Llywodraeth Cymru
Welsh Government

Permitted Development Rights and Non-Domestic Solar PV and Thermal Panels

September 2016

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 WG29674 Digital ISBN: 978 1 4734 7500 7

Mae'r ddogfen yma hefyd ar gael yn Gymraeg / This document is also available in Welsh.

CONTENTS

1 Introduction

1.1 Objectives of the Study

1.1.1 Arcadis was appointed by the Welsh Government in December 2015 to undertake research into permitted development rights and non-domestic solar PV and thermal panels. The aim of the research is to *"investigate if permitted development rights as they currently apply to the installation of non-domestic solar panels (thermal and photovoltaic) are fit for purpose, and to consider alternative approaches to permitted development rights"*.

1.1.2 The objectives of this study are to:

- Review and compare the existing and proposed non-domestic solar and thermal panel provisions across the UK, including their planning impacts;
- Review the nature and capabilities of current and future non-domestic solar panel and thermal technology;
- Advise on the advantages and disadvantages of using a threshold based approach to solar energy output and permitted development rights, and explore appropriate threshold options;
- Advise on the advantages and disadvantages of an approach that excludes an output threshold in favour of permitted development rights based on an assessment of planning impacts. Explore the appropriate limits which could be put in place to mitigate these impacts through regulation; and
- Compare and contrast both methods and recommend a single approach indicating how regulations should be amended in order to achieve this.

1.2 Background to Non-Domestic Solar and PD Rights

1.2.1 The Climate Change Strategy for Wales sets out how the Welsh Government intends to limit greenhouse gas emissions and adjust to changes in our climate. This includes a specific action to ensure that land use and spatial planning promote sustainable development and enable a move towards a low carbon economy. Energy generation from renewable sources is fundamental to this strategy. Wales has significant assets in virtually every energy source including one of the best solar resources in the UK (*Energy Wales a Low Carbon Transition, March 2012*). The Welsh Government is determined that the benefits of delivering energy development are maximised in Wales. Through permitted development rights, the planning system has helped support the provision of small scale power generation (microgeneration) across Wales's domestic and non-domestic sectors.

1.2.2 Solar panels, also known as photovoltaics (PV), capture the sun's energy and use it to generate electricity. Peak performance is achieved during the summer months when the cells are exposed to full, direct sunlight. Solar cells are usually made up of a semi-conducting material, most commonly silicon. When the silicon is exposed to light, electrical charges are generated, which can be conducted away by metal contact as direct current (DC). The electrical charge of the cells is small, so multiple cells are grouped together in modules or panels, which can either be mounted on a roof or on the ground.

1.2.3 There are currently five commercially available types of solar cell, which include: monocrystalline; polycrystalline; thick film silicon; thin film silicon and other thin films such as (CICGS and CdTe). Currently, over 80% of PV electricity is based on crystalline technologies. These are the most common solar cells in use, mainly because they are seen as stable, efficient and rely on well-established technologies.

1.2.4 The power which the cells produce is measured in kilowatts peak (kWp), which is the rate at which energy is generated at peak performance. A rule of thumb in the United Kingdom

is that the average output over a year will be around 750kW per kilowatt-peak of panel installed[1].

1.2.5 Solar water heating systems use energy from the sun to heat water. Such systems make use of thermal panels, called collectors, which are fitted to the roofs of buildings. Currently, there are two types of solar water heating panel, evacuated tubes and flat plate collectors[1]

1.2.6 Flat plate collectors consist of an absorber panel – generally a painted metal, such as copper – attached to copper pipes where water or a heat transfer liquid passes through. This is encased in a metal frame, in order to retain the collected heat, and surrounded by thick insulation. The system is protected by glazing, which also provides an insulating air space.

1.2.7 Evacuated tube collectors are a more recently developed technology. The most commonly used variety comprises a smaller glass tube suspended within a larger glass tube – the air is pumped out of the space between the inner tube and the larger outer tube creating a vacuum thermal insulation layer. The vacuum layer minimises the heat loss from the solar collector.

1.2.8 Solar PV and solar thermal panels are a key renewable energy technology in Wales and benefit from both domestic and non-domestic permitted development rights. These are set out in the *Town and Country Planning (General Permitted Development) Order 1995* as amended. The current permitted development right energy capacity threshold in Wales for both domestic and non-domestic solar panel and thermal installations is determined by the definition of microgeneration set out in the *Energy Act 2004* (Section 82), which is 45kW thermal and 50kW electrical (Section 82, subsection 8).

1.2.9 The current energy generation threshold was introduced in the *Town and Country Planning (General Permitted Development) (Amendment) (Wales) (No.2) Order 2012*. Solar development on the roof or wall of buildings above 50kW requires full planning permission from the local planning authority. Typically 50kW might be generated by 375m^2 of panels. Solar thermal installations which have an output above 45 kilowatts thermal also require full planning permission from the local authority.

1.2.10 In other parts of the UK, moves are underway to adopt a more flexible approach and to increase the capacity of non-domestic solar installations deemed as permitted development. In England, the *Town and Country Planning (General Permitted Development) (Amendment) (England) Order 2015*, increased the permitted development right threshold to 1MW (for roof mounted solar or thermal installations), although proposals greater than the definition of microgeneration in the Energy Act 2004 are subject to a prior approval process to consider siting and design issues. The Scottish Government has recently undertaken a public consultation that puts forward a series of options. Scotland's preferred approach places less importance on the capacity of an installation and more emphasis on the impact of the development on the appearance of a building or place, although not the effect of glare.

1.3 Overview of Research Methodology

1.3.1 The first phase of the research project involved the review and comparison of existing and proposed non-domestic solar provisions within each of the UK administrations. A review of the nature and capabilities of current and future non-domestic solar panel technology was also undertaken including:

[1] (www.nef.org)
[2] www.energysavingtrust

- Defining the sizes and energy outputs of current non domestic solar panels and the scale of arrays necessary to produce various energy outputs;
- How technological advances may impact on the nature of future installations – for example improvements in high efficiency solar technologies, the use of coloured and transparent solar cells to integrate with building and the use of new materials to develop products suitable for installations with glare reduction; and
- Efficiency savings of roof based development over land based development. The advantages and disadvantages of roof and land based development are well documented, including issues relating to orientation, aesthetics, space optimisation and restrictions.

1.3.2 Whilst the majority of this work has been desk-based, it was considered beneficial to supplement research with a series of consultations with various organisations as appropriate, including representatives from:

- Department of Energy and Climate Change (DECC) and Department of Communities and Local Government (DCLG) to discuss further reasons behind the changes made and outcomes to date;
- Scottish Government Planning and Energy Divisions to discuss the impetus for an outputs based approach and initial findings from the consultation undertaken during summer 2015;
- Department of the Environment in Northern Ireland to discuss whether or not any changes are planned in the future;
- The solar industry with an interest in sites across the UK, to seek their views on the barriers presented by the current thresholds, the benefits that could be provided by changes to permitted development rights in Wales and issues to be aware of;
- RenewablesUK Cymru to obtain the views (as a Member of the Strategy Group) of the trade body representing the interests of renewable energy sector in Wales; and
- A small sample of local planning authorities in Wales as to their views on existing permitted development rights as they relate to non-domestic solar PV and thermal panels.

1.3.3 The second phase of the research has been to further assess the implications of the two different approaches that could be undertaken with regard to permitted development rights – of both a specific output threshold approach and an assessment of planning impacts. The methodology for undertaking the assessment has followed a case study approach, and is described further in Chapter 4 of this report.

1.4 Final Report Structure

1.4.1 This Final Report is structured as follows:

Chapter 2 summarises the different approaches that have been undertaken across UK administrations.

Chapter 3 provides a summary of the nature and capabilities of non-domestic solar technologies drawing on experiences from the solar industry and research organisations.

Chapter 4 sets out and assesses the different approaches under consideration with regard to the future of permitted development rights and non-domestic solar developments.

Chapter 5 provides a summary of the various options that could be taken forward by Welsh Government, together with the necessary limits and conditions that would be required for implementation.

2 Approaches across UK Administrations

2.1 Introduction

2.1 This Chapter compares and contrasts the current position in Wales with work being carried out in respect of non-domestic solar PV and thermal panels and permitted development rights across other UK administrations (specifically England, Scotland and Northern Ireland).

2.2 Current Position – Wales

2.2.2 Currently, permitted development rights for photovoltaics are applicable for installations where capacity does not exceed 50kW for the generation of electricity and 45kW for the production of heat. The current permitted development rights energy capacity threshold in Wales for both domestic and non-domestic solar panel and thermal installations is determined by the definition of microgeneration set out in the Energy Act 2004 (Section 82).This threshold was introduced in the *Town and Country Planning (General Permitted Development) (Amendment) (Wales) (No.2) Order 2012*. Roof-mounted solar developments above 50kW require full planning permission by the local planning authority. Stand-alone solar developments within the curtilage of buildings are restricted to a 9sq.m array, which would generate approximately 1kW of electricity.

2.3 Current Position – England

2.3.1 On the 15th April 2015, permitted development rights in England were extended for non-domestic rooftop installations, with a change in the output threshold for photovoltaic installations considered as permitted development increasing to 1MW. The rationale behind this change came from several places, including ministerial support for encouraging solar deployment. The *UK Solar PV Strategy Part 2: Delivering a Brighter Future* was produced by the DECC in 2014, setting out the government's ambitions of a major opening up of the market for mid-size, commercial and industrial onsite generation and a new drive to work with the industry to scale up domestic deployment. The document identified that the mid-size commercial rooftop sector has untapped potential as well as particular advantages, for example in terms of the on-site use of electricity and potentially fewer visual impacts than either domestic or ground-mounted arrays. Planning was identified as one potential obstacle to the further bolstering of this market, with roofs over 50kW in capacity previously requiring planning permission, adding significantly to development timescales, uncertainty and therefore risk (UK Solar PV Strategy Part 2). Anecdotal evidence from various consultations and research appears to bear this out, with a marked falling away in deployment identified above the 50kW level.

2.3.2 Further supporting evidence was highlighted through telephone consultations, which identified a form of capping of non-domestic solar developments, with developers purposefully deploying small scale schemes capped at 49.99kW on commercial roof space, despite comparatively large roof space available for utilisation. This was considered to present evidence that the planning process acted as a barrier to larger solar installations.

2.3.3 Finally, the 50kW output threshold was regarded as an out-dated and somewhat anomalous figure to use, as it is based on the original assumption for microgeneration that solar energy creation was going to be relatively small-scale; however advances in technology have subsequently challenged this.

2.3.4 Throughout the consultation period for the extension of permitted development rights, a consistently raised issue was in relation to glare emanating from solar installations. However, a number of consultees considered there to be sufficient evidence to prove that glare does not present a safety issue with regard to airports and aviation.

2.3.5 The increase in output threshold to 1MW for solar installations has been accompanied by other elements of a revised permitted development rights process. These include the introduction of a prior approval process, whereby the local planning authority determines whether approval will be needed for the design and external appearance of the proposed panels. This process considers whether:

- The development is sited so as to minimise its effect on the external appearance of the building; and
- The applicant building is listed, is within a National Park, Area of Outstanding Natural Beauty or Conservation Area.

2.3.6 Consultation with DCLG has identified that the prior approval process was primarily put in place due to concerns over the impact of glare on the occupiers of neighbouring properties and to ensure the appropriate assessment of glare was included as part of the application process.. No significant feedback has been reported from local planning authorities to date as to how the prior approval process may be functioning.

2.3.7 Discussions with DECC have identified that, whilst there has been no obvious upward trend in deployment from April 2015 to the present time, anecdotal evidence suggests that deployment in the solar sector appears to be increasing, giving confidence that the increased output threshold has had a positive impact. The changes are considered to give additional confidence to developers, rather than necessarily speeding up the consenting process and no evidence has been put forward to suggest that the prior approval notice creates a further barrier. However, as discussed later in this section, discussions with the Solar Trade Association suggested that the prior approval notice period slows the process down almost as much as seeking the necessary consents and that it would be beneficial to reduce this time-consuming process. The costs which are attached to the prior approval notice period were also highlighted (both time and material costs); costs which were considered to have the possibility of reducing the likelihood of schemes going ahead.

2.4 Current Position – Scotland

2.4.1 In June 2015, the Scottish Government consulted on changes to permitted development rights for non-domestic solar panels (and domestic air source heat pumps), with proposals to encourage the installation of non-domestic solar installations whereby planning consent is not required. Key points to note from the consultation document include:

- The removal of a microgeneration output limit, aerodrome and technical site limitations; and
- Inclusion of new limitations in respect of flat roof limits (for example equipment not to extrude more than 1m from the roof).

2.4.2 The anticipated outcomes of the proposed changes include that non-domestic properties could fit larger arrays of solar panels without the need to seek planning consent. This provides similar permitted development rights for domestic properties and reflects the move to permitted development rights for roof mounted solar arrays on non-domestic buildings in England of up to 1MW.

2.4.3 The output limit for proposals is not considered to always represent the most appropriate threshold by which to limit a development. Examples are provided within the consultation document of both an appropriately located system with a large energy output having no harmful impacts and of a poorly located system with a small energy output which may have harmful impacts. No prior approval process is proposed as it is considered to add a further barrier/ delay to the process. The consultation ended in August 2015.

2.4.4 Consultation with Scottish Government representatives has identified that objections to the proposals contained within the consultation have been received from Glasgow and

Prestwick Airports in particular, and also from the Civil Aviation Authority. Objections related to three main areas, namely:

- Glare from solar panels;
- Potential interference with radar and telecommunications equipment; and
- Navigation and any impediments to flight paths from solar panel infrastructure.

2.4.5 In relation to issues surrounding glare, a meeting was held in January 2016 between the Scottish Government and the Solar Trade Association (STA) in order to discuss objections. The STA committed to gathering evidence to demonstrate the lack of impact from solar panels on aviation safety. Discussions have highlighted recent research in the USA, where the United States Aviation Authority produced guidance restricting panels because of issues over glare. However, this was subsequently withdrawn with new advice stating that glare did not have as much of an impact as initially thought. Further new guidance is awaited from the US (further information relating to aviation impacts are considered in Chapter 4 of this report).

2.5 Current Position – Northern Ireland

2.5.1 In Northern Ireland, as is the case in Wales, permitted development rights are currently applicable for installations where capacity does not exceed 50kW for the generation of electricity and 45kW for the production of heat.

2.5.2 The Department of the Environment in Northern Ireland is currently in the process of reviewing these arrangements. A consultation paper reviewing permitted development rights for non-domestic roof-mounted solar photovoltaic panels was issued on 5th May 2016. The consultation paper proposes a new class of permitted development for solar PV panels extending from the existing 50kW microgeneration limit up to 1MW for rooftop non-domestic buildings only. The paper goes on to state that, in order to address any potential issues in relation to airports, a 56 day prior notification period would be introduced for solar PV panels within this output range for proposals located within 3km of an airport. The notification would provide details relating to location, design and orientation of the proposal, as well as to the increase in height to the building as a result of the installed array. The consultation period closes on 30th June 2016.

2.6 Outcomes of Other Consultations

2.6.1 The following section provides an overview of consultations that have been undertaken with local planning authorities, trade organisations and representatives of the private sector in Wales, in order to explore the issues associated with permitted development rights as they currently apply to the installation of non-domestic solar and thermal panels.

Local Planning Authorities

2.6.2 Three Welsh local planning authorities (LPAs) were contacted to discuss their views on current permitted development rights related to non-domestic solar PV and thermal panels. The LPAs (Vale of Glamorgan Council, Newport City Council and Monmouthshire County Council) were selected by virtue of the fact that each authority was known to have dealt with a number of non-domestic solar applications within the past year (ranging from six to nineteen applications) and to include a sample of both urban and rural authorities (reflecting the fact that planning considerations may differ according to the environmental context).

2.6.3 Specific issues to arise from the consultations are summarised as follows:

- All three LPAs identified visual impact on landscape as their main concern with regard to solar applications;

- Concerns were raised over the level of political support from Council Members, who can be sceptical of the benefits of renewables, meaning that officers can struggle to obtain support;
- LPAs highlighted a lack of in-house knowledge (for both officers and Council Members). Solar is an emerging area and volume of applications has only really developed in very recent years; therefore LPAs consider they are 'playing catch-up'. None of the authorities spoken to stated that they had an in-house expert on renewables and that current budgetary pressures meant they were not in a position to fund external consultants;
- LPAs considered there to be a lack of clarity, omissions and discrepancies in national planning policy with regard to renewables, which may take time to be clarified via case law or appeal decisions;
- On the whole, it was felt that that the quality of information attached to submissions was good;
- In respect of the assessment of landscape and visual impact, the LPAs stated it would be beneficial to have additional guidance on when, for example, the landscape and visual impact harm can outweigh the merits of a proposal. It was felt that in the absence of this, inconsistencies would continue to arise.
- No issues were identified in relation to potentially increasing the threshold for permitted development rights for non-domestic solar installations in Wales from a theoretical standpoint. The rationale behind the existing limit was not considered to be clear, as principal impacts relate to the visual impact on the landscape and surrounding buildings / neighbourhoods.

Trade Organisations

2.6.4 Both Renewables:UK (Cymru) and the Solar Trade Association (STA) were contacted to discuss issues in more depth. Renewables:UK is the trade association for wind, wave and tidal power industries in the UK and therefore has a keen interest in all renewables, including solar. Since 1978, the STA has worked to promote the benefits of solar energy and make its adoption easy and profitable for domestic and commercial users. A not-for-profit association, the STA is funded entirely by membership, which includes installers, manufactures, distributors, large scale developers, investors and law firms.

2.6.5 Consultations highlighted the following:

- Instances where companies have specifically stated that the current permitted development rights for solar installations are a continuing barrier to investing in Wales and that organisations currently need to give serious consideration when assessing the viability of investing in Wales;
- Over time, the cost of solar developments will fall as technology improves; as such financial costs in decision making will prove less critical and planning issues are therefore likely to have a greater influence;
- The Welsh Government's Planning Toolkit was highlighted as providing all relevant information that planning officers should need in order to enable them to consider various aspects of individual applications; and
- In relation to the planning process and permitted development rights in particular, the STA identified that the planning system is seen as one of a series of barriers currently faced by the industry and that anything to help remove barriers would therefore be welcome. The focus of LPAs on the aesthetics of solar installations rather than the output of a system was highlighted.

Private Sector

2.6.6 Discussions with a number of private sector companies in relation to issues facing prospective developers of non-domestic solar installations highlighted the following points:

- It is not clear where the 50kW limit comes from. Consultees considered that generally the 50kW limit for commercial buildings is too small and question whether there is a need for a limit on capacity at all. It was considered that a 1MW limit would fit a reasonably sized industrial building;
- The planning system at present adds delays, risk and costs into a project and the current situation regarding permitted development rights can act as a serious disincentive in terms of attracting investment into Wales;
- Although costs are likely to reduce further and there will be technological improvements, this needs to be balanced against recent information published by the DECC. In December 2015, the DECC published new rates for Feed-in-Tariffs (FITs) for small-scale solar, wind and hydro installations. Although these cuts were not as severe as originally proposed during a consultation held in August 2015, it is considered by representatives of the private sector that this could have an effect on future take-up;
- One consultee felt that the installation of PV systems should be mandatory on all new commercial buildings and if not, this has to be justified;
- The difference between England and Wales for private sector developers is now said to be very clear – in Wales the developers stated it takes much longer to install a system with the same output as is the case in England;
- Anecdotal evidence suggested that planning officers in Wales can be constrained in their approach by the current output limit – locally, large systems on industrial roofs may be appropriate, but officers are currently limited by national policy. Examples were cited of large schemes that have not gone ahead in Wales, as a result of the current permitted development rights;
- In order to increase public support for solar installations, the promotion and support of rooftop installation over field based installations would help – perhaps limits could be identified for ground installations, and removed for those on rooftops; and
- A general feeling amongst consultees was that an assessment of planning impacts rather than on the output of the solar development would be beneficial.

2.7 Summary of Key Findings

2.7.1 The review across other UK administrations has identified that changes to permitted development rights in England would appear to be giving additional confidence to developers there. Issues have been cited in both England and Scotland in connection with the prior approval process, as to whether or not it speeds up the process or adds a further layer of delay/cost – there would not appear to be clear evidence to date supporting either perspective. Other issues identified during the review include that of glare in relation specifically to the aviation industry. Further consideration has been given to this issue as part of the assessment in Chapter 4 of this report. Finally, as already highlighted, changes to permitted development rights and non-domestic solar developments are also proposed in Northern Ireland, including the introduction of a 56 day prior notification period for proposals located within 3km of an airport.

2.7.2 In Wales, issues identified from a variety of perspectives include the importance of landscape and visual impacts, knowledge levels of both planning officers and members, and the importance of a clear policy direction (both national and local). Anecdotal evidence

has suggested that companies are choosing not to invest in solar installations in Wales directly as a result of the current threshold based approach to solar installations.

3 Non Domestic Solar Technologies

3.1 Introduction

3.1.1 This Chapter considers the nature and capabilities of current and future solar panel and thermal technologies, with a particular focus on the sizes and energy outputs of current solar panel technologies and the scale of arrays necessary to produce various energy outputs; how technological advances in solar PV and thermal panels may impact on the nature of future installations; and efficiency savings of roof based development over land based development. This part of the research has been primarily desk-based, although consultations with representatives of the Solar Trade Association and the private sector have also contributed.

3.1.2 First it is important to distinguish between solar photovoltaic (PV) and solar thermal technologies. The principle behind both technologies is the same, as they both absorb raw energy from the sun and use it to create usable energy. With solar PV systems, this is through the creation of electricity, whereas thermal systems use the sun directly to heat water or air.

3.2 Current Non Domestic Solar

3.2.1 The area that is required for mounting a solar PV array is determined by the base load required and the type of module that is used. For example, the most commonly used type of solar cell, monocrystalline cells, require $7m^2$ to $9m^2$ for a 1kW system, whilst a polycrystalline system requires $6m^2$ to $7m^2$.

3.2.2 Table 3-1 below provides an indication as to the area required for solar installations of various output specifications.

Table 3-1 System Output by Area

Area	System Specification
$75m^2$	10kW
$190m^2$	25kW
$375m^2$	50kW

Source: www.dulas.org.uk

3.3 Technological Advances

3.3.1 As the use of renewable energy sources continues to grow, the development of more efficient solar cells is increasingly gaining relevance. The most widely used solar technologies (crystalline) currently have a 40% solar-to-electricity conversion efficiency, which is well below the theoretical limit of 87%. This leaves significant room for improvements in the efficiencies of solar cells[3].

3.3.2 Solar crystalline technologies are relatively energy intensive, wafer based devices, which are sawn from crystal ingots. Scientists are currently undertaking research attempting to develop ways in which to reduce the cost of these cells, whilst also improving their performance[4].

3.3.3 Deficiencies in the operation of solar cells are called recombination, the opposite of electrical generation, which leads to voltage and current loss. Defects and impurities found within or at the surface of the solar cells promote recombination. In order to improve the

efficiency and operation of cells, scientists are researching ways to reduce this recombination, through more effectively controlling the effects of impurities[5].

3.3.4 There are two types of defects which researchers are currently studying: surface defects and bulk defects. Surface defects affect the performance of solar cells, whilst bulk defects are found in cheaper materials, which reduce the efficiency of solar units. Work is ongoing to find ways of removing unwanted impurities, a process known as 'gettering' and also improvements in protecting against corrosion, a process which is known as 'passivation'. Through these improvements, not only will this improve the efficiency of the existing cells, but also is likely to result in an improvement to their cost effectiveness[5].

3.3.5 In addition to research seeking to improve the efficiency of existing solar technologies, scientists are also developing new technologies, which utilise new techniques and materials.

3.3.6 For example, the solar industry has witnessed rapid improvements in perovskite solar cells, as they have demonstrated dramatic rises in power conversion efficiency, especially when compared to other types of photovoltaics. Since 2012 the quality of the material has improved, with light-into-energy figures showing significant increases. In addition, perovskite solar cells have much lower rates of energy loss during the conversion process from light to electricity. One of the main advantages of perovskite solar cells is the fact that they can be printed directly onto glass, which can then be integrated into the glazing units of buildings, thus greatly improving the aesthetics of solar technology. In addition, production methods associated with this material are a lot less energy-intensive when compared to the production of other solar cell materials.

3.3.7 Whilst solar cells are becoming increasingly more efficient, many are still failing to make use of the radiation that falls upon them. Hybrid and organic based solar cells overcome this by mimicking natural photosynthesis, converting light that goes unused by the solar cells into heat and converting the heat into electricity. Scientists are undertaking research in order to gain a better understanding of photosynthetic processes and to further realise improvements in these systems[2].

3.3.8 Scientists are currently investigating third generation photovoltaics. The maximum theoretical efficiency of current solar panels is limited to 31-41%, which is known as the Shockley-Queisser limit. First calculated in 1961, scientists are trying to overcome[3] this limit using multi-junction devices and newer quantum technologies such as hot-carriers, multi-exciton generation and also quantum dot photovoltaic devices.[4]

3.3.9 The research and consultations with various representatives from the solar industry, provide a clear picture that technological improvements will continue to further reduce the costs of solar installations. However, the recent changes to FiTs identified earlier and the effects that this would have on solar uptake, should also be noted.

3.3.10 As technological improvements continue to reduce costs, the planning system (and thereby permitted development rights) may prove to be proportionately more of a barrier to commercial viability of installation in the future.

3.3.11 Concerns over solar glare have arisen alongside the significant rise in use of solar technologies. This is an area which has been highlighted particularly by the aviation industry as of serious concern for the navigation of aircraft (although as suggested in

[3] www.solarcellcentral.com

[4] http://www.energy.ox.ac.uk

Chapter 2 of this report, ongoing research both in America and the UK may conclude that there is limited risk to safety). Glare has also been identified as an issue from the perspective of neighbouring properties and on landscape/ visual impact. As such, scientists have been developing technologies where the reflection of the sun from photovoltaic panels is reduced, by developing a multi-layer anti-reflection coating for glass surfaces. This has been developed using the same technology that is used for depositing anti-reflection coatings on eye glasses.

3.3.12 Scientists are evidently focusing their efforts on improving the operational efficiency of solar panels. As such, with continued improvements in efficiencies likely, the anticipated output from one panel will improve; therefore, the size of an array for a particular output is expected to reduce with time.

3.3.13 In respect of solar thermal energy, it is felt by many within the industry that this has the highest potential amongst renewable heating and cooling technologies. However, in order to realise this potential, it is important to continue to strive to make technological improvements in this sector. The Renewable Heating & Cooling – European Technology and Innovation Platform has identified three areas of technological improvements which need to be tackled in unison. These are:

- cost reduction, which can be achieved through improvements in efficiencies and the lowering of the price of components used. There is also scope for improvements in the design and installation for collectors, storage and hydraulic systems;
- increasing the share of solar thermal technology for domestic hot water and space heating demand per building. Research and innovation are key to improving collector arrays, improving the integration of large storage volumes in buildings, hydraulic schemes and control strategies. The ever improving optimisation of systems can increase efficiency, reduce collector surface and storage volumes and further reduce costs; and
- standardised and cost optimal solutions, which integrate solar thermal technology in all industrial processes. A further strand of development focuses on the development of the next generation of medium temperature collectors for temperatures between 100^{o}C and 250^{o}C.

3.3.14 Through the adoption of the methods outlined above, solar thermal technologies have the potential to become cost competitive and prove increasingly attractive to potential customers.

3.4 Roof-based systems and land based systems

3.4.1 Solar PV rooftop installations cover a broad range of outputs and on different types of buildings, from 10kW installations on schools and farm buildings, through to 50-250kW on businesses, public buildings, supermarkets and commercial buildings. These mid-sized projects attract a diverse mix of investment from commercial companies, communities and the public sector. Solar installations on larger commercial buildings from 250kW to 5MW are far less common in the UK than in other countries[5].

3.4.2 Larger-scale solar is categorised by the Department of Energy and Climate Change as projects whose output exceeds 5MW and are usually ground-mounted and standalone schemes away from building curtilage. Usually, large-scale solar is driven by institutional investors, but there are increasing opportunities for local communities to invest at this scale, including on the basis of shared ownership with commercial developers[6].

[5] Solar Trade Association
[6] Solar Trade Association

3.4.3 The advantages and disadvantages of roof and land based developments are well documented. The advantages of rooftop installations include that they are more aesthetically pleasing, as the installations may fit seamlessly onto the pre-existing rooftop; a rooftop installation makes better use of available space, allowing extra land to be utilised for other uses; rooftop installations offer the roof protection from the weather and wear and tear, which will in turn increase the lifetime value of a property; and finally rooftop installations are usually easier and faster to install than ground-mounted systems.

3.4.4 However, there are situations when ground mounted installations are the better option, including: if a property has significant tracts of unused land, a much larger PV system will generate even higher savings; for properties without south-facing roofs, ground-mounted solar installations will allow the maximisation of energy generation potential; it is easier to set up in the sunniest parts of land to avoid shading; and finally, in order to install ground-mounted systems, fewer upgrades will have to be undertaken as for a rooftop installation.

3.4.5 In the last few years, however, policy instability surrounding solar developments has in turn dented the confidence of investors in large-scale solar installations. In the short-term, the amount of decline in large scale installations is unlikely to be matched by growth in rooftop output, as significant investment barriers remain. Consequently, it is vital that policy considers the whole solar market, as there are strong links between each area, with each bringing its own advantages. For example, the dramatic cost reductions in solar as a whole have mainly been driven by the increasing prominence of solar farms giving economies in scale of production. Commercial rooftop schemes are likely to fall to or below the per-kilowatt price of electricity obtained from the grid before field based installation; a process known as socket parity.

3.4.6 Consultations with the private sector have also suggested that there should be a focus on having power storage capabilities on site, which could be used to feed power back into the grid when demand is highest.

3.4.7 Solar panel technology is improving all of the time; it is therefore likely that the relative advantages that ground based systems have over roof-based systems will diminish over time, and that fixed sized panels are likely to be able to achieve ever greater outputs. The Solar Trade Association considers that there may be a technological breakthrough at some point in the future, at which point, a smaller surface will be required to produce the same amount of power. However, the current focus is on improving the efficiencies of existing sized panels.

3.4.8 The most common way to install solar thermal collectors is to mount them directly onto the roof of a property. Solar thermal ground mounted systems are also possible for commercial settings, for example agricultural premises or schools, and are installed and operated in much the same way as a flat roof mounted system. Ground mounted systems have the advantage of being orientated south to give optimal performance. The system itself consists of an ‘A’ frame anchored securely to the ground.

4 Assessment of Different Approaches

4.1 Introduction

4.1.1 This Chapter assesses the two alternative approaches that have been considered in relation to permitted development rights and non-domestic solar projects. The two approaches are a threshold based approach to solar energy output (referred to as the 'output threshold approach') and an approach that excludes an output threshold in favour of permitted development rights based on an assessment of planning impacts (referred to as the 'planning impacts approach').

4.1.2 The approaches are considered with respect to rooftop mounted solar PV and ground mounted installations within the curtilage of a non-domestic property. Whilst the planning issues associated with standalone ground array schemes are discussed, this is to provide context to the assessment rather than policy consideration. The Chapter sets out the methodology that has been used to undertake this assessment, together with key findings, advantages and disadvantages relating to each approach.

4.2 Assessment Framework

4.2.1 In order to effectively compare and contrast the two approaches, a number of case studies were selected comprising applications for non-domestic solar developments of varying outputs for which a planning decision has been made within the past two years. The case studies are from various authorities in Wales as well as some selected from England to increase the number and variety of examples. The case study applications were identified from information available online from local authority websites.

4.2.2 The case studies (of which there are twenty in total) are representative, as far as possible, of:

- Differing output levels: Selected applications conformed to both the current definition of microgeneration as well as those that have higher outputs, for example up to 5MW;
- Rural / urban schemes: In order to fully explore and appreciate the various issues and the impacts associated with individual schemes, a mixture of case study applications from rural and urban areas were identified;
- Types of scheme: Selected applications included a mixture of type of schemes, including both building mounted panels and stand-alone installations.
- Outcome: A mixture of schemes that have been refused and granted planning permission were selected in order to fully understand the considerations in the decision-making process (although the research has identified that very few non-domestic solar applications appear to have been refused planning permission).

4.2.3 For each case study application the following information has been gathered:

- Details relating to consultations received in respect of the application;
- A summary of the development plan considerations in relation to each application; and
- A summary of other material planning considerations that have been highlighted (for example visual impact, glint and glare).

4.2.4 For the purposes of this research, a distinction needs to be drawn between rooftop and ground mounted solar schemes. At present, ground mounted solar arrays of up to 9m^2 in size are allowed within the curtilage of a building under non-domestic solar permitted development rights; large-scale ground based solar arrays are therefore excluded from this research. However, in order to demonstrate the nature of planning impacts associated with

solar developments over 1-2MW in size, which are predominantly large scale solar farms, a selection of such developments have been included in the case studies.

4.2.5 The case studies have been used as a basis from which to identify the implications associated with the two alternative approaches. Consideration is given to whether each case study would have been eligible under either approach to permitted development rights and if so, what issues might have arisen (for example, might there have been an unacceptable visual impact).

4.2.6 Fifteen Welsh case studies and five English case studies have been included in the research. The twenty schemes include eight schemes of under 1MW, with one smaller than the PDR threshold which involved a listed building. No schemes were of 1-2MW and four were of 2-5MW. Detailed information was not available on all of the schemes. Eleven of the schemes were roof top mounted and the remainder ground array. It proved challenging to identify case studies of small scale ground mounted schemes.

4.2.7 The analysis of the case studies shows that all of the applications were granted consent with the exception of one large ground array that was recommended for approval by officers but refused at committee. In terms of consultations, the only schemes receiving objections were two large ground arrays, where there were community / neighbour objections. No roof mounted schemes received objections although additional requirements were identified for one scheme due its proximity to a Scheduled Ancient Monument.

4.2.8 Table 4-1 below identifies the number of times the various planning considerations were discussed in the officer reports and consultee responses (for the twenty Welsh and English case studies). The main issue to arise was related to impact on amenity of the area as well as landscape/ visual impact considerations. Other main issues included the impact on the highway network and impact on agricultural land. It should be noted that in no cases did these issues lead to an officer recommending refusal.

Table 4-1 – Planning Considerations in Applications

Planning Considerations	Number of Times Addressed in Applications
Landscape	7
Scale and Design	3
Listed Building	2
Amenity of area	16
Highway Network	6
Visual Impact	5
Archaeological Resource	3
Glint and Glare	2
Public Rights of Way (PRoW)	2
Agricultural Land	3
Ecology	3
Surface Water Drainage	1

4.2.9 A summary of key information for each of the Welsh and English case studies identified for inclusion in the research can be found in Tables 4-2 and 4-3.

4.2.10 In addition, to the five case studies from England for which planning permission has been sought, a further five schemes have been reviewed that have been through the prior approval process since the change in the threshold for permitted development rights was introduced in April 2015. A summary of key information for each of the English prior notification case studies can be found in Table 4-4.

Table 4-2 Welsh Case Studies – Summary Information

Ref.	Scheme Type	Output	Outcome	Relevant Local Plan Policy Issues Identified	Summary of Material Planning Considerations Identified	Consultations
1	Roof Mounted / Rural	121.9kW	Delegated Decision Approved	• Sustainable Development • General Development Policy • Resource Efficiency and Renewable and Low-Carbon Energy Proposals	Proposed installation will not appear conspicuous in landscape terms or in relation to host building	No objections
2	Roof Mounted / Urban	212kW	Delegated Decision Approved	• Sustainability and High Quality Design • Renewable Energy and Energy Efficiency • Non-wind Renewable Energy Installations	Proposal considered appropriate in terms of scale and design Acceptable in terms of impact on surrounding landscape Does not have a significant impact on the amenity of the adjacent landscape	No objections
3	Roof Mounted / Urban	182kW	Delegated Decision Approved	• Sustainable Development • Climate Change • General Amenity • Quality of Design	Proposal will provide a source of renewable energy on previously developed land Proposal is acceptable in terms of impact on surrounding landscape	No objections
4	Roof Mounted / Urban/ Listed Building	-	-	• Conservation of the Built and Historic Environment • Heritage Assets and Regeneration	Having regard to the siting, scale and design and appearance of the panels, it is considered that the special architectural and historic interest of this listed building would be preserved	No objections

Ref.	Scheme Type	Output	Outcome	Relevant Local Plan Policy Issues Identified	Summary of Material Planning Considerations Identified	Consultations
5	Roof Mounted/ Urban	250kW	Delegated Decision Approved	• Amenity and Accessibility • Quality of Design • Renewable and Non-Renewable Energy	Proposal will not be harmful to the character of application building or immediate vicinity No impact on amenity Not considered detrimental to highway safety	No objections
6	Roof Mounted/ Urban/ Listed Building	-	Delegated Decision Approved	• Design and Sustainable Place Making • Conservation of the Built and Historic Environment • Heritage Assets and Regeneration	Having regard to siting, scale and design and appearance of the panels, considered special architectural and historic interest of this listed building would be preserved	No objections
7	Roof Mounted/ Urban	249kW	Delegated decision Approved	• Design and Aesthetic Quality • Energy Efficient Design	Proposal would accord with local policies and not undermine the aesthetic of the area	No objections
8	Roof Mounted/ Rural	923.8kW	Delegated Decision Approved	• The Environment • Business and Industrial Uses • Community and Utility Facilities • Development in the Countryside • Special Landscape Areas • Conservation of the Countryside • Protected Species • Protection of Built and Historic Environment • Archaeological Field Evaluation • Preservation of Archaeological Remains Space • Design of New Developments • Protection of Environmental Quality • Land for Employment Uses	Visual Impact – works relate solely to the roofs of existing buildings, as such, there will be no impact on existing landscape features Historical Impact – historical interest in the site. Therefore a condition should be attached which safeguards the scheduled ancient monument and the archaeology on the site Neighbouring amenity – no impact beyond existing uses	Cadw – Recommend that Ancient Monument is temporarily protected using surface mounted fencing Glamorgan Gwent Archaeological Trust – Suggest a condition of consent, any site compounds need to be agreed Cardiff Airport (Safeguarding) – No safeguarding objections

Ref.	Scheme Type	Output	Outcome	Relevant Local Plan Policy Issues Identified	Summary of Material Planning Considerations Identified	Consultations
				(allocated site No.19). • New Business and Industrial Development. • General Industry • Protection of Land for Employment Sites • Parking • Other Renewable Energy Sources		
9	Roof Mounted/ Rural	50kW	Delegated decision Approved	• Sustainable Development • The Countryside • General Permitted Development • Resource Efficiency and Renewable Low-Carbon Energy Proposals	Proposal will have some minor adverse effect on landscape quality, however, proposal is considered environmentally acceptable Not considered to have a detrimental impact on local amenity Will not lead to traffic problems	No objections
10	Roof mounted/ Urban/ Conservation Area	3.71kW	Delegated decision Approved	• Development in Conservation Areas • Design and Aesthetic Quality • Energy Efficient Design • Good Design • Residential Amenity • Conservation Areas	Proposal not considered to affect the character and appearance of the Conservation Area Proposal not considered to affect the amenity of neighbours	No objections
11	Ground mounted/ Rural	150kW	Delegated decision Approved	• Sustainable Development Principles • Promoting Design Quality and Reducing Crime • Development Criteria • National Planning Policy Guidance • Energy Efficiency and Renewable Technologies in New	Visual Amenity – proposal is considered acceptable and conditions have been applied as appropriate Neighbour Amenity – considered acceptable and conditions have been applied to mitigate against any issues	Primarily no comments or objections from consultees CPRW – difficult to tell from submission documents what the visual impact will be

Ref.	Scheme Type	Output	Outcome	Relevant Local Plan Policy Issues Identified	Summary of Material Planning Considerations Identified	Consultations
				Development		
12	Ground mounted/ Rural	2.6MW	Delegated decision Approved	• The Environment • Development in the Countryside • Agricultural Land • Water Resources • Conservation of the Countryside • Protection of Landscape Features • Protected Species • Protection of the Built and Historic Environment • Preservation of Archaeological Remains • Design of New Developments • Protection of Environmental Quality • Farm Diversification • Other Renewable Energy Schemes	Proposal represent an acceptable form of development No effect on protected landscapes No effect on amenity of area Scheme would result in reduction in overall levels of visibility from receptors within the local area However, given local nature of such impacts, it is outweighed by benefits in terms of renewable energy production Similar development 1.9KM to the north, however, this is not considered to result in unacceptable cumulative impacts No trees affected Condition recommended to ensure minimal impact on archaeological resource Development not considered to unacceptably impact upon ecology Local road network not considered to be effected	Community Council – Like to see taller screening of the development Highways – No objections, subject to Construction Traffic Method Statement and pre and post development condition survey Highways & Engineering – No objections, subject to Construction Environmental Management Plan (CEMP) Environmental Health Team – Recommend construction and piling activities are limited and a condition included to safeguard workers from risks Ecology – Recommend a Biodiversity Management Plan Landscape – Scheme requires landscape mitigation proposals to reduce effects of the scheme Cardiff Airport (Safeguarding) – No safeguarding objection to proposal National Air Traffic Control Centre – No objections Civil Aviation Authority – No

Ref.	Scheme Type	Output	Outcome	Relevant Local Plan Policy Issues Identified	Summary of Material Planning Considerations Identified	Consultations
					No evidence of glint and glare risks Land is not Best and Most Versatile Land Site crosses PRoW, however measures in place to safeguard	comments received Ministry of Defence – No comments Glamorgan Gwent Archaeological Trust – Proposal will require archaeological mitigation NRW – No objection Representations from neighbouring properties – Concerns raised over – intrusion into local landscape, footpaths cross, fencing and camera will affect amenity, BMVL lost, screening non-existent, will result in no permanent employment in the area, speed surveys inadequate, potential for flood risk, does not constitute farm diversification, contrary to policy and application not supported by noise data.
13	Ground mounted / Rural	3.8MW	Recommended for approval by Officers, rejected by Committee	• Climate Change • General Amenity • Service Infrastructure • Highways and Accessibility • Natural Environment • Quality of Design • Environmental Protection and Public Health • Archaeology • Renewable Energy • Heavy Commercial and Vehicle Movements • Public Rights of Way and New Development	Quality of Agricultural Land – overall, considered site can be restored to original condition Landscape and Visual Impact – proposal not considered to have an unacceptable adverse effect on the character of this rural landscape or the visual amenity of the area Impact on the Highway Network – considered no impact on local highway network and M4 Impact on PRoW is considered acceptable	No objection / response from a number of internal and external statutory consultees Local Archaeological Trust – Potential for undiscovered items, therefore recommend a watching brief from an archaeologist Keep Us Rural – Strongly object on the following grounds – Overriding need not demonstrated, BMVL land will be lost, flawed sequential test, no community consultation or community benefit, significant landscape effects

Ref.	Scheme Type	Output	Outcome	Relevant Local Plan Policy Issues Identified	Summary of Material Planning Considerations Identified	Consultations
					Proposal not considered to affect protected species or any ecological interest on the site Recommend an archaeologist to conduct a watching brief during all ground disturbing works Not considered to impact on neighbouring amenity No issues regarding glint and glare	
14	Ground mounted/ Rural	4.85MW	Granted via Committee decision	• Sustainability • Flood Risk • Countryside • Minerals • Climate Change • General Amenity • Service Infrastructure • Natural Environment • Quality of Design • Environmental Protection and Public Health • Renewable Energy • Public Rights of Way and New Development	Solar installations close by, however, cumulative impact considered negligible Not BMVL land as it is grade 3B Proposal complies with local policy, therefore no reasonable grounds for refusal	Highways – Concerns over parking during construction, therefore, Construction Management Plan required Pollution Control – Construction noise assessment note requested NRW – No objection, subject to implementation of appropriate conditions on flood risk, surface water, European Protected Species Fire Service – Adequate access and water on site for firefighting purposes Glamorgan Gwent Archaeological Trust – Programme of work should be submitted to mitigate impact of proposed development on archaeological resource Local Community Council – Object on following ground – Site is BMVL, affect nature and character of the

Ref.	Scheme Type	Output	Outcome	Relevant Local Plan Policy Issues Identified	Summary of Material Planning Considerations Identified	Consultations
						area, impact on landscape would be unacceptable, panels will reflect sunlight onto the M4 and transformers will create noise. Neighbouring properties object on the following grounds – Increased traffic, glint and glare, BMVL land, no engagement, loss of farming jobs, overdevelopment of the area, detrimental to wildlife, application is incomplete, development will be detrimental to visual quality and rural character of the area, noise from transformers, CCTV will effect privacy, designated greenbelt area, result in joining up of Cardiff and Newport. Local Councillor objects on the same grounds
15	Roof Mounted / Urban	250kW	Delegated Decision Approved	• National Renewable • Energy Efficiency Targets • The Environment and Local Communities • Mineral Resources • Nature Conservation • Historical features • Public Rights of Way Network • Local Amenity • Electromagnetic Disturbance • Local Receptors • Reinstatement	Meets national renewable energy and energy efficiency targets No adverse impact on mineral resources, nature conservation, features of local archaeological or historic interest No detrimental impact on local amenity Development tackles causes of and adapts to impact of climate change Development should contribute to creating high quality, attractive,	Town / Community Council Observations – No objection Network Rail – Any interference with train driver's vision or signal sighting must be addressed through appropriate mitigation measures Scaffold must be positioned, that in the event of failure, it will not fall onto railway land Member of public – Concerns over noise pollution and working hours during construction

Ref.	Scheme Type	Output	Outcome	Relevant Local Plan Policy Issues Identified	Summary of Material Planning Considerations Identified	Consultations
					sustainable places which enhance the community in which they are located, whilst having full regard to the natural, historic and built environment	

Table 4-3 English Case Studies – Summary Information

Ref.	Scheme Type	Output	Outcome	Relevant Local Plan Policy Issues Identified	Summary of Material Planning Considerations Identified	Consultations
1	Roof mounted/ Urban	Not declared	Granted via Delegated Decision	• Amenity • Renewable Energy Sources	Visual impact on the building, on the street scene and on the Conservation Area will be negligible Only real change will be the colour of the building's roof. However, since remains dark this is considered acceptable Listed building is some distance from application building, therefore proposals not considered to impact upon the setting of the listed building	No objections from consultees Conservation Officer – Some historic structure on site, but some distance away. Therefore important to assess impact of proposals on earlier (unlisted) buildings that stand quite close to the application building
2	Roof mounted/ Urban	<1MW, however applicant has chosen to submit a full applicatio n	Granted via Delegated Decision	• Presumption in favour of sustainable development • Jobs and Skills • Design • Health and Wellbeing • Best use of Land and Existing Buildings • Flood Risk Management and Coastal Change • Transport and Accessibility	Principle of development is considered acceptable Proposal would have little impact on visual appearance of the locality Unlikely any significant disturbance to the neighbouring businesses. There are no residential dwellings adjacent to the site No impact on safety of highways users Surface water drainage would remain unaffected	No objections from consultees Parish Council – Support the application as it is eco-friendly
3	Ground mounted/ Rural	24kW	Granted via Delegated decision	• Protecting and enhancing biodiversity and geodiversity • Landscape Character • Development in Open Countryside • Protecting the built and historic environment	Proposal will result in small loss of land, given level of loss, it will not have an adverse impact on the fabric of the landscape Sites' location within topography and existing vegetation screen the development and limits potential	No objections from consultees

Ref.	Scheme Type	Output	Outcome	Relevant Local Plan Policy Issues Identified	Summary of Material Planning Considerations Identified	Consultations
				• Renewable Energy • Rural Diversification Proposals • Development in Open Countryside • Planning in Renewables • Biodiversity and Geodiversity • Landscape • Historic Environment and Heritage Assets • Renewable and Low Carbon Energy Development • Solar Photovoltaic Farms	impact upon landscape character of the area Proposal not considered to result in an adverse impact on visual amenity Proposal not considered to have an adverse impact on the highways in the local area Considered low ecological impact No effect on cultural heritage assets within the local area	
4	Roof Mounted	41.76kW	Granted via Delegated Decision	• To ensure the maintenance, conservation and enhancement of the built heritage of area • Preserve the special architectural or historical interest of listed buildings • To respect the existing context, character and appearance of the townscape • Small scale alterations should achieve high standards of amenity • Neighbouring amenity needs to be protected	Proposal not considered to harm views Not considered that the installation of solar panels would detract from character of the area Panels would not result in any significant harm to existing environment The proposal would not harm neighbouring amenity	Neighbouring properties consulted, no, replies received
5	Roof Mounted	30kW	Granted via Delegated Decision	• Amenity and character of the area • Renewable Energy Sources • Site lies within Conservation Area • Part of the original property is Listed at Grade II	Visual impact on the building, street scene and on Conservation Area will be negligible Negligible visual impact in relation to unlisted building Limited visual impact on outlook of neighbouring property – no overlooking, overshadowing or loss of privacy for occupiers	No objections from consultees

Table 4-4 English Case Studies Subject to Prior Notification

Ref.	Scheme Type	Output	Outcome	Relevant Policy Issues Identified	Summary of Material Planning Considerations Identified	Consultations
1	Roof Mounted	250kW	Prior Approval not required	• Part 14 Class J of the General Permitted Development Order	Proposal would not cause any significant visual harm in terms of design and external appearance	Concerns raised over glare, however glare direct from the sun itself would likely override any glare from reflection
2	Roof Mounted	249.60kW	Prior Approval not required	• Part 14 Class J of the General Permitted Development Order	Key issue is whether the proposed solar PV panels comply with the regulations set out in Part 14	No objections received
3	Roof Mounted	249.1kW	Prior Approval not required	• Part 14 Class J of the General Permitted Development Order	Output of site Impact of glare on neighbouring properties	No objections received
4	Roof Mounted	Not disclosed	Prior Approval Required and to Refuse	• Part 14 Class J of the General Permitted Development Order	Design External appearance Impact of glare Does not comply with GPD, as would be in excess of 0.2m above the pitch of the roof	No objections received
5	Roof Mounted	24kW	Prior Approval not required	• Air Safe Zone (Residual Items) • Surface Water Drainage • S38 Adoption Agreement • Not adopted (Road Maintenance) • Tree Preservation Order	Part 14 Class J of the General Permitted Development order	No objections received

4.2.11 In addition to the planning application case studies, three 'hypothetical' case studies have been prepared. These are summarised in Table 4-5 and include three different types of non-domestic buildings, with different available roofspaces, at different locations in Wales. The hypothetical case studies have been included in order to provide an indication of what capacity typical non-domestic buildings can accommodate and the contribution that rooftop solar PV could potentially make to energy consumptions of businesses. Estimates of roofspace, annual yield and energy consumption have also been made.

4.2.12 The analysis in Table 4-5 identifies that the potential solar development size for these different types of businesses ranges from 283kW for a small industrial unit to 522kW for a superstore and 1.6MW for a large industrial building. Notably all of these solar developments if pursued would currently require planning permission as they are significantly larger than the 50kW threshold. The solar developments show a potential contribution of between 5.6% and 14.4% of the businesses energy needs.

Table 4-5 Hypothetical Case Studies

	Case Study A: Large Supermarket, Cardiff	Case Study B: Industrial Unit, West Wales	Case Study C: Industrial Unit, Deeside
Available roofspace	3,390m^2	1,840m^2	10,435m^2
Potential solar array size (Kw)	522	283	1,605
Annual yield (Kwh)	489,000	270,000	1,450,000
Energy Consumption of Business per annum (Kwh)	3,390,000	4,541,476	25,755,599
Percentage consumption covered by solar PV	14.42%	5.95%	5.63%

4.2.13 The following sections consider research findings to arise from the case studies and wider consultations for each of the two approaches. This has included a research workshop of the Arcadis technical team and Welsh Government planning officers to discuss emerging findings and the likely advantages and disadvantages of the two approaches. For consistency the following areas have been considered for each:

- **Fit with policy and practice** – how might the approach comply with national and local policy considerations;
- **Material impacts** – identification of what these might be for each approach (for example glare, landscape impacts), what might be the implications of changing permitted development rights and what ways could these be limited;
- **Process impacts** – consideration of how the approach might contribute to further streamlining of the planning process, improvements to timescales, effects on the resources of local planning authorities; and
- **Delivery impacts** – consideration of how changes may or may not lead to an increased output of solar PVs through encouraging businesses to invest (such as cost and returns, timescales and certainty.

4.3 An Output Threshold Approach

4.3.1 The output threshold approach considers whether a specific output threshold for solar energy output for rooftop panels should continue to be used to establish permitted development rights, and whether there is an optimum output that is higher than the limits currently set under the definition of microgeneration.

4.3.2 Chapter 2 of this report identified that in England the threshold for permitted development rights for non-domestic solar has recently increased from 50kW to 1MW. Consultations and research have identified that there is no particular evidence base behind the selection of a 1MW threshold over, say, a higher output level. The notion of having an output threshold has its roots in the definitions of microgeneration and is a relatively anomalous concept.

4.3.3 As such, it was considered that a range of output thresholds would be included within this research, in order to ascertain whether or not there would be differences to potential impacts and to seek to identify what an 'optimum' output threshold might be. The following output thresholds have been identified, together with the rationale for doing so:

1MW included to reflect the recent changes in England;

3MW representing a maximum likely capacity on a rooftop for solar PV based on a hypothetical exercise to ascertain what the greatest notional output might reasonably be from a roof-mounted development on some of the largest non-domestic buildings in Wales (for example warehouse development comprising 800,000 sq.ft. in Swansea).

5MW comprises the lower threshold for local authority scale renewable energy development and the upper limit of Feed-in Tariffs. Use of a 5MW threshold incorporates an element of future-proofing; as solar technologies and efficiencies improve, output levels from smaller roof and ground mounted systems are likely to increase.

4.3.4 Of the case studies considered:

- eleven were within the 50kW to 1MW output range;
- one was in the 1MW to 3MW output range;
- two were within the 3MW to 5MW output range; and
- Information is lacking on the other applications.

4.3.5 The advantages and disadvantages of an output threshold approach, taking into account each of the three notional thresholds described above, are considered in the following sections.

Fit with Wider Policy and Practice

4.3.6 Both national and local policy is generally supportive of the promotion of renewable energy schemes in Wales using a variety of technologies. *Planning Policy Wales (PPW) (Edition 8, January 2016)* sets out the consenting arrangements for renewable energy schemes and projects which vary depending on the size and location of the proposed renewable development. For onshore installations of less than 50MW the current consenting body is local authorities and the Welsh Ministers. Thresholds for planning purposes set out in PPW are summarised in Table 4-6.

Table 4-6 Thresholds for Planning Purposes

Scale of development	Threshold (electricity and heat)
Local Authority-wide	Between 5MW and 50MW for all technologies except for onshore wind
Sub Local Authority	Between 50kW and 5MW
Micro	Below 50kW

Source: *Planning Policy Wales (Edition 8, January 2016)*

4.3.7 In addition, the *Developments of National Significance (Wales) Regulations 2016* sets out that energy generating proposals of between 10MW and 50MW will be determined by the Welsh Ministers, and processed by the Planning Inspectorate. As such the local planning authority is responsible for consents for schemes up to a 10MW threshold.

4.3.8 A further consideration set out in PPW relates to Feed-in Tariffs, which provide financial support for projects at the sub-local authority scale. The upper limit of Feed-in Tariffs is currently 5MW.

4.3.9 Taking these factors into account would suggest that, of the three potential output thresholds, a 5MW output threshold could have the best fit with national policy and regulation, subject to other considerations.

4.3.10 Further advantages associated with a 5MW output threshold include future-proofing the permitted development rights in line with the national policy and the regulatory framework. Chapter 3 of this report identified the continuous improvements to both the efficiency of existing types of solar panel as well as research that is underway into new materials and technologies; both these factors could render a 1MW threshold relatively obsolete in the next five to ten years and thus require further policy and regulatory changes. A higher threshold would have the flexibility to allow for the introduction of new technologies.

4.3.11 Case study analysis has identified the following range of local policy considerations.

- Sustainable development and climate change;
- Renewable energy policies;
- General amenity;
- Design and aesthetic quality;
- Development in the countryside;
- Highways and accessibility;
- Archaeology; and
- Public Rights of Way.

4.3.12 While a wide range of local policy considerations have been identified in the case study analysis, the majority applied to large ground mounted solar arrays. In no cases were rooftop schemes assessed as non-compliant with policy. As such a threshold approach is considered unlikely to impact on local policy compliance.

Material Impacts

4.3.13 This section considers what material impacts might arise as a result of increasing the output threshold, whereby the planning issues for a larger number of solar rooftop developments are no longer subject to local authority consideration. Table 4-7 summarises the various impacts that have been identified from case study findings by output threshold.

The table sets out the number of times each impact has been identified for each output threshold.

4.3.14 It should be noted that the larger schemes are all ground arrays which would not form part of a change to permitted development rights for rooftop or ground mounted in the curtilage of properties.

4.3.15 It can be seen that there does not appear to be a strong relationship between the threshold and the consideration of visual impact or residential amenity. The issues of glint and glare and agricultural land quality were common amongst the larger applications (as would be expected for agricultural land which is a potential issue for ground arrays). This indicates that the level of the threshold may not impact greatly on the material considerations – it is more closely related to the type of solar development.

Table 4-7 Planning Considerations by Output Threshold

Nature of Impact	Number of Instances from Case Studies		
	1MW Threshold	3MW Threshold	5MW Threshold
Visual impact on landscape quality	7	1	1
Impact on residential amenity	8	3	1
Traffic impact	4	2	2
Impacts on heritage	5	0	0
Cumulative impacts	0	1	1
Glint and glare	0	1	2
Agricultural land quality	0	1	2

4.3.16 There were however various issues that were material considerations noted in the reports and consultations across all scheme sizes: visual impact/ landscape quality, residential amenity, traffic impact and heritage.

4.3.17 With respect to landscape and visual impacts, some of the roof mounted schemes gave rise to concerns but on balance the wider environmental benefits were said to outweigh the negatives. However none of the case study applications were within a National Park or Area of Outstanding Natural Beauty where the issues would be expected to be more significant.

4.3.18 With respect to residential amenity, these issues were raised in the consideration of applications or by consultees but none of the schemes were considered on balance to have a detrimental impact on neighbours. Likewise whilst highway impacts were considered, no negative impacts were identified although this was in response to the applicants needing to submit information on access arrangements thus there was a checking process to ensure safe access.

4.3.19 Four of the rooftop based schemes required consideration of impacts on heritage assets, with issues identified, with two of the schemes being mounted on Listed Buildings, one in a Conservation Area and one in the vicinity of a Scheduled Ancient Monument (SAM). If these schemes had been allowed under PDR, there could have been detrimental impacts without the ability of the LPA to make the decision and moreover a condition could not have been introduced to safeguard the SAM.

4.3.20 In addition, consultations have identified that there might be issues of glare related to aviation. Whilst none of the case studies gave rise to this issue, and in most cases it would

not give rise to a material impact, the ability to take these issues into account could be lost under a larger PDR threshold.

4.3.21 The analysis leads to the conclusion that a much greater threshold for permitted development of rooftop solar PV could lead to material impacts on particular assets. As such it is suggested there might need to be certain limitations to minimise material impacts such as:

- listed buildings, scheduled ancient monuments, or buildings within the curtilage of a listed building;
- Conservation Areas or World Heritage Sites;
- Registered landscapes of historic interest;
- At sites identified in the Register of Parks and Gardens of Special Historic Interest in Wales;
- AONBs or National Parks; or
- Within the safeguarding areas of airports.

4.3.22 Further limitations could be designed to ensure that effects arising from the siting of the proposal are minimised. The following reflect the current PDR limitations:

- Installations not to exceed the height of the roof ridge or be within 1m of the external edge of the roof;
- Installations not to protrude more than 200mm from a pitched roof or wall surface;
- In the case of flat roofs, not to be more than 1m above the highest part of the roof (excluding chimneys).

4.3.23 Moreover it could also be made clear that any formation of a new access with the public highway for construction would require planning permission.

4.3.24 The discussion above relates to rooftop solar PV schemes. A clear distinction would need to be drawn in relation to thresholds for roof-mounted and ground mounted solar schemes; case studies and wider research have illustrated that impacts associated with large scale ground mounted solar farms extend beyond simply visual impact, but include issues associated with best and most versatile agriculture land (BMVL), wider landscape quality as well as cumulative issues.

4.3.25 The case study research highlighted that not many planning applications have been submitted for ground mounted solar developments within the curtilage of non-domestic properties. As such it has not been possible to comment on the material considerations in connection with these planning applications. However, a higher threshold for ground arrays within the curtilage of non-domestic buildings could lead to complexities around whether or not they are *within* the curtilage, so as to differentiate from larger solar arrays. There could also be other impacts depending on their location such as loss of car parking or amenity space. Given the small number of applications for such solar developments, an increased threshold could potentially lead to additional material issues without significant gain in increased capacity.

Process Impacts

4.3.26 The use of a higher threshold should offer advantages to the streamlining the planning process through lessening the requirements for planning applications to be made and determined by LPAs. The analysis identifies that all but one of the planning applications made, of whatever size, were approved by the LPA. The scheme that was refused at Committee was a large ground array which would not come under the PDR threshold approach. As such, it appears from the case studies that the requirement for planning

permission has added to timescale and administrative burden without changing the outcome.

4.3.27 A threshold approach would however remove the requirement for consultation which takes place as part of the application. This would mean that statutory consultees would have a reduced workload, however it does take away the ability of consultees or neighbours to object and also for details to be taken into account such as might be included in conditions. However, there were no objections to rooftop mounted schemes and conditions were imposed where there were heritage assets involved. Thus providing limitations are set to exclude listed buildings, for example, this might not impact on the outcome, although it changes accountability.

4.3.28 It would be expected that there would be more consistency of approach across Wales with a standard threshold. At present LPAs interviewed noted that they had limited skills in dealing with renewables and it is possible that decisions could vary across different LPAs.

4.3.29 Whilst in England the prior approval notification process has been incorporated into the revised threshold approach, in Scotland they are not anticipating doing so. Reasons given in discussions include to bring improvements to streamlining and the removal of an additional 'layer' of bureaucracy that could be seen by developers as simply replacing the planning application. With each of the three output thresholds under consideration in this section therefore it is not considered necessary that a prior approval notification system would be adopted.

4.3.30 As a disadvantage there are still some concerns over glint and glare from solar panels and the effect this has on aviation safety. Adopting this approach would take this element of control away from local authorities and consultees unless developments within Airport Safeguarding Areas are excluded from the PDR. The Civil Aviation Authority encourages developers and planning authorities to comply with Air Navigation Order (ANO 2009).

4.3.31 Moreover a developer may install a system which exceeds whatever threshold is adopted, be it intentionally or unintentionally. As such, local authorities would have to adopt measures to monitor the installation of solar systems, which they may not have the expertise or resources to undertake.

Delivery Considerations

4.3.32 Advantages associated with raising the output threshold for permitted development from the perspective of developers relate to the removal of barriers (both real and perceived) and cost savings. Perceived barriers can be associated with risk and uncertainty; with a robust output threshold in place, developers can apply a greater level of certainty to their projects, reducing risk and thereby cost. Cost savings are likely to accrue equally from any of the three potential output threshold options – with clarity as to what is and is not permitted development, developers will be able to save costs associated with refused planning applications. The outcome would be expected to be an increased delivery of non-domestic solar PV on rooftops.

4.3.33 It is possible that, with a lower output threshold (say 1MW), developers may not consider this to be enough of an increase to warrant investment. Higher thresholds may therefore be more attractive in achieving return on investments, particularly as solar technologies improve.

4.3.34 To inform the research, analysis has been undertaken of the commercial benefits of the three hypothetical case studies to identify what impact the threshold approach might have on viability. All of the three case study buildings would currently require planning permission to install the potential rooftop capacity identified ranging from 283kW to 1.6MW. The payback period for the investment in the capacity is estimated to be between 7.6 and 9.0 years with Feed in Tariff or 9.0 to 9.5 without Feed in Tariff, with the large output

scheme having the longest payback period. The analysis suggests that a threshold increase to 1MW might assist in bringing forward the most viable schemes and a larger threshold of 3MW or 5MW would assist the largest industrial occupiers.

4.3.35 There would also be the opportunity to deliver wider economic benefits as reductions in the financial and procedural burden of the planning system should help to create a less constrained business environment. It would also help firms within the local area, as there will be a shorter period from quote to installation, thus improving the confidence in potential work coming to fruition. This will be applicable to installers and manufacturers. Additional investment in an area will bring additional job opportunities within the local area.

4.3.36 At present the existing PDR for ground mounted schemes within the curtilage of a property only allows a 9sq.m array, which would generate just 1kW. The hypothetical case studies as shown in Table 4-5 demonstrate that this would only produce a very small proportion of annual energy needs for say, a small industrial unit (0.02%). As such the current threshold does not provide a level of capacity likely to be useful to a non-domestic property and may explain the small number of applications for such solar developments. It would require a significant change in the threshold to provide a capacity that could support businesses. This would be of a scale akin to a large ground mounted solar scheme and it is difficult to find examples of where this might be accommodated without significant impact for example in relation to land or parking. An increase in the threshold for ground-mounted solar schemes to a level that would still be considered acceptable in terms of other material considerations is unlikely therefore to improve the deliverability of schemes.

Conclusions

4.3.37 In order to further understand the implications of the output threshold approach if it were extended across Wales, a more detailed view was taken of non-domestic solar applications (both roof-mounted and ground-mounted) submitted to six LPAs over the course of a calendar year. A total of 34 relevant applications were submitted within the six LPAs during this time, spread out across the different output thresholds as shown in Table 4-8 below. The table shows that the largest proportions of application were in the 2-5 MW and 0-1 MW categories (47% and 41% respectively). It should be noted that the majority of applications within the 2-5 MW threshold were ground-mounted arrays. If the level of applications experienced in the six LPAs is indicative of Wales as a whole, there may be in the region of 140 applications per year at present across Wales of which 58 might be of under 1MW, 66 of 2-5MW and four of more than 5MW. Assuming that the 2MW plus schemes are all ground mounted, there is potential to bring forward something up to 50 rooftop mounted schemes per year within a threshold.

Table 4-8 Number of Applications by Output Threshold for a Sample of Welsh LPAs

	Number of Applications Within Output Thresholds			
	0-1 MW	1-2 MW	2-5 MW	5MW+
Newport	2	0	2	1
Vale of Glamorgan	5	0	9	1
Cardiff	4	0	1	0
Pembrokeshire	2	0	1	0
Conwy	0	0	0	2

Caerphilly	1	0	3	0
TOTAL	14	0	16	4

4.3.38 At present, there are few rooftop installations within the UK that exceed a 3MW threshold – examples include the Bombardier building in Northern Ireland which has an output of 3.8MW on a building with 600,000sq.ft. of roofspace. It is unlikely, that, even allowing for future technology changes, that there would be many instances within Wales of non-domestic structures able to accommodate installations of this size or greater. This potentially raises the question of whether an output threshold may be required at all, with all rooftop solar installations instead restricted by conditions and limitations, or prior notification as necessary.

4.3.39 Table 4-9 below provides a summary of the main advantages and disadvantages associated with the output threshold approach.

Table 4-9 Summary of Advantages and Disadvantages of Output Threshold Approach

Advantages	Disadvantages
A 5MW threshold would be in line with the national policy and regulatory framework	A 1MW threshold could become obsolete as technologies advance
Local policy impacts likely to be limited as not highlighted in case studies as leading to refusals	Increased threshold for PDR could lead to impacts on heritage, landscape, aviation and highway safety unless limitations are in place
More streamlined planning process and reduced consultee workload	For ground mounted schemes, a much higher threshold would be needed to be viable and useful for non-domestic buildings, which would give rise to issues of what is in the curtilage and issues associated with large ground mounted solar arrays
Potential for greater consistency in decision making across Wales	The ability of consultees to object would be removed
Greater certainty and viability for developers and a less constrained business environment	Potential need for a checking process on capacity by LPAs.
A 1MW threshold would be likely to enable the majority of rooftop schemes	A higher threshold of 5MW is unlikely to be exceeded and thus may not serve a purpose.

4.4 Planning Impacts Approach

4.4.1 This section considers an approach to permitted development rights for non-domestic solar and thermal panels that excludes setting an energy output threshold. Instead, the

approach focuses on controlling permitted development rights through setting limitations on PDR based on key potential planning impacts associated with proposals.

4.4.2 The following sections review how this approach would fit with existing policy and practice; consider in more detail the type of impacts that may arise from a removal of the output threshold (based on the case studies set out in this chapter as well as consultation that has been undertaken with relevant organisations); and sets out what impacts this approach might have in relation to process and delivery.

Fit with Wider Policy and Practice

4.4.3 It was noted in Section 4.3 that both local and national policy is supportive of the promotion of renewable energy schemes in Wales using a variety of technologies. *Planning Policy Wales (Edition 8)* notes that the Welsh Government is committed to using the planning system to optimise renewable energy generation and states that "*the impacts from renewable energy developments and associated infrastructure will vary depending on their type, location and scale"* and that "*developers for renewable and low carbon energy developments should seek to avoid or where possible minimise adverse impacts through careful consideration of location, scale, design and other measures*." Criteria suggested in PPW for inclusion in development plans relate to siting and appearance, including location and landscaping requirements designed to minimise any impact on amenity.

4.4.4 *Practice Guidance – Planning Implications of Renewable and Low Carbon Energy (February 2011)* notes in relation to building integrated solar developments that the principal impacts relate to:

- The 'modernising' effect that roof-mounted solar units can have on the character and appearance of properties (this would primarily relate to domestic properties, but could have implications for some non-domestic uses too);
- Visual impact (determined by the size and location of panels necessary to maximise solar energy gain) and which could be minimised through the consideration of the design of solar units and for panels to be flush with the roof and mounted at the same angle as the roof to minimise contrast; and
- Visual impacts specifically in relation to the historic environment (Listed Buildings, Conservation Areas).

4.4.5 PPW also emphasises the importance of good design in protecting and enhancing environmental quality, tackling climate change and improving quality of life, with *TAN 12: Design* identifying five key aspects that are essential in delivering good design (notably access, character, community safety, environmental sustainability and movement).

4.4.6 In controlling permitted development rights through an assessment of key planning impacts, the approach would be policy compliant in that the identified impacts from the review of wider policy and practice, where they are likely to arise, would be afforded due consideration. This would include the importance of design and visual impact on sensitive buildings or locations. Other policies would be supported by the approach including sustainable development and climate change and renewable energy policies.

Material Impacts

4.4.7 This section considers the material impacts that might arise should a planning impacts approach be adopted. Specific issues covered in this section are the siting of solar developments and associated visual impacts; glint and glare (including in relation to aviation); residential amenity; and cumulative impacts. The section considers the extent

and likely severity of material impacts based on the case study findings, and identifies whether material impacts identified could be controlled by means of limitations that would accompany any changes to PDR.

Siting and Visual Impact

4.4.8 Whilst the siting of solar developments was not identified as a specific issue within any of the case studies considered, there is a correlation between the issue of siting and visual impact (which *was* highlighted). Those case studies relating to rooftop solar PV installations typically identify that there would be no detrimental visual impact on existing landscape features, given that the works relate to the roofs of existing buildings. This would appear to be equally applicable to applications in both urban and rural areas. Where visual impact has been identified as a specific issue, mitigation measures have generally been included (for example screening where appropriate). Where landscape and visual impact have been identified as unacceptable by consultees in objection to individual case study schemes, this has typically been in relation to the larger ground-mounted solar arrays or related to schemes on listed buildings. The case studies showed that siting and visual impact issues have not led to refusal, thus in general it would seem that the removal of a threshold should not lead to undue siting and visual impact issues. The exception would be in sensitive landscape and heritage areas and buildings where impacts could be detrimental and thus PDR could be limited to ensure consideration in the planning process. This could be either via full planning being required in the identified locations or a prior notification process being needed with the issues to be addressed focussing on landscape and visual impact, together with glint and glare (see below).

Glint and Glare

4.4.9 Although primarily associated with large scale ground mounted solar arrays, glint and glare can also arise in association with smaller roof-top solar PV installations although the impact is likely to be restricted according to the time of day and year. Glint and glare assessments typically identify times and directions of reflections in relation to nearby properties / facilities (such as airports, discussed in more detail in the section below). The case study analysis and consultations have not identified issues with glint and glare of solar developments leading to refusals necessitating consideration in the planning process for rooftop schemes, with the exception of a continued concern with aviation impacts (discussed in more detail below). Impacts may also be of more concern in sensitive areas, as discussed above, and thus may require limitation.

Aviation Impacts

4.4.10 There are a range of potential issues relating to a link between solar developments and interference of solar panel installations with radar and telecommunications equipment, and impediments to flight paths and navigation. As such, further detailed exploration has been undertaken in order to understand what these issues might be and how they might be affected by changes to permitted development rights in Wales. Consultations have been undertaken with a number of organisations including the Civil Aviation Authority (CAA), the Ministry of Defence (MoD) and operators of Cardiff Airport.

4.4.11 It is interesting to consider feedback that has been provided in relation to changes to permitted development rights in relation to non-domestic solar in England and proposed changes in Scotland. As identified in Chapter 2, feedback from the Scottish consultation (which proposes the removal of an output limit, plus removal of the clause that permitted development rights do not apply…within 3km of the perimeter of an aerodrome or technical site) included objections from Glasgow and Glasgow Prestwick Airports as well as from the

CAA. Discussions are ongoing between the Scottish Government and the Solar Trade Association to present evidence to demonstrate the lack of impact from solar panels on aviation safety. When permitted development rights were modified in England (to increase the threshold for non-domestic solar to 1MW), neither the Ministry of Defence nor the Civil Aviation Authority considered the proposals to have a substantial effect on aviation safety due to the inclusion of a pre-notification/prior approval period that allows consideration of the impact of glare prior to approval.

4.4.12 There remains some uncertainty about the type and extent of impact that solar installations might have with regard to aviation. The US has been at the forefront of research into this matter and the US Federal Aviation Authority (FAA) has produced comprehensive information and guidance[7] which is referred to by the CAA. Currently, the FAA has in place interim policy adopted for safety purposes ('*Review of Solar Energy System Projects on Federally Obligated Airports'*), in relation to proposals to construct solar energy systems on airport property. The policy document identifies that, while the FAA supports solar energy systems at airports, the FAA seeks to eliminate the potential for impacts due to glare from such projects. The policy document goes on to note that proponents of solar energy systems located off-airport property are also strongly encouraged to consider the requirements of this policy when siting such systems.

4.4.13 More recent research has identified that glare may not have as much of an impact as previously thought and detailed technical guidance is now awaited from the FAA (due to be produced in 2016), to include new standards for measuring glint and glare and the provision of enhanced criteria for the siting of solar energy installations in relation to airports. Until such guidance is produced, it is difficult to predict whether it will be more or less restrictive in terms of solar installations. Discussions with the MoD, however, has suggested that the revised guidance is likely to be primarily concerned with concentrated solar technologies (such as the large ground arrays found in desert locations in the US) and the need for measures to ensure these installations do not affect aviation safety, and therefore likely to be less relevant to solar installations in the UK.

4.4.14 In the UK, statutory safeguarding procedures are outlined in DfT/ODPM *Circular 1/2003*, which states that local planning authorities in England and Wales should consult identified airport operators (in Wales, only Cardiff Airport is identified) over proposals for development within safeguarded areas (typically a zone of 13km extending out from the airport boundary). CAA interim guidance is outlined in CAP791, which sets out appropriate processes to be followed for proposals within airport boundaries. Information provided by the Solar Trade Association[8] has identified that all applications made to the CAA to date under this system have been approved. Further, the STA note that there is no requirement to seek CAA approval for applications outside of the airport boundary. The STA has identified a number of locations in the UK where solar installations are located on the aerodrome, next to the runway or under the flightpath, including Gatwick (50kW 150m from the runway), Birmingham (50kW on terminal building) and Southend Airport (120kW on terminal building and 5MW array under the landing flightpath).

4.4.15 The CAA currently advocates that developers utilise a glare assessment tool to assess solar installations (known as the SGHAT (Solar Glare Hazard Analysis Tool)), which is also

[7] https://www.federalregister.gov/articles/2013/10/23/2013-24729/interim-policy-faa-review-of-solar-energy-system-projects-on-federally-obligated-airports

[8] http://www.solar-trade.org.uk/wp-content/uploads/2016/04/STA-glint-and-glare-briefing-April-2016-v3.pdf

used in the US by the FAA. The requirements of a glint and glare assessment may be different for a civilian airport than for a military airport.

4.4.16 It is understood that many LPAs apply Article 4 Directions to solar and other developments subject to permitted development rights; this ensures that airports are consulted via statutory safeguarding procedures.

4.4.17 Issues of relevance to the consideration of impacts on aviation of solar installations that have been identified by a number of consultees are as follows:

- glint and glare assessments are considered to be of relevance primarily for ground solar installations, where there is a substantial change to the existing environment. The roofs of non-domestic properties may already be constructed of materials with reflective properties, such as metal and glass and as such adding solar panels would not necessarily have an additional impact in relation to glint and glare;
- existing land-uses that are already sources of glint and glare in the vicinity of airports include areas of car parking (sunlight reflecting off parked vehicles) and large bodies of water, as well as metal-constructed commercial buildings;
- the introduction of permitted development rights for solar panels on domestic properties has not been restricted close to airports or other sites where radar is operated; and
- whether a proposal may affect the approach of an aircraft to an airport.

4.4.18 The main concern of the MoD relates to the effects of solar installations on navigational systems, with the materials used in construction of solar panels having the potential to cause interference through the reflection of radar.

4.4.19 Consultations with operators of Cardiff Airport have identified that, as a business, they are keen to pursue the inclusion of renewable technologies within the airport and that, provided the appropriate process is followed (i.e. compliance with CAA publication 791) this should not be a problem. Currently, Cardiff Airport is a consultee for planning applications within the airport's safeguarded area – relevant applications are assessed by NATS (National Air Traffic Services) who advise whether or not impacts on radar or on instrument and landing systems would be significant.

4.4.20 In summary, whilst the evidence suggests that the impacts of glint and glare as well as on radar or instrument systems from rooftop solar installations are unlikely to lead to a significant impact, there are potential issues which indicate the need for consultation to take place within the vicinity of airports. Possible options that would address concerns of the aviation industry in relation to solar installations include to:

- impose a limitation on PDR such that proposals falling within the safeguarding area of an airport (in the case of Cardiff Airport, this extends to some 13km) would require full planning permission;
- impose a limitation on PDR such that proposals falling within a tighter boundary from an airport would require full planning permission. A 3km radius has previously been in operation in Scotland, and the same distance has been included within the Consultation Paper recently issued in relation to changes to PDR in Northern Ireland;
- impose a condition on PDR that a glare assessment would need to be submitted for all proposals that fall within either of the above radii; or
- control developments by means of a prior notification process for proposals that fall within either of the above radii (this is discussed further in paragraphs 4.4.31-35).

Residential Amenity

4.4.21 Issues relating to amenity are typically concerned with either visual impact or glint/glare. Impacts on residential amenity were identified in twelve of the case study applications. However on each occasion the impact was considered to be negligible. Controlling the form of the installation within limitations to PDR to require consideration if it protrudes unduly above the roofline for example, can be used to minimise visual amenity impacts for neighbours.

Cumulative Effects

4.4.22 An approach whereby PDR is reliant on the assessment of the planning impacts might give rise to cumulative effects of a number of rooftop installations within an area on neighbour amenity, visual or landscape impacts. However, cumulative effects have not arisen as an issue within the consideration of the large ground mounted solar array schemes where it might be most expected. Moreover, if there are a number of non-domestic installations in an area this is likely to be concentrated in a mainly industrial/ employment area which would be less likely to impact on residential neighbours. Furthermore, existing non-domestic buildings may already be constructed of materials that have reflective properties (metal or glass) and thus the addition of solar panels would be of less impact. It is therefore considered unlikely that cumulative effect would arise with this option, although there is potential for it to be the case.

4.4.23 In summary, the non-threshold, planning impacts approach is considered to be unlikely to lead to adverse impacts with the exceptions of those elements identified in the discussion, namely landscape and visual and glint and glare effects in sensitive areas or on airport operations and safety. However, these issues can, as discussed above, be largely covered by limitations to PDR. This may however not adequately cover each and every eventuality – for example where a commercial property may be located on the edge or within a key line of sight to an AONB or National Park.

Process Impacts

4.4.24 Process impacts related to controlling permitted development rights through the assessment of key planning impacts could include a reduction in the overall numbers of applications, although there may also be an increase locally in numbers of applications where impacts might be considered as material. The planning impacts approach may lead to a greater number of requests confirming that applications are permitted development, particularly for larger installations.

4.4.25 A key question in relation to the planning impacts approach would be can all planning impacts be effectively controlled entirely by limitations and if so, what implications might this have both for assessment of individual applications and where there might be sensitivities (for example where an application is adjacent to or visible from a National Park). Limitations clearly only relate to very objective matters (for example whether the location of a proposal is inside or outside of a sensitive area) and less objective issues including design, siting and amenity may not be so clearly dealt with.

Delivery Considerations

4.4.26 As with the threshold approach described earlier, advantages with controlling permitted development rights by means of an assessment of planning impacts could include the removal of both real and perceived barriers for developers as well as result in potential cost savings.

4.4.27 As mentioned in relation to process impacts, the extent of benefits experienced by developers will relate to the clarity of the approach. In the absence of a specific threshold, it will be necessary to be able to convey to all interested parties (notably developers and local planning authorities) what the new approach entails such that there is a clear understanding. This will be essential in order to ensure that the effects of increased delivery of non-domestic solar PV are minimised.

4.4.28 Potentially extending permitted development rights to a greater number of cases would have the added benefit of reducing costs associated with the planning application process for developers. Although decision times and associated application costs are likely to be reduced with the change proposed, they may still present the introduction of a level of uncertainty / risk for some developers.

Limits and Conditions

4.4.29 As with the threshold approach there would be a need for limitations and conditions to accompany this option in order that planning impacts are minimised. As such, permitted development rights would not apply in the following areas and a full planning application would be required:

- listed buildings, scheduled ancient monuments, or buildings within the curtilage of a listed building;
- Conservation Areas or World Heritage Sites and their settings;
- Registered landscapes of historic interest;
- At sites identified in the Register of Parks and Gardens of Special Historic Interest in Wales;
- AONBs or National Parks;
- Within the safeguarding areas of airports; and
- Requiring the formation of a new access from the public highway.

4.4.30 Further limitations are designed to ensure that effects arising from the siting of the proposal are minimised and could include:

- Installations not to exceed the height of the roof ridge or be within 1m of the external edge of the roof;
- Installations not to protrude more than 200mm from a pitched roof or wall surface;
- In the case of flat roofs, not to be more than 1m above the highest part of the roof (excluding chimneys).

Consideration of the Need for a Prior Notification Process

4.4.31 Other UK administrations have incorporated a prior approval/notification process into changes to permitted development rights – England for example, has included a prior approval process relating to issues such as siting of the proposed development, and Northern Ireland has included in their Consultation Paper a proposal for a prior notification period for proposals located within 3km of an airport.

4.4.32 The revision to permitted development rights in England, where the threshold has been extended to 1MW, requires the developer to make an application to the local planning authority for a determination as to whether the prior approval of the authority will be required. Local planning authorities then have 56 days to provide written notice of their determination. The notification for installation of non-domestic solar in England requires the developer to include relevant information covering the design and external appearance of the proposal, in particular the impact of glare on occupiers of neighbouring land; and details

of the proposed solar installation in relation to protrusion and measurements to the external edge of the roof. Further information may be required from the developer if objections are received in relation to the application.

4.4.33 There are both advantages and disadvantages associated with the introduction of a prior notification process. Advantages would include that local planning authorities would be able to utilise more detailed evidence to assess individual applications (for example in relation to glare, or siting of an installation); disadvantages would include potential delays/financial risks associated with an extended approval period – developers might consider this to be similar to that of a full planning application.

4.4.34 Conditions in addition to the limitations already identified, that could be imposed in relation to a prior notification system might include that the installation be sited so as to minimise:

- its effect on the normal appearance of the building; and
- its effect on the amenity of the area and neighbouring properties.

4.4.35 The prior notification process removes some of the benefits of streamlining that may otherwise be associated with permitted development, and adds a layer of potential uncertainty for developers (albeit a 56 day period as opposed to the eight weeks associated with planning applications). For consultees, it provides an opportunity to comment on the proposals.

4.4.36 If potential impacts can be controlled adequately by limitations, then it is questionable as to whether there is a need for prior notification. This is more akin to the approach proposed in Scotland. The limitations and conditions that have been proposed in the preceding section are considered to effectively control potential impacts that have been identified by case studies and research.

Conclusions

4.4.37 Table 4-10 below provides a summary of the main advantages and disadvantages associated with the planning impacts approach.

Table 4-10 Summary of Advantages and Disadvantages with Planning Impacts Approach

Advantages	Disadvantages
A planning considerations approach would enable due consideration of national and local policy impacts	Less certainty for developers in the requirements of the planning process
Potential design and external appearance and glint and glare impacts can be considered fully through submitted details	Potential for inconsistent decision making process across Wales
Advancing technologies would not change the process and make a threshold obsolete	May continue to constrain the business environment through requiring a planning submission / timescales for adequate assessment of impacts
Does not require LPA to check on outputs for compliance to PDR	

5 Non Domestic Solar and PD Rights – Summary of Options

5.1 Introduction

5.1.1 The previous chapter of the report has considered two approaches to permitted development rights for rooftop solar installations – an approach based on an increased output threshold and an approach based on planning impacts only, with no output threshold. This chapter summarises the potential options that could be pursued by Welsh Government in relation to changes to permitted development rights for non-domestic solar.

5.2 Option 1 – Threshold Approach

5.2.1 Chapter 4 considered the implications associated with raising the output threshold for PDR to 1MW, 3MW and 5MW. The analysis showed the following in summary:

- the majority of rooftop schemes are likely to be under 1MW, thus a raising of the threshold to this level would reflect the nature of schemes;
- there are limited differences in planning impacts at the different thresholds when considering rooftop installations, thus the need to differentiate is not evident;
- higher thresholds of 3MW or 5MW would give flexibility to accommodate future improvements in technology.

5.2.2 A threshold of 5MW would fit most closely with the national policy and regulatory framework for renewable energy generation, provide clarity for developers and local planning authorities and provide flexibility for the future. A threshold approach has the advantage of reducing the costs and uncertainty for the developer associated with the process and providing that there are limitations to the PDR, should not lead to material impacts. Possible exceptions are within the visual envelope, but not within the boundaries, of designated areas such as National Parks.

5.2.3 However, there are no schemes approaching this size in Wales at present, and such a high threshold would effectively enable all current rooftop solar schemes to be permitted development, subject to limitations, raising the question as to whether a threshold is therefore even required and resulting in an approach more akin to that outlined in Option 2 below.

5.2.4 Alongside the threshold approach there would be a need to set limitations to the PDR to reflect sensitive locations and potential impacts. Suggested limitations are set out below as discussed in Chapter 4. Permitted development rights would not apply in the following situations and a full planning application would be required:

- listed buildings, scheduled ancient monuments, or buildings within the curtilage of a listed building;
- Conservation Areas or World Heritage Sites;
- Registered landscapes of historic interest;
- At sites identified in the Register of Parks and Gardens of Special Historic Interest in Wales;
- AONBs or National Parks;
- Within the safeguarding areas of airports, or an alternative appropriate set distance (for example the distance of 3km identified in the Northern Ireland Consultation Paper); and
- Sites requiring the formation of a new access from the public highway.

5.2.5 Further limitations designed to ensure that effects arising from the siting of the proposal are minimised could include:

- Installations not to exceed the height of the roof ridge or be within 1m of the external edge of the roof;
- Installations not to protrude more than 200mm from a pitched roof or wall surface;
- In the case of flat roofs, not to be more than 1m above the highest part of the roof (excluding chimneys).

5.2.6 With respect to ground mounted solar installations within the curtilage of a property, it has been discussed in Chapter 4 that there would be a need to significantly increase the PDR threshold in order to provide a meaningful energy capacity for a non-domestic property. This could then give rise to impacts similar to those of standalone ground mounted solar arrays. Moreover, there are few applications for such developments and changing the process may therefore not bring significant benefits in terms of output from solar across Wales to set against potential disbenefits.

5.3 Option 2 – Planning Impacts Approach Controlled by Limitations

5.3.1 Chapter 4 considered a planning impacts approach to permitted development rights for non-domestic solar that excludes setting an energy output threshold. Instead, the approach focuses on controlling PDR through the assessment of key planning impacts or alternatively utilising a prior notification process (discussed separately as Option 3).

5.3.2 Advantages of the planning impacts approach include that it would generally not have a negative impact on national and local policy areas, including visual impact, residential amenity and design matters. Limitations and conditions relating to each of these areas could be proposed (as set out below). The approach would also remove the need for local planning authorities to confirm outputs of installations as a way of confirming compliance with PDR, and would give developers flexibility to move with advancing technologies without the risk of going over a particular threshold.

5.3.3 Developers may benefit from the greater level of certainty that the approach would begin – as there is no output threshold and planning impacts are dealt with as simple yes/no answers (for example is the proposal within a National Park).

5.3.4 Limitations that could accompany a planning impacts approach include that permitted development rights would not apply in the following areas:

- listed buildings, scheduled ancient monuments, or buildings within the curtilage of a listed building;
- Conservation Areas or World Heritage Sites and their settings;
- Registered landscapes of historic interest;
- At sites identified in the Register of Parks and Gardens of Special Historic Interest in Wales;
- AONBs or National Parks;
- Within the safeguarding areas of airports or an alternative appropriate set distance (for example the distance of 3km identified in the Northern Ireland Consultation Paper); and
- Requiring the formation of a new access from the public highway.

5.3.5 Further limitations or conditions (where planning permission is required) would be designed to ensure that effects arising from the siting of the proposal are minimised and could include:

- Installations not to exceed the height of the roof ridge or be within 1m of the external edge of the roof;
- Installations not to protrude more than 200mm from a pitched roof or wall surface;

- In the case of flat roofs, not to be more than 1m above the highest part of the roof (excluding chimneys);
- That the installation be sited so as to minimise its effect on the normal appearance of the building; and
- That the installation be sited so as to minimise its effect on the amenity of the area and neighbouring properties.

5.4 Option 3 – Planning Impacts Approach with Prior Notification

5.4.1 A final option would be for a planning impacts approach accompanied by prior notification. A prior notification process could be utilised to provide additional control for issues such as the siting and appearance of the proposed installation; for proposals located within set distances of airports; or as a way of controlling issues associated with glint and glare.

5.4.2 Advantages of incorporating prior notification into a planning impacts approach would that local planning authorities would be able to request and consider more detailed evidence in relation to specific topics, although it should be noted that the case study research identified that none of the aspects were issues that led to a refusal for rooftop schemes There would also be an opportunity for stakeholders to comment on proposals. Disadvantages include that the process requires a form of planning submission, giving greater cost and uncertainty to developers and potentially removing some of the benefits of streamlining that may otherwise be associated with permitted development.

5.4.3 The limitations that would accompany this option would be likely to be same as for Option 2, with the exception of appearance and amenity, which could be covered by a prior notification application and thereby apply to all solar developments, not just those not coming under PDR.

5.5 Approaches to Non-Domestic Solar and Aviation

5.5.1 A final area highlighted for consideration within this report relates to how potential aviation concerns may be dealt with. These concerns, discussed in detail in Chapter 4, primarily relate to glint and glare from solar installations but also to potential interference of installations with radar and telecommunications equipment. Possible options that have been identified which would address concerns of the aviation industry in relation to solar installations include to:

- impose a limitation on PDR such that proposals falling within the safeguarding area of an airport (in the case of Cardiff Airport, this extends to some 13km) would require full planning permission (this could be proposed as part of Option 1 or 2);
- impose a limitation on PDR such that proposals falling within a tighter boundary from an airport would require full planning permission. A 3km radius has previously been in operation in Scotland, and the same distance has been included within the Consultation Paper recently issued in relation to changes to PDR in Northern Ireland (this could be proposed as part of Option 1 or 2);
- impose a condition on PDR that a glare assessment would need to be submitted for all proposals that fall within either of the above radii (this could be proposed as part of Option 1 or 2); or
- control developments by means of a prior notification process for proposals that fall within either of the above radii (this could be proposed as part of Option 3).

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