Air flow patterns in naturally ventilated buildings

/ Simulering av luftstrømninger i naturlig ventilerte bygg

What is natural ventilation?

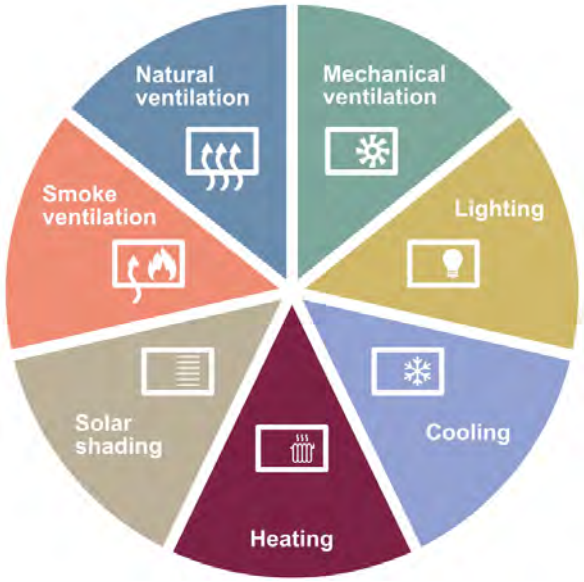
Intelligent control

Control windows based on

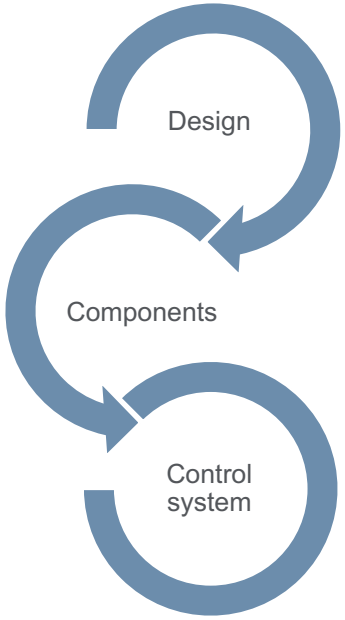
- Indoor air temperature
- Indoor CO_2 levels
- Relative humidity
- Outdoor air temperature
- Wind speed and direction
- Rain
- Other parameters.

Using actuators

Linked to control systems

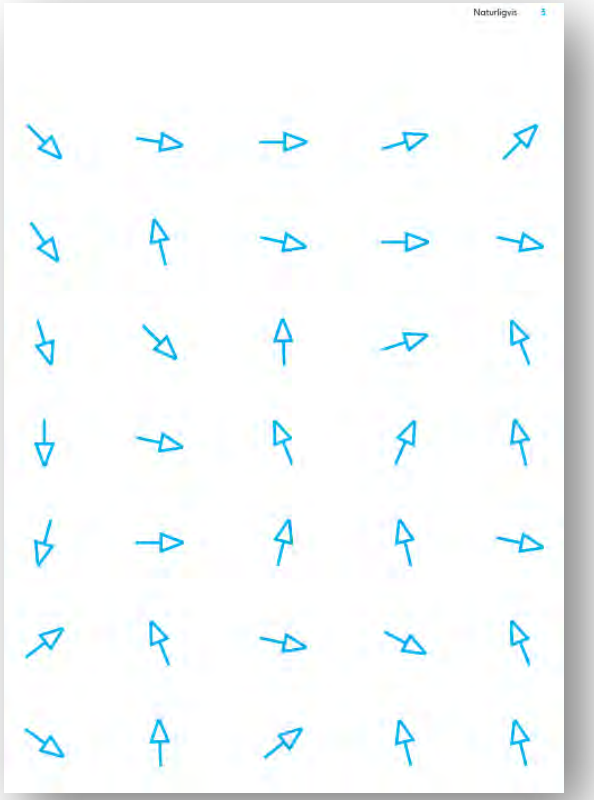


Complete solution

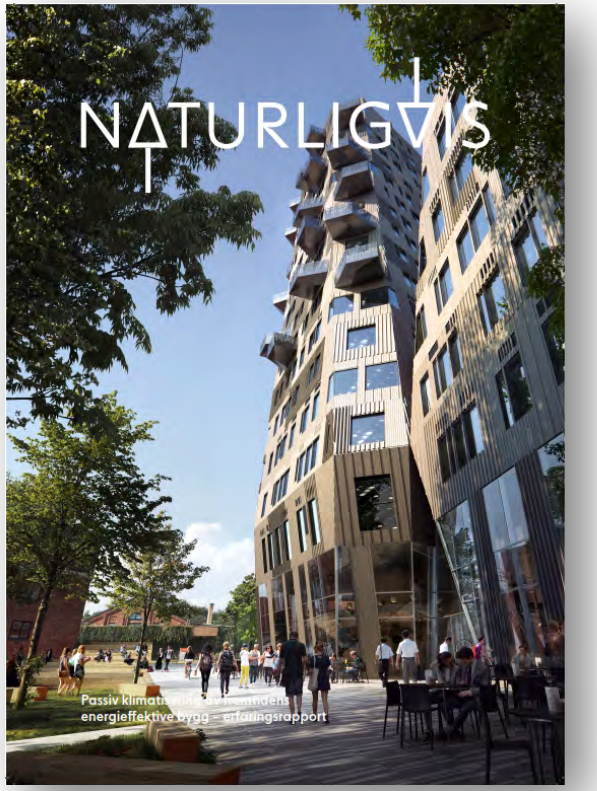


Air flow pattern study

Page 3

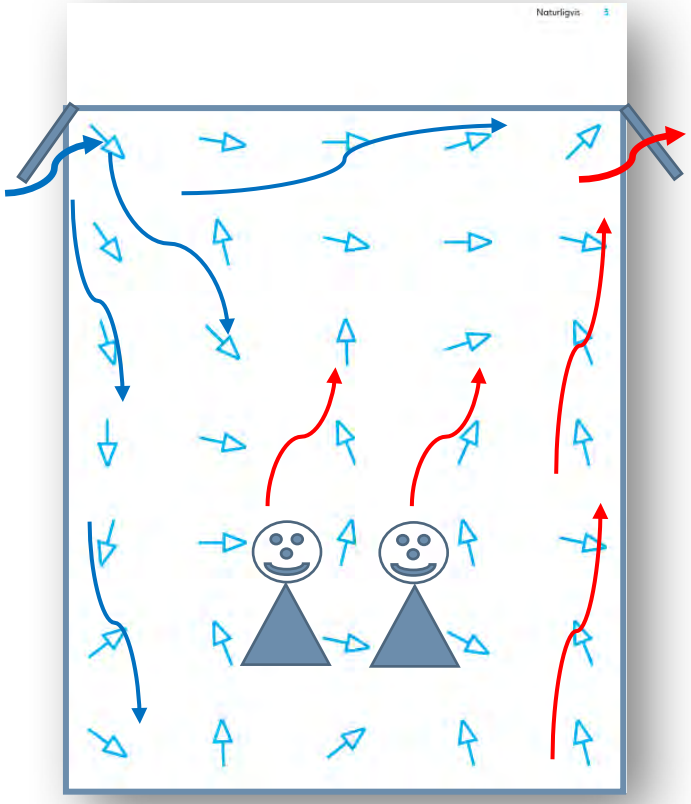


Naturligvis rapport page 32

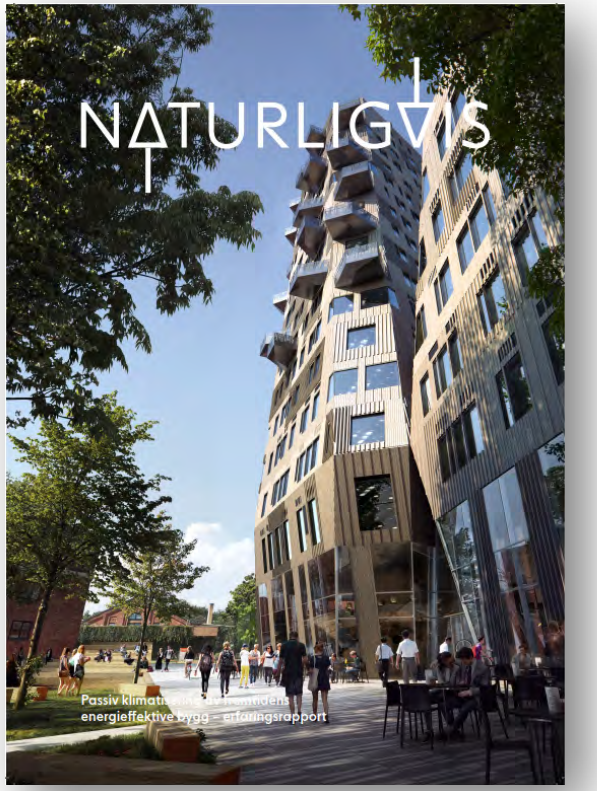


Air flow pattern study

Page 3 – air flow pattern

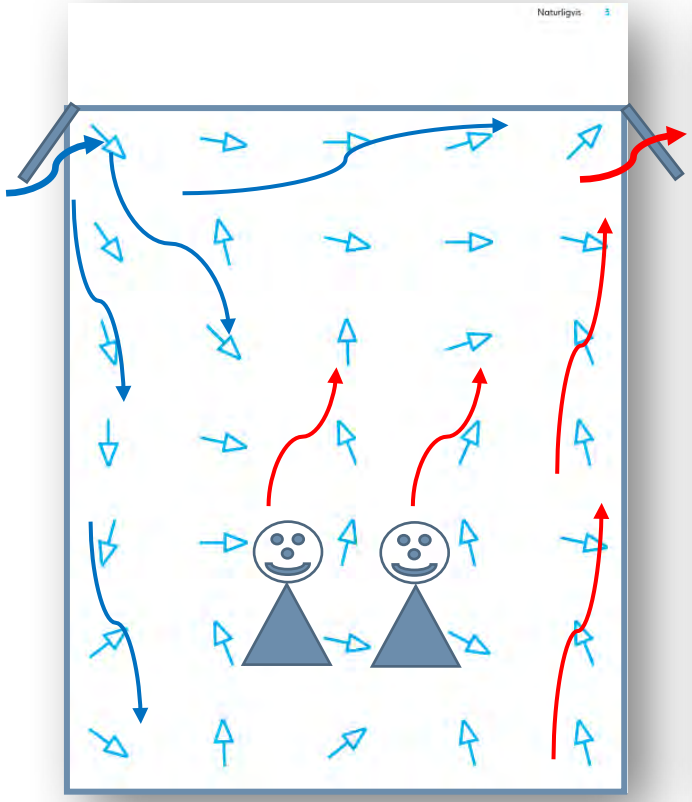


Naturligvis rapport page 32

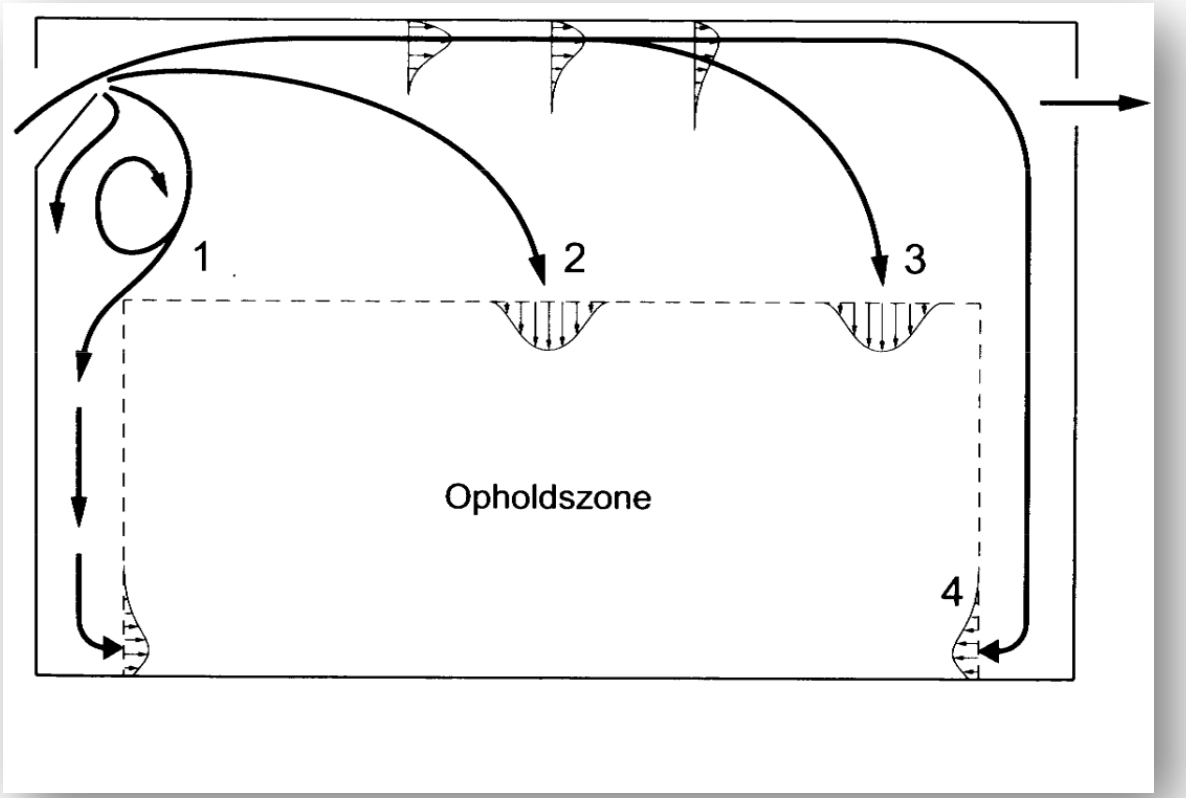


Air flow pattern study

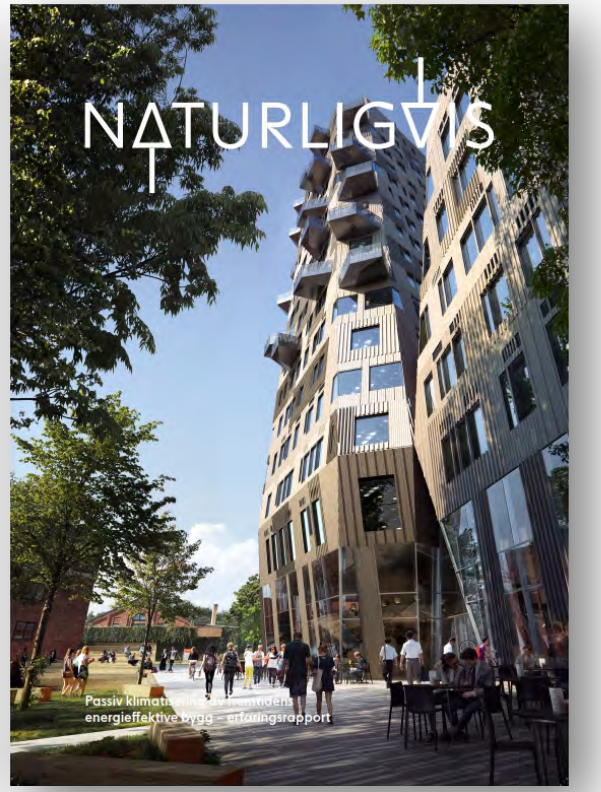
Page 3 – air flow regimes



Possible air flow patterns using natural ventilation

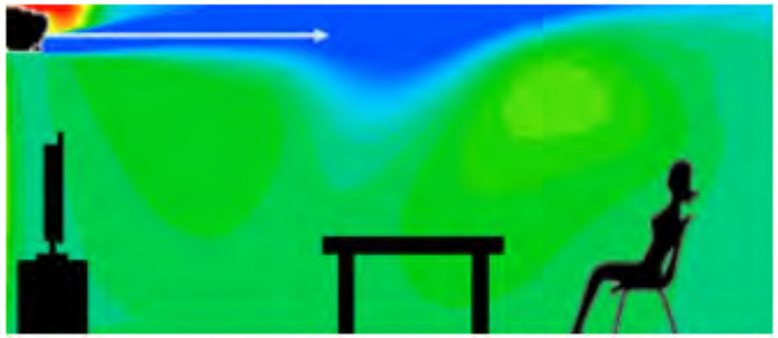


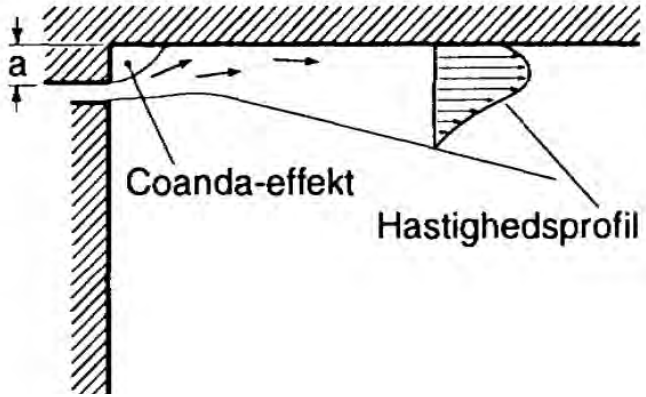
Naturligvis rapport page 32



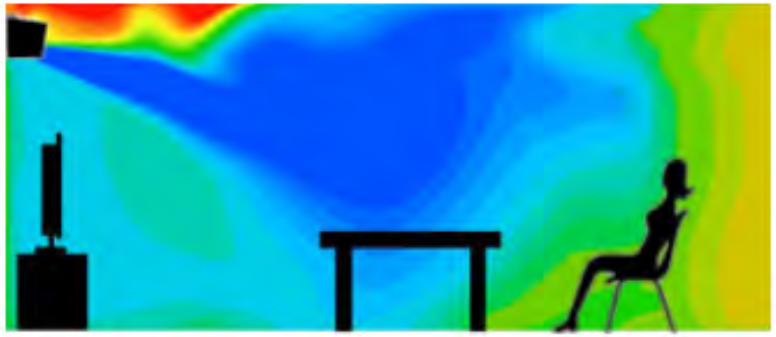
Coanda effect

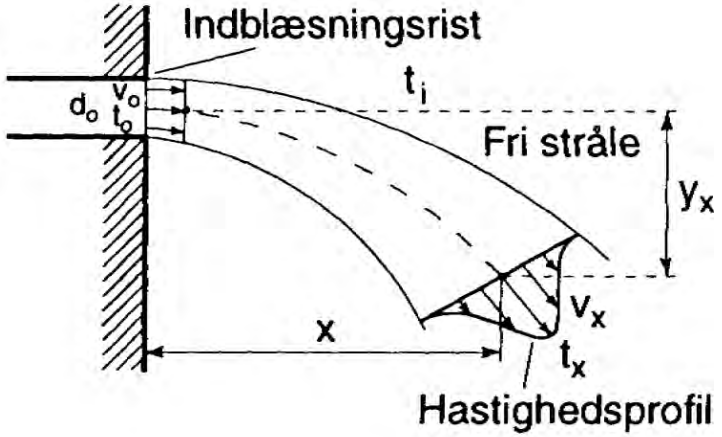
With coanda effect





Without coanda effect



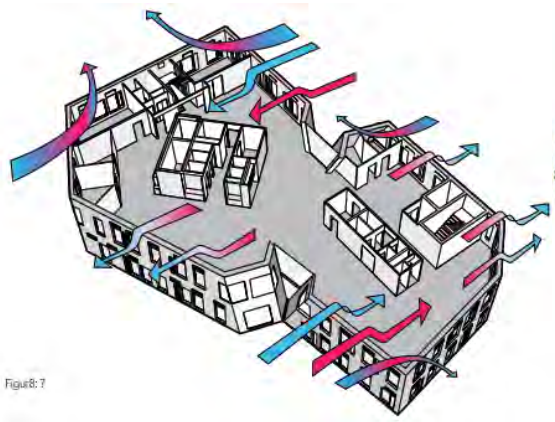


What can you do?

Different techniques

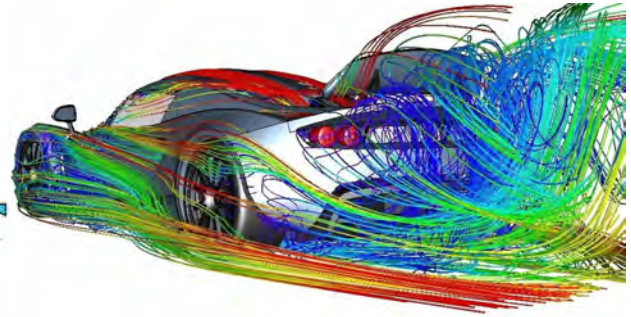
Basic

- E.g. pressure differences across openings/facades and temperature differences.
- Combined with the previous shown slides.
- Airflow:



CFD modelling

- Computational Fluid Dynamics (CFD) is based on the basic physical equations for fluid and gas flow (Navier-Stokes equations).
- E.g. predict air movements.
- Car (Lotus) aerodynamics.



Salt bath modeling

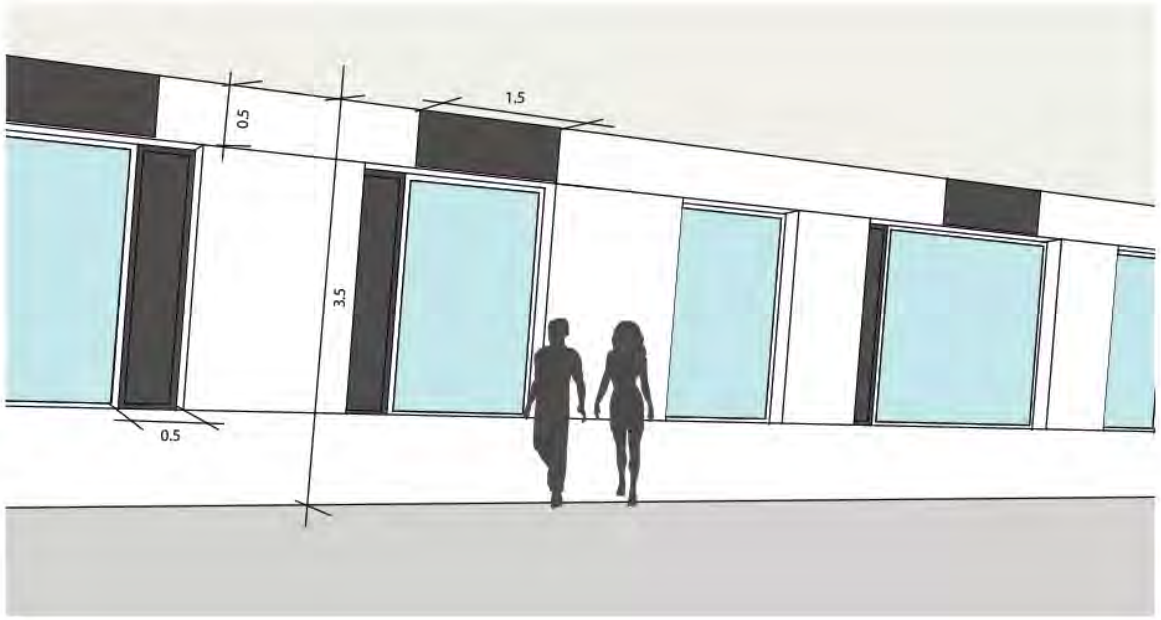
- This is an experimental technique Perspex models of buildings (scale between 1:20 and 1:100) are inverted and placed in a large tank of water.
- Homemade tub “experiments”:

Full scale

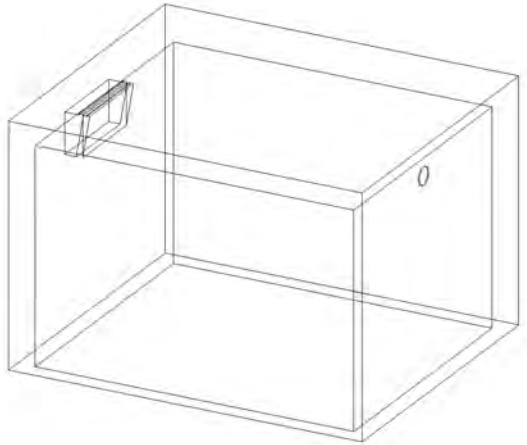
- Can be used for detailed investigation and where not “normal” technologies.
- Lab at SINTEF.

CFD simulation

Layout



E.g. section of the room

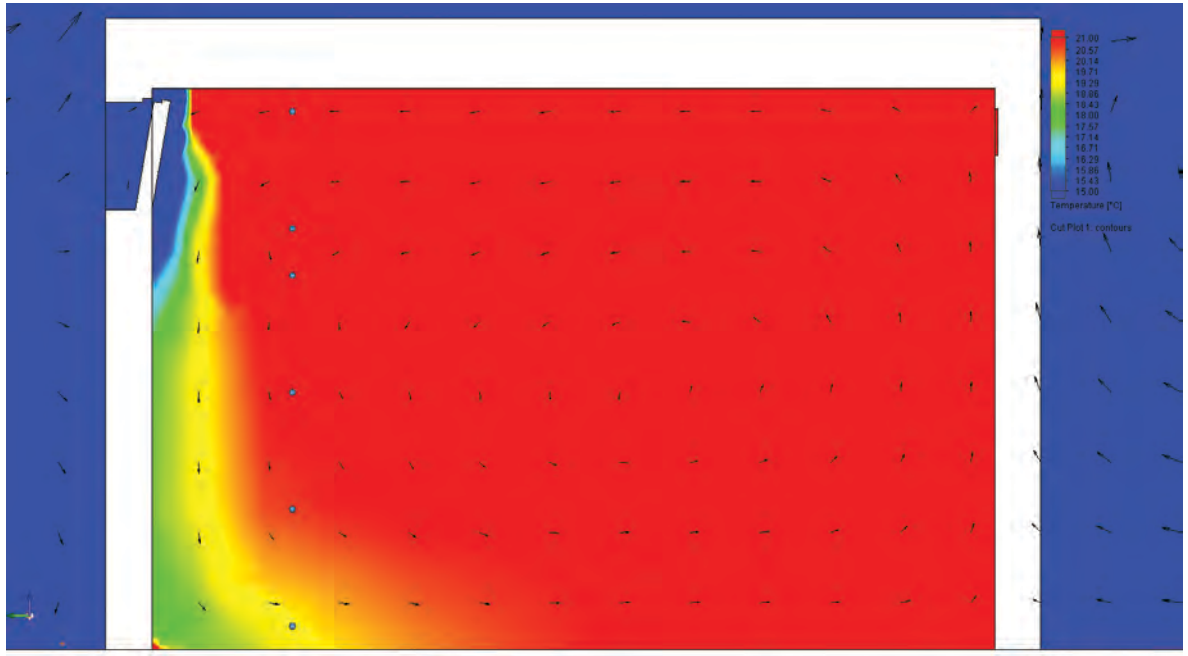


Assumptions

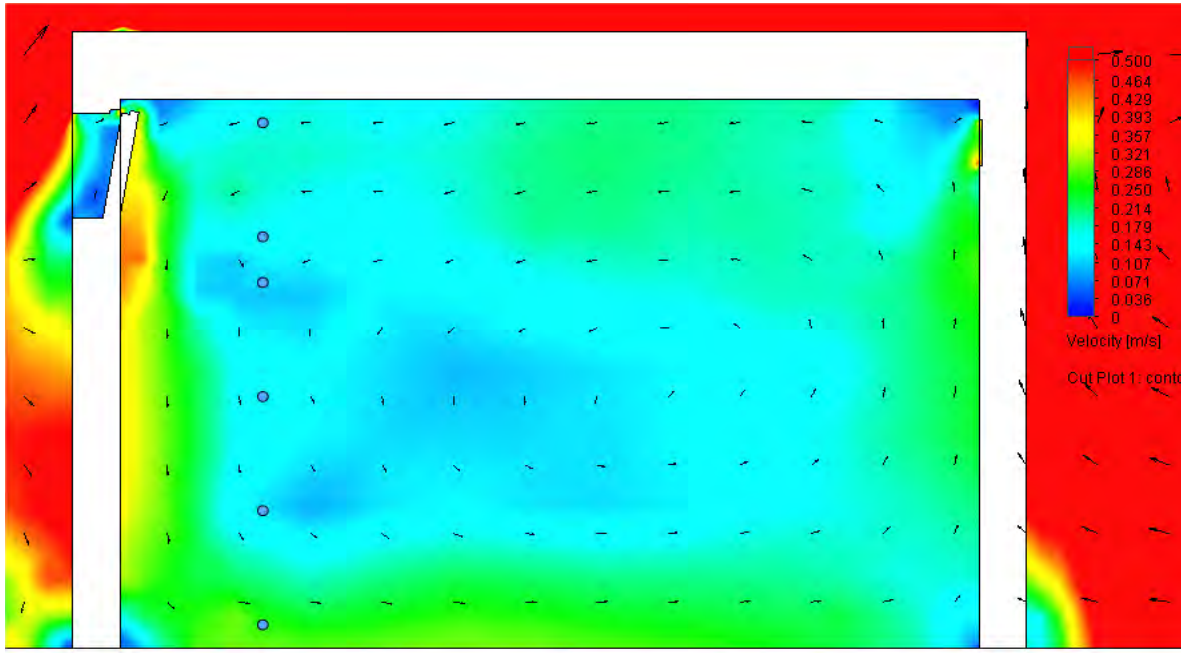
- Outdoor temperature -20ºC
- Indoor temperature 21 º C
- Air flow rate of 40 m^3/h

Results

Temperature plot



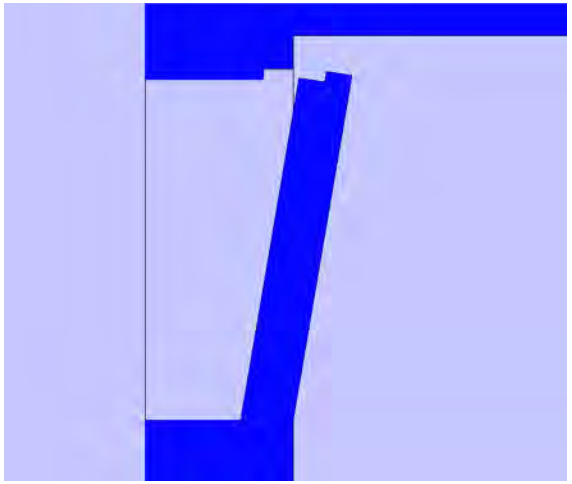
Velocity plot



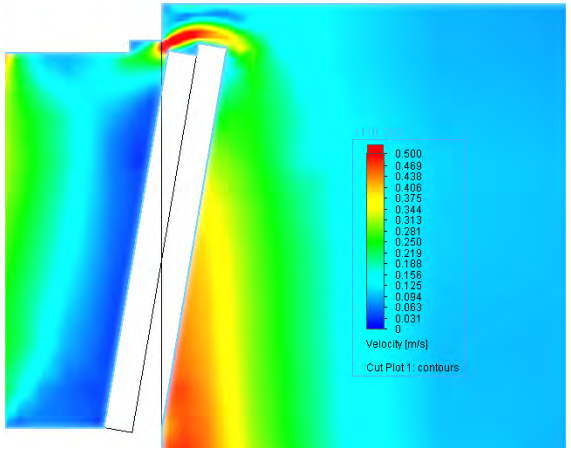
Height [m]	Temperature [ºC]	Air speed [m/s]	DR [%]
0,1	19,6	0,15	14,7
0,6	20,7	0,07	4,3
1,1	21,2	0,08	5,4
1,6	21,5	0,05	0
1,8	21,6	0,08	5,3
2,3	21,8	0,14	11,4

Detailed air flow

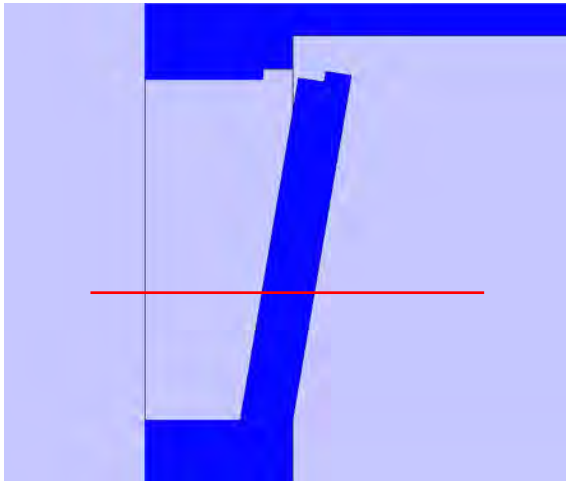
Cross section of window



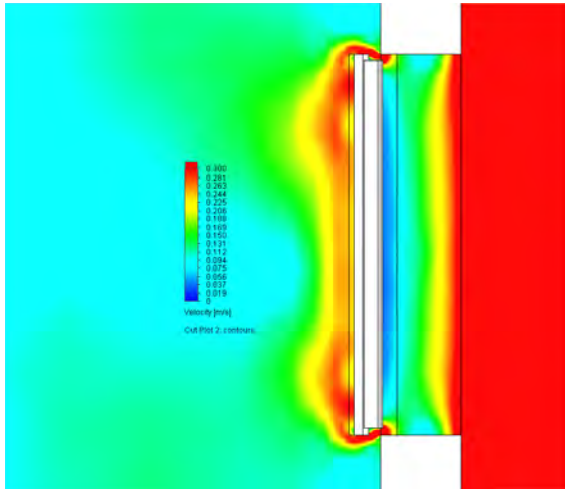
Respective air flow



Cross section (red line)



Respective air flow

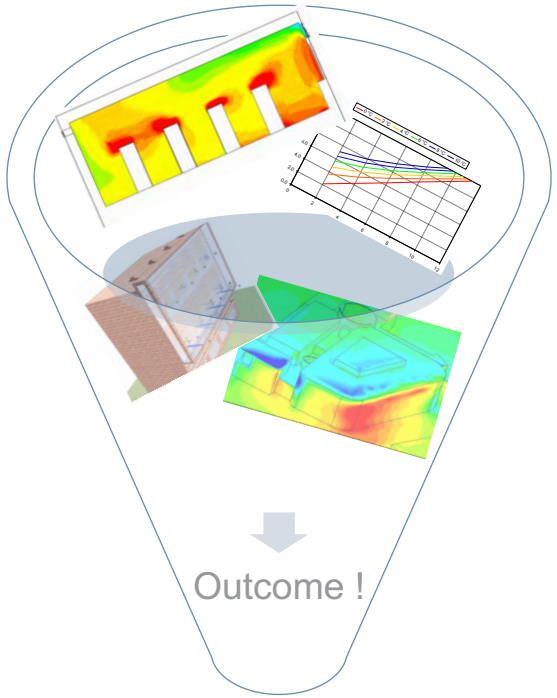


From calculations to reality

How do we get there?

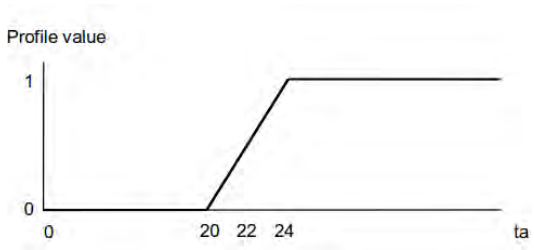
Calculations

- Design calculations (all parameters included)



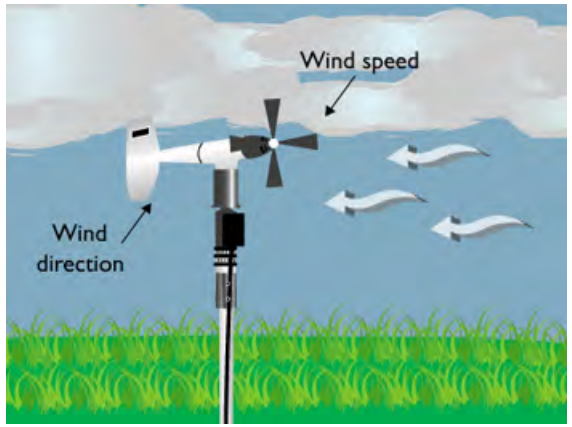
How it is controlled

- Temperature
- CO_2
- (RH)



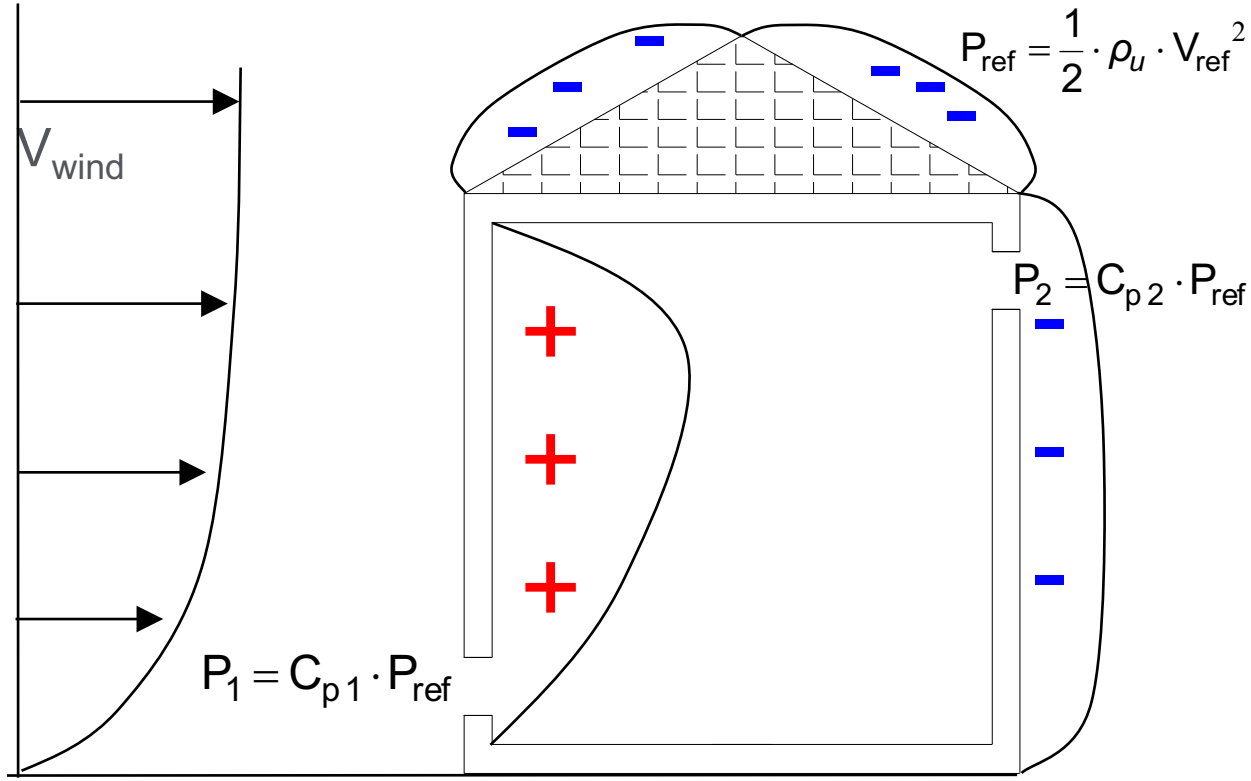
Missing link?

- One of the main driving forces for NV – wind (pressure)!

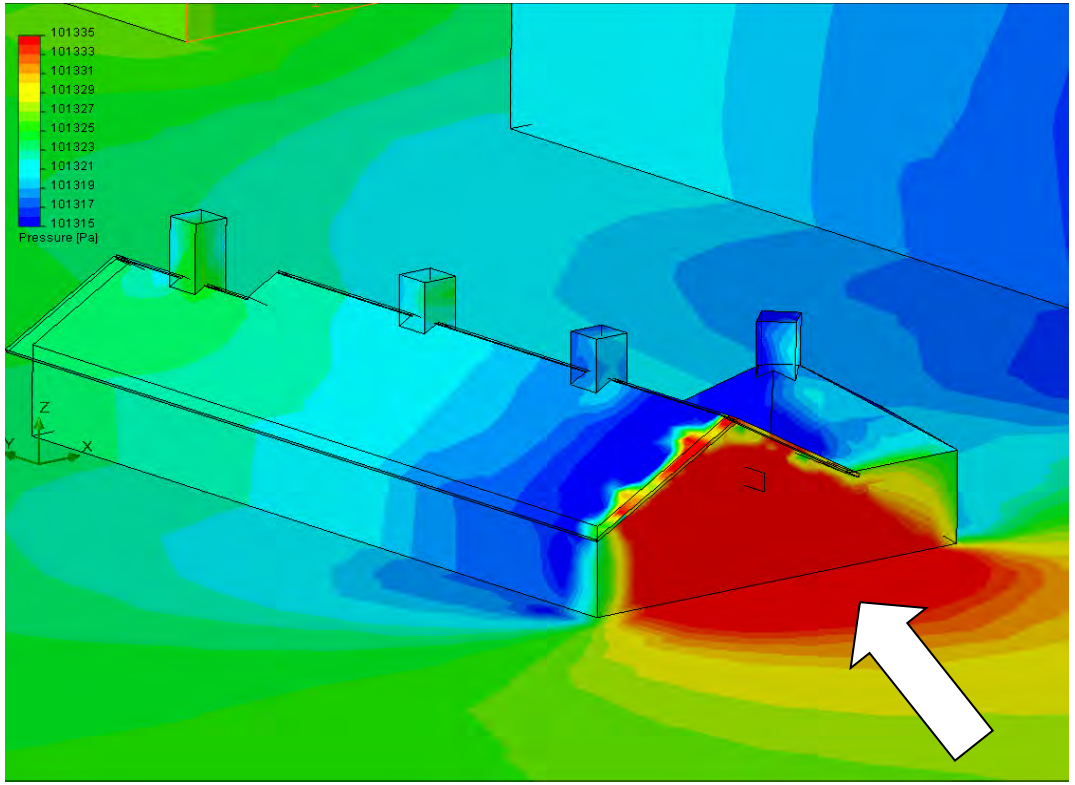


Wind profile and pressure

Theory



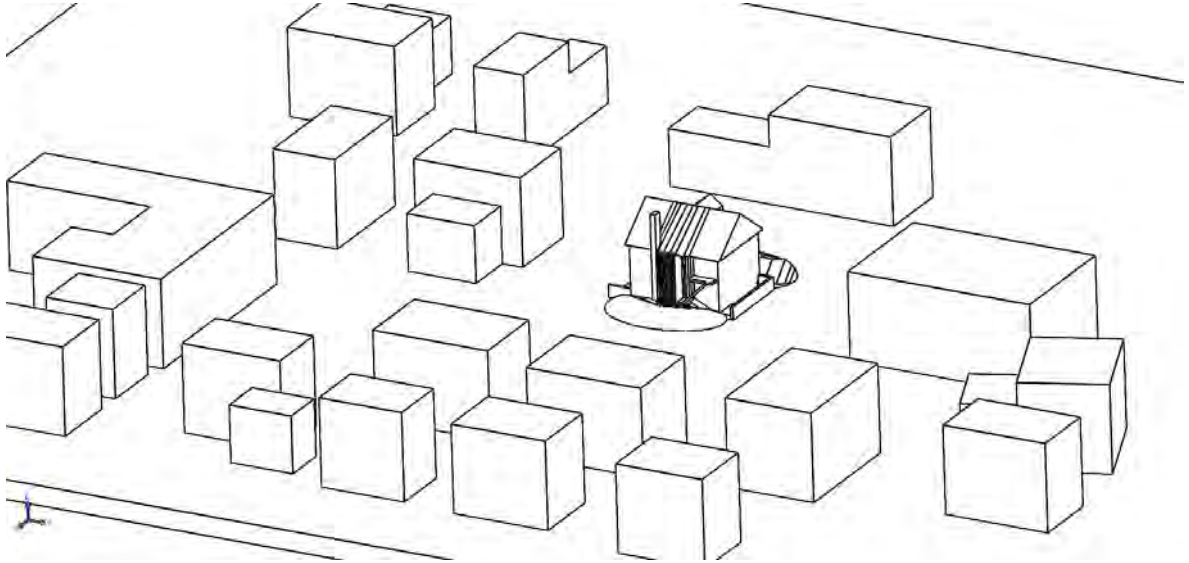
CFD modelling



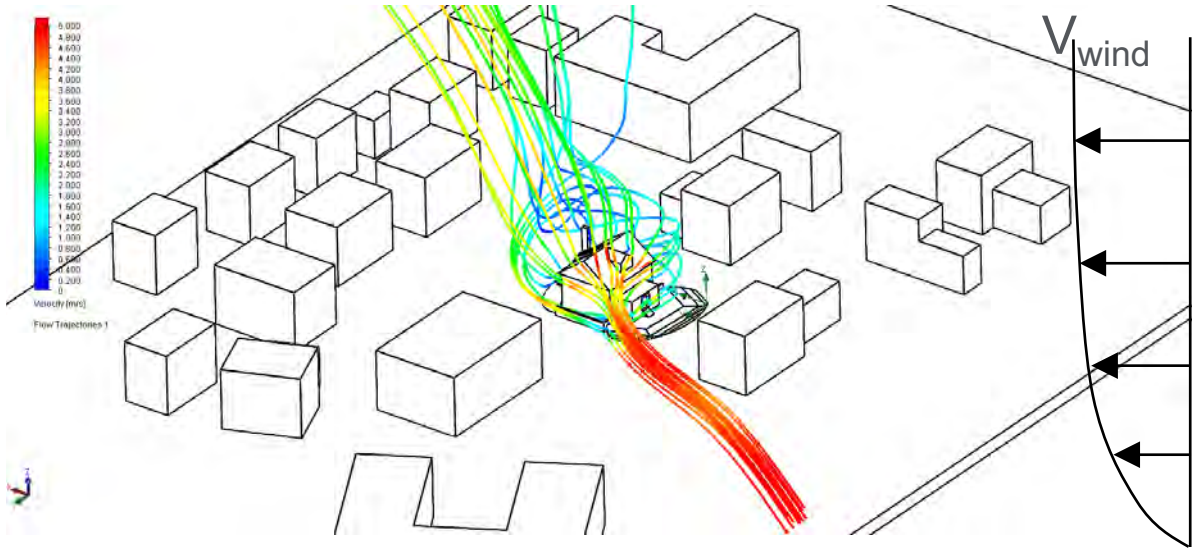
External CFD

HouseZero

Model



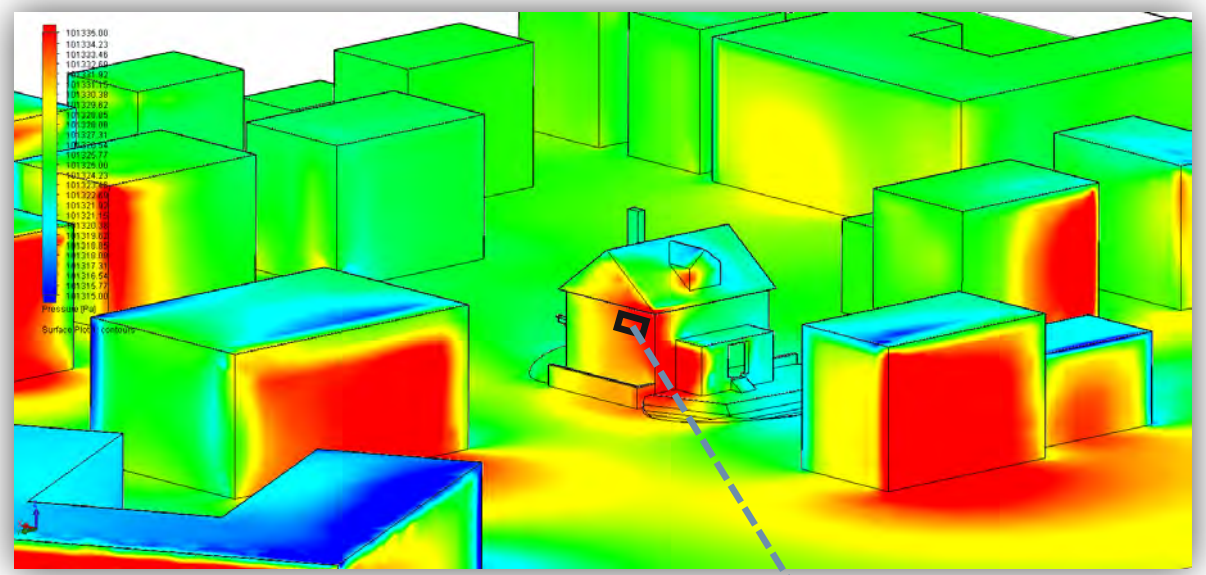
Simulations from different wind directions



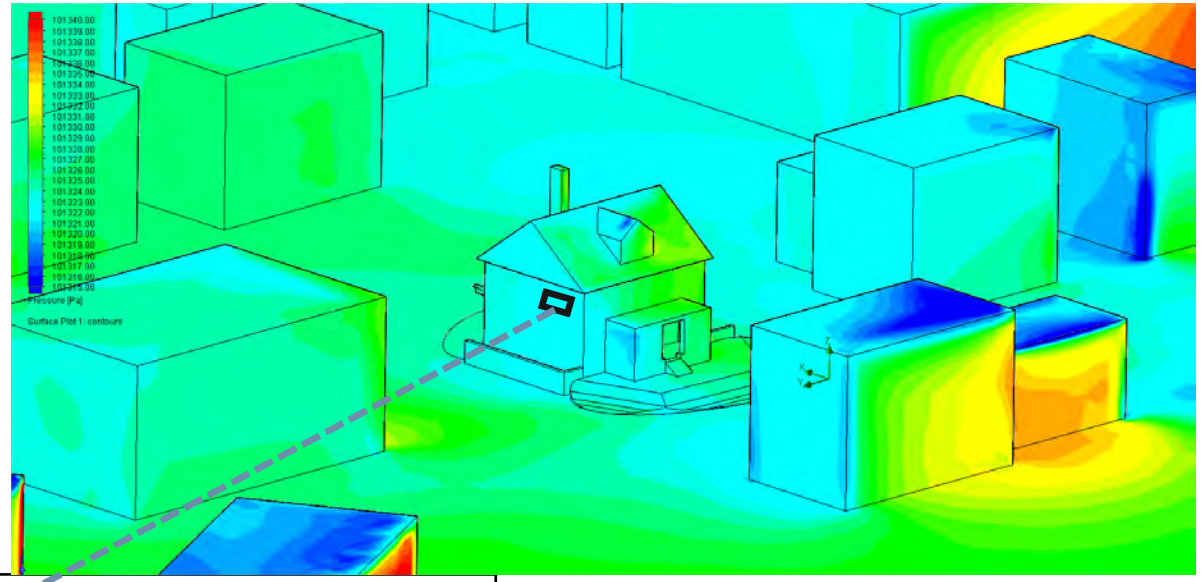
External CFD

HouseZero

Wind direction north west



Wind direction south west



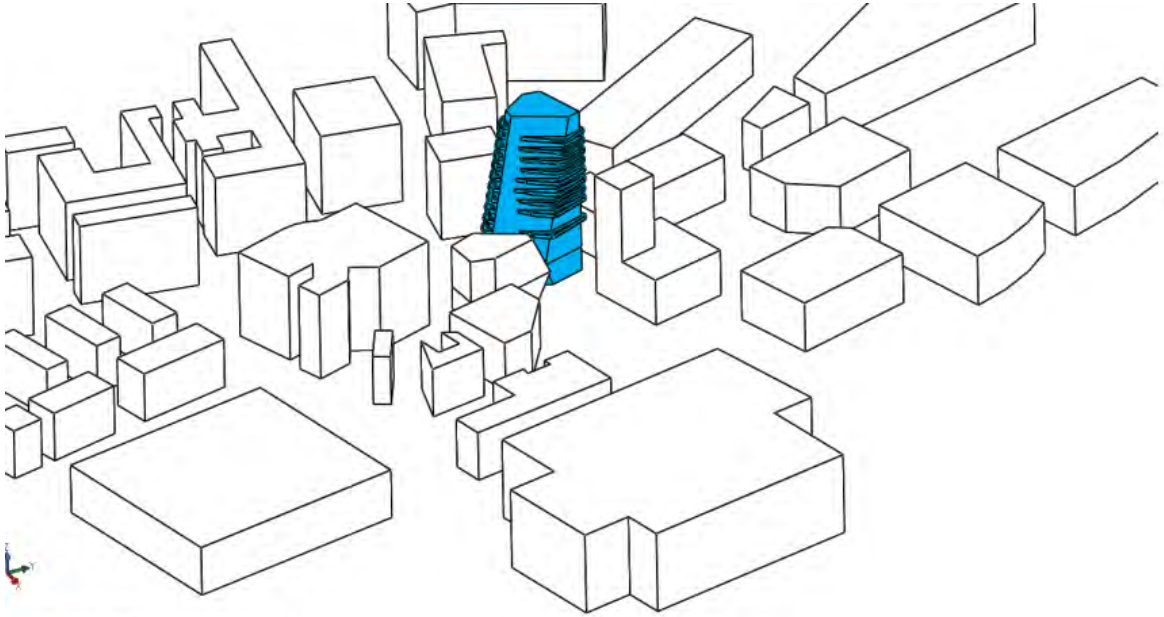
		Wind Speed m/s							
		5	5	5	5	5	5	5	5
Zone		N	NE	E	SE	S	SW	W	NW
Zone 14	1	324	335	335	317	323	323	322	320

Cp 0	Cp 45	Cp 90	Cp 135	Cp 180	Cp 225	Cp 270	Cp 315
-0.06	0.96	0.96	-0.64	-0.13	-0.13	-0.19	-0.32

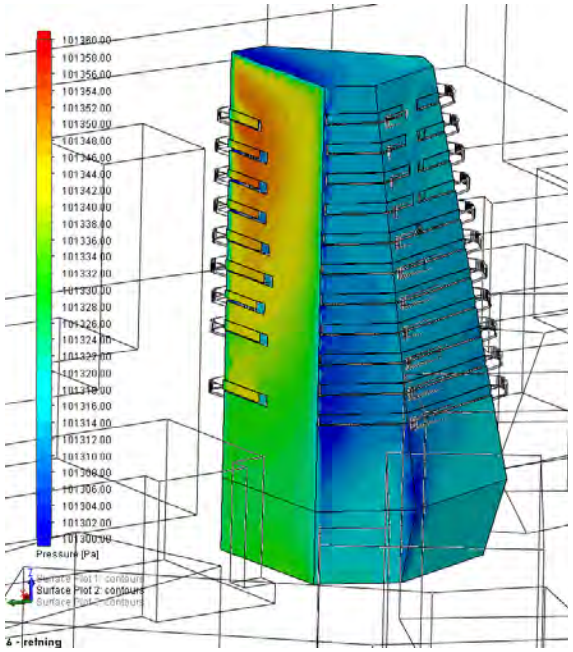
External CFD

Nydalen Vy

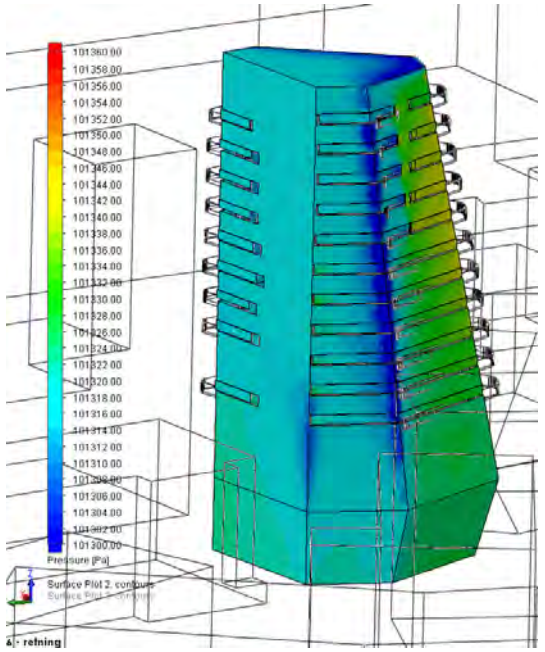
Model



Wind direction north

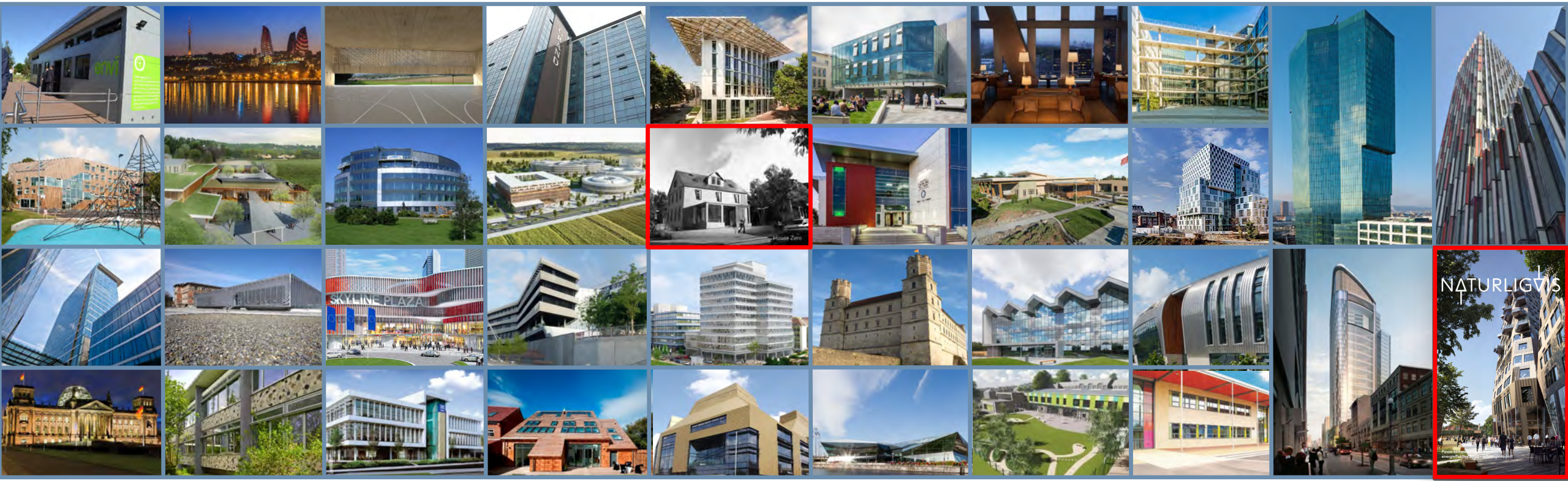


Wind direction south



A proven solution

More than 700 projects around the world



Thanks for listening!

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