Renewable Energy Assessment: Core Strategy Greenfield Sites

Bath and North East Somerset Council

28 October 2013
Contents:

1 Executive summary ................................................................................................................. 4

2 Introduction ............................................................................................................................ 6
  2.1 The opportunity .................................................................................................................. 6
  2.2 The approach ....................................................................................................................... 7

3 Method for PV potential ....................................................................................................... 7
  3.1 Data collection ..................................................................................................................... 8
  3.2 Assumptions ......................................................................................................................... 9
    3.2.1 Shading .......................................................................................................................... 9
    3.2.2 Density and orientation assumptions ........................................................................... 9
    3.2.3 Technology .................................................................................................................... 10
    3.2.4 Estimated system losses .............................................................................................. 10
    3.2.5 Slope ........................................................................................................................... 10
    3.2.6 Grid losses .................................................................................................................... 10
    3.2.7 Grid CO₂ per kWh ........................................................................................................ 10
    3.2.8 Cost per kWh installed ............................................................................................... 10
    3.2.9 FiT rate ........................................................................................................................ 11
    3.2.10 Cost per electrical unit .............................................................................................. 11
    3.2.11 Percentage household electrical use ......................................................................... 11
    3.2.12 FiT electricity export tariff ......................................................................................... 11
    3.2.13 Time period ............................................................................................................... 11
  3.3 Output and assessments .................................................................................................... 12

4 Summary of site by site potential for PV ............................................................................ 13
  4.1 Free standing solar panels summary ............................................................................... 13
  4.2 Building integrated solar panels summary ...................................................................... 14

5 Method for assessing potential for onsite carbon reduction policy .................................. 15
  5.1 Assumptions and variables ............................................................................................ 15

6 Results for assessing potential for onsite carbon reduction policy .................................. 16
  6.1 CO₂ emissions for each location .................................................................................... 16
  6.2 Number of houses with PV to meet a 10% or 20% onsite carbon reduction policy .......... 16

7 Third party delivery partners ............................................................................................. 19

8 Commentary on wind and district heating opportunities .................................................... 19
  8.1 Wind potential .................................................................................................................. 19
  8.2 AECOM district heating assessment .............................................................................. 20

9 Recommendations ............................................................................................................. 22
  a. Appendix A ....................................................................................................................... 23
1 Executive summary

Bath & North East Somerset Council aims to reduce district-wide emissions 45% by 2026. As a result, addressing climate change is a cross cutting objective of Bath & North East Somerset’s draft Core Strategy and this is reflected in Core Policy 3: Renewable Energy, which sets the target for 100MWe of installed renewable electricity capacity and 165MWth of renewable heat capacity to be delivered in the district by 2029. This study lays out how specific sites can contribute to reaching this target, providing an evidence base for solar PV potential and a commentary on other technologies. This report has been delivered to inform Bath and North East Somerset Council’s Core Strategy Update.

This report sits alongside an Excel spreadsheet model that Regen has developed for the Council. The model estimates the potential for each of the Council’s greenfield development sites to accommodate solar PV and as a result the potential for each site to meet an onsite renewable energy requirement policy. The sites studied were: Whitchurch, SW Keynsham, E Keynsham, Odd Down and Weston.

The model contains a number of assumptions about the developments, the technology and the Feed-in Tariff to estimate the potential installed capacity, power output, carbon savings and revenues from installing PV on each site. The assumptions can be changed so that the model can be updated by the Council as circumstances change.
Summary of recommendations

a. Solar PV on the 5 greenfield developments could create significant net revenues
There is significant potential for the greenfield sites to accommodate solar PV. Over the 20 year lifetime of the Feed-in Tariff, the net revenues for these sites are significant.

b. All the sites have the potential to meet an onsite carbon reduction requirement (depending on the site layout), without the developer incurring a net cost
The analysis of the potential for a renewable energy requirement policy shows that all of the 5 sites have the potential to meet either a 10 or 20% carbon reduction requirement through solar PV installations on the buildings. E Keynsham Option 2 cannot meet a 20% carbon reduction requirement under this model due to the assumed layout of the site. The model needs to be updated with the site’s actual layout once this is known, as the requirement could be met if the houses were laid out in more southerly directions. As the financial analysis shows, meeting a carbon reduction requirement need not be a net cost to the developer, due to the Feed-in Tariff revenues on offer and to the potential for third party delivery partners to be involved.

Further analysis of the viability could be undertaken when these sites get to the detailed planning stage. If the Council goes ahead with a carbon reduction requirement and developers do not want to take the opportunity to deliver onsite renewables, the Council could place the onus on the developer to demonstrate that meeting the reduction requirement is not viable.

c. Third party delivery partners would be interested in working with housing developers to deliver PV
Developers who are not interested in taking up this financial opportunity themselves could be interested in working with a renewable energy delivery partner. There are a number of options for this type of model, such as working with a community group, the Council playing a role in delivery, or using a specialist renewable energy company.

d. Other renewable energy opportunities
The potential for other types of renewable energy installations on the greenfield sites has not been analysed in detail. However, there may be the potential for near or offsite wind schemes to be contributed to through Allowable Solutions. In addition, the sites at Weston and East Keynsham could include district heat networks that connect to nearby anchor loads. The Odd Down site is adjacent to a district heat opportunity identified in AECOM’s study and so a network in that area has greater potential.
2 Introduction

2.1 The opportunity

Bath and North East Somerset Council operates in a part of the country that has substantial renewable energy resources. There is the opportunity to incorporate renewable energy technologies into new build housing developments, in order to confront financial, social and environmental issues. These include rising energy bills, increasing numbers of fuel poverty households and working towards meeting the UK’s emission targets and the local renewable energy target in Bath and North East Somerset.

Bath & North East Somerset Council aims to reduce district-wide emissions 45% by 2026. As a result, addressing climate change is a cross cutting objective of Bath & North East Somerset’s draft Core Strategy and this is reflected in Core Policy 3: Renewable Energy, which sets the target for 100MWe of installed renewable electricity capacity and 165MWth of renewable heat capacity to be delivered in the district by 2029. This study lays out how specific sites can contribute to reaching this target, providing an evidence base for solar PV potential and a commentary on other technologies. This report has been delivered to inform Bath and North East Somerset Council’s Core Strategy Update.

The PV model constructed allows the Council to calculate the potential for installing solar PV on 5 greenfield sites. Through a number of assumptions, the model estimates the potential installed capacity, power output, carbon savings, FiT income, bill savings and costs of installing PV across each site. The assumptions behind the model can be altered to enable the Council to adjust it as the site plans come together and as costs and the FiT change and the grid decarbonises in the future. The model could be used to demonstrate to developers the potential financial and environmental benefits of installing PV, supporting the Council in its negotiations with them. In particular, housing developers might be interested in working with third party PV developers.

In addition, the Council is assessing whether to introduce a renewable energy requirement, known in the industry as a ‘Merton rule’ style policy, for the sites. The latest versions of these policies require development to provide onsite renewable energy that produces sufficient energy to reduce carbon dioxide emissions from residual energy use in the development’s buildings, usually by 10 to 20%. The PV model includes an analysis of the potential for the 5 greenfield sites to meet the requirements of such a policy through solar PV.
2.2 The approach

The evidence work brief is as follows:

<table>
<thead>
<tr>
<th>Work</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  Calculating PV potential</td>
<td>Figures for each site</td>
</tr>
<tr>
<td>2  Potential to meet a carbon reduction policy onsite</td>
<td>Figures for each site</td>
</tr>
<tr>
<td>3  Identifying third party/ community energy potential, liaising with BWCE on methodology</td>
<td>Feed into report</td>
</tr>
</tbody>
</table>
| 4  We will provide existing GIS layers that have been produced through other studies to check for renewable potential as follow:  
  1. Camco Renewable Energy Assessment: Wind & hydro  
  2. LUC Landscape Assessment: Wind  
  3. AECOM District Heating Assessment  
  4. Sustainability Statement (Whitchurch) | Commentary on opportunities for wind      |
| 5  Write short report bringing together 1-4 above         | Report                                      |

3 Method for PV potential

Work task 1 is to calculate the PV potential for the five Greenfield sites, providing for each site:

- kWp possible to install
- kWh produced
- CO₂ saved
- revenue generated

This was completed by creating an adaptable Excel file, which will be easy to use and re-usable by Bath and North East Somerset Council. Additional output calculations included in the work:

- cost to install total
- cost to install per household
- FiT revenue and grid export
- per household annual electrical bill savings
3.1 Data collection

In order to calculate power yields, the PV Potential Estimation Utility\(^1\) online tool was used, which is also known as PVGIS. This is a European Commission tool which enables users to calculate daily, monthly and yearly irradiance and electricity production, based on a number of inputs and assumptions for very specific sites. This means accurate power outputs for a given installed capacity at a precise location could be calculated, without the need to use estimated capacity factors.

Data was collected for each of the sites and inputted into the Excel file. The following table details the variables that were relevant.

![Figure 1: PV Potential Estimation Utility online tool](image)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Chosen value</th>
<th>Notes / explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiation database</td>
<td>Climate-SAF PVGIS</td>
<td>This is the newest and most accurate climate model within PVGIS. Other options are older and/ or less accurate</td>
</tr>
<tr>
<td>PV technology</td>
<td>Crystalline silicon</td>
<td>This is the material the vast majority of solar cells are constructed with, being the most developed solar cell technology and providing the best compromise between cost and efficiency</td>
</tr>
<tr>
<td>Installed power</td>
<td>1 kWp</td>
<td></td>
</tr>
<tr>
<td>Estimated system losses</td>
<td>14 percent</td>
<td>These are losses such as inverter and other system losses. 14% is the standard figure for these losses</td>
</tr>
<tr>
<td>Mounted position</td>
<td>Free standing and building integrated</td>
<td>Free standing (raised above roof on mounts) and building integrated are two different building techniques and have different</td>
</tr>
</tbody>
</table>

efficiencies and benefits. Building integrated panels are less efficient and produce less power as there is not a free flow of air behind the panels, but blend into the building’s construction more. Free standing panels are potentially more expensive, while producing more energy.

<table>
<thead>
<tr>
<th>Slope</th>
<th>38°</th>
<th>This is the optimised slope for the locations, providing the maximum power for a fixed system.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orientation</td>
<td>SW, SSW, S, SSE and SE</td>
<td>Five different orientation data sets were collected, between SW to SE since these are the optimal for solar PV.</td>
</tr>
</tbody>
</table>

### 3.2 Assumptions

#### 3.2.1 Shading

Shading can have a drastic effect on a solar panel’s performance, dramatically reducing its energy output. PVGIS has an integral feature to include horizon solar shading, so that is accounted for in the base data. However, solar shading from nearby houses and trees must also be included. The Excel file includes a feature to account for this additional shading.

Estimations were made on additional shading by studying the GIS files, looking at in what direction and at what distance potential obstacles were. Using trigonometry an approximate calculation found what portion of the sky would be shaded. This additional shading was then turned into a percentage loss in power by using a sun chart (Appendix A). This allowed an approximate calculation of the length of time the solar panels were shaded. This is a variable that can be changed in the Excel file.

#### 3.2.2 Density and orientation assumptions

At this high level survey stage, housing density has no quantitative effect on power production. However, it is assumed a larger site will be able to be more carefully planned, maximising power generation, and this can be seen in greater power production from larger sites.

Assumptions on number of houses and their orientation are based on studying the GIS files, maps and nearby housing developments. It is assumed that the new developments will follow the layout pattern of nearby existing housing estates to ensure that the new developments blend with those nearby. This leads to a prediction of the number of houses facing in each direction for each new development area.
3.2.3 Technology

The vast bulk of solar PV panels are constructed with a material called crystalline silicon. If a power production is required for alternative high efficiency technologies, an increase in power of between 5-10% could be assumed.

3.2.4 Estimated system losses

The estimated system losses are all the losses in the system that cause the power actually delivered to the electricity grid to be lower than the power produced by the PV modules. There are several causes for this loss, such as losses in cables, power inverters, dirt (sometimes snow) on the modules and so on. We have given a default value of 14%. If you have a good idea that your value will be different (maybe due to a really high-efficiency inverter), you may reduce this value a little.\(^2\)

3.2.5 Slope

This is the inclination angle from the horizontal plane and for all sites, 38° was chosen. This is the average optimal angle calculated using PVGIS, and is also close to the roof pitch angle 12/9 for building purposes.

3.2.6 Grid losses

Since the majority of energy is not being exported and distributed across the grid, there is an increase in CO\(_2\) saving. Grid transmission and distribution has a loss in energy of 7-8% in the UK, energy which is lost between power production and use. A grid loss figure of 7.7%\(^3\) is used in this work; increasing CO\(_2\) savings from PV installations, since energy is being delivered to the household from the solar panels rather than electricity being delivered from the grid. This is a variable that can be changed in the Excel file.

3.2.7 Grid CO\(_2\) per kWh

The grid CO\(_2\) per kWh data is taken from National Grid\(^4\) and is currently 0.5 kg CO\(_2\) per kWh. A graph of projected grid CO\(_2\) reduction is placed in the Notes tab of the Excel file for reference. This is a variable that can be changed in the Excel file.

3.2.8 Cost per kWh installed

This is included in the Excel file as a variable that can be changed when new information on cost is available. Costs for solar panels are extremely variable since the solar panels themselves make up only between 40-60% of the overall cost. Balance of system components, labor, inverter and mountings take up the remaining amount and these costs vary depending on building practices and design. Installed costs for solar PV have fallen dramatically in recent years.

\(^3\) IEA Electricity Stats. http://data.worldbank.org/indicator/EG.ELC.LOS.SZ
The cost estimate in the work is taken from a report by Element Energy. The cost used is £1,400 per kW installed. This is possibly a high estimate as the installer may be able to install the solar panels for less due to economies of scale. Cost estimates can also be taken from a DECC report on the costs of solar PV, including future projections. This table is included in the notes tab of the Excel file for future reference.

At this high level stage, no cost differences were allocated to building integrated and free standing technologies.

### 3.2.9 FiT rate

The feed in tariff rate used is the current figure of 13.41 pence (medium FiT rate due to multiple builds). This is a constant that can be changed in the Excel file.

### 3.2.10 Cost per electrical unit

It is assumed the unit cost of electricity is 15 pence. This is taken from the 2012 average variable unit costs, calculated by the government. The table from this document is included in the notes for reference. Electrical costs are expected to rise year on year, so the cost of electricity is a variable that can be changed in the Excel file.

### 3.2.11 Percentage household electrical use

It is assumed that 50% of the electricity that the solar panels generate is consumed within the home, the remainder being exported. This is an assumption the FiT makes and is not metered unless a household system is over 30kWp. This is a constant that can be changed in the Excel file.

### 3.2.12 FiT electricity export tariff

This is the current FiT export tariff rate, which is applied to 50% of generation. This could go to the developer, community group or individual houses. This is a variable that can be changed in the Excel file.

### 3.2.13 Time period

The output calculations are for annual figures. For example kWh produced, CO₂ saved and revenue generated are all calculated on an annual basis.

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7 http://tinyurl.com/nuexmya
3.3 Output and assessments

The output figures are based on a number of constants detailed above. The majority of them are the same across all sites, and others are different for each site. The variables different for each location are:

- number of dwellings
- additional shading losses
- installed kWp per house
- number of houses facing in each direction (SW, SSW, S, SSE and SE)

Below are the variables which are the same across all locations:

<table>
<thead>
<tr>
<th>Variables</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grid losses</td>
<td>7.7 percent</td>
</tr>
<tr>
<td>Grid CO₂/kWh</td>
<td>0.5 kg</td>
</tr>
<tr>
<td>Cost per kW installed</td>
<td>£1600</td>
</tr>
<tr>
<td>FiT rate</td>
<td>£0.1341</td>
</tr>
<tr>
<td>Cost per electricity unit (kWh)</td>
<td>£0.15</td>
</tr>
<tr>
<td>Percentage household electrical use</td>
<td>50 percent</td>
</tr>
<tr>
<td>Electricity export per unit</td>
<td>£0.0464</td>
</tr>
</tbody>
</table>

The output data for each site, including the assumptions for each are arranged in this document and on the Excel file as shown in the diagram below. In the Excel file, boxes that are variable and can change are coloured in yellow.
4  Summary of site by site potential for PV

Five greenfield development sites were studied: Whitchurch, SW Keynsham, E Keynsham, Odd Down and Weston. Since this study was undertaken in parallel with site allocation, for SW Keynsham, E Keynsham and Odd Down two options for site size and location were being considered at the time of this study. These options are referred to as “Option 1 and Option 2” for those particular sites.

It should be noted that the maximum installed capacities estimated are maximums based on the assumptions in the model. They could be exceeded if the assumptions change. In particular, they are dependent on assumptions regarding the density and orientation of the buildings in each site. The model should be updated when the layout of each site is known.

4.1  Free standing solar panels summary

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total houses</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>250</td>
<td>250</td>
<td>300</td>
<td>300</td>
<td>200</td>
</tr>
<tr>
<td>Total houses with solar panels</td>
<td>180</td>
<td>170</td>
<td>150</td>
<td>180</td>
<td>120</td>
<td>200</td>
<td>240</td>
<td>180</td>
</tr>
<tr>
<td>Installed capacity kWp</td>
<td>720</td>
<td>680</td>
<td>600</td>
<td>720</td>
<td>480</td>
<td>800</td>
<td>960</td>
<td>720</td>
</tr>
<tr>
<td>Annual power produced kWh</td>
<td>646,684</td>
<td>618,470</td>
<td>541,044</td>
<td>651,571</td>
<td>430,810</td>
<td>738,685</td>
<td>896,582</td>
<td>644,556</td>
</tr>
<tr>
<td>Annual CO₂ saving tonnes</td>
<td>348</td>
<td>333</td>
<td>291</td>
<td>351</td>
<td>232</td>
<td>398</td>
<td>483</td>
<td>347</td>
</tr>
<tr>
<td>Cost to install £</td>
<td>1,008,000</td>
<td>952,000</td>
<td>840,000</td>
<td>1,008,000</td>
<td>672,000</td>
<td>1,120,000</td>
<td>1,344,000</td>
<td>1,008,000</td>
</tr>
<tr>
<td>Cost per house to install £</td>
<td>5,600</td>
<td>5,600</td>
<td>5,600</td>
<td>5,600</td>
<td>5,600</td>
<td>5,600</td>
<td>5,600</td>
<td>5,600</td>
</tr>
<tr>
<td>Annual FIT revenue £</td>
<td>86,720</td>
<td>82,937</td>
<td>72,554</td>
<td>87,376</td>
<td>57,772</td>
<td>99,058</td>
<td>120,232</td>
<td>86,435</td>
</tr>
<tr>
<td>Annual grid export revenue £</td>
<td>15,003</td>
<td>14,349</td>
<td>12,552</td>
<td>15,116</td>
<td>9,995</td>
<td>17,137</td>
<td>20,801</td>
<td>14,954</td>
</tr>
<tr>
<td>Annual per house annual average saving £</td>
<td>269</td>
<td>273</td>
<td>271</td>
<td>271</td>
<td>269</td>
<td>277</td>
<td>280</td>
<td>269</td>
</tr>
<tr>
<td>Total annual revenue £</td>
<td>150,225</td>
<td>143,671</td>
<td>125,685</td>
<td>151,360</td>
<td>100,077</td>
<td>171,596</td>
<td>208,276</td>
<td>149,730</td>
</tr>
</tbody>
</table>
### 4.2 Building integrated solar panels summary

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total houses</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>250</td>
<td>250</td>
<td>300</td>
<td>300</td>
<td>200</td>
</tr>
<tr>
<td>Total houses with PV panels</td>
<td>180</td>
<td>170</td>
<td>150</td>
<td>180</td>
<td>120</td>
<td>200</td>
<td>240</td>
<td>180</td>
</tr>
<tr>
<td>Installed capacity kWp</td>
<td>720</td>
<td>680</td>
<td>600</td>
<td>720</td>
<td>480</td>
<td>800</td>
<td>960</td>
<td>720</td>
</tr>
<tr>
<td>Annual power produced kWh</td>
<td>615,600</td>
<td>588,442</td>
<td>514,748</td>
<td>620,006</td>
<td>410,189</td>
<td>703,248</td>
<td>853,070</td>
<td>613,662</td>
</tr>
<tr>
<td>Annual CO₂ saving tonnes</td>
<td>332</td>
<td>317</td>
<td>277</td>
<td>334</td>
<td>221</td>
<td>379</td>
<td>459</td>
<td>330</td>
</tr>
<tr>
<td>Cost to install £</td>
<td>1,008,000</td>
<td>952,000</td>
<td>840,000</td>
<td>1,008,000</td>
<td>672,000</td>
<td>1,120,000</td>
<td>1,344,000</td>
<td>1,008,000</td>
</tr>
<tr>
<td>Cost per house to install £</td>
<td>5,600</td>
<td>5,600</td>
<td>5,600</td>
<td>5,600</td>
<td>5,600</td>
<td>5,600</td>
<td>5,600</td>
<td>5,600</td>
</tr>
<tr>
<td>Annual FIT revenue £</td>
<td>82,552</td>
<td>78,910</td>
<td>69,028</td>
<td>83,143</td>
<td>55,006</td>
<td>94,306</td>
<td>114,397</td>
<td>82,292</td>
</tr>
<tr>
<td>Annual grid export revenue £</td>
<td>14,282</td>
<td>13,652</td>
<td>11,942</td>
<td>14,384</td>
<td>9,516</td>
<td>16,315</td>
<td>19,791</td>
<td>14,237</td>
</tr>
<tr>
<td>Annual per house annual average saving £</td>
<td>257</td>
<td>260</td>
<td>257</td>
<td>258</td>
<td>256</td>
<td>264</td>
<td>267</td>
<td>256</td>
</tr>
<tr>
<td>Total annual revenue £</td>
<td>143,004</td>
<td>136,695</td>
<td>119,576</td>
<td>144,027</td>
<td>95,287</td>
<td>163,365</td>
<td>198,168</td>
<td>142,554</td>
</tr>
</tbody>
</table>

**Annual power generation for free standing and building integrated at each location**

[Graph showing annual power generation for free standing and building integrated at each location]
5 Method for assessing potential for onsite carbon reduction policy

5.1 Assumptions and variables

In order to assess the potential for an onsite carbon reduction policy, a number of assumptions were made to build on the model for solar PV potential. These include:

<table>
<thead>
<tr>
<th>Variable factor</th>
<th>Amount</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average annual household electrical consumption</td>
<td>3,300</td>
<td>kWh</td>
</tr>
<tr>
<td>CO₂ emission factor electricity</td>
<td>0.5</td>
<td>kg/kWh</td>
</tr>
<tr>
<td>Average annual per meter gas consumption</td>
<td>16,500</td>
<td>kWh</td>
</tr>
<tr>
<td>CO₂ emission factor gas</td>
<td>0.203</td>
<td>kg/kWh</td>
</tr>
</tbody>
</table>

Sources:
- www.carbonindependent.org/sources_home_energy.htm

Further assumptions include:
- Homes can accommodate a 4kWp system on their roofs
- Additional solar shading from trees and other obstacles is between 4-6% depending on location
- The average energy consumption figures are taken from Ofgem’s Domestic Energy Consumption Figures of 2011 for new build houses – i.e. they are for houses that meet 2010 Building Regulation energy efficiency standards.
- Gas use is based on per meter gas used as opposed to per household gas use (due to not all houses having a meter)
- Gas emissions factor includes losses and inefficiencies so can be regarded as a total adjusted emissions amount

Due to the assumptions made, this assessment gives an indication of whether a carbon reduction policy might be possible on each site; it is not definitive evidence on the viability of such a requirement for each site. This will depend on the detailed plans for each site, for example on the type of homes built, the energy efficiency measures that are incorporated and the resulting residual energy use, the direction the homes face and the size of the roofs.

In addition, developers may wish to meet a carbon reduction requirement through other forms of renewable energy, such as solar hot water, heat pumps or biomass heating. This analysis assumes that solar PV will be the cheapest way to meet a requirement and so does not take into account other technologies.
6 Results for assessing potential for onsite carbon reduction policy

6.1 CO₂ emissions for each location

The table below shows the total electrical and gas use for each site, as well as 10 and 20 percent of this total.

<table>
<thead>
<tr>
<th>House numbers</th>
<th>Electrical power consumption (kWh)</th>
<th>CO₂ from electricity use (tonnes CO₂)</th>
<th>Heating power consumption (kWh)</th>
<th>CO₂ from gas heating use (tonnes CO₂)</th>
<th>Total CO₂ emissions (tonnes)</th>
<th>10% CO₂ emissions (tonnes)</th>
<th>20% CO₂ emissions (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Whitchurch</td>
<td>200</td>
<td>660,000</td>
<td>330</td>
<td>3,300,000</td>
<td>670</td>
<td>1,000</td>
<td>100</td>
</tr>
<tr>
<td>2. SW Keynsham</td>
<td>200</td>
<td>660,000</td>
<td>330</td>
<td>3,300,000</td>
<td>670</td>
<td>1,000</td>
<td>100</td>
</tr>
<tr>
<td>3. E Keynsham</td>
<td>250</td>
<td>825,000</td>
<td>413</td>
<td>4,125,000</td>
<td>837</td>
<td>1,250</td>
<td>125</td>
</tr>
<tr>
<td>4. Whitchurch</td>
<td>300</td>
<td>990,000</td>
<td>495</td>
<td>4,950,000</td>
<td>1,005</td>
<td>1,500</td>
<td>150</td>
</tr>
<tr>
<td>5. Weston</td>
<td>200</td>
<td>660,000</td>
<td>330</td>
<td>3,300,000</td>
<td>670</td>
<td>1,000</td>
<td>100</td>
</tr>
</tbody>
</table>

6.2 Number of houses with PV to meet a 10% or 20% onsite carbon reduction policy

The table shows the number of houses at each location that would need to have solar panels in order to meet an onsite carbon reduction of 10 percent and of 20 percent. The same variables and assumptions are applied to the below tables and outputs, as for the maximum potential in section three. A scaling factor was applied, which assumed that the same proportion of houses would face in each direction from SW to SE as when the maximum potential for PV was assessed. This means the number of houses facing in each direction is proportional to the maximum potential analysis, allowing for direct comparison.
It can be seen in the tables below that in order to meet 10% of the annual CO₂ emissions of each location, approximately 25 to 26 percent of all proposed houses will have to have PV panels on, in various directions. Subsequently, 50 to 52 percent of all proposed houses will need to have PV panels on to meet 20% of total emissions.
## 10% total carbon reduction

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total houses</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>250</td>
<td>250</td>
<td>300</td>
<td>300</td>
<td>200</td>
</tr>
<tr>
<td>Total houses with solar</td>
<td>52</td>
<td>51</td>
<td>51</td>
<td>64</td>
<td>65</td>
<td>75</td>
<td>75</td>
<td>52</td>
</tr>
<tr>
<td>Percentage of houses with solar</td>
<td>26%</td>
<td>26%</td>
<td>26%</td>
<td>26%</td>
<td>25%</td>
<td>25%</td>
<td>26%</td>
<td></td>
</tr>
</tbody>
</table>

## 20% total carbon reduction

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total houses</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>250</td>
<td>250</td>
<td>300</td>
<td>300</td>
<td>200</td>
</tr>
<tr>
<td>Total houses with solar</td>
<td>103</td>
<td>102</td>
<td>103</td>
<td>128</td>
<td>129</td>
<td>151</td>
<td>149</td>
<td>104</td>
</tr>
<tr>
<td>Percentage of houses with solar</td>
<td>52%</td>
<td>51%</td>
<td>51%</td>
<td>51%</td>
<td>52%</td>
<td>50%</td>
<td>50%</td>
<td>52%</td>
</tr>
</tbody>
</table>

These totals are well below the maximum potential for PV at each location, with the exception of E Keynsham Option 2. This is because the maximum potential on the E Keynsham Option 2 site has been estimated to be lower due to the layout of the site. The long, thin north-south shape of the site lends itself to the majority of the houses facing east-west, and there are therefore fewer houses facing in southerly directions than the other developments. As a result, a 20% carbon reduction requirement could be difficult to meet with solar PV alone on this site. If a 20% requirement was placed on the E Keynsham Option 2 site, its viability would need to be reviewed when the site layout is confirmed.
7 Third party delivery partners

There is the potential for onsite renewable energy to be developed by a third party, rather than directly by the housing developer. This could reduce or remove the costs of installing PV for developers, whilst potentially providing reduced cost electricity to the homeowners and a revenue stream to repay the investment made by the third party. A third party could be a commercial renewable energy company or a local community energy enterprise. Bath Core Strategy Policy CP3 cites “contribution to significant community benefits” as an assessment criteria for renewable energy projects.

By way of high-level market testing, the local social enterprise Bath and West Community Energy (B&WCE) were contacted to assess their interest in delivering renewable energy projects on new-build developments through a community benefit model. BWCE is a not-for-profit social enterprise with local shareholders and a Community Fund into which a portion of their revenues are contributed. BWCE have installed a range of renewable energy projects which they now own and operate.

BWCE stated an interest in working with new build developments. Their view was that for residential development, projects where the total installed capacity would be 200KW or more, spread over the dwellings in the development would be of interest. All the sites studied in this report meet that criterion. BWCE would also be interested in solar thermal, heat pump or biomass boiler solutions for developments of this scale. For a PV project on a single building, or ground-mounted PV installation, BWCE would be interested in projects with a minimum installed capacity of around 50 kWe.

Other examples of third party delivery models include retrofit projects:
Mid Devon District Council worked with Anesco to install PV on 1000 of its social houses
Alliance Homes set up a framework to purchase one million PV panels in bulk, which it made available to the public sector alongside installing PV on 1,200 of its homes

8 Commentary on wind and district heating opportunities

8.1 Wind potential

Large scale wind is a particularly cost-effective renewable energy technology. Appropriately sited turbines can deliver significant amounts of renewable energy. Camco’s renewable energy study8 shows that there is significant potential for wind energy in Bath & North East Somerset, taking into account the unique landscape and setting of Bath and the surrounding area. The sensitivity to wind turbines of the different landscapes in the area has been considered in Land Use Consultants report, Landscape Sensitivity Analysis for Wind Energy Development in Bath and North East Somerset.

8 CAMCO. (2009). Renewable energy research and planning. (June).
Whilst the greenfield sites under examination in this report do not have the potential to include large wind within their boundaries due to the residential nature of the developments, wind may be an option that could be funded through Allowable Solutions, depending on how these are set out in national policy.

8.2 AECOM district heating assessment

None of the locations are directly within the AECOM heating assessment’s main study areas; however, it is possible to carry out a high level analysis of each site. As these are new greenfield developments, all locations have some potential for localised district heating linking the new houses; however, some have good potential for a district heating network with outside anchor loads. The right anchor loads can be the key to economic viability for a network as they provide baseload demand for the system.

<table>
<thead>
<tr>
<th>Site</th>
<th>DH Network potential</th>
<th>Factors and commentary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Whitchurch</td>
<td>Potential for district heating network with several nearby anchor loads.</td>
<td>Close to multiple possible anchor loads, including a care home and school without roads or other major obstacles in the way. Space for energy centre.</td>
</tr>
<tr>
<td>2. SW Keynsham</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3. E Keynsham</td>
<td>Potential for district heating network with several nearby anchor loads.</td>
<td>Close to multiple schools, industrial estates and employment centres with no roads in-between and possible space for heat energy generation. Space for energy centre.</td>
</tr>
<tr>
<td>4. Odd Down</td>
<td>Potential for district heating network with several nearby anchor loads.</td>
<td>Close to multiple schools, a superstore and a hospital. Most of these have no obstacles in the way such as roads, and space on site for an energy centre. Existing housing development next to site in good position to be a part of the network. Site is also directly next to a potential opportunity identified by AECOM’s heating assessment and so there could be potential for the new housing development to link to the network proposed by AECOM.</td>
</tr>
</tbody>
</table>

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| 5. Weston | - | - |
9 Recommendations

a. Solar PV on the greenfield developments could create significant net revenues
There is significant potential for the greenfield sites to accommodate solar PV. Over the 20 year lifetime of the Feed-in Tariff, the net revenues for these sites are significant.

b. All the sites have the potential to meet an onsite carbon reduction requirement (depending on the site layout), without the developer incurring a net cost
The analysis of the potential for a renewable energy requirement policy shows that all of the 5 sites have the potential to meet either a 10 or 20% carbon reduction requirement through solar PV installations on the buildings. E Keynsham Option 2 cannot meet a 20% carbon reduction requirement under this model due to the assumed layout of the site. The model needs to be updated with the site’s actual layout once this is known, as the requirement could be met if the houses were laid out in more southerly directions. As the financial analysis shows, meeting a carbon reduction requirement need not be a net cost to the developer, due to the Feed-in Tariff revenues on offer and to the potential for third party delivery partners to be involved.

Further analysis of the viability could be undertaken when these sites get to the detailed planning stage. If the Council goes ahead with a carbon reduction requirement and developers do not want to take the opportunity to deliver onsite renewables, the Council could place the onus on the developer to demonstrate that meeting the reduction requirement is not viable.

c. Third party delivery partners would be interested in working with housing developers to deliver PV
Developers who are not interested in taking up this financial opportunity themselves could be interested in working with a renewable energy delivery partner. There are a number of options for this type of model, such as working with a community group, the Council playing a role in delivery, or using a specialist renewable energy company.

d. Other renewable energy opportunities
The potential for other types of renewable energy installations on the greenfield sites has not been analysed in detail. However, there may be the potential for near or offsite wind schemes to be contributed to through Allowable Solutions. In addition, the sites at Weston and East Keynsham could include district heat networks that connect to nearby anchor loads. The Odd Down site is adjacent to a district heat opportunity identified in AECOM’s study and so a network in that area has greater potential.
a. Appendix A