A Model-Based Online Mechanism with Pre-Commitment

and its Application to Electric Vehicle Charging

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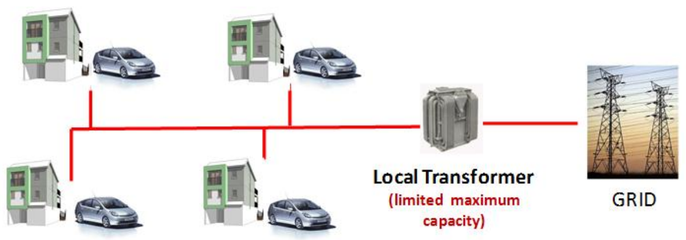
Electric Vehicles

Electric vehicles (EVs) reduce CO_2 emissions and dependence on fossil fuels.

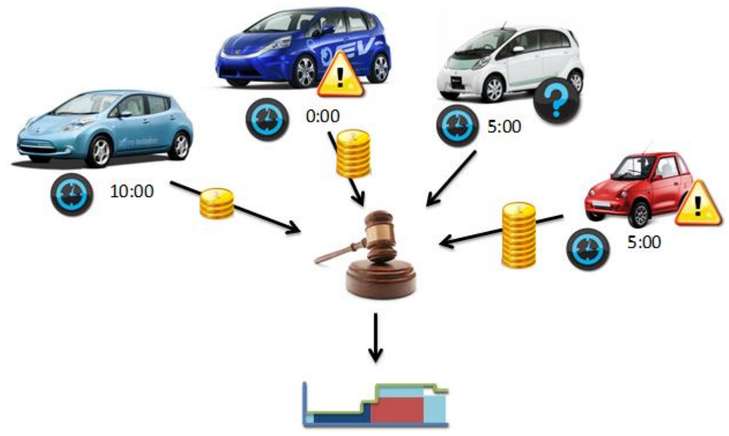
Projected 6.4m EVs on the road in UK by 2030.



Local distribution networks cannot cope with high numbers of EVs charging at once.

Charging needs to be scheduled, but owners may strategise and misreport preferences.

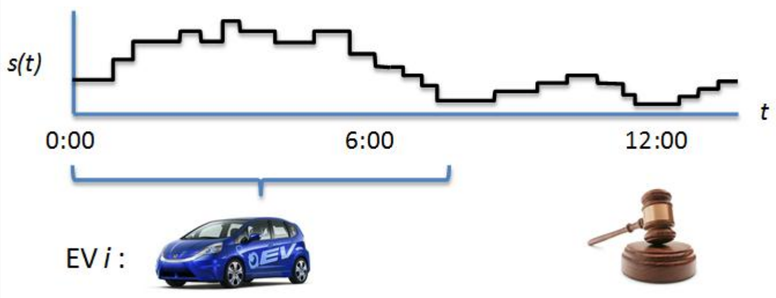
Online Mechanism Design



Solution: Design mechanism that is dominant strategy incentive-compatible (DSIC).

DSIC: Agents are always best off being truthful.

Model

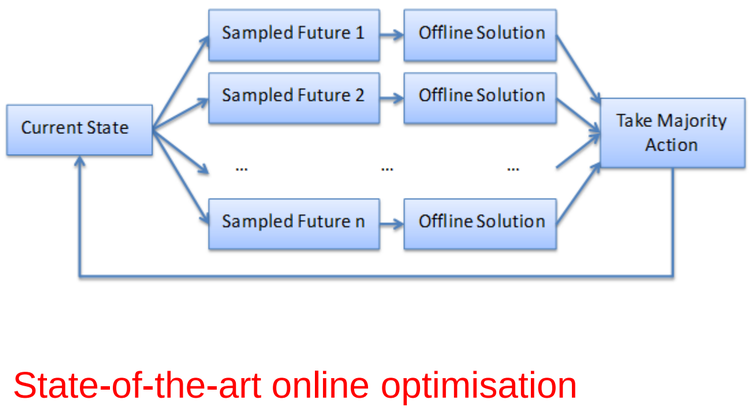


Arrival time: a_i = 0:00
Departure time: d_i = 8:00
Required charge: q_i = 15.2 kWh
Maximum charge rate: r_i = 3 kW
Valuation: v_i = € 5.00

Limited misreports:

- No **early** arrivals
- No **late** departures
- No **higher** charging rates

Consensus Algorithm

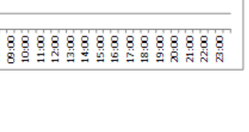


State-of-the-art online optimisation algorithm, based on **sampling** a number of future scenarios and **voting** for agents to schedule.

This algorithm is fast and does not require full knowledge of actual arrival distributions.

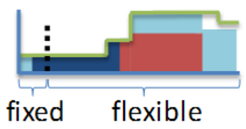
Modifications to Ensure DSIC

- **Pre-Commitments:** Once Consensus votes for particular agent, it is charged regardless of future arrivals.



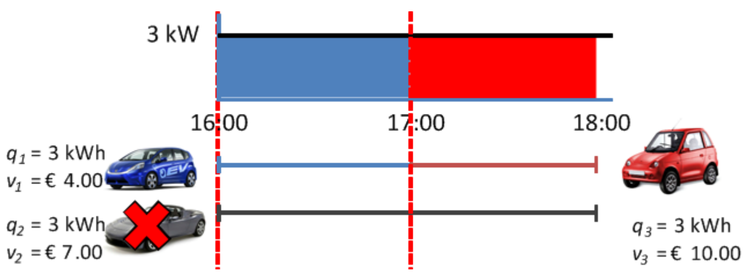
- **Re-Evaluation Points:** Consensus is re-evaluated at certain times.

- **Partly-Fixed Schedules:** Mechanism commits to exact schedule up to next re-evaluation point, but remains flexible beyond.

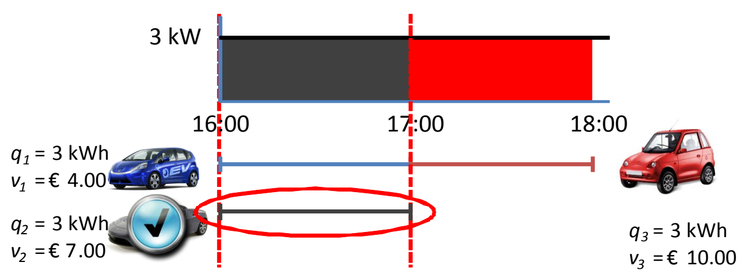


Why Pre-Commitment?

Consensus without pre-commitment:



Incentive to manipulate:



Results

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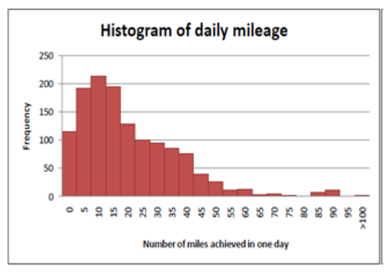
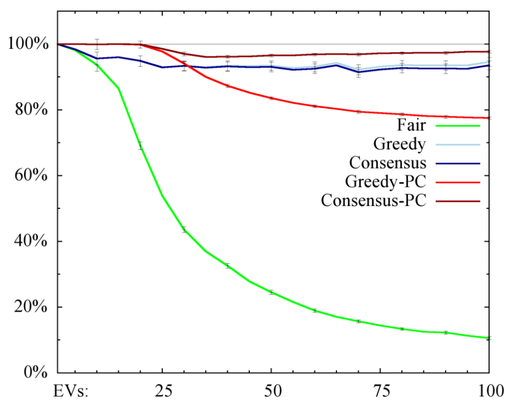
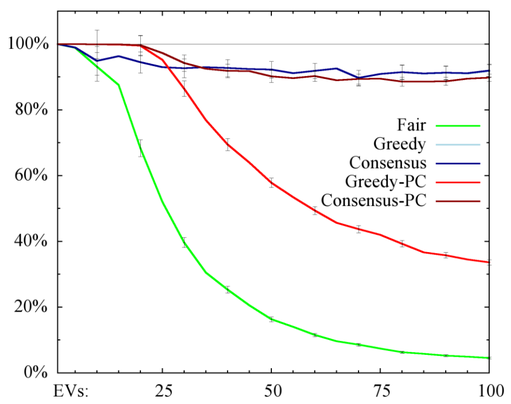
- Based on largest UK field trial of EVs.
- Sampled from real arrivals, departures and per-trip battery consumption.
- Supply based on typical household electricity consumption.



Benchmark	Model?	DSIC?
FairContention	No	**Yes**
OnlineGreedy	No	No
Consensus	**Yes**	No
OnlineGreedy-PC	No	**Yes**
Consensus-PC	**Yes**	**Yes**



Low-value agents



25% high-value agents