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Development of a Low Carbon Investment Decision Making Tool

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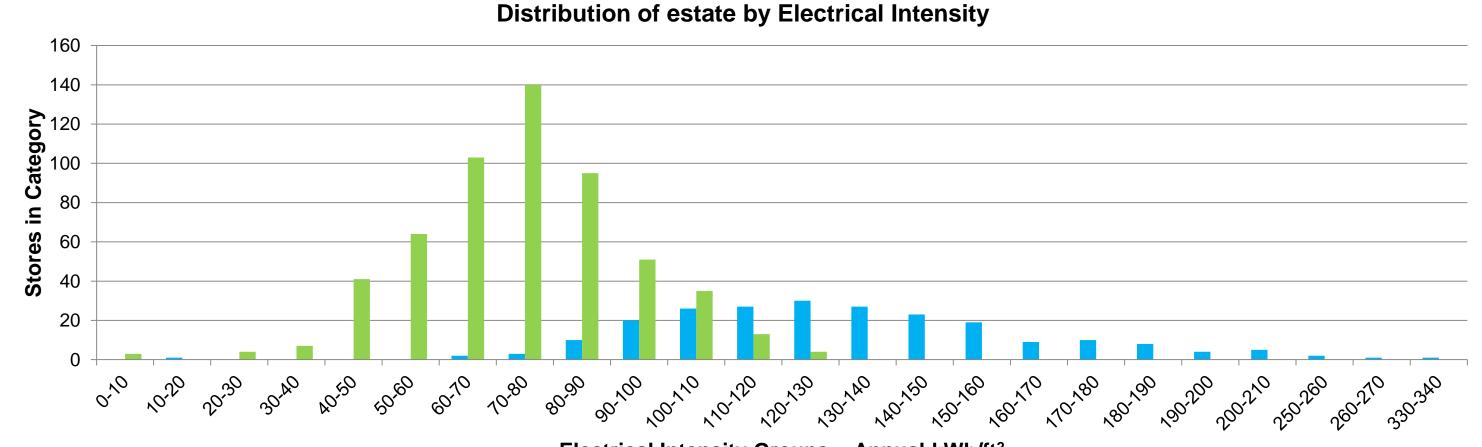
Background

Results

Energy use in the UK Food Retail market is examined in partnership with J Sainsbury Plc. and, from that perspective, conclusions are drawn about how large institutions can make sound financial decisions to meet their environmental targets.

Under pressure to decarbonise and reduce energy bills while expanding their estate, J Sainsbury Plc. has set ambitious targets to reduce absolute carbon emissions by 30% by 2020 and 50% by 2050, from a 2005 baseline [1].

The distribution of Electrical Intensity's within Sainsbury's estate is shown in Fig 1, and loose correlations against Store Opening Year and Store Size are shown in Figs 2 and 3.



Electrical Intensity Groups - Annual kWh/ft

Convenience Supermarket

Figure 1: Electrical Intensity distribution of Sainsbury's estate.

Electrical Intensity by Store Size

Electrical Intensity by Store Opening Year

The completed investment tool displays Key Performance Indicators (KPIs) to the user in a dynamic user interface, for each potential investment. These KPIs are Capital Expenditure, Net Present Value, Internal Rate of Return, Simple Payback Period, Annual Energy Savings and Lifetime Carbon Savings, as shown in Fig 5.

Store Heating Demand 613464 Store Electric Demand 3394728						Cur	rent	Tech	nolo	gy	Report Builder				
						Mod	ern B	oiler			Scenarios Current Scenario - Sainsbury's				
				[S	elect	Curre	nt Ro	w as Current Technology	Technology All Technologies 👻					
Sce	nario: Sainsbury's 🔻									Calculate	Select current ro	w as report technology			
									Report Name			Generate Report			
	Name	el Ty	ting	:tric	Ou	urs	pEx	ion	r Sy	Annual Energy Use (kWh)	NPV (£)	Payback (years)	IRR	Lifetime CO2 Saved (kgCO2)	
1	Modern Boiler	Gas	0	0.0	1	8	2	5	2	4008192.0	0.0	Base Case	None	0.0	
2	Clarke NG 530 kW Gas	Gas	0	0	6	8	5	1	4	8508090.22556	696800.591172	6	0.19829	-10487679.3643	
3	Clarke NG 1 MW Gas	Gas	0	0	1	8	7	1	6	8660020.40816	202868.800452	10	0.10654	-11108618.0205	
4	EnerG NG 505 kW Gas	Gas	0	0	5	8	3	1	3	8726807.19794	859330.394417	4	0.28988	-11381575.6304	
5	Cogenco NG 307 kW Gas	Gas	0	0	3	8	2	1	2	8226561.82834	150666.204432	9	0.13253	-11522563.7396	
6	Cogenco NG 501 kW Gas	Gas	0	0	5	8	3	1	3	9811352.60116	293770.478298	8	0.15528	-15814112.6933	
7	Cogenco NG 600 kW Gas	Gas	0	0	7	8	4	1	6	10194378.3784	-323403.726615	20	0.00495	-17379539.0448	
в	Clarke NG 1 MW Bio Gas	в	0	0	1	8	7	1	6	8660020.40816	-688300.491204	longer than 25 years	None	18049670.6937	
	Clarke NG 530 kW Bio Gas	в	0	0	6	8	5	1	4	8508090.22556	-178734.151508	15	0.04223	18159060.4252	
9															

Figure 5: Screenshot of the investment tool user interface.

Case Studies

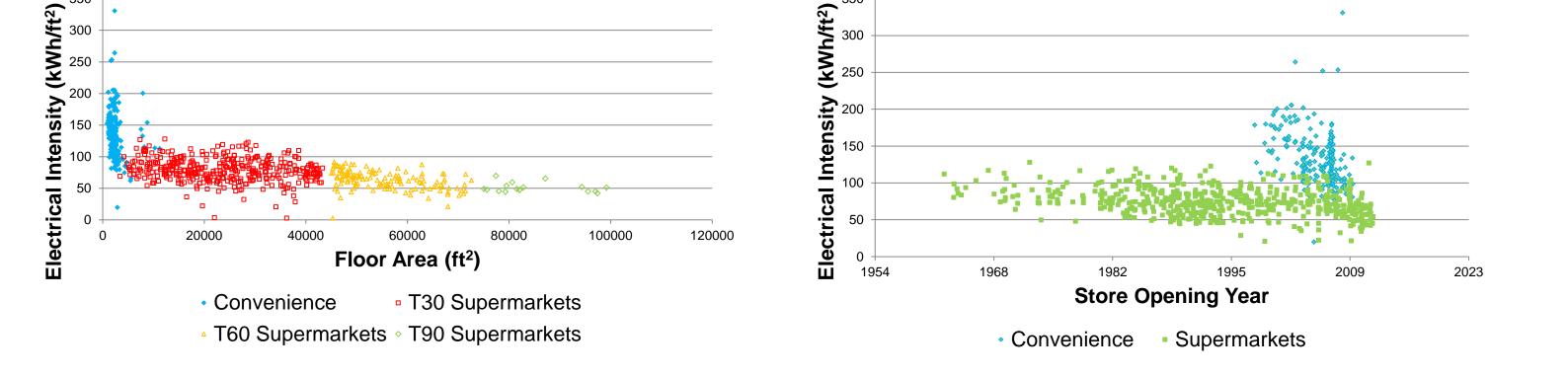


Figure 2 and 3: Electrical Intensity by floor area (2) and opening year(3).

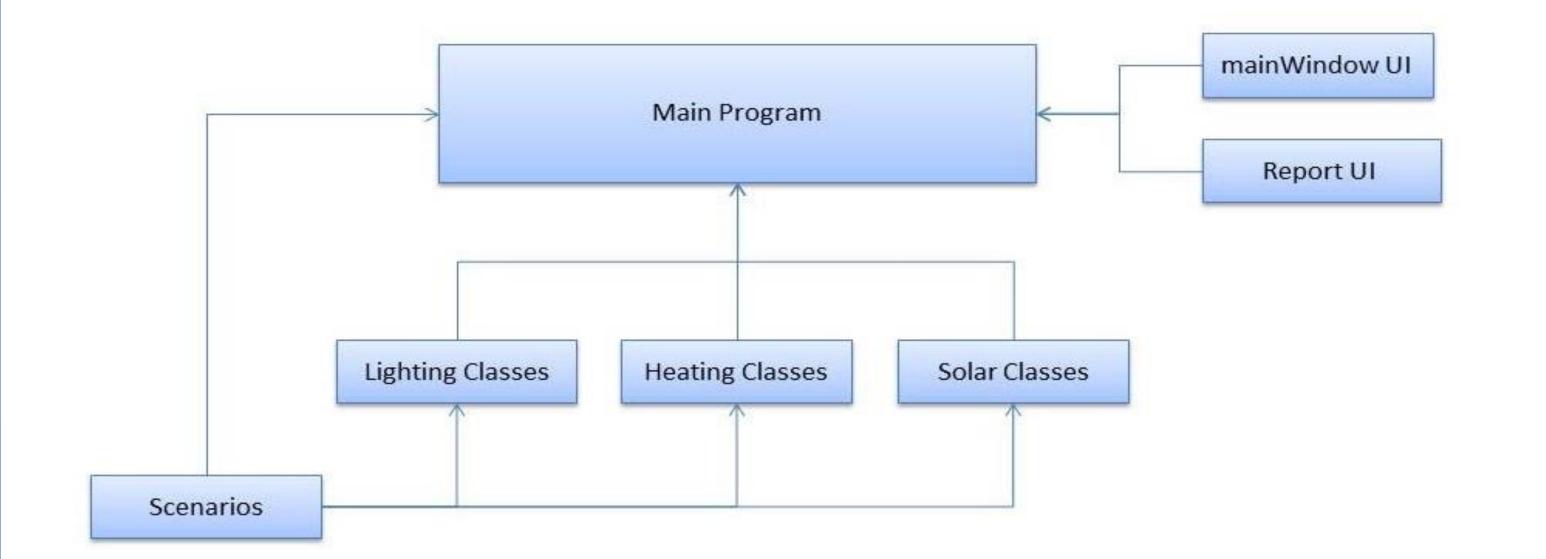
Objectives

This thesis investigates the development of an investment tool in order to deepen understanding of energy investments and with the intended value of providing useful information to decision makers. This value rests on two objectives:

- Ease and speed of use of the investment tool
- Quality and usefulness of information provided by the investment tool

Methodology

The Python programming language, along with the PyQt User Interface framework, is a powerful toolkit for developing applications [2]. A build and patch methodology is followed and the program is developed in modules as shown in Fig 4.



The investment tool has a reporting functionality that allows for the export of financial and social projections, allowing for deep analysis of investments.

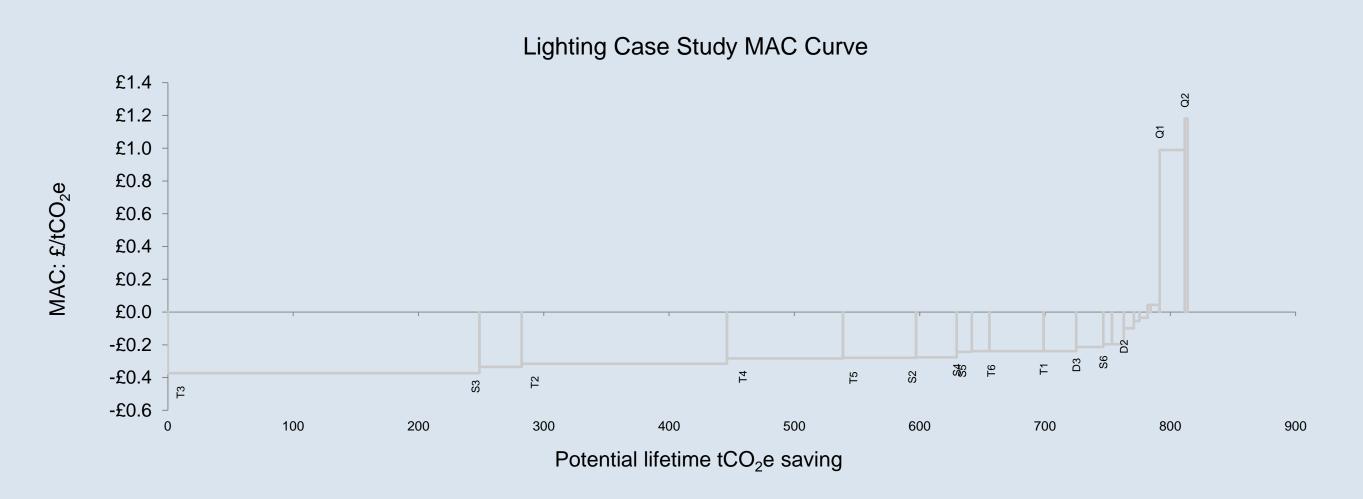


Figure 6: Marginal Abatement Cost (MAC) Curve for lighting investments.

Fig 6 compares investments in lighting technologies across different stores, showing the Marginal Abatement Costs, a combination of Net Present Value and Lifetime Carbon Savings.

Soalr PV - Effect of Changing Financial Variables

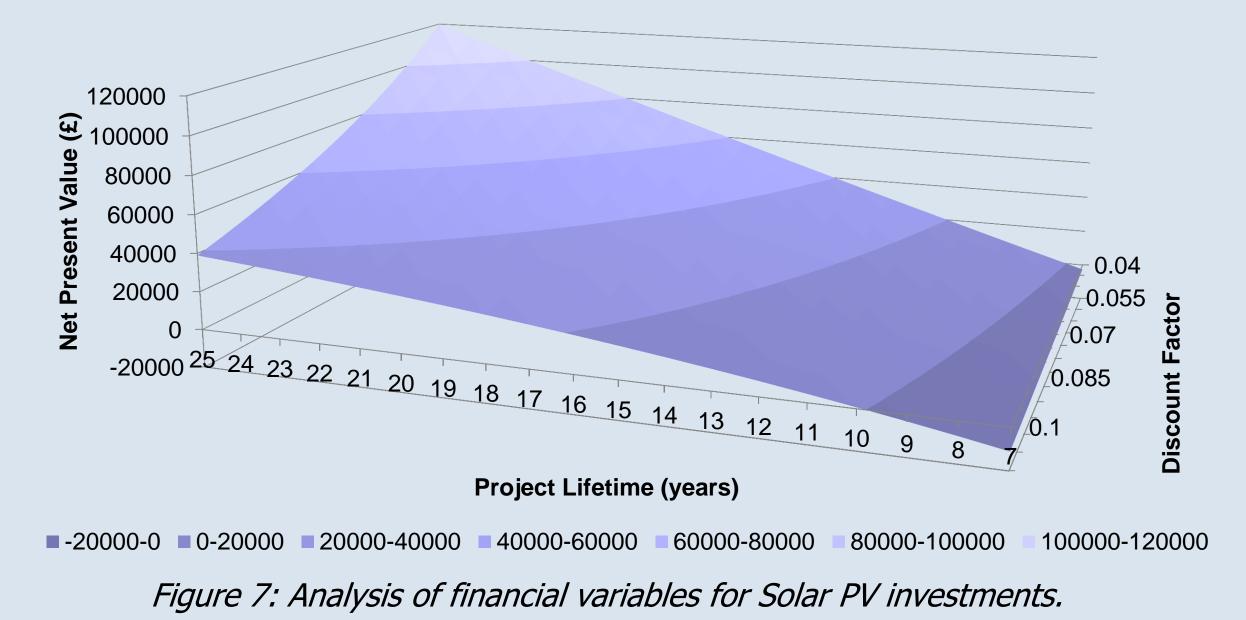


Figure 4: The modular structure of the investment tool program.

Acknowledgements

I would like to thank my supervisors, Nilay and Salvador, whose guidance and advice were invaluable during preparation of the thesis.

References

[1] J SAINSBURY PLC, 2012. *20 x 20. Our 20 commitments to help us all live well for less. Our progress so far.* J Sainsbury Plc.

[2] SUMMERFIELD, M., 2007. *Rapid GUI programming with Python and Qt: the definitive guide to PyQt programming*. Pearson Education.

The choice of discount factor and project lifetime are found to have a significant effect on the Net Present Value of Solar PV investments, as shown in Fig 7.

Conclusions

As a proof of concept, the investment tool can provide value to decision makers, particularly in respect to the speed, formalisation and depth of analysis.

The concept of Energy Service Demand is found to be helpful when developing this kind of program, defined as:

Energy Service Demand = $E_1\eta_1 = E_2\eta_2 = E_3\eta_3$

Where E_i = Energy use of technology i

 $\eta_i = Efficiency of i$

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