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# Investment strategy for the decarbonisation of supermarket buildings in the UK

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## BACKGROUND

Sainsbury's has committed to reduce its GHG emissions 30% by 2020 from 2005/06 levels. On-site co-generation of heat and power (CHP) fuelled by biomethane seems as an attractive option, evidenced from previous CHP projects carried out by Sainsbury's

## AIM

This project focused on defining a strategy for investment in biomethane CHP projects, identifying:

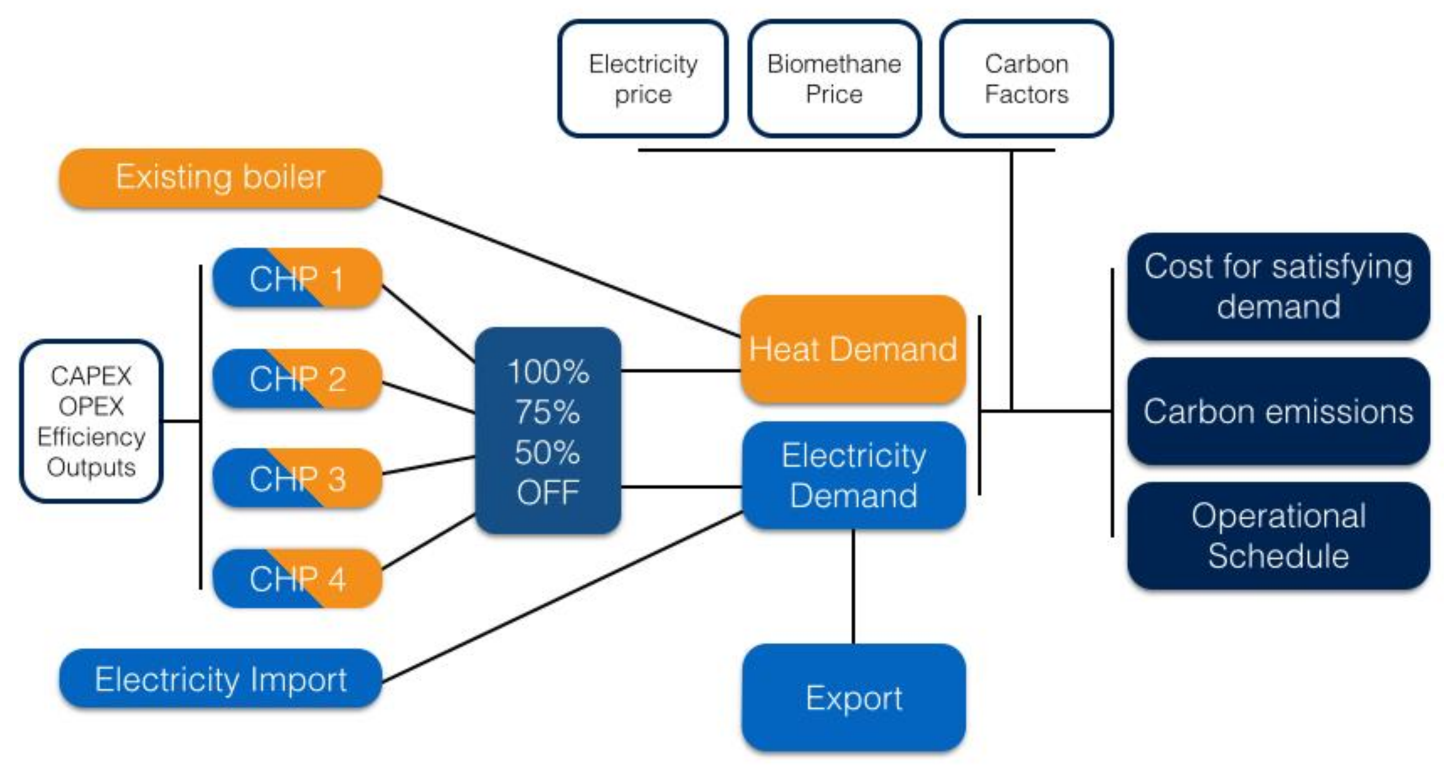
- Where should investments be made? Sainsbury's has more than 1350 buildings
- What is the optimal CHP technology for a certain store, and how should it be operated? Each store has different energy demands and electricity prices

## METHODOLOGY

The approach to defining the appropriate investment strategy consisted of two main activities:

1. **Development of a technology selection and operation (TSO) optimisation model**
2. **Development of an investment allocation optimisation model**

Figure 1. Schematic representation of TSO model



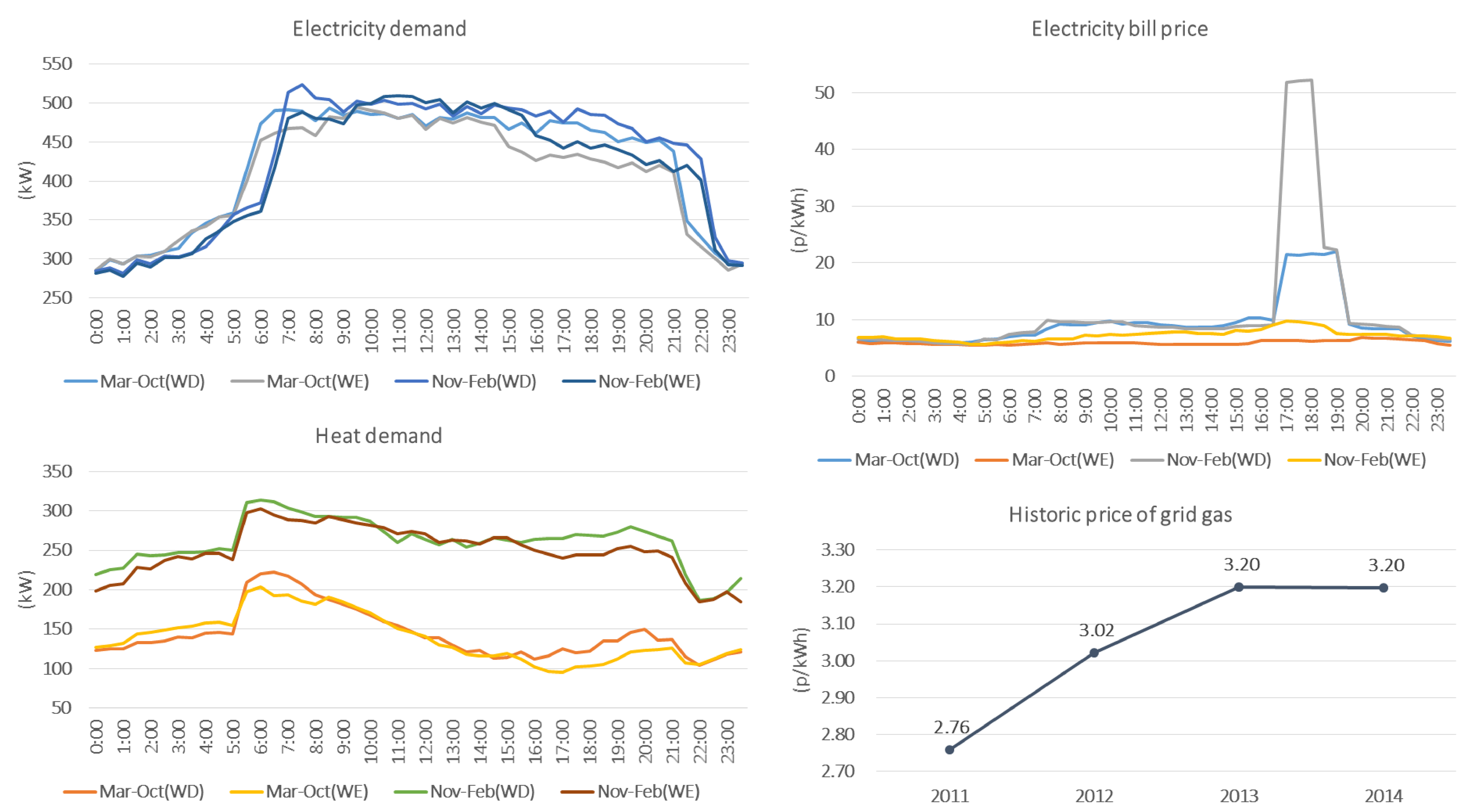

## OPTIMAL TECHNOLOGY SELECTION AND OPERATION (TSO) MODEL

The TSO model defines the optimal selection and operation strategy of a given set of CHP units for a store with the objective of either **minimising cost** or **minimising GHG emissions** when satisfying a store's energy demands for a given period.

- Electricity: the model can decide to import electricity from the grid, generate on-site through the CHP, export electricity to the grid or a mix of any of the previous.
- Heat: the model can decide to produce heat through the existing gas boiler unit or through the CHP unit. Excess heat is released to the environment.

The optimization was performed satisfying the store's energy demands each half-hourly interval for a given time period taking into consideration: the fluctuating price of electricity imported from the grid, possible revenue from exporting electricity to the grid, the price of gas/biomethane, the variation in energy demands for the store, and the capital and maintenance costs of the units.

Figure 1. Demonstration of varying energy demands and costs for a certain store




## INVESTMENT ALLOCATION MODEL

The investment allocation model gathers the technical and economical parameters and results from the TSO model from all the stores in which the TSO model was implemented. Then, it optimises to select which projects to invest in based on a constrained budget while trying to either **maximise aggregated economic benefit** or **maximise GHG emission reductions**.

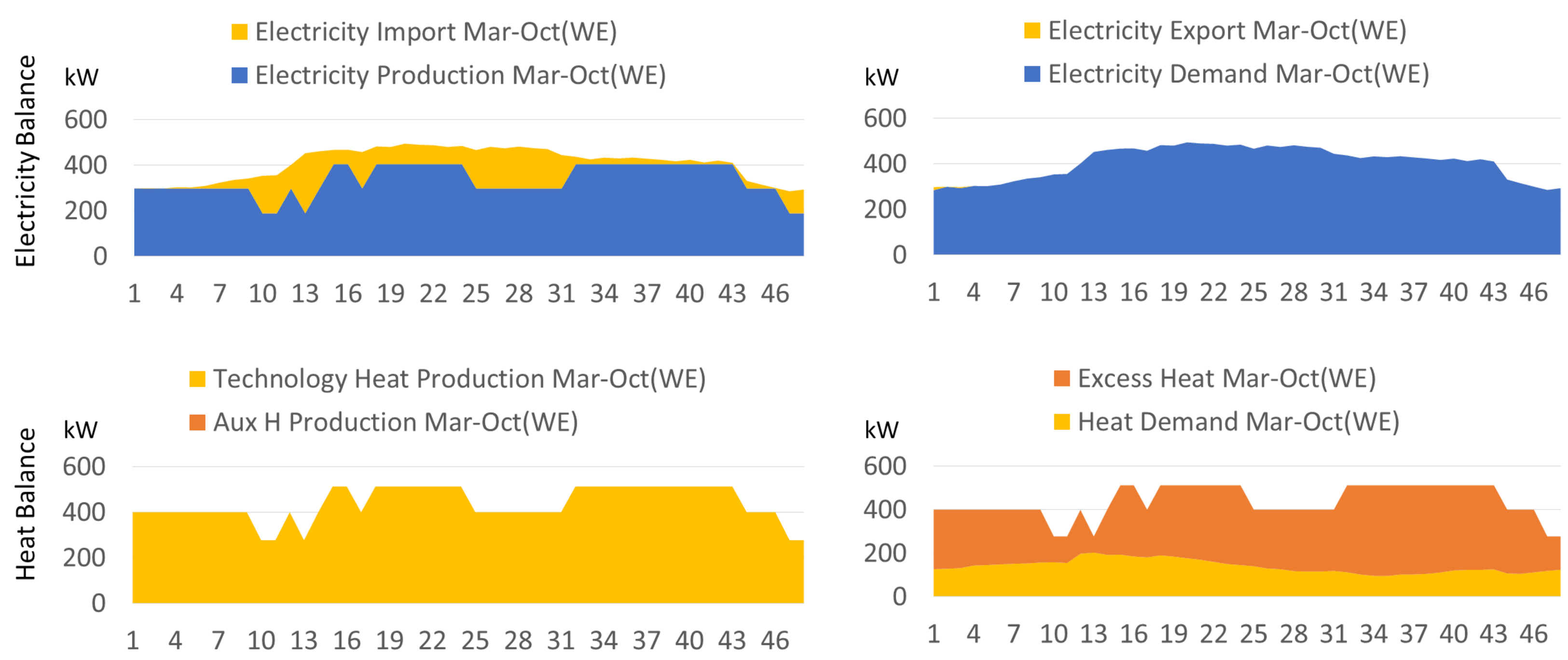
## RESULTS – TSO MODEL

Table 1. Overview of TSO model results for one of the stores

| | Cost (5 yr. period) | GHG reductions | Capital Investment | Benefit (lifetime NPV) | Annual emissions reduction ($tCO_2eq.$) | Abatement Cost (£/$tCO_2$ eq.) | ROI | Payback year |
|---|---|---|---|---|---|---|---|---|
| Min. COST (CHP E400M) | -£1,579,424 | 87.9% | -£233,333 | £589,430 | 1,732 | -31.23 | 281% | 3 |
| Min. GHG (CHP E530M) | -£1,661,807 | 99.8% | -£316,940 | £426,848 | 1,967 | -19.13 | 153% | 5 |

The TSO model was implemented for 32 stores, providing the parameters and results required for the investment allocation model. It was identified that the deecarbonisation of a store can be possible while providing an attractive economic benefit. An example of the optimisation results for one of the stores are presented in Table 1 and Figure 2.

Figure 2. Example operational strategy optimised for a particular store in a summer weekend




## RESULTS – INVESTMENT ALLOCATION MODEL

Under a **£5m budget**, the investment allocation model defined a specific selection of projects in which to invest for both objectives (economic benefit an emission reductions):

Table 2. Investment allocation model results

| | Economic benefit optimisation | GHG emission reductions optimisation |
|---|---|---|
| Aggregated NPV benefit | £9,482,201 | £8,346,776 |
| Total Investment | £4,965,317 | £4,996,848 |
| GHG emission reductions ($tCO_2$/year) | 32,191 | 33,848 |
| Overall ROI | 191% | 167% |
| CHP Projects | 22 | 21 |

## CONCLUSION

The TSO model proved as an optimal tool for the selection and operation of CHP technologies for buildings. Coupled with the investment allocation model, their results can provide a valuable investment strategy that can help Sainsbury's decarbonise while making the implementation of such projects an attractive investment.

If Sainsbury's were to implement any of the two strategies defined by the investment allocation model, it could reduce Sainsbury's emissions by more than **32 ktCO2eq,** putting them at a level **4.7%** below 2005/06 levels. If a similar investment were to be carried out yearly up to 2020, they could reach an emissions level **18.3%** below 2005/06 levels.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