NATIONAL ENERGY EFFICIENCY CONFERENCE 2023

An Initiative by: ENERGY EFFICIENCY NATIONAL PARTNERSHIP

Energy saving through use of Axial Fans

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Overview of Alcon Singapore Manufacturing (ASM) Pte Ltd

- Alcon is the global leader in eye care, dedicated to helping people see brilliantly. With an over 75-year heritage, Alcon is the largest eye care device company in the world, with complementary businesses in Surgical and Vision care. Being a truly global company Alcon work in 60 countries and serve patients in more than 140 countries. Alcon have a long history of industry firsts, and each year Alcon commit a substantial amount in Research and Development to meet customer needs and patient demands.
- Alcon Singapore Manufacturing (ASM) is in production since 2009 and employs approximately 150 people. The Singapore site produces Pharma products for human use. Alcon's seven-decade long history of success rests on a foundation of industry expertise, leading brands and a winning mindset. Alcon aspire to lead the world in innovating life-changing vision products because when people see brilliantly, they live brilliantly. Since its inception in 2009, Alcon Singapore Manufacturing (ASM) has been focused on our mission to grow together by nurturing a continuous improvement culture with highly skilled & agile talents, enabled by innovative technologies, consistently delivering safe & quality aseptic ophthalmology products.

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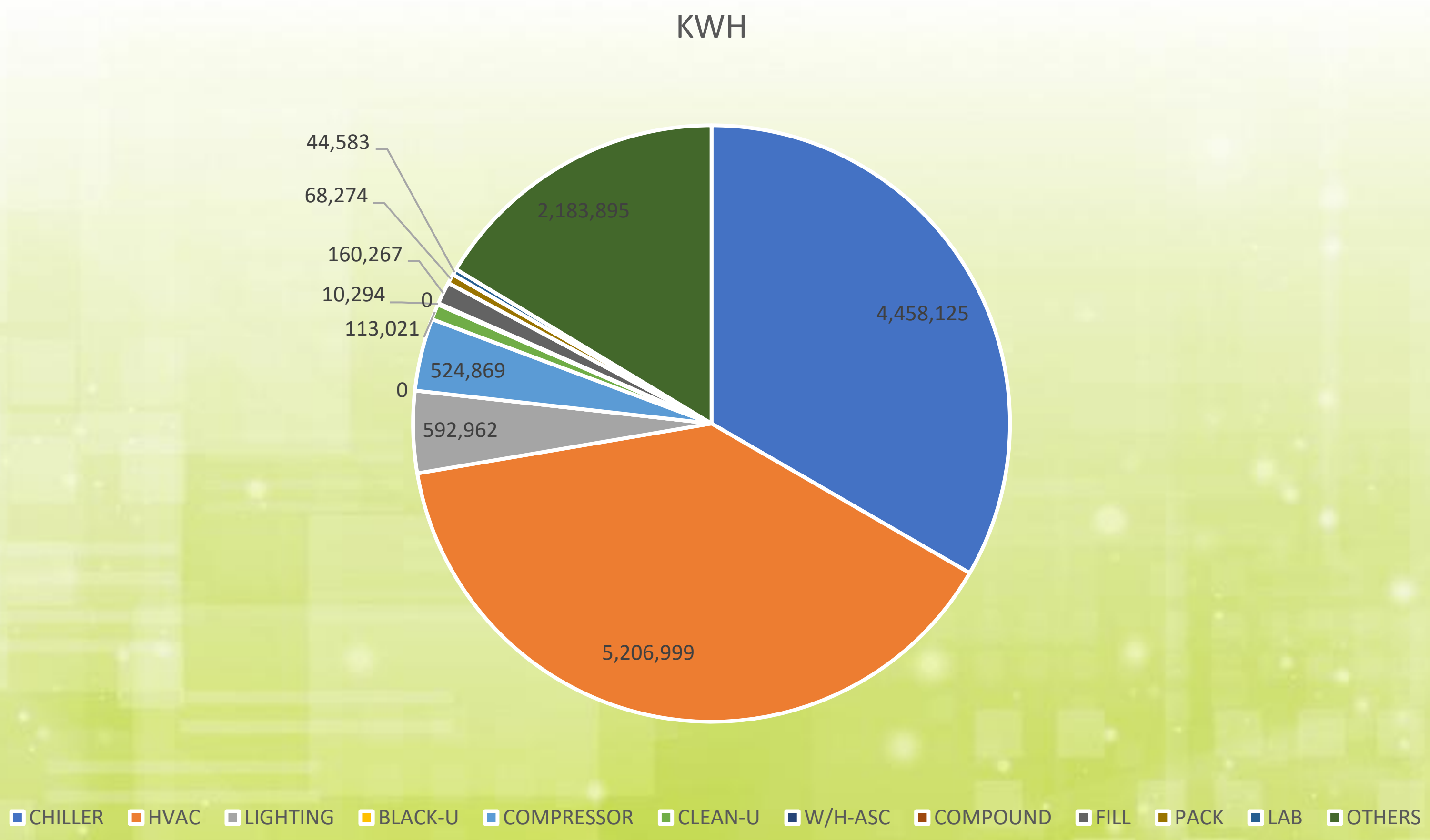
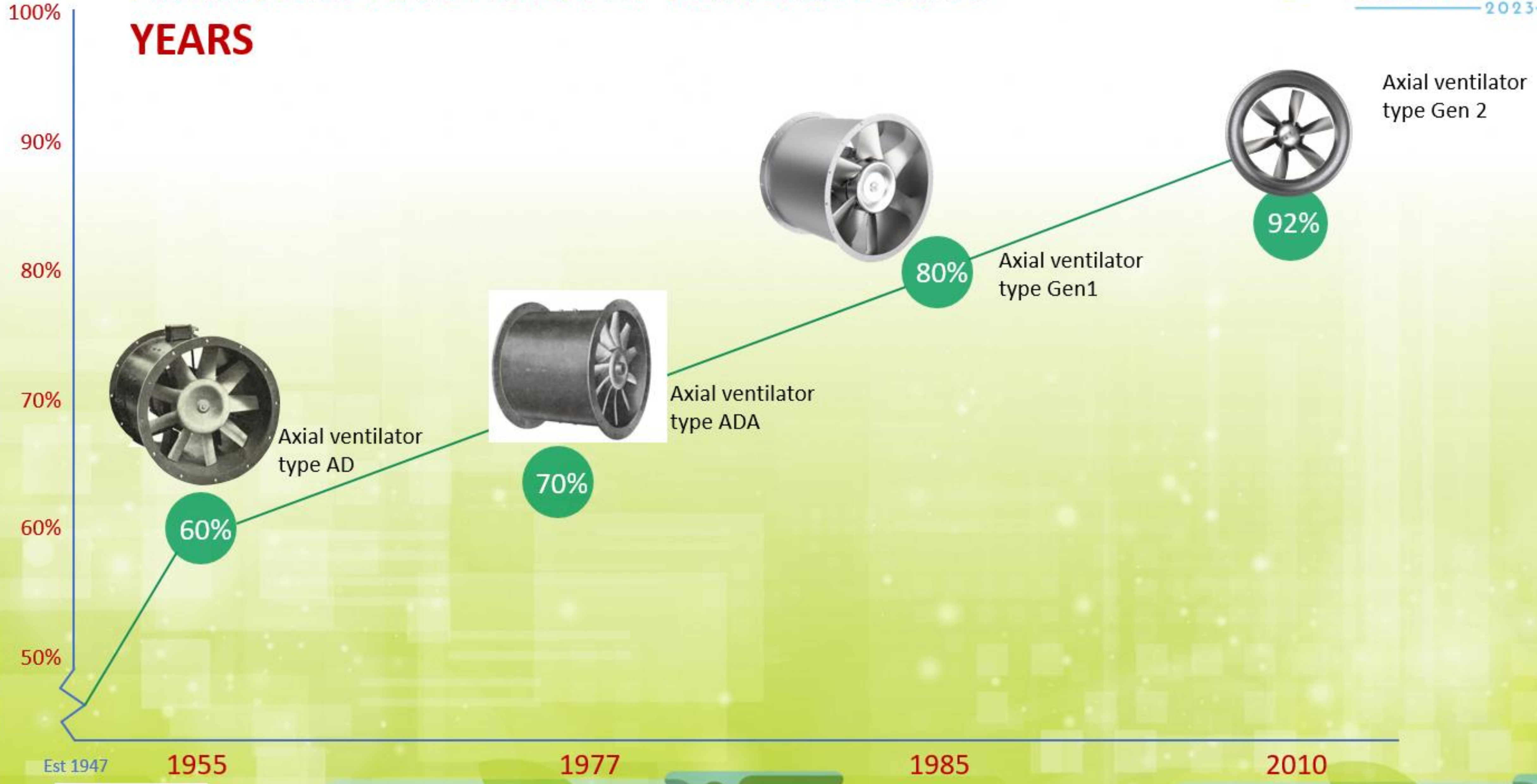
Why concentrate on HVAC system?

As per consumption in 2021, HVAC system is the biggest consumer of electricity



AXIAL FANS HAVE BEEN OPTIMISING FOR 70 YEARS



Improvement over the years on Axial fans that increased the efficiency.

1. Blade efficiency.
2. Minimum Blade tip clearance
3. Hub design,
4. Profiled guide vanes.
5. Durable Fan casing

IT IS ALL THESE FACTORS COMBINED

That has helped to get the efficiency upto 90%

Benefits of high efficiency axial fan

DYNAMIC PRESSURE IS THE KEYWORD

- HVAC systems, which only utilize the static pressure, cannot achieve efficiencies above 90%, as the dynamic pressure goes to waste
- To achieve the most energy-efficient ventilation system, fans that use both the static and dynamic pressures are required
- The efficiency of plug and centrifugal fans is calculated solely on the basis of the static pressure. This is because these systems are unable to utilize the dynamic pressure, which they literally throw away. But, axial fans utilize both the static and dynamic pressures, which means that the efficiencies are based on the total pressure, which makes them capable of achieving efficiencies above 90%
- The majority of centrifugal fans may at best reach efficiencies between 65-70%, while axial fans can perform up to approximately 80%. A main reason for the significant difference is in the way the air moves through the fan. In axial fans the air flows parallel to the fan axis, whereas it flows perpendicular to the fan axis in centrifugal fans and causes loss of velocity energy
- In axial fans, the loss is minimal due to the aerodynamic design that ensures straight airflows with little or no turbulence compared to centrifugal fans. This difference in design generally provides the higher efficiency levels of axial fans
- The newer axial fans can reach unmatched efficiencies of 92%. This is ground-breaking new levels for axial fans and lowers the overall power consumption and sound

- **Difference in air flow between centrifugal fans and axial fans**

Difference in air flow between centrifugal fans and ZerAx® axial fans

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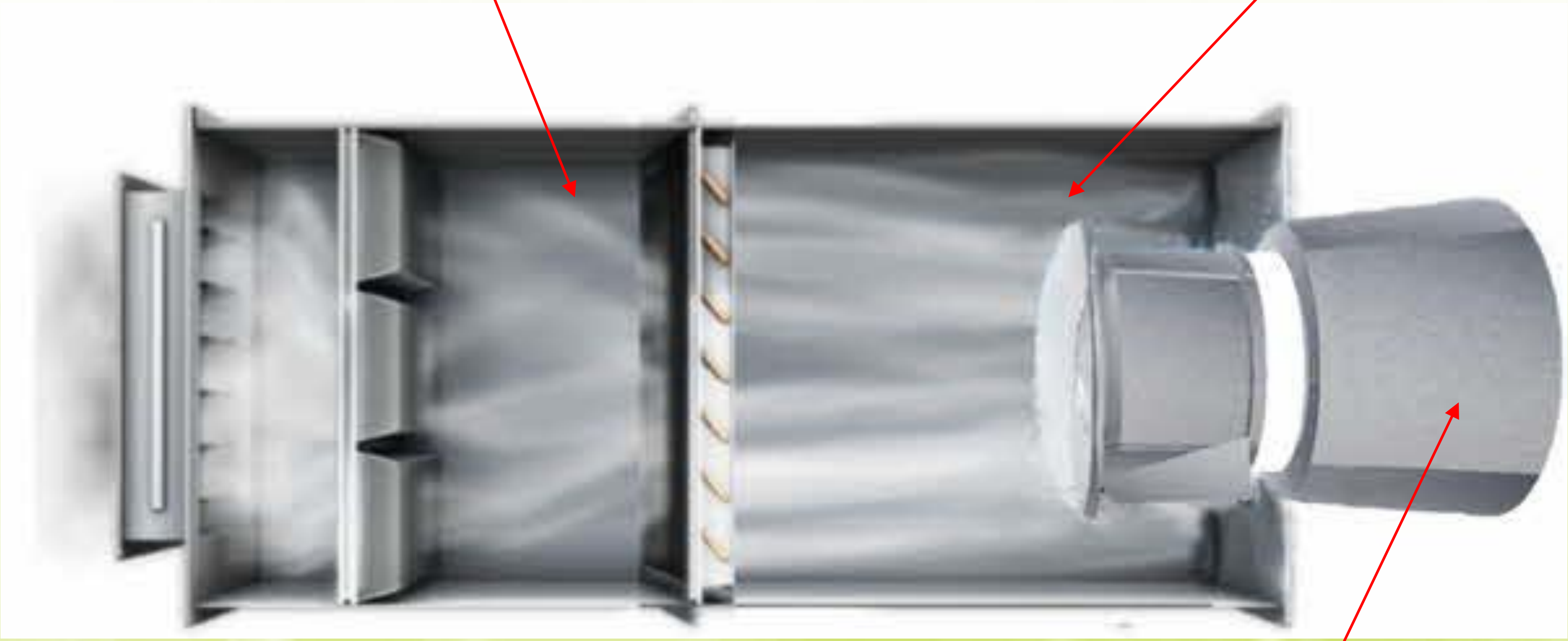
Air flow through AHU using high efficiency axial fan

Uniform air flow through AHU

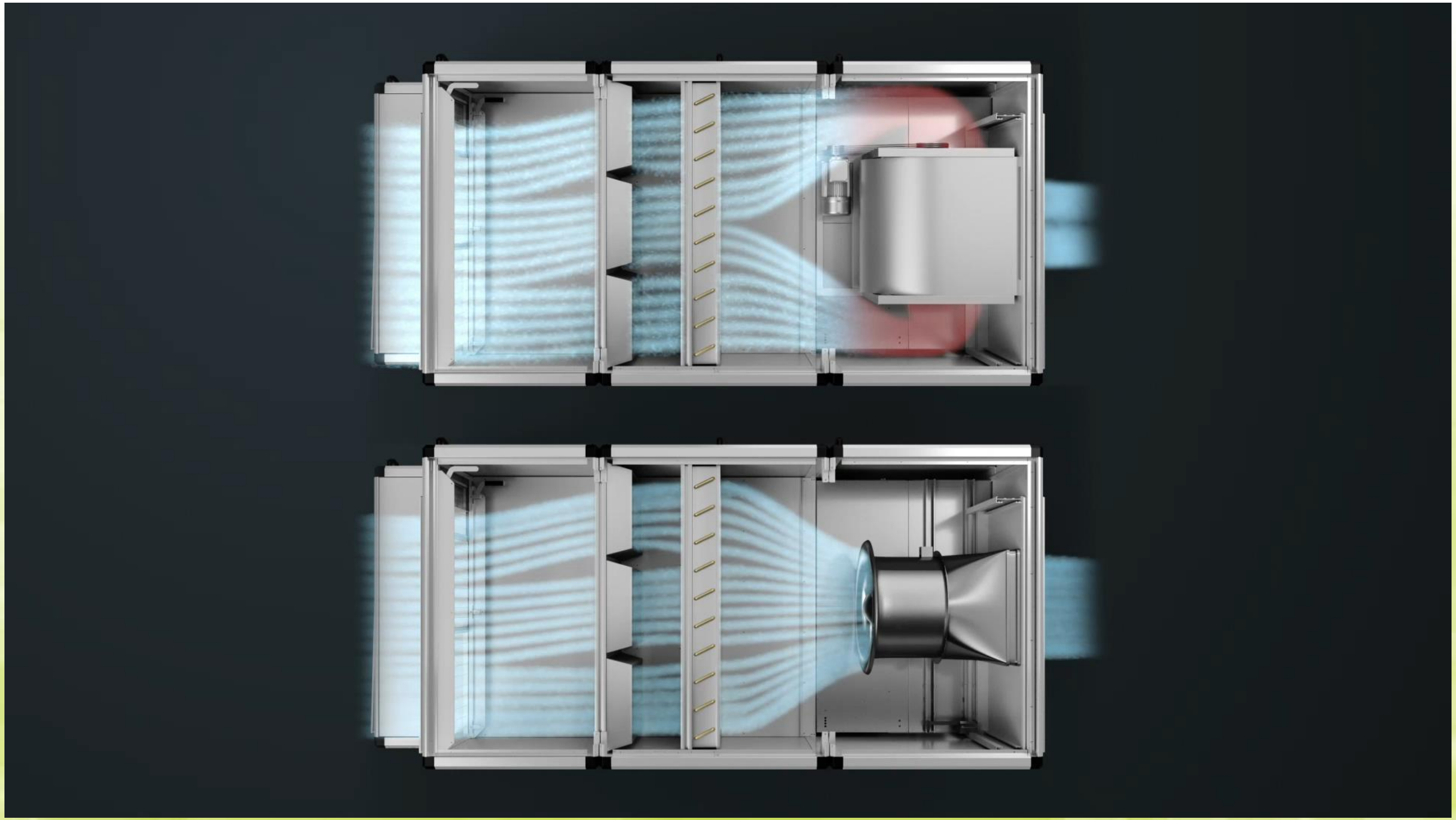
Laminar airflow results in reduced AHU internal pressure loss



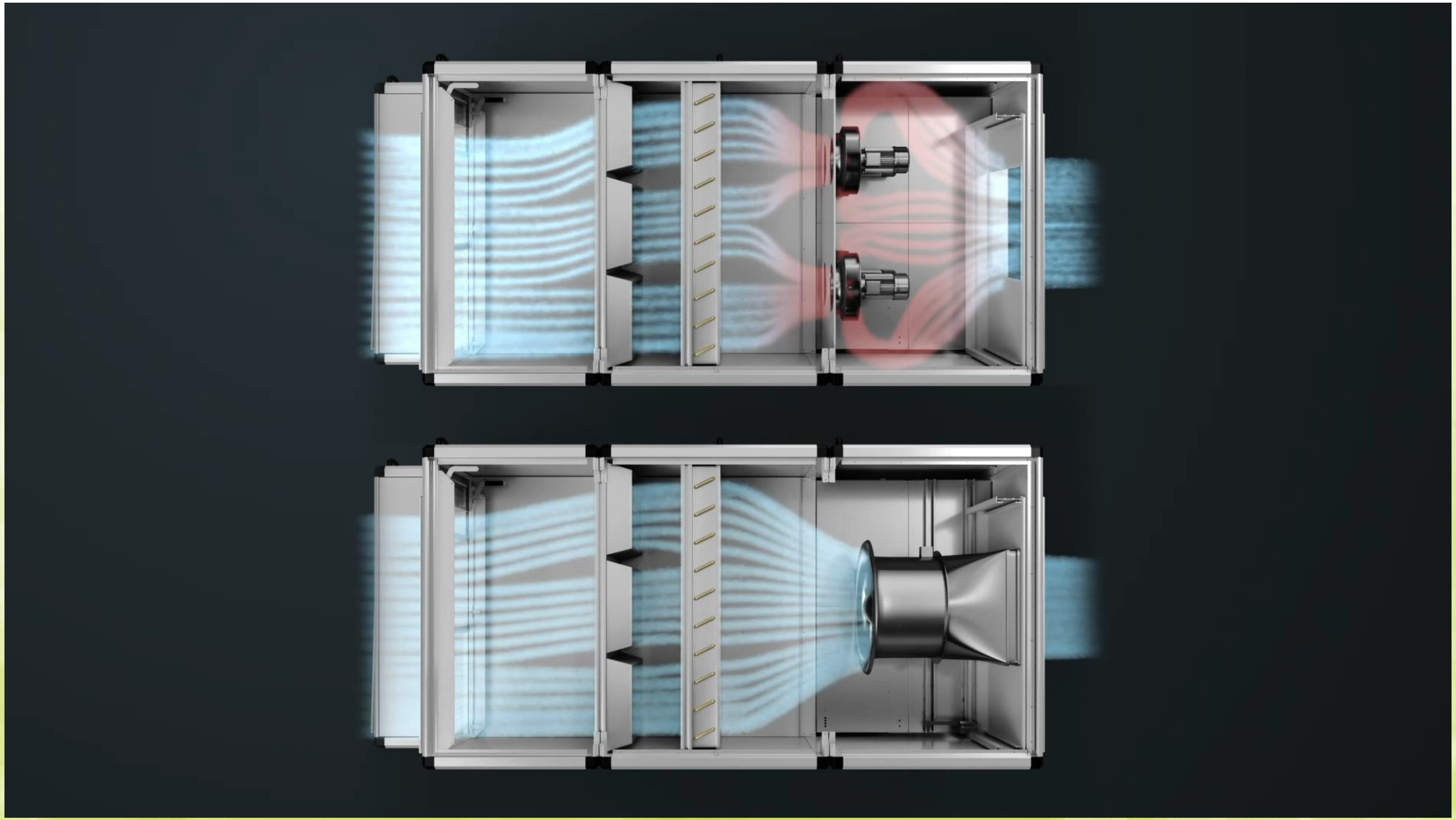
Big reduction in 'System Effect'!!!

Air is discharged directly into ductwork utilizing both static and dynamic pressure

Air flow comparison between centrifugal and axial fan



Air flow comparison between EC plug fan and axial fan



Other benefits of axial fans

- **Less preventive maintenance**
  - Since no belts are there for drive frequent inspection is avoided
  - Less downtime for belt inspection
  - No need to change belts and no need to stock belts in store
- **Safer maintenance**
  - Less maintenance means safer maintenance
  - Belt drives are more prone to accidents than direct drive
- **Less noise compared to centrifugal fans**
- **98% recyclable at end of life**

Differences between axial and centrifugal fans

Axial Fans	Centrifugal Fans
•High Volume/Low Pressure •Airflow parallel to axis •Higher operating speed than centrifugal •Compact designs •Lower power usage than centrifugal •Less audible noise than centrifugal •Typically, less expensive than centrifugal	•High Pressure/Low Volume •Airflow perpendicular to axis •Lower operating speed than axial •Better for specific directed cooling •Typically uses more power than axial •More audible noise than axial •Durable and resistant to harsh environments

Alcon's axial fan project

Situation before the project

- Thirty AHUs are used in the facility and the total operating fan power is estimated to be more than 730 kW. Most of the AHUs are in operation, and the fans are of conventional belt driven centrifugal type. The measured efficiency of the critical AHUs ranges from 0.46 to about 0.92 W /CMH for the critical AHUs, while the efficiency for the non-critical AHUs ranged from 0.23 to 0.74 W /CMH for the non-critical AHUs, which are generally worse than the baseline efficiency for AHUs in the SS530 guideline of 0.47 W /CMH.

How did we arrive at the project?

- **Energy audit**

  Energy audit conducted at the site showed that our W/m3 are higher than the standards and this prompted us to look for a solution

- **Conferences**

  Attending conferences where we were able to get some info on potential suppliers who can help us to solve our problem

- **Engineering team**

  Engineering team worked on alternatives and came up with the solution

- **Management**

  Management was supportive of new ideas and hence they approved the capex

Approval process

- Alcon's facility has over 30 AHUs and more than ½ of them are in the critical areas like the clean room, lab etc.
- To get the necessary approval from the Operations/Management, we decided to do a change out in 2 non critical AHU as 'Proof of concept'
- Prior to change out, all the parameters such as flow, pressure, temperature and Rh were measured
- After completion, the same parameters were checked to make sure that they are the same as before
- The measured energy saving was as predicted and we submitted the report to Operations/Management

Expected project ROI calculation

- Energy saving on 14 AHUs= 677,500kwh
- Saving per year taking electricity cost (2022) @0.16/Kwh= 108,400S$
- Other indirect savings= 13,000S$
- Total savings=121,400S$
- Capex is estimated= 415,000S$
- Return on investment= 121,400/415,000= 29%
- Pay back period= 3.42 years

Project details

- Took about 2 months to finalize the technical details and quotation
- Purchase order was released soon after
- Materials started arriving after 5 months of the PO
- Erection was scheduled during the plant shutdown
- Vendor changed an average of 2 fans per day and completed the erection in around 14 days
- Commissioning went without any major issues
- Post reading taken to confirm the performance
- Final report issued

Photo of AHU before changing Centrifugal fan

Photo of AHU after changing Axial fan

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Example of pre and post measurement of parameters for 1 of the 14 fans

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AH-124-40 Return

Spot Measurement Results (Pre-retrofit) – 15 November 2022

Airflow (CMH)	Total Static Pressure (Pa)	Operating Frequency (Hz)	Input Power (kW)
60005	595	34	14.38

Duct Cross-sectional Area (m^2)

Length	2	m
Width	0.9	m
Area	1.8	m^2

Duct Velocity (m/s)

11.5	8.5	5.5	6.5	9	8.8	9.5	11.5	11.5	10.3
Average	9.26								

Spot Measurement Results (Post-retrofit) – 24 November 2022

Airflow (CMH)	Total Static Pressure (Pa)	Operating Frequency (Hz)	Input Power (kW)
61754	609	157	12.20

Duct Cross-sectional Area (m^2)

Length	2	m
Width	0.9	m
Area	1.8	m^2

Duct Velocity (m/s)

11.3	9.5	6.8	7.2	8.8	9.9	9.7	10.6	10.9	10.6
Average	9.53								

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Design data for existing and new fans

Existing Fan Design

The existing fan design data was taken from the name plates and datasheets provided by the client.

Item	Equipment Designation	Air Flow m^3/h	Total Static Pressure Pa	Motor kW
1	AH-124-00	34,500	1,836	30
2	AH-124-10	45,800	1,940	37
3	AH-124-20 Supply	62,900	1,915	55
4	AH-124-20 Return	63,600	966	30
5	AH-124-30 Supply	41,300	1,946	37
6	AH-124-30 Return	37,600	958	18.5
7	AH-124-40 Supply	82,800	1,948	75
8	AH-124-40 Return	82,000	958	45
9	AH-126-10	50,200	2,046	45
10	AH-127-10	82,500	1,672	75
11	AH-132-10	69,000	2,424	75
12	AH-135-10	52,800	1,380	37
13	AH-139-10	38,600	1,365	30
14	SF-140-10	36,000	450	15

The new fan was sized based on the pre-measurement data.

Item	Equipment Designation	Fan Model	Air Flow m^3/h	Total Pressure Pa	Motor kW
1	AH-124-00	AZL 710/350-6	34,500	1,920	21.7
2	AH-124-10	AZL 800/350-6	45,800	1,500	31
3	AH-124-20 Supply	AZN 1120/560-6	74,000	1,730	55
4	AH-124-20 Return	AZL 1000/350-6	85,000	850	30
5	AH-124-30 Supply	AZL 800/350-6	41,300	1,400	19.3
6	AH-124-30 Return	AZL 900/350-6	37,600	800	13.2
7	AH-124-40 Supply	AZL 1000/350-6	74,000	1,150	44.7
8	AH-124-40 Return	AZL 1000/350-6	60,000	850	31
9	AH-126-10	AZL 800/350-6	50,200	1,800	31
10	AH-127-10	AZN 1120/560-6	82,500	1,672	55
11	AH-132-10	AZL 710/350-6	51,000	2,466	44.7
12	AH-135-10	AZL 900/350-6	54,000	1,300	31
13	AH-139-10	AZL 900/350-6	50,000	1,150	21.7
14	SF-140-10	AZL 900/350-6	36000	450	12.1

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Energy saving
Results of pre and post measurement on energy consumed

Summary of Measurement Data

Equipment Designation	Pre-Measurement Air Flow (m³/h)	Pre-Measurement TSP (Pa)	Pre-Measurement Power (kW)	Post-Measurement Air Flow (m³/h)	Post-Measurement TSP (Pa)	Post-Measurement Power (kW)
AH-124-00	32148	1712	26.92	32570	1645	19.7
AH-124-10	39269	1067	17.28	38146	966	13.1
AH-124-20 Supply	69390	1728	54.43	67878	1559	41.6
AH-124-20 Return	72230	900	31.7	72749	879	22.3
AH-124-30 Supply	36149	930	15.73	35342	955	11.8
AH-124-30 Return	27300	377	6.35	27844	315	3.07
AH-124-40 Supply	62532	775	20.44	56182	717	18.2
AH-124-40 Return	60005	595	14.38	61754	609	12.2
AH-126-10	30960	1009	17.61	31560	898	13.4
AH-127-10	77752	1295	50.58	86305	1173	32.8
AH-132-10	51326	1840	35.77	54220	1821	32.6
AH-135-10	44462	1274	25.33	43659	893	15.4
AH-139-10	66485	941	24.8	66679	1025	16.1
SF-140-10*	-	346	8.56	37000	215	4.517
	Total (Before)		**349.88**	Total (After)		**256.83**
	Average Energy Savings					**26.6%**

*Power consumption taken from SF-140-11 as SF-140-10 was drawing a high power of 16.89 kW.
New fan was adjusted to design air flow based on measured static pressure and power consumption.

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Actual performance of the project

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Item	Result	Calculation (please show your calculations and provide supporting documents)
Actual baseline system performance (e.g. COP, kW/ton, kW/m³, kg steam/litre of diesel or fuel oil, kgCO_2e/tonne of product)	0.508 W/m3	Total air flow for 13 AHU is 670008 m3/hr and the power consumption is 341.32 Kw. So 341.32x1000/670008= .508
Actual post-implementation system performance (e.g. COP, kW/ton, kW/m³, kg steam/litre of diesel or fuel oil, kgCO_2e/tonne of product)	0.374 W/m3	Total air flow for 13 AHU is 674888 m3/hr and the power consumption is 252.27 Kw. So 252.27x1000/674888= .374
Actual annual baseline energy consumption (TJ) and carbon emission (if applicable) (tCO_2e)	10.76 TJ	341.32*24*365=2989963 Kwh yearly Converted to TJ it will be 10.76TJ
Actual annual post-implementation energy consumption (TJ) and carbon emission (if applicable) (tCO_2e)	7.96Tj	252.27*24*365=2209885 Kwh yearly Converted to TJ it will be 7.96TJ
Actual annual energy savings (TJ) and carbon abatement (if applicable) achieved (tCO_2e)	2.8TJ 317MT CO2 indirectly	2989963-2209885=780078 Kwh Converted to TJ it will be 2.8TJ
Actual annual energy costs savings (S$)	130KS$	780078*.167=130273S$. (0.167 S$ is the average cost of electricity for site in 2022)
Actual annual energy savings and carbon abatement (if applicable) (%) on a system level	~16%	780078/4861948=0.16 Project commissioned in December so December system consumption is lower hence 16% is an approximate number.
Actual annual energy savings and carbon abatement (if applicable) (%) on a facility level [3]	~6.5%	780078/12015551=0.065 Project commissioned in December so December site consumption is lower hence 6.5% is an approximate number.
Investment amount (S$)	415KS$	
Payback period (years)	3.19yrs	415/130=3.19

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Major barriers for implementation

- The main barrier was the issues with clean room management regulatory issues. Any change required a lot of study and production pressures kept away any changes which may affect the parameters. This barrier was overcome by convincing the Operations management about the performance of the axial fans and issuing a ‘Proof of concept’ documentation. We went with a trial of changing 2 fans first to back up the ‘Proof of concept’. The results of the trial convinced the management that all parameters are within the limit with a general saving of about 20% power

- The second barrier is an engineering one which is to replace the existing fan with axial fan without too much modification. Even though there were some modification, it was very minor due to the good work done by the contractors

- The third barrier is time. Since the rooms cannot be taken off line for an extended period of time, the replacement need to be done in 1 day or maximum 2 days. Here again, the contractor has done good planning and was able to get it completed on time

Thank You.

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