A Framework for Designing Neighborhood Energy Efficiency through Data Visualization and Calibrated Urban Building Energy Simulation (VIS-SIM)

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Introduction

A new generation of urban building energy models (UBEMs) are currently being developed to estimate neighborhood-scale hourly energy demand loads. The goal for such tools is to explore "what if" scenarios for various design strategies, and to prioritize the most effective solutions. The objectives of this research are to visualize the relationships between three critical and closely related subjects that are not yet integrated within existing UBEMs:

1. The functioning of the electric grid and how it can be made cleaner, more efficient and more resilient,
2. The use of energy by building functionality and the comfort of occupants,
3. The dynamics external available natural resources of solar and wind energy for matching resource with demand.

Using currently acquired energy-use databases form the Pecan Street Institute from residential buildings in Austin, TX combined with our current visualization techniques and urban building simulation tools, a new UBEM will be developed to simulate, test, and visualize future scenarios and strategies.

Integrated Approach

This research leverages integral relationships between visualization platforms, simulation methods, and energy data (VIS-SIM) for enabling future built environments. This workflow is used to create a methodology for VIS-SIM, deployed onto the Mueller neighborhood of Austin, TX.

Methodology

- ### Data Visualization
  Energy use / demand and external energy resources/supply data from Pecan Street is simulated and visualized.

- ### Energy Use Data Analysis
  Home energy usage data in Mueller is compared with Pecan Street Institute data. Segmented in 15-minute and 1-minute intervals y using MS SQL servers, usage trends by minute, hour and day are identified. This reveals insights per appliance to enhance energy management capability in terms of energy load shifting, demand responses and carbon foot print reduction.

- ### Building Energy Simulation
  Using architectural drawings of Mueller neighborhood homes, a 3D massing model was developed in Rhino 5.0 sand simulated in UMI. The UMI energy model uses building templates with inputs such as window-to-wall glazing ratios and construction assemblies to simulated urban scale usage.

- ### VIS-SIM
  In calibrating the urban energy building simulation model to match real use scenarios derived from the data analysis, we will be able to identify opportunities at the urban-scale for energy conservation, energy production, targeted energy policies, and building design and retrofit strategies to reduce building energy use.

Future Impacts

VIS-SIM aims to develop a methodology that can be used in similar studies in Northeast communities such as Syracuse, NY. The calibration and visualization of energy datasets with urban energy models can assist in the development of targeted architectural and urban design strategies for energy conservation and production. Expanding the data visualization platform to include calibrated energy-use positions this interdisciplinary research in areas of energy data visualization and design and testing of renewable energy strategies at the urban scale.