

# Chillers

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ENTR Lot 1 Second Stakeholder Meeting  
Brussels, Belgium, June 4<sup>th</sup> 2010

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



10:00 – 10:20	<b>Welcome, “Tour de table”</b>
10:20 – 10:30	<b>Introduction to the Ecodesign Directive</b>
10:30 – 10:45	<b>Horizontal session: Progress update and selection of Base Cases</b>
10:45 – 11:30	<b>Product focus: Walk-in cold rooms</b>
11:30 – 11:50	<b>COFFEE BREAK</b>
11:50 – 12:30	<b>Product focus: Service cabinets</b>
12:30 – 13:10	<b>Product focus: Blast cabinets</b>
13:20 – 14:20	<b>LUNCH BREAK</b>
14:20 – 15:00	<b>Product focus: Remote condensing units</b>
15:00 – 15:40	<b>Horizontal session: Refrigeration systems</b>
15:40 – 16:00	<b>COFFEE BREAK</b>
16:00 – 16:40	<b>Horizontal session: Refrigerants</b>
16:40 – 17:20	<b>Product focus: Chillers</b>
17:20 – 17:30	<b>Conclusions, next actions and AOB</b>

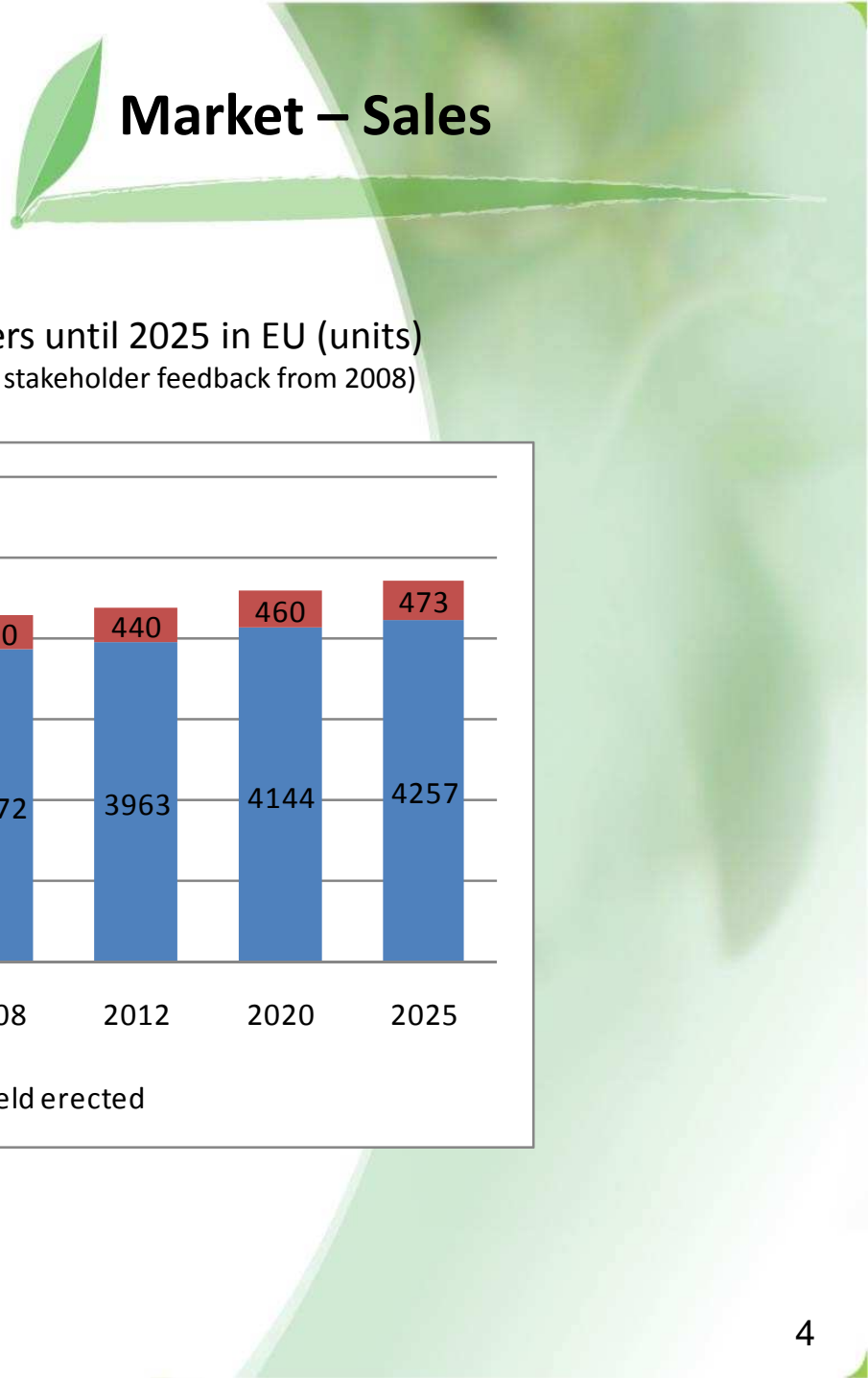
## Product description

- Refrigeration equipment designed to remove heat from a liquid through vapour compression or absorption cycle
- Typically used for air conditioning, but also available for refrigeration of foodstuff and several industrial processes
- Their final use depends on the achievable temperature, in the scope of this study only low and medium temperature are considered



### Functional Unit

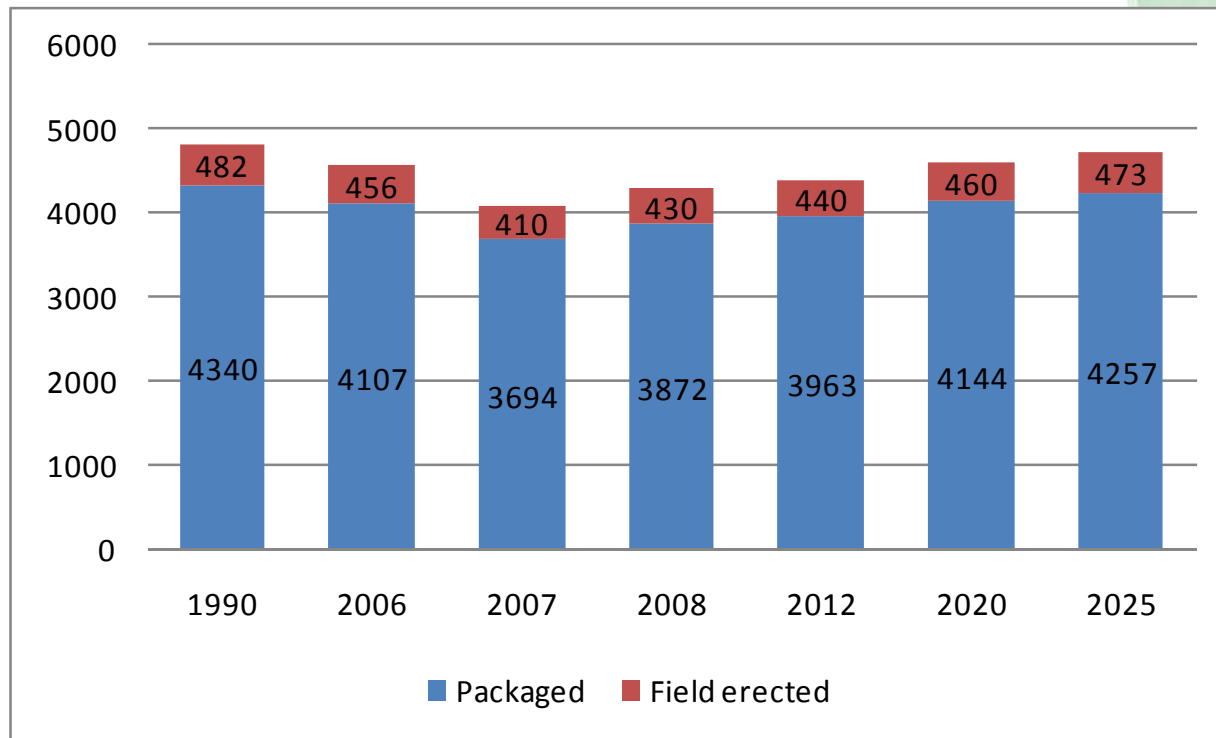
- One kW cooling capacity



## Market – Sales

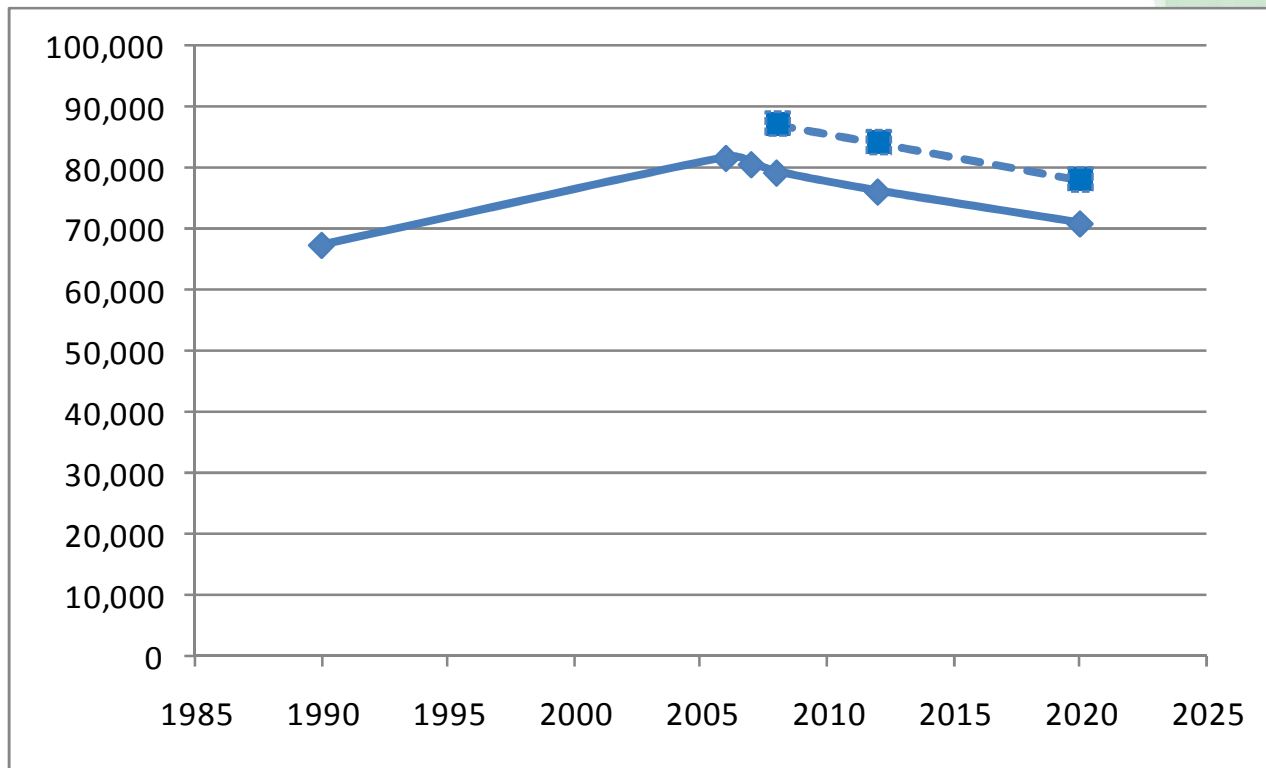
Estimated sales forecast of chillers until 2025 in EU (units)

\*Extrapolation of DEFRA MTP figures (and stakeholder feedback from 2008)



## Estimated stock forecast of chillers until 2025 in EU (units)

\*Extrapolation of DEFRA MTP figures (and stakeholder feedback from 2008)





## Classification

1. Outlet temperature range: medium ( $-12^{\circ}\text{C}$  /  $3^{\circ}\text{C}$ ), and low ( $-25^{\circ}\text{C}$  /  $-8^{\circ}\text{C}$ ) are included in the scope (*high temperature  $+2^{\circ}\text{C}$  /  $+15^{\circ}\text{C}$  considered outside the scope of ENTR Lot 1*)
2. System: packaged, split or remote condenser
3. Power capacity: small (10-100 kW), medium (100-500 kW), large (500-900 kW), extra large ( $>900$  kW)
4. Refrigeration technology: compression or absorption
5. Heat rejection: water cooled or air cooled

Compressor can be considered among the parameters for classification as well.

**Do you agree with these categories for classification?  
Suitable classification from manufacturing or purchasing scope?  
What is the capacity upper limit to be considered?**



## Test Standards

- EU standard EN 14511:2007 (European level)  
Establishes testing methods for determining performance of equipments
- EU standard EN 12309:2008 (European level)  
Establishes safety and rational use of energy for absorption and adsorption appliances  
(heat input < 70kW)
- EU standard prEN 14825 (European level)  
Testing and rating conditions for appliances considering seasonal performance (European  
Seasonal Energy Efficiency Ratio - ESEER)
- AHRI 550/590-2003 (USA)  
Packaged compression chillers (A/C)
- ANSI/AHRI 560-2000 (USA)  
Packaged absorption chillers (A/C)

No identified need to modify the existing EU standards for packaged chillers

- No mandatory requirements are identified at EU level/MS
- MEPS
  - EU: EUROVENT. Certification Programme for Liquid Chilling Packages
  - EU: UK ECA Scheme. Packaged Chillers
  - Australia: AS/NZS 4776:2008. Liquid-chilling packages using the vapour compression cycle (A/C)
  - Canada: CAN/CSA-C743-09. Performance standard for rating packaged water chillers
  - ASHRAE 90.1-2007 (USA)
  - Energy Standard for Buildings Except Low-Rise Residential Buildings (A/C)

**Approach requires homogenisation. Refrigerant require special attention within the legislation due to the big amount used within the appliances**

**What should consider a performance evaluation standard or MEPS for Chillers?**

**What approach is the more suitable for remote Chillers?**



## User Behaviour

- The use pattern corresponds to 4380 hours/year (365 days/year, 12hrs/day).
- Consumption over the course of a year is the sum of the consumption of the components within the unit, calculated through testing.
- Chillers are turned off at some moments of the day

**Do you agree with this use pattern?**

**What is the average energy consumption per component?**

- Average industrial process chiller is air-cooled
- Lifetime estimated to be 15 years
- Various technical specifications unknown

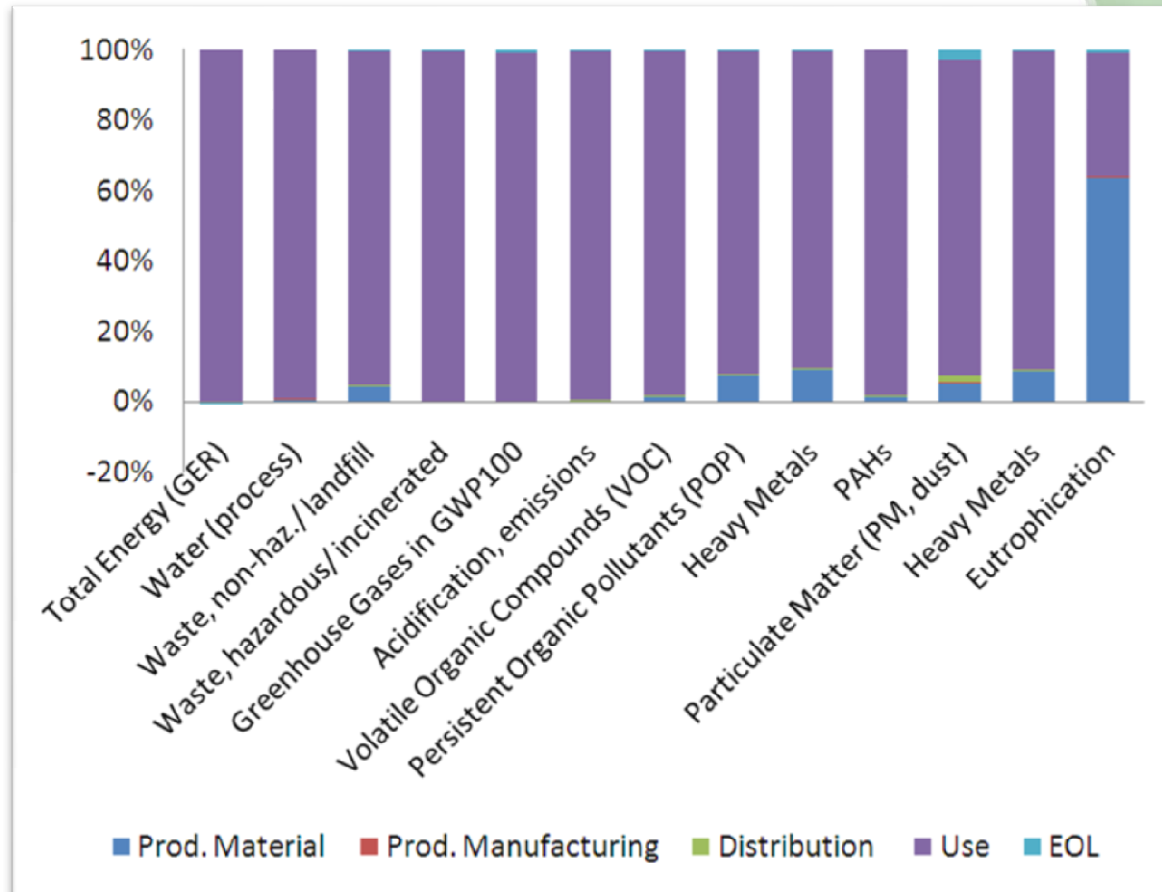
### Average Product vs. Base Case Characteristics (1 BOM received from Industry)

Parameter	Base Case
Design	Packaged
Output temperature[°C]:	(-15°C/+3°C)
Annual electricity consumption [kWh/year]*:	394,200
Cooling capacity [kW]:	270
Power input [kW]:	100
Performance [EER]:	9.21 (COP: 2.70)
Weight of product [kg]:	3,500
Price [€]:	60,000
Lifetime [years]:	15
Refrigerant:	R134a
Type of compressor:	Hermetic reciprocating
Condenser cooling:	Air-cooling
Location condensing unit:	Integral

\*Calculated from Coefficient of System Performance (COSP) table from manufacturer, at 30°C

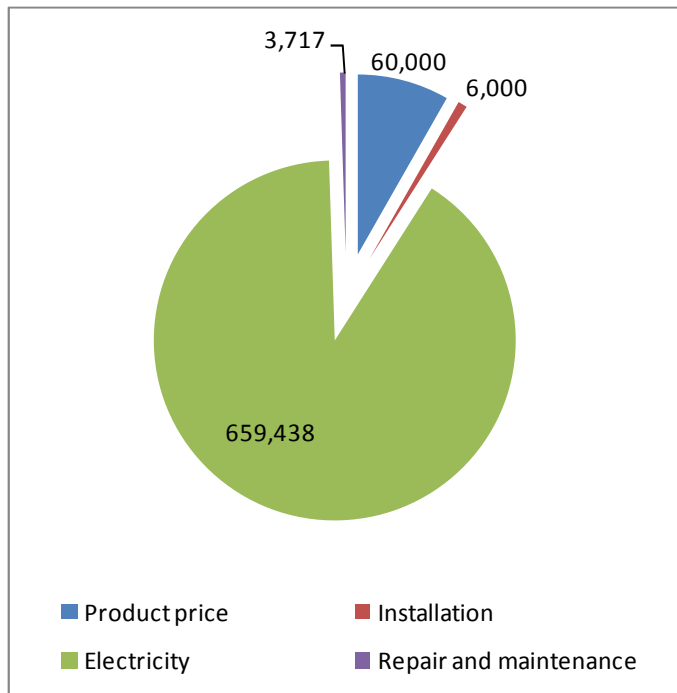
222 euros/kW of cooling capacity

Total Energy (GER) = **15,372.61** MJ/kW cooling capacity per year, of which the use phase represents just under **100%**



\* Impacts in the graph are given by Life Cycle

Life cycle costs of service cabinet: **729,156 EUR**



Chillers <i>Item</i>	total annual consumer expenditure in EU25
Product price	258 mln.€
Installation/ acquisition costs (if any)	26 mln.€
Electricity	4,415 mln.€
Repair & maintenance costs	23 mln.€
<b>Total</b>	<b>4,722</b> mln.€

Parameter	Base Case	BAT
Design	Packaged	Packaged
Output temperature[°C]:	(-15°C/+3°C)	+7°C
Annual electricity consumption [kWh/year]*:	394,200	295,945
Cooling capacity [kW]:	270	275
Power input [kW]:	100	86
Performance [EER]:	9.21 (COP: 2.70)	10.91 (COP: 3.20)
Weight of product [kg]:	3,500	2,116
Price [€]:	60,000	TO BE COMPLETED
Lifetime [years]:	15	15
Refrigerant:	R134a	R134a
Type of compressor:	Hermetic reciprocating (Screw compressor)	TO BE COMPLETED
Condenser cooling:	Air-cooling	Air-cooling
Location condensing unit:	Integral	Integral

\*Calculated from COSP table from manufacturer, at 30°C

Technology	Chillers		
	Applic. Market pen. (%)	Energy savings. (% of TEC)	Increase in price** (€)
High efficiency compressor		4	10%
Variable-speed-drive (VSD) compressor		8	
Increase of the heat exchanger surfaces		5	
Electronic Expansion Valve (EEV) *when integrated with FHP		35*	
Floating head pressure (FHP) *when integrated to EEV		35*	
ECM Fan Motor		4	30%
Fan motor controllers			
High Efficiency Fan Blades			
Zeolite Filter Cassettes			
Ambient subcooling		5	
Mechanical subcooling			
Brazed plate heat exchangers			
Aluminium micro-channel heat exchangers			
Bubble expansion valve		10-20	
Vacuum-process technology		50	60 000

→ High?

→ Low?

\*\* Percentage over component price

The best available chiller within next 5 years could achieve energy savings of up to approximately 65% using the following:

- VSD motor and compressor
- electronic expansion valve together with floating head pressure
- ECM fan motors for fans
- high efficiency fan blades
- fan motor controllers
- ambient subcooling

## BAT potential energy savings

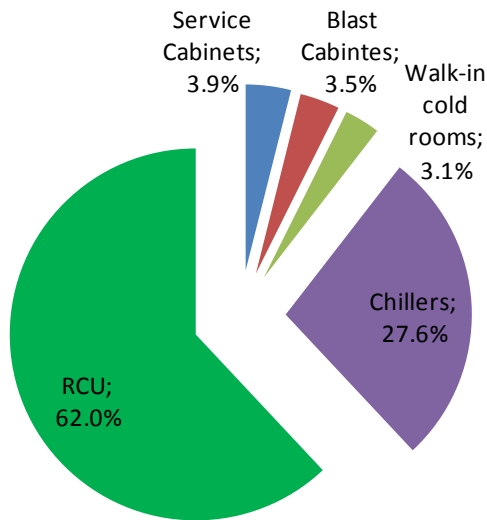
	Annual electricity consumption (kWh/year)	Cooling capacity (kW)
Base Case model	394,200	270
<u>Current</u> available BAT model	295,945	275
<u>Theoretical</u> BNAT product model (available within 5 years)	137,970	270

	Performance (EER) (COP)	Energy saving potential
Base Case model	9.21 (2.70)	-
<u>Current</u> available BAT model	10.91 (3.20)	15%
<u>Theoretical</u> BNAT product model (potentially available within 5 years)	26.32* (7.71*)	65%

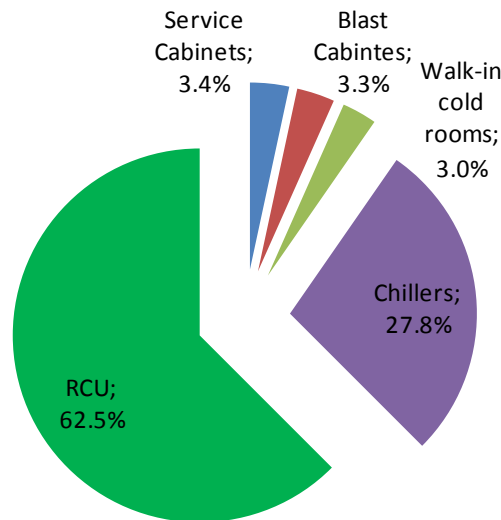
\*Calculated assuming the same cooling capacity as the Base Case and 65% of decrease in electricity consumption

Impact calculation for the total stock (2009) per year of lifetime

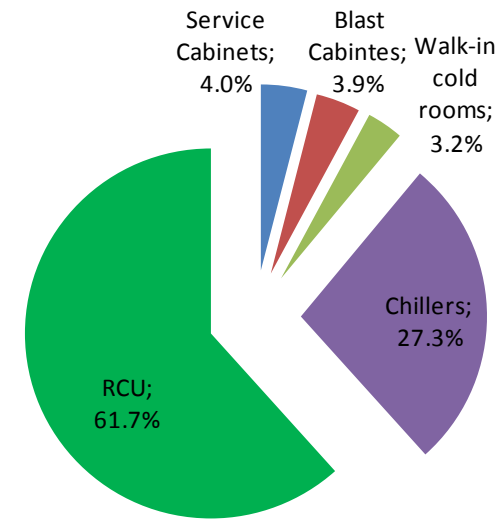
	Service cabinets	Blast cabinets	Walk-in cold rooms	Chillers	Remote condensing units	Total
<b>Total Energy (GER) (PJ)</b>	3.66	3.24	2.90	<b>25.80</b>	58.02	<b>93.62</b>
<b>Electric. Consump (TWh)</b>	0.30	0.29	0.26	<b>2.45</b>	5.51	<b>8.81</b>
<b>GWP (mt CO2 eq.)</b>	0.17	0.16	0.13	<b>1.13</b>	2.56	<b>4.15</b>



Total Energy (PJ)



Electricity Consumption (TWh)



GWP (mt CO2 eq.)



## Gaps

- Consensus on classification
- Market data related to the agreed classification
- Average component specifications used in current stock
- Reliable BOM to assess properly the environmental impacts related to the production phase of the Base Case
- Current BAT models