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Sustainable energy performances of urban morphologies

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Abstract

This dissertation examines the concept of sustainable energy within a urban design context. In essence, the research aims to answer the question: "what role does the city's built environment morphology play, if any, in the sustainability of its energy system?". To answer this question, I first derive an operational definition of sustainable energy in the post carbon era: maintaining the capability to provide non-declining energy services in time. Providing non-declining energy services, in an urban design context, depends on urban morphologies ability to save and conserve energy, be efficient and produce energy from renewable sources without decrease the level of energy services. In other words we can think of a more sustainable energy urban built environment as one that saves energy, is efficient and produces energy from renewable resources per unit of throughput, with energy sustainability measured by urban morphologies energy performances and throughput measured by land unit. This is a normative framework. It can only indicate relative levels of sustainable energy of urban morphologies. Within a specific urban system this framework can allow us to measure which part of the city produce more sustainable energy urban patterns.

To employ this framework I utilize a Spatial Pattern Oriented Modelling approach. The energy performance of an urban morphology metric comes from its basis in the international debate on urban energy sustainability, its ability to account for a specific aspect of sustainable energy and the possibility for its derivation from the spatial pattern analysis. Drawing from the large research based on exploring the role of the urban morphology on urban energy system, I derived several spatial patterns indicators that assess the influence of urban morphology on energy performances of urban settlements. These spatial patterns metrics, combined, enable the exploration of sustainable energy within a given urban morphology configuration. I apply the framework to a case study area located in northern Italy between Alps, the transect

Trento-Pergine-Valsugana, utilizing data from different sources and exploring the possibilities given by a high-resolution 3D spatial database, a LiDAR survey, and by a geolocalized human activities database, internet 2.0, for the urban morphology analysis with focus to energy. The Principal Component Analysis is used to estimate the correlation between different spatial patterns indicators while a ranking system, based on arbitrary thresholds and classes, is used to visually compare the scores of different sustainable energy performances of urban morphologies.

I conclude with the presentation of the results in the face of an international debate on sustainable energy and urban morphologies, with a discussion on the limits of the approach and on the approximation introduced to fill the gap of data scarcity and, finally, proposing further improvement to the methodology.