identify broad areas where the development of specific renewable energy technologies are appropriate. These should encourage the fullest realisation of the potential for renewable energy having regard to the environmental and transport policies of the London Plan. These should include:

- identifying sites for zero carbon development
- identifying suitable locations for wind turbines in developments
- encouraging at least one large wind power scheme in London
- encouraging applications for new street appliances (such as bus shelters, bus stops, parking ticket machines and road signs) to incorporate off-grid solar power and other renewable energy sources where feasible.

**Policy 4A.4 of the London Plan** requires all strategic planning applications to submit an energy assessment demonstrating how the scheme is consistent with the London Plan's energy policies. All major applications to London Borough Councils should include an assessment of energy demand.

Energy assessments should take a site-wide approach and demonstrate how a proposed development incorporates (in a sequential hierarchy) a reduction in energy demand, use of renewable energy and efficient energy supply into the design.

The policy sets a broad target of 25% improved energy efficiency above the minimum requirements of the building regulations. Once energy demand has been reduced it requires the use of 1) combined heat and power and 2) onsite renewable energy generation to reduce carbon dioxide emissions by a further 10%.

### Developer concerns

It is sometimes suggested that developers would shy away from implementing the Merton rule and move on to other areas which do not impose such a policy. Merton and Croydon's experience has not substantiated this concern. Instead developers have embraced the policy and worked with planning to ensure a satisfactory solution. Instances where there have been difficulties in achieving the 10 % rule have involved close consultation with the planners.

In a recent review under taken by IT Power one engineering consultant expressed concern that developers would try to address the renewables target rather than look to reduce the carbon foot print of the building. In reality the policy encourages the developer indirectly to reduce the carbon footprint of the building as reducing on site energy consumption has a resultant reduction in the 10% energy that needs to be generated on site.

Concerns over the cost of implementing new technologies on new developments have to date been unfounded as typically have only added up to 3 % of the development costs. In addition developers have often believed that this can be clawed back through marketing the developments as "sustainable".

### Enforcement Condition

Merton Borough believed that the enforcement condition that accompanied any new development which had been granted planning permission was important. This is to ensure that technologies that are put in place are not just shown to work for the purposes of the final planning inspection but to ensure that they will continue into the future. As a result the following wording accompanies any new planning permission to which the Merton rule applies:

> "Before any unit is occupied the renewable energy equipment shall have been installed and the local planning authority shall be satisfied that their day to day operation will provide energy for the development for so long as the development remains in existence.
>
> The carbon savings which result from this will be above the requirements of the legal Building Regulations."

The final sentence is to ensure that developers do not just employ renewable technologies to overcome the $CO_2$ reduction requirement of Part L of current building regulations and ignore energy efficient measures.

## 12.2 Encouraging strategic approach to energy supply for new developments

In order to achieve lower carbon development and in order to achieve significant contributions from on-site renewables in new developments a strategic approach will be required.

Policies such as the London Energy Policies (described above) encourage developers to take such an approach. This is especially important to link new developments to renewable sources of heat e.g. Anaerobic digestion.

The authorities should also consider giving support to developers to take a strategic approach. This could include training and awareness raising events and encouraging developers to make links with experts in sustainable energy provision. For example Sheffield City Council brought together developers, architects and sustainable energy experts as part of a sustainable design panel to deliver projects as part of the Housing Market Renewal Programme.

## 12.3 Encouraging appropriate large scale RE development

The information contained within the reports provides each authority with information on the potential for renewable within their area.

As set out in section 11, the authorities should consider targets for renewable energy (and monitor progress towards the targets).

In addition to policies to encourage renewable energy within new developments, significant renewable energy development such as wind and biomass should be encouraged within planning policy.

Authorities should ensure that their development control planners are familiar with the technologies found to be suitable in their area. There are a number of national training initiatives to provide development control planners with specific guidance on considering renewable energy technologies. These include the Department for Business and Regulatory Reform (BERR) funded initiative to be continued from summary 2008 http://www.planningrenewables.org.uk

Ensuring the general public and communities are familiar with renewable energy technologies is also important in ensuring development proposals are accepted locally. One good way to help develop public awareness is the development of exemplar projects e.g. in schools and council property. The Brocks Hill Visitor Centre and Country Park in Oadby is a good example.

In order to maximise local benefits it will be important to develop criteria for community involvement and/or ownership. BERR provides guidance on community involvement in wind energy development[24]. The guidance includes a protocol and best practice guidelines to support public engagement, a 'toolkit' for community benefits, and a report on bankable models for community ownership for wind energy developments.

The authorities should build on existing relationships and co-operate to implement the recommendations of this project. The authorities should also co-operate with Leicestershire County Council for example to support the anaerobic digestion initiative.

[24] http://www.berr.gov.uk/energy/sources/renewables/policy/renewables-advisory-board/community-involvment-wind/guidance-local-authority-officers/page35088.html

## ANNEX 1: UK WIND SPEED DATABASE - NOABL 2000

The data in this database is the result of an air flow model that estimates the effect of topography on wind speed. There is no allowance for the effect of local thermally driven winds such as sea breezes or mountain/valley breezes. The model was applied with 1km square resolution and takes no account of topography on a small scale or local surface roughness (such as tall crops, stone walls, or trees), both of which may have a considerable effect on the wind speed. The data can only be used as a guide and should be followed by on-site measurements for a proper assessment.

Each value stored in the database is the estimated average for a 1km square at either10m, 25m or 45m above ground level. The database uses the Ordnance Survey grid system for Great Britain.

# ANNEX 2: MAPS SHOWING WIND RESOURCE AND LOCATIONS OF POTENTIAL WIND SITES

## ANNEX 3: OUTLINE OF AN EXISTING MILL AT CLAYBROOKE

Claybrooke Water Mill contains one of the oldest working water mills in the Leicestershire, dating back further than the Domesday Book to a map dated 962. The Mill is a commercially operating water mill, milling most days by waterpower and has a reputation for consistent high quality flours and muesli with their own brand of flour and muesli mixes.

Although there is evidence that there has been a mill on this site for more than 1000 years, as the Doomsday book mentions a mill at Claybrooke, the current mill building is dated from the 1850's when Marmaduke Fawkes extended and refurbished the mill, giving the building and machinery that is seen today.

The mill ran into problems in the early 20th century along with most other watermills and finally ceased working in the 1950's. The mill was purchased and restoration started in the early 1980's and finally started milling flour again in 1987.

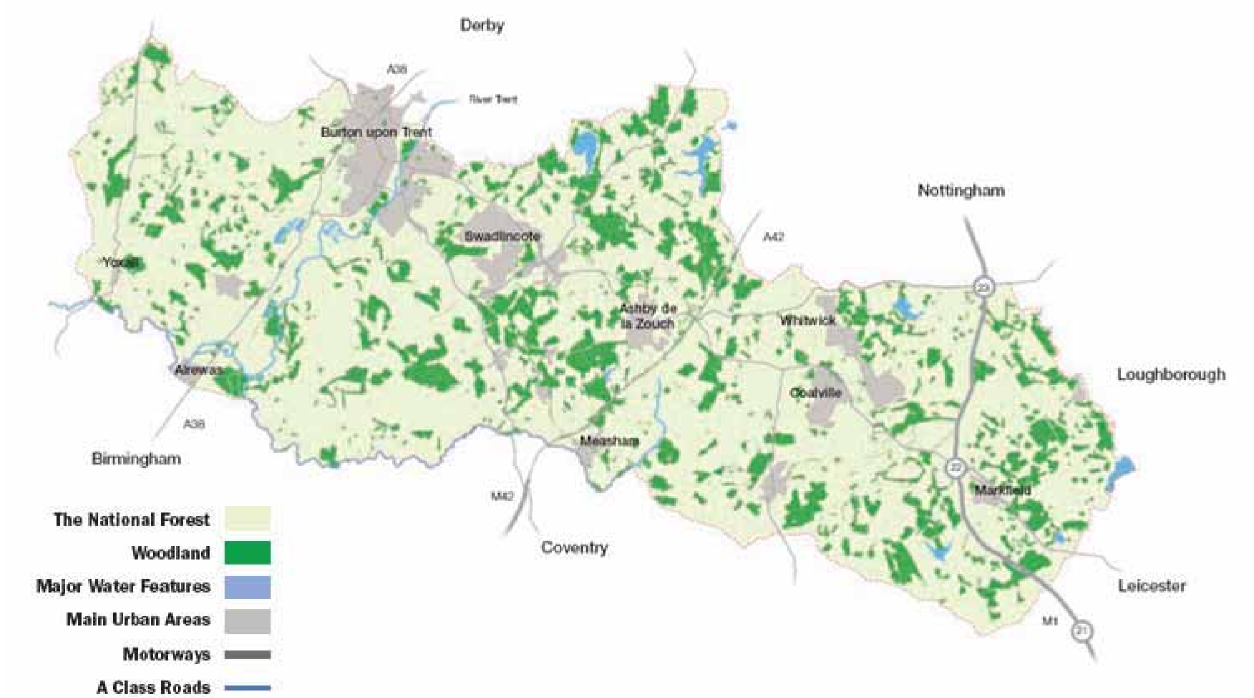
The water mill is a three story building with the 4 metre cast iron water wheel enclosed. The grain is stored on the top floor and is gravity fed into the millstones. The middle floor is where the millstones and most of the equipment are situated.

# ANNEX 4: PHOTOS FROM SITE VISITS TO POSSIBLE HYDRO SITES

# ANNEX 5: MAPS SHOWING LOCATIONS OF POTENTIAL HYDRO SITES

## ANNEX 6: NATIONAL FOREST

### Figure 38: Growing Achievements Map Summer 2007



## ANNEX 7: BIOMASS CONTACT DETAILS

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- Matt Brocklehurst, incentives and land management officer, National Forest Company 01283 551 211

## ANNEX 8: WOODLAND MAPS