Remote condensing units

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A study being conducted for DG ENTR by BIO Intelligence Service

Bio Intelligence Service - Scaling sustainable development
Industrial Ecology - Nutritional Health

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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: Refrigerants and Refrigeration systems**
16:40 – 17:30	**Conclusions, next actions to be taken and AOB**

Product description

- Not a complete refrigeration unit: only condenser, compressor, receiving tanks and auxiliaries
- Connected to remote cooling appliances (evaporator and expansion valves)
- They are used to provide refrigeration to large spaces (walk-in cold rooms).

Functional Unit

- kW cooling capacity

Exclusions

- Compressors packs or racks (not including condenser)
- Condensing units for high temperature
- Split systems (including remote evaporator)

Market data

Technology	Market share (%)
Packaged single compressor	95%
Packaged with multiple compressors	5%
Low temperature (-35°C)	20%
Medium temperature (-10°C)	80%
Cooling capacity 0.2kW-20kW	80%
Cooling capacity 20kW-50kW	15%
Cooling capacity > 50kW	5%
LT reciprocating compressor	95%
LT scroll compressor	4%
LT screw compressor	0.5%
LT rotary compressor	0.5%
MT reciprocating compressor	90%
MT scroll compressor	9%
MT screw compressor	0.5%
MT rotary compressor	0.5%

Main assumptions:

- BSRIA France report used
- Extrapolation based on population and trend

Year	Estimated sales forecast	Estimated stock forecast
2006	632,100	5,048,537
2007	617,516	5,147,339
2008	599,759	5,243,301
2012	573,023	5,618,759
2020	502,614	6,301,534
2025	458,608	6,682,502

Market categories

Evaporating temp. (°C)	Cooling capacity (kW)	Compressor type	Compressor motor drive	Condenser cooling
Low temperature (-35°C) Medium temperature (-10°C)	Low capacity: 0.2-20 kW Medium capacity: 20-50 kW High capacity: >50 kW	Reciprocating	On/off	Air
				Water
			2 speeds	Air
				Water
			VSD	Air
				Water
		Scroll	On/off	Air
				Water
			2 speeds	Air
				Water
			VSD	Air
				Water
		Screw	On/off	Air
				Water
			2 speeds	Air
				Water
			VSD	Air
				Water
		Rotary	On/off	Air
				Water
			2 speeds	Air
				Water
			VSD	Air
				Water

Standards

- **EN 13771:2007** (European level)
  Establishes the refrigerant capacity of condensing units and separate compressor and condensers and testing methods.

- **EN 13215:2000** (European level)
  Provides rating conditions and labeling requirements for comparison of different units. Tests done according to ISO 917.

- **ASHRAE Standard 23-2005** (USA)
  Applies to packaged condensing units evaluation

Legislation and voluntary agreements

- No mandatory requirements are identified at EU level/MS

- MEPS
  - EU: **UK ECA Scheme**. Air-cooled condensing units

Base Case weighting

Technology	Annual Energy Consumption	Power input
Base Case MT	19,070	3.76
Base Case LT	+178%	
Packaged condensing unit with twin compressors	- 10%	
Cooling capacity 20kW-50kW	LT: Ratio 4,345 kWh/kW cooling capacity MT: Ratio 2724 kWh/kW cooling capacity	
Cooling capacity > 50kW		
Scroll compressor	- 10%	
Screw compressor	- 20%	
Rotary compressor	- 10%	
2-speed compressor	- 5%	
VSD compressor	- 10%	
Water cooled condenser	- 20%	

Base Case

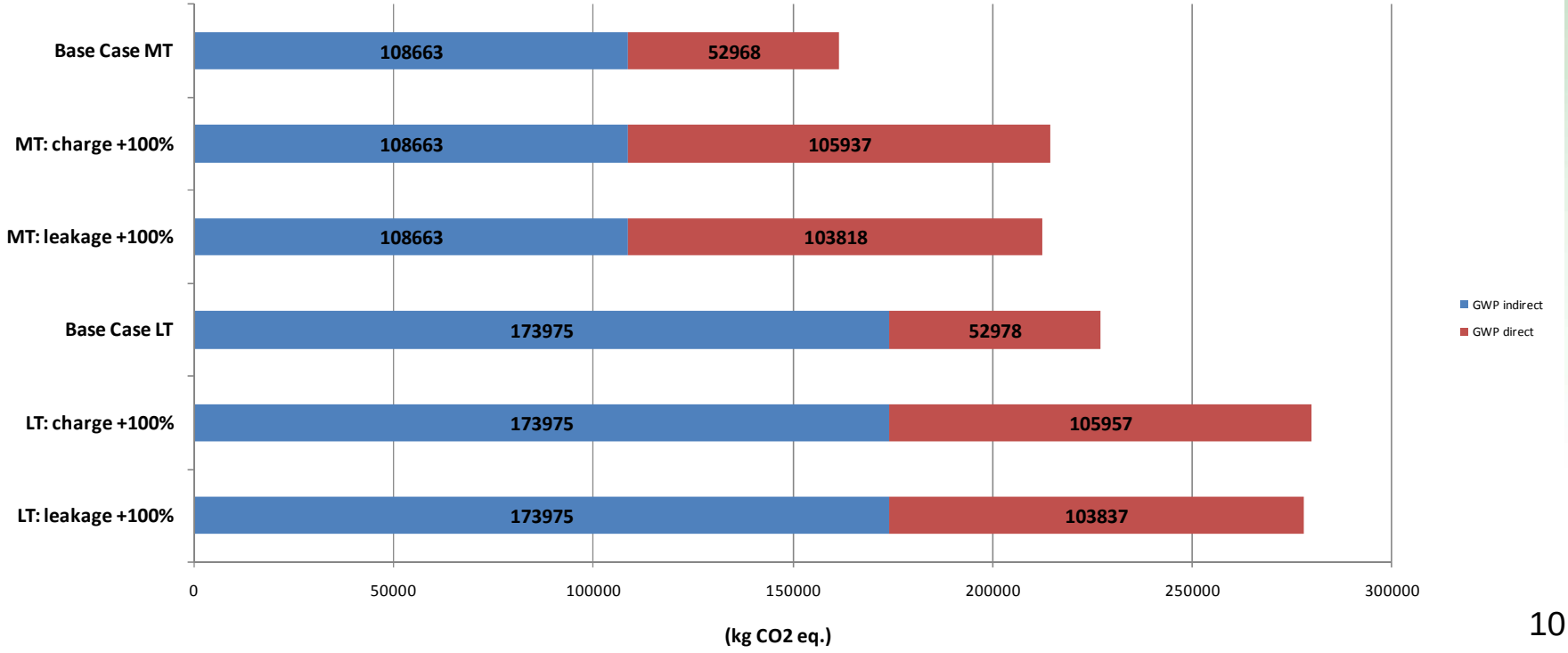
➢1 partial BOM received

Product characteristics	Medium temperature Sub-Base Case (real product)	Medium temperature Weighted Base Case	Low temperature Sub-Base Case (real product)	Low temperature Weighted Base Case
Functional unit:	1kW of cooling capacity at -10°C evaporating temperature/+32°C ambient temperature	1kW of cooling capacity at -10°C evaporating temperature/+32°C ambient temperature	1kW of cooling capacity at -35°C evaporating temperature/+32°C ambient temperature	1kW of cooling capacity at -35°C evaporating temperature/+32°C ambient temperature
AEC [kWh/year]:	19,070	29,492	30,420	47,279
Use pattern:	5,840 hours/year	5,840 hours/year	5,840 hours/year	5,840 hours/year
Price (ex VAT) [€]:	4,886	6,125	5,863	7,189
Cooling capacity [kW]:	7.158	11.22	5.817	10.31
Power input [kW]:	3.76	5.75	5.82	9.37
COP:	1.91	1.95	1.00	1.10
Lifetime [years]:	8	8	8	8
Refrigerant:	R404a	R404a	R404a	R404a
Refrigerant charge [kg]:	7	11	6	10
Refrigerant leakage [% per annum]:	15	15	15	15
Dumped refrigerant EOL [%]	5	5	5	5
Shipping volume [m3] :	0.7	0.7	0.84	0.84
Weight of product [kg]:	117	117	203	203

Environmental impacts

- Medium temperature: Total Energy (GER) = **43,251 MJ**/per kW of cooling capacity per year, of which the use phase represents **99.5%**
- Low temperature: Total Energy (GER) = **85,557 MJ**/per kW of cooling capacity per year, of which the use phase represents **99.5%**

Direct GWP represents about **23%** of the TEWI in Low temperature and **32%** in Medium temperature



BAT models

- 1 partial BOM received

Product characteristics	Medium temperature Sub-Base Case (real product)	Low temperature Sub-Base Case (real product)
Functional unit:	1kW of cooling capacity at -10°C evaporating temperature/+32°C ambient temperature	1kW of cooling capacity at -35°C evaporating temperature/+32°C ambient temperature
AEC [kWh/year]:	15,254	24,334
Use pattern:	5,840 hours/year	5,840 hours/year
Price (ex VAT) [€]:	*TO BE COMPLETED*	*TO BE COMPLETED*
Cooling capacity [kW]:	7.6	6.3
Power input [kW]:	3.5	5.7
COP:	2.12	1.1
Lifetime [years]:	8	8
Refrigerant:	R404a	R410a
Refrigerant charge [kg]:	*TO BE COMPLETED*	*TO BE COMPLETED*
Refrigerant leakage [% per annum]:	15	15
Dumped refrigerant EOL [%]	5	5
Shipping volume [m3] :	*TO BE COMPLETED*	*TO BE COMPLETED*
Weight of product [kg]:	*TO BE COMPLETED*	*TO BE COMPLETED*

Improvement options

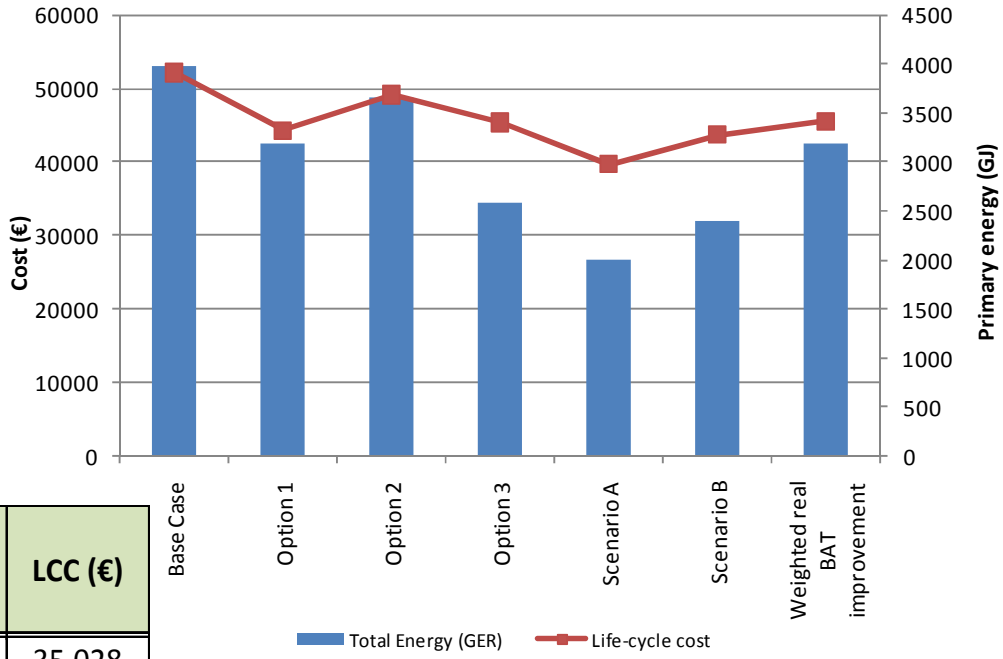
	Applicability (Years)	Market penetration (%)	Energy savings MT (% of TEC)	Energy savings LT (% of TEC)	Increase in price of MT product (€)	Increase in price of LT product (€)	Priority
Water cooling	Now	5	20%	20%	600	700	1
ECM for fans	Now	20	2%	2%	60	70	2
Increase heat exchanger surfaces	Now	5	4%	4%	100	100	3
High efficiency fan blades	Now	20	2%	2%	100	100	4
Scroll compressor	Now	4	20%	20%	3,100	3,600	5
Digital modulation control for compressor	Now	less than 10	10%	10%	1,500	1,800	6
ECM compressor	Now	less than 10	15%	15%	1,800	2,200	7
Parallel compressors	Now	5	10%	10%	2,100	2,500	8
Variable speed drive	Now	2	10%	10%	3,100	3,600	9
Magnetic bearings	Now	less than 10	2%	2%	600	700	10
R290	Now	less than 10	15%	15%	0	0	11
R134a	Now	5	10%	10%	2,100	2,500	12
R410a	Now	2	10%	10%	3,100	3,600	13
CO2	Now	less than 10	2%	2%	600	700	14
BNAT							
Evaporative cooling	1 to 2 years	Less than 5	30%	30%	1,200	1,400	1
Micro-channel heat exchangers	2 to 3 years	0	5%	5%	600	700	2
HFO blends	1 to 2 years	0	0%	0%	300	400	3

Priority based on cost increase, energy saving potential and applicability

LLCC - BAT

Low temperature remote condensing units

Option 1	Water cooled condenser
Option 2	High efficiency condenser (ECM fans + efficient fan blades + increased exchanger surfaces)
Option 3	High efficiency compressor (Scroll + Variable speed + ECM + Digital modulation + Magnetic bearings)
Scenario A	Includes options 1+3
Scenario B	Includes options 2+3

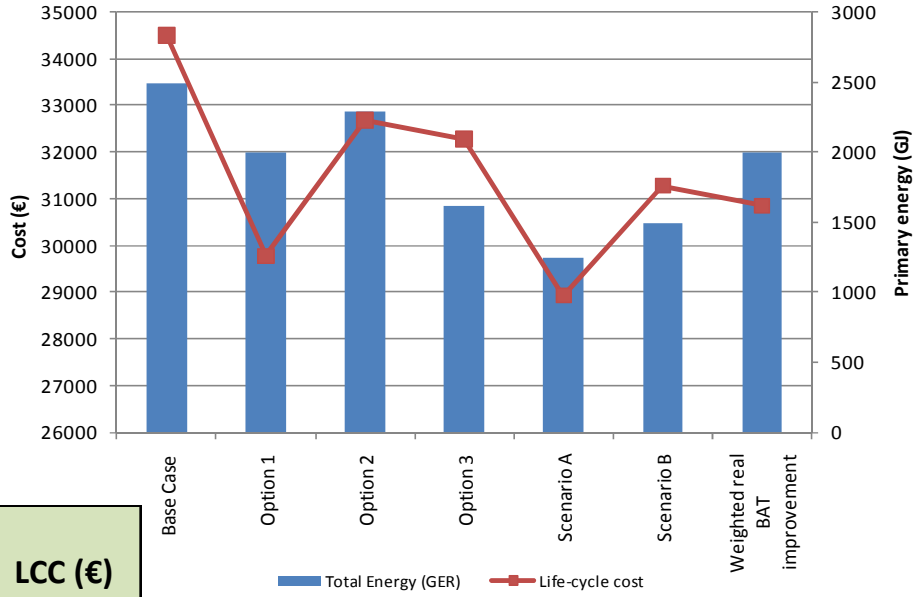


		COP at +32°C ambient temperature	AEC (kWh)	LCC (€)
LT units	Sub-Base Case	1.0	30,418	35,028
	Weighted Base Case	1.1	42,279	52,143
	Real BAT	1.1	24,334	31,178
	Weighted Real BAT	1.17	37,823	45,583
	Theoretical BNAT	2.5	9,125	-
	Weighted BNAT	2.74	18,912	-
	Scenario A	2.2	23,639	39,699
	Scenario B	1.83	28,367	43,695
	LLCC	*Scenario A*		
	BAT	*Scenario A*		

LLCC - BAT

Medium temperature remote condensing units

Option 1	Water cooled condenser
Option 2	High efficiency condenser (ECM fans + efficient fan blades + increased exchanger surfaces)
Option 3	High efficiency compressor (Scroll + Variable speed + ECM + Digital modulation + Magnetic bearings)
Scenario A	Includes options 1+3
Scenario B	Includes options 2+3



		COP at +32°C ambient temperature	AEC (kWh)	LCC (€)
MT units	Sub-Base Case	1.9	19,068	23,406
	Weighted Base Case	1.95	24,972	34,488
	Real BAT	2.1	15,254	21,354
	Weighted Real BAT	2.12	23,593	30,887
	Theoretical BNAT	4.7	5,720	-
	Weighted BNAT	4.86	11,797	-
	Scenario A	3.89	14,746	28,920
	Scenario B	3.24	17,695	31,277
	LLCC	*Scenario A*		
	BAT	*Scenario A*		

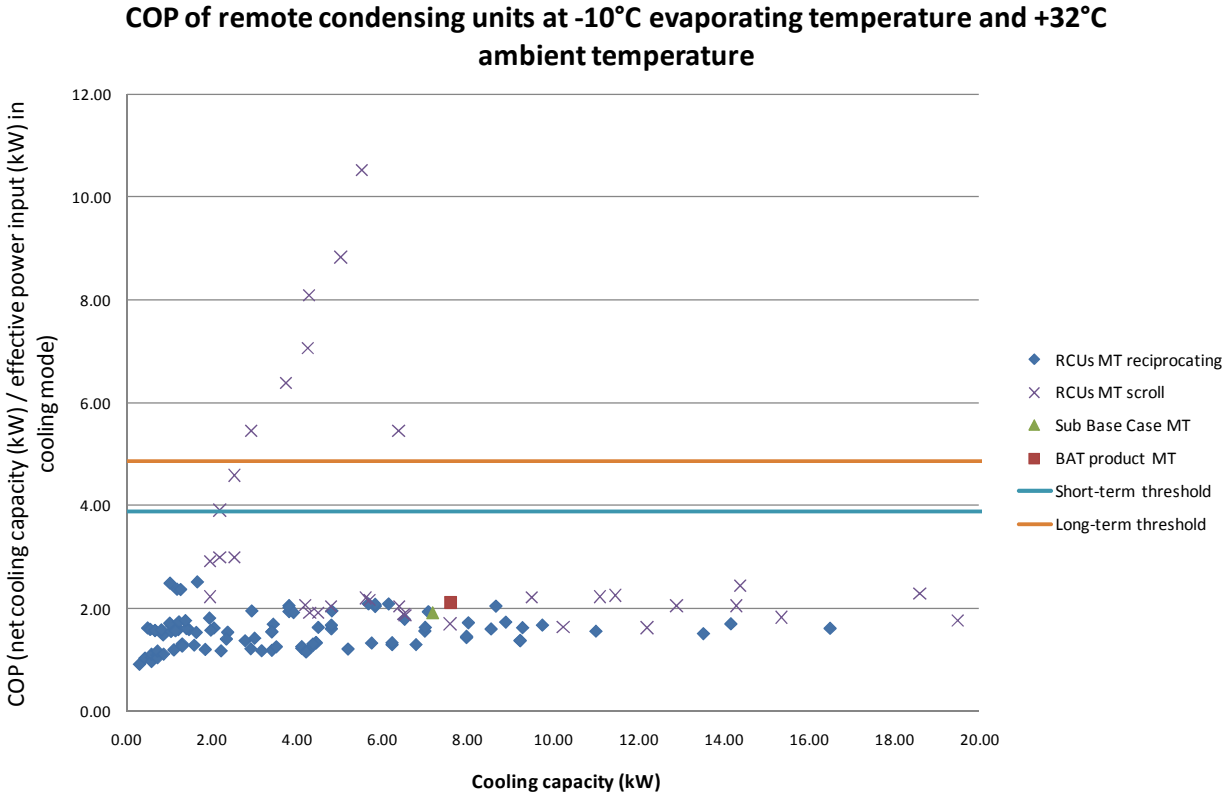
BNAT

The “best” condensing unit within next 5 years could achieve energy savings of up to approximately 60% using the following:

- VSD scroll compressor with ECM motor, digital controls and magnetic bearings;
- ECM motor for fans;
- high efficiency fan blades;
- evaporative cooling
- surface of heat exchangers increased; and
- fan motor controllers.

	Estimated average AEC (kWh)	COP
Medium temperature		
Weighted MT Base Case	29,492	1.95
Weighted MT BAT	23,593	2.12
Weighted MT BNAT	11,797	4.86
Low temperature		
Weighted LT Base Case	47,279	1.1
Weighted LT BAT	37,823	1.17
Weighted LT BNAT	18,912	2.74

MEPS (1/3)

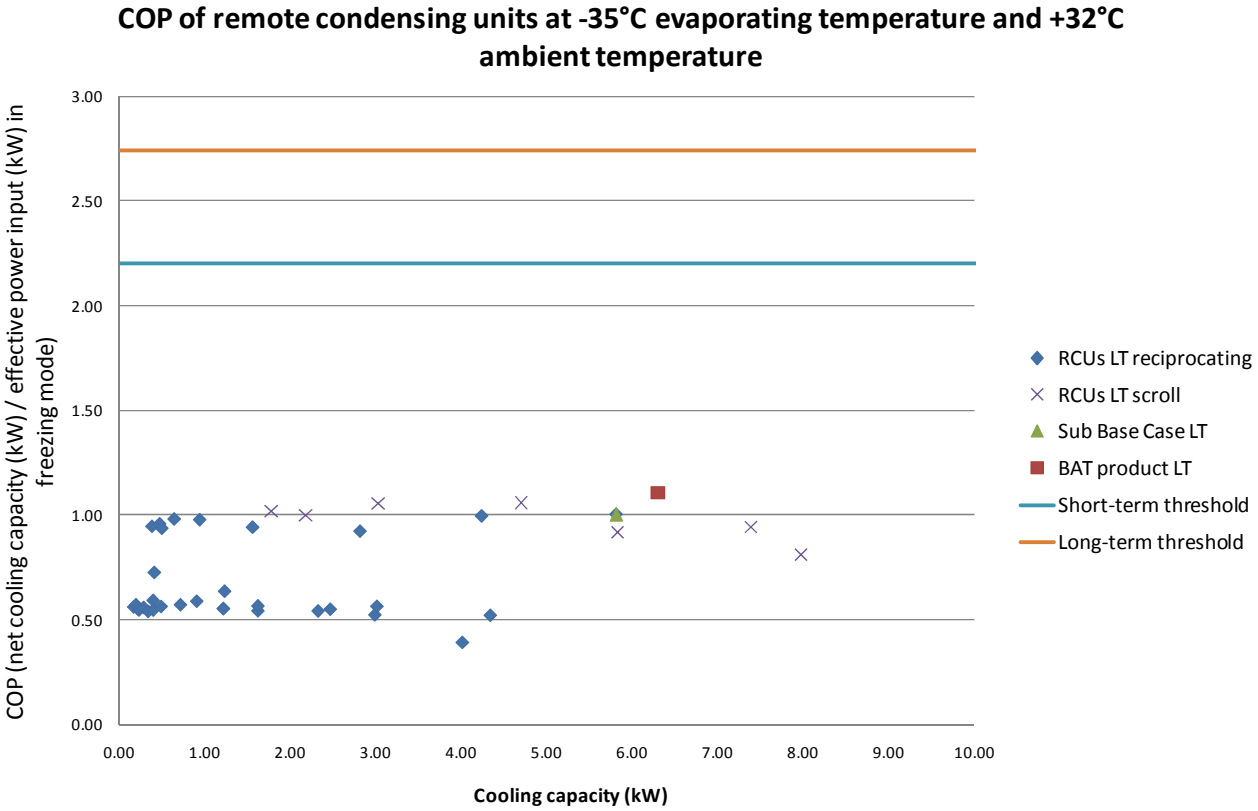


Assumptions:

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

Evaporating temperature	Short-term COP* threshold at +32°C ambient temperature	Long-term COP* threshold at +32°C ambient temperature
Medium temperature (-10°C)	3.89	4.86

MEPS (2/3)



Assumptions:

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

Evaporating temperature	Short-term COP* threshold at +32°C ambient temperature	Long-term COP* threshold at +32°C ambient temperature
Low temperature (-35°C)	2.2	2.74

MEPS (3/3)

- **EN 13215:2000** (European level)
  Provides rating conditions and labeling requirements for comparison of different units. Tests done according to ISO 917.

- Standards to be developed/updated
- Variable load testing
- Ambient temperature variation
- Installation guidelines/requirements

Alternative approaches

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