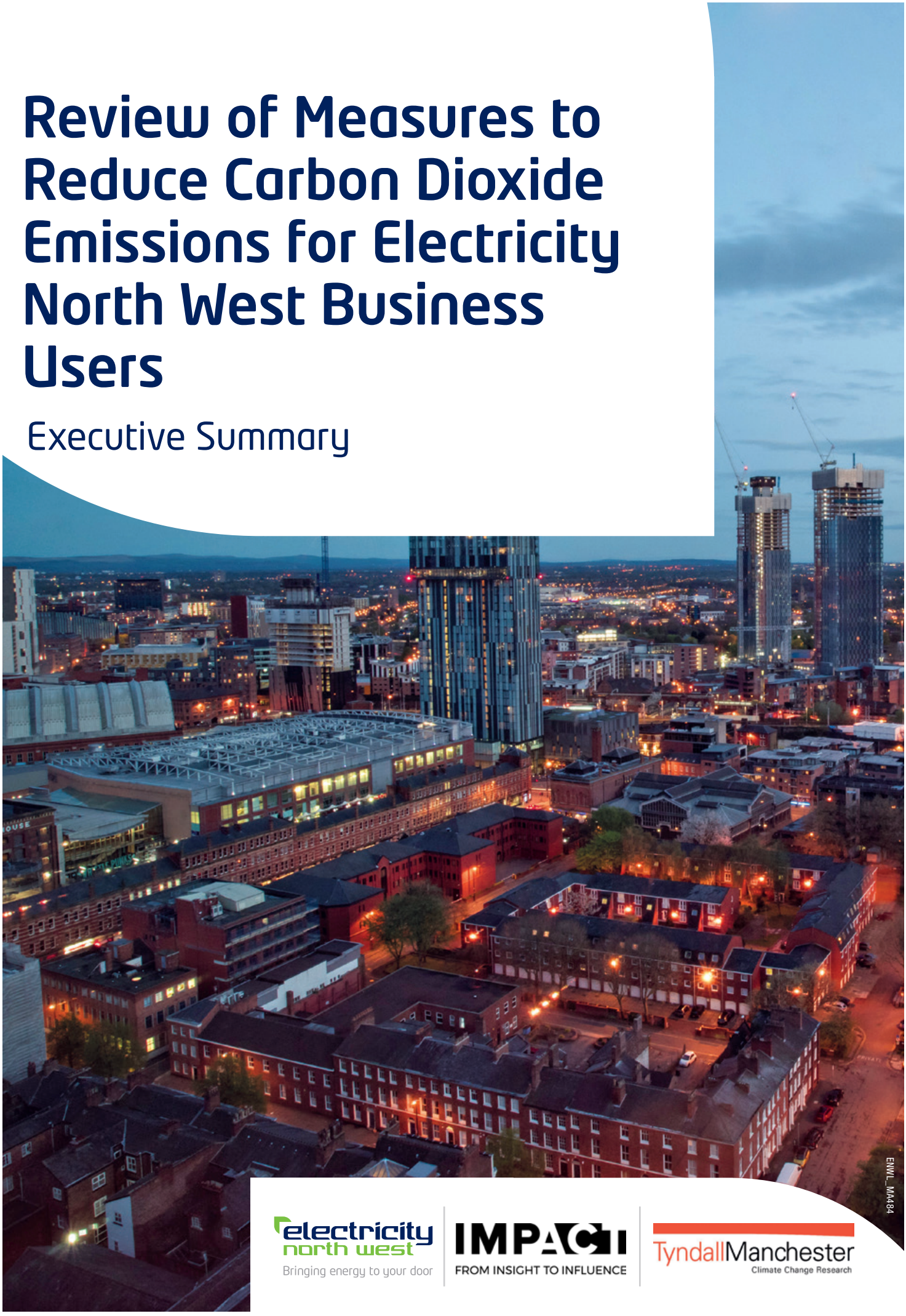
Review of Measures to Reduce Carbon Dioxide Emissions for Electricity North West Business Users

Executive Summary



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FROM INSIGHT TO INFLUENCE

TyndallManchester
Climate Change Research

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1. Introduction

This document summarises the Tyndall Centre's detailed technical report Review of Measures to Reduce Carbon Dioxide Emissions for Electricity North West Business Users, submitted in January 2020, which offers guidance on the immediate steps that businesses in the Electricity North West area can take to help tackle climate change by reducing their carbon emissions through:

- Direct energy use associated with buildings (Scope 1 – from direct combustion of fuel onsite)
- Indirect energy use in buildings (Scope 2 - from the emissions associated with electricity used onsite)
- Emissions associated with commuting, business and customer travel (however not freight logistics).

Full references for points made are given in the main report.

2. Recommendations

The following sector-specific recommendations were made as a result of the research:

Non-food retail

Food retail

Offices

Hotel

Warehousing and factories

Transport and travel emissions

2.1 Non-food retail

The two main areas of energy use – and therefore the main focus for action to reduce energy use and emissions – in non-food retail are lighting and heating, ventilation, and air-conditioning (HVAC).

Based on sector best practice, the following key interventions are recommended:

2.1.1 Energy management and monitoring

The following should be measured and targets set for making reductions:

- Specific energy consumption (kWh/m2/yr) per store and per main energy consuming process, either by sales floor area or total floor area. Best practice levels of 80 kWh/m2/yr are proposed.
- Lighting power density (W/m^2) per store and per store zone where applicable. 30 W/m^2 is proposed as a benchmark for specialist stores.

2.1.2 HVAC

The primary way of addressing energy demand for heating and cooling is through improvements to efficiency and insulation in the building fabric, specifically:

- Wall/roof/façade/floor
- Windows and glazing
- Internal and external solar shading
- Air tightness of external doors and doors between different temperature zones (including materials, seal, ensure they close quickly).

In addition to the use of technology, changes in practice can also result in energy savings. For example, in winter, when customers are dressed in warmer clothing, some stores may still have the heating set to enable staff to wear short sleeved uniforms. By ensuring that staff have seasonal uniforms, the internal temperature can be reduced, lowering energy demand.

2.1.3 Ensure best practice lighting

Best practice lighting requires a well-controlled system that optimises the use of lights, and replacing older lamp types with LEDs. Consider how much lighting is required and whether there is an opportunity to reduce lighting use.

2.1.4 Increase direct use of renewables

There are various options for using renewable energy in the non-food retail sector which can make a contribution to emissions. These include:

- Onsite rooftop photovoltaic (PV) solar panels
- Onsite air or ground-source heat pumps
- PV panels installed at a separate site for specific use by the store.

2.2 Food retail

Food retailers of various sizes generally have higher energy intensity in their buildings compared to other business users (double that of non-food retailers and up to five times that of offices) because of their need to refrigerate goods. Approximately 50% of energy use in supermarkets relates to refrigeration; 25% to lighting; and 20% to HVAC, although the proportion used for refrigeration is lower in larger stores.

Compared with other types of businesses, refrigeration in the food retail sector can have an additional impact through refrigerant leakage; reducing this or using other refrigerants can therefore play an important part in reducing emissions impacts in food retailers alongside the same interventions that are recommended for non-food retailers:

2.2.1 Energy management and monitoring

The following should be measured and targets set for making reductions:

- Specific energy consumption (kWh/m^2/yr) per store and per main energy consuming process, either by sales floor area or total floor area. Best practice levels of 80kWh/m^2/yr are proposed.
- Lighting power density (W/m^2) – This should be looked at per store and per store zone where applicable. 12 W/m^2 is proposed as a benchmark for supermarkets.
- Energy consumption for refrigeration per metre of display case (kWh/m/yr). A benchmark of excellence of 3,000kWh/m/yr is proposed.
- Calculate the percentage of refrigerant leakage in store using annual refrigerant purchases for each store and per refrigerant type.

2.2.2 Implement best practice refrigeration

Options for this involve:

- Adding glass cabinet doors, or air curtains and night shutters to vertical chilled food display cabinets
- Lighting removed from cabinets or replaced with LED lighting
- Installing flooded evaporators
- Reducing air humidity
- Installing compressor speed control of compressor
- Siting fan motor outside cabinets.

There are also innovative ideas for food retailers to play a key role to play in the wider renewable energy system through the use of refrigeration for electricity system services.

2.2.3 Ensure best practice lighting

Best practice lighting requires a well-controlled system that optimises the use of lights (such as motion sensors and zonal controls), and replacing older lamp types with LEDs.

2.2.4 HVAC

The primary way of addressing energy demand for heating and cooling is through improvements to efficiency and insulation in the building fabric, specifically:

- Wall/roof/façade/floor
- Windows and glazing
- Internal and external solar shading
- Air tightness of external doors and doors between different temperature zones (including materials, seal, ensure they close quickly).

Food retailers may also have a specific opportunity too in regards to refrigeration and HVAC systems by implementing heat recovery from refrigeration for a store's own use or even for export to other nearby stores.

In addition to the use of technology, changes in practice can also result in energy savings. For example, in winter, when customers are dressed in warmer clothing, some stores may still have the heating set to enable staff to wear short sleeved uniforms. By ensuring that staff have seasonal uniforms, the internal temperature can be reduced, lowering energy demand.

2.2.5 Increase direct use of renewables

There are various options for using renewable energy in the food retail sector which can make a contribution to emissions. These include:

- Onsite rooftop PV solar panels
- Onsite air or ground-source heat pumps
- PV panels installed at a separate site for specific use by the store.

Food retailers may also have the option of feeding food waste into an anaerobic digester that produces biomethane, which is then used to produce electricity which is transmitted to the store via a direct cable.

2.3 Offices

The nature of work conducted in offices means that their largest potential for emissions reduction is through a reduction in energy consumption. Other contributions include onsite renewable generation and low-carbon travel policies for staff and visitors.

When setting energy reduction goals, it is important to understand what the 'best practice' office building is doing differently to the 'average practice' office while recognising that best practice itself is not a fixed target, particularly as the challenge of reaching 'zero carbon' on a very rapid timescale means new approaches and standards can emerge at any time. This suggests that sharing information to help all office occupants know what might be possible is invaluable.

The three main areas of energy use in offices are HVAC, lighting, and office equipment, and they are the main focus for action to reduce energy use and CO^2 emissions. The following key interventions are recommended:

2.3.1 Energy management and monitoring

The following should be measured an targets set for reducing:

- Specific energy consumption (kWh/m^2/yr) for the office space used by an organisation (if they don't occupy an entire building) and per each main energy consuming process.
- Lighting power density (W/m^2) for the office space and for zoned areas where applicable. In some instances lighting intensity can be reduced while improving overall illumination function.

2.3.2 HVAC

The primary way of addressing energy demand for heating and cooling is through improvements to efficiency and insulation in the building fabric, specifically:

- Wall/roof/façade/floor
- Windows and glazing
- Internal and external solar shading
- Air tightness of external doors and doors between different temperature zones (including materials, seal, ensure they close quickly).

In addition to these measures, the Chartered Institution of Building Services Engineers (CIBSE) suggest a number of energy savings opportunities than can be realised through refurbishment:

- Increasing natural ventilation and daylight
- Increasing passive measures for air-conditioning
- Maximising the use of free cooling
- Removing air-conditioning completely
- Zoning buildings to enable more effective controls
- Installing an efficient and fully insulated hot water system.

2.3.3 Low energy lighting

Best practice lighting requires a well-controlled system that optimises the use of lights (e.g. motion sensors, using natural light where possible), and replacing older lamp types with LEDs.

2.3.4 Office equipment

One of the main issues with office equipment is how it is used. The following best practice in this area is recommended:

- People taking responsibility for the equipment under their control (ensuring it is turned off)
- Any energy saving features are enabled
- Centrally monitor IT equipment where possible
- Only equipment with a high energy efficiency rating is purchased
- Any vending machines are controlled to minimise out of hours energy use.

Assessing the lifetime operational energy use cost of an appliance as well as the upfront cost, and prioritising energy saving when considering renewing equipment will also support a reduction in office building carbon emissions.

2.3.5 Increase direct use of renewables

There are various options for using renewable energy in offices which can make a contribution to emissions. These include:

- Onsite rooftop PV solar panels
- Onsite air or ground-source heat pumps
- PV panels installed at a separate site for specific use by the office.

2.4 Hotels

Compared with retail and office premises, hotels generally contain a wider variety of types of space including bedrooms, function rooms, kitchens, restaurants, bars, and sometimes swimming pools and parking. However, space and water heating are the main contributors to onsite hotel energy demand and most of the energy-related CO^2 emissions from hotel buildings are from natural gas use for heating and hot water use.

Energy demand reduction itself may come not only through equipment and building fabric change, but through new energy management processes and engagement with staff and customers.

The following key interventions are recommended:

2.4.1 Monitoring current energy demand to identify wastage and improved control

Meter point monitoring or more sophisticated monitoring and control systems can identify current avoidable wastage of energy for quick wins and also set a baseline for high use areas and services which should be tackled. Better control of building temperature can reduce heating energy requirements without effecting comfort, and draughts, over-lighting, and countervailing actions such as having windows open or radiators on while air conditioning is operating can be identified and eliminated.

Other interventions include lighting sensors, zonal temperature setting, control hot water flow temperature, and control and improved thermostat location. As well as technical interventions, new protocols for staff to check and correct overheating in parts of the building can also reduce waste energy, as can equipment checking (and cleaning of parts) and avoiding overcooling in refrigeration.

2.4.2 Improving the performance of the building and equipment

Refurbishment and maintenance cycles can be important opportunities to add more efficient equipment or improve the thermal efficiency of the building, for example, by improving the air tightness of windows and doors and insulation levels for walls. Adding complementary ventilation and heat recovery can also reduce the energy needed to heat and cool hotels even further. Easy-to-implement measures to reduce hot water usage through spray taps and shower controls will also lead to reduced energy use and therefore carbon emissions.

2.4.3 Reduce energy used for lighting

Although lighting may only be around 15% of a hotel's onsite energy use, if older lighting technologies and manual controls are currently in place there can be significant immediate reductions in electricity demand.

Best practice lighting requires a well-controlled system that optimises the use of lights (e.g. motion sensors and timers), and replacing older lamp types with LEDs.

2.4.4 Add onsite renewables to reduce imported energy

As hotels have a significant daytime electricity load, rooftop renewables including PV panels for direct generation and also solar thermal for water heating are an appropriate solution.

All electricity generated by an appropriately-sized PV array could be used by a hotel onsite and contribute to reducing the building's energy related emissions by reducing electricity imports from the network.

As between 10% and 20% of hotel energy use is likely to be hot water supply, reducing imported energy to the building by utilising solar irradiance on the building can provide an important emissions saving; some assessments suggest that in some cases 40% of hot water demand could be supplied by solar thermal.

2.5 Warehousing and factories

Warehousing and factory units consist of a wide range of business types with a mix of spaces including warehouse, workshop production and office areas. Within the warehouse sector there is likely to be diversity in energy use depending on the flow of goods (storage to rapid fulfilment centres) and whether there is refrigeration onsite. Factories as a classification cover a wide range of activities including food products and manufacturing which have different process and energy needs, and goods storage requirements.

Best practice interventions for warehouses and factories are:

2.5.1 Implement low energy lighting with monitoring and automation

Lighting may be a significant contributor to onsite electricity consumption in large facilities with near continuous operation, e.g. multi-shift factory and warehouse settings. For a non-refrigerated warehouse, 65% of energy demand may be related to lighting. Where older sodium or metal halide discharge lighting is replaced by LED lighting, the same illumination (lumens) can be provided with around 50% less electricity. Similarly, replacing fluorescent tube lighting with LED will cut electricity use for lighting by around 30%. The specified operating lifetimes of LED lighting bulbs is also significantly longer than for discharge and fluorescent bulbs providing further cost savings over time. Coupling improved lighting sources with occupancy and ambient light sensors to avoid over-lighting can reduce the energy used for lighting even further.

2.5.2 Improving workplace heating, cooling and ventilation

Large volume buildings with regular air flow due to ventilation and open entrances/exits, as is often typical for warehouse and factory settings, are a particular challenge for efficient space heating and cooling, but the following interventions are recommended:

- Increasing the thickness of insulation materials on external walls and roofs may improve the U-value of a building by 50% to 70%, meaning that improved thermal comfort in a building can be achieved with less energy for heating
- Radiant (or infrared) heat panels are a particularly good option for buildings that have high ceilings and a lot of air flow because, instead of increasing the overall air temperature of a building like a standard convection heater, the heat from a radiant heat panel is absorbed only by the bodies it interacts with, therefore achieving the same level of comfort for occupants at a lower temperature
- Passive and active chilled beams can provide direct cooling of building space with less energy requirement and background noise than ventilation air conditioning.

2.5.3 Improve energy efficiency of electrical equipment

Where a warehouse/factory unit has a number of appliances with inductive loads such as motors, compressors, welding sets and induction heaters, carbon emissions could be reduced through power factor correction.

Voltage optimisation is another strategy for improving the energy efficiency of electrical appliances in factories, with the potential to save around 13% in electricity bills and resultant carbon if implemented.

2.5.4 Onsite renewables

Warehouse and manufacturing locations typically have sufficient roof space to support significant solar PV for electricity generation. Utilising vehicle charging equipment for onsite electric vehicles such as electric forklifts, and running equipment such as compressors at times of peak solar PV output can help to maximise onsite self-consumption of renewable energy and provide wider air quality benefits by reducing direct emissions of pollutants compared to diesel and LPG options.

Renewable heat can also be supplied onsite through heat pumps or biomass heaters.

2.6 Transport and travel emissions

Decarbonising surface transport (road and rail) is a significant priority for meeting emissions targets. In terms of carbon reporting, commuting and business travel fall into what are called Scope 3 emissions covers indirect emissions that occur throughout a company's value chain.

Best practice for reducing these cover three areas:

- Staff commutes: Interventions involve shifting journeys to 'active' modes such as cycling or walking, shifting car journeys to public transport, and shifting car use to electric vehicles by creating workplace travel plans.
- Business travel: Interventions involve reducing the need to travel by using technology instead for meetings, reducing travel distances by optimising meeting locations, and reduce greenhouse gas emissions by using low carbon modes of travel holding meetings in places easily accessible by public transport and rail.
- Customer travel: Staff shuttle buses may also be able to bring customers, while stores sited in city centres instead of out of town can more easily be visited by active or public transport modes.

2.7 Recommendations common to all sectors

Some of the key recommendations listed above apply to more than one sector, for example, monitoring energy usage, using low-energy managed by a control system, and installing rooftop solar. Key points relating to these recommendations which apply across sectors are listed below.

2.7.1 Leases

For many businesses, issues with energy and lighting management, and with rooftop solar installation can arise due to the ownership arrangement of the space in buildings e.g. if it rents rather than owns the building. This is particularly the case for non-supermarket retailers and offices. The Better Building Partnership highlight the relationship between owners and occupiers in terms of the responsibilities and benefits for procurement and control of energy as a key barrier to improving the environmental performance of buildings. One approach to overcoming this is through the use of a 'Green Lease'. This is a standard lease with additional clauses that address the environmental management and improvement of a building, making clear the responsibilities for both the owner and the occupier, and is legally binding. Alternatively, a non-legally binding Memorandum of Understanding can be agreed between owner and occupier.

2.7.2 Gains without adverse impact

Evidence suggests that reductions in energy use for lighting, temperature and air quality can be made without any adverse impact on the end-goal service provided.

2.7.3 Financial support

Qualifying heat pumps and biomass boilers can benefit from the Renewable Heat Incentive (RHI) which provides financial support to adopt low carbon heating.

2.7.4 Additional low-carbon power generation

Best practice for buying in renewable energy is that it should be additional low carbon power generation that wouldn't otherwise have been installed, for example, with direct purchase through a Power Purchase Agreement (PPA). Where businesses are closely located there may be opportunities to pool resources and develop technologies that can supply multiple sites with renewable energy. Just switching to an energy retailer specialising in renewables does not directly reduce the carbon emissions of the building.

3. Summary of carbon emissions reduction potential

The potential carbon emissions reduction for each sector that could be achieved if all of the best practice recommendations are implemented is shown below. It should be noted that these are average figures for diverse sectors but that even optimum reductions for an individual business will depend on a number of factors.

Carbon reduction potential if best practice measured are implemented:

Non-food retail

27%

Air-conditioned offices

30%

Food retail

25%

Warehousing and factories

24 - 34%

Hotels

36%