Towards Zero-Energy Architecture by Parametric Strategies

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In recent years the emergence of sustainable architecture has become increasingly important for the built environment. Although the term "sustainable" is well integrated, it doesn't mean this is reality. For this reason European regulations are striving towards Zero-Energy buildings from January 2021 on [1], which is until now a goal without sufficient means. The design of zero energy buildings imposes major conceptual, technical and economic challenges for architects.

In this context, the current research investigates new zero-energy and active building concepts that could generate new ideas and solutions for the future using parametric design methods that integrate pre-optimization principles. Digital models with certain interrelations and restrictions are created which are used for optimizing energy efficiency in the early phases of the design process. These interrelations can be geometric, or non-geometric like energetic or economic restrictions. This technique allows the designer to handle a building on a higher level from the beginning, resulting in better sustainable zero-energy concepts that go beyond traditional architectural designs and superimposed post-optimization techniques.

This poster reports on a case study, in which a building for charging electric cars was designed, using this method as a base. The research aimed at an economic standardized system responsive to its environment which can generate energy for charging. By integrating new concepts of wind and solar energy it is possible to design a building that can digitally adapt to different environmental conditions and this way create the best possible variations. Furthermore, the 3D model is implemented into a Revit BIM model and tested on the interoperability between partners. Plans, sections, renderings, materials and costs were generated and the structure could easily be analyzed.

This new parametric paradigm involves certain shifts in the current traditional methodologies that are noticeable in the process of designing. The identification of these shifts (explicit to implicit geometry, top-down to bottom-up, post-optimization to pre-optimization, document-based to model-based, etc.) provides for a solid framework to discuss the transformation from traditional to parametric architecture. This case study showed that parametric design can improve the performance of a design and counter challenges of sustainability, energy, costs and other important factors early in the design process.

[1. Buzek, J. & López Garrido, D. (2010). Directive 2010/31/EU of the European Parliament and the Council of 19 May 2010 on the energy performance of buildings, Official Journal of the European union, Article 9.]

Towards Zero-Energy Architecture by Parametric Methodologies

POSTER

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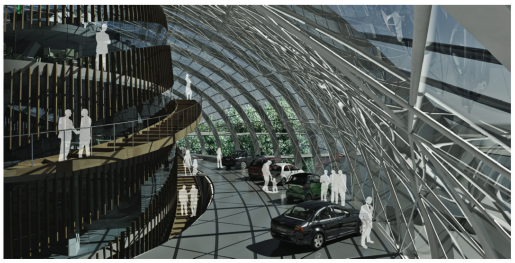
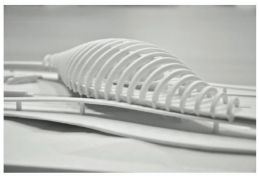


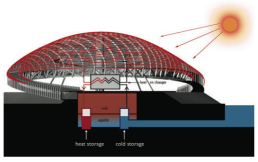
CHALLENGE
In recent years the emergence of sustainable architecture has become increasingly important for the built environment. Although the term 'sustainable' is well integrated, it doesn't mean this is reality. For this reason European regulations are striving towards zero-energy buildings from january 2021 on.

RESEARCH OBJECTIVE
The current research investigates new zero-energy and active building concepts that could generate new ideas and solutions for the future using parametric design methods that integrate pre-optimization principles. The focus lies on implementing parametric design strategies that go further than traditional architectural design to increase energy performance of buildings.

Design drivers

DESIGN DRIVERS	BUILDING TECHNOLOGY TOOLS	GOALS
Energy	Energy performance evaluation	Design for human comfort
Light		
Wind	Interactive and adaptive modeling	zero-energy architectural concepts
Function		
Aesthetics	Intelligent geometries and evolutionary optimization	sustainable solutions
Other		





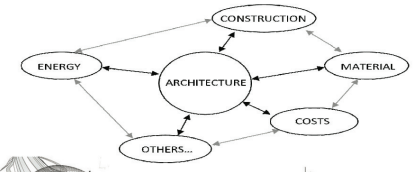
METHODOLOGY
The parametric paradigm involves certain shifts in the current traditional methodologies that are noticeable in the process of designing. The identification of these shifts provides a solid framework to discuss the transformation from traditional to a parametric architecture. These shifts are explored in a case-study in which a building for charging electric cars was designed using parametric methods

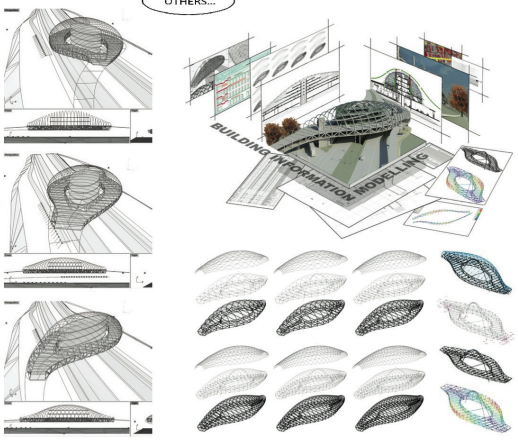
Shifts

- explicit to implicit geometry
- top-down to bottom-up design
- static to dynamic concepts
- post-optimization to pre-optimization
- document-based to model-based (BIM)
- control from design to production

Object oriented design

Concepts will be developed with an object-oriented approach using different categories for optimizing performance.





RESULTS
The charging station resulted in an organic shaped building above the highway, capturing energy from the sun by a facade cladding of vacuum solar collectors. The design therefore diminishes the total CO2 emissions to a minimum. The heat produced in the summer will be stored in the ground by BTES (Borehole Thermal Energy Storage) for the winter, using a heat pump in combination with a HVAC installation for heating or cooling. Considering the shifts to a parametric architecture it proved to be a powerful methodology to create many possibilities for future construction. The research continues with setting up live connections of energy reduced order models to calculate the performance more detailed already when designing. By integrating specific object-oriented design drivers, new defined concepts of zero-energy architecture will be explored, evaluated and developed by different parametric strategies.