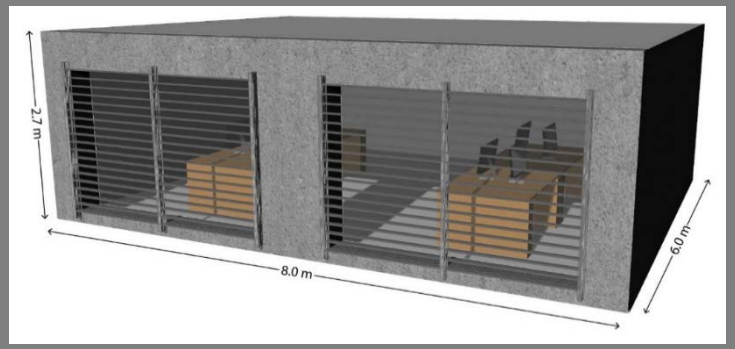
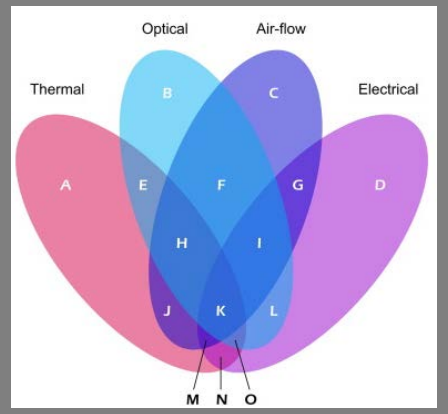
SINTEF / NTNU PROJECTS

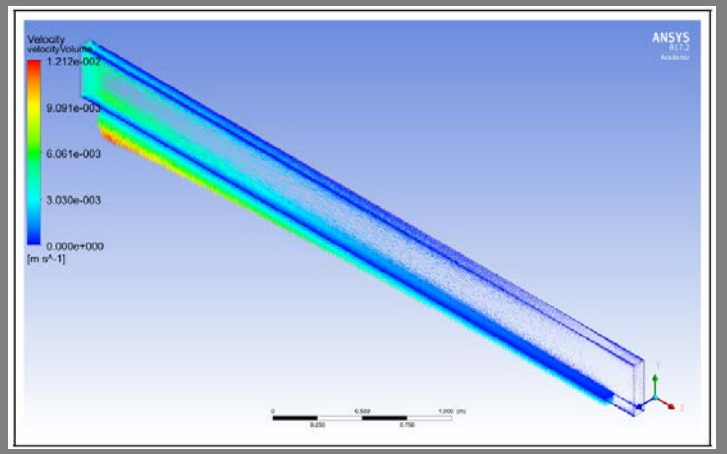
Snapshots for the LBNL Windows Group meeting 13.Feb 2018

Selected topics

- SkinTech project
- Zero Emission Neighbourhoods in Smart Cities
- HVIT – Highly insulating windows
- Lab facilities for the future





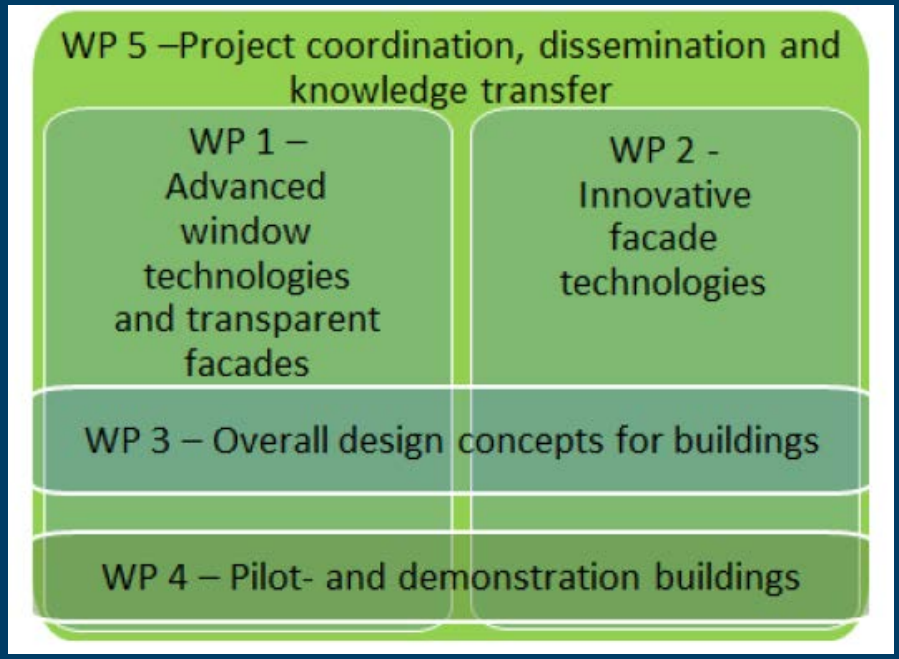


Advanced building skins with integrated technology - SkinTech

3-year project w/ industry partner: Saint-Gobain Byggevarer, **Nordan** og Schüco Norge

Reserach partner: NTNU, Faculty of Architecture and Design
International partners: Lawrence Berkeley Laboratories og Polytechnico Torino

Aim: …to develop robust technically feasible solutions, models and methodology for design of building skins of the future



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The role of facades

- Importance in architecture
- Large array of functions
- The quality of a building envelope is important: globally space heating and cooling account for over 30% of all energy consumed in buildings, and up to 50% in cold climate countries. This share can go over 60% in the residential sub-sector in cold climates (IEA 2013)
- From "passive design" to "active design"

Adapted from IEA Transition to Sustainable Buildings - Strategies and opportunities to 2050 (2013)

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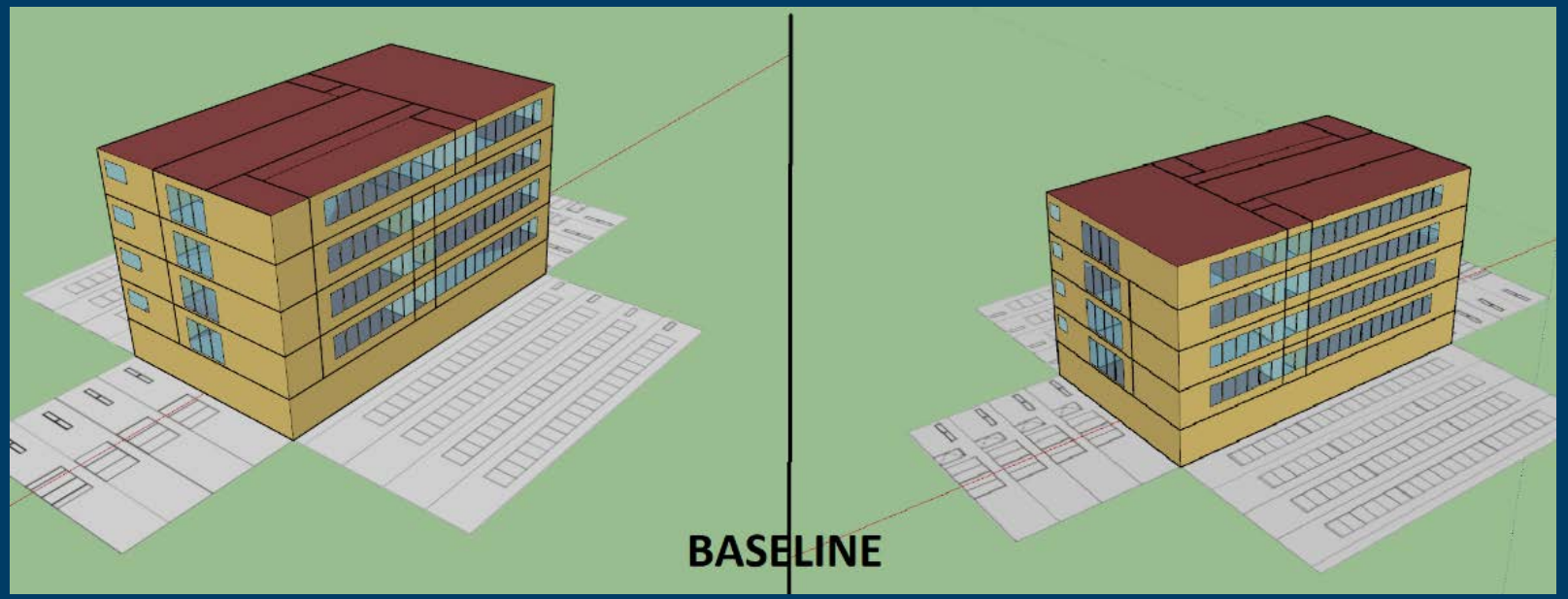
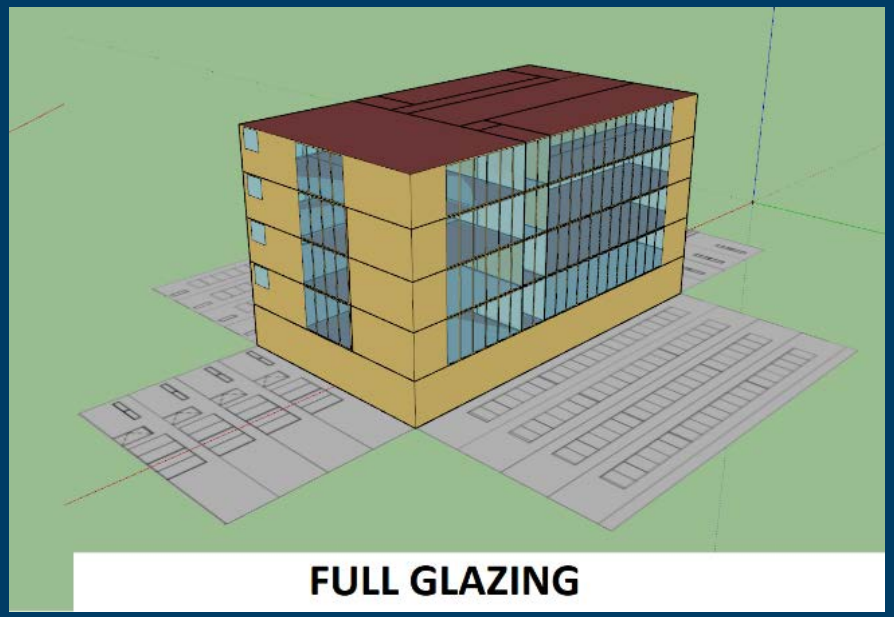
Performance metrics for *advanced* facades

Questions:

1. **How representative are U-value and G-value** of the performance of (glazing) facades when these are in real operation (i.e. not under specific boundary conditions)?
2. **Can U-value and G-value represent** the performance of (more) **advanced dynamic facades** under real operation?

The answere to that is: Advanced facades need **more comprehensive, complete performance descriptors** (metrics)…





- Is it possible to make a "fully glazed" office building with a ZEB performance?
  - E+ simulations for a case office building
  - Baseline; ZEB-level office building
  - Full glazing case; increased glazed areas with various shading control strategies
- Outcomes;
  - Case results…
  - starting point for performance descriptors/criteria work

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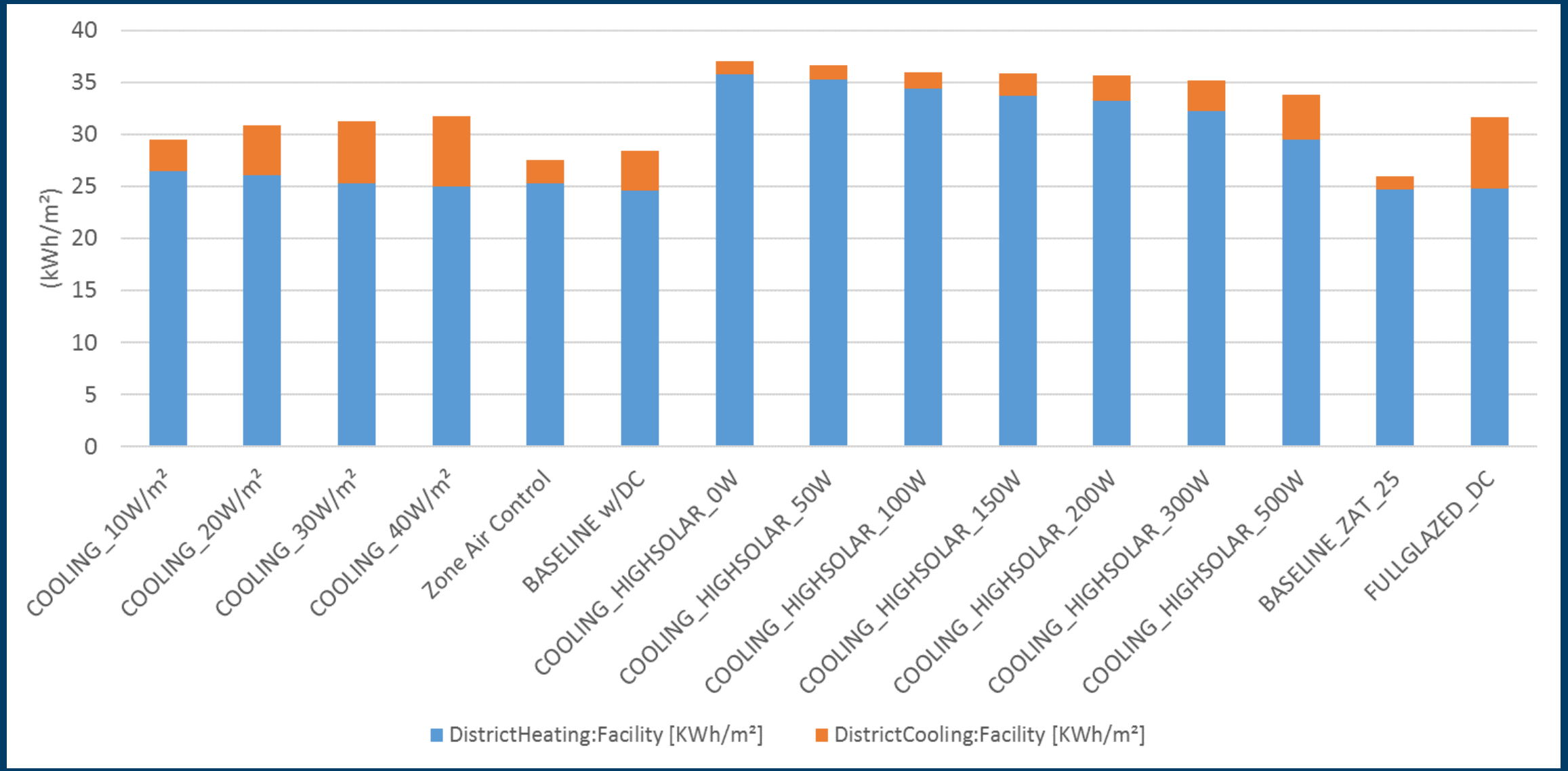
40
35
30
25
20
15
10
5
0
(kWh/m²)
COOLING_10W/m²
COOLING_20W/m²
COOLING_30W/m²
COOLING_40W/m²
Zone Air Control
BASELINE w/DC
COOLING_HIGHSOLAR_0W
COOLING_HIGHSOLAR_50W
COOLING_HIGHSOLAR_100W
COOLING_HIGHSOLAR_150W
COOLING_HIGHSOLAR_200W
COOLING_HIGHSOLAR_300W
COOLING_HIGHSOLAR_500W
BASELINE_ZAT_25
FULLGLAZED_DC
DistrictHeating:Facility [KWh/m²]
DistrictCooling:Facility [KWh/m²]

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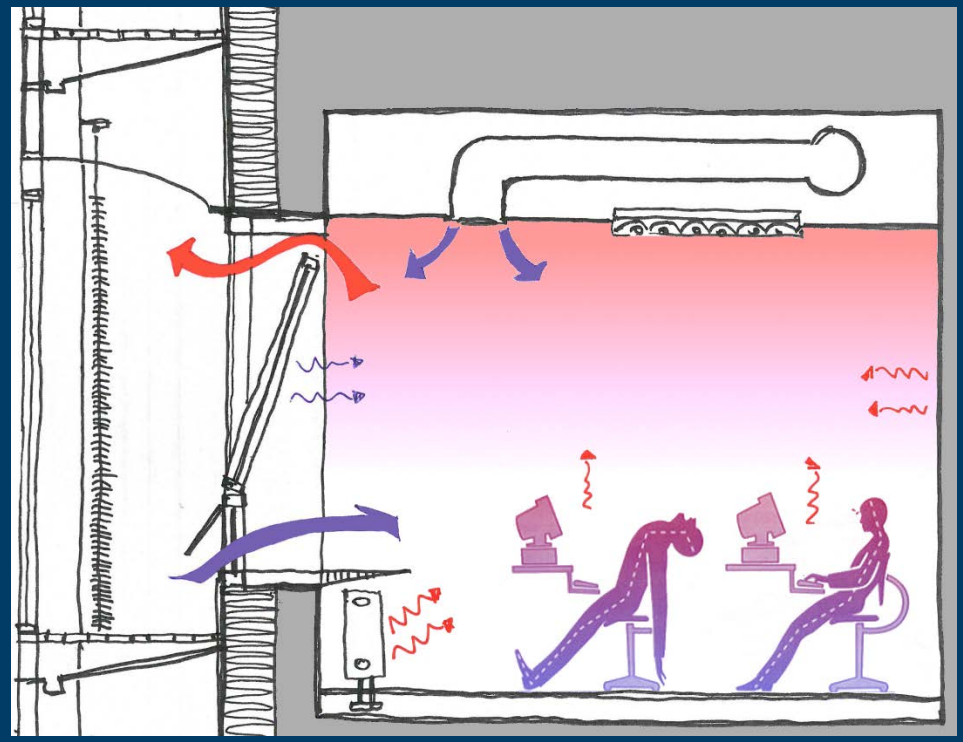
Experimental work

- Evaluate the adaptive thermal comfort (as defined in the ASHRAE 55-2013) in office buildings with advanced facade systems
- running with hybrid ventilation systems (natural and mechanical).
- estimate the influence from natural ventilation and thermal radiation on the thermal comfort of office users

- Preliminary studies ok => CFD and experimental studies in the pipeline

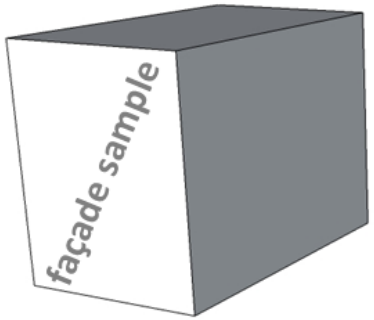


Thermal comfort and energy performance in buildings with *advanced* facade systems - experimental work

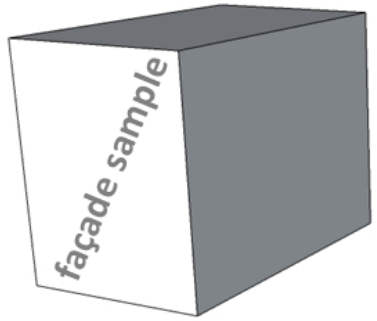
- **Scope of the project is to study**
  - Adaptive thermal comfort models w/ outdoor temp. < 10C (minimum threshold in ASHRAE 55 and EN 15251)
  - Influence of different control strategies for window opening and shading on measured and perceived thermal comfort and energy performance
  - Effects of thermal mass on indoor environment and energy demands

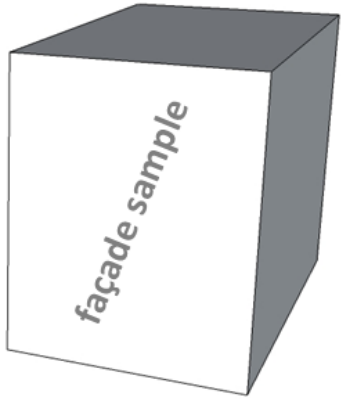
ZEB TEST CELL

Outdoor test cell categories

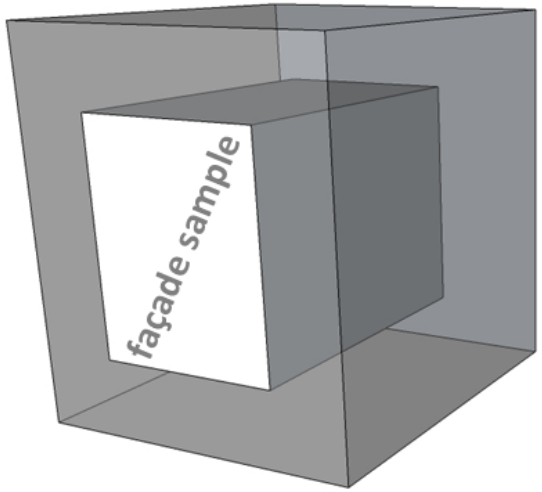


Absolute test

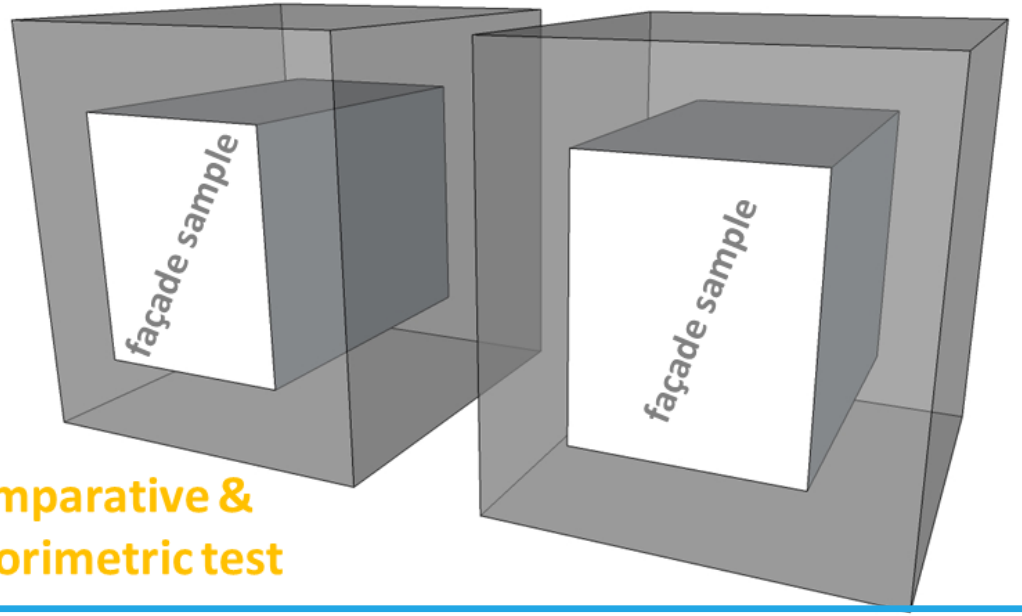




Comparative test

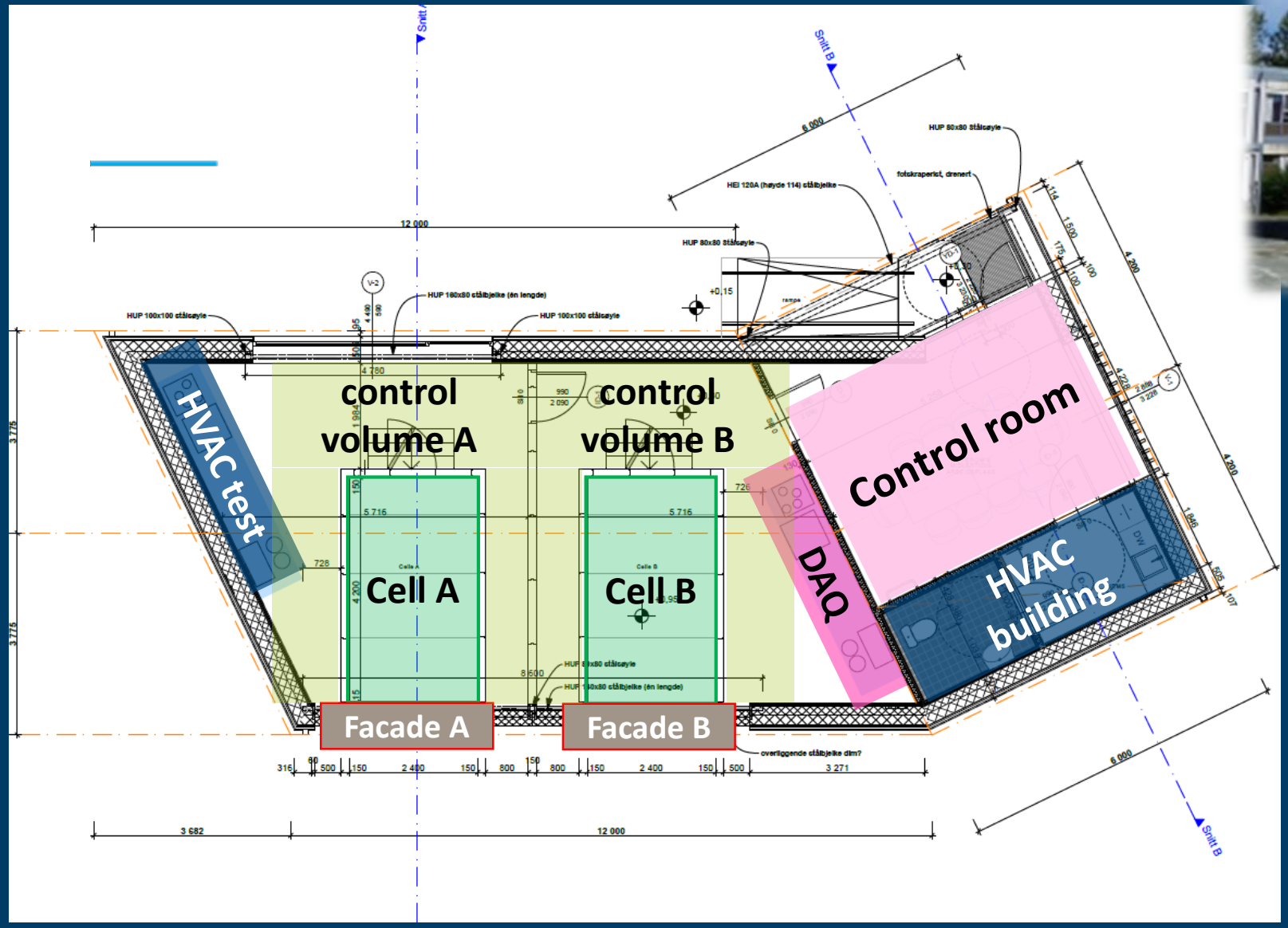


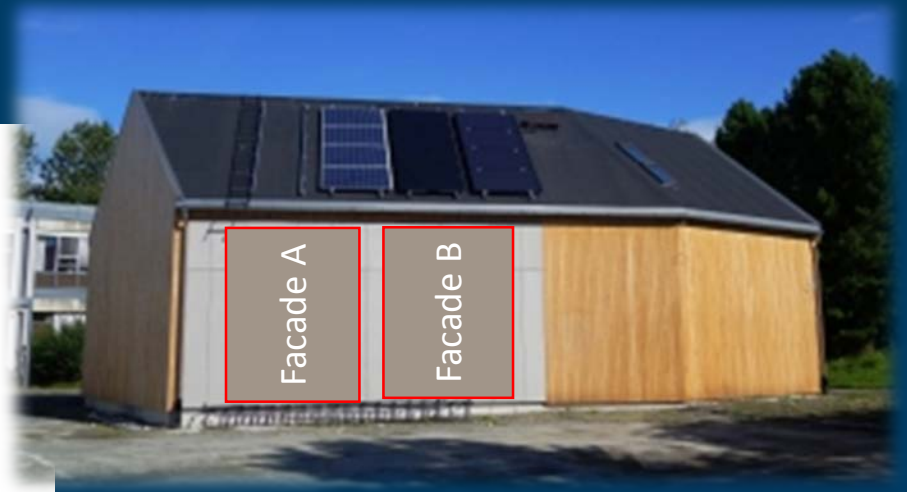
Absolute test, calorimetric

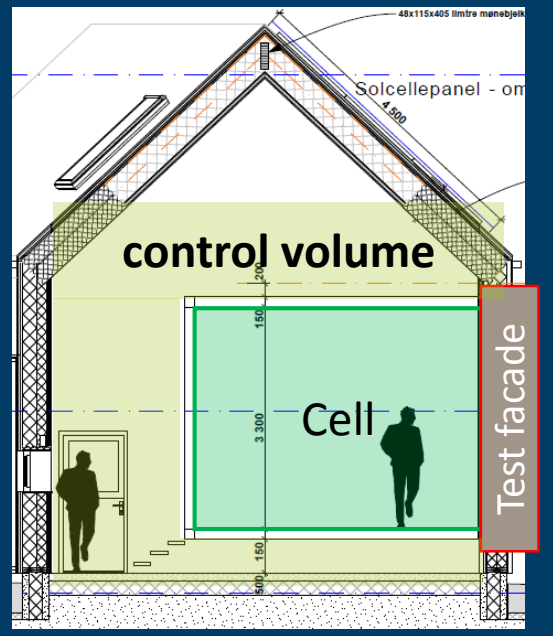


Comparative & calorimetric test

ZEB Test Cell


HVAC test
control volume A
control volume B
Control room
DAQ
HVAC building
Cell A
Cell B
Facade A
Facade B


Facade A
Facade B


control volume
Cell
Test facade

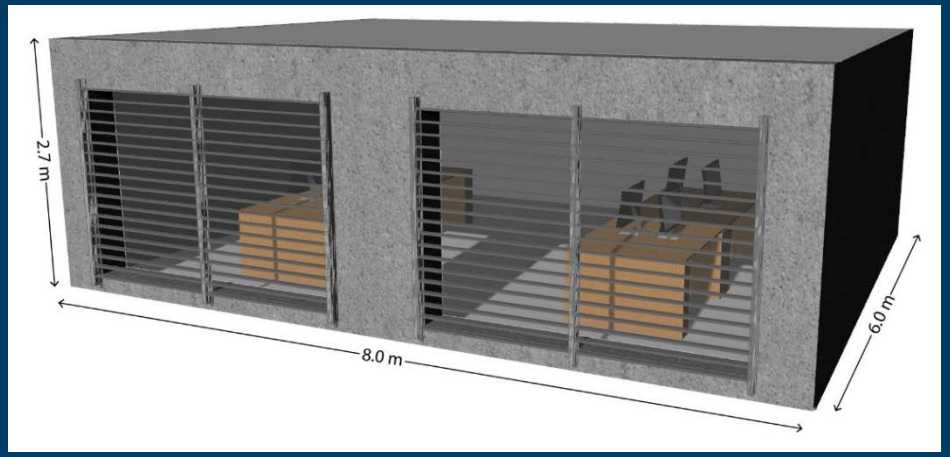
Working plan

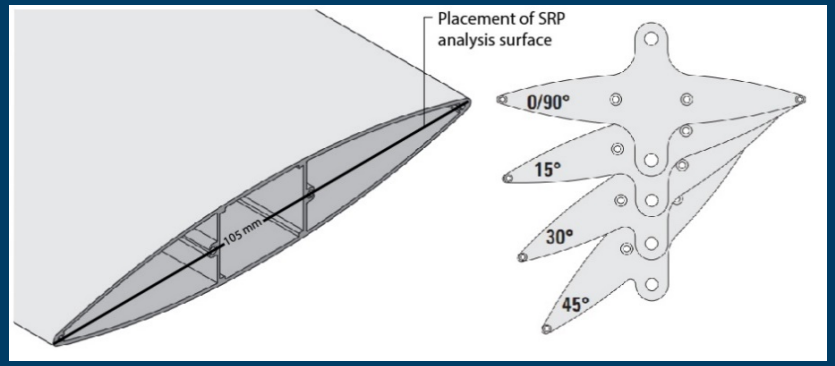
- Phase 1: Getting started…
- Phase 2: test airflow network through opened window to match CD factor in IDA ICE for simulations
- Phase 3: validate IDA-Ice model and CFD model with test cell measurement
- **Phase 4: Qualitative and quantitative comfort assessments combined with energy performance measurements**
- Phase 5: Thermal mass assessments
- Phase 6: Double skin or *Hybrid* double skin facades assessments

BiPV – PV coated sholar shading lamellae

- Bestest case 600
  - Floor area: 48 m^2
  - Window 2 x (3x2m^2)
- 105 mm lamella from Schüco
  - 4 angles:

    0 – 45 deg





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Research questions

1. To what extent is it possible to balance competing uses (electric energy conversion vs. daylighting) of solar energy through advanced façade systems?

2. How can complex simulations tools support the design of such façade systems, optimizing different uses of solar energy?

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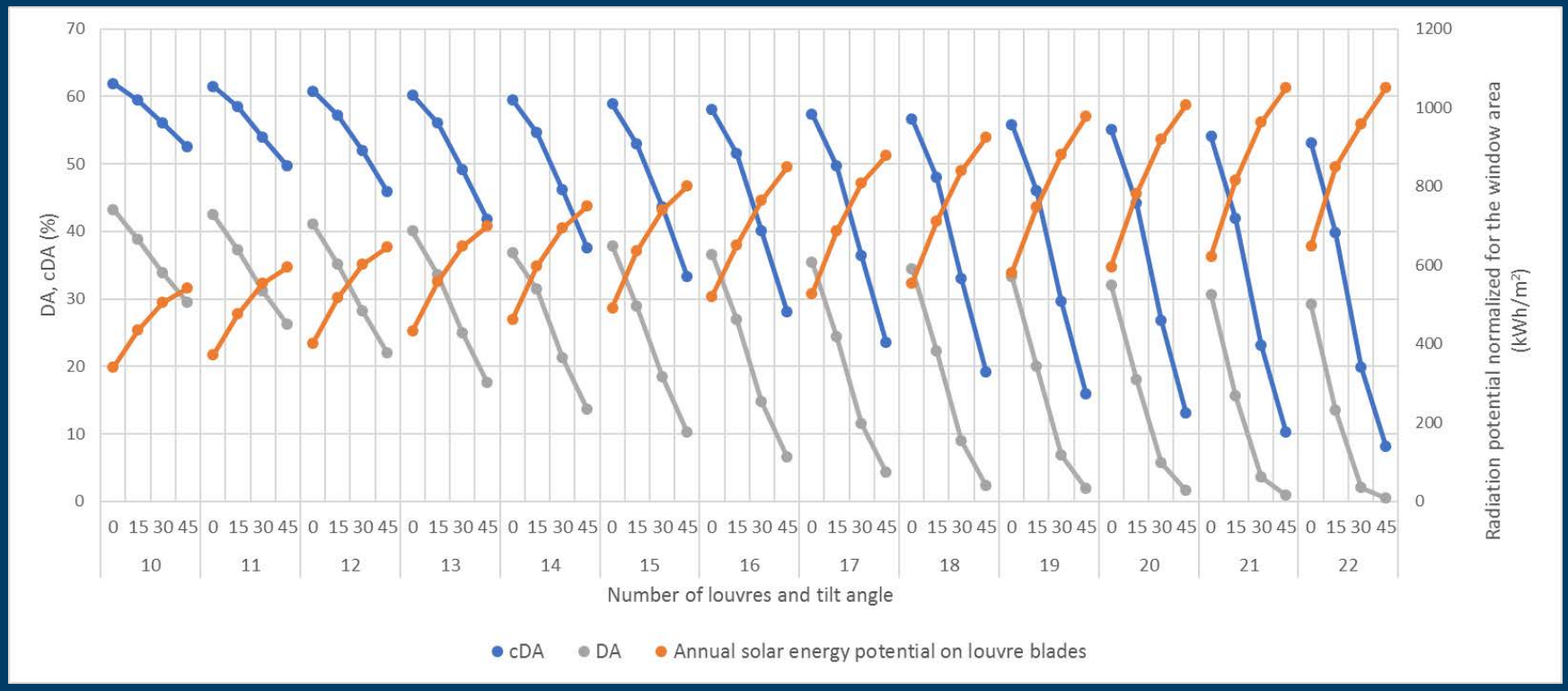
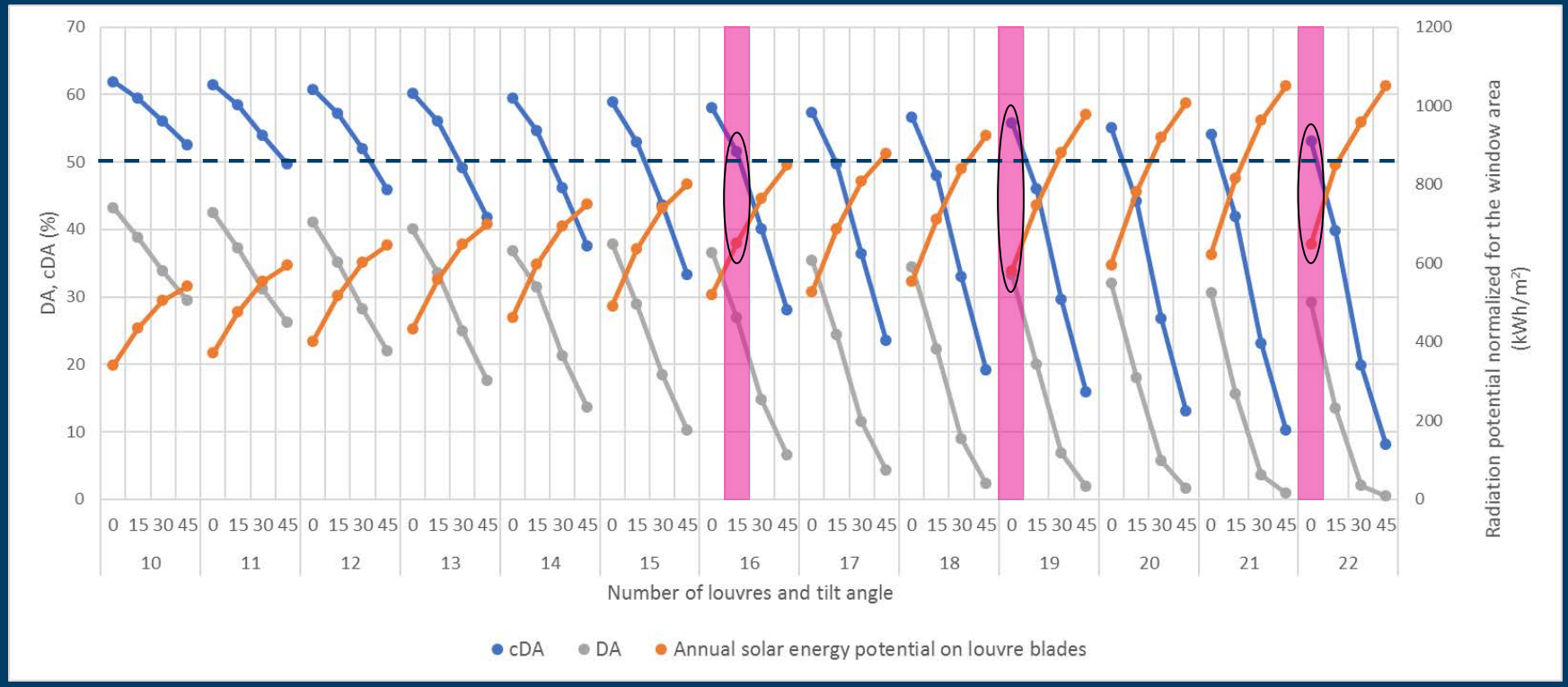
DA, cDA og SRP at different lamella configurations



Cases for further optimization



Theoretical energy demand covereage

ID	Annual SRP (kWh)	Annual electricity conversion (kWh)	Coverage of annual delivered energy (%)	Annual delivered energy (kWh)
16-A	7719	1158	21,0	5520
16-G	8835	1325	24,0	5520
19-B	9498	1425	25,8	5520
22-A	9688	1453	26,3	5520

Assumptions:
Efficiency – 15%
Energy demand– 115 kWh/m2 (Norwegian standard office building)

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WORK PACKAGES

1. WP1 Analytical framework for design and planning of ZEN
2. WP2 Policy measures, innovation and business models
3. WP3 Responsive and energy efficient buildings
4. WP4 Energy flexible neighbourhoods
5. WP5 Local energy system optimization within a larger system
6. WP 6 Pilot projects and living labs

ZERO EMISSION NEIGHBOURHOODS IN SMART CITIES

Responsive buildings definitions

- **What:**
  - Develop a definition of the concept "Responsive buildings".
  - Identify technical solutions that enable responsive buildings
  - Assess energy performance of responsive buildings and technologies (in cooperation with PhD)

- **Why this work is important for ZEN:**
  - To gain a common understanding on what a responsive building is to enable development of technologies, concepts and tools for design and realization of such buildings

ZERO EMISSION NEIGHBOURHOODS IN SMART CITIES

Responsive technologies

- **What:**
  - Mapping and analysis of existing Responsive and Energy Flexible buildings
  - Technical solutions, equipment and building operation that enable buildings to become responsive
  - Energy performance of responsive buildings and technologies (in cooperation with PhD)

- **Why this work is important for ZEN:**
  - To gain better knowledge about state of the art technologies and the energy saving potential of such technologies in buildings located in Norway. This activity will be based on the work on the responsive building definition and will also follow and support the research of the PhD.
- **Connection to pilot project:**
  - Oslo/Furuset

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Highly insulating windows project - HVIT

- Togehter with a mid-size Norweigan, the aim is to evlop windows with U-values as low as 0.43 W/m2K (0.076 Btu/hr-sq ft °F)

- Development of "slim frames"
  - Multiobjective optimization of window frames using 3D modeling
  - Using frame - glazing unit strenght interaction to reduce frame areas?
- 4-pane glazing units with thin intermittent layers
- Plug-and-play window mounting solutions (airtight and easy to use)
- Business models and efficient production methods – mass customization

ZEB Flexible Lab

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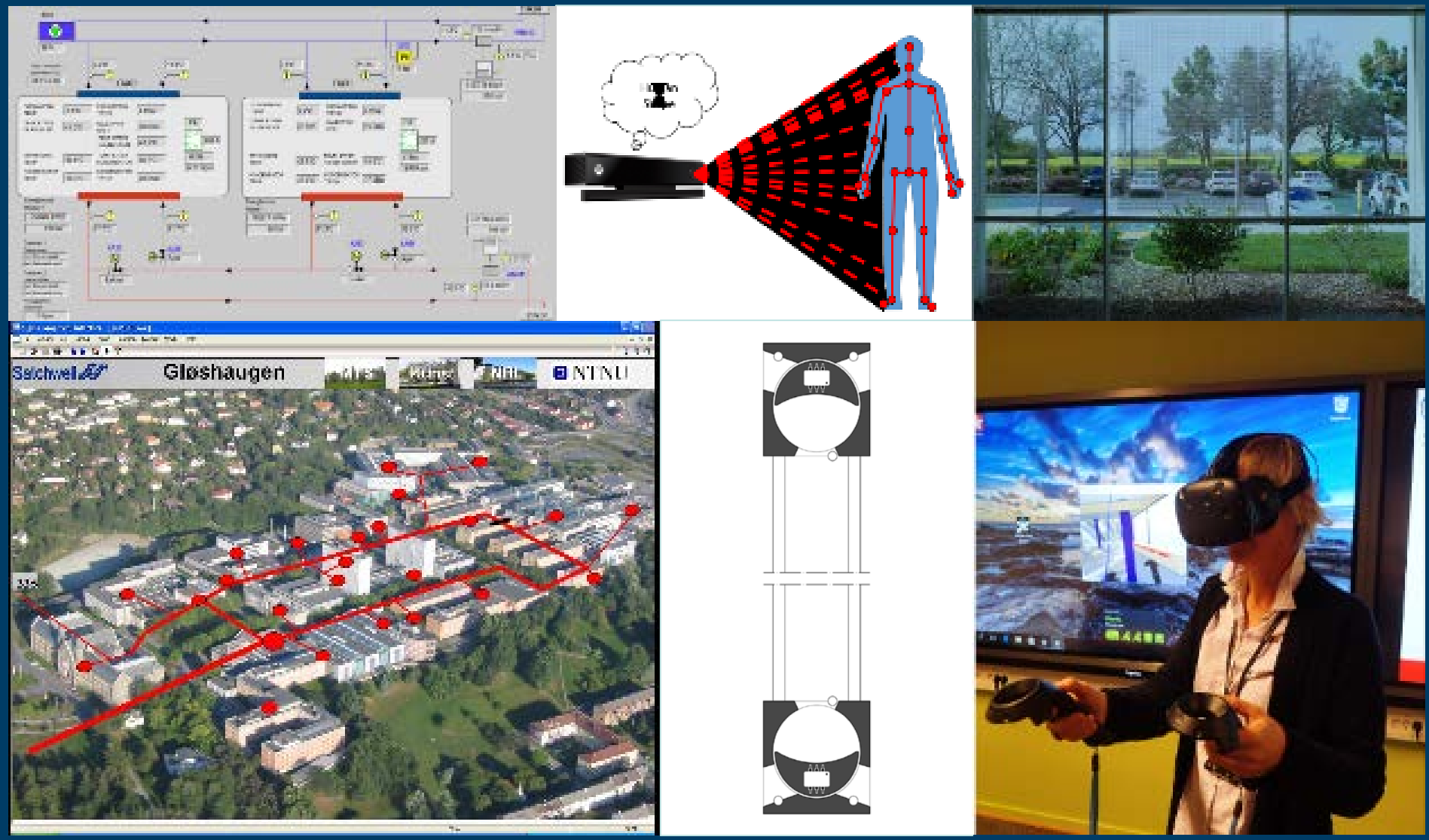
Timeline

- Construction start 1st April
- Completion 1st January 2020

Focus on prosibilites for research and innovation



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