

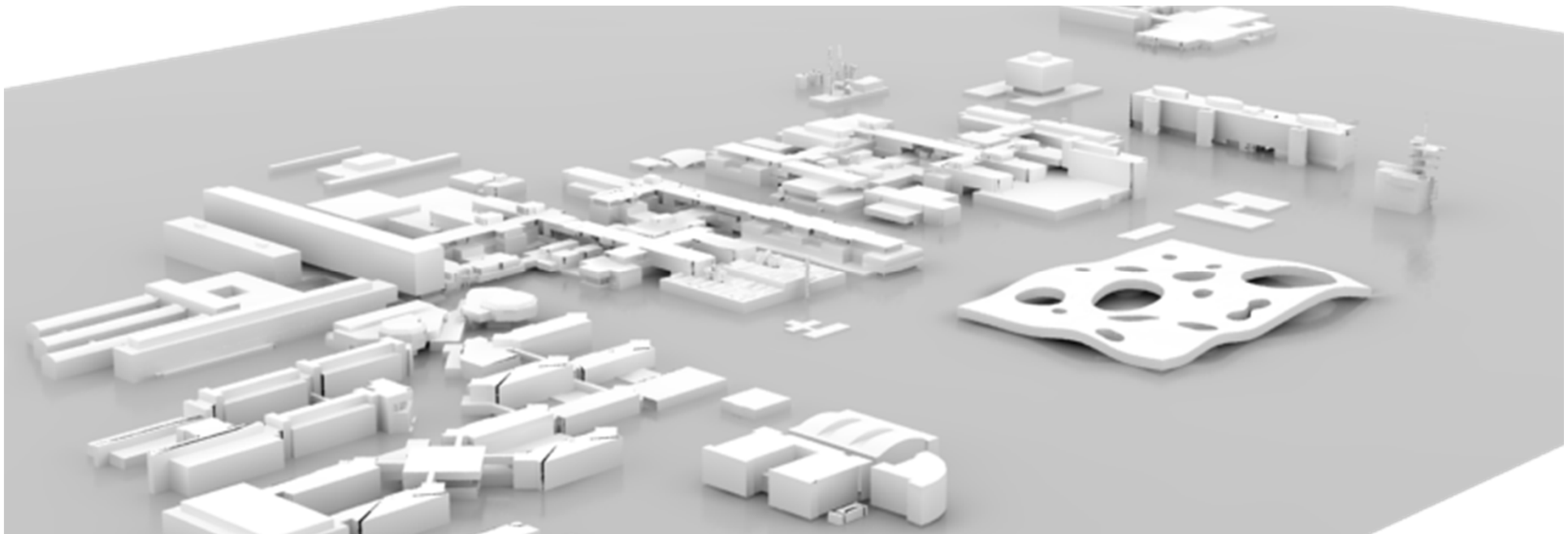
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20th-24th July 2015
Toulouse France



9th International Conference on Urban Climate
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Outdoor human comfort and climate change. A case study in the EPFL campus in Lausanne

Silvia Coccolo, Jérôme Kämpf, Jean-Louis Scartezzini

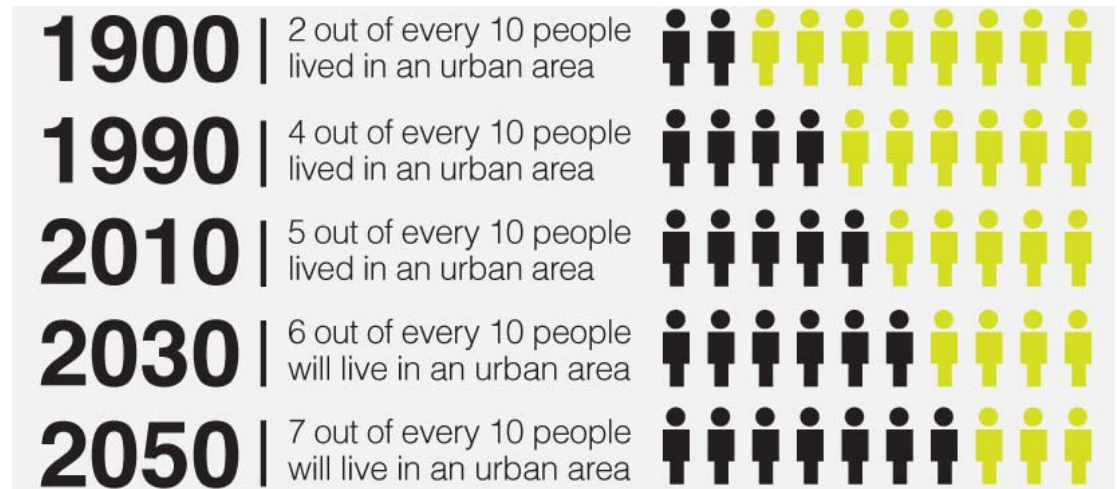


INTRODUCTION

Increase urban population

Climate change

People health and behaviours



(UN HABITAT 2012)

INTRODUCTION

EPFL_ “Energy Concept 2015-2045”:

- -30% of final energy
- ++ electricity coming from renewables
- -50% CO₂ emission



INTRODUCTION

Increase energy reference area (+25% since 2001)

District heating system is facing its efficiency limitation



Energetic model of the campus



Thermic behaviour in 2050

Outdoor human comfort (2050 and 2100)



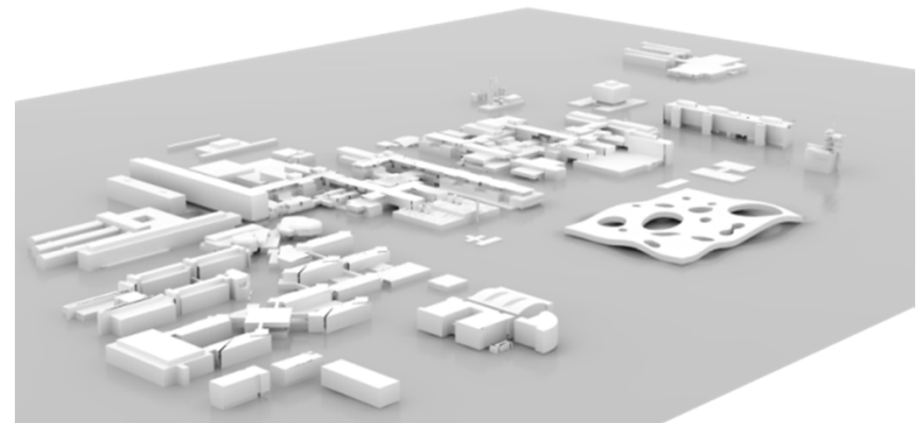
METHODOLOGY_ Energy demand

Physical characteristics of envelope by period of construction (1972-1984, 1980-2002 and today)

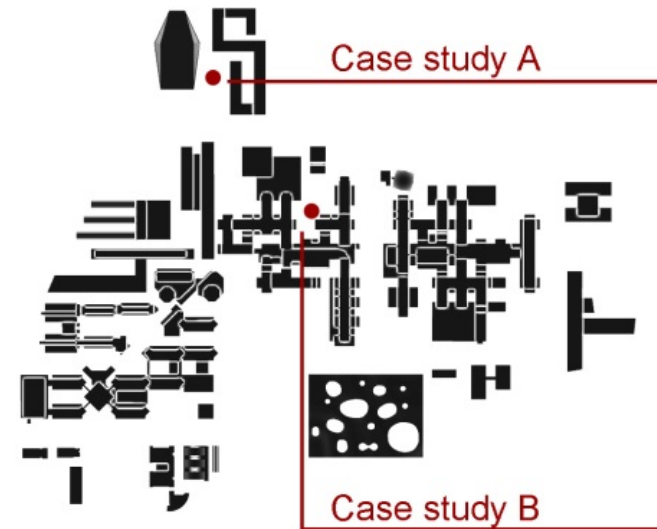
Occupants behaviour (SIA2024)

BiPV

2,000 m² and 2,000 kWh/year



METHODOLOGY_Outdoor Human Comfort



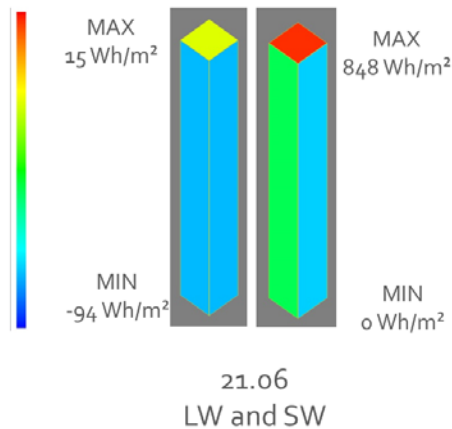
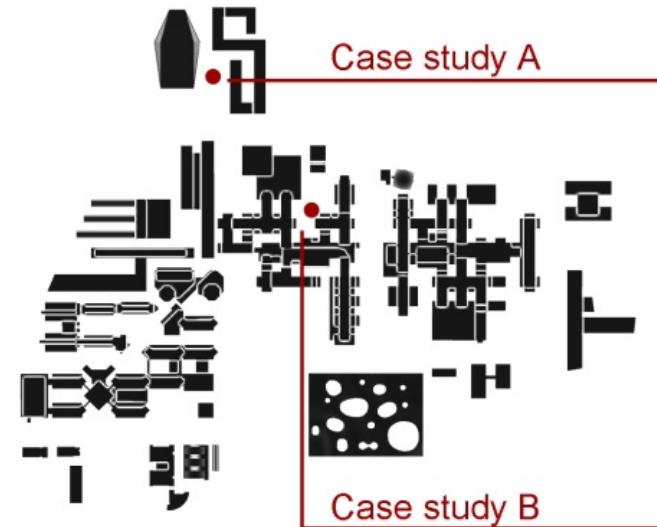
METHODOLOGY_ Outdoor Human Comfort

Actual Sensation Vote (ASV)

$$ASV = 0.068T_a + 0.0006R_g - 0.107v - 0.002RH - 0.69$$

COMFA* Budget

$$B = M + R_{RT} - C - E - L$$

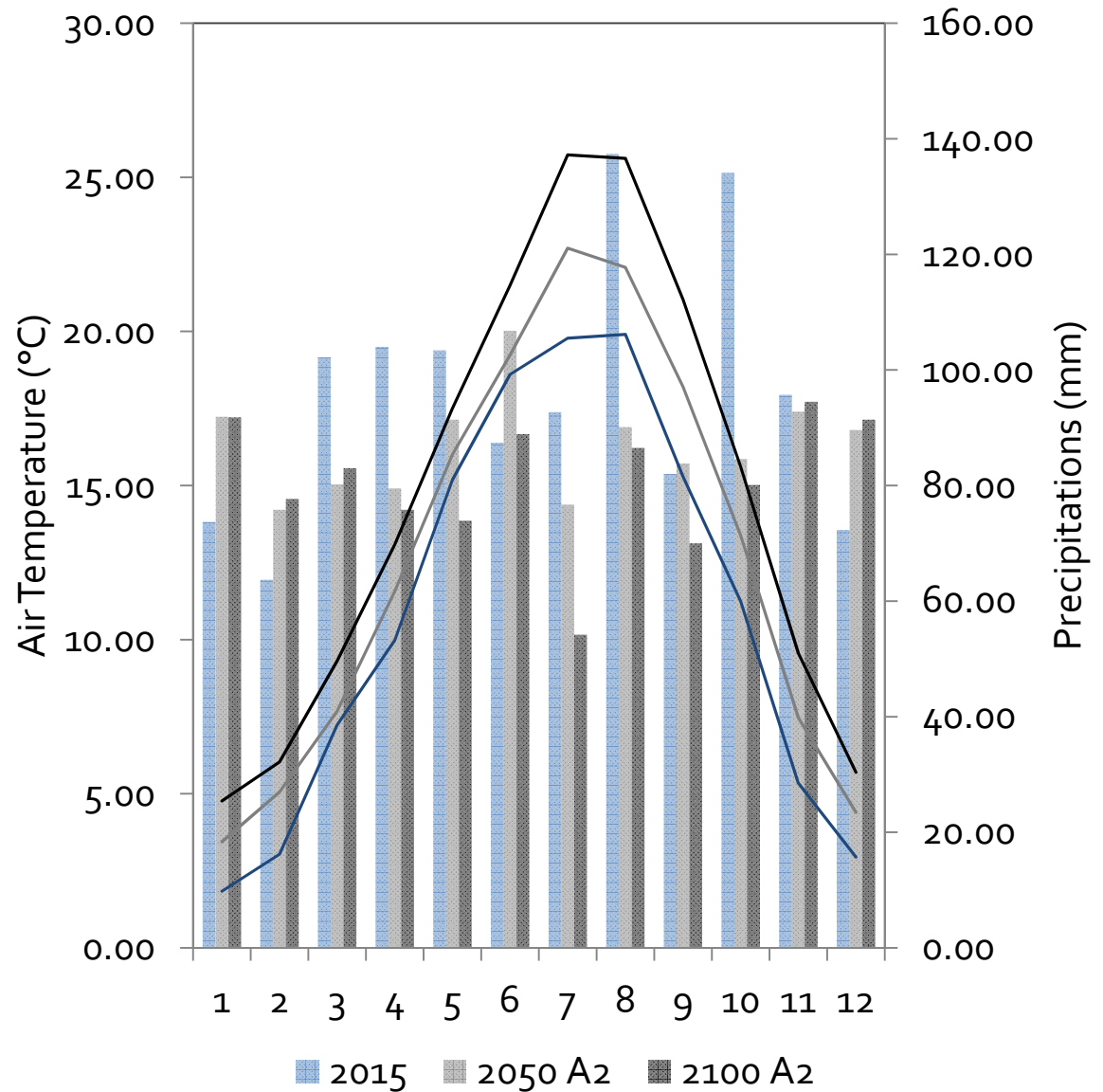


METHODOLOGY_Weather scenarios

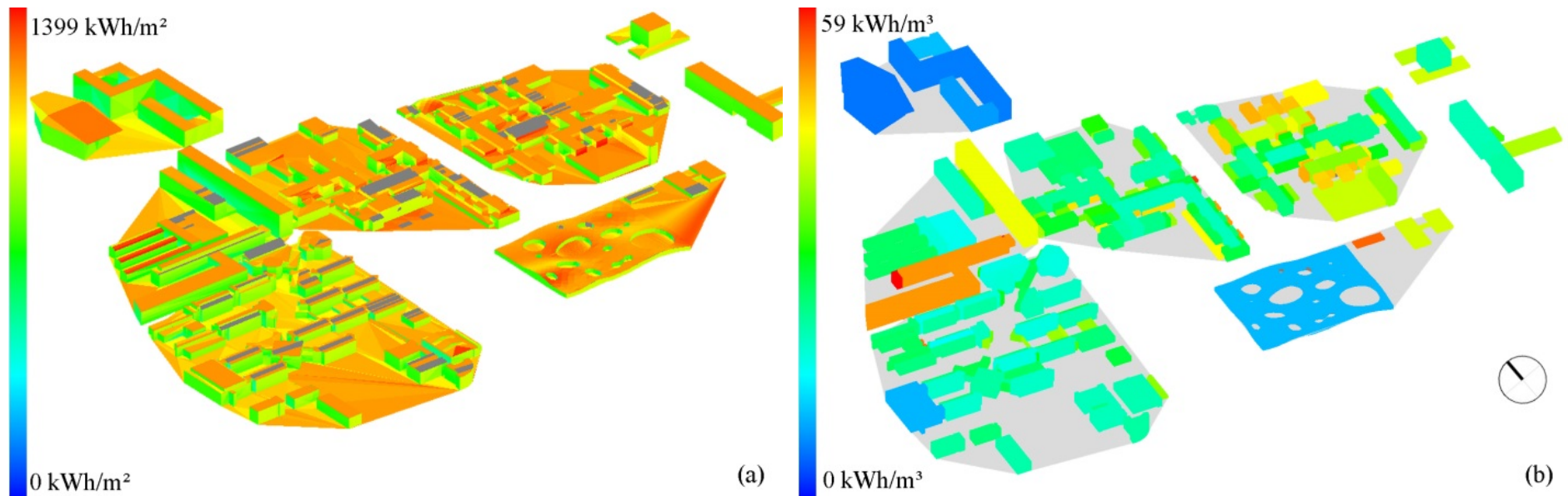
- 2050 and 2100-B1
- 2050 and 2100-A1B
- 2050 and 2100-A2

Air temperature
+5°C and +8°C
(summer)

Precipitations
-13 to -27 %
(summer)



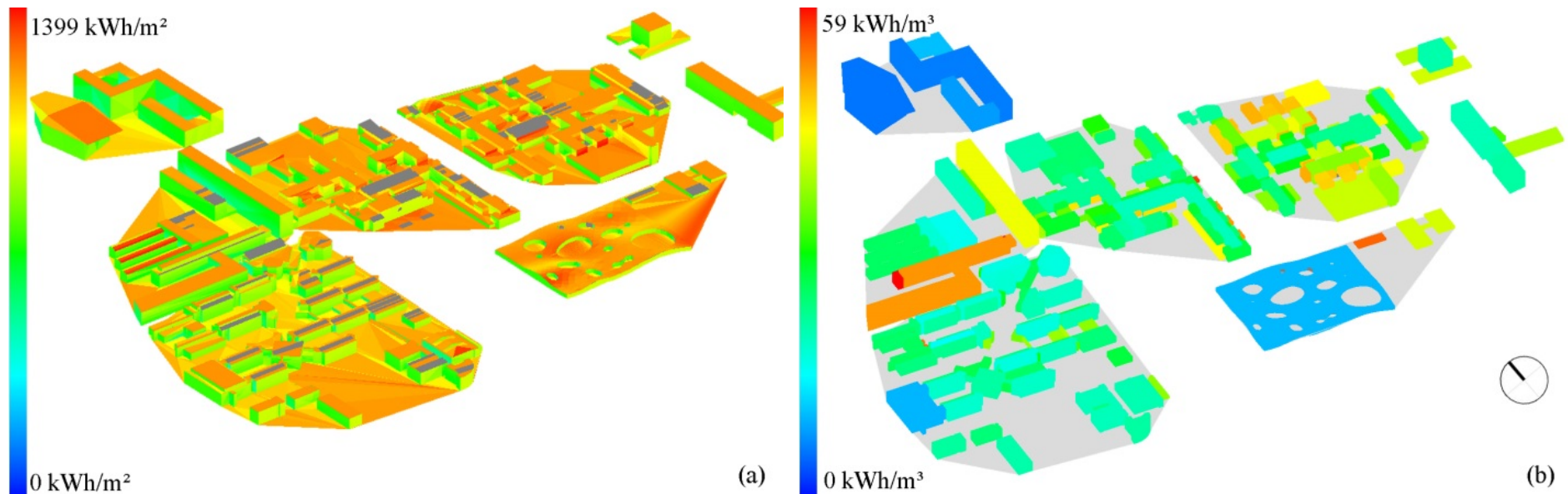
RESULTS_Energy demand



RESULTS_ Energy demand

Refurbishment according to [Minergie](#) and [Minergie-P](#)

Best: [Minergie-P](#) in 2050-B1 (cooling +50%, heating demand -89%)

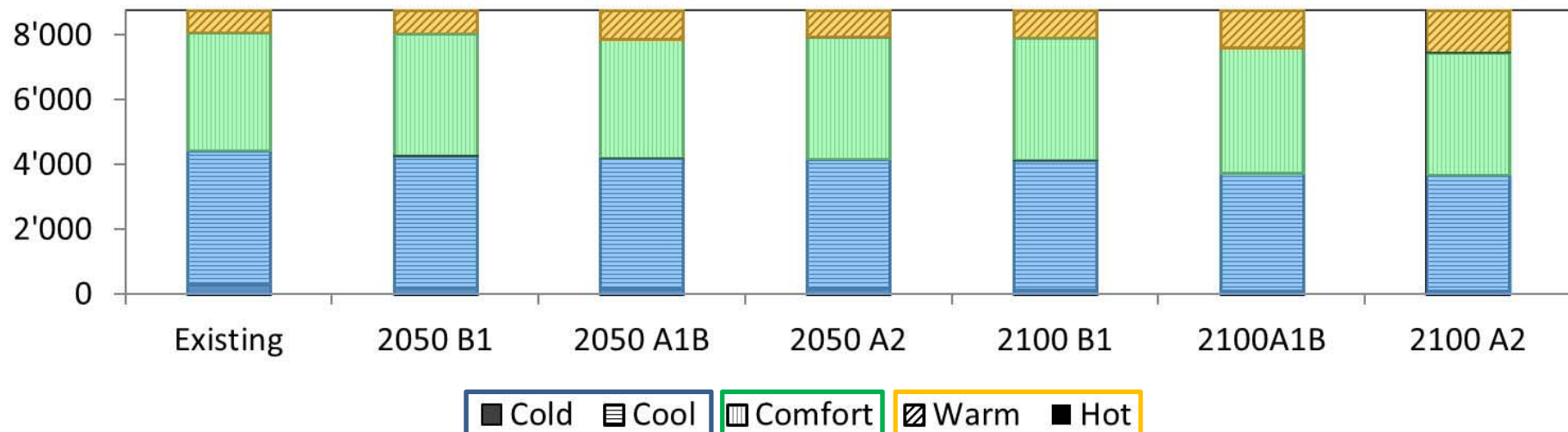
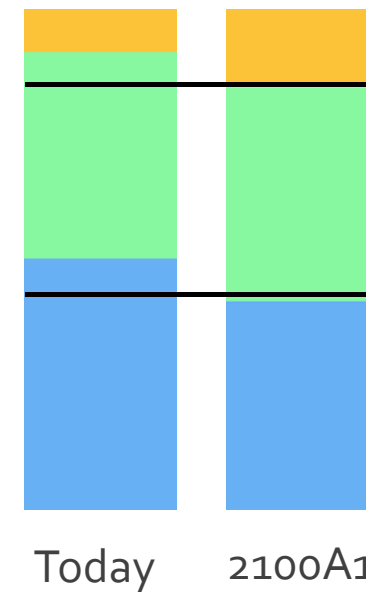


RESULTS_ Outdoor Human Comfort

ASV

2,050: cool and cold events -4%
warm and hot events +20%

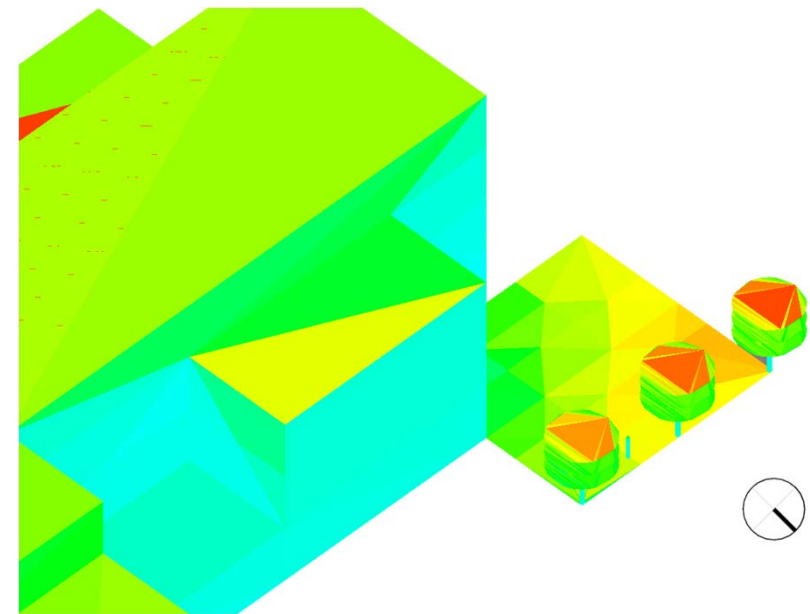
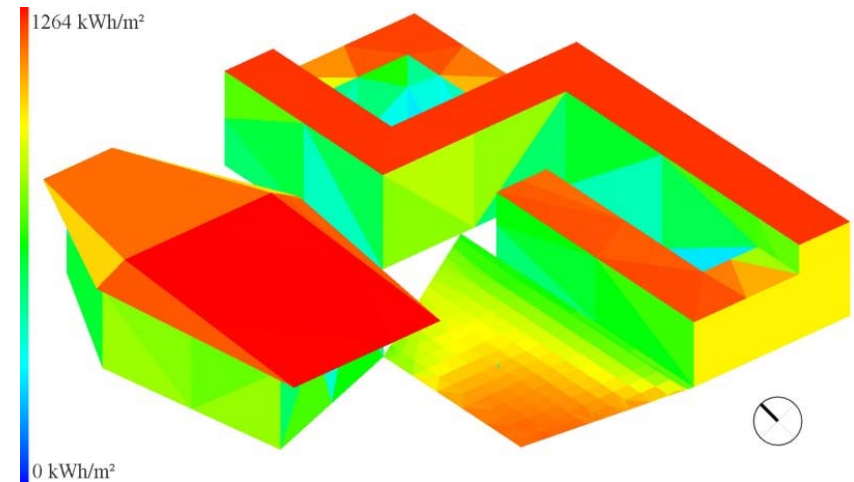
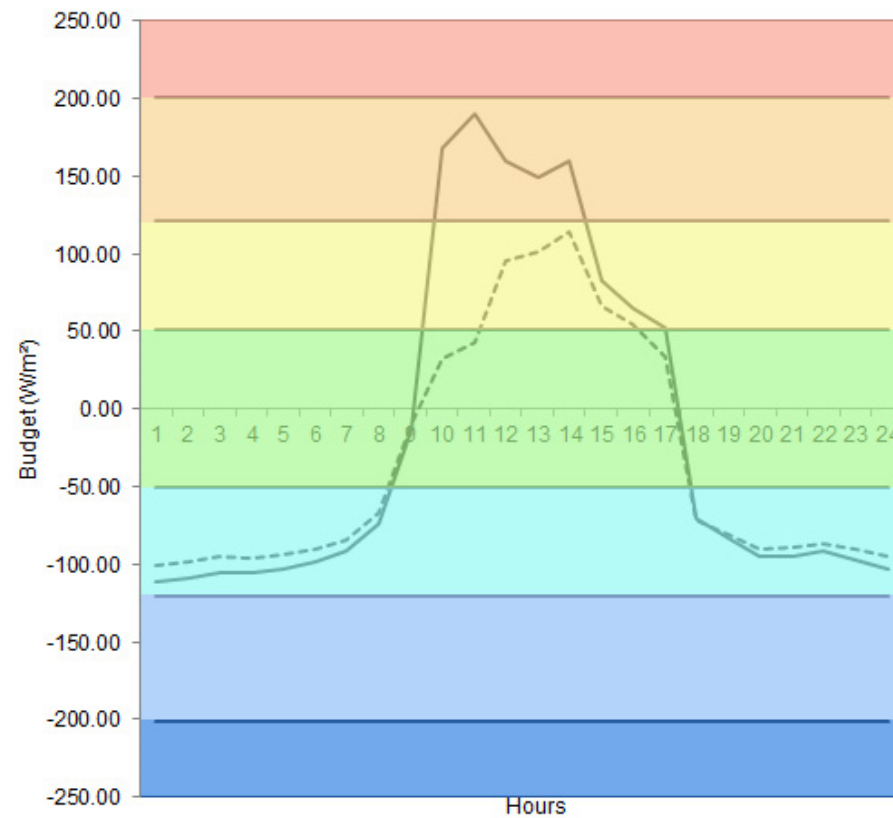
2,100-A2: warm/hot hours will double (1,316
hours ~ 55days)



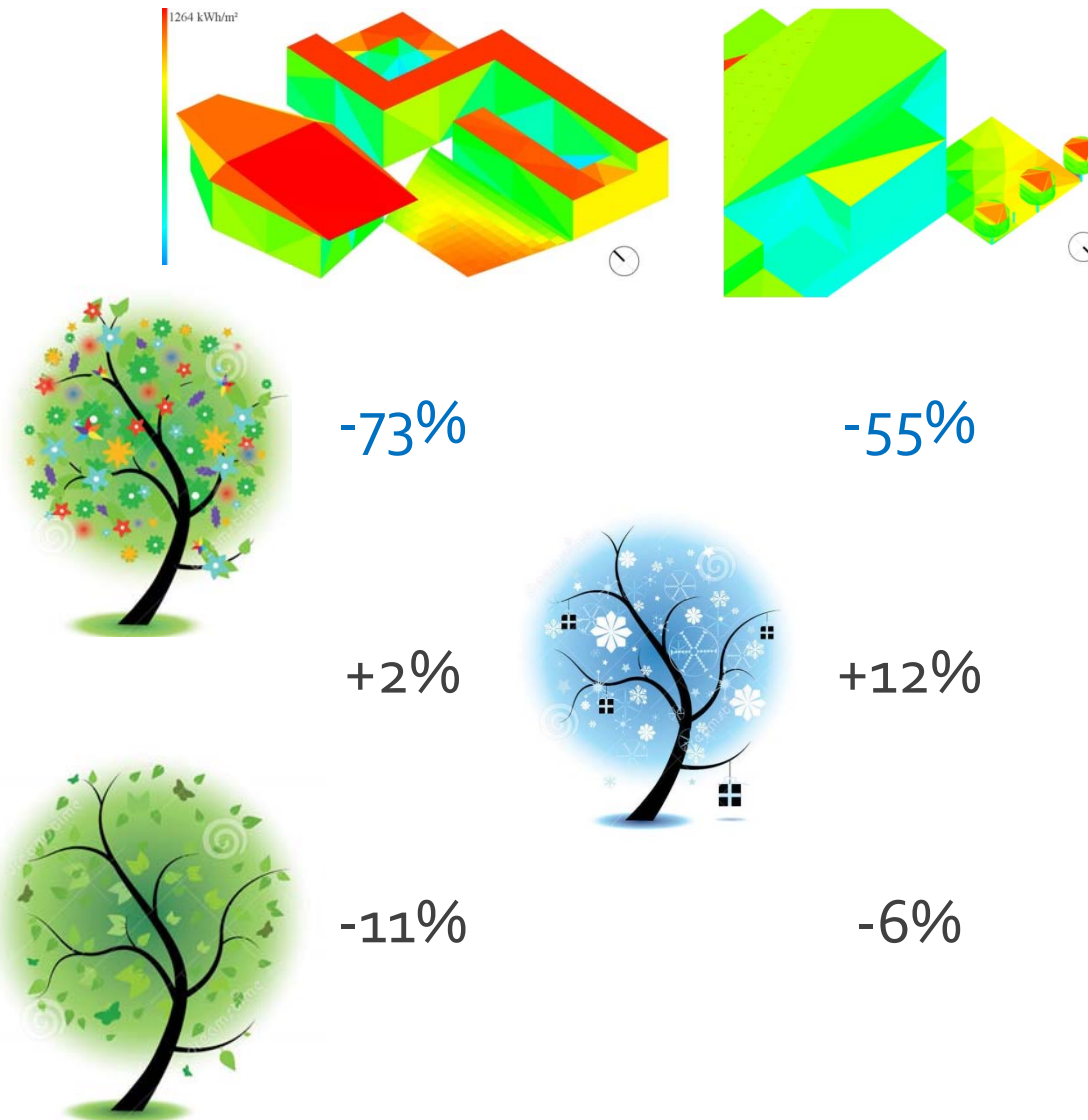
RESULTS_ Outdoor Human Comfort

COMFA* model_microclimate

Day time hours (from 8 am to 7 pm)



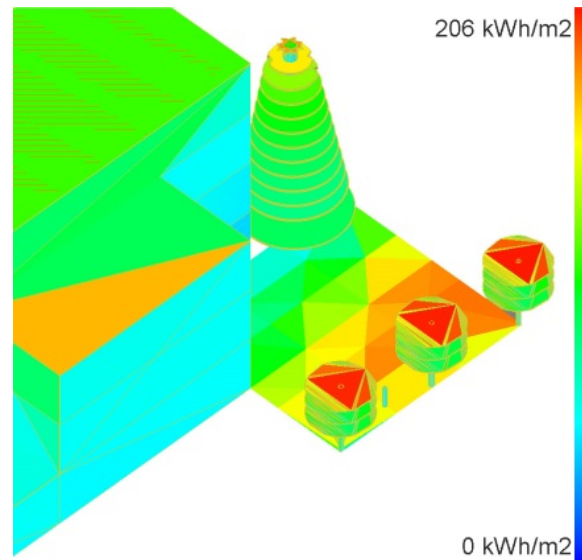
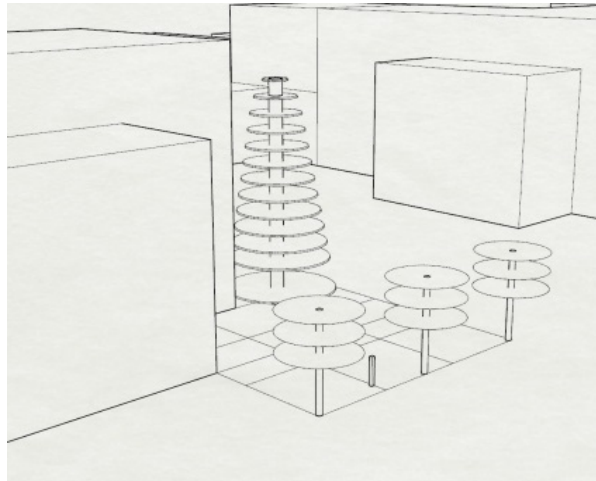
RESULTS_Outdoor Human Comfort



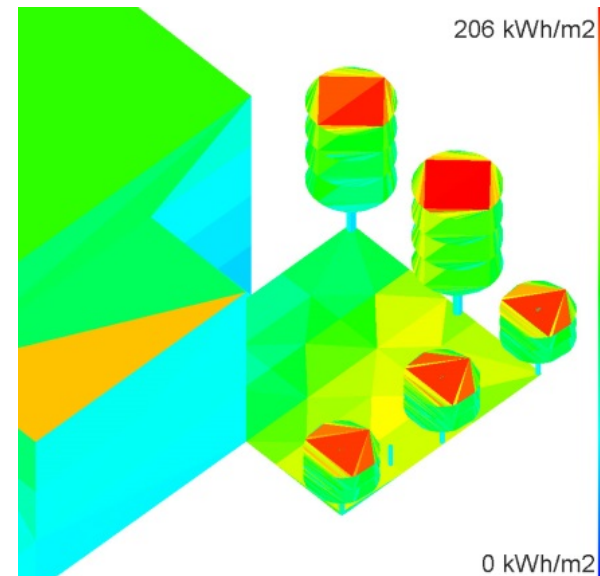
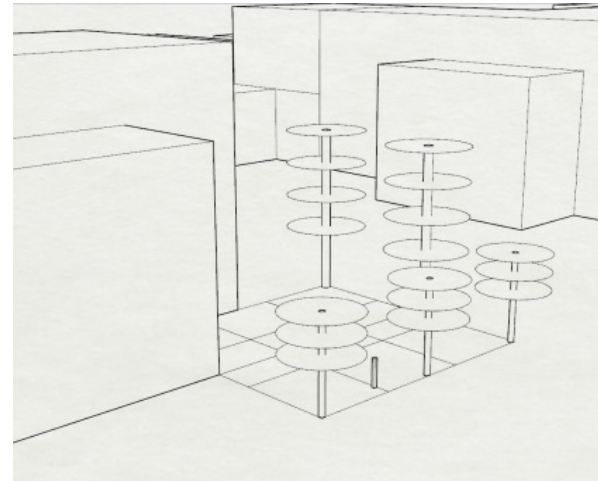
RESULTS_Outdoor Human Comfort

Shadowing strategies

Picea Rubens



Betula Utilis



CONCLUSIONS

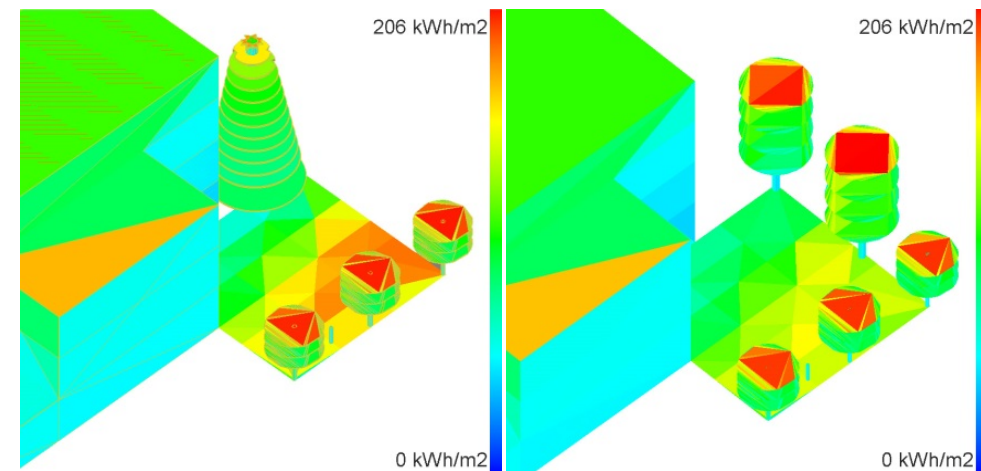
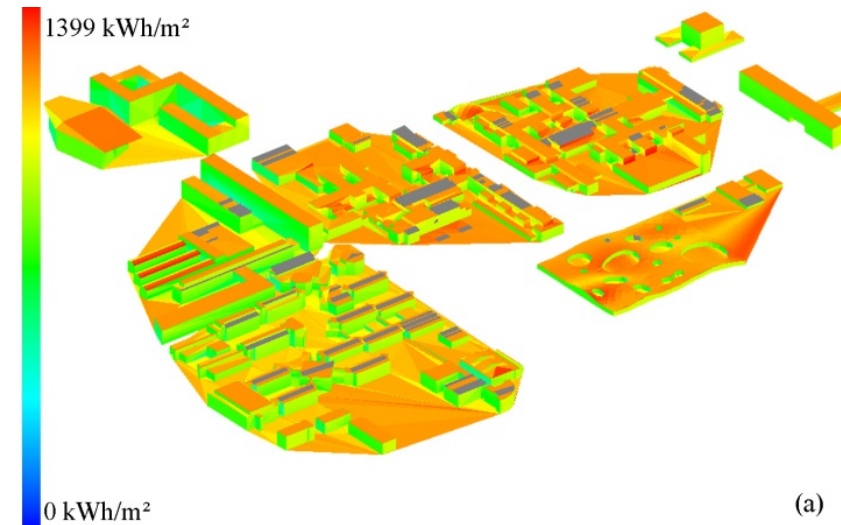
Energy behaviour of EPFL campus

Outdoor human comfort_ artificial
and semi natural environment

Cooling devices (indoor) and passive
strategies (outdoor)

FUTURE WORK
Energy Hub Model

Evapotranspiration in plants design





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