EVALUATION OF IEQ IN RELATION TO CHOICE OF GLAZING AND SOLAR SHADING IN A RESIDENTIAL BUILDING – SENSITIVITY ANALYSIS WITH MOBO

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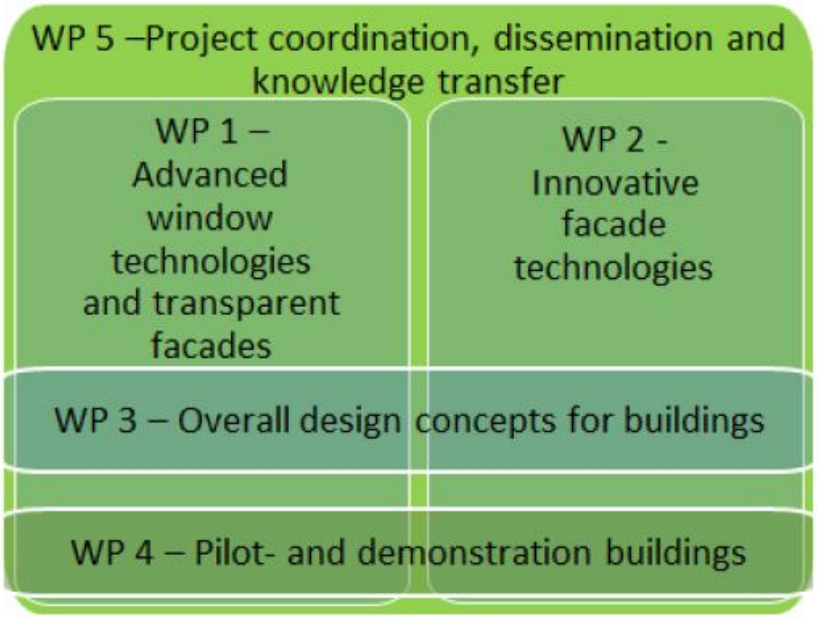
Agenda

- Intro
  - Background
  - Sensitivity analysis
  - Optimization
- Modelling and simulation
- Results
- Conclusions

Introduction

- Background – skintech Norwegian Research Council energix competence project



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Sensitivity analysis

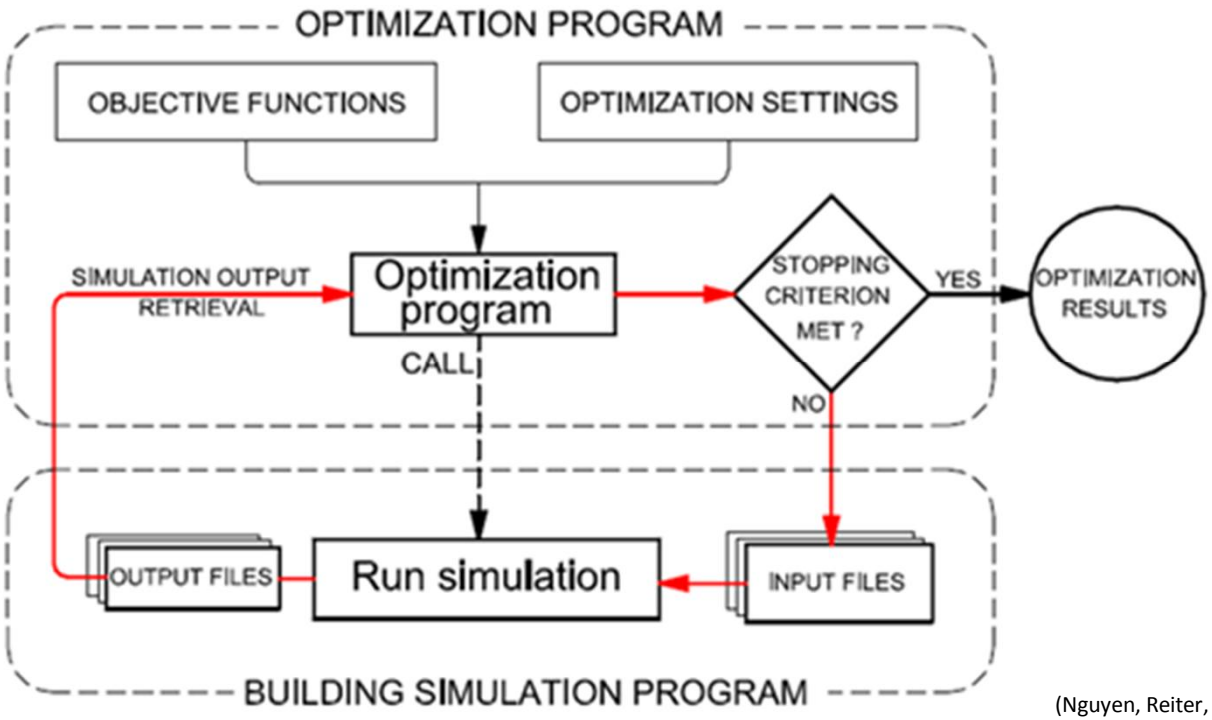
- Parameter studies
- I/O analysis
- Optimisation

- In the design of sustainable buildings it is beneficial to identify the most important design parameters in order to develop more efficiently alternative design solutions or reach optimized design solutions.

Optimisation

- Different tools consist of combinations of optimisation algorithms / methods and building performance simulation tools. Examples of tools which have been developed with focus on optimisation of building performance of buildings (energy, comfort, costs, etc.) are:
  - Opt-E-Plus
  - GENE_ARCH
  - BEopt™
  - TRNOPT
  - MultiOpt2
  - jEPlus+EA
  - MOBO (**M**uli-**Ob**jective_**O**ptimization)

Typical structure



(Nguyen, Reiter, and Rigo 2014)

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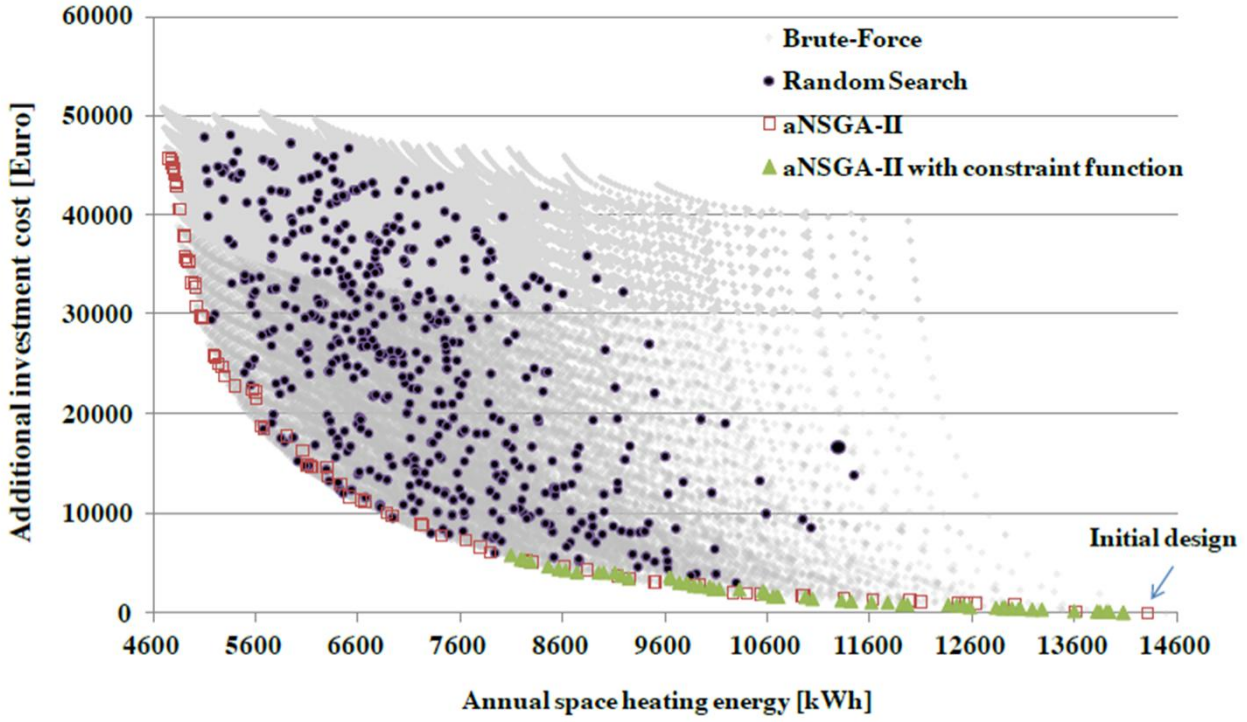
MOBO

- MOBO is a generic freeware able to handle single and multi-objective optimization problems with continuous and discrete variables and constraint functions and can be coupled to many external (simulation) programs like IDA-ice.
- It has a an extendable library of different types of algorithms (evolutionary, deterministic, hybrid, exhaustive and random), is able to handle multi-modal functions and has automatic constraint handling.
- Optimisation is possible with the use of different algorithms:
  - Brute-Force algorithm (general problem-solving technique)
  - Random-Search algorithm (RS)
  - Pareto-Archive NSGA-II algorithm (or **Pareto optimization**)
  - Binary aNSGA-II
  - **Hooke-Jeeves (pattern search)**

*Hooke, R.; Jeeves, T.A. (1961). ""Direct search" solution of numerical and statistical problems". Journal of the Association for Computing Machinery (ACM). **8** (2): 212–229.*

MOBO



(Palonen et al. 2013)

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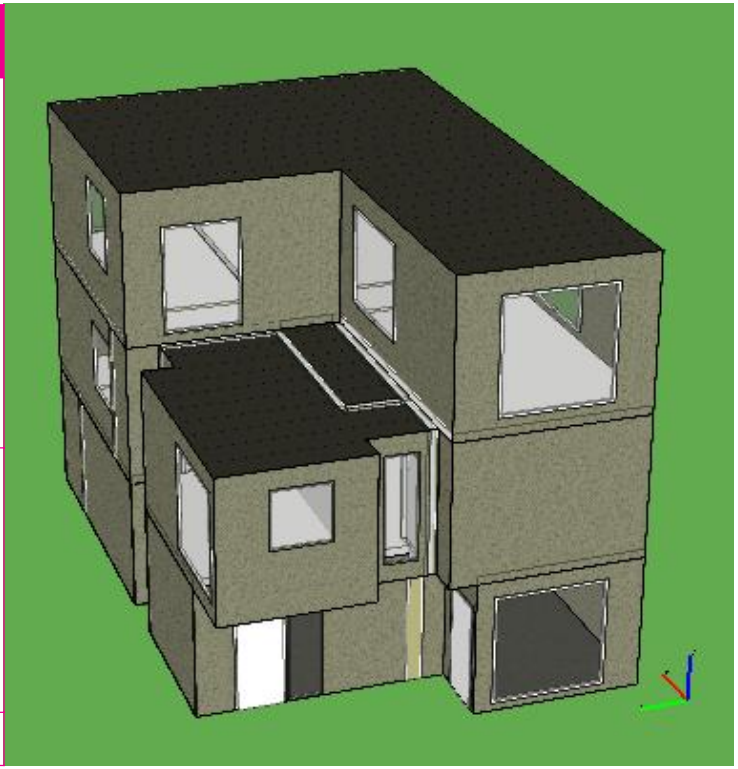
Modelling and simulation

Zone	Total 260 m^2
hybel living	1. et.
hybel sleeping	
hybel bath	
Entrance	
Disp. basement	
Technical room	
disp room	
training 1	2. et.
Sleeping	
Hall	
training 2	
bath/washing room	
living/kitchen/dinner	3. et.



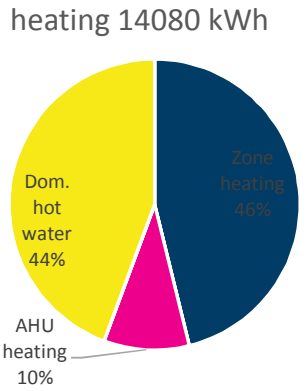
Modelling and simulation

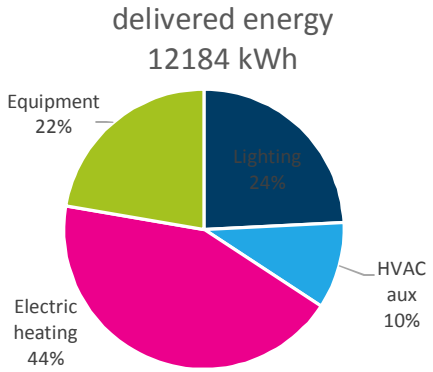
	Glazing	g-verdi (SHGC) (-)	T_{vis} (-)	$U_{glazing}$, W/(m^2 K)	Frame fraction (-)	U_{frame}, W/(m^2 K)	U_{win}, W/(m^2 K)	Shading
1	© SGG Planitherm Ultra-N 3-panes	0.423	0.314	0.703	0.1	2	0.8327	No integrated shading
2	© SGG COOL-LITE SKN-174 3-panes	0.302	0.215	0.702	0.1	2	0.8318	No integrated shading
3	© SGG Planitherm Ultra-N 3-panes	0.041	0.014	0.626	0.1	2	0.825	With integrated shading

Modelling and simulation

- Documentation of thermal comfort with software IDA ICE
  - Daylight conditions (Daylight factor)
  - Hybrid ventilation strategies
  - Summer temperatures

  - Thermal comfort in selected zones for a warm summer day
  - Daylight values were calculated as average values for the whole year





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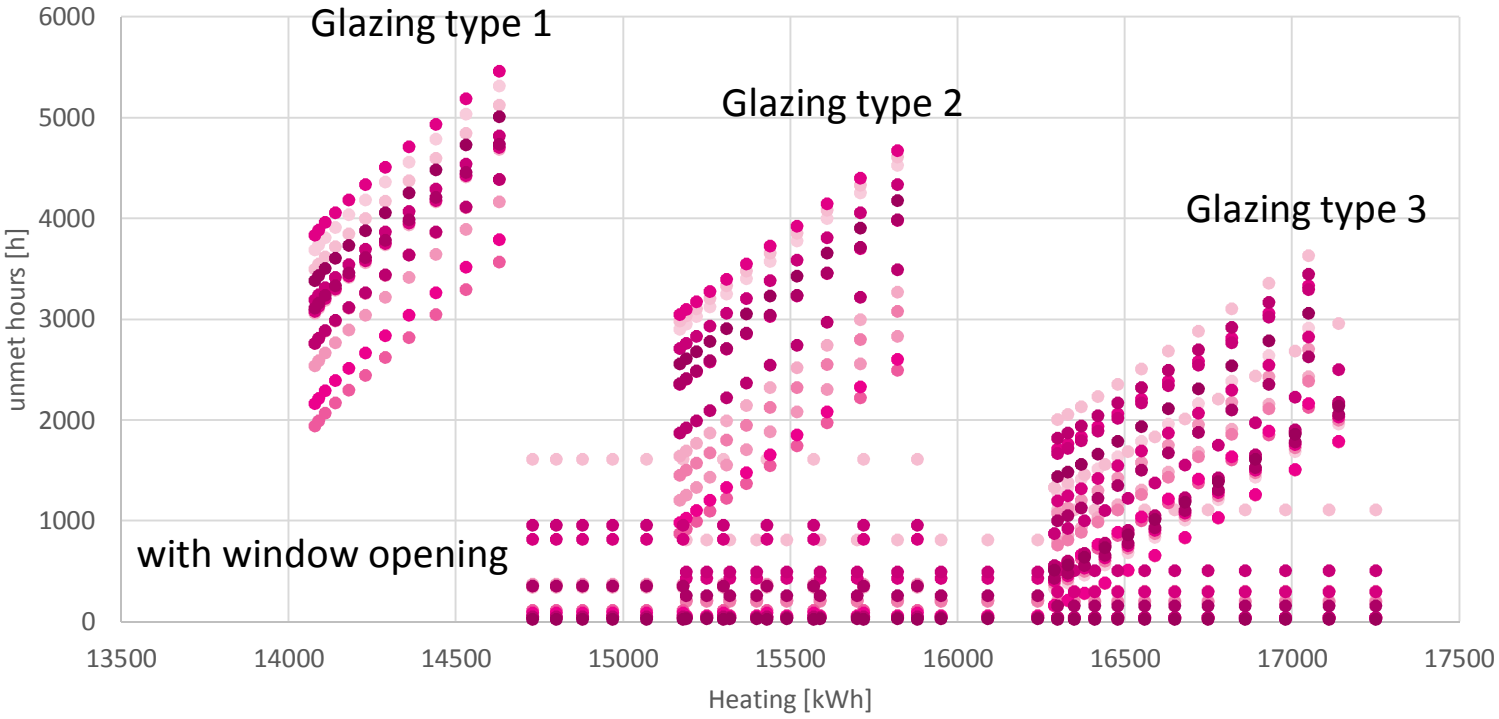
Results



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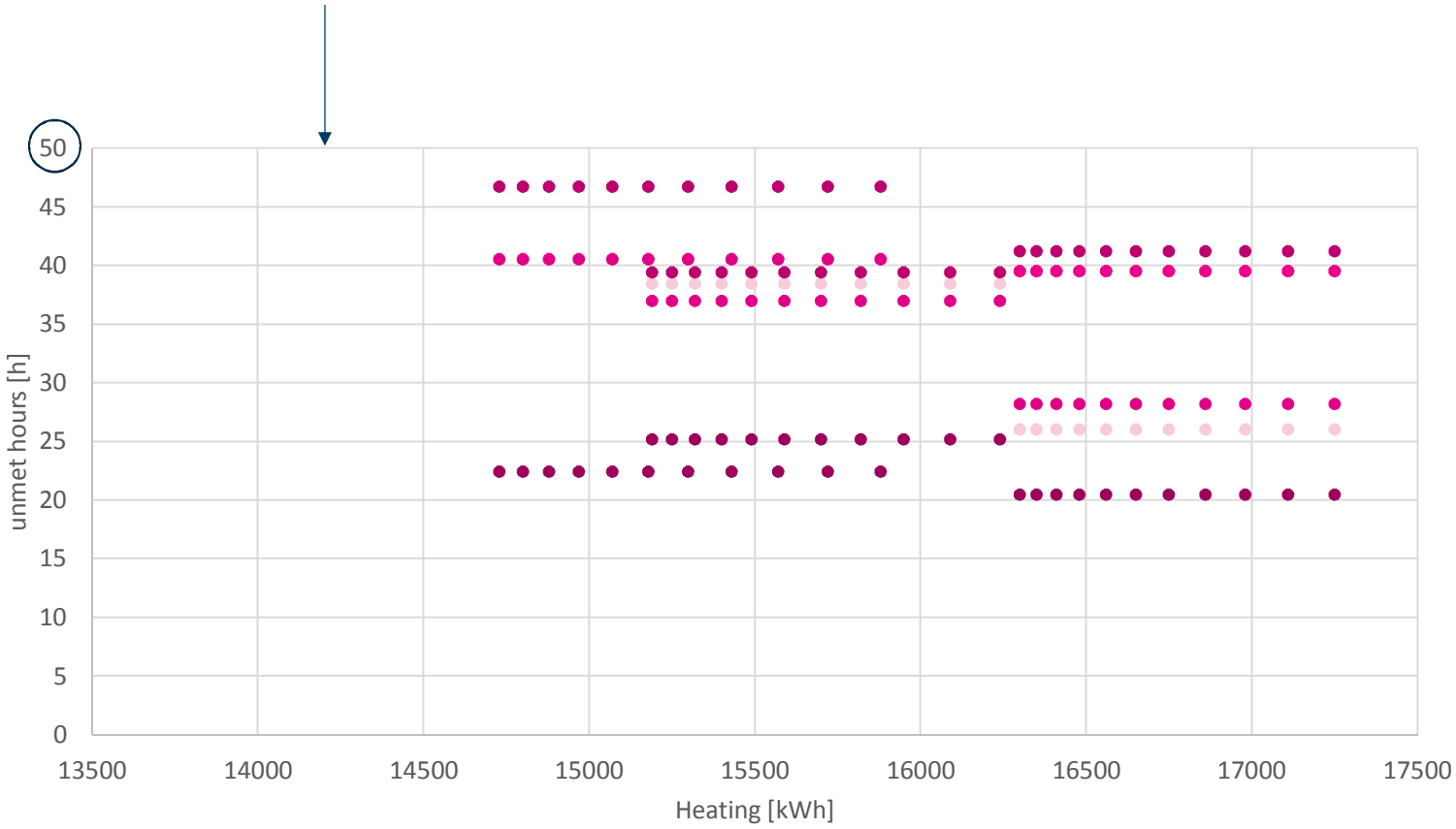
Results



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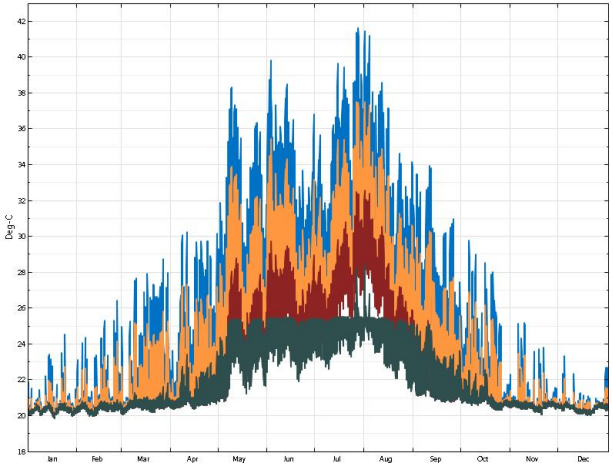
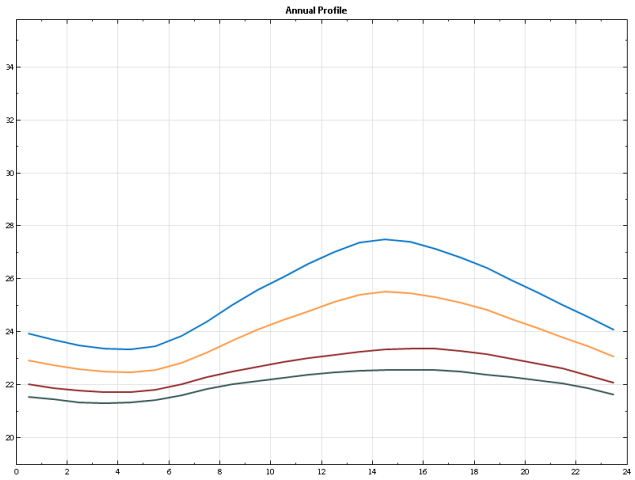
Results

1. without solar shading (g-value 0,423)
2. with solar shading glass (g-value 0,302)
3. with external solar shading (Screens with g-value in closed position 0,04)
4. with solar shading AND natural ventilation (window opening)





*Hourly values of **operative temperature**;* *average annual values for **operative temperature***
without (blue), with solar glazing (yellow), with external screen (red) og with window opening (grey)

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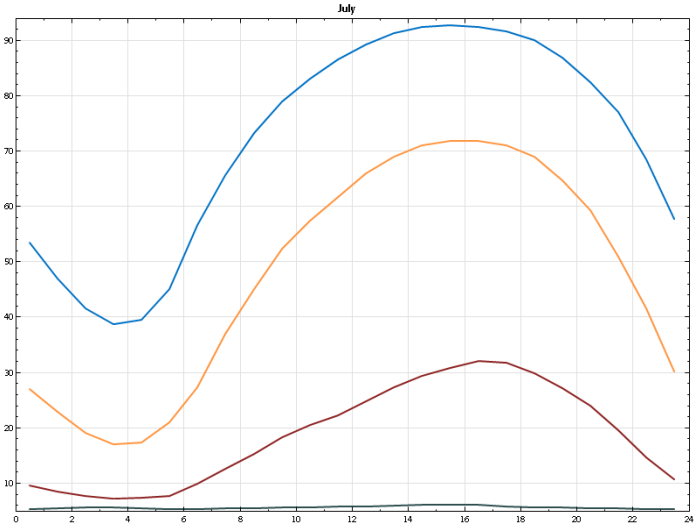
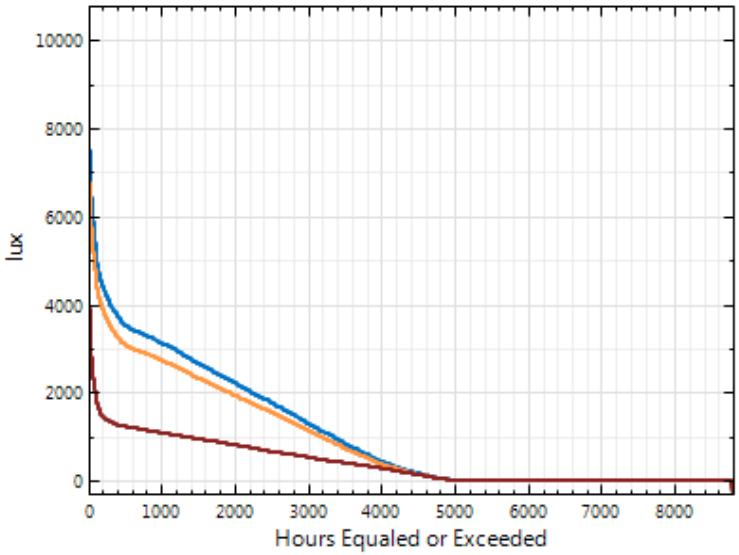
Results





Thermal comfort *PPD in July; average values.*

Daylight *whole year*

without (blue), with solar glazing (yellow), with external screen (red) og with window opening (grey)

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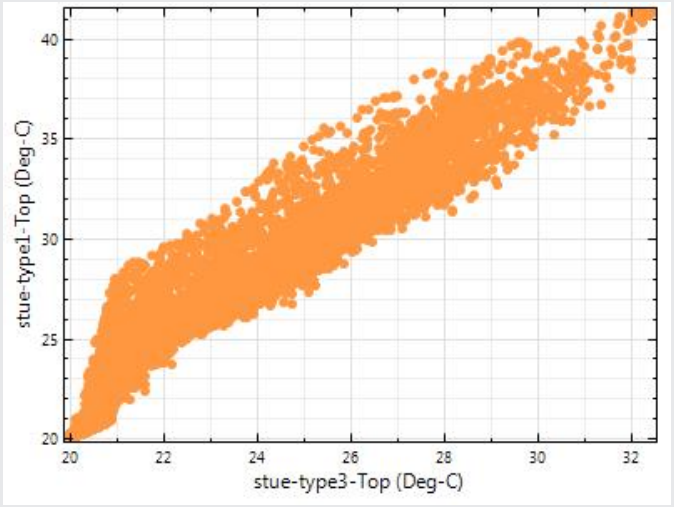
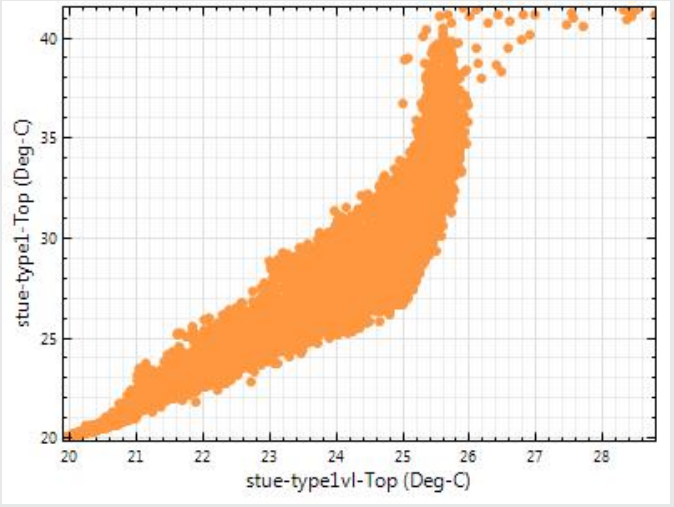
Results

room	Effect of solar shading	Effect of window opening
Living 2.floor		

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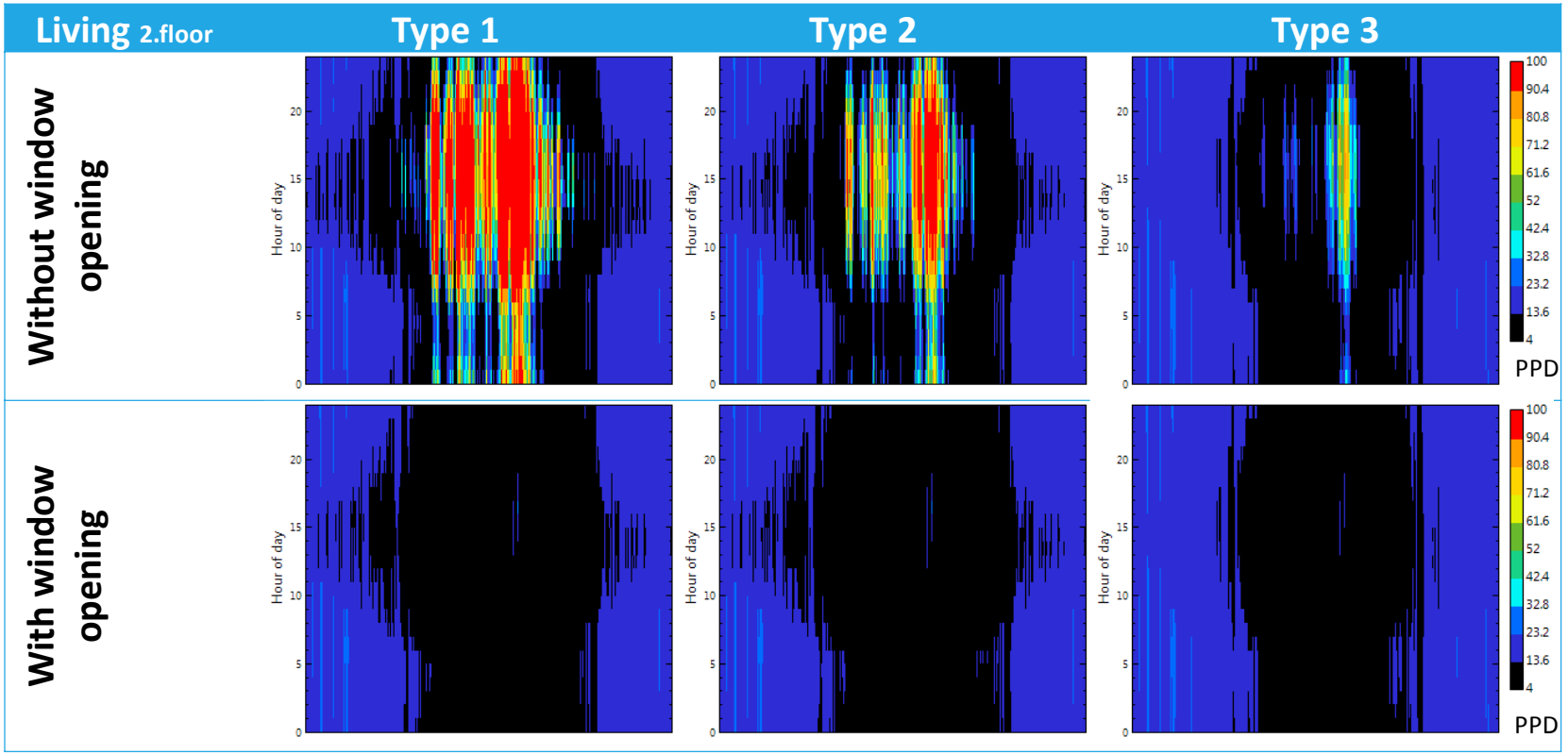
Comfort



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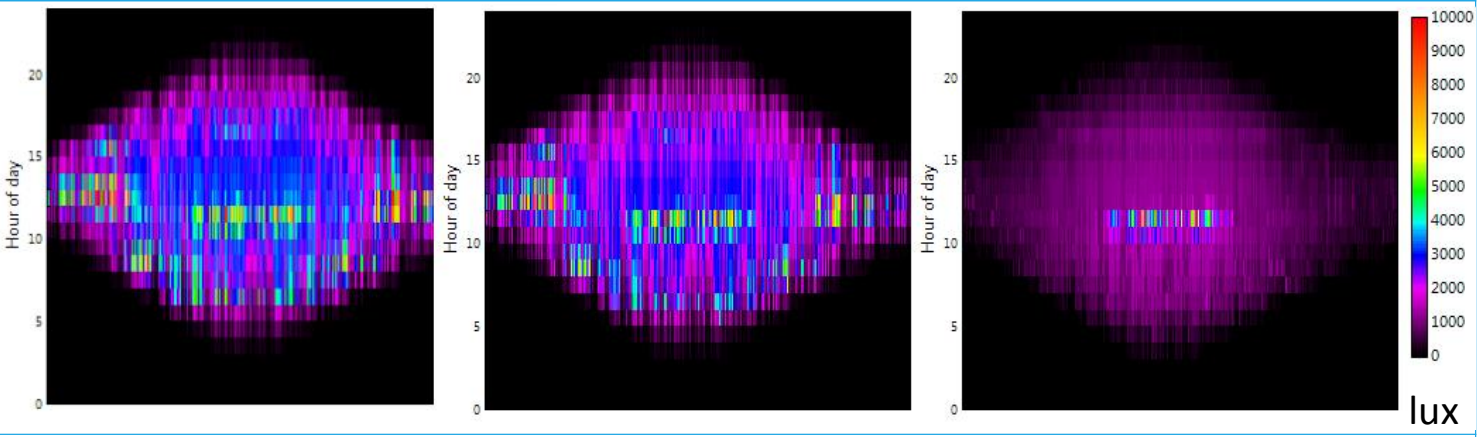
Daylight

room	Type 1	Type 2	Type 3
living 2.floor			
DF [%]	6.416	5.33	6.416

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Conclusions

- Glazing with solar shading reduces operative temperatures and thermal comfort (down to under 72% PPD in July).
- Window opeing can be an effective way to reduce maximum indoor temperatures.
- Daylight conditions reduce for glazing with solar shading.
- Daylight levels in the different zones is satisfactory both for glazing wiht and without shading.

Conclusions

- MOBO works as a design optimizer (with IDA-ICE as simulation engine).
- Dynamic optimisation is difficult to represent in functions (objective function).
- Detailed simulation gives a lot a results (data). It is difficult to focus on the most important ones.

- Can also be used for cost optimisation.
- Can also be used for goal optimisation (maximum investment → best design solution (value for money)

References

- Nguyen, Reiter, and Rigo 2014, A review on simulation-based optimization methods applied to building performance analysis, Applied Energy, 113, pp. 1043-1058
- Palonen, M., Hamby, M. and Hasan, A. (2013), MOBO A NEW SOFTWARE FOR MULTI-OBJECTIVE BUILDING PERFORMANCE OPTIMIZATION, Proceedings of BS13, Chambery, France, 26-28 August

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Teknologi for et bedre samfunn