

Impact and Control of Electric Vehicle charging



Session 3b
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Agenda



Background

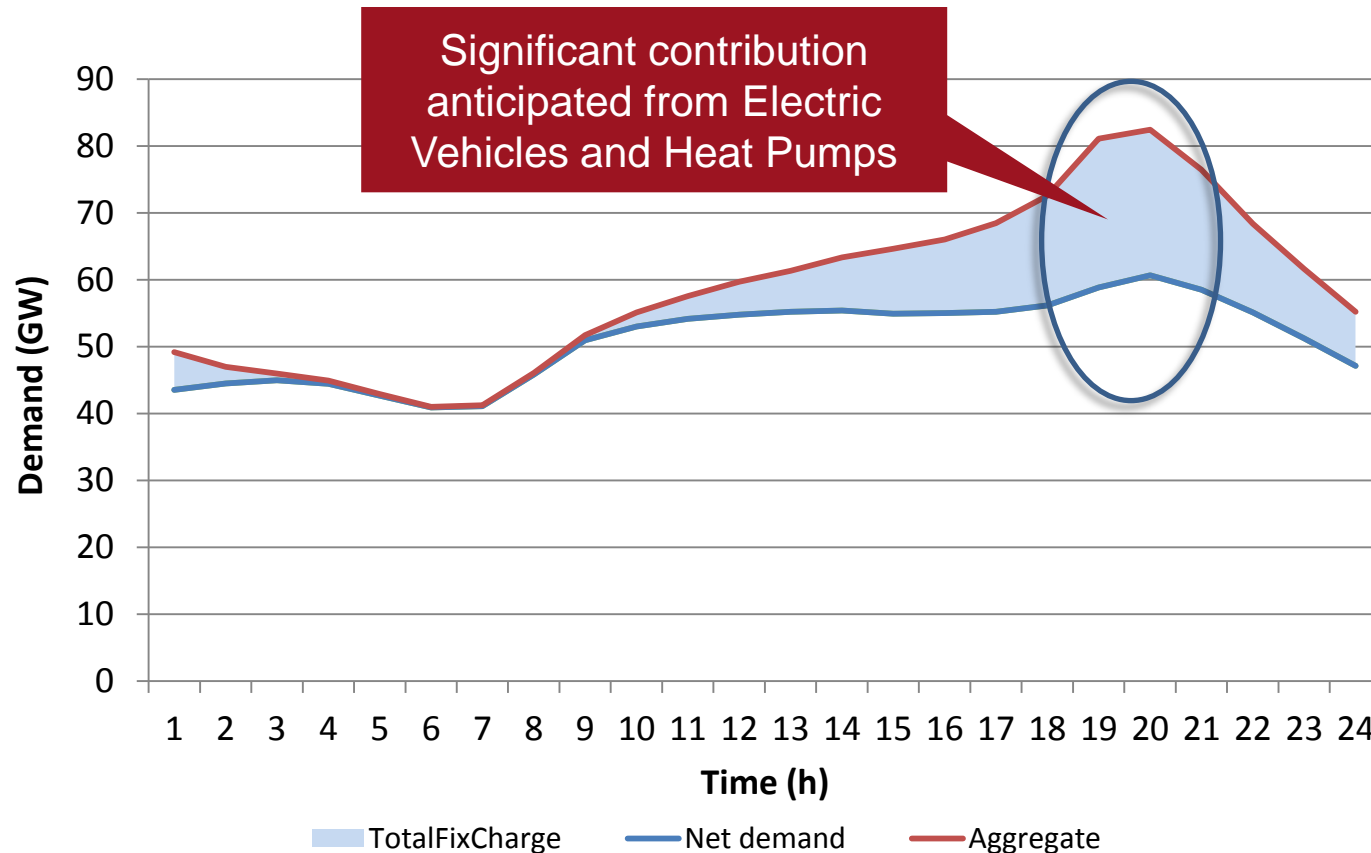
Low Carbon London trials

Insights from the LCL trials

How are we using this insight?

What are the opportunities for control?

2010: Where we were at the start of the project



Source: "Benefits of Advanced Smart Metering for Demand Response based Control of Distribution Networks" Imperial College London, ENA, SEDG

2010: Next steps for DNOs



Update the assumptions used in the previous study, plus other models used, to account for the impact of Low Carbon Technologies (LCT) uptake:

- Models
 - Element Energy Model – predict load and LCT uptake
 - Transform Model – industry model to reflect LCT uptake on generic networks
 - Load Related Expenditure model – specific modelled networks
- Load Forecasting
 - Inform the business plan and investment decisions
 - Build a forecast of the effect of demand and uptake over time
- Further insight into the ability to control or influence demand

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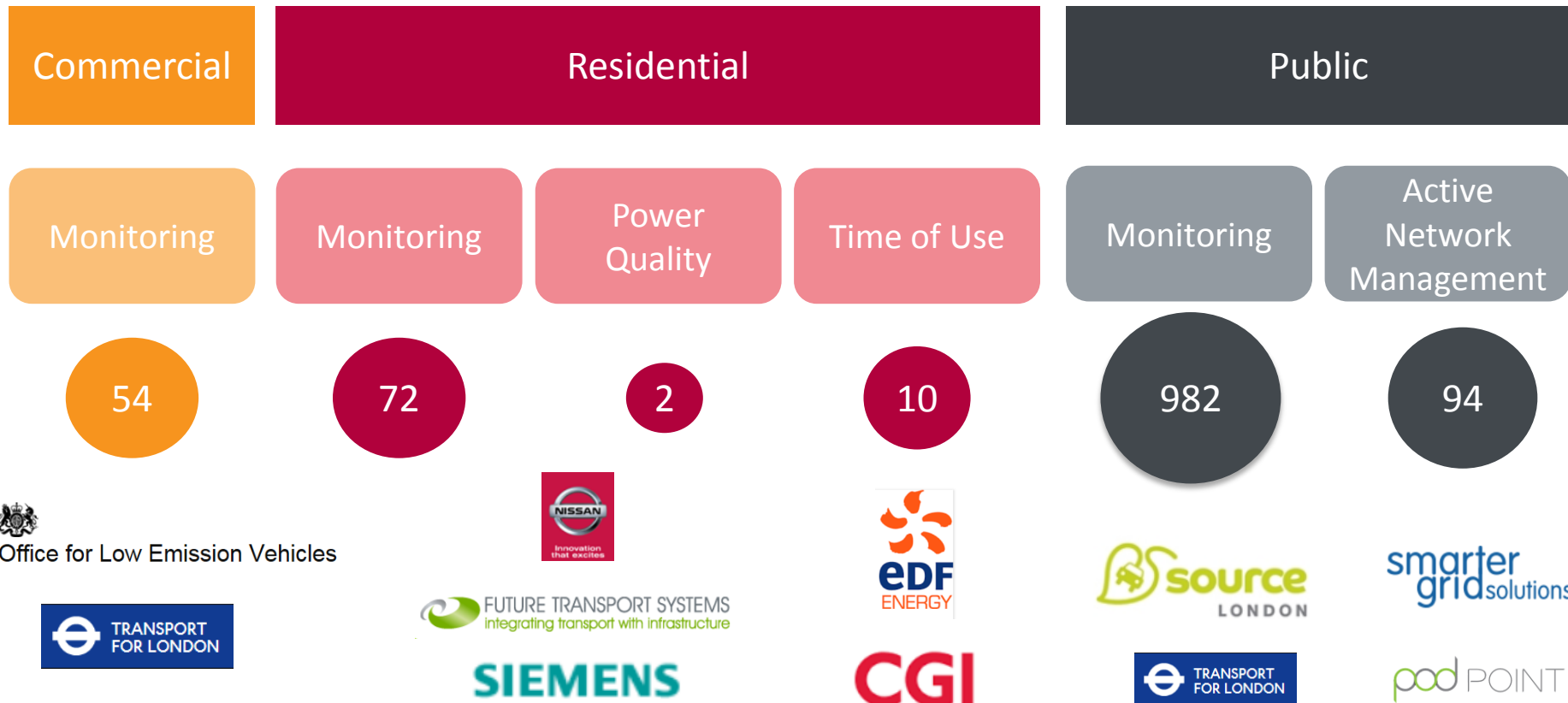
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Electric Vehicle Trials



Heat Pump Trials

Heat Pumps

Monitoring

Power
Quality

23

20

ISOenergy
sustainable energy systems

energy
saving
trust

edf
ENERGY

SIEMENS

passivSYSTEMS

CGI

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Low Carbon London trials

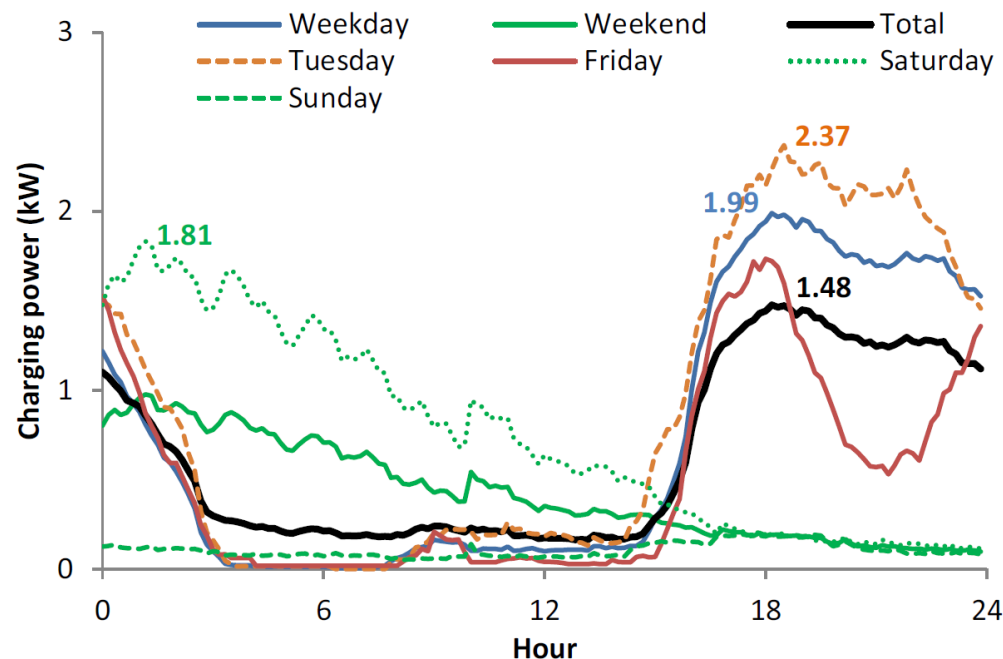
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There is no typical ‘commercial’ EV demand profile

Average heavy duty commercial EV charging profile
for different days of week

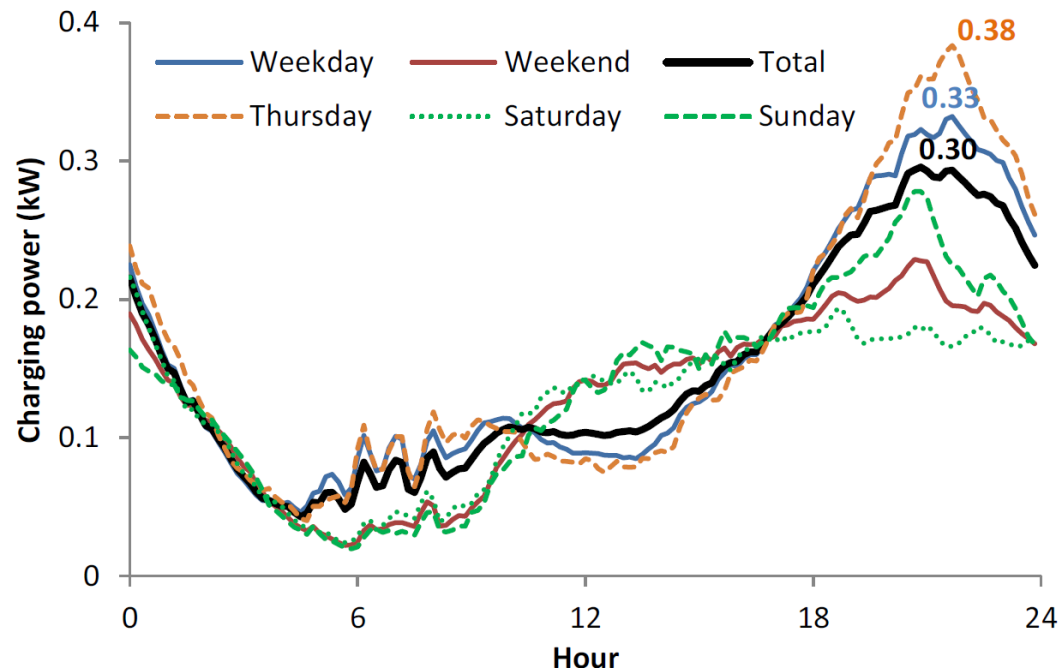


Source: LCL Report B1*

*M. Aunedi, M. Woolf, M. Bilton, G. Strbac, "Impact and opportunities for wide-scale electric vehicle deployment", Report B1 for the "Low Carbon London" LCNF project: Imperial College London, 2014.

Residential EVs represent an additional 0.3kW contribution to peak demand per household

Average residential EV charging profile
for different days of week

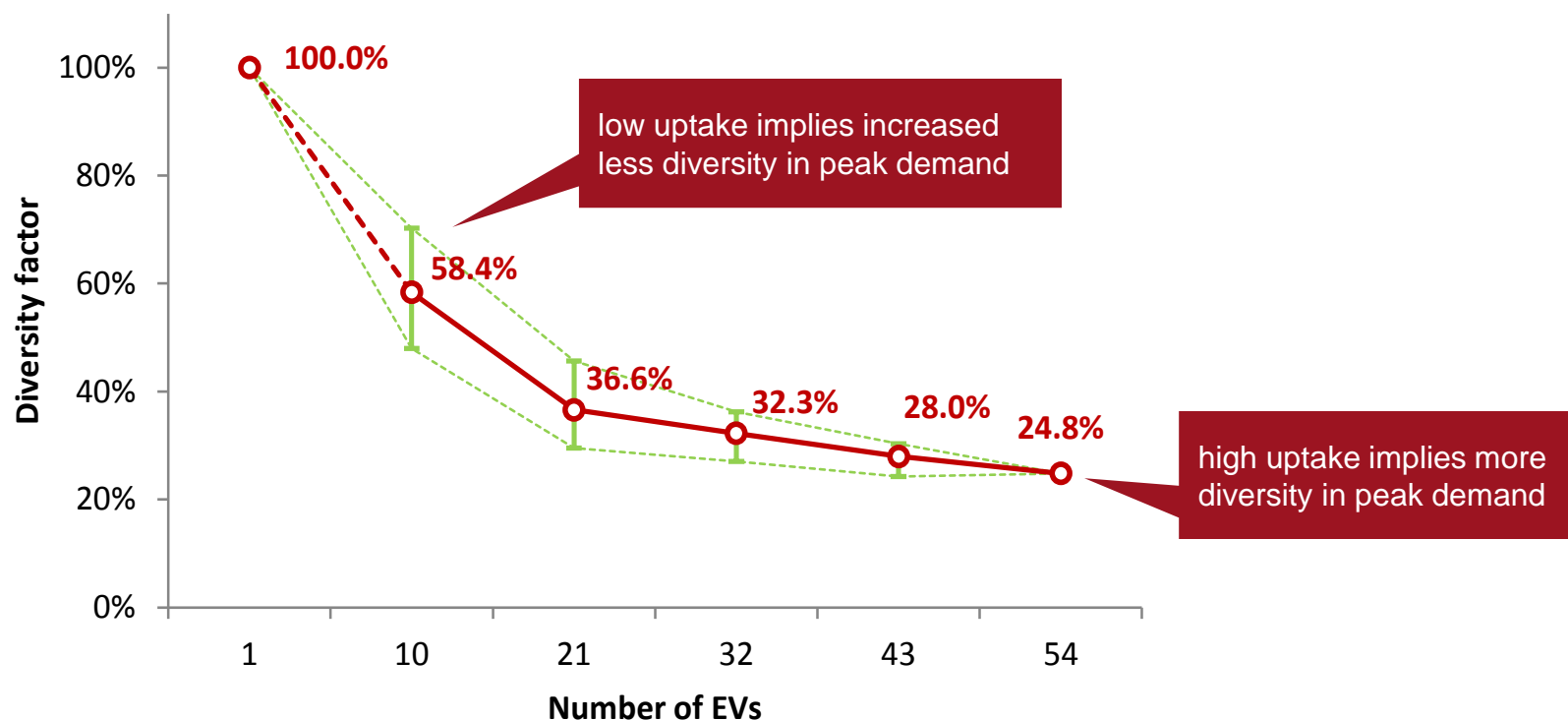


Source: LCL Report B1*

*M. Aunedi, M. Woolf, M. Bilton, G. Strbac, "Impact and opportunities for wide-scale electric vehicle deployment", Report B1 for the "Low Carbon London" LCNF project: Imperial College London, 2014.

Newly developed residential EV demand diversity curves support network planning

Residential EV demand diversity



Source: LCL Report B1*

*M. Aunedi, M. Woolf, M. Bilton, G. Strbac, "Impact and opportunities for wide-scale electric vehicle deployment", Report B1 for the "Low Carbon London" LCNF project: Imperial College London, 2014.

Extreme weather conditions (sub-zero) significantly increases the peak demand from HPs

E.g. average temperature of -4°C and a penetration level of 20% of household owning heat pumps increases peak daily load by 72% above baseline

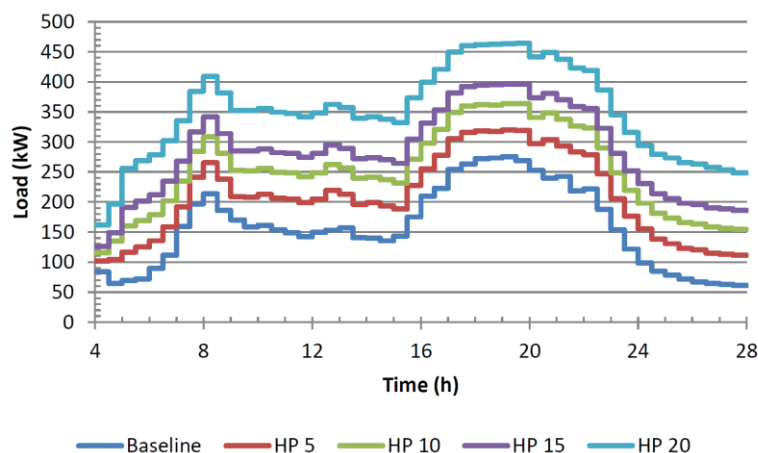


Figure 23: Transformer loading under weather scenario 1 conditions (av. temperature, -4°C)

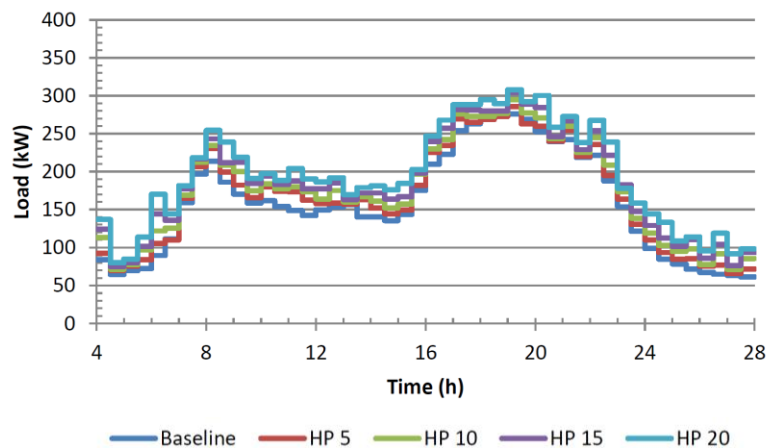
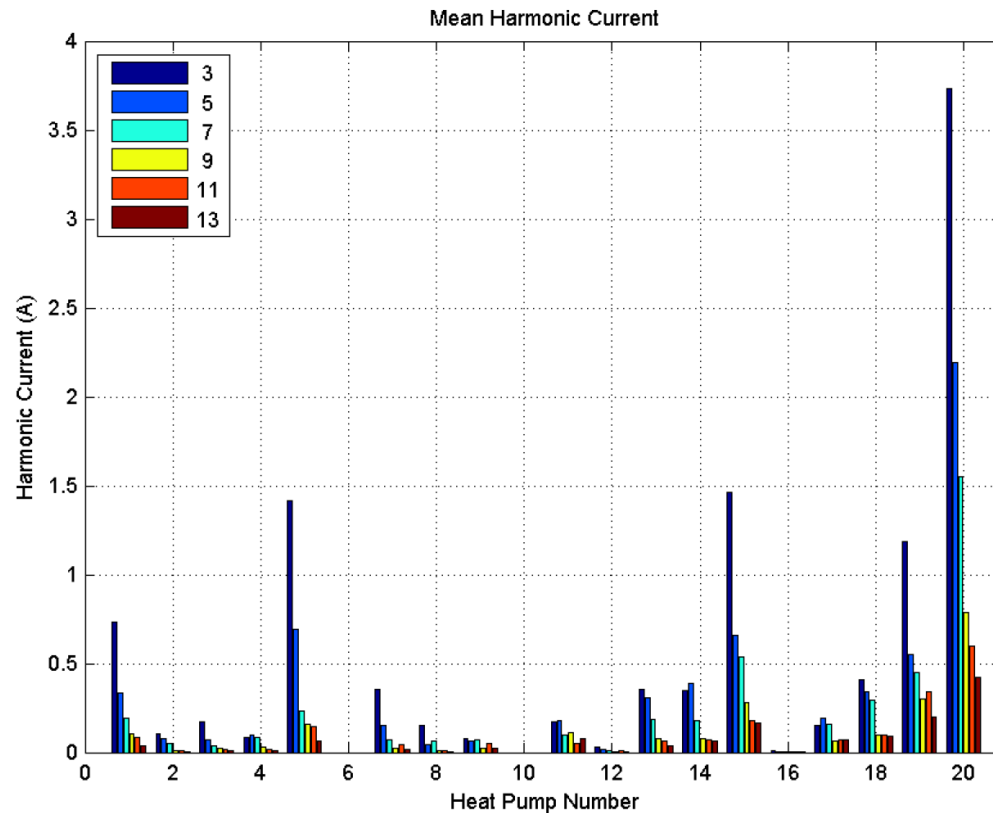


Figure 26: Transformer loading under weather scenario 4 (av. temperature 7°C)

Source: LCL Report B4*

* M. Bilton, N. E. Chike, M. Woolf, P. Djapic, M. Wilcox, G. Strbac, "Impact of low voltage – connected low carbon technologies on network utilisation", Report B4 for the "Low Carbon London" LCNF project: Imperial College London, 2014.

HPs were found to contribute various levels of power quality disturbance



Mean current magnitude of the 3rd, 5th , 7th, 9th, 11th, 13th harmonics for all of the heat pumps

Source: LCL Report B3*

N. Bottrell, E. Ortega, M. Bilton, T. Green, G. Strbac, "Impact of low voltage – connected low carbon technologies on power quality", Report B3 for the "Low Carbon London" LCNF project: Imperial College London, 2014.

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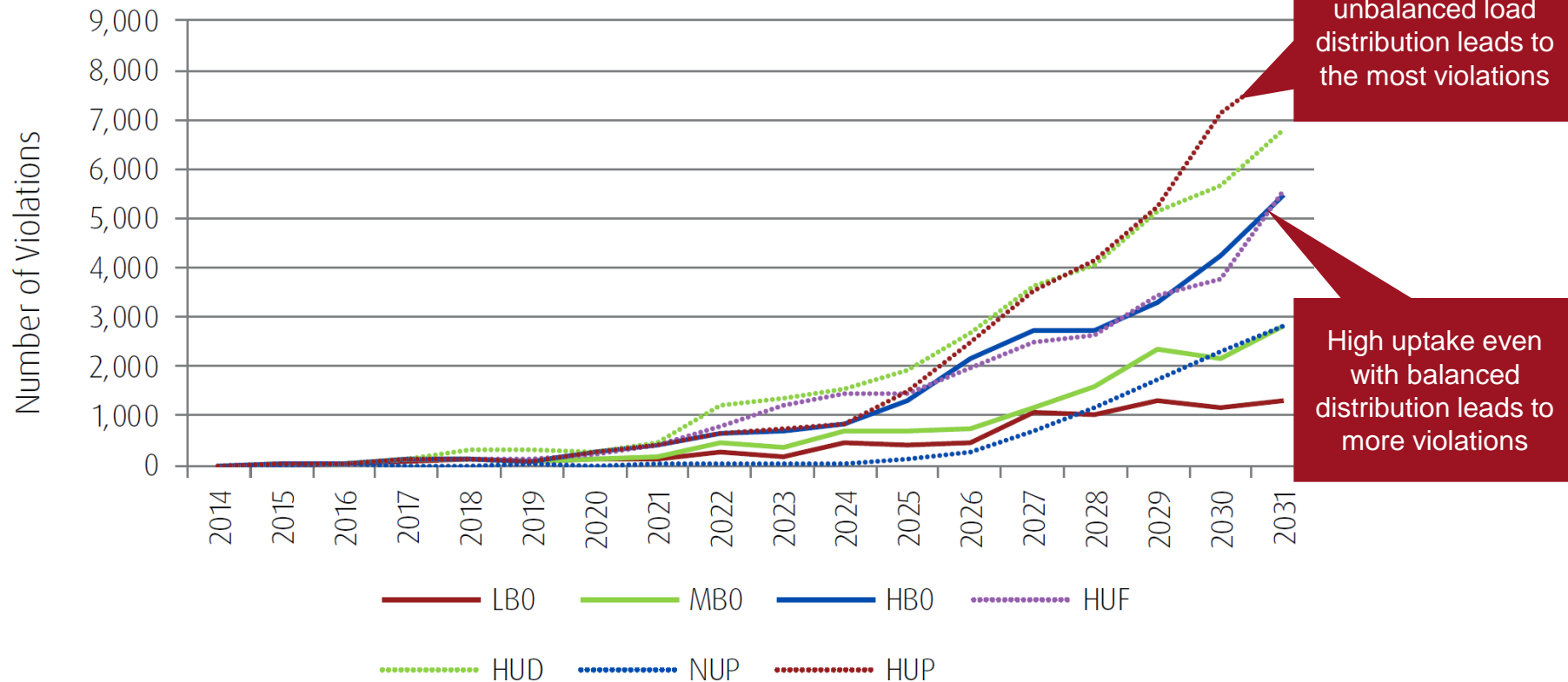
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The most significant impact is on the LV network

Voltage violations per year relative to NB0



Source: LCL Report B2

We are using these insights to inform the business

- Updating load forecast models with the new figures
- Informing policy and standards on the management of LCTs e.g.
ENA notification for heat pump power quality
- Revising design standards and approaches
- There are opportunities for the smart optimisation of LCT loads –
particularly EVs

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Demand shifting can be achieved

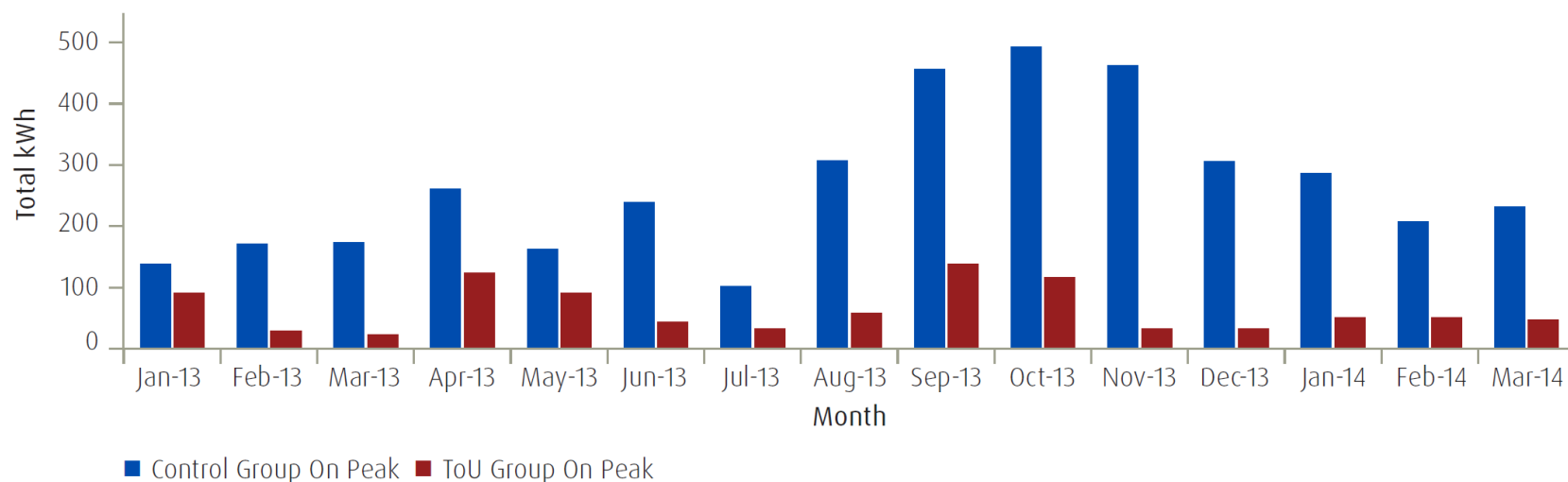


There is potential benefit for DNOs to develop opportunities for smart optimisation of new transport loads

Demand shifting can be achieved in two distinct ways:

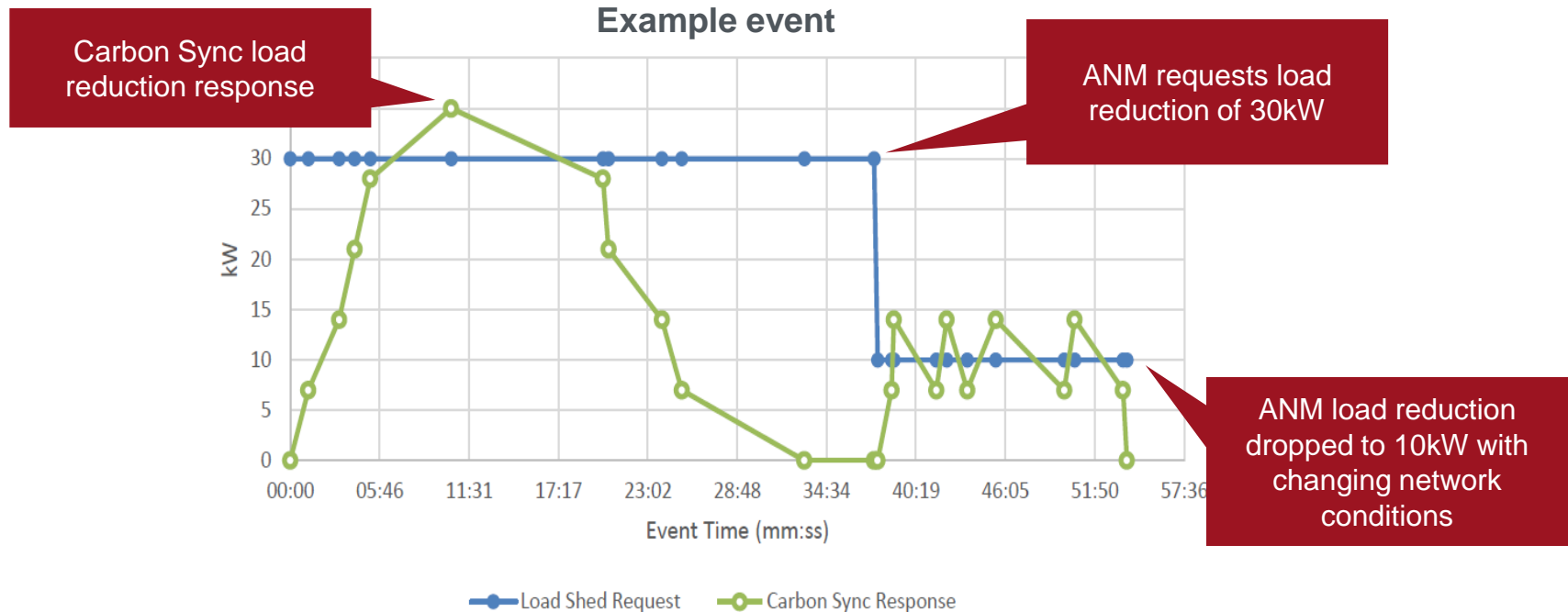
- Encouraging **behavioural** changes consisting of financial incentives aimed at influencing customer behaviour
- **Technical mechanisms**, such as cyclic switching of specific loads at peak times

Time of Use tariffs can be used to encourage a change in consumer behaviour to shift EV charging outside of periods of peak demand.



Source: LCL Report B5

Automated real time network management can be achieved through the combination of ANM and the utilisation of an EV controller



Source: LCL Report B2

Realising the benefits depends on a number of factors

- LCT uptake and concentration
- Coordination across industry is required to extract the benefits of mechanisms such as Time of Use tariffs
- Each consumer group presents a different opportunity
 - Residential: flexible, available and fairly reliable demand
 - Head-duty commercial: e.g. freight, inflexible but potential for smart connections
- A vendor agnostic solution would be most appropriate

LCL has concluded that different EV user groups are suited to different control mechanisms – dictated by their charging behaviour

		Domestic Private	Domestic Public	Fleet	Public Transport
Behavioural Intervention	Education	✓		✓	
	Time of Use	✓		✓***	
Technical Intervention	SMETS ALCS	✓			
	EV Controller		✓	✓	
	ANM		✓	✓	
	Reinforcement / New Connection	✓			

Source: LCL Report B5

The findings from **Low Carbon London** represent a step change in understanding the electricity network required for a low carbon future.

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