Imperial College London

Buildings and Storage

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energy futures lab

Introduction

Assessing policy measures for energy efficiency in UK homes

Natalia Wisniewska

How to boost energy efficiency in domestic households?

Which policy could achieve that?

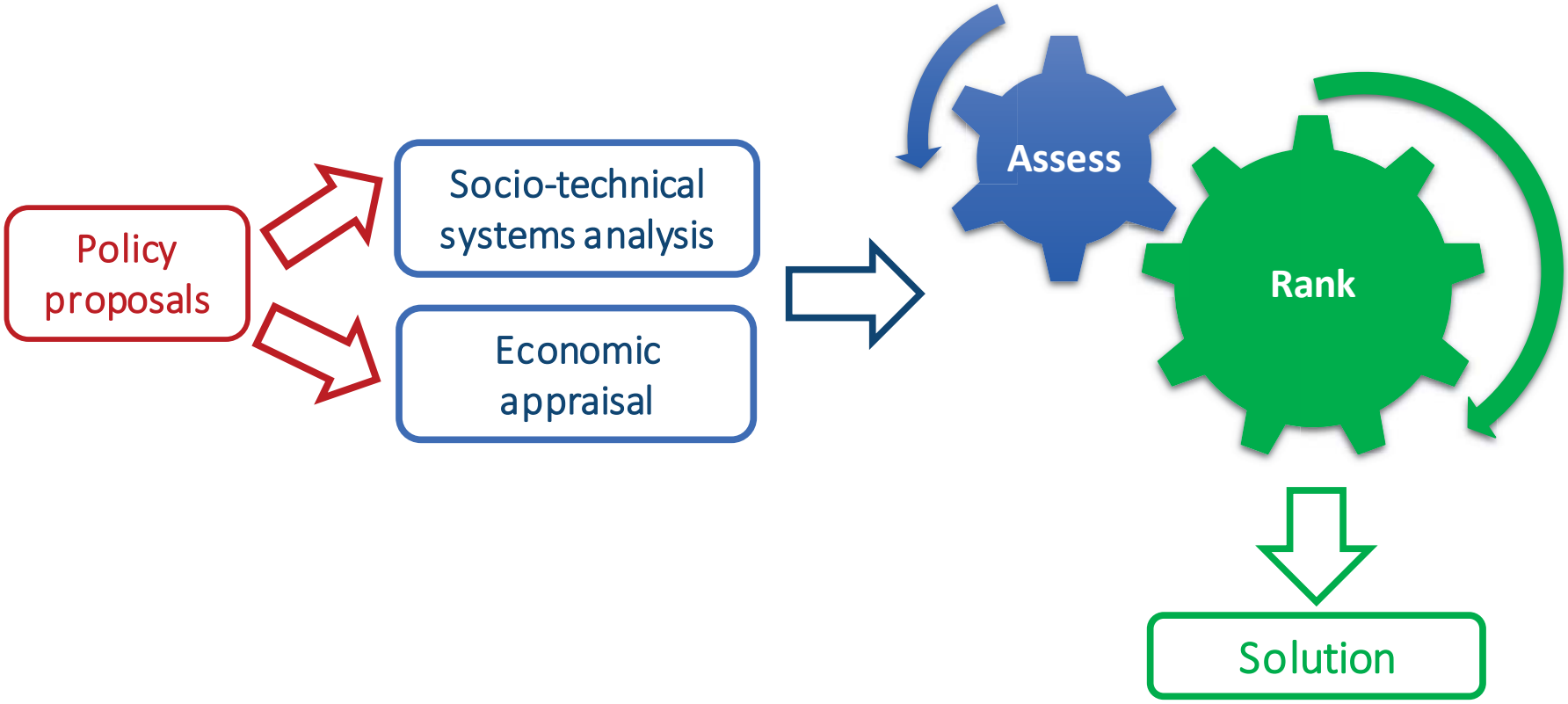
1. Variable Council Tax
2. Variable Stamp Duty

3. Help to Heat Framework
4. Green Mortgage

5. FiT for energy efficiency
6. Demand Reduction Obligation

How to assess the potential of policy prior to its launch?

Policy assessment tool

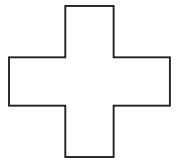


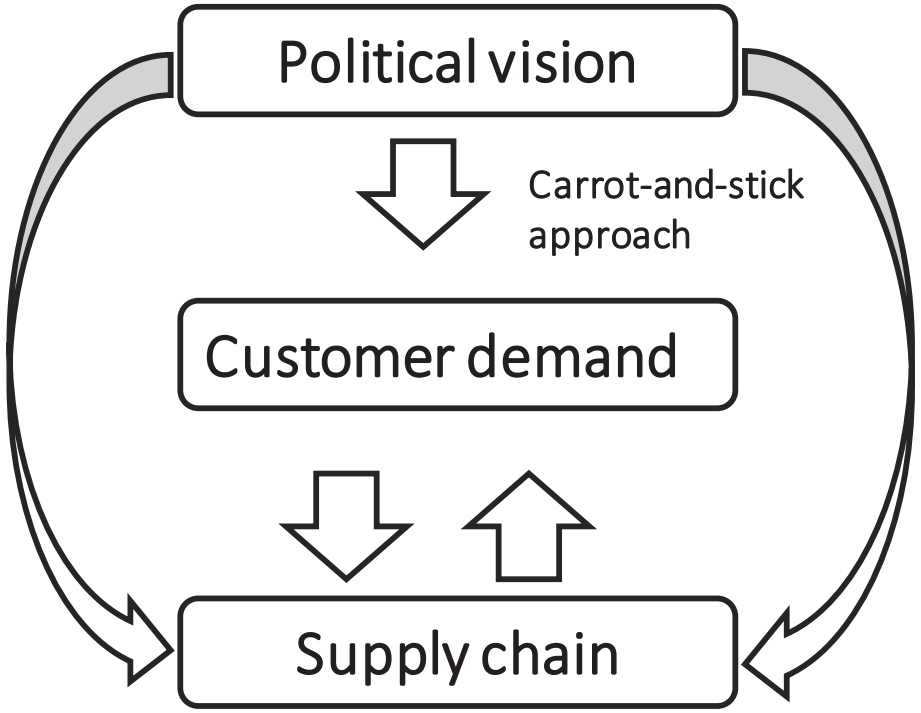
Solution: what will work?

Variable Council Tax

Green Mortgage

Variable Stamp Duty





POSTER 18

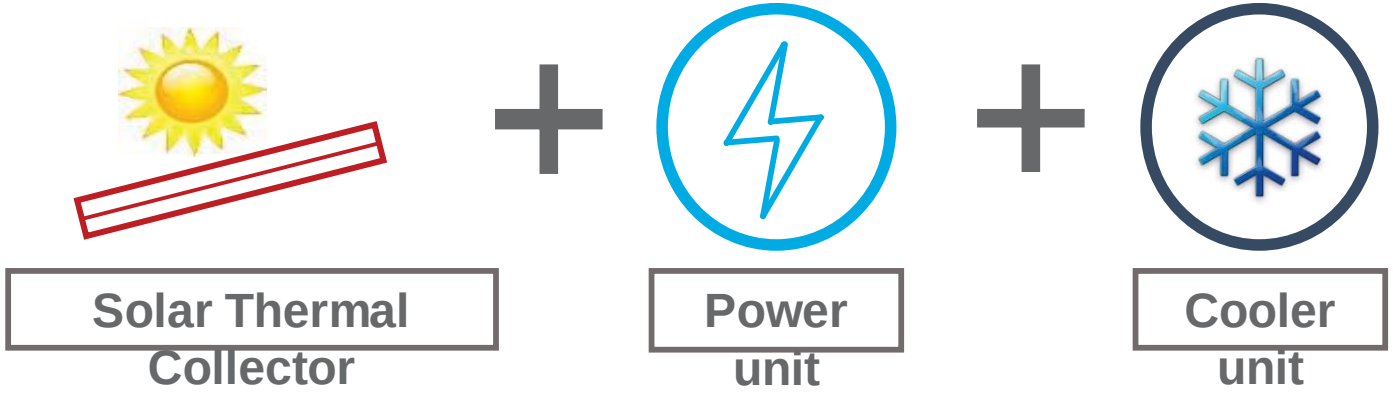
My sincere thanks to my supervisors Chris Mazur, Jeff Hardy and James Luger, but also Simon McGreehin, my interviewees and everyone else who supported this work.

Solar-Combined Cooling, Heating and Power (S-CCHP)
A Techno-economic Assessment

Joseph Juan

Polygeneration Energy System

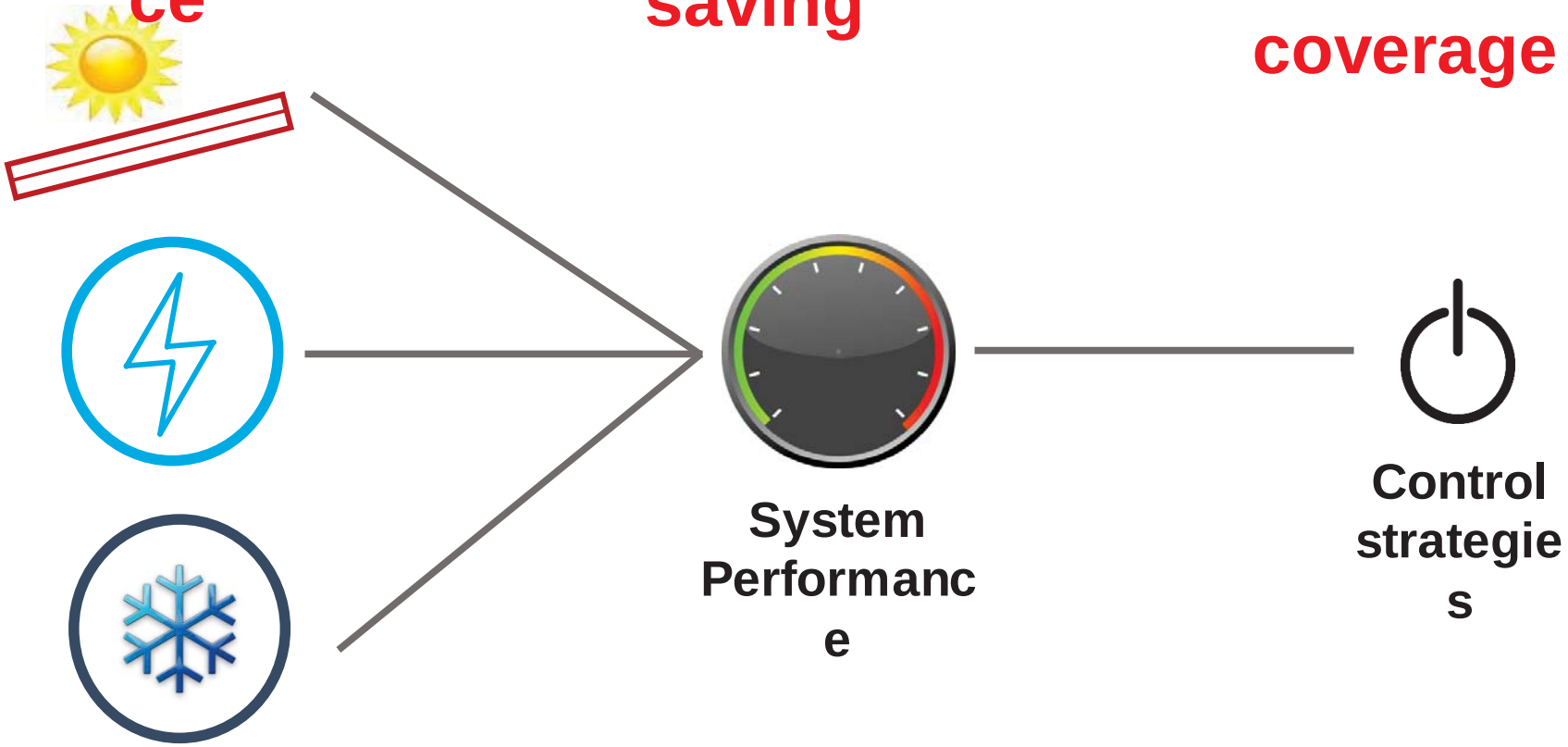
Focus on **combining cooling and power** part, called as **solar combined cooling and power (S-CCP) system**:



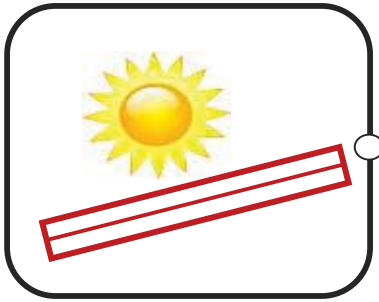
Aim: To assess the **technical** and **economic** feasibility for a **typical house** in **London**

System Performance

System performance ⟷ **The amount of electricity saving** ⟷ **The amount of electricity demand coverage**

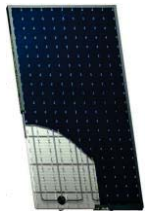


System Combinations



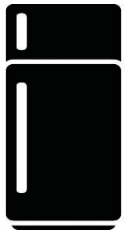
Direct flow collector

Heat pipe collector



Evacuated flat collector

Organic Rankine Cycle (ORC)



Diffusion Absorption Refrigerator (DAR)

Single effect absorption refrigerator

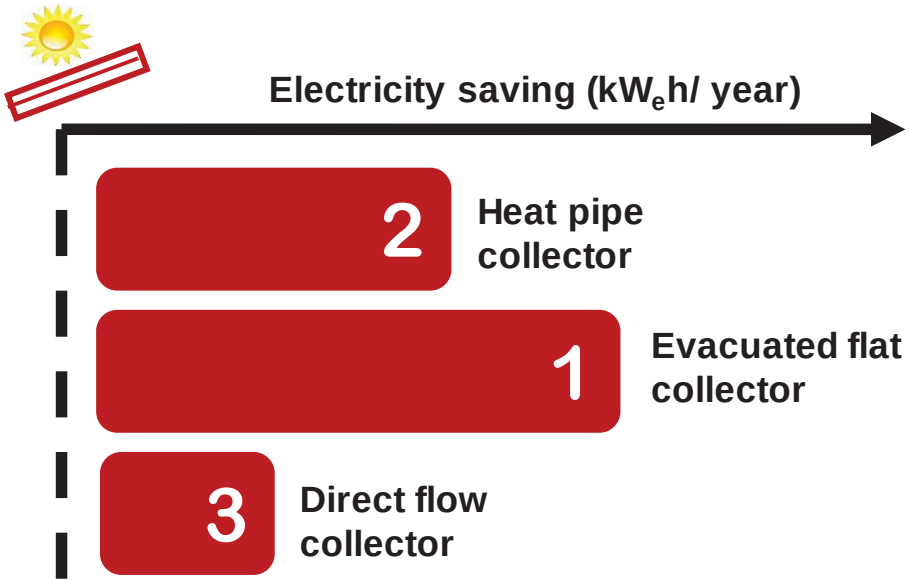
Double effect absorption refrigerator

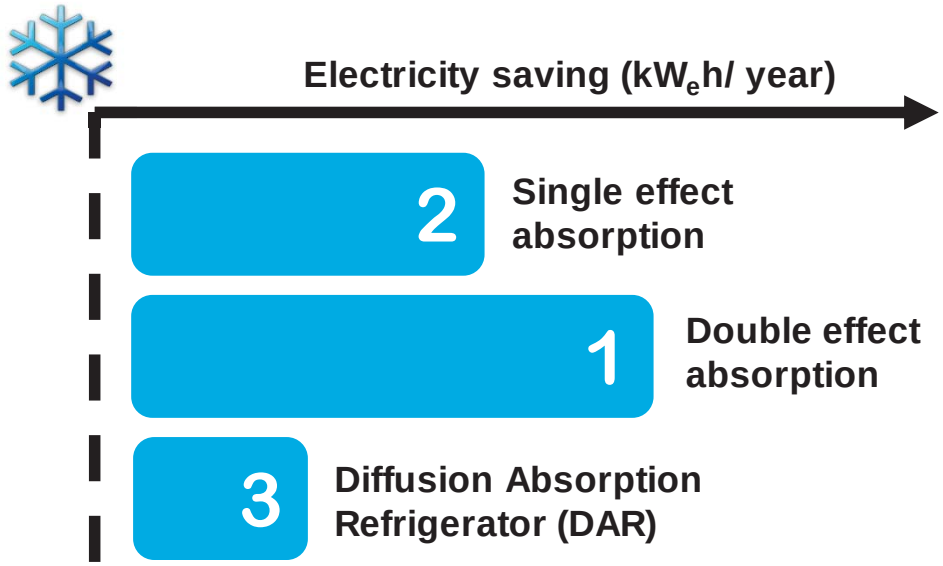
Prioritising cooling

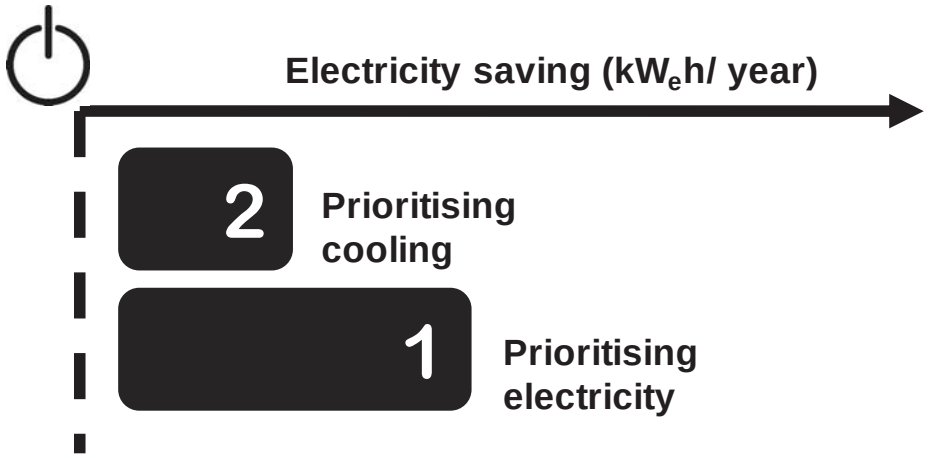
Prioritising electricity

Which combinations give higher electricity saving?

Results: Technical Assessment



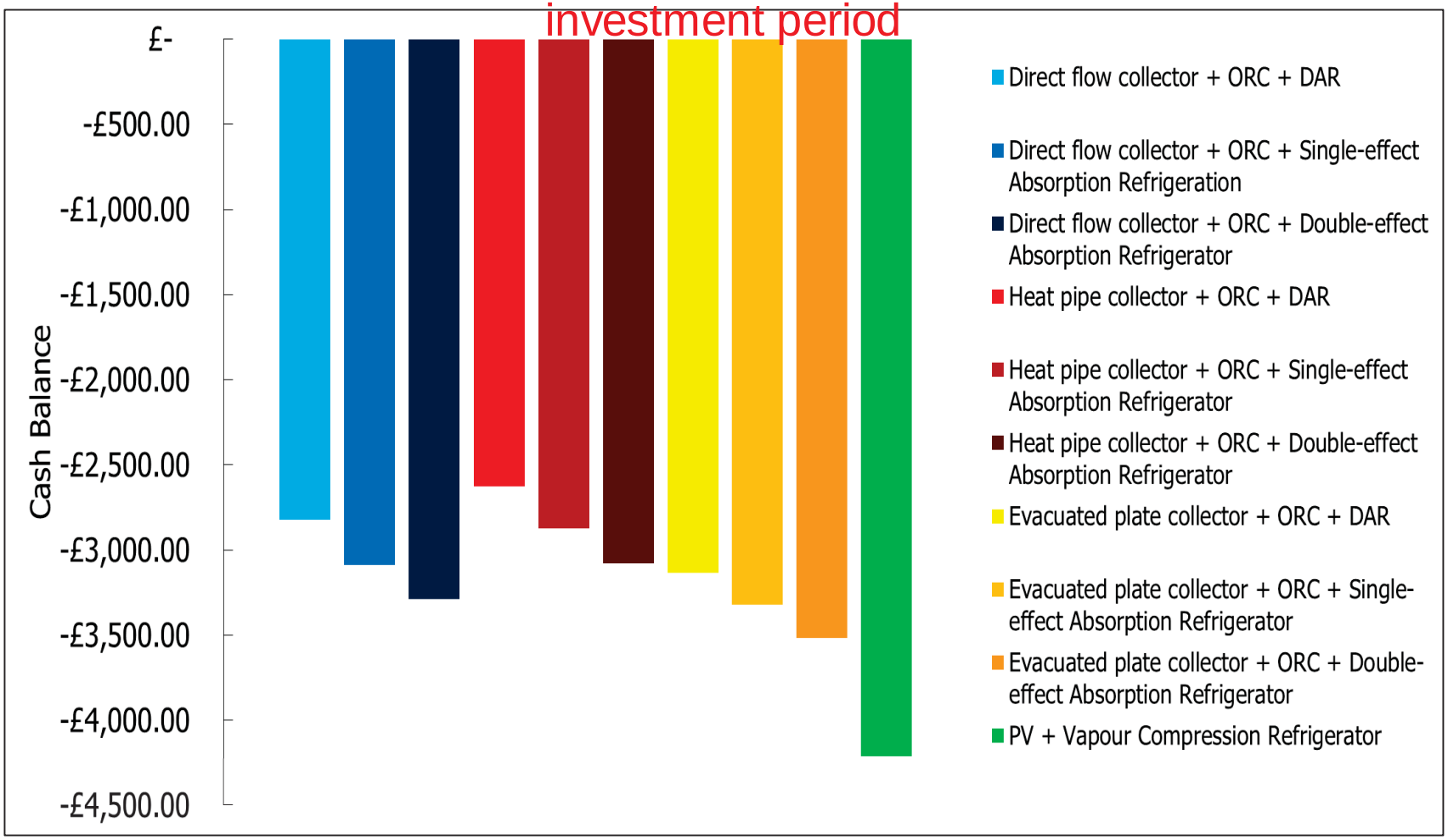




However, the systems only cover **5 – 12% annual electricity demand** because of the **low solar resource** in **London**

Results: Economic Assessment

Net present value of S-CCP system after 20 years investment period

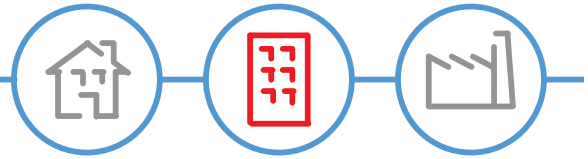


Conclusions

- The considered **solar combined cooling and power (S-CCP) system is not feasible** to provide energy for a **typical house** in **London**
- However, **installing the system in sunnier location** or **applying hybrid system** can be considered further

POSTER 16

My sincere thanks to Dr. Christos Markides, Dr. Antonio Marco Pantaleo, Dr. Robert Edwards and James Freeman for their valuable helps in this project.

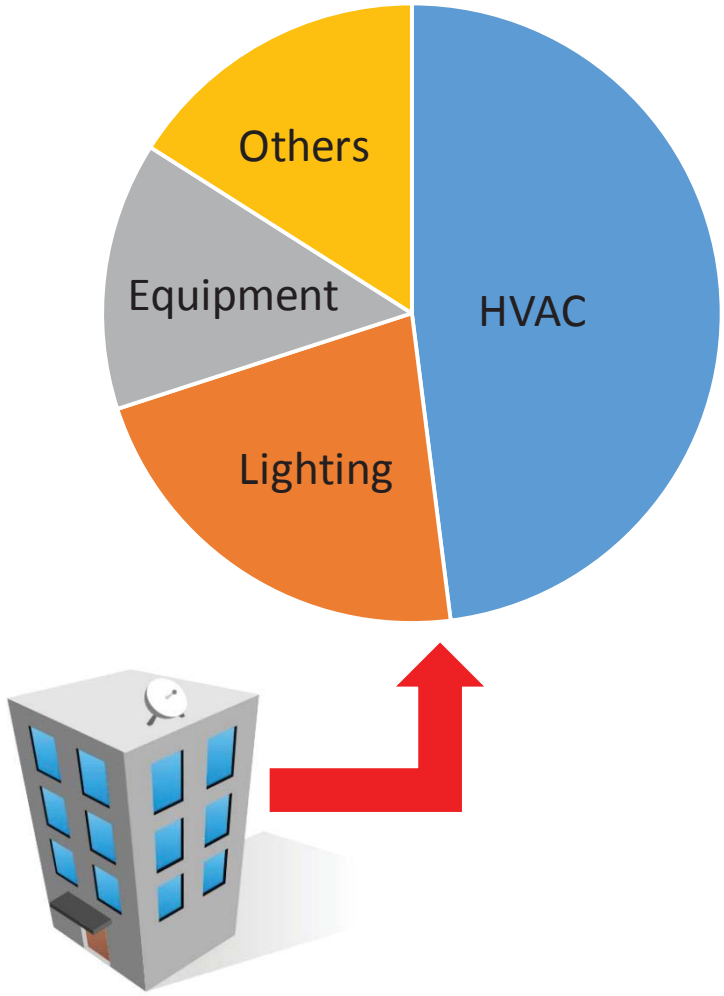


A Design Environment to Enable Smart Buildings

Akash Goenka

Setting the scene

- Can the enormity of energy consumption by buildings be ignored?
- Why do buildings underperform (energy-wise)?



Turn up the heat!

- Takes note and learns your schedule
  - 7 am: A warm welcome
  - 8 am: Off to work
- Slashes bills and energy use
- This is *smart!*

Aim

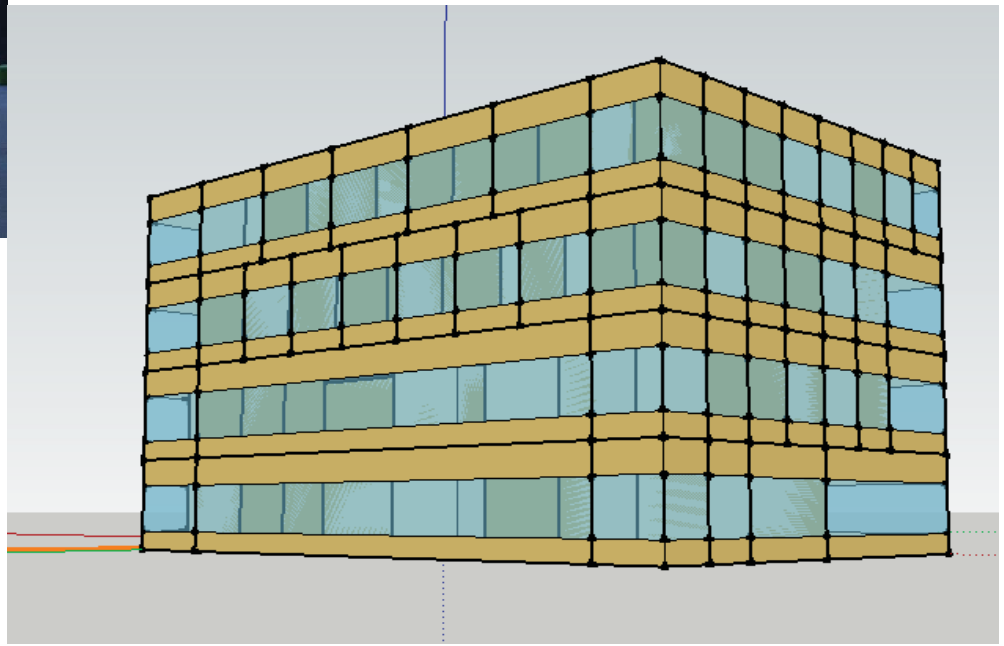
What is the impact of controls on HVAC energy consumption and indoor comfort?

The Faculty Building model

Trench heaters

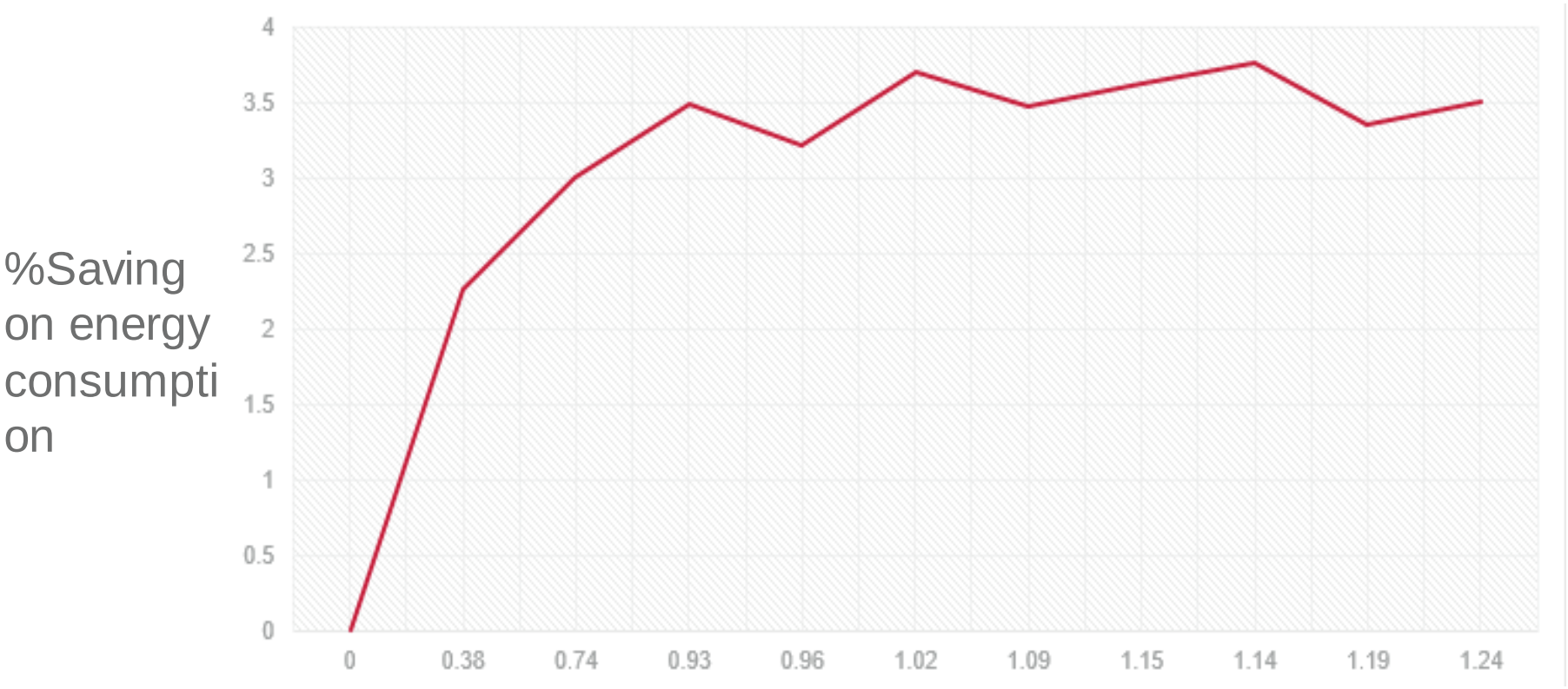
Chilled Beams

A 3D Reconstruction



Simulation Results

- Greater thermal com ⇎ Greater energy consumption



POSTER 15

My sincere thanks to my supervisors, Dr Bianca Howard,
Dr Salvador Acha and Prof John Polak.

An Olympian Challenge:

How do we address retrofitting commercial buildings?

Lara Tarasewicz

Focus: Soft Barriers

Overcome soft barriers to retrofitting

Commercial Buildings

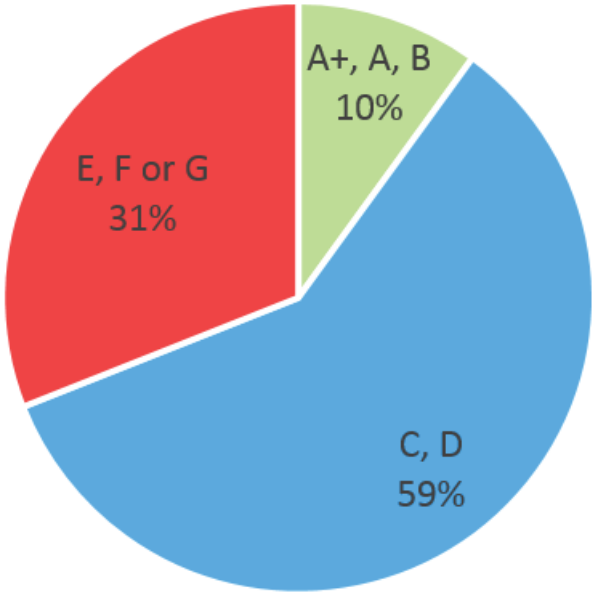
Energy Efficient

Why do soft barriers matter?

We have the technology…

E.g. Insulation, LED lighting

So why aren't all commercial buildings energy efficient yet?



Novel Methodology

INPUTS

ECONOMIC & Carbon

SOCIO-TECHNICAL SYSTEMS

General Case → Case Study

General Case

38 barriers

1. Split Incentives
2. Management
3. Business case

17 Solutions, e.g.

- Individual Responsible
- Demonstration Example
- Finance Team Lead

Key Findings

Key Findings

POSITIVES

Motivated individuals

Good communication

SSD support

Methodology:

Toolkit of Barriers and Solutions

NEEDED

Assurance on energy savings

Payback > 3 years

Government policy

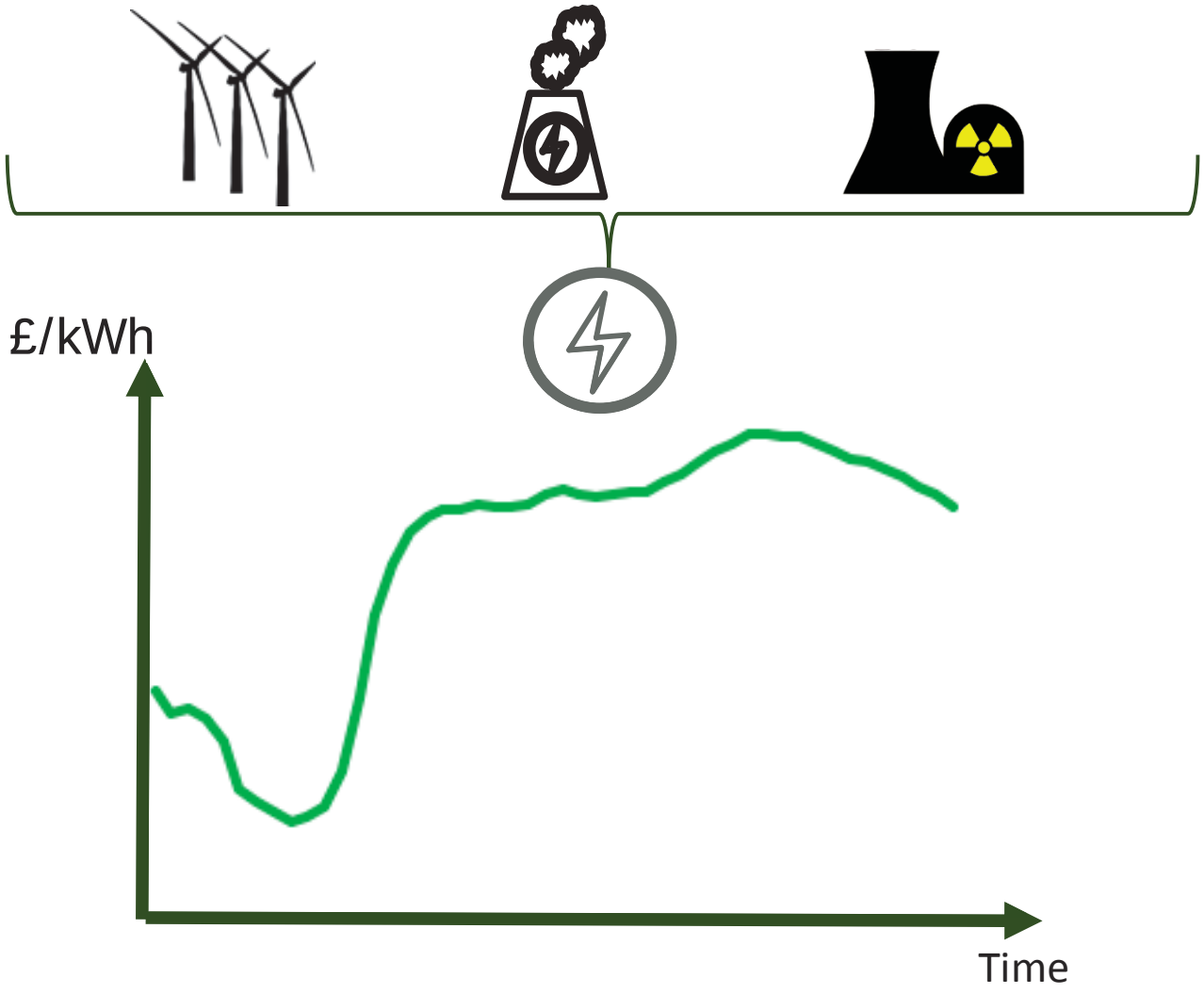
POSTER 17

My sincere thanks to my supervisors Dr Christoph Mazur,
Dr Koen van Dam and Pelumi Solaru.

Carbon Arbitrage with Electrical Energy Storage

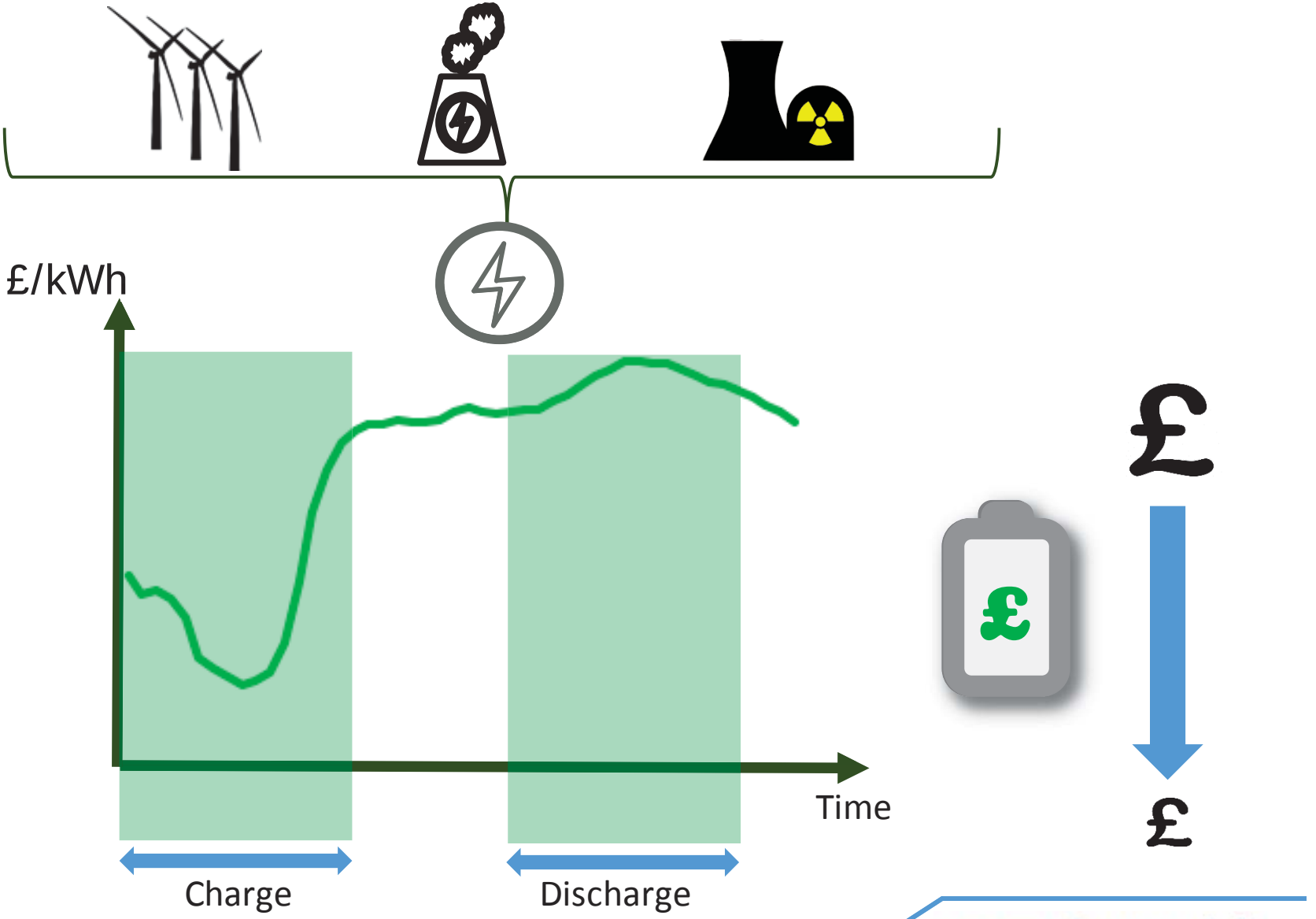
Mauricio Riveros

Arbitrage

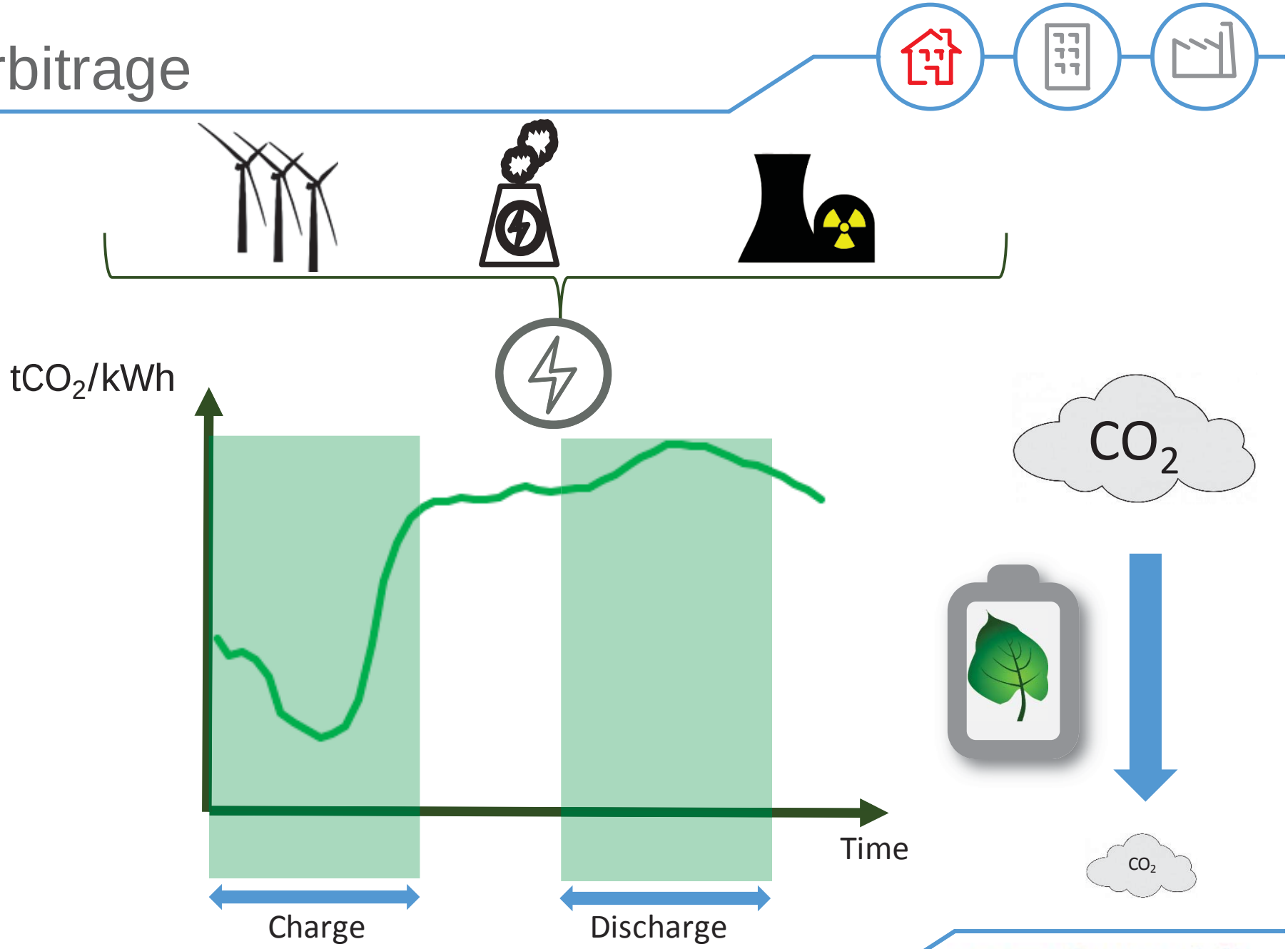


£

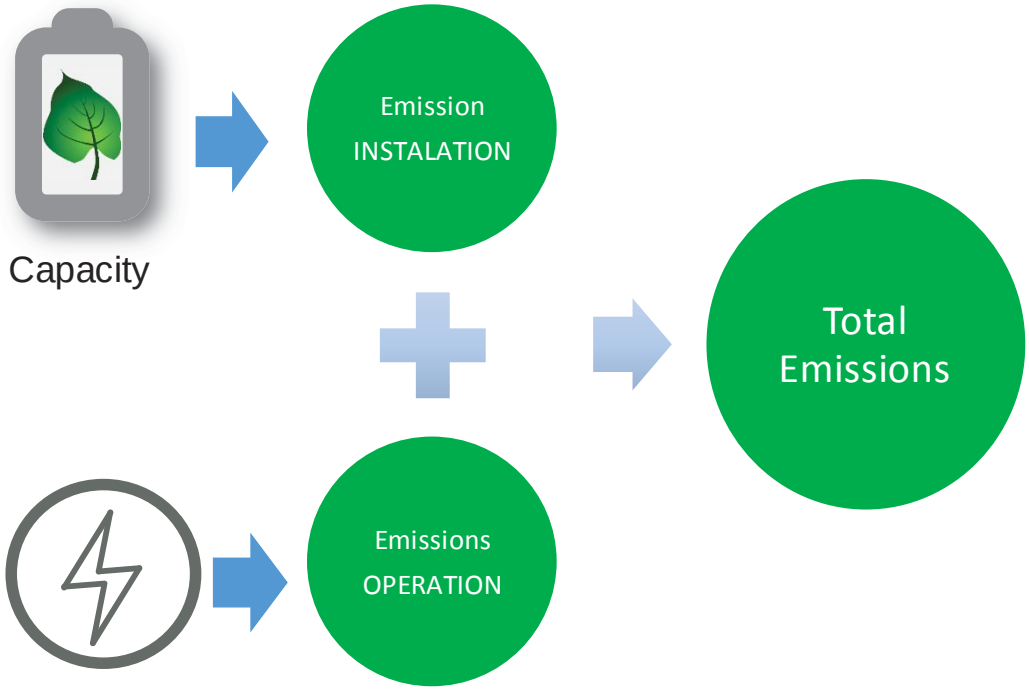
Arbitrage

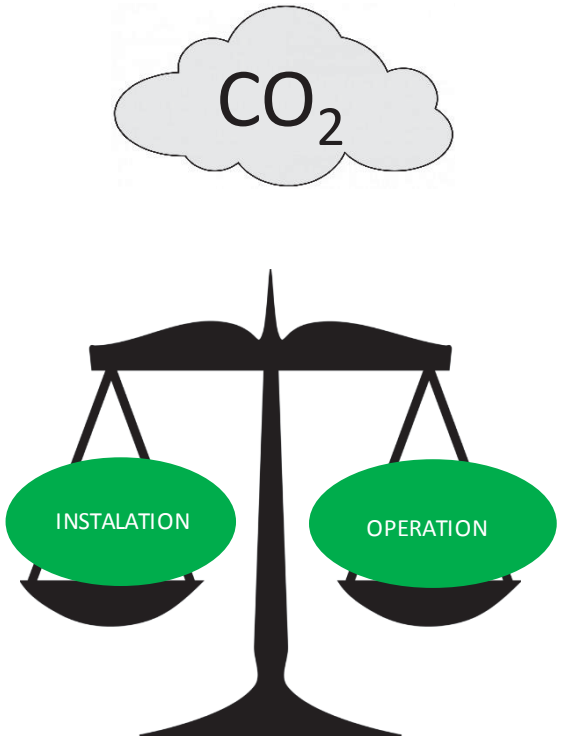


Arbitrage



Methodology





Optimization Problem

Case Study

Technology

- Li-ion
- FB

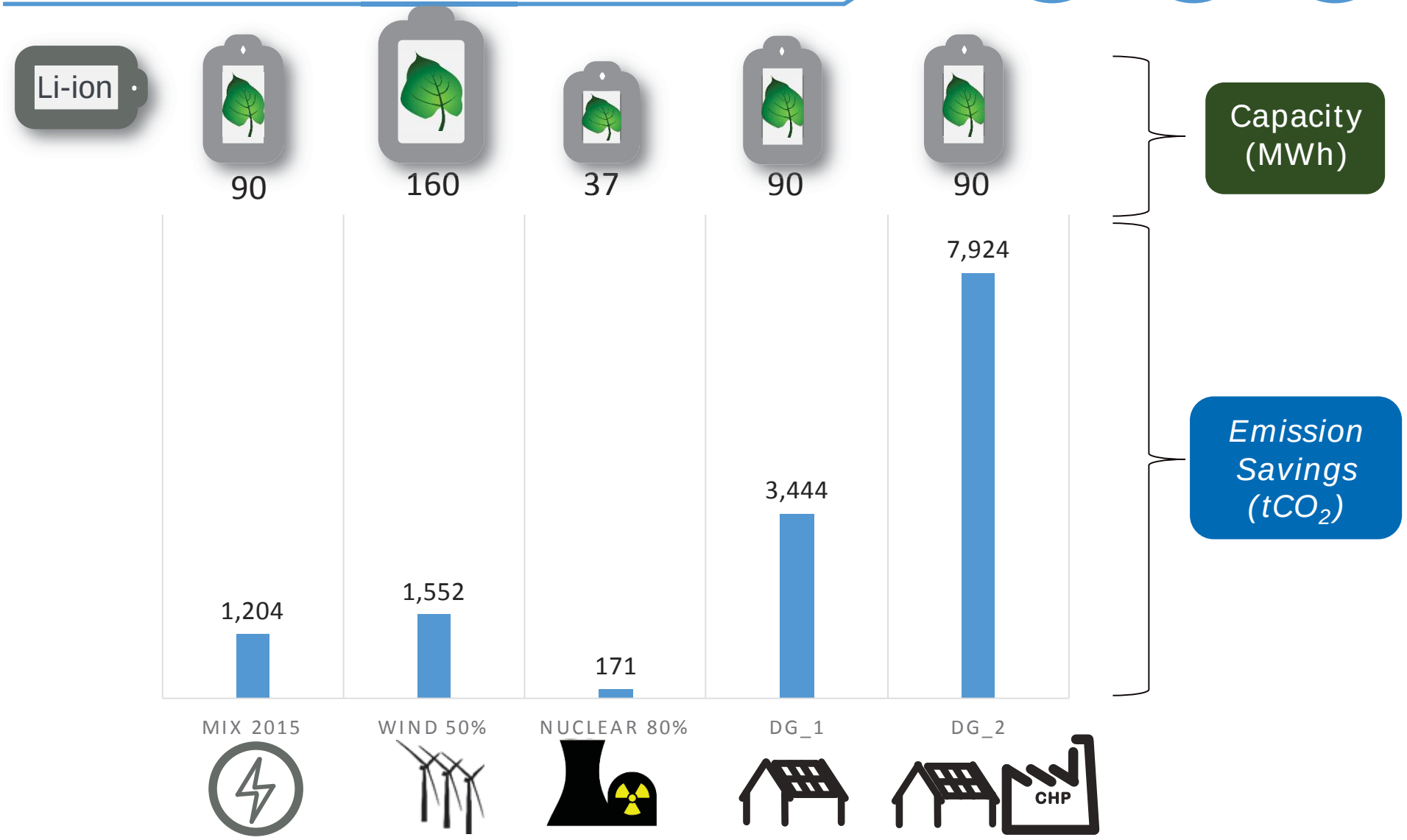
Generation Mix

- Mix 2015
- 50% Wind
- 80% Nuclear

Distributed Generation

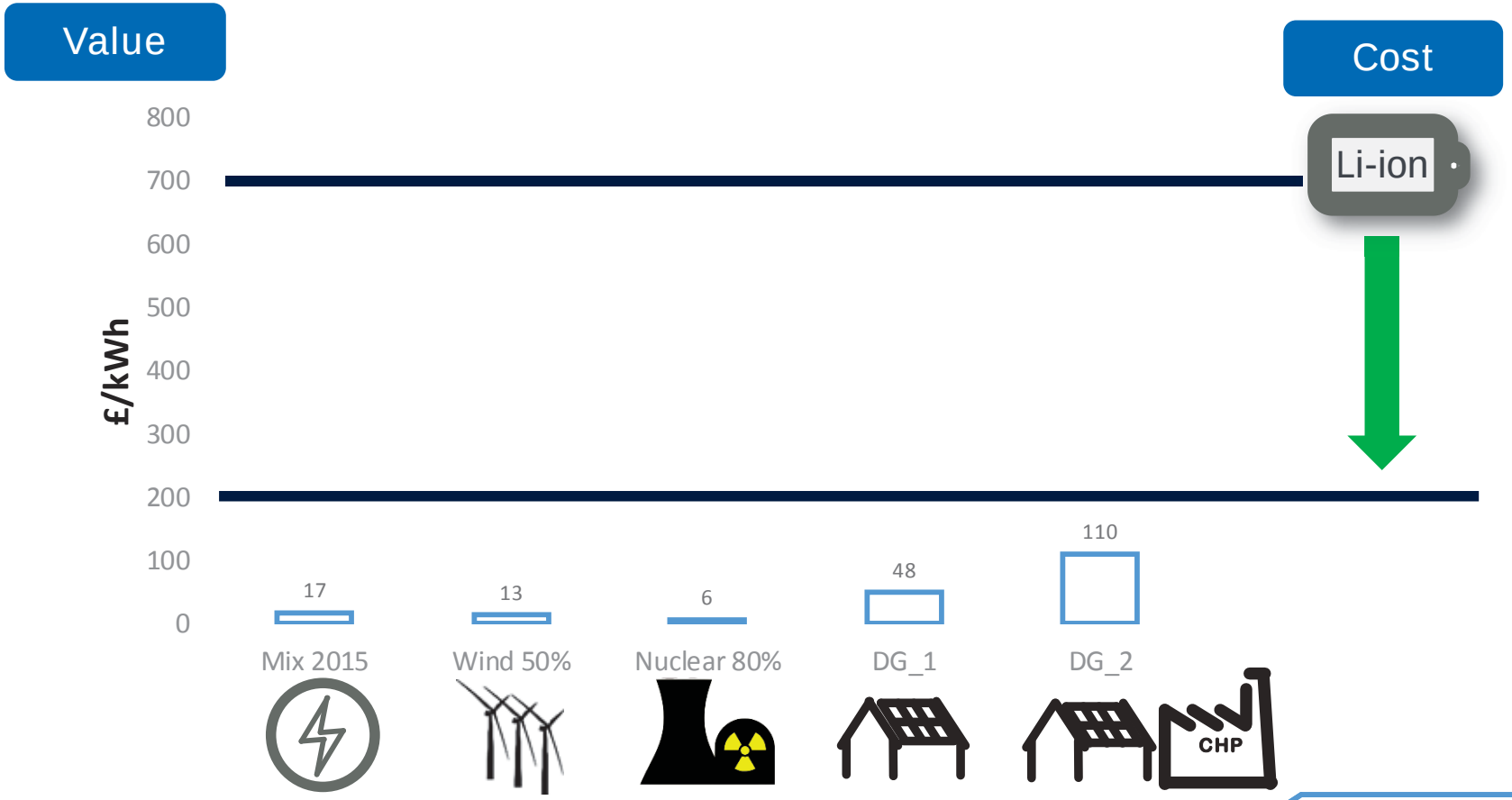
- DG-1
- CHP DG-2

Results: Emissions Savings

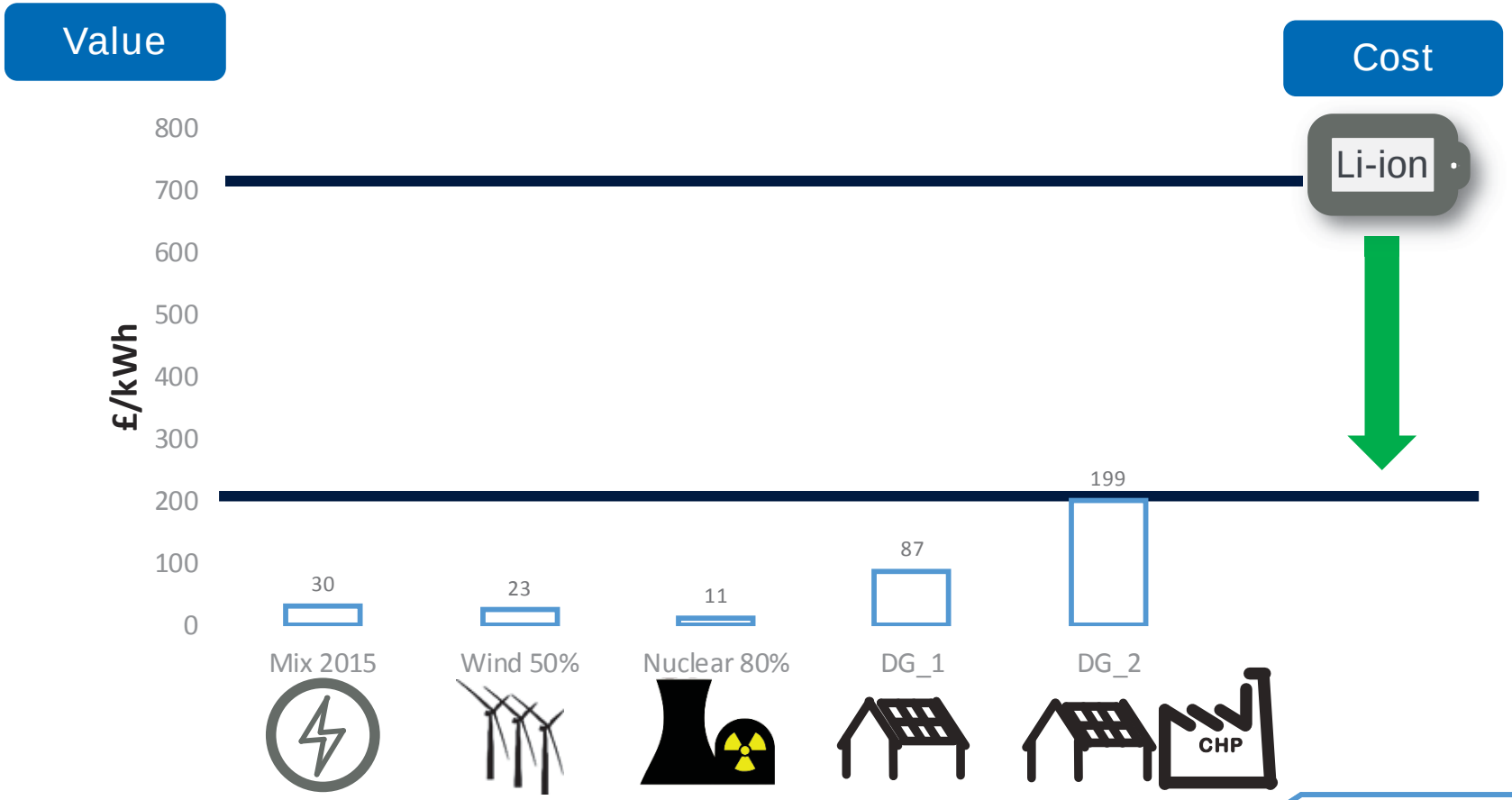


energy futures lab

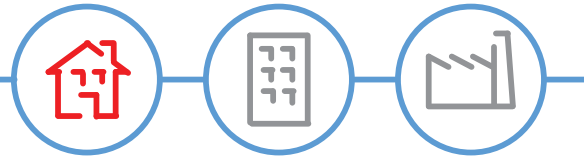
Results: Is it profitable?



Results: Is it profitable?



Conclusions



- A **significant capacity is** needed to maximise the savings in all the scenarios studied.

- **Savings are mainly defined by the carbon intensity** of the grid more than the demand patterns.

- The **emissions reduction is not high enough** to pay the investment at the current carbon price and investment costs.

- That suggest the need to **mix the Carbon Arbitrage with another application** to increase the value.

POSTER 19

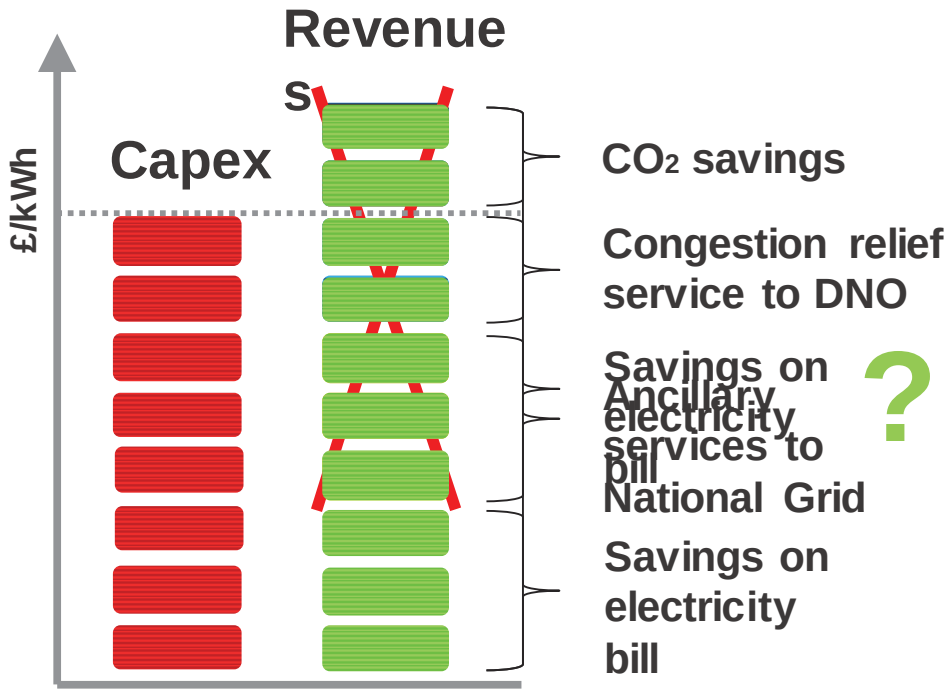
My sincere thanks to my supervisors Dr Miao Guo, Dr Koen Van Dam, Professor Nigel Brandon and Gonzalo Bustos.

The value of energy storage for industrial sites in the UK

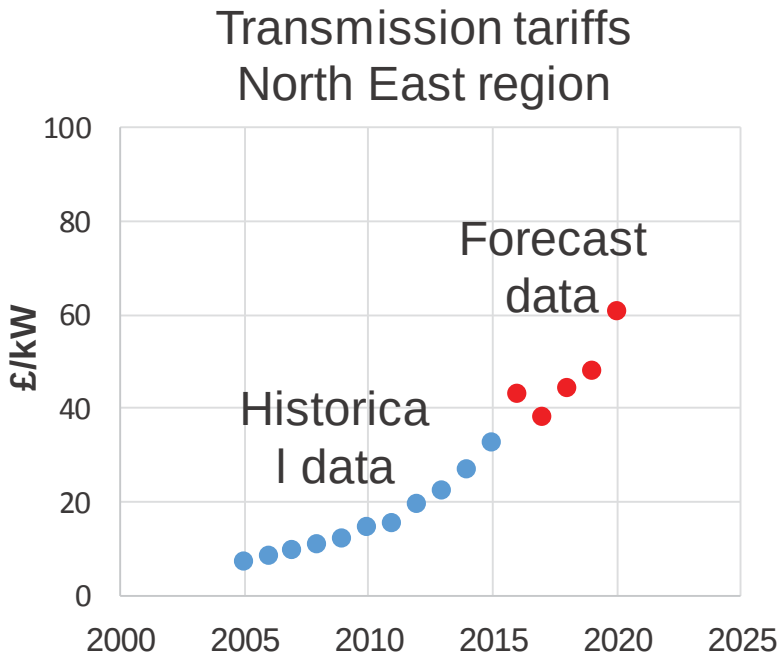
Matteo Silvestri

Background & Research Question

Battery cost vs. benefits

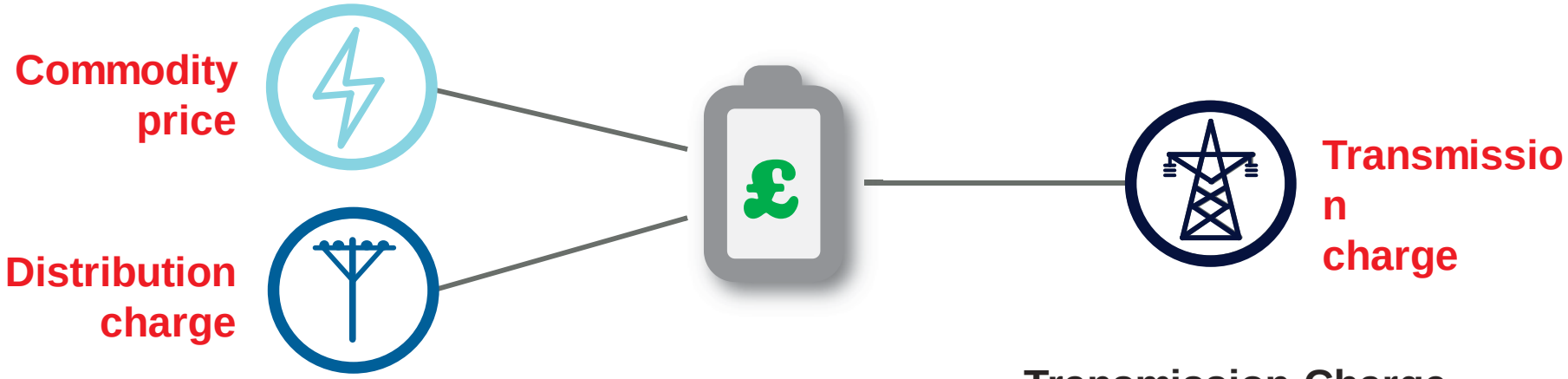


Electricity Price

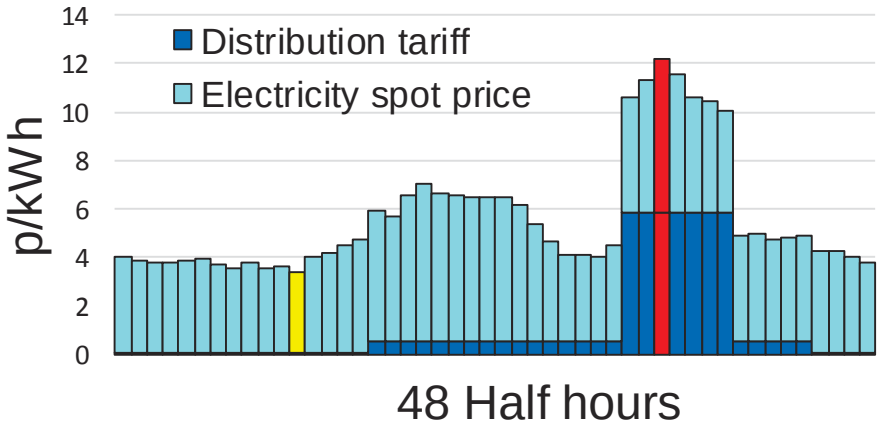


Can a battery system generate net savings on the electricity bills?

Electricity Bill: Saving Opportunities



Intra-day Arbitrage



Transmission Charge

$$£ = \frac{£}{kW} * kW$$

Regional tariff

Power demand during the 3 annual half hours of highest national demand

Case Study

Industrial Site

GlaxoSmithKline

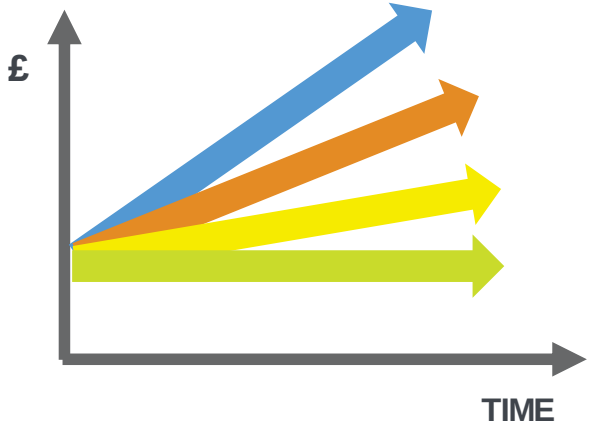
Battery Technologies

Li-ion

FB

NaS

Electricity Pricing Scenarios

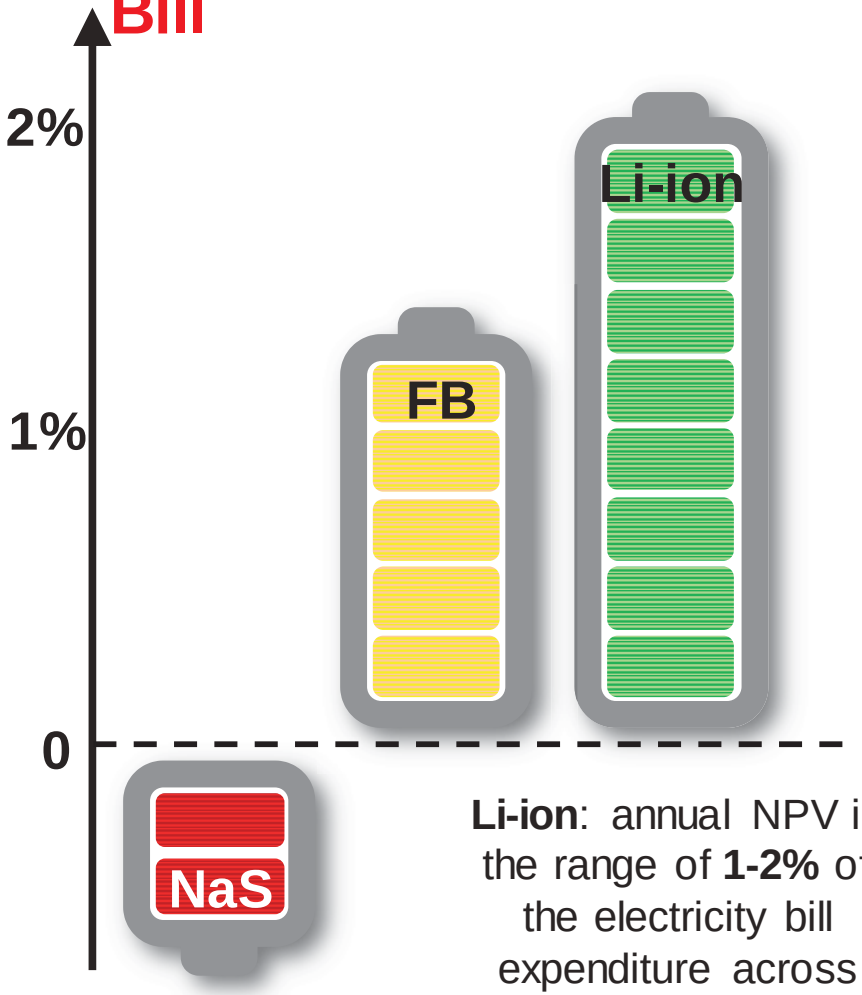


Different combination of trends for:

- Transmission tariff
- Distribution tariff
- Volatility of electricity price

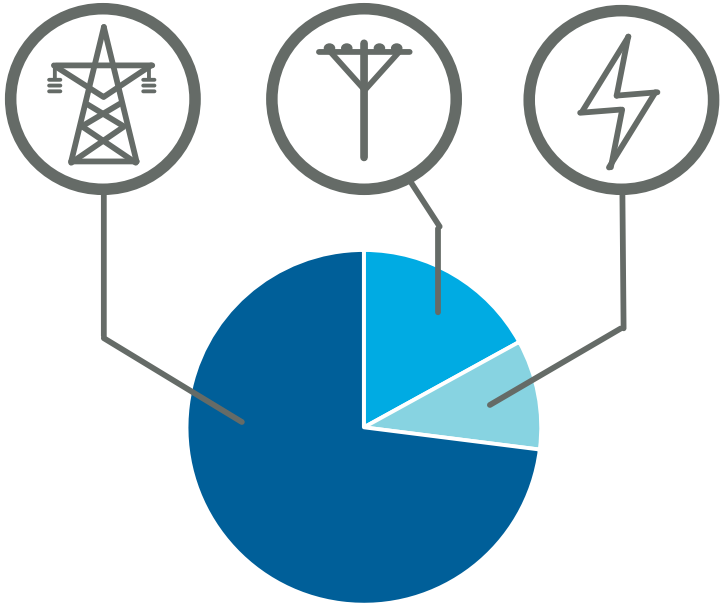
Results

Net Savings on Electricity Bill



Li-ion: annual NPV in the range of **1-2%** of the electricity bill expenditure across various scenarios

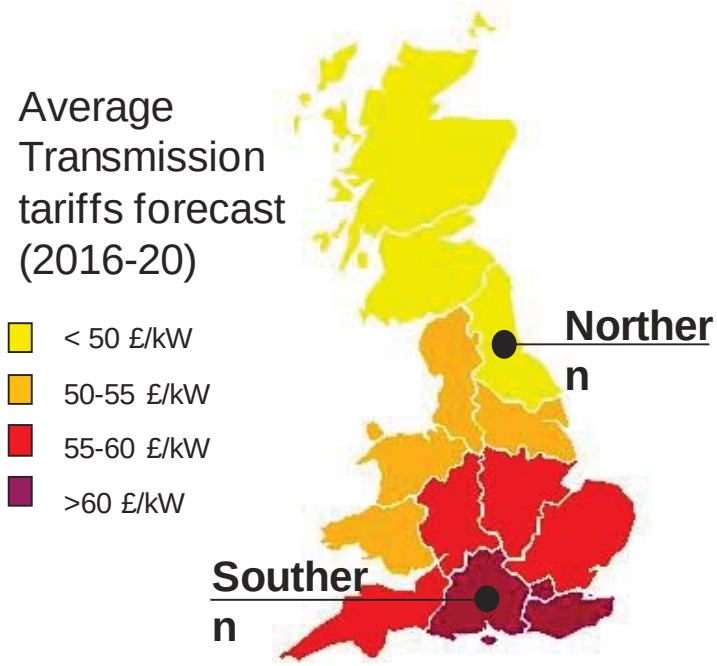
Share of savings for Li-ion and FB



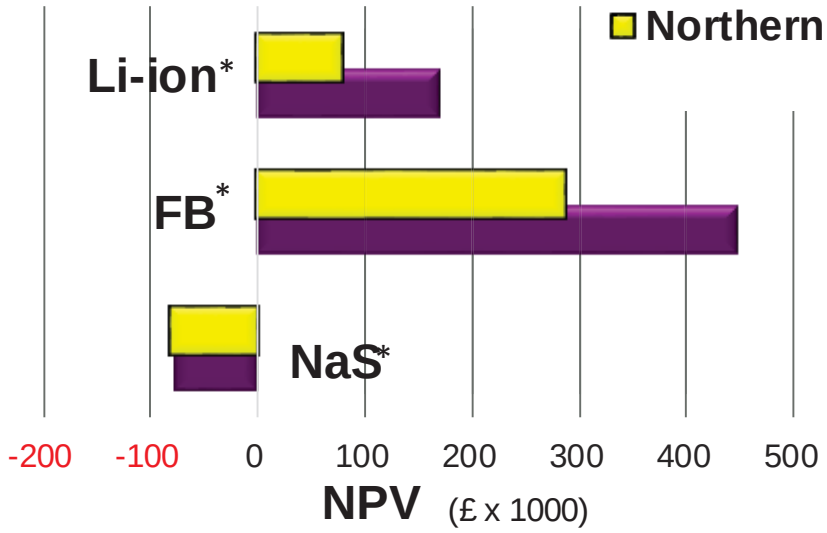
Optimal battery size: energy/power capacities ratio ≈ 0.5 hours

Sensitivity Analysis

Transmission Charges Regional Variation



Effect on Net Present Value



(*) Technologies not to be compared each other due to different lifetimes

Conclusions

There is a business case for properly designed and operated battery systems considering just the savings on electricity bills

POSTER 20

My sincere thanks to my supervisors Professor Nigel Brandon and Mr. Adrien Lebrun.

Thank you!

Natalia

18

Joseph

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Akash

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Lara

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Mauricio

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Matteo

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References

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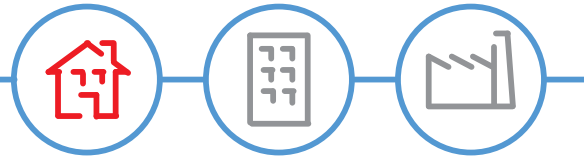
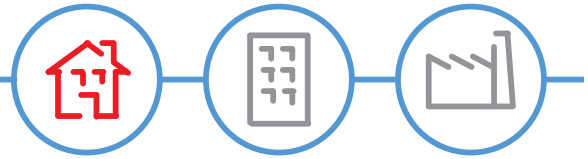
TVP Solar Product Datasheet. (2016). Available from: http://www.tvpsolar.com/files/pagine/1464011780_MT-Power%20Datasheet%20(v4.2x)(ver5).pdf [Accessed 14/09/2016].



	Council tax	Stamp Duty	FiT	DRO	Green Mortgage	Help to Heat	
Customer issues							**STS approach weighting**
boosts customer demand	4	4	2	2	4	3	90%
reduces costs of retrofit per household	3	2	3	3	5	5	73%
generates reasonable payback periods for customers	2	1	3	3	4	4	60%
reduces customer 'hassle factor'	3	3	3	4	3	4	90%
reflects retrofit uptake in property capital value	5	5	2	2	4	3	60%
causes less risk of 'rebound effect'	2	2	4	4	2	2	80%
ensures trust among customers	4	4	3	2	3	2	70%
Political/Economic issues							
prioritises fuel poor households	3	4	1	1	1	5	100%
cost-neutral to Treasury	2	2	1	3	4	1	85%
compatible with other policies	4	4	3	3	4	3	100%
introduces complemetary minimum standards/regulations	5	4	2	2	4	2	60%
CO2 abatement potential	4	3	2	2	3	2	100%
Supply chain issues							
develops expertise of the supply chain	4	4	2	2	4	3	60%
mobilizes the SWI market	2	2	2	2	3	3	100%
improves information base of existing building stock	3	3	2	2	3	3	69%
improves quality of home energy surveys	2	2	2	2	2	2	66%
ensures coordination of stakeholders within the supply chain	4	4	2	2	4	3	60%
compliance with business models of delivery organisations	5	5	2	2	4	3	84%
ensures resident engagement initiatives	4	2	2	2	2	4	80%
	Total						
	50	47	33	35	48	45	
	Ranking						
	1	3	6	5	2	4	



System	Collector types	Total Annual Electrical Output (kWh_e)	Total Annual Cooling Output (kWh_c)	Electrical demand coverage (not including refrigerator)	Cooling demand coverage	Electrical demand coverage
Solar collector + ORC + DAR using control strategy-1	Direct flow collector	122.8	94.3	3.3%	9.8%	4.6%
	Heat pipe collector	172.7	121	4.7%	12.6%	6.3%
	Evacuated flat collector	224.2	125.9	6.1%	13.1%	7.8%
Solar collector + ORC + DAR using control strategy-2	Direct flow collector	128.6	127.1	3.5%	13.3%	5.2%
	Heat pipe collector	198.3	140.4	5.4%	14.7%	7.3%
	Evacuated flat collector	269.7	146.2	7.3%	15.3%	9.3%
Solar collector + ORC + DAR using control strategy-3	Direct flow collector	202.5	9.1	5.5%	1%	5.6%
	Heat pipe collector	256.8	32.7	7%	3.4%	7.4%
	Evacuated flat collector	330.6	37.8	9%	3.9%	9.5%
Solar collector + ORC + Single effect absorption refrigerator	Direct flow collector	157.9	97.4	4.3%	20.3%	7.1%
	Heat pipe collector	207.4	116.8	5.6%	24.4%	9%
	Evacuated flat collector	277.2	139.3	7.5%	29.1%	11.4%
Solar collector + ORC + Double effect absorption refrigerator	Direct flow collector	162.3	98	4.4%	20.5%	7.4%
	Heat pipe collector	211.7	119.6	5.8%	25%	9.3%
	Evacuated flat collector	278.9	151.2	7.6%	31.6%	11.8%