Decision Support for the Evaluation of Sustainable Masterplans

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PROBLEM
As the urban population grows, an increasing emphasis is placed on designing sustainable cities. A challenge for those creating urban designs is incorporating multiple systems along with occupant behaviour and understanding the combined effect on the sustainability of a future urban district.

In the interest of providing decision support to urban planners at the district scale, an agent based model is extended to allow the comparison of masterplans.

CASE STUDY: OLD OAK COMMON
Two major transport projects due to complete in the next decade, Crossrail in 2018 and the high speed 2 (HS2) rail line from London to Birmingham in 2026, are planned to intersect at Old Oak Common. A new interchange station is due to be built to cater to the 250,000 passengers expected to pass through per day. Along with the new station, the Greater London Authority have set out a vision to transform the Old Oak Common site from the current area of 155 ha of inaccessible, derelict or underutilised land into a mixed use district with commercial and recreational destinations, green open space and 19,000 domestic residences (Greater London Authority, 2013).

CHORA International Ltd have developed a masterplan positioning the Old Oak Common area as an incubator for smart urban innovation and see an opportunity to test their proposal against sustainability indicators.

METHOD
The SmartCity model accepts an early-stage architectural masterplan as an input, distributes a population of agents and projects the spatially and temporally disaggregate residential electricity demand of the planned district over 24 hours. The model was extended to also produce heat demand, carbon emissions and the cost to the consumer as sustainability indicators. Adjustments can be made to the masterplan, such as land use changes, inclusion of distributed generation technologies and energy efficient building materials, to view the overall impact on the sustainability of the urban district. This enables an iterative process of altering the design and testing the outcome before making further changes.

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Table 1 scenarios considered

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<tr>
<th>Scenario</th>
<th>Description</th>
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<tr>
<td>1</td>
<td>Baseline, electricity supplied from the grid, heat supplied by individual boilers fuelled with natural gas.</td>
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<tr>
<td>2</td>
<td>District heat network introduced based on CHORA plans. Heat within network supplied by combined heat and power (CHP) with the electricity generated sold within Old Oak Common.</td>
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<td>3</td>
<td>Land use change, buildings with high heat demand relocated close to the heat sources, the heat network size reduced and supplied by CHP.</td>
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<tr>
<td>4</td>
<td>Heat source relocated close to the buildings with highest heat demand, the heat network size reduced and supplied by CHP.</td>
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RESULTS
In comparison with the baseline:
- Scenario 2 produced a reduction in CO₂ emissions and cost; the heat network was found to be inefficient resulting in a significant increase in energy demand.
- Scenario 3 had a more efficient heat network, resulting in a smaller increase in demand. CO₂ emissions and cost were reduced, though less than scenario 2.
- Scenario 4 had the most efficient heat network, with an improved impact on CO₂ emissions and costs compared to scenario 3 with a comparatively smaller increase in heat demand in relation to the CO₂ and cost savings.

The sustainability improvements should be balanced with the livability of the district, with concern around the creation of an area with dense, high-rise buildings in scenario 3 and the location of a heat source close to residential buildings in scenario 4. A collaboration between architects and engineers is recommended.

CONCLUSION
The results from the Old Oak Common case study demonstrate the potential for an agent based model, such as the SmartCity model, to provide support to urban planners and architects in assessing the sustainability of urban masterplans. The spatially disaggregate nature of the demand profiles produced and the visualisation of agents moving around the district enable urban planners to picture how occupants will travel around, and how this movement of occupants and the design of the district can affect the eventual energy use. The results further enable a discussion on sustainability between urban planners and the public, policy makers and local businesses. The process of simulating the CHORA masterplan also reveals the value of close, early interaction between architects and energy systems engineers to create an iterative design process.

REFERENCES

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