What is happening to our oldest wind and solar farms?

End-of-life decision making for onshore wind and solar farms in Great Britain

Research findings and recommendations

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Executive summary

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In the context of a global transition to decarbonise the energy system and meet NetZero targets, expanding energy output from renewables is increasingly important. However, space for renewable energy infrastructure is limited and existing wind farms are beginning to reach the end of their operational or consent life. Given tightening planning and land restrictions, keeping consented infrastructure in place is likely to form a key part of ensuring that renewable energy targets are met. There is also potential to significantly increase the energy generated from existing sites through repowering (replacing existing infrastructure with new). However, the context of existing sites and the opinions of local communities may have changed over time. There is thus a need to consider how we make decisions about the future of our existing onshore renewable energy sites, including how local communities are involved in such decisions.

This report provides the findings of a three-year research project funded by the Economic and Social Research Council. The research explored the policy context and experiences of end-of-life decision-making (repowering, life-extension and decommissioning) for onshore wind and solar farms in Great Britain.

While this research focused on Great Britain, the findings have relevance for a host of other countries, especially in Europe, where there is evidence of tightening spatial constraints around onshore wind energy development.

This research identifies the opportunities that repowering can provide for increasing energy output and providing an opportunity to enhance community benefits. However, it also reveals potential challenges associated with the ability of existing onshore wind and solar generation sites to continue contributing to future energy production, particularly if a longer-term approach to sites is not considered.

It is hoped that the recommendations provided in this report will be of use internationally to policymakers, the renewable energy industry, planners, and communities as more capacity reaches the end of its operational or consent life.

This research would not have been possible without the numerous research participants that gave up their time to speak to me, thank you to all those who participated.

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1. Introduction

With an installed capacity of 594, 253 MW onshore wind and 578, 553 MW solar photovoltaic worldwide, considering the long-term future of our existing onshore renewable energy sites is vitally important. In Great Britain, onshore wind and solar farms are often granted a time-limited planning consent of 25 years. Onshore wind farms are now starting to reach the end of these time-limited consent periods. Elsewhere, sites are beginning to reach the end of their operational life. Consequently, there is a need to understand how decisions are made about their future and with what impacts.

As outlined in section 1.2 below, at the end of the consented or operational life of a wind or solar site developers have three main options; repowering, life-extension or decommissioning. There is also the potential for partial repowering (changing parts of the infrastructure, but keeping the existing foundations and layout), however at the time of the research there was limited experience of this in Great Britain. While collated under the term 'end-of-life decisions', these decisions are not always taken when sites reach the end of their operational or consent life. As discussed in section 5, different factors change over time, potentially making early repowering or life-extension a more viable option.

Given tightening land constraints, the future of onshore renewable energy expansion will largely depend on the ability to continue generation from existing sites. Land is a finite resource and installing more efficient infrastructure enables a greater amount of energy to be produced from the same, or less, land. However, a continuation of a wind or solar farm site will mean the continuation of visual impacts and other impacts on local communities. The decision-making process is thus not straight forward.

This research provided one of the first investigations into how end-of-life decisions are made and considered by the range of groups involved. This report firstly sets out the research aims and methods, it then discusses the results, before providing recommendations for policymakers, renewable energy developers and communities.

1.1 Research aim

The aim of this research project was to understand how decisions regarding end-of-life procedures for solar and wind farms are considered and made by developers, local authorities and planners as well as the communities in which the facilities are located. It sought to explore the details of the decision-making process, including whose interests are included and excluded in that process and with what consequences. It also sought to consider if changes in the surrounding physical, social, cultural, or perceptual area, or shifting opinions of the site, developer, or technology influence considerations regarding duration and end-of-life options.

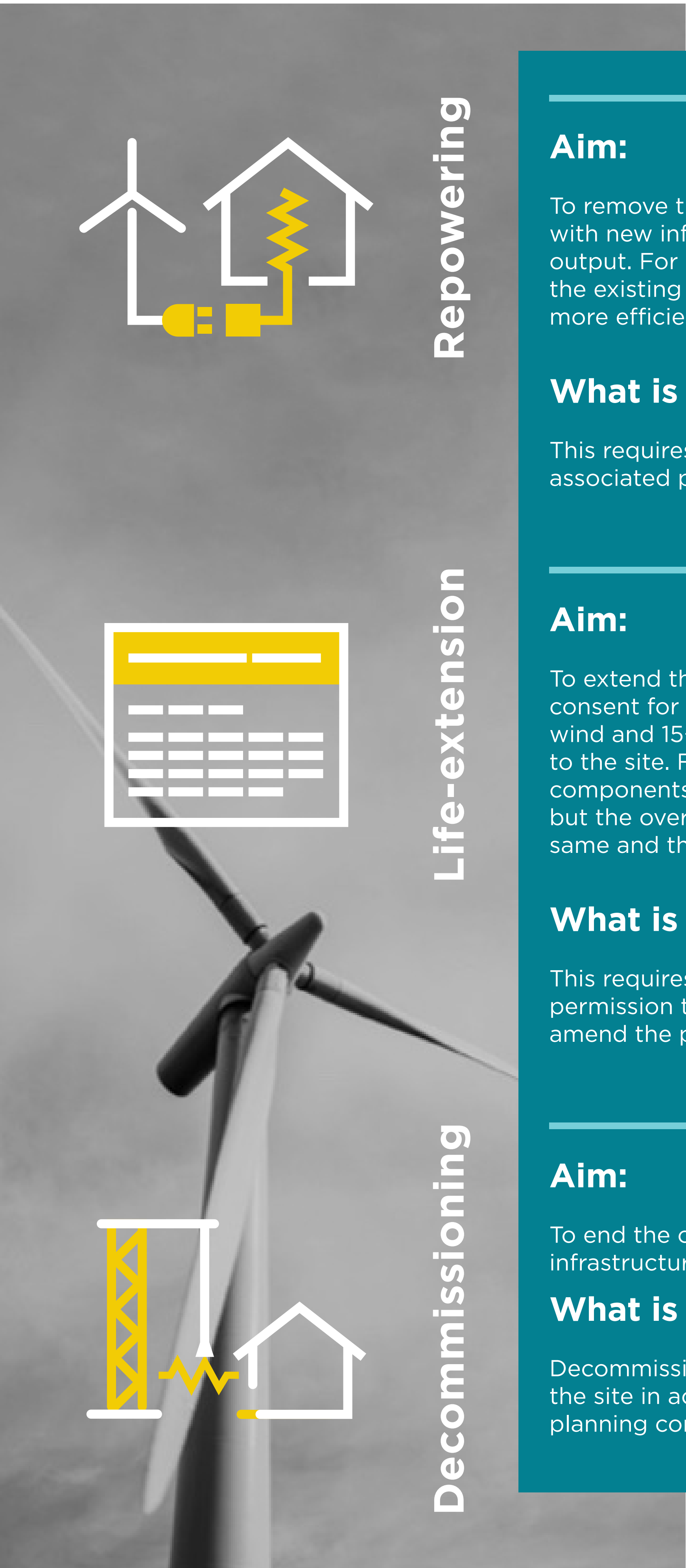
It achieved this through:

i. Mapping and assessing the policy context and current status of the sector for onshore wind and solar farms in Great Britain.

ii. Providing an in-depth investigation of end-of-life decision-making in five cases.

iii. Analysing public perceptions through two public surveys.

1.2 The end-of-life options explored in this research



Repowering

Aim:

To remove the existing infrastructure and replace with new infrastructure, usually with a higher energy output. For wind farms this often involves replacing the existing turbines with a smaller number of larger, more efficient, turbines in a different layout.

What is involved (in GB):

This requires a full planning application and all associated planning reports to be submitted.

Life-extension

Aim:

To extend the duration of the existing planning consent for a period of time (usually 5-10 years for wind and 15+ for solar), with no material changes to the site. For wind farms, during this process some components of the existing turbines may be replaced, but the overall height and layout of the site remain the same and thus compliant with the original consent.

What is involved (in GB):

This requires the duration condition of the original permission to be altered through an application to amend the planning condition.

Decommissioning

Aim:

To end the operation of the infrastructure and remove infrastructure from the site.

What is involved (in GB):

Decommissioning and removing infrastructure from the site in accordance with what is specified in the planning conditions and legal agreements for the site.

2. Research methods

2.1 Research questions

This research sought to answer three questions:

1. How do different actors (including developers, Local Authorities, the public, and any others) prepare and plan for end-of-life decision making for wind and solar facilities? For each actor:

- What end-of-life factors matter?
- What timeframes are sought and invoked?

2. Whose preferences most significantly shape end-of-life decision making?

3. What are the wider consequences of how the temporalities of renewable energy infrastructure are regulated?

2.2 Methods and case study locations

As outlined in figure 1, this research involved four methods. Firstly, the data on the age of existing infrastructure and experiences of repowering (and where available, life-extension) was reviewed[2]. I then undertook a review of relevant policy in England, Wales and Scotland (supplemented with interviews with policymakers) and a review of the planning applications for all repowering and life-extension applications.

Five case studies (four wind farms and one solar farm) were then chosen for in-depth research (see figure 2). The cases were chosen to reflect sites in different locations and with different end-of-life experiences. For each case I undertook a review of the planning files and undertook in-depth interviews with all those involved in the case (communities, local authority planners, planning consultants, developers and opposition groups). In order to get a more detailed understanding of the perspectives of those living closest to existing wind farms, I also undertook survey research with residents living within 3.5km of two wind farms.

The research was undertaken during 2016-2019. The data and policy research was updated in 2021.

[2]Using the GovUK renewable energy planning database

Figure 1: Research methods

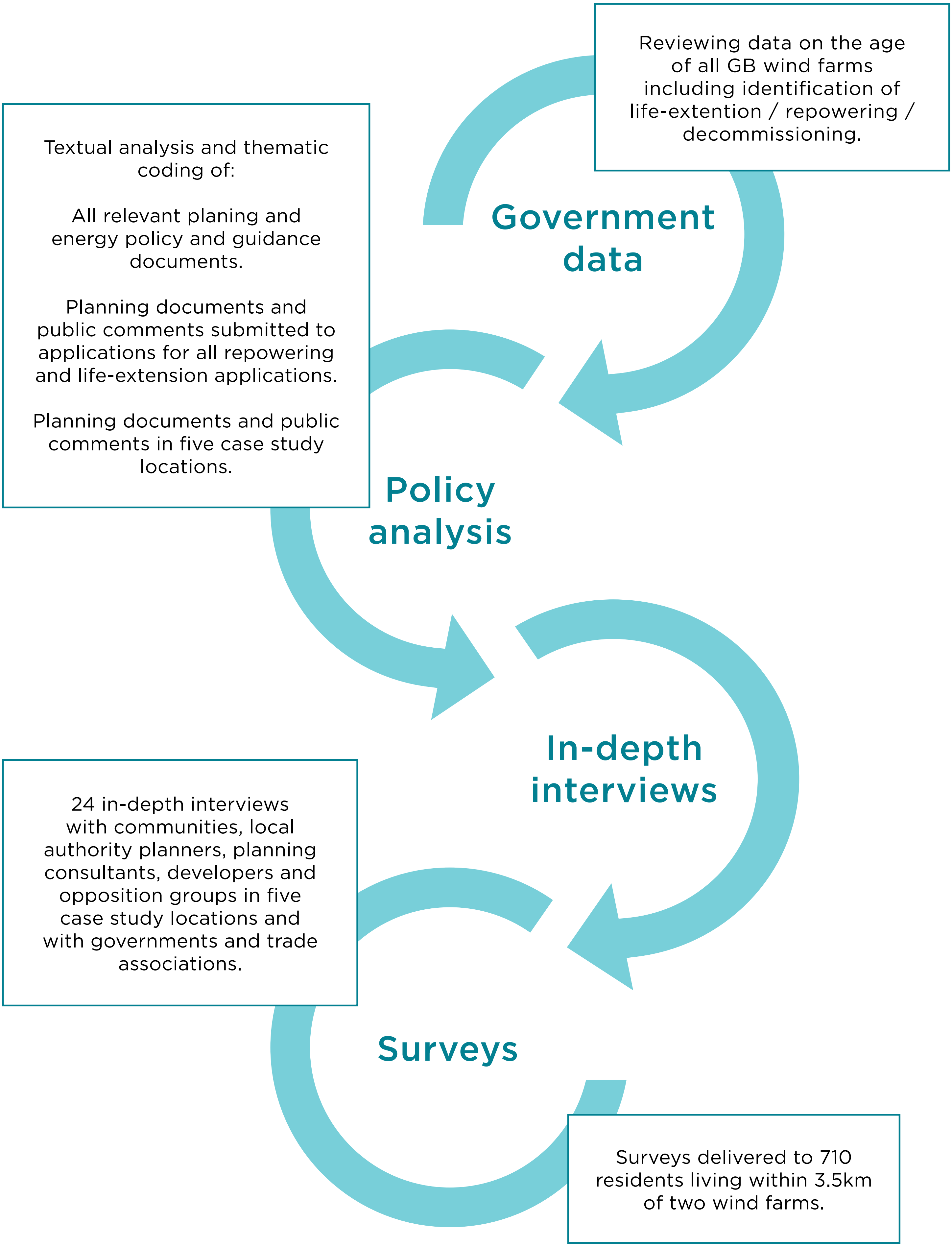


Figure 2: Case study locations

3. Age of infrastructure and end-of-life experiences in Great Britain

3.1 The use of time-limited planning consents

In considering wind and solar energy developments in Great Britain, it is crucial to first reflect upon the use of time-limited planning consents. Wind and solar are distinctive in having been regularly granted time-limited consent periods, often of 25 years. While the research revealed a lack of consensus as to the reasons for the time-limited consents, it is likely to have emerged as a way of managing concerns associated with new, highly visible technology, with the time period based upon the expected operational life of wind turbines.

There is no requirement for 25-year planning consents in England, Wales or Scotland (see table 3), revealing that while the 25-year period is nowhere specified in legislation, it appears to have become treated as a norm. Scottish policy has tried to address this through specifying that there are no statutory or legislative limits to consent duration.

3.2 Age of wind farms in Great Britain

A review of the age and status of existing windfarms revealed the extent to which end-of-life is becoming an increasingly prominent issue. According to the UK Government renewable energy planning database, which provides information on wind farms over 150kW, in 2021 in England, Wales, and Scotland there were 447 wind farms aged 5-14 years (68% of operational wind farms), 67 (10%) aged 15-19 years and 45 (7%) aged 20 or over. The oldest wind farms usually have a lower installed capacity (hence, repowering provides the opportunity to significantly increase the installed capacity of sites). As shown in table 1, 10% of all turbines in Great Britain are now aged 20 or over. However, end-of-life considerations are an issue that is creeping forward steadily rather than reaching a sharp tipping-point. Notably, a more significant proportion of the capacity in Wales has entered the final few years of expected life.

Table 1: Age, turbine numbers and installed capacity of wind farms in England, Wales, and Scotland (Based on 2021 data from Gov.UK)

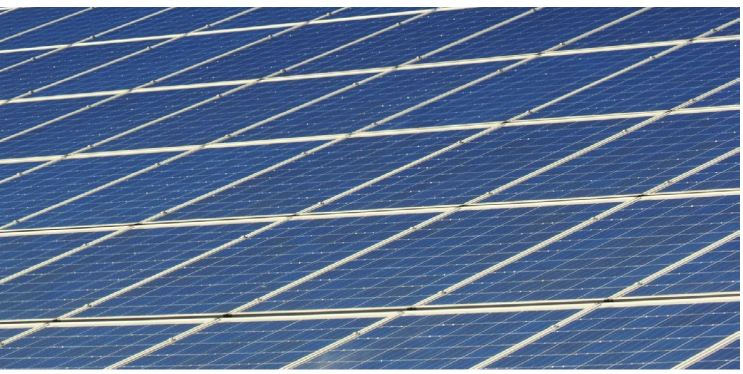
Age of wind farms (years)	England		Wales		Scotland		Total	
	Number and % of all turbines	Installed capacity (MW) and %	Number and % of all turbines	Installed capacity (MW) and %	Number and % of all turbines	Installed capacity (MW) and %	Number and % of all turbines	Installed capacity (MW) and %
5-14	1,097 (74%)	2,281 (80%)	151 (19%)	287 (26%)	2,362 (60%)	5,049 (61%)	3,610 (58%)	7,617 (62%)
15-19	154 (10 %)	215 (8%)	180 (22%)	181 (17%)	492 (13%)	917 (11%)	830 (13%)	1,314 (11%)
20+	133 (9%)	75 (3%)	267 (33%)	131 (12%)	254 (6%)	168 (2%)	654 (10%)	374 (3%)

3.3 Experiences of wind farm repowering

In July 2021, in England, Wales, and Scotland, 23[3] wind farms had been granted permission to repower of which 18 had been implemented. Two schemes had been refused permission to repower, with one (Chelker Reservoir,) refused on two occasions. The situation revealed a high success rate for repowering applications.

To date, most end-of-life applications for solar and wind energy have been granted consent regardless of levels of public opposition. However, for most of the last 25 years specific end-of-life policy has been sparse and the majority of existing repowering (and life-extension) applications were decided before policies were in place.

In order to undertake calculations on the impacts of repowering, the one turbine scheme (Ramsey) was removed from the dataset so that it would not skew the result. Exploring the remaining 22 sites that had been granted repowering permission in Great Britain revealed that on average repowering has decreased the number of turbines on a site by 41% but increased the height of turbines by 98.8%. The average increase in installed capacity (MW) of a site is 143%, (see appendix 4). It is worth considering that despite the significant increases noted here, in some locations land restrictions may create potential barriers to repowering due to the increased space requirements of larger, more efficient turbines with greater rotor diameters. Moreover, the greatest increases in installed capacity are likely to occur from upgrading the earliest sites due to the substantial improvements in turbine technology. Nevertheless, we can see wind farms becoming larger and more economically and energetically efficient.



3.4 Wind farm life-extension

As life-extension varies a condition on a planning consent, rather than requiring a new consent, it is difficult to identify such applications and no database is held. From investigating the oldest wind farms, is estimated that at the time of writing in July 2021 approximately 9 wind farms had been life-extended. No refused life-extension applications had been identified apart from the Kirkby Moor life-extension which was later granted at appeal. Life-extension often occurs when sites are close to the end of their time-limited planning consent. However, there is also evidence of life-extension being undertaken after a short period of operation in order to increase the consent life of an original or repowered scheme, following the granting of a 25-year consent.

3.5 Solar farm life-extension

Ground-mounted solar is a comparatively younger technology than onshore wind. The first schemes in Great Britain became operational in 2011, consequently no sites have repowered and this is unlikely to become a policy concern within the next ten years. However, of more prominence to the solar sector is life-extension. The duration of planning consents for solar farms varies considerably, with most schemes being granted a 25-year consent, some longer and others without time constraints (but with conditions focusing on operational factors). It is now common for solar farms to be sold to investment firms with a 25-year planning consent and then the investment firm will immediately extend the permission to 40-years to ensure that it provides a lower-risk, longer-term investment. There are thus many situations where longer permissions are applied for just a couple of years after the original permission was granted. This is often called ‘pure play development’.

[3] Not including Bu wind farm as permission lapsed and site is now decommissioned. Not including Castle Pill wind farm as it was considered to be an extension rather than repowering.

3.6 Future wind farm repowering potential in Great Britain

Based on sites making end-of-life decisions aged 20 years, the potential number of sites expected to make repowering decisions within the next five and ten years was calculated (see table 2). The table also provides an estimate of the potential energy increase if these sites are repowered based on the average increase in MW discussed in section 3.3.

What this demonstrates is that the potential increase in installed capacity from repowering is significant. However, the figures in table 2 only provide an estimate in terms of potential MW increase from repowering, and this level may decrease as some of the oldest, most inefficient turbines are gradually replaced. It also only provides an estimate in terms of time frames as developers may make end-of-life decisions later due to reasons such as policy constraints or uncertainties and a lack of financial support mechanisms. Developers may also choose to life-extend before repowering, particularly while existing sites benefit from subsidies (many older sites have a subsidy in place until 2027). Moreover, some of the oldest sites do not have time-limited consents and thus do not face the same time-pressures to submit some form of end-of-life application. Additionally, some sites may choose to repower early due to financial reasons such as selling the existing turbines, to achieve greater efficiency benefits, or due to difficulties obtaining replacement parts.

Table 2 Sites expected to make end-of-life decisions in the next 5-10 years (based on 2021)

	Number of sites	Current total MW	Potential MW from repowering (143% increase)	Potential Increase in MW
Making decision within 5 years (aged 15-19 in 2021)	67	1,314	1,879	565
Making decision within 10 years (aged 10-19 in 2021)	211	3,658	5,231	1573

3.7 Experiences of wind farm decommissioning

In Great Britain, two wind farms have been decommissioned without repowering, Bu in Scotland and Chelker Reservoir in England. The limited experience to date suggests that developers carry out decommissioning, as specified in planning conditions, without local planning authority involvement such as approving an updated decommissioning methods statement or specifying additional requirements.

Turbine at Bu wind farm, photo: © Iain Macaulay

Bu wind farm

- Located on the Orkney island of Stronsay.
- 3 turbines.
- Operational in 2002, decommissioned in 2014 after only 12 years of operation.
- Repowering permission granted in 2012 for 3 turbines of a similar output, but not implemented.
- Decommissioning involved removal of the turbines, transformers, and the breaking down of the top 200mm of the foundations and replacement with top-soil.

Chelker Reservoir wind farm, photo: © John Sparshatt

Chelker Reservoir wind farm

- Located in North Yorkshire, England.
- 4 turbines.
- Operational in 1992.
- Decommissioned in 2013, three years before planning permission was due to expire, due to reducing efficiency of the turbines.
- Repowering refused twice (2008 and 2011), reasons included visual impact on the historic landscape and the national park landscape and the impact on nearby residents.
- Site fully decommissioned, no decommissioning plan held by local planning authority.

4. End-of-life policy in Great Britain

4.1 Policy for repowering and life-extension of onshore wind

In England, repowering has come to be treated as an 'exception' from its otherwise very anti-wind policy stance. In 2018, the revised National Planning Policy Framework (NPPF) exempted repowering applications from the constraints on new onshore wind applications, suggesting recognition of the need to support it[4]. However, there is a lack of detail regarding how applications should be assessed. This policy remains in the latest (2021) NPPF. There are no specific policies relating to life-extension in England. However, at the Kirkby Moor life-extension planning appeal the planning inspector agreed that "repowering is an umbrella term covering replacement, replanting and extension of life", therefore potentially setting a precedent for future life-extension applications.

In Wales, 2005 policy (TAN8) considered repowering as a permissible exception to their zoning policy through identifying that there may be opportunities to repower sites located outside of the areas zoned for new large-scale onshore wind; however, it did not consider how applications and their impacts would be assessed. In December 2018, Planning Policy Wales, for the first time, set out a positive approach to repowering and life-extension of all wind farms, identifying the importance of such schemes to meeting decarbonisation and renewables targets[5]. The policy explicitly states that Local Planning Authorities (LPAs) should support schemes, recognising that viability and technological changes may result in repowering schemes having a different format. It specifies that LPAs should set broad criteria for the determination of schemes 'based on the additional impact of the new scheme.' This was also included in the updated Planning Policy Wales (Edition 11 2021). Meanwhile, the 2021 national development framework for Wales 'Future Wales: the national plan 2040' identified that in 'Pre-Assessed Areas for Wind Energy' there is a 'presumption in favour of large-scale wind energy development including repowering'. However, while Welsh policy sets out a supportive approach to repowering and life-extension, it lacks detail regarding assessment of applications and how applications could potentially increase community, environmental, or other benefits.

England and Wales contrast with Scottish Policy, which in 2014 identified that 'areas identified for wind farms should be suitable for use in perpetuity'[6]. This policy also set out a more detailed positive approach to repowering, identifying the benefits of repowering and explicitly classifying the current use of a site (as a wind farm) as a material consideration[7]. 2017 policy built on this positive approach, confirming that the government's position 'remains one of clear support in principle for repowering at existing sites' and identifying the different variations of repowering (including life-extension) and the benefits of repowering, including maximising value for Scotland in terms of economic, social, and environmental benefits[8]. At the time of writing, the Scottish Government were in the process of updating their onshore wind policy statement.

4.2 Decommissioning policy

As outlined in table 3, policy in all three countries gives limited consideration to decommissioning, focusing on ensuring that above-ground visible elements are removed.

[4] UK Government. National Planning Policy Framework 2018, footnote 49

[5] Planning Policy Wales Edition 10, 2018, 5.9.23.

[6] Scottish Government. Scottish Planning Policy. 2014, 170.

[7] Scottish Government. Scottish Planning Policy. 2014, 174

[8] Scottish Government. Onshore wind: policy statement, 2017,35.

4.3 Solar policy

Policy for field-scale solar appears to have been given very little consideration in Great Britain. England has a lack of policy regarding the duration or end-of-life considerations for the infrastructure, with the only mention being in planning guidance that states 'solar farms are normally temporary structures.'[9] Similarly, Scotland has produced no guidance about the duration of solar farm permissions. Welsh policy is supportive of solar, but lacks detail regarding the duration of the infrastructure and associated impacts.

[9] UK Government. Guidance for renewable and low carbon energy 2015, 13.

Table 3: Wind energy policy development 1990-2021

	Consent duration policy	Repowering and life-extension policy	Decommissioning policy
England	Use of temporary consents first suggested in 1993. 2011 policy identified typical turbine design life of 25-years and 25-year consent as typical. Identified that applicants may seek consent for differing time-periods and suggested use of conditions. Identified the time-limited nature of wind farms as an important consideration when assessing impacts.	First mentioned in 2011 - repowering applications should be determined on their individual merits. 2018 National Planning Policy Framework identified that repowered turbines are exempt from the planning constraints placed on new onshore wind farms, providing no further detail. No consideration of life-extension.	First considered in 2011 policy recognising the need for applicants to set out details of what will be decommissioned. 2013 guidance suggested use of conditions to ensure turbine removal and land restoration.
Wales	First mention of the use of temporary planning permissions in 1993 guidance. 25-year consent period mentioned in non-statutory guidance. No policy on consent duration.	TAN 8 (2005) set out a positive approach for repowering or life-extension of sites outside Strategic Search Areas, subject to environmental and landscape impacts (no mention of sites within SSA). Planning Policy Wales 10 (2018) set out positive approach to repowering and life-extension more broadly, including recognition that sites may change. 2021 'Future Wales: the national plan 2040' identified that in 'Pre-Assessed Areas for Wind Energy' there is a 'presumption in favour of large-scale wind energy development including repowering'.	First mention of decommissioning in 1996. Use of decommissioning conditions suggested in various documents from 2005 onwards with lack of detail.
Scotland	1994 policy stated that temporary permissions will rarely be justified. 2007 policy identified temporary consents of 20/25 years as common. 2014 policy stated that areas identified for wind farms should be suitable for use in perpetuity, while recognising that project consents may be time limited. 2017 policy confirmed that there are no current statutory or legislative limits to the duration of consent.	First recognised in 2012. 2014 policy recognised benefits of repowering and identified the current use of a site as a wind farm as a material consideration. 2017 policy identified the various forms of repowering including life-extension and set a position of clear support for repowering. It also recommended renegotiation of community benefits during repowering.	First mentioned as possible consideration in 1994. 2007 policy specified use of conditions to ensure decommissioning and site restoration, taking into account any proposed after use of the site.

5. Changes occurring over the operational life of onshore wind and solar farms

A range of changes occur over the operational life of wind and solar farms, impacting the context for end-of-life decision-making. These are outlined and discussed in more detail below.

Table 4: Changes occurring over the operational life of onshore wind and solar farms

Type of change	Examples
Affecting the project	
Economic Economic changes can: • Make repowering unviable. • If positive, economic changes can remove constraints making repowering viable.	**Variations in:** • Subsidies • Investment strategies • Taxation • Viability calculations • Levelised energy costs • Asset values • Production efficiency
Equipment • A lack of availability of machinery and parts can reduce the potential options for sites. • However, the development of new technology can open up different possibilities.	**Tendencies for:** • Parts of equipment wearing out. • Changes to ability to replace or maintain parts. • Change in size / type of turbines or solar panels available.
Changes in ownership • A change in ownership may offer a range of future options for a site. • A change in ownership may impact community-developer relations and trust.	• Sale of sites. • Changes in structure or priorities of site owners. • Sale of solar farms to investment firms (pure-play development).
Affecting the institutional context	
Policy changes • If restrictive, changes may prevent some end-of-life applications from being submitted or granted. • If supportive of repowering / life-extension, can increase the likelihood of successful applications.	**Changes to:** • National approach to renewable energy expansion. • Spatial steering or zoning of onshore wind / solar. • National end-of-life policies. • Local level policies. • Decisions that form precedents.

Affecting the setting of sites	
Social landscape changes • Perceptions of the site may change over time. • Negative changes can lead to opposition to end-of-life applications. • If perceptions of the site become more positive over time then people are more likely to be open to the continuation of the use.	**Changes in:** • Familiarity with the infrastructure. • Perceptions of the landscape and the presence of the windfarm within the landscape. • Community-developer relations. • Perception of community benefits. • Changes in the local community.
Physical landscape changes • Changes in the surrounding area can create a physical or regulatory restriction on future development.	**Development of:** • Landscape designations (national and local level). • Nearby windfarms. • Houses or other built development in the surrounding area.
Site-specific factors • Site-specific factors can create barriers to certain forms or compositions of development.	• Site access. • Grid availability. • Position of landowner.

5.1 Economic changes

Generally, for developers and owners, economic factors tend to dominate end-of-life considerations. Decisions are linked to the economics of energy generation regarding a net balance of gains and costs over time, with assessments of tipping points when this falls one way or another. These tipping points affect the end-of-life strategy and are influenced by various factors that themselves change throughout time, such as levelized energy costs, taxation, policy, and subsidy regimes. Other economic dimensions of the infrastructure can also influence developer strategies such as production efficiency and asset value. Economic factors can also influence the timing of decisions, i.e. end-of-life decisions may be made when the infrastructure is 15-18 years old so that the existing turbines can be sold.

Subsidy regimes appear to have been a major influence on wind farm developer strategies, directly influencing the timing of decision-making. These are in turn linked to political concerns as well as underpinning legislative commitments. Many wind farms have a subsidy attached to their consent as part of the Renewables Obligation Scheme which was introduced into England, Wales, and Scotland in 2002, requiring electricity suppliers to purchase a set amount of energy from renewable sources. As part of this scheme, Renewables Obligation Certificates (ROC's) were given to renewable energy firms for each megawatt-hour of electricity produced, the certificates would then be sold to electricity suppliers. Reflecting a political move away from onshore wind in England, this scheme ended for new onshore wind farms in 2017, the same year that the government prevented onshore wind from participating in the Contracts for Difference scheme (a scheme of price auctions to acquire new renewable energy at the lowest cost). Subsidies are attached to the original project as consented; the subsidy could thus continue if a site is life-extended (developers could continue to benefit until 2027), but subsidies are not transferable to a (new) repowered scheme. As subsidies are no longer available for new onshore wind projects, developers are faced with the decision of whether it is more viable to extend the life of an existing scheme (and thus continue to benefit from the existing subsidy) or to repower with more efficient turbines that will produce larger energy output but without subsidy, developers thus regularly test end-of-life options. As a result, there is expected to be an increase in repowering in Great Britain after 2027.

5.2 Equipment and site-specific factors

Site-specific factors including site access (e.g. for larger turbines), the ability to extend the lease, grid access and the ability to get planning permission, can have a significant impact on decision-making for the future of existing sites. For example, while repowering can increase output, it depends on grid availability, so if there is no more grid availability then life-extension provides a fall-back option. Such elements are closely tied to the economics of considering the cost of replacement and productivity. The duration of the original consent may also influence decision-making as some of the older sites without time-limited consents may continue to operate through replacing parts.

The lifespan of equipment and availability of replacement equipment can also influence end-of-life strategies. This includes certification and warranties as after a certain period there is a need to do more screening and turbine components may wear more quickly in turbulent sites.

5.3 Changes in site ownership

Changes in the ownership of sites can lead to a change in end-of-life strategy due to the different priorities of site owners. This is particularly common for solar farms due to the practice of companies building then selling solar farms that have a 25-year planning consent as assets. When investors buy operational solar farms to manage they are often looking for a longer-term investment. A 25-year site is considered likely to be a challenging investment whereas 40-year permissions provide longer returns, the new owners thus seek to extend the permission to 40 years in a process known as 'pure play development'. A change in site ownership can also lead to a change in community-developer relations which can impact how a community may respond to an end-of-life application, particularly if there is a lack of relationship or trust between the community and developer.

5.4 Policy changes

Policy change can have a significant influence on end-of-life strategies and decision-making for both developers and local authority decision makers. For example, periods of policy absence and turbulence in England and challenging economic conditions, including the removal of subsidies, have led to delays in submitting repowering applications or in developers pursuing a lower risk strategy of life-extension rather than repowering.

Policy clarity at a national level, particularly in Scotland, has provided greater confidence for developers and reduced uncertainty for local authority decision makers in how applications should be considered. While England, Wales and Scotland now all have a positive stance on repowering onshore wind, difficulties are likely to remain in England and Wales, where there is a lack of detail regarding how applications should be assessed. Meanwhile, to date, the policy absence for solar does not appear to be creating significant challenges, perhaps due to the less-controversial nature of the infrastructure.

Decisions that form precedent can also have an influence here. For example, the Kirkby Moor planning appeal in which life-extension was considered as a form of repowering in the context of the English National Planning Policy Framework.

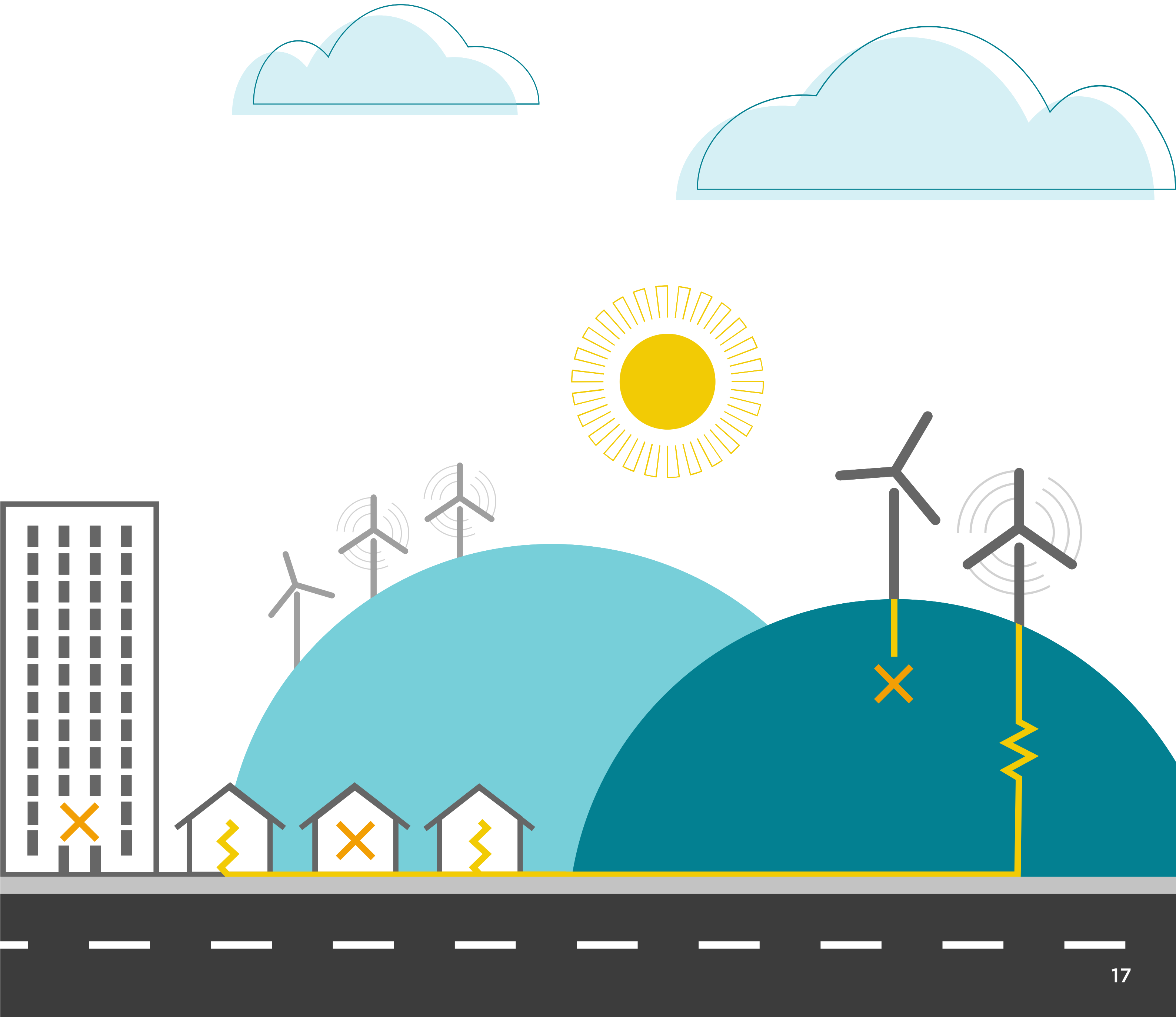
5.5 Landscape changes (physical)

The landscapes in which renewable energy infrastructure is situated may change over time, changing the context in which decisions are made. In some cases, further development, particularly of other wind farms or houses has occurred in proximity to sites, creating a constraint for the developable area of the site and thus the size of turbines that can be accommodated on the site.

In some locations national or local land designations have occurred, providing additional development constraints. Changes in land designation is expected to provide a greater constraint in European countries where sites have been designated as Natura 2000 sites.

5.6 Landscape changes (social)

The composition of the local community may change over the life of the development. People's relationships with the landscape and perceptions of the suitability of the renewable energy infrastructure on the landscape may also change over time. As discussed in more detail in section 6 of this report, familiarity with the wind farm will not always lead to greater levels of acceptance or support, particularly in cases where people perceive the wind farm as not working or not creating any benefits, where the community does not have a good relationship with the developer, or due to changes in the surrounding physical landscape.



6. Community responses to repowering and life-extension

6.1 Changes in community opinions of wind farms

There is an expectation that communities will become more accepting of wind farms over time as a result of familiarity. However, this research found that for many, this is not happening. The survey results show that for many participants, their opinions of the wind farm changed very little over the operational life of the development. However, for some, opinions of the wind farm do improve over time as a result of positive experiences with the site, benefit fund and developer. In other cases, negative experiences of the wind farm over time adversely impact opinions of the site. Such changes in opinion are context dependent, however there are some factors that increase the likelihood of positive responses to repowering and life-extension, these are discussed below.

6.2 Community responses to repowering and life-extension applications for onshore wind

While this research suggests that in many cases local opinions do not change over the life of an operational wind farm, there are several factors that appear to influence support or opposition to end-of-life applications. These are outlined in table 5. Sites that had the most positive reactions to repowering appeared to be those where the local community could identify the benefits that the wind farm had provided, where they had a good relationship with the developer and where the wind farm had become a recognised part of their local area. Conversely, opposition to repowering applications was particularly likely where publics perceived few benefits from the existing site, had bad relations with the developer, felt that the wind farm created a negative impact on the landscape, noise or residential amenity, where there was a perceived negative impact on the local economy, where elements had changed over the life of the site (such as designated landscapes or other developments nearby) and where the community did not feel involved in the end-of-life application.

Generally, life-extension applications have faced low levels of opposition with relatively few public comments compared to cases of repowering. Reasons for support for life-extension reflect those submitted to repowering applications, often identifying the contribution to the local area and renewable energy production as well as acceptance that visual impacts would be unchanged. Reasons for opposition have centred on the argument that the original development was granted 25-year permission and should be removed accordingly, the ongoing impact on views and a lack of trust towards developers.

The context of how the original wind farm planning application was considered and perceptions of the existing site appear to influence responses to end-of-life applications. In emotive cases, memory of resistance can endure over decades and an end-of-life application may provide an opportunity for opposition to resurface. Meanwhile, sites with less opposition to end-of-life applications appear to have often (but not always) been less controversial originally. Additionally, in cases where people have positive experiences with the wind farm over time, fewer people may be aware of, or have an opinion of, an application to repower and thus will be less inclined to respond.

While in many cases people prefer a smaller number of larger turbines, communities will not always consider a smaller number of larger turbines as an improvement and may even consider it as worse, particularly when repowering involves a significant increase in turbine height and when the wind farm is in a highly valued landscape. Perceptions of the suitability of turbine height on a landscape can thus be considered as context-dependent, suggesting that community considerations of the visual impact need to be given consideration in the initial stages of designing a repowering scheme.

Table 5: Common reasons for community support and opposition to onshore wind repowering and life-extension applications

	Repowering	Life-extension
Common reasons for community support	• Positive impacts created by the original scheme (identifiable benefits). • Good relations with the wind farm developer. • Recognisable benefits from the repowering. • Support for renewable energy.	• Contribution to the local area and renewable energy production. • Acceptance that the visual impacts would remain unchanged.
Common reasons for community opposition	• Lack of perceived benefit from the original wind farm. • Sustained dissatisfaction with original sighting choice on landscape / visual grounds. • Poor relations with the developer. • Community not involved from the start of the repowering scheme. • Impact on the local economy and tourism. • Impact on noise and residential amenity. • Change to 'temporary' nature of the development.	• Removal required in accordance with original consent. • Continued visual impact. • Lack of trust towards developers.

6.2.1 The impact of community benefit funds

The research revealed that in many cases community benefit funds appear to positively influence responses to repowering and life-extension applications (particularly for repowering which often involves an increase in the value of community benefits). Either the provision or lack of community benefits was a common element of discussion by communities in all of the wind farm cases in this research. The perception of community benefits appeared to vary across cases, with support for the continuation of a site being reflected where people recognise the benefits that their community has gained from the existing site.

Case study:
Lower income communities valuing a community benefit fund

Taff Ely wind farm, Wales

The Taff Ely community benefit fund has supported a large number of community projects in an area that is home to many lower income communities. The community felt that they had a good relationship with the developer and that they could ask them for support and help with any project ideas. A large proportion of the community were supportive of the repowering application so that the value of this fund would increase.

The findings demonstrate the importance of communities being able to recognise the benefits that the wind farm has provided over its life, for example in being able to identify and value the projects that the community fund has supported, in order to increase support for both the existing site and continuation of a site as a wind farm. A key consideration here is if the community benefits have led to meaningful changes or if they have been considered as a bribe.

Additionally, in some instances the impact of a community benefit fund may diminish over time if the demands for such a fund diminish i.e. if there is a large number of wind farms providing funds to a relatively small local community, the community may run out of projects to spend the funds on and thus attribute less value to their benefit (see the Windy Standard case study). In such cases there is often a desire for different forms of community benefit.

6.2.2 The impact of community-developer relations

The relationship between the developer and the community can have a significant influence on how communities experience living with the wind farm and thus on their response to a repowering or life-extension application. In cases with high community opposition the community often has a poor relationship with the developer, either not knowing who they are or feeling that the developer or site owner have no interest in the local community. Comparatively, in the most positive examples the developer has formed a good working relationship with the community and has been available to answer questions or resolve concerns over the life of the wind farm, rather than only engaging with the community during planning applications.

Another important dimension of this is how developers involve communities in end-of-life applications. As outlined in the St Breock case below, best-practice includes involving communities as early as possible and enabling them to have a meaningful impact on the design of the scheme. In worst case examples, communities have felt that the developer has purposely tried to make it difficult for them to respond to a proposal such as through scheduling community consultations at inconvenient times.

Case study:
The need for different forms of community benefits

Windy Standard / Brockloch Rig wind farm, Scotland

In this case, members of the local community identified that there are approximately 200 turbines nearby and if all of the wind farms that have been considered were built there would be over 600 turbines. The small, rural community are receiving numerous community benefit funds but are struggling to find community projects to spend the money on. They would thus be interested in other forms of community benefit.

6.3 Community responses to solar farm life-extension applications

Generally, solar farm planning applications appear to generate lower levels of controversy and public response than onshore wind farm applications. For solar farm life-extension applications, numbers of community responses are often very low. The research identified that opposition to solar farm life-extension often came from organised countryside protection groups located outside of the community. These groups were responding to a range of planning applications within a region and often did not reflect the perspectives of those living close to the site. A key reason for opposition for these groups was concern regarding life-extension applications setting precedent and thus making longer consent periods more likely elsewhere. Meanwhile, for local communities, the increase in the duration of the site appeared to have little impact with many not having an interest in the application.

Case study:
Best-practice in community-developer relations

St Breock Wind Farm, England

In St Breock, the developer maintained good relationships with the community and involved them from the very start of the repowering scheme. They worked with a local community energy organisation to help with information provision about renewable energy and did a lot of community engagement, including offering trips to look at the existing wind farm. The community were actively engaged in the design of the project and feedback from public exhibitions led to changes in the layout and number of turbines on the repowered site.

6.4 Public opinions of time-limited planning consents

Awareness of the duration of planning consents for wind and solar farms can be seen as context-dependent and particularly influenced by opposition. Usually, the public are not aware of time-limited planning consents and have not considered what may happen to the infrastructure in the future. Public awareness of the duration of planning consents is often only raised by an end-of-life application. However, in more controversial cases, communities may be aware of the time-limited nature of a consent and may be waiting for an end-of-life application in order to try to campaign for the removal of the infrastructure.

In many cases, communities appear more concerned with ensuring that the infrastructure will be removed at end-of-life, avoiding dereliction, rather than the exact duration of the consent. The public often recognised the benefits of time-limits in terms of providing an opportunity to review applications, but did not have a definite opinion on what that duration should be.

7. Key end-of-life challenges for wind and solar farms

7.1 Key challenges for policymakers

English, Welsh, and Scottish Governments have all moved to adopt supportive policy stances on repowering and life-extension of onshore wind, although there is a lack of detail regarding how applications should be assessed, particularly in England and Wales. Many developers and local authority planners are thus seeking policy development in order to provide more clarity and guidance on how applications should be assessed. Policymakers also need to consider how local community opinions should be reflected in decision-making and how policy can ensure that both the environment and communities can benefit from end-of-life applications.

Additionally, as discussed in section 7.5 below, there is a potential challenge for sites without adequate decommissioning conditions. Policymakers will thus have to decide how to best prevent potential infrastructure abandonment.

As solar infrastructure begins to age, there may be a need for policymakers to consider policy development for end-of-life scenarios. There is also a potential need to reconsider consent durations both for onshore wind and solar farms as infrastructure is increasingly capable of lasting longer than the 25-year consent period (see 7.6 below). Policymakers may also need to consider whether existing wind and solar farms are in the best locations going into the future and if there is a public interest argument for reconsidering appropriate locations as temporary consents run out.

7.2 Key challenges for Local Planning Authority (LPA) decision makers

To date, many LPA planners have experienced difficulties in assessing end-of-life applications for wind farms in the absence of detailed national policy. Particular difficulties have been faced where there is a high level of public opposition. LPA officers in multiple locations identified that they have struggled to make decisions due to a lack of guidance. Meanwhile, decision-making has been easier for solar farm life-extension due to the less controversial nature of this infrastructure. Additionally, the research found a perceived lack of uniformity in planning officers' experience, creating challenges in decision-making for both developers and LPAs.

> "I was right up to the wire on it in sort of making my mind up"
>
> **Local Authority Planner discussing a repowering application in England**

LPA decision makers have faced particular difficulties in assessing the visual changes of repowering wind farms. Visual impacts have long been identified as a critical factor shaping wind energy consent decisions and this remains the case for repowering. LPA decision makers revealed that assessing the impacts of the visual change upon the landscape was particularly difficult in terms of deciding if a smaller number of larger turbines or a larger number of smaller turbines was visually preferable. More clarity and support for decision makers is thus required here.

A further major concern for LPA decision makers is ensuring that infrastructure will be removed at the end of its operational life as discussed in section 7.5 below.

7.3 Key challenges for developers

A central challenge for developers is making decisions on their ageing assets in the context of an uncertain policy and economic context. Periods of policy absence and turbulence (particularly in England) and challenging economic conditions, including the removal of subsidies, have led to delays in submitting repowering applications or in developers pursuing a lower-risk (and often financially beneficial) strategy of life-extension. While England, Wales and Scotland all now have a positive policy stance on the repowering of onshore windfarms, difficulties are likely to remain in England and Wales, where there is a lack of detail regarding how applications should be assessed.

Changes in subsidy regimes (as discussed in section 5.1) create difficulties for both making end-of-life decisions as well as deciding whether to implement granted repowering consents, particularly as a lack of subsidy creates the need for larger turbines. This is likely to change from 2027 onwards when the renewables obligation scheme benefitting older sites ends.

A further challenge in the future may relate to site-specific constraints including nearby developments and changes in land designations impacting the developable area of the site.

> “Without more clarity on the change in government policy…it’s hard to envisage much repowering happening in the UK”
>
> **Wind farm developer, England**

This is likely to be a key challenge in many European countries with sites that have been impacted by Natura 2000 land designations. Community relations also pose a potential challenge to developers. As discussed in section 6, communities will not always be supportive of repowering and may be anticipating infrastructure removal. Access (for larger turbines) and grid connections / capacity are also expected to create potentially significant challenges for some sites.

Solar farm developers are likely to experience less challenges than wind farm developers as applications for life-extension have been relatively uncontroversial. However, clarity about the use of longer consents would provide more certainty for applicants.

7.4 Key challenges for communities

Currently, local community opinions do not appear to significantly influence end-of-life decision-making as repowering and life-extension applications appear to have been granted irrespective of levels of opposition. Communities thus currently face challenges in ensuring that their opinions on the future of existing renewable energy sites are taken into consideration in decision-making. Communities have also raised concerns regarding decommissioning challenges and the need for adequate decommissioning policy (see section 7.5 below).

7.5 Decommissioning challenges

Only a small proportion of sites have been decommissioned compared to those that have been repowered or life-extended. Such trends can be seen to continue, for the next few years at least. Considerations of decommissioning by many developers and LPAs appear to assume that it will be relatively straight forward and will, at a minimum, involve the removal of all visible and above-ground impacts. This is reflected in the lack of detailed decommissioning policies across the devolved planning systems. There is also an expectation that longer-term legacy issues will not present an issue for decommissioned sites and the two wind farms that have already been successfully decommissioned appear to support this.

The use of planning conditions and legal agreements has developed over time, decommissioning bonds are typically used as well as the requirement for decommissioning method statements which usually cover how the site will be reinstated and any monitoring of the landscape which may be carried out following decommissioning. Meanwhile, although bonds are not always used in the solar sector, it is felt that decommissioning will not present a challenge. Some developers identified that decommissioning may be self-funding through the value of the materials or resale of the turbines to other sites (particularly if sold after about 20 years and refurbished). However, they also cautioned that if the turbines had no life left in them, selling the turbines or parts would not cover decommissioning costs.

However, there is a potential for challenges to occur for some of the oldest sites that lack adequate decommissioning conditions or bonds. Significantly, UK Government policymakers recognised that cases of abandonment might occur in instances where insufficient decommissioning conditions were put in place during the original permission (see Kirkby Moor on page 28), identifying that there is nothing that can be done in such instances. However, they felt that this is less likely to occur in the context of the recent positive approach to repowering, reflecting how repowering and life-extension defer the final end-of-life but provide an opportunity to tighten commitments to managing the process. However, this creates situations in which site restoration and the difficulties of securing this without regulatory support, may be used to try to gain support for the new application. In such cases a longer life for a wind farm is the public ‘price’ of greater assurance of the eventual end-of-life outcome.

Additionally, some of the earliest wind farms do not have time-limited consents, instead specifying removal of the turbines when the infrastructure stops working for a specified period of time (often 6-12 months). Such consents rely on enforcement action from the council to ensure that turbines are removed unless the developer decides it is in their interest to do so. A lot of enforcement activity is reactive in character and responsive to complaint as enforcement is discretionary in UK planning systems.

Kirkby Moor wind farm

7.6 The challenges of using 'temporary' planning consents

Time-limited 25-year consents have created challenges for both developers and local authority decision makers in terms of considering the future of existing sites. While the 25-year period may not be considered as the most suitable, due to the infrastructure often being capable of working for longer, the benefits of having some temporal limits appear to be widely recognised in terms of ensuring that eventual removal will occur and to provide flexibility for future developments and changes in the interim including land use, viability, or technology changes. While many developers would prefer longer (than the common 25-year period) consent periods for infrastructure, many have not yet pushed for such longer consents due to perceived risks of refusal. However, economic considerations are now starting to change the consent durations being sought, with some developers beginning to push for longer periods in planning applications.

The benefits of the 'temporary and reversible' nature of schemes are often promoted and discussed in planning documents; however, the time-limited nature of consents does not appear to be the most important factor influencing decision-making, as the crucial consideration is the suitability of the infrastructure and its impact on the landscape rather than its duration. Additionally, assurance that the site will be fully decommissioned and restored appears more important than duration. Thus, it is the assurances provided by the use of time-limited consents rather than the rhetoric of temporariness which appears to be important.

Decision-making is often different if the original site has permanent planning consent as this provides the fall-back position of continuing to run the existing site through replacing parts rather than requiring removal after a set period. For LPA decision-making in such cases, the potential for permanence is a key consideration and thus they may favour repowering with a time-limited consent.

Case study insight – the potential for infrastructure abandonment in Kirkby Moor:

Original consent granted - 1992

Repowering application refused - 2015

Life-extension application refused - 2017

Life-extension granted at appeal - 2019

- The original planning consent for Kirkby Moor wind farm imposed conditions requiring removal of the turbines but not the associated infrastructure such as transformer substations, cabling and access tracks.
- There was no legal onus on the developer or any other party to remove these items, creating the potential for their abandonment on the moorland.
- This created a situation for both the repowering and life-extension applications where the developer was able to offer significantly improved decommissioning and site restoration as part of the applications.
- Members of the local community felt that improved decommissioning provisions were used as a bribe during the applications.
- The choice between partial removal after 25 years versus more complete removal in the future proved finely balanced, and highly contested, with the appeal inspectors ultimately siding with developers.

8. Recommendations

8.1 Recommendations for policy

8.1.1 Policy for repowering and life-extension

- There is a need for a clear policy approach to repowering at the national level including confirmation of the aspects that need to be given material consideration and detailed guidance on how local authorities should assess the change in visual impacts. This should involve a confirmation of the baseline on which repowering applications should be assessed.

- A supportive policy for repowering needs to provide details regarding what should be considered as part of applications including greater environmental enhancements and the option for different forms of community benefits.

- Repowering in appropriate sites should be supported with an efficient planning process. However, policy should recognise that not all existing sites will be suitable for repowering and thus there is a need for a positive policy approach to new sites as well.

- There is also a need for separate policies that enable a quicker decision-making process for life-extension, partial repowering (replacing smaller parts but keeping the turbines the same) and blade length extensions.

- Policy should also promote co-location where possible e.g. wind with solar PV or battery storage.

- Aside from policy, there is a need to address the capacity of the planning system to consider applications. Part of this involves providing additional guidance for local authority planners on the various end-of-life options for the sector. Such changes could be achieved through additional training and knowledge sharing.

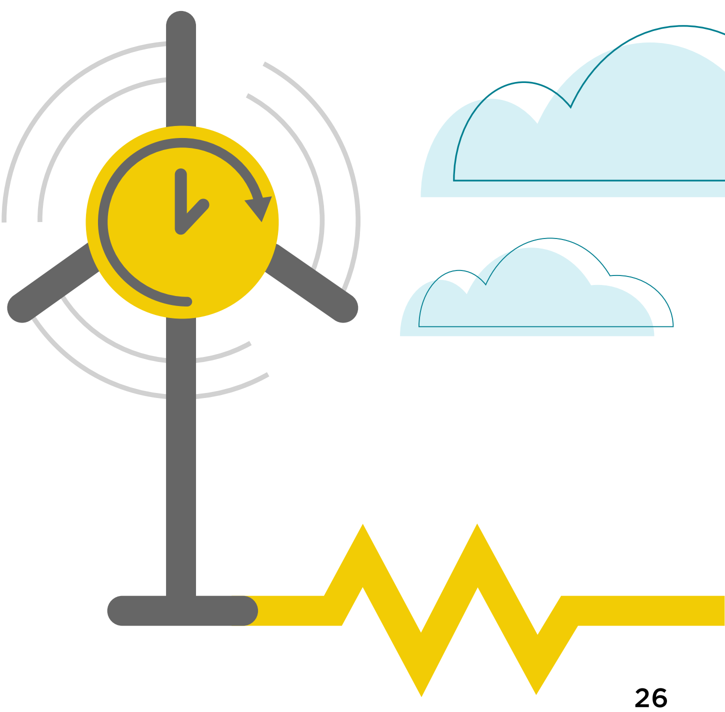
- There is also a need for consideration of a suitable market mechanism to support repowering.

8.1.2 Preventing abandonment

- Options for preventing infrastructure abandonment should be explored, particularly for those sites without adequate decommissioning conditions. It should not be assumed that repowering or life-extension will address all such issues, as not all sites will be suitable for repowering and improved decommissioning should not constitute the justification for granting an end-of-life application.

8.1.3 The duration of planning consents

- Wind and solar infrastructure is often capable of lasting longer than 25 years. Applications to extend the planning consent can be expensive and challenging. It is thus recommended that either longer consent durations are used or are replaced by the use of conditions based on the operational life of the infrastructure (i.e., they should be removed once they fail to operate for a set period of time). To reduce the need for reliance on enforcement action from local planning authorities, such consents could involve a review after a set period of time i.e. 30 years.



8.2 Recommendations for renewable energy developers

- Consider communities over the life of the scheme, not only during planning applications. Doing so provides the opportunity to address community concerns or misinformation as issues arise and to develop a good relationship and trust with the local community.
- Ensure that communities are aware of, and using, the community benefit fund and that they are aware of the local projects that it has already supported.
- If taking over a site, establish relationships with the local community so they are aware of who you are and so that you can build a relationship with them.
- Involve communities from the very start of a repowering or life-extension process and ensure they understand why the application is required. Seek to understand what issues have been faced by local communities over the life of the existing scheme and how the application can address them in order to provide a better experience.
- Ensure that communities are able to have a meaningful role in shaping the design of a repowered scheme. Go beyond the minimum public consultation requirements and involve communities from the start of the design process.
- A community benefit fund may not be desired by all communities. Provide the opportunity for communities to suggest what form of benefit they desire. This may include a form of community co-ownership.
- Consider that communities may be aware of the original planning consent and the associated conditions e.g. the duration of planning consent. Some communities may be anticipating removal and this will influence their responses to an application.
- Carefully consider how improved decommissioning is presented so that it is not considered to be a bribe, particularly in situations where the original consent does not have adequate decommissioning requirements.

Considering the site context is crucial.

- What are the conditions of the original planning application?
- What has changed in the surrounding area?
- Has the relationship with the community been maintained?

8.3 Recommendations for communities

End-of-life applications provide an opportunity for communities to influence the future of a local wind or solar farm and to renegotiate terms. However, there are also benefits in communicating with developers over the operational life of an existing scheme.

- Familiarise yourself with the original planning consent so you are aware of the duration of the planning consent and the associated planning conditions.
- Communicate with developers over the life of the infrastructure, ask them to address any of your concerns or questions and raise any issues that you may be facing.
- Ensure you are aware of the community benefit fund and how to use it. If not, ask the developer.
- Think about what type of community benefit would be most useful for your community and ask for it during a repowering application.
- Ensure that the wider community is aware of an end-of-life application and how to respond.

Appendices

Appendix 1: Solar farm case studies

Name and location	Age and life stage in 2018	Details	Developer	Size
Pitworthy Solar farm England (Devon)	4 years. Granted Life-extension of extra 15 years in 2017.	Became operational in 2014 with 25-year permission, extended to 40 years. Spurred local discussion about 'temporary' durations and 'precedent.'	Hive Energy, Foresight	109 acres

Appendix 2: Wind farm case studies

Name and location	Age and life stage in 2018	Details	Developer	Turbine number
St. Breock England (Cornwall)	Repowered scheme 3 years (granted in 2012, operational 2015). Original scheme operated for 18 years.	Significant public support for repowering. Original permission granted in perpetuity.	REG & Blackrock	Original:11 Repower:5
Taff Ely Wales (Rhondda Cynon Taff)	25 years (repowering permission granted but not yet implemented).	Not located in an area allocated for wind energy. Mixed response to repowering application (greater levels of support than opposition). Original permission granted in perpetuity.	RWE Npower Renewables / Innogy	Original:20 Repowered:7
Kirkby Moor England (Cumbria)	25 years. Permission was due to expire in 2018. (Life extension granted at planning appeal in 2019.)	High levels of local opposition to the original application, life-extension and repowering applications. Original permission granted for 25 years.	RWE Renewables. Ventient Energy.	Original:12
Windy Standard (Brockloch Rig) Scotland (Dumfries and Galloway)	22 years (phase i). Phase i life-extended in 2018. Phase ii under construction. Phase iii in the planning process.	The area around the wind farm is within an agricultural designation, designated as an Environmentally Sensitive Area. Original permission granted for 25 years.	Fred Olsen Renewables	Phase i:36 Phase ii:30 Phase iii: 25

Appendix 3: Characteristics of the case study communities

1. St Breock Wind Farm

St Breock is a village in North Cornwall, one mile from Wadebridge.

The 2011 census population was 725, with 31% of the population aged 60 or over.

It is a rural community with approximately 30 farms situated within the parishes of St Breock and nearby Egloshayle.

In 2011 70.1% of the population were economically active with 26.3% in full-time employment.

The most common local occupations in the Wadebridge & Padstow Community Network Area in 2011 were:

1. Agriculture, Forestry & Fishing (17.3%)
2. Retail (15.7%)
3. Accommodation & Food Services (13.3%)
4. Construction (12.9%)

St Breock wind farm. Photo author's own

Taff Ely wind farm. Photo © Gareth James

2. Taff Ely Wind Farm

The Wind Farm lies immediately south of the villages of Hendreforgan and Gilfach Goch.

The population of the 'Hendreforgan / Gilfach Goch built up area' in the 2011 census was 4,395. The average age of residents was 38.6 years.

In 2011 57.6% of the population were economically active with 33.2% in full-time employment, 44.4% had no qualifications.

In 2011 the majority of the population worked in the following industries:

1. Manufacturing (20%)
2. Human health and social work activities (15.6%)
3. Wholesale and retail trade; repair of motor vehicles and motorcycles (15.5%)
4. Construction (11.4%).

4. Windy Standard wind farm

The Wind farm is located within Carsphairn Forest in Dumfries and Galloway.

The closest settlements are the rural village of Carsphairn (with approximately 115 residents) and the very small, rural settlement of Brockloch.

Due to the size and rural nature of the settlements there is no further information available about the communities.

Windy Standard wind farm, Photo © Iain Russell

3. Kirkby Moor Wind Farm

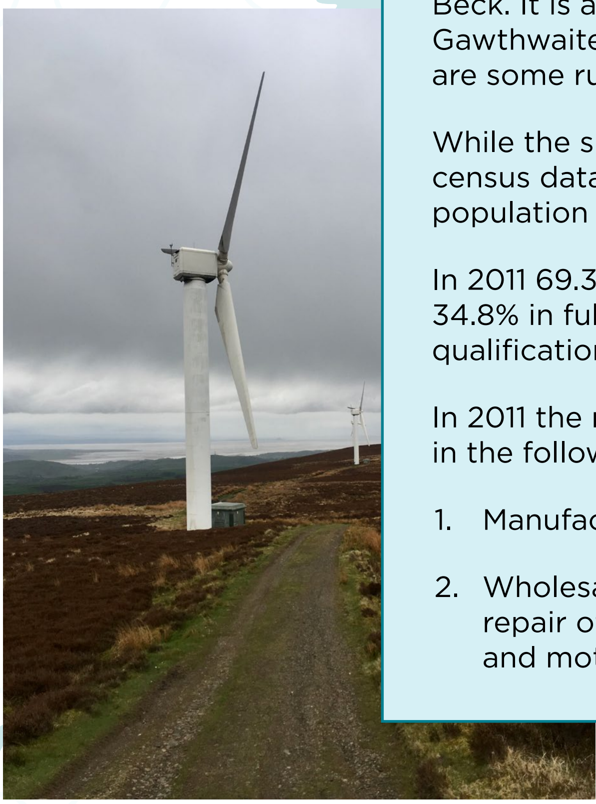
The wind farm is situated on an upland area of moor land 2km from the villages of Grizebeck, Kirkby in Furness and Broughton Beck. It is also located close to the smaller settlements of Gawthwaite, the Netherhouses, Chapels and Beck Side. There are some rural and farm properties within 1km of the site.

While the surrounding population is rural in character, 2011 census data was available for Kirkby-in-Furness, revealing a population of 554 with an average age of 48.6 years.

In 2011 69.3% of the population were economically active with 34.8% in full-time employment. 22.2% of the population had no qualifications.

In 2011 the majority of the Kirkby-in-Furness population worked in the following industries:

1. Manufacturing (17.1%)
2. Wholesale and retail trade; repair of motor vehicles and motorcycles (13.5%)
3. Human health and social work activities (12.7%)
4. Education (11.3%).



Kirkby Moor wind farm. photo: Photo author's own

5. Pitworthy Solar Farm

Pitworthy solar farm is located in Holsworthy, a small market town in Devon.

The 2011 census for Holsworthy Parish reported a population of 2,641 with the mean age of residents as 45.1 years.

69.3% of the population were economically active with 31.1% in full-time employment. 31.8% of the population had no qualifications.

In 2011 the majority of the population worked in the following industries:

1. Wholesale and retail trade; repair of motor vehicles and motorcycles (23.2%)
2. Human health and social work activities (14.2%)
3. Construction (10.3%).
4. Lower managerial, administrative and professional occupations (14.5%).

Pitworthy Solar farm, Photo Foresight group

Appendix 4: Characteristics of approved repowering applications in England, Wales, and Scotland

Sites granted repowering permission (Country and County)	**Change in turbine numbers (Original = O, Repower = R) and (%)**	**Height change to turbine blade tip (Original= O, Repower=R) and (%)**	**Change in installed capacity (MW) (Original = O, Repower = R) and (%)**
Blood Hill (England Norfolk)	O= 10 R= 2 **-80%**	O=43 R=45.5 **5.8%**	O= 2.25 R= 0.8 **-64%**
Camas Nan Geall (Scotland Highlands)	O= 2 R= 2 **0%**	O=27 R=45 **66.7%**	O= 0.1 R= 0.45 **350%**
Carland Cross (England Cornwall)	O= 15 R= 10 **-33%**	O= 49 R=100 **104.1%**	O= 6 R= 20 **233%**
Caton Moor (England Lancashire)	O=10 R= 8 **-20%**	O=48.4 R=90 **86.0%**	O= 3 R= 16 **433%**
Cemmaes (Wales Powys)	O= 24 R= 18 **-25%**	O=42 R=76 **81.0%**	O= 7.2 R= 15.3 **113%**
Coal Clough (England Lancashire)	O= 24 R= 8 **-67%**	O=49 R=110 124.5%	O= 9.6 R= 16 **67%**
Delabole (England Cornwall)	O= 10 R= 4 -60%	O=49.5 R=110 **122.2%**	O= 4 R= 9.2 **130%**
Goonhilly Downs (England Cornwall)	O=14 R=6 **-57%**	O=49 R=107 **118.4%**	O=5.6 R=12 **114%**
Great Eppleton (England Tyne and Wear)	O= 4 R= 4 **0%**	O=71 R=115 **62.0%**	O= 3 R= 8.2 **173%**
Great Orton II (England Cumbria)	O= 10 R= 6 **-40%**	O=60 R=68.5 **14.2%**	O=3 R= 3.96 **32%**
Hagshaw Hill (South Lanarkshire, Scotland)	O= 26 R= 14 **-46%**	O=57 R=200 **250.9%**	O=15.6 R=84 **438%**
Harlock Hill/Furness (England Cumbria)	O= 5 R= 2 **-60%**	O=53 R=99.5 **87.7%**	O= 2.5 R= 4.6 **84%**
Haverigg (England Cumbria)	O=5 R= 4 **-20%**	O=45 R=76 **68.9%**	O= 1.125 R= 3.4 **202%**
Llandinam (Wales Powys)	O= 103 R=34 **-67%**	O=45.5 R=122 **168.1%**	O= 31 R= 102 **229%**
Llangwyryfon (Wales Ceredigion)	O= 20 R=11 **-45%**	O=42 R=66 **57.1%**	O= 6 R= 9.35 **56%**
Ovenden Moor (England West Yorkshire)	O= 23 R= 9 **-61%**	O=48.9 R=115 **135.2%**	O=9.2 R= 18 **96%**
Ramsey (England Cambridgeshire)	O= 1 R= 1 **0%**	O=45 R=125 **177.8%**	O= 0.225 R= 1.8 **700%**
Rhyd-y-Groes (Wales Ceredigion)	O= 24 R= 13 **-46%**	O=46 R=79 **71.7%**	O=7.2 R= 11.7 **63%**
Spurness (Scotland Orkney)	O= 3 R= 5 **67%**	O=100 R=105 **5.0%**	O= 8.25 R= 10 **21%**
St Breock (England Cornwall)	O=11 R=5 **-55%**	O=53.5 R=100 **86.9%**	O= 4.95 R= 12.5 **153%**
Taff Ely (Wales Rhondda Cynon Taff)	O= 20 R= 7 **-65%**	O=53.5 R=110 **105.6%**	O= 9 R= 17.5 **94%**
Tangy 4 (Scotland Argyll and Bute)	O=22 R= 16 **-27%**	O=77 R=149.9 **94.7%**	O=18.7 R= 80 **97%**
Wansbeck Blyth Harbour (England Northumberland)	O=9 R= 1 **-89%**	O= 45 R=125 **177.8%**	O=2.7 R=3.4 **26%**

The table is based on Gov.UK data correct as of July 2021. Not including Bu wind farm as permission lapsed and the site is now decommissioned. Not including Castle Pill wind farm as it was considered to be an extension rather than repowering.



Please contact Dr Rebecca Windemer at rebecca.windemer@uwe.ac.uk if you would like to delve deeper into the research or discuss ideas for acting on these findings.

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