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UNIVERSIDADE NOVA DE LISBOA

Programa de Doutoramento em Avaliação de Tecnologia | PhD Program in Technolog Assessment

Technology assessment as a powerful tool to analyse the impact of urban form on the energy consumption of cities - an approach towards sustainable cities

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Agenda

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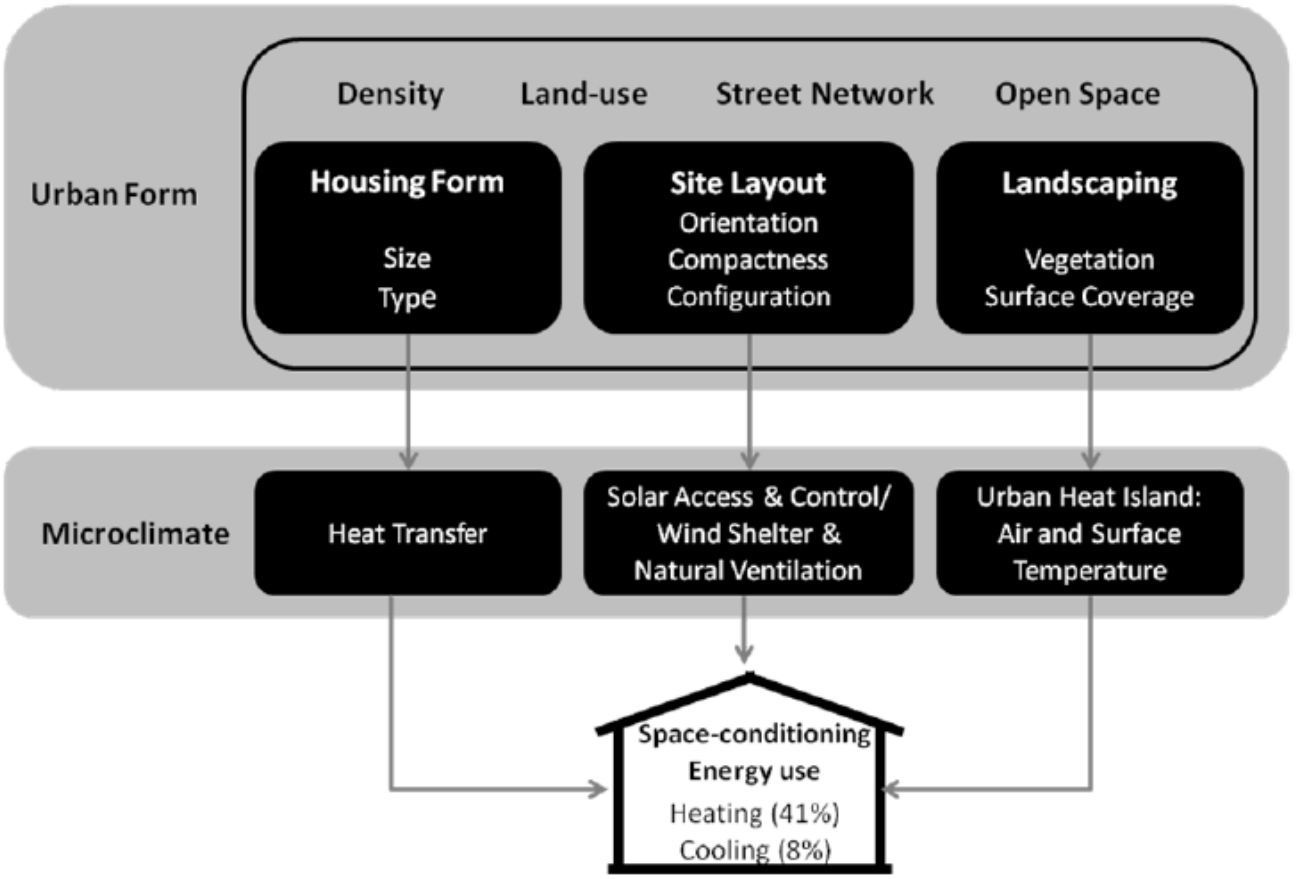
Introduction

The energy performance of building (i.e., the energy demand of buildings) at urban scale can be assessed in the scope of urban morphology. The influence of urban form parameters such as green area, building height and building density on energy consumption showed that the higher buildings surrounding in a highly dense green area reduces the external temperature and the cooling loads of the building by around 5%.

www.turbosquid.com


Urban Form
Density
Land-use
Street Network
Open Space
Housing Form
Size
Type
Site Layout
Orientation
Compactness
Configuration
Landscaping
Vegetation
Surface Coverage
Microclimate
Heat Transfer
Solar Access & Control/
Wind Shelter &
Natural Ventilation
Urban Heat Island:
Air and Surface
Temperature
Space-conditioning
Energy use
Heating (41%)
Cooling (8%)

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Four parameters have been introduced in the new building design:

-Orientation
-Over-shading
-Construction type
-Internal heat gains

literature review

Previous studies showed some major challenges with the urban form parameters and increasing the energy consumption. Urban form parameters such as house size, type, street layout and trees have been implied to be influential on the microclimate (the urban climate) and conditions the solar access, wind flow and air and surface temperature and subsequently the energy usage.

The energy performance of building (i.e., the energy demand of buildings) at urban scale can be assessed in the scope of urban morphology and hence the influence of urban form parameters such as green area, building height and building density on energy consumption can be analyzed.

literature review

Various researches illustrated sets of original urban morphological indicators such as density, rugosity, sinuosity, contiguity and solar admittance. The relationship between built forms, density and solar potential (i.e., sky view factor at ground level, and daylight availability on building façade) can provide beneficial information for planning solar cities.

Measuring the heating and cooling demands of the building revealed the significant role of urban settings in the solar access.

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Objectives

Technology assessment approach will be applied to analyze the energy efficiency in the existed and newly constructed urban areas considering various urban form parameters in these cities. Considering the key urban parameters, their qualitative and quantitative impacts on the energy consumption, as well as the energy consumption patterns obtained from technology assessment, it is possible to promote a model with the means of big data, in order to promote the urban planning processes. The resultant model could be developed to other cities with different urban parameters and introduced through urban planning on a strategic level, as an effective tool for reducing energy consumption and supporting the energy efficient technologies in the urban context.

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Research questions

Does the urban form affect the urban climate and consequently the residential energy use?

How would the building architecture and design influence the energy performance of the buildings?

How can Technology Assessment and Big Data influence urban energy modeling base on urban form?

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Methodology

Current urban planning in the cities is not sufficient for the global energy consumption. Therefore, it is essential to establish a rough strategy towards energy consumption in the urban scale, based on the current energy consumption methods and the ways to combine with urban form parameters in order to improve and integrate those systems into the urban planning and energy efficacy policies.

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Methodology

The resultant model could be developed to other cities with different urban parameters and introduced through urban planning on a strategic level, as an effective tool for reducing energy consumption and supporting the energy efficient technologies in the urban context. Considering these challenges and limitations, the purpose of this study is to provide a detailed framework of how urban parameters contributes significantly in the adaptation, optimization and development of energy efficient cities, specifically in two case studies of Lisbon (Portugal) and Karlsruhe (Germany).

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Research Design

1) In the first stage, we have to do the preliminary studies in order to obtain the urban design theories and parameters, influential on the energy consumption. Population density, street orientation, roof type, density (population density and dwelling unit density), green space density, water body densities (such as rivers), vegetation (tree heights in relation to the houses) and etc.

2) Afterwards, we will select the urban form parameters, considering the current urban morphology, demographic and socio-economic conditions of each of these two case studies. Socieconomic parameters includes variables such as median household income or ethnicity.

3) Based on such information, the study sites will be chosen in various residential neighbourhoods in different parts of the cities (particularly with a varied climate with a hot summer and a cold winter). To this aim, we need to be in close collaboration with municipality in order to obtain the cities map with the detailed information regarding the urban forms.

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Research Design

4) In the next step, we have to collect the urban energy consumption, province energy consumption, and occupant energy use patterns in those area. The occupant behavior is the only parameter existed in the response to the microclimate changes (resulted from the urban form variables). The behavior of occupant that can be slightly affected by their socioeconomic status, has a significant role in the energy consumption. Hence, using technology assessment approaches and collecting the energy usage data, with the help of energy companies such as EDP, we can obtain the energy usage of buildings as well as the pattern of occupant energy usage.

5) Using GIS analysis, we can create a model based on all the variables (such as demographic and socioeconomic variables as well as urban form parameters) and the energy consumptions in the urban city neighborhoods. In the case of urban form influence on the urban energy exchanges and the impact of urban heat fluxes on energy consumption in cities, we can use the specific satellite observations to map the spatial distribution of heat fluxes in the urban area. It can be also used as the validation of our model.

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Thank you for your attention

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