National Energy Services

Assessing the impact of the proposed building regulation revisions for new dwellings:

PART L1A

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a response from National Energy Services
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Executive Summary

Background

The proposed revisions to Part L1A of the Building Regulations aim to improve the energy efficiency of new build dwellings and reduce the carbon emissions they produce by 25%. The current regulations allow three methods of compliance, the Elemental Method, the Target U-value Method and the Carbon-Index Method. In the proposed revisions, these three methods are abandoned and replaced by the TCER (target carbon emission rate) vs. DCER (dwelling carbon emission rate) Method. This method includes a whole building energy calculation which is sensitive to fuel type.

This project aims to:

- Examine the impact of the proposed changes;
- Investigate whether a 25% reduction in carbon emissions is feasible;
- Look at the practicalities of compliance.

Method

Four hundred dwellings that complied with the 2002 Building Regulations were randomly selected from the NHER Monitoring database. The Carbon Index Method is the most stringent of the current compliance methods as it considers the overall energy performance of the dwelling. The proportion passing through the Carbon Index Method was recorded and the potential carbon emissions savings if all the dwellings had passed through the Carbon Index Method were calculated.

Eighteen case study dwellings were selected from the random sample, covering different built forms and fuel types. All had typical floor areas and had Carbon Indexes suggested as typical of new build in the ODPM consultation document. The TCERs and DCERs were calculated to determine if the dwelling could pass the TCER vs. DCER Method with its 2002-compliant specification. If the dwelling did not pass, packages of energy efficiency measures were added until compliance was achieved.

Results

Thirty six percent of the 400 dwellings passed the 2002 regulations through the Carbon Index Method. If all dwellings had passed via this method, carbon emissions would decrease by 16%. The dwellings currently complying by the Carbon Index Method contribute no savings thereby reducing the overall potential savings. If none of the dwellings currently comply using the Carbon Index Method, emissions would decrease by 21%.

The maximum carbon emissions permitted under the proposed TCER vs. DCER Method and the current Carbon Index Method were compared. In most cases, the Carbon Index Method permitted lower carbon emissions and therefore would save more carbon than the TCER vs. DCER Method.

The implications of the new regulations were examined using the case study dwellings. For gas-heated dwellings, the new regulations will produce a 14% saving in carbon emissions compared to the worst acceptable 2002 specification. However, many dwellings are being built in excess of the worst acceptable 2002 specification and moving to the worst acceptable 2005 specification would achieve an 11% saving in carbon emissions. The consultation document has also defined a more demanding specification called the Base Case, which ODPM suggested implementing prior to adding packages of renewables and other energy efficiency measures, in order to meet the TCER. If all gas-heated dwellings achieved the Base Case specification, a 17% saving in carbon emissions could realised. For oil-heated dwellings, meeting the TCER will achieve 21% savings and for electrically heated dwellings, 7%. OPDM estimated an overall 25% saving.

To meet the TCER, packages of energy efficiency measures had to be added to seven of the eighteen case study dwellings. In all but one case, the packages were sufficient to enable compliance. In the one exception, an oil-heated large mid-terrace dwelling compliance was achieved by converting all fixed lighting to CFLs, in addition to fitting an A-rated boiler, mechanical ventilation with heat recovery and triple glazed windows with a U-value of 1.0W/m^2K.

Conclusions

ODPM's estimation of a 25% carbon emission saving through the implementation of the proposed 2005 regulations is unlikely to be realised.

The savings associated with the new regulations depend greatly on the fuel type of the dwelling. A 21% saving may be achieved in oil-heated dwellings. However, such dwellings will only make up a very small proportion of the total new build dwellings. In gas-heated dwellings, which represent the majority of new build dwellings, the saving is only 11%. Therefore to increase the carbon emissions savings, the fuel factor in the TCER should be altered to make compliance more difficult in gas-heated dwellings.

If all dwellings complied with the Building Regulations using the current Carbon Index Method, savings in carbon emissions will be between 16% and 21% (depending on the proportion of dwellings currently using this method of compliance). If the current Building Regulations were changed so that dwellings had to reach a Carbon Index of 8.2 to comply, carbon emissions savings would range from 24% to 28%. As electrically heated and oil-heated dwellings may have difficulty complying using the current Carbon Index Method, a fuel factor could be used, similar to that in the proposed TCER v DCER method.

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Who is National Energy Services?

National Energy Services (NES) undertakes research, consultancy and management of projects relating to energy use and the promotion of energy efficiency in buildings.

It provides energy assessment software and consultancy services to Local Authorities, Housing Associations, utilities and government bodies. In addition, the organisation runs the National Home Energy Rating (NHER) scheme, which is the national membership scheme for energy efficiency professionals in the UK, and runs an accreditation scheme for Chartered Surveyors and Home Inspectors.

NES created the UK's first energy rating scheme in the late 1980s. Today its training, extensive range of advanced software, highly accurate energy rating scheme and quality assurance procedures all place the NHER scheme at the forefront of promoting energy efficiency in housing. The NHER serves a variety of organisations from architects and builders to social housing providers such as Housing Associations and Local Authorities. More than 1,600 organisations are now part of the NHER.

Previous research reports by the NHER scheme include:

- 'Selling the SAP' (published in January 2003), which investigated the display of energy ratings in new homes; and
- 'The Appliance of Science' (published in June 2004), which investigated the uptake of energy efficient appliances in new homes.

What is the Pilkington Energy Efficiency Trust?

Pilkington established the Pilkington Energy Efficiency Trust (PEET) in 1999 to give financial support for research, testing or evaluation projects that are designed to improve the knowledge or practice of energy efficiency in buildings. PEET is funded by Pilkington but is run by a board of trustees independent of the company. The trustees meet twice a year to consider applications and to award grants.

1. Background

1.1. The Aim Of The New Regulations

The proposed revisions to Part L1A of the Building Regulations aim to improve the energy efficiency of new dwellings and reduce the carbon emissions they produce by 25% (Section 2, page 3, paragraph 3 of the Part L Consultation document, entitled 'Proposals for amending Part L of the Building Regulations and Implementing the Energy Performance of Buildings Directive). The baseline from which the 25% reduction will be calculated was not clearly explained by ODPM in the consultation document, but has subsequently been clarified as the minimum 2002 regulations.

1.2. Aim Of This Project

This project examines the impact of the proposed changes and investigates whether a 25% reduction in carbon emissions is feasible. It aims to assist ODPM's decision-making process in finalising the new regulations and to increase awareness of the regulations within the housing industry.

1.3. The Importance Of The New Regulations

Buildings account for approximately half the UK's carbon emissions and therefore reducing emissions from buildings is vital if the UK is to meet the 60% carbon emissions reduction target in the Energy White Paper. In ODPM's view, 'Building Regulations are perhaps the most important instrument in achieving a widespread improvement to the energy performance of buildings.' Therefore these proposals may play a crucial role in determining whether the UK achieves its carbon emissions reduction targets.

1.4. Main Differences Between The Proposed 2005 Regulations And The Current 2002 Regulations

The proposed 2005 regulations for new dwellings differ from the 2002 regulations in:

- The method of compliance. The current regulations allow three methods of compliance (the Elemental Method, the Target U-value Method and the Carbon Index Method). Most dwellings comply by the Target U-value Method, which allows the builder to trade off energy efficiency measures, as long as the overall U-value is lower than a prescribed target. However, in the new regulations, the three methods of compliance are abandoned and replaced by a target carbon emission rate (TCER) based on a whole building energy calculation which is sensitive to fuel type and shape (Section 1.5);
- The worst acceptable standards. A worst acceptable value for air permeability is introduced (10 m^3/m^2 per hour at 50Pa) and the minimum specification for boiler efficiency is 86%. The worst acceptable U-values for the floor, roof, walls and windows remain the same as the 2002 regulations.
- The SAP 2005 methodology. The new SAP method includes factors such as renewable energy, fixed electric lighting and non-repeating thermal bridges.

The SAP 2005 methodology continues to be insensitive to electricity usage for appliances and for non–fixed lighting, which are now likely to be the main energy users within new build dwellings. The TCER also varies with the type of fuel used for heating. Consequently, it is much harder to visualise the effect that the new regulations are likely to have on dwellings. This project intends to clarify the new regulations by:

- Assessing the claims that the 2005 regulations will reduce carbon emissions by 25%;
- Looking at the practicalities of compliance.

1.5. Description Of The TCER vs. DCER Calculation

The TCER vs. DCER is the new whole building energy calculation that is proposed for use by new build dwellings to show compliance with the 2005 Building Regulations. The TCER (target carbon emissions rate) is the maximum mass of CO_2 emissions in kg per m^2 of floor

area per year, as calculated by the SAP, that the dwelling should emit. This target will be dwelling-specific and will take into account the size and shape of the dwelling and the fuel type used for heating. The DCER is the dwelling carbon emissions rate in kg per m^2 of floor area per year. To demonstrate compliance, the calculated CO_2 emissions from the actual dwelling (the DCER) must not be greater than the target value (the TCER).

2. Methodology

2.1. SAP 2005 software

A SAP 2005 automated worksheet was been designed as an internal NES tool to allow investigation of the new procedure.

The SAP 2005 automated worksheet software is an implementation of the following documents:

1. The SAP 2005 draft document, published in four parts on the BRE website http://projects.bre.co.uk/sap2005/
2. The Errata document (issued July 2004) posted on the same website.
3. An amended SAP 2005 Appendix L calculation (e-mailed directly from B. Anderson to NES in mid September 2004)

The software is currently a draft version as the SAP 2005 methodology has not yet been finalised.

2.2. An Examination Of Emissions Under The Current Building Regulations

To examine the current Building Regulations, four hundred dwellings were randomly selected from the NHER Monitoring Database. Only dwellings that were added to the database between April 2003 and April 2004 were selected, to ensure that the dwellings had passed under the current Building Regulations.

2.2.1. NHER Monitoring Database

Assessors registered under the National Home Energy Rating (NHER) scheme are authorised to issue quality-assured SAP ratings. The Assessors work throughout the United Kingdom for many different customers, including private housebuilders, NHBC, Housing Associations and Local Authorities. The Assessors provide their customers with Authorised SAP ratings, which they use to demonstrate compliance with the Building Regulations. As part of the quality assured system, Registered Assessors submit details of all new build dwellings assessed, to NES for monitoring purposes. These details are stored in the NHER Monitoring database.

The Monitoring database therefore contains a wide cross-section of all the building undertaken in the UK. It contains entries for at least 10% of all new build dwellings (based on ODPM's new build figures and the number of dwellings entered in the database between April 2003 and April 2004). Overall, the NHER membership issues over 15,500 quality-assured SAP ratings for new build dwellings annually. For this study, only dwellings in England and Wales were selected.

2.2.2. The Sample Dwellings Are Typical Of New Build Dwellings

The sample is random with respect to geographic spread, fuel type and built form. The sample was checked in detail to determine whether the floor areas and Carbon Indexes were typical (see below).

2.2.2.1 Floor Areas In The Sample

The average floor areas in the sample of 400 new build dwellings differ from ODPM's typical floor areas (Table 1). ODPM appear to have underestimated the typical floor areas of new build dwellings. Although the footprint of new build dwellings is decreasing, three storey dwellings are becoming more common, therefore increasing the total floor area. There is no

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reason for the NHER Monitoring Database to be unrepresentative with respect to floor areas. Data from Elmhurst on over 4,000 post 2002 dwellings suggests an overall average floor area of 120m^2 (no breakdown by built form) which seems closer to NES' data than ODPM's data. Therefore in the rest of this report, the NHER floor areas are used as they have been assumed to be typical of new build dwellings.

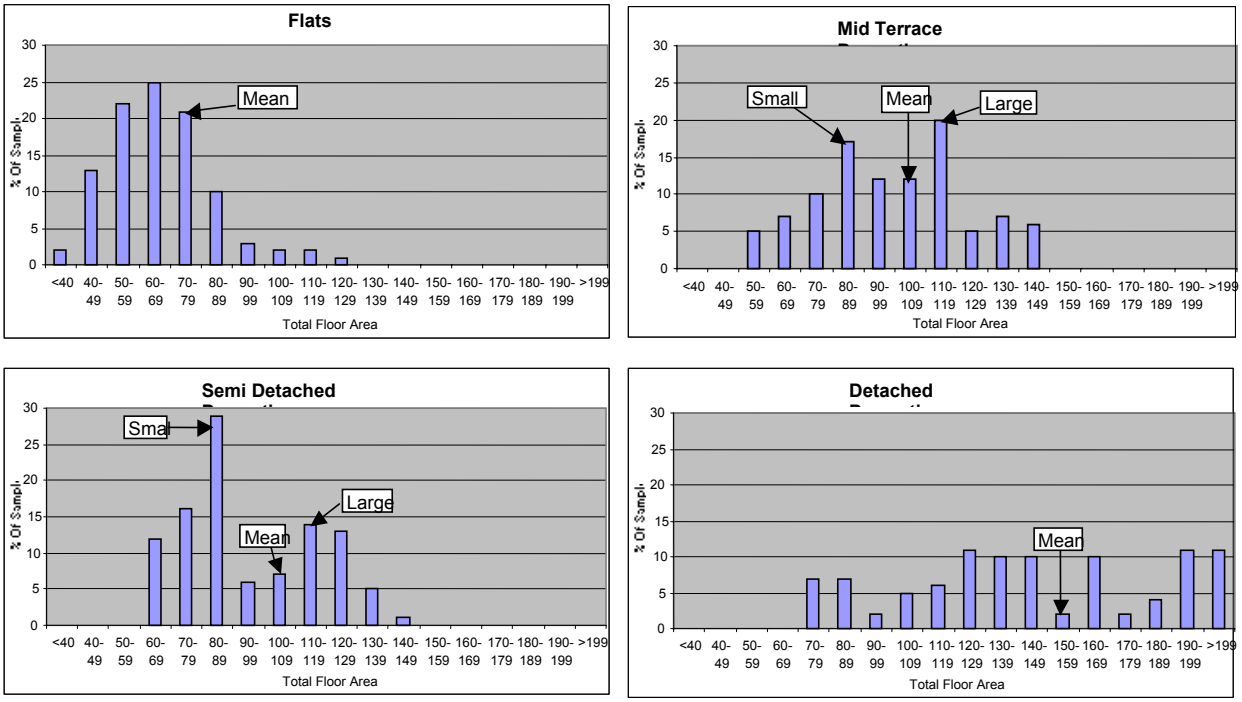
Table 1: Average Floor Areas From ODPM And NES

Built form	ODPM's Typical Floor Area (m^2)	NES' Mean Floor Area (m^2)
Flats and Maisonettes	50	70
Mid-terrace	55	100
Semi-detached houses and bungalows	80	100
Detached houses and bungalows	100	154

ODPM's figures come from Section 2, page 24, paragraph 1 of the Part L Consultation document

A closer look at the NES sample of 400 (Figure 1) shows that for mid-terraced and semi-detached dwellings, the average floor area was not the most common floor area. Floor areas of approximately 85m^2 or 115m^2 were typical for mid terraced and semi-detached dwellings, yet the mean floor area for both was 100m^2. This has implications for the selection of case study dwellings (discussed in Section 2.3.1).

Figure 1: Floor Area By Built Form For Sample Of 400

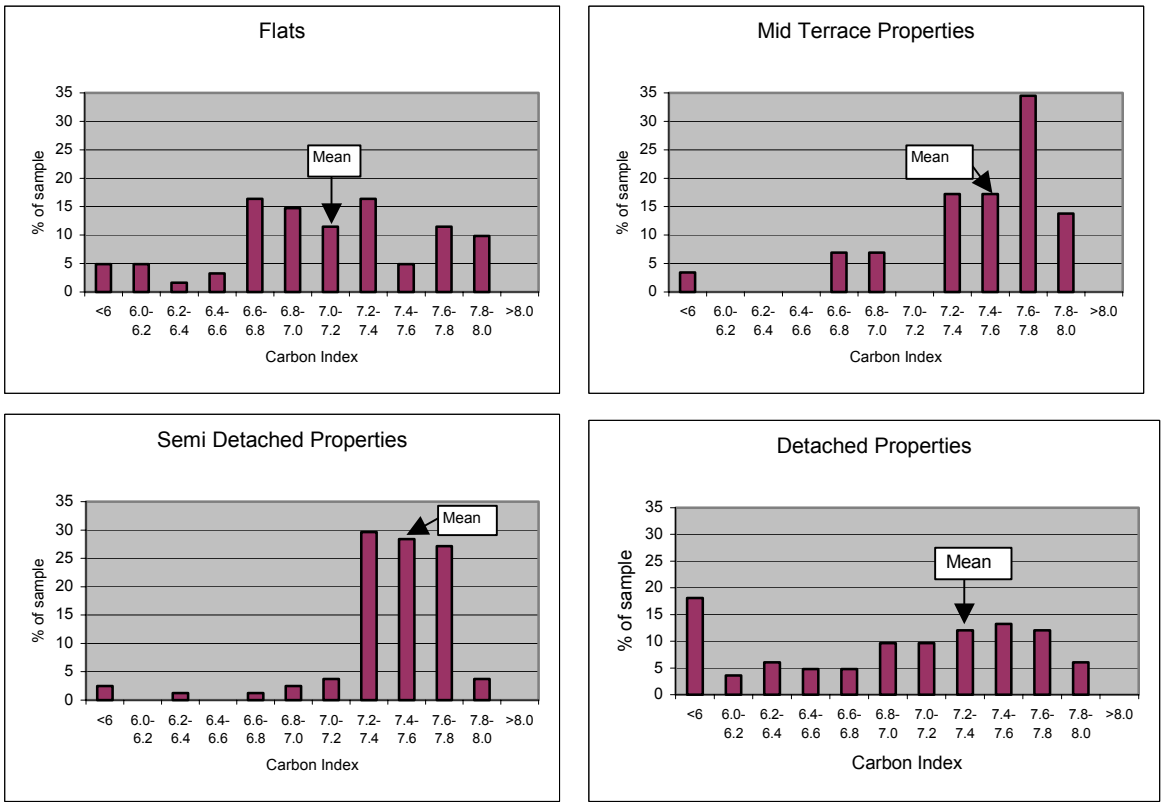


2.2.2 Carbon Index In The Sample

ODPM states that the average Carbon Index for new build dwellings is 7.4 (Section 1, page 33, paragraph 7 of the Part L Consultation document), yet the 400 randomly selected dwellings had an average Carbon Index of 7.7. Therefore to make the sample selected from the NHER Monitoring Database more representative, dwellings that passed by the Carbon Index Method (i.e. those with a Carbon Index of 8.0 or more) were excluded from the sample. By excluding dwellings that complied with the Carbon Index, an optimistic view of the potential carbon emissions savings is being presented, because the most energy efficient dwellings are being removed from the analysis.

Excluding dwellings with a Carbon Index of 8.0 or more, left a sample of 254 dwellings that did not pass by the Carbon Index Method and therefore must have used the Elemental or Target U-value Methods to comply with the 2002 Building Regulations. The average Carbon Index for the 254 dwellings was 7.2 (Figure 2), which is close to ODPM's estimated average Carbon Index of 7.4, therefore the sample of 254 dwellings appears to be reasonably representative of new build dwellings as a whole.

Figure 2: Carbon Index By Built Form For The Sample Of 254



2.2.3. Potential CO_2 Savings Through The Carbon Index Method

Dwellings can currently pass the 2002 Building Regulations by the Elemental Method, Target U-value Method or Carbon Index Method. The Carbon Index Method is the most stringent as it considers the overall energy performance of the dwelling. Therefore it is instructive to calculate the potential savings in carbon emissions if all dwellings had to pass by the Carbon Index Method.

2.3 Examination Of The Proposed 2005 Building Regulations

2.3.1. Selection Of The Case Study Dwellings

To examine the impact of the proposed 2005 Building Regulations, a variety of case study dwellings were investigated. Case study dwellings were selected from the sample of 254 dwellings that complied with the 2002 Building Regulations using the Elemental Method or Target U-value Method. Eighteen dwellings were chosen to cover a range of built forms and fuel types. Some combinations of built form and fuel type did not occur in our sample of 254 dwellings. For example, there were no electrically heated detached houses or oil-heated flats. Therefore electrically heated detached houses and oil-heated flats were assumed to be very rare and so were not investigated in this project. Dwellings with typical floor areas were selected. In the case of mid-terraced and semi-detached dwellings, this meant selecting dwellings with large and small floor areas, as well as with average (mean) floor areas (Section 2.2.2 and Figure 1).

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2.3.2. Description of the Case Study Dwellings

The eighteen case study dwellings are described in Table 2.

Table 2 : Description Of The Case Study Dwellings

Ref	Description
1	Top floor, gas-heated flat. D-rated boiler. Wall U-values do not meet worst acceptable standards under the 2005 regulations. SAP (2001) 88, CI 6.9
2	Top floor, electrically heated flat. Underfloor heating. U-values meet worst acceptable standards under the 2005 regulations. SAP (2001) 80, CI 6.1
3	Mid floor, gas-heated flat. D-rated boiler. Wall U-values do not meet worst acceptable standards under the 2005 regulations. SAP (2001) 91, CI 7.1
4	Mid floor, electrically heated flat. Fan-assisted storage heaters. Wall U-values do not meet worst acceptable standards under the 2005 regulations. SAP (2001) 91, CI 6.8
5	Ground floor, gas-heated flat. Wall U-values meet the worst acceptable standards under the 2005 regulations SAP (2001) 89, CI 7.0
6	Ground floor, electrically heated flat. Modern, slim-line storage heaters. Floor U-values do not meet worst acceptable standards under the 2005 regulations. SAP (2001) 80, CI 6.3
7	Average floor area, gas-heated mid-terrace. D-rated boiler. U-values meet the worst acceptable standards under the 2005 regulations. SAP (2001) 100, CI 7.9
8	Two storey, small gas-heated mid-terrace. D-rated boiler. U values meet worst acceptable standards under 2005 regulations. SAP (2001) 93, CI 7.3
9	Three storey, large gas-heated mid terrace. A-rated boiler with thermal store. Floor and wall u- values do not meet the worst acceptable standards under the 2005 regulations. SAP (2001) 91, CI 7.4
10	Oil-heated mid-terrace, based on size and shape of dwelling 8, as no small oil-heated mid-terrace was present in the sample of 254 dwellings from the NHER Monitoring Database
11	Oil-heated, mid-terrace, based on size and shape of dwelling 9, as no large oil-heated mid-terrace was present in the sample of 254 dwellings from the NHER Monitoring Database
12	Average floor area, gas-heated semi. A-rated boiler. Floor and wall U-values do not meet the worst acceptable standards under the 2005 regulations. SAP (2001) 98, CI 7.7
13	Two storey, small floor area, gas-heated, semi. D-rated boiler. Floor and wall U-values do not meet the worst acceptable standards under the 2005 regulations. SAP (2001) 96, CI 7.5
14	Three storey, large floor area, gas-heated semi. A-rated boiler. Floor U-values do not meet the worst acceptable standards under the 2005 regulations. SAP (2001) 96, CI 7.4
15	Small floor area, oil-heated semi. D-rated boiler. Floor and wall U-values do not meet the worst acceptable standards under the 2005 regulations. SAP (2001) 96, CI 6.3
16	Large floor area, oil-heated semi. C-rated boiler. Floor and wall U-values do not meet the worst acceptable standards under the 2005 regulations. SAP (2001) 86, CI 5.8
17	Gas-heated detached. D-rated boiler and gas secondary heating. U-values meet the worst acceptable standards under the 2005 regulations. SAP (2001) 92, CI 7.1
18	Oil-heated detached. D-rated boiler and solid fuel secondary heating. Wall U-values do not meet the worst acceptable standards under the 2005 regulations. SAP (2001) 86, CI 5.6

2.3.3. Procedure For Calculating The TCER and DCER

To examine the impact of the proposed 2005 Building Regulations, the ease with which 2002-compliant dwellings could comply with the new regulations was investigated. To do so, the target emissions (TCER) and dwelling emissions (DCER) were calculated for each case study dwelling. A formula exists for calculating a TCER for use with SAP 2001. The formula for calculating the TCER with SAP 2005 has not been finalised but the relationship between the TCER and DCER under SAP 2001 is expected to be the same as the relationship between the TCER and DCER under SAP 2005. The TCER under SAP 2001 is termed the $TCER_{01}$ to differentiate it from the $TCER_{05}$ (which should be calculated in conjunction with the SAP 2005 methodology). The $TCER_{01}$ formula considers the size, shape and fuel type of the dwelling in calculating the target. It includes a simple fuel factor, which recognises that electrically or oil-heated dwellings have greater carbon emissions than gas-heated dwellings.

For the $TCER_{01}$ to be meaningful, it must be compared with a DCER calculated from SAP 2001. Therefore the $DCER_{01}$ was calculated by dividing the CO_2 emissions from the dwelling, as calculated by SAP 2001, by the total floor area. The difference between the $DCER_{01}$ and the $TCER_{01}$ is the amount that must be subtracted from the $DCER_{05}$ to produce a $TCER_{05}$. The $DCER_{05}$ was calculated by inputting the case study dwelling into the SAP 2005 worksheet (described in Section 2.1). To determine if the case study dwelling complied with the 2005 Building Regulations, the $TCER_{05}$ and the $DCER_{05}$ were compared. If the $DCER_{05}$ was less than the $TCER_{05}$, then the dwelling complied with the 2005 regulations.

The $TCER_{01}$ calculation from the draft 2005 Building Regulations includes a factor for lighting. This takes account of low energy lighting, and is calculated using Appendix L of the draft SAP 2005. The draft regulations state 'the precise formulation of the TCER will need to be revisited once the new version of the SAP is available. However, the equation as given will allow consultees to assess designs using the current version of SAP.' It should be noted that the project team have followed this logic and the $DCER_{01}$ has been calculated from the emissions figures in SAP 2001. Therefore the calculated $DCER_{01}$ does not include any allowance for low energy lighting.

2.3.4. The Worst Acceptable Standards And The Base Case Specification In The 2005 Regulations

To examine the impact of the 2005 Building Regulations, the $DCER_{05}$ of the 2002-compliant dwelling was compared to the worst acceptable standards in the 2005 regulations. The worst acceptable standards cover U-values, air permeability and boiler efficiency (Table 3). Dwellings must meet these worst acceptable standards if they are to comply with the 2005 Building Regulations. Therefore the DCER of the dwelling was calculated in relation to the worst acceptable standards. Two DCERs were calculated:

- $DCER_{05Worst}$; the DCER of the dwelling if it had been built using all the worst acceptable standards. This meant **improving or worsening** the U-values, air permeability and boiler efficiency of the chosen dwellings so that they matched the worst acceptable standards. This was calculated to investigate whether the dwelling could pass if it was built entirely to the worst acceptable specification.
- $DCER_{05Improved}$; the DCER of the dwelling improved to meet the worst acceptable standards. This included **improving** the U-values, air permeability or boiler efficiency. In this calculation, standards were **never worsened**, for example if the floor U-value was better than the worst acceptable value, it was not worsened to meet the worst acceptable value.

The DCER was also calculated in relation to the worst acceptable standards for 2002 Building Regulations, termed $DCER_{05Worst2002}$. The only differences between the worst acceptable standards for 2005 and 2002 are that in the 2002 regulations the worst acceptable standard for boiler efficiency is 78% and no worst acceptable standard exists for air pressure.

Table 3 : Worst Acceptable Standards (2005 Regulations)

Element	Worst Acceptable Standard
Wall U-value	0.35
Floor U-value	0.25
Roof U-value	0.25
Windows, doors, roof windows and rooflights U-value	2.2
Air permeability (m^3/m^2 per hour at 50Pa)	10
SEDBUK Boiler Efficiency (%)	86

Defined in Section 2, page 13 of the Part L Consultation document

ODPM has also defined a Base Case specification for the 2005 Building Regulations (Table 4). The Base Case specification covers U-values, air permeability and boiler efficiency. ODPM has assumed dwellings will be built to the Base Case specification before packages of further energy efficiency measures are added. According to ODPM, gas-heated, mid floor flats, mid-terraced dwellings and semi-detached dwellings will pass the 2005 Building Regulations if they are built to the Base Case specification. For other built forms and fuel types, packages of energy efficiency measures must be added to the Base Case specification to enable compliance. The DCER was calculated for the dwellings as if they had been built to the Base Case specification ($DCER_{05Base}$). This involved improving or worsening the U-values, air permeability and boiler efficiency to match the Base Case specification.

Table 4 : Base Case Standards (2005 Regulations)

Element	Base Case Specification
Wall U-value	0.27
Floor U-value	0.22
Roof U-value	0.13
Windows, doors, roof windows and rooflights U-value	2.2
Area of windows and doors as percentage of total floor area	25
Air permeability (m^3/m^2 per hour at 50Pa)	7
SEDBUK Boiler Efficiency (%)	86

Defined in Section 2, page 26 of the Part L Consultation document

2.3.5. Application Of Packages

Dwellings whose $DCER_{05}$ is equal to or lower than their $TCER_{05}$ pass the 2005 Building Regulations with their current specification. However, dwellings whose $DCER_{05}$ is greater than their $TCER_{05}$ must alter their current specification to comply with the 2005 regulations. Therefore packages of energy efficiency measures were applied to these case study dwellings to enable compliance with the 2005 regulations.

The packages outlined in the Part L Consultation document were used (Table 5). None of the packages included the use of CFLs or a change of fuel; therefore the potential value of these in enabling compliance has not been investigated fully in this project .

ODPM has assumed that dwellings will be built to the Base Case specification before adding packages (Section 2.3.4). However, in this project, we have not followed this assumption for all dwellings. Instead, for gas-heated dwellings, packages have been added to the specification of the dwelling improved to meet the minimum requirements under the 2005 Building Regulations (corresponds to $DCER_{05Improved}$ in Table 6, see Section 2.3.4). The explanation for this is that it will give a clearer illustration of how the specification of the 2002-compliant dwelling has to be changed to comply with the 2005 Building Regulations. If a dwelling is close to complying with the TCER vs. DCER Method with its 2002 specification, NES believe the developer is unlikely to change the whole specification to meet the Base Case. Meeting the Base Case specification may be costly and complicated as it may involve changing all the U-values and the air permeability, and it is possible that the dwelling may

actually pass with its current specification if its boiler is simply changed from a B-rated boiler to an A-rated model.

In contrast, for oil-heated dwellings, packages have been added to the specification for the dwelling built to the Base Case (corresponds to $DCER_{05Base}$). This difference is due to the greater difficulty in enabling oil-heated dwellings to pass the 2005 regulations. Compliance is unlikely be achieved if packages are added to the 2002 specification improved to meet the 2005 Building Regulations (corresponds to $DCER_{05Improved}$) because of the large difference between the $DCER_{05Improved}$ and $TCER_{05}$. Improving up to the Base Case specification first, reduces this difference and means that adding packages can enable compliance in oil-heated dwellings.

Table 5: Packages Applied To The Case Study Dwellings

Fuel Type	Package Number	Contents Of Package
Gas	1	Replacement of B-rated with A-rated boiler
	2	Upgrade U-values to the Base Case 10% reduction in opaque U-values Reduction of window area to 22% of gross floor area Soft coat low-e double glazed windows with U-value of 1.5 W/m^2K
	3	High performance MVHR (mechanical ventilation with heat recovery) Reduction of air leakage to 5 m^3/m^2 per hour at 50Pa
	4	Orientation of dwelling to south Redistribution of windows and doors to place 60% of glazing on the south façade Soft coat low-e double glazed windows with U-value of 1.3 W/m^2K
	5	2m^2 solar hot water system
Oil	1	Replacement of B-rated with A-rated boiler 3m^2 of solar hot water system
	2	Replacement of B-rated with A-rated boiler High performance MVHR Reduction of air leakage to 3.5 m^3/m^2 per hour at 50Pa
	3	Replacement of B-rated with A-rated boiler High performance MVHR Soft coat low-e triple glazed windows with U-value of 1.0 W/m^2K
Electric	1	Reduction of window area to 20% of floor area Soft coat low-e glass windows with a U-value of 1.3 W/m^2K Reduction in wall U-values from 0.27 to 0.25 W/m^2K High efficiency MVHR Reduction in air leakage to 3m^3/m^2 per hour at 50Pa
	2	3m^2 solar thermal hot water system
	3	Heating by air source heat pump

Described in Section 2, pages 26-30 of the Part L Consultation document

2.3.6. Summary Of The Calculation Procedure For The DCER, TCER, Base Case Specification And Worst Acceptable Standards

The procedure for calculating the TCER and the various DCERs is summarised in Table 6.

Table 6 : Procedure For Calculating The TCER And DCER

Ref	Description	
1.	Calculate the dwelling's carbon emissions from the SAP 2001 worksheet on a per m^2 basis.	$DCER_{01}$
2.	Calculate the target carbon emissions using the calculation set up to work with SAP 2001.	$TCER_{01}$
3.	Calculate the savings required to meet the target emissions ($TCER_{01}$-$DCER_{01}$).	$Savings_{01}$
4.	Input the full details of the case study dwelling into the SAP 2005 worksheet and calculate the carbon emissions on a per m^2 basis	$DCER_{05}$
5.	Calculate the target emissions for case study dwelling built under the 2005 regulations ($DCER_{05}$-$savings_{01}$).	$TCER_{05}$
6.	For the case study dwelling, calculate the DCER using the worst acceptable specification under the 2002 regulations Section 2.3.4 and Table 3). This includes checking the U-values and the boiler efficiency. If any part of the specification exceeds the worst acceptable standards, then it is worsened to meet the worst acceptable standards.	$DCER_{05Worst2002}$
7.	For the case study dwelling, calculate the DCER using the worst acceptable specification under the 2005 regulations (Section 2.3.4 and Table 3). This includes changing the U-values, air permeability and the boiler efficiency. If any part of the specification exceeds the worst acceptable standards, then it is worsened to meet the worst acceptable standards.	$DCER_{05Worst}$
8.	For the case study dwelling, improve any part of the specification that is worse than the worst acceptable standard. This could involve improving the U-values, air permeability and boiler efficiency. If any part of the specification already exceeds the worst acceptable specification, this is left unchanged.	$DCER_{05Improved}$
9.	For the case study dwelling, calculate the DCER if the dwelling was built to the 'Base Case' specification listed in the Part L Consultation document (Section 2.3.4 and Table 4).	$DCER_{05Base}$
10.	Apply packages suggested in the ODPM consultation document to the case study dwelling improved where necessary to meet the 2005 regulations ($DCER_{05Improved}$). Apply packages in the order they are listed in the Part L Consultation document, until the target carbon emission rate is achieved.	$DCER_{05PackageX}$ where x relates to the package number

3. Results

3.1. Examination Of The 2002 Regulations

3.1.1. Potential CO_2 Savings Through The Carbon Index Method

Four hundred dwellings were randomly selected from the NHER Monitoring Database and their CO_2 emissions investigated (Table 7). All complied with current 2002 Building Regulations. However, only 36% passed by the Carbon Index Method.

The remaining 254 dwellings had a Carbon Index of less than 8.0 and must have passed the 2002 regulations by the Target U-value Method or the Elemental Method. The CO_2 emissions if all dwellings had achieved a Carbon Index of 8.0 were calculated using the equation for the Carbon Index:

CI = 17.7 – 9.0 log10 (CF)
Where CF is a carbon factor, calculated using the equation:
CF = CO_2/(TFA+45.0)
Where:
CO_2 is the CO_2 emissions in kg/year
TFA is the total floor area in m^2.

If all dwellings had achieved a Carbon Index of 8.0, annual CO_2 emissions from over the whole sample of 400 would have been reduced by 16%, which equates to approximately 130,000kgs of CO_2 per year.

Table 7 : Average CO_2 Emissions For The 400 Dwellings Sampled

Built form	No. in sample	Average SAP CO_2 emissions (kg)	Average total CO_2 emissions† (kg)
Flats and Maisonettes	136	1420	1690
Mid-terrace	60	1850	2200
Semi-detached houses and bungalows	113	1910	2310
Detached houses and bungalows	91	3335	3935

† CO_2 emissions from the SAP 2001 with the addition of a factor for lights but not appliances. The factor for lights was calculated using the SAP 2005 worksheet, assuming three CFLs per dwelling.

As dwellings that currently pass by the Carbon Index Method may be unrepresentative of new build dwellings as a whole, the CO_2 emissions were also investigated for only those dwellings whose Carbon Index was less than 8.0 (Table 8). As expected, these dwellings had a higher average CO_2 emission rate than the rate for the sample of 400 as a whole. Annual CO_2 emissions for the subset of 254 non-Carbon Index compliant dwellings would have been reduced by 21% if they had been designed and built to comply with the current building regulations under the Carbon Index method. This is close to ODPM's target carbon emission saving of 25% through the implementation of the 2005 regulations.

Table 8: CO_2 Emissions From 254 Dwellings With A Carbon Index Of Less Than 8.0

Built form	No. in sample	Average SAP CO_2 emissions (kg)	Average total CO_2 emissions† (kg)
Flats and Maisonettes	61	1650	1920
Mid-terrace	29	2075	2420
Semi-detached houses and bungalows	81	2215	2610
Detached houses and bungalows	83	3400	4540

† CO_2 emissions from the SAP 2001 with the addition of a factor for lights but not appliances

3.1.2. ODPM May Have Overestimated The Potential Carbon Emissions Savings

ODPM has estimated the carbon emissions savings in kg per year, per dwelling, that will be realised through the implementation of the 2005 Building Regulations (Section 1, page 21 of the Part L Consultation document). These estimated savings can be compared to current CO_2 emissions from dwellings passing the 2002 Building Regulations (Table 9). Such a comparison reveals that ODPM's estimated savings represent a large percentage of current CO_2 emissions, certainly greater than the 25% saving mentioned elsewhere in the Part L Consultation Document (Section 2, page 3, paragraph 3 of the Consultation document and see also Section 1.1 of this report). NES are concerned that this level of saving will be very difficult to achieve. For example, ODPM suggests that 1200kg CO_2 emissions could be saved by improving a flat to the 2005 Building Regulations standard, but data from the NHER Monitoring database suggest that flats, on average, currently emit only 1920kg. Therefore 1200kg CO_2 represents a saving of 65% and is unlikely to be feasible.

Table 9: Current Emissions From 254 2002-Compliant Dwellings And ODPM's Estimated Savings

Built form	Average annual Total† CO_2 (kg) emission per dwelling (from Table 8)	CO_2 (kg) annual saving per dwelling per year (ODPM)	% saving needed to meet ODPM target %
Flats and Maisonettes	1920	1200	62
Mid-terrace	2420	1000	41
Semi-detached houses and bungalows	2610	1300	50
Detached houses and bungalows	4540	1500	33

† Emissions due to SAP and lighting

3.1.3. Comparison Of The 2002 And 2005 Regulations: The Carbon Index Method May Produce Greater Carbon Emissions Savings Than The TCER Method

The Carbon Index was formally published in SAP 2001 and is based on the emissions from space and water heating, adjusted for floor area. The $TCER_{01}$ has been developed to work with SAP 2001 and therefore is comparable to the Carbon Index. A high TCER represents high levels of carbon emissions, whereas a high Carbon Index represents low levels of carbon emissions. Like the Carbon Index, the TCER is based on emissions from space and water heating, adjusted for floor area. The $TCER_{01}$ is also however affected by the ratio of exposed surface area to total floor area. Two storey detached dwellings always have a shape factor of 1.01 and most terraced or semi detached dwellings have a shape factor of 0.99 or 1.01.

The DCER can be calculated for dwellings with a Carbon Index of 8.0 ($DCER_{CI=8}$). This $DCER_{CI=8}$ can be compared to the $TCER_{01}$ for different floor areas and shape factors (Table 10). Such a comparison reveals that for most two storey, detached, semi or terrace dwellings over 85m^2, the TCER allows greater emissions than a Carbon Index of 8 does. This implies that insisting dwellings pass the current regulations by the Carbon Index Method would generally produce greater carbon emissions savings than allowing them to pass through the TCER vs. DCER Method.

Table 10: TCER By Floor Area Compared To The Emissions Associated With A Carbon Index Of 8

Floor area	Shape factor	$TCER_{01}$	$DCER_{CI=8}$
50	0.95	20.0	22.4
	0.99	21.2	22.4
	1.01	21.6	22.4
85	0.95	17.9	18.2
	0.99	18.7	18.2
	1.01	19.0	18.2
100	0.95	17.3	17.3
	0.99	18.0	17.3
	1.01	18.4	17.3
115	0.95	16.3	16.6
	0.99	17.0	16.6
	1.01	17.3	16.6

3.2. Examination Of The 2005 Regulations Using The Case Study Dwellings

3.2.1. Gas-Heated Dwellings

Table 11 shows the target carbon emission rate (TCER) and different dwelling carbon emission rates (DCER) under various scenarios using the case study dwellings (described in Section 2.3). The $TCER_{05}$ is generally lower than the $DCER_{05}$, indicating the dwelling, as currently built, must be modified to meet the 2005 regulations. However, for the smaller dwellings, TCER is actually greater than the DCER of a dwelling built to the worst acceptable standards under the 2005 regulations ($DCER_{05Worst}$), i.e. the TCER is achieved even though the dwelling does not meet the worst acceptable standards. Therefore simply achieving the TCER will not be sufficient for compliance with the 2005 regulations. For flats, terraced dwellings and semi-detached dwellings improving the current specification to meet the worst acceptable 2005 specification, where necessary, ($DCER_{05Improved}$) will be sufficient to pass the TCER vs DCER Method. Improving to the Base Case specification (described in Section 2.3.4 and Table 4) enables all the gas-heated dwellings to comply with the TCER vs DCER Method.

Table 11: TCERs And DCERs For The Gas Case Study Dwellings By Built Form And Size

Ref	Built form	$TCER_{05}$	$DCER_{05}$	$DCER_{05Improved}$	$DCER_{05Worst}$	$DCER_{05Worst2002}$	$DCER_{05Base}$
1	Top Floor Flat	25.7	27.5	22.9	24.0	26.8	20.3
3	Mid Floor Flat	18.3	13.2	13.2	16.2	16.9	14.0
5	Ground Floor Flat	24.8	21.8	20.3	21.6	22.9	19.2
7	Mid-terrace – Average	23.0	22.7	20.1	20.7	22.8	18.4
8	Mid-terrace – Small	25.4	25.3	22.2	23.2	26.0	21.1
9	Mid-terrace - Large	23.8	24.7	23.8	25.4	28.7	22.6
12	Semi-detached – Average	24.1	24.9	23.3	25.0	26.9	21.5
13	Semi-detached – Small	24.7	26.2	24.9	26.5	27.2	21.8
14	Semi-detached – Large	24.0	26.4	25.4	27.0	30.3	23.3
17	Detached	21.4	25.0	22.8	24.3	26.3	20.2

$DCER_{05Improved}$; DCER if dwelling improved to meet the worst acceptable standards. This included **improving** the U-values, air permeability or boiler efficiency. Standards were **never worsened**.
$DCER_{05Worst}$; DCER if dwelling had been built using all the worst acceptable standards in the 2005 regulations. This meant **improving or worsening** the U-values, air permeability and boiler efficiency.
$DCER_{05Worst2002}$: DCER if dwelling had been built using all the worst acceptable standards in the 2002 regulations. This meant **improving or worsening** the U-values.
$DCER_{05Base}$: DCER if dwelling had been built to ODPM's Base Case specification. This meant improving or worsening the U-values, air permeability and boiler efficiency to match the Base Case specification

The percentage savings associated with the gas-heated case study dwellings passing the 2005 Building Regulations can be calculated. The 2005 regulations will produce on average a 14% saving in carbon emissions compared to minimum 2002 regulations (Table 12). However, some of the case study dwellings have been built to exceed the 2002 regulations so the realised savings will be less. The savings achieved for the case study dwelling, in meeting the 2005 regulations are shown in the second column of results in Table 12 and average just 9%. If the new regulations were strengthened, so that the minimum specification became the Base Case specification, then savings would increase to 17%. However, the savings associated with all three scenarios are lower than ODPM's 25% saving.

Table 12 : Carbon Emissions Savings For The Worst Acceptable And Base Case Standards Compared To The DCER05 For Gas Dwellings

Ref	Built form	$TCER_{05}$ † v $DCER_{05Worst2002}$ (%)	$TCER_{05}$ † v $DCER_{05}$ (%)	$DCER_{05Base}$ v $DCER_{05}$ (%)
1	Top Floor Flat	10	13	26
3	Mid Floor Flat	4	0	0
5	Ground Floor Flat	6	1	12
7	Mid-terrace – Average	9	9	19
8	Mid-terrace – Small	11	8	17
9	Mid-terrace - Large	17	4	9
12	Semi-detached - Average	10	3	14
13	Semi-detached - Small	9	6	17
14	Semi-detached - Large	21	9	12
17	Detached	19	14	19
Weighted Average		**14**	**9**	**17**

† TCER05 or $DCER_{05worst}$, whichever is the smaller.

The weighted average in Table 12 has been calculated by considering the breakdown of new build dwellings by built form, shown in Table 13.

Table 13 : Breakdown of New Build Dwellings By Built Form

Built form	Percentage of new build dwellings
Flats	37
Terraced and Attached	19
Semi Detached	16
Detached	28

Figures from page 25, Section 2 of the Part L Consultation document

3.2.2. Oil-Heated Dwellings

In contrast to the gas-heated dwellings, oil-heated dwellings (see Section 2.3 for description) always have a lower $TCER_{05}$ than $DCER_{05}$ (Table 14) and therefore do not pass the TCER vs. DCER Method with their current, 2002-compliant specification. The $TCER_{05}$ is also always lower than the worst acceptable standards ($DCER_{05Worst}$) and in all but two cases is lower than the Base Case ($DCER_{05Base}$).

Table 14 : TCERs and DCERs For Oil Case Study Dwellings By Built Form And Size

Ref	Built form	$TCER_{05}$	$DCER_{05}$	$DCER_{05Worst}$	$DCER_{05Base}$
10	Mid-terrace - Small	28.0	33.8	31.4	28.0
11	Mid-terrace - Large	25.7	32.4	33.5	29.9
15	Semi-detached - Small	28.9	35.2	33.7	29.1
16	Semi-detached - Large	25.1	31.6	29.0	24.2
18	Detached	25.6	34.9	33.6	27.4

$DCER_{05Worst}$; DCER if dwelling had been built using all the worst acceptable standards in the 2005 regulations. This meant **improving or worsening** the U-values, air permeability and boiler efficiency.
$DCER_{05Base}$: DCER if dwelling had been built to ODPM's Base Case specification. This meant improving or worsening the U-values, air permeability and boiler efficiency to match the Base Case specification

For oil-heated dwellings, unlike the gas-heated dwellings, the 2005 Building Regulations are likely to produce large savings (approximately 21%) in carbon emissions (Table 15). In many cases, the Base Case specification is not sufficient to enable the oil-heated dwelling to pass the TCER vs. DCER Method, so the possible savings if the dwelling only had to be built to the Base Case specification are actually lower than the savings available from the TCER vs. DCER Method.

Table 15 Carbon Emissions Savings For The Worst Acceptable And Base Case Standards Compared To The $DCER_{05}$ For Oil Dwellings

Ref	Built form	$TCER_{05}$ v $DCER_{05}$	$DCER_{05Worst}$ v $DCER_{05}$	$DCER_{05Base}$ v $DCER_{05}$
10	Mid-terrace - Small	17	7	17
11	Mid-terrace - Large	21	0	8
15	Semi-detached - Small	18	4	17
16	Semi-detached - Large	21	8	23
18	Detached	27	4	21
	Average†	21	5	17

† As no information is available on the breakdown of built form for dwellings heated by oil, a straight average has been taken

3.2.3. Electrically Heated Dwellings

For electrically heated dwellings (see Section 2.3 for description), the $TCER_{05}$ is lower than the $DCER_{05}$, except in the mid floor flat (Table 16). However the mid floor flat, chosen as typical in this report, will have to change its specification to meet the 2005 regulations because the $DCER_{05Improved}$ column shows that some aspects of its specification are worse than the worst acceptable standards. For all built forms, the $TCER_{05}$ is always lower than the worst case specification, and the Base Case specification is only sufficient to enable compliance in the mid floor flat. For the ground floor and top floor flat, packages of energy efficiency measures must be added to the dwelling to enable compliance.

Table 16 : TCERs and DCERs For Electric Case Study Dwellings By Built Form And Size

Ref	Built form	$TCER_{05}$	$DCER_{05}$	$DCER_{05Improved}$	$DCER_{05Worst}$	$DCER_{05Base}$
2	Top Floor Flat	29.9	31.8	31.7	36.1	31.8
4	Mid Floor Flat	31.9	31.7	30.4	32.6	29.6
6	Ground Floor Flat	27.4	32.5	31.5	33.8	31.9

$DCER_{05Worst}$; DCER if dwelling had been built using all the worst acceptable standards in the 2005 regulations. This meant **improving or worsening** the U-values, air permeability and boiler efficiency.
$DCER_{05Improved}$; DCER if dwelling improved to meet the worst acceptable standards. This included **improving** the U-values, air permeability or boiler efficiency. Standards were **never worsened**.
$DCER_{05Base}$: DCER if dwelling had been built to ODPM's Base Case specification. This meant improving or worsening the U-values, air permeability and boiler efficiency to match the Base Case specification

For electrically heated dwellings, like the gas-heated dwellings, the 2005 Building Regulations are unlikely to produce large savings in carbon emissions (Table 17). A 7% carbon emission saving is expected for electrically heated dwellings. For the ground floor and top floor flat, the Base Case specification is not sufficient to enable the dwelling to pass the TCER vs. DCER Method, so the possible savings if the dwelling had to be built to the Base Case are actually lower than the savings available from the TCER vs. DCER Method.

Table 17: Carbon Emissions Savings For The Worst Acceptable And Base Case Standards Compared To The DCER05 For Electric Dwellings

Ref	Built form	$TCER_{05}$ v $DCER_{05}$	$DCER_{05\text{-worst}}$ v $DCER_{05}$	$DCER_{05\text{-base}}$ v $DCER_{05}$
2	Top Floor Flat	6	0	0
4	Mid Floor Flat	0	0	7
6	Ground Floor Flat	16	0	2
	Average†	7	0	3

† A straight average has been taken, this represents the most optimistic level of saving

3.3. Applying Packages To The Case Study Dwellings

If the case study dwelling did not pass the TCER vs. DCER calculation, then the packages of energy efficiency measures suggested in the Part L Consultation document were applied (Section 2.3.5 and Table 5). Before applying packages, the dwelling was improved where necessary to meet the 2005 worst acceptable standards (corresponds to $DCER_{05Improved}$). In many cases, this change was sufficient to enable the dwelling to comply and it was not necessary to add any packages. For this reason, the gas-heated top floor flat, gas-heated large mid-terrace, gas-heated average semi and gas-heated small semi did not need any packages even though their $DCER_{05}$ was more than their $TCER_{05}$. For oil-heated dwellings, the Base Case specification was implemented before any packages were applied. Improving to the Base Case specification meant that the oil-heated small mid-terrace and the oil-heated large semi did not need any packages even though their $DCER_{05}$ was more than their $TCER_{05}$.

Packages had to be added to seven of the eighteen case study dwellings. Addition of packages enabled compliance in all dwellings, except the oil-heated large mid-terrace. Therefore the impact of using CFLs was investigated in this case study dwelling to determine whether they would enable the dwelling to comply. Converting all the fixed lighting to CFLs in the Base Case plus package three reduced the DCER to 24.9 and enabled it to pass.

Table 18 : Packages Applied To Case Study Dwellings

Built Form	Fuel Type	Size	TCER	DCER To Which Packages Applied†	$DCER_{05Pack1}$	$DCER_{05Pack2}$	$DCER_{05Pack3}$
Top floor flat	Gas	Av	25.7	23.0	-	-	-
	Elect	Av	29.9	31.8	25.5	-	-
Mid floor flat	Gas	Av	18.3	13.2	-	-	-
	Elect	Av	31.9	30.4	-	-	-
Ground floor flat	Gas	Av	24.8	20.3	-	-	-
	Elect	Av	27.4	31.5	30.4	21.8	-
Mid-terrace	Gas	Av	23.0	20.1	-	-	-
		Small	25.4	22.2	-	-	-
		Large	23.8	23.8	-	-	-
	Oil	Small	28.0	28.0	-	-	-
		Large	25.7	29.9	26.0	26.1	25.8
Semi-detached	Gas	Av	24.1	23.3	-	-	-
	Gas	Small	24.7	23.8	-	-	-
		Large	24.0	25.4	-	23.7	-
	Oil	Small	28.9	29.1	26.6	-	-
		Large	25.1	24.2	-	-	-
Detached	Gas	Av	21.4	22.8	20.2	-	-
	Oil	Av	25.6	27.4	25.3	-	-

† For gas-heated and electrically heated dwellings, packages were applied to the $DCER_{05Improved}$ unless all minimum standards were already met, in which case the packages were applied to the $DCER_{05}$. For oil-heated dwellings, packages were applied to the $DCER_{05Base}$.

4. Conclusions

4.1. Examination Of The 2002 Building Regulations

4.1.1. Potential Carbon Emissions Savings Through The Carbon Index Method

Currently dwellings can pass the 2002 Building Regulations through either the Elemental Method, the Target U-value Method or the Carbon Index Method. Of the 400 dwellings, randomly sampled from the NHER Monitoring Database, only 36% passed the 2002 regulations via the Carbon Index Method. If the Building Regulations were changed so that all dwellings had to pass by the Carbon Index Method, carbon emissions would decrease by 16%, which equates to approximately 130,000kg of CO_2 per year. Even if we assume no dwellings currently comply by the Carbon Index Method, the savings associated with forcing dwellings to pass via the Carbon Index Method would increase to only 21%. This is close to ODPM's estimated carbon emission saving of 25% through the implementation of the 2005 regulations, but in reality some dwellings do currently pass via the Carbon Index Method, so the true savings would be somewhere between 16% and 21%.

4.1.2. ODPM May Have Overestimated The Potential Carbon Emissions Savings

ODPM appear to have overestimated the potential carbon emission saving through the implementation of the 2005 Building Regulations. Comparing ODPM's estimated savings, presented in the consultation document on a kg per dwelling, per year basis, to the current CO_2 emissions from new build dwellings, shows that ODPM expect to reduce CO_2 emissions by up to 63%. For example, flats currently emit 1920kg yet ODPM estimate that 1200kg can be saved from flats through the new regulations. Such high levels of savings do not appear to be feasible.

4.1.3. Comparison Of The 2002 And 2005 Regulations: The Carbon Index Method May Produce Greater Carbon Emissions Savings Than The TCER Method

Comparing the emissions allowed under the TCER vs. DCER Method with those allowed by the current Carbon Index Method reveals that in most gas-heated dwellings over 85m^2, the TCER allows greater emissions than a Carbon Index of 8 does. Therefore forcing dwellings to pass the current regulations by the Carbon Index Method would actually produce greater carbon emissions savings, in most cases, than allowing them to pass through the new TCER vs. DCER Method.

4.2. Examination Of The 2005 Regulations Using The Case Study Dwellings

4.2.1. Gas-Heated Dwellings

The TCER does not appear to be a very demanding target for gas-heated dwellings and consequently the carbon emissions savings from the new regulations are likely to be modest. Based on our examination of case study dwellings, the 2005 regulations will produce a 11% saving in carbon emissions compared to dwellings currently passing the Building Regulations by the Elemental or Target U-value method, for gas-heated dwellings. If the new regulations were strengthened, so that new dwellings had to be built to the Base Case specification, then savings would increase to 17%. However, the savings associated with both scenarios are far below the 25% saving estimated by ODPM.

4.2.2. Oil-Heated Dwellings

The TCER appears to be more challenging for oil-heated dwellings and so the savings from the new regulations for oil-heated dwellings are likely to be higher than those for gas-heated dwellings, at around 21% compared to 11%. Twenty one percent is closer to ODPM's estimation of a 25% saving. However, the majority of new build dwellings are gas-heated rather than oil-heated, so the savings in oil-heated dwellings will make only a small contribution to the overall savings in new build dwellings.

4.2.3. Electrically Heated Dwellings

For electrically heated dwellings, the 2005 Building Regulations are likely to produce a 7% carbon emission saving compared to dwellings currently passing the 2002 regulations, far below the 25% saving estimated by ODPM.

4.2.4. Summary For Case Study Dwellings

Overall, the effect of the new regulations depends greatly on the fuel type of the dwelling. This is evidenced by the fact that all the gas-heated dwellings, except the detached house, passed the 2005 regulations with their current specification, improved where necessary to meet the worst acceptable standards in the 2005 regulations. In fact, all the gas-heated flats could have passed even if they were built entirely to the worst acceptable standards. In contrast, more than half of the oil-heated dwellings did not pass with their current specification, even when it was improved where necessary to meet the worst acceptable standards in the 2005 regulations. Of the electrically heated dwellings, all but the top floor flat passed with their current specification, improved where necessary to meet the worst acceptable standards in the 2005 regulations. However, only electrically heated flats were investigated and it is likely that it would be more difficult for electrically heated houses to pass. Therefore the 2005 regulations will discourage the use of oil-heating and possibly electric heating, whilst encouraging the use of gas-heating, in new build dwellings.

The effect of the new regulations also depends on the exposed surface area of the dwelling. Built forms with small exposed surface areas, such as mid floor flats will comply much more easily than more exposed built forms, such as detached dwellings. For example, both the gas-heated and electrically heated mid floor flats passed without any packages, yet neither gas-heated nor the oil-heated detached house passed without packages. Therefore the result of these regulations may be an increase in the proportion of new build dwellings that are flats and terraced housing, and a corresponding decrease in the proportion that are detached houses.

Overall, the 2005 regulations are predicted in this study to save 9% in carbon emissions compared to dwellings currently being constructed. The 2005 regulations could be strengthened by altering the fuel factor in the TCER, to achieve greater savings from gas-heated and electrically heated dwellings. The magnitude of such savings has not been evaluated in this project. Alternatively, if the 2005 regulations were strengthened so that dwellings had to be built to the Base Case specification, then the CO_2 savings would be 17%. This compares with a predicted 16% to 21% saving if the regulations were amended to require a pass under the Carbon Index Method. Therefore it seems unlikely that ODPM's estimated carbon emission saving of 25% will be realised and even less likely that the large savings estimated by ODPM in Table 9 will be achieved.

4.3. Applying Packages To The Case Study Dwellings

Packages were only required in seven of the eighteen case study dwellings. In all cases, except the oil-heated large mid-terrace, the packages were sufficient to enable compliance. This indicates that the packages have been well designed by ODPM and in most cases will allow the dwelling to comply. Converting all the fixed lighting to fittings that will only take CFLs in the oil-heated large mid-terrace enabled this dwelling to pass and it is therefore possible that developers may frequently use CFLs to comply with the new regulations, as they are a cheap and easy method of reducing the DCER of the dwelling.