WHITE PAPER

Retrofitting legacy AHUs for up to 60 per cent reduction in power costs: Upgrading to fully digitized, intelligent air handling

Today, with rising costs and limited availability of power and space, intelligent and efficient air-handling has become essential. Comfort, health, productivity and greater energy efficiencies in large commercial buildings and facilities depend on their air handling capabilities. “Intelligence” in Air Handling Units (AHUs) gains even greater importance in critical manufacturing premises such as for pharma and semi-conductors; high footfall large spaces such as airports, five star hotels and malls; as well as for all other buildings that need superior air quality management for critical hygiene such as hospitals and clean rooms.

However, shifting from manually controlled assembled legacy air handlers to high end digitally controlled AHUs with seamlessly working factory fitted parts may pose a business challenge from a capex perspective – especially when the legacy machines are yet to fully depreciate. Intelligent air handling retrofits solution and support services address exactly this challenge. Customized solutions to fully upgrade existing AHUs with an advanced BMS compatible, programmable controller with optional CO_2 sensors along with EC fans reduces energy usage up to a whopping 60 percent. Retrofitting just EC fans into legacy systems, even without the controller and sensors

would deliver up to 25 per cent improved energy efficiency. However, the full benefit of adding EC fans is truly derived only from fully digitizing the legacy AHU.

To understand how the solution delivers that level of performance, we need to understand the collaborative functioning of its constituent parts:

1) BMS ready programmable intelligent controller with instrumentation
2) EC fan motor technology
3) VOC / CO_2 sensing with option to incorporate chemical media filtration

1) BMS ready programmable intelligent controller with instrumentation

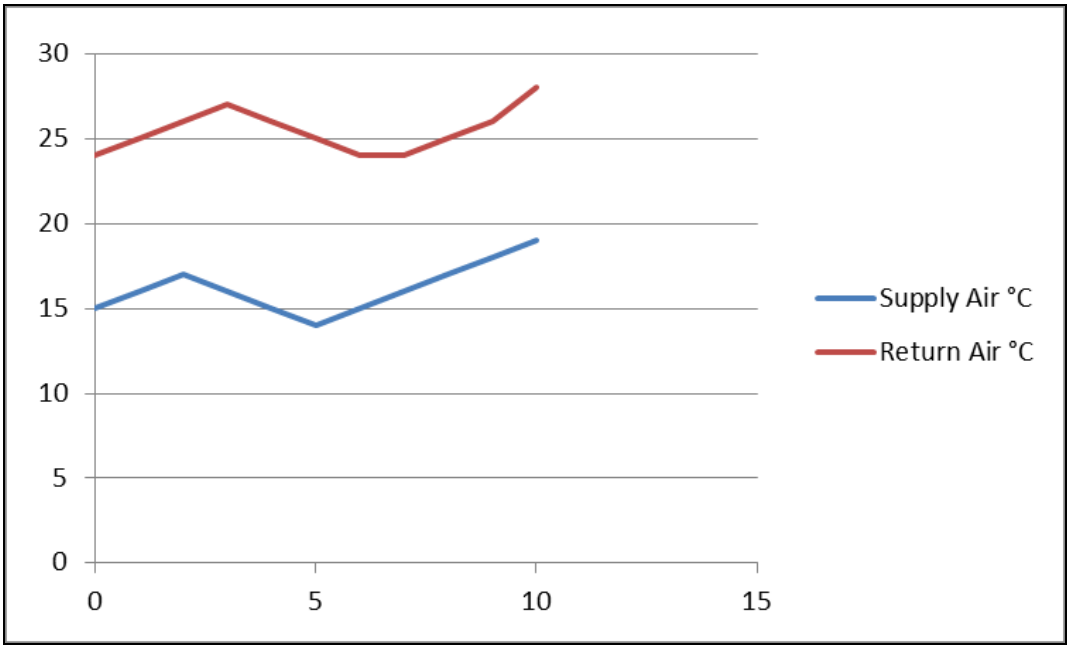
For Air Handling Unit retrofits, the greatest impact is from installing the Intelligent Controller for seamless operation of the AHUs. This enables not just more efficient fan usage, but also controls return and supply air temperature via chilled water valve modulation and receives feedback on various parameters via instrumentation with option to monitor via a remote PC or BMS. The Controller has optional CO_2 sensing for indoor air quality management and options for auto operation control logic. It therefore requires insignificant manual intervention after being programmed. The smooth user interface and available data on a touch screen makes it very easy to operate. Apart from the significant opex savings, a major advantage of installing the Intelligent Controller in an AHU retrofit is the complete flexibility and better response capabilities for user to set key parameters. The user can easily set these key parameters to meet specific local requirements at the centralized BMS and/or AHU level operation, as required.

The Controller has information as well as configuration features which continuously provide feedback on Supply Air Temperature, Return Air Temperature, Fan Power Consumption KW and Air Volume ie CFM data. High energy efficiency is achieved by Supply Temperature data input controlling the Chilled Water Valve and Return Air Temperature data input regulating fan speed from 0 to 100 percent. Return Air Temperature can also optionally control the existing 2 way, 3 way or Pressure Independent Valve for modulation purposes while the differential pressure switch installed in the duct controls the fan speed, as required based on pressure set points. All the intelligent controllers installed in the building can be looped and The Controller can be directly integrated with the BMS via Modbus RTU or Bacnet protocol communication. The controller data can also be directly communicated to a standalone PC for centralized AHU control in absence of a BMS system. All data is recorded in graphical format on the touch screen as well as on the remote computer as below.

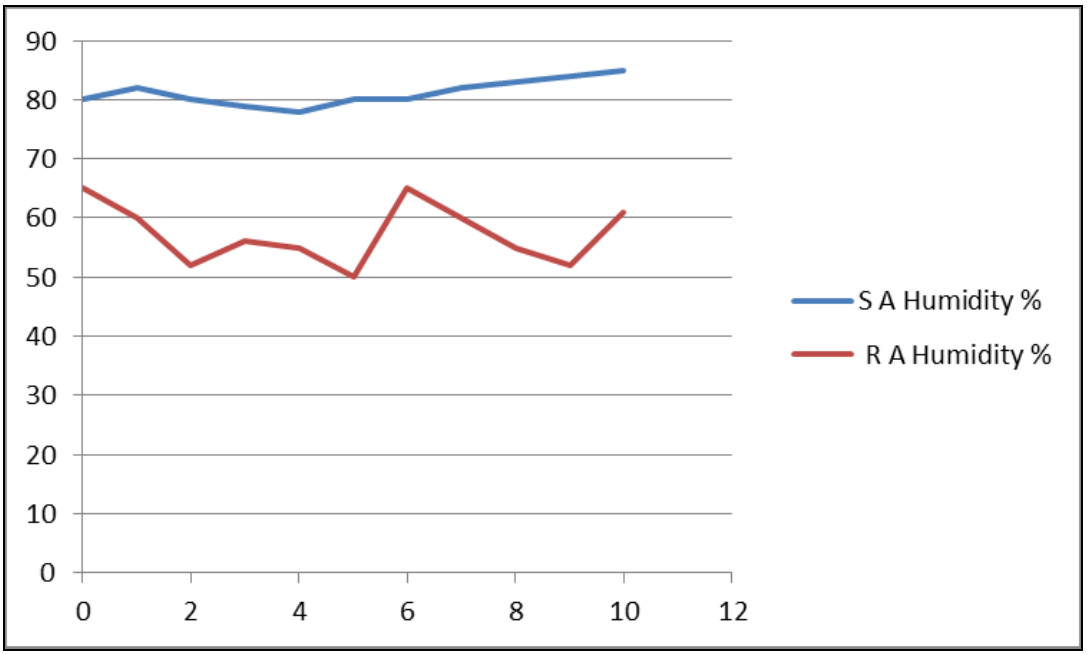
ILLUSTRATION OF PARAMETERS AND CONTROL INPUT	
RETURN AIR TEMP	FAN INPUT
SUPPLY AIR TEMP	CHW VALVE INPUT
RETURN AIR HUM	DUCT PRESSURE
SUPPLY AIR HUM	CW IN TEMP
CW OUT TEMP	OTHERS

TYPICAL DATA DISPLAY AS BELOW:

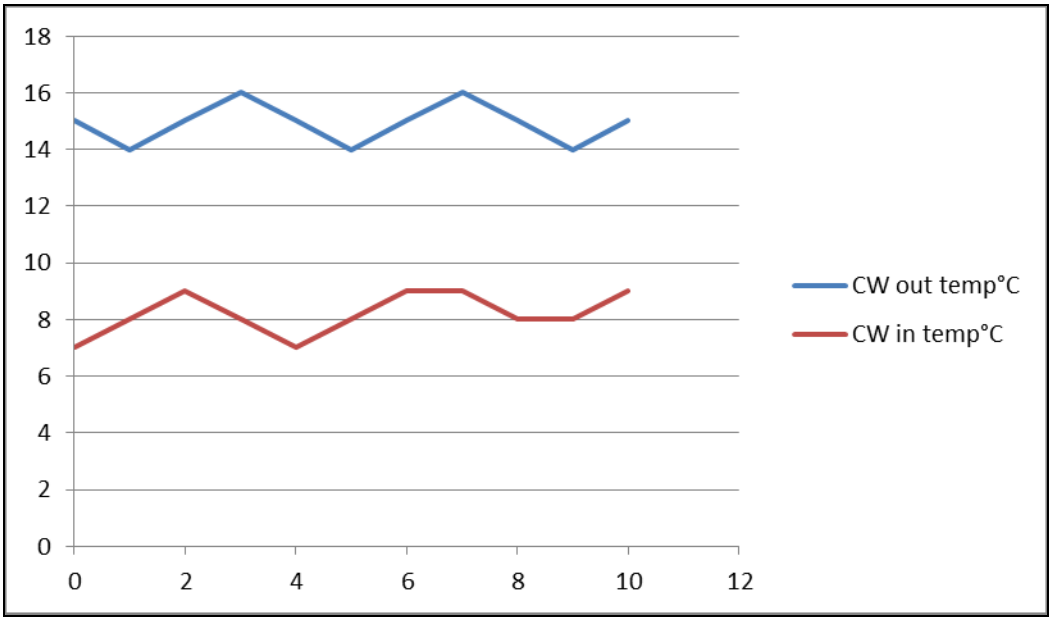
RETURN AIR / SUPPLY AIR TEMPRATURE GRAPH



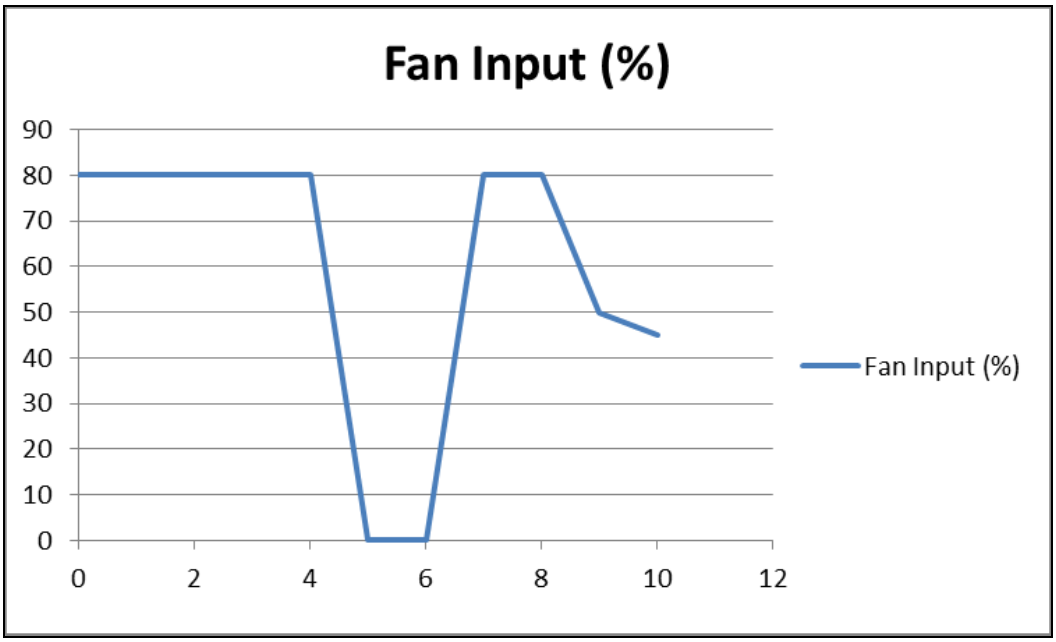
SUPPLY AIR HUMIDITY / RETURN HUMIDITY GRAPH



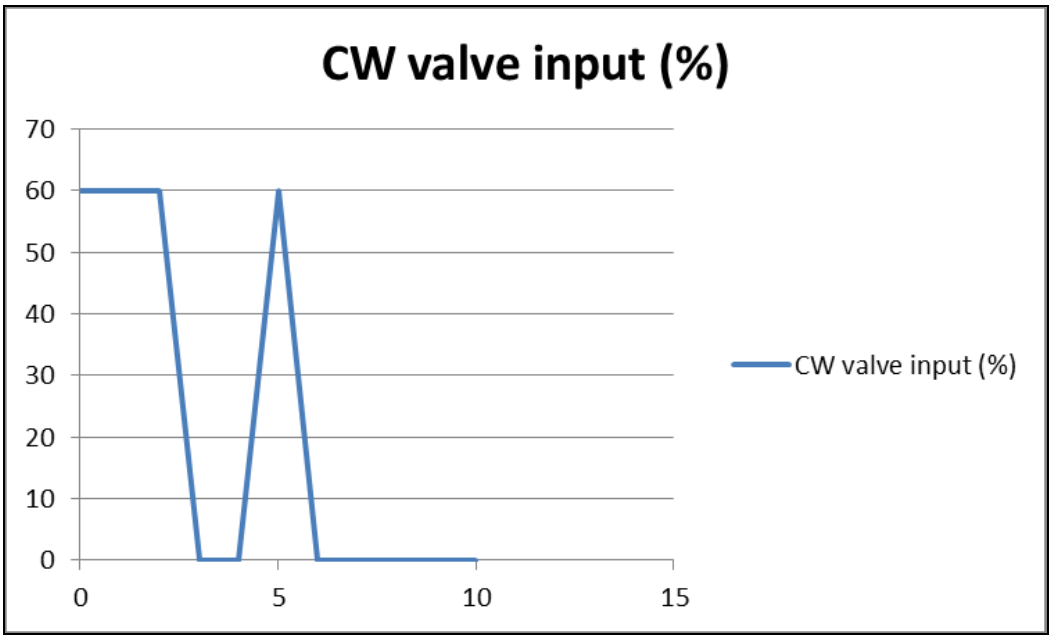
CHILLED WATER IN / OUT TEMP



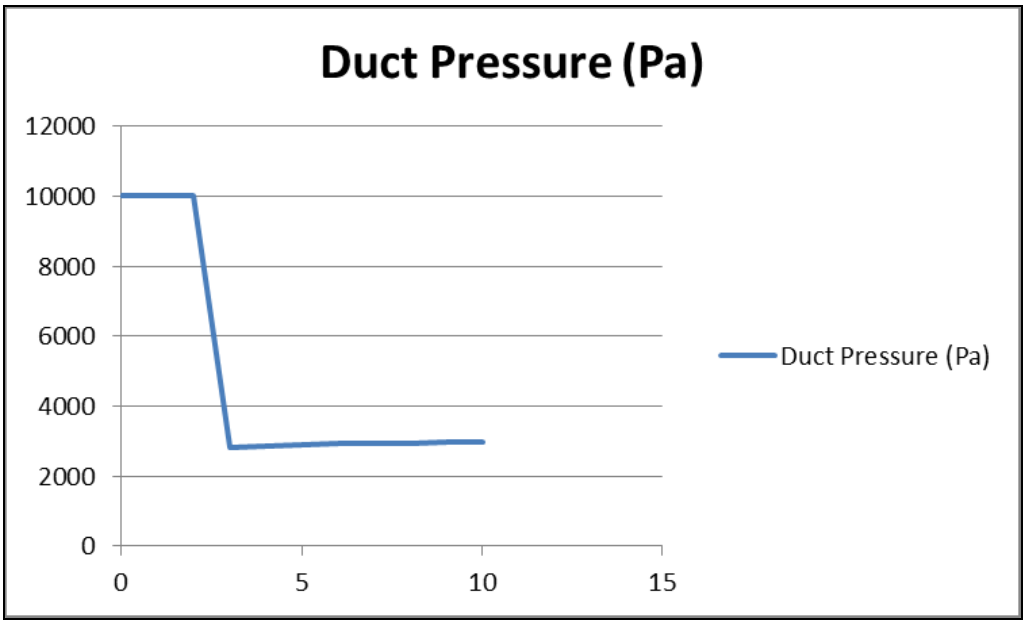
FAN INPUT GRAPH



CW VALVE INPUT GRAPH



DUCT PRESSURE



2) EC Fan Motor Technology -

The other important element in an AHU retrofit solution is the replacement of traditional forward / backward curved centrifugal fans with an AC motor with EC fan-motor. EC stands for Electronically Commutated which basically means it is a Fan with a brushless DC motor. Basic DC motors rely on carbon brushes and a commutation ring to switch the current direction, and therefore the magnetic field polarity, in a rotating armature.

Types of Motors and Efficiencies at 500 Watts

Shaded pole motors:

- Motors with efficiencies between 20% to 30%

- Motor is restricted to 30 W shaft power only. The other motors provide 500 W shaft power each.

Permanent split capacitor motor (PSC motor):

- Motor with maximum efficiency between 60% and 70%
- Requires external run capacitor

Three phase induction motor:

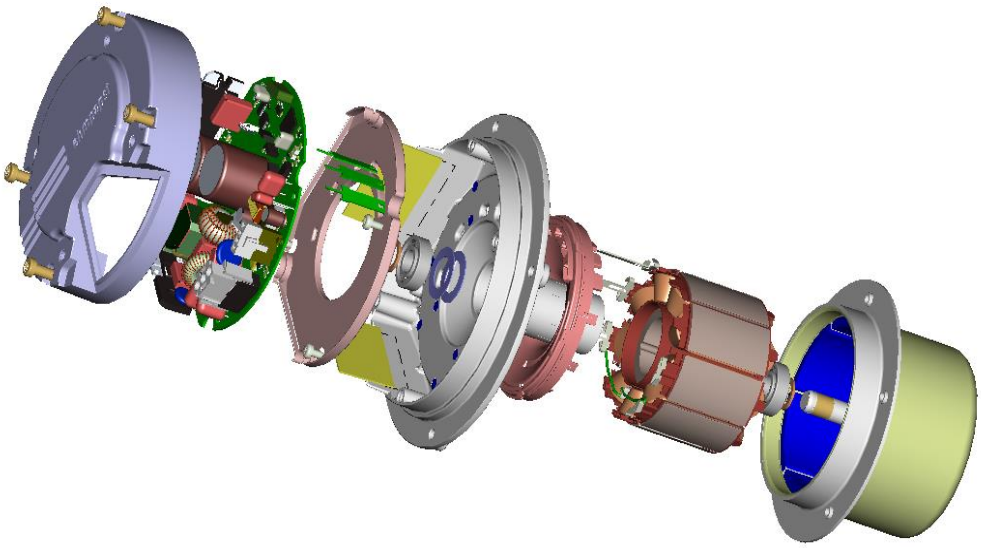
- Motor efficiency of about 75% along with Fan.
- Only capable of speed control with external variable frequency drive

EC motor:

- Motor efficiency ranging between 80% and 90% (motor and electronics combined)
- Speed control and speed monitoring can be built into the motor electronics

EC External Rotor Motor

Integrated drive electronics capable of speed control and communication
High efficiency DC permanent magnet motor



EC Motors vs. AC Motors at Partial Load

- A major advantage of an EC motor is the use of speed control. The Fan has an operating working range of about 10% - 100% of the maximum speed.
- The power required by a Fan has a cubic relationship to the speed the Fan is running.
- When using multiple Fans in parallel there is a substantial energy savings to speed control the Fans down to reach lower cooling levels than to turn Fan off.

EC Motor features:

- Efficiency of motors is up to 90% depending on selection
- Variable speed adjustable by analog and digital inputs
- Mean time between failures of 80,000 hours ensures highest reliability.
- Possible option temperature control, constant flow, or pressure systems.
- Compact design and foot print minimizing space usage.
- Eliminates need for external plenum at AHU outlet in specific applications.

3) VOC / CO_2 sensing with option to incorporate chemical media filtration

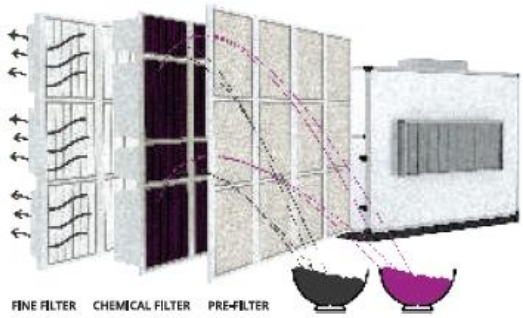
Specially in applications of retrofit for Treated fresh air units

One of the biggest challenges faced today by high foot fall, long work hour commercial buildings like hospitals, office buildings, hotels etc. is to maintain a good level of indoor air quality while optimizing the air conditioning load addition resulting from inducing fresh air into the buildings. Apart from this even fresh air brought into the buildings in metro cities very often contain high levels of pollutants which further adds to the deterioration of indoor air quality, while adding load on the air conditioning system. This is a major contributor to sky rocketing energy bills with negligible positive results.

Improper ventilation design is known to account for as much as 60 per cent of indoor air quality (IAQ) issues. Combined with inefficient temperature management and air handling – an inadequate exchange of treated fresh air in proportion to recirculated air contributes to an increased risk of several building related symptoms and illnesses. Concerns about developing the 'sick building syndrome' is relatively recent. This poses significant challenges in fixing older building that were built before ASHRAE revised design specifications for ventilation around 2008. Tolerances were then increased to tackle the inherent problems of poor ventilation and high volatile organic compound readings indoors. Retrofitting with more "intelligent" parts is a viable option in many cases, to meet newer tolerance level specifications, especially in older buildings.

In legacy AHU systems, this important aspect of fresh air treatment and indoor air monitoring was independently done, as the need of instrumentation and controls did not make it possible to integrate Air Purification with the AHU. However, with the use of intelligent controllers while

undertaking retrofit of the AHU it is now possible also to integrate carbon dioxide / VOC sensing in the air stream of the AHU plant room and further enable/disable intake of fresh air into the buildings. Further, if the vicinity ambience where the building is located has a high level of pollution due to reclaimed land banks, sewerage lines, drainage lines, industrial surroundings, high traffic conditions etc. - fresh air brought into the buildings would have high levels of pollutants. It therefore needs gas phase filtration treatment before it is infused in the indoor air stream to have better control of the VOC – CO2 levels indoors. This is possible by integrating air purification via chemical media filters in the filter section design of the AHU in addition to particulate filtration which would be already available in the unit. Based on the additional estimated pressure drops on account of the chemical media filter , either the air purification system can be designed as a standalone module and it's working could be controlled based on inputs from the intelligent controller so the entire system works as an integrated unit or in case of treated fresh air unit application the EC fan selection for retrofit needs to be selected taking into account the additional pressure drop due to chemical media filters which can vary from 100Pa upto 400Pa.



Summarizing the key benefits of an intelligent AHU retrofit solution:

1) Up to 60% more energy efficiency by installing a BMS compatible, intelligent controller and instrumentation.
2) Up to 25% more energy efficient on retrofitting only EC fans.
3) Optimize fresh air loads with real time VOC or CO2 sensing.
4) Improve indoor air quality with added chemical media filters in addition to particulate filters.
5) Reduce maintenance and manpower cost.

CASE STUDY – SAMPLE ILLUSTRATION AND ANALYSIS

Intelligent Retrofit Solution

AUDIT		DESIGN		INSTALL		MAINTAIN	
OPERATING COST SAVINGS ILLUSTRATION							
				Legacy AHUs		**Intelligent Retrofit (Controller + Sensors + EC Fan)**	
Area	**Level / Floor**	**No. Of AHUs**	**CFM**	**KW / AHU**	**Total Power**	**KW / AHU**	**Total Power**
Lab	2	7	18000	8.75	61.25	6.45	45.15
Total (A)		**7**			**61.25**		**45.15**
	Ground	5	12000	5.2	26	4.3	21.5
Commercial	1	6	6000	2.6	15.6	2.15	12.9
	3	6	30000	15.05	90.3	10.75	64.5
Total (B)		**17**			**131.9**		**98.9**
Grand Total (A+B)		**24**			**193.15**		**144.05**
Total Savings in Power Consumption with Intelligent Retrofit Solution (KW-Hr)							**49.1**
Lab Area: Annual Savings in INR with Retrofit Solution (Assumed Tariff @ Rs.10 for 24 hrs operations)							**14,10,360**
Commercial Area: Annual Savings in INR with Retrofit solution (Considering Tariff @ Rs.10 & 12 hrs operations)							**14,45,400**
Total Savings / Year in INR							**28,55,760**
Total Savings for 5 Years in INR							**1,42,78,800**

Replacement of Legacy AHU with an Intelligent AHU

Case Study Analysis of Opex savings with Intelligent AHU Retrofit Solution													
					Legacy AHU Solution				Intelligent AHU Solution (Controller + Sensors + EC Fan)				
SN.	AREA	Level / Floor	No of AHUs	CFM	Dimension (LxWxH)	BMS Control Type	KW/AHU	Total Power	Dimension (LxWxH)	BMS Control Type	Floor Space savings in %	KW/AHU	Total Power
1	Office Area	7	1	6000	2160 x 1950 x 1270	Controlled via BMS	2.32	2.32	2100 x 1350 x 1350	Local Control with intelligent Controller and instrumentation	33%	1.32	1.32
2		8	1	12000	2500 x 1500 x 2200		7.5	7.5	2500 x 1970 x 1820		Designed to suite site conditions for lower noise	4.41	4.41
3		7	1	6000	1970 x 1060 x 1680		2.3	2.3	2100 x 1350 x 1350			0.98	0.98
4		8	1	3000	1430 x 1460 x 670		2.12	2.12	1150 x 1500 x 700			1.08	1.08
	Total		4					14.24					7.79
Total Savings in Power Consumption with Intelligent AHU Solution (Kw/Hr)					6.45								
Total Savings in Power Consumption with Intelligent AHU Solution in %					45%								
Annual Savings in INR with AHU Solution (Considering Tariff @ Rs.10 & 24 hrs operation)					565,020								
Total Savings for 5 Years in INR					2,825,100								

About the Author

Suresh Balakrishnan
Co-Founder and Joint Managing Director, STULZ- CHSPL INDIA PVT.LTD.

Suresh Balakrishnan, co-founder and joint managing director of STULZ CHSPL India Pvt Ltd. is a HVAC industry business leader. Over the two decades under his leadership, STULZ grew to market leadership position in mission critical cooling solutions, in India. The introduction of the EC fan technology to HVAC industry in India by STULZ group in 2005 was under his leadership and today this technology is widely accepted and used across HVAC applications in the country. STULZ's has more recently expanded to industrial and commercial cooling applications with its i-AHU product range which is an upgrade from the legacy systems currently in use. Suresh holds a Bachelor of Engineering degree in Production from Mumbai University.