

# Process Chillers

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ENTR Lot 1 3<sup>rd</sup> Stakeholder Meeting  
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*A study being conducted for DG ENTR by BIO Intelligence Service*



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

### Exclusions

- High temperature chillers: industrial and comfort

Year	Estimated sales forecast *	Estimated stock forecast *
2006	28,222	382,087
2007	31,821	393,533
2008	32,207	404,643
2012	34,588	447,355
2020	40,525	532,208
2025	44,743	586,408

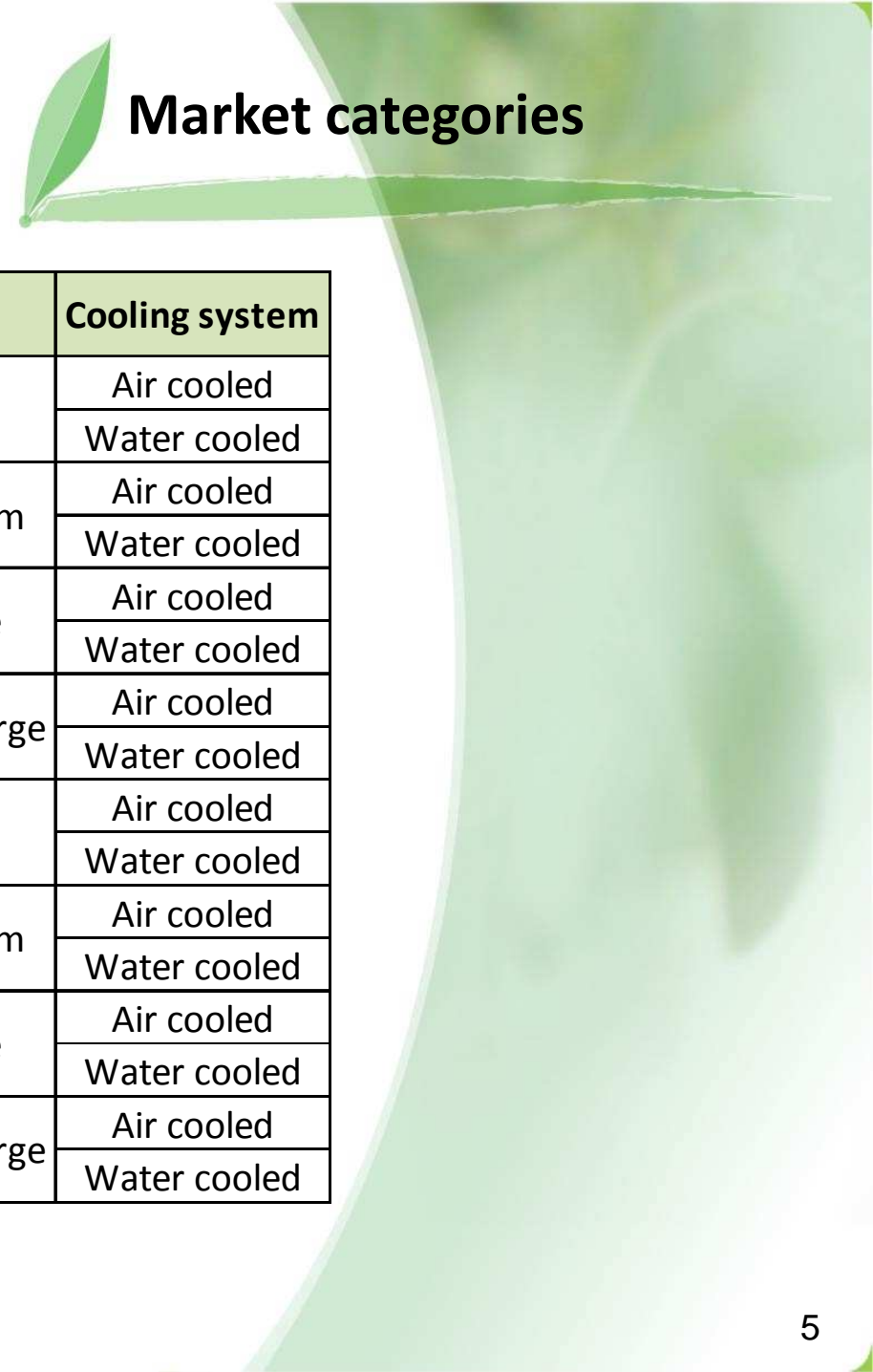
\*Extrapolation of figures provided by stakeholders

### Main assumptions:

- Constant growth rate
- BSRIA report used
- MTP report used
- CAGR (2010-2014): 2.28%

## Market data

Technology	(%)
Packaged	90
Field erected	10
MT (-12°C to +3°C)	56
LT (-25°C to -8°C)	44
Small (<100kW)	30
Medium (101-499kW)	45
Large (500-999kW)	20
Extra-large (>1000kW)	5
Air-cooled	74
Water-cooled	26



Operation temperature	Size	Cooling system
Medium temperature	Small	Air cooled
		Water cooled
	Medium	Air cooled
		Water cooled
	Large	Air cooled
		Water cooled
	Extra-large	Air cooled
		Water cooled
Low temperature	Small	Air cooled
		Water cooled
	Medium	Air cooled
		Water cooled
	Large	Air cooled
		Water cooled
	Extra-large	Air cooled
		Water cooled

- **EN 14511:2007** – Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling
- **prEN 14825:2009** – Air conditioners, liquid chilling packages and heat pumps, with electrically compressors, for space heating and cooling
- **EN 15218:2006** – Air conditioners and liquid chilling packages with evaporatively cooled condenser and with electrically driven compressors for space cooling.
- **AHRI 550/590-2003** – Standard for performance rating of water-chilling packages using the vapor compression cycle
- **ANSI/AHRI 560-2000** – Absorption water chilling and water heating packages
- **CAN/CSA-C743-09** – Performance Standard for Rating Packaged Water Chillers
- **AS/NZS 4776:2008** – Liquid-chilling packages using the vapour compression cycle

- No mandatory requirements are identified at EU level/MS
- **EU EUROVENT** certification programme for liquid chilling packages
- **UK ECA incentive scheme** for packaged chillers
- ASHRAE Standard 90.1.2007
- CAN/CSA-C743-09 “Performance Standard for Rating Packaged Water Chillers”
- AS/NZS 4776.1:2008 concerns water chillers with a capacity higher than 350kW; these do not deal with energy performance, but with the function within kitchens for food safety reasons

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



## Base Case weighting

Type of equipment	Relative energy consumption
Low-temperature	2.5*X
Medium-temperature	X
Small low-temperature	Y
Medium low-temperature	4.6*Y
Large low-temperature	8.33*Y
Extra-large low-temperature	16*Y
Small medium-temperature	Y
Medium medium-temperature	4.6*Y
Large medium-temperature	8.33*Y
Extra-large medium-temperature	16*Y
Air-cooled	1.4*Z
Water-cooled	Z

## 2 BOM received from industry

Product characteristics	Sub-Base Case (MT temperature)	Weighted Base Case MT	Sub-Base Case (LT temperature)	Weighted Base Case LT
Product type:	Medium size, medium temperature, water-cooled	Weighted	Medium size, low temperature, water-cooled	Weighted
Functional unit:	1 kW cooling capacity to reach -10°C at 30°C ambient temperature	1 kW cooling capacity to reach -10°C at +30°C ambient temperature	1 kW cooling capacity to reach -25°C at 30°C ambient temperature	1 kW cooling capacity to reach -25°C at +30°C ambient temperature
Cooling capacity [kW]:	276	279	252	260.2
AEC [kWh/year]:	346,206	390,184	450,068	503,878
COP:	2.80	2.33	1.96	1.79
Use pattern:	4380 hours/year (12 hour/day, 365 days/year)	4380 hours/year (12 hour/day, 365 days/year)	4380 hours/year (12 hour/day, 365 days/year)	4380 hours/year (12 hour/day, 365 days/year)
Price (ex VAT) [€]:	55,000	55,000	70,000	70,000
Lifetime [years]:	15	15	15	15
Shipping volume [m3] :	11.6	11.6	13.34	13.9
Weight of product [kg]:	2,757	2,667	3,171	3,067
Refrigerant:	R134a	R134a	R134a	R134a
Refrigerant charge [kg]:	100	91	250	90
Refrigerant leakage [% per annum]:	12	12	12	12
Refrigerant dumped at EoL [%]:	5	5	5	5

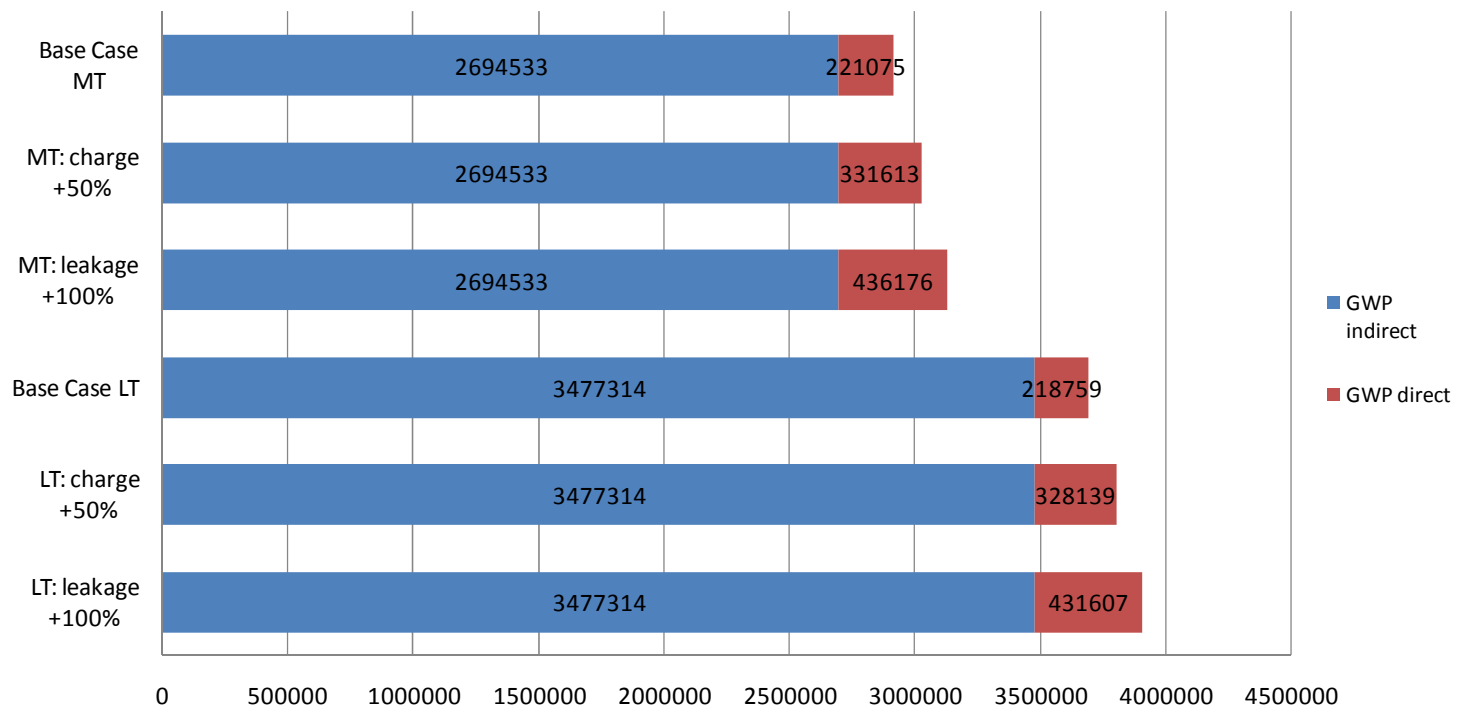


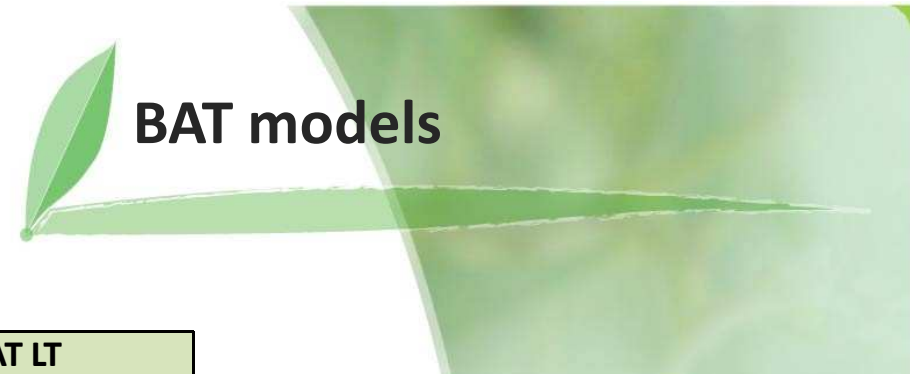
# Environmental impacts

Total Energy (GER) MT = 15823.27 MJ/kW of cooling capacity of which the use phase represents almost **100%**

Total Energy (GER) LT = 20565.24 MJ/kW of cooling capacity of which the use phase represents almost **100%**

Direct GWP of MT chillers represents about **8%** of the TEWI  
 Direct GWP of LT chillers represents about **6%** of the TEWI





## BAT models

Product characteristics	BAT MT	BAT LT
Product type:	Medium size, medium temperature, water-cooled	Medium size, medium temperature, water-cooled
Functional unit:	1 kW cooling capacity to reach -10°C at +30°C ambient temperature	1 kW cooling capacity to reach -25°C at +30°C ambient temperature
Cooling capacity [kW]:	279	260.2
AEC [kWh/year]:	315,360	409,968
COP:	2.89	2.10
Use pattern:	12 hour/day, 365 days/year	12 hour/day, 365 days/year
Price (ex VAT) [€]:	82,500	105,000
Lifetime [years]:	15	15
Refrigerant:	R717	R717
Refrigerant charge [kg]:	26	32
Refrigerant leakage [% per annum]:	12	12
Refrigerant dumped at EoL [%]:	5	5

Product	AEC (kWh/year)
Weighted Base Case MT	390,184
Weighted BAT MT	355,067
Weighted Base Case LT	503,878
Weighted BAT LT	458,529

**8%** of saving potential based on real models (sub-Base Case vs. real BAT)



# Improvement options

	Applicability (years)	Market penetration (%)	Savings MT (% TEC)	Savings LT (% TEC)	Increase in price of MT product (€)	Increase in price of LT product (€)	Priority
ECM Fan condensor	Now	N.A.	4	4	30	30	1
Electronic expansion valve	Now	N.A.	5	5	200	200	2
Improved heat exchangers*	Now	N.A.	15	10	1,750	1,750	3
High efficiency compressor*	Now	N.A.	35	20	6,000	7,000	4
Ambient subcooling	Now	less than 5	5	5	3,000	3,000	5
<b>BNAT</b>							
Energy integration	Now	less than 5	15	10	6,000	6,000	1
Vacuum-process technology	Now	less than 1	50	10	55,000	70,000	2
Pool boiling	Now	less than 5	15	10	82,500	105,000	3

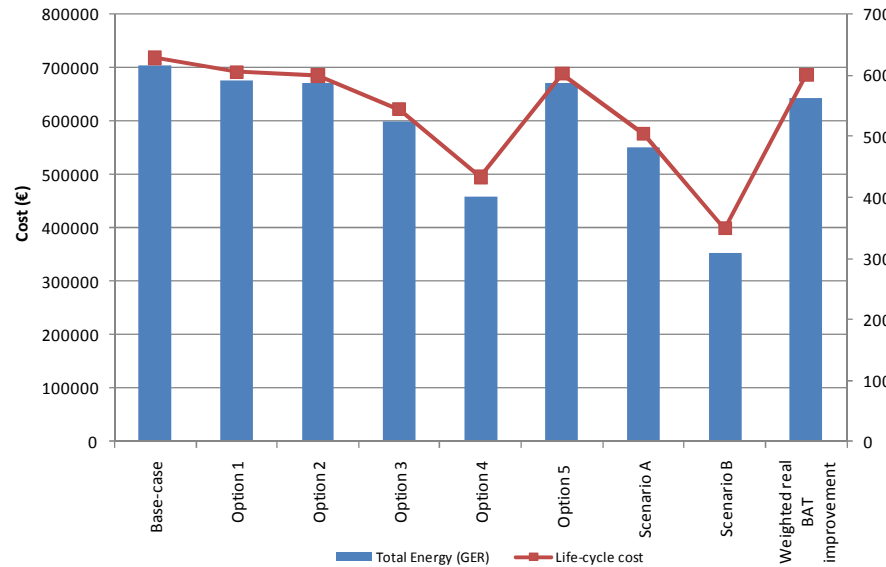
\*Selected from technologies related to the component

N.A.: Data not available

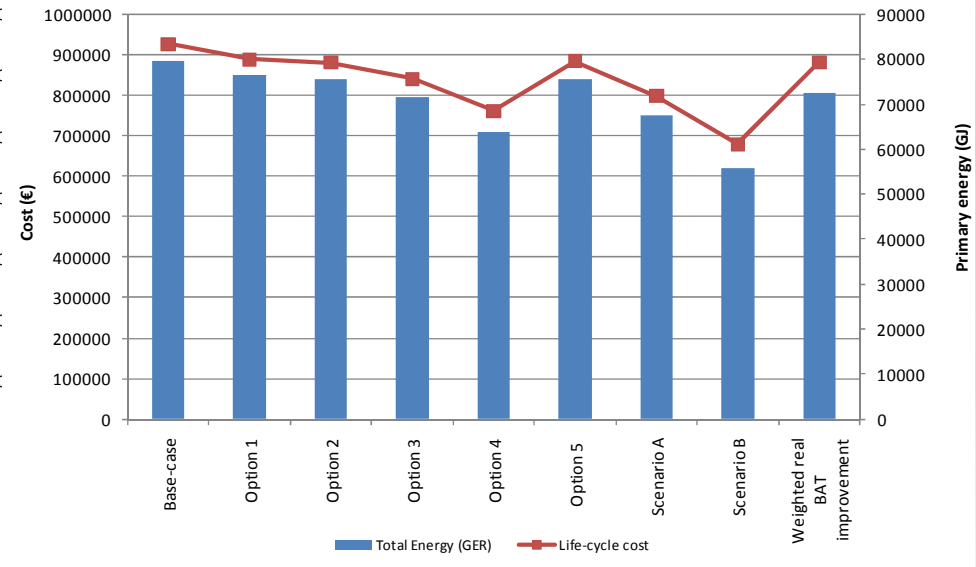
Note: Savings are not additive.

Priority based on cost increase, energy saving potential and applicability

**Primary Energy Consumption and LCC (MT)**



**Primary Energy Consumption and LCC (LT)**



Options	
1	ECM fan condensor
2	Electronic expansion valve
3	Improved heat exchangers
4	High efficiency compressor
5	Ambient subcooling

**Scenario A:** includes options 1 + 2 + 3

**Scenario B:** includes options 2 + 3 + 4

		Energy consumption (kWh/year)	Savings	Product price (€)
MT	Weighted Base Case	390,184	-	55,000
	LLCC = BAT = Scenario B	195,092	50%	63,000
	Weighted BAT	355,067	9%	72,000
LT	Weighted Base Case	503,878	-	70,000
	LLCC = BAT = Scenario B	352,715	50%	105,000
	Weighted BAT	458,529	9%	79,000

The “best” blast cabinet within next 5 years could achieve energy savings of up to around 60% for MT and 35% for LT using the following:

- ECM fans condenser,
- pool boiling,
- economiser cooling,
- vacuum-process technology,
- magnetic,
- ambient subcooling

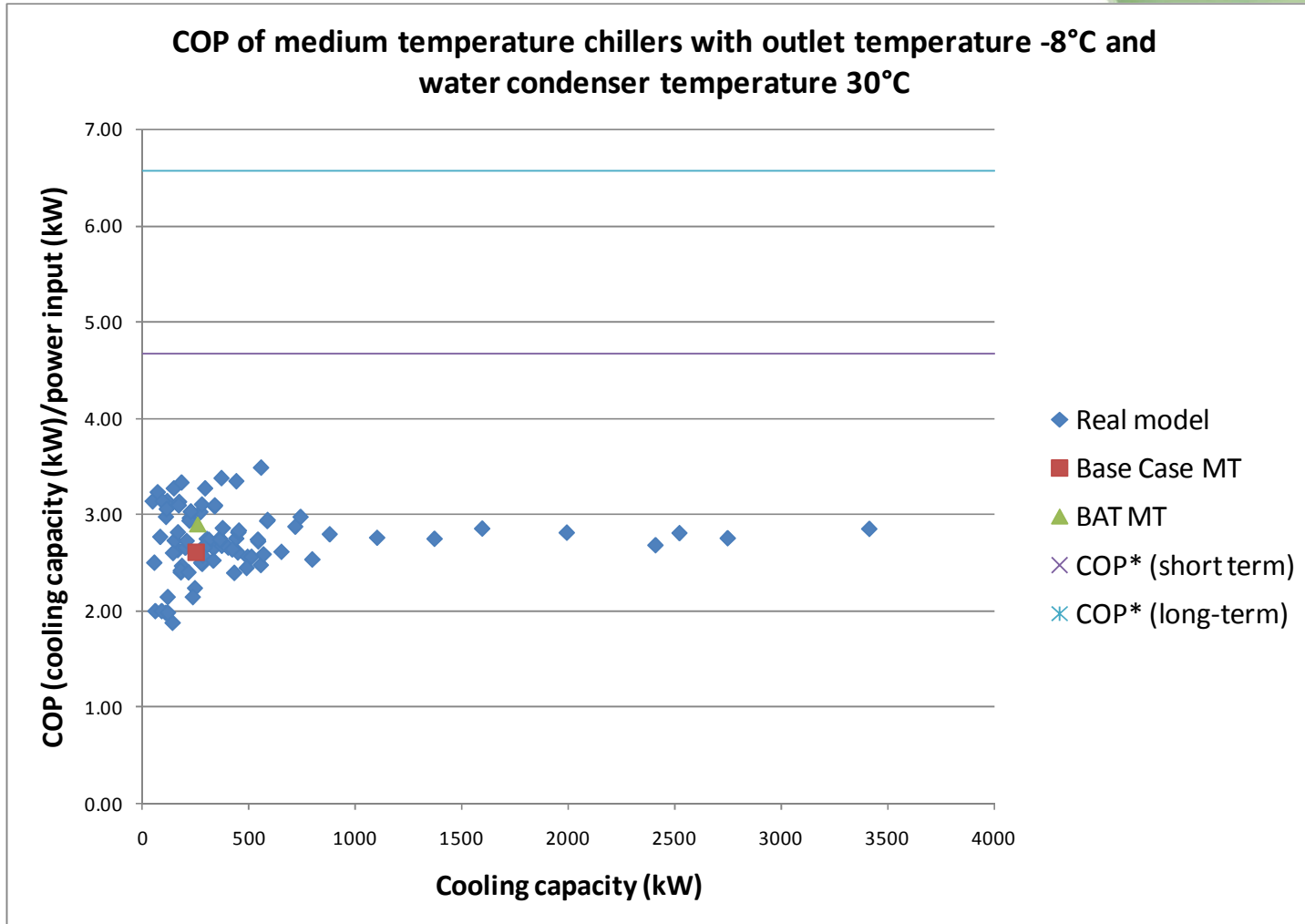
Model	Estimated average AEC (kWh/year)
<i>Medium temperature</i>	
Weighted MT Base Case	390,184
Weighted MT BAT	355,067
Weighted MT BNAT	234,110
<i>Low temperature</i>	
Weighted LT Base Case	503,878
Weighted LT BAT	458,523
Weighted LT BNAT	327,521

**Assumptions:**

- Short-term MEPS: LLCC
- Long-term MEPS: BNAT
- Improvement potentials applied to all categories in the same proportion
- No differentiation by cooling capacity
- Possible standards to be considered: prEN 14825:2009 and EN 14511:2007
- The variation in load and ambient conditions is to be considered by standards

Evaporating temperature	COP* (short term)	COP* (long-term)
Medium temperature (-8°C)	4.67	6.57
Low temperature (-25°C)	2.56	3.09

\*Net cooling capacity (kW)/effective power input (kW), condenser inlet temperature 30°C.





## Alternative approaches

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