New energy evaluating methodology of Air conditioner and Heat pump

The 3rd Asia Heat Pump & Thermal Storage Technologies Network Conference
Research and Development of Heat Pump and Thermal Storage Technologies in Industrial and Residential Sectors

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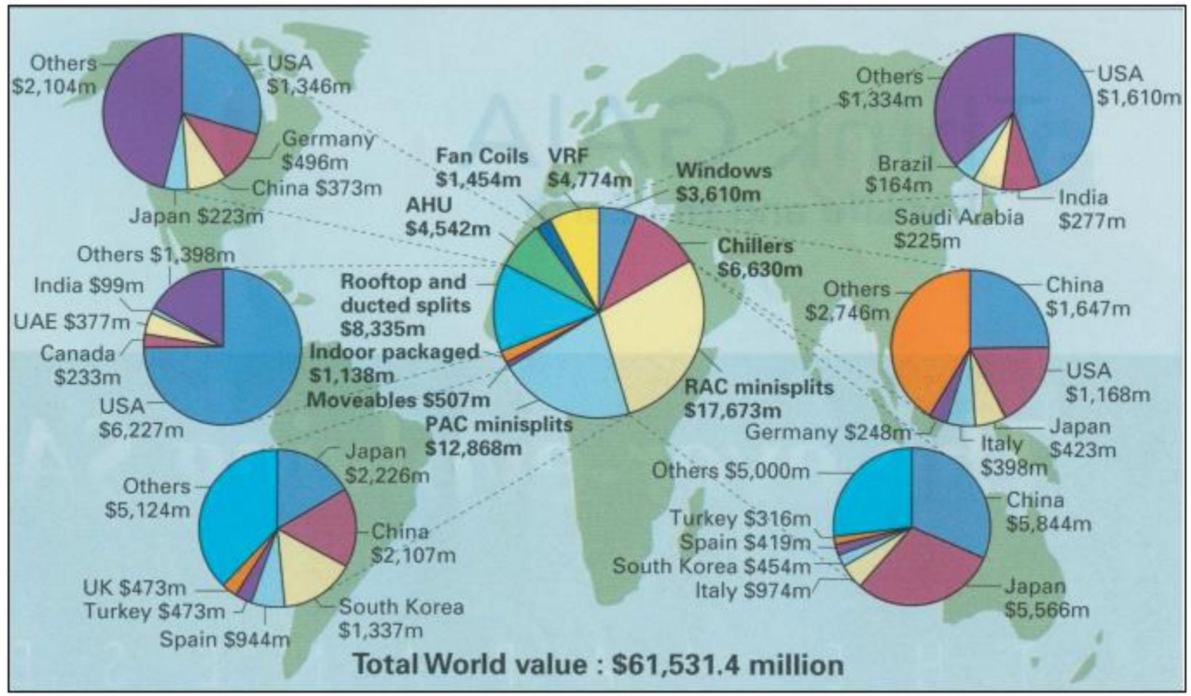
Jun Choi
Korea Testing Laboratory

Global Market

World market : 170 B$ in 2012

- **Global market : 61.5B$(2008)→170B$ (2012)**
- **Major Market : US, Japan, Europe, China**
- **CAGR : more than 14%**
- **Ductless(67%)>Chiller(AHU included, 19%)>Unitary(14%)**
- **China(20%)>NA(19%)>Europe(16%)>Japan(14%)**

히트펌프 제품군 시장규모 현황(BSRIA, 2008)

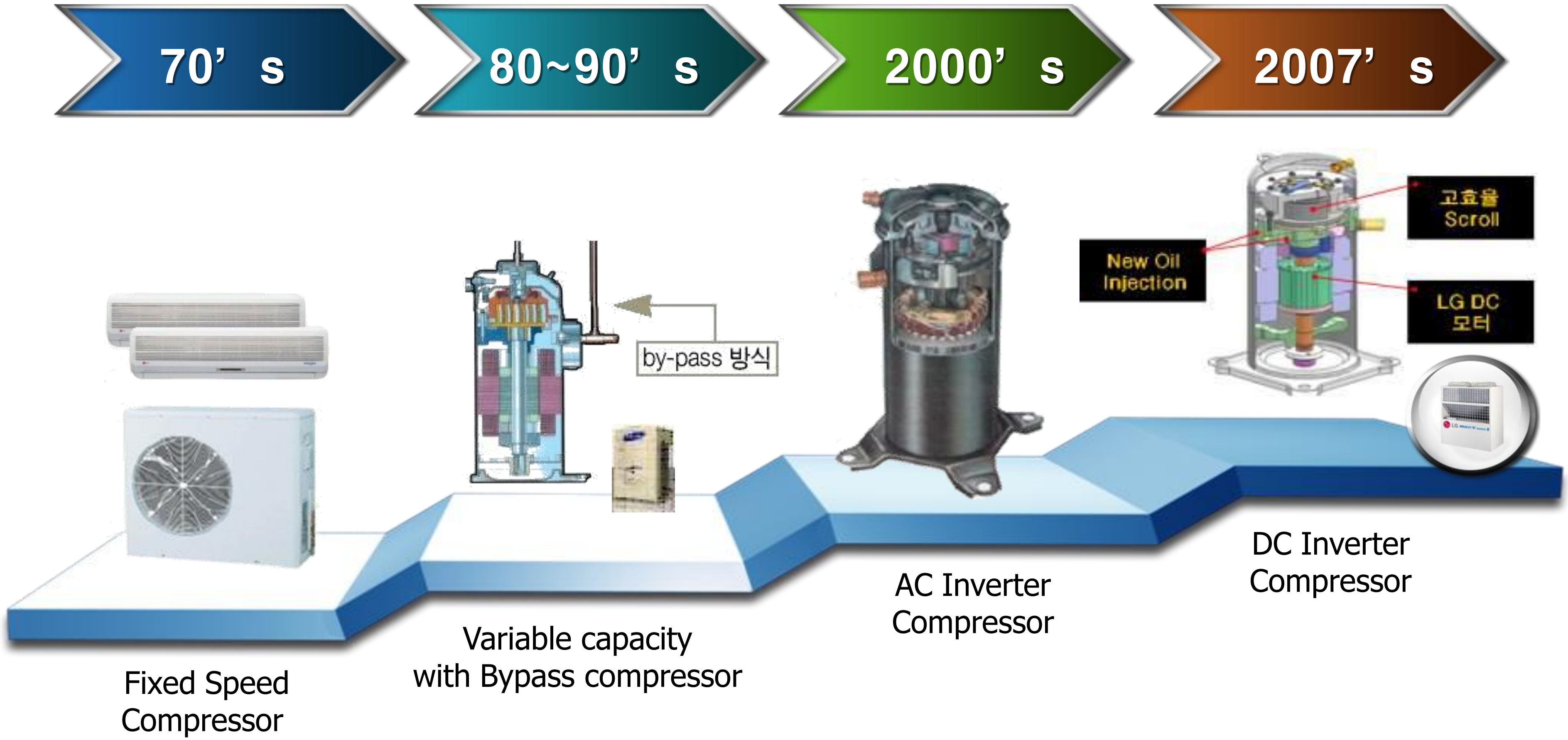


※ BSRIA : Building Service Research and Information Association

High Efficiency

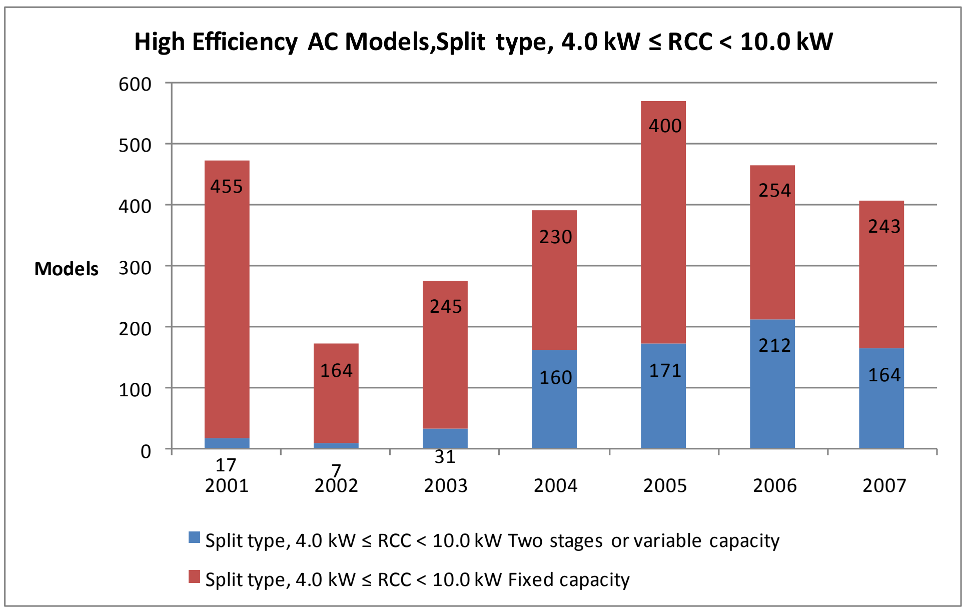
- **What is high efficiency ?**
  - *Cooling*
    - EER = Cooling Capacity / Effective Power Input
    - Large is Efficient
  - *Heating*
    - COP = Heating Capacity / Effective Power Input
    - Large is Efficient
  - *Averaged COP = (EER + COP)/2*
    - Japan
- **But, COP and EER at one point is not real usage**
  - *Part load efficiency is necessary*
  - *SEER (CSPF and HSPF) is using in some countries, but complicated*
  - *New high efficiency products are adopted with inverter-driven compressor and 2 or 3 combined compressors*

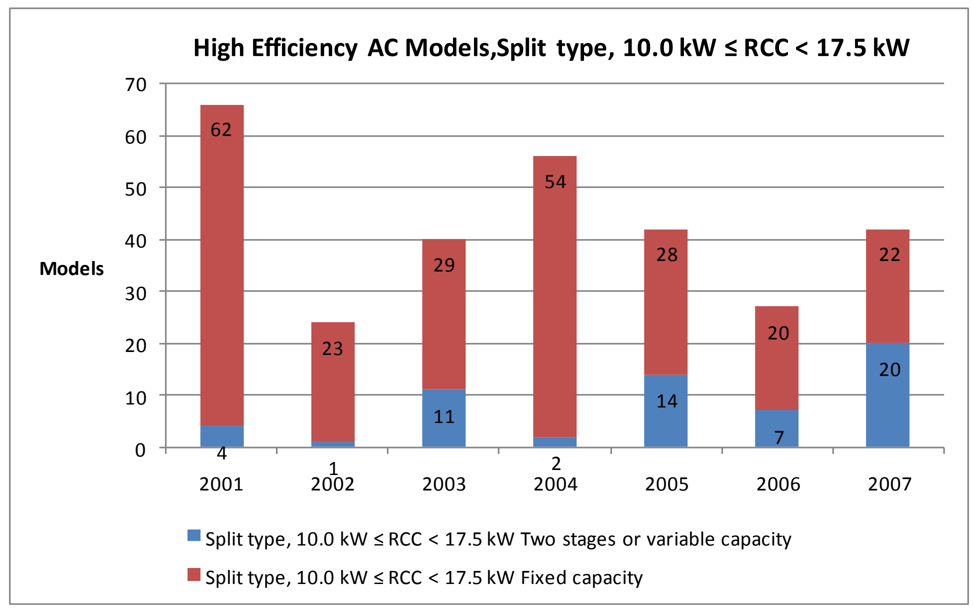
Improved Technology Trend



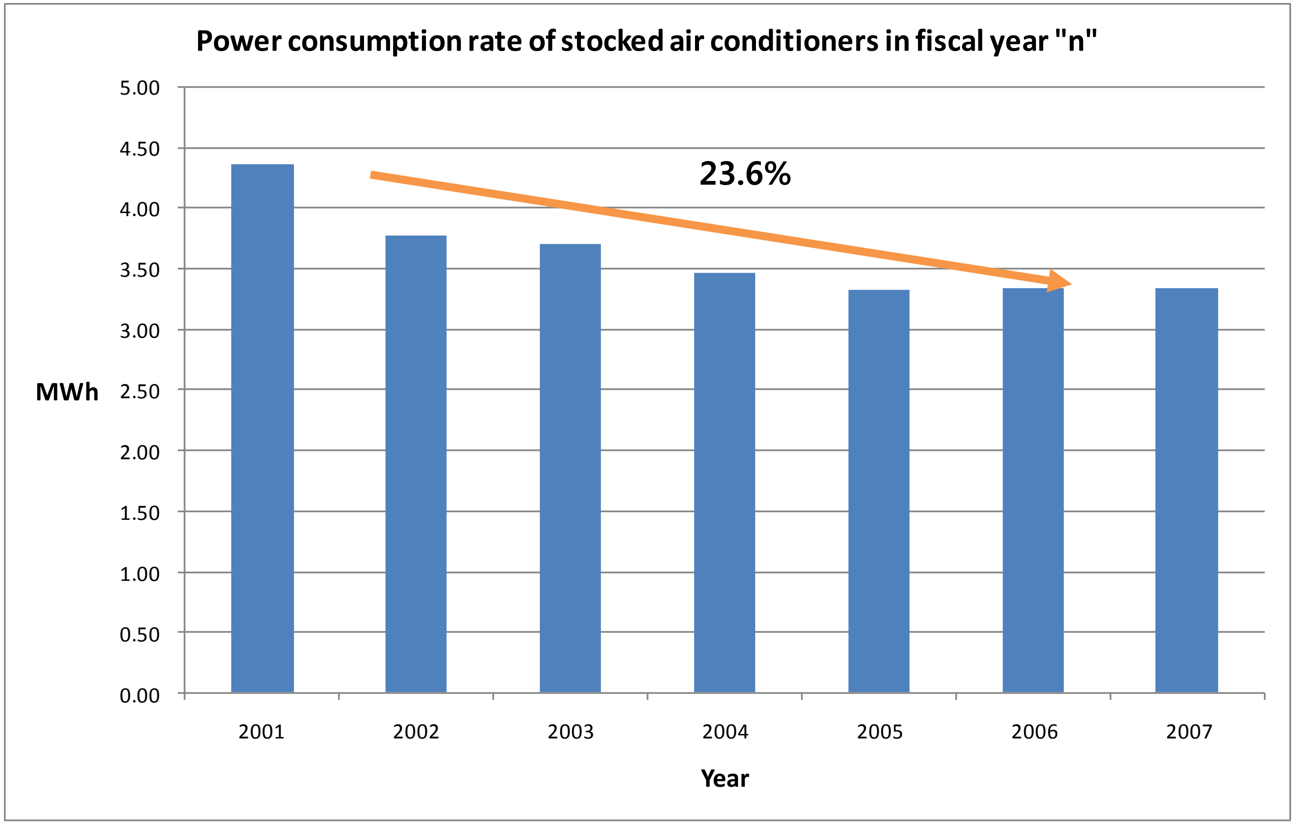
High Efficiency Air conditioners

- **Korean Market**
  - ✓ a new model adopted with a new technology, two stage or variable capacity models in order to meet a new high EELSP in a market even a high price





✓ Power consumption rate of stocked AC in fiscal year has reduced 23.6% from 2001 to 2007



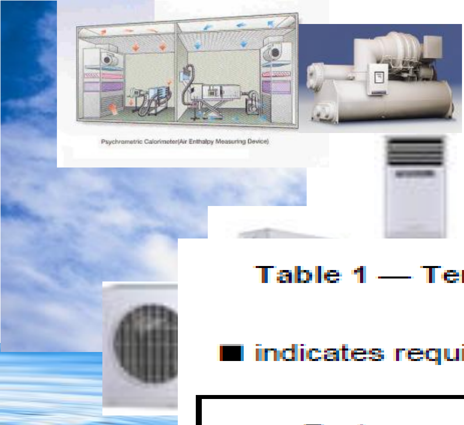
Energy efficiency for Part loads

- **SEER (Seasonal Energy Efficiency Ratio)**
  - *Annual energy use for the appliances or system, unitary AC*
    - Variable-speed, two-speed systems
  - *SEER was developed by NIST, US (Parken et al 1977; Kelly & Parken 1978; Parken et al 1985)*
  - *Based on a bin analysis that calculated the cooling load, capacity and efficiency over a range of ambient temperature*
  - *CSPF (Cooling Seasonal Performance Factor) & HSPF (Heating Seasonal Performance Factor)*
  - *US, Japan, Korea*
- **IPLV (Integrated part load value)**
  - *For Chiller developed in 1986, US*
  - *IPLV (Integrated part load value)*

ISO TC86 SC6 WG1

- **Japan proposed APF(Annual Performance factor) NWIP in 2006, and it was accepted in 2007**
- **ISO TC86 SC6 WG1 is running to develop a new test method for AC/HP**
  - *ISO 16538 "Air-cooled air conditioners and air-to-air heat pumps -Testing and calculating methods for seasonal performance factors"*
    - Part1 : Cooling seasonal performance factor
    - Part2 : Heating seasonal performance factor
    - Part3 : Annual performance factor
- **Convenor is Mr. Bernard Hugh from England**
  - *Japan, USA, Korea, France, and Spain are participated*
- **Currently FDIS ballot stage, ISO FDIS 16358**
- **Not available on water source**
  - *Air-to-Water, Water-to-Air, Water-to-Water, Water-to Brine etc*

- **Types**
  - *fixed capacity unit*
    - equipment which does not have possibility to change its capacity. This definition applies to each cooling and heating operation individually.
  - *two (2)-stage capacity unit*
    - equipment where the capacity is varied by no more than two steps. This definition applies to each cooling and heating operation individually.
  - *multi-stage capacity unit*
    - equipment where the capacity is varied by 3 or 4 steps. This definition applies to each cooling and heating operation individually
  - *variable capacity unit*
    - equipment where the capacity is varied by 5 or more steps to represent continuously variable capacity. This definition applies to each cooling and heating operation individually.



● Cooling mode

Table 1 — Temperature and humidity conditions and default values - for cooling at T1 moderate climate condition of ISO 5151, 13253 and 15042

■ indicates required test. ○ indicates optional test.

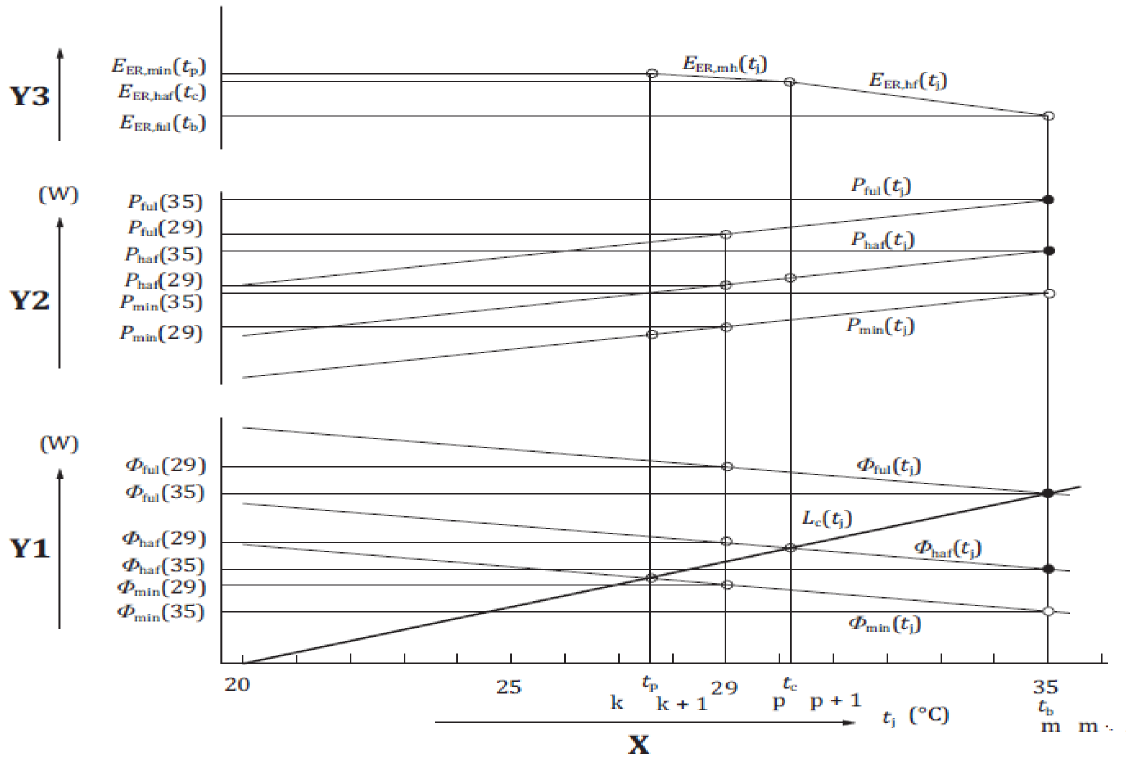
Test	Characteristics	Fixed	2-stage	Multi-stage	Variable	Default value
Standard cooling capacity Indoor DB 27°C WB 19°C Outdoor DB 35°C WB 24°C	Full capacity $\phi_{ful}(35)$ (W)	■	■	■	■	
	Full power input $P_{ful}(35)$ (W)					
	Half capacity $\phi_{haf}(35)$ (W)	-	-	○	■	$\phi_{haf}(29)/1,077$
	Half power input $P_{haf}(35)$ (W)					$P_{haf}(29)/0,914$
	Minimum capacity $\phi_{min}(35)$ (W)	-	○	○	○	$\phi_{min}(29)/1,077$
	Minimum power input $P_{min}(35)$ (W)					$P_{min}(29)/0,914$
Low temperature cooling capacity Indoor DB 27°C WB 19°C Outdoor DB 29°C WB 19°C	Full capacity $\phi_{ful}(29)$ (W)	■	■	■	-	$1,077 \times \phi_{ful}(35)$
	Full power input $P_{ful}(29)$ (W)					$0,914 \times P_{ful}(35)$
	Half capacity $\phi_{haf}(29)$ (W)	-	-	■	○	$1,077 \times \phi_{haf}(35)$
	Half power input $P_{haf}(29)$ (W)					$0,914 \times P_{haf}(35)$
	Minimum capacity $\phi_{min}(29)$ (W)	-	■	○	○	
	Minimum power input $P_{min}(29)$ (W)					
Low humidity and cyclic cooling Indoor DB 27°C WB 16°C or lower Outdoor DB 29°C WB -	Degradation coefficient C_D — Full capacity	○	-	-	-	0,25
	Degradation coefficient C_D — Half capacity	-	-	○	-	0,25
	Degradation coefficient C_D — Minimum capacity	-	○	○	-	0,25

NOTE 1 If the minimum capacity test is measured, min(29) test is conducted first. Min(35) test may be measured or may be calculated by using default value.

NOTE 2 Voltage(s) and frequency(ies) are as given in the three referenced standards.

Table 3 — Reference outdoor temperature bin distribution

Bin number j	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
Outdoor temperature t_j °C	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	—
Fractional bin hours	0,055	0,076	0,091	0,108	0,116	0,118	0,116	0,100	0,083	0,066	0,041	0,019	0,006	0,003	0,002	
Bin hours n_j	n_1	n_2	n_3	n_4	n_5	n_6	n_7	n_8	n_9	n_{10}	n_{11}	n_{12}	n_{13}	n_{14}	n_{15}	—
Reference bin hours (n_j) h	100	139	165	196	210	215	210	181	150	120	75	35	11	6	4	1 817



Key
X outdoor temperature
Y1 capacity or load
Y2 power input
Y3 energy efficiency ratio (EER)

Figure A.4 — Cooling capacity, power input, cooling load and EER for variable capacity units

Table 2 — Defined cooling load

Parameter	Load zero (0)	Load 100 %
Cooling load (W)	0	$\phi_{ful}(t_{100})$
Temperature (°C)	t_0	t_{100}

$$F_{CSP} = \frac{L_{CST}}{C_{CSE}}$$

$$L_{CST} = \sum_{j=1}^{m} L_c(t_j) \times n_j + \sum_{j=m+1}^{n} \phi_{ful}(t_j) \times n_j$$

$$C_{CSE} = \sum_{j=1}^{n} X(t_j) \times P_{ful}(t_j) \times \frac{n_j}{F_{PL}(t_j)}$$

• TCSPF(Total cooling seasonal performance factor)

Table B.1 — Default weighting factors for determination of reference inactive energy consumption

Temperature condition	5 °C	10 °C	15 °C	20 °C
Weighting factor	0,05	0,13	0,27	0,55

$$F_{TCSP} = L_{CST} / (C_{CSE} + C_{IAE}) \qquad C_{IAE} = H_{ia} \times P_{ia}$$

where

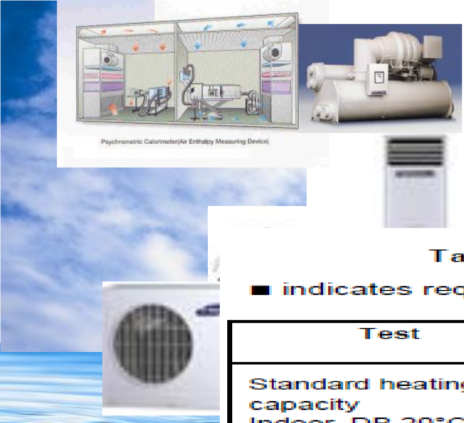
C_{IAE} is the inactive energy consumption;

H_{ia} is the number of hours of inactive mode as given in Table B.2;

P_{ia} is the weighted average power consumption.

Table B.2 — Default hours by mode for the calculation of reference total cooling seasonal performance factor

Unit	Active mode h	Inactive mode, H_{ia} h	Disconnected mode h
Cooling only unit	1 817	4 077	2 866
Cooling unit with sup-plemental heat	1 817 (Heating operation: 2 866)	4 077	0
Reversible unit	1 817 (Heating operation: 2 866)	4 077	0



● Heating mode

Table 1 — Temperature and humidity conditions and default values - for heating

■ indicates required test. ○ indicates optional test. □ test is required when there is not an extended mode.

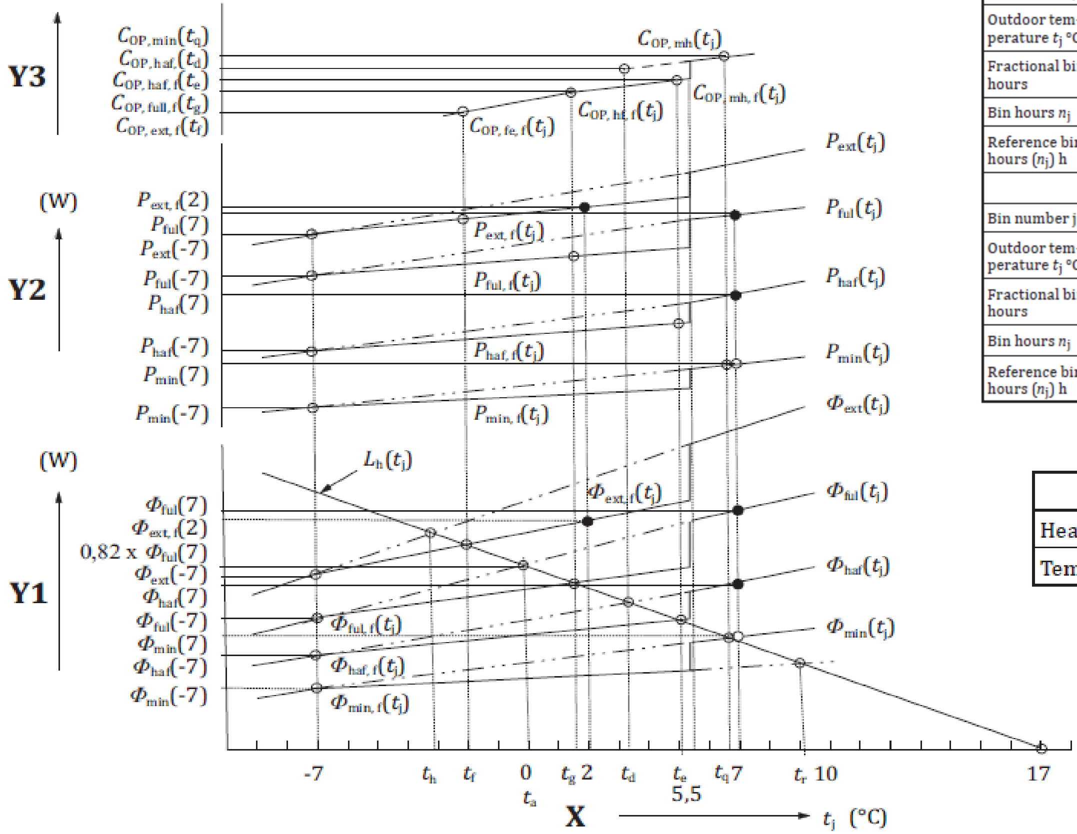
Test	Characteristics	Fixed	2-stage	Multi-stage	Variable	Default value
Standard heating capacity Indoor DB 20°C WB 15 °C Max. Outdoor DB 7°C WB 6°C	Full capacity $\phi_{ful}(7)$ (W)	■	■	■	■	
	Full power input $P_{ful}(7)$ (W)					
	Half capacity $\phi_{haf}(7)$ (W)	—	—	■	■	
	Half power input $P_{haf}(7)$ (W)					
	Minimum capacity $\phi_{min}(7)$ (W)	—	■	○	○	
	Minimum power input $P_{min}(7)$ (W)					
Low temperature heating capacity Indoor DB 20°C WB 15°C Max. Outdoor DB 2°C WB 1°C	Extended capacity $\phi_{ext,r}(2)$ (W)	—	—	■ *1	■ *1	
	Extended power input $P_{ext,r}(2)$ (W)					
	Calculated extended capacity $\phi_{ext}(2)$ (W)	—	—	*2	*2	1,12 $\phi_{ext,r}(2)$
	Calculated extended power input $P_{ext}(2)$ (W)					1,06 $P_{ext,r}(2)$
	Full capacity $\phi_{ful,r}(2)$ (W)	■ *3	■ *3	□ *1*3	□ *1*3	$\phi_{ful}(2)$/1,12 see *4
	Full power input $P_{ful,r}(2)$ (W)					$P_{ful}(2)$/1,06 see *4
	Half capacity $\phi_{haf,r}(2)$ (W)	—	—	○ *3	○ *3	$\phi_{haf}(2)$/1,12 see *4
	Half power input $P_{haf,r}(2)$ (W)					$P_{haf}(2)$/1,06 see *4
	Minimum capacity $\phi_{min,r}(2)$ (W)	—	○ *3	—	—	$\phi_{min}(2)$/1,12 see *4
	Minimum power input $P_{min,r}(2)$ (W)					$P_{min}(2)$/1,06 see *4
Extra-low temperature heating capacity Indoor DB 20°C WB 15°C Max. Outdoor DB -7°C WB -8°C	Extended capacity $\phi_{ext}(-7)$ (W)	—	—	○	○	0,734 $\phi_{ext}(2)$
	Extended power input $P_{ext}(-7)$ (W)					0,877 $P_{ext}(2)$
	Full capacity $\phi_{ful}(-7)$ (W)	○	○	○	○	0,64 $\phi_{ful}(7)$
	Full power input $P_{ful}(-7)$ (W)					0,82 $P_{ful}(7)$
	Half capacity $\phi_{haf}(-7)$ (W)	—	—	○	○	0,64 $\phi_{haf}(7)$
	Half power input $P_{haf}(-7)$ (W)					0,82 $P_{haf}(7)$
	Minimum capacity $\phi_{min}(-7)$ (W)	—	—	—	—	0,64 $\phi_{min}(7)$
	Minimum power input $P_{min}(-7)$ (W)					0,82 $P_{min}(7)$
Cyclic heating Indoor DB 20°C WB 15°C Max. Outdoor DB 7°C WB 6°C	Degradation coefficient C_D — Full capacity	○	—	—	—	0,25
	Degradation coefficient C_D — Half capacity	—	—	○	—	0,25
	Degradation coefficient C_D — Minimum capacity	—	○	○	—	0,25

NOTE 1 *1 When the equipment has an extended mode, low temperature extended capacity measurement is mandatory and low temperature full capacity measurement is optional. When the equipment has not an extended mode, low temperature full capacity measurement is mandatory.
*2 This value shall be calculated using default value.
*3 When this value is measured, $\phi_x(2)$ and/or $P_x(2)$ shall not be calculated from this value, but the equations in *4 shall be used instead.
*4 The following two equations apply to the full capacity, half capacity and minimum capacity data when $\phi_{x,r}(2)$ and $P_{x,r}(2)$ are calculated.

$$\phi_x(2) = \phi_x(-7) + \frac{\phi_x(7) - \phi_x(-7)}{7-(-7)} \times (2-(-7)) \qquad P_x(2) = P_x(-7) + \frac{P_x(7) - P_x(-7)}{7-(-7)} \times (2-(-7))$$

Where, x means full, half and minimum

NOTE 2 Voltage(s) and frequency(ies) shall be as given in the three referenced standards.



Key

X outdoor temperature

Y1 capacity or load

Y2 power input

Y3 coefficient of performance (COP)

Figure A.4 — Heating capacity, power input, load and COP for variable capacity units

Table 3 — Reference outdoor temperature bin distribution for heating

Bin number j	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Outdoor temperature t_j °C	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3
Fractional bin hours	0	0	0	0	0	0	0	0	0	0,001	0,005	0,012	0,024	0,042
Bin hours n_j	n_1	n_2	n_3	n_4	n_5	n_6	n_7	n_8	n_9	n_{10}	n_{11}	n_{12}	n_{13}	n_{14}
Reference bin hours (n_j) h	0	0	0	0	0	0	0	0	0	4	15	33	68	119
Bin number j	15	16	17	18	19	20	21	22	23	24	25	26	27	Total
Outdoor temperature t_j °C	4	5	6	7	8	9	10	11	12	13	14	15	16	
Fractional bin hours	0,059	0,070	0,082	0,087	0,091	0,092	0,091	0,085	0,075	0,067	0,053	0,038	0,027	
Bin hours n_j	n_{15}	n_{16}	n_{17}	n_{18}	n_{19}	n_{20}	n_{21}	n_{22}	n_{23}	n_{24}	n_{25}	n_{26}	n_{27}	
Reference bin hours (n_j) h	169	200	234	250	260	265	260	245	215	192	151	110	76	2 866

Table 2 — Defined heating load

Parameter	Load zero (0)	Load 100 %
Heating load (W)	0	$0{,}82 \times \phi_{ful}(H1)$
Temperature(°C)	t_0	t_{100}

$$F_{HSP} = \frac{L_{HST}}{C_{HSE}}$$

$$L_{HST} = \sum_{j=1}^{n} L_h(t_j) \times n_j$$

$$C_{HSE} = \sum_{j=1}^{n} \frac{X(t_j) \times P(t_j) \times n_j}{F_{PL}(t_j)} + \sum_{j=1}^{n} P_{RH}(t_j) \times n_j$$

● THSPF(Total heating seasonal performance factor)

Table B.1 — Default weighting factors for determination of reference inactive energy consumption

Temperature condition	5 °C	10 °C	15 °C	20 °C
Weighting factor	0,05	0,13	0,27	0,55

$$F_{THSP} = \frac{L_{HST}}{C_{HSE} + C_{IAE}} \qquad C_{IAE} = H_{ia} \times P_{ia}$$

where

C_{IAE} is the inactive energy consumption;

H_{ia} is the number of hours of inactive mode as given in Table B.2;

P_{ia} is the weighted average power consumption.

Table B.2 — Default hours by mode for the calculation of reference total heating seasonal performance factor

Unit	Active mode h	Inactive mode, H_{ia} h	Disconnected mode h
Heating only unit	2 866	4 077	1 817
Reversible unit	2 866 (Cooling operation: 1 817)	4 077	0

APF(Annual Performance Factor)

$$F_{AP} = \frac{L_{CST} + L_{HST}}{C_{CSE} + C_{HSE}}$$

Symbol	Description	Unit
C_{CSE}	cooling seasonal energy consumption (CSEC)	Wh
C_{HSE}	heating seasonal energy consumption (HSEC)	Wh
F_{AP}	annual performance factor (APF)	—
F_{CSP}	cooling seasonal performance factor (CSPF)	—
F_{TAP}	total annual performance factor (TAPF)	—
L_{CST}	cooling seasonal total load (CSTL)	Wh
L_{HST}	heating seasonal total load (HSTL)	Wh

The test report for this part of ISO 16358 shall include the calculation of APF (and TAPF if applicable) and test reports from ISO 16358-1 for cooling and ISO 16358-2 for heating.

Europe Standard - EN 14825

- EN 14825 “Air conditioners, liquid chilling packages and heat pumps, with electrically compressors, for space heating and cooling — Testing and rating at part load conditions and calculation of seasonal performance“. Published March 2012.
- Will be the harmonized standard for the European Directive on seasonal efficiency of air conditioners (revision summer 2013).
- Developed using the data of a preliminary study of the European Commission, determining average climates in Europe and representative types of buildings and internal loads schedules.
- Bin method (number of hours at a given outdoor temperature)
- Includes the electrical input when the unit is not cooling nor heating.
- Testing methods for the cooling and heating capacities: EN 14511

- reference design conditions for cooling (Tdesignc)
  - ✓ temperature conditions at 35 °C dry bulb (24 °C wet bulb) outdoor temperature and 27 °C dry bulb (19 °C wet bulb) indoor temperature

- reference design conditions for heating (Tdesignh)
  - ✓ temperature conditions for average, colder and warmer climates

Tdesign "average"	temperature conditions at -10^{o}C dry bulb outdoor temperature and 20^{o}C dry bulb indoor temperature
T design "colder"	temperature conditions at -22°C dry bulb outdoor temperature and 20°C dry bulb indoor temperature
T design "warmer"	temperature conditions at +2°C dry bulb outdoor temperature and 20°C dry bulb indoor temperature

- bivalent temperature (Tbivalent)
  - ✓ lowest outdoor temperature point at which the heat pump is declared to have a capacity able to meet 100% of the heating demand
    - for the average heating season, the bivalent temperature is +2°CDB or lower
    - for the colder heating season, the bivalent temperature is -7°CDB or lower
    - for the warmer heating season, the bivalent temperature is +7°CDB or lower
- operation limit temperature (TOL)
  - ✓ lowest outdoor temperature at which the heat pump can still deliver heating capacity, as declared by the manufacturer

- Important: both temperatures are declared by the manufacturer.

- The cooling demand Pc(Tj) can be determined by multiplying the full load value (Pdesignc) with the part load ratio % for each corresponding bin. This part load ratio % is calculated as follows:

- Cooling mode:

Part load ratio % = (Tj-16) / (35-16)

	Part load ratio (%)	Outdoor air dry bulb temperature (°C)	Indoor air dry bulb (wet bulb) temperatures (°C)
A	100%	35	27(19)
B	74%	30	27(19)
C	47%	25	27(19)
D	21%	20	27(19)

- The EER values at each bin are determined via interpolation of the EER values at part load conditions A,B,C,D as mentioned in the tables of Clause 4 of this standard.
  - ✓ For part load conditions above part load condition A, the same EER values as for condition A are used.
  - ✓ For part load conditions below part load condition D, the same EER values as for condition D are used.

$$SEER_{on} = \frac{\sum_{j=1}^{n} hj \times Pc(Tj)}{\sum_{j=1}^{n} hj \times \left(\frac{Pc(Tj)}{EER(Tj)} \right)}$$

Tj = the bin temperature;
j = the bin number;
n = the amount of bins;
Pc(Tj) = the cooling demand of the building for the corresponding temperature Tj;
hj = the number of bin hours occurring at the corresponding temperature Tj;
EER(Tj) = the EER values of the unit for the corresponding temperature Tj.

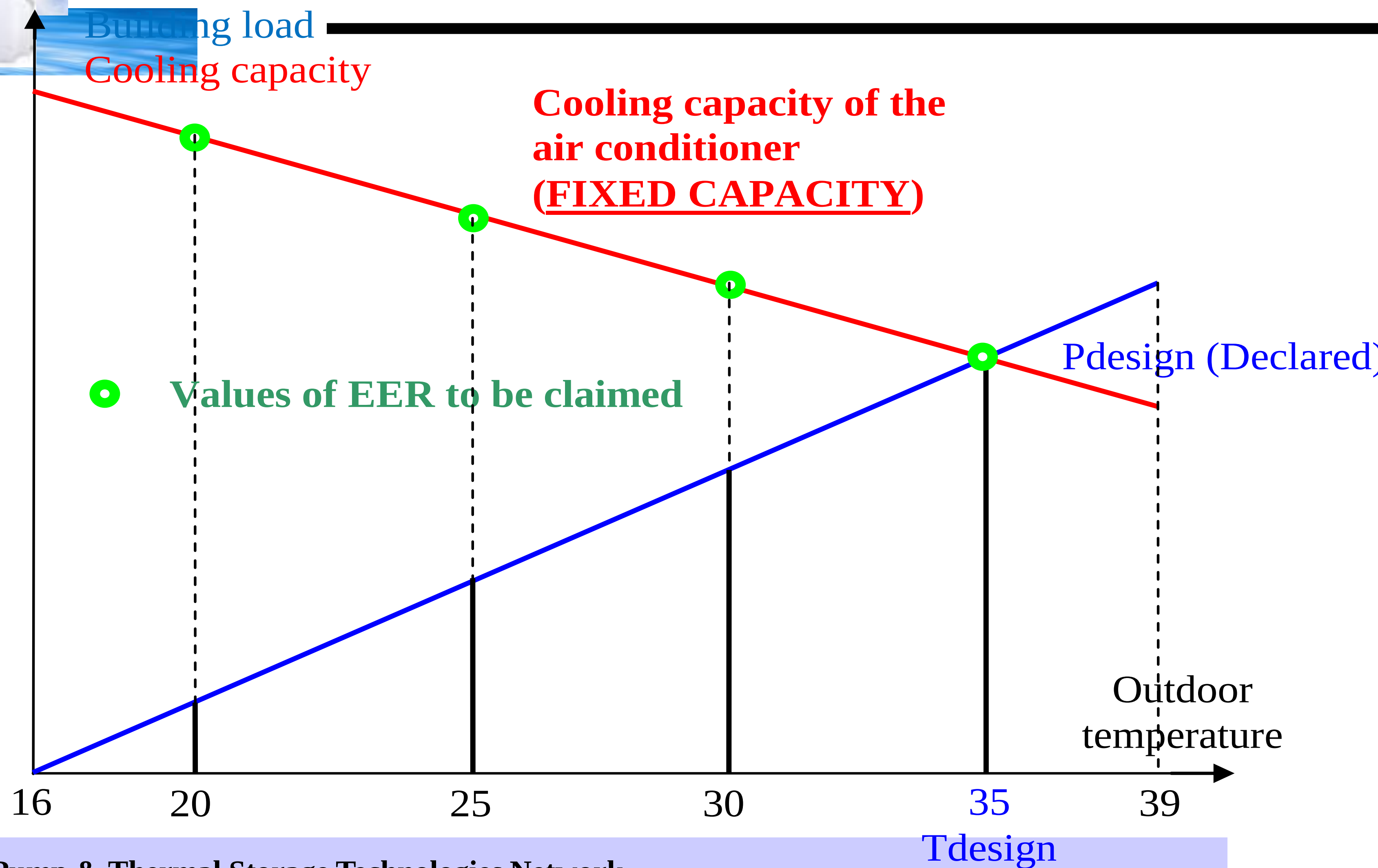
- for fixed capacity units
  - ✓ For each part load conditions B,C,D the EER is calculated as follows:

$$\mathrm{EER}_{\mathrm{B,C,D}} = EER_{DC} \times (1 - Cd \times (1 - \frac{Pc}{DC}))$$

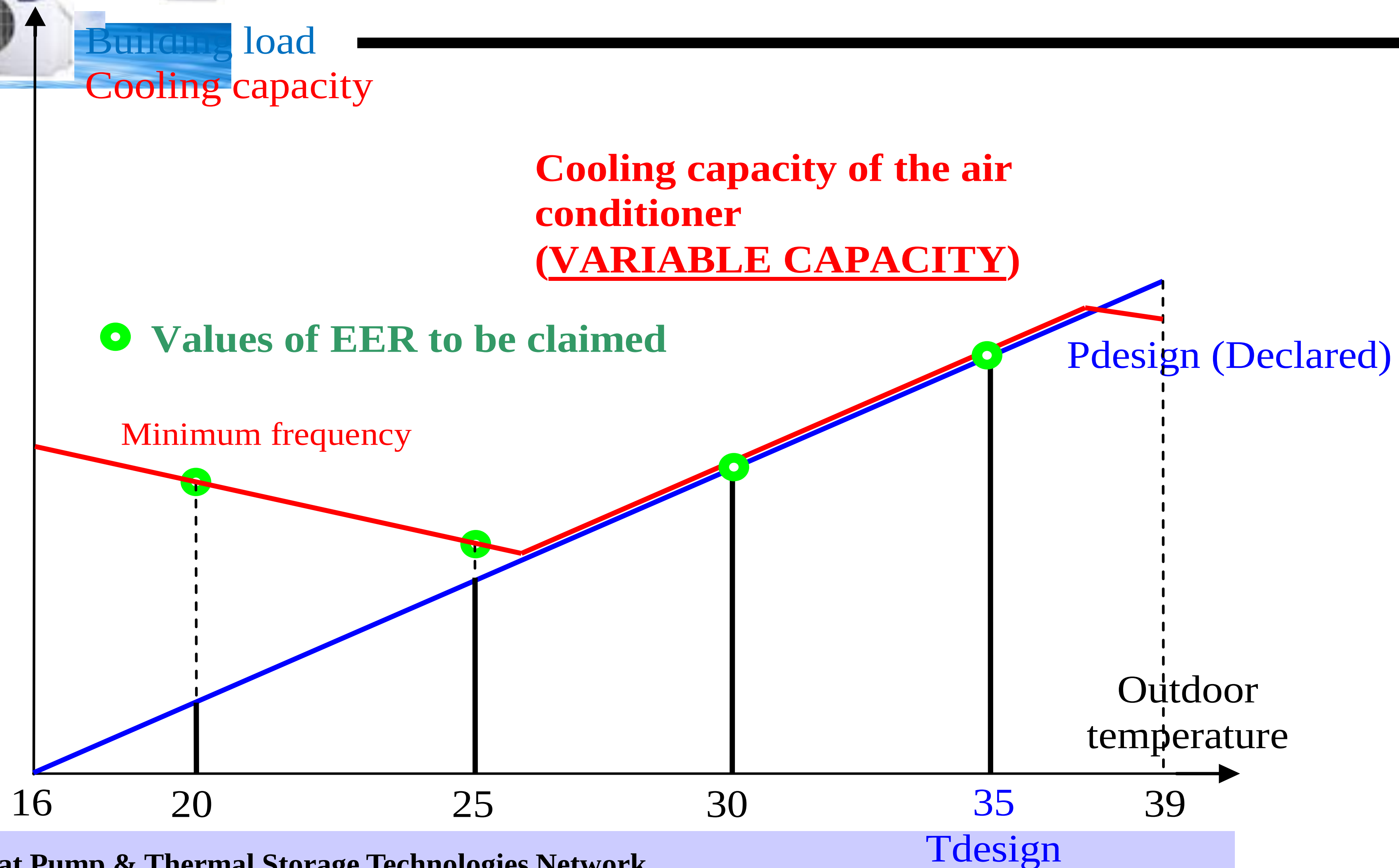
EER_{DC} = the EER corresponding to the declared capacity (DC) of the unit at the same temperature conditions as for part load conditions B,C,D.
Cd = the degradation coefficient
Pc = cooling demand of the building in conditions B, C, D;
DC= declared capacity of the unit at the same temperature conditions as for part load conditions B,C,D.

  - ✓ If the degradation coefficient Cd is not measured, a default value of 0.25 shall be used.

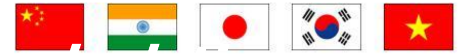
- for variable capacity units
  - ✓ For each part load conditions B,C,D the EER has to be measured and during the test
  - ✓ the part load capacity shall be within ± 10% of the target load. If not possible, the measu rement is done at the closest steps and the EER is calculated in a linear way from the two results. If there is no step giving a load lower than the target, then Cd is used.



Building load
Cooling capacity
Cooling capacity of the air conditioner (FIXED CAPACITY)
Values of EER to be claimed
Pdesign (Declared)
Outdoor temperature
16
20
25
30
35
39
Tdesign



Building load
Cooling capacity
Cooling capacity of the air conditioner
(VARIABLE CAPACITY)
Values of EER to be claimed
Pdesign (Declared)
Minimum frequency
Outdoor temperature
16
20
25
30
35
39
Tdesign



- Reference SEER

$$SEER = \frac{Q_{CE}}{\frac{Q_{CE}}{SEER_{on}} + H_{TO} \times P_{TO} + H_{SB} \times P_{SB} + H_{CK} \times P_{CK} + H_{OFF} \times P_{OFF}}$$

- ✓ HTO, HSB, HCK, HOFF = the number of hours the unit is considered to work in respectively thermostat off mode, standby mode, crankcase heater mode and off mode;
- ✓ PTO, PSB, PCK, POFF = the electricity consumption during respectively thermostat off mode, standby mode, crankcase heater mode and off mode, expressed in kW.

With $Q_{ce} = P_{designc} \times H_{ce}$ (Hce = 350 hours)

- Heating mode (Average climate):

	Part load ratio (%)	Outdoor air dry bulb (wet bulb) temperatures (°C)	Indoor air dry bulb temperature (°C)
A	88%	-7(-8)	20
B	54%	2(1)	20
C	35%	7(6)	20
D	15%	12(11)	20
E		TOL	20
F		Tbivalent	20

TOL: Temperature operation limit (lower temperature)

Tbivalent: Lower temperature the heat pump can satisfy the heating load

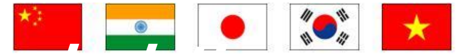
Outdoor wet bulb temperature at TOL and Tbivalent: not required below -7ºC

$$SCOP_{on} = \frac{\sum_{j=1}^{n} hj \cdot Ph(Tj)}{\sum_{j=1}^{n} hj \cdot \left(\frac{Ph(Tj) - elbu(Tj)}{COP_{PL}(Tj)} + elbu(Tj) \right)}$$

$$SCOP_{net} = \frac{\sum_{j=1}^{n} hj \cdot (Ph(Tj) - elbu(Tj))}{\sum_{j=1}^{n} hj \cdot \left(\frac{Ph(Tj) - elbu(Tj)}{COP_{PL}(Tj)} \right)}$$

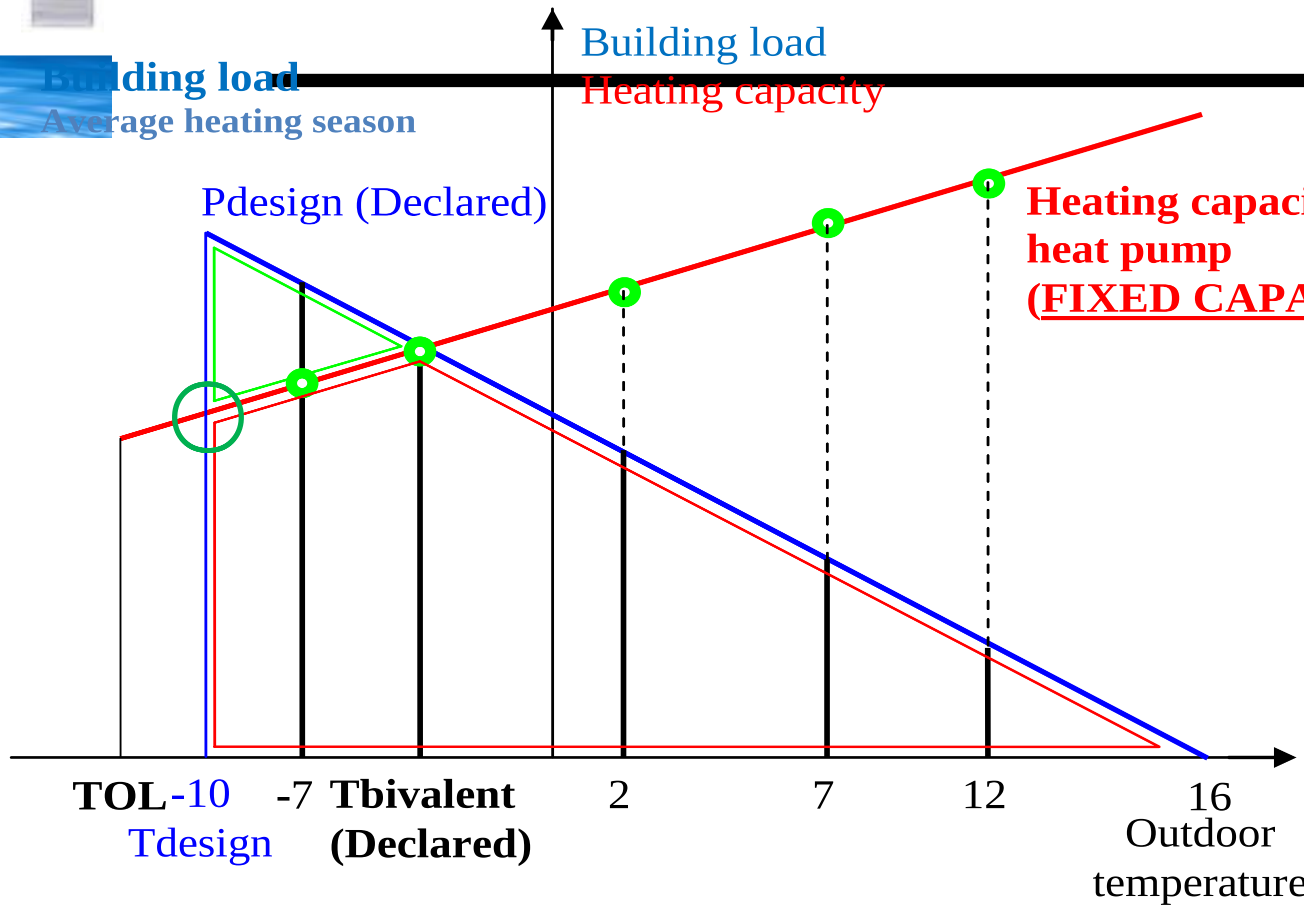
Tj = the bin temperature;
j = the bin number;
n = the amount of bins;
Ph(Tj) = the heating demand of the building for the corresponding temperature Tj;
hj = the number of bin hours occurring at the corresponding temperature Tj;
COP_{PL}(Tj) = the COP values of the unit for the corresponding temperature Tj.
Elbu(Tj) = the required capacity of an electric backup heater for the corresponding temperature Tj, , expressed in kW

- The heating demand Ph(Tj) can be determined by multiplying the full load value (Pdesignh) wi th the part load ratio % for each corresponding bin. This part load ratio % is calculated as follo ws :
  - ✓ For the average climate : Part load ratio % = (Tj-16) / (-10-16) %
  - ✓ For the warmer climate : Part load ratio % = (Tj-16) / (+2-16) %
  - ✓ For the colder climate : Part load ratio % = (Tj-16) / (-22-16) %



Building load

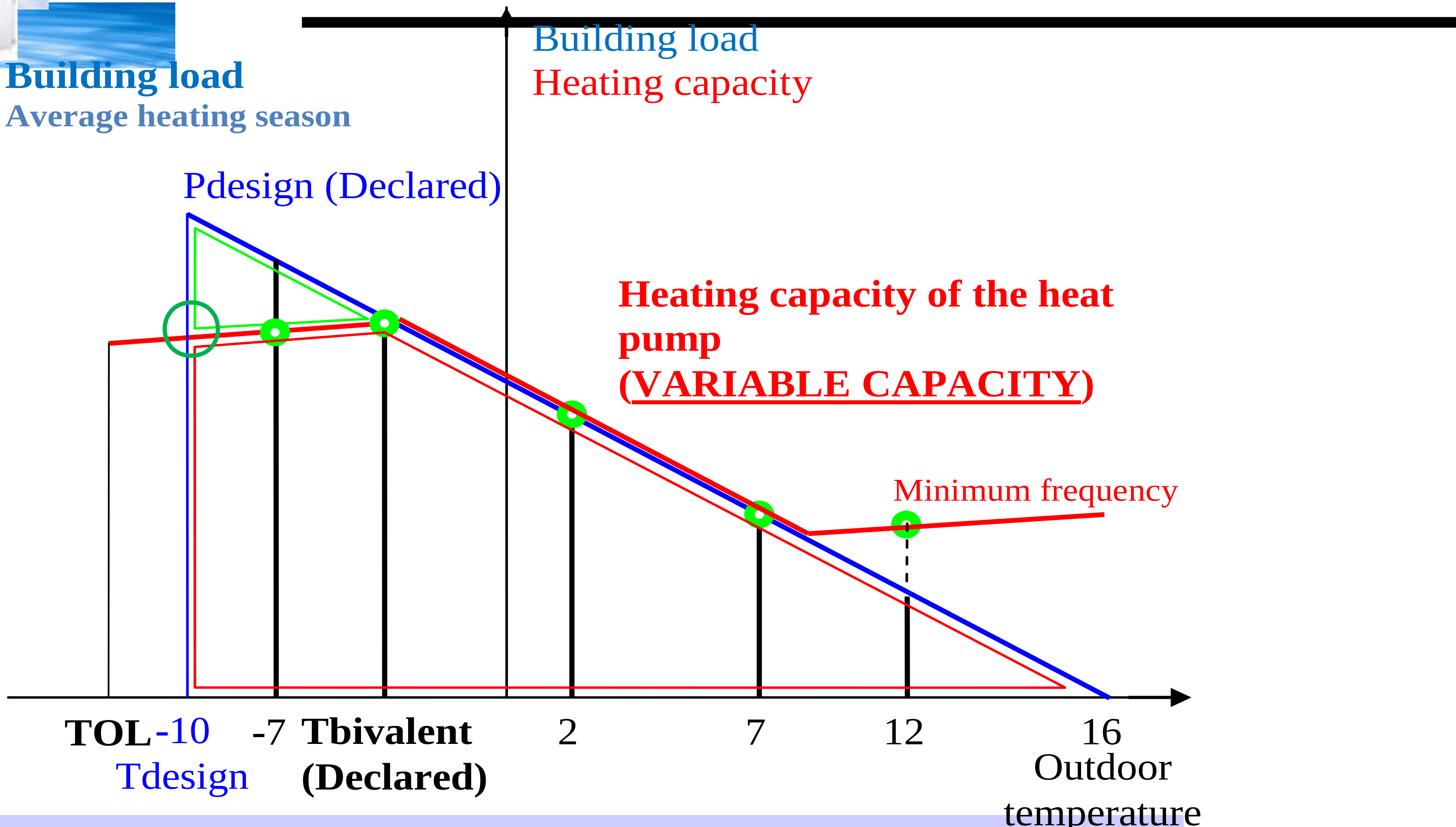
Average heating season



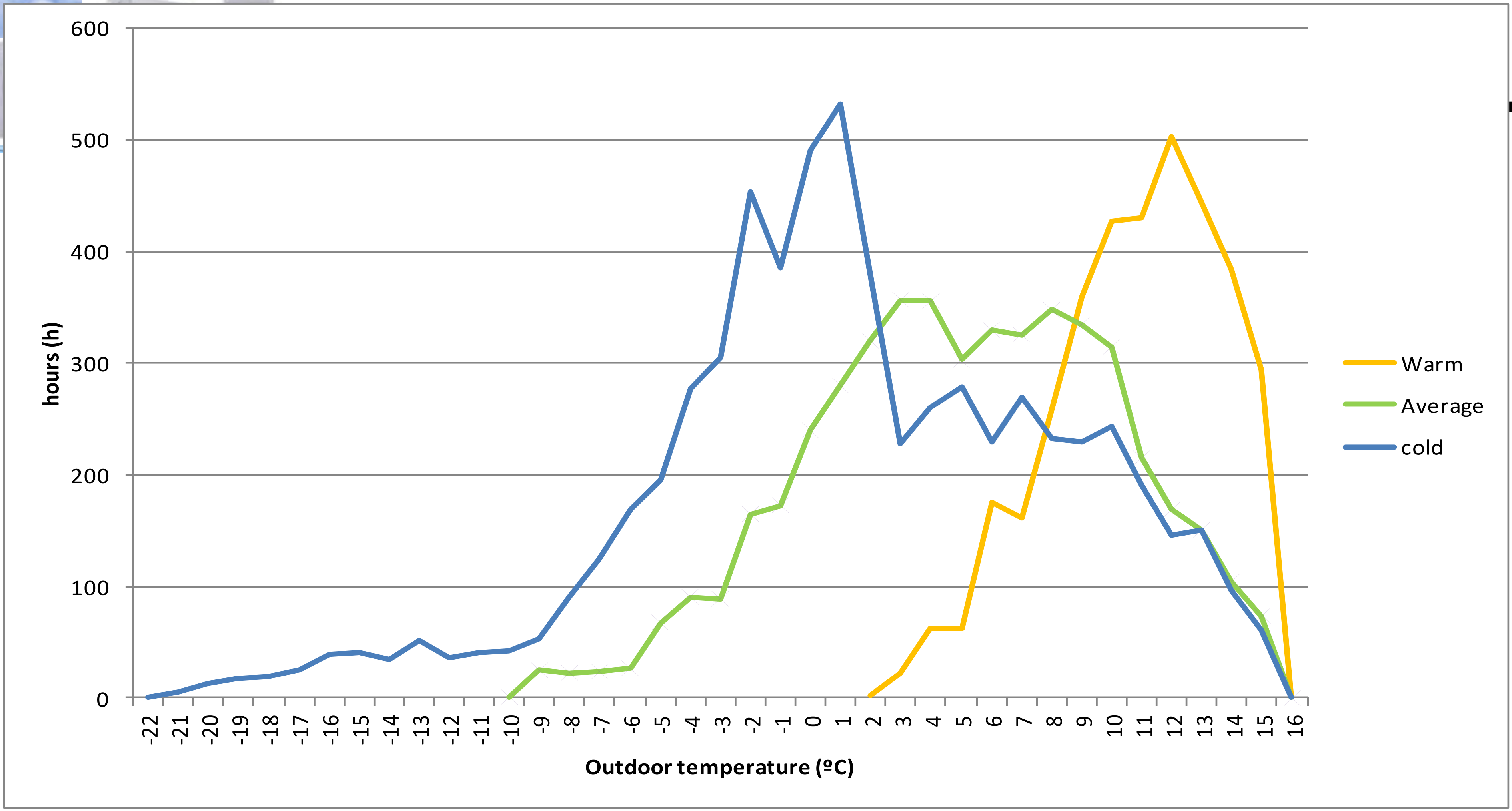
Values of COP to be claimed

Heating needs covered by the heat pump

Heating needs covered by an electrical heater COP = 1



Building load
Average heating season
Building load
Heating capacity
Pdesign (Declared)
Heating capacity of the heat pump
(VARIABLE CAPACITY)
Minimum frequency
TOL
-10
Tdesign
-7
Tbivalent
(Declared)
2
7
12
16
Outdoor temperature



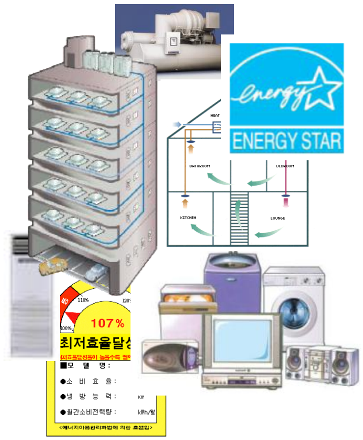
600
500
400
300
200
100
0
hours (h)
-22 -21 -20 -19 -18 -17 -16 -15 -14 -13 -12 -11 -10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Outdoor temperature (ºC)
Warm
Average
cold

Standards in KOREA

- **KS C 9306-2007 is available for SEER (CSPF & HSPF)**
  - ✓ Annex 5 provides the guidelines to define CSPF & HSPF
- **Originally it come from ARI, and ASHRAE (US) standards, and developed in 1992**
- **Compromised with ISO 16358**
- **It was effective for Energy Efficiency Label and Standard**
- **Three types**
  - ✓ Fixed–Speed Compressor
  - ✓ Multi-speed & 2-Compressor
  - ✓ Variable speed compressor

Revision

- **KS provides information to calculate SEER**
- **Two stage capacity units and variable capacity units should be adopted with CSPF method**
  - *But, KS is a little bit different with proposed ISO method*
    - Temperature bin
    - Temperature conditions, and etc..
  - *KS is being considered to revise with ISO*



Energy Efficiency Level for heatpump in KOREA

- **Effective from Jan. 2009 : Single heat Pump**

$$R = \frac{\text{Cooling EER(CEER)} + \text{Heating EER(HEER)}}{2}$$

Non-ducted and ducted unitary (Including window type)

R	Level
3.20 ≤ R	1
2.90 ≤ R < 3.20	2
2.60 ≤ R < 2.90	3
2.30 ≤ R < 2.60	4
2.00 ≤ R < 2.30	5

Split type, RCC < 4kW

R	Level
4.00 ≤ R	1
3.60 ≤ R < 4.00	2
3.20 ≤ R < 3.60	3
2.80 ≤ R < 3.20	4
2.40 ≤ R < 2.80	5

Split type, 4kW ≤ RCC < 10kW

R	Level
3.80 ≤ R	1
3.40 ≤ R < 3.80	2
3.00 ≤ R < 3.40	3
2.60 ≤ R < 3.00	4
2.20 ≤ R < 2.60	5

Split type, 10kW ≤ RCC < 23.0kW

R	Level
3.20 ≤ R	1
2.90 ≤ R < 3.20	2
2.60 ≤ R < 2.90	3
2.30 ≤ R < 2.60	4
2.00 ≤ R < 2.30	5

Conclusion

- *Promote higher energy efficiency product*
- *Need a actual usage under a range of climates, and more realistically and accurately assessing the performance of variable-speed drive compressor systems under conditions of actual use. (e.g. a range of part load conditions)*
- *Aligning to ISO 5151 (ISO 13253 and ISO FDIS 15042 as applicable) would appear to be a feasible option*
- *Some member countries already introduced*
- *New products were introduced ; Heat Pump water heater*