Ventilating Shallow Platinum Mine Shafts in a More Energy Efficient Manner

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ABSTRACT

- Design and develop an alternative more energy-efficient axial flow main surface fans for shallow platinum mine shafts
- Replace older generation 110kW contra-rotating dual stage fan sets with the new generation 75kW fans.
- Definite financial gain
- Significant reduction in noise
- Simplicity with regards to maintenance

CONTENT

INTRODUCTION

“A well designed fan is required to improve the overall ventilation system efficiency. With the correct system considerations in the design process it reduces wasted air power while enhancing system efficiency.”

- Key focus - Electricity cost
- High powered auxiliary fans - High energy demand
- Replace energy inefficient operating units
- Main contributors to low efficiency
  - Fan Design, & Fan Selection
- Previously used of the shelve products closest to system requirements
- Design critical
  - Performance requirements
  - Energy consumption
  - Fan selection for application

BACKGROUND

Contra-rotating dual stage 110kW fan sets

- Older generation 110 kW contra-rotating dual stage fan sets.
- Robust good performance vs Low Energy Efficiency
- No energy efficient alternative with similar duties available on the market.
- A total of 46 of these 110 kW fan sets installed at the different shallow platinum mine shafts

Original 110kW fan performance

Description	Unit	Measurements
Average airflow Quantity per fan set	m^3/s	24.5
Average Pressure loss	kPa	1.78
Power Consumption at duty	kW	115
Fan efficiency at duty	%	42

NEW GENERATION 75KW FANS

Objective: Improve on the energy usage and associated energy cost

- Close fit to the design requirements -standard 75 kW fan units.

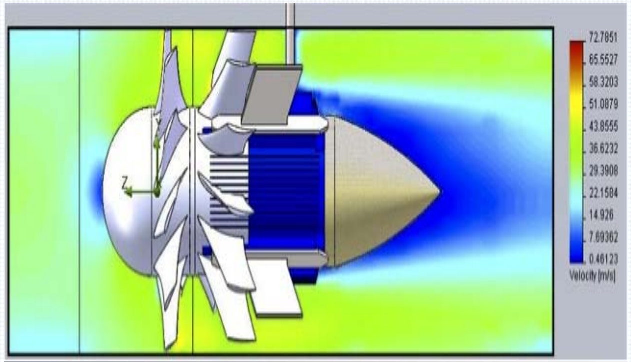
- Development - increase performance

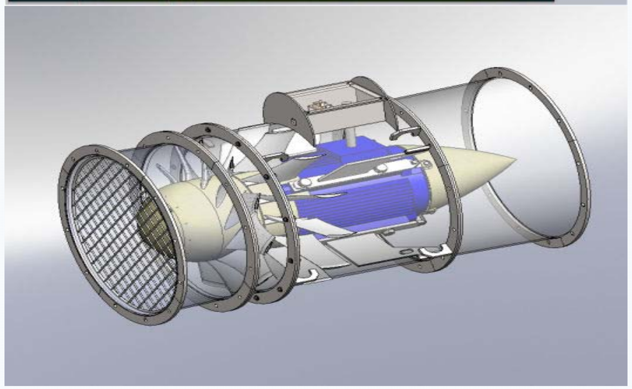
  - the actual fan performance requirements
  - in a more energy efficient manner

- Design Parameters
  - Minimum 20 m^3/s @ 2kPa
  - Ability to handle higher pressures (of up to 2.5 kPa)

NEW GENERATION 75KW FANS (CONTINUE)

Advanced Technology



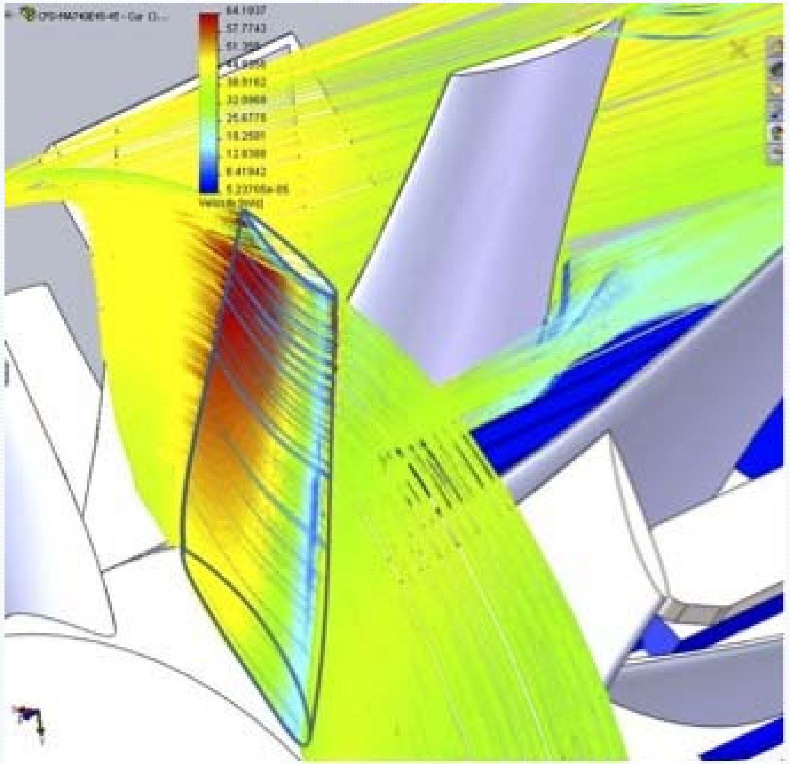


- 3-D computer aided design (CAD) model,
  - Aerodynamic design
- Computational fluid dynamics (CFD) analysis
  - Verify the aerodynamic design
- Finite element analysis (FEA) for the stressing of the structure.
  - Optimise the strength of structures under load and vibration
  - Minimise vibration

NEW GENERATION 75KW FANS (CONTINUE)

Aerodynamic Design

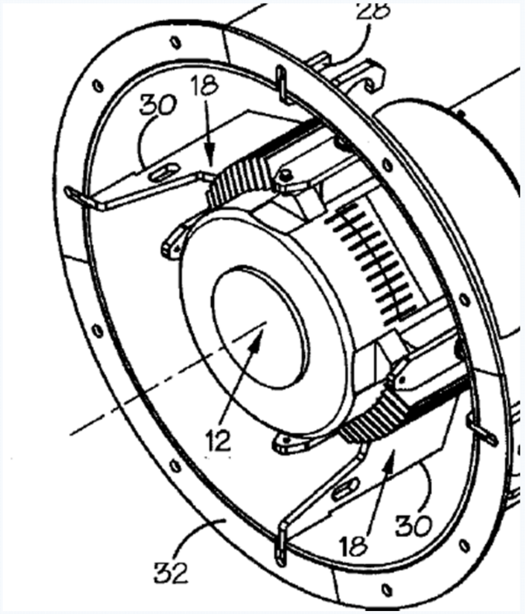
- The "aerodynamic profile" is decisive when it comes to blade performance and efficiency.
- Slight alterations to the shape of the profile can greatly alter the power and noise level.
- Higher efficiencies in an axial flow fan can be achieved if the rotor blades are profiled and have a certain <u>twist.</u>
- Aerodynamic profiles have better lift-to-drag ratios than cambered plates and hence reduce the drag on the rotor, thereby reducing the power required.
- Nose and tail cones are shaped and positioned to improve efficiencies.



NEW GENERATION 75KW FANS (CONTINUE)

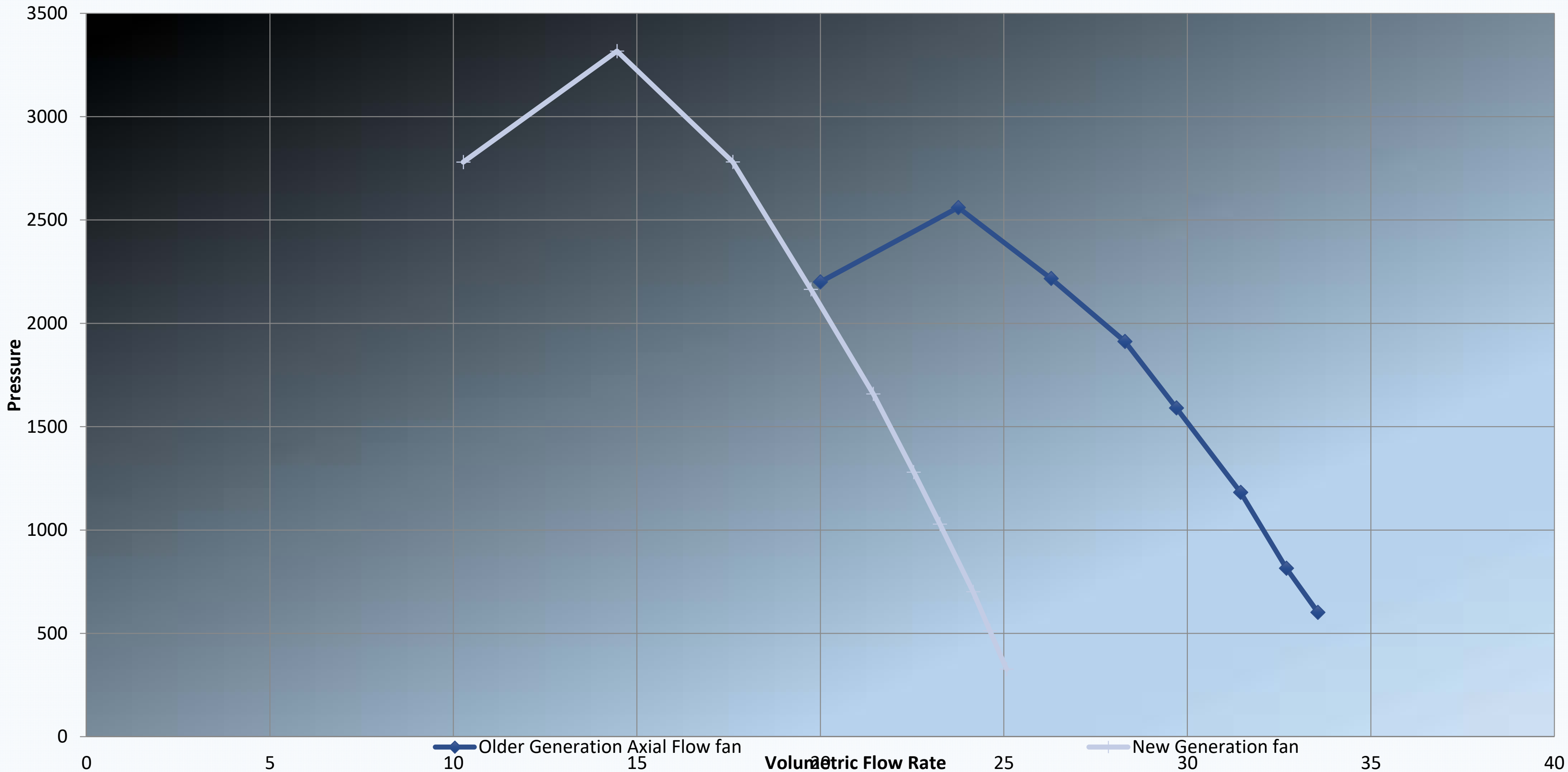
Reduced Vibration

- Vibrations reduced by dynamically balancing rotors.
- Improve stiffness in the axial direction by replacing the tie rod with a strut arrangement.
- Reduction of vibrations in the axial direction.
- Typical vibration measurements for the strut assembly are generally below 0.5 mm/s with motors attached by this method.



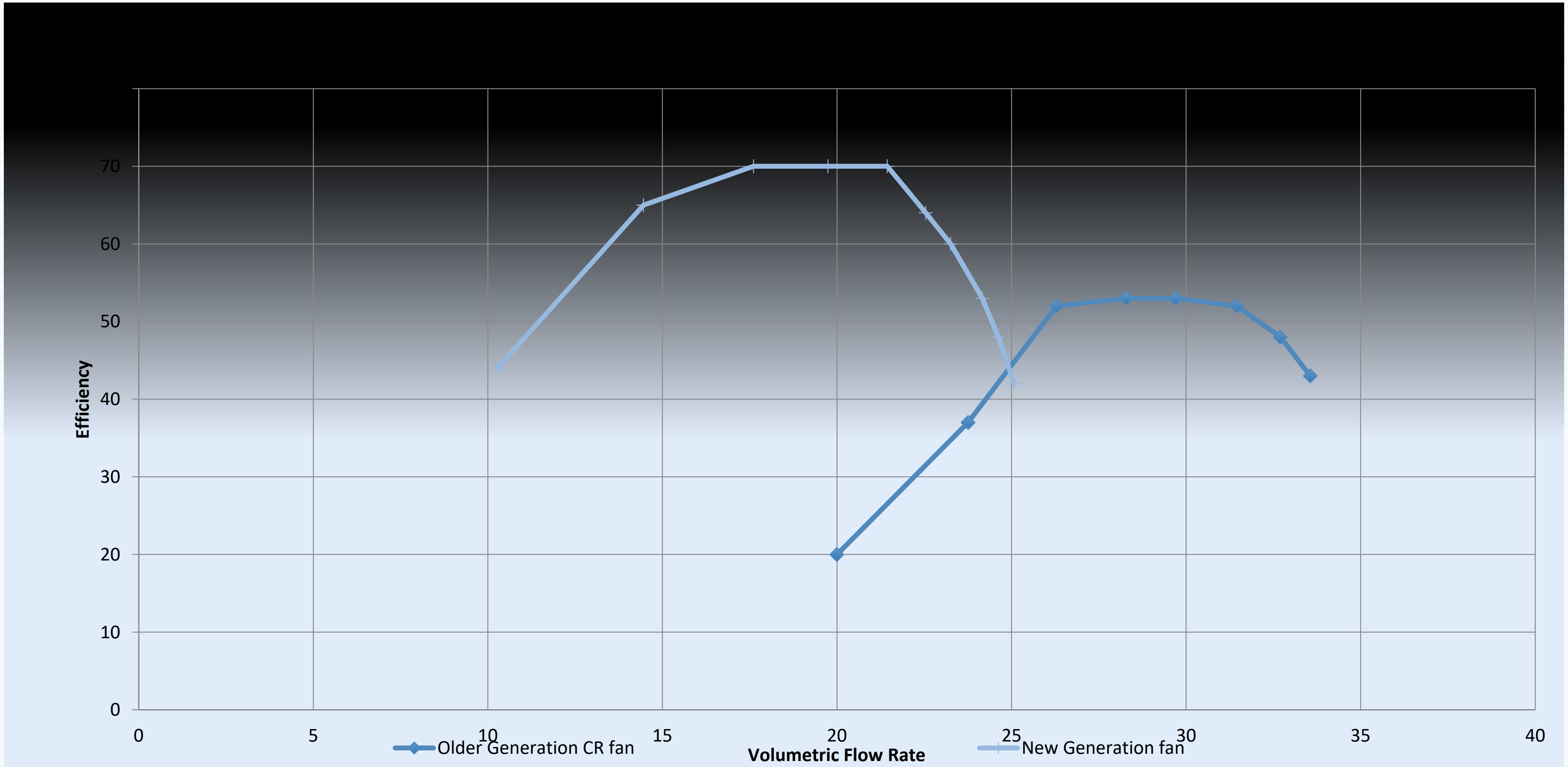
75 KW FAN VS 110KW CONTRA-ROTATING

TEST COLUMN PERFORMANCE



75 KW FAN VS 110KW CONTRA-ROTATING

TEST COLUMN EFFICIENCY



75 KW FAN VS 110KW CONTRA-ROTATING
INSTALLED AT SITE PERFORMANCE

POSITION	Type of Fans	PRESSURE	VOLUME (m^3/s)
Position 1	110kW CR	1540 Pa	26.7
Position 1	110kW CR	1480Pa	28.4
Position 2	110kW CR	1940Pa	24.6
Position 2	110kW CR	2160Pa	25.4
Position 3	110kW CR	1560Pa	24.1
Position 3	110kW CR	1900Pa	22.5
Position 3	110kW CR	1620Pa	22.3
Position 4	75kW New	2200Pa	23.0
Position 4	75kW New	2200Pa	22.1

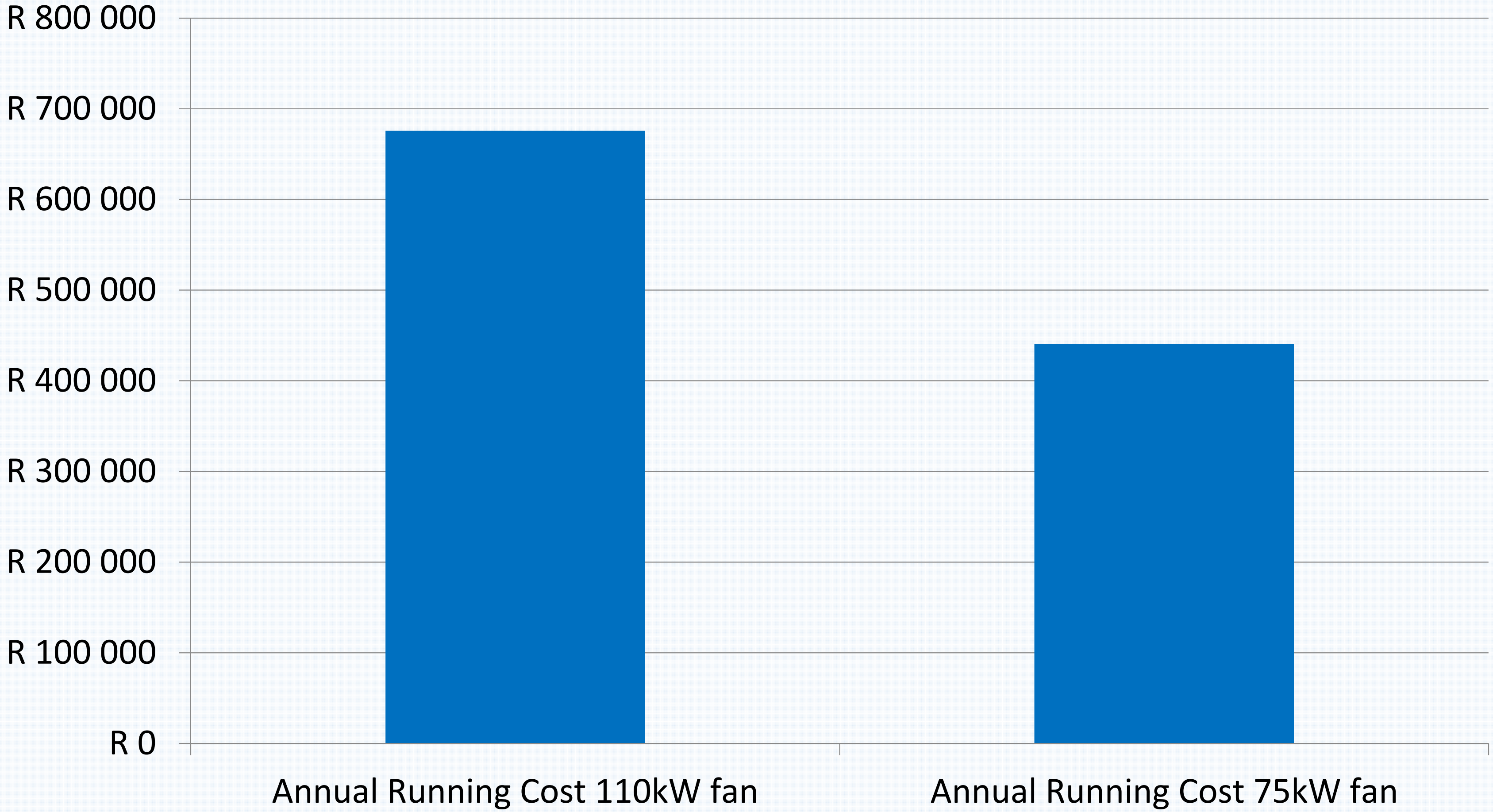
CONVERSION

- Pre-manufactured and specifically designed diffusers and reducers
  - Conversion to similar dimensions
  - Ease of installation & direct fitment
  - 1016mm fan fitting directly larger1200mm ducting.

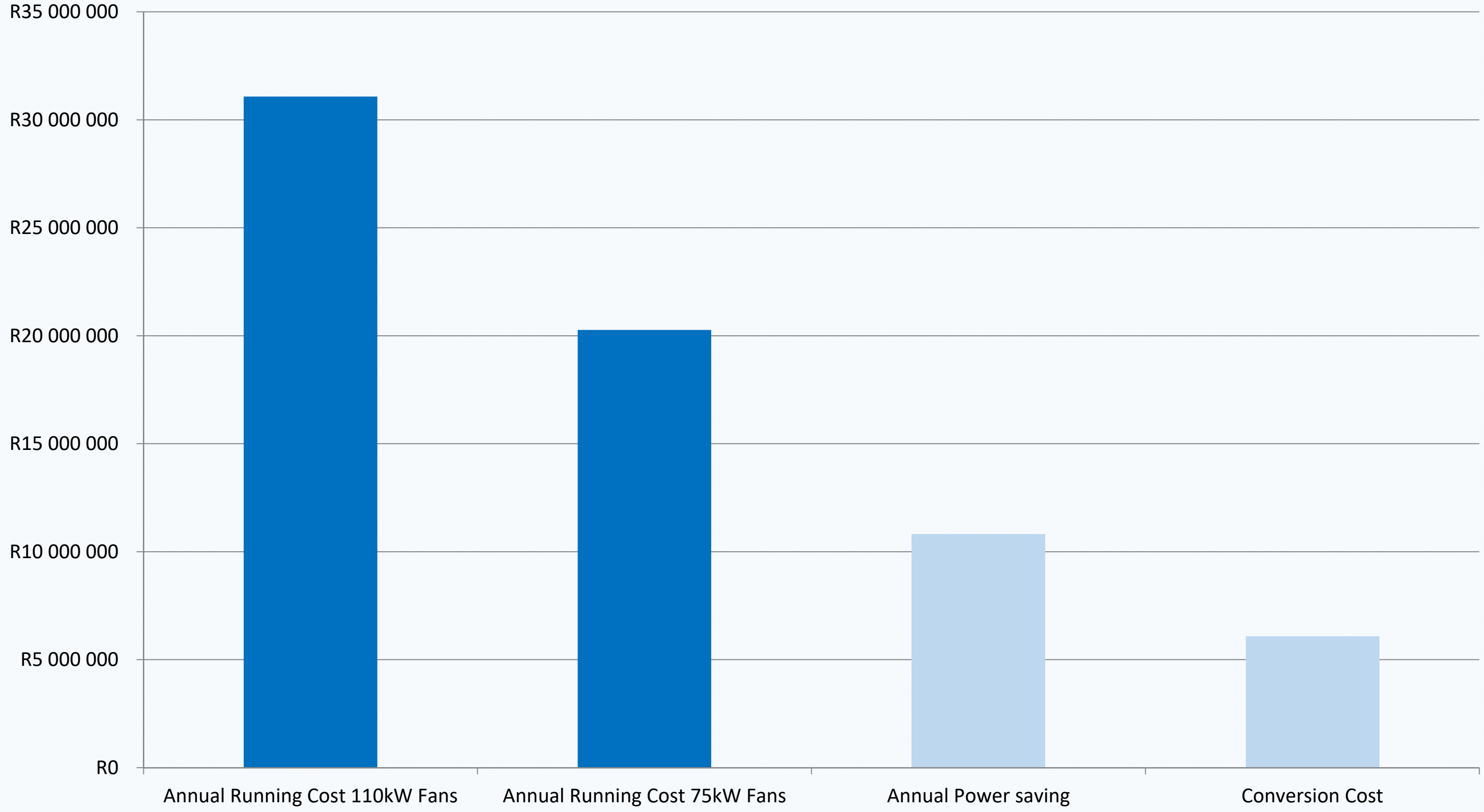
- Replacement Cost per fan

9 blade, 1016mm, 2 pole 75kW fan	R 92 900
Diffuser and Reducer	R 6 335
Junction Boxes	R 3 349
Mother Boxes, DW225	R 8 500
150A Feeders, DW150	R 8 100
75kW Fan Starter,DW75F	R 13 200
Total replacement cost per fan	R 132 384

Running Cost Comparison



PROJECT COST BENEFIT



PROJECT PAYBACK

Annual Running Cost 110kW Fans	R 31 079 808
Annual Running Cost 75kW Fans	R 20 269 440
Annual Power saving	R 10 810 368
Conversion Cost	R 6 089 572

Direct saving in the first year of R4 720 704,00

(excluding any consideration for the maintenance costs)

CONCLUSION

"A well designed fan is required to improve the overall ventilation system efficiency, with the correct system considerations in the design process as it reduces wasted air power while enhancing system efficiency"

- Definite financial gain
- Other advantages
  - the significant reduction in noise of more than 10dB(A),
  - less vibration
  - the simplicity with regards to maintenance.
- Short payback period 7 months
- Long term running cost saving

THANK YOU