VantagePoint Modelling Scenario Report

MEETING THE NATIONAL TARGETS SCENARIO FOR DERBY CITY COUNCIL

Commissioned by:	East Midlands Regional Efficiency and Improvement Partnership	**Developed by:**	Loukas Botsis
Prepared for:	Anne Gayfer	**Written by:**	Jonas Rooze
Modelled Area:	Derby City Council	**Checked by:**	Craig Copeland
Scenario Type:	Meeting the National Targets	**Date:**	22/11/2011

Purpose of Scenario Development

As part of the analysis of the East Midlands' emissions reductions, Carbon Descent has produced a Scenario that aims for Derby City Council to meet its obligation towards the national Climate Change Act (CCA) and interim targets in all periods, based upon a scaling of the deployment of Measures prescribed by the Low Carbon Transition Plan (LCTP). The Scenario delivered is a snapshot, which has been developed, based on current policy, therefore, it will be important to periodically update the Scenario as additional data becomes available and national policies are refined and updated. The periods chosen to be modelled are: 2020, 2035, and 2050.

Scenario Results

The Derby City Council Meeting the National Targets Scenario calculates that the LCTP will provide insufficient carbon savings for Derby City Council to achieve its carbon emissions reduction target in 2020. By increasing the LCTP-derived Measure Deployment, subject to deployment and other constraints, this Scenario achieves the 2020, 2035 and CCA 2050 targets.

Carbon Descent Third Floor 84 Long Lane London SE1 4AU
www.carbondescent.org.uk T 020 7089 6970 F 020 7407 9646

carbondescent
Delivering a Sustainable Future

CARBON DESCENT

Carbon Descent is an independent social enterprise and environmental trust with the experience, expertise and commitment to create strategies and deliver solutions that measurably reduce carbon footprints, creating a sustainable and equitable future for all.

Working in the key areas of energy, resource use, transport, the built environment and renewables for over 10 years, we partner with local authorities, private business, charities and communities to foster a low carbon world. We have wide experience of conducting energy and water audits, environmental assessments and technical feasibility studies, identifying carbon reduction Measures, investigating the potential for renewable energy in new and existing developments and project management.

As awareness of climate change and the urgency to reduce our impact on the environment increases, Carbon Descent continues to help organisations take mitigation actions. By working with large organisations on strategies that reach thousands of people to working at the coal face directly with community members we understand the mechanisms and investment needed to create lasting behaviour change.

Table of Contents

1 Introduction 4

1.1 Commissioning Background 4

1.2 The Low Carbon Transition Plan 4

1.3 The purpose of this report 4

2 Scenario 6

2.1 Report Structure 6

2.2 Description 6

2.3 Constraints of the Model 6

2.4 Methodology for Business as Usual 7

2.5 Methodology for determining Deployment Potentials 7

2.6 Methodology for Deployment of Measures 8

3 Results and Analysis 9

3.1 Key Scenario Results 9

3.1.1 Business As Usual (BAU) 9

3.1.2 Scenario Savings Overview 9

3.1.3 Scenario System Graph 9

3.2 Analysis & Discussion 10

3.2.1 Effect of Business As Usual Emissions Growth 10

3.2.2 Sectoral Analysis 11

3.2.3 Energy Analysis 12

3.2.4 Measure-Specific Analysis 14

4 VantagePoint Outputs from Scenario 19

Table of Figures

Figure 1: Scenario System Graph 10
Figure 2: Demand Sector Decarbonisation 12
Figure 3: Scenario Energy Performance 13
Figure 4: Effort Level for the Large Generation Sector 15
Figure 5: Effort Level for the Transport Sector 16
Figure 6: Effort Level for the Commercial & Industrial Sector 17
Figure 7: Effort Level for the Domestic Sector 18

Table of Tables

Table 1: Business As Usual (BAU) 9
Table 2: Scenario CO_2 Savings Overview 9
Table 3: Breakdown of savings achieved per Sector for all periods 11
Table 4: Notable Large Savings Summary for 2005-2020 14
Table 5: Notable Large Savings Summary for 2021-2035 14
Table 6: Notable Large Savings Summary for 2036-2050 14
Table 7: Scenario Deployment Potentials 20
Table 8: Scenario Resource Potentials 20
Table 9: Scenario Deployment 21
Table 10: Scenario CO2 savings by Measure 23
Table 11: Scenario capital costs by Measure 24

1 Introduction

1.1 Commissioning Background

This report has been produced on behalf of the East Midlands Regional Efficiency and Improvement Partnership with the aim of investigating the impact of the Low Carbon Transition Plan (LCTP) on the local authorities within the East Midlands. In particular, this scenario translates the policies encapsulated in the government's Low Carbon Transition Plan into specific carbon reduction measures and technologies, which belong to the Transport, Domestic, Commercial and Industrial (C&I) and Large Generation sectors. The report then details one possible solution for the local authority in meeting the national targets set by the Government. The ultimate purpose of this study is to calculate what savings over and above the LCTP are required for Derby City Council to meet its 2020 and longer term carbon reduction targets. This report should be read in conjunction with the *LCTP report* and three additional focused scenarios that detail the impacts of focusing on the three core technologies of Solar PV, Biomass and the electrification of heating and transport.

1.2 The Low Carbon Transition Plan

The LCTP details how 43 UK and EU policies aim to achieve emissions cuts of 18% on 2008 levels by 2020. According to the LCTP all major UK government departments have been allocated their own budget and have been tasked with producing their own carbon reduction plan. The LCTP aims for 40% of UK's electricity to be delivered from low carbon sources; this will be achieved through policies that will lead to 30% production of electricity from renewable and facilitation of the building of new nuclear power stations and funding up to 4 carbon capture and storage projects in power stations. Moreover it will aid the greening of the domestic sector by channeling some £3.2 billion to help households become more energy efficient, roll out smart meters to every household, steer "pay as you save" ways in which the savings on energy bills will be used to repay upfront costs, aid emerging clean energy cash back schemes so that energy consumers will be rewarded when they use low carbon sources and by opening a competition for 15 towns and villages to take a leading role in community green development and innovation. The plan also sets out a way to help more vulnerable energy consumers by creating mandated social price support at the earliest opportunity with increased resources compared to the current voluntary system, helping 90,000 homes by leading a community based approach to greening the domestic sector of low income areas and by increasing the level of Warm Front grants so the majority of eligible applicants can receive their energy saving measures without having to put in a payment themselves. Furthermore LCTP aims to establish UK as a leader in the green industry by investing in clean technologies and specifically by investing £120 million in offshore wind and an extra £60 million to establish UK's position as a global leader in marine energy. New projects will be supported in the transport sector in order to reduce the average car emissions by 40% compared to the 2007 levels and to deliver 10% of UK transport energy by renewable resources. LCTP also sets out a framework to reduce emissions from farming. Finally in order to increase energy security, gas imports will be 50% lower than would otherwise have been the case.

1.3 The purpose of this report

This report and associated scenario has been developed in order to outline one way in which the authority may meet the national carbon reduction targets at the local level. The suggested deployment was selected by utilising the measure levels within the LCTP scenario and then increasing measure deployment in equal proportions until the target was met i.e. each measure was increased at the same rate. During this uplift process, if a measure reached its defined maximum potential then it was frozen at that level and not increased.

As with the LCTP report, the deployment mechanism that is utilised for each of the LCTP policies is not explored within this report and the reader should refer back to the LCTP. For example, some measures, such as the decarbonisation of the national electricity grid, will require no direct intervention from the Local Authority. Other measures, such as Cavity Wall insulation, will have varying degrees of intervention at the Local Authority level.

2 Scenario

2.1 Report Structure

This report is designed to provide the key results and the majority of the understanding at the start, while the latter sections are used to provide additional, in-depth analysis and detailed data results. As such, there is no separate conclusion section at the end of this report – refer to the Title Page or Section 3.1 instead.

As such, Section 1 provides a basic description of the Scenario and modelling process, required in order to understand and interpret the results. This Section is augmented by the separate Business as Usual Methodology and Deployment Potentials Methodology reports, which detail the methodology and assumptions of the VantagePoint model setup work.

Section 3 first summarises the key results before engaging in sectoral and energy-based analysis of the Scenario results, while the last part of this section provides more extensive Measure-specific detail. As such, the first two parts of Section 3 are the most relevant in terms of providing a broad understanding of the Scenario. For even greater detail, Section 4 provides the raw Scenario VantagePoint input and output data.

2.2 Description

As part of the analysis of the East Midlands' emissions reductions, Carbon Descent has produced a Scenario for Derby City Council, which has been outlined below. Derby City Council's LCTP Translation Scenario showed that national policy encapsulated in the LCTP and subject to the current understanding of technology, is insufficient to meet the 2020, 2035 and 2050 carbon emissions reduction targets. This Scenario has therefore, been developed in order to determine to what degree the deployment of technological solutions, as determined by the LCTP, has to be increased in order to allow Derby City Council to meet its 2020 and 2050 Climate Change Act carbon reduction targets and its interim 2035 target. Furthermore, this Meeting the National Targets Scenario also enables Derby City Council to investigate the impact of increasing the deployment of Measures beyond that prescribed by the LCTP. Reference to the independent LCTP Translation Scenario Report for Derby City Council would allow the reader to compare and understand the level of deployment increase and effort required for Derby City Council to meet the aforementioned National Targets.

It must be noted that while this Meeting the National Targets Scenario is a comprehensively designed simulation that successfully meets all of Derby City Council's carbon reductions targets, it still only represents a single iteration of how the solution to this complex problem may be achieved. It is designed to investigate, illustrate and inform and does not guarantee that an optimal solution can be found. While significant meaningful analysis may be drawn from this Scenario, it should not be considered the only, or best, solution.

The chosen modelling years are: 2020, 2035 and **2050.**

2.3 Constraints of the Model

The development of the Meeting the National Targets Scenario is based on a proportional increase of the Measures prescribed by the LCTP. This increase is limited by the constraints listed below:

- Resource Potentials
    - Available Biomass Resource
    - Community Heating Potential

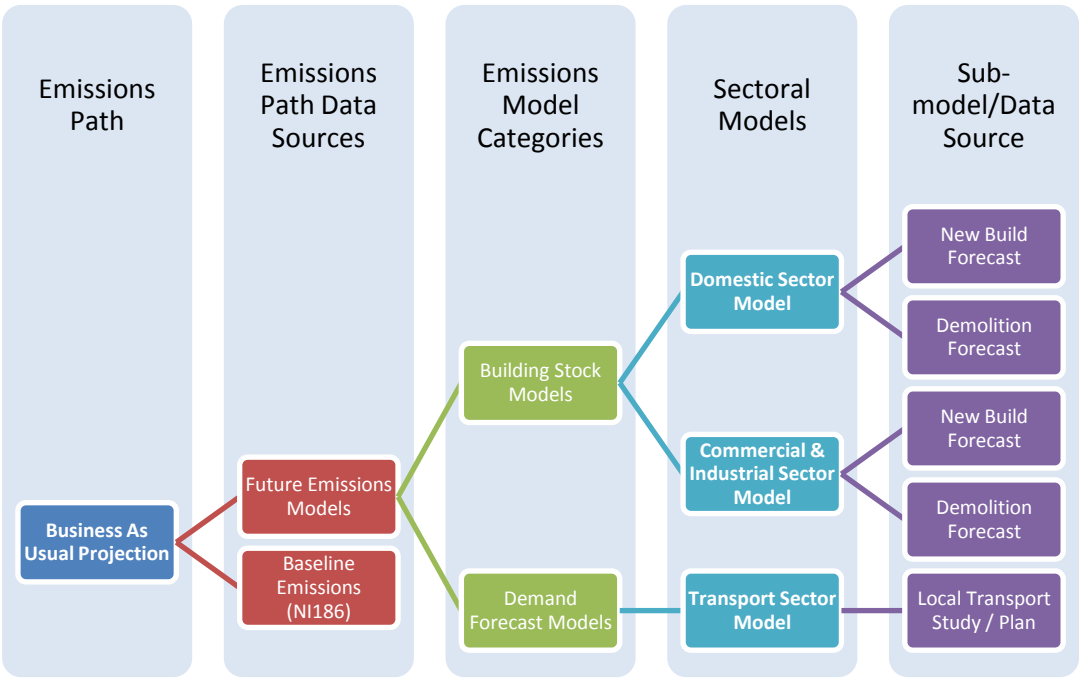
  - Number of homes available for domestic heating Measure installation
- Projected Energy Demands by energy carrier
  - Total Power Demand
  - Total Thermal Demand
- Measure Deployment Potentials

While these are the usual constraints for any Scenario (along with Road Transport Fuel Consumption), for the Meeting the National Targets Scenario they effectively acted as practical constraints on deployment.

2.4 Methodology for Business as Usual

The Business As Usual (BAU) projection for emissions is calculated in accordance with the separate *Business as Usual Methodology* report. The BAU emissions projection up to 2050 is used as a reference 'no further intervention' CO_2 emissions case – typically led by energy demand growth – to which the emissions reductions Measures are applied during the Scenario modelling stage.

The BAU modelling process is portrayed diagrammatically below. The projection takes the current emissions from the National Indication 186 (NI 186) as a basis in the starting year. It then forecasts emissions change in all three Sectors: Domestic, Commercial & Industrial (C&I) and Transport. Both the Domestic and C&I models are building-stock based – the Domestic model in terms of the number of dwellings, and the C&I model in terms of m^2 of floorspace. For both, the pertinent questions relating to emissions growth are what the level of new build and demolition will be. The transport model is demand-based, typically extrapolating emissions using local transport demand growth forecasts.



2.5 Methodology for determining Deployment Potentials

The Deployment Potential for a given Measure was calculated wherever possible using pertinent local data or studies. Where this was not available, standard Carbon Descent methodology was applied to regional or national datasets in order to calculate the Deployment Potential. The methodology used for

each Deployment Potential is given in the separate *Deployment Potentials Methodology* report. The Deployment Potentials for this particular Scenario are provided in Table 7 in Section 4.

2.6 Methodology for Deployment of Measures

The Scenario delivered provides an investigation of whether Derby City Council can meet its carbon emissions reduction targets under the conditions outlined below, subject to the current understanding of technology, and subject to current policies. It will be important to periodically update the Scenarios as additional data becomes available and national policies are refined and updated.

The Scenario modelled here is based on the LCTP Scenario. The suite of national policies this represents has been mapped on to Derby City Council. As the LCTP aims to meet the 2020 national Climate Change Act carbon reduction target of 34% (on a 1990 baseline), no deployment is prescribed by it after 2020.

However, as this Scenario aims to meet subsequent 2035 and 2050 targets, a more aggressive deployment path is followed in the second and third period for all Measures, in accordance with a specific set of steps. First of all, deployment is increased over that prescribed by the LCTP in the first period, 2005-2020, so that Derby City Council can increase its savings in order to meet its Targets for the first period.

After 2020, all Measures are increased in proportion with one another in order to meet the National Targets. However, it was not possible to increase deployment for all the Measures by the same scaling factor; it was found that, in practice, this would have resulted in either the targets not being met or the constraints, listed in section 2.3, being violated. A methodology was, therefore, developed that would ensure Measure Deployment was scaled up in a consistent and valid manner; this is described below.

The initial step gradually scaled deployment for all Measures by the same factor. When a constraint was reached, deployment for all Measures associated with the relevant constraint was frozen. This resulted in a separate scaling factor, which was then fixed for those Measures and that period. This procedure was repeated until the reduction target for 2035 was met. The same procedure was repeated for the 2036-2050 period until the target was met, with the added rule that deployment could not be lower than for the previous period. Moreover, it was decided that a degree of electrification of transport should be introduced in the second and third periods, as this was not included under the LCTP.

The actual Measure deployment for this particular Scenario is provided in Table 9 in Section 4.

3 Results and Analysis

3.1 Key Scenario Results

3.1.1 Business As Usual (BAU)

When modelling emissions into the future it is important to understand the *doing nothing* position and how that may affect the magnitude of measure deployment. This is what is encapsulated within the BAU model that has been completed as part of this work. As noted above the methodology for our BAU is contained within a separate report, the reader should refer to this is more detail is required.

In most instances each local authority will have some growth in emissions over the next few years and may have significant estimates of emissions up to and including 2050. That being said caution is required when looking at the growth projections up to 2050.

CO_2 comparison	2020	2035	2050
Baseline data (2005)	1678	1678	1678
Growth kt	295	555	815
Percentage growth from 2005	18%	33%	49%

Table 1: Business As Usual (BAU)

3.1.2 Scenario Savings Overview

From the LCTP Scenario, it is estimated that Derby City Council's savings under the LCTP will be 510.39ktCO_2 in period one which is 76% of the target savings. This means that, Derby City Council's savings will not be sufficient for it to achieve its 2020 target and, as can be seen from the Table below, in the Meeting the National Targets scenario the deployment has been increased so that Derby City Council could meet its targets. What is important to note is that the LCTP Scenario only relates to savings up to 2020 and it is probable that the deployment of Measures solely linked to the LCTP will probably not be sufficient to meet the short, medium and long term national objectives of carbon reduction. However, with the increased deployment of most of the Measures in all periods, the Meeting the National Targets Scenario for Derby City Council manages to meet all of the 2020, 2035 and 2050 target.

The table below provides an overview of the Scenario savings for each period in relation to the savings required to meet the targets in each period.

CO_2 comparison	2005-2020	2021-2035	2036-2050
CO_2 savings targets (ktpa)	672.99	1543.34	2098.72
Total CO_2 savings for the Scenario (ktpa)	675.27	1547.11	2105.2
Comparison of targets vs. savings (ktpa)	2 (0%)	4 (0%)	6 (0%)

Table 2: Scenario CO_2 Savings Overview

3.1.3 Scenario System Graph

Figure 1 shows the system graph of CO_2 savings for the Scenario. Cumulative savings per Sector from the BAU emissions case (dotted dark blue line) provides the final Scenario emissions projection (solid orange line) in relation to the Scenario targets (on a 2005 baseline).

The graph shows the CO_2 emissions on the vertical axis in kilotonnes of CO_2 saved per annum (ktpa). The horizontal axis indicates the modelling points between 2005 and 2050, as well as the emissions targets (recalculated to show the percentage savings required on a 2005 baseline). Following this, the graph depicts a wedge display of cumulative savings down from the BAU emissions case for each target period. From top to bottom, the savings have been grouped into the following wedges: ***Large Generation***, ***Green Grid*** (effectively the savings 'achieved' in Derby City Council by the national electricity grid becoming cleaner), ***Commercial & Industrial***, ***Domestic*** and ***Transport***. Transport, the final savings wedge, leads to the overall Scenario emissions (shown as a solid orange line).

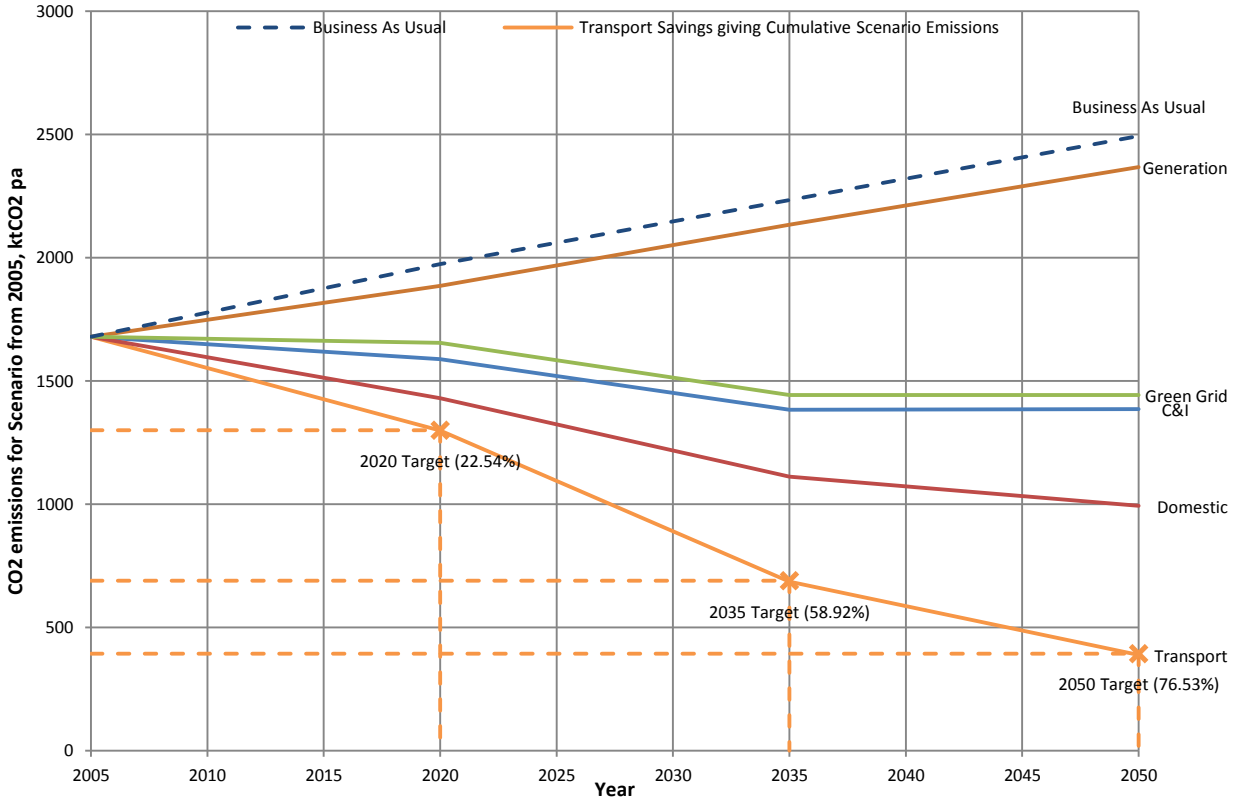


Figure 1: Scenario System Graph

3.2 Analysis & Discussion

3.2.1 Effect of Business As Usual Emissions Growth

Figure 1 shows the savings achieved by the Domestic, Generation and Transport Sectors increase in the second period and the savings from the Domestic and Transport Sectors increase significantly in the final period. As expected, the savings achieved from the greening of the national electricity grid increase in every period. This impacts the savings achieved by the Generation Sector; as the electricity generated here is offsetting increasingly cleaner electricity from the national grid, savings returns are diminished. It must be noted that the Generation Sector also produces heat for district heating networks – as this offsets gas use, there is no element of diminishing returns for heat generation.

In all instances the savings assume that emissions growth under BAU (typically led by energy demand growth) will be as predicted. If growth is less than calculated within the BAU and as depicted on Figure 1, then it would bring the authority closer to its interim targets; effectively the absolute savings target in $ktCO_2pa$ increases or decreases with greater or lesser BAU emissions growth, respectively.

Consequently, greater or lesser emissions growth will move the final Scenario emissions projection up or down on Figure 1. This could affect whether or not targets are met.

3.2.2 **Sectoral Analysis**

The following section will analyse the carbon savings on a Sectoral basis. In conjunction with the Measure-Specific Analysis given in Section 3.2.4, as well as the raw Scenario deployment numbers provided in Section 4, an understanding can be gained from this section as to the effectiveness of decarbonisation efforts in each of the Sectors, and potentially where significant potential still exists for decarbonisation in order to meet the targets.

3.2.2.1 Sectoral Savings Breakdown

The savings are split between the Sectors in the following proportions:

	2020 Target Period		2035 Target Period		2050 Target Period	
Sector	Savings $ktCO_2pa$	As percentage of total savings	Savings $ktCO_2pa$	As percentage of total savings	Savings $ktCO_2pa$	As percentage of total savings
Domestic	157.603	23%	271.977	18%	392.084	19%
Commercial and Industrial	66.945	10%	60.254	4%	57.831	3%
Transport	131.802	20%	424.955	28%	605.222	29%
Large Generation	87.618	13%	99.833	6%	125.405	6%
Green Grid	231.3	34%	690.088	45%	924.659	44%

Table 3: Breakdown of savings achieved per Sector for all periods

From the Table, we can see that the greatest savings in the first period are achieved by the Green Grid, followed by the Domestic Sector. In the following periods the greatest savings are achieved by the Green Grid followed by the Transport sector.

3.2.2.2 Demand Sector Decarbonisation

Further analysis is provided in Figure 2. This figure shows to what extent the energy demand Sectors (Transport, C&I and Domestic) have been decarbonised in each period. This is shown as the savings achieved in the Sector in each period as a percentage of the Sector emissions predicted under the BAU for each period. Consequently, it gives an indication of the success achieved by the relevant Measure deployment in abating emissions from each demand Sector.

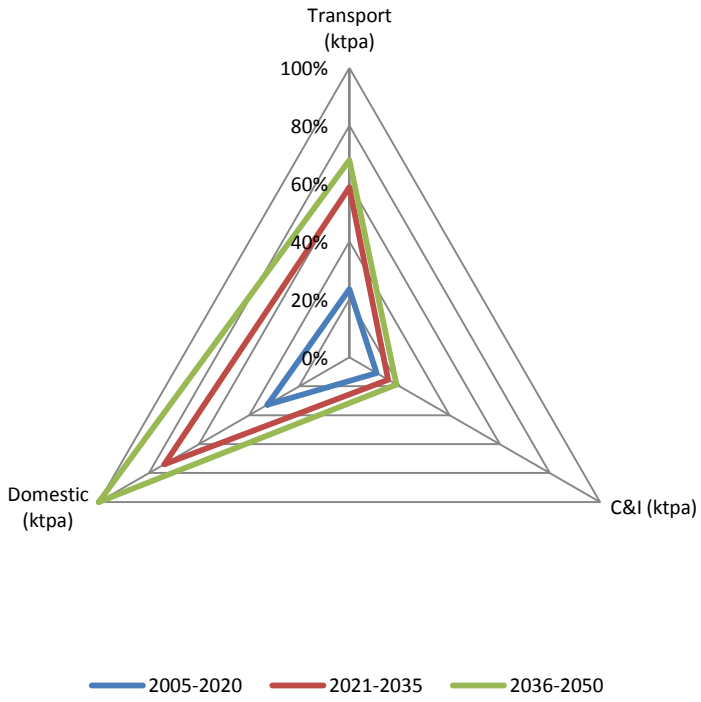


Figure 2: Demand Sector Decarbonisation

It is clear from the above figure that under the Meeting the National Targets Scenario the decarbonisation of the Domestic and Transport Sectors are the most intense at some 30% and 20% respectively between 2005 and 2020, while the decarbonisation of the C&I Sector is the lowest at some 10%. This is in accordance with the impression given by Section 3.2.4.2, which indicates that the LCTP prescribes significantly more deployment effort for the Domestic Sector.

In the subsequent periods it is clear that the growth in decarbonisation of the Domestic Sector is especially rapid and reaches 100% by the end of the third period.

The decarbonisation of the C&I Sector is quite slow between increases slightly in the two last periods, attaining 20% by the end of that final period.

The Transport sector has a rather intense growth in the second period reaching some 60 %. In the final period its decarbonisation slightly increases by another 10% reaching some 70% by the end of it. Electrification of transport is not one of the LCTP-derived measures; therefore it is not deployed at all during the first period, which is in accordance with the LCTP scenario. However, during the last two periods a proportion of road transport fuels is displaced by electricity, as indicated by transport policy researchers.

3.2.3 **Energy Analysis**

Having considered the Scenario results from a carbon savings perspective, the following section takes an alternative view on the Scenario results by examining energy instead. In particular, energy demand may be split into the following categories: thermal demand and power demand, both Measured in MWh, as well as transport fuel demand (whether conventional fossil fuel, biofuel or electricity, but all Measured for convenience in thousands of fossil fuel litres). Two exploitable energy ‘resources’ are also included:

biomass resource (MWh), and community heating potential (the amount of Derby City Council's heating demand that could be met by a district heating network).

Figure 3 considers the Scenario's energy performance, split into the categories defined above, giving the extent to which BAU energy demand has been offset under the Scenario, or the extent to which available energy resources have been utilised. In more detail, the graph shows, as a percentage of the predicted energy demand under BAU, the extent to which energy demand has been displaced by the installed Measure deployment for the three energy demand categories. It also shows the utilisation of the two exploitable energy resource categories as a percentage of their Deployment Potentials.

It must be understood, however, that energy demand displacement does not necessarily translate into direct emissions reductions; for example, the Fuel Switch Measure displaces a certain amount of domestic thermal demand, previously supplied by electric heating, with only marginally cleaner gas heating, giving limited carbon savings. This observation makes an instant case for energy efficiency Measures.

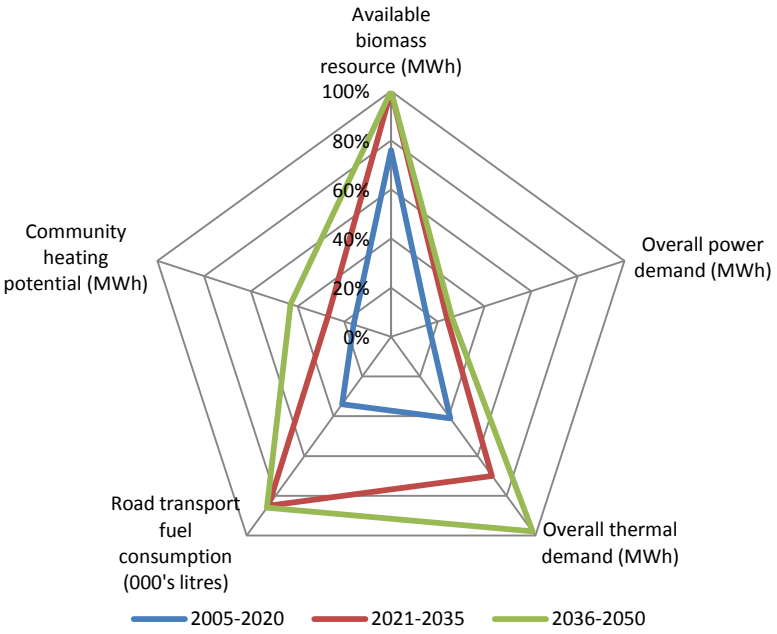


Figure 3: Scenario Energy Performance

As is usual under LCTP Scenarios, the overall 2020 demand displacement and resource utilisation is fairly low in the first period. From the above figure it is clear that, in the first and second period, Biomass resource utilisation reaches around 80%, contributing indirectly, to an increase of thermal demand offsetting to some 70%. Increasing biomass Measure Deployment is therefore, a significant factor in allowing Derby City Council to meet its 2035 interim carbon emission reduction target. In the final period there is a significant increase in the extent to which road transport fuel consumption and overall thermal demand is offset or abated. This indicates among other things, that the increase in the savings required for Derby City Council to meet its 2050 Climate Change Act target has been achieved in part by increasing the displacement of conventional road transport fuels with biofuels and electricity; large increases in the deployment of wind turbines to offset grid-derived power demand; and finally heat-saving or generating Measures, such as insulation measures or domestic heat pumps, to abate or offset conventional heating fuel demand.

3.2.4 **Measure-Specific Analysis**

In this section, deployment and savings are examined on a Measure-by-Measure basis, considering the key sources of savings, discussing any Deployment Potentials that have been exceeded and finally reviewing the effort level of each Measure.

3.2.4.1 Notable Large Savings

In 2020, the four largest CO_2-saving Measures within the Scenario are provided in Table 4, and similarly the four largest Measures are provided for 2035 in Table 5 and for 2050 in Table 6. These tables also show what percentage of the total Scenario savings are achieved by these four Measures. For example, in the case of 2020, the four Measures together account for 62% of the total CO_2 savings within the Scenario, or 63% of the target savings.

Measure	CO2 Savings (ktCO2pa)	CO2 Savings as % of Total Scenario CO2 Savings	CO2 Savings as % of Target CO2 Savings
Green grid	231.3	34%	34%
Replace road transport fuels with biofuels	77.259	11%	11%
Solid wall insulation (Domestic)	57.513	9%	9%
CHP biomass	54.845	8%	8%
Total	**420.917**	**62%**	**63%**

Table 4: Notable Large Savings Summary for 2005-2020

Measure	CO2 Savings (ktCO2pa)	CO2 Savings as % of Total Scenario CO2 Savings	CO2 Savings as % of Target CO2 Savings
Green grid	690.088	45%	45%
Replace road transport fuels with biofuels	230.34	15%	15%
Replace road transport fuels with electricity	124.095	8%	8%
CHP biomass	78.875	5%	5%
Total	**1123.398**	**73%**	**73%**

Table 5: Notable Large Savings Summary for 2021-2035

Measure	CO2 Savings (ktCO2pa)	CO2 Savings as % of Total Scenario CO2 Savings	CO2 Savings as % of Target CO2 Savings
Green grid	924.659	44%	44%
Replace road transport fuels with electricity	296.438	14%	14%
Replace road transport fuels with biofuels	222.286	11%	11%
Ground source heat pump (Domestic)	121.033	6%	6%
Total	**1564.416**	**74%**	**75%**

Table 6: Notable Large Savings Summary for 2036-2050

It is interesting to note that two out of four Measures remain in the top four across all periods. Road Transport Measures are dominant, namely replacement of conventional fuels with biofuels and electricity. However, as is usual for most Scenarios, the projected decarbonisation of the wider national electricity grid means that Green Grid remains the Measure to provide the largest savings, consistently providing more than a third of all savings. Finally, in the final period electrification of transport also becomes dominant in the final period.

3.2.4.2 Deployment Effort Levels

The following charts set out the effort levels for each Measure, grouped by Sector. The effort level is defined as the Measure Deployment divided by the Deployment Potential. Effectively, this gives an indication of the amount of effort that has been undertaken in relation to the complete utilisation of that Measure's Deployment Potential, giving an idea of the scale of savings that could still be achieved by further deployment. For the LCTP-defined Measures, deployment remains more or less constant across all periods (for these, where deployment changes this is usually due to Deployment Potentials changing with time).

The first effort level graph, Figure 4, shows how much focus has been given to Large Generation Measures in this Scenario. As usual, the Green Grid Measure increases strongly over time; the Green Grid Measure is modelled based upon the national grid decarbonisation projection made in DECC's 2050 Pathways Analysis work (Scenario Alpha), and is therefore, independent of either the LCTP or the Scenario's focus, remaining constant for each District across Scenario types. The Green Grid effort level is expressed as a percentage of its ultimate 2050 value.

Power only and CHP biomass are considered Large Generation Measures and clearly show a marked increase in deployment between 2021 and 2050. Power only Biomass reaches its full potential at the end of the third period. In the case of Derby City Council large Wind Generation technologies show a significant increase in all three periods eventually reaching some 95% of its full potential.

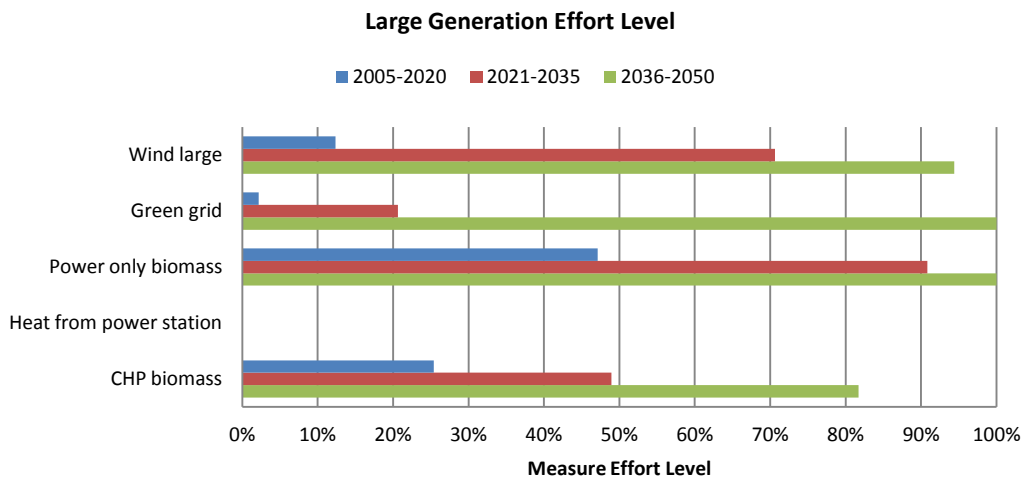


Figure 4: Effort Level for the Large Generation Sector

The next effort level graph, Figure 5, is for the Transport Sector Measures. Here the Meeting the National Targets results in road transport efficiency improvements and partial replacement of road transport fuel with biofuel by 2020. In the 2021-2035 period, the Meeting the National Targets Scenario deployment

methodology results in an increase in biofuel use from some 25% to 55%, while there is also some electricity utilization in Transport. In the final period the displacement of conventional transport fuel with biofuels reduced to 45% due to the increase of the increase of Transport in the last two periods as indicated by the BAU. In the final period the use of electricity in transport is further increased to about 30%.

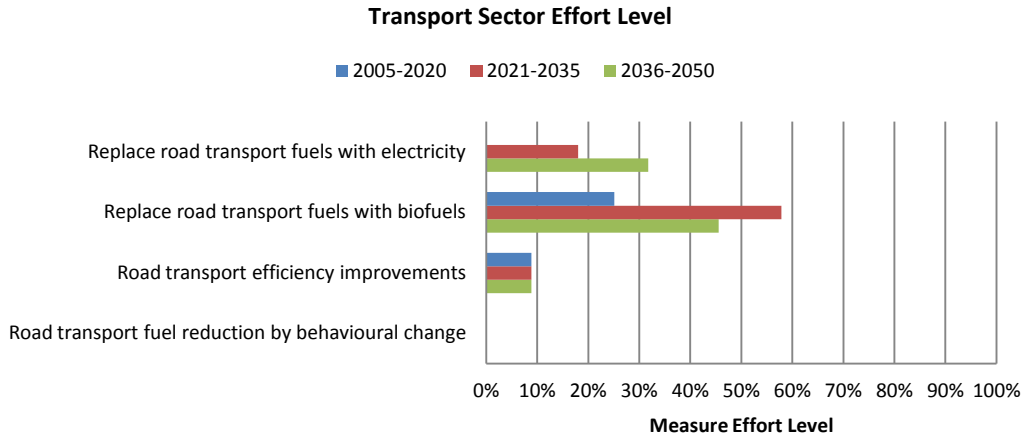


Figure 5: Effort Level for the Transport Sector

The Commercial and Industrial Sector effort levels are shown in Figure 6. The Meeting the National Targets Scenario results in a strong effort levels for Energy Efficient Lighting, Biomass boilers and non domestic Solar PV installation. Non domestic solar PV reach their maximum effort level in the final period. Biomass boilers also demonstrate a significant increase and eventually reach some 95% of their potential.

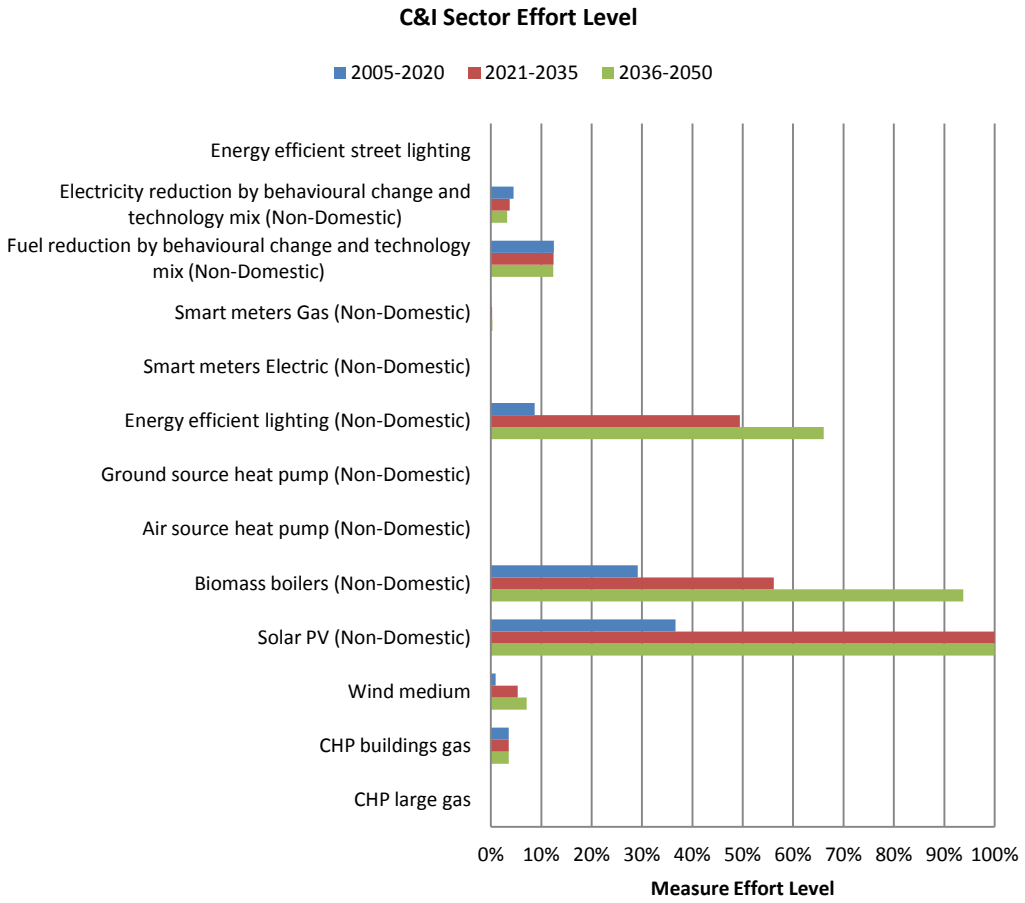


Figure 6: Effort Level for the Commercial & Industrial Sector

Finally, Figure 7 shows the deployment effort level undertaken in the Domestic Sector. In Carbon Descent's experience, the LCTP prescribes the greatest deployment focus in this Sector in 2020. This is therefore where higher 2020 effort levels can be found for this Scenario, particularly for the domestic energy efficiency and insulation Measures, such as Cavity Wall Insulation, Smart Meters and Energy Efficient Appliances. These are Measures which the LCTP typically assumes will be more or less fully deployed by 2020. Moreover, in order to meet the 2035 and 2050 targets, very high effort levels are observed for the majority of energy efficiency Measures, with most reaching full deployment. Domestic scale solar technologies and Biomass Boilers also see relatively strong deployment effort. Given that the methodology adopted for increasing deployment adopts a scaling approach, it is logical that the greatest 2035 and 2050 effort levels will be for those Measures where the LCTP prescribed the highest deployment in 2020. This also highlights a potential shortcoming of the scaling approach; while in 2020, domestic energy efficiency may be the 'low-hanging fruit', in later periods this may no longer be the case, and it may be more effective, or viable, to focus deployment on other Measure types or Sectors.

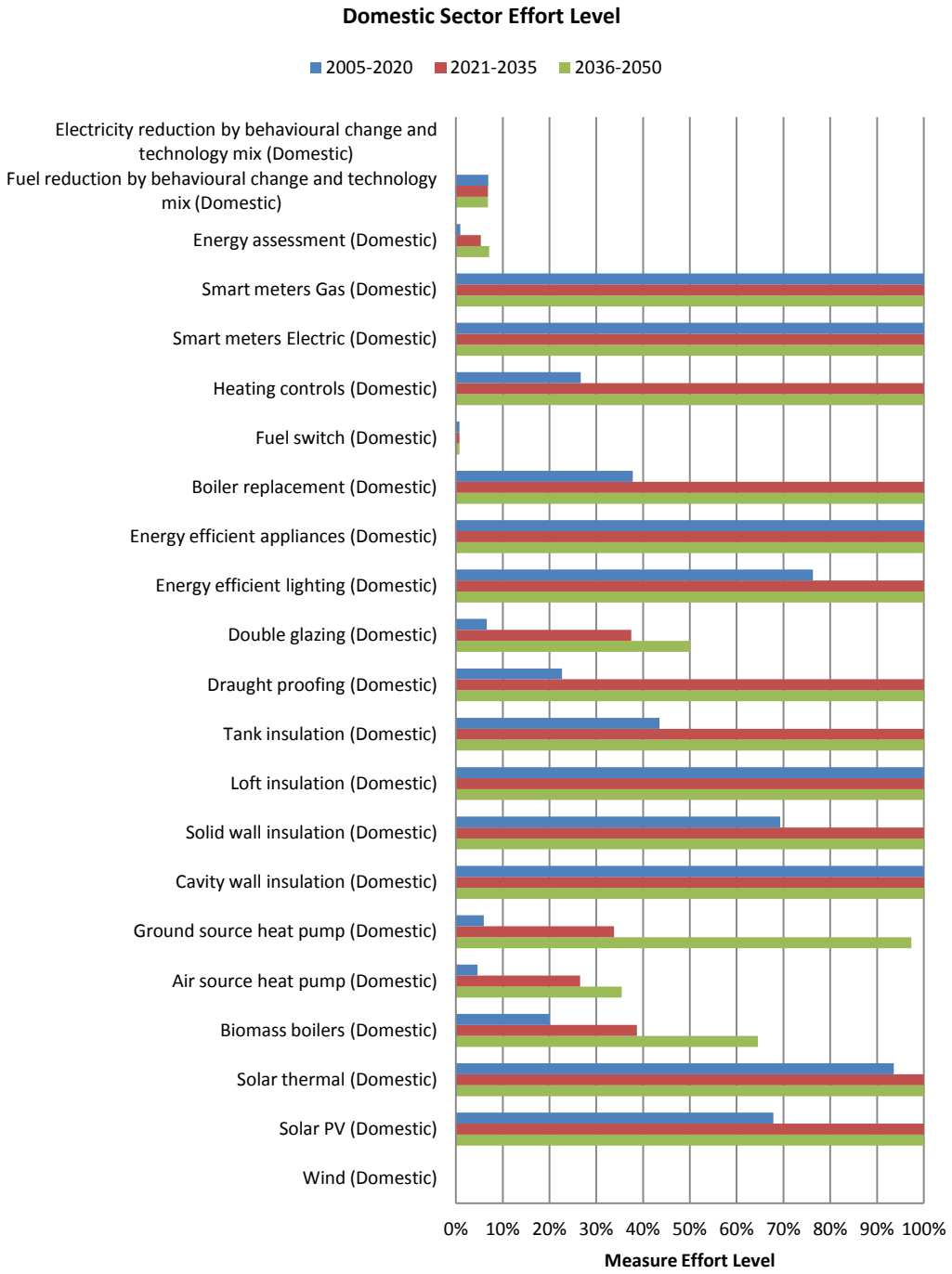


Figure 7: Effort Level for the Domestic Sector

4 VantagePoint Outputs from Scenario

This section of the report will provide the raw outputs as given by the VantagePoint software. This is the output used in the analysis above.

The Deployment Potentials within the Scenario are defined below and are used to provide an upper limit on the number of installations of each Measure.

Deployment Potentials	Units	2005-2020	2021-2035	2036-2050
CHP biomass	MWe	31.142	31.142	31.142
CHP large gas	MWe	124.793	124.793	124.793
CHP buildings gas	MWe	163.174	163.174	163.174
Heat from power station	MWth	0	0	0
Power only biomass	MWe	31.142	31.142	31.142
Green grid	%	298.28	298.28	298.28
Wind large	MWe	9.95	9.95	9.95
Wind medium	MWe	8.65	8.65	8.65
Wind (Domestic)	Homes	0	0	0
Solar PV (Domestic)	Homes	15,248.00	15,248.00	15,248.00
Solar thermal (Domestic)	Homes	15,248.00	15,248.00	15,248.00
Biomass boilers (Domestic)	Homes	8,101.00	8,101.00	8,101.00
Air source heat pump (Domestic)	Homes	98,588.00	98,588.00	98,588.00
Ground source heat pump (Domestic)	Homes	46,247.00	46,247.00	46,247.00
Solar PV (Non-Domestic)	MWe	30	30	30
Biomass boilers (Non-Domestic)	MWth	6.504	6.504	6.504
Air source heat pump (Non-Domestic)	MWth	75.021	75.021	75.021
Ground source heat pump (Non-Domestic)	MWth	37.511	37.511	37.511
Cavity wall insulation (Domestic)	Homes	23,066.00	23,066.00	23,066.00
Solid wall insulation (Domestic)	Homes	32,784.00	32,784.00	32,784.00
Loft insulation (Domestic)	Homes	52,564.00	52,564.00	52,564.00
Tank insulation (Domestic)	Homes	2,554.00	2,554.00	2,554.00
Draught proofing (Domestic)	Homes	9,836.00	9,836.00	9,836.00
Double glazing (Domestic)	Homes	30,309.00	30,309.00	30,309.00
Energy efficient lighting (Domestic)	Lamps	777,516.00	777,516.00	777,516.00
Energy efficient appliances (Domestic)	Homes	98,588.00	98,588.00	98,588.00
Boiler replacement (Domestic)	Homes	13,402.00	13,402.00	13,402.00
Fuel switch (Domestic)	Homes	933.00	933.00	933.00
Heating controls (Domestic)	Homes	34,506.00	34,506.00	34,506.00
Smart meters Electric (Domestic)	Homes	31,909.00	31,909.00	31,909.00
Smart meters Gas (Domestic)	Homes	24,562.00	24,562.00	24,562.00
Energy assessment (Domestic)	Homes	98,588.00	98,588.00	98,588.00
Fuel reduction by behavioural change and technology mix (Domestic)	%	100	100	100

Electricity reduction by behavioural change and technology mix (Domestic)	%	100	100	100
Energy efficient lighting (Non-Domestic)	000's m2	916	916	916
Smart meters Electric (Non-Domestic)	%	100.00	100.00	100.00
Smart meters Gas (Non-Domestic)	%	100.00	100.00	100.00
Fuel reduction by behavioural change and technology mix (Non-Domestic)	%	100	100	100
Electricity reduction by behavioural change and technology mix (Non-Domestic)	%	100	100	100
Energy efficient street lighting	Lamps	35,000.00	35,000.00	35,000.00
Road transport fuel reduction by behavioural change	%	100	100	100
Road transport efficiency improvements	%	100	100	100
Replace road transport fuels with biofuels	000's litres	244,696.13	316,374.80	388,053.46
Replace road transport fuels with electricity	000's litres	244,696.13	316,374.80	388,053.46

Table 7: Scenario Deployment Potentials

The following table provides the Resource Potentials and Projected Energy Demands per energy carrier, as found for Derby City Council. These are the limits to the amount of biomass available and the total amount of heat that could viably be provided by a district heating scheme, and the total amount of electricity, heat and conventional transport fuel Derby City Council is projected to use (and is therefore available for offsetting or abating).

Resource Potentials	Units	2005-2020	2021-2035	2036-2050
Community Heating Potential	MWe	1,515,236	1,515,236	1,515,236
Biomass Resource Potential	MWe	1,112,115	1,626,273	2,140,431
Overall Power Demand	MWe	1,498,150	1,725,792	1,953,435
Overall Thermal Demand	MWe	2,698,710	2,885,325	2,914,761
road transport fuel Consumption	MWe	244,696	316,375	388,053

Table 8: Scenario Resource Potentials

The following table provides the Measure deployment used to build this specific Scenario – these are the installations assumed to be in place by the end of the relevant period.

Deployment	Units	2005-2020	2021-2035	2036-2050
CHP biomass	MWe	7.907	15.24	25.441
CHP large gas	MWe	0	0	0
CHP buildings gas	MWe	5.8	5.8	5.8
Heat from power station	MWth	0	0	0
Power only biomass	MWe	14.677	28.287	31.142
Green grid	%	6.48	61.62	298.28
Wind large	MWe	1.232	7.029	9.395

Wind medium	MWe	0.08	0.459	0.614
Wind (Domestic)	Homes	0	0	0
Solar PV (Domestic)	Homes	10,350.00	15,248.00	15,248.00
Solar thermal (Domestic)	Homes	14,268.00	15,248.00	15,248.00
Biomass boilers (Domestic)	Homes	1,625.00	3,131.00	5,227.00
Air source heat pump (Domestic)	Homes	4,582.00	26,151.00	34,951.00
Ground source heat pump (Domestic)	Homes	2,739.00	15,633.00	45,001.00
Solar PV (Non-Domestic)	MWe	10.987	30	30
Biomass boilers (Non-Domestic)	MWth	1.896	3.654	6.1
Air source heat pump (Non-Domestic)	MWth	0	0	0
Ground source heat pump (Non-Domestic)	MWth	0	0	0
Cavity wall insulation (Domestic)	Homes	23,066.00	23,066.00	23,066.00
Solid wall insulation (Domestic)	Homes	22,727.00	32,784.00	32,784.00
Loft insulation (Domestic)	Homes	52,564.00	52,564.00	52,564.00
Tank insulation (Domestic)	Homes	1,112.00	2,554.00	2,554.00
Draught proofing (Domestic)	Homes	2,231.00	9,836.00	9,836.00
Double glazing (Domestic)	Homes	1,990.00	11,357.00	15,180.00
Energy efficient lighting (Domestic)	Lamps	593,462.00	777,516.00	777,516.00
Energy efficient appliances (Domestic)	Homes	98,588.00	98,588.00	98,588.00
Boiler replacement (Domestic)	Homes	5,067.00	13,402.00	13,402.00
Fuel switch (Domestic)	Homes	7.00	7.00	7.00
Heating controls (Domestic)	Homes	9,192.00	34,506.00	34,506.00
Smart meters Electric (Domestic)	Homes	31,909.00	31,909.00	31,909.00
Smart meters Gas (Domestic)	Homes	24,562.00	24,562.00	24,562.00
Energy assessment (Domestic)	Homes	917.00	5,233.00	6,994.00
Fuel reduction by behavioural change and technology mix (Domestic)	%	6.926	6.871	6.817
Electricity reduction by behavioural change and technology mix (Domestic)	%	-4.93	-4.69	-4.47
Energy efficient lighting (Non-Domestic)	000's m2	79.341	452.799	605.182
Smart meters Electric (Non-Domestic)	%	0.00	0.00	0.00
Smart meters Gas (Non-Domestic)	%	0.04	0.22	0.30
Fuel reduction by behavioural change and technology mix (Non-Domestic)	%	12.52	12.43	12.34
Electricity reduction by behavioural change and technology mix (Non-Domestic)	%	4.498	3.753	3.219
Energy efficient street lighting	Lamps	0.00	0.00	0.00
Road transport fuel reduction by behavioural change	%	0.089	0.089	0.089
Road transport efficiency improvements	%	8.86	8.86	8.86
Replace road transport fuels with biofuels	000's litres	61,399.23	183,056.76	176,655.93
Replace road transport fuels with electricity	000's litres	0.00	56,979.75	123,300.60

Table 9: Scenario Deployment

For the Scenario deployment provided above, VantagePoint calculates the CO_2 savings. The full breakdown of Measures has been detailed in terms of their $ktCO_2pa$ reduction in each of the three periods.

CO2 Saved by Measure	Units	2005-2020	2021-2035	2036-2050
CHP biomass	ktCO2pa	54.845	78.875	118.906
CHP large gas	ktCO2pa	0	0	0
CHP buildings gas	ktCO2pa	11.416	10.763	10.739
Heat from power station	ktCO2pa	0	0	0
Power only biomass	ktCO2pa	31.811	19.234	5.861
Green grid	ktCO2pa	231.30	690.09	924.66
Wind large	ktCO2pa	0.962	1.724	0.638
Wind medium	ktCO2pa	0.038	0.068	0.025
Wind (Domestic)	ktCO2pa	0	0	0
Solar PV (Domestic)	ktCO2pa	7.82	3.61	1.00
Solar thermal (Domestic)	ktCO2pa	5.46	5.50	5.50
Biomass boilers (Domestic)	ktCO2pa	4.83	8.77	14.63
Air source heat pump (Domestic)	ktCO2pa	5.92	59.51	92.73
Ground source heat pump (Domestic)	ktCO2pa	4.69	37.64	121.03
Solar PV (Non-Domestic)	ktCO2pa	3.334	2.856	0.791
Biomass boilers (Non-Domestic)	ktCO2pa	2.025	3.675	6.114
Air source heat pump (Non-Domestic)	ktCO2pa	0	0	0
Ground source heat pump (Non-Domestic)	ktCO2pa	0	0	0
Cavity wall insulation (Domestic)	ktCO2pa	14.63	13.81	13.79
Solid wall insulation (Domestic)	ktCO2pa	57.51	78.30	78.21
Loft insulation (Domestic)	ktCO2pa	19.39	18.30	18.28
Tank insulation (Domestic)	ktCO2pa	0.18	0.39	0.39
Draught proofing (Domestic)	ktCO2pa	0.59	2.44	2.44
Double glazing (Domestic)	ktCO2pa	1.39	7.46	9.96
Energy efficient lighting (Domestic)	ktCO2pa	2.75	1.13	0.31
Energy efficient appliances (Domestic)	ktCO2pa	13.51	4.24	1.17
Boiler replacement (Domestic)	ktCO2pa	3.85	9.60	9.59
Fuel switch (Domestic)	ktCO2pa	0.02	-0.01	-0.01
Heating controls (Domestic)	ktCO2pa	0.31	1.10	1.10
Smart meters Electric (Domestic)	ktCO2pa	1.00	0.31	0.09
Smart meters Gas (Domestic)	ktCO2pa	0.42	0.39	0.39
Energy assessment (Domestic)	ktCO2pa	0.09	0.42	0.53
Fuel reduction by behavioural change and technology mix (Domestic)	ktCO2pa	21.685	21.684	21.683
Electricity reduction by behavioural change and technology mix (Domestic)	ktCO2pa	-8.403	-2.636	-0.729
Energy efficient lighting (Non-Domestic)	ktCO2pa	0.453	0.811	0.3
Smart meters Electric (Non-Domestic)	ktCO2pa	0.00	0.00	0.00

Smart meters Gas (Non-Domestic)	ktCO2pa	0.84	4.49	5.97
Fuel reduction by behavioural change and technology mix (Non-Domestic)	ktCO2pa	32.415	32.441	32.463
Electricity reduction by behavioural change and technology mix (Non-Domestic)	ktCO2pa	16.429	5.155	1.426
Energy efficient street lighting	ktCO2pa	0.00	0.00	0.00
Road transport fuel reduction by behavioural change	ktCO2pa	0.542	0.701	0.86
Road transport efficiency improvements	ktCO2pa	54.001	69.819	85.638
Replace road transport fuels with biofuels	ktCO2pa	77.26	230.34	222.29
Replace road transport fuels with electricity	ktCO2pa	0.00	124.10	296.44

Table 10: Scenario CO2 savings by Measure

In addition to the $ktCO_2pa$ savings per Measure, where known, the indicative capital expenditure has been outlined in the table below. The costs are for each period and are not cumulative.

Capital Expenditure	Units	2005-2020	2021-2035	2036-2050
CHP biomass	£k	45665.748	68029.353	97160.777
CHP large gas	£k	0	0	0
CHP buildings gas	£k	5011.376	3758.532	0
Heat from power station	£k	0	0	0
Power only biomass	£k	84762.316	126273.912	87484.092
Green grid	£k	0.00	0.00	0.00
Wind large	£k	1846.5	8698.5	3549
Wind medium	£k	243	1134	462
Wind (Domestic)	£k	0	0	0
Solar PV (Domestic)	£k	65,593.13	31,041.08	0.00
Solar thermal (Domestic)	£k	57,072.00	3,920.00	0.00
Biomass boilers (Domestic)	£k	11,700.00	10,843.20	15,091.20
Air source heat pump (Domestic)	£k	32,074.00	150,983.00	61,600.00
Ground source heat pump (Domestic)	£k	27,390.00	128,940.00	297,959.69
Solar PV (Non-Domestic)	£k	43952	76048	0
Biomass boilers (Non-Domestic)	£k	0	327.06	323.472
Air source heat pump (Non-Domestic)	£k	0	0	0
Ground source heat pump (Non-Domestic)	£k	0	0	0
Cavity wall insulation (Domestic)	£k	8,767.39	0.00	2,739.81
Solid wall insulation (Domestic)	£k	85,226.25	37,713.75	79,899.61
Loft insulation (Domestic)	£k	15,043.82	0.00	4,701.19
Tank insulation (Domestic)	£k	36.49	65.44	24.03
Draught proofing (Domestic)	£k	380.66	1,499.47	659.10
Double glazing (Domestic)	£k	7,960.00	42,443.00	42,758.17
Energy efficient lighting (Domestic)	£k	593.46	184.05	0.00
Energy efficient appliances (Domestic)	£k	90,577.73	43,132.25	0.00

Boiler replacement (Domestic)	£k	13,863.31	22,804.56	0.00
Fuel switch (Domestic)	£k	29.05	0.00	0.00
Heating controls (Domestic)	£k	1,011.12	2,784.54	0.00
Smart meters Electric (Domestic)	£k	7,370.98	0.00	0.00
Smart meters Gas (Domestic)	£k	6,951.05	0.00	0.00
Energy assessment (Domestic)	£k	91.70	431.60	176.10
Fuel reduction by behavioural change and technology mix (Domestic)	£k	0	0	0
Electricity reduction by behavioural change and technology mix (Domestic)	£k	0	0	0
Energy efficient lighting (Non-Domestic)	£k	1983.536	9336.449	3809.569
Smart meters Electric (Non-Domestic)	£k	0.00	0.00	0.00
Smart meters Gas (Non-Domestic)	£k	0.00	0.00	0.00
Fuel reduction by behavioural change and technology mix (Non-Domestic)	£k	0	0	0
Electricity reduction by behavioural change and technology mix (Non-Domestic)	£k	0	0	0
Energy efficient street lighting	£k	0.00	0.00	0.00
Road transport fuel reduction by behavioural change	£k	0	0	0
Road transport efficiency improvements	£k	0	0	0
Replace road transport fuels with biofuels	£k	0.00	0.00	0.00
Replace road transport fuels with electricity	£k	0.00	0.00	0.00

Table 11: Scenario capital costs by Measure