# USING REAP FOR AN ENVIRONMENTAL ASSESSMENT OF THE LEEDS CITY REGION RSS HOUSING POLICY

A Rapid Review by the Stockholm Environment Institute

Commissioned by the Environment Agency and WWF on behalf of the Yorkshire and Humber Environment Forum


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## Executive Summary

- This study addresses the carbon dioxide emissions and Ecological Footprint from existing and new buildings in the Leeds City Region. It takes into account the materials required to build new homes and direct energy use (i.e. space and water heating, and lighting). There are other significant impacts associated with providing housing, as each new resident will add his own lifestyle impacts to the area – for example, emissions from goods and services as well as mobility. These effects were not included in this study.

- The study looks at how 15 different policy scenarios will effect the carbon dioxide emissions associated with housing between 2003 and 2026. Given a "business as usual" scenario in line with policies in the draft Regional Spatial Strategy (RSS), emissions from housing will increase overall by 8% by 2026.

- Retrofitting the existing housing stock is the single most important housing policy with regard to $CO_2$ reductions – on a per household basis as well as in reducing long-term overall emissions. The potential net carbon savings are between 19% and 39% compared to business as usual.

- A better market transformation with homes built to the "Ecohomes excellent" standard, in combination with an increased demolition rate, is important to slow the increase of carbon emissions under the RSS policy.

- Most scenarios will achieve a certain degree of energy efficiency on a per household or per person basis, but only the scenarios which focus on retrofit or a combination of measures (regulatory efficiency improvements, increase of renewables, faster transformation with Ecohomes and implementation of retrofit measures) will achieve long-term energy conservation and subsequent $CO_2$ reductions.

- Scenarios using a combination of all these options can deliver "Factor 2" energy reductions. Within these scenarios, retrofitting can achieve the lion's share of energy savings. Over time, the combined scenarios can save up to 43 mt of $CO_2$ compared to the business as usual scenario.

- The study shows how REAP can provide the necessary evidence to inform better policy options towards reducing energy use, reducing emissions, and for using renewable energy sources.

# 1 Introduction

This report demonstrates how the Resources and Energy Analysis Programme (REAP), can be used in the process of developing regional and sub-regional planning guidance. The report focuses on the environmental pressures associated with housing in the Leeds City Region (LCR), and the evidence provided is intended to inform the Examination in Public (EiP), of the Yorkshire and Humber draft Regional Spatial Strategy (RSS). The report was commissioned by the Environment Agency with WWF on behalf of the Yorkshire and Humber Environment Forum.

The Leeds City Region (LCR) contains the districts of Bradford, Leeds, Wakefield, Calderdale, Kirklees, Selby, Barnsley and the unitary authority of York in their entirety. It also includes the Southern parts of Craven and Harrogate districts. REAP can provide information down to the local authority area level but is restricted to modelling districts in their entirety. For this reason the results and scenarios presented in this report take into account the whole of Craven and Harrogate Districts.

This report comes in 3 parts. *Part 1* provides an overview of housing projections in Leeds City Region and the role of Planning Policy Statements 1 and 11 in assessing the RSS's soundness. This is followed by a description of REAP and how it can be used to develop policy scenarios at the regional and sub-regional level. *Part 2* provides a baseline summary of the Ecological Footprint and $CO_2$ emissions for the Yorkshire and Humber Region and the Leeds City-Region broken down by local authority area. This is followed by a set of REAP generated comparative housing scenarios based on Leeds City Region RRS housing figures. *Part 3* draws together conclusions and explains how the REAP methodology could be used to further inform the evidence base in the future. This report was undertaken as a rapid review rather than an all encompassing study and the issues covered here can be explored at a greater level of detail. It is hoped that opportunities will arise for this to happen in the future.

As part of this report the Environment Agency have been provided with a REAP support spreadsheet. This can be used to model alternative housing scenarios in the Leeds City Region and can be adapted for other regions and sub-regions in the UK using data from REAP. An overview of the variables that can be changed to create scenarios through the model is provided in part 2 of the report.

# 2 Overall context

Addressing climate change and resource use is central to the core approach of the draft Yorkshire and Humber Regional Spatial Strategy (RSS). YH2 of the RSS states that 'all plans, strategies, investment decisions and programmes' should help to meet the Region's target to reduce greenhouse gas emissions by at least 20% below 1990 levels by 2010 and 25% below 1990 levels by 2015. These are ambitious targets but as the RSS also acknowledges, climate change has 'potentially devastating consequences to the global environment, and poses a significant threat to social cohesion and economic systems'[1].

The challenge of reducing carbon dioxide emissions is made all the more stark when progress in the region so far is taken into account. Looking purely at territorial – or producer – greenhouse gas emissions[2], a study by Cambridge Econometrics has shown that they reduced by 6.8% between 1990 and 2001. Since 2003 however emissions have significantly increased due to changes in the energy market[3] .

Another way of measuring greenhouse gas emissions is by end user; this enables us to look at emissions arising from consumption activities related to goods and services, transport, housing and energy use. This report takes this latter approach and uses the REAP methodology to look at the carbon dioxide emissions associated with housing projections alongside their Ecological Footprint.

## 2.1 RSS Housing projections and planning policy

Policies YH1 to YH9 in the draft RSS establish the Core Approach to spatial planning in the Yorkshire and Humber Region. The housing section of the RSS sets out operational priorities for managing the provision of new housing and provides local authority housing projections up to 2021.

The housing scenarios in this report run from 2003 to 2026. In 2003, the baseline year, there were 1,159,000 houses in Leeds City Region. Extrapolating RSS projections from 2021 to 2026 we can say that by 2026 there will be a further 248,500 houses. This brings the total housing stock in the City Region to 1,407,500 in 2026.

[1] See the Core Approach section of the December 2005 Draft RSS. Available at: http://www.yhassembly.gov.uk/index_library.cfm?routine=content&channel=Document%20Library

[2] Territorial or producer emissions include the emissions from goods and services produced in the region even if those goods and services are consumed elsewhere.

[3] Climate change fact sheet. http://www.yorkshirefutures.com

The RSS housing projections are based on 2003 ONS population projections converted into households with economic forecast B for the RSS taken into consideration from 2016 onwards. Since these figures were published the Department of Communities and Local Government (DCLG), has published its 2003 housing projections up to 2026, these provide different projections for the absolute number of households to the RSS. Although there is a disparity in these figures we cannot say that one projection is right and the other wrong, we just have to be aware that there is an inherent uncertainty in projections, forecasts and scenario development. This is an uncertainty which affects economic forecasting models as much as those that provide environmental scenarios. REAP scenarios are flexible from this perspective as the user can choose the housing figures they are most comfortable with. In this report we have used the projections from the RSS but these can be replaced by DCLG figures using the REAP support spreadsheet.

Regardless of the projections used it is important for decision-makers to be able to understand and take into account the environmental impacts associated with additional housing. This can be expressed in terms of the environmental impact per household or – in this case - the total impact of housing in Leeds City Region. It is important to consider these together because even when the environmental impact per household goes down, the total environmental impact caused by additional housing can go up.

Planning Policy Guidance in the UK makes it clear that issues of this nature should be considered during the RSS development process. Planning Policy Statement (PPS) 11 sets out a number of criteria for assessing the soundness of an RSS:

- whether it is consistent with national planning policy and if not whether the case has been adequately made for departing from national policy
- whether the policies are consistent with one another
- whether it is founded on robust and credible evidence

In addition PPS1: Delivering Sustainable Development requires that:

*"development plans contribute to global sustainability by addressing the causes and potential impacts of climate change – through policies that reduce energy use, reduce emissions…promote the development of renewable energy sources, and take climate change impacts into account in the location of design and development"*

The December 2005 Sustainability Appraisal of the Draft RSS provides a qualitaive assessment of SA/SEA objectives. It describes how climate change and resource use is dealt with in the draft RSS as a core strategic approach and is given a strong symbolic importance. In contrast the housing componant of the RSS does not directly address climate change or global sustainability. There is

no mention in this section of policies which reduce energy use, reduce emissions or promote the development of renewable energy resources. The last two of these are dealt with in the draft RSS chapter on energy but there is no stated consideration of the additonal environmental impacts associated with housing projections.

Although housing policies in the RSS do not explicitly address the environmental impact per household or total environmental impact of housing this does not mean that robust and credible evidence is unavailable to make this happen. The following section demonstrates how quantative evidence based on REAP methodologies can be used to explore these issues at the regional and sub-regional level.

## 2.2 Using REAP to develop policy scenarios

Designed by SEI with CURE and WWF, REAP's powerful scenario tool models the impacts of policy and creates plausable scenarios of the future. These scenarios can be set against targets or compared to alternative futures based on selected trends or assumptions. For housing policy it is possible to explore the impact of intoducing policies that reduce energy use, reduce emissions and promote the development of renewable energy sources. This impact can be expressed in carbon dioxide emissions or by using the Ecological Footprint.

*Carbon Dioxide emissions*

REAP can be used to calculate all greenhouse gases associated with our consumption activities, including Carbon dioxide ($CO_2$), Methane and Nitrous oxide. Though its effect is not as intense per tonne emitted as some other greenhouse gases, $CO_2$ is the most significant of any greenhouse gas in terms of total tonnes emitted and in terms of its total effect on the global climate. It is therefore a useful indicator of the potential impacts of housing on climate change and on the environmental component of global sustainability.

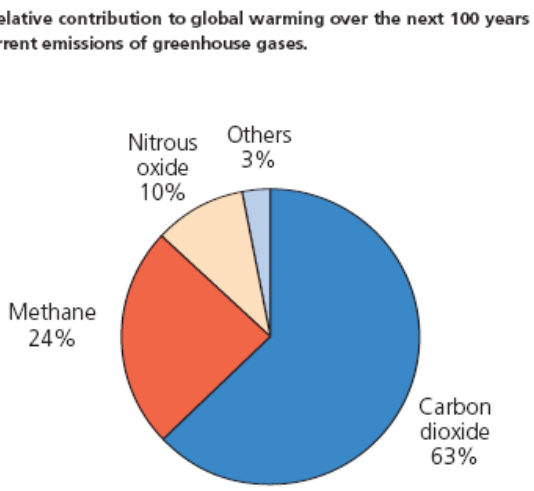


**Figure 1.** Contributions to global warming. Source: Climate Change Programme Review 2006

Most tools measure the $CO_2$ emitted from production and direct fuel processes within a given region – this approach is called producer, or territorial responsibility. REAP provides an alternative measure by calculating the $CO_2$ emissions from consumption. This takes into account the direct and indirect emissions related to the consumption of products and services throughout the economic supply chain. In this study the $CO_2$ emissions associated with housing include those produced during the construction, use and maintance of households.

*The Ecological Footprint*

The Ecological Footprint is a calculation method that estimates the demand of human activities on nature. It measures the resources consumed by a population and the balance between human demand and nature's supply. At the moment, REAP can calculate the current and potential Ecological Footprint for the U.K. as a whole, at the regional and devolved county level, or for every local authority.

The Footprint calculates how much productive land and sea is needed to provide the energy, food and materials we use in our everyday lives, and how much land is required to absorb our waste. It also calculates the emissions generated from the oil, coal and gas we burn, and determines how much land is required to absorb them.

Ecological Footprints are calculated in "global hectares." A global hectare is one hectare (2.47 acres) of biologically productive space with world-average productivity (since some areas are more biologically productive than others). Standardized global hectares make the Ecological Footprint comparable between

different regions and countries, regardless of where on the globe their resources are harvested. This standardization is an important element of REAP, which can compare The Ecological Footprints of different U.K. local authorities, regions and devolved countries with those at the national level.

*The REAP methodology*

*"All models are wrong but some models are useful" William Deming*

The information REAP provides is a simplification of the complex interactions that take place in the economy. REAP should not be used as the sole source of information when developing policy or making decisions. It provides standardized, quantified results that have many applications to policy but it does not provide the last word. There is no difference here between REAP and any econometric forecasting model used by policy makers to predict population, housing or changes in GDP; no model can provide a complete picture of real life

The strength of REAP is that it uses the best available methods and applies them at a greater level of detail than has been done before. This means it is possible to use REAP to calculate all greenhouse gas emissions and the Ecological Footprint by:

- Economic sector (agriculture, food processing, textiles etc)
- Final demand category (private household, central government etc)
- Consumption category by household (food, clothing, transport etc)
- National, regional and local area
- Socioeconomic group

The basic methodology underpinning REAP combines existing Material Flow Accounts (MFA), National Environment Accounts and National Footprint Accounts (NFA) with input-output analysis. Environmental input-output analysis is a well established approach that makes it possible to track and assign intermediate resource flows to consumption categories. This is important because industries trade resources with each other in the process of producing goods and services and we need to be able to track these 'indirect' or 'offsite' impacts as well as those associated by the 'direct' or 'onsite' use of resources. The total impact of the resources used can then be assigned to a product or service and, ultimately, to the consumer. Within REAP Material flows (MF), Greenhouse Gasses and Ecological Footprints (EF) are allocated to detailed household consumption activities using the United Nations COICOP classification system and detailed household expenditure data.

The strength of this approach is that it addresses production and consumption processes and their underlying technical, social and behavioral drivers simultaneously. The indicators that REAP produces illustrate the impacts

associated with our consumption activities but the methodology used makes it possible to track product groups through every stage of their lifecycle.

*Using Econometric models in the Region*

Most Regions in the UK make use of some degree of econometric modelling. In Yorkshire and Humber the Regional Econometric Model (REM) has been developed for Yorkshire Futures by Experian Business Strategies Ltd (EBSL). The table below provides a summary of the similarities and differences between REAP and REM. This should not be seen as a direct comparison as the models are used for different purposes. It does however demonstrate that REAP is not out of place when considered alongside econometric tools.

| **Overview** | **REM**[4] | **REAP** |
|---|---|---|
| **Context** | Provides a consistant view of regional, sub regional and local economies and their sectoral relationships | Provides a consistant view of regional, sub regional and local economies and their sectoral relationships |
| | Provides a view of the Yorkshire economy grounded with national/international "macro" economic developments | Provides a view of the environmental impact of consumption patterns within Yorkshire and Humber broken down by 59 COICOP Consumption categories |
| **Baseline updates** | Updated twice a year | Updated once a year |
| | Sub regional and local forecasts constrained to the Integrated Regional Sectoral Model (IRSM) | Update function allows for up to 73 individual variables to be updated if specific local information is available |
| | Every 5 years supply chain relationships are updated nationally. The most up-to-date national data publically available is for 1995 | Supply chain relationships updated every year. SEI produced its own supply chain relatonships for 2000 with support from Cambridge Econometrics. In 2007 REAP will use 2003 data |
| **Scenario modelling** | Can alter the baseline estimates through variation in sectoral job numbers. Allows creation of separates set of baseline forecasts which can be compared with central view going forward. | Can create baseline transport, energy and food scenarios and create alternatives using regional, national or local trends or assumptions made by the user. Will be able to alter waste and housing in near future. |
| **Availability** | REM is currently available to members of the Yorkshire Futures network on a subscription basis. Different parts of the draft RSS use different REM generated scenarios | REAP was launched in March 2006 and is available to every Region in England through SCP-NET. Version 0.9 Beta is currently available, Version 1 will be available by the end of the year |

**Table 1.** Overview of REM and REAP

[4] Commentary adapted from 'Overview of the Regional Econometric Model', a Yorkshire Forward presentation by the Chief Economist Unit

# 3. Results

## 3.1 Leeds City Region Baseline Ecological Footprint and Carbon dioxide emissions

Using the most up-to-data National Accounts available[5] through REAP the Ecological Footprint of Yorkshire and Humber is **5.25 global hectares per capita (gha/cap)**[6], and the $CO_2$ emissions from consumption are **11.36 tonnes per capita (t/cap)**.

In both cases the results for Leeds City Region are marginally higher; the Ecological Footprint is **5.28 gha/cap** and the $CO_2$ emissions are **11.42 t/cap.** The inclusion of Harrogate and Craven in their entirety will have increased the averages for Leeds City Region because they have the highest $CO_2$ emissions and Ecological Footprint in the City Region (see figure 2 below).

:

- **19%** of the total Ecological Footprint of Leeds City Region was accounted for by housing
- **23%** of the total carbon dioxide emissions attributed to Leeds City Region was accounted for by housing

**Figure 2.** Housing accounts for a significant proportion of the Ecological Footprint and carbon dioxide emissions in Leeds City Region in 2003

[5] This Report uses 2001 National Footprint Accounts entered into REAP. Counting Consumption UK and the freely available SEI standard reports at www.sei.se/reap use 2000 National Footprint accounts

[6] Gha/cap stands for Global Hectares per capita; per capita means per person. A global hectare is the same size as a normal hectare but the number required is adjusted to take account of average world productivity

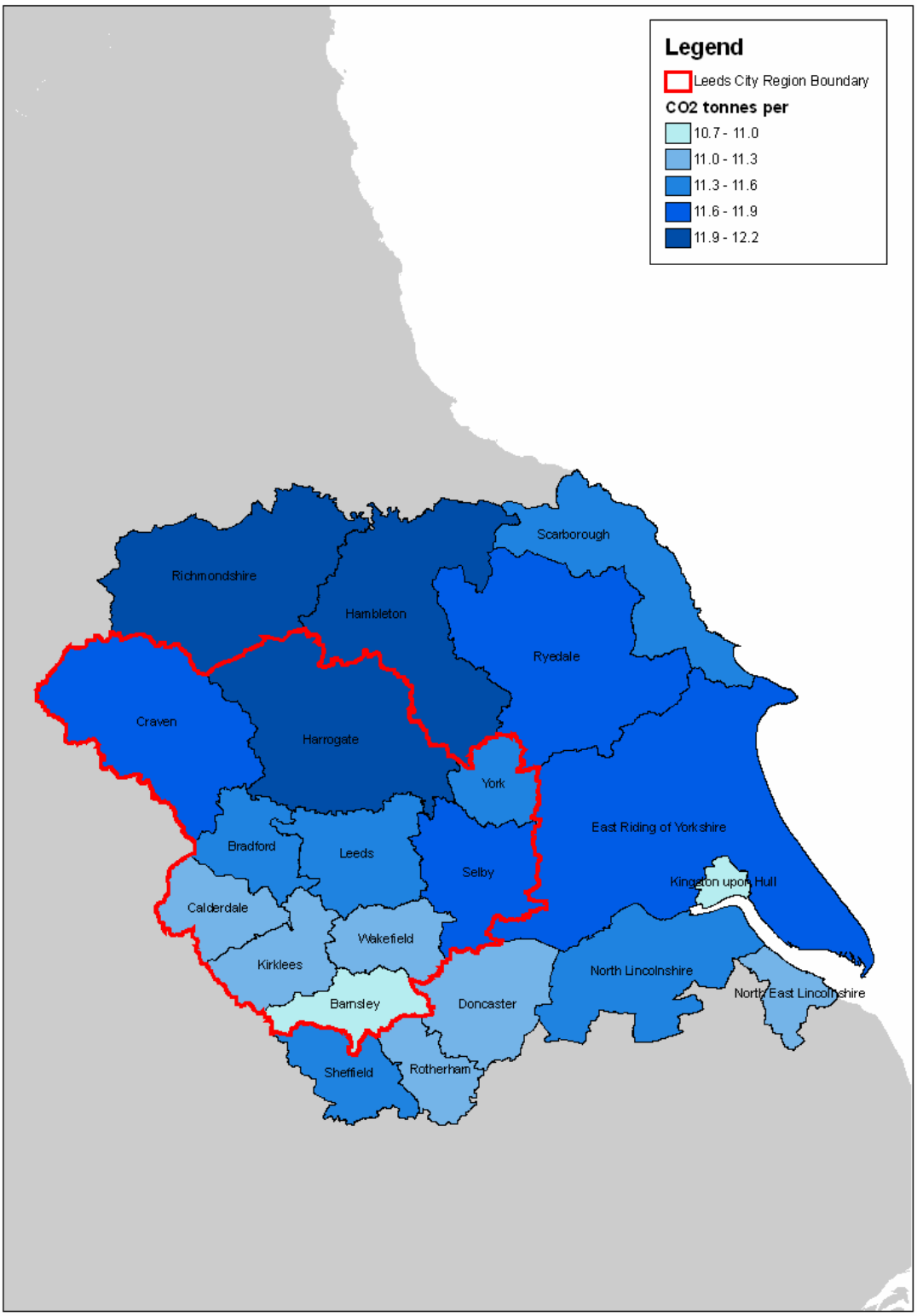


**Figure 3.** Carbon dioxide emissions in tonnes per capita and by local authority area in Yorkshire and Humber

### 3.2 Modelling REAP housing scenarios

The following set of scenarios explores the impact of housing on total carbon dioxide emissions in Leeds City Region. The REAP Housing spreadsheet also provides the results for the Ecological Footprint.

*Variables and general assumptions*

The baseline year for all scenarios is 2003; each scenario is modelled up to 2026

Within the REAP housing spreadsheet it is possible to model the impact of housing related policies by including 5 core variables.

1. **Demolition rate of existing houses.** It is assumed that when a house is demolished it has the average energy efficiency performance of existing houses.

2. **Introduction of "Ecohomes"** (energy efficiency of new build)**.** This is based on the percentage of new build that is built to the "Ecohomes excellent" standards. It is assumed that a home built to Ecohomes excellent standards is always 30% more energy efficient than the specifications in the UK building regulations for new houses.

3. **Retrofit of existing houses.** The RSS places a strong focus on the provision of new housing. However, from a sustainability and climate change perspective it is equally important to consider the environmental impacts from the existing housing stock (pre-2003). This study presumes average energy efficiencies for typical UK dwellings. The retrofit options considered in the retrofit scenarios are:

   Reduce heating by 2 $^{o}$C, loft and cavity wall insulation, draught stripping, double glazing, flow and hot water tank insulation, gas and central heating controls, condensing boilers, behavioural change – taking a shower instead of a bath

4. **Effectiveness of Building regulations for new houses.** This takes into account how building regulations affect the energy efficiency on new houses over time.

5. **Electricity mix.** This variable changes the mix of renewable, gas, coal, oil and nuclear power used by households. The projection used in each scenario is provided under the sub-heading 'assumptions'.

Projected occupancy rates based on regional DCLG figures are used in all scenarios but are not changed in the scenarios in this report.

## *Description of scenarios*

In total, 15 scenarios have been created for the Leeds City Region; those highlighted in yellow are presented on the following pages. These cover the full range of policy scenarios and include 'business as usual', 'plausible' and 'aspirational' policy interventions.

The assumptions used are listed with each scenario that has been presented. Where appropriate the scenarios that are not presented in this report are referred to and explained

| Scenario | Description |
|---|---|
| BL I * | BAU[7] baseline scenario |
| BL II | 3% p.a. "natural" energy efficiency improvements |
| A1 * | Gradual introduction Ecohomes (5% p.a.) |
| A2 | Ecohomes 100% as of 2010 |
| B1 | Increase demolition rate |
| B2 | Demolition increased & Ecohomes |
| C1 * | Retrofit "HECA" |
| C2 * | Retrofit "current ambitious" potential (-42% by 2026) |
| C3 | Retrofit Factor 2 by 2026 (-50%) |
| D1 * | UK renewables target gas favoured |
| D2 | UK renewables target gas &coal |
| D3 | EU renewables target gas &coal |
| D4 | EU renewables target gas favoured |
| E1 * | Combined "plausible" |
| E2 * | Combined "aspirational" |
| | |

**Table 2.** Description of scenarios

[7] Business as usual

## *Business as usual scenario (BL I)*

Under the Business as usual scenario assumptions are based on existing national and regional targets and policies (see below).

### Headline Results

- Between 2003 and 2026, the total number of residential dwellings in the LCR will emit around 181 million tonnes (mt) of $CO_2$.

- Carbon dioxide emissions in 2026 will be 8% higher than in 2003 due to the overall increase in housing stock, and with the additional carbon emissions mainly coming from the new houses built to "typical" UK standards.

- $CO_2$ Emissions in tonnes (t) per household are 11% lower in 2026 than in 2003 due to energy efficiency improvements in new homes.

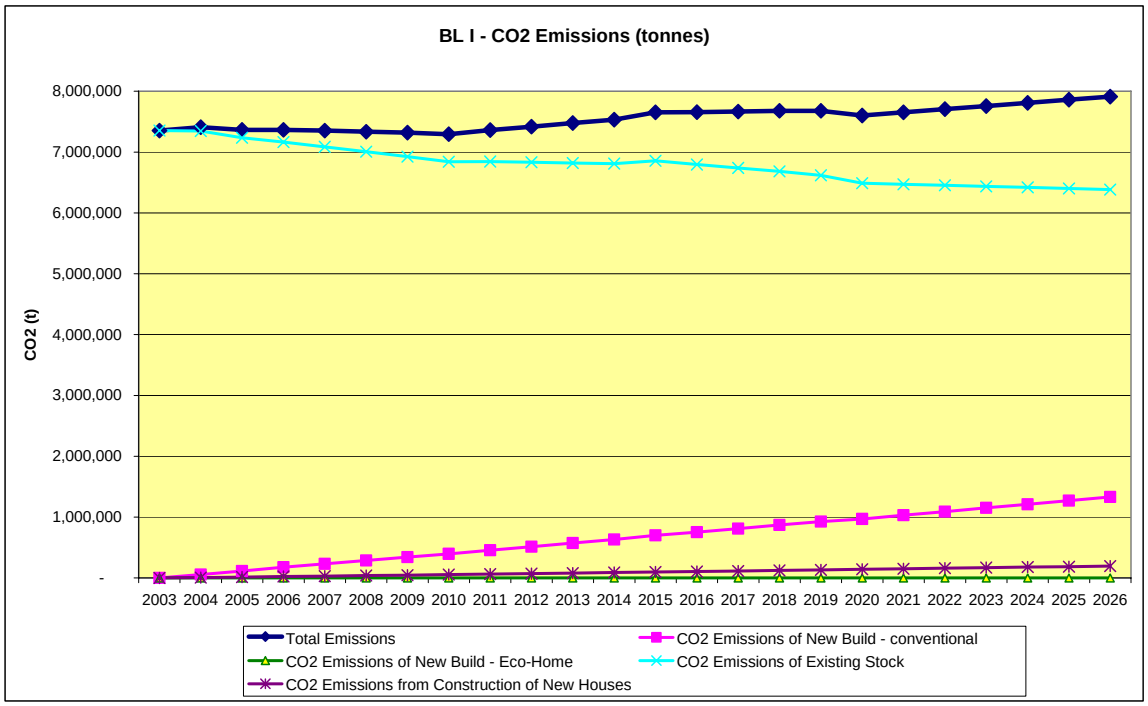


**Figure 4.** Business as Usual scenario

**Assumptions**

- **Demolition rate of existing houses**: Demolition of 1390 houses per year based on sub-regional Draft RSS projections.

- **Retrofit of existing houses**: Increased energy efficiency through passive design in line with target SAP rating of 65 by 2016 for all stock in the LCR. This trend is presumed to continue to 2026.

- **Energy efficiency of new build**: There is no requirement for Eco-home excellent standards in the Draft RSS, consequently no new homes are built to this standard.

- **Effectiveness of Building regulations for new houses**: National building regulations will improve the energy efficiency of new houses over time. Overall we assume a 2% improvement by 2026.

- **Electricity mix:** National projections based on DTI (2006), with 9% of electricity supplied by renewable sources in 2010, and 14% by 2026.

**Commentary**

Building regulations provide a design standard for new housing rather than an actual performance standard. This means that on average only two thirds of new buildings comply with building regulations for energy efficiency (EST 2004[8]). In the baseline scenario this is reflected in only a small improvement in the energy efficiency of new houses by 2026. Higher compliance of new building stock to energy efficiency regulations could lead to energy efficiency improvements of 3-5% a year. If current building regulations were met, resulting in efficiency improvements of around 3% per year, then

- Emissions from the housing stock in 2026 are 1% lower in 2026 than in 2003.

- In 2026, houses are 19% more efficient than today.

The 3% improvement is modelled in the scenario BLII which is not represented here. Unless otherwise mentioned BLI assumptions are used in the following scenarios.

## *Eco-homes Excellent Scenario (A1)*

[8] Energy Saving Trust (2004). Assessment of energy efficiency impact of building regulations compliance. Client report no 219683.

## Headline Results

- Between 2003 and 2026, the total number of residential dwellings in the LCR will emit around 178 million tonnes (mt) of $CO_2$, 2% less than in the Baseline scenario.

- Carbon dioxide emissions from housing stock in 2026 will be 2% higher than in 2003

- $CO_2$ Emissions in tonnes (t) per household are 16% lower in 2026 than in 2003. These improvements are explained by the gradual introduction new houses which meet Ecohomes excellent standards for energy efficiency.

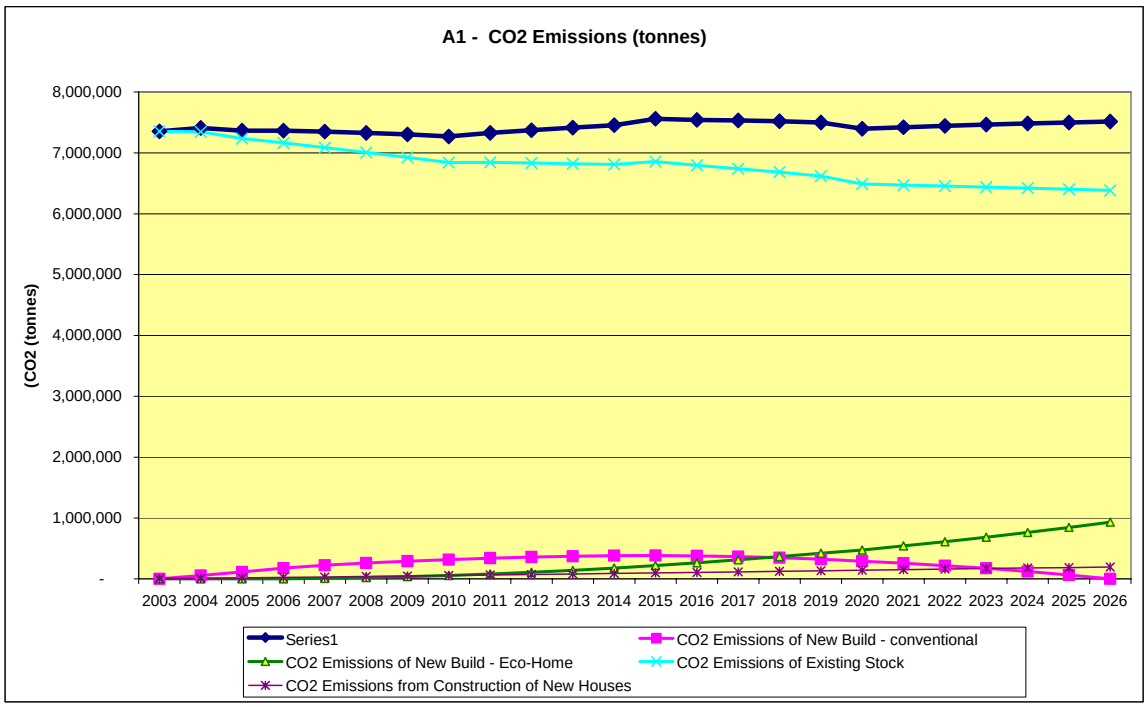


**Figure 5.** Scenario A1, gradual introduction of Ecohomes standard

## Assumptions

Energy efficiency of new build: In this scenario there is a 5% annual increase in new housing is built to Eco-home excellent standards from 2007. By 2026, 100% of new housing is built to eco-home excellent standards. All other variables are the same as in the baseline scenario.

## *Retrofit scenario (C1)*

Local authority HECA[9] data in Leeds City Region shows that a mix of energy efficiency measures in existing housing stock has improved their energy efficiency by 1.65% a year. Continuing the facilitation of these measures and assuming the same energy efficiency improvement per year gives us the following results.

**Headline Results**

- Between 2003 and 2026, the total number of residential dwellings in the LCR will emit around 168 million tonnes (mt) of $CO_2$. This is 7% less than in the BAU scenario

- Total Carbon dioxide emissions from housing stock in 2026 will be 12% lower than in 2003

- $CO_2$ Emissions in tonnes (t) per household are 27% lower in 2026 than in 2003.

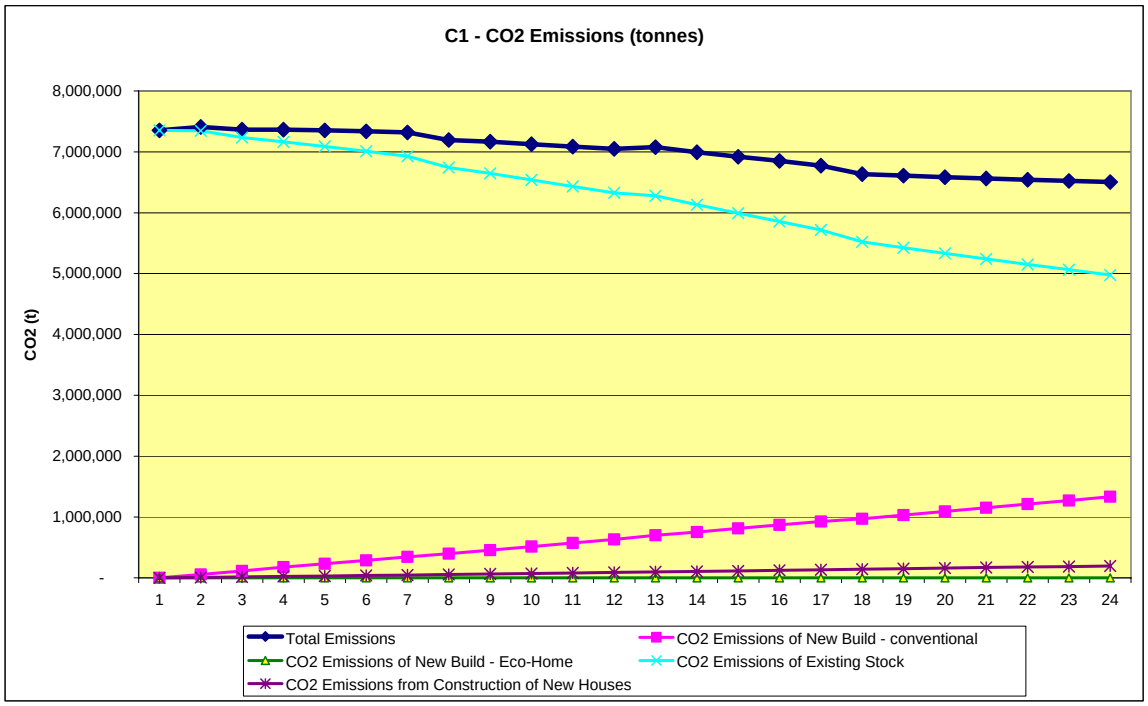


**Figure 6.** C1 Retrofit scenario based on HECA data

[9] HECA stands for the Home Energy Efficiency Conservation Act. It required every UK local authority with housing responsibilities - "energy conservation authorities" - to prepare, publish and submit to the Secretary of State an energy conservation report identifying practicable and cost-effective measures to significantly improve the energy efficiency of all residential accommodation in their area; and to report on progress made in implementing the measures. For more information see: http://www.defra.gov.uk/environment/energy/heca95/index.htm

## *Retrofit scenario (C2)*

### Headline Results

- Between 2003 and 2026, the total number of residential dwellings in the LCR will emit around 140 million tonnes (mt) of $CO_2$. This is 13% less than in the BAU scenario

- Total Carbon dioxide emissions from housing in 2026 will be 27% lower than in 2003

- $CO_2$ Emissions in tonnes (t) per household are 40% lower in 2026 than in 2003.

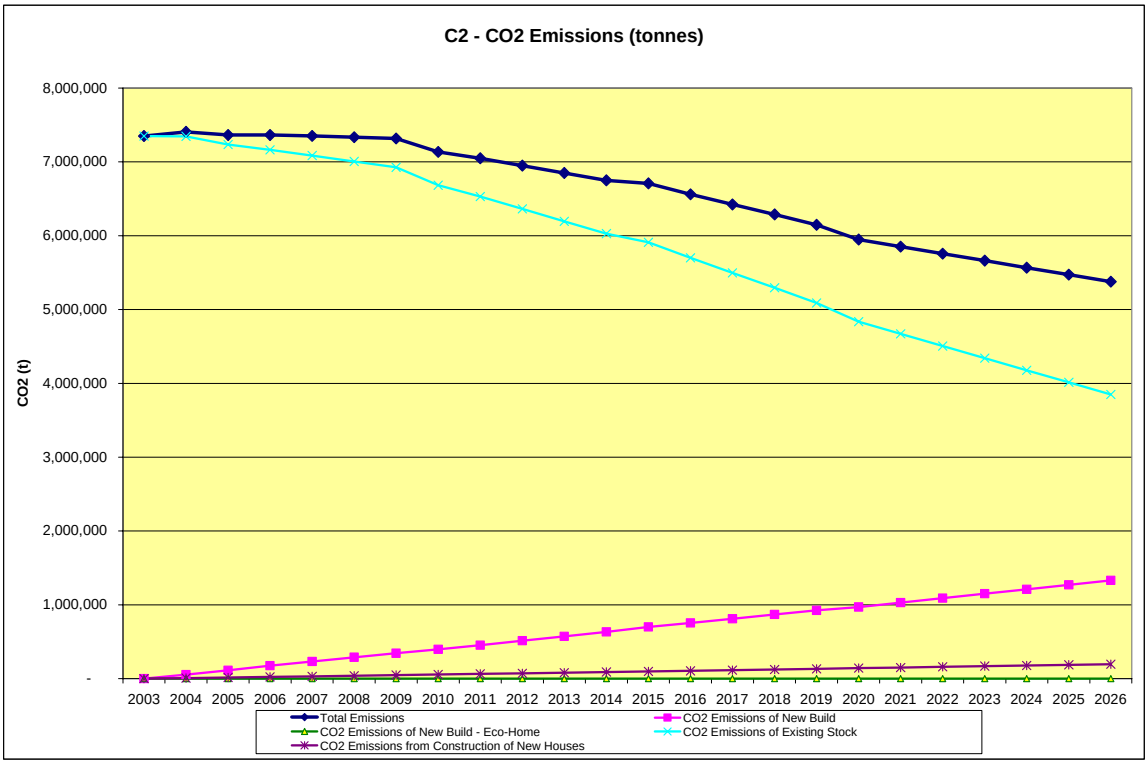


**Figure 7.** Scenario C2, retrofit exploiting available present retrofit options

### Assumptions

**Retrofit of existing houses:** We assume that an energy efficiency improvement of 42% can be achieved in all existing housing by 2026. This is an annual energy efficiency improvement of 2.4% beginning in 2010. A Factor 2 scenario (C3)

would improve energy efficiency per household by 50% over the time period (an annual increase of 3%). The results for this are shown in table 3.

## *Electricity mix scenario D1 (UK renewable targets)*

### Headline Results

- Between 2003 and 2026, the total number of residential dwellings in the LCR will emit around 180 million tonnes (mt) of $CO_2$. This is 1% less than in the BAU scenario

- Total Carbon dioxide emissions from housing in 2026 will be 4% higher than in 2003

- $CO_2$ Emissions in tonnes (t) per household are 14% lower in 2026 than in 2003

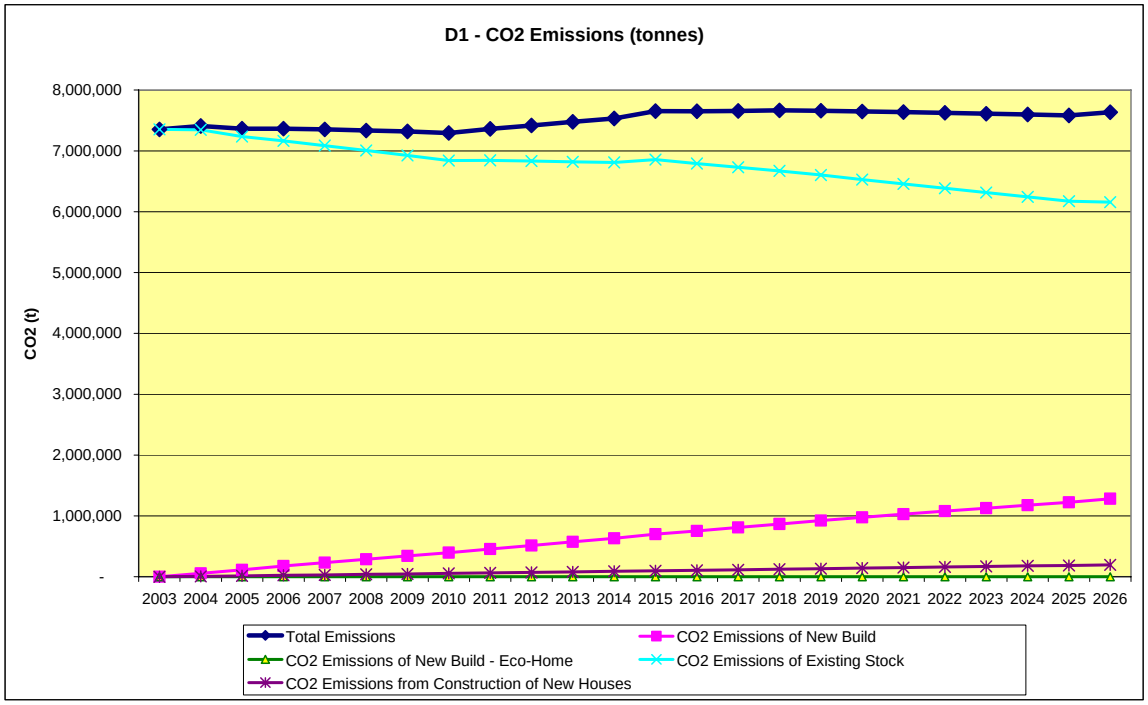


**Figure 8.** Scenario D1, UK renewable targets

### Assumptions

**Electricity mix:** a slight increase in renewable energy from the projections in the baseline scenario, with 10% coming from renewables in 2010 and 20% in 2020 based on RSS and UK targets. In this scenario there is a gas rather than coal favoured electricity mix. All other variables are as in baseline scenario.

## *Combined scenario E1 ("aspirational")*

### Headline Results

- Between 2003 and 2026, the total number of residential dwellings in the LCR will emit around 138 million tonnes (mt) of $CO_2$. This is 24% less than in the BAU scenario

- Total Carbon dioxide emissions from housing in 2026 will be 50% lower than in 2003

- $CO_2$ Emissions in tonnes (t) per household are 56% lower in 2026 than in 2003

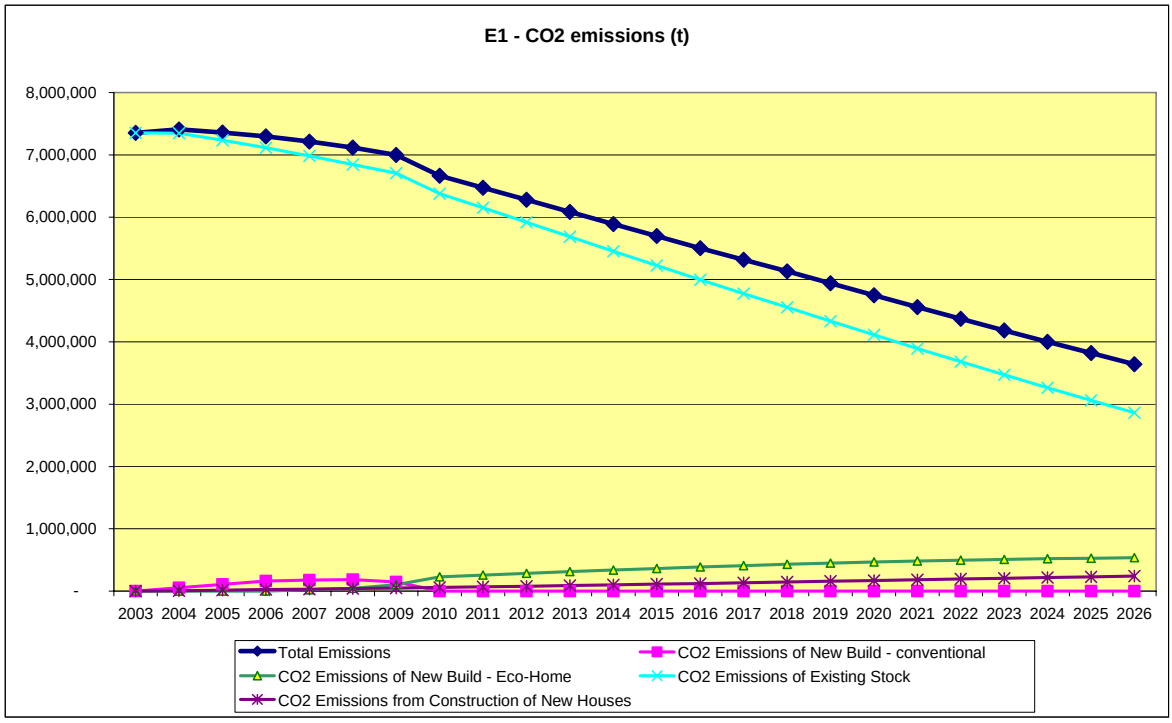


**Figure 9.** Scenario E1 "aspirational"

**Assumptions**:

This scenario brings together the most effective individual policy options from the 15 scenarios modelled. This means that:

- **Enforced building regulations** achieve a 3% improvement in energy efficiency in new homes per year.
- **100% of new homes are built to "Ecohomes excellent**" standard by 2010.
- **There is an increased demolition** rate from 1390 to 5560 houses by 2026.

- **EU renewable energy targets** are met (20% by 2010, 25% by 2020 and assuming 30% by 2026 with gas favoured co-fuels).

## *Combined scenario E2 ("plausible")*

### Headline Results

- Between 2003 and 2026, the total number of residential dwellings in the LCR will emit around 149 million tonnes (mt) of $CO_2$. This is 18% less than in the BAU scenario

- Total Carbon dioxide emissions from housing in 2026 will be 41% lower than in 2003

- $CO_2$ Emissions in tonnes (t) per household are 52% lower in 2026 than in 2003

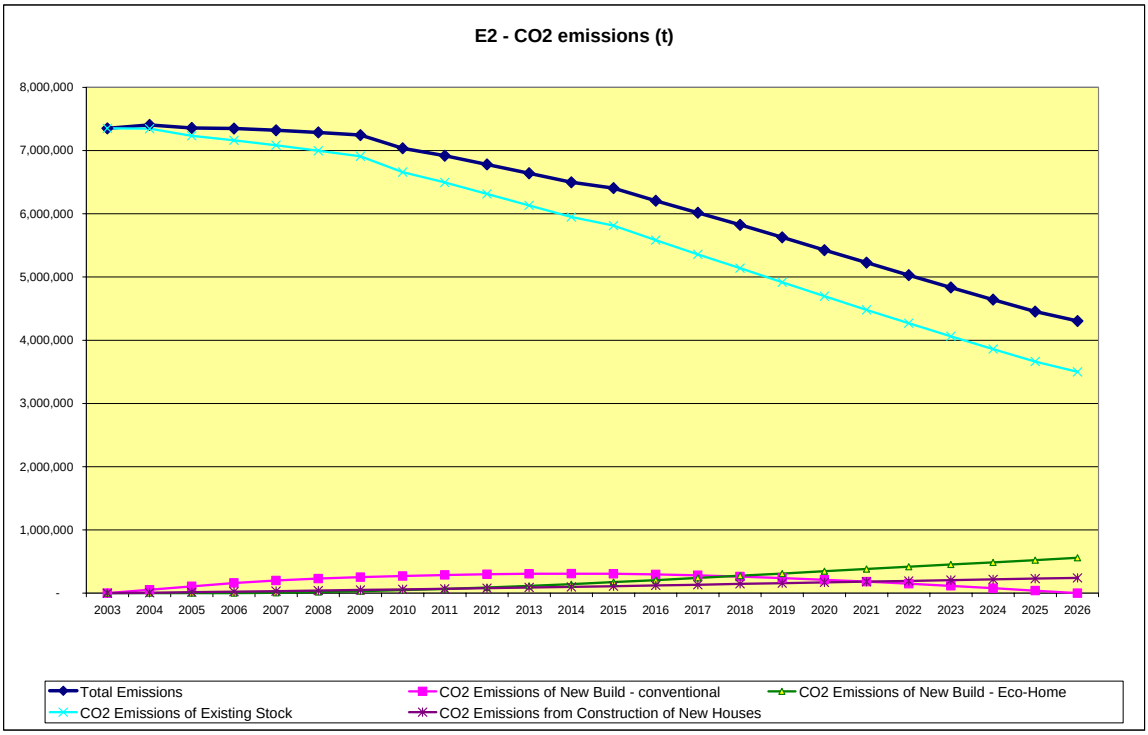


**Figure 10.** Scenario E2 ("plausible")

**Assumptions:**
In this scenario we assumed that the:

- **Application of building regulations**, result in annual efficiency gains of 3%.
- The number of "Ecohomes excellent" standard houses built increases by 5% per year.

- There is an increased demolition rate (400%) by 2016.
- **The full retrofit potential** described in scenario C2 is implemented.
- **UK /RSS renewable targets are met** and the remaining electricity mix is gas favoured

*Summary of scenarios*

Figure 11 shows the cumulative amount of carbon dioxide in tonnes emitted by the the total number of residential dwellings in the LCR between 2003 and 2026. This corresponds with the first headline bullet point for each scenario presented above. By implementing scenarios E1 or E2 by 2026 between 32 and 43 mt of carbon dioxide can be saved.

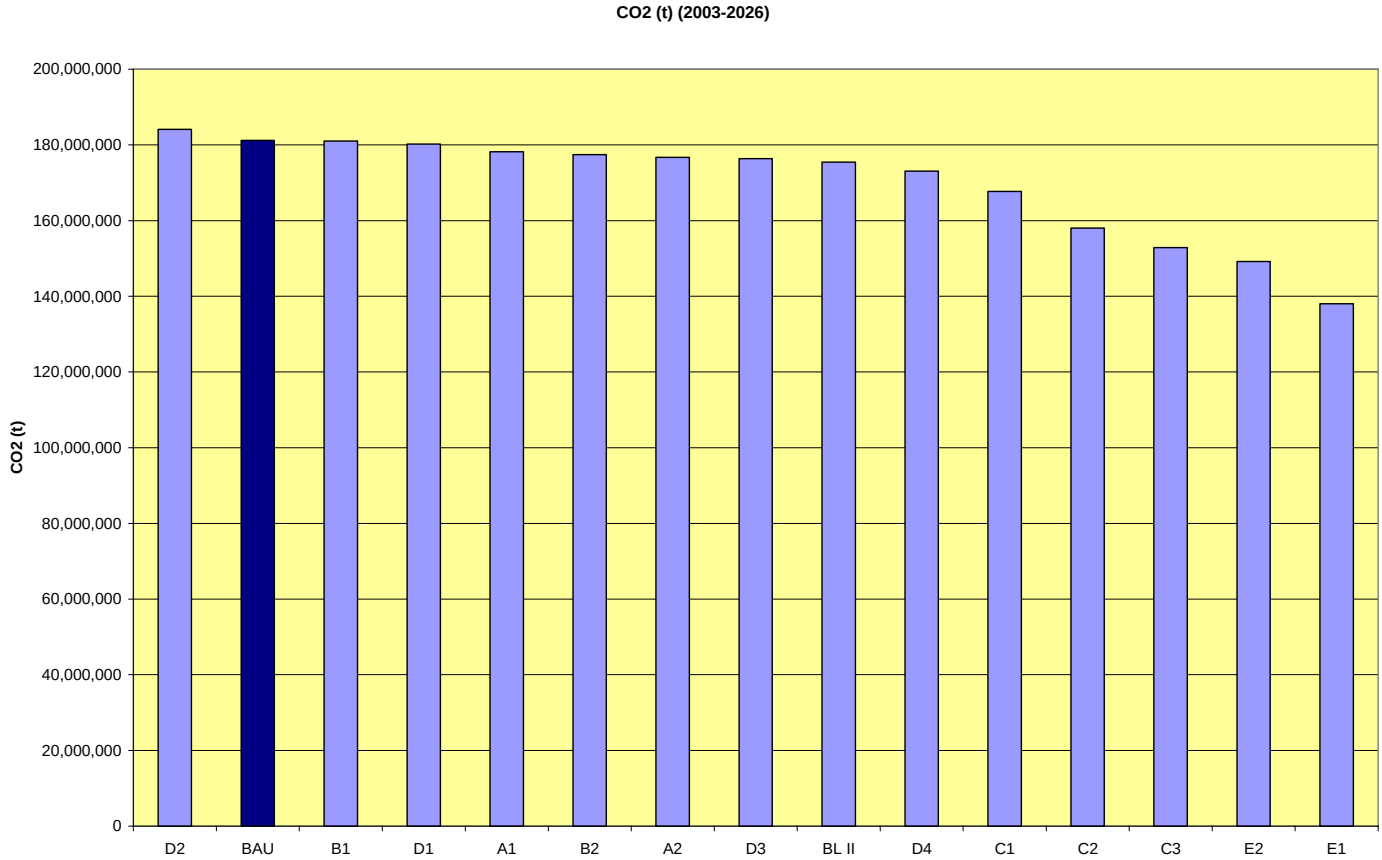


**Figure 11.** Cumulative $CO_2$ emissions 2003 – 2026. Retrofit scenarios (C) and the combined scenarios (E) achieve the most significant carbon savings.

Figure 12 shows the total amount of carbon dioxide emissions from housing in 2003 (shown as BL1 2003 in the graph), set against the total amount of carbon dioxide emissions from housing in 2026 for each separate scenario. This corresponds to the second headline bullet point for each scenario presented above.

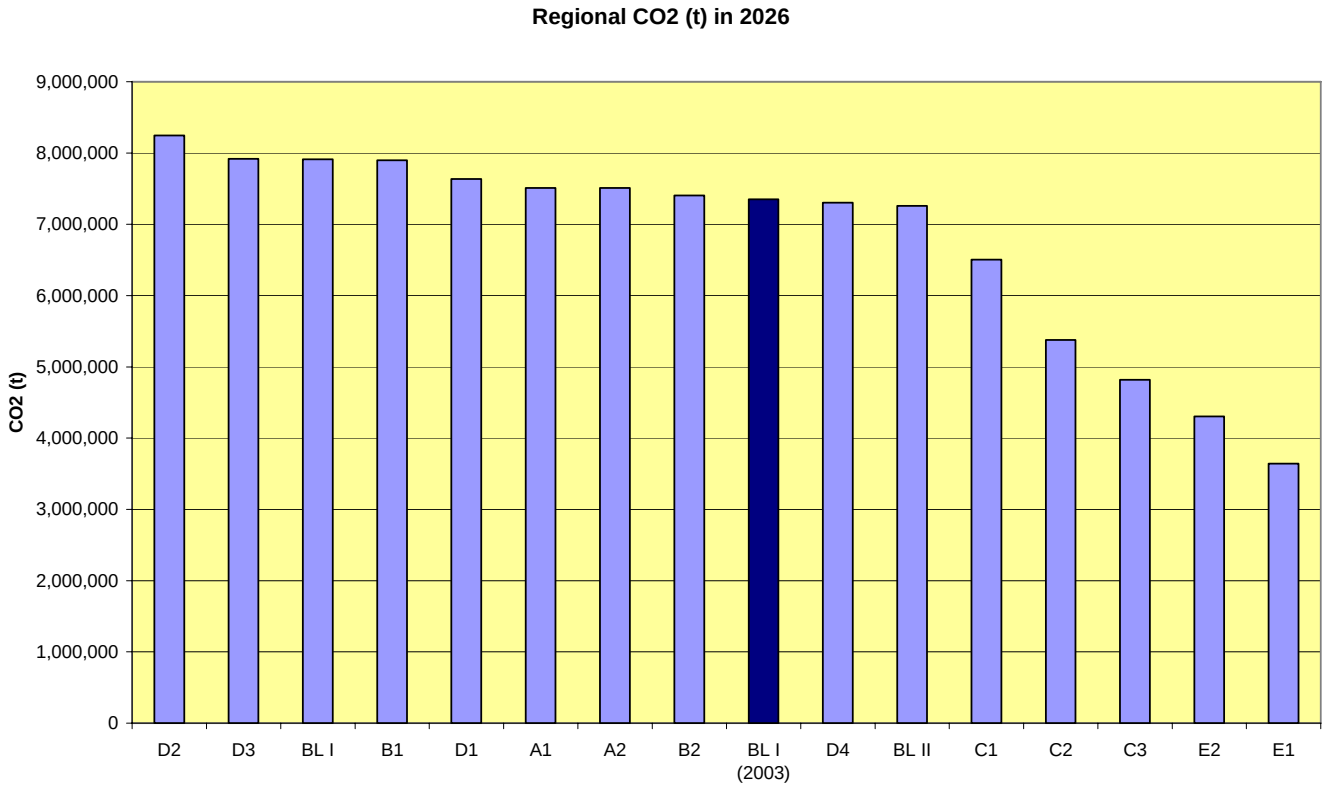


**Figure 12.** Comparison of $CO_2$ from total stock (2026 vs. 2003 baseline)

Table 3 ranks the scenarios according to the difference between total housing emissions in 2003 and 2026 for each scenario (stock change 2026 vs. 2003 in column 3 below). This again corresponds to the second headline bullet point in the scenarios presented above.

The Fourth column in table 2 – Net change from BAU in 2026 - shows the difference in carbon dioxide emissions between each scenario and BL1 in 2026.

| Ranked Scenarios | Description | Stock Change in 2026 vs. 2003 | Net change from BL1 in 2026 | |
|---|---|---|---|---|
| D2 | UK renewables target gas & coal | 112% | 4% | > BAU |
| D3 | EU renewables target gas & coal | 108% | 0% | = BAU |
| BL I | BAU | 108% | 0% | |
| B1 | Increase demolition rate | 107% | 0% | |
| D1 | UK renewables target, gas favoured | 104% | -3% | |
| A1 | Gradual intro Ecohomes (5% p.a.) | 102% | -5% | $CO_2$ growth slowed |
| A2 | Ecohomes 100% as of 2010 | 102% | -5% | |
| B2 | Demolish & Ecohomes | 101% | -6% | |
| D4 | EU renewables target, gas favoured | 99% | -8% | Efficiency gains outweigh overall increase in $CO_2$ |
| BL II | Enforced building regulations, 3% energy efficiency improvements per year | 99% | -8% | |
| C1 | Retrofit "HECA" | 88% | -18% | |

| | | | | |
|---|---|---|---|---|
| C2 | Retrofit "current ambitious" potential (-42% by 2026) | 73% | -32% | |
| C3 | Retrofit F2 by 2026 (-50%) | 66% | -39% | |
| E2 | Combined "plausible" | 59% | -46% | |
| E1 | Combined "aspirational" | 50% | -54% | |

**Table 3.** Scenarios and carbon dioxide savings

## *Combined results*

- Figure 13 shows the main scenario options “Ecohomes excellent” standard, “Renewables”, and “Retrofit” in comparison with the business as usual scenario.
- The retrofit scenario shown is an average of the 3 retrofit scenarios tested (C1-C3)
- The renewables scenario uses EU targets and a gas favoured electricity mix.
- As a single measure, the retrofit of existing housing can achieve the most significant net reductions against the BAU, between 19% and 39%.

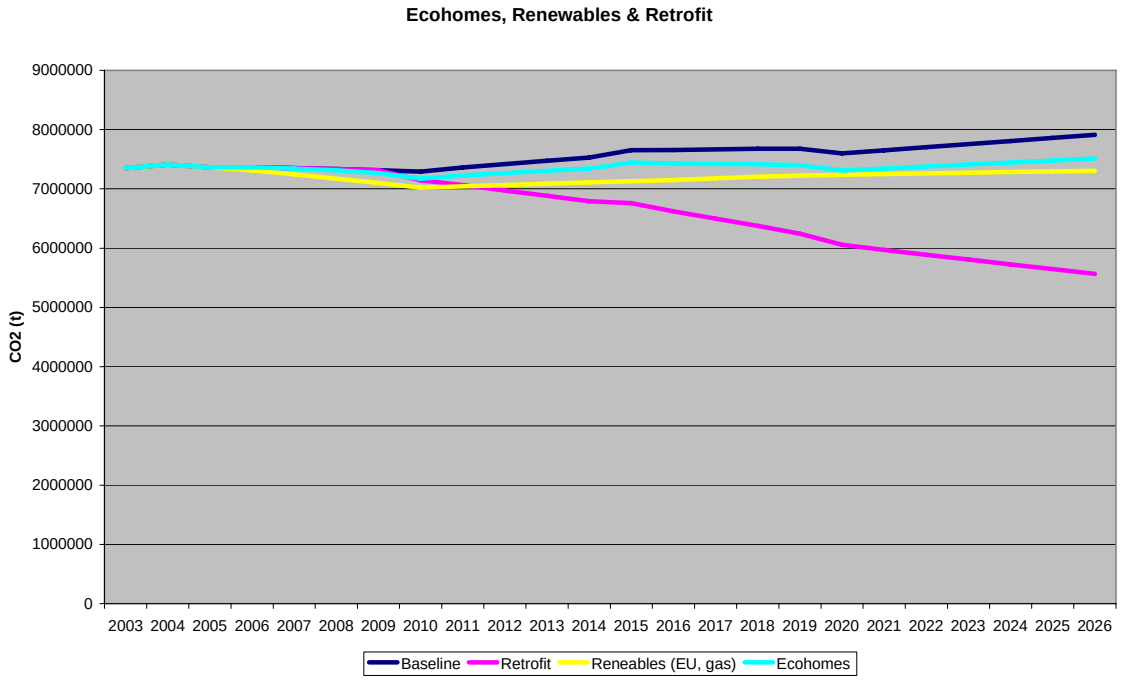


**Figure 13.** Retrofitting, renewables (EU, gas favoured) and "Ecohomes Excellent" compared to the business as usual scenario.

## *Commentary*

The scenarios presented in this report are intended to illustrate how housing and energy policy interventions can be tested for their effectiveness in mitigating carbon dioxide emissions. Although some scenarios are more aspirational than others the message presented by the "business as usual" scenario is clear: RSS housing projections could bring about an 8% increase in carbon dioxide emissions from housing by 2026.

For illustration purposes figure 10 below shows the business as usual scenario against the combined scenarios and what is required to reduce the carbon dioxide emissions associated with housing by 25% below 1990 levels by 2021[10].

[10] Targets in YH2 in the RSS include a reduction in greenhouse gases of 20% below 1990 levels by 2010, we have extrapolated this to aim for a reduction in CO2 emissions of around 30% below 1990 levels by 2021. Taking into account UK trends in carbon dioxide reduction we have assumed that $CO_2$ emissions are around 5% below 1990 levels. This gives us a target of 25% reduction in carbon dioxide emissions by 2021

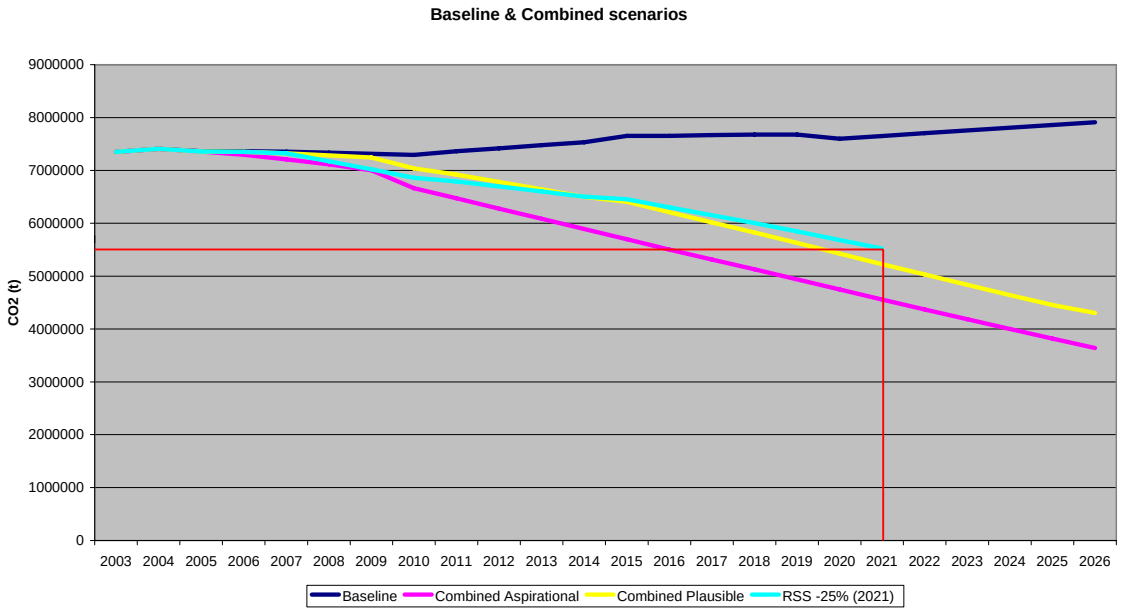


**Figure 14.** Scenarios E1 ("combined aspirational") and E2 ("combined plausible") compared to the RSS "business as usual" scenario. The two red lines indicate what would be required to meet a 25% reduction target by 2020

## 3. Lessons learnt

**This study shows that by using REAP it is quite possible to develop quantitative scenarios to inform our understanding of the environmental impacts associated with housing. The difficulty comes in modelling scenarios that achieve the balance between political plausibility and real progress towards environmental sustainability.**

In the development of any Regional Spatial Strategy there is room for debate on the extent to which policies can go beyond national guidance. Yorkshire and Humber has progressive renewable energy targets and the extent it can go beyond these is down to practical questions of capacity as well as political will. It is clear however that meeting these targets alone can not mitigate the increase in carbon dioxide emissions associated with an increase in housing. This places the emphasis on energy use and efficiency in existing and new housing.

Currently, energy use in existing homes is tackled through the Regional Housing Strategy but there is no real consideration in the draft RSS of how the additional burden of new housing could be offset by efficiency improvements in the existing stock. Without a strong push from central government to go beyond the encouragement of Eco homes standards, this makes it difficult to model scenarios that will be generally accepted as 'plausible'. Until policies on climate change and energy use are revitalised and alternatives beyond current standards are considered this will remain the case.

REAP is now available to policy makers at the local and regional level and can be used to help decision makers understand the implications of policies they are considering. To improve the plausibility of REAP scenarios they could be developed and compared against issues such as cost-effectiveness, value for money, or exposure to the public. In an ideal world this would draw on knowledge across regional and sub-regional organisations.

Because REAP covers a wide range of policy areas it can also be used to understand the indirect impacts of policy decisions. Depending on the regional and sub-regional data available, more detailed housing studies could also cover:

- Housing types
- Densities (urban sprawl or compact city)
- Mix of residential and non-residential buildings
- Effects of different planning densities on transport requirements (link to transport scenario)

Overall the data available at the sub-regional and regional level was sufficient to model housing scenarios for Leeds City Region. In the case of the more advanced issues listed above more detailed information would be required. This highlights the need to regional organisations to determine what constitutes a robust evidence base for understanding the climate change and global environmental impacts associated with regional and local policy.