



# Lit up: an LED lighting field trial

The Energy Saving Trust



energy saving trust<sup>®</sup>

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## Executive summary

There is a revolution in lighting. Although Light Emitting Diode (LED) technology has been used in electronic products for many years, it has only recently become practical as a replacement for existing commercial light fittings.



St John's Wood, Ada Court

LED technology is developing very quickly, and the costs are falling. McKinsey & Company (management consultants) forecast that LED lighting has the potential to be the dominant technology in domestic and commercial lighting by 2015<sup>1</sup>.

The Energy Saving Trust recognised the potential of LED lighting several years ago. In 2008, we successfully bid for funding from the UK government's Environmental Transformation Fund to conduct a field trial into the feasibility of installing LED lighting into communal areas of social housing. Communal areas included stairwells, corridors and common rooms. Cost-effective, functional lighting is especially important in social housing, where communal areas are illuminated up to 24 hours a day.

The trial measured the performance, energy-saving potential and maintenance of light levels of over 4,250 LED light fittings across 35 different sites.

We found that LED lighting can:

- Significantly improve the lighting in social housing
- Reduce energy consumption
- Lower the cost of maintenance

The field trial categorically proved the effectiveness of modern LEDs as an energy-efficient source of light. The quality of lighting showed marked improvement at almost every site in the trial. This is true in terms of brightness, colour and distribution of light.

The improved performance of LED lighting when compared with previously existing lighting in the test sites is clearly demonstrated in the "before and after" photographs in the appendix.

<sup>1</sup> [http://www.mckinsey.com/en/Client\\_Service/Semiconductors/Latest\\_thinking/LED\\_at\\_the\\_crossroads.aspx](http://www.mckinsey.com/en/Client_Service/Semiconductors/Latest_thinking/LED_at_the_crossroads.aspx)

## The future

There is a key role for the Energy Saving Trust in helping to develop the LED lighting market in the UK.

The Energy Saving Trust believes that it is essential for consumers to have a good first impression. We are now promoting the benefits of LED lighting through our Energy Saving Trust Recommended programme.

The Energy Saving Trust will discuss the results of the field trial with the UK government and with OFGEM to encourage the inclusion of LED light fittings in existing and future energy-saving initiatives.

### Key findings

1. Lighting levels increased in both phases of the field trial. In phase 1, the increase was 100 per cent. In phase 2, it was 57 per cent.
2. When LED performance is normalised to account for increased light levels it is calculated that the new LED lighting in the sites will generate ongoing savings in excess of 3,372,058kWh per year across both project phases. This is equivalent to the energy needed to light 5,788 typical UK homes for a year.
3. The LED installations increased the "colour temperature" in buildings, giving a brighter, whiter light much closer to that of daylight. ("Colour temperature" is a measure of how "warm" or "cold" a light is. The old lighting systems in the sites had an average colour temperature of 3,344 Kelvin across both phases, which is close to the "warm white" that is typical of fluorescent lighting. The LED lighting typically raised the colour temperature to 5,086 Kelvin.)
4. The brighter, whiter light enhanced the ambience in most of the sites, as can be seen by the photographs in the appendix.
5. Colour rendering improved across most of the sites. This means that colours appear as they would under natural lighting conditions.
6. LEDs in the trial demonstrated an excellent sustained performance. Lighting levels, when measured after about six months of use, maintained an average performance of 93.6 per cent.
7. Using normalised figures, both phases of the trial suggested that return on investment could be around 2 years.

## Foreword

The Energy Saving Trust has been at the forefront of the development of energy-efficient lighting products for over sixteen years. We developed the first performance specifications for compact fluorescent light bulbs in 1995, when EESoP<sup>2</sup>, the first energy-efficiency obligations for energy suppliers, introduced subsidies for lighting products. EESoP was the predecessor of the current Carbon Emissions Reduction Target (CERT) which runs until the end of 2012.

Throughout this period, the performance specifications were adopted by the Energy Saving Trust Recommended scheme<sup>3</sup> with the requirement that any lighting product provided by energy suppliers had to be registered with Energy Saving Trust Recommended. This has ensured that the hundreds of millions of lamps supplied to domestic householders over this period have been of the highest quality and efficiency.

In recent years, the Energy Saving Trust Recommended scheme has widened its scope to include lighting products that utilise light-emitting diode (LED) technology. LED lighting technology has developed rapidly, and it now provides one of the most energy-efficient forms of lighting available. Little or no data was available on the actual performance of LED lighting when installed in real buildings, so it was decided to implement a field trial to carry out the necessary research.

The Energy Saving Trust is the UK's leading impartial organisation helping people to save energy and reduce carbon emissions. One of the key ways we do this is by providing expert insight and knowledge about energy saving methods and technologies. Our activity in this area includes policy research, technical testing and consumer advice. This field trial is one of many implemented by the Energy Saving Trust as part of our extensive market transformation activity in the low-carbon technology sector. It follows last year's report on our trial of heat pumps, *Getting Warmer: a field trial of heat pumps*. Other trials have looked at wind turbines, condensing boilers, advanced heating controls and various insulation products. *Here comes the sun*, our report presenting the results of our solar water heating field trial, was published on 13 October 2011.

The Energy Saving Trust is impartial, and is not tied to any particular commercial organisation or driven by political or corporate motivations. This enables us to work with a variety of industry stakeholders, who know our findings will be without bias. We use the results of our work to inform our advice services to the public, industry, governments, local authorities and other customers and stakeholders. The conclusions of this field trial of LED lighting will be of particular interest to the local authority sector and other sectors with similar day time lighting demands.

<sup>2</sup> Energy Efficiency Standards of Performance

<http://www.ofgem.gov.uk/Pages/MoreInformation.aspx?docid=171&refer=Sustainability/Environment/EnergyEff>

<sup>3</sup> <http://www.energysavingtrust.org.uk/business/Business/Energy-Saving-Trust-Recommended>

## The background

**Domestic energy use and associated CO<sub>2</sub> emissions account for a significant 32 per cent of UK totals. Lighting accounts for approximately 20 per cent of the electricity used in domestic homes in the UK<sup>4</sup>.**

**The Energy Saving Trust has always considered energy-efficient lighting an important area, and has led several different initiatives in this sector.**



Lewisham, Knowles Hill

LED lighting is a rapidly developing, energy-efficient technology. We were keen to test the performance of some of the newer products on the market when it was installed in social housing. As with other new technologies, a lack of independently assessed performance data can act as a barrier to investment. The Energy Saving Trust was therefore keen to undertake a field trial to provide the information needed to inform consumers, policymakers and industry on the actual performance of LED lighting.

In 2007, the Energy Saving Trust Innovations Programme funded a feasibility study into the installation of LED lighting in communal areas (stairwells, corridors etc.) of social housing. The study showed that there was considerable potential for achieving energy savings in such areas, particularly as the lighting is typically on for 24 hours every day. A methodology for a field trial of LED lighting was subsequently developed, and we were successful in bidding for funding from the Environmental Transformation Programme<sup>5</sup> to implement in 2008-09 and 2009-10.

Funds of up to £400 million were earmarked for the period 2008/09 to 2010/11 for the DEFRA Environmental Transformation Fund (ETF). The ETF aimed to encourage the development of low-carbon energy and energy-efficiency technologies in the UK, speeding up their commercial use and reducing overall energy demand. A field trial of LEDs, which analysed the product performance in detail, which in turn could be used to inform and stimulate demand for the technology, met the ETF criteria perfectly. The Energy Saving Trust was subsequently awarded £1m to implement the field trial.

The trial was originally planned to run in three separate phases, beginning in April 2008. Phase 1 and phase 2 were completed but, unfortunately, phase 3 had to be cancelled in September 2010 due to Government spending cuts to a wide range of programmes. Despite this, the field trial still succeeded in installing and monitoring the performance of over £900,000 worth of LED lighting in a wide range of social housing sites throughout England.

<sup>4</sup> Energy Consumption in the UK: DECC 2011

<http://www.decc.gov.uk/en/content/cms/statistics/publications/ecuk/ecuk.aspx>

<sup>5</sup> [http://www.decc.gov.uk/en/content/cms/funding/funding\\_ops/innovation/historic/historic.aspx](http://www.decc.gov.uk/en/content/cms/funding/funding_ops/innovation/historic/historic.aspx)

This report presents the results and conclusions of the field trial. Particular attention should be given to the appendix of this report. It contains samples of the 'before and after' photography taken at a range of the test sites. Pictures can speak louder than words.

### Energy Saving Trust Innovation Programme feasibility study

In 2007, an Innovation Programme grant was awarded to Lighting Association Laboratories<sup>6</sup>. The grant was for a feasibility study that looked into the benefits of LED lighting systems, with a particular focus on their installation in social housing sites.

The desk study focused on the lighting requirements of communal areas in Denseat House sheltered accommodation facility in Aberdeen. Areas where lighting was in continuous use, such as corridors, stairwells and other areas of frequent use, were chosen to demonstrate the potential of LED lighting to reduce costs and relative CO<sub>2</sub> emissions. In most instances, the areas were already fitted with energy-efficient compact fluorescent lamps (CFLs).

The feasibility study showed that LED lighting had a number of potential benefits over existing CFL and incandescent lighting systems in 'like for like' replacement installations. It was found that LED lighting had lower operating costs, consumed less electricity and resulted in lower CO<sub>2</sub> emissions. Reductions in these could be as high as 19 per cent. LED lighting technology was significantly more expensive to purchase than CFL technology, which resulted in higher installed costs, but LEDs had an additional cost-benefit because of their reduced maintenance costs and their much longer operating life span. LED light fittings are likely to follow a trend similar to that of CFLs by reducing in cost over the coming years. If that proves to be the case, then the reduced emissions and lower operating costs would make LED lighting a cost-effective way to reduce CO<sub>2</sub> emissions.

The study also concluded that the lack of 'off the shelf' lamps, and the requirement of bespoke fittings for a new installation, significantly impacts upon the payback time for installing LED-based lighting.

By the time phase 1 of the Energy Saving Trust field trial was implemented, it was clear that this last conclusion had been rectified by the rapid development of LED technology. There were several companies in the UK who were by now manufacturing 'off the shelf' fittings, which were suitable for installation as direct retrofits for the existing lighting. The variety and efficiency of available products increased throughout the trial and continues to do so today.

.....  
**LED lighting has lower operating costs, consumes less electricity and results in lower CO<sub>2</sub> emissions.**  
 .....

<sup>6</sup> <http://www.lightingassociation.com/lighting-association-laboratories/>

## What is a light-emitting diode (LED) and how does it work?

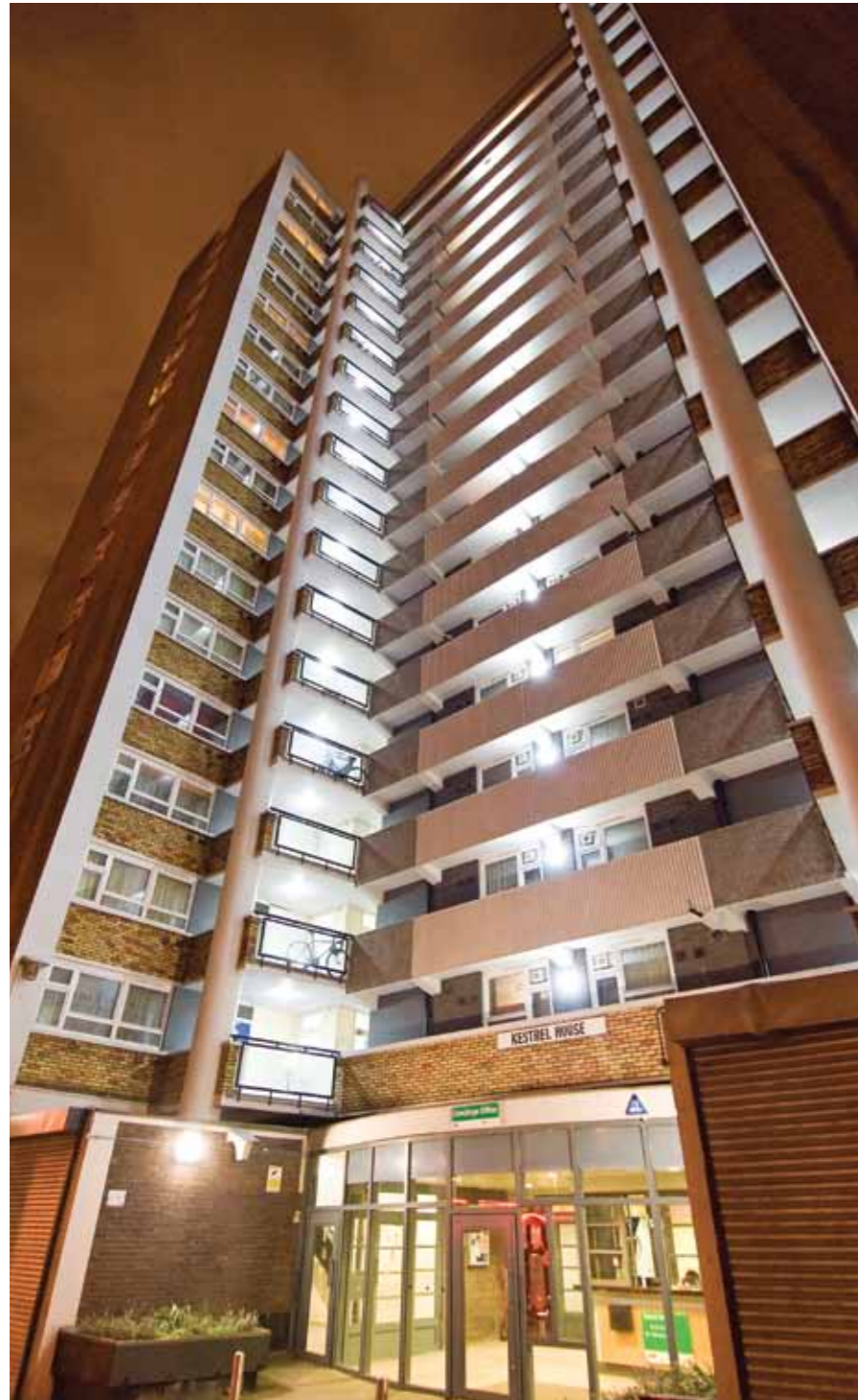
Light-emitting diodes have for many years been used as indicators (such as red standby indicators on TVs). At first, they were available only as a red light source, and their output was not high enough for general illumination. As the technology developed, other colours became available and so LEDs successfully found other roles in a wide range of appliances and equipment.

The next stage of development saw the material's technology becoming more advanced: light output rose while maintaining efficiency and reliability at acceptable levels. The invention and development of high-power white light LED led to its use as illumination. It is now fast replacing incandescent and fluorescent lighting.

LEDs are available in many different colours. White light is created by one of several methods: for example, by mixing red, blue and green light (RGB LEDs), by mixing blue LED plus yellow phosphor or by mixing ultraviolet LED and RGB phosphors.

It is claimed that LEDs can last up to 100,000 hours compared with 1,000 hours for typical incandescent lamps, 10-15,000 hours for CFLs and 15-30,000 hours for fluorescent tubes. They use solid state technology: they have no moving parts, no glass and no filament breakage. The LED products installed in the field trial were typically constructed from LED chips and an associated driver contained in a light fitting – thus classed as an LED luminaire.

LED lamps differ from all other lamp types. They combine the highest efficiency (using up to 90 per cent less energy than conventional incandescent lamps) and a very long life span. The long service lives of the LED lamps therefore have the additional benefits of reducing waste volumes and conserving production resources due to less frequent maintenance and replacement.



Kestrel House exterior



Kestrel House exterior

## Field trial methodology

The trial was developed as a competitive grant scheme originally planned to run in three separate funding phases in 2008/09, 2009/10 and 2010/11. Funding for the field trial was cut in 2010, so the third phase was cancelled.

Initial work focused on establishing expressions of interest from social housing providers and LED manufacturers and suppliers. Guidance documents setting out the scope, objectives and timescales of the trial were developed and disseminated via several routes. The Energy Saving Trust works closely with both of the main UK lighting trade bodies, the Lighting Association (LA) and Lighting Industry Federation (LIF). Both of these organisations disseminated the guidance documents to their members who are active in the LED sector, which led to many expressions of interest.

Given the nature of our work, the Energy Saving Trust also has substantial interaction with the social housing sector. The guidance documents were disseminated to them through two main routes. The first was a presentation to the Energy Efficiency Partnership for Homes Local Authority Group and subsequent distribution of documents to all its members. The involvement of our Practical Help programme was also instrumental in ensuring we were able to issue the guidance documents to all social housing providers in England. A stipulation of the trial's ETF funding was that the money could be spent only in England. Interested parties were asked to provide details of potential sites and the numbers and types of lighting that was currently being used. Approximately 40 expressions of interest were received through this process.

LED suppliers and social housing providers were subsequently invited to work together to develop bids for funding from the Energy Saving Trust. Approximately £300k was available for phase 1 of the trial. Those who were preparing bids were advised that the LED field trial would provide 80 per cent of the cost of the LED fittings and that they would have to cover the cost of installation. It should be noted that the

LED fittings were all retrofit products that could easily be installed by existing maintenance staff in place of the old fittings. Drivers and control gear were all contained within the LED fittings. This means that they did not need complicated electronics.

The Energy Saving Trust's experience in assessing various energy efficient lighting technology has made it clear that the quality of performance can differ significantly between different products. A performance specification was therefore developed to ensure the new LED lighting was of high quality, and included requirements for lifetime, maintenance of performance and electrical safety. LED suppliers provided data to prove their products met the field trial specification.

Funding, in the form of a grant offer letter, was then disseminated to the most favourable bids until the funding pot was exhausted. Grants were paid to the participating social housing providers as soon as they provided evidence that the LED fittings had been both procured and installed.

Phase 2 of the trials was carried along very similar lines to phase 1. The main difference was that the percentage of funding the trial provided towards the cost of the LED fittings was reduced to 70 per cent. Approximately £300k was available in the funding pot and the reduction in percentage costs provided allowed a greater number of sites to participate. We had noted that the social housing providers had experienced some difficulties in deciding which LED manufacturers/suppliers to potentially work with. A location in central London was hired for a day and representatives from interested LED companies and social housing providers were invited to attend. This gave the LED companies a chance to display their products and discuss their potential with the housing managers. Several relationships were forged during this event that led to successful bids for funding.

## On-site performance monitoring undertaken during the trial

A key aspect of the LED field trial was to take in-situ measurements of the performance of the lighting that was already in place, and then to take in-situ measurements of the performance of the new LED lighting. The Energy Saving Trust needed to measure the performance of the existing lighting in several areas throughout each social housing site. Lux (light) levels and colour temperature were then measured in exactly the same positions as soon as the LED lighting had been installed. A further set of measurements was taken approximately six months later, to establish the maintenance of the lux levels and colour over time. Digital photographs of the lighting and measurement locations were also documented. The final task was to identify and report on the number and type of existing light fittings on site as well as the new LED lighting once they had been installed.

There was a tender process to select a suitable monitoring contractor to undertake these measurements. The contract was awarded to The Lighting Association Laboratories, who had undertaken much of the product testing for Energy Saving Trust Recommended lighting applications. They undertook all the measurements required throughout phase 1 and phase 2 of the field trial. Suitably calibrated measurement equipment was used at all times. The results were presented in site-specific reports.

## Laboratory testing of old light fittings and new LED fittings

In addition to the on-site measurements, the Energy Saving Trust also required measurements of the actual performance of both old light fittings and new LED fittings to be undertaken in laboratory conditions. The purpose of these measurements was to establish the true performance of the lighting rather than relying on manufacturers' claims. The measurements would also help to validate calculations of energy savings generated by the LED lighting.

The contract to undertake these measurements was also subject to tender and was again awarded to The Lighting Association Laboratories. The measurements specified were:

- Lux level
- Colour temperature (CCT)
- Colour rendering (CRI)
- Power factor
- Actual power consumption of the fittings

Social housing managers participating in the trial were required to make old light fittings and new LED fittings available to The Lighting Association Laboratories for the purposes of these measurements. The results of the measurements were added to the site-specific reports.

## 'Before and after' photography

When planning the LED field trial it was clear that professional photography would be a valuable aid in assessing the performance of both the old and new lighting. While the Lighting Association Laboratories measurements are essential in understanding the true performance of the lighting, they are relatively meaningless to the layman. Well-structured photographs, taken at several locations in a selection of the social housing sites, give an excellent visual record of the performance of both the old and new lighting. A selection of the 'before and after' photographs is displayed in the appendix of this report.

The photography contract was awarded to Simon Punter<sup>7</sup>. One of the key aspects of this part of the trial was to ensure that the 'before and after' photographs were taken from exactly the same positions and that they used identical exposure settings. The photographs contained in this report were taken using this methodology and were not subjected to any post-production processing. This ensured that they were un-doctored records of the true performance of the lighting.

The text below was submitted by Simon Punter to discuss his approach in undertaking the project. It sets out the methodology he employed and it discusses the importance of representing the performance of lighting through photography.

<sup>7</sup> <http://simonpunter.com/>

*The methodology behind this shoot for the Energy Saving Trust was unlike any other I have followed before. In the most scientific way possible, we hoped to show pictorially a comparison of the old fluorescent lighting and the new LED lighting installed at the various social housing locations. "Before and after" photographs were taken to illustrate brightness, colour temperature, spread of light and rendering of colour.*

*My approach was as follows. I would visit each location and choose a number of areas to shoot. Then I would photograph each view using a broad range (4-6) of exposure settings.*

*I would then photograph my camera tripod in position, usually including a conspicuous object or feature (such as a numbered door of a flat).*

*Once the new lighting had been installed I returned to each property. The tripod was then placed in exactly the same position as before to ensure that I captured the same view. I shot these photos at all the same camera settings, regardless of how the photo looked. This then gave us a direct comparison.*

*One of the ways in which this job was unlike a normal interiors shoot is that normally, when photographing an interior, I would use studio-style flash heads to evenly light a room or space and I would aim to balance this light with any ambient daylight (coming in from any windows and doors) and to complement any existing artificial lighting there, such as tungsten or fluorescent lighting. However, with this project absolutely no additional lighting was used - the only light sources in the photos are the old and new lights that are being compared.*

*Another aspect of this shoot that made it unusual is that I would normally do some post-production work on my computer in Photoshop. Adjustments are usually made to the raw file of every photo that a client chooses to use, to improve the image. This includes adjustments to numerous aspects such as colour temperature, tint, exposure, contrast, shadow detail, colour saturation, etc. However, the necessity for this shoot to produce photos that were an exact*

*un-doctored record of a real situation meant that I did none of this work.*

*The combined effects of the eye and the human brain made it necessary to record images photographically (with a digital sensor or with film) for this project, rather than just rely on getting feedback on performance from the tenants/landlords.*

*Our eyes have a broader dynamic range than any camera sensor or film emulsion, so we are able to record detail in a wider range of shadow and highlight areas. If we were to look around a scene our eyes would automatically adjust so that we can see into dark areas and similarly into very light areas. Our brains also take into account all the extraneous light around these views, so that we believe that the poor "before" lighting was actually not as bad as the photos show and as it really is. Interpretation of colour is also adjusted. For example, if one views a scene lit by traditional household bulbs, one would see the colour white as white, but if we were to photograph this scene using film there would be an orangey colour cast - as there would also be in an uncorrected digital camera raw file. So, when I did the "after" photographs, although it was instantly obvious in many of the situations that the new lighting was better than the old, it was only when we looked at the photos that we saw the full extent of the improvement. Not only were the new light levels generally higher, the colour temperature was much closer to daylight, which means that colours were recorded as they should be. An example of this was a blue doormat at one location which appeared on the "before" photos as a dark patch, but appeared on the "after" photos as blue. This shows that the colour rendering of the new lighting is superior.*

*The spread of light was now much more uniform, so a lot of the areas of shadow and pools of harsh direct light of the old lighting were now shown in the photos (but not seen by the eye, because of the reasons mentioned above) as being lit evenly.*

*In every aspect, in most of the locations in this field trial, the photographs I took prove that the new LED lighting is superior to the old lighting.*

## Phase 1 of the LED field trial – Results

### Phase 1 Overview

Phase 1 of the field trial was implemented in 2008–09, beginning in June. Approximately £300k was available in the funding pot, this money providing 80 per cent of the cost of the LED fittings. Eight social housing providers were successful in bidding for funds for the installation of LED light fittings at a total of sixteen different sites. Seven different LED lighting suppliers were involved, and the fittings they provided were installed by the end of March 2009.

Exactly 1,846 individual LED light fittings were installed. The Energy Saving Trust provided a total of £290k towards the cost of the lighting. The total value, including VAT, of

the new LED lighting was £394k, an average of approximately £213 per fitting. In nearly all cases, the new LED fittings were installed in place of various types of fluorescent fittings.

Energy and carbon savings would be considerably greater should incandescent light fittings be replaced. The most typical type of existing fittings replaced were circular 2D fluorescent fittings, various lengths of fluorescent tubes and recessed modular fittings. LEDs are particularly suitable for replacing lighting in communal areas where it is on for up to 24 hours a day. This is because the additional savings from switching to LEDs will repay the extra capital cost over a shorter period, compared with other lighting technology.

Table 1

Social housing provider	Name of site	LED supplier	Number of LED fittings installed	Funding awarded (£)
Suffolk Heritage Housing Association	Richard Kitson Court	Philips	160	14,234
New Charter Homes Ltd	Cavendish Mill	ASD Lighting (Ideal Lights)	413	85,629 (10,292)
	Assheton House	ASD Lighting	321	62,900
	Hunters Court	ASD Lighting	27	5,989
Homes for Islington	Kestrel House	Design Plan	154	18,357
	Gambier House	LEDxON	97	18,629
East Midlands Housing Association Ltd.	James Murray Mews	Illuma	86	18,087
	Rendell Street	Illuma	45	9,464
	Hicks Court	Illuma	15	3,155
Coastline Housing Ltd	Miners Court	ASD / Illuma / Philips	253	49,503
Gateshead	Kellsway Flats	Park Electrical	18	3,995
Places for People	Ridings Court	Ideal Lights	64	n/a (3,729)
	Connaught House	Ideal Lights	43	n/a (2,323)
Solihull Community Housing	Dasset Road	Ideal Lights	56	n/a (3,581)
	Longview	Ideal Lights	52	n/a (3,181)
	Masons Way	Ideal Lights	42	n/a (2,654)
Summary			1,846	289,942

**Table 1 Note.** Sites with n/a in the 'Funding Awarded' column did not receive funding from the field trial but still installed LEDs using their own funding. The figures in brackets show the value of this levered funding.

### Phase 1 Site details

Table 1 shows the different sites that successfully had LED lighting installed, the social housing provider, the total number of fittings installed at each site and the amount of funding awarded.

### Phase 1 Energy savings

The field trial did not involve actual energy monitoring of the lighting energy used at each site, mainly due to the fact that at most sites it would be difficult to isolate and monitor just the electricity used for lighting. Calculations of lighting energy-use before and after the installation of the LEDs have

therefore been undertaken, based on the number and wattage measured of the old and new light fittings and the assumption that the lights are on for 24 hours per day, seven days per week, for fair and equal comparison as some of the LEDs were installed with additional controls.

Table 2 (below) summarises the calculated amount and value of energy savings generated by the LED lighting for each site. The table also illustrates annual CO<sub>2</sub> savings, the cost of the LEDs and the lifetime CO<sub>2</sub> savings. It is not possible to compare different sites on a like-for-like basis, nor is it possible from these results to fully understand the energy saving potential of the LEDs installed. This is due to the fact that in some cases the new LED fittings also contained an emergency lighting unit (therefore increasing the cost)

Table 2

Name of site	Total energy saving (kWh/a)	Annual value of energy saved (£)	LED cost (£)	Investment payback (years)	CO <sub>2</sub> Saving (t/a)	tCO <sub>2</sub> Saving lifetime (t)
Richard Kitson Court	8,122	1,133	17,793	15.7	5	26
Cavendish Mill	-19,091	-2,663	117,327	n/a	-11	-61
Assheton House	-45,679	-6,372	81,306	n/a	-26	-147
Hunters Court	-3,786	-528	7,487	n/a	-2	-12
Kestrel House	28,195	3,933	26,388	6.7	16	90
Gambier House	12,224	1,705	23,286	13.7	7	39
James Murray Mews	8,438	1,177	22,608	19.2	5	27
Rendell Street	4,415	616	11,830	19.2	2	14
Hicks Court	1,472	205	3,943	19.2	1	5
Miners Court	73,156	10,205	61,879	6.1	41	235
Kellsway Flats	389	54	4,944	92	0.2	1
Ridings Court	15,101	2,107	3,729	1.8	8	48
Connaught House	5,977	834	2,323	2.8	3	19
Dasset Road	18,504	2,581	3,581	1.4	10	59
Longview	14,363	2,004	3,181	1.6	8	46
Masons Way	13,251	1,849	2,654	1.4	7	43
Summary	135,051	18,840	394,309	20.9	74.2	432

**Table 2 Note.** Value of energy saving is based on an average unit price of 13.95p (2008 prices). Lifetime CO<sub>2</sub> savings based on average LED lifetime of 50,000 hours, lamps being used 24hrs per day.



and in nearly all sites the opportunity was taken to greatly enhance the existing light levels by installing brighter lighting and sometimes additional fittings. In order to fully reflect the energy saving potential of the LED lighting, additional calculations have been undertaken using a normalised methodology. This is explained later in the report.

The wattages of both the old fittings and the new LED fittings were confirmed (where samples were provided) by the Lighting Association Laboratories tests and used in the energy and CO<sub>2</sub> saving calculations. The return on investment shown in table 2 is calculated in simple terms – by comparing the total cost of the LED fittings against the energy they save. They do not factor in other savings that are generated by the much longer lives of the LED products – typically between

two and five times greater than the fittings they replaced. The longer lifetime will lead to additional savings from avoiding the costs of replacement lamps and the maintenance time to fit them. These estimated costs are factored into the case study for Cavendish Mill shown later in the report.

The results have shown the significant energy savings that can be generated by LED lighting, even when replacing existing fluorescent fittings. With increased investment in this type of LED fittings, unit costs should reduce and payback periods will become shorter. Energy supplier subsidies for CFLs has led to a price reduction of around £15 in the late 1990s to approximately £2–3 in 2010, showing as an example the effect that increased production and distribution numbers can have on price.

Table 3

Name of site	Normalised energy saving (kWh/a)	Annual value of energy saved (£)	LED cost (£)	Return on investment (years)	CO <sub>2</sub> Saving (t/a)	tCO <sub>2</sub> Saving lifetime (t)
Richard Kitson Court	30,702	4,283	17,793	4.2	17.3	98.5
Cavendish Mill	365,278	50,956	117,327	2.3	205.3	1,171.7
Assheton House	214,946	29,985	81,306	2.7	120.8	689.5
Hunters Court	22,274	3,107	7,487	2.4	12.5	71.4
Kestrel House	128,267	17,893	26,388	1.5	72.1	411.4
Gambier House	78,366	10,932	23,286	2.1	44	251.4
James Murray Mews	10,549	1,472	22,608	15.4	5.9	33.8
Rendell Street	2,108	294	11,830	40.2	1.2	6.8
Hicks Court	-58	-8	3,943	n/a	0	0
Miners Court	139,425	19,450	61,879	3.2	78.4	447.2
Kellsway Flats	1,087,598	151,720	4,994	0.03	611.2	3,488.7
Ridings Court	n/a	-	-	-	-	-
Connaught House	n/a	-	-	-	-	-
Dasset Road	16,467	2,297	3,581	1.6	9.3	52.8
Longview	n/a	-	-	-	-	-
Masons Way	n/a	-	-	-	-	-
Summary	2,095,922	292,381	382,422	1.31	1,178	6,723.20

**Table 3 Note.** Sites with n/a in the 'Normalised energy saving' column were not visited by the Lighting Association. We are therefore unaware of the performance of the LEDs and are not able carry out the normalised energy saving calculations.

As mentioned previously a good way of illustrating the true energy saving potential of LED lighting is to calculate energy savings on a 'normalised' basis. By this we mean this takes into account the lighting levels at each site both before and after the installation of the LED lighting.

In order to perform a fair and equal comparison between the LEDs and the existing lighting, energy saving calculations were normalised based upon measured light levels. The energy consumed by the existing lighting was multiplied by the percentage change in light levels generated by the LED lighting enabling a comparison to be made on a like for like basis.

The Lighting Association Laboratories measurements, discussed in the next section of this report, clearly illustrate how the LED lighting has greatly enhanced lighting levels at the majority of sites (a 100 per cent increase in lux levels in phase 1). In many cases an increase was specifically required by the participating housing managers.

Table 3 presents the results of these normalisation calculations for each site involved in phase 1. The table illustrates what the energy savings would be if the existing lighting had the same light levels as the new LEDs – they would have had to consume far more energy (and have far more fittings in place) to generate such an increase in light.

The key fact that the table shows is that, on a normalised energy saving basis, the LED lighting would return its original investment cost in less than two years – far less than the approximate lifetime of the products installed.

Interest generated by phase 1 of the trial resulted in a lot of enquiries from LED manufacturers, resulting in a wider range of products becoming available for phase 2.



Gambier House (before)



Gambier House (after)



Miners Court (before)



Miners Court (after)

## Phase 1 LED performance – Lighting Association Laboratories measurements

Lighting Association Laboratories was employed to undertake in-situ measurements of lighting levels at each site where new LED fittings were installed. Measurements of colour temperature were also taken. Colour temperature (measured in degrees Kelvin) illustrates how 'warm' or 'cold' the light colour is. Most domestic lighting has a colour temperature of around 2,800K, often described as 'warm white'. LED lighting is available in a wide range of colour temperatures, but is most commonly found in much higher temperatures such as 5,500K – 6,500K. This gives a bright, whiter light much closer to that provided by natural daylight.

An initial set of readings was taken with the original lighting in place. Several representative measurement points were used throughout each site with the same points used for subsequent readings. A second set of readings was taken after the LEDs were installed. A final set of readings followed approximately six months after the LEDs had been installed to ensure that they were still functioning satisfactorily.

Table 4 sets out the results of the Lighting Association Laboratories measurements. The Lux (lx) levels and colour temperatures displayed are an average of readings taken throughout each site. The percentage change in light output at each visit is also displayed.

The results shown in the table clearly illustrate the improvements created by the LED lighting.

Existing lux levels were generally unsuitable (an average of 63lx across the sample) for communal spaces where 24-hour illumination is needed. In some areas, existing lux levels were “satisfactory” or “good” as reported by Lighting Association Laboratories but most of the sites needed an upgrade in lighting levels.

In some cases the installation of LED fittings led to very significant increases in lux levels. There was an average increase of 100 per cent across the sample (126lx). This is despite three sites (James Murray Mews, Rendell Street and Hicks Court) where lighting levels barely increased or even decreased. The LED fittings installed at these three sites were described by Lighting Association Laboratories as ‘not fit for purpose’.

All the remaining sites, except Dasset Road, took the opportunity to install brighter lighting and enhance the lighting levels throughout. Hunter’s Court and Assheton House improved average lighting levels by 664 per cent and 512 per cent respectively, which was achieved by installing a greater number of higher efficiency and brighter light fittings. The new lighting has also reduced ‘pooling’ of light and areas of shadow and gives a much more even distribution of light. The dramatic increase in light levels at these two sites meant that there was no energy saved. This was typical of many of the sites involved in the field trial. The majority of sites, with properly specified LEDs, have saved energy and improved lux levels which clearly illustrates the dual benefits LED lighting can bring.

The same measurements were taken again after approximately six months of operational use. Average lux levels had decreased slightly, which is to be expected with all lighting technology, to an average of 119.5lx across the sample. This represents maintenance of lux levels of 93.6 per cent over the six-month period. Miners Court and Hunters Court actually experienced increases in light output of 23.9 per cent and 5.5 per cent respectively. Overall, the LED lighting experienced excellent ongoing performance over the first six months of operation.

The impact of the LED lighting on colour temperature is also clear. The existing lighting had an average colour temperature of 3,219K, which is close to the typical ‘warm white’ colour produced by fluorescent lighting. LEDs are more efficient the whiter or colder the light is, and this obviously influenced the type of LEDs specified for installation. The average colour temperature across the sample significantly increased to a cooler 4,883K. This shift in colour is clearly illustrated in the photographs in the appendix of this report. The cooler, brighter light has greatly enhanced the ambience within most of the sites.

Colour rendering has also improved, which means that colours appear much sharper. Interestingly, average colour temperature had increased by approximately six per cent when the six-monthly measurements were taken. While some sites experienced huge increases in colour temperature (Cavendish Mill, Kestrel House) others, such as Gambier House and Richard Kitson Court, maintained similar colour temperatures. This shows that LED lighting can give familiar ‘warm’ colour temperatures if desired.

Due to the funding cuts suffered by the field trial, the planned customer satisfaction exercise was not undertaken. Despite this, many anecdotal comments were received from the housing managers involved. Some examples are given below:

- *“The lighting has made a major transformation at all three sites, the results are fantastic; it will be interesting to compare ‘before and after’ photographs and data; staff and residents at all sites have made favourable comments on the improvements. Anyone willing to visit is quite welcome – if they contact me I will arrange.” – Mike Walsh, New Charter.*
- *“Fantastic! Everyone’s happy: staff and residents! We will be internally decorating the scheme shortly to complement the new fittings as the new level of light actually shows the true colours of the walls. Might pay to have photos taken following the new decorations.” – David Wilkinson, Flagship Housing.*
- *“Yes, tenants are very happy with lighting, especially in the knowledge that they are cheaper to run, which will reflect in their service charge.” – Vince Ward, Southern Housing Group.*
- *“During a recent consultation regarding community heating, residents commented on how the lights had improved the building.” – Alan Sandey, Gateshead Housing Company.*
- *“We have now finished another big scheme using ASD with the microwave sensors and have also installed LED street lights on another project; we are now looking into an even bigger scheme for communal LEDs.” – Vince Ward, Southern Housing Group.*

Table 4

Name of Site	Existing average lux	Initial LED average lux	% Change	6 Month LED average lux	% Maintenance	Existing colour (K)	Initial LED colour	6 Month LED colour
Richard Kitson Court	121.3	215.8	77.90	173.7	80.5	3,145	3,900	3,761
Cavendish Mill	62.3	291.7	368	242.8	83.2	3,143	6,098	6,510
Assheton House	51.1	311.8	512.40	298.4	95.4	3,307	6,576	6,893
Hunters Court	18.9	144.1	664	123	85.4	3,772	5,808	6,376
Kestrel House	20.7	62.4	201	59.43	95.3	3,194	5,775	6,845
Gambier House	22	71	223.40	66.9	94.2	3,641	3,925	4,396
James Murray Mews	11.8	13.3	12.70	12.95	97.7	2,803	3,726	3,721
Rendell Street	17.6	12.93	-26.60	11.24	86.7	2,970	3,778	3,865
Hicks Court	20.8	9.81	-52.90	10.4	105.5	2,811	3,935	4,474
Miners Court	97.7	158.2	62	196	123.9	3,423	5,050	4,940
Kellsway Flats	12.3	79.8	547.41	-	-	3,017	6,552	-
Ridings Court	79.9	-	-	-	-	3,544	-	-
Connaught House	93.2	-	-	-	-	3,155	-	-
Dasset Road	154.6	143.52	-7.2	-	-	3,035	3,477	-
Longview	161.8	-	-	-	-	3,321	-	-
Masons Way	-	-	-	-	-	-	-	-
Summary	63	126	100%	119.5	92.6	3,219	4,883	5,178

Table 4 Note. Maintenance calculated from all sites except Kellsway Flats and Dasset Road due to lack of 6 month LED lux data.

The installation of LED fittings led to very significant increases in lux levels. The new lighting has also reduced ‘pooling’ of light and areas of shadow and gives a much more even distribution of light.

The impact of the LED lighting on colour temperature is also clear. The cooler, brighter light has greatly enhanced the ambience within most of the sites. Colour rendering has also improved, so that colours appear much sharper.

## Phase 1 Case Study – Cavendish Mill

Cavendish Mill received the biggest grant under phase 1, with £87,837 awarded. Cavendish Mill is a Grade 2\* listed former cotton mill converted to flats in 1994. It contains 161 one-bedroom and four two-bedroom flats arranged over seven floor levels, plus offices, staircases, communal areas, storerooms and a car park.

The existing lighting operated satisfactorily in some areas, while others were dim and suffered from pooling of light and areas of shadow. All of the lighting operated for up to 24 hours per day. The light fittings consisted of the following:

- 600 x 600mm recessed modular 2 x 18W
- 600 x 600mm recessed modular 3 x 18W
- Bulkhead 28W 2D
- 1500mm 58W fluorescent tubes IP44

New Charter Homes Ltd chose to contract with ASD lighting to procure the new LED fittings, using in-house staff to install them. The new LED fittings were

- ASD Harmony 532mm White Opal 18/LED bulkhead type fittings (many of these fitted with emergency lighting unit)
- Ideal Lighting units with up to four 600mm LED tubes and diffusers
- Ideal Lighting units with 1200mm LED tubes and diffusers.

The energy savings generated by the new LED fittings were calculated as follows:

- Combined wattage of original lighting fittings = 11,922W
- Increase in lighting levels when LEDs installed = 368.036%
- Normalised wattage of original lighting:  $11,922 \times (1 + 368.04\%) = 55,799.7\text{kWh}$
- Annual normalised energy use of original lighting:  $(55,799.7 \times 8,760) / 1000 = 488,805\text{kWh}$
- Wattage of new LED Lighting fittings = 14,101W
- Annual energy use of new LED fittings:  $(14,101 \times 8,760) / 1000 = 123,527\text{kWh}$
- **Annual energy saving:**  $488,805 - 123,527 = 365,278\text{kWh}$

The LED fittings have a declared lifetime of at least 50,000h. When used for 8,760h per year (continual use) the LEDs should have an operational lifetime of approximately five years. This is a much longer operational lifetime than the existing fittings (little more than one year for fluorescent products with an assumed 10,000h lifetime) meaning that there should be cost reductions in maintenance time spent replacing bulbs and replacing fittings. Table 5 compares the cost of procuring and running both the existing lighting and the new LED lighting, taking into account unit cost, energy consumption and maintenance costs.

This worked example shows that, on a normalised energy saving basis, lighting the site using LEDs over a five-year period could cost over £150,000 less than with the original lighting assuming similar light levels. The vast majority of this saving is due to reduced energy bills, but there is also a significant saving in the cost of replacing the existing light bulbs as they are assumed to fail every 10,000 hours or so. The cost of the LED fittings used at this site would also have been significantly cheaper if the decision hadn't been taken to have a large number of emergency lighting units installed within the new light fittings. Further reductions in the cost of LED fittings as the sector grows will further increase the feasibility and cost effectiveness of such installations in the future.

**The LED fittings have a declared lifetime of at least 50,000h. Lighting the site using LEDs over a five-year period could cost over £150,000 less, not only due to reduced energy bills, but also savings on replacing existing bulbs.**

Table 5

Cost / Energy	Existing lighting	New LED lighting
Number of fittings	323	413
Installation cost (£)	34,709	44,380
Fittings (£)	12,370	117,327
Lamps (£)	1,444	0
5 Year energy consumption (kWh)	2,444,028	617,637
Operation cost (£)	340,942	86,160
Lamp lifetime (h)	10,000	50,000
Lifetime maintenance cost (£)	9,154	0
<b>Summary lifetime cost (£)</b>	<b>398,619</b>	<b>247,867</b>

**Table 5 Note.** Installation cost assumed to be £107 per fitting for both existing and LED lighting. Modular fittings and fluorescent tube fittings assumed to cost £40. 2D fittings assumed to cost £35. 18W T8 tubes assumed to cost £4, 2D lamps £5 and 58W tubes £8. All cost inc. of VAT. Maintenance cost is for replacement lamps and includes an assumption of cost for time spent changing bulbs which is £2 per bulb. Lifetime of existing lighting assumed to be 10,000 hours.

## Site photographs

More examples can be found in the appendix.



Cavendish Mill (before and after)

## Phase 2 of the LED field trials – Results

### Phase 2 Overview

Phase 2 of the field trial was implemented in 2009–10, beginning in May with approximately £300k available in the funding pot. There were far more expressions of interest in phase 2 than in phase 1, largely due to increased awareness of the field trial and the facilitation event hosted by the Energy Saving Trust.

In order to incorporate more sites and housing providers it was decided that ETF funding would provide 70 per cent of the cost of the LED fittings installed. This allowed the funding to focus on maximising the number of LED fittings installed in phase 2.

In phase 2, twelve social housing providers were successful in bidding for funds for the installation of LED light fittings at

a total of nineteen different sites. Nine different LED lighting suppliers were involved. The fittings they provided were all installed between January and March 2009.

Phase 2 saw the procurement and installation of 2,410 individual LED light fittings. The Energy Saving Trust provided a total of £292k towards the cost of the lighting. The total value, including VAT, of the new LED lighting was approximately £507k, an average of £210 per fitting. As in phase 1, the new LED fittings were installed in place of various types of fluorescent fittings.

Table 6

Social housing provider	Name of site	LED Supplier	Number of LED fittings installed	Funding awarded (£)
Bracknell Forest Homes	Ladybank	Photon Star	106	16,110
Peddars Way	Doris Barnes Court	ASD / LEDxON	209	35,112
St Leger	Woodland View	Ideal Lighting	57	2,521
	Park View	Ideal Lighting	43	2,119
South Wight	Rope Walk	ASD Lighting	73	9,037
United Residents	Elmore House	Coughtree	42	9,914
	Leicester House	Coughtree	95	24,921
Central & Cecil	Ada Court	LED Eco Lights / SH Lighting	233	14,113
	Dora House	LED Eco Lights / SH Lighting	283	17,616
Gateshead	Eslington Court	Park Electrical	321	46,081
	Redheugh Court	Park Electrical	321	46,081
Lewisham	Knowles Hill	ASD lighting	20	n/a (2,633)
	Adamsdrill Road	ASD Lighting	16	n/a (1,986)
	Lewisham Park	ASD Lighting	71	n/a (8,498)
Wrekin	Maddocks Court	ASD Lighting	90	9,525
Homes for Islington	Ilex House	Illumination	104	13,270
Devon & Cornwall	Vivian Court	ASD Lighting	72	11,917
	Michelle Court	ASD Lighting	100	21,339
Peabody	Ipsden Buildings	Illumination Lighting	154	12,241
Summary			2,410	291,917

**Table 6 Note.** Sites with n/a in the 'Funding Awarded' column did not receive funding from the field trial but still installed LEDs using their own funding. The figures in brackets show the value of this levered funding.

### Phase 2 Energy savings

Calculations of lighting energy use before and after the installation of the LEDs have been undertaken, based on the number and wattage of the old and new light fittings and the assumption that the lights are on for 24 hours per day, seven days per week.

Table 7 summarises the calculated amount and value of energy savings generated by the LED lighting for each site. The table also illustrates CO<sub>2</sub> savings, the cost of the LEDs and the lifetime CO<sub>2</sub> savings. As in phase 1, it is not possible to compare different sites on a like-for-like basis. This is due to the fact that in some cases the new LED fittings also contained an emergency lighting unit (therefore increasing cost). In other cases a greater number of light fittings or brighter light fittings were installed as the opportunity was taken to improve poor levels of lighting.

The wattages of both the old fittings and the new LED fittings were confirmed (where samples were provided) by Lighting Association Laboratories tests and used in the energy and CO<sub>2</sub> saving calculations. The investment payback shown in table 7 is calculated in simple terms – by comparing the total cost of the LED fittings against the energy they save. They do not factor in other savings that are generated by the much longer lives of the LED products – typically at least five times greater than the fittings they replaced. The longer lifetime will lead to additional savings both from avoiding the costs of replacement lamps and the maintenance time to fit them.



Ilex House (before and after)

There were far more expressions of interest in phase 2 than in phase 1... twelve social housing providers and nine different LED suppliers were involved.

Energy savings of 402,183kWh per annum are forecast to be generated by the new LED products. The financial value of these savings is £56,104 per annum and comparing this with the total cost of the LEDs results in an average return on investment period of 9.03 years. This is lower than in phase 1, due to both the increasing efficiency of LEDs and also the fact that more sites in phase 2 chose to simply replace existing lighting rather than increase light levels. An additional

factor in this reduced payback figure is that more applications for funding were received in phase 2, which allowed more choice when selecting sites on a value-for-money basis.

As with phase 1, a series of normalised energy saving calculations has been carried out for the phase 2 sites. For phase 2 all the sites were visited by Lighting Association Laboratories so we have been able to carry out these

Table 7

Name of site	Total energy saving (kWh/a)	Annual value of energy saved (£)	LED cost (£)	Return on investment (years)	CO <sub>2</sub> Saving (t/a)	£/tCO <sub>2</sub> Saving lifetime (t)
Ladybank	-1,678	-234	27,042	n/a	-1	-5.4
Doris Barnes Court	9,490	1,323	64,614	48.8	5.3	30.4
Woodland View	14,099	1,966	4,231	2.2	7.9	45.2
Park View	15,968	2,228	3,557	1.6	8.9	51.2
Rope Walk	29,616	4,131	23,064	5.6	16.6	95.0
Elmore House	964	134	16,643	123.8	0.5	3.0
Leicester House	-2,681	-374	24,922	n/a	-1.5	-8.5
Ada Court	93,584	13,055	23,689	1.8	52.6	300.2
Dora House	106,799	14,899	29,570	2	60	342.6
Eslington Court	-29,513	-4,117	77,350	n/a	-16.5	-94.7
Redheugh Court	-35,792	-4,993	77,350	n/a	-20.1	-114.8
Knowles Hill	3,427	478	2,633	5.5	1.9	11.0
Adamsdrill Road	2,807	392	1,986	5.1	1.6	9.0
Lewisham Park	51,502	7,185	8,498	1.2	28.9	165.2
Maddocks Court	15,152	2,114	22,235	10.5	8.5	48.6
Ilex House	1,318	184	22,276	121.2	0.7	4.2
Vivian Court	3,428	478	21,629	45.2	1.9	11.0
Michelle Court	111,552	15,561	35,820	2.3	62.7	357.8
Ipsden Buildings	12,141	1,694	19,938	11.8	6.8	38.9
Summary	402,183	56,104	507,047	9.03	225.7	1,289.9

**Table 7 Note.** Value of energy saving is based on an average unit price of 13.95p. Lifetime CO<sub>2</sub> savings based on average LED lifetime of 50,000 hours.

calculations for all sites. Table 8 below shows the result of these calculations and again clearly illustrates the effectiveness of LED lighting as an energy saving measure. On this normalised basis energy savings would have been in excess of 1.2GWh per year, generating lifetime CO<sub>2</sub> savings of over 4,000 tonnes. The return on investment period is similar to phase 1 and much less than the lifetime of the products – an average of 2.85 years.

Realised energy savings of 402,183 kWh per annum are forecast to be generated by the new LED products. The financial value of these savings is £56,104.

Table 8

Name of site	Normalised energy saving (kWh/a)	Annual value of energy saved (£)	LED cost (£)	Return on investment (years)	CO <sub>2</sub> Saving (t/a)	tCO <sub>2</sub> Saving lifetime (t)
Ladybank	185,624	25,895	27,042	1.0	104.3	595.4
Doris Barnes Court	96,626	13,479	64,614	4.8	54.3	301.0
Woodland View	18,752	2,616	4,231	1.6	10.5	60.2
Park View	7,834	1,093	3,557	3.3	4.4	25.1
Rope Walk	115,001	16,043	23,064	1.4	64.6	368.9
Elmore House	5,951	830	16,643	20	3.3	19.1
Leicester House	32,651	4,555	24,922	5.5	18.3	104.7
Ada Court	89,090	12,428	23,689	1.9	50.1	285.8
Dora House	91,035	12,699	29,570	2.3	51.2	292.0
Eslington Court	58,863	8,211	77,350	9.4	33.1	188.8
Redheugh Court	43,877	6,120	77,350	12.6	24.7	140.7
Knowles Hill	3,263	455	2,633	5.8	1.83	10.5
Adamsdrill Road	16,510	2,303	1,986	0.9	9.3	53.0
Lewisham Park	229,989	32,083	8,498	0.3	129.2	737.8
Maddocks Court	96,051	13,399	22,234	1.7	54.0	308.1
Ilex House	498	69	22,276	320.6	0.3	1.6
Vivian Court	14,840	2,070	21,629	10.4	8.3	47.6
Michelle Court	139,707	19,489	35,820	1.8	78.5	448.1
Ipsden Buildings	29,974	4,181	19,938	4.8	16.8	96.1
Summary	1,276,136	178,018	507,046	2.85	717.0	4,093.5

## Phase 2 LED performance – Lighting Association Laboratories measurements

Lighting Association Laboratories was again employed to undertake in-situ measurements of lighting levels at each site where new LED fittings were installed. As in phase 1, measurements of colour temperature were also taken and the same measurement methodology employed.

Table 9 sets out the results of Lighting Association Laboratories measurements. The Lux (lx) levels and colour temperatures displayed are an average of all measurement points throughout each site. The percentage change in light output at each visit is also displayed.

As in phase 1, the results clearly illustrate the improvements created by the LED lighting.

Existing lux levels, at an average of 60.5lx across the sample, were slightly worse than the 63lx measured in phase 1. 'Yellow' light was common in many sites, as were areas of shadow and pooling of light.

Lux levels significantly improved with the installation of the LED fittings, increasing by an average of 56.7 per cent to a reading of 94.8lx. This is quite a bit less than in phase 1, where lux levels increased by 100 per cent, due to many sites specifying LED lighting that was better than the existing lighting. This is reflected in the energy savings from phase 2, which are on average higher than phase 1 because far fewer sites chose to increase existing lighting levels.

The photography for phase 2 sites again shows the marked visual improvement to lighting levels and the eradication of light-pooling and areas of shadow. Park View appears to be the only site where the new LED fittings have significantly reduced lighting levels. This may have been due to the fact that existing light levels were deemed too high. The light output of the existing fittings was very good to begin with, but the average lux level dropped from 151lx to 98lx, a decrease of 34.9 per cent.

The maintenance of lux levels provided by the new LED fittings was again impressive, with an average lux reading of 91.9 across the sites (maintenance of performance of 96.9 per cent). This is slightly better than the figure of

92.6 per cent reported in phase 1 of the field trial. It is clear from the results of both phases 1 and 2 that the performance of the new LED light fittings is maintained at impressive levels despite continuous use. Two sites – Park View and Woodland View – stand out as having a significant reduction in lux maintenance over the first six months of operation. They experienced 34.9 per cent and 32.2 per cent reductions in average lux levels.

In these isolated cases, it was clear from Lighting Association Laboratories reports that significant numbers of the LED fittings had failed, leading to greatly reduced lux levels. The type of LED fitting installed at these sites was quite rare in the field trial in that it was an LED tube designed for direct retrofitting into an existing fluorescent tube fitting. The incidences of lamp failure were discussed with the housing manager and a probable cause was identified. The retrofit LED tubes were not supplied with any specific installation instructions: this led to the conclusion that they could simply be installed in place of the existing fluorescent tube. Subsequent discussions with the LED supplier showed that the ballast in the existing fluorescent fitting should be removed before the installation of the LED tube. This had not been done and had most likely resulted in the high levels of failure experienced as soon as the LEDs had been installed. The LED supplier in question provided replacement fittings under the terms of the product warranty manufacturers were required to offer as part of the trial.

Changes in colour temperature provided by the new LED fittings was generally similar to that experienced in phase 1. Existing colour temperature averaged 3,469K (3,219K in phase 1), rising to 5,225K as soon as the LEDs were installed (4,883K in phase 1). Colour temperature rose slightly in phase 1 after initial installation to 5,178K, but in phase 2 the average figure dropped slightly to 4,994K.

The LED fittings installed in both phase 1 and phase 2 of the field trial have now been operating continuously for up to two-and-a-half years. It would be extremely useful to revisit the sites and undertake a third set of performance readings to see how lux levels and colour temperature has been maintained over a much longer period. This data could be used to calculate an accurate set of assumptions as to how the LED fittings will perform over their whole lifetime.

Table 9

Name of Site	Existing average lux	Initial LED average lux	% Change	6 Month average LED lux	% Maintenance	Existing colour (K)	Initial LED colour	6 Month LED colour
Ladybank	11.4	96.2	747.6	82.7	85.9	3,431	3,992	3,464
Doris Barnes Court	47.3	117.5	148.2	118.2	100.6	3,130	6,627	6,806
Woodland View	72.7	87.7	20.6	59.5	67.8	3,857	4,817	5,166
Park View	151.1	98.4	-34.9	64	65.1	3,440	4,375	4,388
Rope Walk	59.6	163.1	173.7	164.7	100.9	3,516	5,571	4,974
Elmore House	32.5	47.54	46.21	89.2	187.75	3,816	4,225	3,701
Leicester House	25.3	64.1	153.2	69.9	109	3,671	4,284	3,815
Ada Court	95.6	92.4	-3.3	88.1	95.3	3,536	4,986	4,674
Dora House	137.2	123.4	-10.1	96.9	78.6	3,731	5,264	5,031
Eslington & Redheugh Court	52.1	124.4	138.7	101.5	81.6	3,272	4,426	4,317
Knowles Hill	18.5	18	-2.3	18.9	104.9	3,706	5,879	5,688
Adamsdrill Road	33.7	102.5	203.7	108.8	106.1	3,382	5,463	5,384
Lewisham Park	32.3	119.6	270	125	104.5	3,335	5,829	5,743
Maddocks Court	18.1	63.5	250.3	62.8	98.9	3,338	6,432	6,419
Ilex House	49.9	47.5	-4.8	49.8	104.9	3,646	6,609	5,556
Vivian Court	59.8	103.3	72.7	92.2	89.3	3,257	3,202	3,237
Michelle Court	180.3	218.2	21	210.6	96.5	3,410	5,845	6,038
Ipsden Buildings	10.7	19.84	84.61	51.12	1,265.85	2,970	5,752	5,502
<b>Average Summary</b>	<b>60.5</b>	<b>94.8</b>	<b>56.69</b>	<b>91.9</b>	<b>96.90</b>	<b>3,469</b>	<b>5,225</b>	<b>4,994</b>

**Table 9 Note.** Eslington Court and Redheugh Court are identical buildings that had the same lighting installation. The Lighting Association therefore only undertook measurements at Eslington Court. Initial LED performance measurements were not undertaken at Elmore House or Ipsden Buildings.

## Conclusions

The field trial can be considered a great success due to the fact that an energy-saving measure has been proven to save significant amounts of energy while at the same time leading to an extremely noticeable increase in performance.

The results of the various monitoring activities clearly shows that the installation of LED light fittings in communal areas of social housing can lead to very significant improvements in lighting levels, and quality of light, while at the same time generating energy savings. The fact that the LED light fittings could last over five times as long as the replaced fittings is another very important factor when considering the benefits of this technology. It would be useful to carry out further testing of this finding. This would enable the evaluation of the true cost of the additional labour and product cost involved in maintaining traditional fluorescent light fittings in locations such as those involved in this field trial.

The trial has shown that the installation of LED light fittings can be used to either maintain or enhance light levels, and in both cases can generate energy savings. The increase in colour temperature typically produced by LEDs also improved the environments monitored in the field trial, a factor much appreciated by the social housing tenants. Brighter, whiter light is very effective in the corridors and stairwells in all of the social housing sites.

Interest in the LED field trial from social housing providers and LED suppliers increased as it progressed. It is a great shame that phase 3 had to be cancelled, as it is likely that new LED suppliers would have got involved and the products installed would have developed yet further. LED technology is developing very quickly and may soon dominate both the commercial and domestic lighting markets. It is sufficient to conclude that a social housing provider considering installing LED light fittings today will have an even better choice of products to choose from than those discussed in this report.

With the rising price of electricity, the high efficiencies of LED lighting technology will make it an even more attractive investment in the years ahead.

The field trial has demonstrated the excellent performance of LED lighting. The photographs in the appendix of this report clearly show this. Despite this, there remains a substantial price difference in the cost of LED fittings when compared with traditional fluorescent fittings. Discussions with many of the social housing managers involved in the trial have shown that only a few of them have undertaken further installations of LED lighting in their housing stock. The up-front additional costs remain a serious constraint. Without grant funded support it is unlikely that the technology would be installed, despite its obvious benefits.

Levels of production and installation need to be increased in order to bring down the cost of LED light fittings. A clear mechanism for assisting in this process would be to encourage and stimulate the involvement of LED products in programmes such as CERT<sup>8</sup> and the forthcoming ECO<sup>9</sup>. Such programmes have very successfully transformed markets for measures such as CFLs, cavity wall and loft insulation, and the same could be done for LED lighting. The Energy Saving Trust will discuss the results of this field trial with both DECC and OFGEM and encourage the inclusion of LED light fittings in both existing and future energy-efficiency initiatives.



Richard Kitson Court (before and after)

The installation of LED light fittings in communal areas of social housing can lead to very significant improvements in lighting levels, maintenance of light levels and quality of light, while at the same time generating energy savings.

8 Carbon Emissions Reduction Target: [http://www.decc.gov.uk/en/content/cms/funding/funding\\_ops/cert/cert.aspx](http://www.decc.gov.uk/en/content/cms/funding/funding_ops/cert/cert.aspx)

9 Energy Company Obligation: <http://www.decc.gov.uk/assets/decc/legislation/energybill/540-energy-security-bill-brief-energy-company.pdf>

# Appendix – Site photographs

## Bracknell



Pre-installation and post-installation

## Doncaster (park view)



Pre-installation and post-installation

## Gambier House



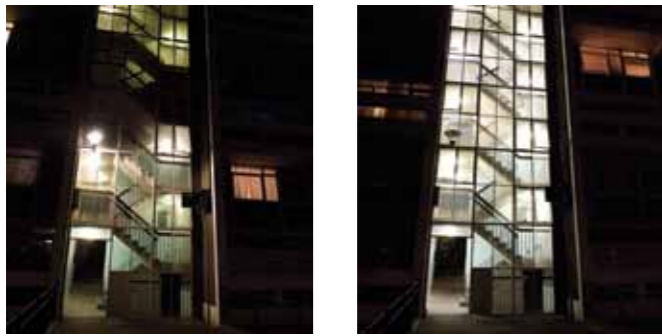
Pre-installation and post-installation

## Miners Court



Pre-installation and post-installation

## Brixton – Ellmore House



Pre-installation and post-installation

## Doncaster (Woodlands)



Pre-installation and post-installation

## Gambier House



Pre-installation and post-installation

## St Johns Wood – Dora House



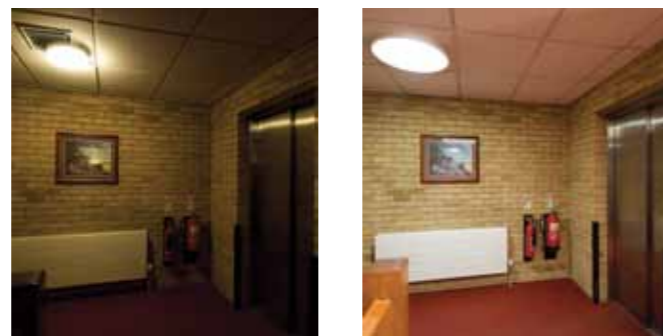
Pre-installation and post-installation

## Cavendish Mill



Pre-installation and post-installation

## East Dereham



Pre-installation and post-installation

## Lewisham – Knowles Hill



Pre-installation and post-installation

## Telford



Pre-installation and post-installation





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