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Enhancing the Re-Commissioning of Retail HVAC Systems and Building Envelope

28

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INTRODUCTION

Research Objectives

End-use energy efficiency is recognised as a predominant contributor to achieve UK carbon reduction target that is still far from reach today [1]. The opportunity in retail buildings is apparent, especially supermarkets that account for 4 $MtCO_2$ of total UK carbon footprint [2]. This research delivers an enhanced re-commissioning (Re-Cx) framework that aims to mitigate supermarket with poor thermal performance, known as "cold store". The framework outlines a holistic approach in sustaining supermarket thermal efficiency throughout its operational lifecycle. This includes 4 critical strategies as shown in Figure 2 as compared to the business as-usual scenario in Figure 1.

What is a "cold store"?

A supermarket that consumes significantly higher heat than other equivalent stores or is not able to deliver the desired indoor thermal comfort.

Figure 1

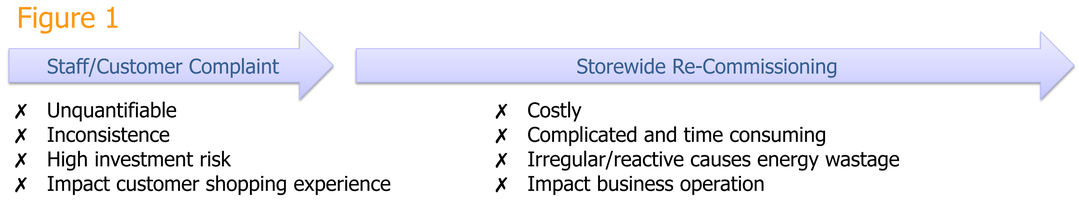
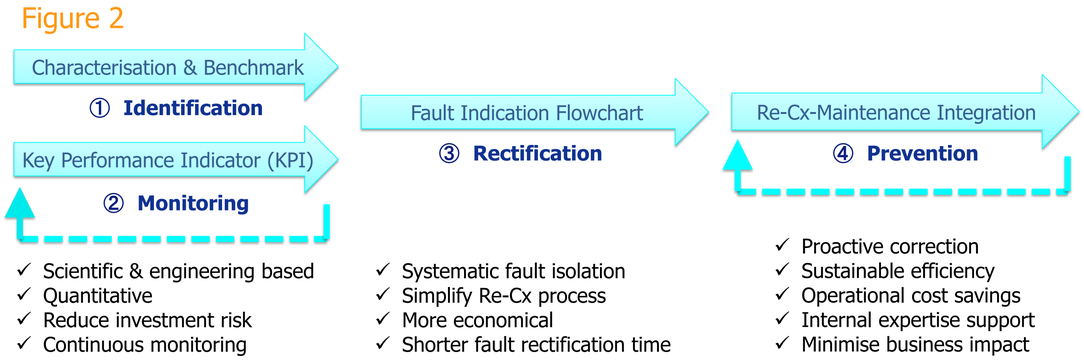


Figure 2



METHODOLOGIES AND RESULTS

① Cold Store Identification

Heat consumption of 350 Sainsbury's supermarkets are benchmarked against their store size, business operating hours and heating degree-days (HDD) as shown in Figure 3. They are further characterised based on their location, design model, heating technology and age as shown in Figure 4. These have led to the identification of 7 cold stores as summarised in Table 1.

Table 1

Cold Store	Heat Intensity (Wh/ft²/hr)	Location	Design Model	Heating Technology	Age (year)	Building Type
Kings Heath	38.64	West	30K	Gas	> 30	Competitor Impact
Pocklington	28.30	North	30K	Gas	< 10	Extension
Fulwell	27.52	North	30K	Gas	< 10	New
Slough	23.42	East	30K	Gas	< 10	Competitor Impact
Richmond	20.81	South	30K	CHP	10 – 30	Competitor Impact
Greenwich	19.84	South	30K	GSHP	10 – 30	Existing
Cromwell Road	17.11	South	30K	CHP	> 30	Refresh

Figure 3

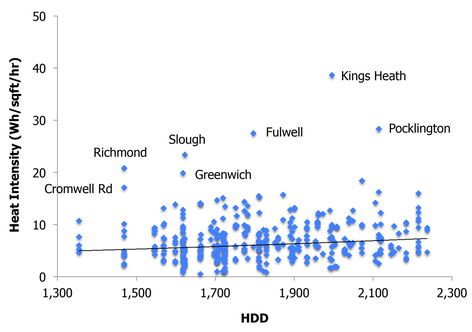
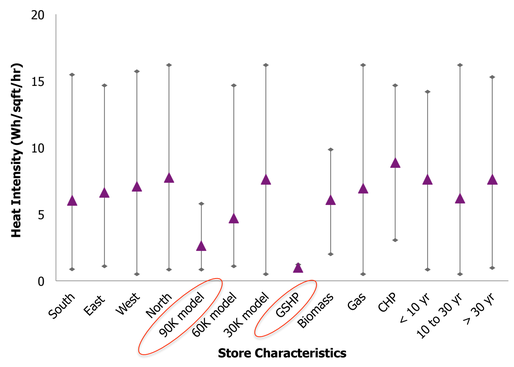


Figure 4



② Thermal Performance Monitoring

Two KPIs are designed with control chart and Psychrometric chart for store thermal efficiency and indoor thermal comfort monitoring. The identified cold stores are further validated with the control chart as shown in Figure 5. Figure 6 demonstrates the Psychrometric chart with hourly thermal comfort data from one of the Sainsbury's "zero carbon" store, Leicester on 28th August 2014.

Figure 5

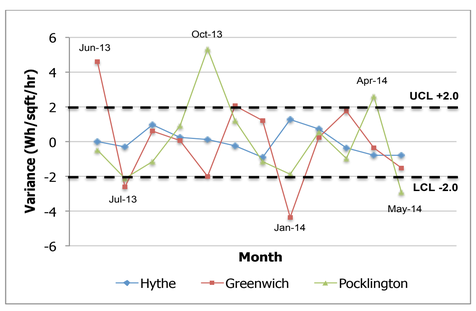
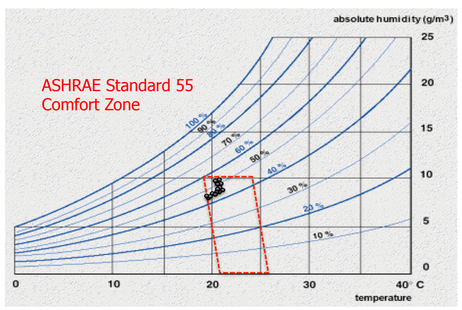


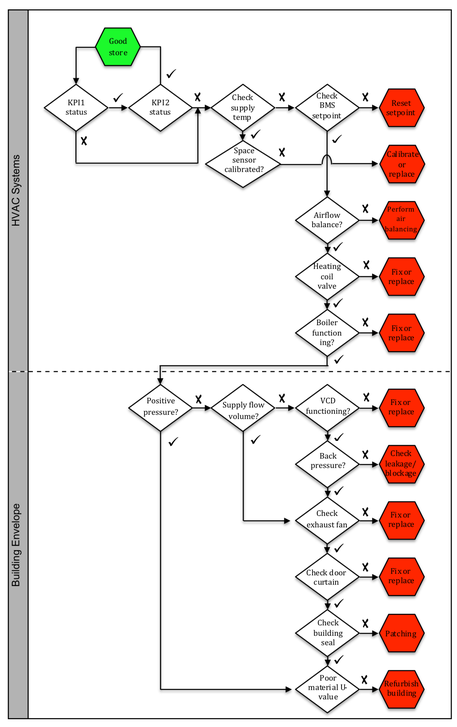
Figure 6



③ Efficiency Gap Rectification

A fault indication flowchart is developed based on building system logics to simplify the overall Re-Cx process as shown in Figure 7. It can be applied to systematically isolate various efficiency gaps of HVAC and building envelope. Hence, corrective actions are taken only on relevant system issues rather than carrying out storewide Re-Cx activities.

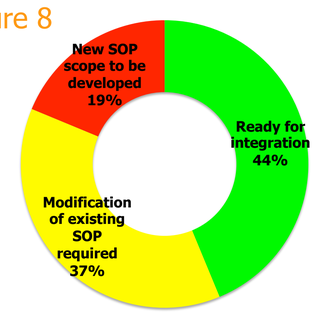
Figure 7



④ Cold Store Prevention

A novel Re-Cx and maintenance integration approach is introduced in this research to prevent cold store in a sustainable manner. This is achieved through proactive system efficiency optimisation and performance gaps correction during maintenance routines. Figure 8 shows the results of feasibility study with EnergyStar Re-Cx strategies and Sainsbury's maintenance procedures. It is found more than 80% of the Re-Cx measures are integrate-able into the existing maintenance activities.

Figure 8



CONCLUSION

This framework brings a new perception to retail Re-Cx regimes that can be applied to identify, monitor, rectify and prevent "cold store" in a cost-effective and sustainable manner. It successfully reveals 7 cold stores from Sainsbury's supermarket stores. Besides that, more than 80% of EnergyStar Re-Cx measures are integrate-able into the present Sainsbury's maintenance activities. This has also ascertained the feasibility of the suggested framework in this research.

REFERENCES

[1] International Energy Agency. (2009) World Energy Outlook. pp. 210-211.

[2] Tassou, S. A., Ge, Y., Hadawey, A. & Marriott, D. (2011) Energy consumption and conservation in food retailing. *Applied Thermal Engineering.* 31 (2-3), 147-156.

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