Department of Energy & Climate Change

# Appendix H: Deemed Measure Overviews and Data Calculations

Electricity Demand Reduction Pilot

M&V Manual

Deemed Savings Manual

Measure overviews and technical data and calculation sheets

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# Contents

# Measure overviews and Technical data and calculation sheets

## This document provides supporting material for Appendix B of the EDR pilot M&V manual regarding deemed savings

For each technology type on the deemed list this document contains:

- **Measure overview** – this defines the eligibility criteria for each of the technologies covered under the deemed savings approach. Please use this to confirm your project is suitable for the deemed savings approach and understand what information will be required to complete your submission and fill out the calculators.
- **Technical data/calculation sheets** – these provide information to show how the kW demand savings are determined within the spreadsheet calculator. They detail the formulae for the calculations, the deemed factors which are used, and a worked example calculation.

Note that the Spreadsheet calculators referred to in Appendix B are provided separately.

# 1. Process Chillers

## Measure overview

### Description

This measure allows for replacement of working process chillers. It covers factory-built pieces of refrigeration equipment which are primarily intended to cool down and maintain the temperature of a liquid (water or brine) using a vapour compression cycle within a refrigeration process, including at least a compressor and an evaporator within a “package”. This measure is limited to chillers intended for process cooling applications, being those that are generally designed to operate all year round, including in ambient temperatures below approximately +10℃, and optimised for efficient operation at 80% loading and above and for which the load is generally independent of ambient conditions.

### Target Market Segments

Commercial, Industrial, Public, Not For Profit

### Target End Uses

Supply of continuous cooling as part of a process.

### Applicability

- This measure applies to the replacement of one or more currently working process chillers in one or more premises with more efficient products.
- The measure applies to products which are functioning 24hours per day, 5 or 7 days per week over their entire lifespans.
- The measure only applies where the existing and replacement chillers are <1MW capacity.
- The measure applies to “high temperature” chillers i.e. that the process chiller is capable of delivering its rated cooling capacity at an indoor heat exchanger outlet temperature of 7℃, at standard rating conditions;

### Exclusions

- This measure does not apply to chillers used in ventilation and air conditioning systems i.e “comfort chillers”
- This measure does not apply to replacement of failed process chillers.
- This measure does not apply to the installation of process chillers in new premises or expansion of existing facilities i.e. increasing the number or overall capacity of process chillers.

- This measure does not apply to the installation of absorption process chillers
- This measure does not apply to “medium temperature” or “low temperature” chillers i.e. chillers in which the rated cooling capacity is delivered at an indoor heat exchanger outlet temperature of -8℃ or -25℃ at standard rating conditions;

## Definitions

- Coefficient of Performance (COP) is a dimensionless number quantifying the efficiency of a given refrigeration system. It is the ratio between the net cooling capacity over the effective power input (kW).
- Cooling capacity is the total amount of cooling a given plant can supply (kW).
- Loading factor is the proportion of cooling capacity in utilisation by the plant (%).
- Refrigeration load is the product between the cooling capacity and the loading factor of the plant (kW).
- Performance of the units (i.e. COP) is usually tested by manufacturers according to BS EN 1511:2013 series under stated test conditions.

# Technical data and calculation sheet

## Deemed Savings Formula & Tables

$$EDR_{savings} = kW_{existing} - kW_{proposed} \tag{1}$$

$$where\ kW_{existing} = \frac{Capacity_{proposed} \times load\ factor}{COP_{existing} \times free\ cooling\ factor \times ageing\ factor \times (1 - sizing\ factor)} \tag{2}$$

$$where\ kW_{proposed} = \frac{Capacity_{proposed}}{COP_{proposed}} \times (load\ factor) \tag{3}$$

**Load factor** = 0.8 (this average value should be used for all calculations)

$\boldsymbol{Capacity_{proposed}}$ = Cooling Capacity of the replacement chiller, as per manufacturer specification

$\boldsymbol{COP_{proposed}}$ = COP of the replacement chiller, as per manufacturer specification, stated at operational temperature of +7$^{O}$C

$\boldsymbol{COP_{existing}}$ = COP of the current chiller. Look up on tables below, depending whether air or water cooled.

Free cooling factor = 1.3 if existing chiller has free cooling
Free cooling factor = 1.0 if existing chiller doesn’t have free cooling
(It is assumed that if current chiller has free cooling, then its COP is estimated to be 30% higher than the average for $COP_{existing}$)

| **Ageing Factor (years)** | |
|---|---|
| 0 to 5 | 1.00 |
| 6 to 10 | 0.94 |
| 11 to 15 | 0.90 |
| 16 to 20 | 0.86 |
| 21 to 25 | 0.82 |
| Over 25 | 0.80 |

$$Capcacity\ ratio = \frac{Capacity_{proposed}}{Capacity_{existing}} \times load\ factor$$

Sizing factor = assumed reduction in COP resulting from different loading level compared to 80% load. Look up value on table below based on capacity ratio.

**Sizing factor:**

| Look up Capacity ratio | Sizing factor |
|---|---|
| >=0.8 | 0.00 |
| 0.7 to 0.79 | 0.01 |
| 0.6 to 0.69 | 0.06 |
| 0.5 to 0.59 | 0.14 |
| 0.4 to 0.49 | 0.23 |
| >=0.39 | 0.33 |

**$COP_{existing}$**

| Air Cooled Chiller $Capacity_{existing}$ | $COP_{existing}$ |
|---|---|
| High temp <400 kW | 2.7 |
| High temp >=400 kW | 2.9 |

| Water Cooled Chiller $Capacity_{existing}$ | $COP_{existing}$ |
|---|---|
| High temp <400 kW | 4.4 |
| High temp >=400 kW | 4.8 |

**Example calculation**

Replacement of 1 x 150kW 12 year old air cooled chiller with 1 x 100kW new water cooled chiller with free cooling (COP 5.6).

| | Existing units | Proposed units |
|---|---|---|
| **COP** | 2.7 (from table) | 5.6 |
| **Free cooling** | 1 | n/a |

| | | |
|---|---|---|
| **factor** | | |
| **Ageing factor** | 0.9 (from table) | n/a |
| **Capacity ratio** | =100/150 x 0.8 = 0.533 | n/a |
| **Sizing factor** | = 0.14 (from table, using above capacity ratio) | n/a |
| **kW** | =100 x 0.8 / (2.7 x 1 x 0.9 x (1-0.14)) | =100 x 0.8 / 5.6 |
| | =38.28 | =14.29 |
| **Step 6** | $\text{Peak kW savings} = 38.28 - 14.29 = 23.99\ \text{kW}$ | |

# 2. Heating controls

## Measure overview

### Description

This measure allows for the installation of new modern automatic heating controls that serve electrically driven heating systems.

Heating controls are used to regulate the environmental conditions (e.g. temperature) within a building or individual zones i.e. rooms or areas. They can be programmed to automatically maintain user-specified environmental conditions within pre-set limits in a manner that reflects occupation schedules, occupation status and/or level of activity in the zone, whilst also taking account of environmental conditions, and the specific operating requirements of the zone. Only the heating savings are included within the deemed savings approach and other measures under the “HVAC” category.

### Target Market Segments:

All building types (industrial, commercial and public) are eligible, excluding domestic premises.

### Target End Uses

Enhanced, automatic time and/or temperature control over electrically driven heating systems.

### Applicability

- Only automatic controls that serve direct electric heating systems e.g. wall mounted panel heaters, quartz infrared heaters and electrically driven heat pump/VRF/VRV type systems are eligible.
- Only controls that provide improved control functionality over the existing control system are eligible.
- Controls may be stand-alone unitary controllers, centralised controllers or a building energy management system.
- Improved controls should include three or more of the following features that are not already available:
  (a) More accurate time scheduling; (b) Optimum on/off; (c) Enforced switch-off at close of business e.g. BEMS interface with intruder detection; (d) Remote supervisory control; (e) Occupancy control; (f) Tamperproof / restricted temperature sensors; (g) Replacement of room thermostats with sensors; (h) Remote supervisory control

### Exclusions

- Projects will not be eligible where the existing control system(s) is/would be capable of providing the same functionality as the proposed system, but such capability is not being utilized e.g. having fallen into disuse, being manually over-ridden or have not been properly maintained.
- HVAC control upgrades that directly relate to air and/or water volume flow rate control savings arising from control of electric motors associated with centralised systems e.g.

demand controlled ventilation, or duct static pressure reset control are not eligible. Installing variable speed drives (VSDs) to control heating fans and pumps is covered on a separate Motors and Drives spreadsheet calculator.

- Savings on fans, pumps, and heating using other fuels are not included in the savings calculation. Only electrical heating savings are covered through the deemed savings approach.
- Projects situated in residential premises are not eligible under deemed savings.

## Definitions

| Term | Description |
|---|---|
| Direct electric heating | Any form of electrical heating system that is used to provide real-time space heating e.g. wall mounted panel convector heaters, quartz radiant heaters |
| Heat pump | A system that employs a refrigerant cycle to draw heat energy from a cooler source e.g. external air, to provide space heating to an internal space. In this context only electrically driven systems are eligible. |
| VRF/VRV (Variable Refrigerant Flow/Variable Refrigerant Volume) | A system in which a single outdoor unit serves multiple indoor units each of which has an electronic liquid expansion valve to control refrigerant supply to match the demand of the space it serves. In this context only electrically driven systems are eligible. |
| Building Energy Management System (BEMS) | A micro-processor based system that can set and control the temperature and/or humidity in levels in multiple zones, allow for different time control to be exercised in each zone as well as providing other control and management functions e.g. control of lighting, monitoring of plant alarms. |
| Optimum start/stop | A control function that calculates the optimal time to switch on/off heating (or zone) according to thermal characteristics of the building and the desired temperature (and often the prevailing external conditions). |
| Time-switch | An electronic or electro-mechanical means of controlling the operating times of heating systems/equipment. These can range from simple 7-day timers with limited time resolution and switching periods to electronic controllers that allow multiple cycles per day to a high degree of resolution e.g. 1-minute. |
| Zone control | A means of exercising individual time and/or temperature control of an individual space that is served from a larger system. |

# Technical data and calculation sheet

## Deemed Savings Formula & Tables

$$EDR_{savings} = kW_{existing} \times (1 - ACF) \quad (1)$$

$where:$

$$kW_{existing} = \frac{Heated\ Floor\ Area\ \times\ IHCF\ \times\ SLF}{SCOP\ \times\ 1{,}000} \quad (2)$$

ACF = Assessed Control Factor

Heated Floor Area = Building or zone floor area affected by the enhanced controls ($m^2$)

IHCF = Installed Heating Capacity Factor (Watts per $m^2$)

SLF = System Load Factor=0.8 i.e. system deemed to be operating at 80% of its rated capacity

SCOP = Seasonal Coefficient of Performance = 1 for direct electric; 4 for heat pump/VRF

**Installed Heating Capacity Factors (IHCF)**

| Building Type | Watts/$m^2$ |
|---|---|
| Retail | 100 |
| Offices | 70 |
| Industrial | 80 |
| Educational | 87 |
| Other | 70 |

**Assessed Control Factor (ACF)**

| Enhancement | Control Factor |
|---|---|
| Improved time control | 0.90 |
| Closer temperature control | 0.92 |
| Time & temperature control improved | 0.82 |

## Example calculation

Offices having a heated floor area of 5,000$m^2$ served by multiple heat pump systems under basic local time and temperature (fixed time schedule and adjustable wall mounted thermostats) intend to install a mini Building Energy Management System to provide optimum start and stop time control, set-point enforcement and zone (time) control through occupancy detection. Office is open throughout the 4-8pm peak period, 5 days per week.

$$EDR_{savings} = kW_{existing} \times (1 - ACF)$$

*where*:

$$kW_{existing} = \frac{Heated\ Floor\ Area\ \times\ IHCF\ \times\ SLF}{SCOP\ \times\ 1{,}000}$$

$$kW_{existing} = \frac{5000\ \times\ 70\ \times\ 0.8}{4\ \times\ 1{,}000}$$

$$kW_{existing} = 70\ kW$$

$$EDR_{savings} = 70 \times (1 - 0.82)$$

$$EDR_{savings} = 12.6\ kW$$

# 3. Lighting and lighting controls

## Measure overview

### Description

This measure allows for replacement of functional existing luminaires and lamps with high efficiency lighting units including light emitting diode units. This measure also allows for the inclusion of lighting control within a lighting project or as a separate project.

High efficiency lighting units are products that are specifically designed to provide energy efficient illumination e.g. T5 fluorescent lighting units. Units are a combination of a light fitting, one or more lamps, and associated control gear that have been assembled either into a single packaged unit or a luminaire with remote control gear.

Light emitting diode (LED) lighting units are products that are specifically designed to provide light by means of solid-state lighting devices. LED lighting units are products that consist of one or more LEDs incorporated into a light fitting (or luminaire) and includes associated electronic control gear. The luminaire generally also includes an optical system that reflects and/or focuses the product's light output onto the item(s) being illuminated.

Lighting controls are products that are specifically designed to switch electric lighting on or off, and/or to dim its output. Lighting controls enable electric lighting levels within specific areas to be adjusted, as and when required by changes in occupancy or daylight, or individual activities. A wide variety of lighting control products are available, and these range from simple manual switches to fully automatic control systems that adjust electric lighting levels to reflect planned operating hours, occupation levels and the availability of daylight in specific areas.

### Target Market Segments

Commercial, Industrial, Public, Not for profit, Residential

### Target End Uses

All Target End Uses

### Applicability

- This measure applies to the upgrade of lighting systems with more efficient products, which may include lighting controls.
- Both current and proposed systems should illuminate the same areas
- Lighting units must have a luminaire efficacy that is greater than or equal to the thresholds set out in the 2013 Non-domestic building services compliance guide which supports Part L of the Building Regulations. http://www.planningportal.gov.uk/uploads/br/non_domestic_building_services_compliance_guide.pdf
- All products must have a power factor greater than, or equal to, 0.7 at all levels of product light output
- This measure must include the installation of products to meet the sufficient minimum light levels required according to HSG38 - Lighting at Work http://www.hse.gov.uk/pubns/books/hsg38.htm

- It is expected that the design of the new lighting and/or control system conforms to good lighting practice, and that the installation has been designed by a competent professional (for example the area is not over-lit, and the level of control is adequate to ensure that individual lighting zones dim or turn off when not required).

**Note:**

Measures involving luminaire replacements should be completed on the lighting replacement spreadsheet calculator. Measures which only involve fitting controls to existing lighting, should be entered onto the lighting controls only spreadsheet calculator.

Exclusions:

- This measure does not apply to replacement of failed lighting systems or the introduction of new lighting systems where a system didn't exist before
- This measure only includes replacement of whole luminaires. Replacement of lamps within existing luminaires are not eligible.
- This measure does not apply to new buildings or currently un-lit spaces of existing buildings
- This measure does not apply to projects which solely introduce photocell/daylight controls
- The proposed lighting systems must not illuminate different buildings and/or building areas; no benefit is attributable to the removal of existing lighting from unused areas.

## Definitions

- Light Sources - Defined according to the details in Table 1 below
- Lighting Controls - Defined according to the details in Table 2 below
- Luminaire – The whole light fitting and associated lamp(s) and control gear
- Lamp Rating – The stated watts (W) given for the luminaire
- Efficacy – Luminaire efficiency defined by lumens of light output emitted by the luminaire per circuit watt of electrical power consumed

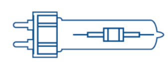
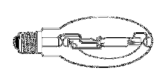
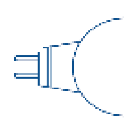
| Light Source | Control Gear | Description | Image |
|---|---|---|---|
| T12 Fluorescent | Switch start | 38mm diameter fluorescent tube typically found in older lighting systems. |  |
| T8 - Fluorescent | Switch start | Commonly used 26mm diameter fluorescent tube – available with switch-start or high frequency control gear. |  |
| | HF standard | | |
| | HF dimming | | |
| T5 - Fluorescent | HF standard | More modern 16mm diameter fluorescent tube. |  |
| | HF dimming | | |
| Compact Fluorescent (single ended) | Switch start | Used commonly in down-lights and bulkhead luminaires – available with switch-start or high frequency control gear. |  |
| | HF standard | | |
| | HF dimming | | |
| High intensity discharge (HPS & Metal Halide <200W) | Electro magnetic | Commonly used discharge lighting including either high pressure sodium (HPS) or metal halide. Available with electro-magnetic, electronic or hybrid ballasts depending on type and size. |  |
| | Electronic | | |
| | Electronic dimming | | |
| High intensity discharge (HPS & Metal Halide >200W) | Electro magnetic | | |
| | Hybrid | | |
| Mercury | Electro magnetic | Similar to the discharge lamps detailed above, but less widely used. |  |
| Incandescent (tungsten halogen) | Mains | Used in many display and hospitality applications – may be direct mains voltage or low voltage via a transformer. |  |
| | E transformer | | |
| | M transformer | | |
| LED | Electronic | Low energy light source which is available in a range of lamp and luminaire arrangements. |  |
| Induction | Electronic | A form of discharge lighting in which power is induced in the lamp without the need for internal electrodes. | |

**Table 1: Light Source Descriptions**

| Lighting Control Type | Description |
|---|---|
| None | Where no lighting controls are present and the lighting operates continually. |
| Manual/timer | Where the lighting is manually switched with no automated controls, or is switched off or dimmed at a set time of day using a timer. |
| Presence/PIR Dimming | Lighting controls which dim lighting based on presence detection i.e. when no presence is detected the lighting dims to a lower energy saving level. Detection may be based on Passive Infrared (PIR) sensors or other sensors. |
| Presence/PIR on-off | Lighting controls which switch off lighting based on presence detection i.e. when no presence is detected the lighting switches off. Detection may be based on Passive Infrared (PIR) sensors or other sensors. |
| Presence & daylight dimming | Where both daylight control and presence detection is used to dim lighting. Daylight control uses photocells to determine brightness levels and reduce lighting intensity where possible. Note this measure is attributed a low level of saving reflecting the short duration of daylight hours during the winter peak period. |
| Presence & daylight on-off | Where both daylight control and presence detection is used to switch off lighting. |

**Table 2: Lighting Control Descriptions**

# Technical data and calculation sheet

## Deemed Savings Formula & Tables

The formulae below describe the methodology to calculate the Electricity Demand Reduction for lighting systems. For more information please see the guidance notes.

$$EDR_{savings} = kW_{existing} - kW_{proposed} \tag{1}$$

where

$$kW_{existing} = \frac{Quantity_e \times LPLe \times We \times (1 + loss\ factor) \times (1 - controls\ factor)}{1{,}000} \tag{2}$$

$$kW_{proposed} = \frac{Quantity_p \times LPLp \times Wp \times (1 + loss\ factor) \times (1 - controls\ factor)}{1{,}000} \tag{3}$$

Where:

Controls factor = lighting control factor x building control factor

- $Quantity_e$ - The quantity of existing luminaries
- $Quantity_p$ - The quantity of proposed luminaires
- $LPL_e$ - The number of lamps per luminaire in the existing fittings
- $LPL_p$ - The number of lamps or light sources per luminaire in the proposed fitting
- $W_e$ - The wattage of the existing lamps
- $W_p$ - The wattage of the proposed lamps or light-sources
- Loss factor - The associated overhead, ballast loss or LED driver loss applicable to the control of the existing and proposed lamps and light sources. Note this is based on the type of lamp or light source used with losses referenced from the associated tables.
- Controls factor – The level of controls saving applicable based upon the building type, building area and controls type entered. The factors applied are taken from the associated standardised lighting control factor and building control factor tables. The product of the Lighting Control Factor and Building Control Factor is the control factor.

## Example calculation

The example below details an Electricity Demand Reduction calculation for a warehouse proposing to upgrade their lighting from metal halide sources to LED technology with improved controls through occupancy detection.

### Example

Replacement of 100 400W Metal Halide luminaires in a warehouse. The existing luminaires have a single lamp per fitting, electronic ballasts, manual controls and operate in the main storage area of the warehouse. The proposed system is to utilise 100 150W LED luminaires with automatic presence detection which turn the luminaires off when not required. The warehouse is open from 4-8pm every weekday.

$$kW_{existing} = \frac{100 \times 1 \times 400 \times (1 + 0.15) \times (1 - 0)}{1{,}000} = 46kW$$

$$kW_{proposed} = \frac{100 \times 1 \times 150 \times (1 + 0.05) \times (1 - (0.9 \times 0.5))}{1{,}000} = 8.663kW$$

$$EDR_{savings} = kW_{existing} - kW_{proposed} = 46kW - 8.663kW = 37.338kW$$

**Deemed Savings Tables**

Table 1 details the exiting light ballast and control gear losses used in the calculations.

| Light Source | Control Gear | Attributed Loss factor<br>(% of Lamp Wattage) |
|---|---|---|
| T12 – Fluorescent | Switch start | 0.20 |
| T8 - Fluorescent | Switch start | 0.15 |
| | HF standard | 0.10 |
| | HF dimming | 0.10 |
| T5 - Fluorescent | HF standard | 0.05 |
| | HF dimming | 0.06 |
| Compact Fluorescent (single ended) | Switch start | 0.15 |
| | HF standard | 0.10 |
| | HF dimming | 0.10 |
| High intensity discharge<br>(High Pressure Sodium & Metal Halide <200W) | Electro magnetic | 0.15 |
| | Electronic | 0.08 |
| | Electronic dimming | 0.10 |
| High intensity discharge | Electro magnetic | 0.15 |

| | | |
|---|---|---|
| (High Pressure Sodium & Metal Halide >200W) | Hybrid | 0.10 |
| Mercury | Electro magnetic | 0.15 |
| Incandescent (tungsten halogen) | Mains | 0.00 |
| | E transformer | 0.075 |
| | M transformer | 0.10 |

**Table 1: Existing light source loss factors**

Table 2 details the proposed light ballast and control gear losses used in the calculations

| Light Source | Control Gear | Attributed Loss factor (% of Lamp Wattage) |
|---|---|---|
| LED | Electronic | 0.05 |
| T5 – Fluorescent | HF standard | 0.05 |
| | HF dimming | 0.06 |
| Induction | Electronic | 0.10 |
| Compact Fluorescent (single ended) | HF standard | 0.10 |
| | HF dimming | 0.10 |
| High intensity discharge (HPS & Metal Halide <200W) | Electronic | 0.08 |
| | Electronic dimming | 0.10 |
| High intensity discharge (HPS & Metal Halide >200W) | Hybrid | 0.12 |

**Table 2: Proposed light sources loss factors**

**Lighting controls**

Table 3 below details the control type factor which is multiplied by the relevant building control factor in Table 4 to give the percentage level of controls saving applicable. This provides a deemed control saving based on the participants' details.

| Controls | Lighting control factor |
|---|---|
| None | 0 |
| Manual/timer | 0 |
| Presence/PIR Dimming | 0.8 |
| Presence/PIR on-off | 0.9 |
| Presence & daylight dimming | 0.9 |
| Presence & daylight on-off | 0.9 |

**Table 3: Lighting Control Factors**

**Table 4: Building Control Factors**

| Building Type | Area of Building | Building Control Factor |
|---|---|---|
| Office | Open Plan | 0.20 |
| | Corridor | 0.10 |
| | Cellular Offices | 0.40 |
| | Meeting Room | 0.40 |
| | Break-out/Canteen | 0.20 |
| | External | 0.00 |
| | Other | 0.20 |
| Education | Corridor | 0.10 |
| | Classroom | 0.20 |
| | Canteen | 0.20 |
| | Office | 0.40 |
| | Auditorium | 0.40 |
| | External | 0.00 |
| | Other | 0.20 |
| Healthcare | Corridor | 0.10 |
| | Waiting | 0.40 |
| | Office | 0.40 |
| | Ward | 0.00 |
| | Treatment Area | 0.10 |
| | External | 0.00 |
| | Other | 0.10 |
| Retail | Main Store | 0.10 |
| | Customer Toilets | 0.40 |
| | Staff Lounges/Canteens | 0.40 |
| | Offices | 0.20 |
| | Corridors/ Storage | 0.40 |
| | External | 0.00 |
| | Other | 0.20 |

| Building Type | Area of Building | Building Control Factor |
|---|---|---|
| Warehousing/Logistics | Main Warehouse | 0.50 |
| | Offices | 0.20 |
| | Corridors | 0.15 |
| | Dispatch | 0.20 |
| | Goods Inwards | 0.20 |
| | External | 0.00 |
| | Other | 0.15 |
| Industrial / Manufacturing | Production Areas | 0.10 |
| | Offices | 0.20 |
| | Corridors | 0.20 |
| | Warehousing | 0.50 |
| | Canteen/Meeting Rooms | 0.40 |
| | External | 0.00 |
| | Other | 0.20 |
| Hospitality | Reception | 0.20 |
| | Corridors | 0.10 |
| | Bedrooms | 0.00 |
| | Restaurant Areas | 0.20 |
| | Staff Areas | 0.20 |
| | External | 0.00 |
| | Other | 0.10 |
| Other | Open Plan | 0.20 |
| | Corridor | 0.10 |
| | Cellular Offices | 0.40 |
| | Meeting Room | 0.40 |
| | Storage | 0.40 |
| | External | 0.00 |
| | Other | 0.10 |

**Table 4: Building Control Factors**

# 4. Motors - Single Speed AC Induction, Permanent Magnet Synchronous and Integrated Motor Drive Units

## Measure overview

### Description

Single Speed AC Induction Motors cover products that are specifically designed to convert electrical power into mechanical power to rotate a drive shaft at a fixed speed that is directly related to the frequency of the electrical power supply. This is by means of a standard three phase AC induction motor. These motors are used to drive plant and machinery throughout industry and commerce. A wide range of 'general purpose' products are available in internationally agreed standard designs with different rated power outputs, frame sizes, fixed operating speeds and energy efficiency ratings.

Permanent Magnet Motors Synchronous Motors are products that are specifically designed to rotate a mechanical drive shaft by converting a multi-phase electrical power input into a rotating magnetic field and applying it to an array of permanent magnets that turn the mechanical drive shaft. These motor drives consist of a permanent magnet synchronous motor and a matched electronic variable speed drive (VSD) that is specifically designed to provide the variable frequency, multiphase electrical power input needed to operate the permanent magnet synchronous motor and to vary its speed in a controlled manner in response to an external signal. These motors are generally more compact and more energy efficient than AC induction motors with the same power rating because they do not require rotor windings.

Integrated Motor Drive Units are a combination of an electronic variable speed drive (VSD) and an AC induction motor. The VSD is physically mounted on the motor, and is specifically designed to drive that particular motor and thus is optimally matched to it. This makes an integrated motor drive unit easier to deploy than purchasing two separate components.

### Target Market Segments

Commercial, Industrial, Public

### Target End Uses

Fans, Pumps, HVAC, Compressors, Process and Other

### Applicability

- This measure allows for replacement of functional Single Speed AC Induction Motors, Permanent Magnet Synchronous Motors and Integrated Motor Drive Units in industrial, commercial and public applications
- This measure allows for the replacement of different sized motors
- This measure only applies to replacing the same number of motors as already installed
- This measure allows for the calculation to be made with or without the existence of variables speed drives for induction motors

- This measure allows for the addition of a variable speed drive as part of the proposed installation
- This measure also allows for variable speed drives to be fitted to existing motor systems without replacing the motor.
- Replacement motors must be at least IE3 efficiency class to be eligible.

## Assumptions

- Degradation in efficiency due to the age of the existing motors has been embedded into the calculations
- Load factors have been deemed by motor size and application (i.e. fans, pumps, compressors) and have been embedded in the calculation
- VSD efficiency loss and harmonic losses have also been embedded in to the calculations

## Exclusions

- This measure does not apply to the replacement of failed motors
- This measure does not apply to the installation of new motors in new build/expansion application
- Replacement motors below IE3 efficiency class are not eligible.

## Definitions

- Efficiency of Motor – The ratio of usable shaft power to electrical input. This is classified by IEC 60034-30 and currently specifies motor electrical efficiency classes for motors into IE1, IE2, IE3 or IE4
- Power Rating – The maximum input power for the motor given in kW. This is commonly located on the rating plate or otherwise in manufacturer documentation
- Application – Refers to where the motor(s) are being used i.e. Fans, Pumps, Air Compressors etc.
- Age of Motor – Refers to the date the motor was purchased
- Variable Speed Drive – An electronic power convertor that generates a multiphase variable frequently output that can be used to drive a standard AC induction motor, or permanent magnet synchronous motor in order to modulate speed, torque and mechanical power output
- Rpm/Poles – Motor speed (given in Rpm) and the No. of poles are related and have an effect on the overall efficiency of motors (average used within calculations)

# Technical data and calculation sheet

## Deemed Savings Formula & Tables

$$EDR_{savings} = kW_{ex} - kW_{pr}$$

$$kW_{existing} = \ Rated\ kW_{ex}\ \ x\ (FSLF_{ex} x\ VSLFM_{ex})\ \div ((0.01\ x\ \ Efficiency_{ex} - VSHL_{ex})\ x\ VSD\ EF_{ex})$$

$$kW_{proposed} = \ Rated\ kW_{ex}\ x\ \left(FSLF_{ex} x\ VSLFM_{pr}\right)\ \div\ ((0.01\ x\ Efficiency_{pr}\ - VSHL_{pr})\ x\ VSD\ EF_{pr})\quad *$$

***Rated kW<sub></sub>*** 

***Rated*** $\boldsymbol{kW_{ex}}$ = rated output of existing motor – from rating plate*

***Rated*** $\boldsymbol{kW_{pr}}$ = rated output of existing motor – from supplier documentation

$\boldsymbol{Efficiency_{ex}}$ = Current efficiency of existing motor = $\boldsymbol{Efficiency_{base}}$ – ***Ageing factor***

$\boldsymbol{Efficiency_{base}}$ = Efficiency of existing motor at time of purchase – as selected using the relevant kW rating from the tables below

$\boldsymbol{Efficiency_{pr}}$ = Efficiency of replacement motor – as selected using the relevant kW rating from the tables below

***Ageing factor*** = Factor to account for efficiency loss – read from tables below

$\boldsymbol{FSLF_{ex}}$ = (Fixed Speed Load Factor) = factor to account for typical loading - read from tables below (always based on Rated kW existing)

$\boldsymbol{VSLFM_{ex}}$ **and** $\boldsymbol{VSLM_{pr}}$** (Variable Speed Load Factor Multiplier) = Factor to account for VSD saving - read from tables below (based on rated kW existing or proposed as appropriate)

$\boldsymbol{VSHL_{ex}}$ **= (Variable Speed Harmonic Loss - existing) = (0.13 x (100-$Efficiency_{ex}$)/100) = factor to account for motor losses when using existing VSD - read from tables below

$\boldsymbol{VSHL_{pr}}$** = (Variable Speed Harmonic Loss - proposed) = (0.13 x (100-$Efficiency_{pr}$)/100) = factor to account for motor losses when using VSD for proposed measure - read from tables below

***VSD*** $\boldsymbol{EF_{ex}}$ and ***VSD*** $\boldsymbol{EF_{pr}}$ ** = VSD Efficiency Factor = factor to account for VSD losses - read from tables below (based on rated kW existing or proposed as appropriate)

*Please note, the rated kW of the *existing* motor (not the proposed motor) is used to calculate the kW of the proposed motor to consistently account for motor loads in any instance where larger motors are replaced by smaller ones. For example, if a 10kW motor with a load factor of 60% is replaced by a 6kW motor the new motor will need to run at 100% load to carry out the same work. By using the kW rating and fixed load factor of the existing motor in the proposed motors calculation this is accounted for.

**Please note, VSLFM, VSHL and VSD EF are only applicable where variable speed driven motors are part of the proposed and/or existing project.

**Where no variable speed is present you should use:**

**VSLFM= 1  VSHL= 0  and  VSD EF = 1**

## Deemed Savings Tables

### Base efficiency and aging factor

The base efficiency is determined by the age and size of the motor and where appropriate by applying a degradation factor due to age.

The relevant efficiency class using age as a proxy is shown in the table below. This also shows the adjusted aging factor which should be subtracted from the efficiency value:

| Selection of Motor Efficiency and ageing factor | | | | |
|---|---|---|---|---|
| | **Efficiency table to use** | | **Aging factor** | |
| Age | AC single speed induction | Permanent Magnet Synchronous | AC single speed induction | Permanent Magnet Synchronous |
| <1995 | IE1 | IE2 | 2% | 2% |
| 1995 – 2000 | IE1 | IE2 | 1% | 1% |
| 2001 – 2004 | IE1 | IE2 | 0.5% | 0.5% |
| 2005 – 2010 | IE1 | IE2 | 0 | 0 |
| >2010 | IE2 | IE3 | 0 | 0 |

For Permanent Magnet Motors the efficiency is assumed to be one class higher to account for enhanced efficiency of the technology (e.g. where a single speed motor from 2005-2010 is assumed to be IE1, a PM motor of the same age is assumed to have an efficiency of IE2)

## Efficiency tables

The following table shows the efficiency classes (IE1-IE4) adapted from IEC 60034-34 version 2//1679/CDV. An average of 2, 4, 6 and 8 Pole values is taken (not shown), but with the omission of 8 pole from the calculation for motors below 18.5kW in size due to its relative infrequent occurrence:

| | **IE1:** Nominal Efficiency Limits (%) 50 Hz | **IE2:** Nominal Efficiency Limits (%) 50 Hz | **IE3:** Nominal Efficiency Limits (%) 50 Hz | **IE4:** Nominal Efficiency Limits (%) 50 Hz |
|---|---|---|---|---|
| **Motor kW** | **Efficiency** | **Efficiency** | **Efficiency** | **Efficiency** |
| **0.75** | 71.40 | 77.63 | 80.70 | 83.97 |
| **1.1** | 74.30 | 79.70 | 82.60 | 85.63 |
| **1.5** | 76.53 | 81.30 | 84.00 | 86.87 |
| **2.2** | 79.03 | 83.10 | 85.63 | 88.30 |
| **3** | 80.90 | 84.47 | 86.80 | 89.37 |
| **4** | 82.53 | 85.67 | 87.83 | 90.20 |
| **5.5** | 84.17 | 86.90 | 88.93 | 91.10 |
| **7.5** | 85.57 | 88.00 | 89.87 | 91.87 |
| **11** | 87.20 | 89.30 | 90.97 | 92.73 |
| **15** | 88.37 | 90.20 | 91.73 | 93.37 |
| **18.5** | 88.83 | 90.55 | 91.98 | 93.48 |
| **22** | 89.45 | 91.03 | 92.40 | 93.80 |
| **30** | 90.38 | 91.83 | 93.08 | 94.33 |
| **37** | 90.95 | 92.33 | 93.48 | 94.65 |
| **45** | 91.50 | 92.78 | 93.83 | 94.90 |
| **55** | 91.95 | 93.18 | 94.20 | 95.23 |
| **75** | 92.63 | 93.75 | 94.65 | 95.55 |
| **90** | 92.95 | 94.05 | 94.93 | 95.75 |
| **110** | 93.28 | 94.33 | 95.15 | 95.95 |
| **132** | 93.50 | 94.58 | 95.38 | 96.13 |
| **160** | 93.80 | 94.78 | 95.60 | 96.30 |
| **200** | 93.95 | 94.98 | 95.80 | 96.45 |
| **250** | 93.95 | 94.98 | 95.80 | 96.50 |
| **315** | 93.95 | 94.98 | 95.80 | 96.53 |
| **355** | 93.95 | 94.98 | 95.80 | 96.53 |
| **400** | 93.95 | 94.98 | 95.80 | 96.53 |

**Fixed Speed Load Factor – FSLF**

The following table is used to determine the load factor on a fixed speed motor according to application and motor size (FSLF):

| Fixed Speed Load Factors by Application – FSLF | | | | | | |
|---|---|---|---|---|---|---|
| **Rated Power output (kW)** | **Pumps** | **Fans** | **Air Compressor** | **Refrigeration Compressor** | **Air Conditioning Compressor** | **Other** |
| **0.75** | 0.60 | 0.60 | 0.60 | 0.70 | 0.40 | 0.60 |
| **1.1** | 0.60 | 0.60 | 0.60 | 0.70 | 0.40 | 0.60 |
| **1.5** | 0.60 | 0.60 | 0.65 | 0.70 | 0.40 | 0.60 |
| **2.2** | 0.60 | 0.60 | 0.65 | 0.70 | 0.40 | 0.60 |
| **3** | 0.60 | 0.60 | 0.65 | 0.70 | 0.40 | 0.60 |
| **4** | 0.60 | 0.60 | 0.65 | 0.70 | 0.45 | 0.60 |
| **5.5** | 0.60 | 0.60 | 0.65 | 0.70 | 0.45 | 0.60 |
| **7.5** | 0.60 | 0.60 | 0.65 | 0.70 | 0.45 | 0.60 |
| **11** | 0.60 | 0.60 | 0.65 | 0.75 | 0.45 | 0.60 |
| **15** | 0.60 | 0.60 | 0.65 | 0.75 | 0.45 | 0.60 |
| **18.5** | 0.60 | 0.60 | 0.65 | 0.75 | 0.45 | 0.60 |
| **22** | 0.60 | 0.60 | 0.65 | 0.75 | 0.45 | 0.60 |
| **30** | 0.60 | 0.60 | 0.65 | 0.75 | 0.45 | 0.60 |
| **37** | 0.60 | 0.60 | 0.65 | 0.75 | 0.45 | 0.60 |
| **45** | 0.60 | 0.60 | 0.65 | 0.75 | 0.45 | 0.60 |
| **55** | 0.60 | 0.60 | 0.65 | 0.75 | 0.45 | 0.60 |
| **75** | 0.65 | 0.65 | 0.65 | 0.80 | 0.50 | 0.60 |
| **90** | 0.65 | 0.65 | 0.65 | 0.80 | 0.50 | 0.60 |
| **110** | 0.65 | 0.65 | 0.65 | 0.80 | 0.50 | 0.60 |
| **132** | 0.65 | 0.65 | 0.65 | 0.80 | 0.50 | 0.60 |
| **160** | 0.65 | 0.65 | 0.65 | 0.80 | 0.50 | 0.60 |
| **200** | 0.65 | 0.65 | 0.65 | 0.80 | 0.50 | 0.60 |
| **250** | 0.65 | 0.65 | 0.65 | 0.80 | 0.50 | 0.60 |
| **315** | 0.65 | 0.65 | 0.65 | 0.80 | 0.50 | 0.60 |
| **355** | 0.65 | 0.65 | 0.65 | 0.80 | 0.50 | 0.60 |
| **400** | 0.65 | 0.65 | 0.65 | 0.80 | 0.50 | 0.60 |

**Variable Speed Load Factor Multiplier – VSLFM**

The following table is used to determine the load factor multiplier (i.e. proportion saving) when a VSD is fitted according to application and motor size (VSLFM).

Were no VSD is fitted then use VSLFM=1

| Variable Speed Load Factor Multiplier by Application – VSLFM | | | | | | |
|---|---|---|---|---|---|---|
| **Rated Power output (kW)** | **Pumps** | **Fans** | **Air Compressor** | **Refrigeration Compressor** | **Air Conditioning Compressor** | **Other** |
| **0.75** | 0.75 | 0.75 | 0.90 | 0.90 | 0.90 | 0.90 |
| **1.1** | 0.75 | 0.75 | 0.90 | 0.90 | 0.90 | 0.90 |
| **1.5** | 0.75 | 0.75 | 0.90 | 0.90 | 0.90 | 0.90 |
| **2.2** | 0.75 | 0.75 | 0.90 | 0.90 | 0.90 | 0.90 |
| **3** | 0.75 | 0.75 | 0.90 | 0.90 | 0.90 | 0.90 |
| **4** | 0.75 | 0.75 | 0.90 | 0.90 | 0.90 | 0.90 |
| **5.5** | 0.75 | 0.75 | 0.90 | 0.90 | 0.90 | 0.90 |
| **7.5** | 0.75 | 0.75 | 0.90 | 0.90 | 0.90 | 0.90 |
| **11** | 0.75 | 0.75 | 0.90 | 0.90 | 0.90 | 0.90 |
| **15** | 0.75 | 0.75 | 0.90 | 0.90 | 0.90 | 0.90 |
| **18.5** | 0.75 | 0.75 | 0.90 | 0.90 | 0.90 | 0.90 |
| **22** | 0.75 | 0.75 | 0.90 | 0.90 | 0.90 | 0.90 |
| **30** | 0.75 | 0.75 | 0.90 | 0.90 | 0.90 | 0.90 |
| **37** | 0.75 | 0.75 | 0.90 | 0.90 | 0.90 | 0.90 |
| **45** | 0.75 | 0.75 | 0.90 | 0.90 | 0.90 | 0.90 |
| **55** | 0.75 | 0.75 | 0.90 | 0.90 | 0.90 | 0.90 |
| **75** | 0.75 | 0.75 | 0.90 | 0.90 | 0.90 | 0.90 |
| **90** | 0.75 | 0.75 | 0.90 | 0.90 | 0.90 | 0.90 |
| **110** | 0.75 | 0.75 | 0.90 | 0.90 | 0.90 | 0.90 |
| **132** | 0.75 | 0.75 | 0.90 | 0.90 | 0.90 | 0.90 |
| **160** | 0.75 | 0.75 | 0.90 | 0.90 | 0.90 | 0.90 |
| **200** | 0.75 | 0.75 | 0.90 | 0.90 | 0.90 | 0.90 |
| **250** | 0.75 | 0.75 | 0.90 | 0.90 | 0.90 | 0.90 |
| **315** | 0.75 | 0.75 | 0.90 | 0.90 | 0.90 | 0.90 |
| **355** | 0.75 | 0.75 | 0.90 | 0.90 | 0.90 | 0.90 |
| **400** | 0.75 | 0.75 | 0.90 | 0.90 | 0.90 | 0.90 |

**Variable Speed Harmonic Loss (VSHL) and VSD Efficiency Factors (VSD EF)**

The following table shows the Variable Speed Harmonic Loss (VSHL) and VSD Efficiency Factors (VSD EF) to use in the formulae according to motor size.

Were no VSD is fitted then use VSHL = 0 and VSD EF=1

| VSD Factors | | |
|---|---|---|
| **Motor Size** | **VSHL** | **VSD EF** |
| **0.75 kW** | 0.13 x (100% - motor efficiency)/100 | 0.90 |
| **1.1 kW** | 0.13 x (100% - motor efficiency)/100 | 0.90 |
| **1.5 kW** | 0.13 x (100% - motor efficiency)/100 | 0.91 |
| **2.2 kW** | 0.13 x (100% - motor efficiency)/100 | 0.92 |
| **3 kW** | 0.13 x (100% - motor efficiency)/100 | 0.93 |
| **4 kW** | 0.13 x (100% - motor efficiency)/100 | 0.93 |
| **5.5 kW** | 0.13 x (100% - motor efficiency)/100 | 0.94 |
| **7.5 kW** | 0.13 x (100% - motor efficiency)/100 | 0.94 |
| **11 kW** | 0.13 x (100% - motor efficiency)/100 | 0.95 |
| **15 kW** | 0.13 x (100% - motor efficiency)/100 | 0.95 |
| **18.5 kW** | 0.13 x (100% - motor efficiency)/100 | 0.95 |
| **22 kW** | 0.13 x (100% - motor efficiency)/100 | 0.95 |
| **>30 kW** | 0.13 x (100% - motor efficiency)/100 | 0.96 |

## Example Calculation

**One 75kW fixed speed induction motor installed in 2004 attached to a pump, replaced with a new IE3 55kW and variable speed drive:**

$$EDR_{savings} = kW_{ex} - kW_{pr}$$

$$kW_{existing} = \ Rated\ kW_{ex}\ \ x\ (FSLF_{ex} x\ VSLFM_{ex})\ \div ((0.01\ x\ \ Efficiency_{ex} - VSHL_{ex})\ x\ VSD\ EF_{ex})$$

$$kW_{proposed} = \ Rated\ kW_{ex}\ x\ \left(FSLF_{ex} x\ VSLFM_{pr}\right)\ \div\ ((0.01\ x\ Efficiency_{pr}\ - VSHL_{pr})\ x\ VSD\ EF_{pr})$$

$$VSHL_{pr} = (0.13\ x\ (100\text{-}Efficiency_{pr})/100)$$

Where:

***Rated kW$_{ex}$* =** 75kW $FSLF_{ex} = 0.65$ $VSLFM_{pr}$=0.75 $VSD\ EF_{pr}$= 0.96

***Efficiency$_{base}$*** = 92.63 [use IE1 motor value for 75kW as motor is from 2004]

***Efficiency$_{pr}$***=94.20 [Use IE3 55kW motor value]

***Efficiency$_{ex}$*** = 92.63-0.5 = 92.13 [subtract 0.5% ageing factor as motor is from 2004]

***VHSL$_{pr}$*** = 0.13 x (100-94.20)/100 = 0.00754

Therefore:

***kW $_{existing}$*** = 75kW x 0.65 x 1 / [(0.9213 - 0) - 0]

= 52.914 kW

***kW $_{proposed}$*** = 75kW x 0.65 x 0.75 / [(0.942 – 0.00754) x 0.96]

= 40.757 kW

**EDR $_{savings}$ = 52.914 – 40.757 = 12.16 kW**

# 5. Professional Refrigerated Storage Cabinets (PRSCs)

## Measure overview

### Description

This measure allows for replacement of working Professional Refrigerated Storage Cabinets (PRSC). PRSCs are specifically designed to store but not to display chilled and/or frozen foodstuffs. They are widely used in the catering industry to store frozen or chilled foodstuffs. They are differentiated from Retail Display Cabinets in that a door, lid or drawer must be opened to view and access the contents of the cabinet.

### Target Market Segments

Commercial, Industrial, Public, Not for profit

### Target End Uses

Preservation of chilled or frozen foodstuff.

### Applicability

- This measure applies to the replacement of one or more currently working PRSCs in one or more premises with more efficient products.
- It applies only to “plug in” products with an integral refrigeration system (i.e. compressor and condensing unit)
- Both current and proposed PRSCs should be of the same basic type i.e. both fridges or both freezers.
- The measure applies to products which are functioning 24 hours per day, 5 or 7 days per week over their entire lifespans.

### Exclusions

- The deemed savings approach cannot be used for “remote” PRSCs i.e. those that are connected to a remote refrigeration system i.e. where the condenser and/or compressor are not contained within the unit.
- This measure does not apply to replacement of failed PRSCs.
- This measure does not apply to the installation of PRSCs in new premises or expansion of existing facilities i.e. increasing the number or overall capacity of PRSCs.

### Definitions

- The total Energy Consumption (TEC) is sum of the Direct Energy Consumption (DEC) and Refrigeration Electrical Energy Consumption (REC). The former is the energy consumption of electrical components of the cabinet and the latter is that of the refrigeration system necessary to operate the cabinet.

- Gross internal volume is the volume within the inside walls of the cabinet without internal fittings, doors or lids if any being closed, as defined in BS EN ISO 441.
- Net volume (as defined in BS EN 441-1: 1995) is the volume that can contain food products within the load limit. The volume of parts necessary for the proper functioning of the cabinet, including shelves, is deducted from the gross volume to determine the net volume.

# Technical data and calculation sheet

## Deemed Savings Formula & Tables

$$EDR_{savings} = kW_{existing} - kW_{proposed} \tag{1}$$

$$where\ kW_{existing} = \frac{TEC_{existing}}{24} \times (100\% + age\ factor) \tag{2}$$

$$where\ kW_{proposed} = \frac{TEC_{proposed}}{24} \tag{3}$$

**TEC** (the Total Energy Consumption over 24 hours) is either obtained from manufacturers' data sheet where possible or (for existing units where TEC is not available) using equations (4) to (8):

$$TEC_{Vertical\ MT} = 0.0041 \times net\ volume + 1.5026 \tag{4}$$

$$TEC_{Horizontal\ MT} = 0.0063 \times net\ volume + 4.4145 \tag{5}$$

$$TEC_{Vertical\ LT} = 0.0122 \times net\ volume + 3.6294 \tag{6}$$

$$TEC_{Horizontal\ LT} = 0.0144 \times net\ volume + 5.868 \tag{7}$$

$$Net\ volume = Gross\ volume \times 77\% \tag{8}$$

MT = Medium temperature i.e. chillers

LT = Low temperature i.e. freezers

Vertical/Horizontal refer to the geometry of the cabinet

Gross volume is the total volume within the inside walls of the cabinet or compartment without internal fittings, doors or lids if any being closed, and is defined in BS EN ISO 441.

Net volume (as defined in BS EN 441-1: 1995) is the volume that can contain food products within the load limit. The volume of parts necessary for the proper functioning of the cabinet, including shelves, is deducted from the gross volume to determine the net volume.

**Ageing factor**

| Age of the unit | Aging factor |
|---|---|
| 0 to 5 | 0% |
| 5 to 10 | 5% |
| more than 10 | 8% |

## Example calculation

Replacement of 100 PRSCs vertical chiller aged 7 years (Gross volume= 600 litres) with 100 new vertical chiller PRSCs alternatives (unitary TEC=2.5 Kwh/day). As per equations (1) to (8), the calculations will be as follows:

| | Existing units | Proposed units |
|---|---|---|
| **Calculate TEC** | TEC=$(0.0041 \times 600 \times 77\% + 1.5026)$ | |
| **Calculate kW demand** | $\mathrm{kW} = \frac{(0.0041 \times 600 \times 77\% + 1.5026)}{24} = 0.14$ | $\mathrm{kW} = \frac{2.5}{24} = 0.1042$ |
| **Factor in age** | $= 0.14 \times (100\% + 5\%) = 0.1486$ | |
| **Multiply by number of units** | $= 0.14 \times 100 = 14.86$ | $= 0.1042 \times 100 = 10.42$ |
| **Total** | $\mathrm{kW}_{\mathrm{existing}} = 14.86$ | $\mathrm{kW}_{\mathrm{proposed}} = 10.42$ |
| **Step 6** | $\text{Peak kW savings} = 14.86 - 10.42 = 4.44\ \mathrm{kW}$ | |

**Calculating gross volume**

$$\textit{Gross volume}\ \langle \text{in litre} \rangle = (\text{height}\ \langle \text{in metre} \rangle \times \text{width}\ \langle \text{in metre} \rangle \times \text{depth}\ \langle \text{in metre} \rangle) \times 1{,}000$$

# 6. Refrigerated Display Cabinets (RDCs)

## Measure overview

### Description

This measure allows for replacement of working Refrigerated Display Cabinets (RDCs). RDCs are specifically designed to store and display chilled and/or frozen foodstuffs and beverages. There are many different designs, but all enable the customer to view the foodstuff stored in the cabinet, either through an opening in the cabinet, or through a transparent door or lid. The measure only covers ‘Plug in’ RDCs with an integral refrigeration system (i.e. incorporating a compressor and condensing unit inside the cabinet).

### Target Market Segments

Commercial, Industrial, Public, Not for profit

### Target End Uses

Preservation, display and sale of chilled or frozen foodstuff.

### Applicability

- This measure applies to the replacement of one or more currently working RDCs in one or more premises with more efficient products. They must enable the customer to view the foodstuff stored in the cabinet, either through an opening in the cabinet, or through a transparent door or lid.
- Both current and proposed RDCs should be of the same basic type and function (e.g replacing a freezer with a freezer)
- The measure applies to products which are functioning 24 hours per day, 5 or 7 days per week over their entire lifespans.

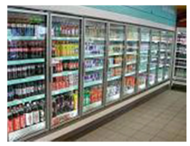
### Exclusions

- The deemed savings approach cannot be used for “Remote” RDCs, designed to work with a non-integral refrigeration system (i.e. where the compressor and/or condensing unit are located at a different location to the cabinet.
- This measure does not apply to replacement of failed RDCs.
- This measure does not apply to the installation of RDCs in new premises or expansion of existing facilities i.e. increasing the number or overall capacity of RDCs.

### Definitions

- The total Energy Consumption (TEC) is sum of the Direct Energy Consumption (DEC) and Refrigeration Electrical Energy Consumption (REC). The former is the energy consumption of electrical components of the cabinet and the latter is that of the refrigeration system necessary to operate the cabinet.

- The Total Display Area (TDA) is the total visible foodstuffs area, including visible area through the glazing, defined by the sum of horizontal and vertical projected surface areas of the net volume, as defined in Annex A BS EN ISO 23953
- For the avoidance of doubt, only standardised geometries/configurations of RDCs are included into the scheme. These are illustrated in the table below:

| | Vertical | Horizontal |
|---|---|---|
| **Geometry** | Vertical RDCs include tall, open units used for displaying produce and dairy. Tall fridge and freezer units with glass doors are also considered to be vertical RDCs. | Horizontal RDCs include typical delicatessen-style display counters and deep well reach-in freezers. |
| **Picture** |   |  |

## Technical data and calculation sheet

### Deemed Savings Formula & Tables

$$EDR_{savings} = kW_{existing} - kW_{proposed} \quad (1)$$

$$where\ kW_{existing}(\text{rating}) = \frac{TEC}{24} \times (100\% + ageing\ factor) \quad (2)$$

$$where\ kW_{proposed}\ (\text{rating}) = \frac{TEC}{24} \quad (3)$$

**TEC** (the Total Energy Consumption over 24 hours) is either obtained from manufacturers' data sheet or using equations (4) or (5):

$$TEC\ (chilled\ RDC) = 9.8053 \times\ TDA \times (100\% + configuration\ factor) \quad (4)$$

$$TEC\ (frozen\ RDC) = 16.263 \times TDA\ \times (100\% + configuration\ factor) \quad (5)$$

**TDA** is Total Display Area. It is either obtained from manufacturer data sheet or calculated in compliance with BS EN ISO 23953 and expressed in square metres.

**Configuration factor**

| Geometry+ temperature range | Configuration factor |
|---|---|
| Vertical chiller | 43% |
| Horizontal chiller | -43% |
| Vertical frozen | 61% |
| Horizontal frozen | -61% |

**Ageing factor**

| Age of the unit | Aging factor |
|---|---|
| 0 to 5 | 0% |
| 5 to 10 | 5% |
| more than 10 | 8% |

## Example calculation

Replacement of 10 vertical chiller RDC aged 7 years (TDA=3 $m^2$) with 10 new and efficient RDC alternative (TEC=30 Kwh/day*$m^2$). As per equations (1) to (5), the calculations will be as follows:

| | Existing RDC | Proposed RDC |
|---|---|---|
| **Calculate TEC** | $TEC = \frac{9.8053 \times 3}{24} = 1.22$ | $kW_{proposed} = \frac{30}{24} = 1.25$ |
| **Factor in age** | $\frac{9.8053 \times 3}{24} \times (100\% + 5\%) = 1.29$ | |
| **Factor in configuration** | $\frac{9.8053 \times 3}{24} \times (100\% + 5\%) \times (100 + 43\%) = 1.84$ | |
| **Total kW** | $kW_{existing} = 1.84$ | $kW_{proposed} = 1.25$ |
| **Total for 100 units** | $kW_{existing} = 1.84 * 10 = 18.4$ | $kW_{proposed} = 1.25 * 10 = 12.5$ |

**Peak kW savings = 18.4-12.5 = 5.9 kW**

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