# Walk-in cold rooms

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*A study being conducted for DG ENTR by BIO Intelligence Service*

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# Agenda

| | |
|---|---|
| 10:00 – 10:20 | **Welcome, explanation of the meeting structure and "Tour de table"** |
| 10:20 – 10:30 | **Short introduction to the Ecodesign Directive** |
| 10:30 – 10:40 | **Horizontal session: Progress update** |
| 10:40 – 11:30 | **Product focus: Walk-in cold rooms** |
| 11:30 – 11:50 | **COFFEE BREAK** |
| 11:50 – 12:40 | **Product focus: Service cabinets** |
| 12:40 – 13:30 | **Product focus: Blast cabinets** |
| 13:30 – 14:20 | **LUNCH BREAK** |
| 14:20 – 15:10 | **Product focus: Remote condensing units** |
| 15:10 – 15:40 | **Product focus: Chillers** |
| 15:40 – 16:00 | **COFFEE BREAK** |
| 16:00 – 16:40 | **Horizontal session: Refrigeration systems and refrigerants** |
| 16:40 – 17:30 | **Conclusions, next actions to be taken and AOB** |

# Product description

- A walk-in cold room is a refrigerated space, large enough to walk into, maintained at a temperature lower than ambient by a refrigerating system temperature.
- Walk-in cold provide refrigerated storage for a variety of items (foodstuff).
- The rooms are constructed from self supporting, pre-fabricated panels.
- They may exist solely as refrigerators or freezers, or a refrigerator-freezer combination.

**Functional Unit**

- One $m^3$ of net volume at storage temperature

# Product description

## Exclusions

- pharmaceutical storage or other application using a double refrigeration system;
- above 400m$^3$ in size;
- incorporating loading bays designed to provide access to vehicles;
- forming part of a building, having load-bearing walls or supporting the roof of a building; and
- constructed as a stand-alone external building.

# Market data

- UK MTP data extrapolated to EU
- Cross-checked against BSRIA data for France
- CAGR (2010-2014): 0.93%

| Year | Estimated sales forecast * | Estimated stock forecast * |
|---|---|---|
| 2006 | 87,926 | 1,491,948 |
| 2007 | 88,052 | 1,507,074 |
| 2008 | 88,289 | 1,521,659 |
| 2009 | 89,112 | 1,543,838 |
| 2012 | 91,059 | 1,578,022 |
| 2020 | 99,230 | 1,690,370 |
| 2025 | 103,522 | 1,785,024 |

*Extrapolation of figures provided by stakeholders

| Technology | (%) |
|---|---|
| Small | 67 |
| Medium | 31 |
| Large | 2 |
| | |
| Refrigerators | 69 |
| Freezers | 31 |
| Refrigerators-freezers | 1 |
| | |
| Factory-built (packaged) | 30 |
| Tailor-made | 60 |
| | |
| Integral | 20 |
| Monoblock | 25 |
| Remote condensing unit | 40 |
| Remote plant | 15 |

| Size | Operation temperature | Design |
|---|---|---|
| Small (up to 20m3) | Refrigerators | Factory-built (packaged) |
| | | Tailor-made |
| | Freezer | Factory-built (packaged) |
| | | Tailor-made |
| | Refrigerator / freezer | Factory-built (packaged) |
| | | Tailor-made |
| Medium (20m3 to 100m3) | Refrigerators | Factory-built (packaged) |
| | | Tailor-made |
| | Freezer | Factory-built (packaged) |
| | | Tailor-made |
| | Refrigerator / freezer | Factory-built (packaged) |
| | | Tailor-made |
| Large (100m3 to 400m3) | Refrigerators | Factory-built (packaged) |
| | | Tailor-made |
| | Freezer | Factory-built (packaged) |
| | | Tailor-made |
| | Refrigerator / freezer | Factory-built (packaged) |
| | | Tailor-made |

# Standards

- **US DOE** test standard currently separates shell (envelope) and refrigeration system; adapting the **ANSI/AHRI 1250:2008** standard
- Computer modeling
- **EN ISO 23953:2005** for factory-built?

- Food safety and construction standards
  - **EN 1672 :1997**: Food processing machinery hygiene requirements
  - **EN ISO 14159:2002**: Hygiene requirements
  - **DE VDMA 11499**: Operation and use of refrigerated display cabinets
  - **US NSF/ANSI 7:2009**: minimum food protection and sanitation requirements

# Legislation and voluntary agreements

- No MEPS or voluntary agreements
- Legislation relates to components: **US California Energy Commission** requirements
- **ETAG 021** – only refers to prefabricated equipments:
  - Thermal performance
  - Air permeability
  - Water vapour permeability

- These do not deal with energy performance, but with the function within kitchens for food safety reasons:
  - French commercial food preparation hygiene requirements law of 29/09/1997
  - UK Department of Health Guidelines
  - Austrian Hygiene Certificate Guideline

# Base Case weighting

- AEC based on UK MTP assumptions
- Estimated average size of 25m$^3$

| Size | Operation temperature | MTP estimated market proportion | MTP estimated average cooling load (kW) | MTP estimated average COP | MTP estimated average AEC of sub-categories (kWh/year) | Estimated average net internal volume (m$^3$) |
|---|---|---|---|---|---|---|
| Small (up to 20m$^3$) | Chiller | 44.49% | 1.4 | 1.84 | 6,665 | 12 |
| | Freezer | 22.54% | 1.3 | 1.32 | 8,627 | 12 |
| Medium (20m$^3$ to 100m$^3$) | Chiller | 23.36% | 4.5 | 2.41 | 16,357 | 40 |
| | Freezer | 8.10% | 4.58 | 1.47 | 27,293 | 40 |
| Large (100m$^3$ to 400m$^3$) | Chiller | 1.13% | 18 | 2.66 | 59,278 | 300 |
| | Freezer | 0.48% | 19 | 1.47 | 113,224 | 300 |

# Sub-Base Case and Weighted Base Case

Based on a partial Bill of Material obtained for a 25m$^3$ envelope + extrapolated Bill of Materials for a monoblock unit of correct specifications to supply the 25m$^3$ cold room.

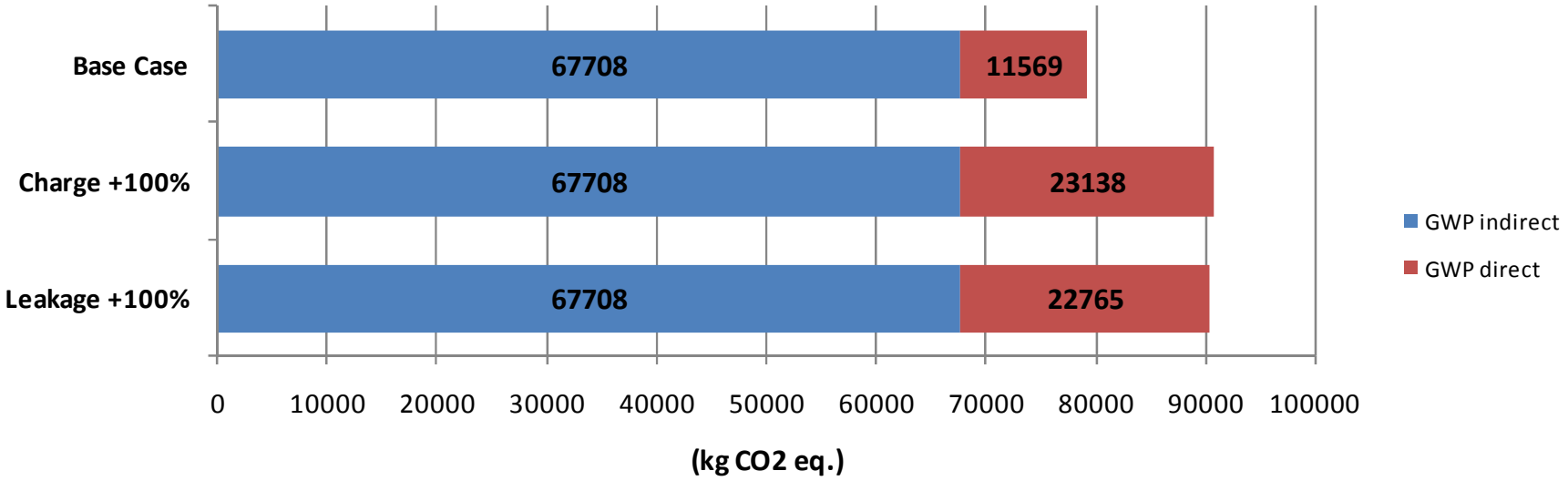
| Product characteristics | Sub-Base Case (estimated) | Weighted Base Case (abstract product) |
|---|---|---|
| Design: | Monoblock, factory-made | - |
| Functional unit: | m$^3$ net volume at +2°C | m$^3$ net volume at storage temperature |
| Net internal volume [m$^3$]: | 25 | 25 |
| AEC [kWh/year]: | 10,570 | 12,155 |
| Use pattern: | 8760 hours per year | 8760 hours per year |
| Price (ex VAT) [€]: | 8,800 | 8,800 |
| Lifetime [years]: | 10 | 10 |
| Shipping volume [m$^3$] : | 15 | 15 |
| Weight of product [kg]: | 1000 | 1000 |
| Refrigerant: | R404a | R404a |
| Refrigerant charge [g]: | 2,400 | 3,000 |
| Refrigerant leakage [% per annum]: | 5 | 9 |
| Refrigerant dumped at EoL [%]: | 5 | 5 |

# Environmental impacts

Total Energy (GER):

**5901.34 MJ** / $m^3$ at storage temperature / year, of which the use phase represents **94%**

Direct GWP represents about **15%** of the TEWI



# BAT model

Saving potential of **35% AEC** is estimated for BAT

| Parameter | BAT |
|---|---|
| Design | Monoblock, factory-built |
| Functional unit: | $m^3$ net volume at +2°C |
| Net internal volume [$m^3$]: | 25 |
| AEC[kWh/year]: | 6,870 |
| Use pattern: | 8760 hours per year |
| Price [€]: | 10,560 |
| Lifetime [years]: | 12 |
| Weight of product [kg]: | *TO BE COMPLETED* |
| Refrigerant: | R134a for HT / R410a for LT |
| Refrigerant charge [g]: | 2,040 |
| Refrigerant leakage [% per annum]: | 5 |
| Type of compressor: | Hermetic reciprocating |
| Power input of compressor [W]: | *TO BE COMPLETED* |
| Condenser cooling: | Air-cooled |
| Performance [kWh/$m^3$ at 2°C/year]: | 275 |
| Cooling capacity [kW]: | 3.485 |
| Power input [kW]: | 1.42 |

| Product | AEC (kWh /year) |
|---|---|
| Weighted Base Case | 12,155 |
| Weighted BAT | 7,901 |

# Improvement options

| | Applicability (years) | Market penetration (%) | Savings (% TEC) | Increase in price of product (€) | Priority |
|---|---|---|---|---|---|
| Strip door curtains | Now | N.A. | 13 | 60 | 1 |
| Auto door closer | Now | N.A. | 12 | 111 | 2 |
| PSC evaporator fan | Now | N.A. | 10 | 100 | 3 |
| ECM evaporator fan | Now | N.A. | 13 | 150 | 4 |
| High efficiency fan blades | Now | N.A. | 3 | 50 | 5 |
| Insulation thickness | Now | N.A. | 15 | 250 | 6 |
| ECM condenser fan | Now | N.A. | 3 | 60 | 7 |
| High efficiency LED light bulbs | Now | N.A. | 4 | 200 | 8 |
| R134a to replace R404a at HT, and R410a to replace R404a at LT | Now | N.A. | 0** | 0 | 9 |
| Floating head pressure (plus electronic expansion valve) | Now | 1 | 8 | 150 | 10 |
| Ambient subcooling | Now | N.A. | 4 | 170 | 11 |
| High efficiency compressor* | Now | N.A. | 5 | 200 | 12 |
| Anti-condensation control | Now | N.A. | 3 | 370 | 13 |
| Defrost control | Now | 0 | 5 to 10*** | N.A. | 6 |
| BNAT | | | | | |
| VSD compressor | 2 to 3 | N.A. | 15 | N.A. | 1 |
| ECM compressor | 2 to 3 | N.A. | 4 | N.A. | 2 |
| Hot gas defrost | 2 to 3 | N.A. | 4*** | 81 | 3 |
| Hot gas anti-condensation | 2 to 3 | N.A. | 13*** | 323 | 4 |
| Fan motor control | 2 to 3 | 0 | 3 | N.A. | 5 |

**Selected from technologies related to the component*

***The benefit of this improvement is also the lower GWP of the refrigerant*

****Applicable to low temperature only*

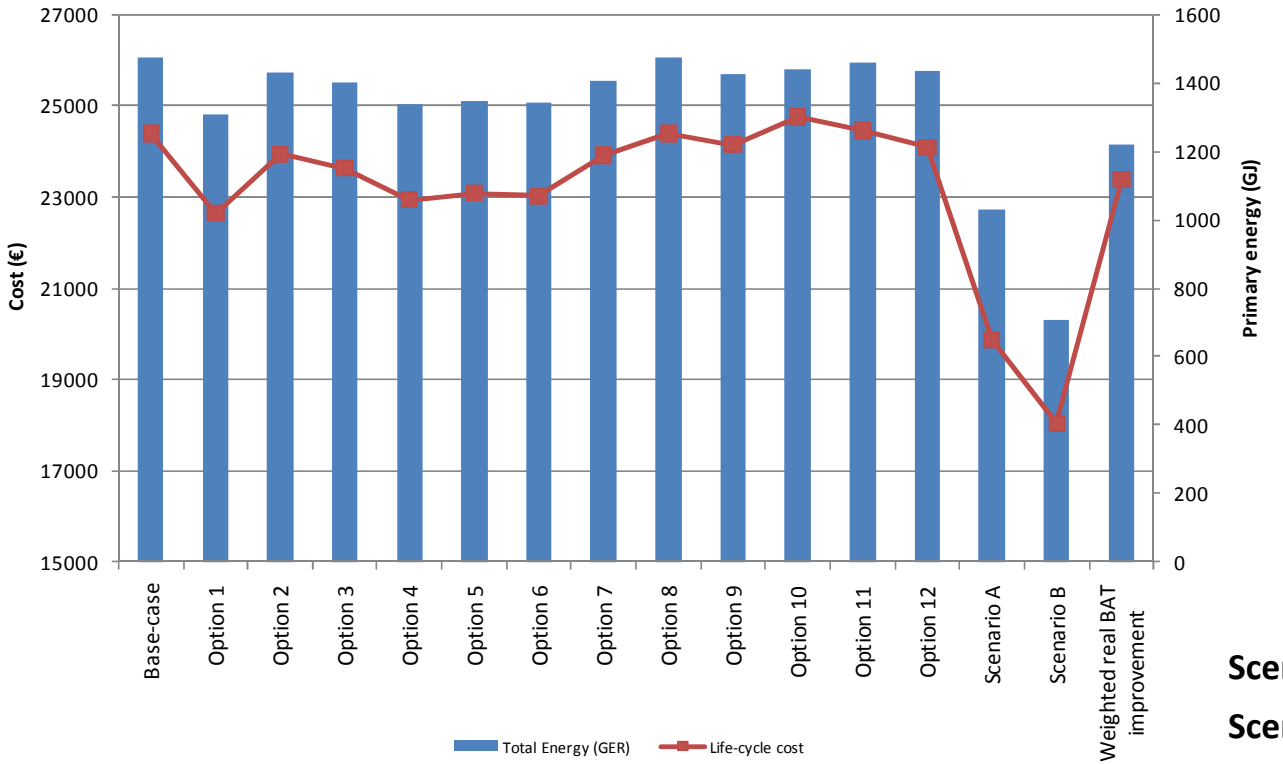
*N.A.: Data not available*

*Note: Savings are not additive.*

Priority based on cost increase, energy saving potential and applicability

# LLCC - BAT

## Primary Energy Consumption and LCC




| Options | |
|---|---|
| 1 | Strip door curtains |
| 2 | Auto door closer |
| 3 | PSC evaporator fan |
| 4 | ECM evaporator fan |
| 5 | High efficiency fan blades |
| 6 | Insulation thickness |
| 7 | ECM condenser fan |
| 8 | R134a to replace R404a at HT, and R410a to replace R404a at LT |
| 9 | High efficiency LED light bulbs |
| 10 | Floating head pressure (plus electronic expansion valve) |
| 11 | Ambient subcooling |
| 12 | High efficiency compressor |

**Scenario A**: includes options 1 to 6

**Scenario B**: includes options 1 to 12

| | Energy consumption HT (kWh) | Savings HT | Product price HT (€) |
|---|---|---|---|
| Weighted Base Case | 12,155 | - | 8,800 |
| LLCC = BAT = Scenario B | 4,862 | -60% | 10,431 |
| Real weighted BAT | 7,901 | -35% | 10,560 |

# BNAT

The “best” walk-in cold rooms within next 5 years could achieve energy savings of up to approximately 80% using the following:

| | |
|---|---|
| **Refrigerant:** | **R134a; or R410a; or R744; or R717** |
| **Compressor:** | **VSD ECM** |
| **Expansion device:** | **EEV** |
| **Evaporator:** | **ECM with efficient fan blades and improved heat exchanger** |
| **Condenser:** | **ECM with efficient fan blades and improved heat exchanger** |
| **Defrost :** | **Hot gas, controlled** |
| **Anti-condensation heaters :** | **Hot gas, controlled** |
| **Lighting:** | **LED** |
| **Insulation:** | **+25% thickness PUR** |
| **Other:** | **Strip door curtain and auto door closer; floating head pressure and ambient subcooling** |

| | **Estimated average AEC (kWh)** |
|---|---|
| Weighted Base Case | 12,155 |
| Weighted BAT | 7,901 |
| Weighted BNAT | 2,431 |

# MEPS (1/3)

| Size | Operation temp. | Average volume ($m^3$) | Average Base Case AEC (kWh /year) | Average real BAT AEC (kWh /year) | Average BNAT AEC (kWh /year) | Base Case EEI | LLCC EEI | BNAT EEI |
|---|---|---|---|---|---|---|---|---|
| Small (up to 20$m^3$) | Chiller | 12 | 6,665 | 4,332 | 1,333 | 3.04 | 1.22 | 0.61 |
| | Freezer | 12 | 8,627 | 5,608 | 1,725 | 3.94 | 1.58 | 0.79 |
| Medium (20$m^3$ to 100$m^3$) | Chiller | 40 | 16,357 | 10,632 | 3,271 | 2.24 | 0.90 | 0.45 |
| | Freezer | 40 | 27,293 | 17,740 | 5,459 | 3.74 | 1.50 | 0.75 |
| Large (100$m^3$ to 400$m^3$) | Chiller | 300 | 59,278 | 38,531 | 11,856 | 1.08 | 0.43 | 0.22 |
| | Freezer | 300 | 113,224 | 73,596 | 22,645 | 2.07 | 0.83 | 0.41 |

**Assumptions:**

- Short-term MEPS: LLCC
- Long-term MEPS: BNAT
- Improvement potentials applied to all categories in the same proportion

| Size | Location of the condensing unit | Short-term MEPS based on LLCC (max. EEI) | Long-term MEPS based on BNAT (max. EEI) |
|---|---|---|---|
| Small (up to 20$m^3$) | Refrigerator | 1.22 | 0.61 |
| | Freezer | 1.58 | 0.79 |
| Medium (20$m^3$ to 100$m^3$) | Refrigerator | 0.90 | 0.45 |
| | Freezer | 1.50 | 0.75 |

# MEPS (2/3)

- The MEPS would be measured under the following:
  - It is proposed that Total Electrical Energy Consumption could be measured under EN ISO 23953:2005.
  - Net Volume: the product of the internal dimensions.
  - Adjustment factor for refrigerator-freezers:
    - AV = volume of refrigeration compartment in litres + (1.33 x volume of freezing compartment in litres).
    - If energy consumption of freezing per unit volume is 1.5 times that of refrigeration adjustment allows for approximately 75% internal volume to be freezing storage.

# MEPS (3/3)

- The following minimum requirements are proposed:
  - **automatic door closers**;
  - **strip door curtains** or other method of minimising infiltration;
  - minimum heat resistance **insulation**;
  - minimumheat resistance **floor insulation for freezers**;
  - for **evaporator fan motors**: ECMs or 3-phase motors;
  - for **condenser fan motors**: ECMs or 3-phase motors.
- It is estimated that this will enable a reduction in consumption of an average of approximately 30%.

- Further requirements, based on the US CEC (or other improvement options) could also be set, including for example:
  - **efficient lighting**;
  - **Double- or triple-pane glass** with either heat-reflective treated glass or gas fill;
  - maximum total **door rail, glass, and frame heater power draw**; or with anti-sweat heat controls, above this, the controls reduce energy use in a quantity corresponding to the relative humidity in the air outside the door or to the condensation on the inner glass pane.

- **Test standards to measure performance of components required.**

# Alternative approaches

- **Installation requirements/guidelines**
- **Information requirements**
- **Generic requirements**
- **Voluntary initiative (benchmarks)**
- Energy labelling