Electric Vehicles (EVs) & Electricity Supply

A Webinar Presented for:

green power ACADEMY

&

by

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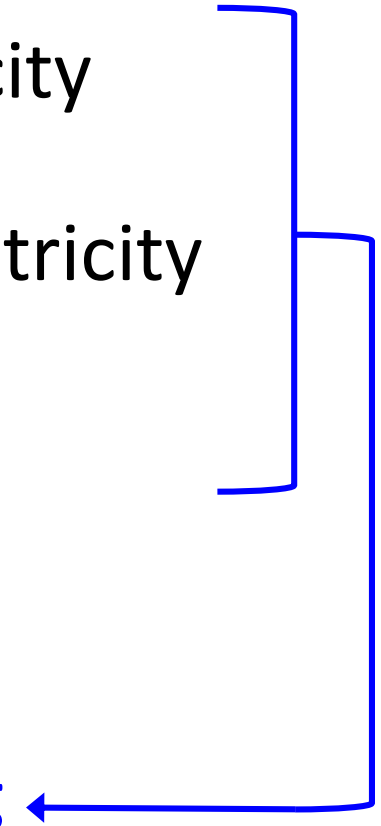
3 Key Issues → 1 Conclusion

1. The additional demand for electricity
2. Local constraints on accessing electricity
3. The “cleanliness” of electricity



Additional Demand for Electricity

Additional Demand for Electricity

Policy
Cost
Performance
Image

Number of EVs → Rate of growth?

x

Policy
Cost
Need

EV **usage** (km driven) → Alternatives?

x

Technology

EV **efficiency** (kWh/km) → Improves?

=

Electricity used (kWh)

+

Grid Losses (7-8%) → Distributed generation?

=

+ Other electricity demands?

Required electricity **generation** (kWh) → Growth?

Example calculation

10 million EVs ← UK has 31 million cars

x

12,500 km per year ← UK average (2016)

NB. this has been falling

x

20 kWh per 100km ← Nissan Leaf, kWh/100km: 14 (Nissan) to 18 (EPA)

NB. usual "real world" caveats…

=

25,000,000,000 kWh per year

↑ *8% grid losses*

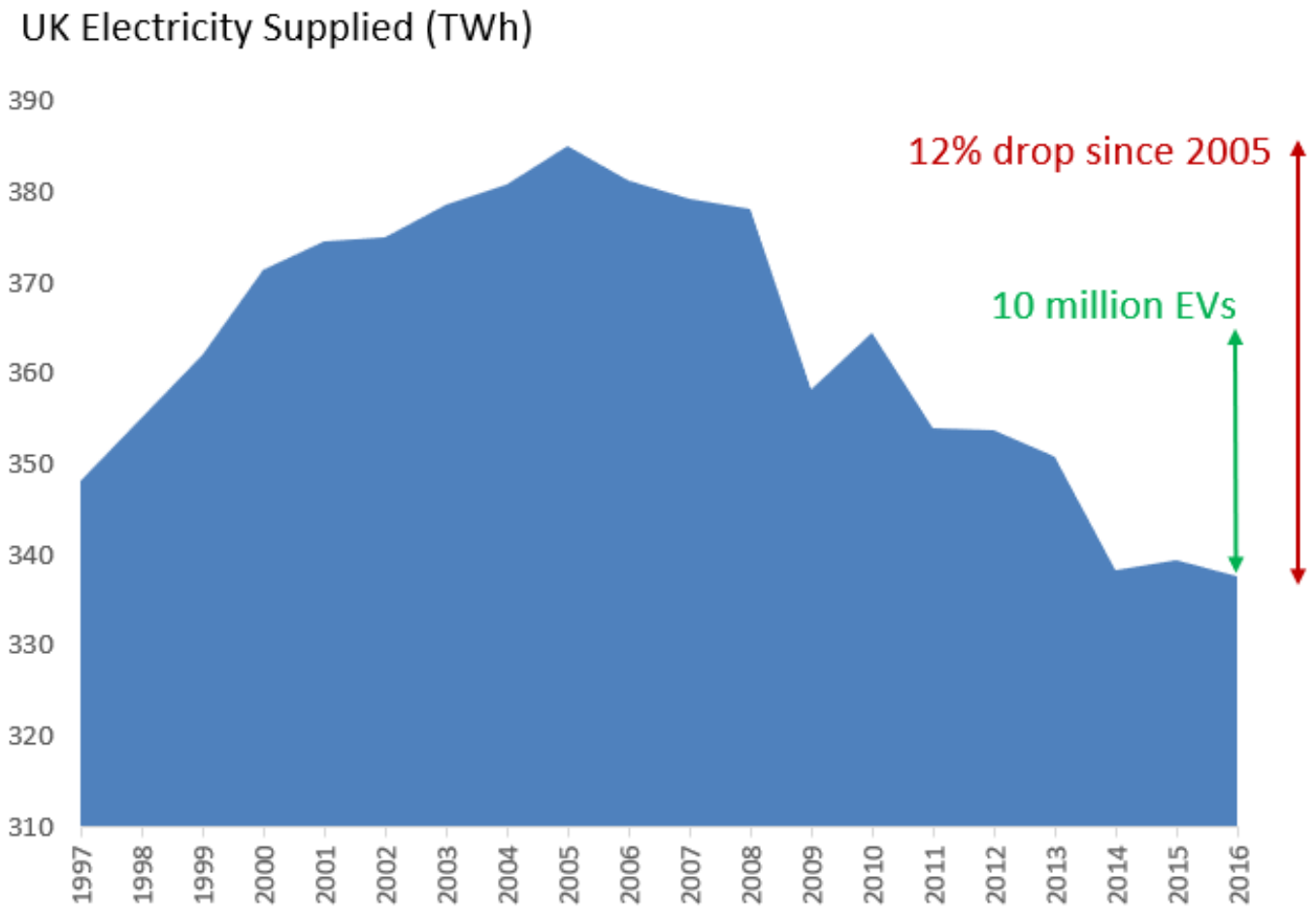
27,174 GWh per year supplied

Compared to:

8% increase ← UK total electricity supply (2016): 338,000 GWh

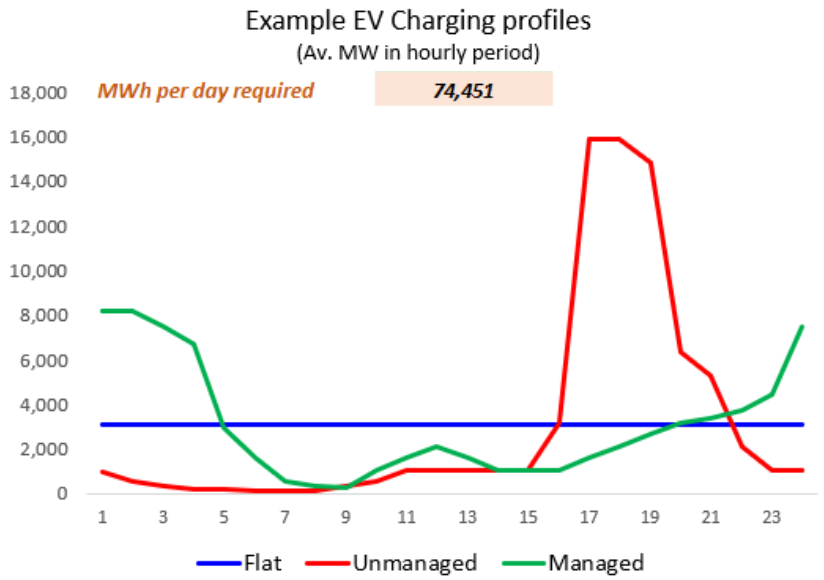
Q: Do EVs need more power plants?

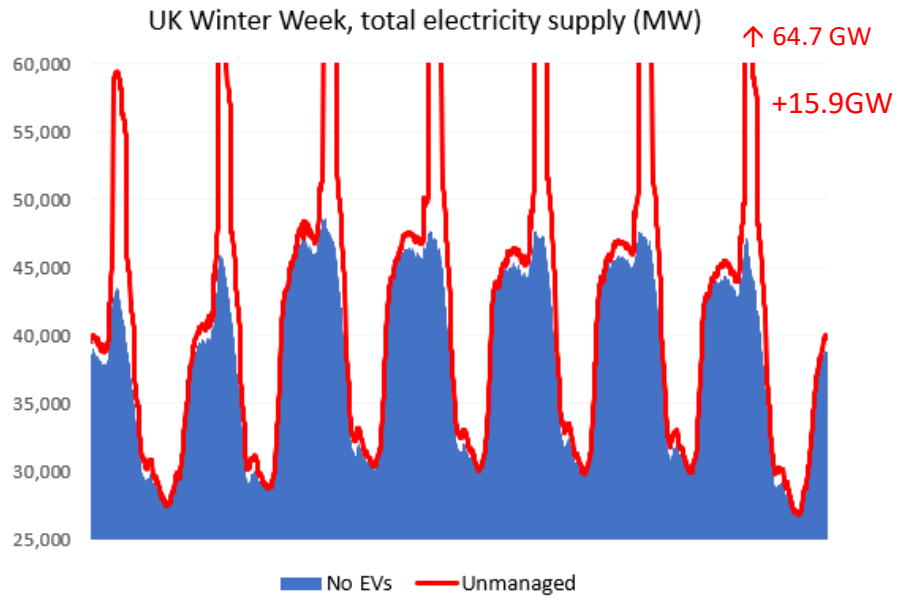
A: This doesn't just depend on EVs!

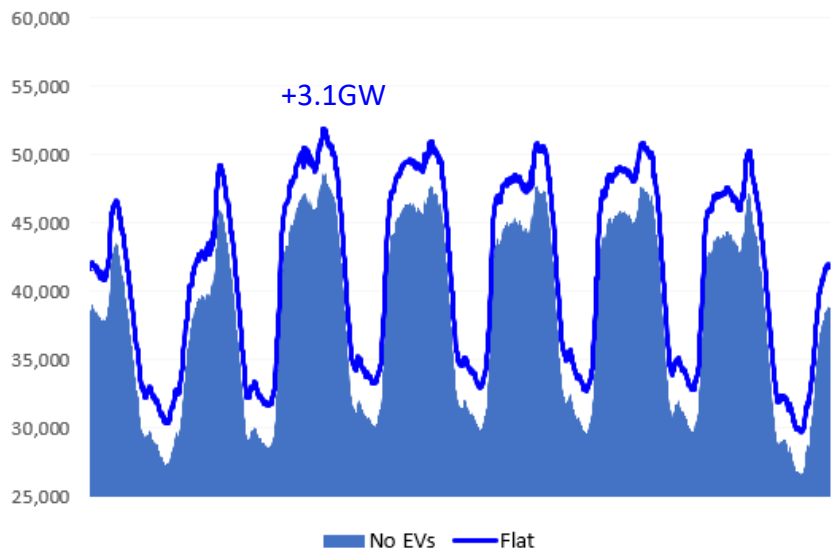


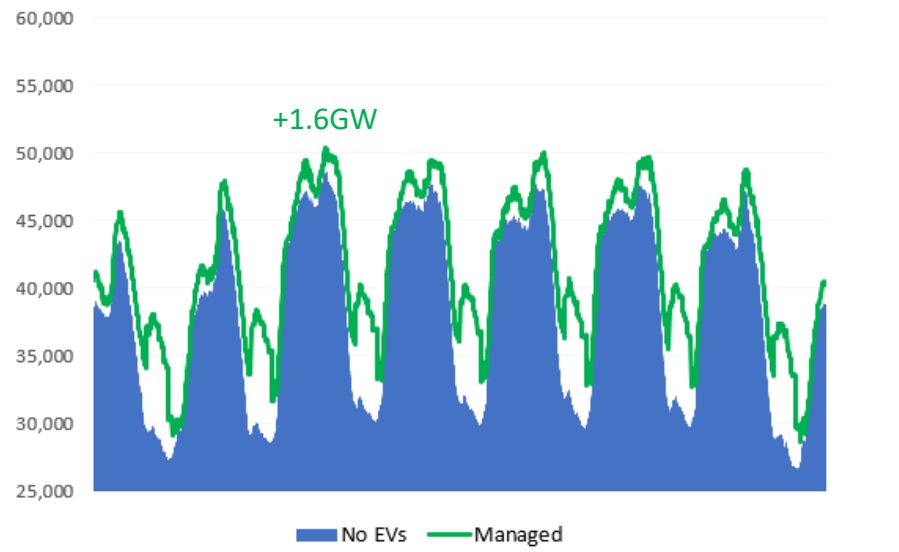
Data: UK government; note that "electricity supplied" is *total* supply, including imports and before grid losses

Charging & Peak Demand (Power)









Demand data is for noon 6th – noon 13th January 2018, from "gridwatch". EV impact analysis by Grey Cells Energy

Local Distribution Capacity Constraints

Local Capacity Constraints

Individual devices, e.g.:

Electric shower:	7-10 kW	*5 mins?*
Standard EV charger:	3-7 kW	***2-8 hours?****
Oven:	2-5 kW	*½ - 3 hours?*
Kettle:	2-3 kW	*1 minute?*

?

Individual home capacity, e.g.: 14-24 kW

"Demand Diversity"

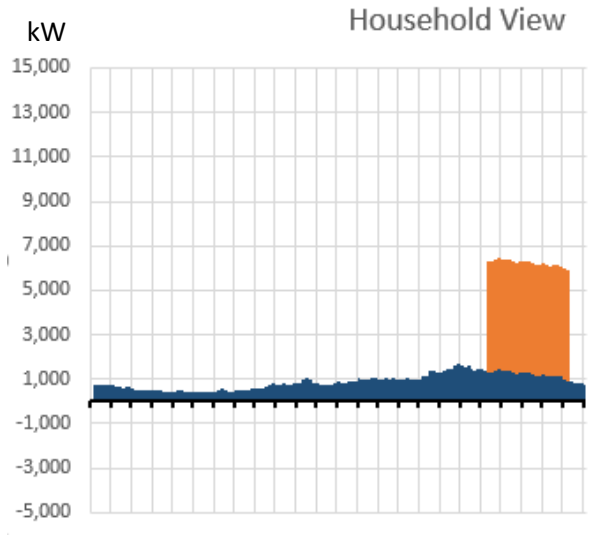
Distribution network feeder, e.g.: 100 homes, 200 kW

(Voltage drop design envelope)

*** Note:**

- An annual mileage of 12,500 km means an average of just **34 km per day**.
- Using 50 km per day (higher weekday usage?) and 20 kWh/100km, that's **10 kWh per day**.
- Charging at an average rate of 3-5 kW, that's just **2-3 hours per day**.

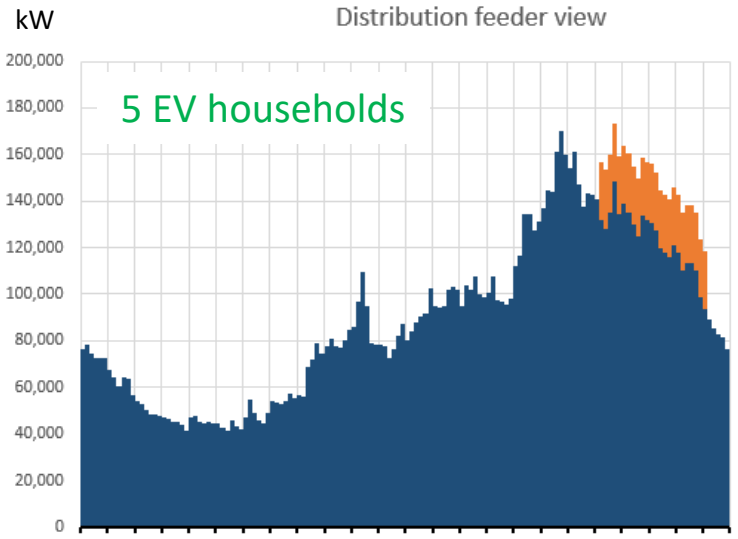
Example: House vs. Street

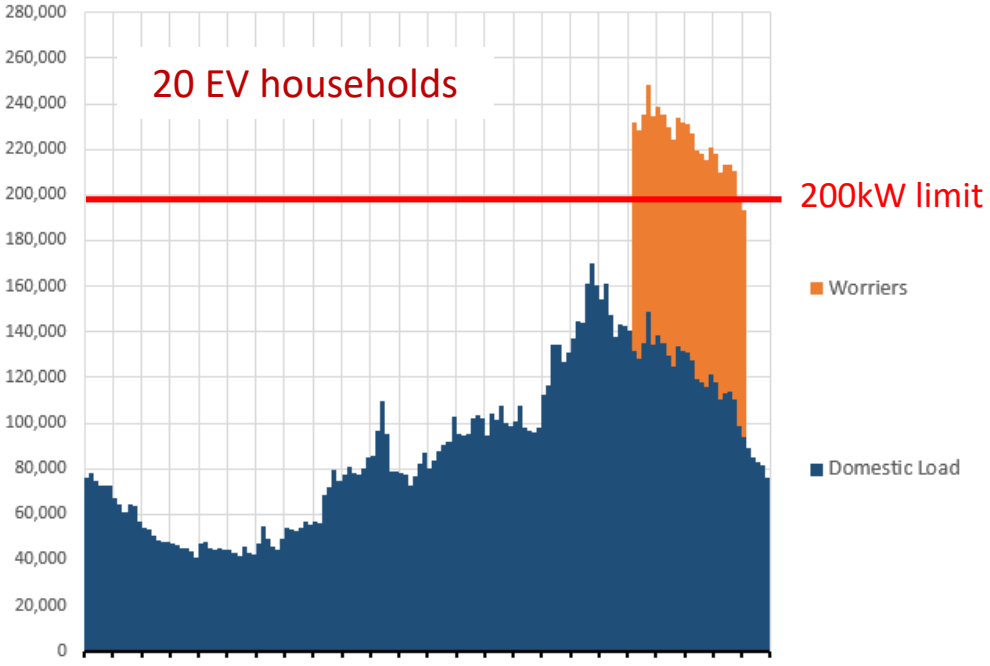


- 40kWh battery, 100km commuter, 20kWh/100km efficiency = 50% SoC
- 7pm plug-in and av. 5kW charge rate
- Fully charged by 11pm

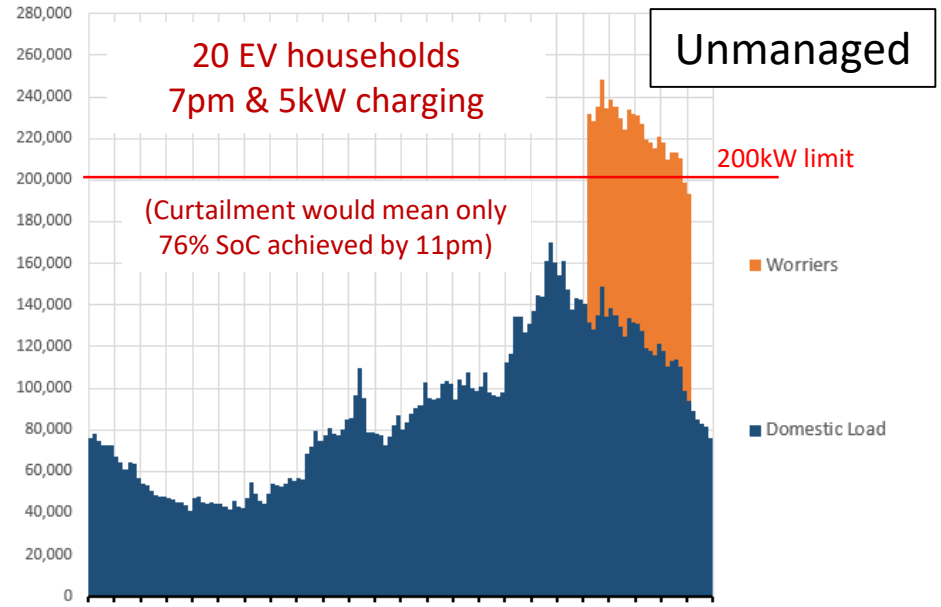
Average **January**, based on UK gov. household electricity survey, detached 99-149m^2 home

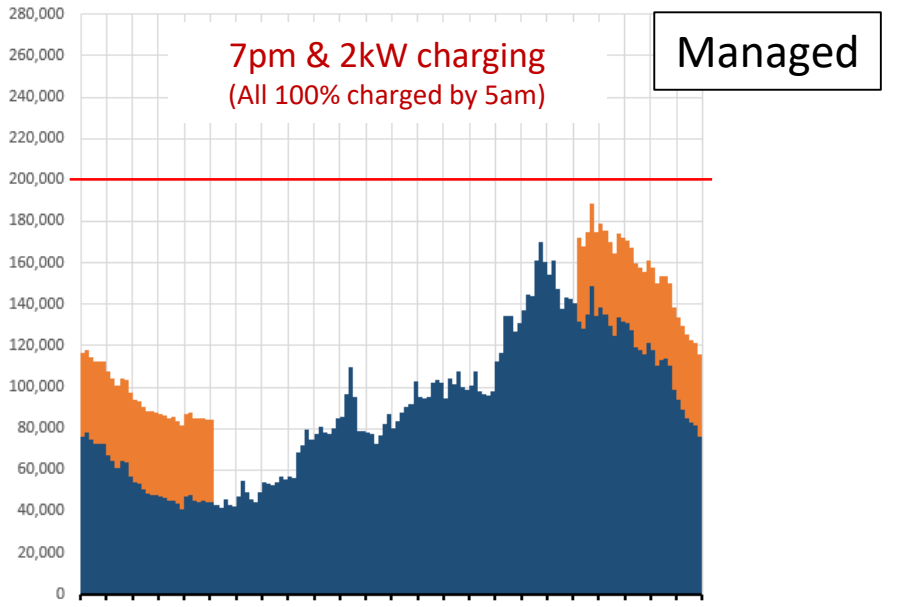
100 households:

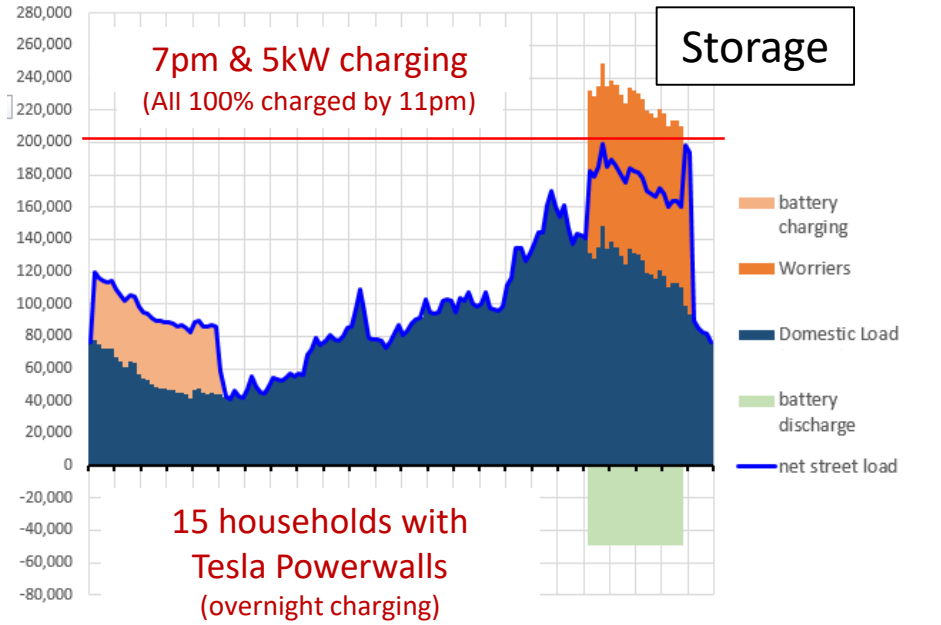


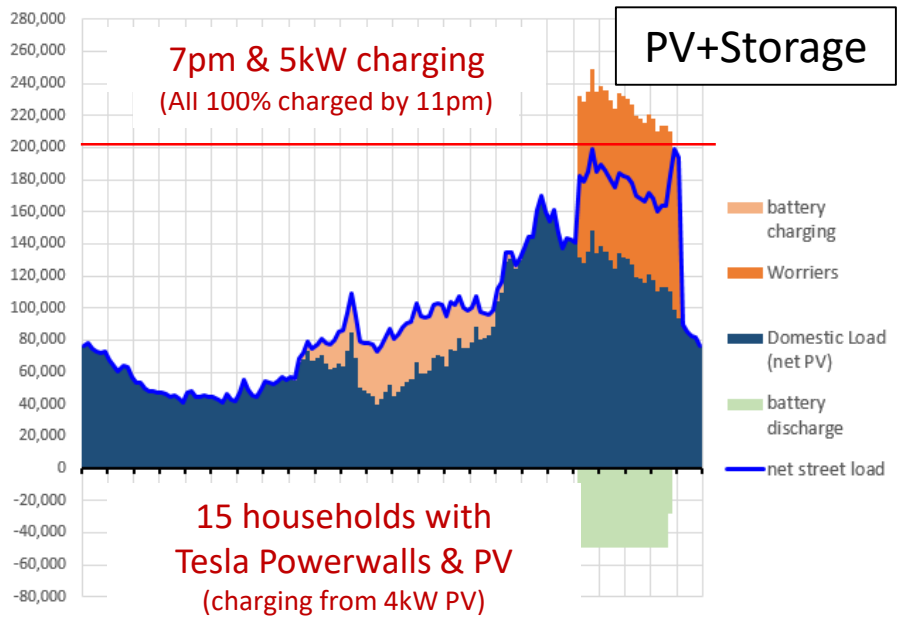


Solutions?


Unmanaged
20 EV households
7pm & 5kW charging
200kW limit
(Curtailment would mean only
76% SoC achieved by 11pm)
Worriers
Domestic Load

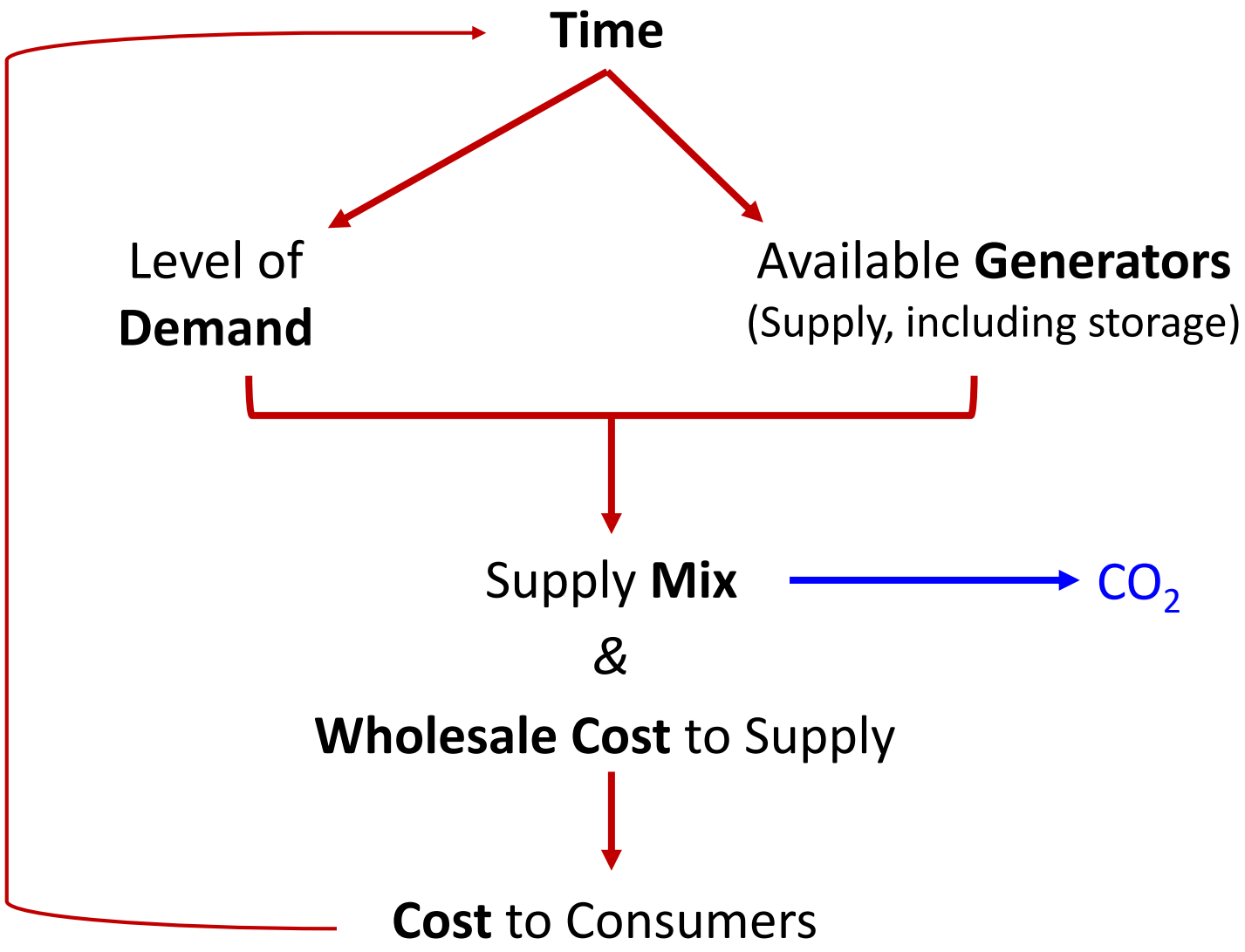

Managed
7pm & 2kW charging
(All 100% charged by 5am)


Storage
7pm & 5kW charging
(All 100% charged by 11pm)
battery charging
Worriers
Domestic Load
battery discharge
net street load
15 households with
Tesla Powerwalls
(overnight charging)


PV+Storage
7pm & 5kW charging
(All 100% charged by 11pm)
battery charging
Worriers
Domestic Load (net PV)
battery discharge
net street load
15 households with
Tesla Powerwalls & PV
(charging from 4kW PV)

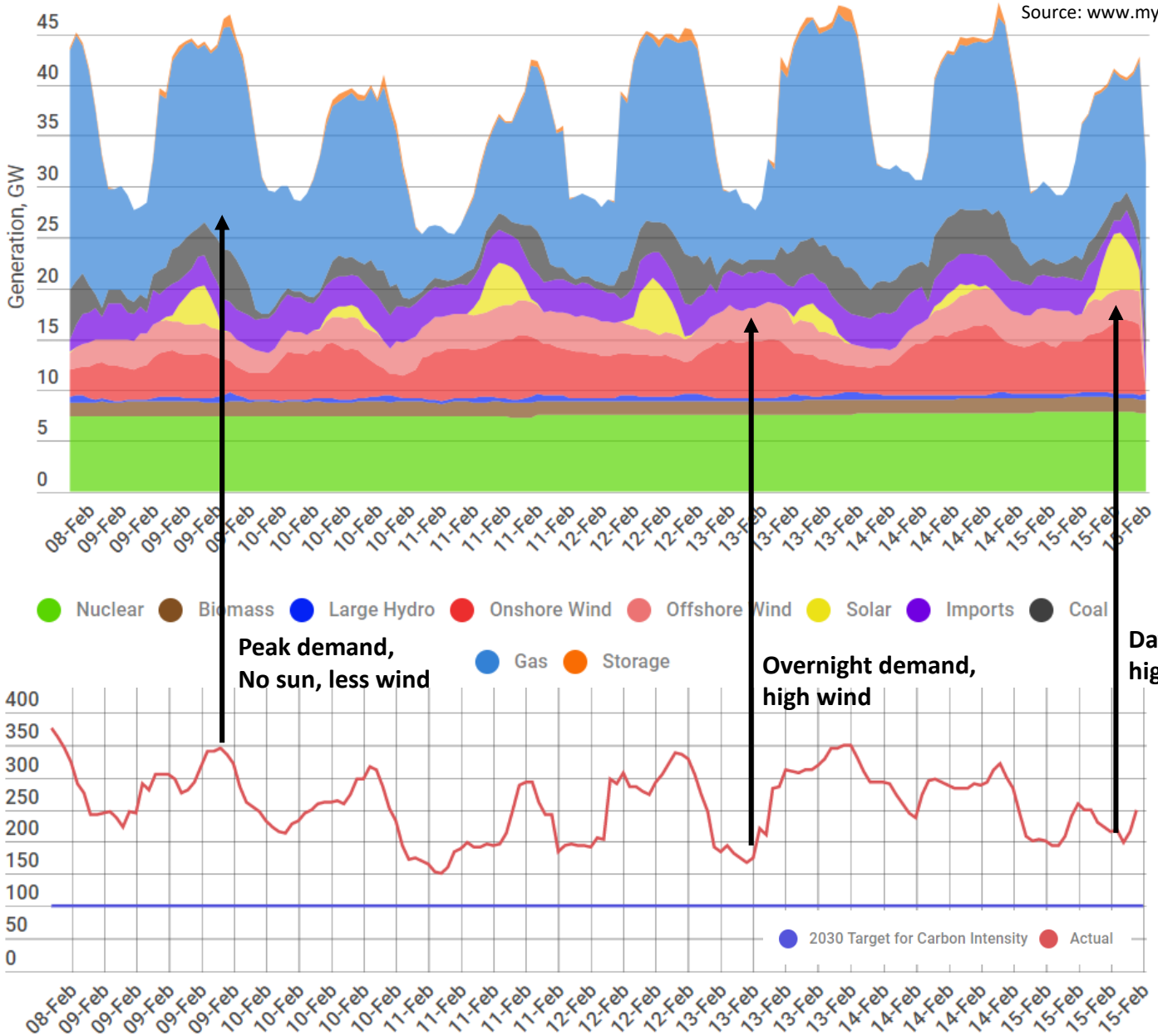
EVs, the Generating Mix and CO_2

“Cleanliness” of Electricity (CO_2)



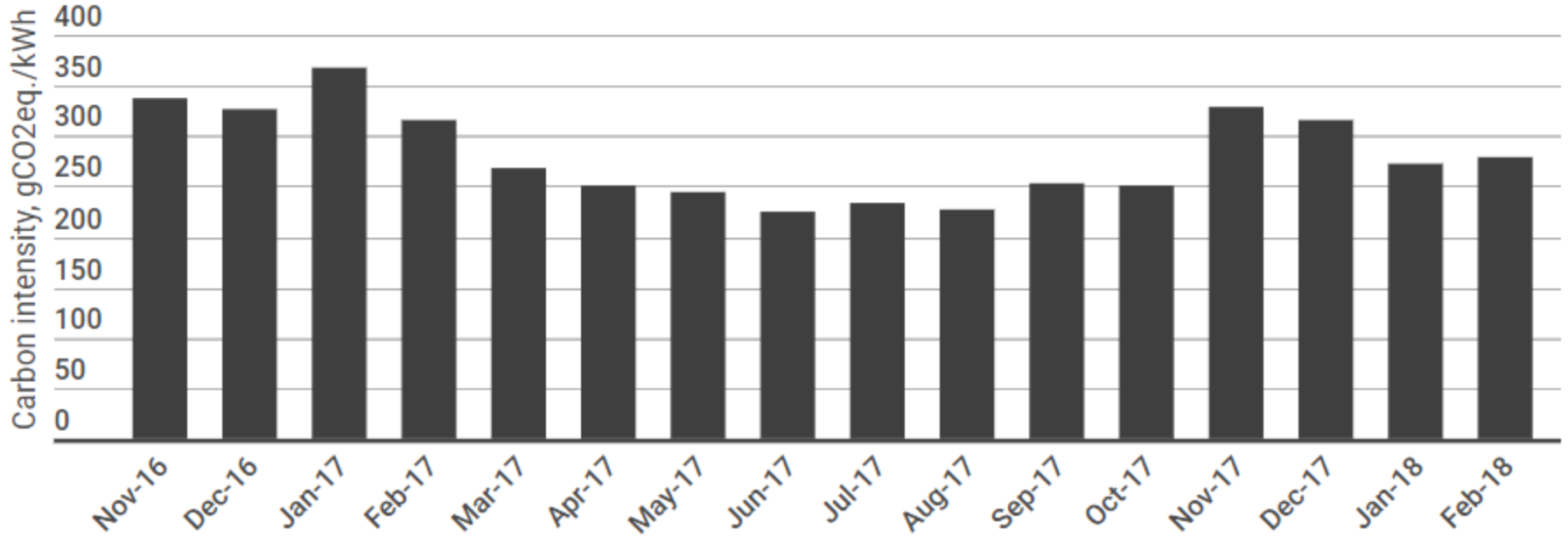
Electricity Mix & CO_2

Source: www.mygridgb.co.uk/last-7-days/



Seasonal variation & Annual Trends

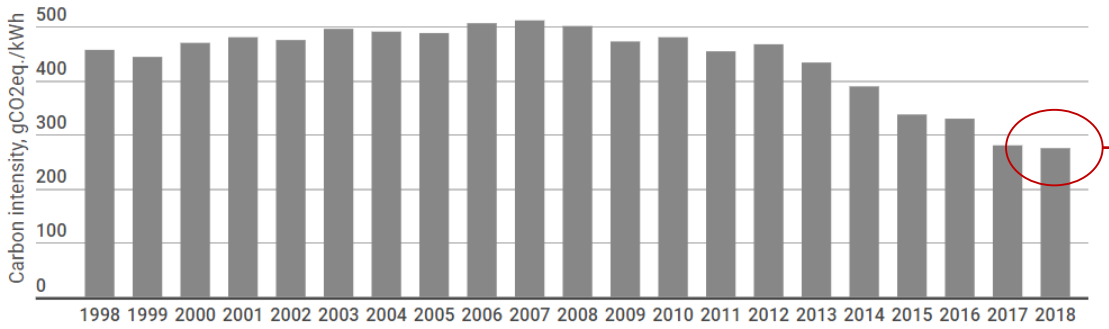
Monthly averages: CO_2 intensity of electricity generation



www.mygridgb.co.uk/last-12-months/

Summer: *lower demand, more sun,* ***no coal & less gas***

Annual Trend:



Year-to-date
(will fall in summer)

CO_2: EV vs. Petrol

EV	Petrol
kWh per km ("efficiency") x km x gCO_2 per kWh (electricity generated) = CO_2 emissions	litres per km ("fuel economy") x km x gCO_2 per litre (combustion) = CO_2 emissions

Assuming 12,500 km per year for both:

EV	Petrol
20 kWh per 100km & 150 – 300 gCO_2 per kWh (electricity) = 410 – 820 $kgCO_2$ per vehicle per year	3 – 7 litres per 100 km & 2.35 $kgCO_2$ per litre (combustion) = 880 – 2000 $kgCO_2$ per vehicle per year

"Dirtiest" generation mix *vs.* Best fuel economy (= 94 mpg, UK)

Summary: Managed Charging Options

Least CO_2?

Off-peak charging *is usually* low-C charging

*+ **Storage** (time-shifting)*

Lowest cost (ToU tariffs)?

Off-peak charging *should be* cheaper charging

*New **tariffs** needed*

Available distribution capacity?

Off-peak charging *helps with* available capacity

*Charging **options** & **controls** needed*

Thanks for Listening!

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More articles & analysis here: ***greycellsenergy.com***

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