Business Unit

Supply Chain Analysis for Inverter Air Conditioners in India

CLASP

Strictly Private and Confidential
Final

23 October 2014

pwc

Agenda

Section 1
Background

1.1. RAC market at a glance

- The RAC market in India, stood at **3.3 million** units in **2013-14** and has been on a high growth trajectory in the past one decade. It grew from a market size of 1.25 million units in 2004-05 to 3.3 million units in 2013-2014, growing at a healthy CAGR of **11.38%**.

- The household penetration of Room air conditioners in India stood at a meagre **3.8 %** in 2013 *(**Source**: Euromonitor International)*. Data reveals that penetration of ACs in other Asian economies, viz. China, Korea, Singapore, Taiwan etc. stand at 53%, 50%, 72% and 89% respectively. *(**Source**: Secondary research)*

Such low penetration rate in Indian economy illustrates the huge opportunity the AC industry in India is yet to seize.

1.1.1. RAC Market segmentation in India

- The RAC market in India comprises of window AC and split AC. In **2013-14**, the **split ACs** accounted for **82%** of the total RAC market while window AC market formed the remaining 18%.

- Majority of RACs used in India use fixed speed/ fixed capacity compressors.

1.1.2. Penetration of Inverter Air conditioner in Indian market

- In the recent years, the Indian market witnessed penetration of variable speed/variable capacity ACs, commonly known as Inverter ACs.

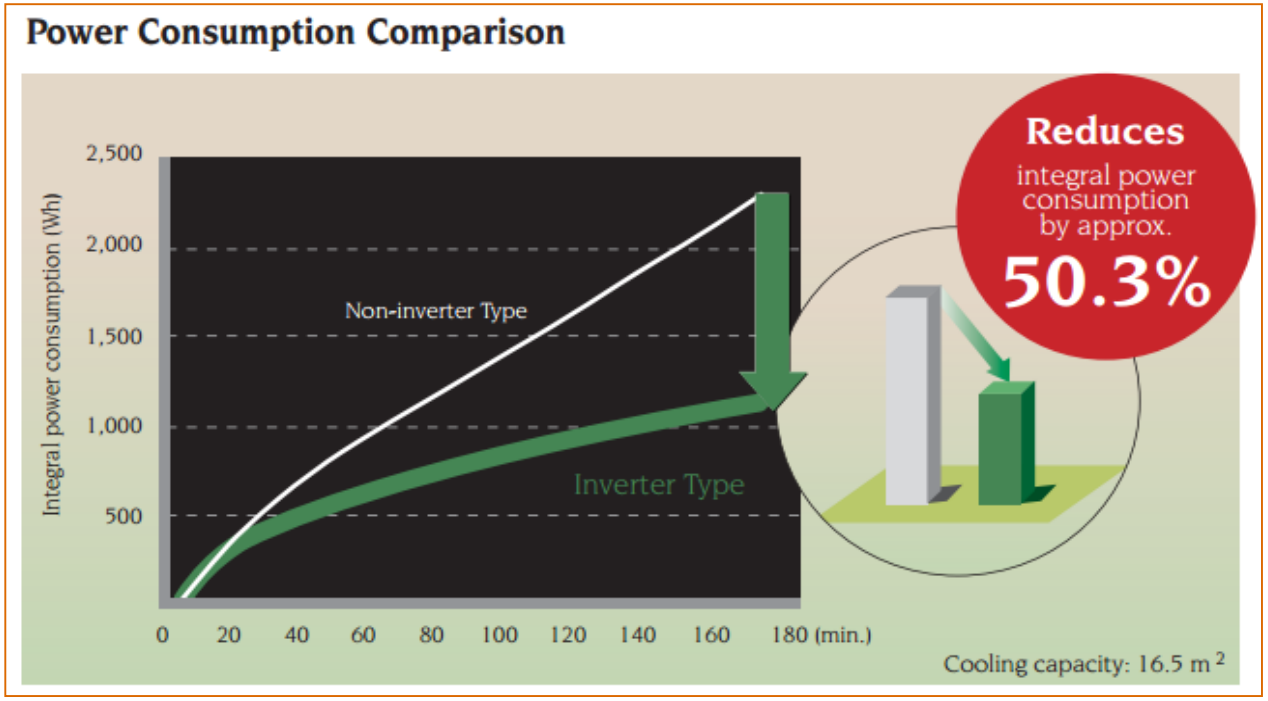
- Considering the existing market dynamics, BEE initiated an exercise to develop energy efficiency standards & labels for inverter air conditioners in India.

- The program is well accepted by manufacturers and BEE plans to launch this program very soon.

1.2. *Inverter AC Benefits portrayed over Fixed AC*

The benefits of an inverter air conditioner over a fixed speed air conditioner with same EER compressor are as follows :

- Quick cooling
- 30 to 50% less power consumption
- Precise temperature control
- Quiet operation



Manufacturers sometimes use 'integral power consumption' interchangeably with 'energy consumption'.

***Source** : Manufacturer's brochure*

1.3. Rationale for this study

- The market sentiments for inverter air conditioners are very positive and manufacturers are planning to launch more models of this category of products in India.

- It is very important to understand supply chain, map key technical specification of products in India as well as globally, existing capacity to manufacturer inverter ACs in India and international best products.

- Currently, no efficiency metric is available for inverter ACs and these are not covered under BEE's star rating program. Such a study will set up a base for a star rating program which eventually may transform the market towards more efficient inverter ACs.

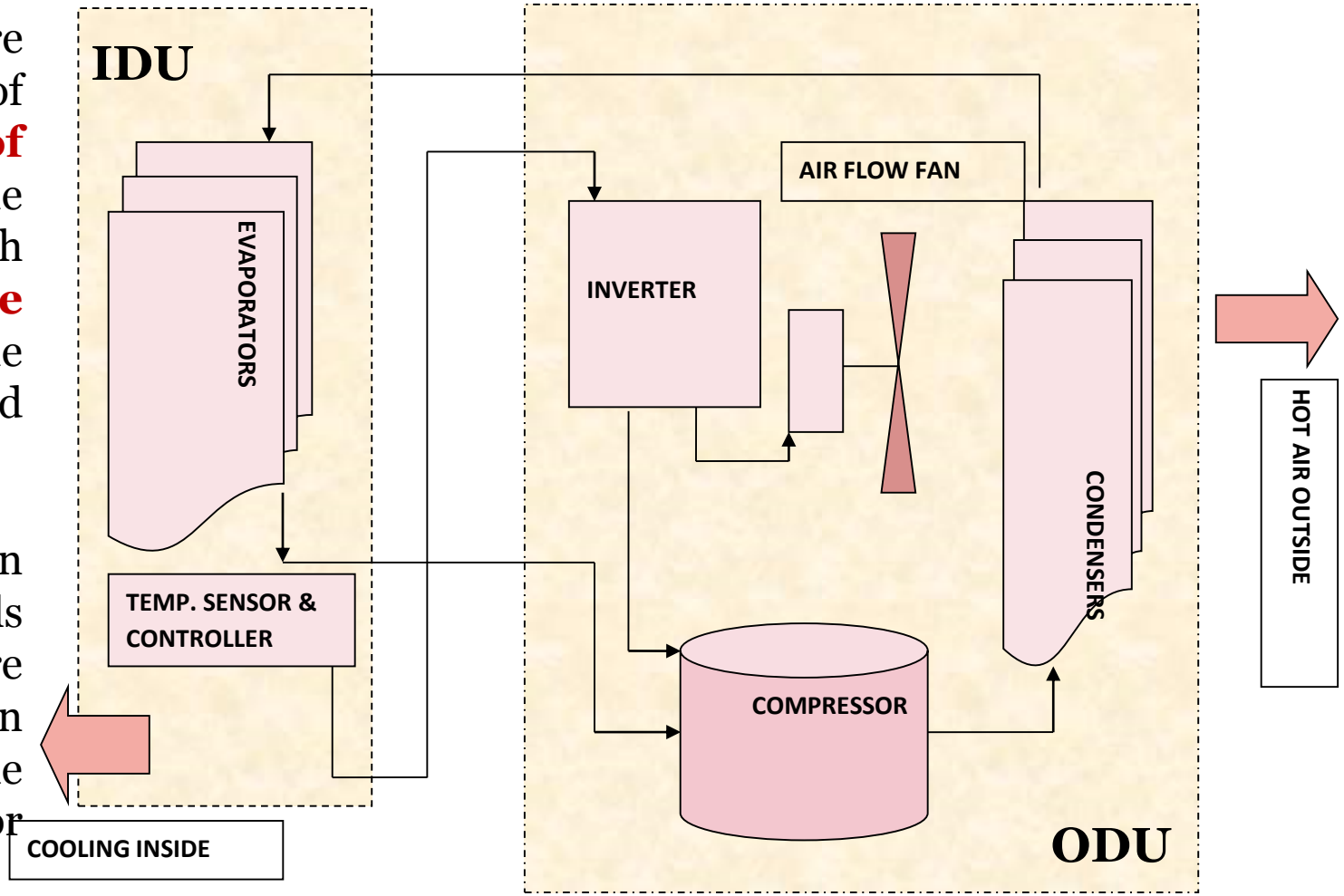
- Considering the progress of Standards & Labelling programme for Inverter ACs, it is a very timely initiative to assess the supply chain for supporting smooth introduction of Inverter ACs in the country.

Section 2
Inverter AC market in India

2.1. Inverter air conditioner : An overview

- Inverter compressors are based on the principle of **varying the speed of motor** at which the compressor runs with the support of **variable frequency drives**. The purpose is to vary load as per the requirement.

- The inverter control in the ODU receives signals from temperature sensors and controller in the IDU and adjusts the speed of the compressor appropriately.



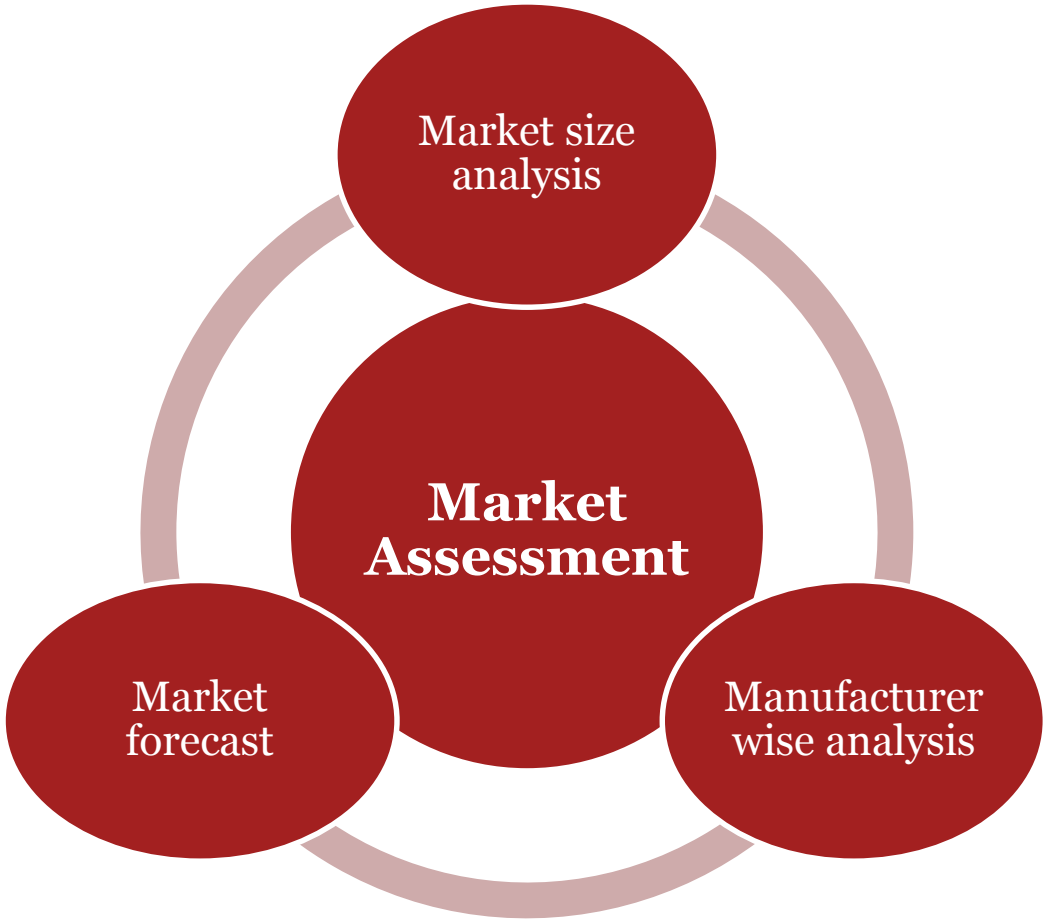
Inverter AC Cycle diagram (**Source**: *PwC study*)

- A rectifier in the Inverter compressor converts the AC current into DC current. Pulse width modulation of the DC current is done to produce AC current of desired frequency.

Inverter compressor

2.2. *An overview of market assessment*

This chapter focusses on assessment of Inverter AC market in India. The overall market assessment is divided into three broad aspects as depicted in the figure.



2.2.1. *List of stakeholders consulted*

AC manufacturers

- Sharp
- Panasonic
- Daikin
- Hitachi

Compressor manufacturers

- Highly
- SIAM
- Daikin

Heat Exchanger manufacturers

- Amber
- Lloyd

Refrigerant manufacturers

- DuPont
- Daikin

Fan manufacturers

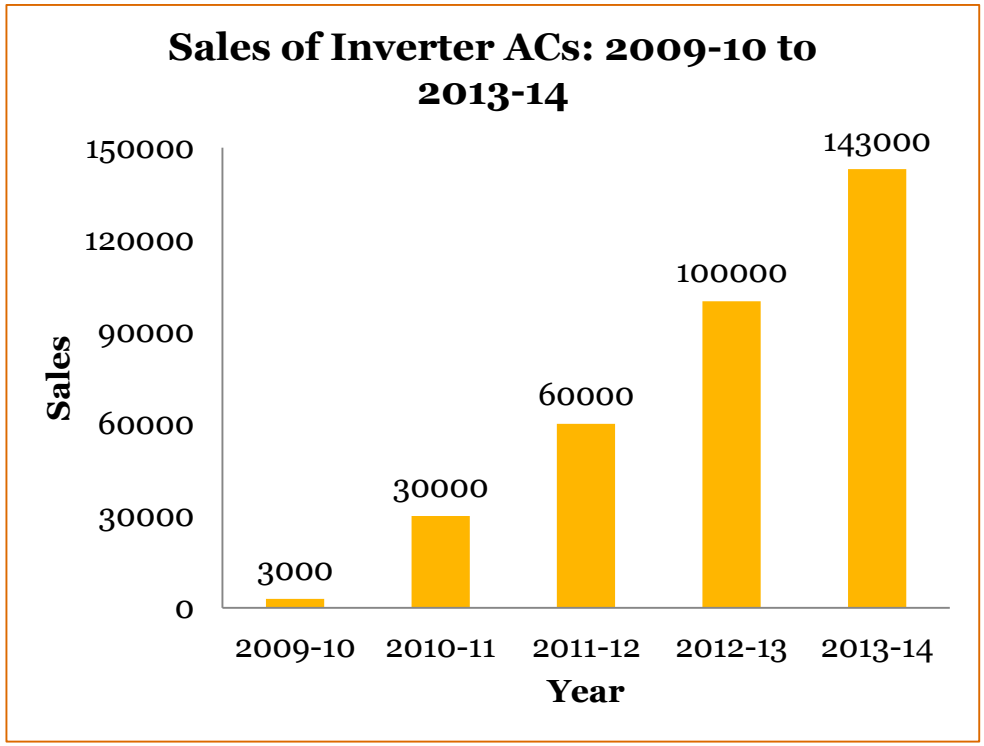
- Welling

2.2.2. *Inverter AC market size*

The Inverter AC market has grown considerably in last few years. The sales numbers for year 2013-2014 and 2009-2010 are presented below.

Annual Sales of Inverter ACs in 2013-14 : 143000 unit
Annual Sales of Inverter ACs in 2009-10 : 3000 units

Discussions with manufacturers suggest that they are selling few models/units of inverter ACs in Indian market to assess consumer's response. A similar growth in market size is expected for Inverter AC segment in the coming years too.

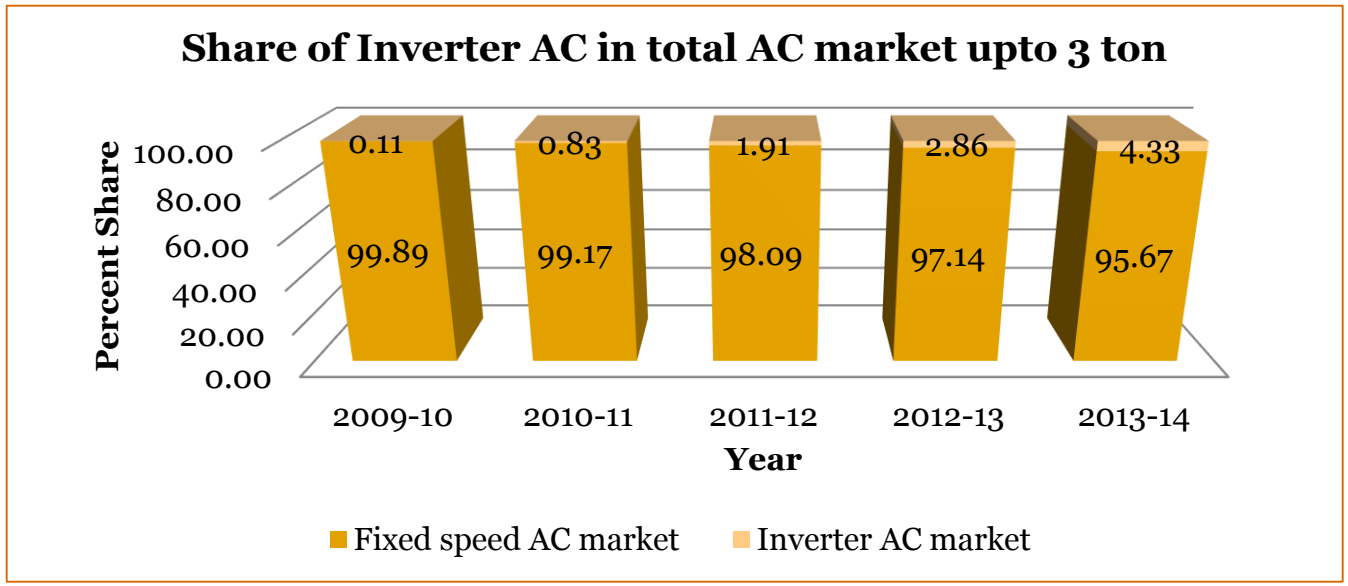


***Source** : Stakeholders Interaction*

2.2.3. *Market penetration of Inverter ACs in RAC segment*

Inverter AC market has witnessed a tremendous growth in the last 4 to 5 years. However, the penetration of Inverter ACs in overall RAC market is still very low. Inverter ACs form a minimal part of overall RAC segment.

The inverter AC market in India in 2013-14 stood at 4.33% of overall RAC market.



***Source** : Stakeholder Interactions*

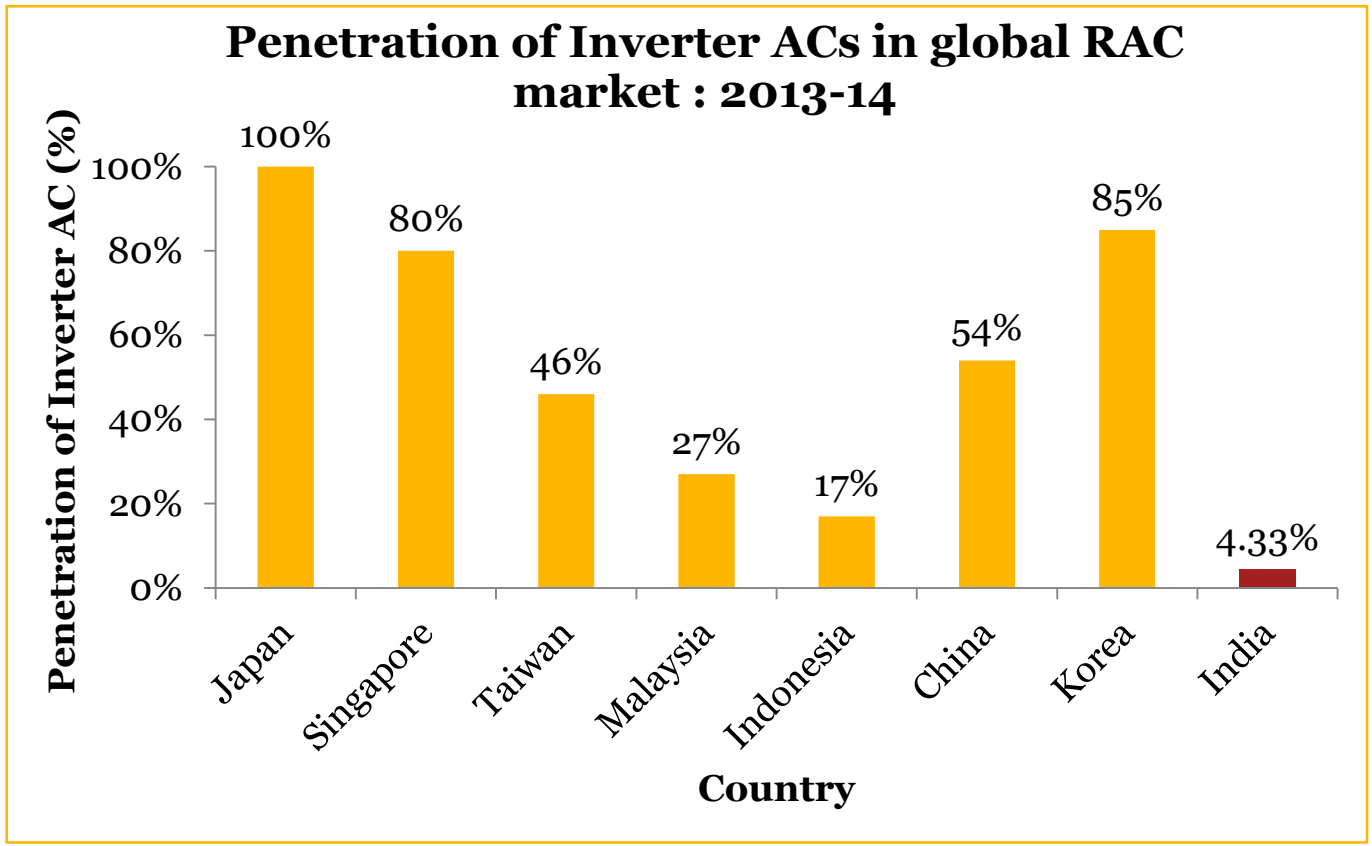
2.2.4. Penetration of Inverter AC in global RAC market

- Inverter AC is a globally recognized technology to move towards energy efficiency.
- Japan has achieved 100% penetration of Inverter ACs in the RAC segment. China has more than 50% penetration while Korea has around 85% penetration.

India stands at a meagre 4.33% market penetration of Inverter ACs in the RAC segment. The major reasons for such minimal penetration are:

- *Inverter ACs are completely imported leading to high initial costs*
- *Lack of awareness and effective outreach program*

Looking at global trends, there is huge opportunity for inverter AC penetration in India.



Source: *Product brochure, Stakeholder Interactions*

2.2.5. *Major manufacturers /suppliers of Inverter AC in India*

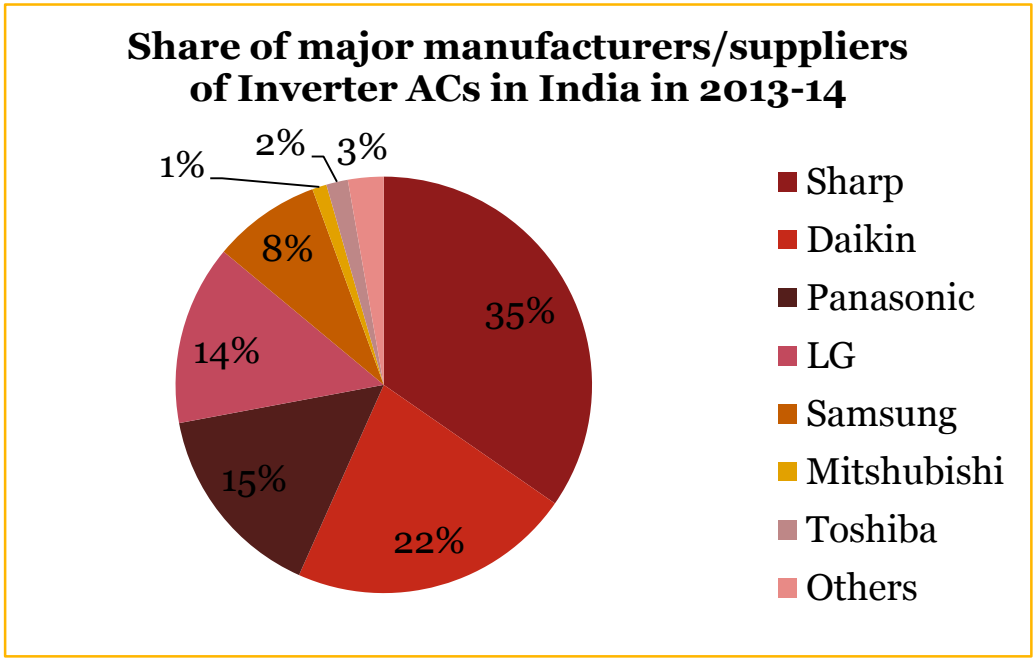
The inverter AC market in India constitutes national as well as multi-national manufacturers. For better understanding, we have divided the manufacturers in **four categories**, i.e. Indian and international (viz. Japanese, Korean and others).

The data for annual sales of Inverter AC for different manufacturers and their respective market share in the year 2013-14 is presented next.

***Source**: Stakeholder interactions*

Japanese	Korean	Indian	Others
Daikin	LG	Blue star	Carrier
Sharp	Samsung	Voltas	Whirlpool
Panasonic			Gree
Hitachi			Haier
Toshiba			
Mitsubishi			

Manufacturer/Supplier	Sales (2013-14)
Sharp	49541
Daikin	31500
Panasonic	22000
LG	20000
Samsung	12000
Mitshubishi	1600
Toshiba	2400
Others	3959



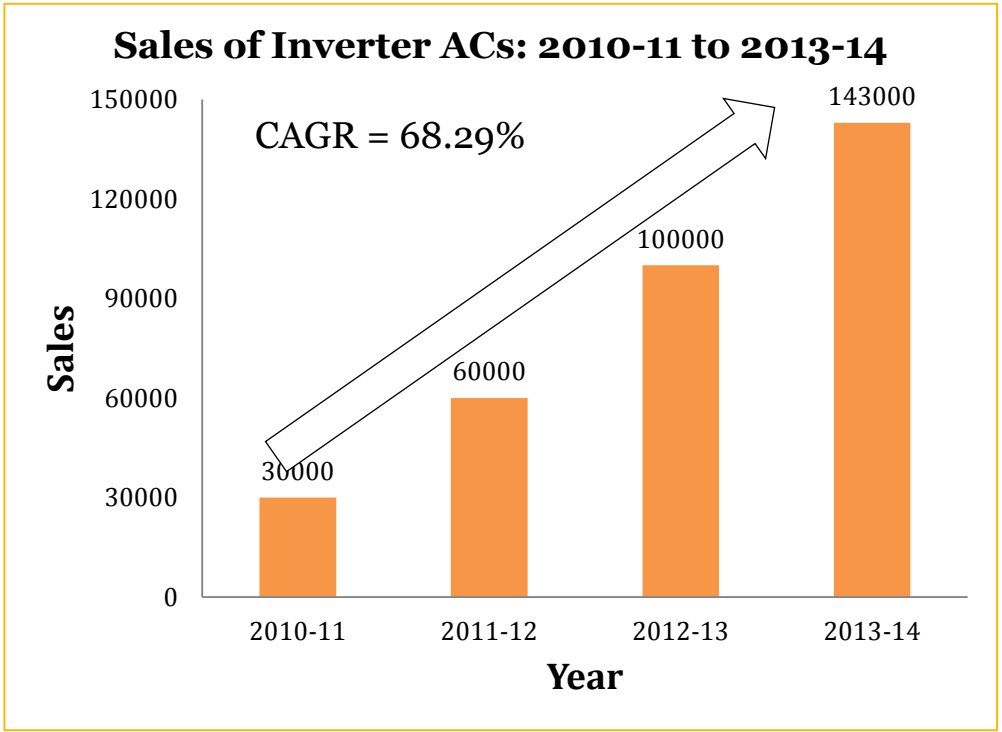
- Inverter AC market in India is mostly **dominated by multi-national manufacturers** from Japan and Korea.

- According to data, in 2013-14, **Sharp** was the **market leader** with sales of around 50,000 units.

- **Sharp**, **Daikin**, **Panasonic** and **LG** dominate the Inverter AC market in India, with these 4 manufacturers accounting for more than **85%** of sales of Inverter AC units in 2013-14.

2.2.6. *Three year market forecast for Inverter ACs*

The Compound Annual Growth Rate (CAGR) method is used to develop a forecast for the Inverter AC market in India. CAGR for annual sales is calculated using 2010-11 as the base year and 2013-14 as the final year. The resulting **CAGR** comes out to be **68.29%** for the period. Stakeholder interaction suggested that Inverter AC market will grow more rapidly considering the policy push from BEE and aggressive outreach being carried out by different manufacturers. A forecast for Inverter AC market has been developed for the next three years considering Business As Usual (CAGR). Stakeholder interaction suggested that this is the minimum rate with which market will definitely grow.



Year	Overall sales (in millions)
2013 -14	0.143
2014 -15	0.24
2015 -16	0.405
2016 -17	0.681

Sales forecast for Inverter AC market

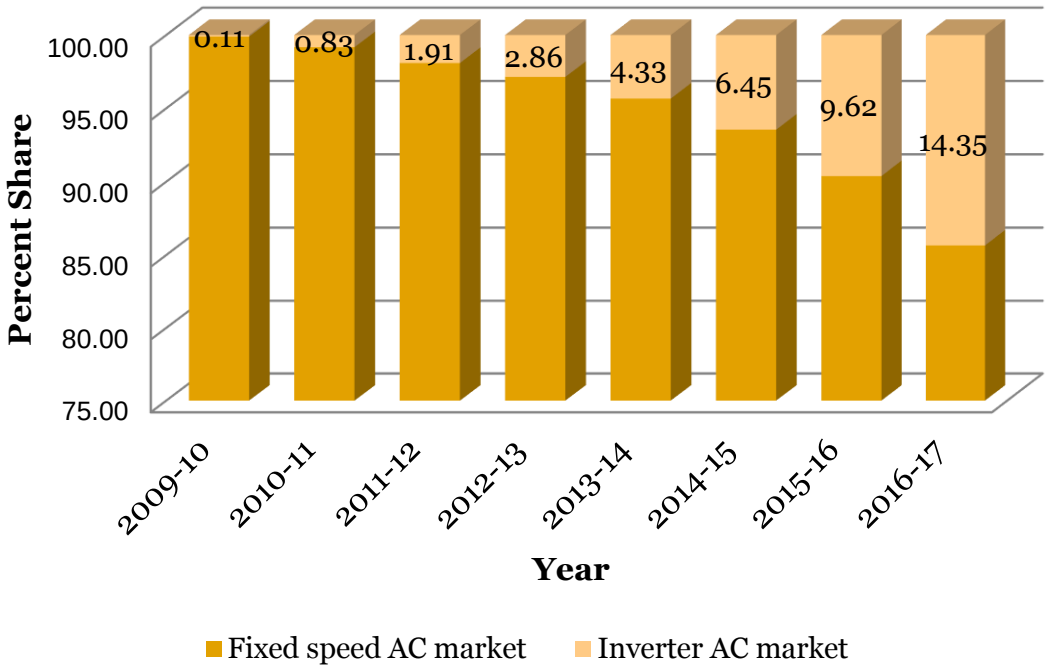
Year	Overall sales (in millions)
2013 -14	3.30
2014 -15	3.73
2015 -16	4.21
2016 -17	4.75

Sales forecast for Overall RAC market *

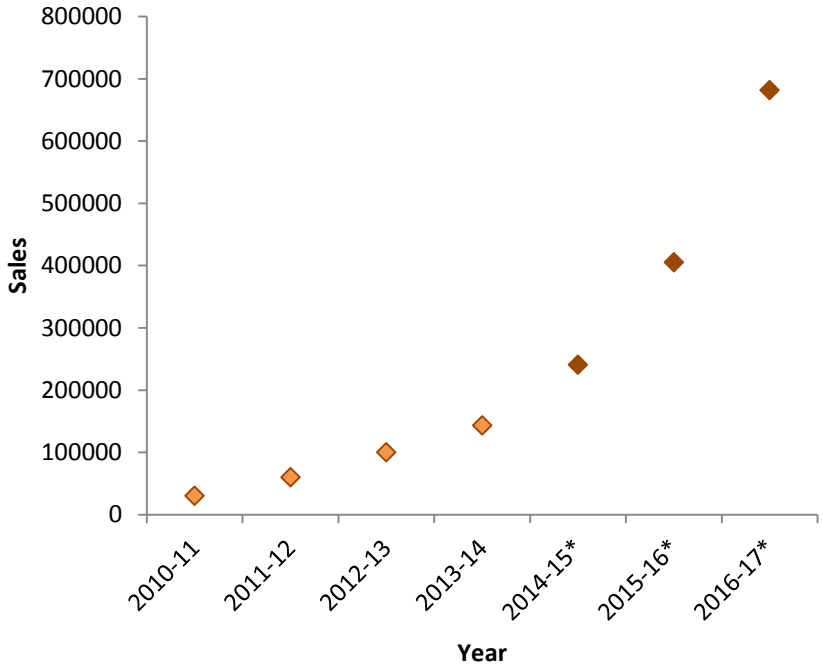
* ***Source**: PwC study*

- By 2016-17, the Inverter AC market is estimated to reach **0.681 million units from 0.143 million units in 2013-2014, constituting 14.35% of overall RAC market.**

Share of Inverter AC in total AC market - A forecast



Sales forecast for Inverter ACs in Indian market



***Source** : Stakeholder Interactions, PwC study*

2.2.7. *Take away from this chapter*

- The Inverter AC market in India has grown tremendously over the period from 2010-11 to 2013-14, registering a CAGR of 68.29%.

- Despite the growth, the market penetration of Inverter ACs in RAC segment remains a meagre 4.33% in India. An analysis of global economies shows that countries like Japan, Korea, Singapore, etc. have a majority proportion of RAC market constituted by Inverter ACs.

- Analysis shows that the Inverter AC market in India is dominated by four manufacturers, viz. Sharp, Daikin, Panasonic and LG.

- A forecast based on CAGR method shows that the Inverter AC market is estimated to reach 0.681 million in the next three years, constituting 14.35% of total RAC market.

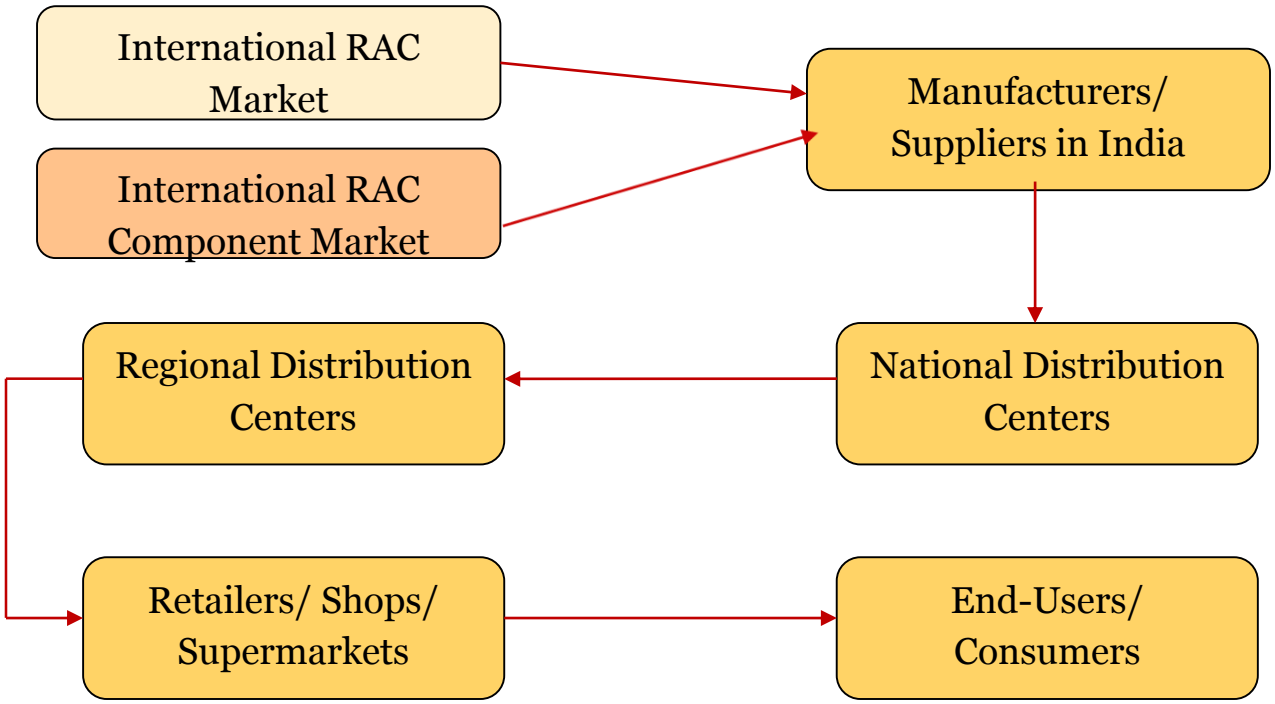
Section 3
Supply Chain for Inverter AC market

3.1. Components of an Inverter AC

S. No.	AC Components	Function
	Indoor Unit	
1	Evaporator (Heat Exchanger Coils)	Extracts heat from the room with the help of refrigerant circulating inside air conditioner and turns the state of refrigerant from liquid to vapour inducing cooling effect inside the room.
2	Temperature Sensor and Controllers	Senses the heat load inside the room and sends signal to the inverter control in the ODU to control the speed of the compressor as per the heat load
3	Indoor Fan	Directs the room air to flow over the evaporator coil for effective evaporation of refrigerant.
	Outdoor Unit	
1	Inverter Control	Receives signal from the temperature sensor and controllers in IDU and vary the speed of the compressor based on the heat load inside the room.
2	Variable speed compressor	It is the major energy consuming component inside the air conditioner and is the driver for inducing cooling effect inside the room by compressing the refrigerant vapours to high pressure for extracting maximum heat out of the indoor system.
3	Condenser (Heat Exchanger Coils)	The high pressure refrigerant vapours expels heat to the outdoor air there by again converting the refrigerant from vapour into liquid state.
4	Outdoor Fan	Directs the outside air to flow over the heated condenser coils to extract maximum heat out of the condenser for effective condensation of refrigerants.

Key components which differentiate Fixed speed and Variable speed Inverter AC

3.2. Supply chain overview



- Most of the manufacturers are **importing complete Inverter AC units** either from their own facilities in other countries or from manufacturers in China and Thailand.
- Some global manufacturers have started **assembling** Inverter ACs at their **Indian facilities.** These manufacturers are assembling components obtained from imports/in-house manufacturing /local procurement depending on economic viability.

- It was also reported during stakeholder interactions that few manufacturers have set up/are planning to set up their **pilot facilities** in India for manufacturing Inverter ACs. The manufacturers see huge growth potential in the Inverter AC market in India, considering the unprecedented growth witnessed in the past 3-4 years.

3.2.1. Component-wise supply chain analysis

Component	Import	In-house manufacturing/Local procurement
Compressor	√	x
PCB (sensors & micro controller)	√	x
Fan motor	√	√
Heat Exchanger	√	√
Fan blades	√	√
Refrigerant	√	√
Sheet metal	x	√
Expansion Valves	√	√

***Source**: Stakeholder Interactions*

contd…

Most of the manufacturers/suppliers are importing complete Inverter ACs from international markets, as discussed earlier. That is the reason, most of the components are shown as imported.

This analysis provides insights into the sourcing of the components used by manufacturers while assembling an Inverter AC in an Indian facility.

- Variable speed compressors and PCB, which differentiate an Inverter AC from a fixed speed AC at the component level, are completely imported from international markets, viz. Thailand, Malaysia, China, Japan, Korea etc. Manufacturers like Sharp, Daikin and Panasonic are importing compressors from their global facilities. PCB is imported from different global vendors.

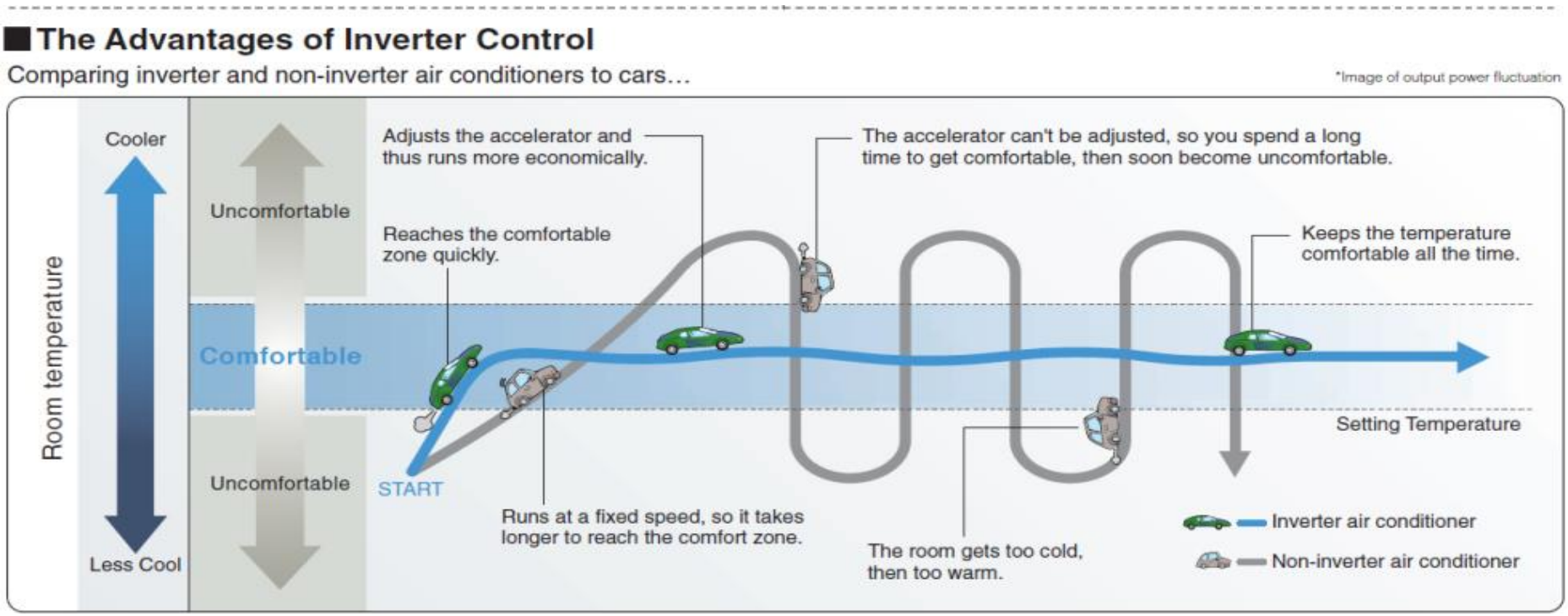
contd…

- Other components are both being imported as well as procured locally/manufactured in-house. The sourcing of these components is similar to that for fixed speed ACs.

3.2.1.1. *Variable Speed Compressors*

A variable speed or Inverter Compressor uses an external variable speed drive to change the **speed of the compressor motor**. The changing motor speed changes the **refrigerant flow** and consequently the cooling capacity of the compressor, so as to completely regulate the temperature. The compressor used in Variable capacity AC's have higher efficiencies than the compressor used in fixed speed AC's particularly at half loads. (***Source**: www.inventorairconditioner.com*)

Creative picture to show comparison between Inverter and non inverter AC



***Source**: www.bijlibachao.com*

Types of compressor

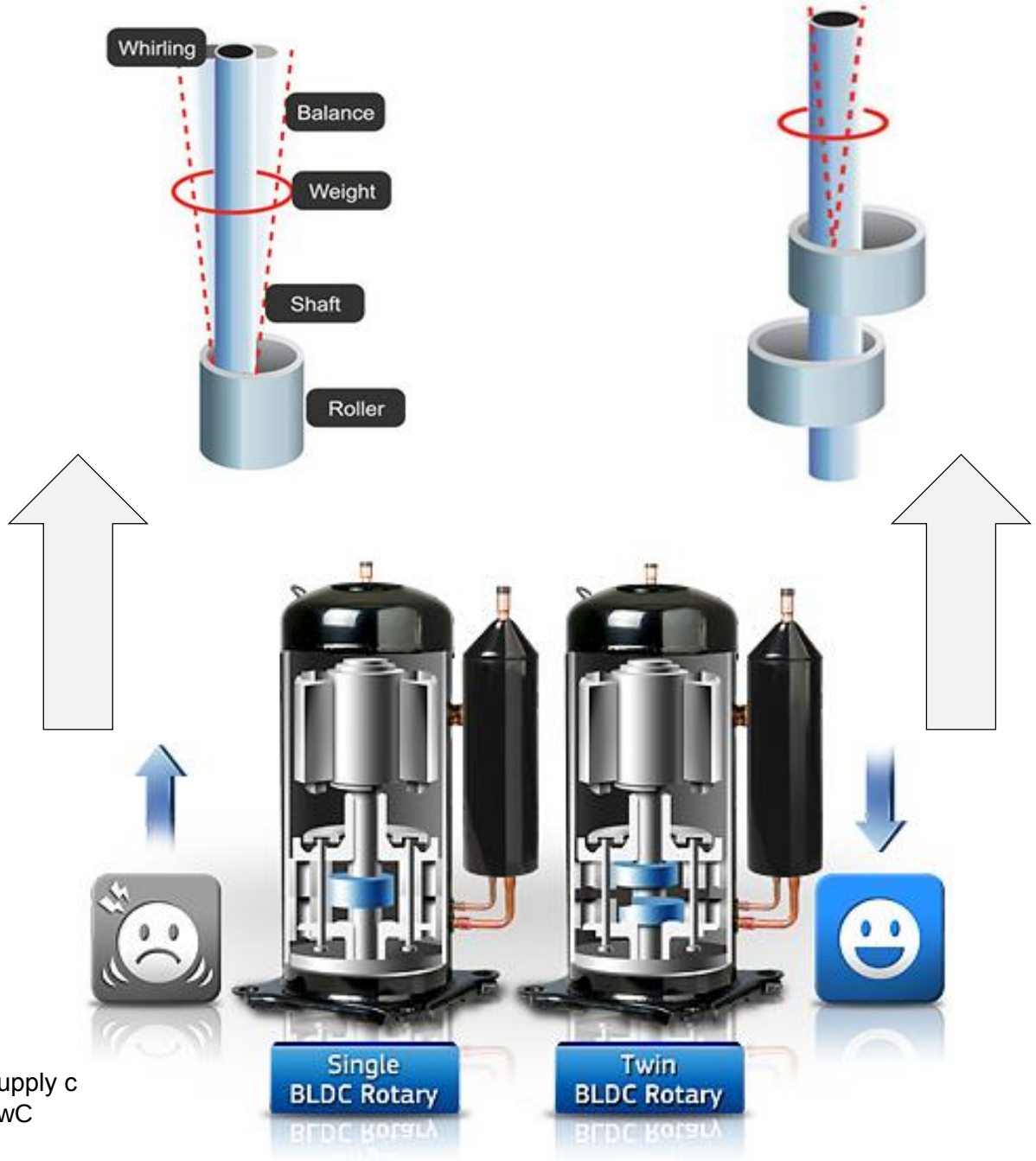
Single-cylinder DC Inverter Compressor

Refrigerant: R410A
Displ. (Cc/rev) : 7.8 – 13.0
Capacity (W) : 2200 – 4000
COP (W/W) : 3.75 -4.05

Twin-cylinder DC Inverter Compressor

Refrigerant: R410A
Displ. (Cc/rev) : 11.0 – 26.0
Capacity (W) : 3000 – 13000
COP (W/W) : 3.45 -4.15

***Source** : www.chinagmcc.com*



Types of compressor and energy efficiency:

Twin rotary has improved rotational balancing and compressive torques resulting in efficient operation.

Single rotary suffers from shaft whirling associated with rotational imbalances, high noise and vibrations and consequent energy and efficiency losses.

***Image source(s)**: www.samsung.com, http://toshiba-aircon.com.au/twin-rotary-compressor*

Comparison - Types of Inverter compressor

Type	Compression Chambers	Costing* (USD)	Efficiency aspects**			
			Energy losses	Vibration	Noise	Working RPM range
Single Rotary	One	90	High	High	High	Large
Twin Rotary	Two	100-105	Low	Low	Low	Small

* ***Source**: Stakeholder interactions*
** ***Source**: toshiba-aircon.com , "Study of Twin Rotary Compressor for Air Conditioner with Inverter System", K.Okoma, M.Tahata, H. Tsuchiyama, Purdue University, 1990*

Major manufacturers/suppliers of variable speed compressors

- Siam
- GMCC
- Rechi
- LG
- Highly (Shanghai Hitachi)
- Daikin
- Panasonic
- Mitsubishi
- Toshiba
- Sharp

From the list of aforesaid manufacturers, case for three major compressor manufacturer/suppliers are discussed next.

Sourcing of variable speed compressors

Variable speed or inverter compressors are imported by manufacturers from international markets, viz. Thailand, China, Malaysia, Japan, Korea etc. Manufacturers like Sharp, Daikin and Panasonic import compressors from their own facilities.

Specifications of inverter compressors sold by major compressor manufacturers *(Source : Manufacturers' brochures)*

a) Rechi

Refrigerant	Type	Model	Capacity (W)	Tonnage (T)	Input Power (W)	COP (W/W)
R410	DC Inverter Twin	45A33LP	4010	1.15	1305	3.07
		45A33LN	4010	1.15	1300	3.08
	DC Inverter Single	39A23VS	2725	0.78	905	3.01
		43A23DE	2725	0.78	910	2.99
		43A23DN	2725	0.78	910	2.99
		43A23DP	2725	0.78	910	2.99
		43A23DS	2725	0.78	910	2.99
		43A23EE	2725	0.78	905	3.01
		43A23ES	2725	0.78	905	3.01
		43A26DE	3185	0.91	1075	2.96
		43A26DS	3135	0.90	1060	2.96
		43A26EF	3135	0.90	1050	2.99
		43A26XN	3185	0.91	1050	3.03
		39A18VB	2160	0.62	715	3.02
		39A18XP	2160	0.62	720	3
		39A18YA	2160	0.62	740	2.92
		39A18YP	2185	0.62	715	3.06
		39A23VP	2740	0.78	910	3.01

R410	DC Inverter Single	39A23YP	2740	0.78	900	3.04
		39A26VP	3185	0.91	1045	3.05
		39A26XP	3185	0.91	1050	3.03
		39A28XP	3485	1.00	1160	3
		43A23VB	2740	0.78	905	3.03
		43A23YB	2740	0.78	890	3.08
		44A23W	2765	0.79	940	2.94
		44A28W	3430	0.98	1170	2.93
		44A28W	3500	1.00	1185	2.95
		44A33W	4030	1.15	1390	2.9
		44A33XN	4150	1.19	1385	3
		44A37WN	4530	1.29	1530	2.96
		39A23W	2740	0.78	915	2.99
		39A23XP	2740	0.78	905	3.03
		39A23YA	2740	0.78	935	2.93

Testing conditions: ASHRAE/T (Condensing temp : 54.4°C, Evaporating temp. : 7.2°C, Ambient temp. : 35°C, Liquid temp. : 46.1°C, Suction temp. : 35°C)

Approach for Analysis

For better understanding of the products sold by Rechi and other compressor manufacturers, the analysis is done on following parameters:

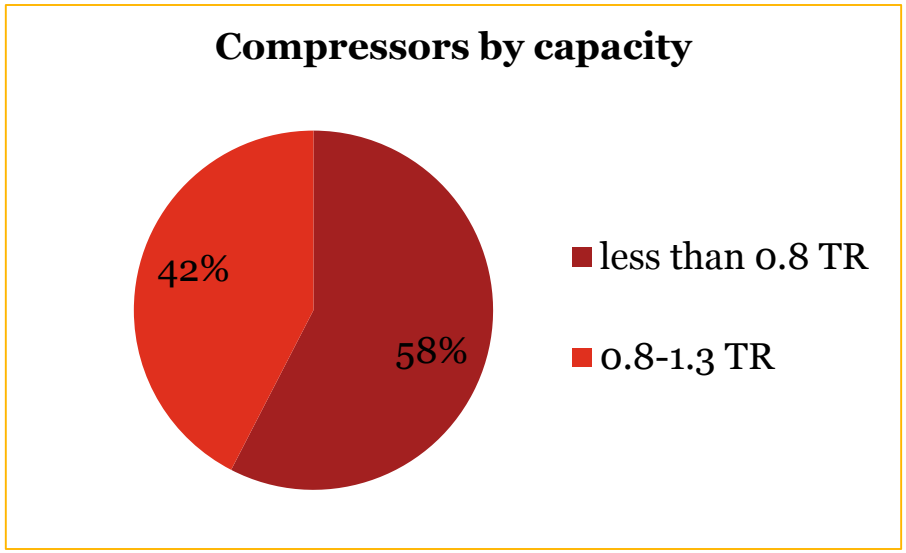
- Less than 0.8 Tonnes
  - 0.8 to 1.3 Tonnes
  - 1.3 to 1.7 Tonnes
  - 1.7 – 2.2 Tonnes
  - > 2.2 Tonnes

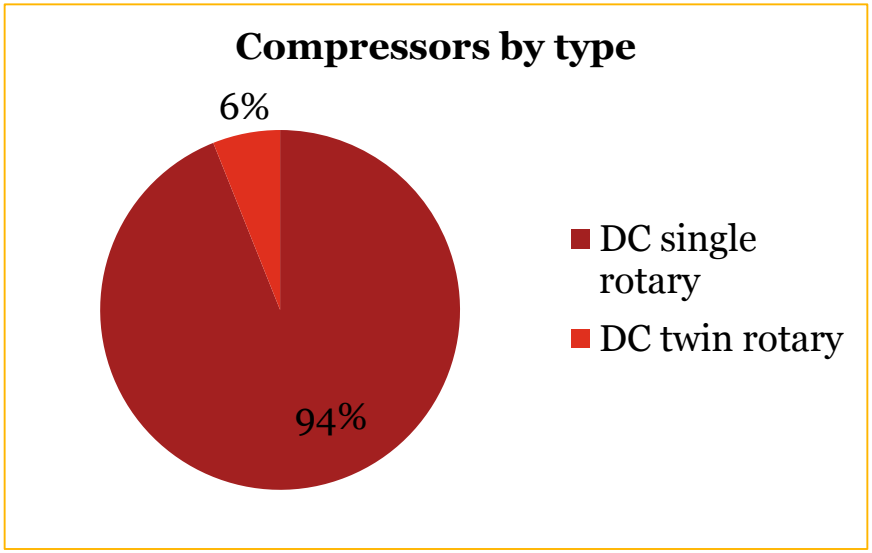
- By compressor type
- Compressor based on refrigerant types
- COP range with different capacities
- There is important comparison with respect to test conditions. As different compressors are rated for different test conditions and it would not be a right COP comparison if they are not covered under same test conditions and also the same test procedure/method .

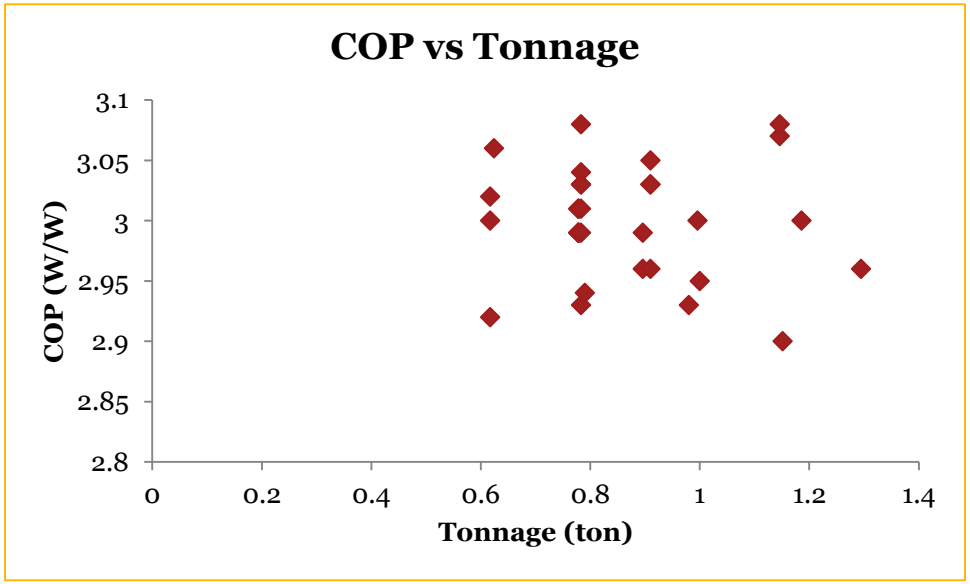
The terms COP and EER are used interchangeably across the air conditioner industry. In India, the term EER is more prevalent while most of the global manufacturers use the term COP.

Testing Conditions : A comparison

	ASHRAE/T	SEER 60
Condensing temp.	54.4°C	42.3°C
Liquid temp.	46.1°C	34.3°C
Evaporating temp.	7.2°C	2.7°C
Suction temp.	35°C	12.8°C
Return Gas temp.	-	-
Ambient temp.	35°C	35°C


Compressors by capacity
42%
58%
less than 0.8 TR
0.8-1.3 TR


Compressors by type
6%
94%
DC single rotary
DC twin rotary


COP vs Tonnage
COP (W/W)
3.1
3.05
3
2.95
2.9
2.85
2.8
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Tonnage (ton)

Analysis - Rechi

- Rechi is mainly concentrating on Single rotary compressors .
- Rechi is mainly manufacturing compressors having cooling capacities ranging between 2700 to 4100 W catering to (less than 0.8 Tonnes category and 0.8 to 1.3 Tonnes category)
- The refrigerant type for all the compressors is R 410 A.

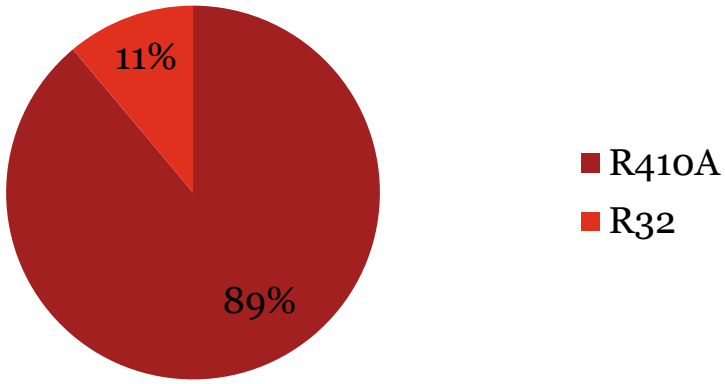
b) GMCC

Refrigerant	Type	Model	Capacity (W)	Tonnage (T)	Input Power (W)	COP (W/W)
R410a	DC Inverter Single	ASN89D22UFZ	2650	0.76	676	3.92
		ASN89D32UFZ	2650	0.76	669	3.96
		ASN89D**UFZ	2650	0.76	663	4
		ASN98D22UFZ	2900	0.83	736	3.94
		ASN98D32UFZ	2900	0.83	729	3.98
		ASN98D**UFZ	2900	0.83	721	4.02
		ASN108D22UFZ	3250	0.93	825	3.94
		ASN108D32UFZ	3250	0.93	817	3.98
		ASN108D**UFZ	3250	0.93	808	4.02
		ASM89D12UFZ	2650	0.76	694	3.82
		ASM89D1UFZ	2650	0.76	663	4
		ASM98D17UFZA	2900	0.83	747	3.88
		ASM98D1UFZA	2900	0.83	721	4.02
		ASM108D13UFZ	3205	0.92	846	3.79
		ASM108D1UFZA	3205	0.92	797	4.02
		ASM155D2UFZ	4650	1.33	1160	4
		DA89M1C-30FZ	2645	0.76	665	3.98
		DA98M1C-30FZ	2900	0.83	735	3.95
		DA108M1C-30FZ	3240	0.93	820	3.95
		DA130M1C-31FZ	3905	1.12	995	3.9
		DA130M1C-28FZ	3930	1.12	990	3.95

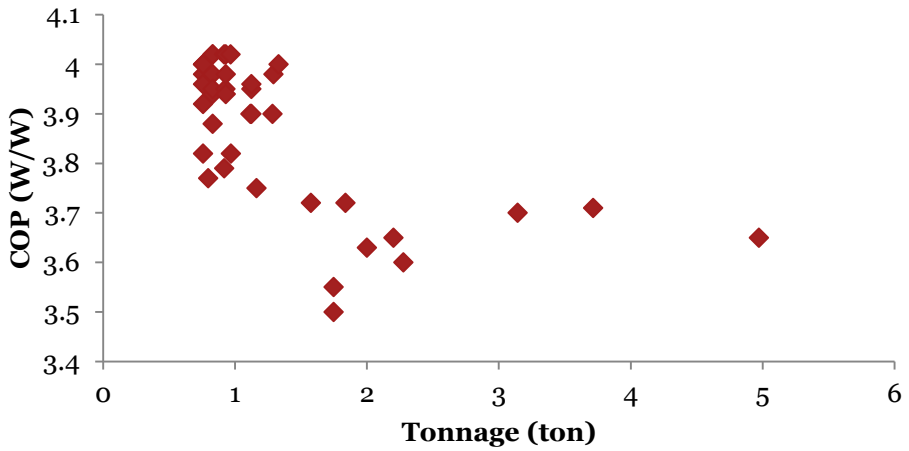
R410a	DC Inverter Twin	DA115S1B-27FZ	3380	0.97	840	4.02
		DA131S1B-31FZ	3930	1.12	1005	3.9
		DA131S1B-28FZ	3934	1.12	993	3.96
		DA150S1C-20FZ	4490	1.28	1145	3.9
		DA150S1C-28FZ	4515	1.29	1135	3.98
		DA180S1CS-28MT	5510	1.57	1481	3.72
		DA210S1CS29MT	6430	1.84	1728	3.72
		DA200S2C-10MT	6115	1.75	1745	3.5
		DA200S2C-30MT	6110	1.75	1720	3.55
		DA230S2C-31MT	7000	2.00	1930	3.63
		DA250S2C-30MT	7700	2.20	2110	3.65
		ATQ360D1UMU	11000	3.14	2973	3.7
		ATQ420D1UMU	13000	3.71	3505	3.71
		ATQ550D3UMU	17400	4.97	4765	3.65
R32	DC Inverter	KSM89D16UEZ2	2780	0.79	730	3.77
		KSM108D10UEZ2	3385	0.97	885	3.82
		KSM130D12UFZ2	4065	1.16	1090	3.75
	DC Inverter Twin	KTF250D1UMT2	7965	2.28	2210	3.6

Testing conditions: SEER 60 (Condensing temp. : 42.3°C, Liquid temp. : 34.3°C, Evaporating temp. : 2.7°C, Suction temp. : 12.8°C, Ambient temp. : 35.0°C)

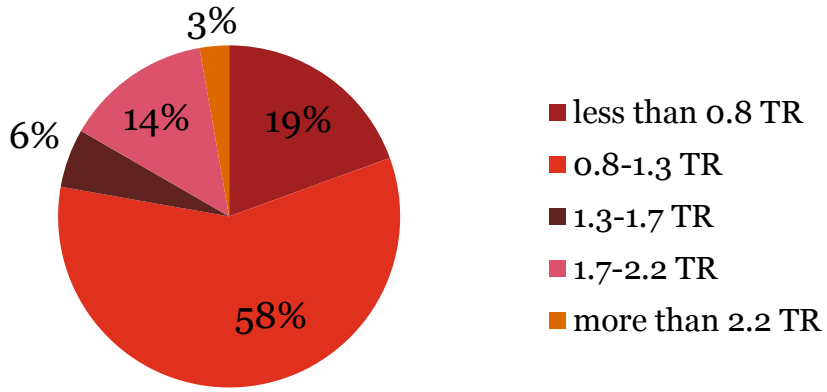
Compressors by refrigerant



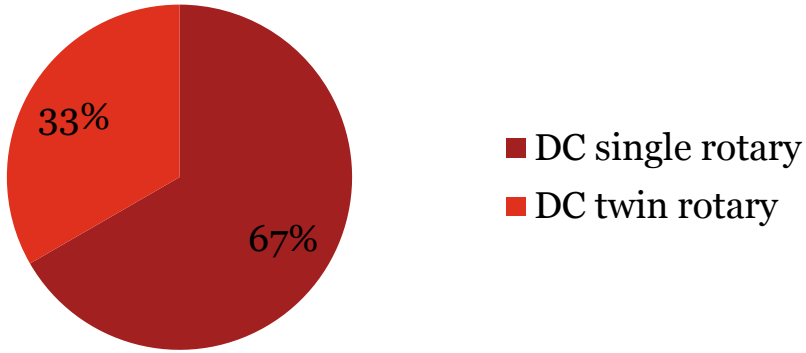
COP vs tonnage



Compressors by capacity



Compressors by type



Analysis - GMCC

- GMCC is concentrating both on Single rotary compressors as well as double rotary compressors.
- GMCC is manufacturing compressors having cooling capacities meeting all categories as mentioned in previous categorization with majority share coming from 0.8 to 1.3 Tonnes category.
- The refrigerant type for most of the compressors is R 410 A and few of the compressors is R32.
- The COP values are mentioned at SEER 60 test conditions against ASHRAE-T conditions mentioned by Rechi and Siam. The COP values for GMCC cann't be directly compared with COP value mentioned by Rechi and Siam.

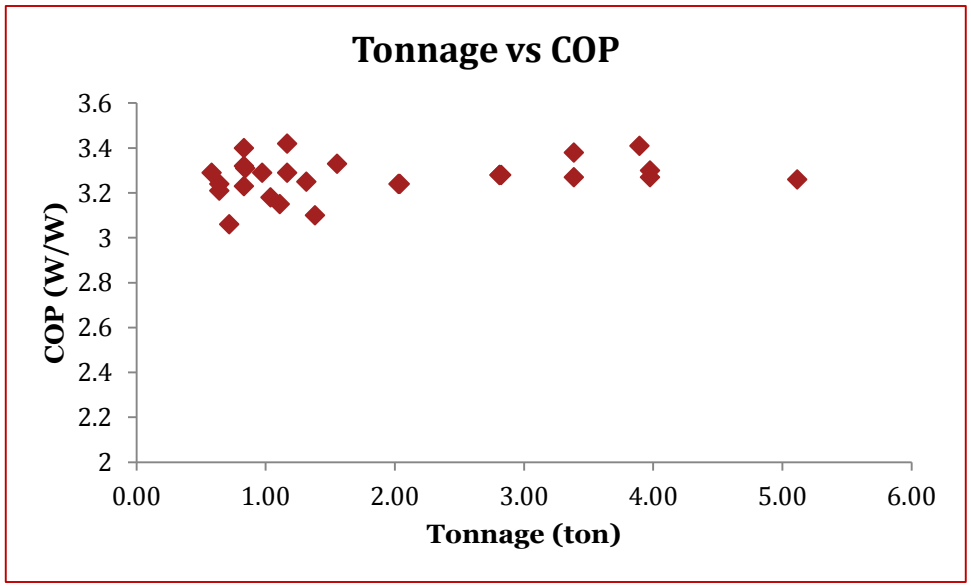
c) Siam

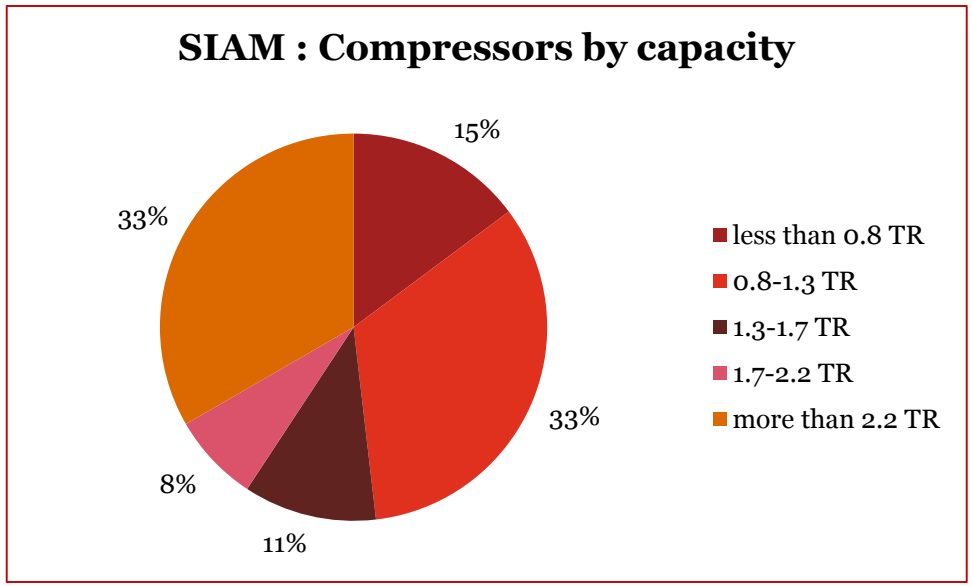
Refrigerant	Type	Model	Capacity (W)	Tonnage (T)	Input Power (W)	COP (W/W)
R410A	DC Twin Rotary	SNB092FQAMT	2510	0.72	820	3.06
		SNB110FGYMT	3400	0.97	1035	3.29
		SNB130FGBMT	3630	1.04	1140	3.18
		SNB140FRUMT	3880	1.11	1230	3.15
		SNB172FEKMT	4830	1.38	1560	3.1
		TNB220FLHMT	7130	2.04	2200	3.24
		TNB306FPGMT	9880	2.82	3010	3.28
		SNB130FGYMC	4100	1.17	1245	3.29
		SNB130FGAMC	4100	1.17	1200	3.42
		SNB150FGAMC	4620	1.31	1420	3.25
		SNB172FJGMC	5460	1.55	1640	3.33
		TNB220FLHMC	7130	2.03	2200	3.24
		TNB306FPGMC	9880	2.81	3010	3.28
		TNB306FPNMC (3Ph)	9880	2.81	3010	3.28
		MNB36FAAMC	11900	3.38	3520	3.38
		MNB36FABMC (3Ph)	11900	3.38	3640	3.27
		MNB42F	13690	3.89	4015	3.41
		LNB42FSCMC	13980	3.98	4240	3.3
		LNB42FSAMC (3Ph)	13980	3.98	4270	3.27
		LNB53FCAMC (3Ph)	17980	5.11	5510	3.26

Refrigerant	Type	Model	Capacity (W)	Tonnage (T)	Input Power (W)	COP (W/W)
R410A	Single Rotary	KNB065F	2040	0.58	620	3.29
		KNB073FKVMC	2250	0.64	700	3.21
		KNB073FFDMC	2250	0.64	695	3.24
		KNB092FHBMC	2960	0.84	895	3.31
		KNB092FFYMC	2920	0.83	880	3.32
		KNB092FTAMC	2920	0.83	860	3.4

Testing conditions: ASRE-T

ASRE-T : Evaporating Temp. : 7.2°C, Return Gas Temp. : 35°C, Condensing Temp. : 54.4°C, Liquid Temp. : 46°C, Ambient Temp. : 35°C





Analysis - Siam

- Siam is mainly concentrating on twin rotary compressors .
- Siam is mainly manufacturing compressors having cooling capacities ranging between 2800 to 14000 W catering to (from 0.8 Tonnes category and 4.0 Tonnes category)
- The refrigerant type for all the compressors is R 410 A.

3.2.1.2. Printed Circuit Board (PCB)

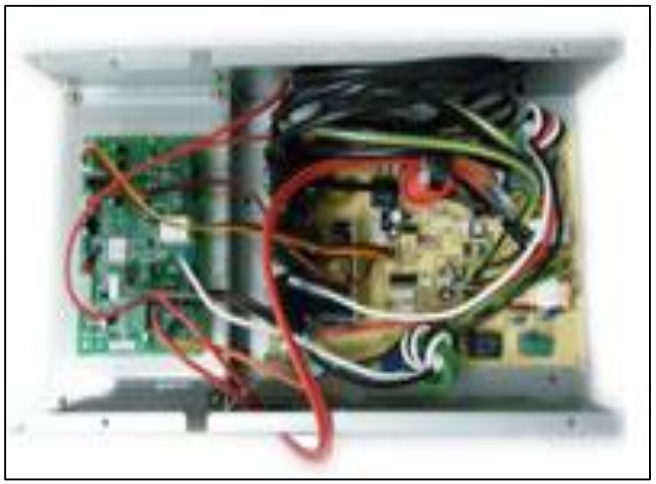
PCB in an Inverter Air Conditioner consists of a master controller in the outdoor unit (ODU) and many controllers and sensors in the indoor unit (IDU).

IDU has sensors and controllers which sense the heat load inside the room.

Master control in ODU controls the speed of the compressor as per the heat load.

***Source**: www.aliexpress.com*

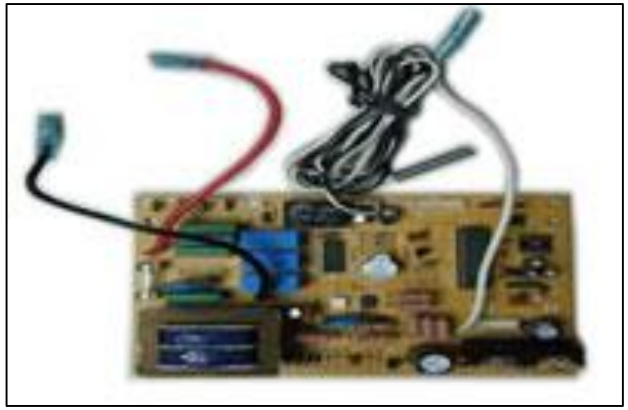
Product Specification *(Source : www.rechi.com)*



Outdoor unit controller set product

Outdoor unit controller board

Compressor driver board



Indoor unit controller board

DC motor drive

Operating voltage (single phase)	Frequency	Capacity
187Vac~253Vac	50/60Hz	2.2KW / 7500Btu
187Vac~253Vac	50/60Hz	2.8KW / 9000Btu
187Vac~253Vac	50/60Hz	3.6KW / 12000Btu
187Vac~253Vac	50/60Hz	4.1KW / 14000Btu
187Vac~253Vac	50/60Hz	5.2KW / 18000Btu
187Vac~253Vac	50/60Hz	6.3KW / 21000Btu
187Vac~253Vac	50/60Hz	7.2KW / 24500Btu

Specifications for Inverter controller

(Source : www.rechi.com)

Key manufacturers of Inverter Controllers

- Rechi
- Hisense
- Gree
- Haier
- Midea

Sourcing

Imported from Thailand, Malaysia, South Korea, China and Japan. Foreign brands import PCBs from manufacturing plants in their respective countries.

Component Costing

PCB is one of the major costing component in an inverter air conditioner. For a 1.5 ton air conditioner, good quality PCB master controller cost in is equivalent to (~ USD 80-90). Software cost is included in the PCB cost. Software development is a separate cost.

3.2.1.3. Heat Exchanger

Heat exchanger in an air conditioner includes

- Condenser – inside Outdoor Unit

- Evaporator – inside Indoor Unit

Fixed speed AC

R22 mainly used as a refrigerant

Inverter AC

R410 used as refrigerant

Higher refrigerant pressure vapour pressure, more wall thickness of condenser and evaporator tubes, changes in system design

15-20 % higher costs in heat exchanger

Types of Heat Exchanger

There are three main types of heat exchangers:

- Copper Tube – Aluminium Fin (CTAF)
- Copper Tube – Copper Fin
- Brazed Aluminium Micro Channel (BAM)

CTAF

BAM

Discussions with manufacturers suggest that most of the inverter air conditioner manufacturers prefer BAM heat exchanger in comparison to CTAF heat exchangers in 1.5 T category as well as high capacity categories. For capacity lower than 1.5 T category only CTAF heat exchanger is preferred.

Possible benefits of BAM over CTAF

- Increased surface area, improved heat transmission and consequent higher efficiency
- 40% reduction in weight than current Cu-Al heat exchanger
- Reduced refrigerant volume
- Lower costs vis-à-vis Cu-Al or pure Copper heat exchangers
- Higher resistance to corrosion due to formation of a non-reactive oxide layer

***Source**: Stakeholder interactions*

Results of a Cyclic Corrosion Test (Condition : JASO M 609, Japanese Automobile Standard) – Claims by manufacturers

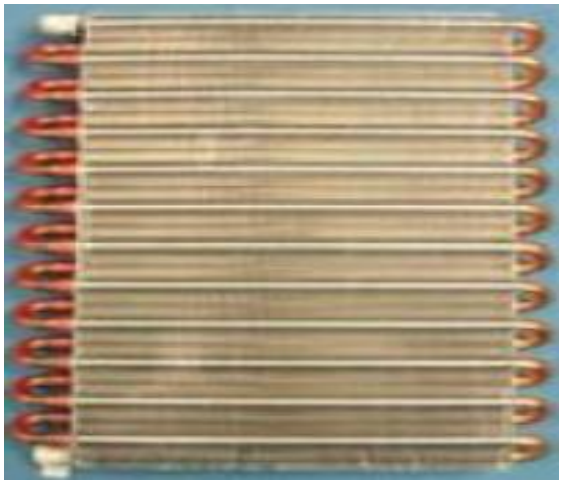
Equivalent to 10 years operation

Before testing

400 cycles

All-Aluminium

Copper-Aluminium



Supply Chain

The supply chain for heat exchangers for Inverter air conditioner is more of less same to Fixed speed air conditioners. There are two scenarios for heat exchangers.

Scenario 1 – Inverter AC imported as complete unit

For this kind of scenario, the heat exchanger is inbuilt into the complete unit which is imported.

Scenario 2 – Inverter AC assembled in India

Few of the global manufacturers like Sharp, Daikin and Panasonic have started assembling Inverter AC in India at their respective facilities. Most of these manufacturers are mainly fabricating heat exchangers in house or sometimes procuring from local vendors. Sharp is fabricating nearly 50% of its products in-house in India, whereas Daikin & Panasonic are fabricating approximately 20-30% in-house and rest are being imported.

3.2.1.4. Fan Motors

Fan motors are used in indoor as well as outdoor units of air conditioners. There are following two types of motors used in air conditioners.

- AC motors
- Brushless DC motors

The sourcing of motors happens in following two scenarios.

Scenario 1 – Inverter AC imported as complete unit

For this kind of scenario, the motor is coming as part of complete set, which is imported. But, mostly, the indoor units are coming up with AC motors and Outdoor units are coming up with DC motors.

Scenario 2 – Inverter AC assembled in India

For this scenario, either the indoor unit with AC fan motor is imported from China or AC motor for indoor unit is procured from local market.

For outdoor unit, the DC motor is procured mainly from China and Thailand.

Major manufacturers of DC motors

- Welling
- Wolong
- Rechi

Fan motor Price

An estimate for the costing of fan motors for 1.5 Ton inverter air conditioners, as obtained from stakeholder interactions, is presented.

Cost	AC motor (INR) (USD)	BLDC motor (INR)(USD)
ODU	450-550 (8-9)	750-850(12-14)
IDU	250-300(3- 4)	525-575 (9-10)

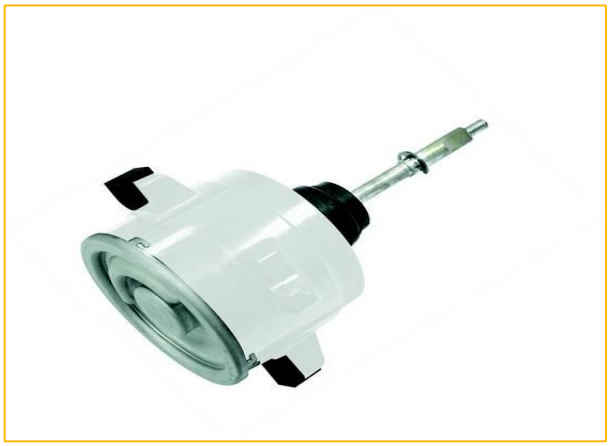
Specifications of products sold in the market

a) Welling (China)

***Source** : Guangdong Welling Motor Manufacturing Co., Ltd. Website*

DC motor for indoor unit

Voltage : 35VDC; 55 VDC; 140 VDC; 280VDC
Output : 10 – 40W
RPM : 0~2500 rpm



DC motor for outdoor unit

Voltage : 280VDC
Output : 80 – 160W
RPM : 0~1500 rpm

AC motor

Voltage : 208/230V; 115V; 240V;208/240V
Frequency : 60Hz; 60/50 Hz; 50/60 Hz
HP : 1/3hp; 1/2hp; 3/4hp;1/4hp;1/8hp;1hp

Considering the power supply scenario in India, motor manufacturers and suppliers provide a wide range of operating voltages for fan motors.

b) Wolong (China)

DC motor
Sensor voltage (V) : 5
Rated speed (r/min) : 900
Output (W) : 50

DC motor
Control voltage (V) : 15
Rated speed (r/min) : 1300
Output (W) : 35

Source *: www.wolong.com.cn*

c) Rechi (China)

DC motors (above) and their specifications (right)

Motor Series	Model	ID (Inch)	OD(Inch)	Hp
AC Series	39 frame	1.922	3.981	0.5-1.0
	39 frame	2.007	3.981	0.5-1.0
	44 frame	2.208	4.418	1.0-1.5
	48 frame	2.4	4.791	1.5-2.5
	50 frame	2.4	4.921	1.5-2.5
	53 frame	2.65	5.733	1.5-3.5
	53 frame	2.65	6.48	2.0-3.5
	59 frame (1ph)	2.65	6.48	2.0-3.5
	59 frame (3ph)	2.65	6.48	2.0-3.5
DC Series	39 frame	2.208	3.981	1.0-1.5
	44 frame	2.4	4.416	1.5-2.0

***Source** : www.rechi.com*

Voltage and speed figures could not be extracted from the brochures of Rechi. Motor rating in HP is provided for different models of Rechi.

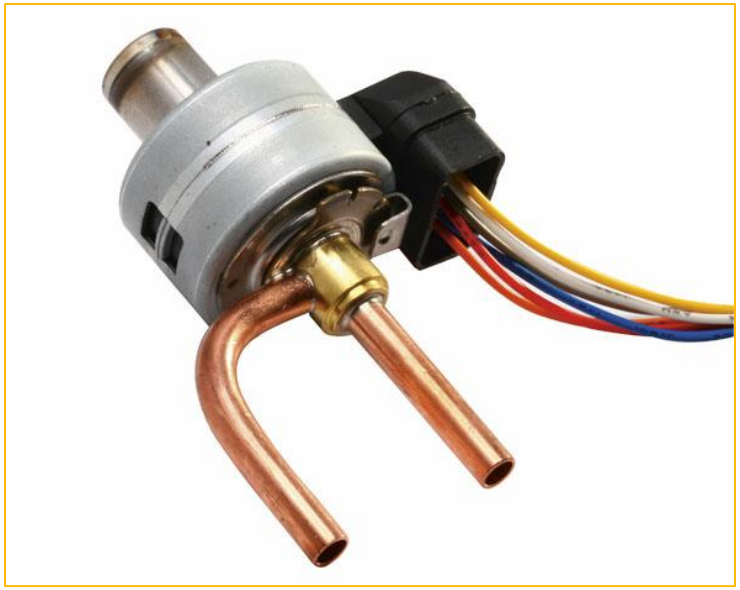
3.2.1.5. Expansion Valves

Stakeholder interaction suggested that, mainly two types of expansion valves are used in air conditioners. These include:

- Capillary expansion valve
- Electronic expansion valve

Capillary Expansion valve

Source: www.indiamart.com/



Electronic Expansion valve

Source: www.zjshc.com

Advantages of Electronic Expansion Valves over Capillary Valves*

- High precision and efficiency over wide temperature and evaporator load range.
- Variation in refrigerant charges can be handled.
- Suppression of less cooling at long piping condition.
- Reduces possibility of liquid slugging by improving the liquid flood back issues, thus protecting the compressor from damage.

Sourcing

Capillary Expansion Valves : Procured from local OEMs
Electronic Expansion Valves : Imported from manufacturers in Thailand, Malaysia.

* ***Source*** *: Product brochure, Sharp Corporation and Stakeholder interactions*

Costing of Expansion valves

Capillary Expansion Valve : INR 35-40 (< 1 USD)
Electronic Expansion Valve : INR 250 (3-4 USD)

Discussion with stakeholders suggest that most of the manufacturers are using electronic expansion valves in inverter air conditioners.

***Source** : Product brochure, Sharp Corporation and Stakeholder interactions*

3.2.2. *Manufacturer-wise supply chain analysis*

Manufacturer/Supplier	Facility in India	Import	In house manufacturing /local procurement	Remarks
Sharp	Pune	√	√	• Full fledged manufacturing facility with research facility for inverter ACs at Pune • Compressors are imported from China while inverter controllers are imported from Sharp Thailand • DC motors for ODU are imported from China. • IDU Fans (blowers) are imported from China and Thailand. • Heat Exchanger (mostly CTAF), AC fan motors and ODU fans blades are locally procured/manufactured in-house.

Manufacturer-wise supply chain analysis (contd.)

Manufacturer/Supplier	Facility in India	Import	In house manufacturing /local procurement	Remarks
Panasonic	Jhajjar	√	√	• Start up facility at Jhajjar • There is serious plan to upgrade this facility an enhance production. This may be done on the same assembly line. • Research for Inverter AC is happening at Malaysia. • ODU of Inverter AC is designed and assembled at Malaysia • IDU of Inverter AC is designed at Malaysia and produced at India facility. • Till date, there is no facility for Aluminum heat exchangers at Malaysia, but there is plan to move to BAM heat exchangers. • Micro-controllers, fan motors are imported from Malaysia and China. • Compressors are imported from Malaysia and China manufacturing plants.

Manufacturer-wise supply chain analysis (contd.)

Manufacturer/Supplier	Facility in India	Import	In house manufacturing /local procurement	Remarks
Daikin	Neemrana	√	√	• Setting up a facility at Neemrana and is in the initial phase • There is a plan to upgrade this facility and enhance the production. This may be done on the same assembly line. • Heat Exchangers are manufactured at Neemrana facility. • Rest all the components are imported from Thailand, Malaysia , China and Japan. • "Swing compressors" are imported from Japan and Thailand. Fan blades are imported from Thailand and fan motors from China. • PCB is imported from Malaysia.

Manufacturer-wise supply chain analysis (contd.)

LG	Pune	√	√	• Facility at Pune • Locally procured BAM heat exchangers are used • Compressor and Controllers are imported from LG Korea
Voltas	No	√	×	Inverter ACs imported from GREE (China).
Bluestar	No	√	×	Inverter ACs imported from GREE (China).
Videocon	No	√	×	Inverter ACs imported from GREE (China).
Carrier Midea				
Whirlpool	No	√	×	Inverter ACs imported from Hisense (China).
Toshiba	No	√	×	Imported ACs are sold in the market through dealer chains.
Mitsubishi	No	√	×	Inverter ACs imported from Thailand.

Section 4
Specifications of Inverter ACs sold in Indian market

Manufacturers considered for the analysis are listed in the table.

According to sales data for 2013-14, these manufacturers account for more than 85% of the Inverter AC market. Thus, this set of manufacturers can be assumed to represent the overall market as a whole.

Japanese	Korean	Indian	Others
Daikin	LG	Blue star	Carrier
Sharp	Samsung		
Panasonic			
Hitachi			
Toshiba			

The specifications of inverter ACs models recorded for these manufacturers include:

- Compressor type
- Refrigerant
- Tonnage
- Rated Cooling Capacity
- Rated Power Input
- COP
- Testing conditions

Source: *Manufacturer's websites/ Product brochures*

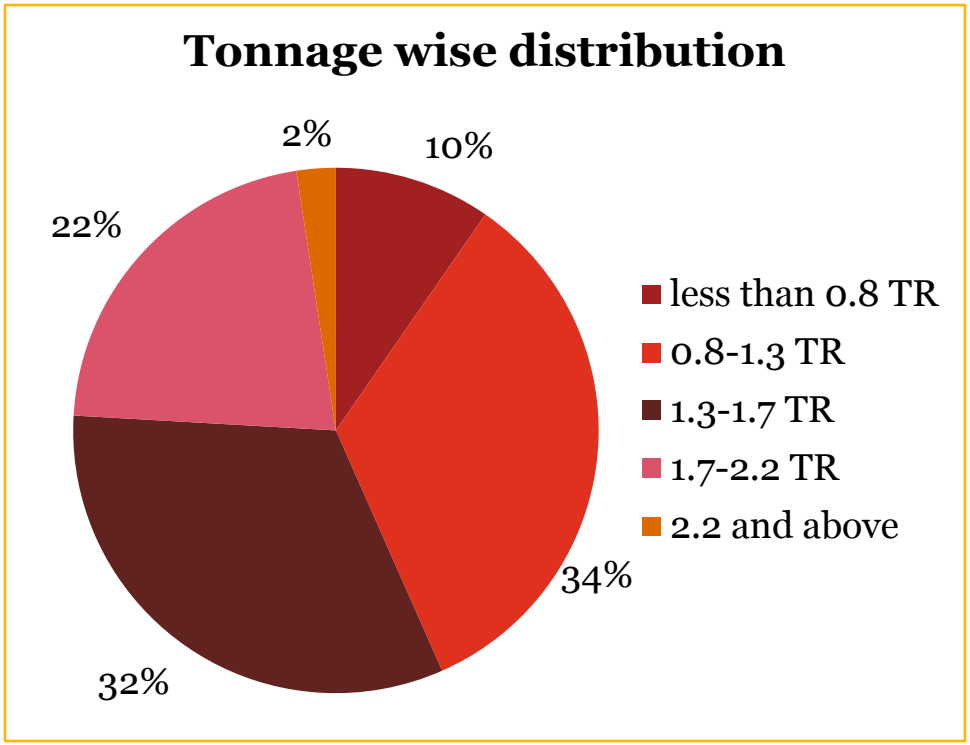
4.1. Tonnage wise distribution

The summary for tonnage wise distribution of Inverter ACs for different manufacturers is presented in the table. The tonnage is divided in five categories as given:

Manufacturer/ Supplier	Number of Models				
	Less than 0.8 TR	0.8 – 1.3 TR	1.3 – 1.7 TR	1.7 – 2.2 TR	Above 2.2 TR
Daikin	6	6	6	4	2
Sharp	-	5	3	2	-
Blue star	-	2	2	2	-
LG	-	3	2	2	-
Hitachi	-	4	4	1	-
Samsung	-	2	2	1	-
Toshiba	-	2	4	2	-
Panasonic	2	4	4	4	-
Total	8	28	27	18	2

Data for Carrier could not be captured

- Analysis of the data shows that the inverter AC market in India is **dominated by 0.8-1.7 TR range**, accounting to 66% of the total inverter AC market.
- 1.7 – 2.2 TR range constitutes 22% of the total inverter AC market .
- Products below 0.8 ton and above 2.2 ton constitutes around 10% market, indicating that the manufacturers are not offering these products in large numbers as of today considering the consumer preferences.



4.2. Refrigerant wise distribution

The summary for refrigerant wise distribution of Inverter ACs for different manufacturers is presented in the table.

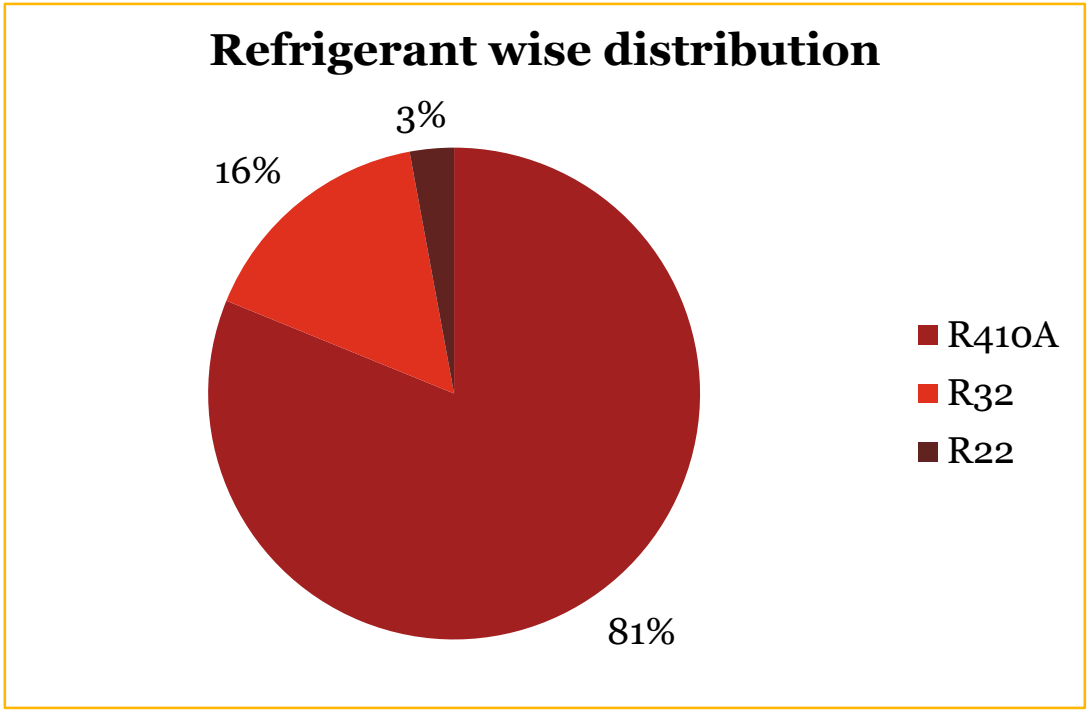
Manufacturer/ Supplier	Number of models based on refrigerant type		
	R410A	R32	R22
Daikin	11	11	2
Sharp	10	-	-
Blue star	6	-	-
LG	7	-	-
Samsung	5	-	-
Toshiba	8	-	-
Carrier	9	-	-
Panasonic	NA	NA	NA
Hitachi	NA	NA	NA
Total	56	11	2

NA : Data not available

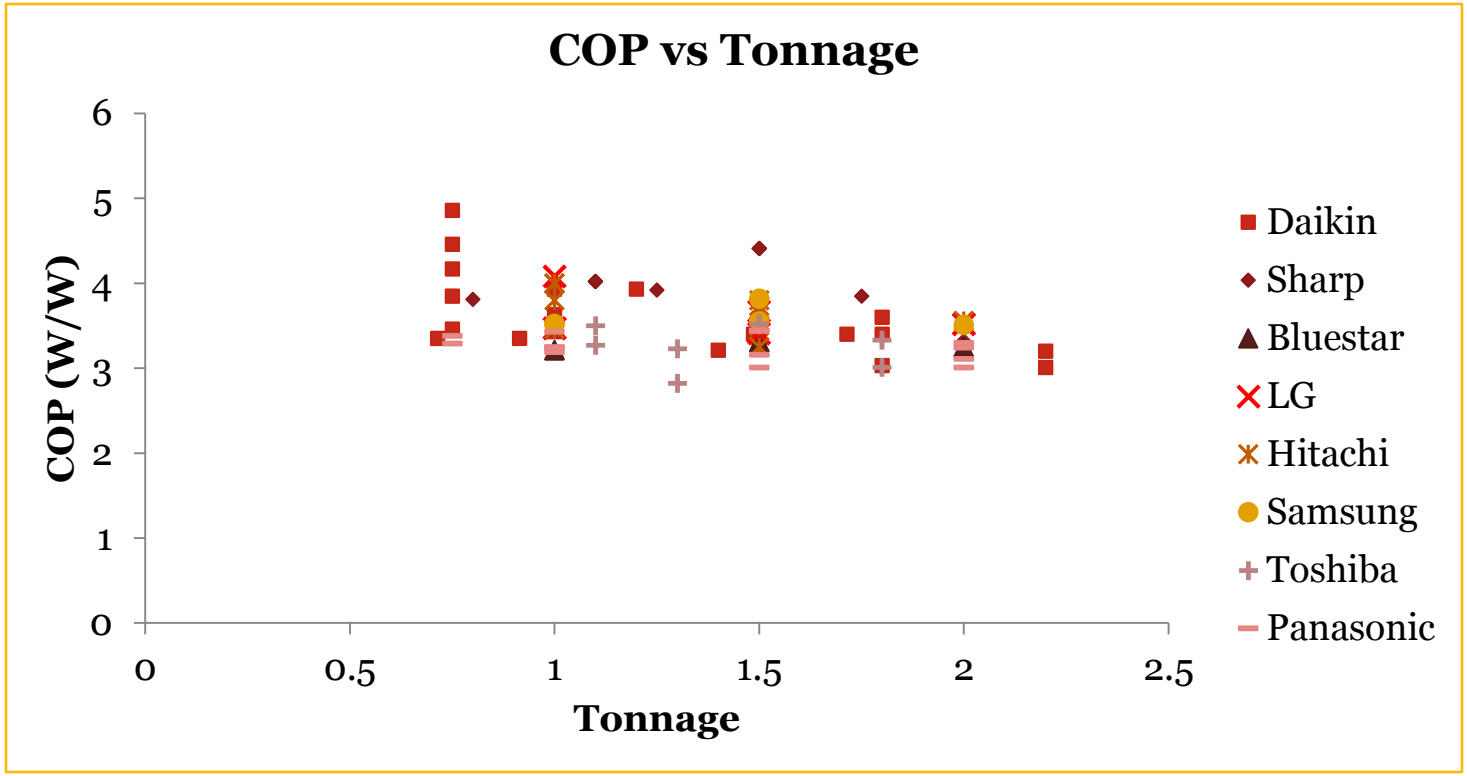
- Analysis of product data shows that around 80% of the Inverter AC products being offered in the market use **R410A as a refrigerant**.

- **R32** constitutes 16% of products and manufacturers are considering this as a good option because of its low global warming potential, zero ozone-depletion potential and low flammability.

- **R22** refrigerant is mostly used in fixed speed ACs and is **rarely being used** in inverter ACs.



4.3. COP wise distribution for Inverter ACs



An important observation from the plot is that **lower tonnage products offer higher COP values as compared to high tonnage products**. As we move towards higher tonnage products, the COP values observed are lower.

4.4. Take away from this chapter

- The inverter AC market in India is dominated by products in 0.8 – 1.7 tonnage range, constituting two-thirds of the entire market.

- Around 80% of the Inverter AC units sold in the Indian market use R410A as the refrigerant.

- The Inverter AC products available in the market offer wide range of COPs. As we move towards higher tonnage products, it has been observed that COP values are lower vis-à-vis lower tonnage products.

As such, comparison of COP is presented in this report, but we strongly feel especially for Inverter ACs, it is not right to compare these products at rated full cooling load and power.

Section 5
Specifications of Inverter ACs sold in global markets

This chapter presents an analysis of the technology available in Inverter AC products in international markets. The markets considered for this analysis are:

- China
- Australia – New Zealand
- Singapore
- United States of America

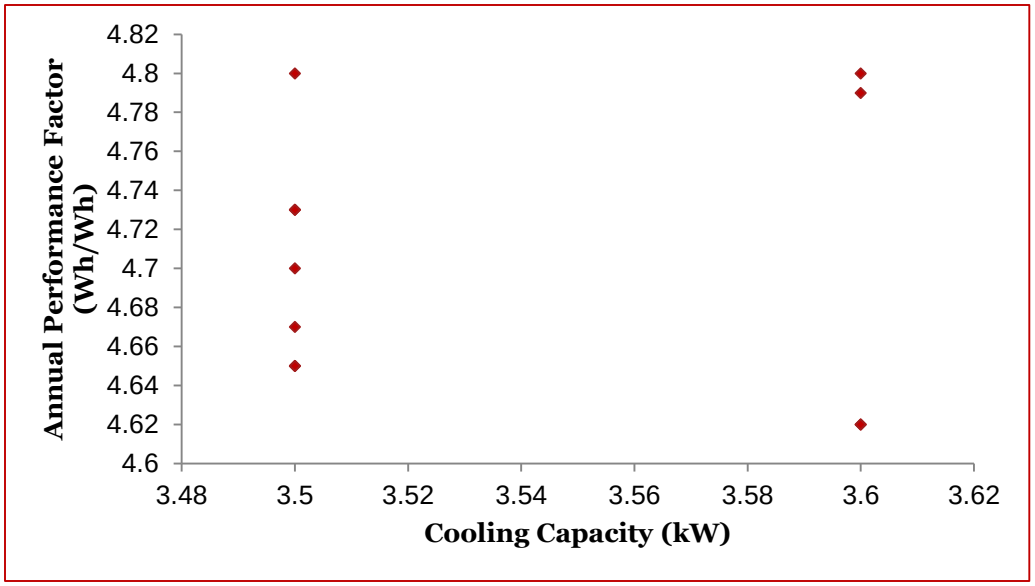
The data captured for the purpose of analysis includes specifications of Inverter ACs in 1-1.5 ton range.

The specifications of inverter ACs models recorded for these manufacturers include:

- Brand and Model name
- Cooling Capacity
- Power Input

A simplistic calculation for COP has been performed by dividing the rated cooling capacity by rated power input for the Inverter AC.

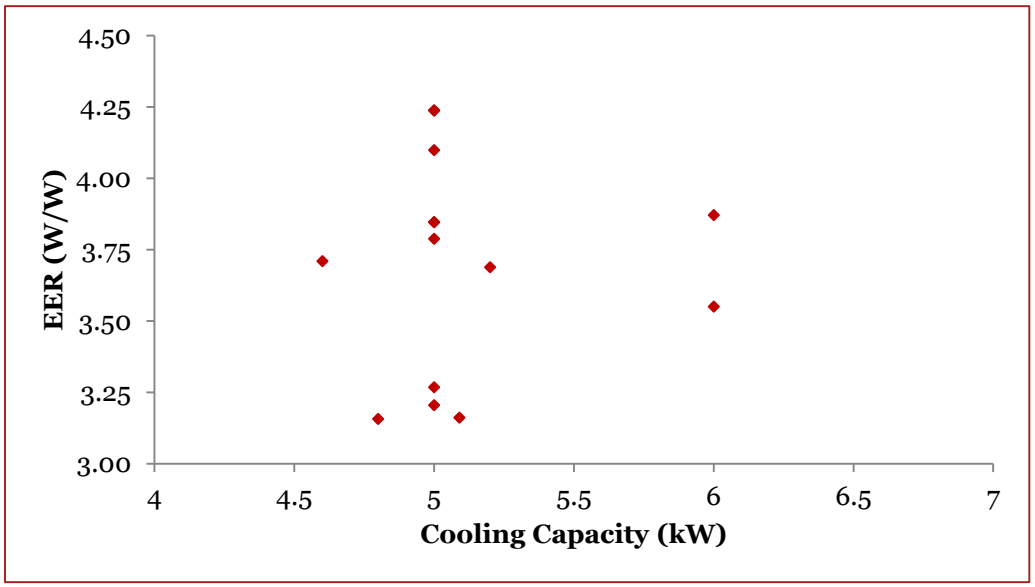
The detailed specifications of all the models are listed in tables in Annexure 2.



CHINA

Source:

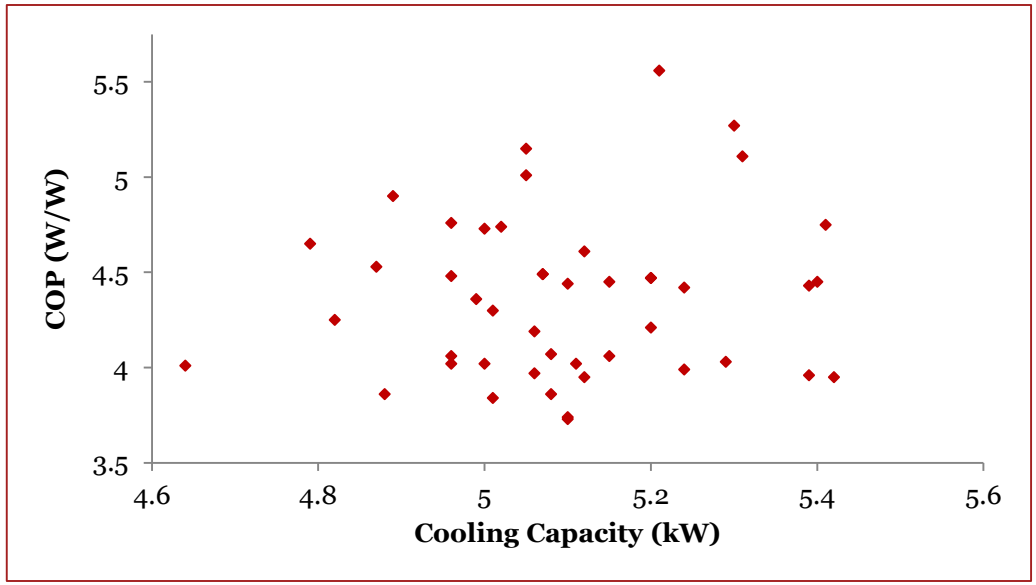
http://www.top10.cn/



AUSTRALIA-NEW ZEALAND

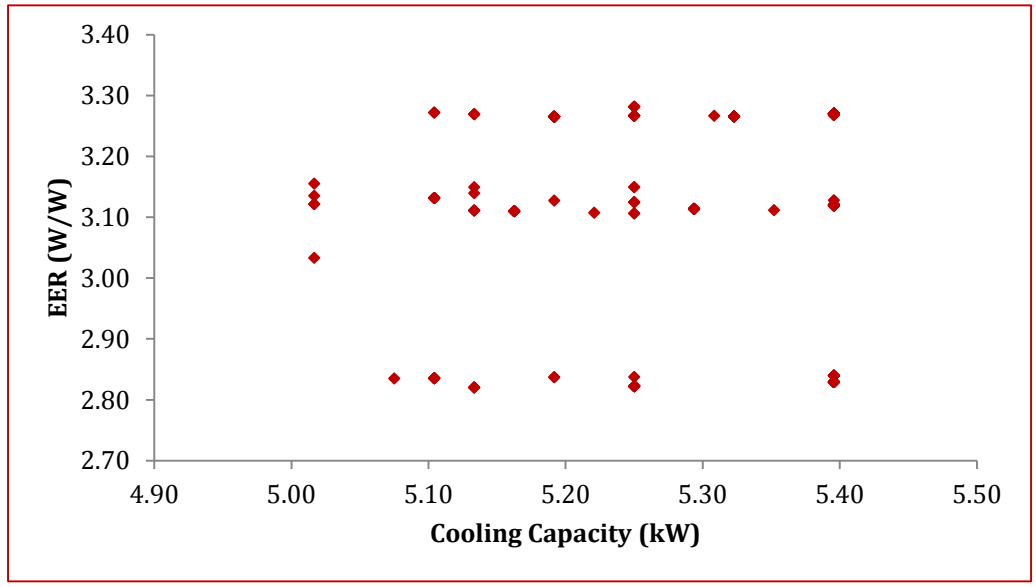
Source:

http://reg.energyrating.gov.au/



SINGAPORE

Source:
https://app.mels.nea.gov.sg



UNITED STATES OF AMERICA

Source:
http://www.regulations.doe.gov/

Take away from this chapter

- The Annual Performance Factor (APF - ratio of cooling capacity and power input) as observed in Chinese market varied from 4.62-4.8 for cooling capacities ranging from 2800 – 4500 W ranges. Below 2800 W cooling capacity APF is as high as 5.45.

- The COP levels (ratio of rated cooling capacity and rated power input) available in Australia-New Zealand market ranges from 3.16 to 4.24 and 2.82- 3.28 for US market.

- COP levels in Singapore are based on weighted COP concept, with 60% contribution from part load (50% load) COP and rest from full load COP.

Section 6
Energy Efficient models in Inverter ACs

Energy efficient Inverter AC categories

The inverter AC market in India is in early stages. Most of the manufacturers are extending their portfolio to introduce Inverter ACs to Indian market. Also, EER/COP at full load is not the best basis to compare Inverter ACs. Based on stakeholder consultation, following conclusions are drawn.

- The Indian manufacturers mainly categorizes Inverter AC into two categories i.e. Low EER/COP compressor models and High EER/COP compressor models. EER/COP compressor value close to 3.4 at full rated load is considered as Low EER/COP models and EER/COP compressor value close to 3.8 at full rated load is considered as High EER/COP models.

- The difference between Low and High EER/COP models comes in selection of efficient compressor, Outdoor unit Controllers, fan motor and expansion value. All the other components remain same.

- *In India Inverter ACs with ISEER as high as 5.2 have been observed.* ISEER is calculated based on performance of Inverter AC at Full rated load and half rated load at 35°C and 29°C outdoor dry bulb temperature, keeping all other parameters constant as per ISO 61358 – 1:2013.

Component wise costing Low COP vs High COP Inverter AC

Component	Low COP system	High COP system
Indoor Unit (IDU)		
Heat Exchanger	INR 1200	INR 1200
PCB	INR 1100	INR 1100
Fan motor	INR 600	INR 600
Outdoor Unit (ODU)		
Inverter compressor	INR 5200	INR 6500
Heat Exchanger	INR 3000	INR 3000
PCB	INR 2500	INR 4600
Fan motor	INR 600	INR 1500
Expansion valve	INR35(Capillary)	INR 200 (Electronic)
Total	**INR 14235**	**INR 18700**

***Source**: Stakeholder interactions*

The above table indicates, 'the cost the AC Manufacturers/OEMs pay for individual AC components'.

Section 7
Summary of findings

Conclusions

- The sentiments in the air conditioning industry is very good as most of the manufacturers are planning to invest on inverter AC manufacturing.
- 2-3 manufacturers have set up their facilities in India to manufacturer Inverter AC, out of which 2 manufacturers also have research/designing in India, while other is getting their designs done in Malaysia.
- The BAM heat exchangers used in Inverter air conditioners offers the option of increased energy efficiency with reduced cost.
- Manufacturers like Daikin, Panasonic are importing complete inverter AC set from their own manufacturing facilities. Other manufacturers like Voltas, BlueStar, Videocon, Whirlpool, Mitsubishi etc. are importing from China, Thailand and other countries.
- Components like compressors, controllers, DC motors and expansion valves are imported from other countries.
- Different countries have program for Inverter air conditioners. Different models are compared on EER/COP based on rated full load and power. EER/COP at full load is not the best basis to compare Inverter ACs, but is adopted in absence of test data and labelling conditions. The cooling capacity and power consumption values at half load and intermediate loads could give much better analysis and basis for comparison.

Section 8
Annexures

Annexure 1

Manufacturer wise specifications of Inverter ACs sold in Indian market
*(**Source**: Manufacturers' websites and product brochures, accessed in September 2014)*

- Daikin
- Sharp
- Blue star
- LG
- Hitachi
- Samsung
- Toshiba
- Panasonic
- Carrier

Daikin

Model		Compressor	Refrigerant	Tonnage	Rated Cooling/ Heating Capacity (kW)		Total Power Input (W)		COP (W/W)	
Indoor	Outdoor				Cooling	Heating	Cooling	Heating	Cooling	Heating
FTXR28KVMA	RXR28KVMA	swing	R410 A	0.75	2.77 (1.55-3.60)	3.57 (1.30-5.00)	570 (250-800)	710 (220-1410)	4.86	5.03
FTXR42KVMA	RXR42KVMA	swing	R410 A	1.2	4.20 (1.55-4.60)	5.08 (1.30-5.60)	1070 (260-1320)	1170 (220-1600)	3.93	4.34
FTXR50KVMA	RXR50KVMA	swing	R410 A	1.5	4.88 (1.55-5.50)	5.91 (1.30-6.20)	1470 (260-1800)	1490 (230-1770)	3.32	3.97
FTXG25JV1BA	RXG25K3V1B	swing	R410 A	0.75	2.5 (1.3-3.0)	3.4 (1.3-4.5)	560 (350 - 820)	780 (320 - 1320)	4.46	4.36
FTXG35JV1BA	RXG35K3V1B	swing	R410 A	1	3.5 (1.4-3.8)	4.0 (1.4-5.0)	890 (360 - 1220)	990 (320 - 1500)	3.93	4.04
FTXG50JV1BA	RXG50K3V1B	swing	R410 A	1.4	5.0 (1.7-5.3)	5.8 (1.7-6.5)	1560 (450 - 1880)	1600 (520 - 2500)	3.21	3.63
FTXS25EVMA	RXS25EBVMA	swing	R410 A	0.75	2.5 (1.2-3.0)	3.4 (1.2-4.5)	600 (300-800)	830 (290-1,340)	4.17	4.1
FTXS35EVMA	RXS35EBVMA	swing	R410 A	1	3.5 (1.2-3.8)	4.0 (1.2-5.0)	1,020 (300-1,200)	1,080 (290-1,550)	3.43	3.7
FTXS50FVMA	RXS50FVMA	swing	R410 A	1.5	5.0 (1.7-6.0)	5.8 (1.7-7.7)	1,550 (440-2,080)	1,600 (400-2,530)	3.23	3.63
FTXS60FVMA	RXS60FVMA	swing	R410 A	1.8	6.0 (1.7-6.7)	7.0 (1.7-8.0)	1,980 (440-2,390)	2,040 (400-2,810)	3.03	3.43
FTXS71FVMA	RXS71FVMA	swing	R410 A	2.2	7.1 (2.3-8.5)	8.2 (2.3-10.0)	2,360 (570-3,200)	2,520 (520-3,730)	3.01	3.25
FTKM25PRV16	RKM25PRV16	swing	R32	0.75	2.5 (1.0-3.2)	-	650 (220-900)	-	3.85(4.55-3.55)	-

Model		Compressor	Refrigerant	Tonnage	Rated Cooling/ Heating Capacity (kW)		Total Power Input (W)		COP (W/W)	
Indoor	Outdoor				Cooling	Heating	Cooling	Heating	Cooling	Heating
FTKM35PRV16	RKM35PRV16	swing	R32	1	3.5 (1.0-4.0)	-	964 (220-1300)	-	3.63 (4.55-3.08)	-
FTKM50PRV16	RKM50PRV16	swing	R32	1.5	5.0 (1.0-6.0)	-	1315(230-1700)	-	3.80(4.35-3.52)	-
FTKM60PRV16	RKM60PRV16	swing	R32	1.8	6.0 (1.0-7.0)	-	1666(230-2250)	-	3.60(4.35-3.11)	-
FTKM71PRV16	RKM71PV16	swing	R32	2.2	7.1 (2.1-8.0)	-	2220 (530-3300)	-	3.20 (3.96-2.42)	-
FTKP25PRV16	RKP25PRV16	swing	R32	0.75	2.5 (2.0-3.2)	-	723(480-900)	-	3.46(4.17-3.55)	-
FTKP35PRV16	RKP35PRV16	swing	R32	1	3.4 (2.0-4.0)	-	982(480-1310)	-	3.46(4.17-3.05)	-
FTKP50PRV16	RKP50PRV16	swing	R32	1.5	5.0 (2.5-5.7)	-	1445(710-1750)	-	3.46(3.52-3.26)	-
FTKP60PRV16	RKP60PRV16	swing	R32	1.8	6.0 (2.5-6.7)	-	1765 (720-2220)	-	3.40(3.47-3.02)	-
FTKV50NRV16	RKV50NRV16	swing	R32	1.485714286	5.2 (1.5-6.0)	-	1530 (415-1730)	-	3.4	-
FTKV60NRV16	RKV60NRV16	swing	R32	1.714285714	6.0 (1.5-7.0)	-	1765 (420-2350)	-	3.4	-
FTKE25GV1	RKE25GV1	swing	R22	0.714285714	2.5 (1.6-3.2)	-	746 (455-1180)	-	3.35	-
FTKE35GV1	RKE35GV1	swing	R22	0.914285714	3.2 (1.6-4.0)	-	955 (455-1550)	-	3.35	-

Sharp

Model	Refrigerant	Tonnage	Rated Cooling Capacity (W)	Rated Power Input (W)	COP
AH-XP10LV	R410A	0.8	2800 (900-3280)	735 (250-1030)	3.81
AH-X13PET	R410A	1.1	3670 (900-4200)	1010 (230-1440)	4.02
AH-XP13PMT	R410A	1.1	3670 (900-4200)	1010 (230-1440)	4.02
AH-XP13PHT	R410A	1.1	3670 (900-4200)	1010 (230-1440)	4.02
AH-X15RET	R410A	1.25	4180 (900-4180)	1420 (230-1420)	3.92
AH-X18PET	R410A	1.5	5270 (1600-6000)	1440 (320-1900)	4.41
AH-XP18PMT	R410A	1.5	5270 (1600-6000)	1440 (320-1900)	4.41
AH-XP18PHT	R410A	1.5	5270 (1600-6000)	1440 (320-1900)	4.41
AH-X21RET	R410A	1.75	6000 (1600-6000)	2230 (320-2230)	3.85
AH-XP24MV	R410A	2	6240 (1700-7100)	2230	3.32

Blue star

Model	Compressor	Refrigerant	Tonnage	Rated Cooling/ Heating Capacity (kW)		Total Power Input (W)		COP (W/W)	
				Cooling	Heating	Cooling	Heating	Cooling	Heating
CNHW12CAF	Inverter Rotary	R410A	1	3530 (600-3960)	-	1100 (220-1450)	-	3.21	-
CNHW18CAF	Inverter Rotary	R410A	1.5	5300 (800-6500)	-	1600 (330-2200)	-	3.31	-
CNHW24CAF	Inverter Rotary	R410A	2	6450 (1500-7000)	-	1985 (350-2500)	-	3.25	-
HNHW12CCF	Inverter Rotary	R410A	1	3530 (600-3960)	4100 (600-5130)	1100 (220-1450)	1135 (220-1550)	3.21	3.61
HNHW18CBF	Inverter Rotary	R410A	1.5	5300 (800-6500)	5700 (950-6800)	1600 (330-2200)	1578 (320-2200)	3.31	3.61
HNHW24CBF	Inverter Rotary	R410A	2	6450 (1500-7000)	7000 (1200-7800)	1985 (350-2500)	1930 (350-2700)	3.25	3.63

LG

Model	Compressor	Refrigerant	Tonnage	Rated Cooling/ Heating Capacity (kW)	Total Power Input (W)	COP (W/W)
BS-Q126B8A4	Rotary	R410A	1	826~3400~4038	980/1320	3.47
BS-Q186C8A4	Rotary	R410A	1.5	1172~4982~5567	1460/1814	3.41
BS-Q246C8A2	Rotary	R410A	2	899~6200~7034	1760/2400	3.52
BS-Q126B8R8	Rotary	R410A	1	826~3400~4038	980/1320	3.47
BS-Q186C8R6	Rotary	R410A	1.5	899~5400~6008	1470/2300	3.67
BS-Q246C8R3	Rotary	R410A	2	899~6200~7034	1760/2400	3.52
AS-W126B1U1	Rotary	R410A	1	890~3500~4040	900 / 980	4.08
AS-W186C2U1	Rotary	R410A	1.5	900~5200~6000	1,500 / 1,650	3.47/3.82
AS-W246C2U1	Rotary	R410A	2	900~6300~8650	2,190 / 2,330	3.21/3.62

Hitachi

Model	Compressor	Tonnage	Rated Cooling/ Heating Capacity (kW)		Total Power Input (W)		COP (W/W)	
			Cooling	Heating	Cooling	Heating	Cooling	Heating
RAU013EUEA	Rotary	1	3780 (1700-4200)	-	945 (410-1130)	-	4.00 (3.75-4.15)	-
RAU019EUEA	Rotary	1.5	5500 (1760-6300)	-	1448 (440-1820)	-	3.80 (3.46-4.00)	-
RAU023EUEA	Rotary	2	6759 (2130-7526)	-	1900 (560-2400)	-	3.56 (3.14-3.80)	-
RAU012HUEA	Rotary	1	3590 (1700-4000)	-	945 (410-1130)	-	3.80 (3.54-4.15)	-
RAU018HUEA	Rotary	1.5	5280 (1760-5600)	-	1510 (440-1860)	-	3.50 (3.01-4.00)	-
RAU013IUEA	Rotary	1	3780 (1700-4200)	-	945 (410-1130)	-	4.00 (3.72-4.15)	-
RAU018IUEA	Rotary	1.5	5400 (1760-5865)	-	1448 (440-1800)	-	3.73 (3.26-4.00)	-
RAU012ITXAI	Rotary	1	3700 (1600-4050)	4200 (1600-5200)	1070 (400-1320)	1020 (370-1400)	3.46 (3.07-4.00)	4.12 (3.71-4.32)
RAU018ITXAI	Rotary	1.5	5200 (1600-6000)	6200 (1700-8300)	1600 (400-2140)	1660 (400-2700)	3.25 (2.80-4.00)	3.73 (3.07-4.25)

Samsung

Model	Compressor	Refrigerant	Tonnage	Rated Cooling Capacity (W)	Rated Power Input (W)	COP
AR24HV5NBWK	BLDC Inverter	R410A	2	6000	1750	3.51
AR18HV5NFWK	BLDC Inverter	R410A	1.5	5000	1410	3.55
AR18HV5DAWK	BLDC Inverter	R410A	1.5	5000	1310	3.82
AR12HV5DAWK	BLDC Inverter	R410A	1	3200	910	3.52
AR12HV5NBWK	BLDC Inverter	R410A	1	3200	910	3.52

Toshiba

Model	Refrigerant	Tonnage	Rated Cooling/ Heating Capacity (kW)		Total Power Input (W)		COP (W/W)	
			Cooling	Heating	Cooling	Heating	Cooling	Heating
RAS-13N3KCV-IN	R410A	1.1	3.5 (1.1-4.0)	-	1.07 (0.25-1.33)	-	3.27 (4.40-3.01)	-
RAS-16N3KCV-IN	R410A	1.3	4.5 (1.6-5.0)	-	1.595 (0.46-1.90)	-	2.82 (3.48-2.63)	-
RAS-18N3KCV-IN	R410A	1.5	5 (1.1 -6.0)	-	1.42 (0.18-2.00)	-	3.52 (6.11-3.00)	-
RAS-22N3KCV-IN	R410A	1.8	5.80 (1.20-6.50)	-	1.74 (0.20-2.20)	-	3.33 (6.00-2.95)	-
RAS-B13N3KV2-E	R410A	1.1	3.50 (0.80-4.10)	4.20 (0.90-5.60)	1.00(0.15-1.25)	1.08 (0.15-1.58)	3.50 (5.33-3.28)	3.89 (6.00-3.54)
RAS-16N3AV2-E	R410A	1.3	4.50 (0.80-5.00)	5.50(0.90-6.90)	1.395 (0.15-1.72)	1.52 (0.15-1.98)	3.23 (5.33-2.91)	3.62 (6.00-3.48)
RAS-18N3KV2-E	R410A	1.5	5.00 (1.10-6.00)	5.80 (0.80-6.30)	1.42 (0.18-2.00)	1.56 (0.14-1.70)	3.52 (6.11-3.00)	3.72 (5.71-3.71)
RAS-B22N3KV2-E	R410A	1.8	6.00 (1.20-6.70)	7.00 (1.00-7.50)	1.995 (0.20-2.65)	2.05 (0.18-2.21)	3.01 (6.00-2.53)	3.41 (5.56-3.39)

Panasonic

Model	Tonnage	Rated Cooling/ Heating Capacity (kW)	Total Power Input (W)	COP (W/W)
CS-S12PKYP	1	3500	1020	3.43
CS-S18PKYP	1.5	5130	1490	3.44
CS-S24PKYP	2	6000	1820	3.3
CS-TS12PKYP	1	3250	1000	3.25
CS-TS18PKYP	1.5	5130	1490	3.44
CS-TS24PKYP	2	5900	1900	3.11
CS-YS9PKYP	0.75	2500	740	3.38
CS-YS12PKYP	1	3160	990	3.19
CS-YS18PKYP	1.5	5000	1580	3.16
CS-YS24PKYP	2	5860	1950	3.01
CS-YE9PKY	0.75	2500	760	3.29
CS-YE12PKY	1	3300	1020	3.24
CS-YE18PKY	1.5	5000	1660	3.01
CS-YE24PKY	2	6150	1900	3.24

Carrier

Model		Refrigerant	Tonnage	Rated Cooling/ Heating Capacity (Btu/Hr)		Total Power Input (W)
Indoor	Outdoor			Cooling	Heating	
MS11D12-11HRDN1-QC2	MOB-11HDN1-QC2C	R410A	1	2450~13500	2800~16000	1000/1010
MS11D12-18HRDN1-QC2	MOF-18HDN1-QC2C	R410A	1.5	5100~22000	5300~23000	1552/1461
MS11D12-24HRDN1-QC2W	MOF-24HDN1-QC2WC	R410A	2	5300~25000	5400~27000	1917/1891
MS11D12-12CRDN1-QC2	MOB - 12CDN1 - QC2C	R410A	1	2450~13500	-	1048
MS11D12 - 18CRDN1 - QC2	MOB - 18CDN1 - QC2C	R410A	1.5	8000~20000	-	1727
MS11D12 - 21CRDN1 - QC2W	MOF - 21CDN1 - QC2WC	R410A	2	10000~23000	-	1947
42NGL - 012A	51NSA - 012R	R410A	1	4000~13900	-	1140
42NGL - 018A	51NSA - 018RA	R410A	1.5	5100~20000	-	1650
42NGL - 024A	51NSA - 024RA	R410A	2	12000~24900	-	2080

Annexure 2

Manufacturer wise specifications of Inverter ACs sold in International markets:

- China
- Australia- New Zealand
- Hong Kong
- Singapore
- United States of America (EER values provided are on the lower side and part load capacities could not be extracted)

China

Brand(s)	*Model*	*Output (kW)*	*Annual Performance Factor (Wh/Wh)*
Panasonic	KFR-36GW/BpHH1	3.6	4.62
Midea	KFR-35GW/BP3DN1Y-QA100(A1)	3.5	4.73
Midea	KFR-35GW/BP3DN1Y-KB(A1)	3.5	4.7
Midea	KFR-35GW/BP3DN1Y-HB201(A1)	3.5	4.73
Hisense	KFR-35GW/A8U900Z-A1	3.5	4.8
Mitsubishi	MSZ-ZHJ12VA	3.6	4.79
Mitsubishi	MSZ-AHJ12VA	3.6	4.8
Mitsubishi	MSZ-PZFJ12VA	3.6	4.62
Daikin	FTXF135NC-W	3.5	4.65
Haier	KFR-35GW/01CEA21A	3.5	4.67
Haier	KFR-35GW/05SEC21AT	3.5	4.65

Australia – New Zealand

Brand(s)	*Model*	*Output (kW)*	*Power Input (kW)*	*EER (W/W)*
Daikin	FTKM50P / RKM50P	5	1.18	4.24
Fujitsu	ASTG18CMCA/AOTG18CMCA	5	1.22	4.10
Daikin	FTKS50L / RKS50L	5	1.32	3.79
Panasonic	CS_CU-S18NKR	5	1.3	3.85
Panasonic	CS_CU-S18PKR	5	1.3	3.85
Daikin	FTKM46P / RKM46P	4.6	1.24	3.71
Daikin	FTKS50KA / RKS50KA	4.8	1.52	3.16
Fujitsu	ASTG18JVCA/AOTG18JVCA	5	1.53	3.27
Mitsubishi	SRK18YL-S / SRC18YL-S	5	1.56	3.21
Daikin	FTKM50P / RKM50P	5	1.18	4.24
Daikin	FTKM60P / RKM60P	6	1.55	3.87
Fujitsu	ASTA18JCC	5.2	1.41	3.69
Daikin	FTKS60L / RKS60L	6	1.69	3.55
Daikin	FTKS60KA / RKS60KA	5.09	1.61	3.16

Hong Kong

Brand (s)	Model	Output (kW)	Refrigerant
Panasonic	CS-YS18MKA / CU-YS18MKA	4.85	R410A
Toshiba	RAS-18N3KCV(HK)	4.99	R410A
Carrier	42KCEF18V/38KCEF18V	5.03	R410A
Rasonic	RS-PS18MK / RU-PS18MK	5.03	R410A
Toshiba	RAS-18SKCV(HK)	5.04	R410A
Panasonic	CS-PS18NKA / CU-PS18NKA	5.07	R410A
Rasonic	RS-PS18NK / RU-PS18NK	5.07	R410A
York	Y8HJZC018BAMLAFX	5.09	R410A
Hitachi	RAS-X18CXK/RAC-X18CXK	5.15	R410A
Hitachi	RAS-X18CBK / RAC-X18CBK	5.17	R410A
Panasonic	CS-PS18QKA / CU-PS18QKA	5.18	R410A
Rasonic	RS-PS18QK / RU-PS18QK	5.18	R410A
Panasonic	CS-S18KKA / CU-S18KKA	5.21	R410A
Panasonic	CS-S18MKA / CU-S18MKA	5.21	R410A
Rasonic	RS-S18KK/RU-S18KK	5.21	R410A
Rasonic	RS-S18MK / RU-S18MK	5.21	R410A
Fuji Electric	RSA18JPC	5.34	R410A
General	ASWA18JCC	5.34	R410A

Singapore

Brand(s)	Model	Cooling Capacity (kW)	Full Load COP	Part Load COP	Weighted COP
Panasonic	CU-S18MBZ	4.64	3.42	4.4	4.01
Toshiba	RAV-SP564ATP-SG	4.79	3.87	5.17	4.65
FEDDERS	FBH018B1CA	4.82	3.6	4.68	4.25
Mitsubishi Electric	MUY-GE18VA	4.87	3.43	5.26	4.53
Samsung	RC052DHXEH	4.88	3.39	4.18	3.86
Mitsubishi Heavy Industries	SRC50ZJX-S	4.89	3.82	5.62	4.9
Daikin	RKS50GVMG, RKS50GVMGE	4.96	3.35	4.47	4.02
Hitachi	RAC-X18CBS	4.96	3.45	5.16	4.48
Mitsubishi Heavy Industries	SRC50ZJ-S1	4.96	3.12	4.69	4.06
Sanyo	SPW-C186VEH	4.96	3.78	5.41	4.76
Panasonic	CU-PS18NKZ	4.99	3.12	5.18	4.36
Carrier	38CVUR018-703	5	3.52	5.54	4.73
York	YPHJYC018BAMSA-X	5	3.59	4.3	4.02
LG	BSUQ186C4A7	5.01	3.46	4.86	4.3
Toshiba	RAV-SM563AT-SG	5.01	3.55	4.04	3.84
Toshiba	RAS-18N3ACV	5.02	3.55	5.54	4.74
Daikin	RZR50LVVM	5.05	3.85	6.02	5.15
Mitsubishi Electric	MUY-GL18VA	5.05	4.39	5.43	5.01
LG	BSUQ186C4A1	5.06	3.36	4.38	3.97
Mitsubishi Heavy Industries	SRC18YL-S	5.06	3.13	4.89	4.19
Fujitsu	AOYA18LALL	5.07	3.21	5.34	4.49

Brand(s)	*Model*	*Cooling Capacity (kW)*	*Full Load COP*	*Part Load COP*	*Weighted COP*
General	AOHA18LACL	5.07	3.21	5.34	4.49
Samsung	ASV18ESLX	5.08	3.4	4.17	3.86
Sanyo	SAP-CRV186GDX	5.08	3.54	4.43	4.07
Daikin	RKD50BVM	5.1	3.11	4.15	3.73
LG	AUUQ18GH1	5.1	3.77	4.88	4.44
Midea	MOU-18HFN1-QRC8	5.1	3.37	3.98	3.74
Mitsubishi Heavy Industries	SRC50ZMA-S	5.11	3.19	4.57	4.02
Panasonic	CU-S18NKZ	5.12	3.55	4.22	3.95
Toshiba	RAS-18SACV, RAS-18SACV-1	5.12	3.57	5.3	4.61
LG	AUUQ18GH0	5.15	3.57	5.04	4.45
Panasonic	CU-S18PKZ	5.15	3.63	4.34	4.06
Fujitsu	AOAR18JCC	5.2	3.52	5.11	4.47
General	AOGR18JCC	5.2	3.52	5.11	4.47
Samsung	AR18HVSSBWKX	5.2	3.65	4.59	4.21
Daikin	RZR50LUV1	5.21	4.88	6.02	5.56
Samsung	ASV18EWRX	5.24	3.54	5.01	4.42
York	YMKJYC018BAMVA-X	5.24	3.36	4.41	3.99
York	YMFJYC018BAMVA-X	5.29	3.42	4.44	4.03
Daikin	RKS50JVMG	5.3	4.02	6.1	5.27
Saijo Denki	CWIA-18-CGS1	5.31	4.8	5.31	5.11
EuropAce	ESAC S1-18V CU	5.39	3.46	4.3	3.96
Mitsubishi Electric	SUY-KA18VA	5.39	3.69	4.93	4.43
Fujitsu	AOAG18LBLA	5.4	3.47	5.11	4.45
Fujitsu	AOAG18JFC	5.41	3.52	5.57	4.75
Midea	MNSO-18	5.42	3.48	4.27	3.95

USA

Brand Name(s)	Basic Model Number	Cooling Capacity (BTU/Hour)	Cooling capacity (W)	Power Input (W)	EER (W/W)
GE	AEE18DR** (208)	17600	5133	1820	2.82
GE	AEE18DR** (208)	17600	5133	1820	2.82
GE	AEE18DQ** (208)	17600	5133	1820	2.82
GE	AEE18DR** (230)	18000	5250	1860	2.82
GE	AEE18DR** (230)	18000	5250	1860	2.82
Thermal zone	WAC418230R	18000	5250	1860	2.82
Thermal zone	WAH418230M	18000	5250	1860	2.82
Seabreeze	WA418ZR	18000	5250	1860	2.82
Seabreeze	WH418ZM	18000	5250	1860	2.82
Seabreeze	419-0075	18000	5250	1860	2.82
Thermal zone	419-0075	18000	5250	1860	2.82
GE	AEE18DQ** (230)	18000	5250	1860	2.82
Arctic King	MWK-18ERN1-MI7	18500	5396	1907	2.83
Comfort-Aire	MWK-18ERN1-MI7	18500	5396	1907	2.83
Comfort-Aire	MWK-18ERN1-MI7	18500	5396	1907	2.83
Comfort-Aire	MWK-18ERN1-MI7	18500	5396	1907	2.83
Arctic King	MWK-18ERN1-MI7	18500	5396	1907	2.83
Arctic King	MWK-18ERN1-MI7	18500	5396	1907	2.83
PerfectAire	MWK-18ERN1-MI7	18500	5396	1907	2.83
PerfectAire	MWK-18CRN1-MI7	18500	5396	1907	2.83
midea	MWK-18CRN1-MI7	18500	5396	1907	2.83
midea	MWK-18ERN1-MI7	18500	5396	1907	2.83

Brand Name(s)	*Basic Model Number*	*Cooling Capacity (BTU/Hour)*	*Cooling capacity (W)*	*Power Input (W)*	*EER (W/W)*
Westpointe	MWK-18ERN1-MI7	18500	5396	1907	2.83
Garrison	MWK-18ERN1-MI7	18500	5396	1907	2.83
Garrison	MWK-18CRN1-MI7	18500	5396	1907	2.83
AMANA	AE183E35AXAA(208V)	17400	5075	1790	2.84
LG	LW1813HR	17500	5104	1800	2.84
Friedrich	EP18G33	17500	5104	1800	2.84
LG	LW1813HR	17500	5104	1800	2.84
Friedrich	LW1810HRY1	17500	5104	1800	2.84
LG	LW1810HRY1	17500	5104	1800	2.84
LG	LW1810HRY1	17500	5104	1800	2.84
Friedrich	EP18G33	17500	5104	1800	2.84
AMANA	AE183E35AXAA(230V)	17800	5192	1830	2.84
Commercial Cool	CWH18B	17800	5192	1830	2.84
LG	LW1810HR	18000	5250	1850	2.84
Frigidaire	FFRA1811Q2	18500	5396	1900	2.84
Frigidaire	FFRA1811Q2	18500	5396	1900	2.84
Frigidaire	FFRA1811Q2	18500	5396	1900	2.84
Kenmore	FFRA1811Q2	18500	5396	1900	2.84
Frigidaire	FRA182MT2	18500	5396	1900	2.84
Crosley	FRA182MT2	18500	5396	1900	2.84
Friedrich	YM18N34B	17200	5017	1654	3.03
GREE	GJE18BM-D3RND2B(230V)	18000	5250	1690	3.11
GREE	GJE18BM-D3RND2B	18000	5250	1690	3.11

Brand Name(s)	*Basic Model Number*	*Cooling Capacity (BTU/Hour)*	*Cooling capacity (W)*	*Power Input (W)*	*EER (W/W)*
GE	AHH18DQ (208)	17900	5221	1680	3.11
GE	AEW18DQ** (208)	17700	5163	1660	3.11
GE	AEW18DQ** (208)	17700	5163	1660	3.11
GE	AEW18DQ** (208)	17700	5163	1660	3.11
GE	AEW18DQ** (208)	17700	5163	1660	3.11
GE	AEW18DQ** (208)	17700	5163	1660	3.11
Soleusair Powered by Gree	GJC18BM-D3RNC5G	17700	5163	1660	3.11
Soleusair Powered by Gree	GJC18BM-D3RNC5G	17700	5163	1660	3.11
GE	AEW18DQ** (208)	17700	5163	1660	3.11
GE	AEZ18DPH1 (208V)	17600	5133	1650	3.11
GREE	GJE18BM-D3RND2B(208V)	17600	5133	1650	3.11
Soleusair Powered by Gree	GJE18BM-D3RND2B	17600	5133	1650	3.11
GE	AHH18DQ (230)	18350	5352	1720	3.11
GE	AEW18DQ** (230)	18150	5294	1700	3.11
GE	AEW18DQ** (230)	18150	5294	1700	3.11
GE	AEW18DQ** (230)	18150	5294	1700	3.11
GE	AEW18DQ** (230)	18150	5294	1700	3.11
GE	AEW18DQ** (230)	18150	5294	1700	3.11
GREE	GJC18BM-D3RNC5G	18150	5294	1700	3.11
THERMOCORE	GJC18BM-D3RNC5G	18150	5294	1700	3.11
COOL-LIVING	GJC18BM-D3RNC5G	18150	5294	1700	3.11

Brand Name(s)	*Basic Model Number*	*Cooling Capacity (BTU/Hour)*	*Cooling capacity (W)*	*Power Input (W)*	*EER (W/W)*
GE	AEW18DQ** (230)	18150	5294	1700	3.11
Kenmore	FFRH1822R2	18500	5396	1730	3.12
Crosley	FFRH1822R2	18500	5396	1730	3.12
Frigidaire	FFRH1822R2	18500	5396	1730	3.12
Frigidaire	FFRH1822R2	18500	5396	1730	3.12
Crosley	FFRH1822R2	18500	5396	1730	3.12
Arctic King	MWK-18CRN1-MJ7	18500	5396	1729	3.12
Arctic King	MWK-18CRN1-MJ7	18500	5396	1729	3.12
PerfectAire	MWK-18CRN1-MJ7	18500	5396	1729	3.12
midea	MWK-18CRN1-MJ7	18500	5396	1729	3.12
Westpointe	MWK-18CRN1-MJ7	18500	5396	1729	3.12
Friedrich	SM18N30	17200	5017	1607	3.12
Friedrich	SM18N30	17200	5017	1607	3.12
LG	LW1810ER	18000	5250	1680	3.13
LG	LW1810ER	18000	5250	1680	3.13
GE	AEZ18DPH1 (230V)	18000	5250	1680	3.13
Haier	ESA418M	17800	5192	1660	3.13
Koldfront	WAC18001W	18500	5396	1725	3.13
LG	LW1812ERS	17500	5104	1630	3.13
LG	LW1811ER	17500	5104	1630	3.13
Friedrich	CP18G30	17500	5104	1630	3.13
LG	LW1810ER	17500	5104	1630	3.13
LG	LW1811ER	17500	5104	1630	3.13
LG	LW1810ER	17500	5104	1630	3.13
AMANA	AE183G35AX (208)	17200	5017	1600	3.14
AMANA	AE183G35AX (230)	17600	5133	1635	3.14

Brand Name(s)	*Basic Model Number*	*Cooling Capacity (BTU/Hour)*	*Cooling capacity (W)*	*Power Input (W)*	*EER (W/W)*
GE	AEM18DS** (208)	17800	5192	1590	3.27
GE	AEM18DS** (208)	17800	5192	1590	3.27
Haier	ESA418N	17800	5192	1590	3.27
Haier	ESA418N	17800	5192	1590	3.27
GE	AEM18DS** (208)	17800	5192	1590	3.27
GE	AEM18DS** (208)	17800	5192	1590	3.27
GE	AEM18DS** (208)	17800	5192	1590	3.27
GE	AEM18DS** (230)	18250	5323	1630	3.27
GE	AEM18DS** (230)	18250	5323	1630	3.27
GE	AEM18DS** (230)	18250	5323	1630	3.27
GE	AEM18DS** (230)	18250	5323	1630	3.27
GE	AEM18DS** (230)	18250	5323	1630	3.27
GE	AEM18DS** (230)	18250	5323	1630	3.27
GE	AEM18DS** (230)	18250	5323	1630	3.27
GE	AEM18DS** (230)	18250	5323	1630	3.27
GE	AEM18DS** (230)	18250	5323	1630	3.27
AMANA	AE183G35AX (230V)	17600	5133	1630	3.15
midea	FEUS1-KCD53/N1Y-KE(J7)-[J2]	18000	5250	1667	3.15
AMANA	AE183G35AX (208V)	17200	5017	1590	3.16
GE	AEM18DS** (208)	17800	5192	1590	3.27
GE	AEM18DS** (208)	17800	5192	1590	3.27
GE	AEM18DS** (208)	17800	5192	1590	3.27
GE	AEM18DS** (208)	17800	5192	1590	3.27

Brand Name(s)	*Basic Model Number*	*Cooling Capacity (BTU/Hour)*	*Cooling capacity (W)*	*Power Input (W)*	*EER (W/W)*
PerfectAire	MWK-18CRN1-MK2	18500	5396	1651	3.27
midea	MWK-18CRN1-MK2	18500	5396	1651	3.27
GE	AEM18DT** (208)	17600	5133	1570	3.27
GE	AEM18DT** (208)	17600	5133	1570	3.27
GE	AEM18DT** (208)	17600	5133	1570	3.27
Arctic King	EWK+18CR5a(230V)	18500	5396	1650	3.27
Frigidaire	FFRE1823Q2	18500	5396	1650	3.27
Frigidaire	FFRE1823Q2	18500	5396	1650	3.27
Frigidaire	FFRE1833Q2	18500	5396	1650	3.27
Crosley	FFRE1833Q2	18500	5396	1650	3.27
GLUX	AVGL-18R2	18500	5396	1650	3.27
Westpointe	MWK-18CRN1-MK2	18500	5396	1650	3.27
Thermal Zone	422-0103	18500	5396	1650	3.27
Sea Breeze	422-0103	18500	5396	1650	3.27
PerfectAire	2PAC18000	18500	5396	1650	3.27
midea	MWK-18CRN1-MK2	18500	5396	1650	3.27
Frigidaire	FFRE1823Q2	18500	5396	1650	3.27
Frigidaire	FFRE1823Q2	18500	5396	1650	3.27
Crosley	FFRE1823Q2	18500	5396	1650	3.27
Kenmore Elite	FFRE1823Q2	18500	5396	1650	3.27
Arctic King	MWK-18CRN1-MK2	18500	5396	1650	3.27
Kenmore	FFRE1823Q2	18500	5396	1650	3.27

Brand Name(s)	*Basic Model Number*	*Cooling Capacity (BTU/Hour)*	*Cooling capacity (W)*	*Power Input (W)*	*EER (W/W)*
Danby	DAC180EB1GDB	18000	5250	1607	3.27
Danby	MWK-18CRN1-MK2	18000	5250	1607	3.27
Danby	DAC180EB1*	18000	5250	1607	3.27
Arctic King	MWK-18CRN1-MK2	18000	5250	1607	3.27
Danby	MWK-18CRN1-MK2	18000	5250	1607	3.27
Danby	DAC180EB1	18000	5250	1607	3.27
TGM	MWK-18CRN1-MK2	18500	5396	1651	3.27
CLASSIC	MWK-18CRN1-MK2	18500	5396	1651	3.27
Arctic King	MWK-18CRN1-MK2	18500	5396	1651	3.27
Comfort-Aire	MWK-18CRN1-MK2	18500	5396	1651	3.27
Comfort-Aire	MWK-18CRN1-MK2	18500	5396	1651	3.27
Arctic King	MWK-18CRN1-MK2	18500	5396	1651	3.27
Friedrich	CP18G30A	17500	5104	1560	3.27
Friedrich	CP18G30A	17500	5104	1560	3.27
GE	AEM18DT** (230)	18000	5250	1600	3.28
GE	AEM18DT** (230)	18000	5250	1600	3.28
GE	AEM18DT** (230)	18000	5250	1600	3.28
LG	LW1813ER	18000	5250	1600	3.28

Thank You