

CONCEPT - Connecting Power and District Energy Systems in Singapore

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MOTIVATION

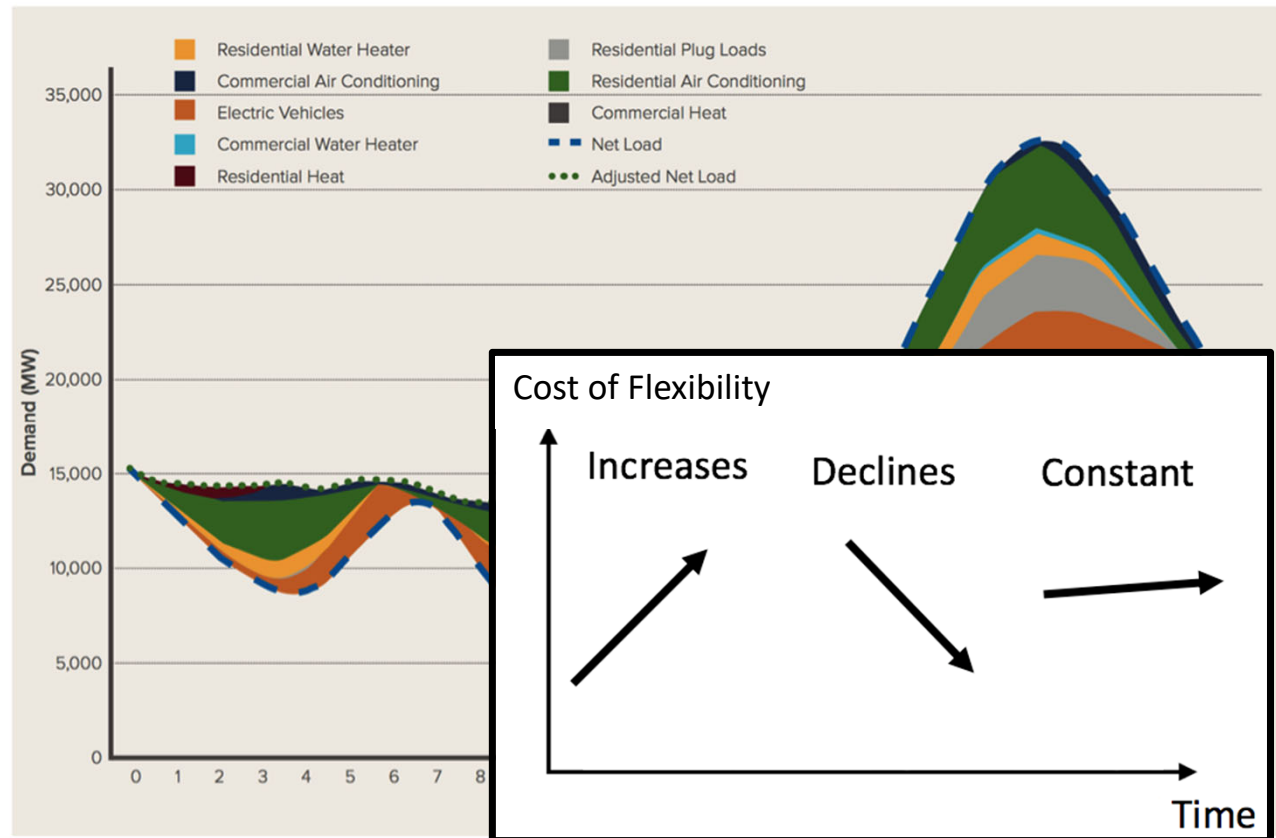
High on-site generation and the advent of demand side flexibility calls for the integration of power and district energy systems operations.

While this integration could lead to savings during operation, It is not clear what the effects are on capital costs of future districts.

At the moment, there is no framework nor tools to better understand the economic trade-offs of such a coupling.

RESEARCH QUESTION

- What are the effects (costs) of demand flexibility in integrated power and district energy systems?



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METHODS

The methodology followed the next three main steps:

- Step 1. Development of realistic scenarios of urban development of future districts.
- Step 2. Build a GA+MILP model for co-optimizing micro-grids and thermal grids.
- Step 3. Evaluate and Compare the capital and operational costs of all scenarios

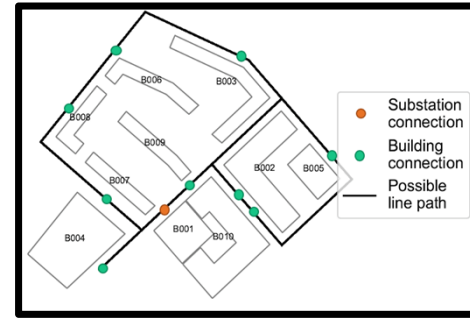


Step 1

Four mixed-land-use Scenarios

Output:

- Energy Demand
- Demand flexibility

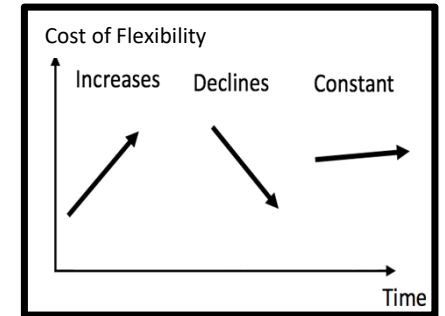


Step 2

Fixed and non-flexible Demand Optimization

Output:

- Equipment size
- Distribution network
- Solar Energy Penetration



Step 3

For all eight Scenario Combinations

Output:

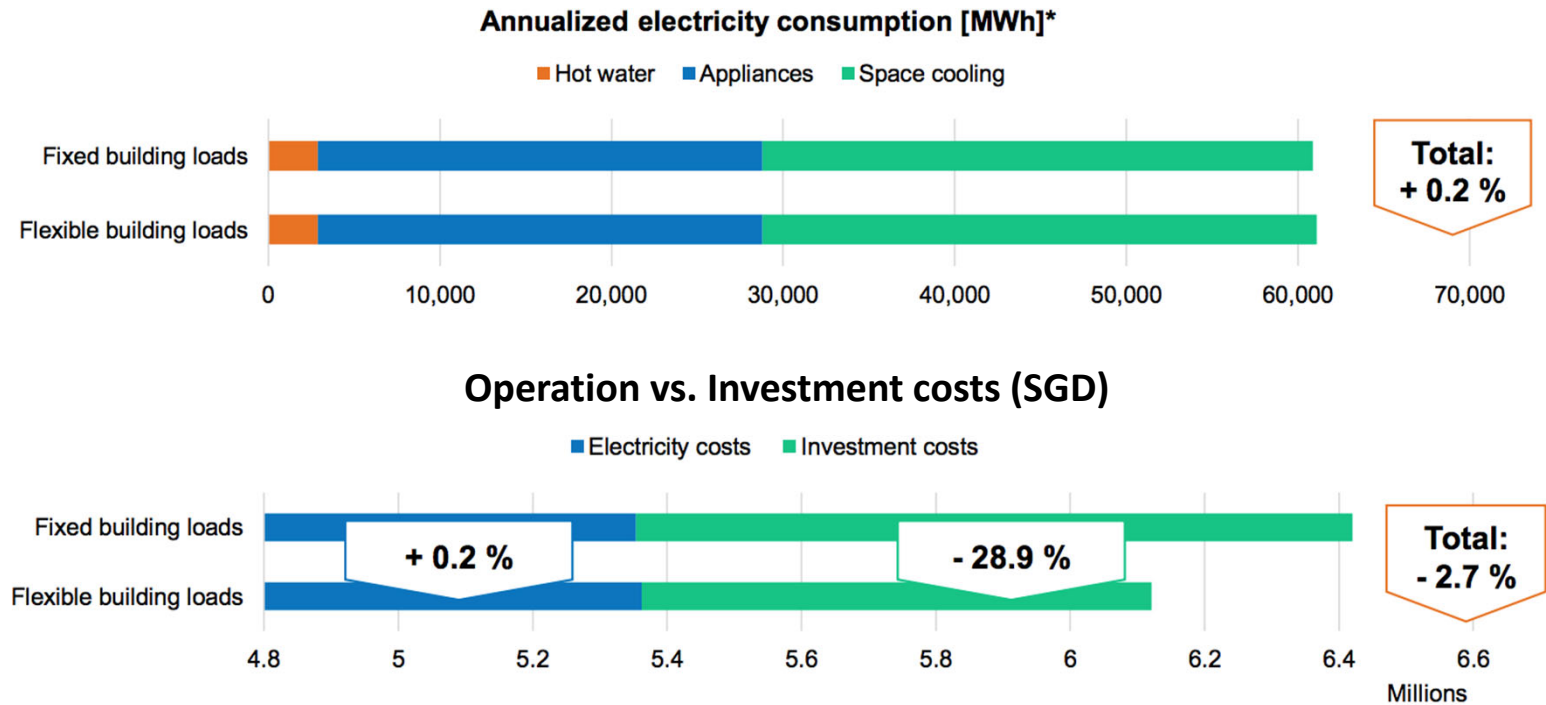
- Capital costs
- Operation and Maintenance costs

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FINDINGS

The main conclusions of the study were:

- The electricity consumption marginally rises with demand flexibility due to increased inefficiency in load shifting.
- In an annualized basis, operational costs increase in 0.2%, while investment costs decrease in 28.9%.
- However, the total effects in all the lifecycle costs are just -2.7%, since operational costs are 95% of the total lifecycle costs.

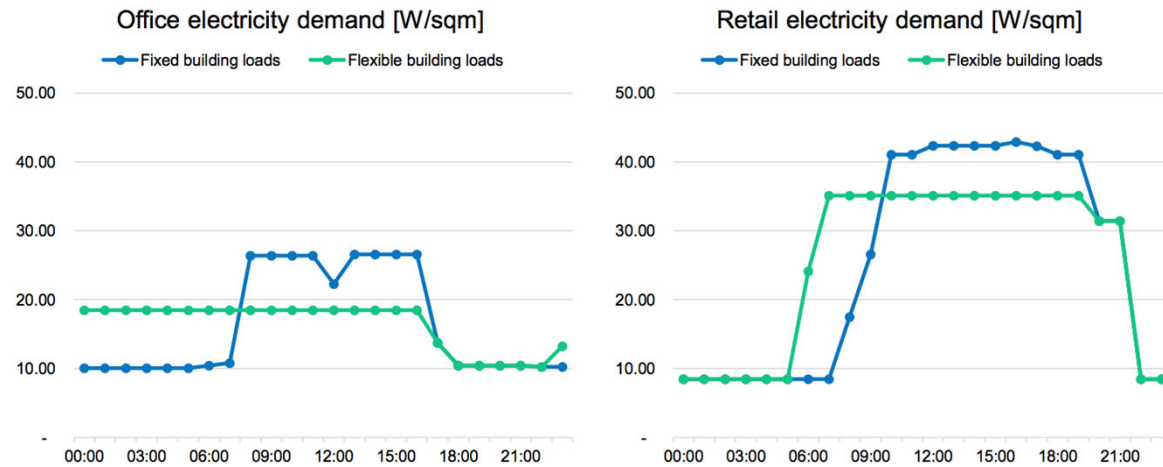


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- More chances to offset investment costs are in office space and less in Retail.



	Mixed occupancy	Office occupancy	Residential occupancy	Retail occupancy
Annualized Total Costs	- 2.7 %	- 3.8 %	- 2.6 %	- 2.1 %
Investment Costs	- 28 %	- 31 %	- 21 %	- 19 %

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FORESEEN IMPACT

The contributions of this study includes:

1. New methodological framework and Software application for the CEA ecosystem.
2. New knowledge for the local energy company on the economical effects of Flexibility in Singapore.
3. New knowledge for the Urban Planning authority on the effects of land-use on costs of future district energy systems.



New Methods and
Computational tools
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New Insights for
Energy Authority



New Insights for
Planning Authority

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REFERENCES

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S. Troitzsch, B. Sreepathi, J. A. Fonseca, S. Hanif, and T. Hamacher, “Optimal Electric-Distribution-Grid Planning considering the Demand-Side Flexibility of Thermal Building Systems for a Test Case in Singapore,” Applied Energy. 2020. [PDF](#)

CEA Team. The City Energy Analyst Tool. <https://www.cityenergyanalyst.com>