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3/9/21

Should my Electric Vehicle be used for **my benefit** or for the **greater good**?

Alicia Blatiak &
Federica Bellizio

Control and Power Research Group, EEE

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The Story of Tim

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Now picture the future…

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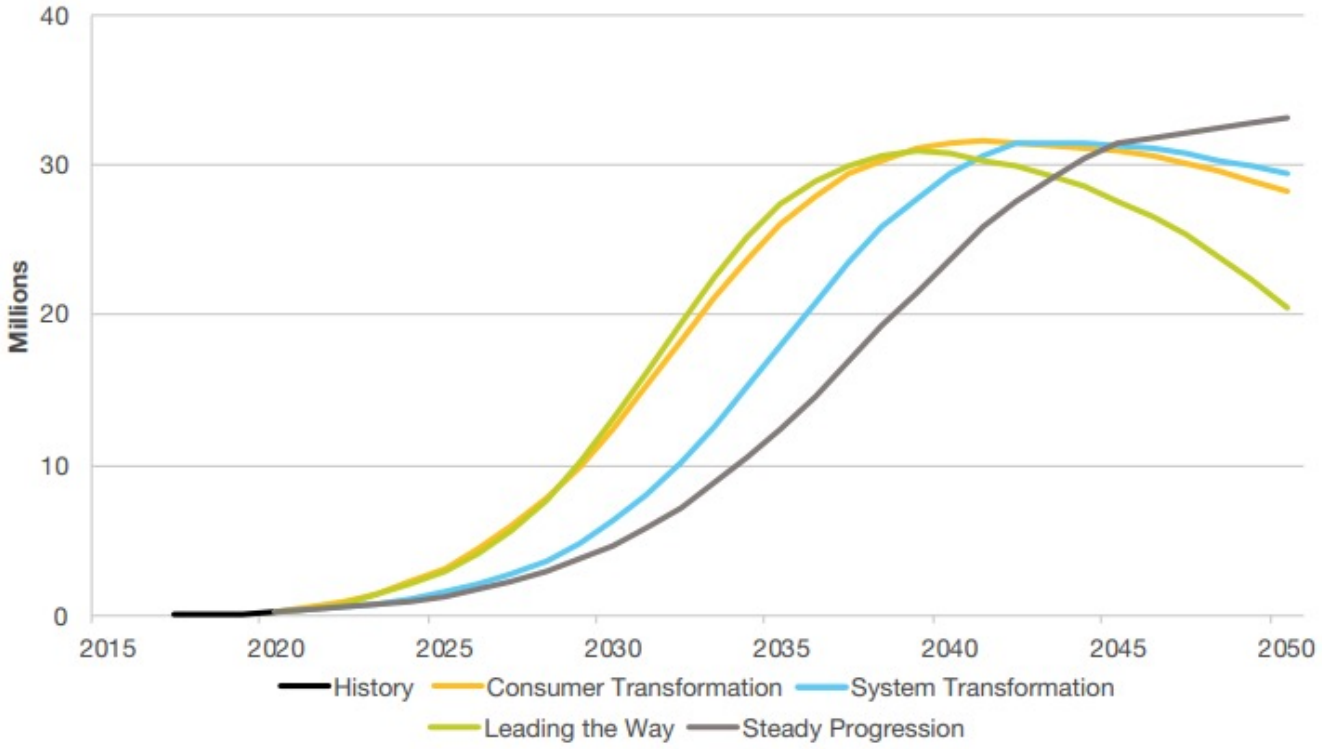
Electric Vehicles are coming!



UK Government

- Banned the sale of new petrol / diesel (2030)

- Mandated smart-charging on public chargers

Future Energy Scenarios Report 2021, National Grid

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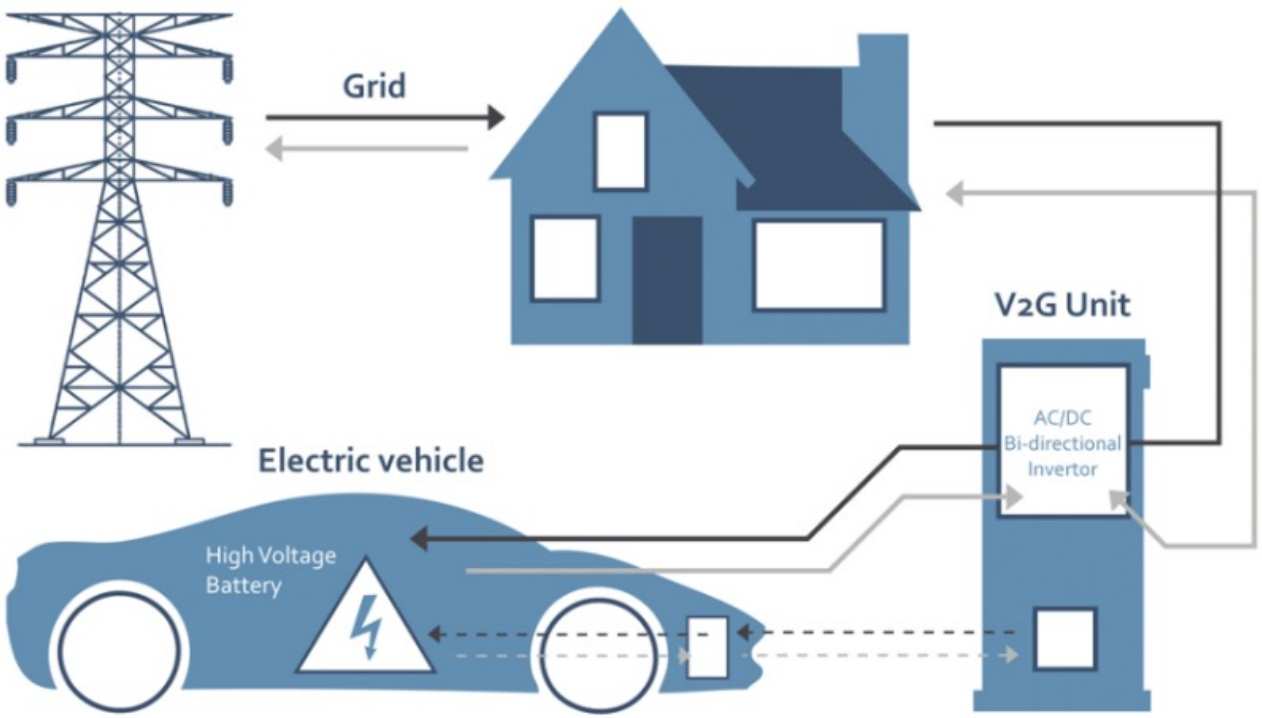
What is Vehicle-to-Grid?



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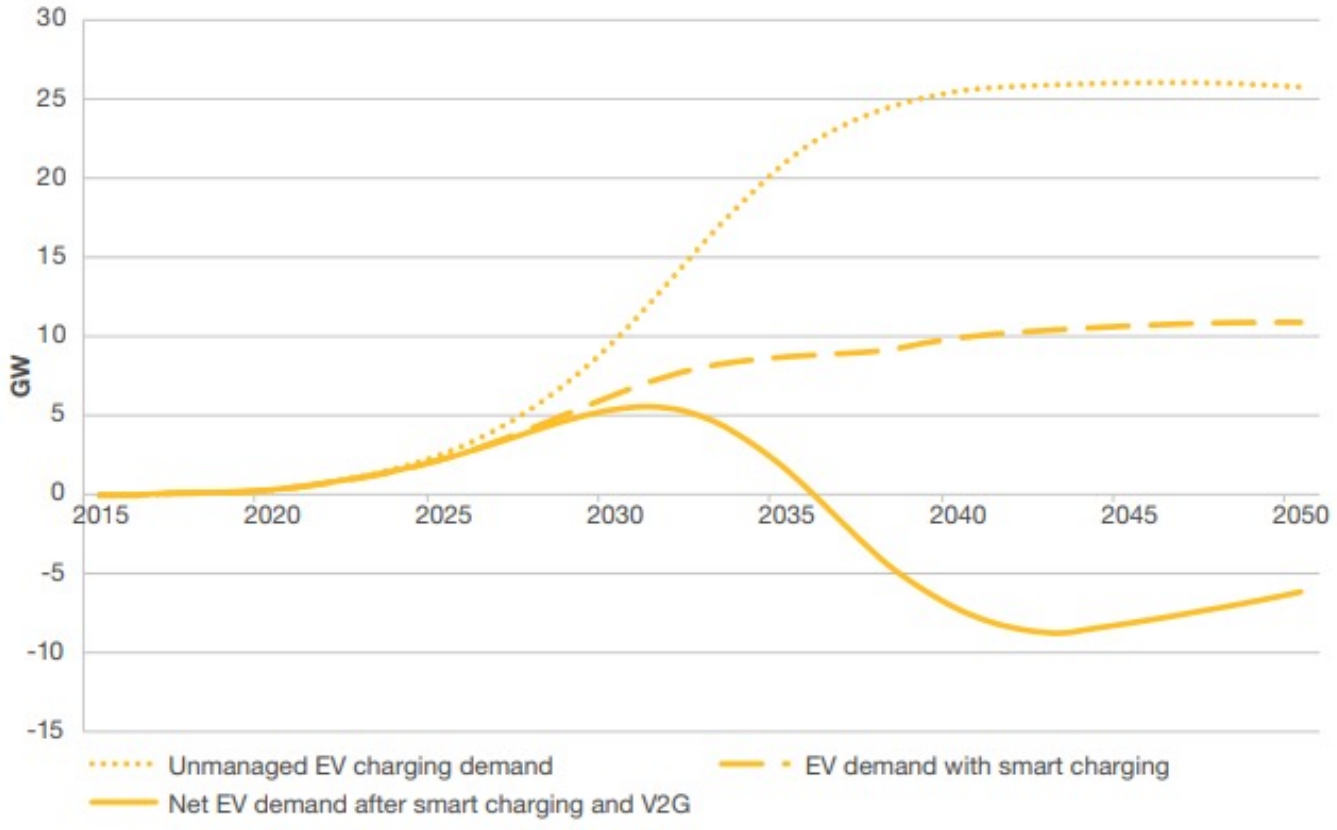
Could go either way…

GB Winter Peak System Demand from EV Charging



'Consumer Transformation' from Future Energy Scenarios Report 2021, National Grid

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So, what can I do with my energy?

How does this look?

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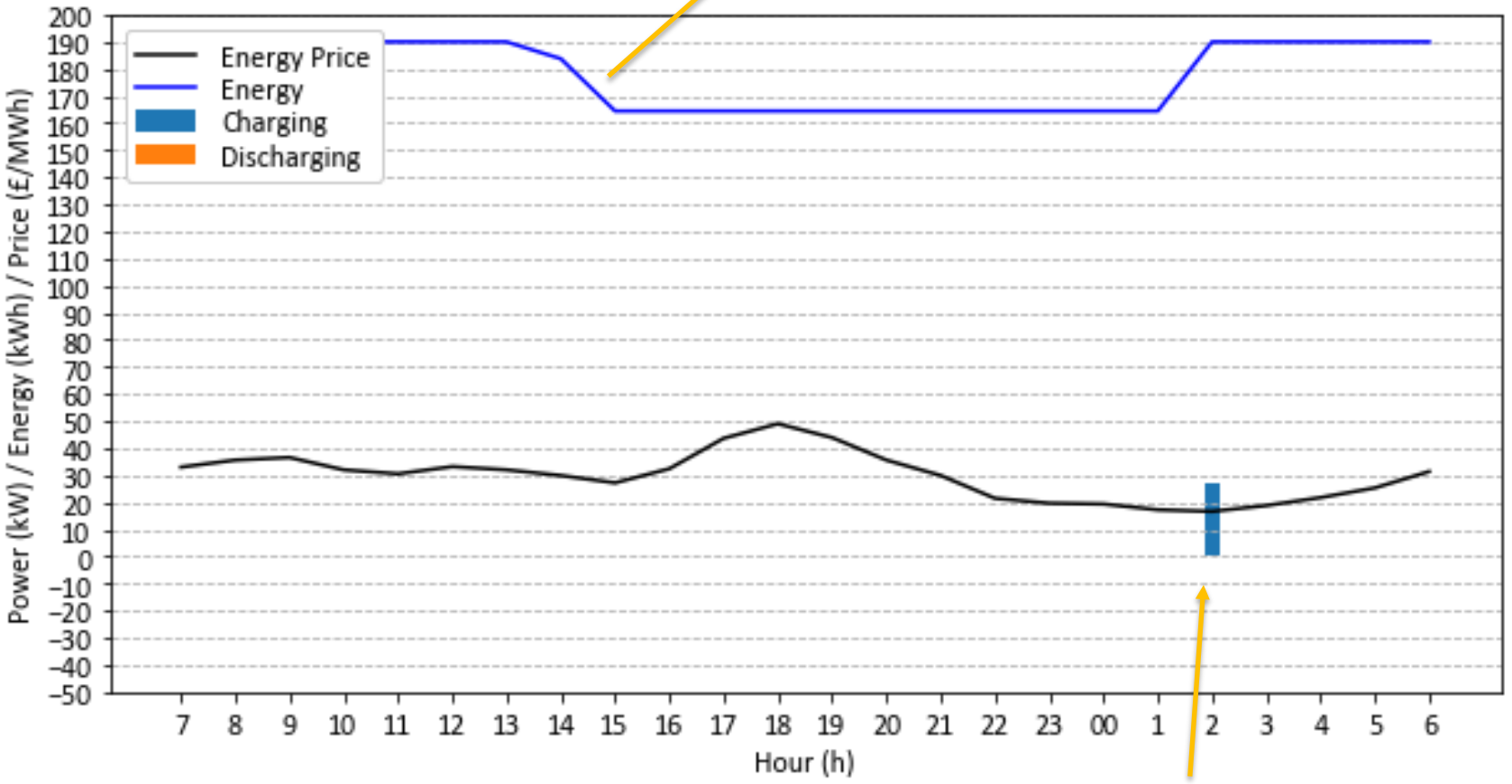
Smart Charging

EVs using energy for travelling



EVs charging when price is lowest (2am)

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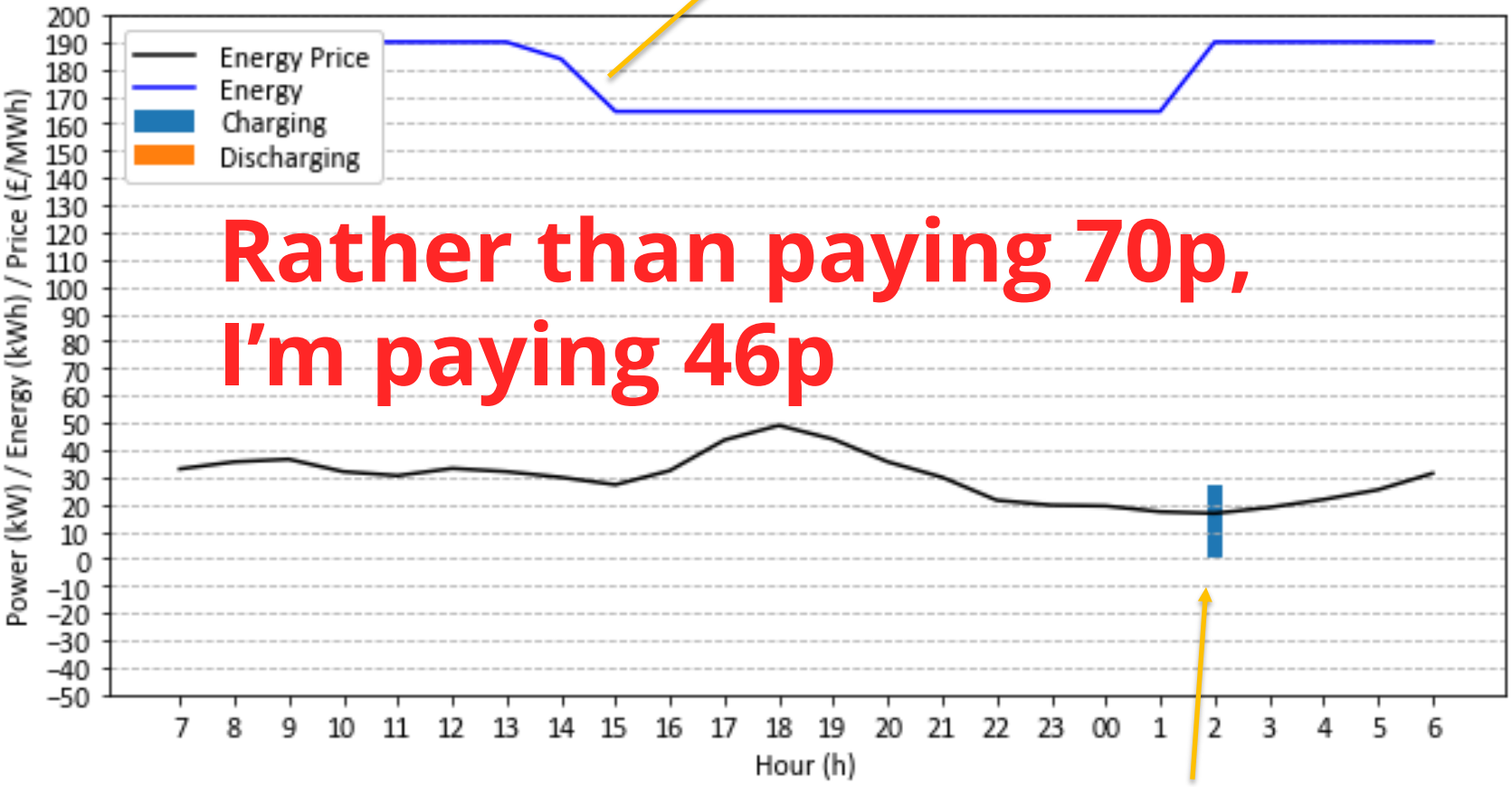
Smart Charging

EVs using energy for travelling



Rather than paying 70p, I'm paying 46p

EVs charging when price is lowest (2am)

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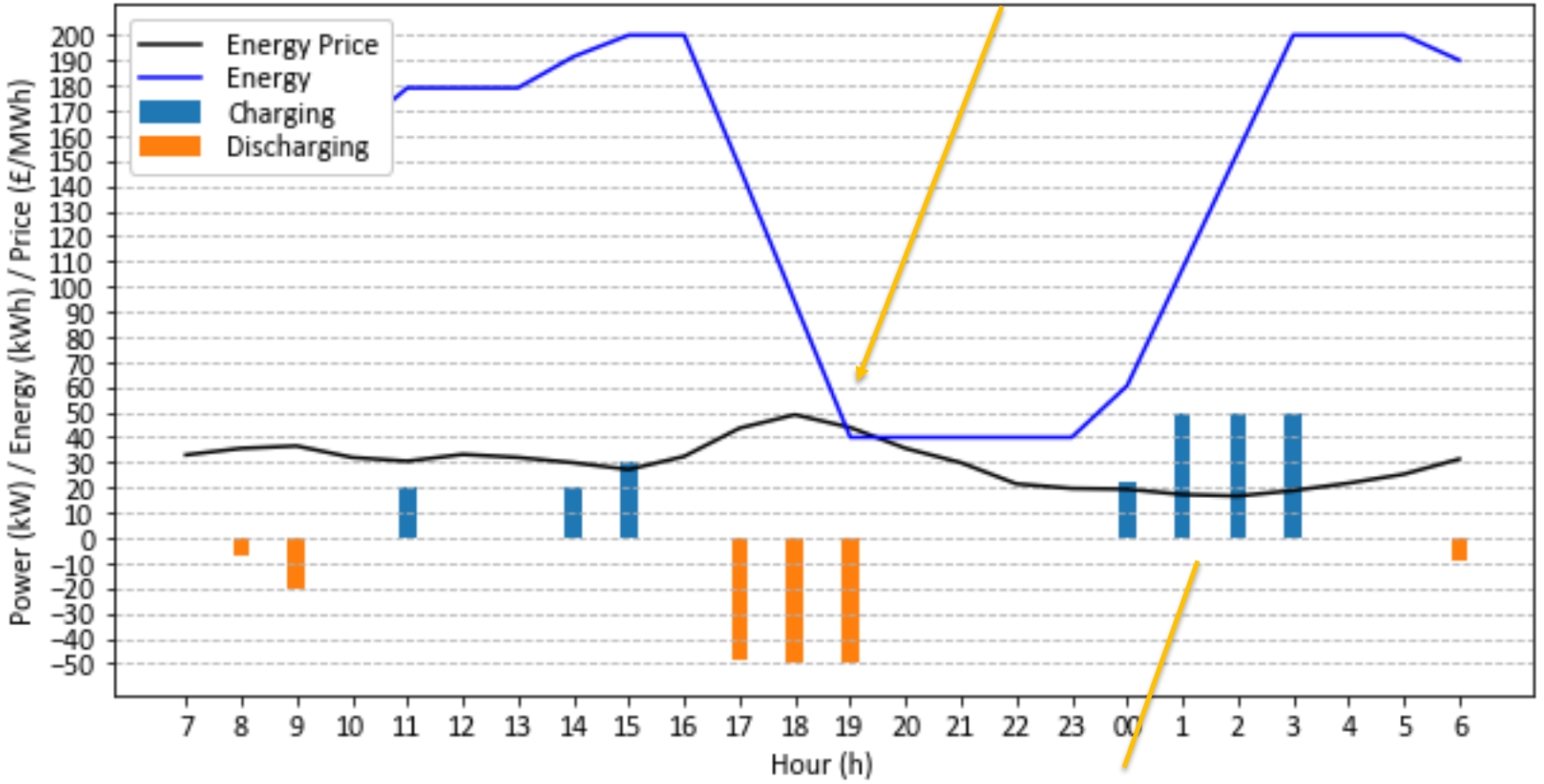
Energy Arbitrage (V2G)

EVs charging when price is lowest (at night)



EVs discharging when prices high

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Energy Arbitrage (V2G)

EVs charging when price is lowest (at night)

Rather than paying 46p, I'm *earning* £3!

EVs discharging when prices high

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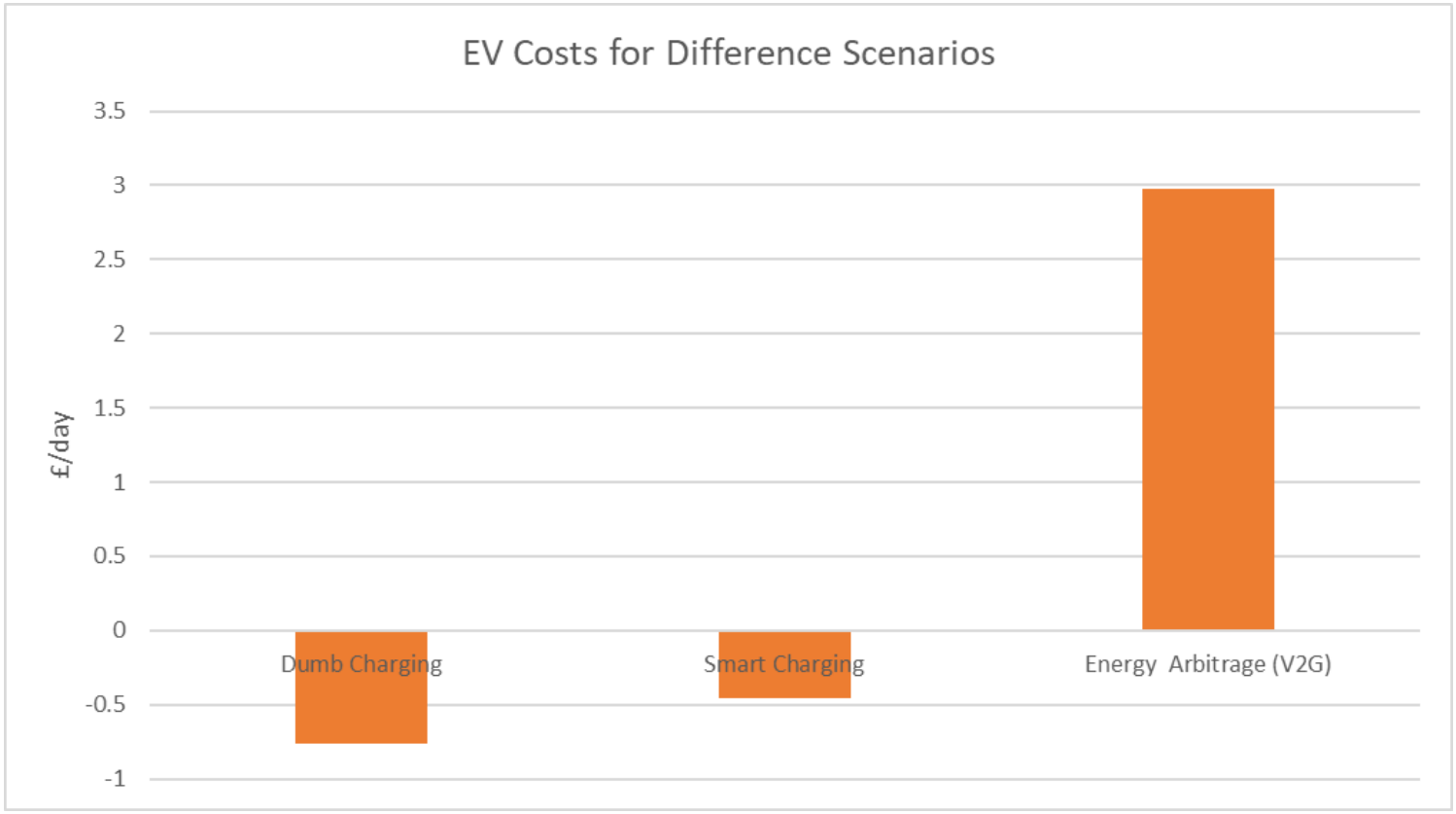
How do the charging modes compare?



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To summarise…

EV owners can use the high flexibility EVs have to offer to:

- Reduce their **electricity bills** with a time-of-use tariff
- **Earn money** by buying and selling energy (to the grid or to their neighbours)
- Reduce the **electricity peak** nationally by controlling their charging

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Introducing the ‘greater good’

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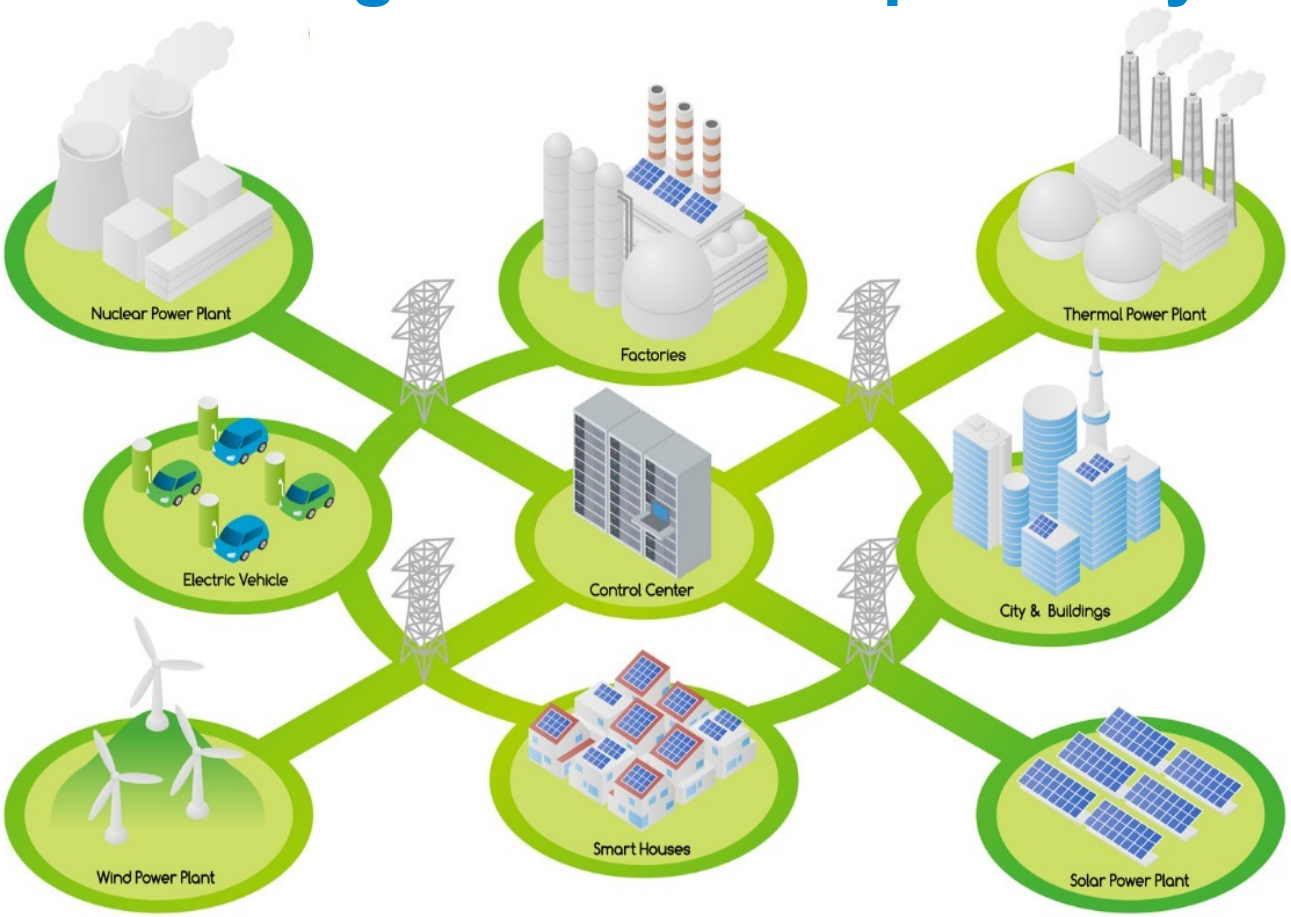
Challenges in modern power system



- Lots of renewable generation
- Integrated distributed resources
- Decentralised control
- Bidirectional power flow
- Low inertia

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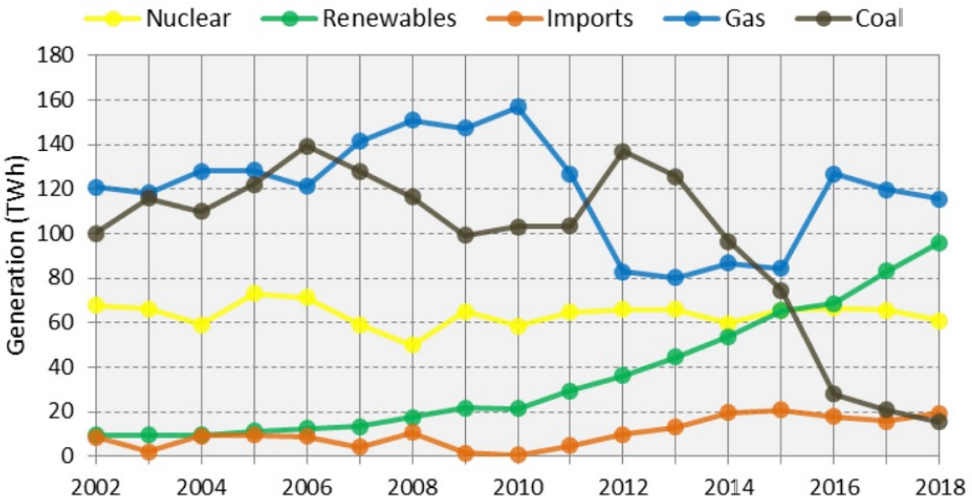
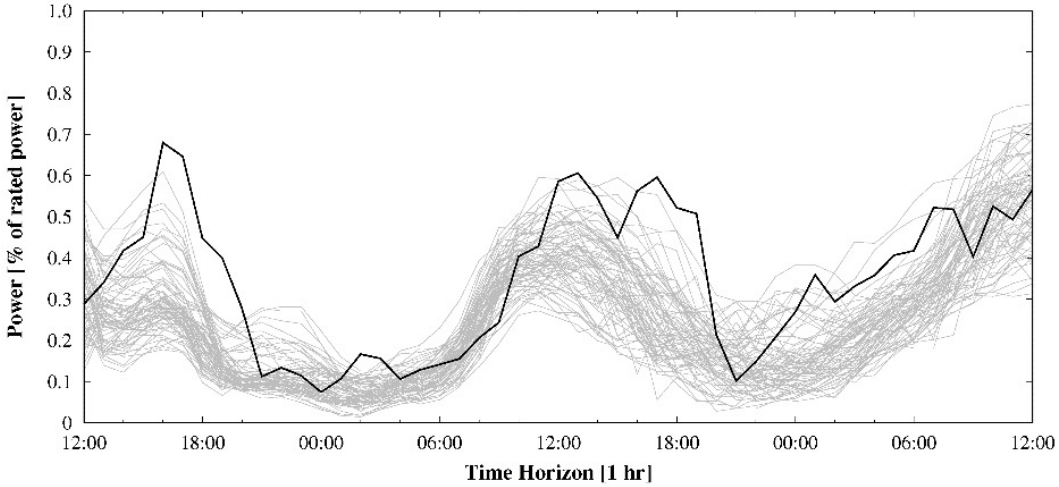
GB power generation



High operational uncertainty

High flexibility



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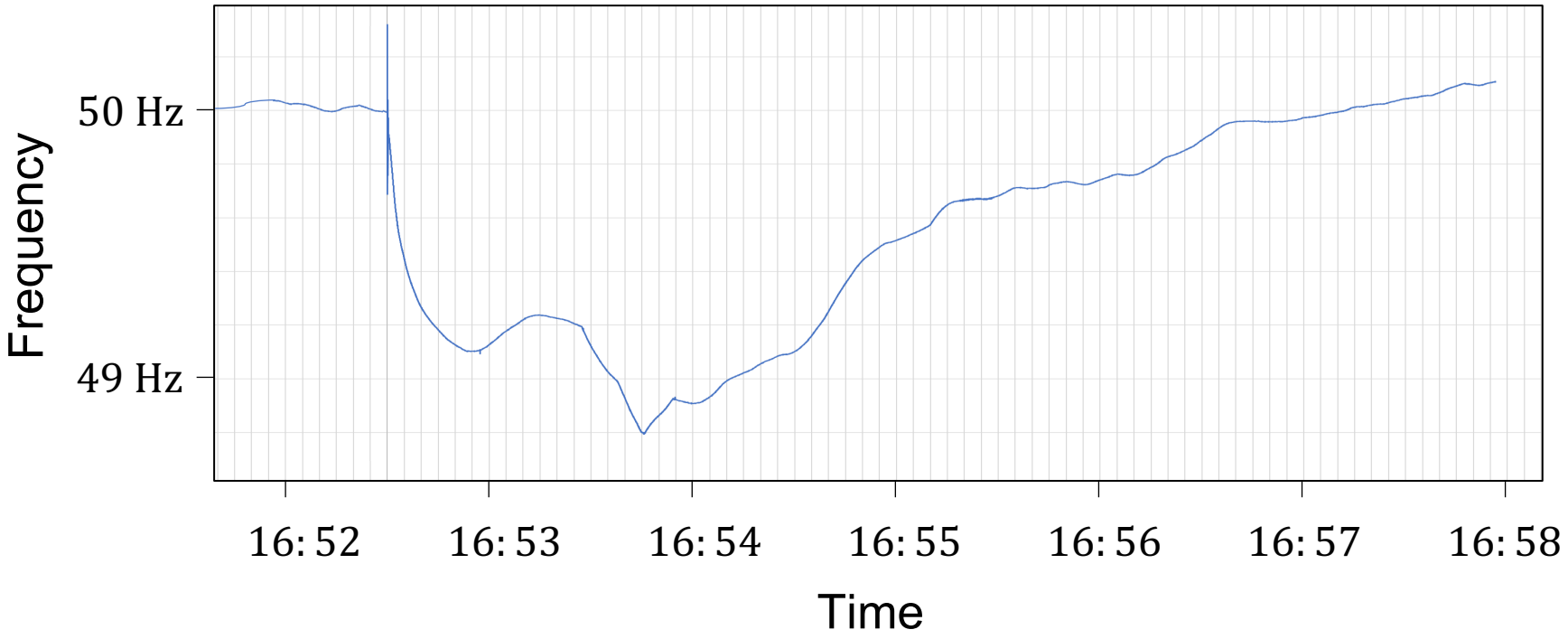
UK frequency, 9th August 2019



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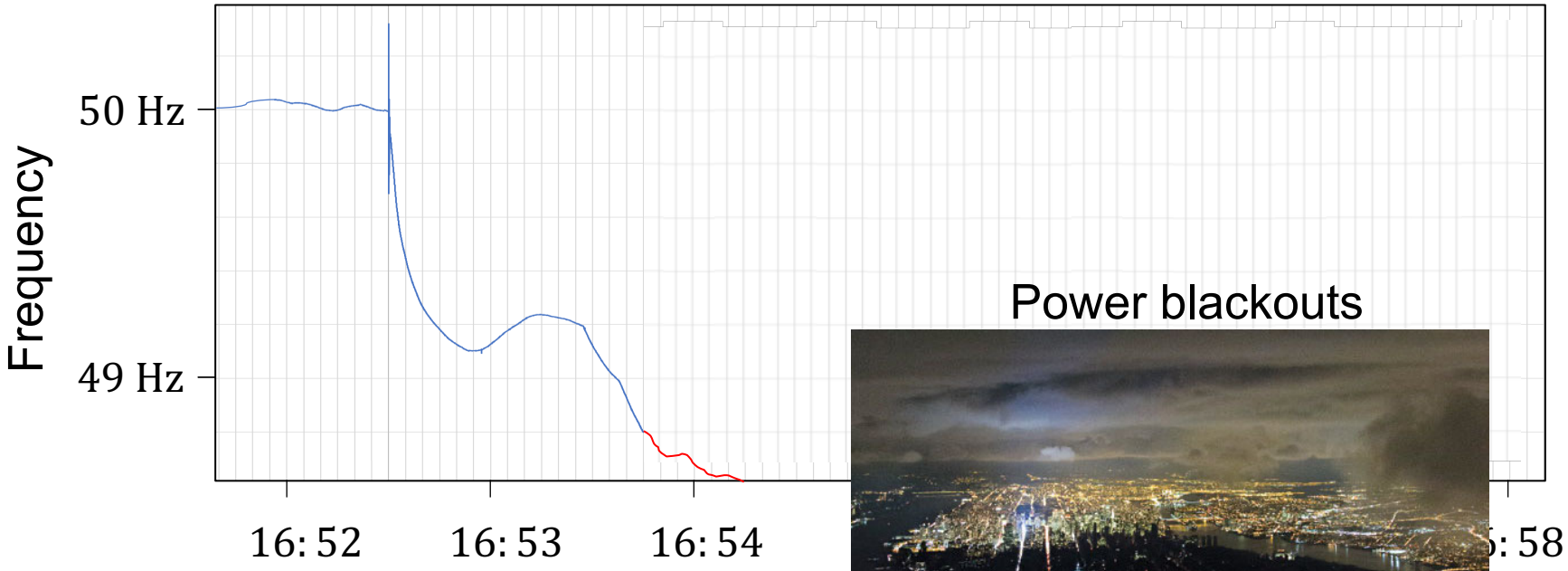
Were we just lucky?



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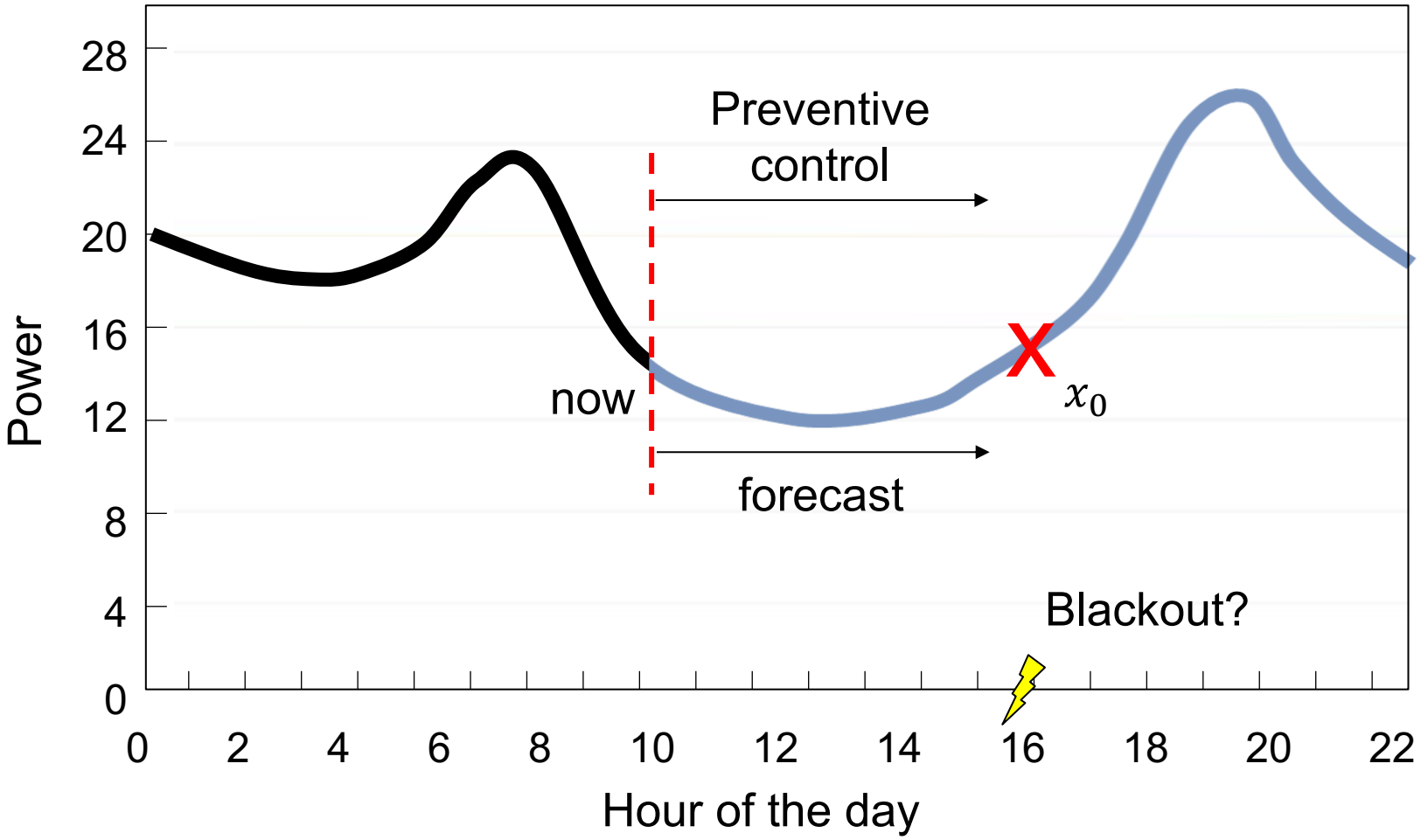
Preventive control can fail



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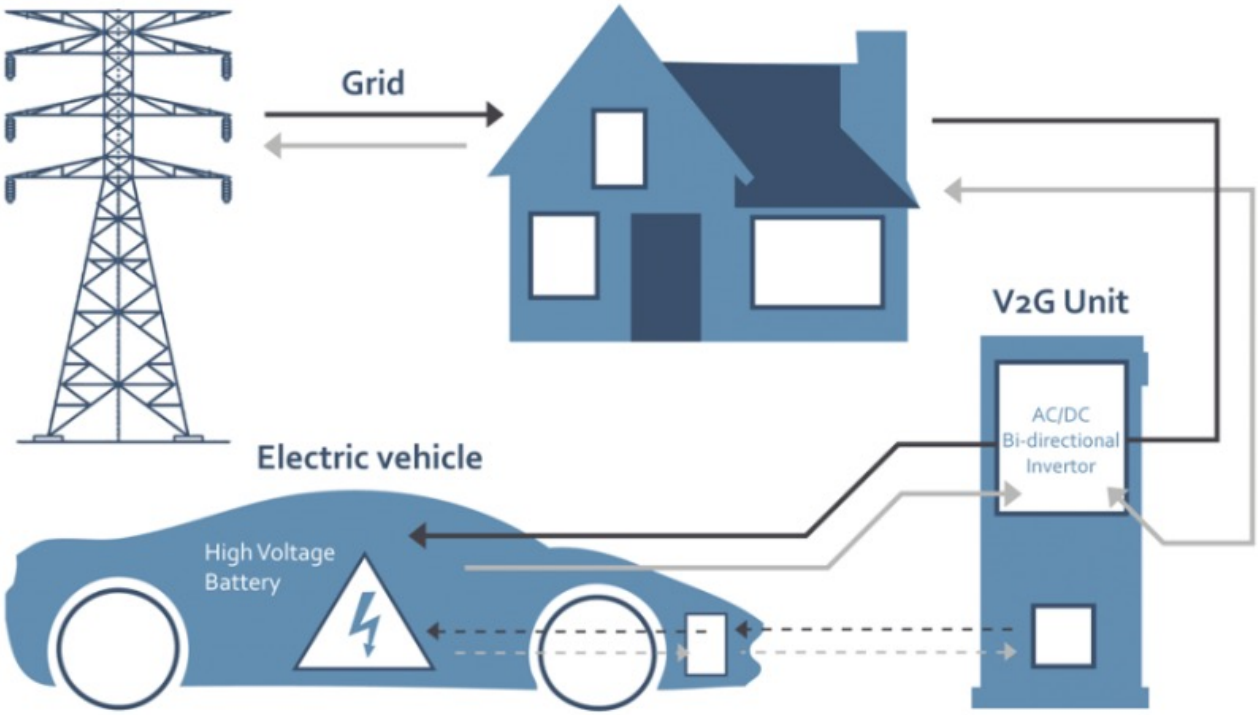
Unlock the real value of EVs



- Support the grid when preventive fails (frequency response)
- Help balancing supply/demand
- Raise pre-fault transfer limits
- Reduce CO2 emissions

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How EVs can support operators?

- Enhance the utilization of the grid assets
- Avoid investments in new grid infrastructure
- Reduce operating/generation costs
- Prevent renewable power curtailment

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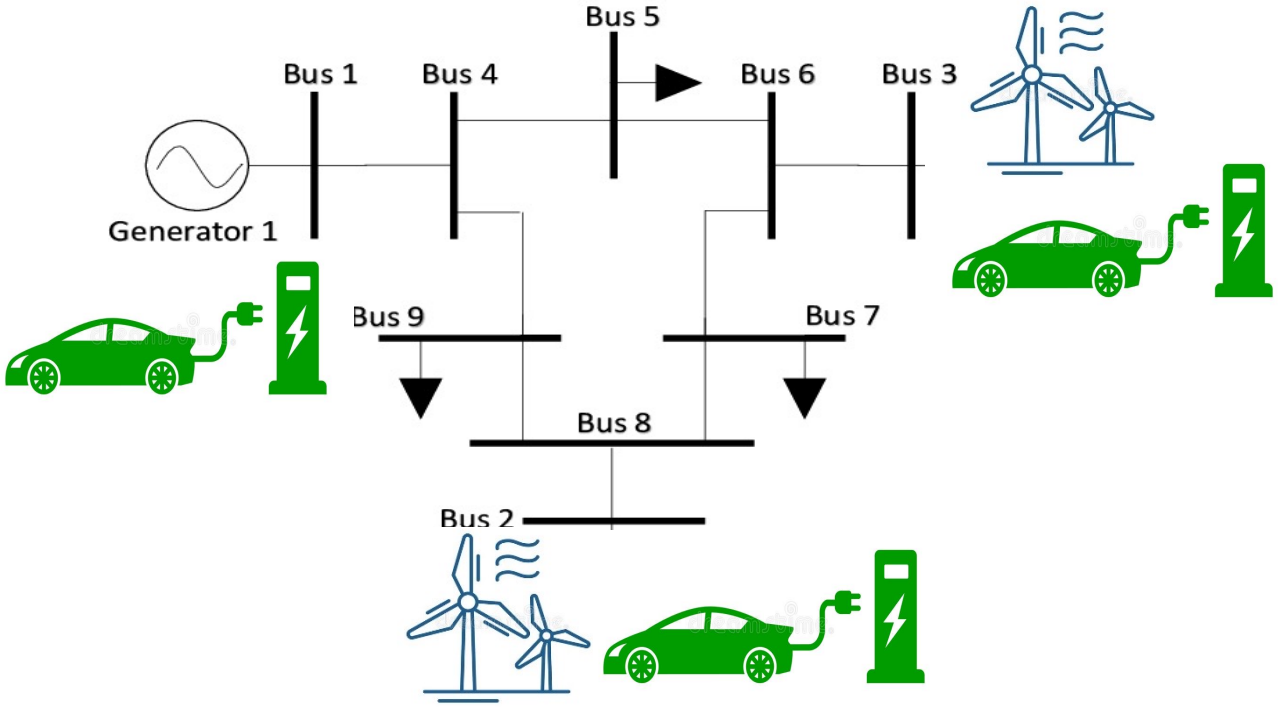
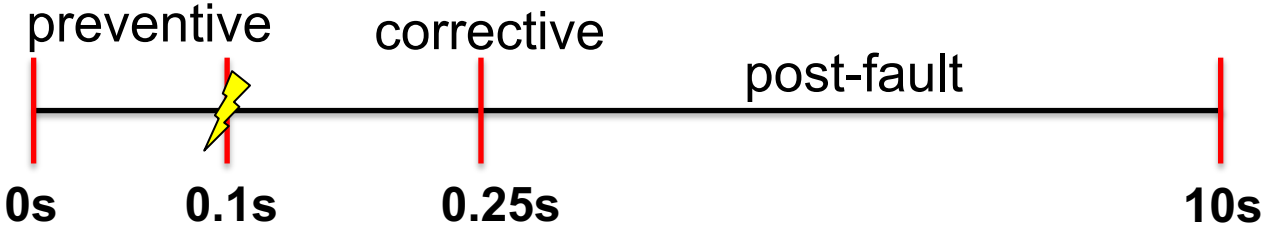
Prove the value of EVs

Data-driven approach to optimise the use of EVs in real-time





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Some interesting results

	No control	Wind curtailment	Preventive + EVs
Unstable conditions	990/1000	510/1000	0/1000

- £3.7m

- 80m kg of CO2

- The low inertia of the system makes 99% of post-fault operating conditions unstable
- Assuming 2/3 faults are expected every day, the system could experience ~1000 faults per year

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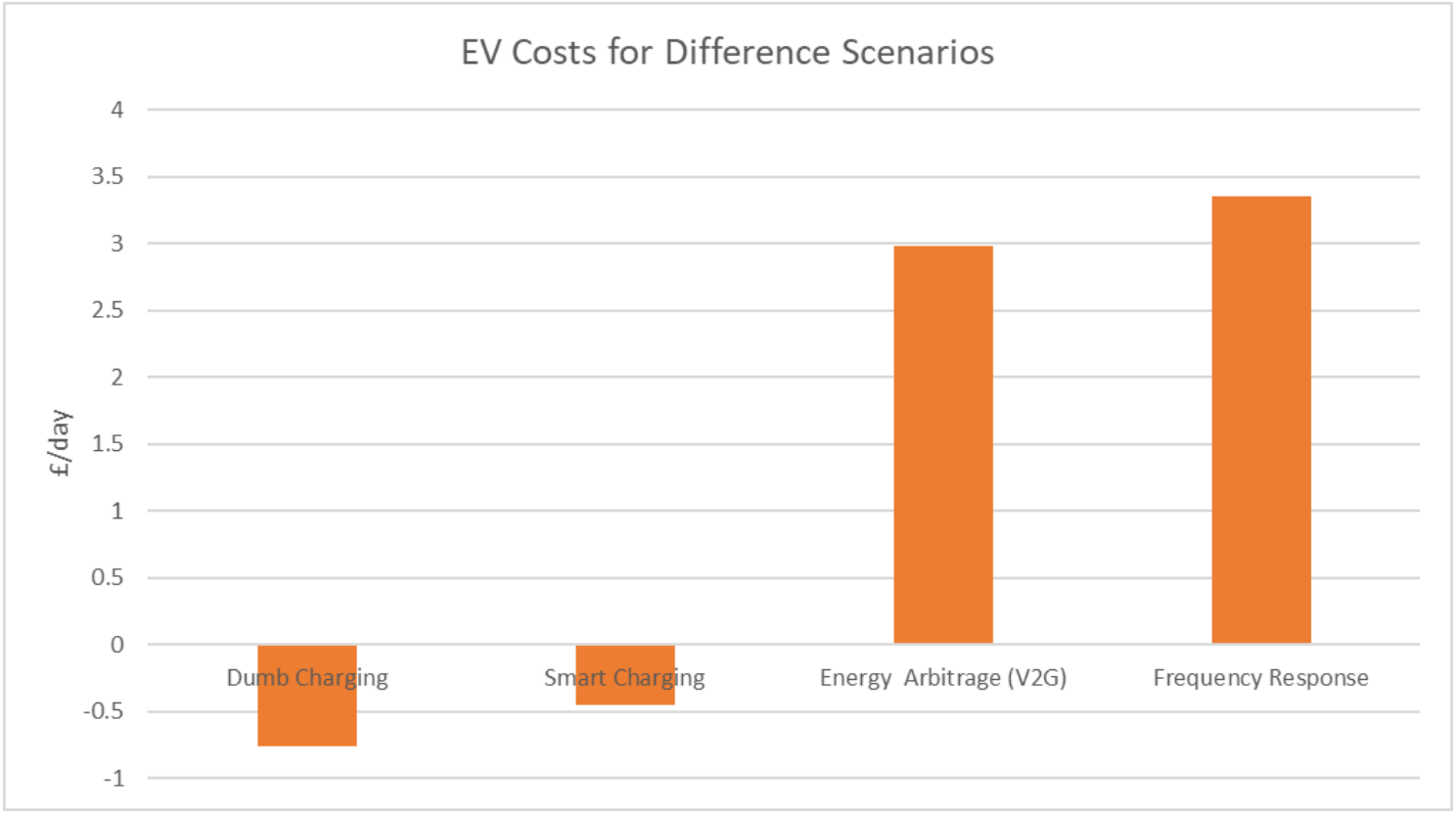
How do the charging modes compare?



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To summarise…

How EV owners can support the grid operation:

- Reduce investment, operating and generation costs
- Improve the system's reliability (fewer blackouts!)
- Support the transition towards a low-carbon economy