Bath & North East Somerset Council

On-Site Renewable Energy Policy SCR1: Summary of Evidence

Placemaking Plan Evidence Base

December 2015

Report prepared by B&NES Council

1. Introduction

This paper provides a summary of the key findings of the analysis conducted as part of the evidence base for the Placemaking Plan's 'On-Site Renewable Energy Policy' SCR1:

> *SCR1: Developers of major proposals above a threshold of 1,000 square meters or 10 dwellings, excluding Industrial B2 and B8 uses, will be required to provide sufficient renewable energy generation to reduce carbon emissions from anticipated (regulated) energy use in the building by at least 10%.*

2. Approach

Regen South West was originally commissioned by B&NES Council to conduct analysis into the technical and financial viability of an 'On Site Renewable Energy' policy for domestic development. The analysis reviewed the viability of different levels of target (10% and 20%, of both 'regulated' and 'unregulated' sources of energy use) for different scales of domestic development (single dwelling, a development of 200 units and a high density flatted development).

Building on the Regen South West methodology and assumptions, the analysis was subsequently extended by B&NES Council to encompass mixed use development and industrial sites, assessing viability for a high density mixed-use development as well as for a lower viability industrial development.

The analysis focuses on two key questions:

1. Technical viability: is the policy technically achievable? (i.e. is sufficient roof space likely to be available for this type of development to accommodate the necessary area of solar PV for the range of target definitions considered?)
2. Financial viability: is the policy financially viable? (i.e. is the capital cost of achieving the target likely to be financially viable in the context of the development type?)

Only solar PV has been considered since it is the cheapest renewable energy technology available to deliver these on-site carbon emission reductions.

The different levels of target investigated were as follows:

- '10% regulated' – sufficient on-site renewable energy generation to offset carbon emissions from regulated sources of energy consumption by 10%[1]
- '10% total' - sufficient on-site renewable energy generation to offset carbon emissions from total sources of energy consumption by 10%
- '20% regulated' - sufficient on-site renewable energy generation to offset carbon emissions from regulated sources of energy consumption by 20%

[1] 'Regulated emissions' refers to the carbon emissions associated with the consumption of energy from sources that are regulated under Building Regulations Part L via the Standard Assessment Procedure, namely space heating, domestic hot water, lighting and ventilation. 'Unregulated emissions' encompasses carbon emissions from cooking and appliance use.

- '20% total' - sufficient on-site renewable energy generation to offset carbon emissions from total sources of energy consumption by 20%

Full detail of the methodology, assumptions and results is provided in Appendices.

3. Conclusions

The conclusions from the analysis are summarised in Table 1 below. Green shading indicates that the analysis concluded positive viability, amber indicates marginal viability and red indicates non viability.

The analysis concluded that a '10% regulated' target is both financially and technically viable for the range of domestic and mixed use developments considered. However it was not found to be financially viable for B2 and B8 use industrial sites. These sites have therefore been excluded from the policy.

	Technical Viability				**Financial Viability**			
	10% R	**10% T**	**20% R**	**20% T**	**10% R**	**10% T**	**20% R**	**20% T**
Domestic:								
Single Dwelling	(green)	(green)	(green)	(amber)	n/a	n/a	n/a	n/a
200 Units	(green)	(green)	(green)	(green)	£749-£855 (green)	£1,311-£1,520 (amber)	£1,489-£1,520 (amber)	£2,598-£3,040 (amber)
Flat Development	(green)	(amber)	(amber)	(red)	£429-£455 (green)	n/a	n/a	n/a
Non Domestic:								
Mixed Use	(green)	(amber)	(amber)	(red)	£3.9/m2 (green)	n/a	n/a	n/a
Industrial	(green)	n/a	(green)	n/a	£3.2/m2-£16.0/m2 (red)	n/a	n/a	n/a

Table 1: Summary of results technical and financial viability assessment for on-site renewables policy SCR1

Key:
10% R = carbon emissions from regulated sources of energy reduced by 10%
10% T = carbon emissions from total sources of energy reduced by 10%
20% R = carbon emissions from regulated sources of energy reduced by 20%
20% T = carbon emissions from total sources of energy reduced by 20%
n/a = analysis not conducted (option already precluded by preceding analysis, or data not available)

4. Appendices

Full detail of the methodology, assumptions and results for all analysis is provided in the appendices:

- Appendix 1: Residential development – technical viability
- Appendix 2: Residential development – financial viability
- Appendix 3: Industrial and mixed use development – technical and financial viability

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APPENDIX 1

Renewable Energy On-Site Requirements for Different Site Typologies: Domestic Development – Technical Viability

Placemaking Plan Evidence Base

September 2015

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1 Introduction

Regen SW have been asked by Bath & North East Somerset Council to provide evidence to support an on-site renewable energy target (based on solar PV) for residential led development sites. The Council has already successfully implemented a 10% Merton Rule policy for Bath Western Riverside since 2008.

The following scoping study contains scenario testing for different site typologies to support the technical delivery of 10% or 20% CO_2 reduction requirements via on site renewables - considering both regulated and unregulated emissions, and delivered utilising solar PV. Only Solar PV is considered since it is the cheapest renewable energy technology available to meet these on-site emission reductions.[1]

2 Results

2.1 Delivery on a single house

Domestic energy consumption for a typical UK household (as defined by Ofgem; see Section 4 on Assumptions) gives rise to the annual emission of 2,203 kg of CO_2 from regulated emissions sources and 3,896 kg of CO_2 total emissions (regulated plus unregulated sources)[2].

The carbon savings which would be required in order to deliver a 10% and a 20% reduction in both regulated and total emissions respectively are summarised in Table 1.

	Regulated emissions	Total emissions
Total emissions	2,203 kg CO_2 emissions	3,896 kg CO_2 emissions
10 % emissions	220 kg CO_2 saving required	390 kg CO_2 saving required
20 % emissions	441 kg CO_2 saving required	779 kg CO_2 saving required

Table 1: Total and percentage emission from single houses in different scenarios

Table 2 shows the size of solar PV array which would be required in order to deliver this carbon emissions saving for each scenario.

Scenario	Regulated emissions	Total emissions
10 % reduction	0.45 kW per household 1.8 x 250 kW panels	0.8 kW per household 3.2 x 250 W panels
20 % reduction	0.91 kW per household 3.6 x 250 kW panels	1.6 kW per household 6.4 x 250 W panels

Table 2: Capacity of solar PV system to meet required emissions saving under different scenarios (each panel occupies approximately 1.6 m²)

[1] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/6378/1972728.pdf

[2] 'Regulated emissions' refers to the carbon emissions associated with the consumption of energy from sources that are regulated under Building Regulations Part L via the Standard Assessment Procedure, namely space heating, domestic hot water, lighting and ventilation. 'Unregulated emissions' encompasses carbon emissions from cooking and appliance use.

These results show that the required size of PV array for each Scenario is below the typical roof space available to solar PV a range of different housing types (as defined in Table 8), so long as the properties are oriented to maximize the proportion of roof space in a south west to south east facing direction. Only for the '20% total emissions' Scenario might the size of the required PV array exceed the available roof space (although this could be accommodated with careful orientation and design).

2.2 Delivery on multiple houses

For the purpose of testing the different site typologies, a 200-unit residential development has also been examined. This was assumed to encompass a range of different housing types and densities, as described in Table 3.

Scenario	Densities	Housing mix
Rural	20 dph- 40 dph	Detached, semi-detached and terrace (even mix)
Suburban	30 dph- 50 dph	Detached, semi-detached and terrace (even mix)

Table 3: Scope of stress test scenarios

Tables 4 demonstrates how many houses in the development would require solar panels (oriented in a south west to south east direction) in order to meet the necessary level of emission savings under each Scenario.

		Number of houses requiring solar PV panels on to meet different emission saving targets in 200 residence development	
Scenario	Emission saving	Regulated emissions	Total emissions
Rural	10%	33	57
	20%	63	108
Suburban	10%	33	57
	20%	63	108

Table 4: Results of stress testing of rural and suburban housing mixes specified in Table 3, using assumptions of available roof sizes and suitable size of solar PV array seen in table 8 from the Energy Saving Trust

Table 5 shows how many houses would require solar panels if all properties in the indicative 200 house development were the same property type. This is calculated for all emission saving scenarios taking assumptions from Table 8, as Table 4 does above also.

		Number of houses requiring solar PV panels on to meet different emission saving targets in 200 residence development	
Property type	Emission saving	Regulated emissions	Total emissions
Detached	10%	23	40
	20%	46	80
Semi detached	10%	35	61
	20%	70	123
Terrace	10%	41	73
	20%	83	146

Table 5: Results of stress testing on different housing typologies

The results show that both the 10% and the 20% targets can be easily accommodated by placing PV on a portion of the overall 200 house development.

2.3 Delivery on flats

Development comprising flats provide the greatest challenge to delivery of the emissions reduction Scenarios due to the high density of energy demand combined with low relative available roof area.

Table 6 shows the results of analysis on flat based developments for a range of different variables, including number of floors (maximum likely is 7 for a city centre location) and the percentage of roof space available for solar PV (dependent on requirements for services and whether a 'cut-back' is required to allow for roof terracing). The analysis looks at how many kW solar PV could be accommodated on the roof in each case, and calculates what percentage of regulated and unregulated emissions this could deliver.

Roof area (m²)	Percentage of roof available	Flats per floor	Floors	Total emissions (approx. - tCO2/yr)	Regulated emissions (approx. - tCO2/yr)	kW on roof	Generation total (kWh)	Tonnes saving (approx. - tCO2/yr)	Regulated emission saving	Total emission saving	10 percent total tonnes	10 percent regulated tonnes
1,000	70%	15	7	295	157	44	43,271	22	**14.2%**	7.5%	30	16
1,000	50%	15	5	211	112	32	30,908	16	**14.2%**	7.5%	21	11
1,000	30%	15	3	127	67	19	18,545	10	**14.2%**	7.5%	13	7
1,000	50%	15	7	295	157	32	30,908	16	**10.1%**	5.4%	30	16
1,000	30%	15	5	211	112	19	18,545	10	8.5%	4.5%	21	11
1,000	70%	15	3	127	67	44	43,271	22	**33.1%**	**17.6%**	13	7
1,000	30%	15	7	295	157	19	18,545	10	6.1%	3.2%	30	16
1,000	70%	15	5	211	112	44	43,271	22	**19.9%**	**10.6%**	21	11
1,000	50%	15	3	127	67	32	30,908	16	**23.6%**	**12.6%**	13	7

Table 6: Results of stress testing for different flat based developments (highlighted figures show where the saving in total or regulated emissions is >10%)

The results show that delivering a reduction of 20% of total emissions is not possible for any scenario considered, and that meeting a reduction of 10% of total emissions, or 20% of regulated emissions, is challenging where either number of floors is high and / or availability of roof space low.

However, a reduction of 10% of regulated emissions is found to be possible for all but two of the scenarios tested (see highlighted cells). The critical factor in determining whether this target can be met is found to be the availability of roof space. Providing that at least 50% of roof space can be made available for the location of solar PV panels (on developments with 5 or more storeys), then a reduction target of 10% of regulated emissions can be satisfied.

3 Conclusions

The results of this study show that a '10% reduction in regulated emissions' can be easily satisfied by provision of solar PV on individual household developments and multi-household developments, providing that the properties are not significantly overshadowed, and can be oriented to enable a south west to south east facing roof pitch. The target was also found to be feasible for residential flats, so long as where the number of residential storeys exceeds 5, at least 50% of the roof area is available to accommodate solar PV.

Targets of '10% reduction in total emissions' and '20% reduction in regulated emissions' can also be accommodated on both single and multi-household developments, again providing that the properties are not significantly overshadowed, and can be oriented to enable a south west to south east facing roof pitch. These targets were also found to be feasible for some flat based developments, but could not be satisfied where the number of residential storeys is 5 or more and the availability of roof space is 50% or less.

A '20% reduction in total emissions' was found to be feasible for multi-household developments, and potentially for single household developments, provided that careful attention was given to building orientation and design. However this target was much more challenging for flats, with none of the high density flat scenarios under consideration being able to satisfy this target.

4 Assumptions

The table below outlines the key figures used and their source.

Variable factor	Amount	Unit	Notes	Source
Ofgem typical medium household electrical consumption	3,100	kWh		Ofgem
Flats electricity consumption	2,500	kWh		DECC
Total consumption emission factor for electricity (including transmission losses, CO_2, CH_4, N_2O)	0.5148	kg/kWh	This is the average of last 5 years of data	DECC
Ofgem typical medium per meter gas consumption	12,500	kWh		Ofgem
Flats gas consumption	8,300			DECC
CO_2 emission factor gas	0.184	kg/kWh		DECC
Solar generation per kW south facing	975	kWh		PVGIS
Solar generation per kW south west/ south east facing	930	kWh		PVGIS
Typical m² per kW	6.34	m²/ kW		Sungift
Roof pitch	12/9	Ratio	Typical roof pitch (37^o)	
kW to m²	0.0634	kW/ m²		Sungift
Typical area per flat	67	m²	Plus additional 5 percent for communal areas	
Flats solar spacing	It is assumed that solar on the roofs of flats are mounted in frames on the flat roof, mounted horizontally at an optimum angle of 35-38^o with spacing of approximately 1.8-2 m			

Table 7: Assumptions

The below table is from the Energy Saving Trust and details the typical roof space available to solar PV on different typical housing types.

Property type	Typical suitable roof area (m^2)	Appropriate number of panels	Power rating (kW)
Period mid-terrace or end terrace	16.5	10	2.2
Small semi-detached house	17	10	2.2
Modern mid terrace or end terrace	18	10	2.2
Modern 3 storey town house	18	10	2.2
Average semi-detached house	20	12	2.6
Small detached house	21.5	12	2.6
Old 3 storey town house	23	12	2.6
Semi-detached bungalow	27	16	3.5
Two bedroom top floor flat	28	16	3.5
Average detached house	29.5	18	4.0
Detached bungalow	31	18	4.0

Table 8: Property types used in analysis are highlighted. Source: www.pvfitcalculator.energysavingtrust.org.uk/Documents/150224_SolarEnergy_Calculator_Sizing_Guide_v1.pdf

APPENDIX 2

Renewable Energy On-Site Requirements for Different Site Typologies: Domestic Development – Financial Viability

Placemaking Plan Evidence Base

August 2015

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1 Introduction

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The following scoping study contains cost figures (for viability testing) and evidence to support the technical delivery of 10% or 20% CO2 reduction requirements via on site renewables - considering both regulated and unregulated emissions, and delivered utilising solar PV. Only Solar PV is considered since it is the cheapest renewable energy technology available to meet these on-site emission reductions.[1]

2 Results

2.1 Delivery on a single house

Based on the assumptions in the next section, it has been found that for typical households, 2,203 kg of CO_2 is emitted from regulated emissions and 3,896 kg of CO_2 is emitted from total emissions. The carbon savings required for each scenario is summarised here:

	Regulated	Total
Total emissions	2,203 kg CO_2 emissions	3,896 kg CO_2 emissions
10 % emissions	220 kg CO_2 saving required	390 kg CO_2 saving required
20 % emissions	441 kg CO_2 saving required	779 kg CO_2 saving required

Table 1: Total and percentage emission from single houses in different scenarios

These required emission savings result in a variety of solar PV system sizes being required for the different scenarios:

	Regulated emissions	Total emissions
10 % reduction	0.45 kW per household 1.8 250 kW panels	0.8 kW per household 3.2 250 W panels
20 % reduction	0.91 kW per household 3.6 250 kW panels	1.6 kW per household 6.4 250 W panels

Table 2: Capacity of solar PV system to meet emissions in different scenarios (each panel occupies approximately 1.6 m²)

2 kW would cost in the order of £3,800 plus VAT and 3.3 kW would cost £5,350 plus VAT.[2] The sizing of systems was chosen for cost effectiveness since the ratio of inverters to panels was at their most efficient. These costs can fall by up to £350 if multiple houses are installed on at once, but SunGift's experience is that this rarely happens and installing on one household at a time is far more common.

[1] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/6378/1972728.pdf

[2] These were typical installs that SunGift Energy, an experienced and well reputed solar installer, has completed for housing developments.

2.2 Delivery on multiple houses

In order to meet 10 and 20 percent emission reduction for total and regulated emission scenarios, there are a variety of different costs involved. The table below shows these costs for 2 kW systems on different numbers of houses in order to meet a 10 and 20 percent target for an indicative development of 200 houses (all costs exclude VAT):

	Regulated	Total
10 % reduction	90 kW required 45 houses with 2 kW on each £171,000 total cost £855 per household	160 kW required 80 houses with 2 kW on each £304,000 total cost £1,520 per household
20 % reduction	182 kW required 91 houses with 2 kW on each £345,800 total cost £1,729 per household	320 kW required 160 houses with 2 kW on each £608,000 total cost £3,040 per household

Table 3: Costs for meeting emission scenarios for indicative 200 houses with 2 kW systems

The table below shows these costs for 3.3 kW systems on different numbers of houses in order to meet a 10 and 20 percent target for a development of 200 houses (all costs exclude VAT):

	Regulated	Total
10 % reduction	28 houses with 3.3 kW on each £149,800 total cost £749 per household equivalent	49 houses with 3.3 kW on each £262,150 total cost £1,311 per household equivalent
20 % reduction	56 houses with 3.3 kW on each £299,600 total cost £1,498 per household equivalent	97 houses with 3.3 kW on each £518,950 total cost £2,595 per household equivalent

Table 4: Costs for meeting emission scenarios for indicative 200 houses with 3.3 kW systems

These tables show that it is technically possible to meet a 20 percent emission reduction of total emissions for a development of 200 houses, if 97 of these houses are able to accommodate 3.3 kW. It is perfectly reasonable to assume there would be at least 97 houses with a roof in an appropriate aspect (SW-S-SE) as logically half of all duo-pitch roofs face in these directions. In addition, it is in the household's best interest to have aspects in these directions due to greater solar heating gains. In addition the tables show it is more cost effective to install 3.3 kW systems on fewer houses than 2 kW on more houses, in order to meet a required capacity of solar PV.

3 Assumptions

The table below outlines the key figures used and their source.

Variable factor	Amount	Unit	Notes	Source
Ofgem typical medium household electrical consumption	3,100	kWh		Ofgem
Total consumption emission factor for electricity (inc transmission losses, CO_2, CH_4, N_2O)	0.5148	kg/kWh	This is the average of last 5 years of data	DECC
Ofgem typical medium per meter gas consumption	12,500	kWh		Ofgem
CO_2 emission factor gas	0.184	kg/kWh		DECC
Solar generation per kW south	975	kWh		PVGIS
Solar generation per kW south west/ south east	930	kWh	This value is used	PVGIS
Typical m² per kW	6.5	m²/ kW		Sungift
Roof pitch	12/9	Ratio	Typical roof pitch (37^{o})	

Table 5: Table of assumptions used

4 Technical viability note

The below table shows that a 1.6 kW solar system covering 10-12 m² would fit onto all typical sizes of UK household roofs. However, not necessarily all houses will be able to have a south facing roof, but given logically at least 50 percent of houses will have a south east to south west facing roof, it is not too hard to imagine a development could ensure enough houses have roofs facing in a suitable direction. A typical 3.3 kW system would cover 20-22 m², while a 2 kW system would cover 12 m². Our analysis shows that 1.6 kW per household is an achievable amount for most house developments.

Property type	Typical size (m²)
Period mid-terrace or end terrace	16.5
Small semi-detached house	17
Modern mid terrace or end terrace	18
Modern 3 storey town house	18
Average semi-detached house	20
Small detached house	21.5
Old 3 storey town house	23
Semi-detached bungalow	27
Two bedroom top floor flat	28
Average detached house	29.5
Detached bungalow	31

Table 6: Source: Energy saving trust- Typical area available for solar PV on a roof. Note- the roofs are larger than this and these figures allow for 'rooftop furniture' including chimneys

Bath & North East Somerset Council

APPENDIX 3

Renewable Energy On-Site Requirements for Different Site Typologies: Mixed Use and Industrial Development

Technical and Financial Viability

Placemaking Plan Evidence Base

November 2015

Report prepared by B&NES Council

1. Introduction

This paper was prepared to provide evidence to support an on-site renewable energy target for mixed use and non-residential development sites as part of the forthcoming Placemaking Plan.

It investigates the technical and financial viability of achieving different levels of on-site renewable energy generation, using solar PV, at two illustrative developments:

1. **Mixed use, high density urban development** – for this the area schedule developed as part of the Enterprise Area Masterplan 2014 for the North Quays site was used, as it represented a mixed use site in a high density, urban setting for which floor areas and projected energy consumption figures were already available as a result of the 2014 masterplanning process.
2. **Industrial development** – for this the Old Mills industrial site at Paulton was used, as it represented a site typical of a B&NES Industrial B2 and B8 site allocation, for which data in relation to floor area was available as a result of the masterplanning process.

2. Mixed Use, High Density Development

2.1 Introduction

The North Quays site at Bath Enterprise Area was selected to test the technical and financial viability of an on-site renewable energy target for an area of high density, mixed use, urban development. The purpose was to ‘stress test’ the technical viability of the proposed on-site renewable energy target in the context of a high density development where roof space was likely to be limited in comparison to the projected energy consumption of the building.

2.2 Assumptions

Figures for floor area, use and projected energy consumption were taken from the Bath Enterprise Area Masterplan 2014, developed by architects Fielden Clegg Bradley and consultants Buro Happold for B&NES Council in 2014. While a revised and more detailed area schedule for the North Quays site is currently under development at the time of writing this paper, the projections made in the 2014 Masterplan still provide a reasonable example of a typical urban mixed use development for which data was readily available.

The key details of the site from the 2014 area schedule are summarised in Table 1 below.

Other assumptions used in the analysis (drawing on assumptions developed by Regen South West – see Appendices 1 and 2) are as follows:

- Area of 1 kWp PV is $6.5m^2$ (typically 4 * 250W panels)
- 50% of 'available roof area' is available for PV generation (the remainder being required for frames, margins, etc)

- Each m^2 of flat roof space is therefore capable of accommodating 0.077 kWp solar PV
- 85% of total heating demand is from sources of energy consumption regulated under Building Regulations Part L
- 15% of total electricity demand is from sources of energy consumption regulated under Building Regulations Part L
- Carbon intensity of grid electricity offset by PV generation is 0.54kgCO2/kWh
- Capital cost of is £1500/kWp installed

North Quay Building	Gross Internal Floor Area (m2)	Typical Floor Area (m2)	Available Roof Area (m2)	Annual total heating demand (kWh/yr)	Annual electricity demand (kWh/yr)
Block 1	18,621	2,184	1,400*	553,000	964,000
Block 2	11,297	2,316	1,090*	1,520,000	780,000
Block 3	6,095	1,050	1,050	214,000	375,000
Block 4	1,019	340	340	107,000	65,000
Block 5	7,868	1,109	1,109	214,000	196,000
Block 6	4,334	1,116	1,116	216,000	122,000
Total	**49,234**	**8,115**	**6,105**	**2,824,000**	**2,502,000**

Table 1: Summary of data used from 2014 Masterplan for North Quays ** indicates cut back top floor*

2.3 Technical Viability

Analysis was conducted to investigate technical viability of installing solar PV sufficient to offset carbon emissions from energy consumption in the buildings based on the 4 different targets under consideration. The results of the analysis are presented in Table 2 below.

North Quay Building	Carbon emissions from regulated sources of energy (tCO_2/yr)	Carbon emissions from total sources of energy (tCO_2/yr)	PV capacity potential (kW)	Carbon saving from PV generation (tCO_2/yr)	% emissions saving from PV - regulated (%)	% emissions saving from PV - total (%)
Block 1	167	626	107.8	55.3	33%	9%
Block 2	309	710	83.9	43.1	14%	6%
Block 3	65	243	80.9	41.5	64%	17%
Block 4	23	55	26.2	13.4	60%	24%
Block 5	50	147	85.4	43.8	87%	30%
Block 6	45	107	85.9	44.1	98%	41%
Total	**659**	**1,888**	**470.1**	**241.2**	**37%**	**13%**

Table 2: Carbon emissions reduction potential from solar PV for regulated and total sources of energy consumption

The green shading indicates that delivery of a 10% or 20% target (regulated / total) would be technically viable. The amber shading shows where only a 10% (regulated / total) target would be technically viable. The red shading shows where neither a 10% or a 20% target would be technically viable.

The table shows how a ‘10% regulated’ target is technically viable for all the blocks, and is easily achieved across the development as whole.

NB a separate, parallel study is currently ongoing examining the technical and financial viability of district heating at Bath Enterprise Area. This has identified North Quays as the most promising location for a new district heating network, which could connect to renewable sources of energy such as river source heat pumps. District heating provides an alternative means of satisfying a ‘10% target for mixed use, high density developments.

2.4 Financial Viability

The final column of Table 3 shows the cost per m^2 of Gross Internal Floor Area of meeting a ‘10% regulated’ on-site renewable energy target through solar PV. Overall, across the North Quays site, this adds £3.91/m^2 GIFA to the construction cost.

North Quay Building	Carbon reduction required for 10% regulated target (tCO_2/yr)	PV capacity required for 10% regulated target (kW)	Total roof area required for PV for 10% regulated target (m^2)	Capital cost of PV for 10% regulated target (£)	Capital cost per m^2 of 10% regulated target (£/m^2 GIFA)
Block 1	16.7	32.6	424	£ 48,945	£ 2.63
Block 2	30.9	60.2	782	£ 90,251	£ 7.99
Block 3	6.5	12.7	165	£ 18,987	£ 3.12
Block 4	2.3	4.4	57	£ 6,592	£ 6.47
Block 5	5.0	9.8	128	£ 14,748	£ 1.87
Block 6	4.5	8.7	113	£ 13,089	£ 3.02
Total	**65.9**	**128.4**	**1669**	**£ 192,613**	**£ 3.91**

Table 3: Capital cost per m^2 of GIFA of achieving a ‘10% regulated’ target

3. Industrial Development

3.1 Introduction

The Old Mills industrial site at Paulton was selected to test the technical and financial viability of an on-site renewable energy target for an industrial site allocation in B&NES. The purpose was to ‘stress test’ the viability of the proposed on-site renewable energy target in the context of a lower viability development where although roof area might be easily available, financial viability might be more constrained.

3.2 Assumptions

Figures for floor area and use were taken from the site's masterplan prepared by GVA in 2011. Figures for energy benchmarks were taken from a range of sources as described in Section 3.2 below.

The assumptions used in the analysis are those outlined in Section 2.2, plus:

- Old Mills (Option 2) at Paulton is c. 42,000 m^2 Gross Internal Floor Area (GIFA)
- This splits approximately:
  - 70% industrial : 40% general B2 industry – 30% B1(c) light industrial
  - 30% B8 storage and distribution
- Buildings a maximum of 2-storey on average
- Therefore available roof area is 50% of total GIFA
- Costs associated with roof strengthening in order to accept PV / wind loading not considered (assumed contained within PV capital cost figure).
- As uses are not yet defined in detail for the Old Mills site, a 'maxima and minima' approach to energy benchmarks has been used.
- Range of energy benchmarks for industrial taken informed by CIBSE Guide F (via UK Green Building Council) - 30kWh/m^2 for distribution warehouse; 150 kWh/m^2 for retail warehouse. Also for reference:
  - CIBSE TM46 gives energy consumption benchmark for general retail of 165kWh/m^2.
  - A car showroom might typically consume c.130 kWh/m^2 (Verco, personal communication)
  - Meanwhile a small office (eg for business start ups) might consume c.40kWh/m^2 (CIBSE Guide F)
- Energy consumption assumed to be split evenly 50/50 electricity/gas; however some uses e.g. car showroom may be majority electricity use.
- Benchmarks for non-regulated energy use for industrial sites were not readily available.
- Carbon intensity of grid electricity offset by PV generation is 0.54kgCO_2/kWh
- Carbon intensity of gas is 0.19kgCO_2/kWh

3.3 Technical Viability

Table 4 below shows that the available roof area is in principle sufficient to accommodate up to 1,540 kW solar PV (1.5MW). This would be sufficient to offset carbon emissions arising from regulated energy use by 36-180% (depending on the intensity of energy use on the site). The green shading shows it would therefore be technically viable to achieve a '10% regulated' or '20% regulated' target at this site.

Industrial unit	Regulated energy use (kWh/m^2)	Carbon emissions from regulated energy use (tCO_2/yr)	PV max. capacity potential (kW)	Carbon saving from PV generation (tCO_2/yr)	% emissions saving possible from PV (%)
Distribution warehouse	30	438	1540	790	180%
Retail warehouse	150	2,190	1540	790	36%

Table 4: Carbon emissions reduction potential from solar PV for low and high energy benchmarks (for regulated energy use)

3.4 Financial Viability

Table 5 below shows the cost per m^2 of satisfying a '10% regulated' target for both a low and high energy benchmark scenario.

	Carbon reduction required to meet 10% target (tCO_2/yr)	PV capacity required to meet 10% target (kW)	Total roof area required for PV to meet 10% target (m^2)	Capital cost of PV required to meet 10% target (£)	Capital cost per m2 of Gross Internal Floor Area (£/m^2 GIFA)
Distribution warehouse	43.8	85.4	1,110	£128,070	**£ 3.2**
Retail warehouse	219.0	426.9	5,550	£640,351	**£ 16.0**

Table 5: Capital cost per m^2 of GIFA of achieving a '10% regulated' target for low and high energy benchmarks