



Research  
Programme  
2011-2015

## SUMMARY

# Costing Energy Efficiency Improvements in Existing Commercial Buildings

This research was commissioned by the IPF Research Programme 2011–2015



JULY 2012

# Costing Energy Efficiency Improvements in Existing Commercial Buildings

This research was funded and commissioned through the IPF Research Programme 2011–2015.

This Programme supports the IPF's wider goals of enhancing the understanding and efficiency of property as an investment. The initiative provides the UK property investment market with the ability to deliver substantial, objective and high-quality analysis on a structured basis. It encourages the whole industry to engage with other financial markets, the wider business community and government on a range of complementary issues.

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# Costing Energy Efficiency Improvements in Existing Commercial Buildings

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## Summary

**IPF Research Programme 2011–2015**

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# Costing Energy Efficiency Improvements in Existing Commercial Buildings

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# Costing Energy Efficiency Improvements in Existing Commercial Buildings

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# Costing Energy Efficiency Improvements in Existing Commercial Buildings

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## 1. INTRODUCTION

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In recent years, brand new, highly efficient office buildings have tended to grab the headlines when discussing improved energy performance in commercial properties. Opportunities to reduce energy consumption in existing buildings have been underpublicised for a variety of reasons, the most notable being a lack of available cost data, appropriateness of certain technologies and their respective energy savings, perceived level of disruption to occupiers and the 'who pays, who gains' issue between landlords and tenants.

In January 2009, the Investment Property Forum (IPF) published a report investigating the costs of making energy efficiency improvements to existing commercial buildings. The primary aims of the original research<sup>1</sup> were to identify the key improvements that could be made to existing commercial buildings and the building types that presented the greatest opportunities to reduce carbon dioxide (CO<sub>2</sub>) emissions.

Since its publication, the research has been used to support strategic decision making by the property and investment community through identifying those buildings in a portfolio that can yield the largest CO<sub>2</sub> savings for the least cost. The research has been of particular value to investment fund managers, asset managers, property managers and letting agents.

In the past three years, regulations, incentives and Government initiatives have evolved and are driving a much greater interest in improving the energy performance of existing buildings. Key drivers include:

- Revised Building Regulations 2010 (and a proposed future change in 2013/14) that will mean that existing buildings will all demonstrate a lower EPC rating when re-assessed;
- Introduction and subsequent changes made to the Feed In Tariff incentive scheme for solar photovoltaic panels and wind turbines plus a new incentive for the production of renewable heat known as the Renewable Heat Incentive;
- Proposed simplification of the CRC Energy Efficiency Scheme;
- Imminent implementation of the 'Green Deal' innovative funding mechanism, whereby owners and occupiers of buildings can take out finance to fund energy efficiency improvements with the repayment obligation being attached to the electricity meter rather than the party applying for the finance; and
- Government plans to introduce a minimum energy performance standard preventing landlords from letting commercial properties with F and G EPC ratings from 2018 at the latest.

The aim and objectives of the updated research are consistent with the original research to provide the same value to users as before. However, attention to certain additional objectives is necessary to respond to the changed environmental agenda affecting existing commercial buildings. Two additional areas of focus of the work are:

1. Identifying the cost and improvement measures required to improve EPC ratings from the baseline position for the building types analysed.
2. Determining what EPC/CO<sub>2</sub> reduction targets should be set now to prevent a building being either F or G rated in 2018.

The study analyses a number of commercial building types and the findings are presented from the perspective of a landlord, investor, developer or owner occupier. Therefore, only the base specification of each building has been assessed and not the CO<sub>2</sub> emissions produced by the tenants' own equipment, nor how to reduce them.

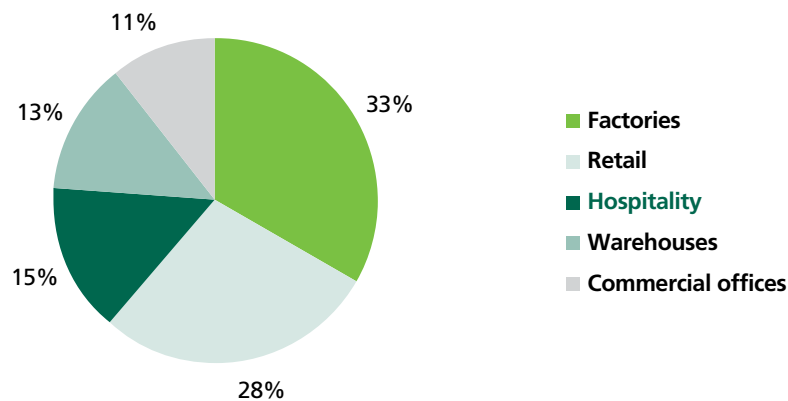
<sup>1</sup> Costing Energy Efficiency Improvements in Existing Buildings, IPF London, 2009

## 2. ENERGY, CO<sub>2</sub> AND COMMERCIAL BUILDINGS

### 2.1 CO<sub>2</sub> emissions from commercial buildings

In 2003, commercial buildings were responsible for around 14% of total CO<sub>2</sub> emissions in the UK (source: BRE, 2006). Remaining emissions were produced by transport (33%), domestic buildings (26%), industrial processes (22%) and public and other buildings (5%). Total emissions from commercial buildings can be further sub-divided as presented in Figure 2.1.

**Figure 2.1: CO<sub>2</sub> emissions from commercial buildings**



Source: BRE, 2006

CO<sub>2</sub> emissions are most significant from the stock of and retail buildings, accounting for over 60% of all emissions from the commercial sector.

### 2.2 Improvement opportunities for landlords

The actions of both landlords and tenants have a direct influence on the energy consumption within a building and, in turn, the CO<sub>2</sub> emitted. The landlord has sole control over the performance of the building fabric, whereas the tenant is solely responsible for using the building in terms of hours of use, density of occupants, IT equipment efficiency and setting internal temperatures. However, both landlords and tenants have some influence on the energy efficiency of the installed building services insofar as the landlord may install the electrical and mechanical systems and the tenant will run them to suit their occupational requirements. A tenant may also influence the specification of the installed building services where, for example, an office development has been built to a shell and core specification by a developer or where a retail unit has been let on a 'shell only' basis.

There are significant opportunities for landlords to improve the energy efficiency of the commercial buildings they let to tenants. Key buildings are offices, supermarkets, retail warehouses, light industrial buildings and warehouses. Factories and many retail buildings were excluded from the study because the vast majority of their emissions result from building operations by the tenant (for example, factory processes and refrigeration equipment) rather than from the building. A more detailed discussion of the decision to omit these is included in the full research report.

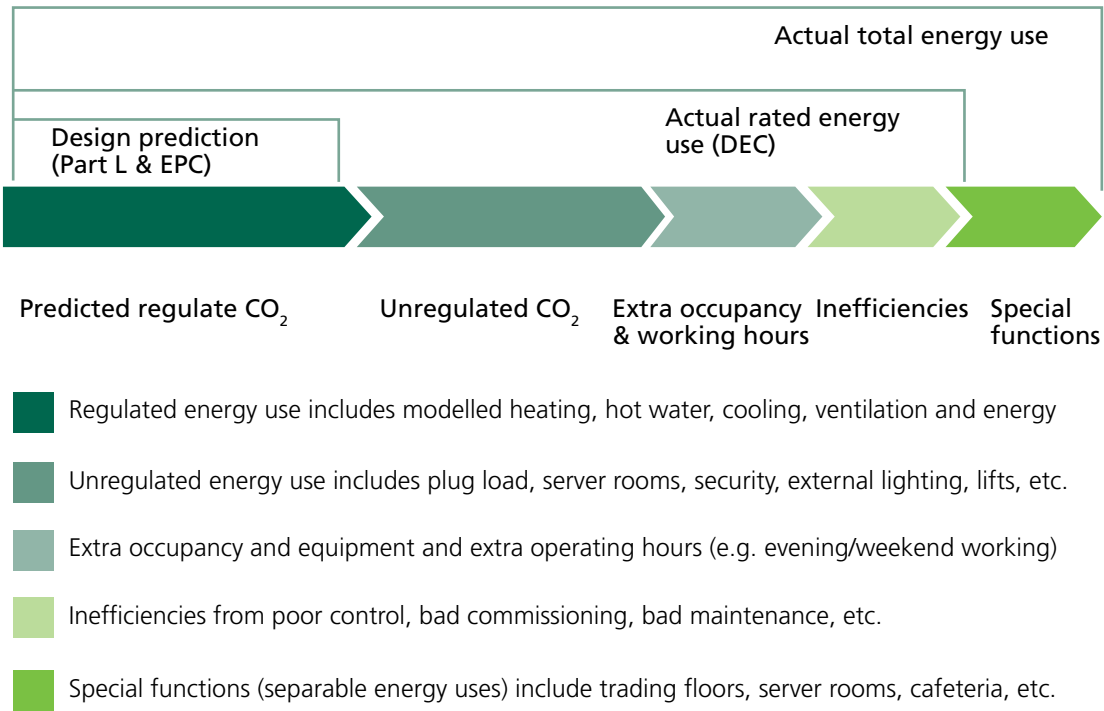


## 2. ENERGY, CO<sub>2</sub> AND COMMERCIAL BUILDINGS

### 2.3 Modelling CO<sub>2</sub> emissions and energy consumption

Part L of the Building Regulations and Energy Performance Certificates (EPCs) only regulate and predict a proportion of CO<sub>2</sub> emissions in a building as shown in Figure 2.2. Specifically, only heating, cooling, hot water, ventilation and lighting energy consumption is accounted for and standard working hours and occupancy are assumed. The modelling process therefore does not include any allowance for the occupants' equipment or appliances or account for extended working hours for example.

**Figure 2.2: Building energy consumption measures by Part L, EPCs and DEC<sup>2</sup>**



A Display Energy Certificate (DEC), currently only mandatory for public buildings or buildings with public tenants, measures almost all elements of actual energy use in a building whereas an EPC includes a theoretical prediction of how a building could perform if realistically upgraded. An EPC therefore reflects the scale of influence a landlord has to affect energy consumption and CO<sub>2</sub> emissions in a building.

<sup>2</sup> Carbon Trust (2011), Closing The Gap, available from the Carbon Trust website (ref CTG047) www.carbontrust.co.uk

### 3. BUILDING SELECTION AND RESEARCH METHOD

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#### 3.1 Buildings analysed

The types of commercial building analysed have been largely maintained as per the original study but with certain revisions. Two key changes are:

1. The number of office types analysed has been reduced to produce more consolidated results based on the findings of the original study.
2. The introduction of an office building compliant with the 2006 Part L regulations to investigate how the 2010 revised regulations will impact upon its EPC rating.

Since the original work was published, Part L of the Building Regulations has been revised (in 2010). This revision means that new non-domestic buildings must achieve on average a 25% reduction in CO<sub>2</sub> emissions compared with the 2006 regulations. The change also signifies that buildings constructed prior to the introduction of the 2010 regulations would achieve a poorer EPC rating if they were to be reassessed now. This is because a building that is compliant with the latest regulations will score either a B or C rating (depending on the servicing strategy) but the change in regulations will mean that the building is comparatively less efficient, so it will be lower on the EPC scale (i.e. D- or E-rated for example).

It should be noted that the buildings modelled are best-fit representations of the existing stock and not case studies of actual buildings. These models represent a building that is let by a landlord to a tenant and do not consider how the tenant uses the building or the implications of IT and other equipment they install.

Figure 3.1 gives a notional representation of the base buildings analysed in the update study.

**Figure 3.1: Example buildings representing the base building models**

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##### Office 1

Reflects mid-town and West End offices, which are predominantly period, dating from pre-1940. Heating system only.



##### Office 2

Partly glazed air-conditioned early 1990s, narrow-plan office. Compliant with 1990 Part L Building Regulations.



### 3. BUILDING SELECTION AND RESEARCH METHOD

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#### Office 3

Fully glazed deep-plan air-conditioned office. Compliant with 2002 Part L Building Regulations.



#### Office 4

As Office 3 but compliant with 2006 Part L Building Regulations.



#### Retail

Single storey with lighting, heating and air conditioning. Limited windows. Office and warehouse space included. Compliant with 1990 Part L Building Regulations.



#### Industrial/warehouse

Single storey with lighting and heating. Limited windows or rooflights. Offices included. Compliant with 1990 Part L Building Regulations.



### 3.2 Commercial building refurbishments

The refurbishment of an existing building to meet a 'market standard' specification would naturally reduce operational CO<sub>2</sub> emissions. The definition of 'market standard' is the minimum energy efficiency standard a building could be refurbished to, given available technology, and to meet regulations. It does not include any plant, systems or equipment that are more energy efficient compared to other versions on the market, which, in most cases, would come at an increased cost. For example, replacing a 20 year old boiler with a 'market standard' boiler will see a reduction in gas consumption because the new version will be typically 90% efficient compared to 65% for the old model. However, a 95% efficient boiler could be specified as part of the refurbishment, which would be more expensive but would save more energy. This study examines the reduction in CO<sub>2</sub> emissions resulting from a market standard refurbishment and the additional reduction that can be achieved if enhanced energy efficiency improvements are specified.

## 3. BUILDING SELECTION AND RESEARCH METHOD

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### 3.3 Costing process and assumptions

#### 3.3.1 Capital costs

The basis of the research was to assess the costs associated with making certain energy efficiency improvements that are typically beyond the scope of a market standard refurbishment. To demonstrate which of these improvements were most cost effective, it was necessary to quantify the 'extra over' capital cost of the upgrade compared with the respective like-for-like replacement under a market standard refurbishment.

The extra over cost was derived from the difference between the capital cost of the upgrade and the capital cost of the standard refurbishment item. These costs were estimated individually for each building type modelled and represent the total cost to a client of construction work (i.e. cost to the landlord). All costs are current at Q2 2012 price levels.

The extra over capital cost has also been calculated for those improvements that could be carried out whilst a tenant is (or multiple tenants are) in occupation of the building. Most improvements can be carried out during evenings and weekends although there would be an extra cost for undertaking work at these times.

#### 3.3.2 Lifecycle costs and energy savings

For each energy efficiency improvement, the operational costs and energy savings were also calculated. Previously, the internal rate of return (IRR) and discounted payback period were calculated in order to indicate investment potential. The update study shows all costs and savings on an undiscounted basis and provides enough data to allow the user to calculate the financial metrics to suit their own particular requirements. In particular, the detailed results include the additional capital cost of each improvement, estimated life of the installation, gas, electricity and CO<sub>2</sub> savings (in terms of reduced CRC payments) and available incentives (where applicable).

Current and projected future gas and electricity prices as published by the Department for Energy and Climate Change (DECC) were used to estimate the likely financial benefit from the energy saved under two energy price scenarios.

## 4. KEY FINDINGS

### 4.1 Summary

A key objective of the update study was to identify the cost of improving the EPC rating for each building. This required:

- The modelling of the building's baseline EPC rating;
- An assessment of how a 'market standard' refurbishment (i.e. no extra expenditure on energy efficiency beyond meeting regulatory compliance) would inherently improve the EPC rating; and
- Establishing the additional cost and benefit of specifying a series of enhanced energy efficiency improvements.

Summary results for all buildings are presented in Table 4.1.

**Table 4.1: Additional capital cost to improve EPC ratings when refurbishing existing commercial buildings**

	Office 1	Office 2	Office 3	Office 4	Retail	Industrial / warehouse
<b>EPC rating</b>						
Baseline	E	G	F	E	D	F
Market refurb	D	F	F	E <sup>3</sup>	C	B
<b>Additional capital cost extra over market standard refurbishment<sup>4</sup> (%)</b>						
E		0.3%	1.0%			
D		1.7%	1.9%	1.0%		
C	0.8%	14.6%	12.6%	12.8%		
B	14.1%	37.3%	44.7%	45.7%	2.6%	
A	40.0%	-	-	-	-	20.7%

Headline findings are:

- As expected, offices have become more energy efficient since the early 1990s because building regulations have driven a reduction in CO<sub>2</sub> emissions. Non-air-conditioned offices also perform better in terms of their EPC rating compared to air-conditioned offices.
- A 'market standard' refurbishment can improve the EPC rating by at least one grade for most buildings. The improvement is substantial for the industrial/warehouse building (i.e. rating improves from an F to a B).
- All offices can be improved by an extra grade for an additional cost of up to 1% of the refurbishment budget which is potentially viable for most projects.
- Air-conditioned offices built over 10 years ago (Offices 2 and 3) represent the most cost effective opportunity because EPC ratings can be improved by two EPC grades for a total extra spend of circa 2%.
- The EPC rating of the retail building can be improved to a B for an additional capital sum of 2.6% above the standard refurbishment cost and, therefore, this is attractive in terms of future-proofing the asset.
- It is unviable to achieve an A-rated EPC for all buildings (including the industrial/warehouse, which can achieve a B rating through refurbishing to a market standard).

<sup>3</sup> A 'market refurbishment' would not be carried out to a building which is less than 10 years old hence no improvement in the EPC rating.

<sup>4</sup> All costs are cumulative.

## 4. KEY FINDINGS

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It is also anticipated that the EPC rating for the office built after 2006 (Office 4) will drop from an E to an F following the next revision to Part L based on a comparison between the 2006 and 2010 versions of the regulations. The proposed minimum energy efficiency standards for buildings let by landlords to be introduced by 2018 will mean that even offices built to recent standards will be affected by this forthcoming legislation.

This will also apply to retail and industrial/warehouse buildings. The increased energy efficiency standards under the Building Regulations will undoubtedly result in the industrial/warehouse building being rated as a G by 2018 and it is likely that the retail building would be rated as F or G and thus be affected by the minimum standards. An EPC is valid for 10 years and, therefore, a currently certified building might be temporarily shielded from the impact of the 2018 standard but any refurbishment work or request from a prospective buyer or tenant for an updated EPC might expose the landlord to the new rules.

### 4.2 Energy efficiency 'quick wins'

The update study has demonstrated that there are common energy efficiency 'quick wins' across a range of commercial building types that are low cost to implement and can improve EPC ratings by either one or two grades. These 'quick wins' are:

- Boilers (95% efficiency);
- Daylight controls;
- Improving air tightness;
- Variable speed heating and cooling pumps;
- Heating controls;
- Power factor correction (>0.95);
- High-efficiency chillers;
- T5 lighting;
- Heat recovery; and
- DC drive fan coil units.

These 'quick wins' can either form part of a general refurbishment during a period of vacant possession or be 'one-off' improvements when the building is wholly or partly occupied. This is an important consideration when a planned refurbishment is some years away and one or more leases are due to expire. The introduction of EPCs has made tenants acutely aware of how buildings perform in terms of their energy performance and the issue is likely to be prevalent during lease negotiations. If a landlord carries out a few 'quick wins' to improve the rating of a building, these could assist a lease renewal, reduce void periods and potentially affect the rental level achieved.

Replacing lighting and fan coil units poses particular challenges, especially for retail buildings, but can still be implemented 'out of hours', over an extended period of time.

The premium to undertake these works out of hours would typically be no more than 7% because the extra cost of labour is offset by not having to pay main contractor's preliminaries, overheads and profit.

## 4. KEY FINDINGS

### 4.2.1 Individual improvements to office buildings

Table 4.2 identifies the energy efficiency improvements that need to be implemented to improve the EPC ratings above market standard for each office and the additional cost of specifying these measures compared to the cost of a market standard refurbishment. All costs are cumulative.

The research found that there were often alternative strategies that were more cost effective to meet particular EPC ratings rather than a strategy based on market standard cost only. It is recommended that a full options appraisal with financial cost-benefit analysis is undertaken prior to any refurbishment works to determine the most cost-effective way of cutting CO<sub>2</sub> and securing improved EPC ratings.

**Table 4.2: Office EPC improvement strategies**

EPC Rating	Additional Capital Cost (%)							
	Office 1		Office 2		Office 3		Office 4	
	Cost	Improvements	Cost	Improvements	Cost	Improvements	Cost	Improvements
E			0.3%	Daylight controls VS pumps	1.0%	Power factor VS pumps Chiller		
D			1.7%	Power factor Chiller Air tightness Boiler 95% Heat recovery	1.9%	Specific fan power Daylight controls	1.0%	VS pumps Chiller Daylight controls
C	0.8%	Daylight controls Air tightness VS pumps Heating controls Power factor	14.6%	Heating controls Specific fan power PIR controls LED lighting Passive chilled beams	12.6%	Boiler 95% External shading	12.8%	Boiler 95% Specific fan power External shading
B	14.1%	Air source heat pumps PV 375m <sup>2</sup>	37.3%	PV 375m <sup>2</sup> External shading	44.7%	LED Lighting Heating controls Passive chilled beams	45.7%	Heat recovery LED lighting Passive chilled beams
A	40.0%	LED lighting PIR controls Double glazing	-	-	-	-	-	-

Key: PV = photovoltaic panels; PIR = passive infra-red; VS = variable speed; LED = light-emitting diode

The foregoing results indicate that EPC ratings for all offices can be improved by an extra grade for an additional cost of up to 1% of the refurbishment budget. This is a relatively minor amount to spend when undertaking a refurbishment project to secure a better EPC rating.

Air-conditioned offices built over 10 years ago (Offices 2 and 3) represent the most cost effective opportunity to further enhance EPC ratings and cut CO<sub>2</sub>. For a total extra spend of circa 2%, the EPC can be improved by two ratings above a market standard refurbishment (i.e. F to D for both Offices 2 and 3). Improving the EPC to a C rating becomes significantly more expensive and requires additional expenditure of 12% or more.

## 4. KEY FINDINGS

For Offices 1 and 4, improving EPC ratings by two grades is less cost effective compared to the other offices, as an additional total investment of around 12% to 15% is required.

It is possible to improve the EPC ratings to either a C or B for air-conditioned offices but it is expensive to do so. An A-rated EPC was not practically achievable based on the improvements considered although it might be possible if a more detailed analysis was undertaken and further options explored. The naturally ventilated office could achieve an A rating but the cost would be prohibitive as refurbishment costs would need to increase by a staggering 40%.

The 'quick wins' shown in Table 4.2 can either form part of a general refurbishment during a period of vacant possession or as 'one-off' improvements when the building is wholly or partly occupied. The work will be done predominantly out of hours. However, significant items of work in an occupied office will take considerably more time to undertake. This includes lighting and fan coils units. It might be favourable to refrain from undertaking these types of improvements until the next planned refurbishment if it is in the short to medium term. Chilled beams and fabric enhancement measures (with the exception of external shading) would not be undertaken when a building is occupied due to the level of disruption such works would cause.

### 4.2.2 Individual improvements to retail buildings

Table 4.3 identifies the energy efficiency improvements that need to be implemented to improve the EPC rating for the retail building and the additional cost of specifying these measures compared to the cost of a market standard refurbishment. All costs are cumulative.

**Table 4.3: Retail EPC improvement strategy**

EPC Rating	Additional Capital Cost (%)	
	Cost	Improvements
B	2.6%	Power factor correction Variable speed pumps DC drive fan coils Air tightness Heat recovery Boiler 95% Chiller
A	-	-

The results indicate that a B-rated EPC can be achieved by spending an additional 2.6% over and above the cost of a market standard refurbishment project. Further improvements become significantly more expensive and, in practice, it would be difficult to achieve an A rating based on the improvements considered (which included several low- and zero-carbon energy sources).

The 'quick wins' shown in Table 4.3 can either form part of a general refurbishment during a period of vacant possession or as 'one-off' improvements when the building is wholly or partly occupied. However, due to the high hours of use of retail buildings compared to offices, improvements to lighting and fan coil units out of hours are not likely to be feasible without a high risk of disrupting trading activities. It is advisable, therefore, to refrain from undertaking these types of improvements until the next planned refurbishment.



## 4. KEY FINDINGS

### 4.2.3 Individual improvements to industrial/warehouse buildings

Table 4.4 identifies the energy efficiency improvements that need to be implemented to improve the EPC rating for the industrial/warehouse building and the additional cost of specifying these measures compared to the cost of a market standard refurbishment. All costs are cumulative.

**Table 4.4: Industrial/warehouse EPC improvement strategy**

EPC Rating	Additional Capital Cost (%)	
	Cost	Improvements
A	20.7%	Power factor correction Variable speed pumps Boiler 95% External wall insulation Heat control Warm air blowers Wind turbine (20kWp) Photovoltaics (750m <sup>2</sup> )

The results indicate that an A-rated EPC can be achieved by spending an additional 20% over and above the cost of a market standard refurbishment. This would be a significant increase to the base refurbishment cost and not feasible in most cases. A large photovoltaic array and a wind turbine would also be needed to achieve an A rating, which will not be feasible for some buildings.

Most improvements considered for the refurbishment scenario are potentially viable as ‘one-offs’ when the industrial/warehouse building is occupied. However, replacing the full lighting system would require more time to complete if undertaken at weekends.

## 5. CONCLUSION

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The current research demonstrates that a business case remains for taking action to improve energy performance in existing commercial buildings. The Energy Performance Certificate (EPC) rating for an office, retail building or industrial/warehouse building can be improved cost effectively by either specifying more energy efficient building services when undertaking a refurbishment project or through ad hoc improvements when the building is wholly or partly occupied. Implementing measures recommended in this report can significantly reduce the exposure to landlords of the planned minimum energy performance standards scheduled to be introduced by 2018 and also satisfy increasing demand for low energy commercial buildings. It is imperative, therefore, that landlords review their portfolios to identify those assets that are at risk and prepare a strategy (with timescales and cost benefit analysis) to improve energy performance accordingly.

The split incentive to invest in energy efficiency improvements between landlords and tenants is often cited as the main cause for the lack of action being taken. However, better available data on the costs and efficiency savings from implementing a range of improvement options, as detailed in the full report, is a critical first step in enabling landlords and tenants to negotiate more effectively lease terms to support more sustainable property occupation and management.





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