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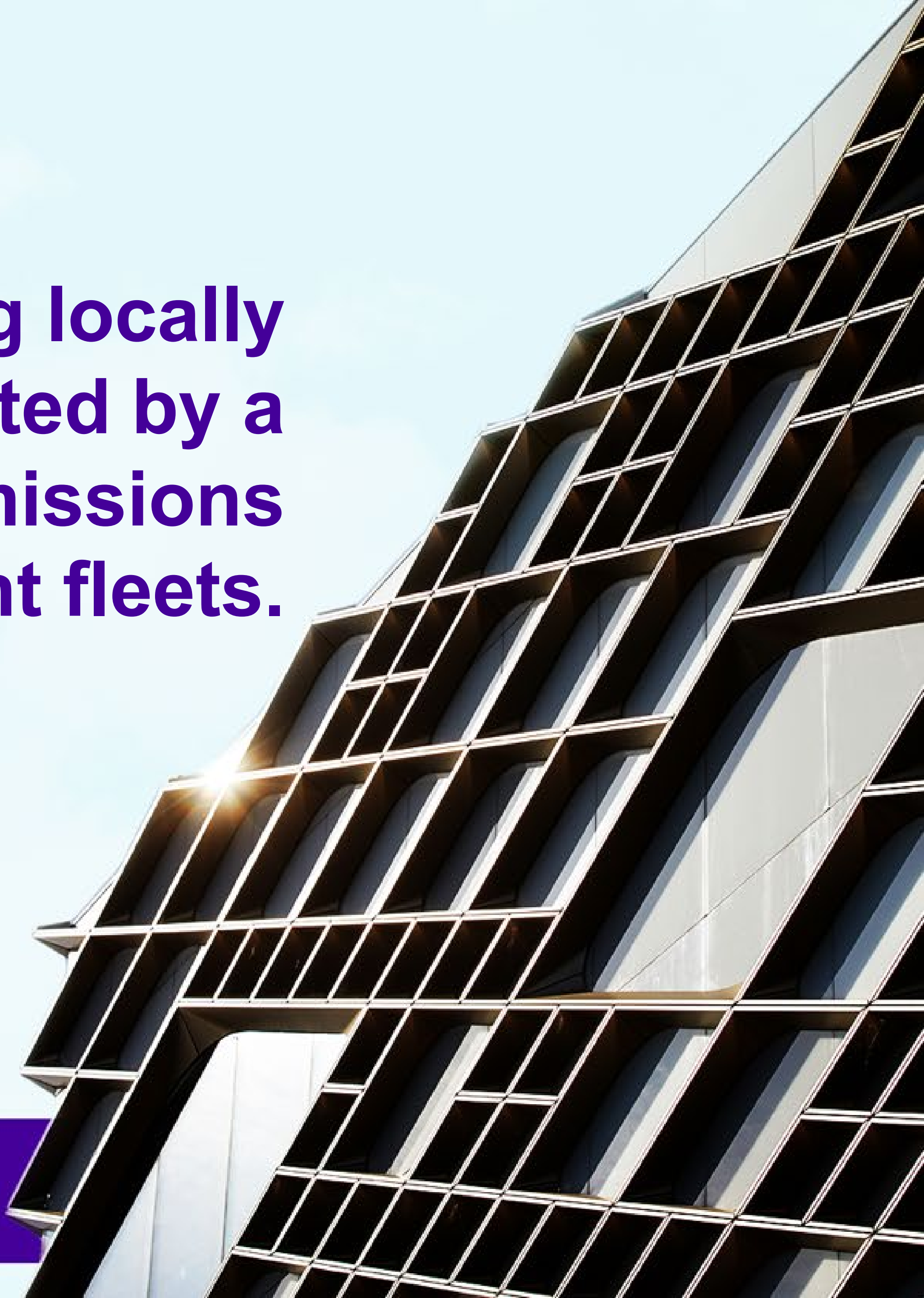
# Exploring the benefits of using locally generated solar energy, supported by a BESS, in reducing Well-to-Tank emissions associated with electric road freight fleets.


Maria Nunez Munoz,
Dr Erica E. F. Ballantyne and
Professor David A. Stone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# Overview

- Electrification of Refuse Collection Vehicles (RCV) fleets
- Case study: local authority waste management depot
- Results
- Conclusions

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# HGVs – Transport statistics

The appropriate **management** of **222 million tonnes** of waste generation in the UK **relies** heavily **on HGVs**.

**13%**

*DfT, "Data on energy and environment from transport. 2022.

Of the total **NOx emissions** from road transport in the UK

**19%**

*DfT, "Data on energy and environment from transport. 2022.

Of the total **GHG emissions** from road transport in the UK

**6%**

*DfT, "Transport and environment statistics 2022"

Of total **vehicle miles** in the UK

# What makes the electrification of RCVs a potential solution?


26-tonne electric Refuse Collection Vehicle (eRCV) from Veolia at the City of Westminster

1. Well-structured and planned daily routes.
2. Operating during off-peak hours.
3. High potential for charging with localised solar energy.

# Study aim

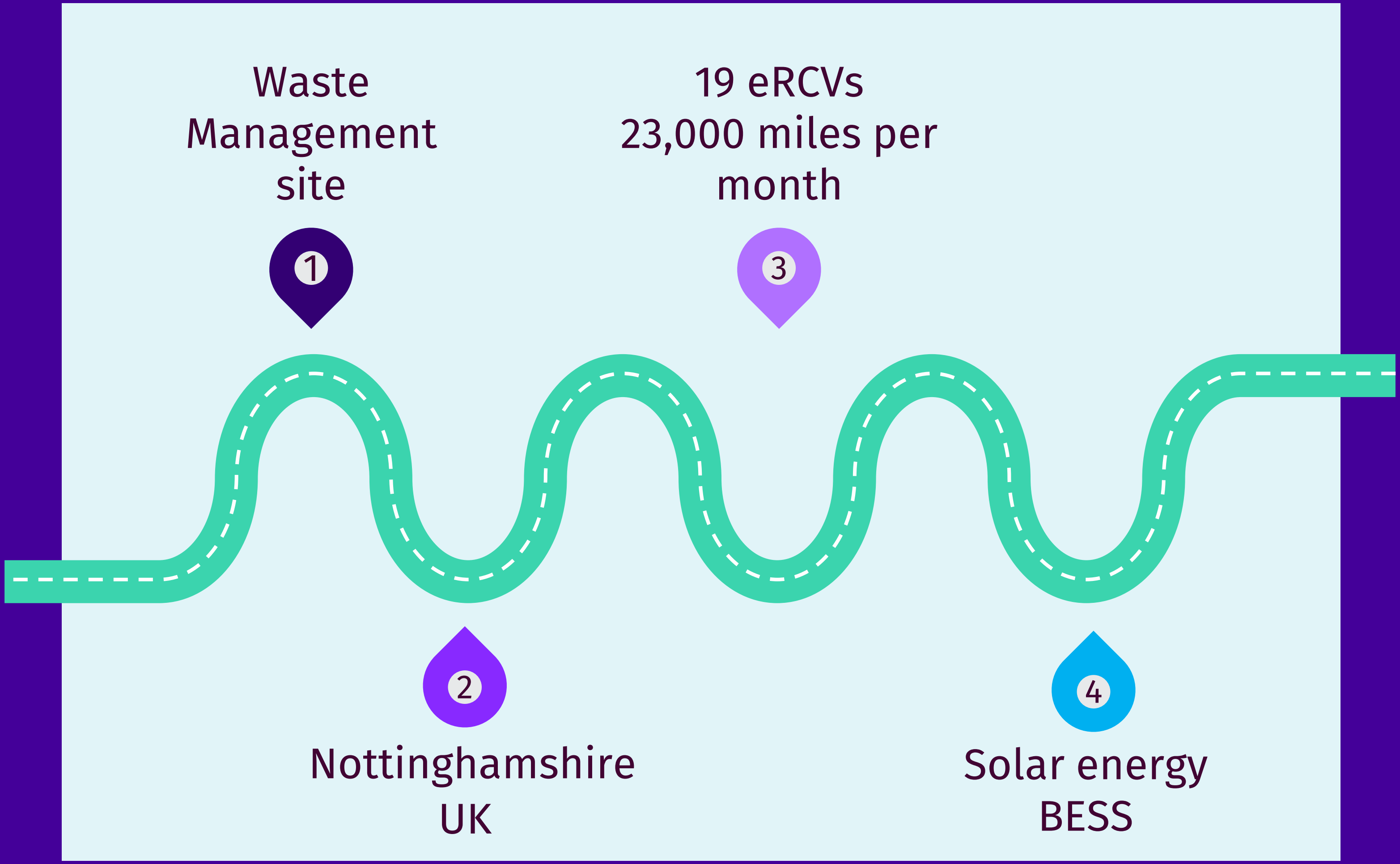
Assess the impact that different charging patterns have on grid dependency, total cost, and GHG emissions when an eRCV fleet is charged, considering the power connection capacity constraint:

1) From the grid

2) Using solar energy and energy storage

# Case study

## Local Authority Waste Management Depot



# Scenarios under study

- ❑ Electrified RCV fleet charged from the grid.

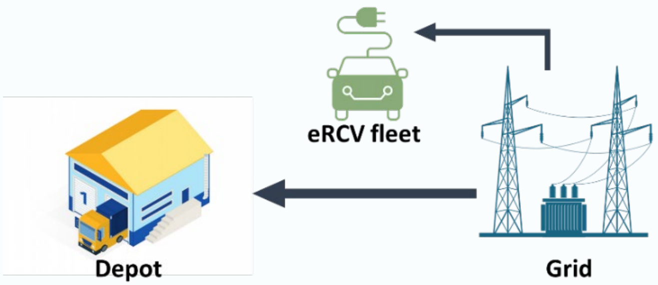



Figure 1. Flow chart of **scenario 1 (BCS)**

- ❑ Electrified RCV fleet charged from the grid and PV solar installation with the help of a BESS.

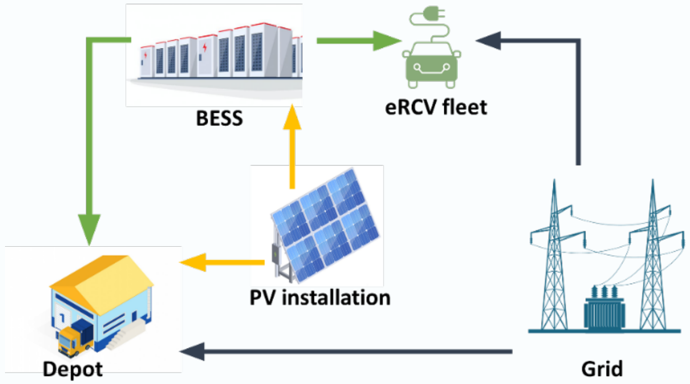



Figure 2. Flow chart of **scenario 2** (upgrade of the power capacity connection)

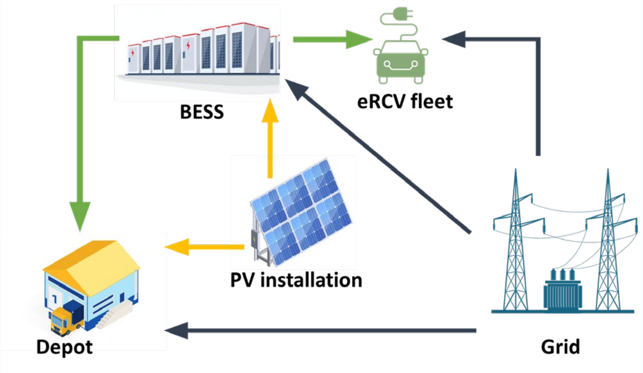



Figure 3. Flow chart of **scenario 3** (without upgrade of the power capacity connection)

| | Scenario 1 | Scenario 2 | Scenario 3 |
|---|---|---|---|
| Power connection capacity (0.15 MW) | | | ✓ |
| Power connection capacity (0.6 MW) | | ✓ | |

# Charging patterns and operational times

| Charging pattern | Number of eRCV | Operational times | Charging starts at |
|---|---|---|---|
| Day | 19 | 06:00h to 14:00h | **16:00h (up to 8.5 hours)** |
| Night | 19 | 06:00h to 14:00h | **21:00h (up to 8.5 hours)** |
| Mixed | 10 | 06:00h to 10:00h<br>18:00h to 22:00h | **11:00h (up to 6 hours)** |
| | 9 | 06:00h to 14:00h | **23:00h (up to 6 hours)** |

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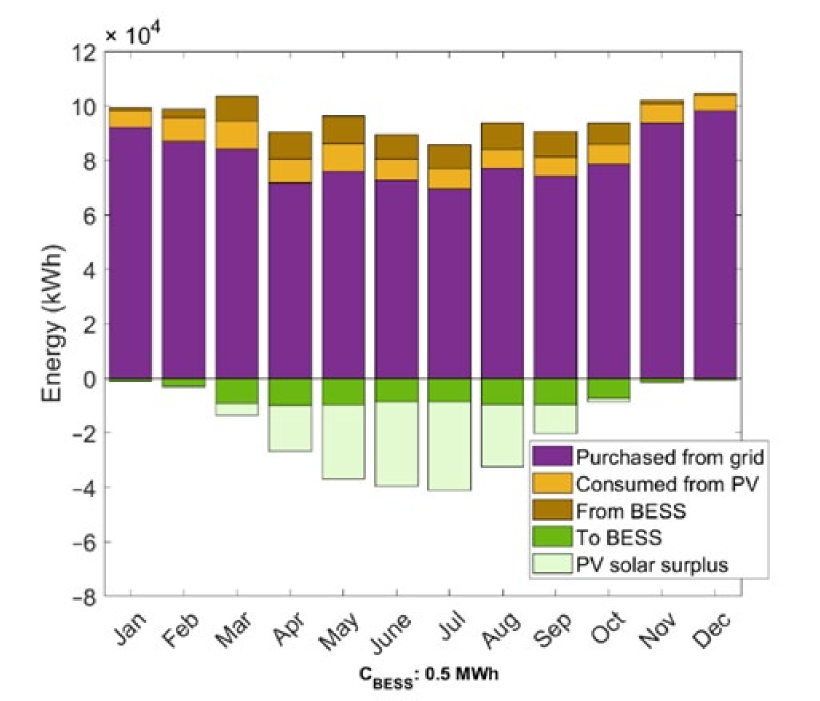
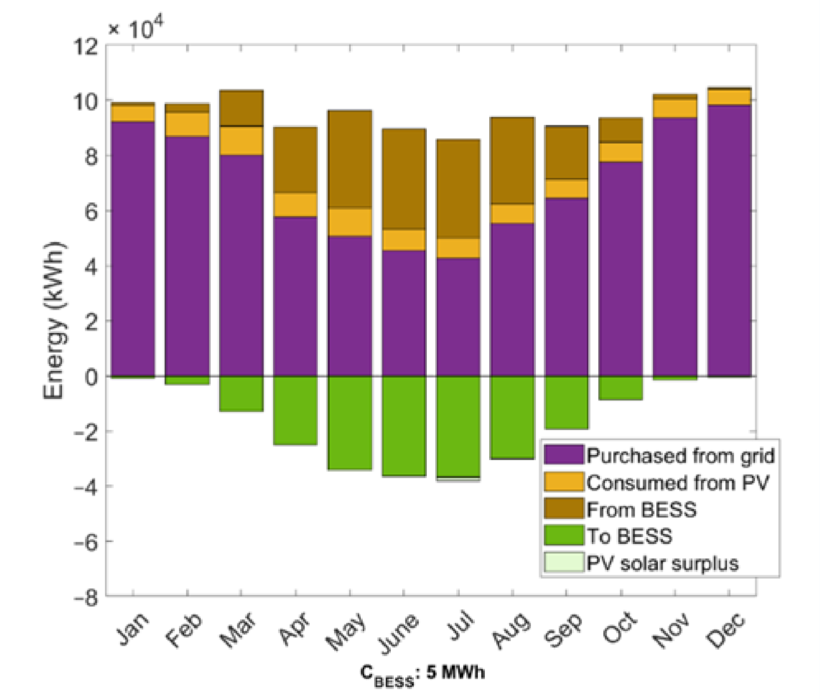
# Energy management algorithm

The capacity of the BESS directly influences the extent to which the depot relies on the grid, thereby impacting energy and network expenses.




(a)




(b)

Figure 4. Monthly energy simulation results using a BESS with a capacity of: (a) 0.5 MWh and (b) 5MWh. The positives values on each graph represent the energy consumption from the grid, from solar, either directly or via the BESS. The negative values indicate solar energy generation and energy storage in the BESS"

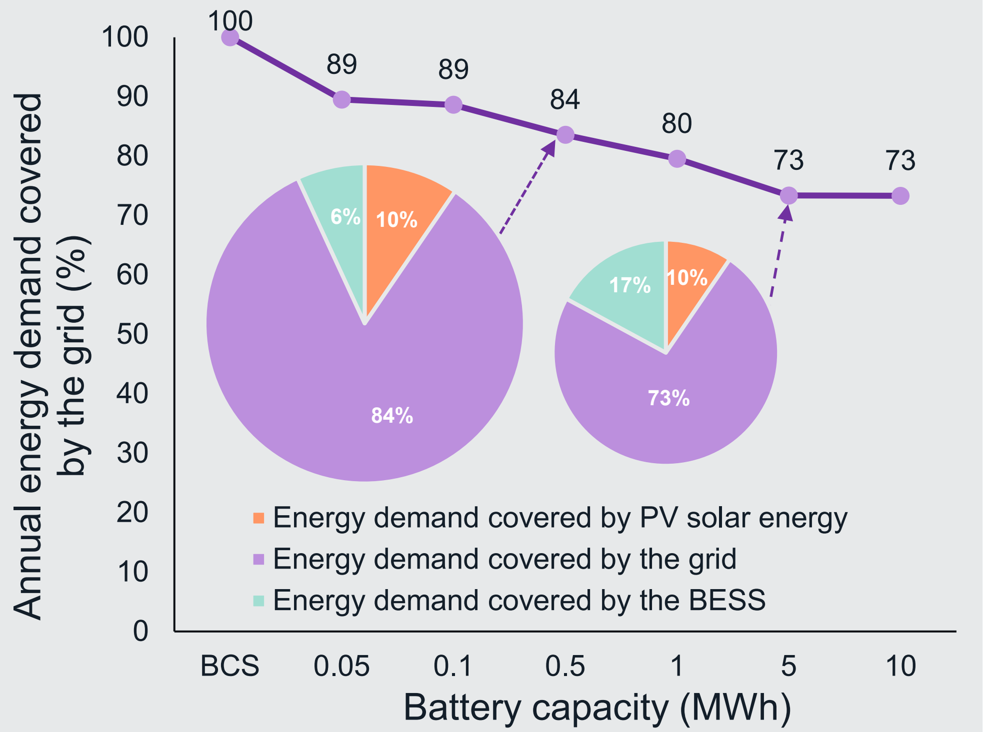


Nunez Munoz M, Ballantyne EEF, Stone DA. Assessing the Economic Impact of Introducing Localised PV Solar Energy Generation and Energy Storage for Fleet Electrification. Energies 2023;16:3570. https://doi.org/10.3390/en16083570.

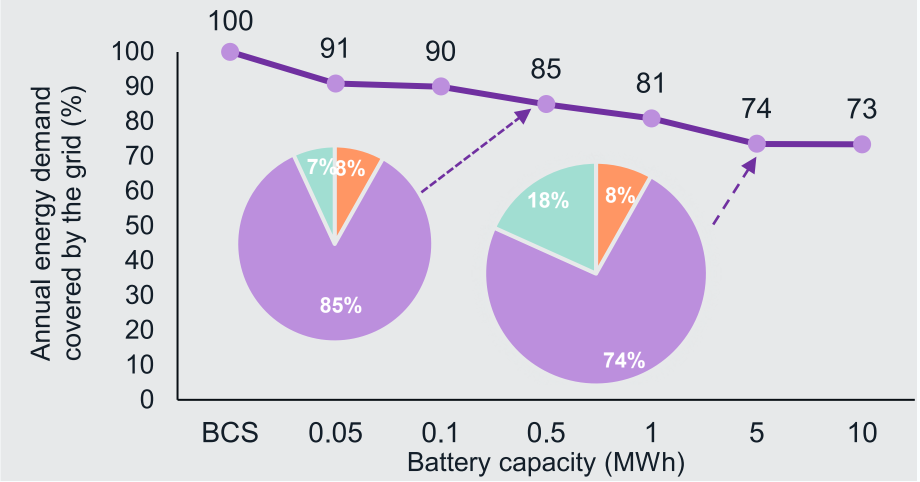
# Results – Grid dependency

The grid dependency is most reduced for smaller BESS capacities when the eRCV fleet is split and charged at 11:00h and 23:00h (mixed charging pattern).

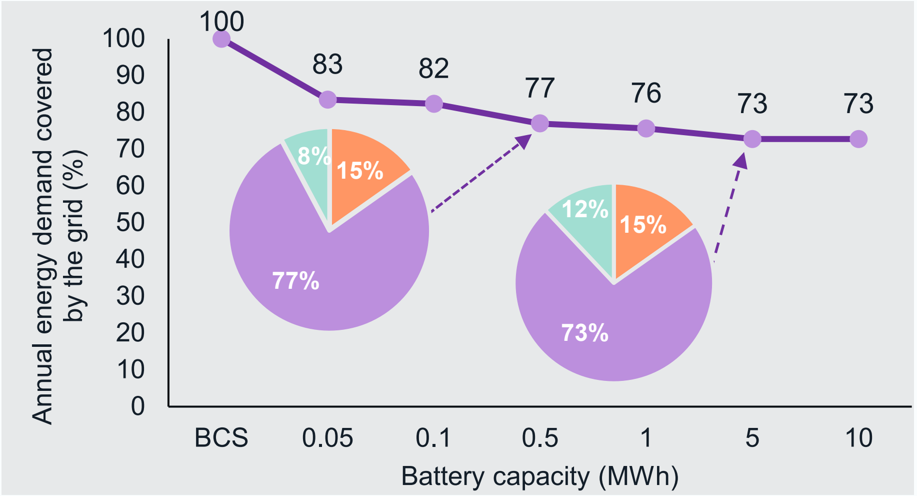
Day charging pattern




Night charging pattern



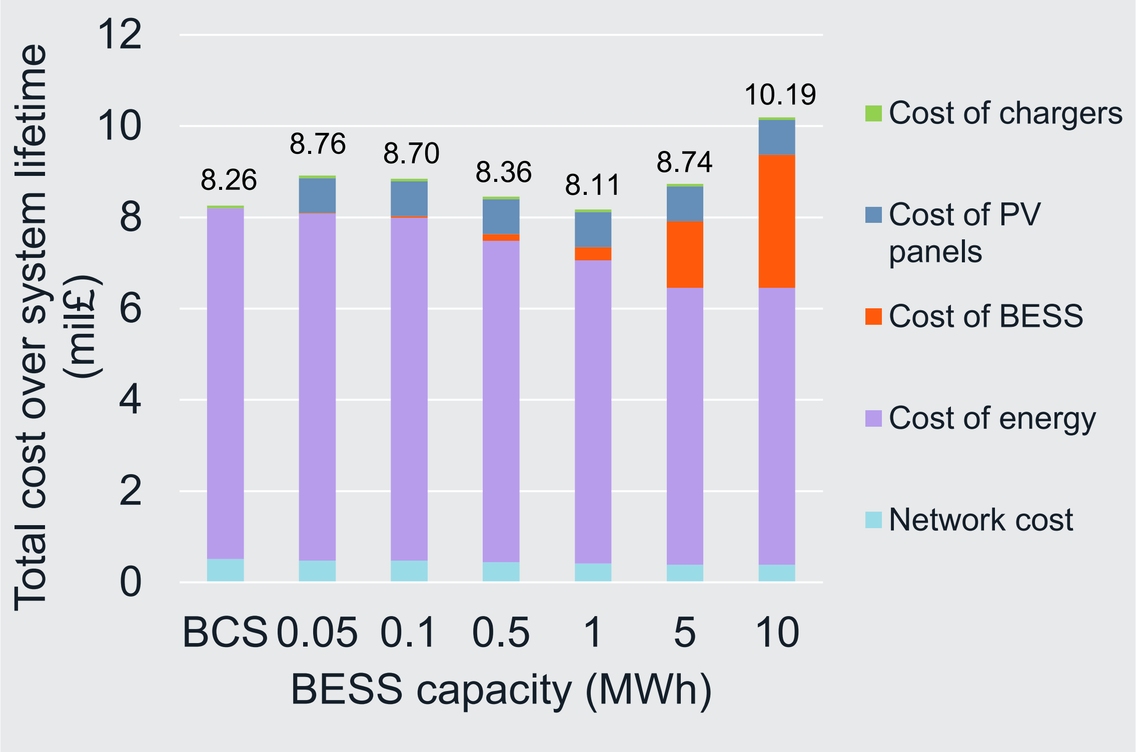

Mixed charging pattern



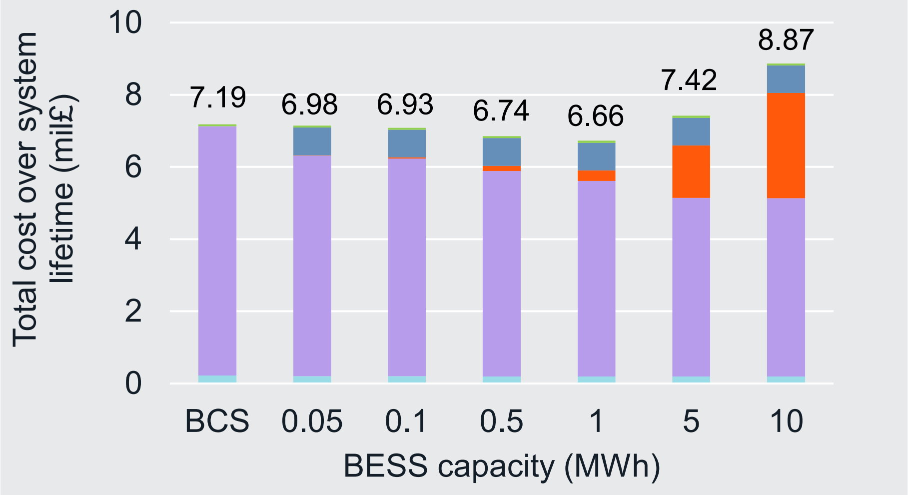
# Results – Total cost

The maximum cost reduction is achieved with a BESS of 0.5MWh when the eRCV fleet is split and charged at 11:00h and 23:00h. This provides savings of approximately £1M.

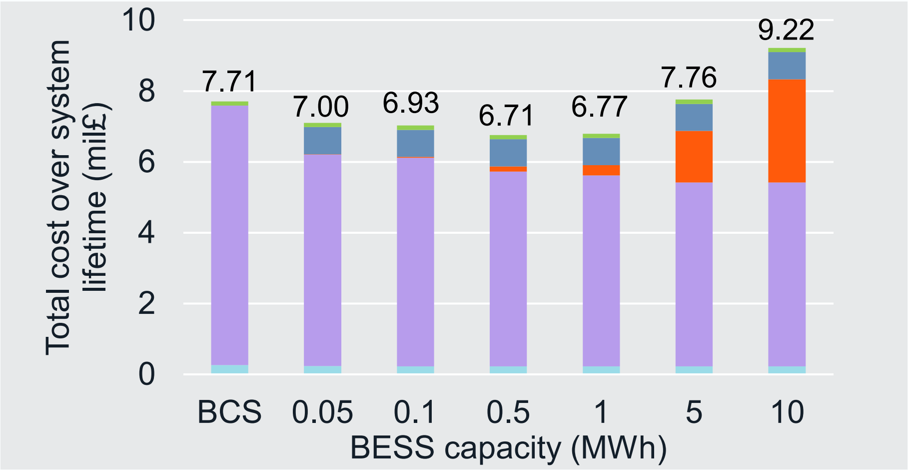
Day charging pattern




Night charging pattern




Mixed charging pattern

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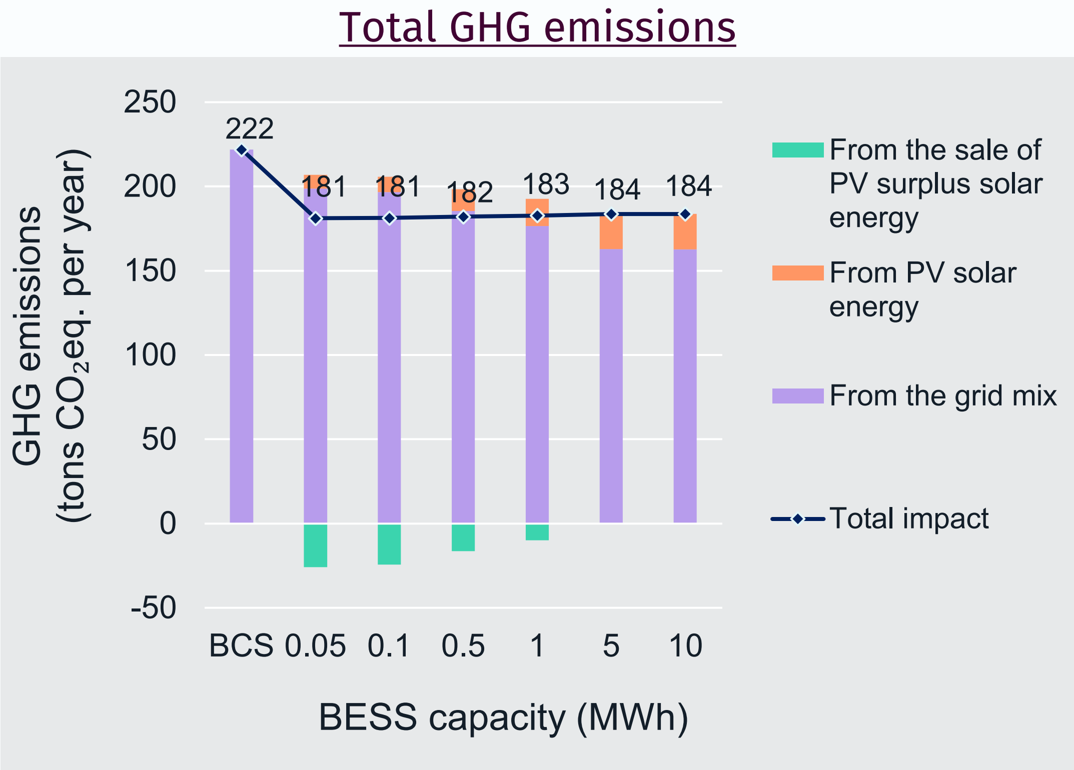
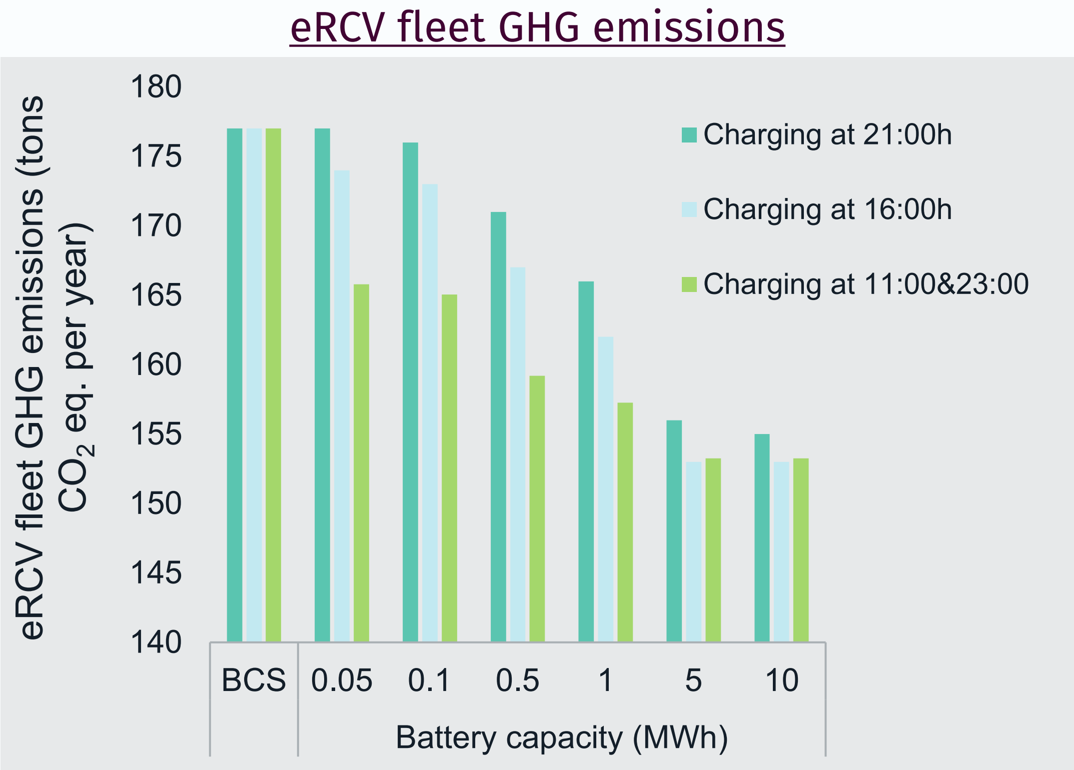
# Results – GHG emissions

The GHG emissions from the whole system are very similar as the overall energy consumed is the same but distributed differently over time.

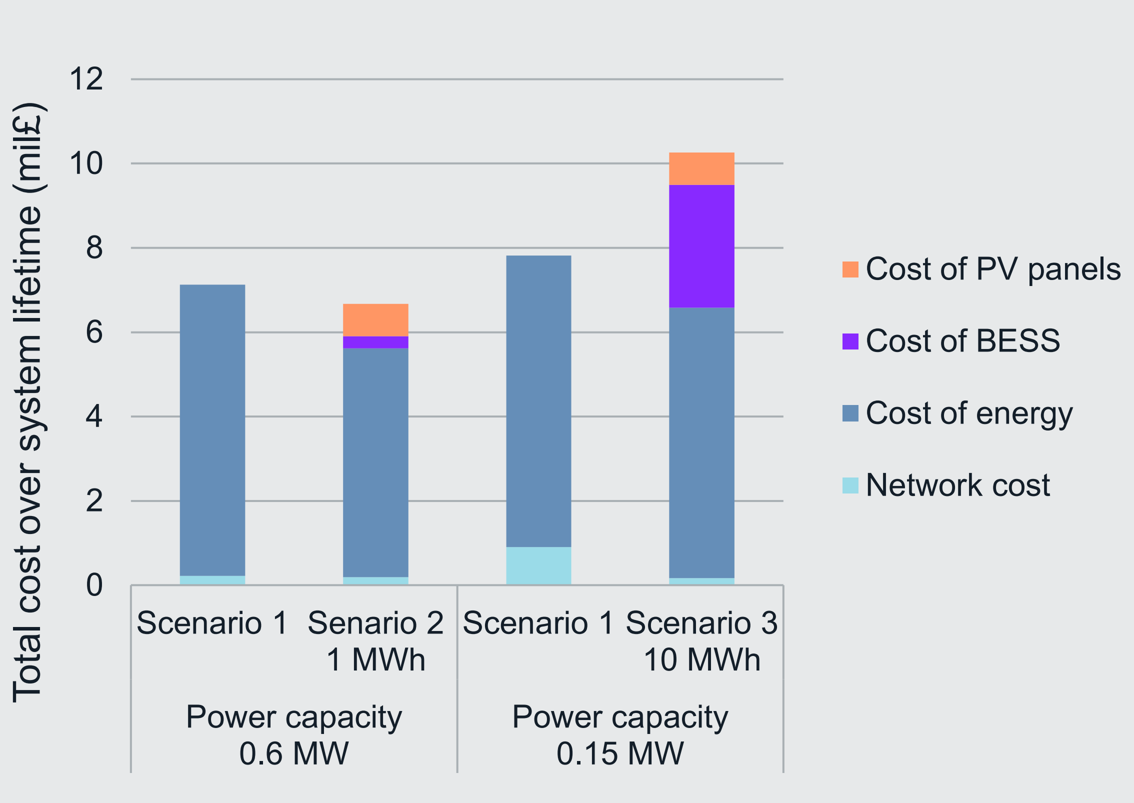
The different charging patterns impact the eRCV fleet GHG emissions when PV solar energy and BESS are installed on-site.

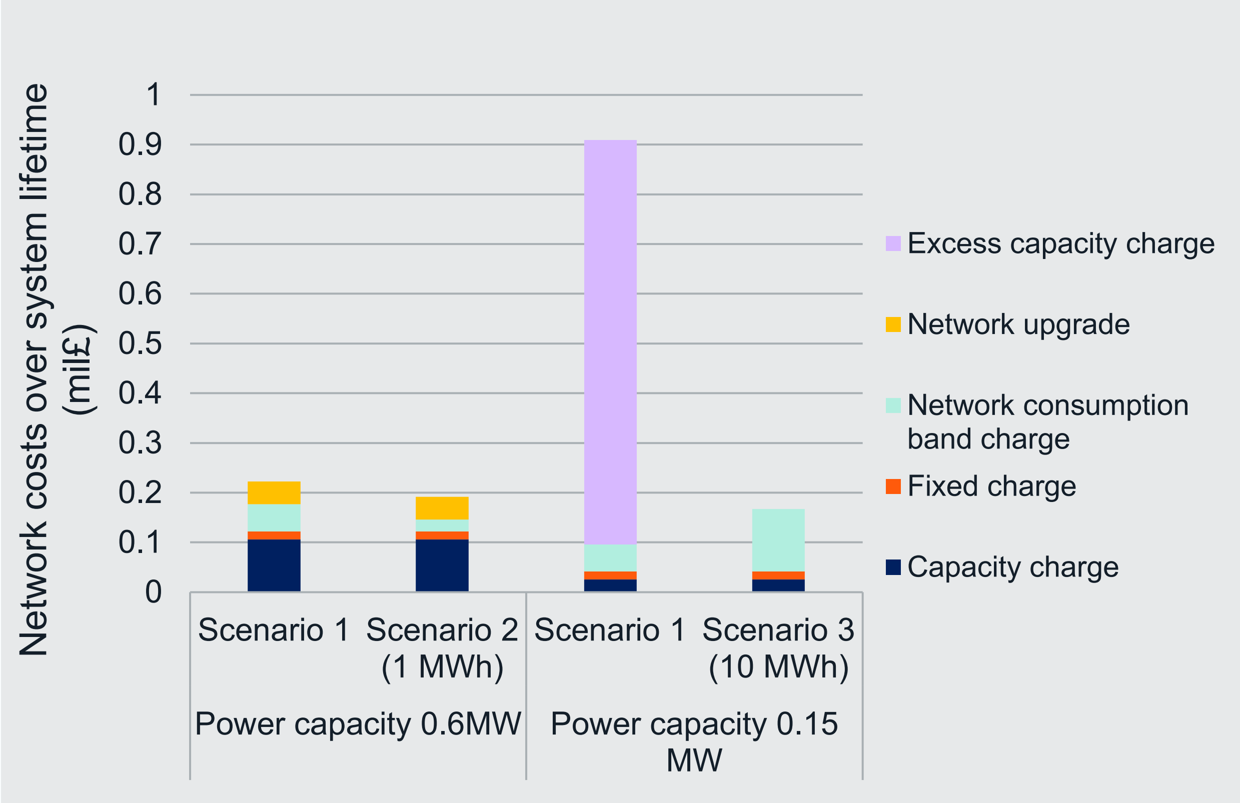


# Results - Power capacity connection

- 10 MWh BESS effectively fulfils energy requirements without surpassing the contracted grid connection power capacity.
- Considering all amortized costs, using PV panels and the required 10 MWh BESS becomes unfeasible, as the BESS cost outweighs the potential benefits.

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# Conclusions

- Overall, the findings presented suggest that **from an economic point of view**, it is feasible to use local solar energy generation and a BESS on-site to certain logistics or commercial companies, like the WMD, when they decide to electrify their fleet when the power capacity connection is not constrained.

- The generation of on-site solar energy and the use of a BESS allows the system to reduce its **dependency on the grid**, to a greater or lesser extent depending on the charging strategy used, for all the scenarios analysed when the power connection capacity is not constrained.

- According to the results presented, the use of solar energy and BESS in a commercial or logistics company contribute to a greener future by minimising their **carbon footprint** and promoting sustainable practices in their operations.

- If the network **power capacity connection is constrained**, a 10 MWh BESS, in this case, effectively fulfils energy requirements without surpassing the contracted grid connection power capacity. However, other strategies, such as smart charging, must be implemented with the BESS to make it an economically viable option.

# Thank you for your attention

# Do you have any questions?

Maria Nunez Munoz

PhD candidate at the University of Sheffield

m.nunezmunoz@sheffield.ac.uk

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