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Urban Energy Systems

Sustainable Energy Futures Annual Conference | 16 Sep. 2016

Group 4

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Urban Energy Systems (UES)

- Global Population over ½ urban
- Cities responsible for ¾ of global energy
- Challenges of UES
  - Economics
  - Increasing demands
  - Managing complexity

Analysis of community energy schemes

Hayden Dahmm

Supervisors: Professor Nilay Shah, Professor Timothy Green, and Dr Salvador Acha

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Community Energy (CE)

- 5,000 UK communities participating or considering CE
- 2015 Energy Restart disruptive
- 90% of CE groups reconsidering
- Research questions
  - Alternatives for community participation?
  - Role for energy integration?
  - Use of Renewable Heat Incentives (RHI)?

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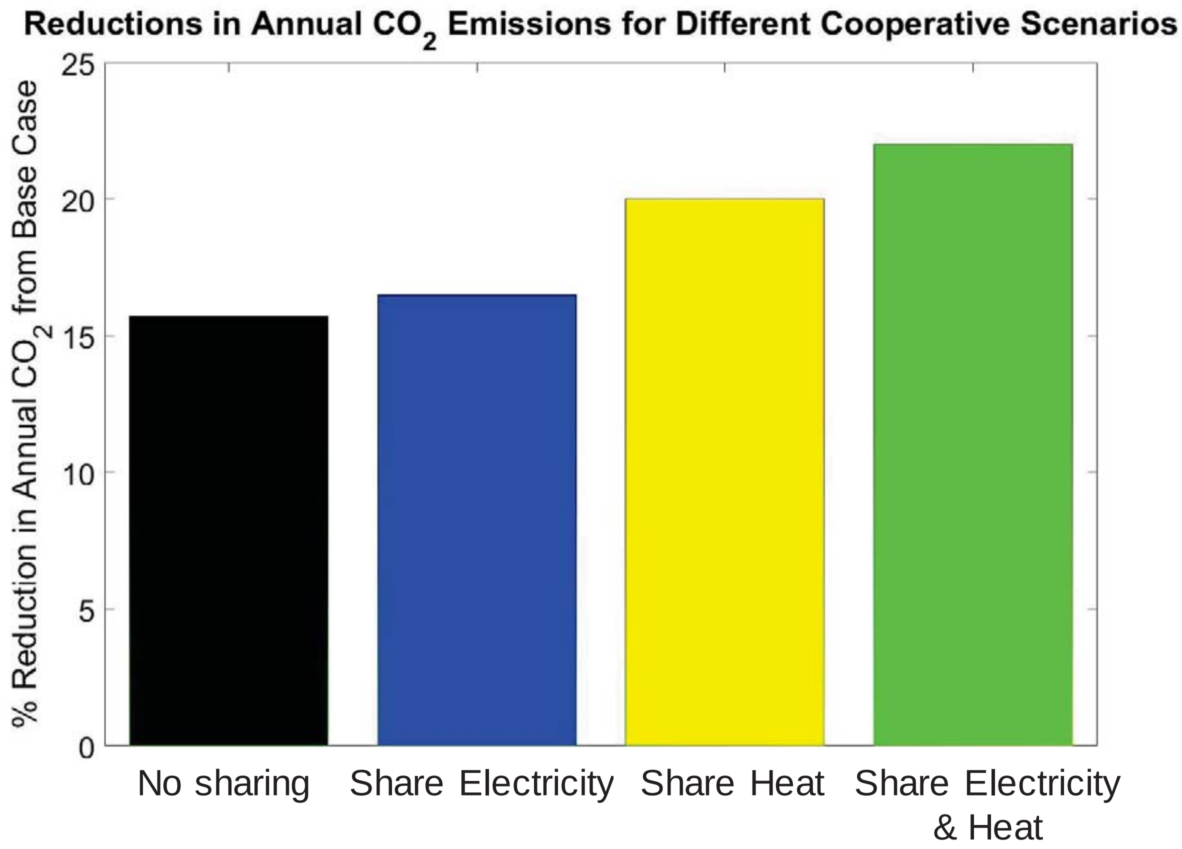
Methods

- Created generic community from London data
- Divided into sectors, time of day, and time of year
- Modeled economics for each sector
- Nash Bargaining from 'Game Theory'

Levels of cooperation

- No Sharing
- Share Electricity
- Share Heat
- Share Electricity and Heat
- Cooperation magnifies environmental benefits



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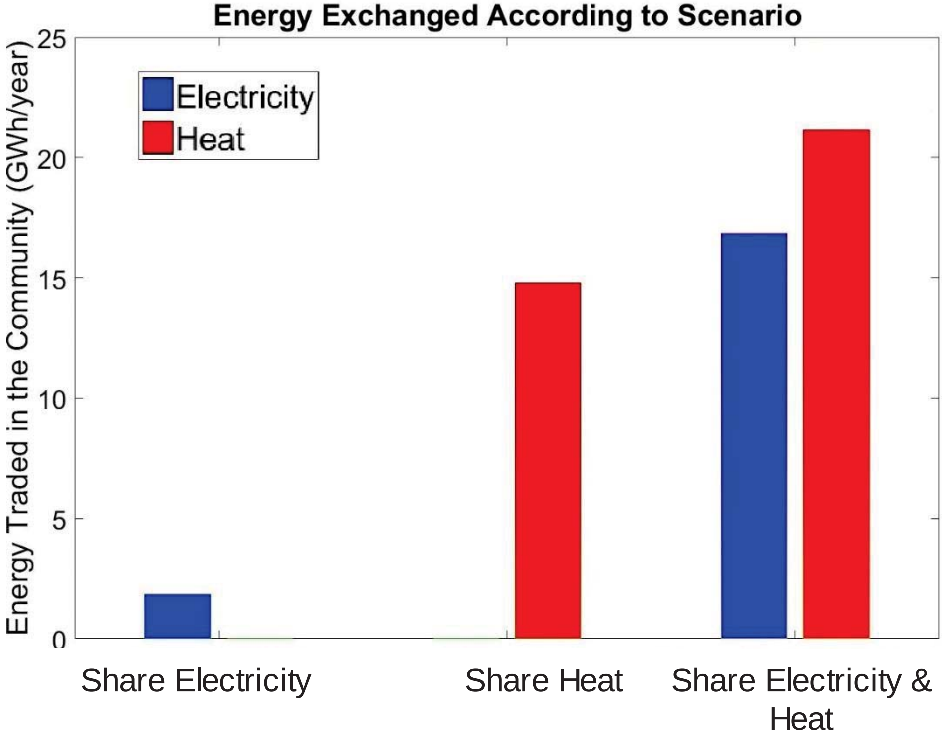
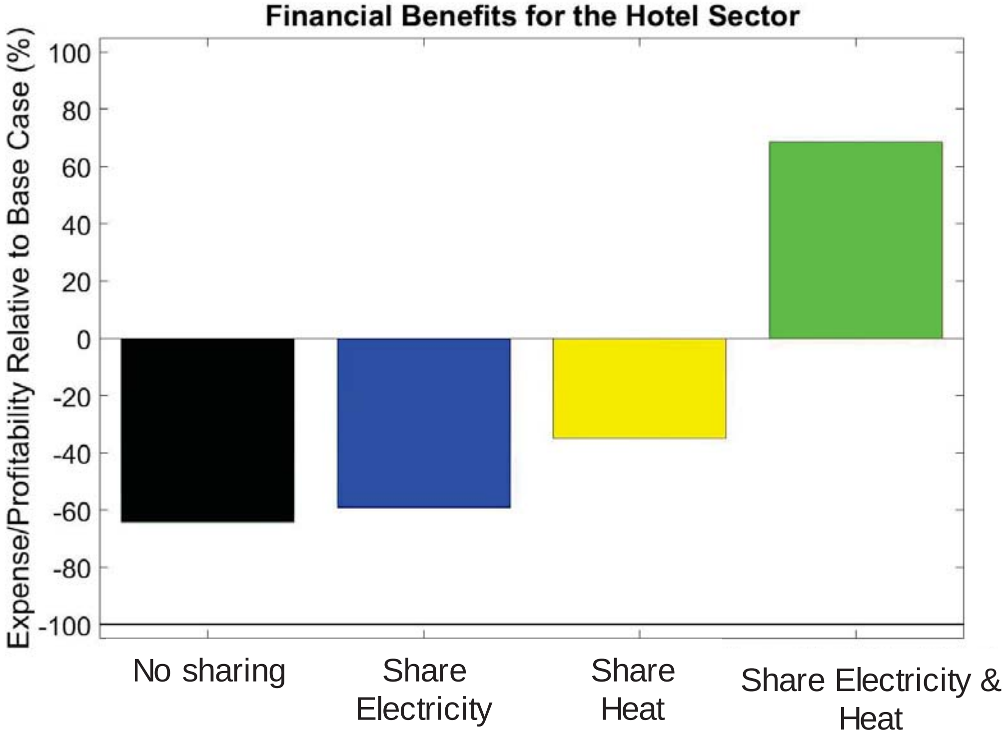
Scenario details

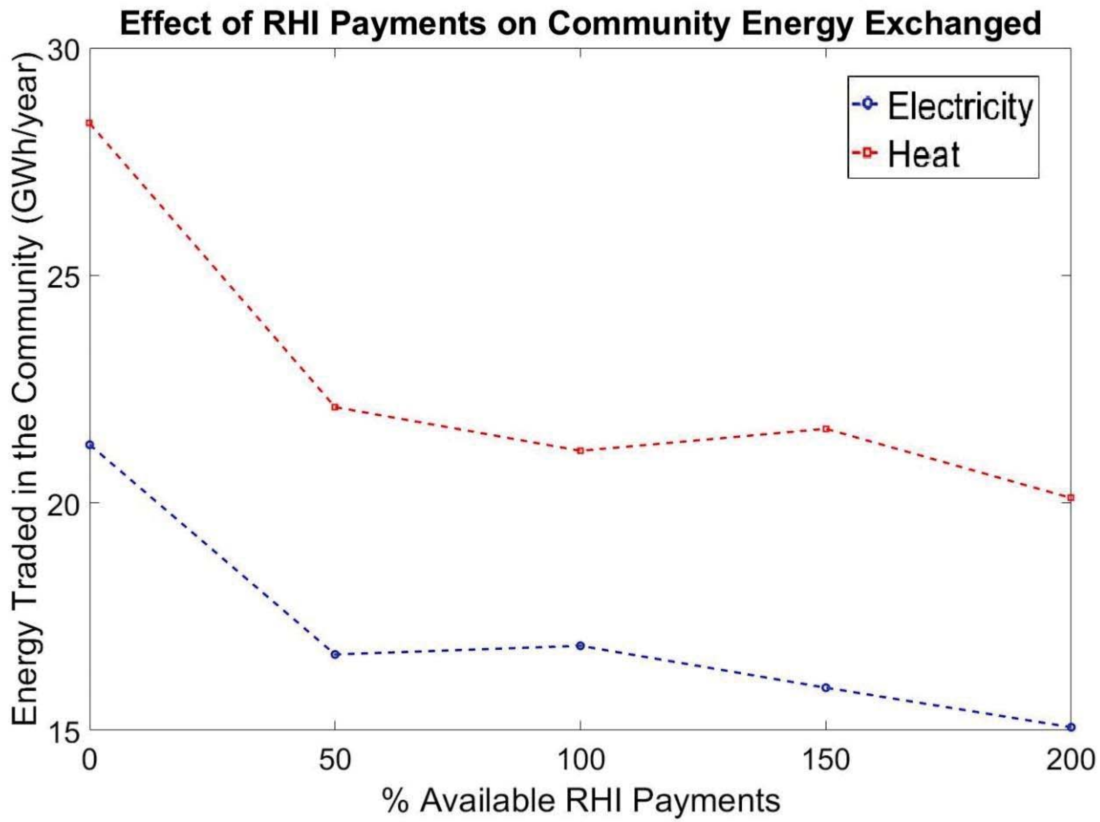
- Sharing both energy resources together captures greater value
- More of both energy vectors traded
- Some sectors profit





Effect of government payments

- Increasing payments discourages cooperation
- More options through independent action
- Cooperation makes communities resilient to policy changes



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Urban AC grid with embedded HVDC network for reliable, efficient and economic power distribution

Myrto Thoma

Supervisor: Professor Timothy Green

Motivation and Objective

Challenge

+

+

=

Distribution grid reinforcement → **How?**

Technologies

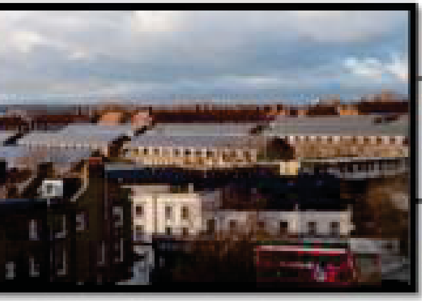
AC/DC

Project objective

Application of AC and DC on an urban grid and comparison in terms of **power losses**, **volume** of the equipment and **cost**

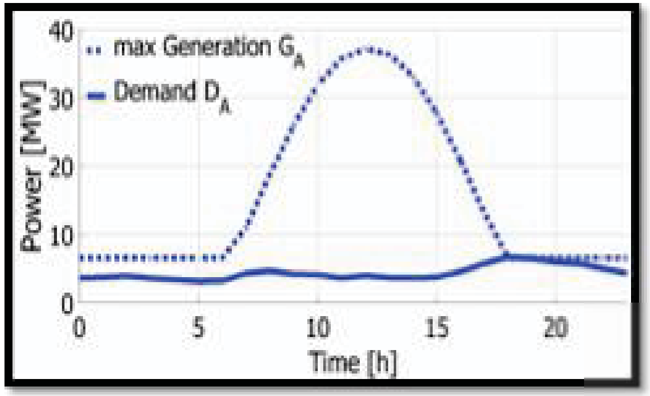
Case Study

Residential Area



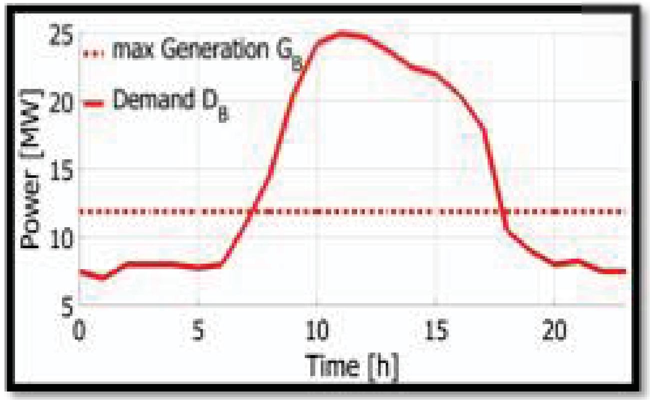
5% load growth

Solar PV on rooftops



Commercial Area

20% load growth



Demand and Generation mismatch

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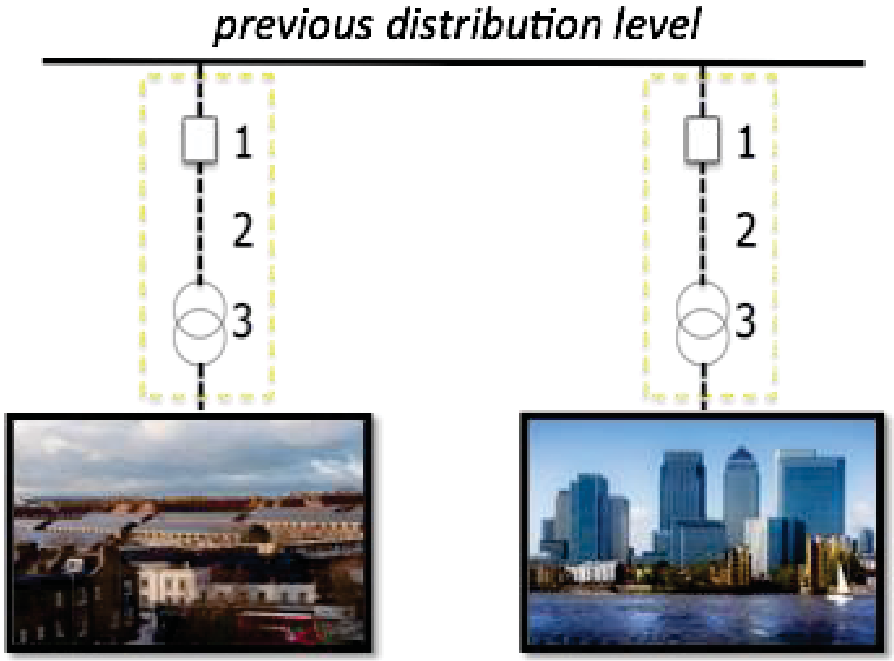
AC and DC Scenarios

Conventional AC Scenario



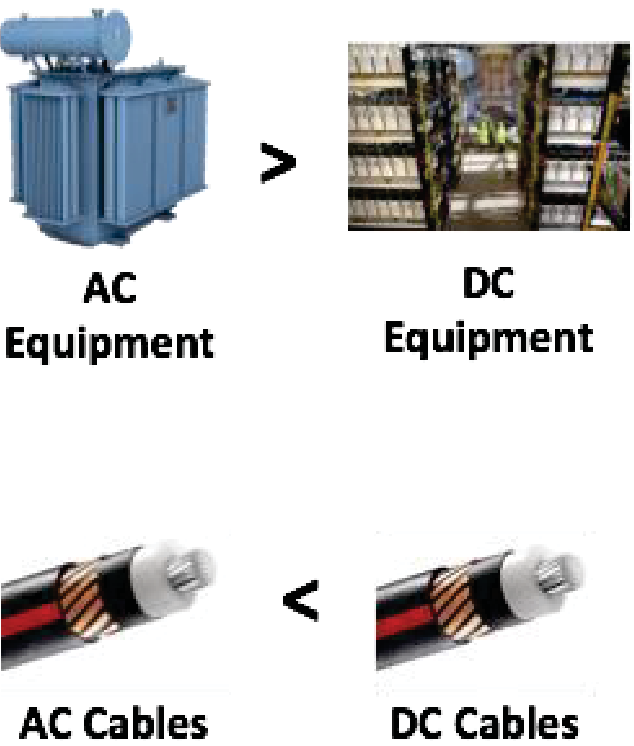
1: Switchgear equipment
2: AC feeder
3: Transformer

Smart DC Scenario

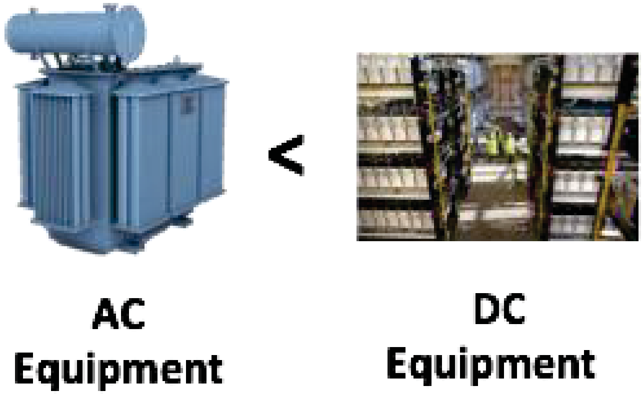
1: Switchgear equipment
2: DC Substation
3: DC link

Results

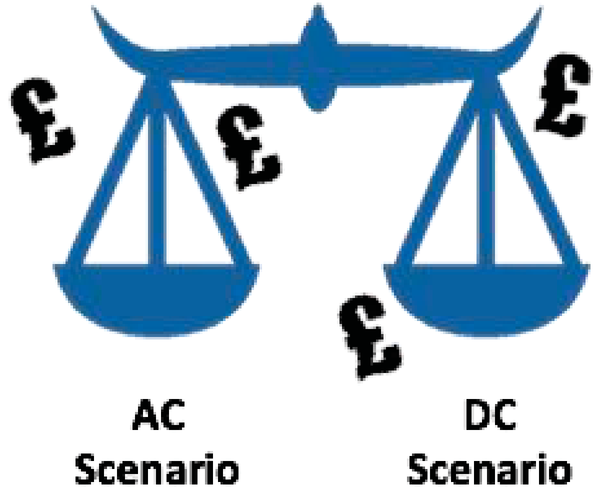
Losses



Volume



Cost



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Conclusions

DC systems are competitive to AC in terms of power losses, volume and cost.

However, the results of the scenarios examined here depend on the generation pattern and the assumptions made.

In real applications the feasibility of AC and DC systems depends on the availability and the cost of land, which vary significantly with the intended installation location.

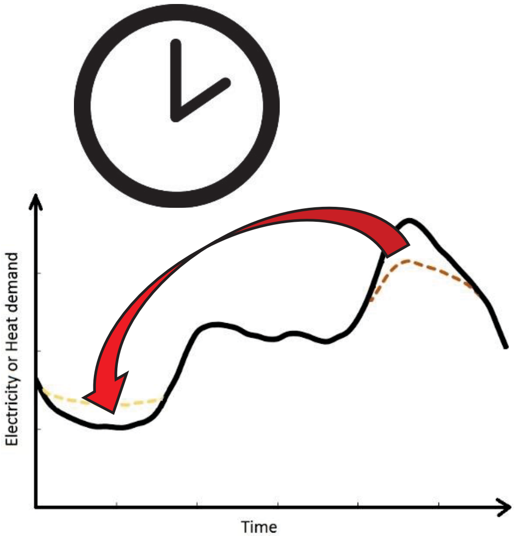
Demand Side Management & Distributed Generation: challenges for UES design and operation

Stephane Cremel

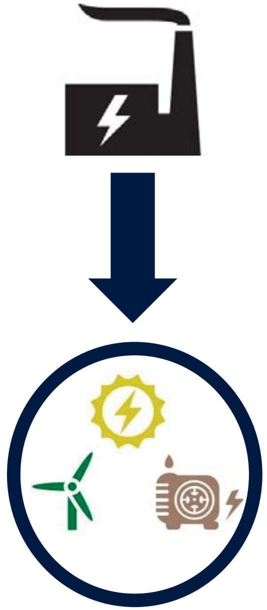
Supervisor: Dr Miao Guo

Two disruptive concepts

Demand Side Management (DSM)



Distributed Generation (DG)



URBAN ENERGY SYSTEMS

Specific opportunities from:

- High energy densities
- High interactions between energy services

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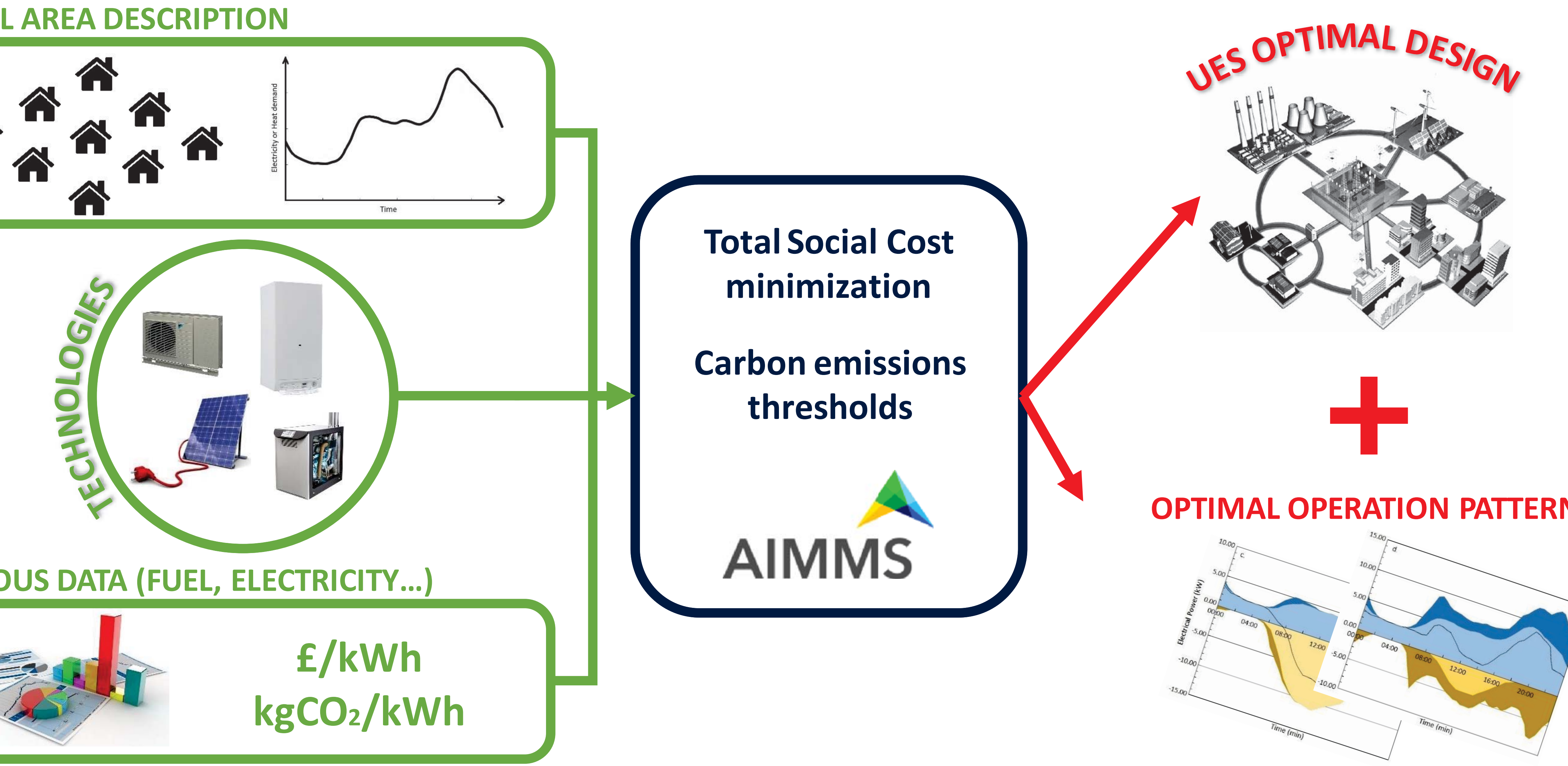
Approach developed & model descriptior



Case study, results & conclusions

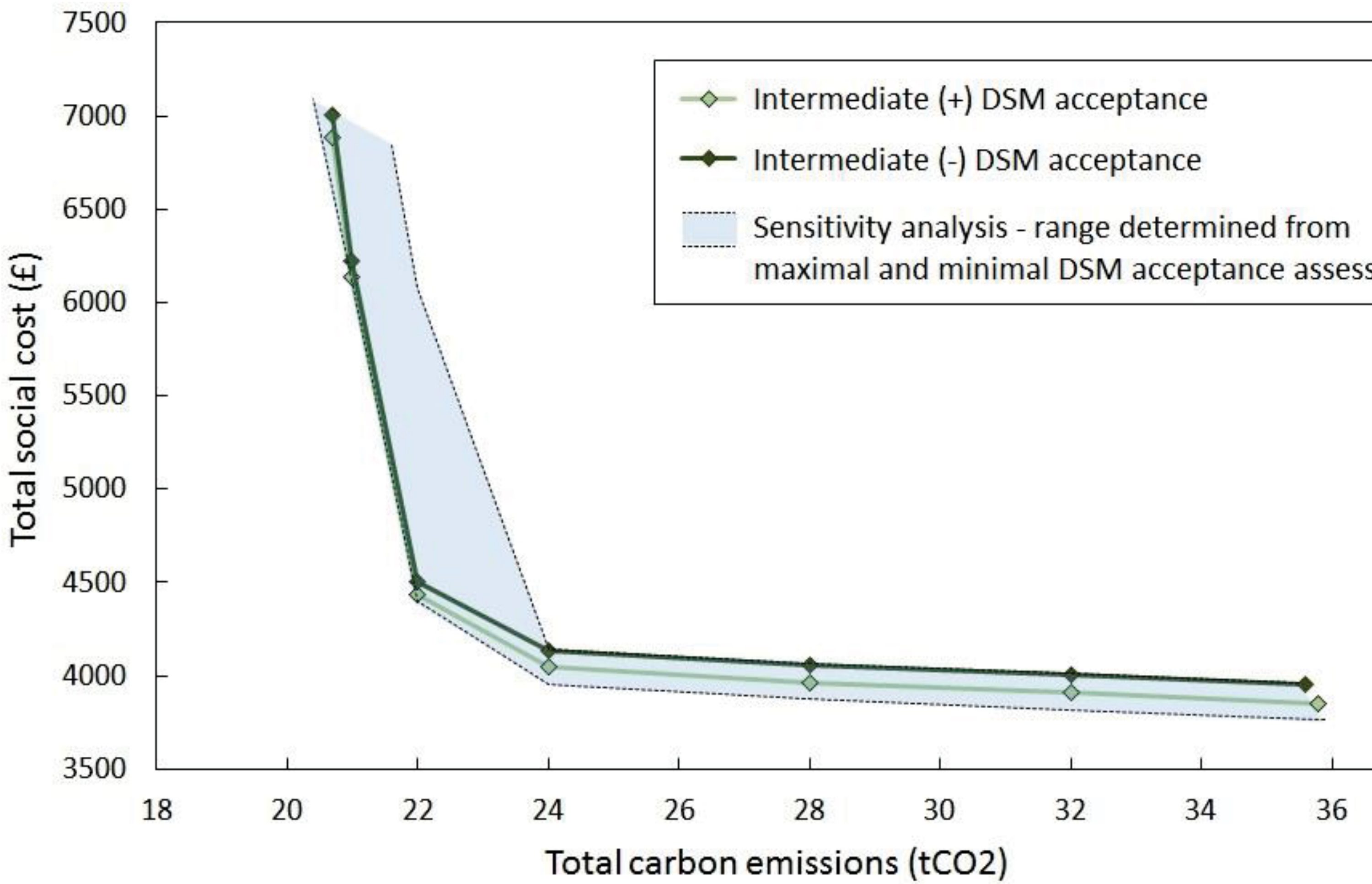
STUDY

- ctive local area of 10 households
- K energy context
- mited range of technologies

CLUSIONS

- nited impact of DSM, major role DG
- rforming tool for local districts
- plore other promising concepts g. electrical energy storage)

Series of Simulations: test DSM impact with varying agents' characte



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Simulation and Characterisation of Charging Infrastructure for Electric Taxis in London

Wei Xin

Supervisor: Dr Salvador Acha, Dr Koen H. van Dam, Mr Gonzalo Bustos-Turu

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Why we want electric taxis?

Challenges of electric vehicle uptakes

Drivers

- Nowhere to charge

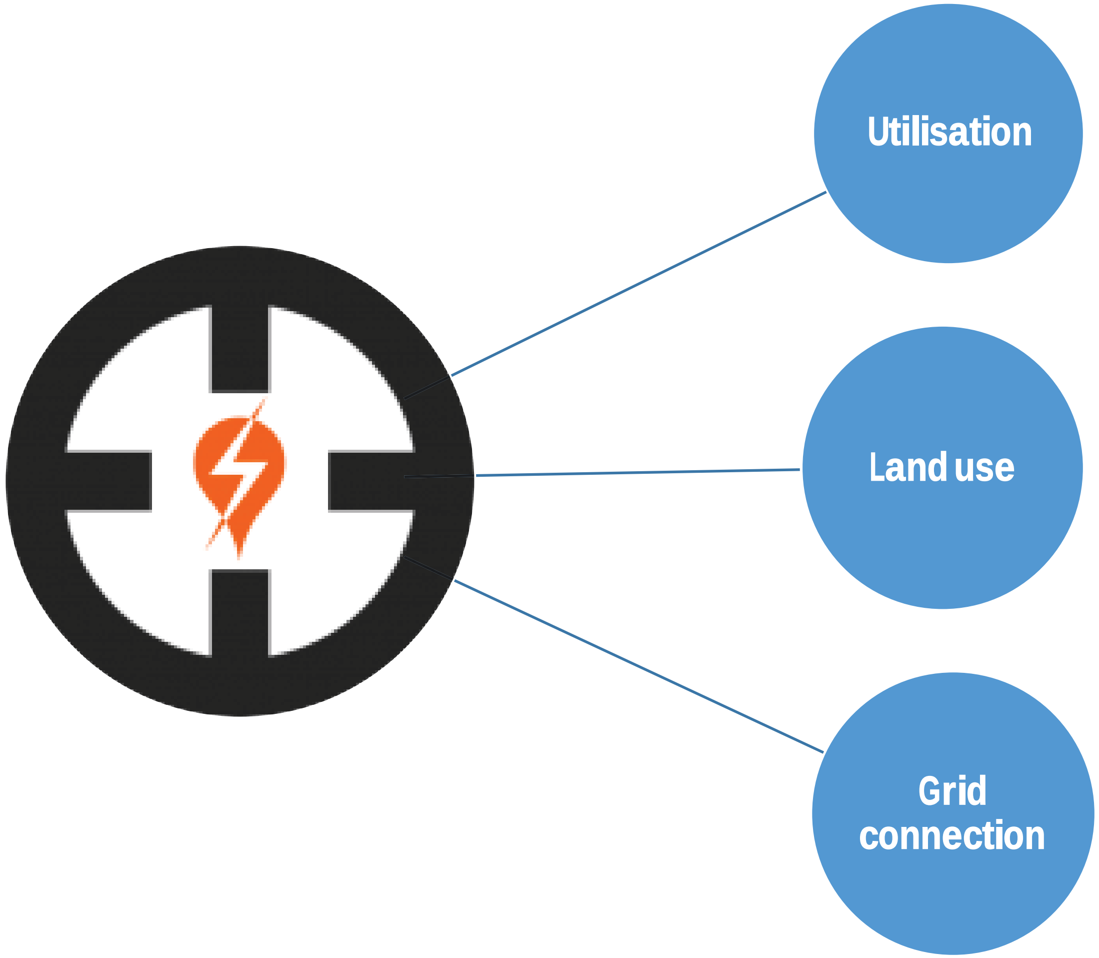
Investors and Operators of Charging Infrastructure

- Limited number of users

Electric taxis with rapid charging network could be the solution

- Have stable travelling demand
- Relatively simple management needed
- Grow public's confidence in this new technology

Charge Point Locating

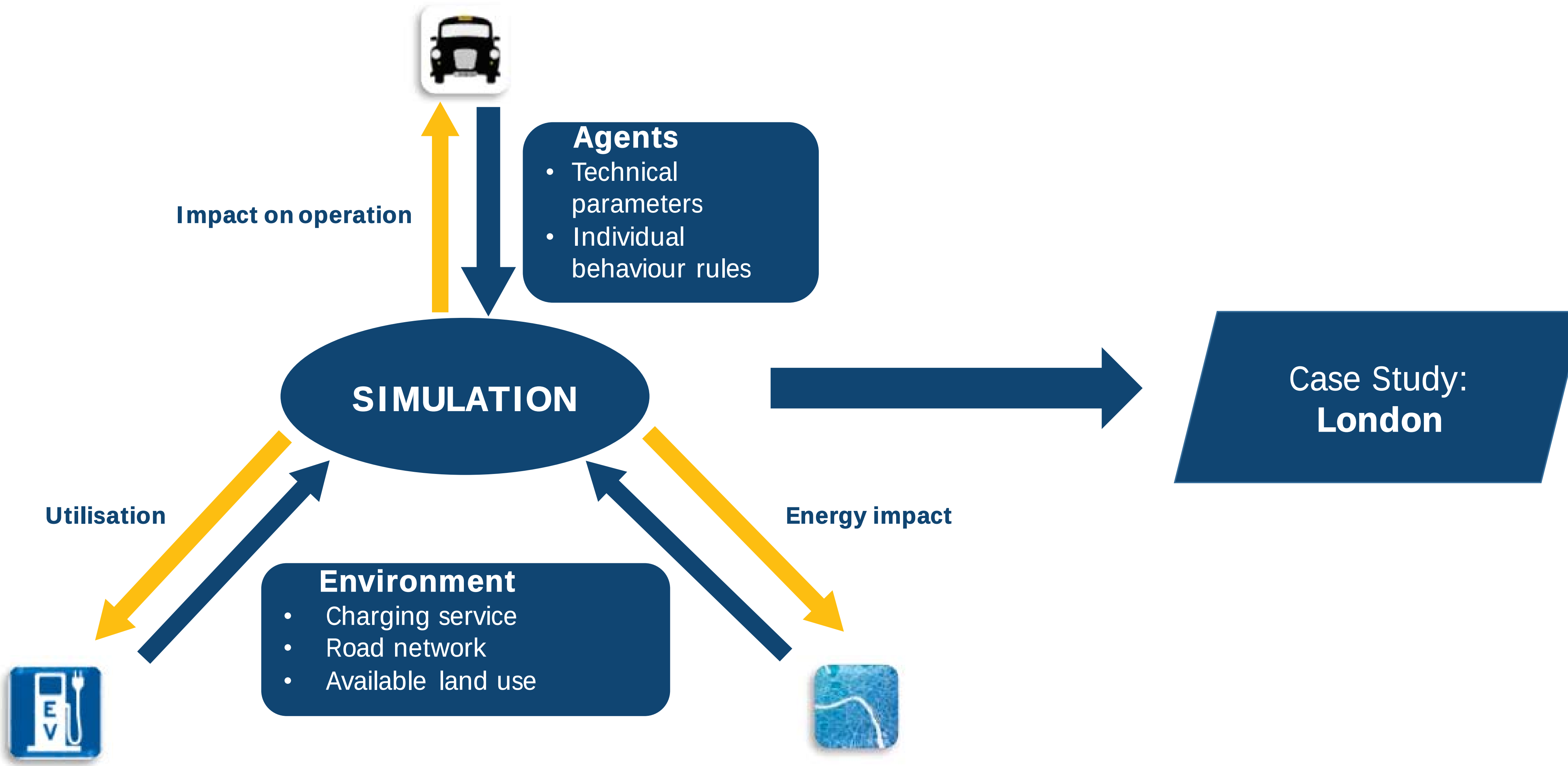


- **Profitability**
- **Availability**

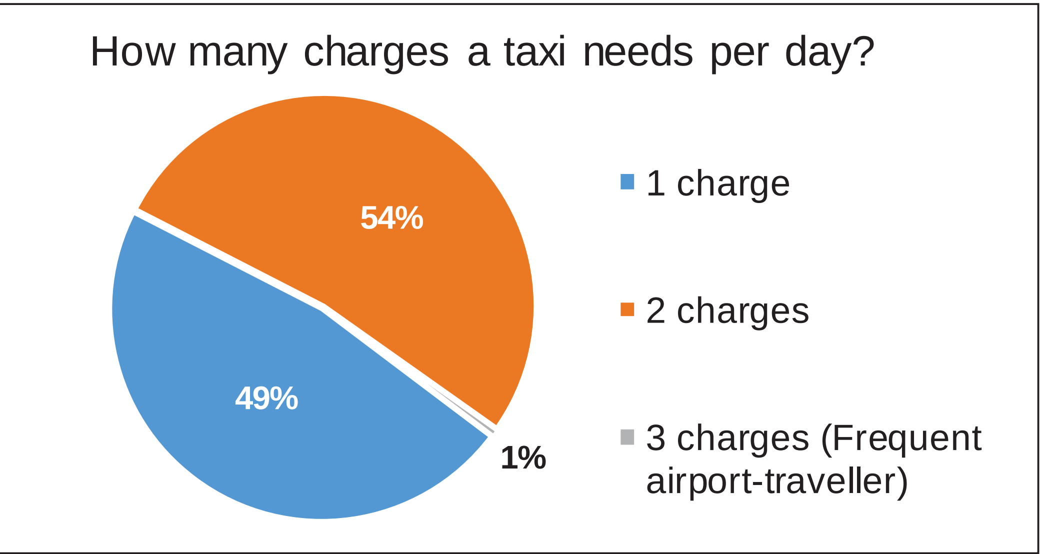
Enough space
Cost

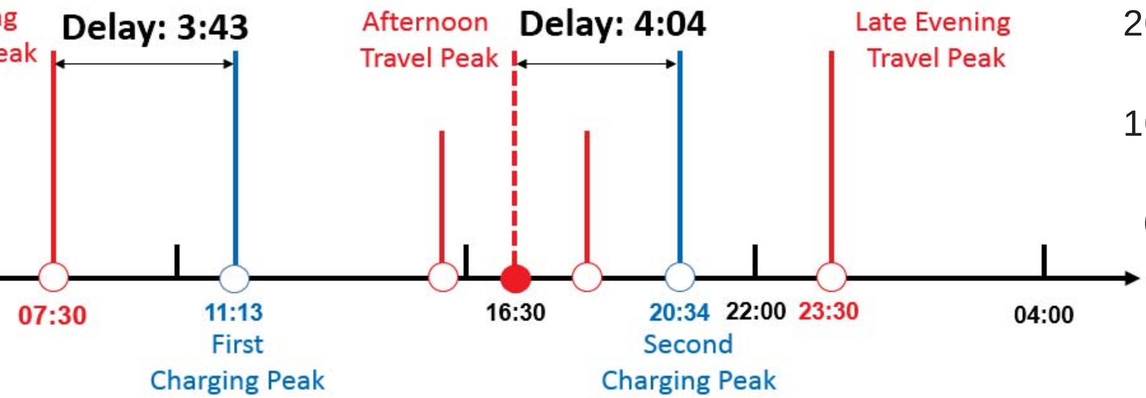
- **Viability**
- **Impact on local network**

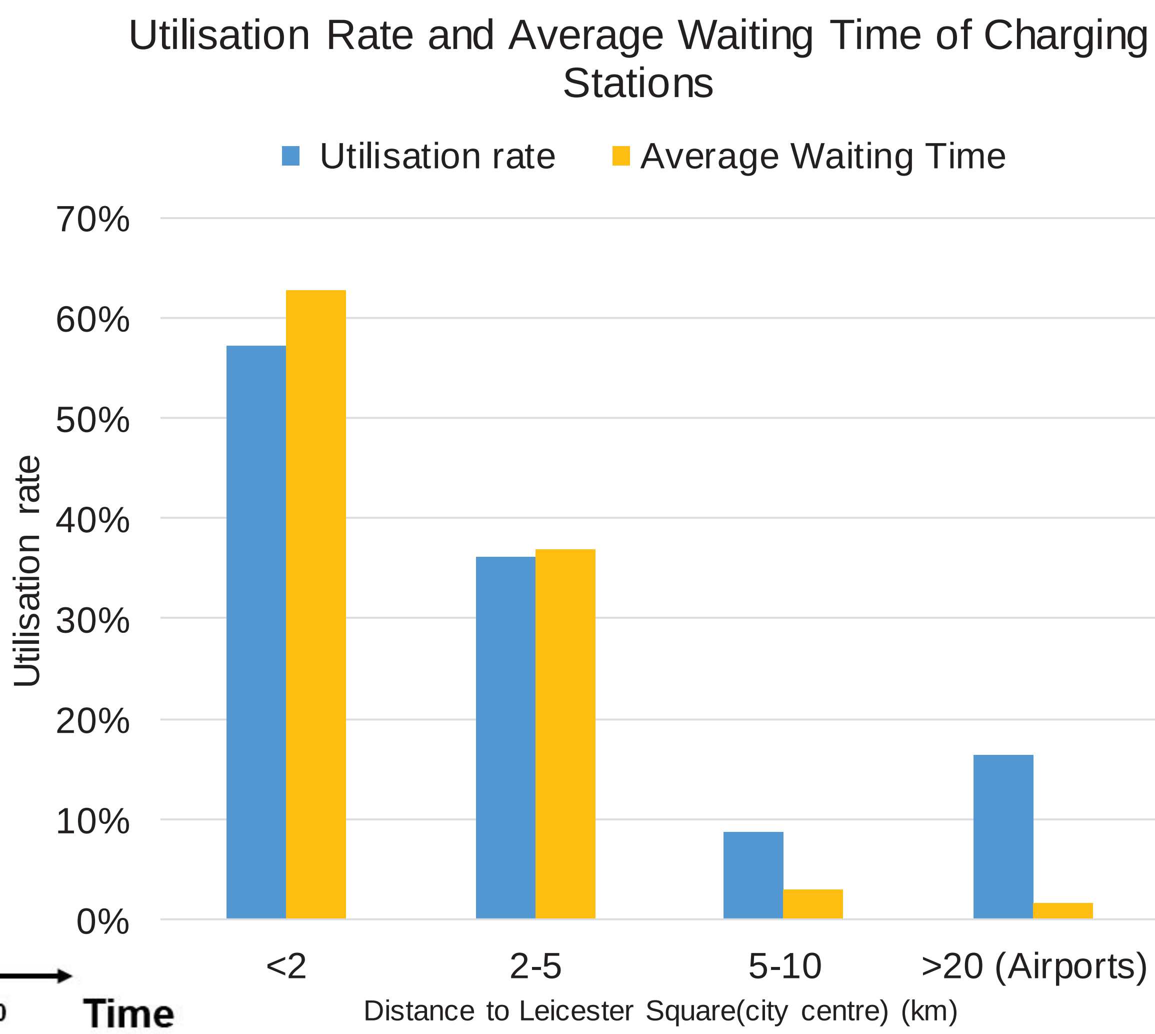
A Brief Modelling Framework



Results and Discussions







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Conclusions

- Charging network in the case study: can uptake more taxis
- Imbalanced utilisation rate
- Unexpected energy demand and congestion in central area
- More detailed behaviour rules and behaviour-adaption can be integrated in the model
- Optimisations of strategic planning on the charging network expansions would be insightfu

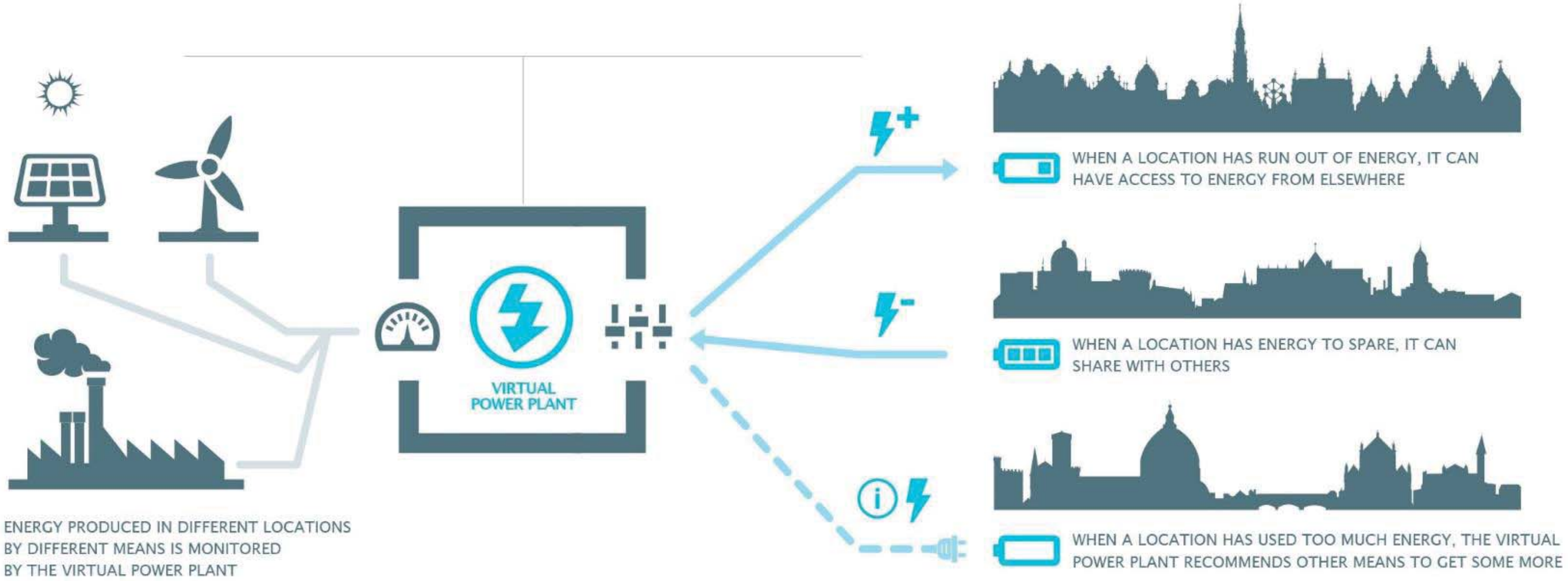
Commercial Framework and Risk Management of VPP

Orkhan Karimzada

Supervisor: Dr Danny Pudjianto

Virtual Power Pant (VPP)

A virtual power plant is a way of linking up small and distributed power stations into a single operational network that is controlled to form one integrated central place.



Uncertainties

Demand

- Load Profile

Price

- Market Price
- System Sell Price
- System Buy Price

Production

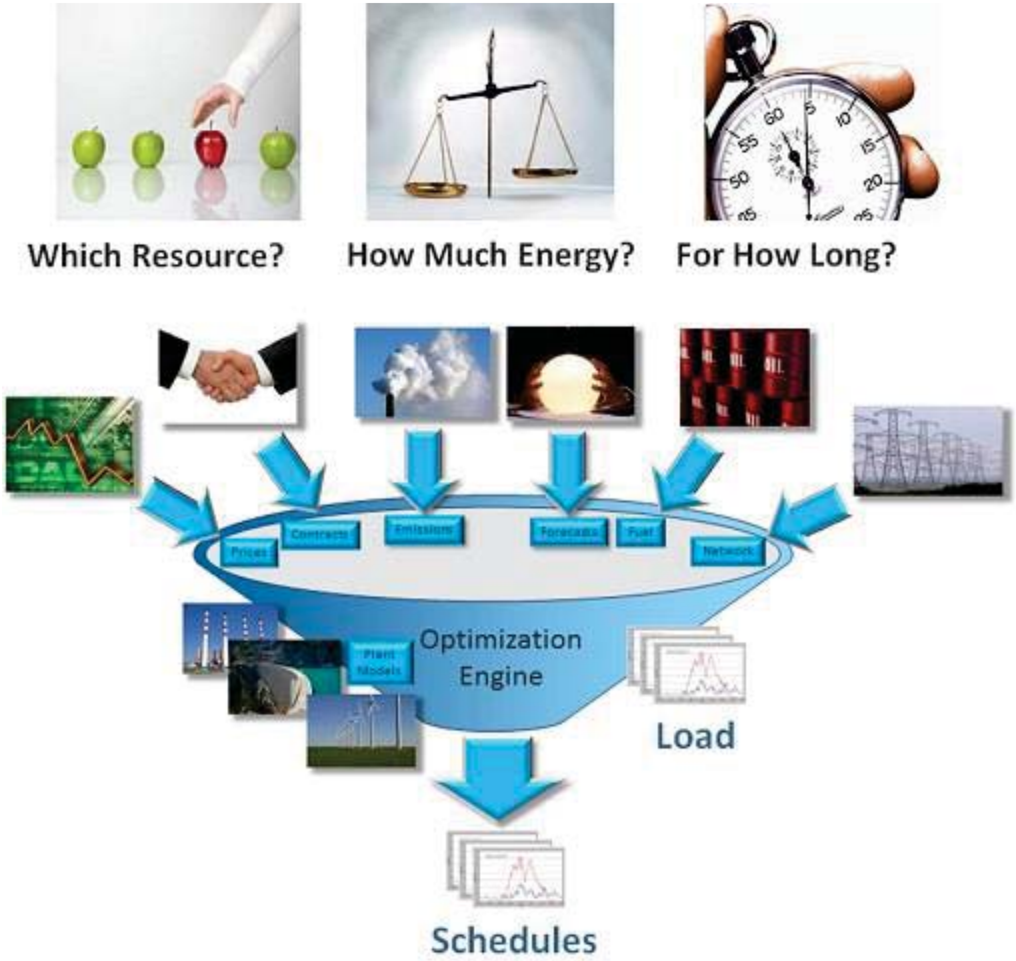
- Wind Generation Level Availability
- Conventional Generation Probability

Methodology

Case Studies:

- Conventional generation
- Renewable generation
- Aggregated generation

Several optimization methods were investigated to deals with the problems of making optimal decisions under uncertainty and solve of profit maximization problems



Result & Conclusion

- The proposed optimization strategy of VPP operation planning model is intended to help the VPP owner maximize its profit in a daily time-frame, and it is more capable of handling the situations with high forecast uncertainties in both supply and demand sides
- Combining the portfolio of conventional and intermittent generation in the VPP portfolio increases the expected profit of system.
- Investigating of energy storage technologies is beneficial in terms of maximization of profit and choosing the best strategy to optimize VPP portfolio.

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Urban renewables and energy resilience

Veronica Uribe

Supervisors: Dr Miao Guo, Dr Koen Van Dam, and Mr Gonzalo Bustos-Turu

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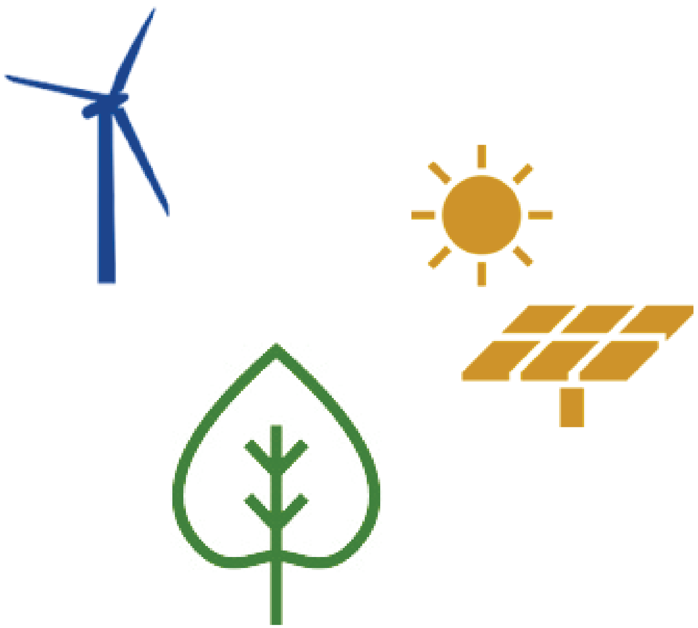
Energy resilience is important for countrie

Distributed energy and resilience

Distributed energy provides **diversity** in **energy sources** and **locations**

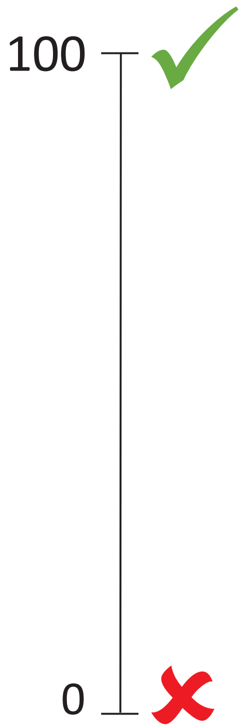


Could be, but…

- How significant is the contribution?
- Is it sustainable?

Method

Simplified Supply Demand Index (SSDI) to evaluate resilience



- Low energy intensities
- Electricity capacity exceeding the peak load
- Diversity in primary energy sources
- No imports

Life Cycle Approach for sustainability

Case study: Colombian energy resilience

The challenge

Colombian SSDI will decrease

Distributed generation strategy

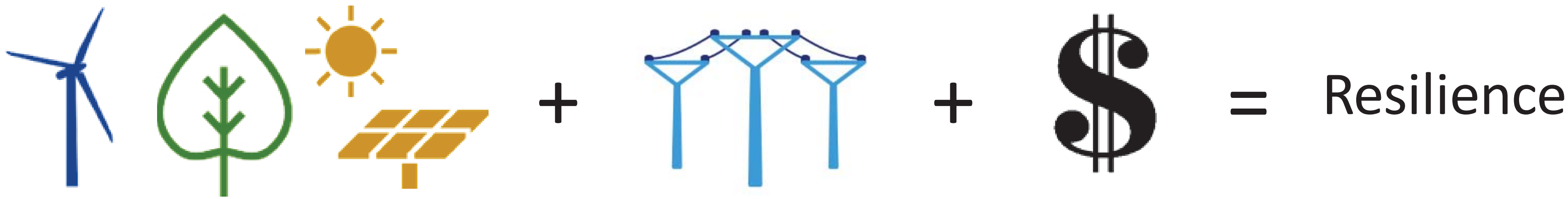
Solar PV in the main cities

Results

- Solar increased resilience by 2%
- Solar + lower energy intensities increased resilience by 7%
- Sustainability impacts increased by adding solar
- If solar displaces a portionº of coal the impacts are reduced

Conclusions

- The method was effective to evaluate resilience and sustainability.
- The impact of urban renewables on resilience depends on techno-economic feasibility.
- Grid and commercial strategies are fundamental for success.



We want to thank our supervisors

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Dr Salvador Acha (Department of Chemical Engineering)

Dr Danny Pudjianto (Department of Electrical and Electronic Engineering)

Your questions are welcome

Poster # 29

Poster #31

Poster #28

Poster #33

Poster #30

Poster #32

Thank you!