

# Overview of World ATW (Air to Water) Heat Pump Market and Opportunities with Respect to the Air-Conditioning Industry

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## Abstract

A heat pump is a device that transfers heat energy from a heat source to a heat sink against a temperature gradient. Heat pumps are designed to move thermal energy opposite to the direction of spontaneous heat flow. A heat pump uses some amount of external high-grade energy to accomplish the desired transfer of thermal energy from heat source to a heat sink. While compressor-driven air conditioners and freezers are familiar examples of heat pumps, the term "heat pump" is more general and applies to Heating Ventilation and Air Conditioning (HVAC, hereafter) devices used for space heating or space cooling. When a heat pump is used for heating, it employs the same basic refrigeration-type cycle used by an air conditioner or a refrigerator but in the opposite direction, releasing heat into the conditioned space rather than the surrounding environment. There are two types of heat pump technology, geothermal and aerothermal. Geothermal types include ground to water and water to water type heatpumps, while aerothermal heatpump technology is broadly used by the air-conditioning industry. Among the two types of aerothermal heat pumps, these are (a) Air to Air (ATA) and (b) Air to Water (ATW). Though ATA heat pumps were widely used so far in the air-conditioning industry, predominantly, there is a sudden and significant growth observed in the ATW heat pump market due to their energy efficient performance; and hence, the market is observing a technology shift. The present paper attempted to study the market segmentation of the heat pump industry with special focus on technical detailing and applications of ATW heat pumps. The research paper further described the key competitive players competing in the world market of ATW heat pump business. Secondary data analysis and review of global market for the last one decade (2004 to 2012) was carried out with a focus on leading countries or subcontinents' performance like that of Japan, China, Europe, Australia, United States, and some other small markets to draw the 'opportunities and challenges' roadmap for the ATW heat pump industry.

**Keywords :** industrial firm, firms, market performance, market structure.

**JEL Classification :** F1, L1, M200

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A heat pump systems (HP, hereafter) is a device that transfers heat energy from a heat source to a heat sink against a temperature gradient. Heat pumps are designed to move thermal energy opposite to the direction of spontaneous heat flow. Heat pumps, which utilize the thermal energy of air, water or the earth to perform heating, cooling, and/or hot water or air supply, are considered one of the most energy-efficient and cost-effective ways to significantly reduce carbon dioxide emissions and reliance on fossil fuels.

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In heating ventilation and air conditioning (HVAC, hereafter) applications, the term *heat pump* usually refers to easily reversible vapor-compression refrigeration devices optimized for high efficiency in both directions of thermal energy transfer, which means it is able to maintain indoor air of the room or water temperature at desired level in both hot or cold conditions outside using refrigeration cycle in reversible directions. Heat spontaneously flows from warmer places to colder spaces. A heat pump can absorb heat from a cold space and release it to a warmer one, and vice-versa. "Heat" is not conserved in this process, which requires some amount of external high grade (i.e., low-entropy) energy to be expended.

Heat pumps are usually used to provide heating because less high-grade energy is required for their operation than appears in the released heat. Most of the energy for heating comes from the external environment, and only a fraction comes from electricity (or some other high-grade energy source required for running a compressor). In electrically powered heat pumps, the heat transferred can be three or four times larger than the electrical power consumed.

The present paper attempts to explain technical details of heat pumps, their market segmentation, types of products, uses and applicability, global market review, and analysis of ATW (Air to Water hereafter) heat pumps and its applications.

## **Objectives and Research Methodology**

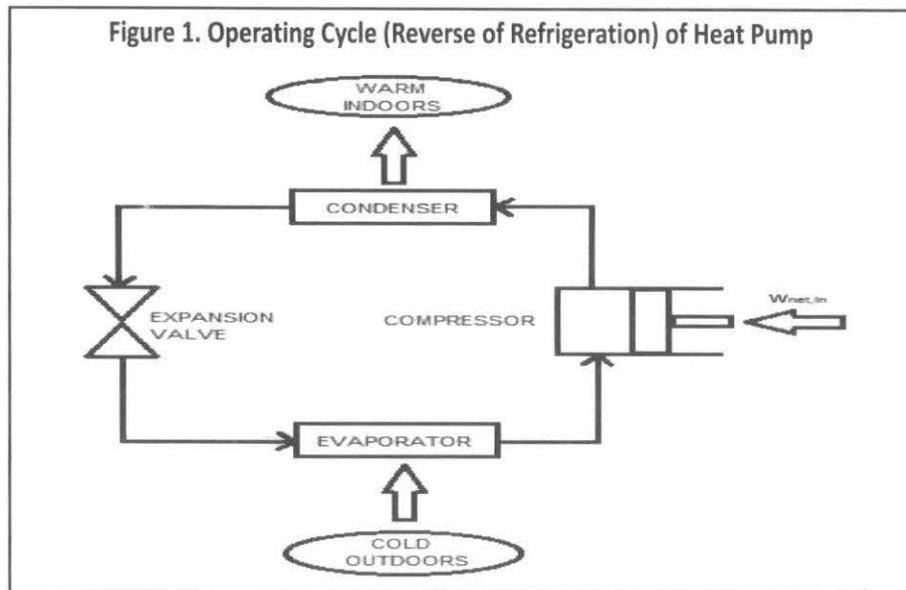
The prime objective of this research paper is to understand the industrial product 'Heat Pump' which is widely gaining popularity across the world; and the benefits world will derive on the global contemporary issues like energy consumption and environment protection out of its usage. Research paper also attempts to understand the global market, market dynamics, firms operating in the industrial product category and their structures. Attempt has also been made to understand and analyze global market data and to draw conclusion on the challenges the product is facing and the efforts various countries are putting in to support the Heat Pump industry.

For the study, secondary data of the world market for the period of 09 years – FY 2004 to 2012 has been collected and analyzed. The secondary data has been obtained from the world's leading players of the industry as well as from the international associations like JARN (Japan Air-conditioning and Refrigeration News), ASHRAE (American Society of Heating Refrigeration and Air-conditioning Engineers); ISHRAE (Indian Society of Heating, Refrigeration and Air-conditioning Engineers) as well as RAMA (Refrigeration and Air-conditioning Manufacturing Association). Data have also been obtained from the leading heat pump manufactures of the world, conventional heater manufacturers and the air-conditioning leading companies. Information was also sought from the personal interviews of the professionals involved in the air-conditioning industry in India through the organized association or societies like ISHRAE (Indian Society of Heating, Refrigeration and Air-conditioning Engineers).

## **Operating Principle and Innovative Energy Efficient Design of a Heat Pump**

Heat pumps use a refrigerant as an intermediate fluid to absorb heat where it vaporizes, in the evaporator, and then to release heat the refrigerant condenses, in the condenser. The refrigerant flows through insulated pipes between evaporator and condenser, allowing for efficient thermal energy transfer over relatively long distances.

**(1) Operating Principle of a Heat Pump :** Mechanical heat pumps exploit the physical properties of a volatile evaporating and condensing fluid known as a refrigerant. The heat pump compresses the refrigerant to make it more hot on the side to be warmed, and releases the pressure at the side where heat is absorbed. Figure 1 explains the 'Operating Cycle of the Heat Pumps'. A simple stylized diagram of a heat pump's vapor-compression refrigeration cycle: condenser, expansion valve, evaporator and compressor as shown in the Figure 1.



The working fluid, in its gaseous state, is pressurized and circulated through the system by a compressor. On the discharge side of the compressor, the now hot and highly pressurized vapor is cooled in a heat exchanger, called a condenser, until it condenses into a high pressure, moderate temperature liquid. The condensed refrigerant then passes through a pressure-lowering device also called a metering device. This may be an expansion valve, capillary tube, or possibly a work-extracting device such as a turbine. The low pressure liquid refrigerant then enters another heat exchanger, the evaporator, in which the fluid absorbs heat and boils. The refrigerant then returns to the compressor and the cycle is repeated.

Reversible heat pumps work in either thermal direction to provide heating or cooling to the internal space. They employ a reversing valve to reverse the flow of refrigerant from the compressor through the condenser and evaporation coils.

In *heating mode*, the outdoor coil is an evaporator, while the indoor is a condenser. The refrigerant flowing from the evaporator (outdoor coil) carries the thermal energy from outside air (or soil) indoors, after the fluid's temperature has been augmented by compressing it. The indoor coil then transfers thermal energy (including energy from the compression) to the indoor air, which is then moved around the inside of the building by an air handler. Alternatively, thermal energy is transferred to water, which is then used to heat the building via radiators or under floor heating. The heated water may also be used for domestic hot water consumption. The refrigerant is then allowed to expand, cool, and absorb heat to reheat to the outdoor temperature in the outside evaporator, and the cycle repeats. In *cooling mode* the cycle is similar, but the outdoor coil is now the condenser and the indoor coil (which reaches a lower temperature) is the evaporator.

**(2) Energy Efficiency and Environment Friendliness of Heat Pumps :** According to a report released by the non-profit international energy agency IEA 2008 , heat pump systems can reduce the Carbon Dioxide emissions by about 40 – 60% compared to conventional combustion types European heating systems. Estimated reduction in the CO<sub>2</sub> emission is 8% if the global replacement takes place of conventional heaters to heatpumps. It is also estimated that only if in Japan the combustion types heaters are replaced with heatpump the economic benefit of energy saving will be close to US \$ 21 billion by the year 2020 (Japan Air Conditioning, Heating & Refrigeration News (JARN), 2008). The Table 1 explains the environmental benefits of the heat pump systems compared with mainly conventional heating systems used.

**Table 1. Environmental Benefits of Heat Pump Systems and CO<sub>2</sub> Emissions**

Fuel & System	CO <sub>2</sub> Emissions in Kilogram(Kg) / Kilo watt hours (Kwh)	
Kerosene based space and water heating systems	0.3	These traditional systems has highest CO <sub>2</sub> emissions
Natural gas based space heaters and water heaters	0.2	Even natural gas base systems had double CO <sub>2</sub> emissions than HP systems
Heat Pumps systems heating application	0.1	Heat pumps can realize significant CO <sub>2</sub> emission reduction during the space and water heating application

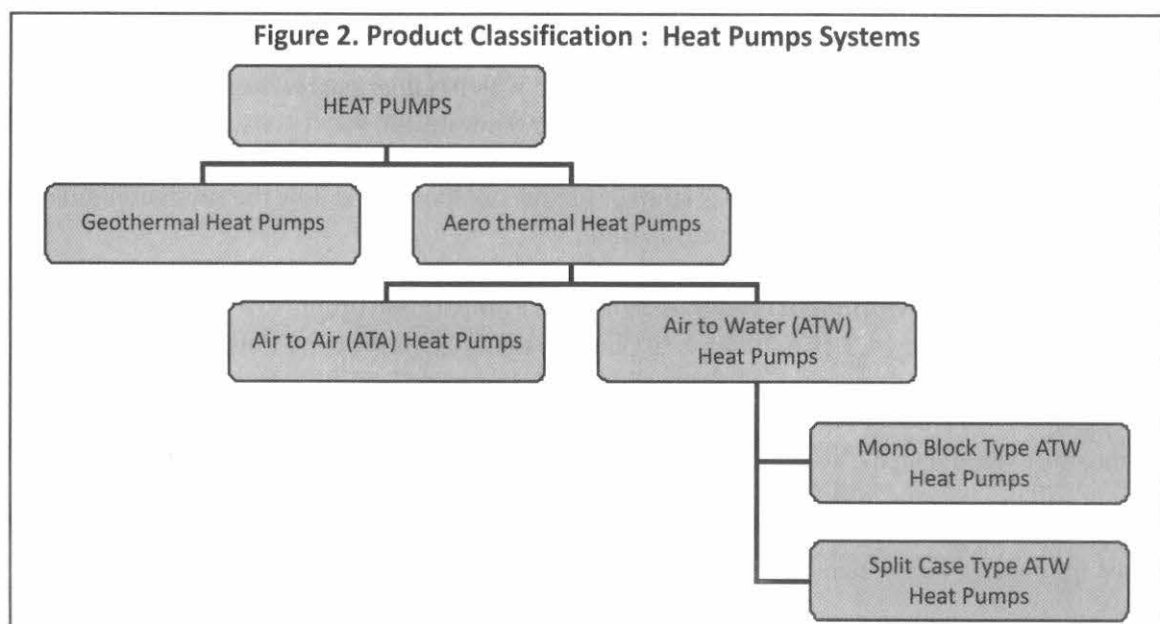
Source : Daikin (n.d. a)

## Product Classification and Cost Dynamics of Heat Pumps

**(1) Product Classification :** Heat pumps are segmented mainly based on their mechanical operating cycle like (a) Compression Cycle, (b) Absorption cycle. The two main types of heat pumps are compression and absorption heat pumps. Compression heat pumps operate on mechanical energy (typically driven by electricity), while absorption heat pumps may also run on heat as an energy source (from electricity or burnable fuels). An absorption heat pump may be fueled by natural gas. Further they are classified based on the heat sources or heat sinks, like (a) Geothermal heat pumps, and (b) Aerothermal heat pumps. Geothermal types include ground to water and water to water types heat pumps while Aerothermal heat pumps include air to air (ATA type heat pump) or air to water (ATW) heat pumps.

Usage of aerothermal heat pumps has been estimated at 78% specially in airconditioning systems, though the most popular type of heat pumps were ATA pumps and were being widely used, ATW heat pumps have gained lot of popularity due to their dual application and energy efficiency. The Figure 2 represents diagrammatic representation of heat pump systems product classification.

**(2) Initial Cost Structure of Heat Pumps :** Table 2 indicates the approximate average initial cost of various Heat pumps systems averaged out in Euros , during the year 2010. It is important to note that the initial cost being



**Table 2. Approximate Average Costs of Heat Pump Systems (FY, 2010)**

In Euro (As on August ,2010)	ATA HP Systems	ATW HP Systems	Ground-Source HP Systems
Euro	1700-2600	10,000-12000	12000-17000

Note : The cost motioned are the tentative end consumer prices, including taxes for turnkey supply and installation in single family houses (equivalent capacity).

higher and longer payback period is one of the limitation for the ATW heat pumps compared to conventional systems which is being aimed to over come by promoting the systems with the incentive scheme and developing scale of economies to lower it's initial cost by the companies.

## **Competitive Environment of the Heat Pump Systems Industry**

Pioneered by Japanese company like Daikin , Mitsubishi Electric innovated the Air To Water Heat pump systems following to it. They dominate the Asian Markets. Sanyo , Hitachi , Panasonic , Melco Fujitsu General are the other leading Japanese players in India. Midea , Gree are the leading China based companies attempting to get advantage of their mass manufacturing capabilities. Samsung and LG are South Korean giants have understood the need of the competitive product in highly expanding market. Dimplex (Germany), Atlantic , Alpha-Inno Tech are the leading European manufacturer of ATW heatpumps. There are strategic joint ventures and collaborative tie ups between Asian ATW heat pump manufacturers and conventional heater manufacturers of Europe for ATW market expansion and technology conversion. Similarly Carrier USA ( A strategic business unit of United Technologies Corporation) has a joint venture with Toshiba Japan for the heatpump technology business for USA market specifically. The details of world wide leading manufacturers of heatpump technologies and their colorations have been listed in the Appendix 1.

## **World Overview of Market of ATW Heat Pump System : 2004 to 2012**

HP Technology has been innovated and pioneered by Japanese companies, and has started gaining popularity in most part of the world. Cold countries and cold zones are major markets for HP technology and it is directly competing with conventional combustion type boiler heater industry. The Table 3 gives overview of world ATW heat pump market for the period of 2004 - 2012.

ATW HP technology has been innovated and pioneered by Japanese companies. As indicated in Table 3, during the year 2003-04 ATW HPs were marketed in Japan and manufactures started aggressively promoting and marketing this product. World market was around 132 thousand units during the year 2004, majority of them being sold in Japan around 115 thousand units. World market of ATW heat pumps has grown substantially during last decade and as reported by JRAIA (Japan Refrigeration and Airconditioning Industry Association) it has been close to 1.45 million units (1.448) by the year 2012 and has been estimated to continue to grow at a very high rate in the near future. Followed by Japan other major markets for ATW heatpumps are China and Europe. During the initial years product sales growth rate remained phenomenal with multi fold growth in all the markets, for example during the period 2004 to 2006 Japan market grew from 115 thousands units to over 323 thousand units, Europe market grew from 10 thousand units to 60 thousand units, China registered a major growth from 7 thousand units to 120 thousand plus units by the end of year 2007. That gave a huge confidence to producers and the innovation started proving a very useful , energy efficient and environment friendly technology. The world market continued to grow at a very fast rate till 2008 to reach a sale of close to 1 million unit of ATW HP systems with expansion in almost all the markets, however growth has remained stagnant from year 2008, onwards due to anticipated fear of economic slow down or due to post affect of the sub-prime economic crisis of USA and world

economic recession. For year 2009 all the markets have shown recovery with positive growth rate to have a cumulative growth rate of over 20% plus, but last couple of years have been quite uncertain once again due to European economic crisis. That has affected major markets of ATW heatpumps across the world and has restricted growth rate close to only 5 to 9% during the years 2011 and 2012 respectively. The world market review has been briefly discussed below.

## **Review of Major Asian Markets**

Major Asian air-conditioning markets are China and India in terms of market size and consistency in the demand, most of the companies are focusing on the markets of China and India, as far as air-conditioning systems are concerned. Developing nations like South Korea, Japan, Singapore, Malaysia and Thailand are other emerging Asian markets. Use of heat pump technology is a fractional in India due to hot and humid weather but they are widely used with high average gradient temperature places like Japan, Soviet Union, South Korea, North Korea and China.

**(1) Japan :** Japanese ATW market has reached to 454 thousand units in the year 2012, recording a decrease of 9.5% and 8.5% during the last two years 2011 and 2010 respectively after reaching a mega mark of 548000 units in the year 2009 from beginning of around 115 thousand units in the year 2004. The anticipated threat due to economic slow down; following the down turn in most of the European countries; along with the slowly reviving American economy are assumed to be the factors affecting growth rate of ATW heat pumps due to their high initial capital investments and longer payback periods (Japan Air Conditioning, Heating & Refrigeration News (JARN), 2008, 2009, 2013).

**(2) China :** In China, ATW heat pumps are often used as commercial water heaters to replace boilers, and market is growing at a faster rate than air-conditioner market. That is one of the reasons that Chinese ATW market has grown by around 11% to reach to 699 thousand units from 630 thousand units in 2011. However the growth rate is certainly slower than the initial period growth rate from 2004 to 2008 (Japan Air Conditioning, Heating & Refrigeration News (JARN), 2008, 2009, 2013).

**(3) Others :** The other countries where, HP systems are gaining popularity are South Korea and Hong Kong where Asian manufacturer's are attempting to develop market and have started gaining momentum, however leading air-conditioner markets like India, and other small emerging economies of South Asian countries like Singapore, Thailand etc have a very low probability of HP systems market development due to relatively hot and humid climate, specially for space heating (Japan Air Conditioning, Heating & Refrigeration News (JARN), 2008, 2009, 2013).

## **Review of Major European Markets**

Heat pump products utilize renewable energy and can help reduce CO<sub>2</sub> emission levels that is the key driving factor which has made ATW HP systems eligible to get included in the energy incentive product category as a result of which the price of HP systems have fallen by a sizable amount to compete with traditional heating and boiler heating systems. Sales of HP systems in Europe has grown to a level of 300 thousands in the year 2008 but growth was than affected by economic recession and growth of sales during the year 2009 to 2011 started contracting. However, market has shown gradual recovery after 2011 and during 2012 to reach to a level of 214 thousands units after experiencing bottom of 170 thousand units in 2011. Table 4 and Table 5 explain the Heat Pump systems market movements in the European belt during the year 2004-2012 (Japan Air Conditioning,

**Table 3. World Wide Market Data (Number of Units Sold) of ATW Heat Pump and Year to Year Change in Percentage**

World Wide Market Data ATW Heat Pump												
Year	Japan		China		Europe		Australia		USA and Others		Total Global Change	
	Nos.	% Chang YTY - Japan	Nos.	% Chang YTY China	Nos.	% Chang YTY Europe	Nos.	% Chang YTY Australia	Nos.	% Chang YTY Others	Total Sales Nos.	Year to Year Changes in %
2004	115100		7500		10300		0		0		132900	
2005	194400	68.90	26800	257.33	35000	239.81	700		1000		257900	94.06
2006	323000	66.15	48500	80.97	60500	72.86	1000	42.86	3000	200	436000	69.06
2007	399000	23.53	120100	147.63	150700	149.09	3000	200	5000	66.67	677800	55.46
2008	500200	25.36	190300	58.45	300000	99.07	10000	233.33	10000	100	1010500	49.09
2009	510000	1.96	228000	19.81	240000	-20.00	40000	300	10000	0	1028000	1.73
2010	548500	7.55	450000	97.37	206000	-14.17	25000	-37.5	20000	100	1249500	21.55
2011	497000	-9.39	630000	40.00	170000	-17.48	26000	4	45000	125	1368000	9.48
2012	454000	-8.65	699000	10.95	214000	25.88	26000	0	55000	22.22	1448000	5.85

Source : Statistic from JRAIA (Japan Refrigeration and Airconditioning Industry Association)

Obtained from the issues of JARN ( Japan Air-Conditioning, Heating and Refrigeration News) of ( August 2008, August 2009, August 2010, August 2011, August 2013 issues).

Heating & Refrigeration News (JARN), 2008, 2009, 2013).

As indicated in Table 4 , for European countries due to the cold weather conditions heat pumps are used for both space heating and air-conditioning as well as they are also widely used in water heating applications. Approximate around 158 thousands ATW HPs have been sold as air-conditioning application and around 56 thousand units for water heating applications against the conventional boiler heating applications. The country wise break up of the market size as presented in the Table 5 indicates that France has always remained a leading major market with around 54 thousand and 89 thousand units sold in the year 2011 and 2012 respectively. Germany is at second position with 39 thousand units and 48 thousand units sold during the respective period and United Kingdom has remained the other leading market. It is noteworthy that in both France and Germany the usage of ATW HP systems has shown positive growth rate for the year 2012 with respect to 2011 , but in UK the same has de-grown, this perhaps the effect of recession and slow down in the economy. On the other hand the other markets of Europe like eastern European countries has shown positive growth rate comparative to United Kingdom.

### **United State of America (USA) and Other Emerging Markets**

All the major world players of ATW HP systems have been attempting to develop USA market for the HP systems but at present no major developments are seen in the current state of USA specifically with the high initial cost of the product. In the year 2012 it has just touched around 1000 plus units of ATW HP systems. Currently the only HP systems eligible for tax incentives in USA are Ground source heat pumps (GSHP). The other developing ATW HP markets are , Northern American countries like Canada, Mexico, Switzerland in Europe, South Korea, Hong Kong and a very fractional part of North India of Asia where climatic conditions are observed in minus temperature during the winter seasons (Japan Air Conditioning, Heating & Refrigeration News (JARN), 2008, 2009, 2013).

**Table 4. Break Up of Europe ATW Heat Pump System Utilization**

Year	Nos. of Units of ATW HPs sold for Space Heating and Airconditioning	Nos. of Units of ATW HPs sold for Water Heating Application	Total Numbers of Units sold
2012	158000	56500	214000

**Table 5. Market Break of ATW HP Systems in Europe**

Year	France	Germany	United Kingdom	Others	Total
2011	54000	39000	19000	58000	170000
2012	89100	48100	14500	62300	214000

## Australia

ATW HP systems market grew at quite faster rate at the developed country of southern pole like Australia and did take an early momentum with a sales of 40 thousand units during the year 2008-09 from its beginning with around 1000 units during the year 2004-05. However economic slow down has also impacted the growth rate of ATW HP systems at Australia during the last couple of year it has gone down and have remained steady at around 26 thousand units (Japan Air Conditioning, Heating & Refrigeration News (JARN), 2008, 2009, 2013).

## Overview of Opportunities, Threats, and Incentives for ATW Heat Pumps

**(1) Japan :** The Agency for Natural Resources and Energy (ANRE) and Ministry of Economy Trade and Industry (METI) have jointly formed an energy saving strategy 2011 and there have been advantages for the research and development as well as promotion of energy and environment friendly technologies. ATW heat pumps have been identified as one among the most efficient energy saving technology in space and water heating. The programme have been designed to promote the HP technology with the subsidies and incentives and it is estimated that HP systems will be installed in 80-90 % of all households by the 2030.

The leading Japanese HP manufacturers' are Daikin, Mitsubishi Electric , and Hitachi and they have been the larger suppliers of the world ATW HP systems. Continuous threat for them is the slow down of the economy in the major parts of the world , specifically Europe market and the higher initial cost with longer payback cycles of the heat pump technology.

**(2) China :** Chinese air-conditioners and water heater manufactures have entered in to the ATW heaters market and have mastered the art of mass manufacturing and they have been now also exporting the ATW heat pumps to the European and American boiler manufacturers. With the low cost strategy and advantage they have scaled up the units sales more than the Japan and have been continuously working on the lowering the cost at a better quality to serve the market. Analyst estimates a shining future of ATW heat pump manufacturers' and marketers in the China, due to its energy efficiency and gaining popularity across the world.

**(3) Europe :** Due to the environment friendliness and low carbon dioxide emissions, various developed countries of Europe, have started promoting the product, by offering the incentives on the purchase of the initial cost. These drives have been pushed with the two perspectives, One is to save energy and environment and have low carbon dioxide emissions and second is to bring down initial cost of the Heat Pump systems , so that lower payback periods can be reduced and it attracts the buyers. France being the leader in the Europe has offered the incentives as indicated in the Table 6.

The Table 7 provides the summary of the incentives and probable outcomes of the opportunities for heat pump



**Table 6. Incentives Offered By France For Heat Pump Purchase in Europe**

Heat Pump Type	2009	2010	2011	2012
Air to Water (ATW)	25%	25%	22%	15%
Ground Source Heat Pump (GSHP)	40%	40%	36%	26%
Heat Pump Water Heater	40%	40%	36%	26%
Air to Air (ATA) Heat Pumps	Incentive programme concluded in the year 2008			

Note: These incentives are offered on the initial purchase cost the equipments to the while purchasing the equipments.

Source : Ministere du Budget, des Comptes Publics et de la Fonction Publique, France ; Obtained from JARN August, 2013

market in the various parts of the worlds. It is an opportunity for the Heat pump systems manufacturers that, various countries realizes the end benefit the HP systems offers in terms of the energy savings and environment prevention, and supporting the growth of the industrial product ; though the capital investment is high initially.

## Managerial Implications for Decision Making

The present paper drives the fact that, the world market data review indicates that heat pump systems are the innovative product and in it's inception state , not having adequate volumes as well as economies of scale. The initial cost is still high due to the cost of innovation and volume limitations , these leads to longer pay back periods. The other major challenge is unstable demand. However though these are the challenges for the product marketers at present ; it has something to offer is very strongly is 'low energy consumption' and 'low CO<sub>2</sub> emissions'. Study in the present paper directs that , to over come these challenges developed nations and major markets are taking initiatives and supporting the innovation. Present paper explains the measures various government has been taking to promote the product technology. The brief guidelines can be outlined for the management decision making are as under :

- ↳ Energy conservation and environment privation are leading concerns.
- ↳ Both developed and developing nations of the global community are working on innovative solutions to these problems through research and development.
- ↳ Heat pumps systems have sizable benefits in terms of energy consumption and it is certainly an environment friendly technology.
- ↳ As a result of above, the world market is gradually shifting from conventional high energy consuming heating systems to the heat pump systems.
- ↳ Manufacturers and marketers sooner or later will have to understand the technology shift and may need to adopt to innovative changes.

## Conclusion

Air to Water Heatpumps are innovative designs for the space and water heating and gaining popularity in the coldcountries specifically, market opportunities are immense and it is getting expanded with more numbers of players entering in to the business. ATW heat pumps have an advantage over conventional boilers or electric heaters in terms of their lower operating cost, energy efficiency and environment friendliness. However higher initial cost at present is the area of concern for the manufacturers and marketers. Considering the fact that the ATW heatpumps are energy efficient device and environment friendly product, developed nations of Europe and

Asian sub quotients have been offering incentives in the supply and installation of the ATW heatpumps under energy efficiency drive, which will certainly help in the market development of the product.

The incentive is expected to drive the volumes in future and advantage of economies of scale will be further be helpful in the drop of initial cost of the product hopefully. These leads to predict that, though the world market of the ATW heat pumps appears to be stagnant at present due to the effect of the economic recession and European economic crisis, it has a progressive future with growth.

## Limitations of Study and Scope for Further Research

One of the limitation of the present research paper is that data regarding technical performance of heat pump products were taken from the technical product brochures provided by the manufactures' in manufacturers catalogues, and hence, the actual performance may have variation based on the climatic conditions at the time of installation. Second, the present research has conducted a data analysis of the World Heat Pump Market review for the years from 2004 to 2012. Data analysis for the market movements after the year 2012 have not been included.

**Table 7. World Wide Opportunities and Incentives for ATW Heat Pump Systems**

Sub quotient and Country	Incentives for HPs Market	Anticipated Results
Asia , China	China has been offering the subsidy of RMB 600 (Approximately US \$ 100, or 10% of the initial cost) on purchase of HP System, under the special energy efficiency drives.	Local Chinese market has grown to a great extent and has crossed Japanese market in terms of the numbers of units sold and has not declined in growth rate.
	Strategies built which are driving towards the mass manufacturing and to achieve the economies of scale advantage as well as export promotion to lower the initial cost.	China has contributed to lower the cost of HP systems and they are also exporting to European market, supplying the HPs to boiler manufacturers and now aiming to develop USA and North American markets.
Asia, Japan	Subsidies have been offered under new energy policy towards purchase of environment and energy savings devices.	New environment friendly strategy aims to sell or replace around 80-90% of the house hold space and water heating applications to HP systems.
	Japanese innovation leaders companies like Daikin, Mitsubishi Electric , Hitachi are attempting to develop ATW HPs which can function for the lower ambient temperature range of (-15 to -25 ) Degree centigrade, at present which is a major limitation of HP system.	The innovation will open up some of the market of Northern Europe , Northern America, where ambient goes below -25 deg c. However still at Northern European parts where temp. reaches close to -40 deg c, HP systems won't be able to work.
Europe, France	Economic recession and decline in real estate has resulted the decline in the sales of ATWs at France post 2008, however Government has offered subsidies on purchase of	HP systems as indicated in the Table 5 below It is estimated that with new incentives market will pick up gradually and as forecasted it has started gaining momentum in the year 2012 with the marginal increase in the year 2012.
Europe, United Kingdom (UK)	UK has been aiming to generate more than 1% of the renewable heat generation of what heat is demanded, From April 2011 the Renewable Heat Incentives (RHI) scheme has been introduced which is benefiting to the HP systems too.	Following the Greece economy and European economic down turn UK HP systems market had been declining since 2008 onwards, due to the incentives the market has got stabilized and it has been picking up gradually.

The research paper has not included substitute performance analysis (like conventional heating system manufactures' performance) in the present paper.

Some of the pointers for future research are as follows :

↳ As found during the study , many countries in European and Asian regions have initiated incentive schemes to promote the environment friendly products from the year 2011 onwards. Hence, future studies can be carried out to measure the impact of these incentive schemes on the market of these industrial products.

↳ The study regarding impact assessment of incentives on markets can also be extended to similar industries like automobiles , air- conditioners, consumer durables, and so forth where energy consumption and environment prevention are the key contemporary issues.

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### Appendix 1. Leading Manufacturers of Heat Pumps & Substitute Products

Leading European Manufactures	Leading Asian Manufactures	Cooperation of Leading HP Systems Corporations
Dimplex (Germany) , Atlantic and Alpha-Inno Tec are the leading Manufacturers of Europe	Japans players Daikin and Mitsubishi Electric hold dominant market players, Daikin takes the top share in the France also, while Mitsubishi Electric holds major market share in France	Carrier USA has tied up with Toshiba of Japan for the supply and installation of Heat pump business in the various parts of the globe.
Nibe (Sweden) has a technology agreement with Mitsubishi Electric Japan for ATW HP Systems	Sanyo, Hitachi, Panasonic , Melco, Fujitsu General are the other Japan based players holding ATW markets	Asian Manufactures are using strategic tie ups with European Partners and leading heaters manufactures' for the OEM business, and supply them the complete or partial technology of HP systems to develop the markets
Stiebel, Eltron, AJ Tech, (Germany) CIAT, Technibel, Airwell, (France), are the leader HP space heating system suppliers.	Midea, Gree, are the important China players, major supplier of Japan Mitsubishi Electric has also set up manufacturing base at China and Thailand.	
Buderus (Bosch), Junkers (Bosch) Vaillant, Viessmann, Weishaupt, Wolf , (Germany) Baxi (UK) , DeDietrich (Netherlands) , Ferroli and Clivet (France) etc. are the major combustion heating manufactures which are major competitors and substitutes, in European heating business	Samsung and LG are the leading South Korean Brands which supplies HP systems and does have manufacturing facilities at China and Europe	