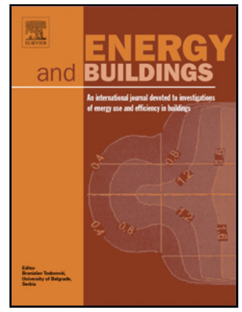

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PII: S0378-7788(16)31369-X
DOI: http://dx.doi.org/doi:10.1016/j.enbuild.2016.10.047
Reference: ENB 7106

To appear in: *ENB*

Received date: 22-6-2016
Revised date: 23-9-2016
Accepted date: 28-10-2016

Please cite this article as: Joshua Hester, Jeremy Gregory, Randolph Kirchain, Sequential Early-Design Guidance for Residential Single-Family Buildings Using a Probabilistic Metamodel of Energy Consumption, Energy and Buildings http://dx.doi.org/10.1016/j.enbuild.2016.10.047

Sequential Early-Design Guidance for Residential Single-Family Buildings Using a Probabilistic Metamodel of Energy Consumption

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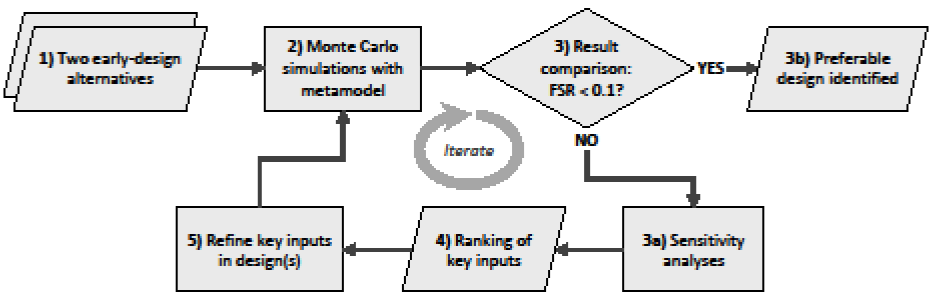
Graphical abstract



Abstract

In order to reduce the energy consumption of a proposed building, it is valuable to be able to estimate the energy consumption at early stages of the design process when influential attributes are being decided upon. We present a novel use of a regression-based energy metamodel to guide the early design of single-family residential buildings by providing guidance on key early-design decisions through quantitative, probabilistic analyses that accommodate the flexibility and low detail of conceptual designs. Monte Carlo simulations provide a distribution of energy consumption predictions reflecting the design uncertainty, and sensitivity analyses reveal which parameters contribute the most to the variability in the metamodel output based on the current level of detail in the design. By sequentially specifying the most influential parameters, we show that the variability in predicted energy consumption can be reduced by approximately 90% (as measured by the coefficient of variation), even when the average input specification increases by only 40% compared to the original parameter ranges. In a case study, we demonstrate that a statistically significant difference between design alternatives can be seen even when limited information is available for many aspects of the design.