3D Simulation tool to evaluate the urban energy efficiency performance

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Arch. MSc. Susan Knodel – kaemco

Summary

1. Introduction
2. CitySim 3D Simulation Tool
3. Previous and Current Projects
4. Stakeholders

1. Introduction

Who We Are

Prof. PhD Jérôme Kaempf

EDUCATION

3 Masters - Physics (University of Lausanne)
- Computer Science (University of Lausanne)
- Pedagogics (HEPL)

PhD on the modelling and optimisation of urban energy fluxes (EPFL)

Haute école d'ingénierie et d'architecture Fribourg
Hochschule für Technik und Architektur Freiburg

ACTIVITIES

- Professor of Building Energy Efficiency (University of Applied Sciences of Western Switzerland, Fribourg)
- Host Professor at EPFL
- Founder and managing partner of kaemco - Consulting in energy and urban physics (CitySim)

Arch. Susan Knodel

EDUCATION

- Bachelor in Architecture and Urban Planning (Brazil)

2 Specialisations – Urban Environmental Management (Brazil / France)
- Geomatics (University of Geneva)

1 Master - Environnemental Sciences (University of Geneva)

ACTIVITIES

- Architecture and Urban Planning Projects (Brazil)
- Consultant for J.I.C.A (Japan International Cooperation Agency), Japan
- Urban Planning Department in Carouge City (Geneva)
- Consultant for kaemco - Consulting in energy and urban physics (CitySim)

1. Introduction

- Building sector consumes nearly 40% of total final energy consumption in the EU. (Eurostat's data)
- Energy performance tools and policies have primarily addressed the performance of single buildings and implementation of smart energy systems.
- The building energy performance and renewable energy strategies depend on the urban morphology configuration.
- There is a need to expand the energy performance assessment from the building scale to urban scale.

Building scale

Urban scale

1. Introduction

- How can we identify the inefficient buildings?

- How to increase their efficiency?

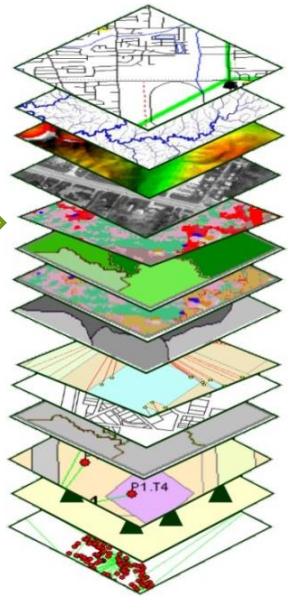
- How to analyse the impact of retrofitting measures?

- How to simulate different scenarios?

- How to evaluate the energy performance of a city or neighbourhood?

- How to measure the impact of UHI effect on energy consumption of buildings?

City GIS Data



ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Solar Energy and Building Physics Laboratory

3D Simulation of Energy System

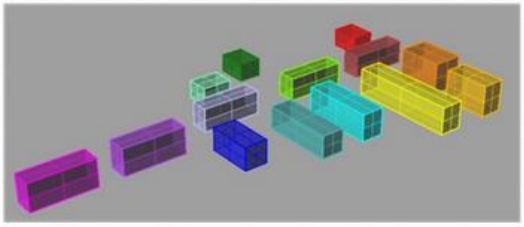
CitySim

3D simulation is an important tool for city decision-makers to foresee the urban development, including the impact of climate change.

1. Introduction

Spin-off company of the
Solar Energy and Building Physics Laboratory at EPFL
(École Polytechnique Fédérale de Lausanne)

Architects



Masterplan
3D Geometry

DXF

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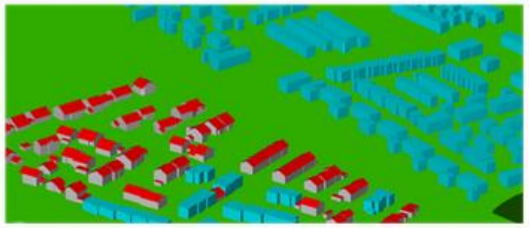
CitySim

CityGML



Urban Planner

Cadaster
2D /3D Geometry

Energy Demand & Production

+

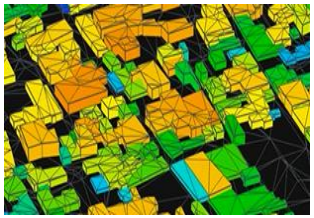
Urban Comfort

Partnership with the Swiss Competence Center in Energy Research (FEEB&D) Future Energy Efficient Buildings and Districts

2. CitySim 3D simulation tool

CitySim

Establish an Energy ADE Database (3D City DB with energy-related attributes)

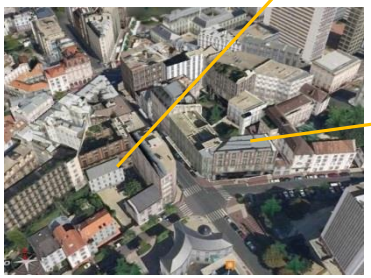


Energy Demand (Heating & Cooling)

Considering:
-Passive solar gains (Glazing)
-Fixed and Moveable Solar shading (blinds)
-Internal heat gains due to occupants' activities

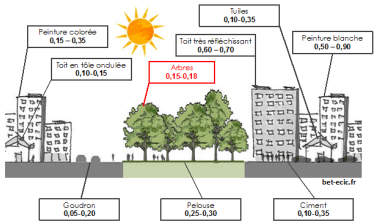
Solar Potential Analysis

Considering:
-Urban Morphology



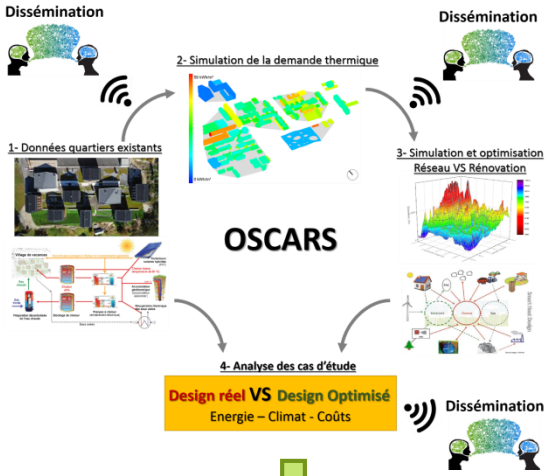
Evaluate the energy performance of retrofitting Buildings / Neighbourhoods

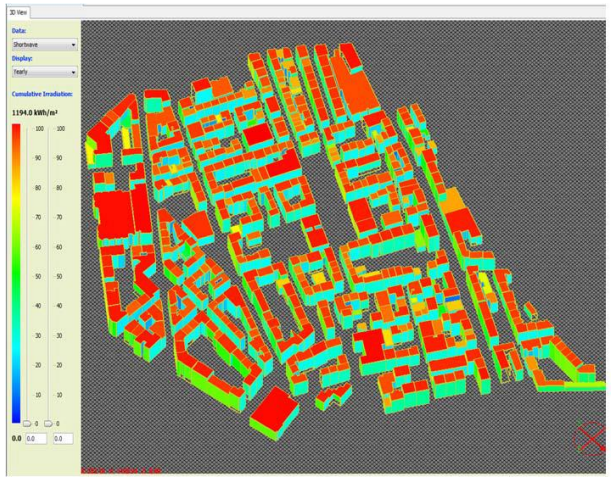
Radiant Urban Comfort (Urban Heat Island Effect)

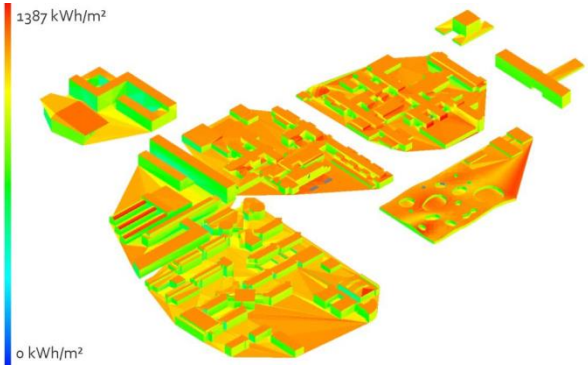


Source: CCEM-Retrofit Project

3. Previous and current projects







Competence Center for Energy and Mobility (Switzerland)

OSCARS (on-going)

- Compare building retrofit strategy considering connections of district heating, integrating renewable energy and economic analysis.

Urban Multiscale Energy Modelling (UMEM)

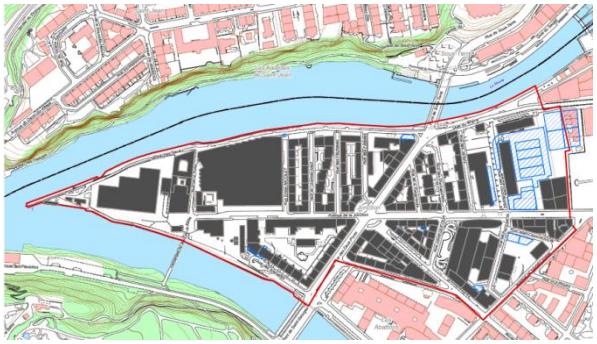
- Develop an integrated multiscale modelling approach interfacing 3 domains: urban microclimate, building energy systems and human flows.
- Evaluate different urban energy retrofit scenarios.

Integration of Decentralized Energy Adaptive Systems for cities (IDEAS4cities)

- Introduce the concept of the urban energy hub
- Simulate the energy demand, generation, storage and management of the buildings in the city.

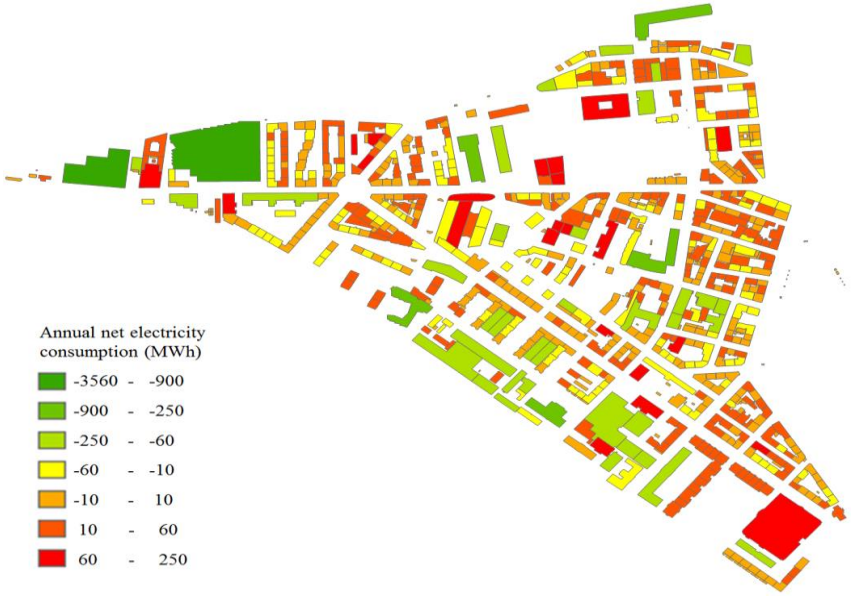
3. Previous and current projects

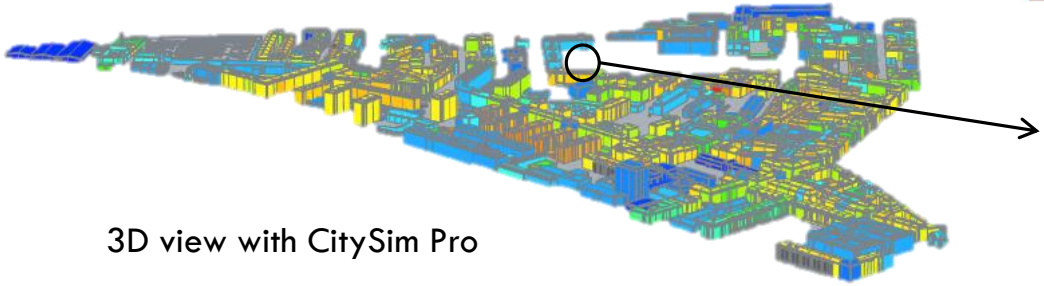
Research EPFL (July 2016)



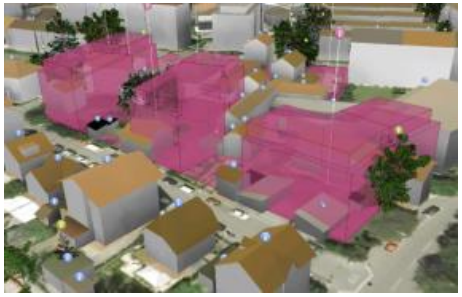
Source: SITG

Jonction, Geneva





3D view with CitySim Pro



Evaluate the energy performance of retrofitting scenarios or new buildings implementation.

Ref. Vázquez Canteli, J. (2016). Massive 3D models and physical data for building simulation at the urban scale. A focus on Geneva and climate change scenarios.

Favre, Adrien (2017). Développement et test d'un modèle 3D pour la modélisation énergétique des bâtiments. Monograph for the Master degree at the Ecole Polytechnique Fédérale de Lausanne (EPFL).

3. Previous and current projects

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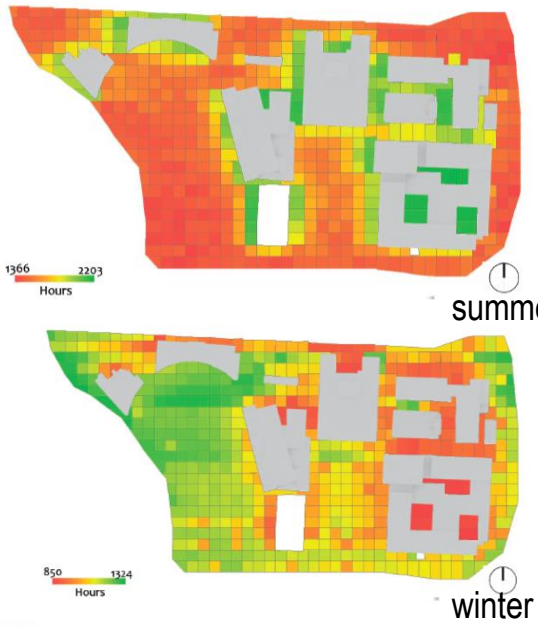
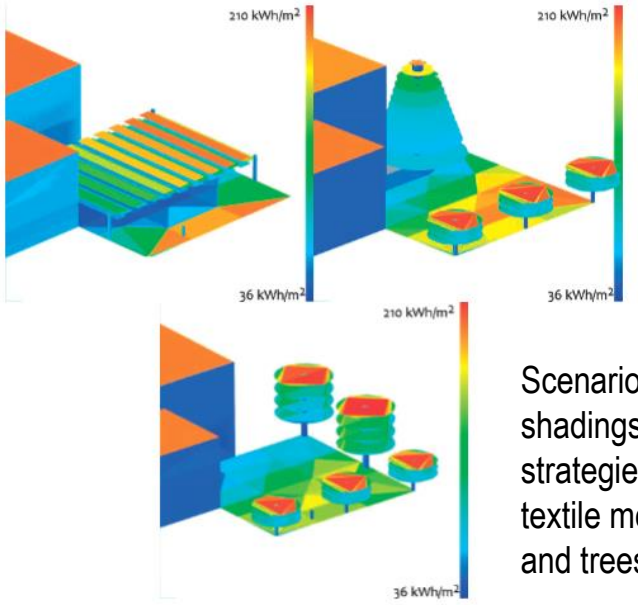
Comfort map

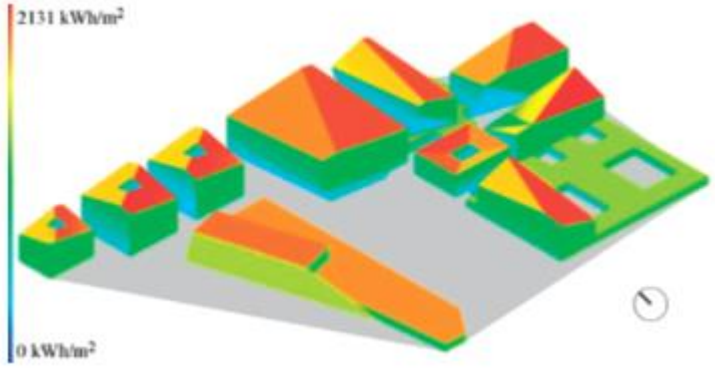


PhD research EPFL "Bioclimatic Design of Sustainable Campuses using advanced optimisation methods", Silvia Coccolo (2017)

What is the cooling effect of greening, and how does it impact both the energy demand of buildings and the outdoor thermal comfort?



Scenarios of shadings strategies with textile meshing and trees.

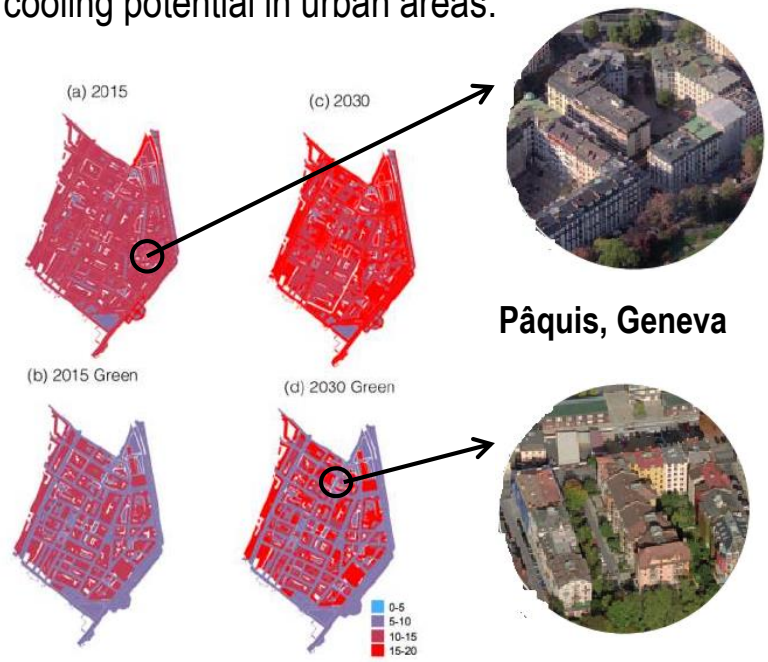


Annual Solar irradiance in the Swiss International School Campus in Dubai.

Energy simulations were performed in order to provide recommendations for the architectural design and the development of a Minergie Standard for topical climate.

3. Previous and current projects

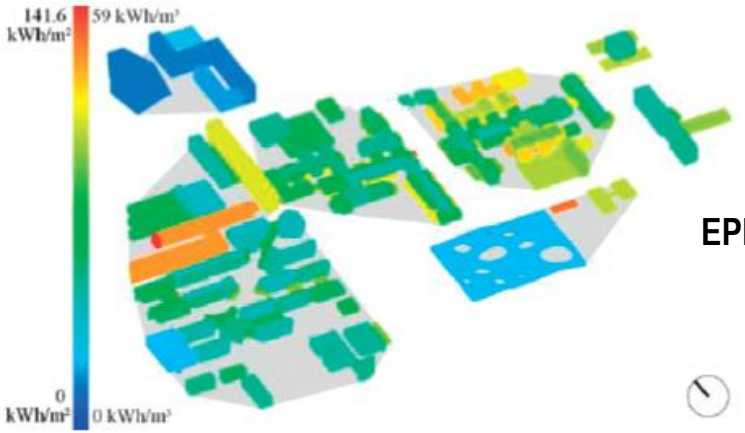
Evapotranspiration model to evaluate the cooling potential in urban areas.



Pâquis, Geneva

There is a significant decrease in the surface temperature using vegetation (annual decreasing of 2.4° C in 2030 scenario)

Multi-scale modelling to evaluate building energy consumption at the neighbourhood scale. (Dasaraden Mauree et al., 2017)



EPFL

New methodology to couple a meteorological model with a building energy use model, CitySim.

The importance of vegetation for reducing energy costs of building heating and cooling demands has been increasingly recognized as a cost effective reason for improving urban greenery.

4. Stakeholders

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CitySim

CITIES | ENERGY SUPPLIERS | HOUSING COMPANIES | ENERGY SERVICE PROVIDER | CITIZENS

The energy performance simulation model “CitySim” provides a decision support tool for urban energy planners, collectivities and stakeholders.

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Thanks for your attention!

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