Eskom

Large Scale Testing Of A Fan Design For ACCs Under Adverse Conditions

ACCUG 2017

October 2017

MinWaterCSP

NOTUS Fan Engineering

Content of the presentation

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- The “problem” with solving the problem
- Previous studies
- Basics of fan performance
- A different approach - pilot project
- Results
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About the ACC

- At the time of construction, the Matimba ACC was **11 times** larger than the largest ACC in operation anywhere in the world.
- Eskom established itself as a world leader in dry-cooled technology.
- 6 x 665 MW
- Historic load losses, published, specifically in windy months.
- During 2016, 7 cases of >1000 MW station load loss due to vacuum.

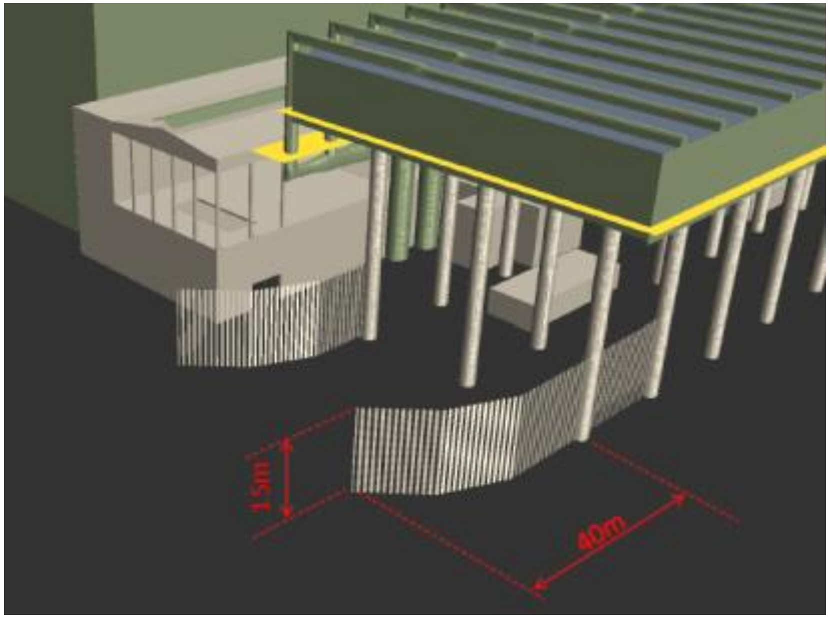
Date	Time	MW Load loss
September	16:00-17:00	1003
October	15:00-16:00	1025
October	14:00-17:00	1121
October	15:00-16:00	1041
October	14:00-15:00	1082
October	13:00-16:00	1135
December	14:00-15:00	1077

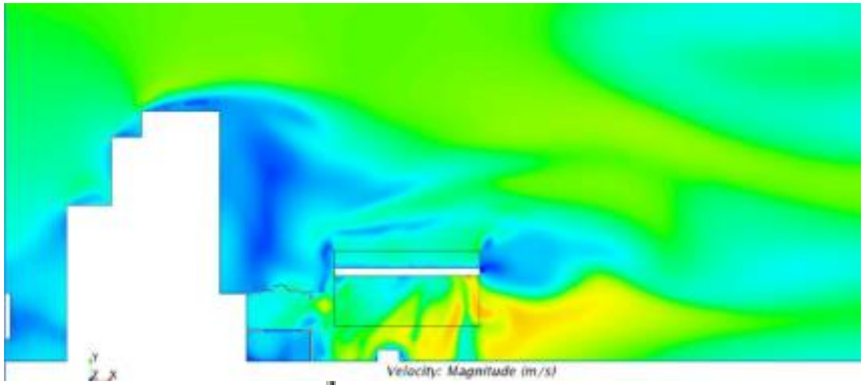
The “problem” with solving the problem

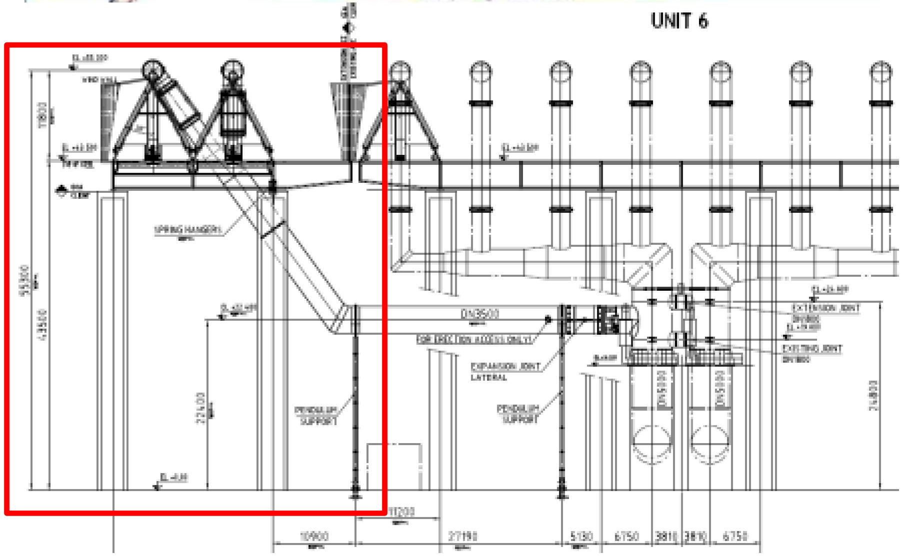
- Not feasible to reduce load losses entirely
- Typical average production ~ 24 000 GWh
- MWh loss due to vacuum related problems in 2016 ~ 350 000 MWh
- Loss percentage of total average production < 1.5%
- Economics makes it difficult to find a solution that justifies the capital expenditure without the guarantee of total load loss reduction.

Previous work

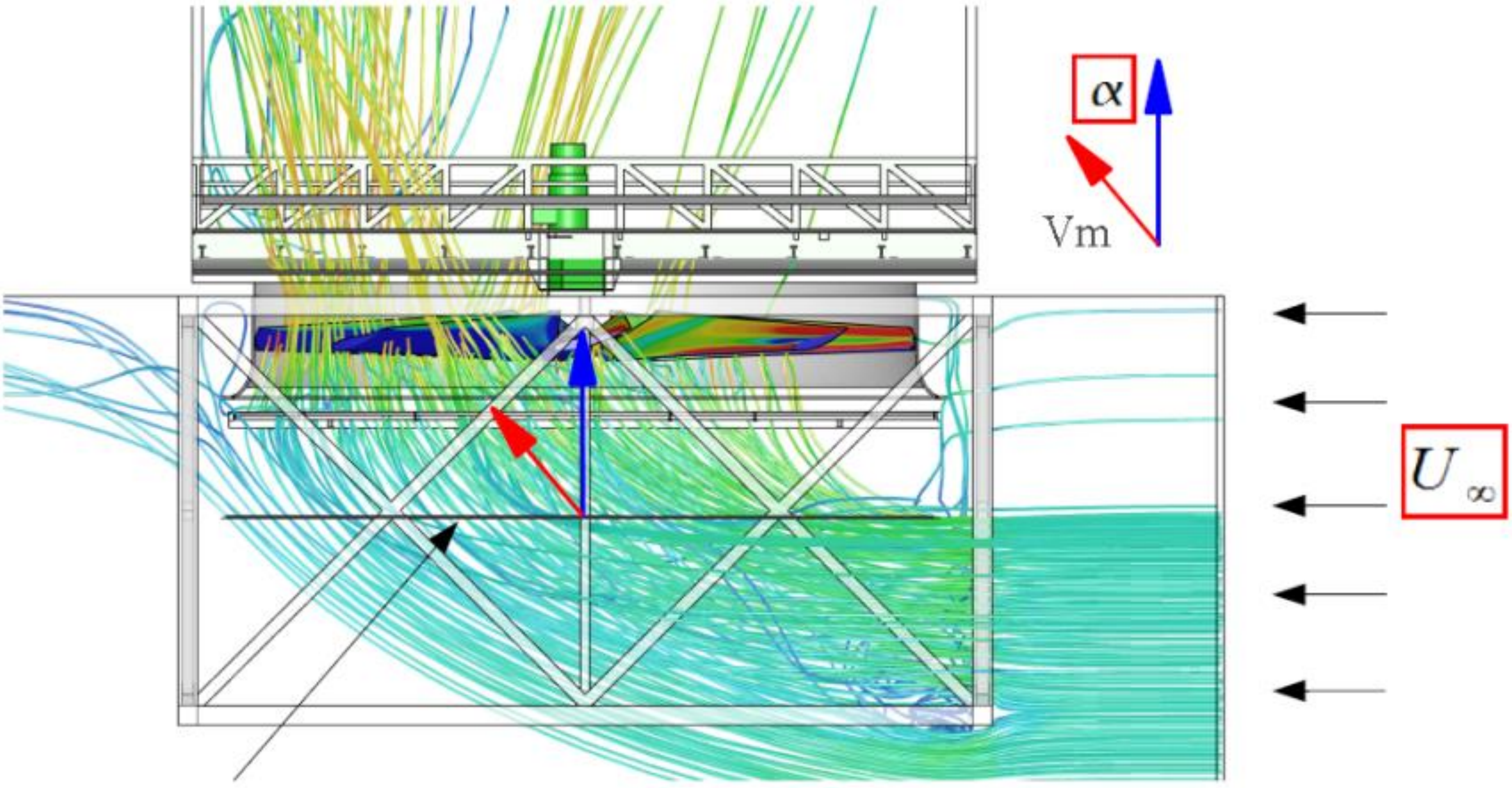
- CFD studies
- Unit 1 & 6 project
- Ash dam-condenser project







Basics of fan performance



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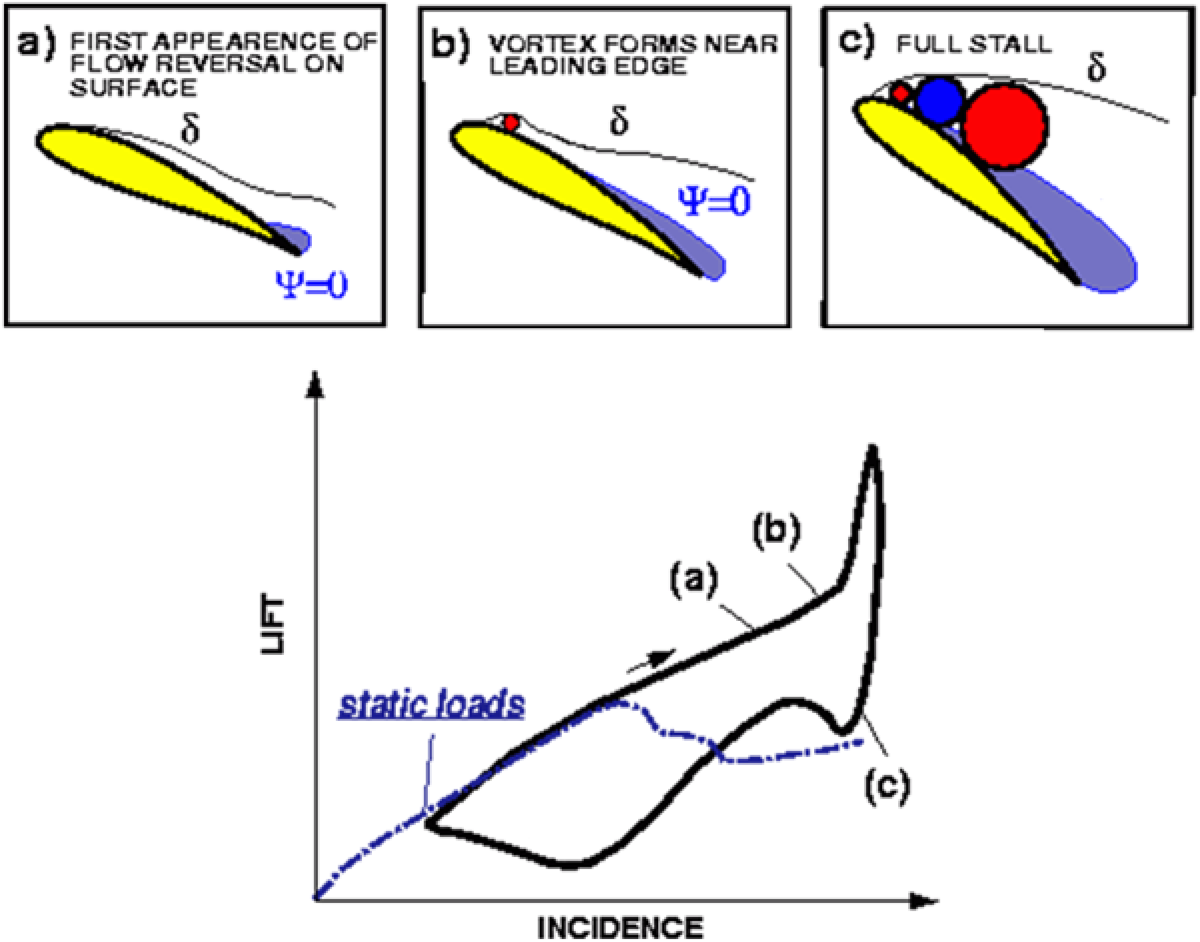
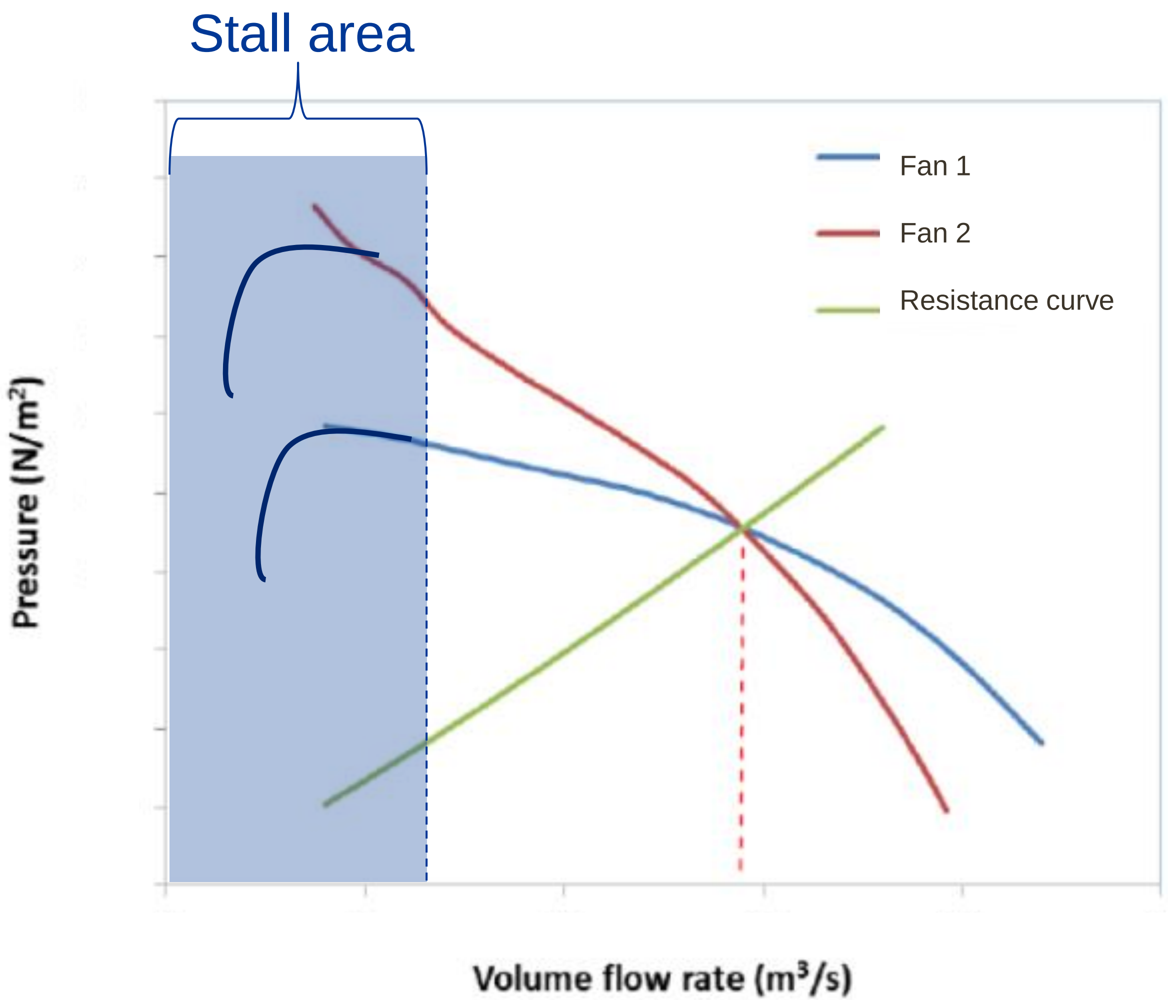
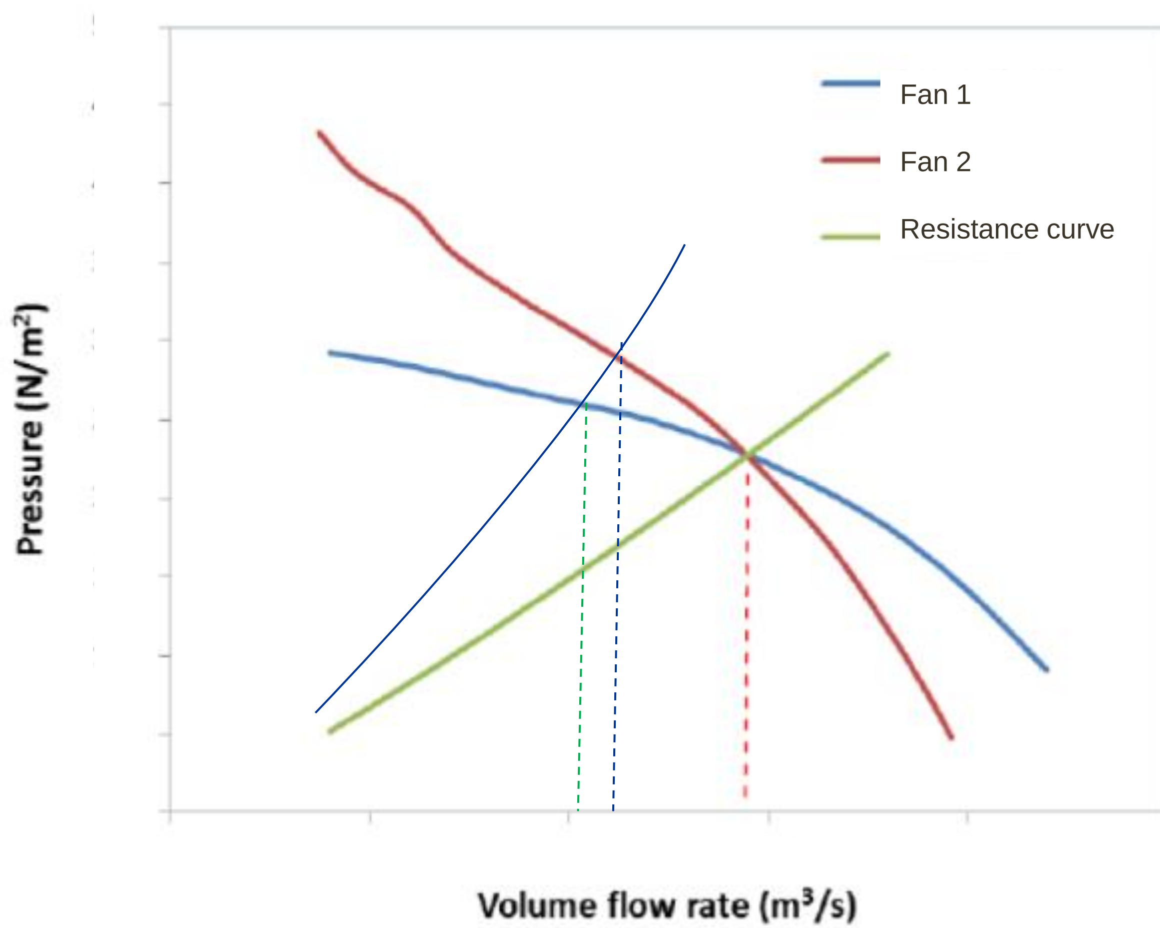


Basics of fan performance



Basics of fan performance



A different approach

- Horizon 2020: MinWaterCSP; EU funding program
- Reduction of water consumption in CSP applications
- Consortium: Kelvion & Enexio, ECILIMP Thermosolar, Soltigua, IRESEN, WATERLEAU Group, Notus Fan Engineering.
- Design, manufacture, install and commission a 30ft. Diameter ACC fan

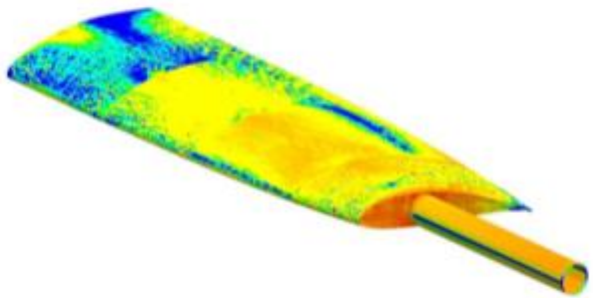
A different approach – fan design

Aerodynamic design

- Computational Fluid Dynamics (CFD)
- Duty point – same as current fan installed at Power station
- High fan static efficiency (~ 60%)
- Protection against wind (“steep” curve)

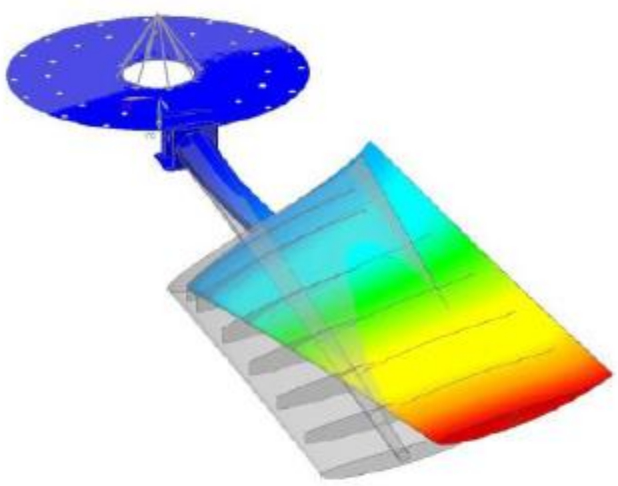
A different approach – fan design

Structural design



- Finite Element Analysis (FEA)
- Ultimate strength
- Fatigue (safety factor)

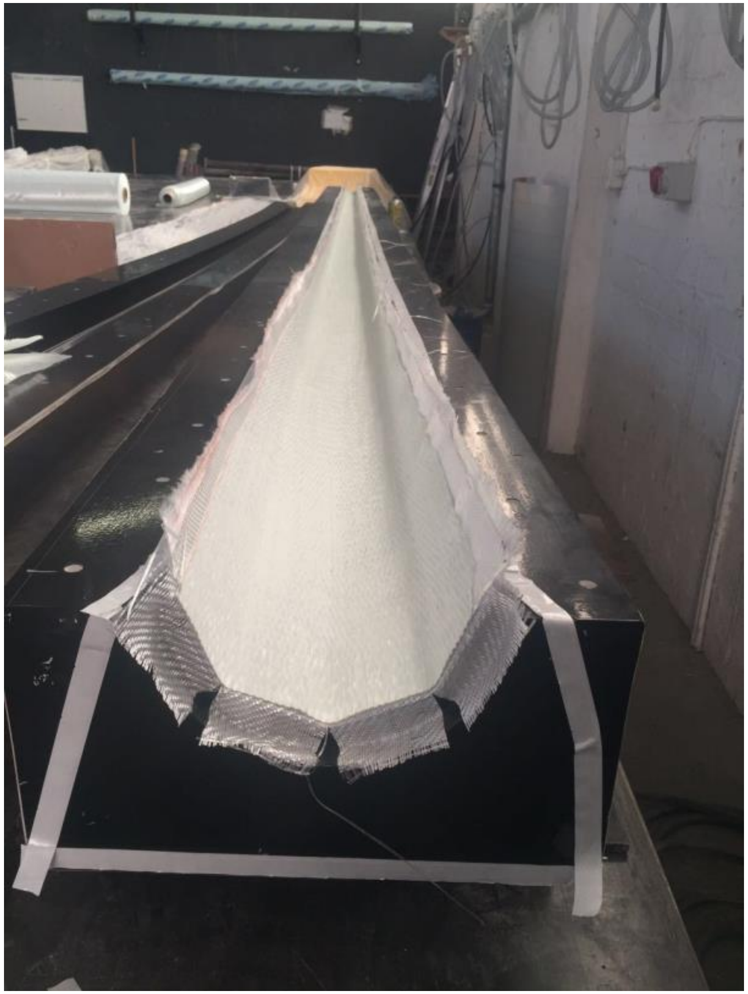
Dynamic design



- FEA – Modal analysis (vibration)
- Experimental data from PS (MSc)

A different approach - manufacturing

- Large scale ↔ model scale
- Blade setting angle - vibration
- Consistent weight
- Consistent weight distribution
- Infusion process > repeatable



A different approach – static tests

A different approach – pilot testing

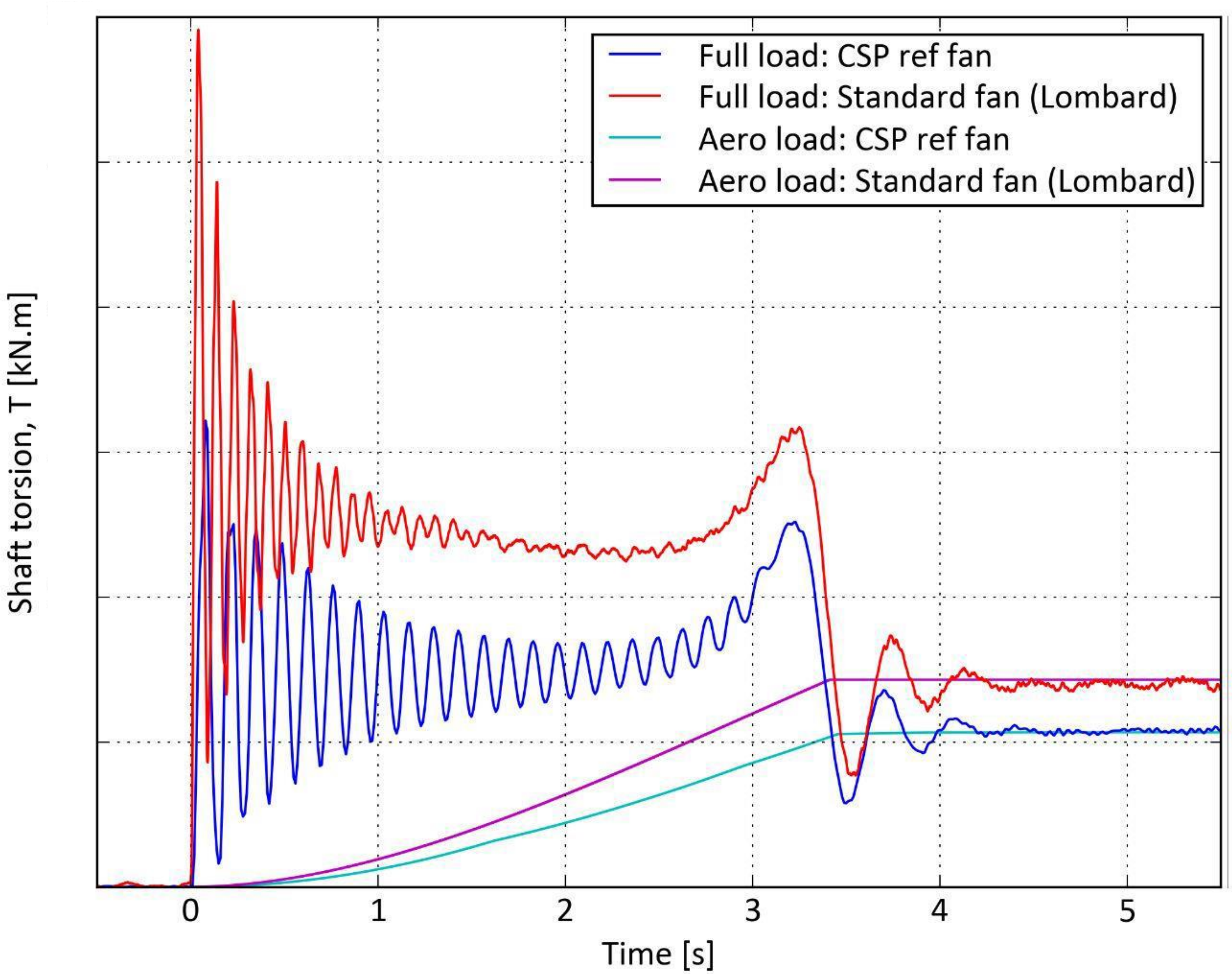
- Retrofit
- No modifications
- Lightweight (50% reduction)

A different approach – results

Motor current [A]	
	Difference, %
Test 1	-21.5
Test 2	-18.8
Test 3	-16.3
Test 4	-20.1

Bundle outlet velocity [m/s]	
	Difference, %
Test 1	-0.43
Test 2	-2.68
Test 3	0.78
Test 4	-3.77

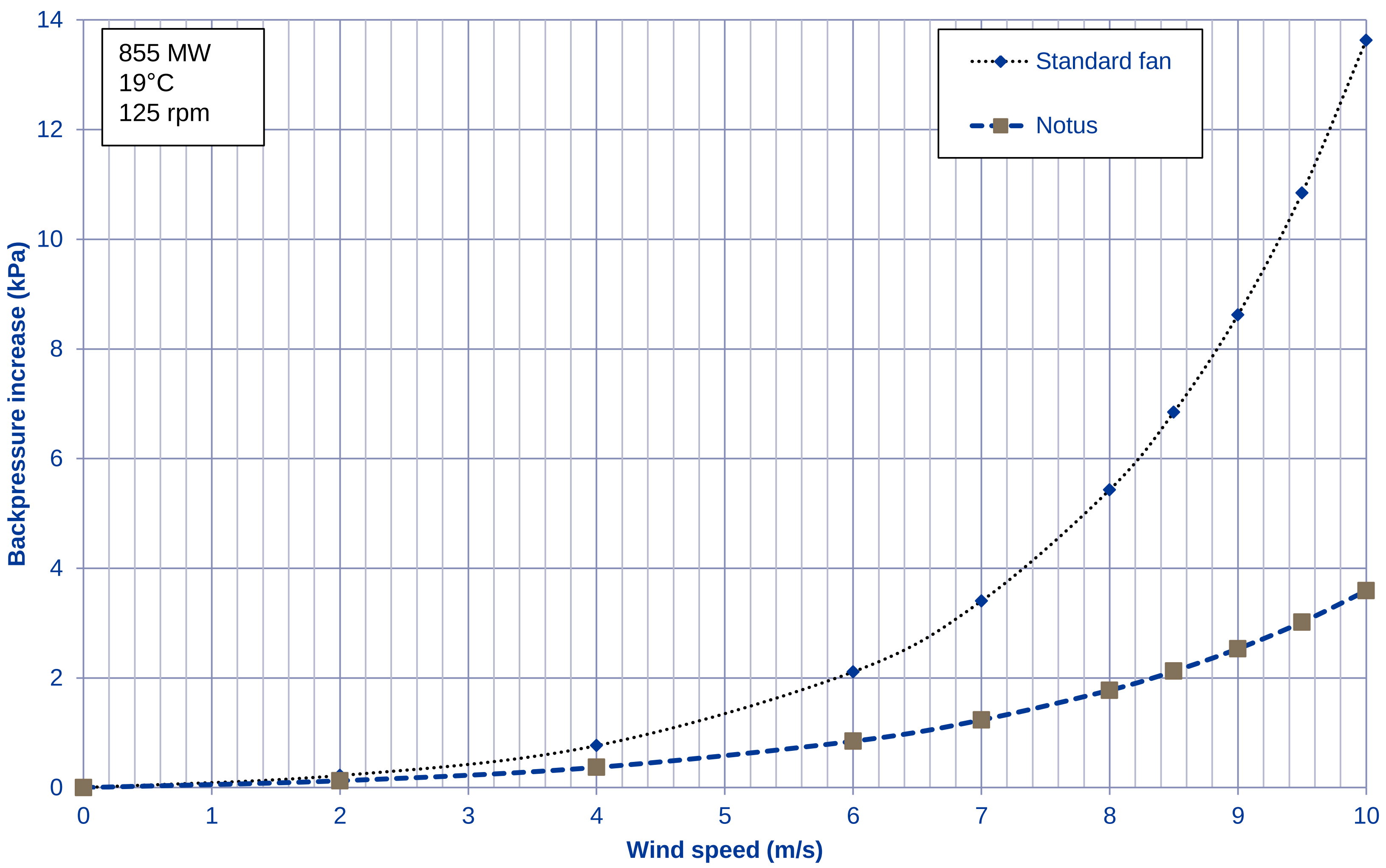
A different approach – results



A different approach – results

Increase in blade setting angle (°)	Fan volume flow rate increase (%)	Fan power consumption increase (%)
Reference	-	-
+4	11	44
+6	16.6	70.5
+8	22.5	100

So what is the effect on backpressure?



Conclusion

Aerodynamic improvement:

- New fan consumes 15-20% less power than current fan for similar flow displacement.
- Alternatively volume flow rates can be increased by 10-20%.
- Greater protection against detrimental effects of wind.

Structural improvements:

- Blades are not resonating (vibrational loads on gearbox greatly reduced).
- Fan blade weight is reduced by 50%.
- Blade shape and structure is consistent (interchangeable blades).
- Maximum operational load far below yield point > fatigue negligible.

Acknowledgements

Team effort by many stakeholders

- EU providing funding through HOR2020
- Matimba Power Station
- Notus Fan Engineering
- Stellenbosch University