Smart Grid Flexibility 2019

Dreev: Vehicle to Grid

Preparing the energy system for the mass uptake of EVs and exploring their potential as a flexible asset delivering Vehicle-to-Grid response

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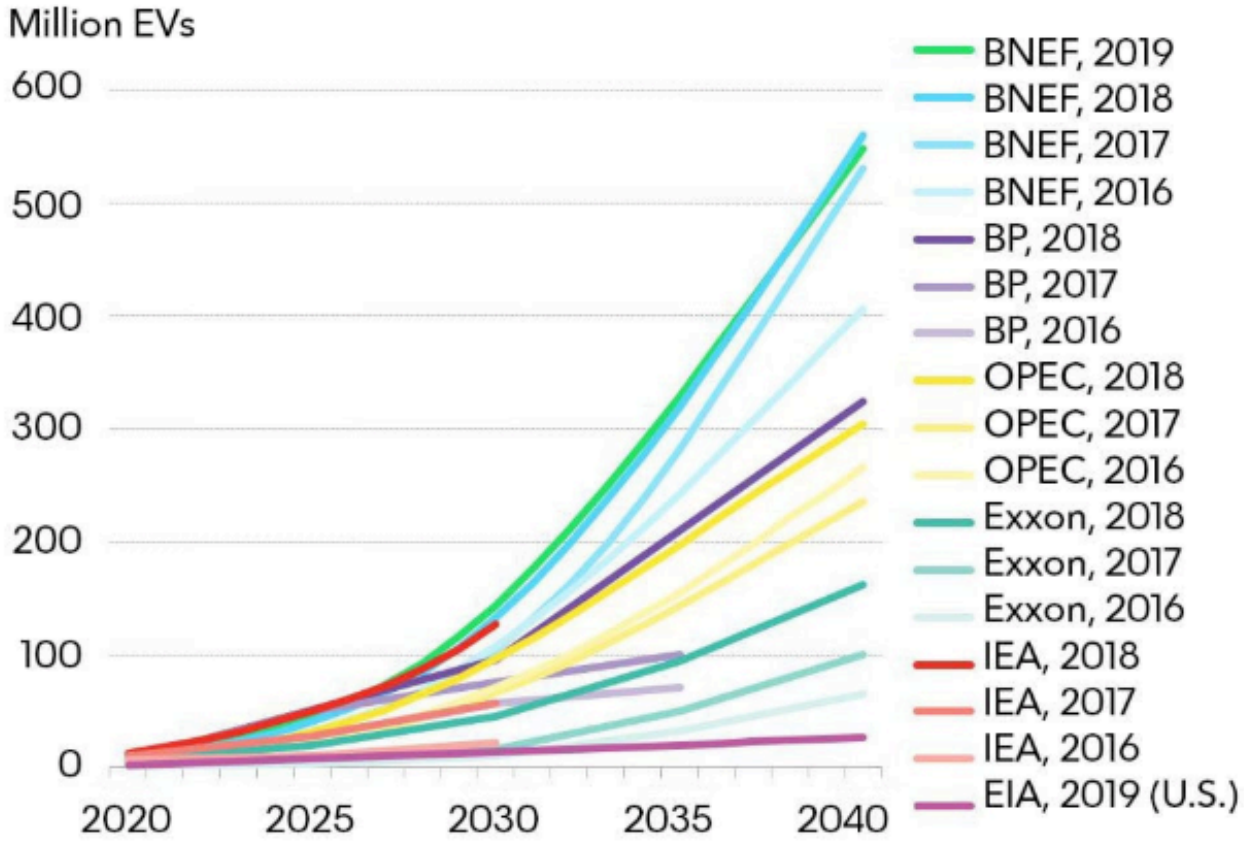
Dreev, EV aggregator, Specializing in V2G and Smart Charging

- Dreev manages the charge and discharge (V2G) of Electric Vehicles
- By monetizing EV's storage potential on the energy markets, **Dreev helps reducing EV Total Cost of Ownership**
- While making sure that EV drivers mobility needs are always met
- Dreev solutions relies on Nuvve's patented technology, already deployed and validated on 5 continents
- V2G enables a **larger integration of renewables**
- Dreev is a joint-venture by Nuvve and EDF

The Adoption of Electric Vehicles

Organizations are adjusting their forecasts for faster rates of EV uptake and adoption

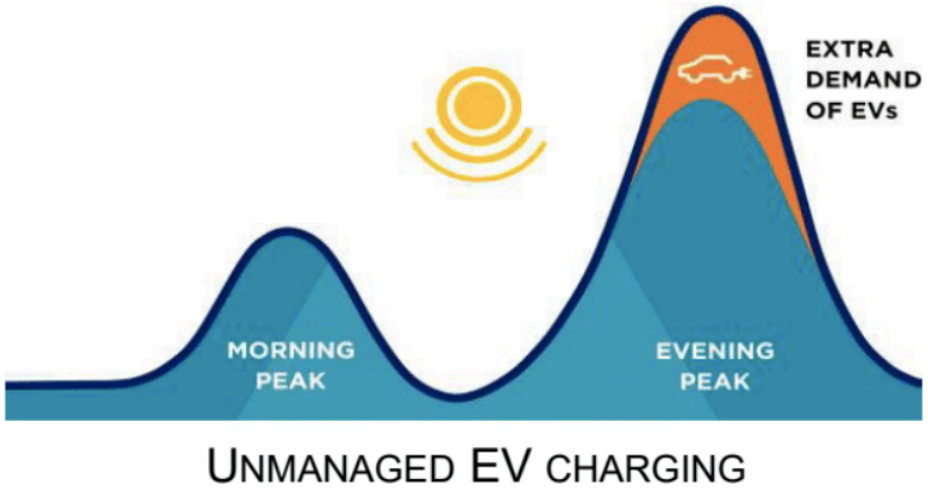
EV Outlooks then and now



Source: BloombergNEF, organization websites. Note: BNEF's 2019 outlook includes passenger and commercial EVs. Some values for other outlooks are BNEF estimates based on organization charts, reports and/or data (estimates assume linear growth between known data points). Outlook assumptions and methodologies vary. See organization publications for more.

By 2040, we expect ***57% of all passenger vehicle sales***, and over ***56% of light commercial sales***, will be electric

– Electric Vehicle Outlook 2019, BloombergNEF



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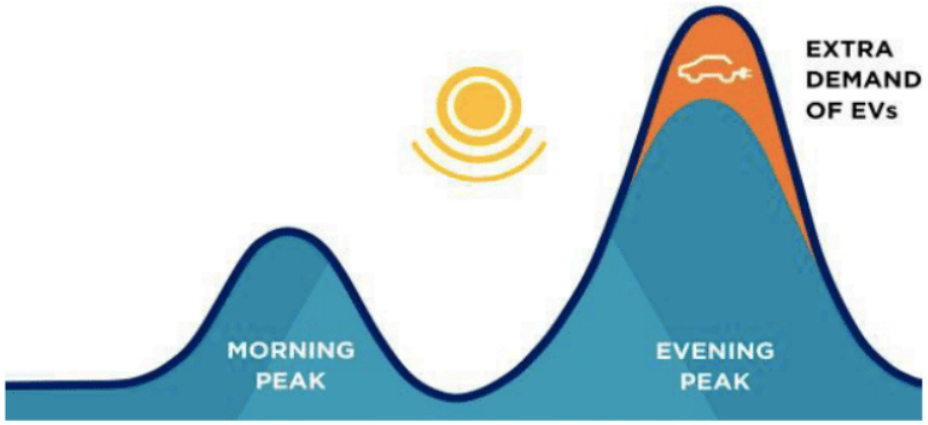

UNMANAGED EV CHARGING

5 GW to 18 GW of additional peak demand in the UK with unmanaged EV charging[1]

£17 billion in Network Reinforcement costs in the UK by 2050[2]

5% of Global Energy Consumption in 2040

[1)] *National Grid Future Energy Scenarios 2017*
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[3)] *Bloomberg New Energy Finance Electric Vehicles Outlook 2017*

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How do we continue to support the uptake of renewables while meeting the rapidly increasing global EV adoption?

Why should we integrate EVs and renewables?

The Problem

Air pollution and green house gas emissions are mainly driven by the energy and the transport sectors.

There is a lack of common approach to jointly integrate renewables and electric vehicles to accelerate the adoption of both technologies.

Our Solution

We bridge the gap between intermittent renewables and powering electric vehicles.

We provide solutions to integrate transport and energy by adding up flexible means for renewables, grid services and EV charge optimization.

From lab research to commercial deployments

A first fleet of 10 EVs officially participates in grid services and helps integrating renewables

Nuvve gets financial support from Toyota Tsusho and EDF RE

Nuvve and EDF launch a joint-venture to address the EU market

1996 — 2012 — 2015 — 2017 — 2018 — 2019

Professor W. Kempton (Nuvve CTO) develops the concept of V2G and proves its feasibility

Nuvve manages the charging process of 19,000 charging stations in the NL

Nuvve operates projects on the 5 continents

What is Vehicle to Grid?

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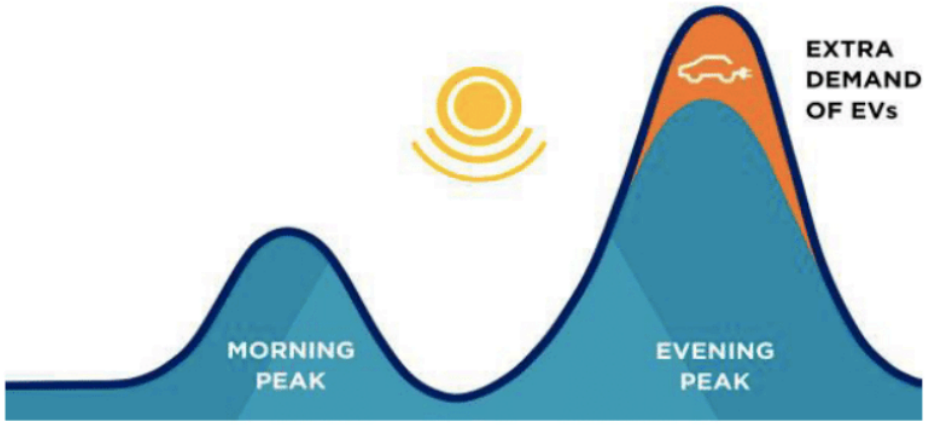

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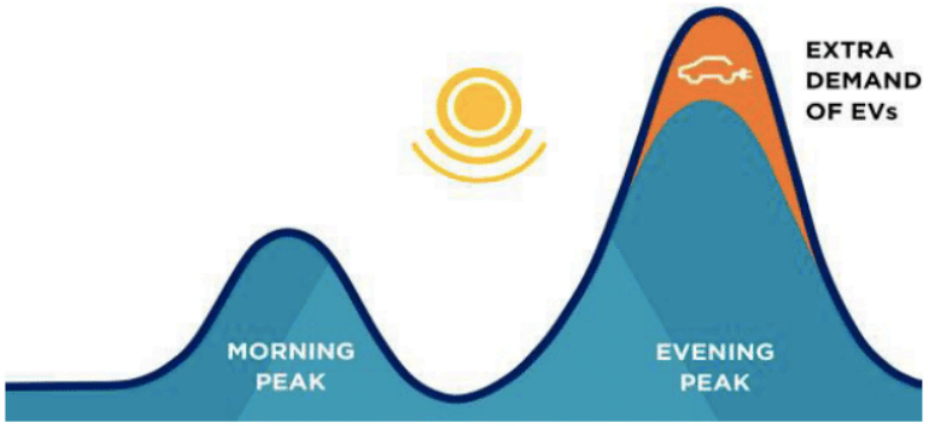

UNMANAGED EV CHARGING

SMART EV CHARGING

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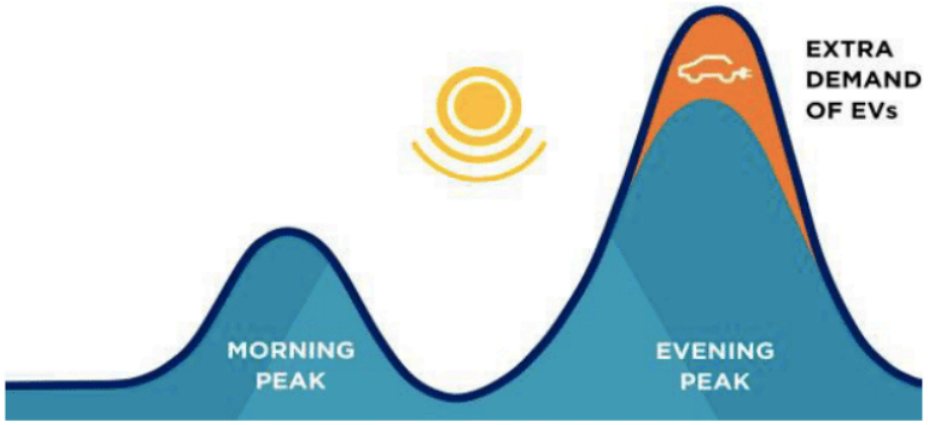

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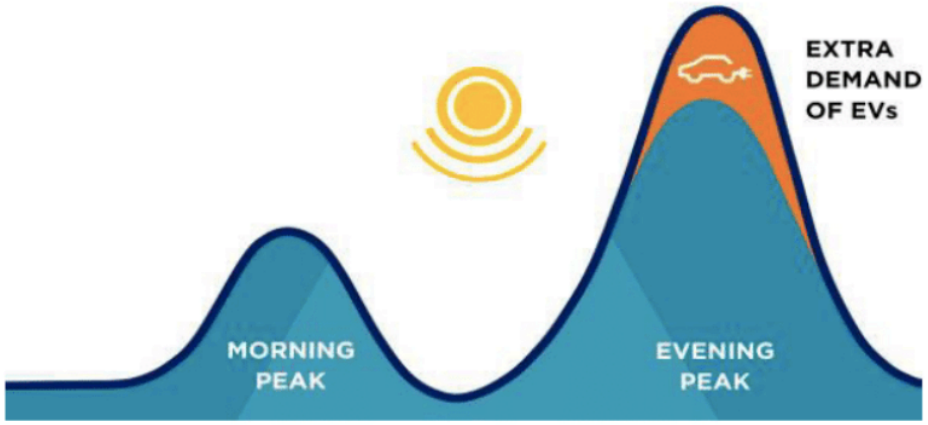

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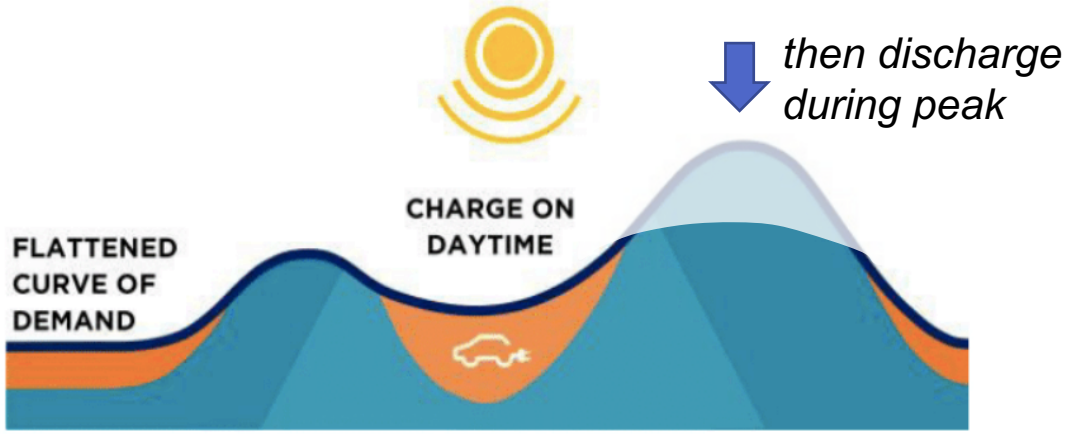


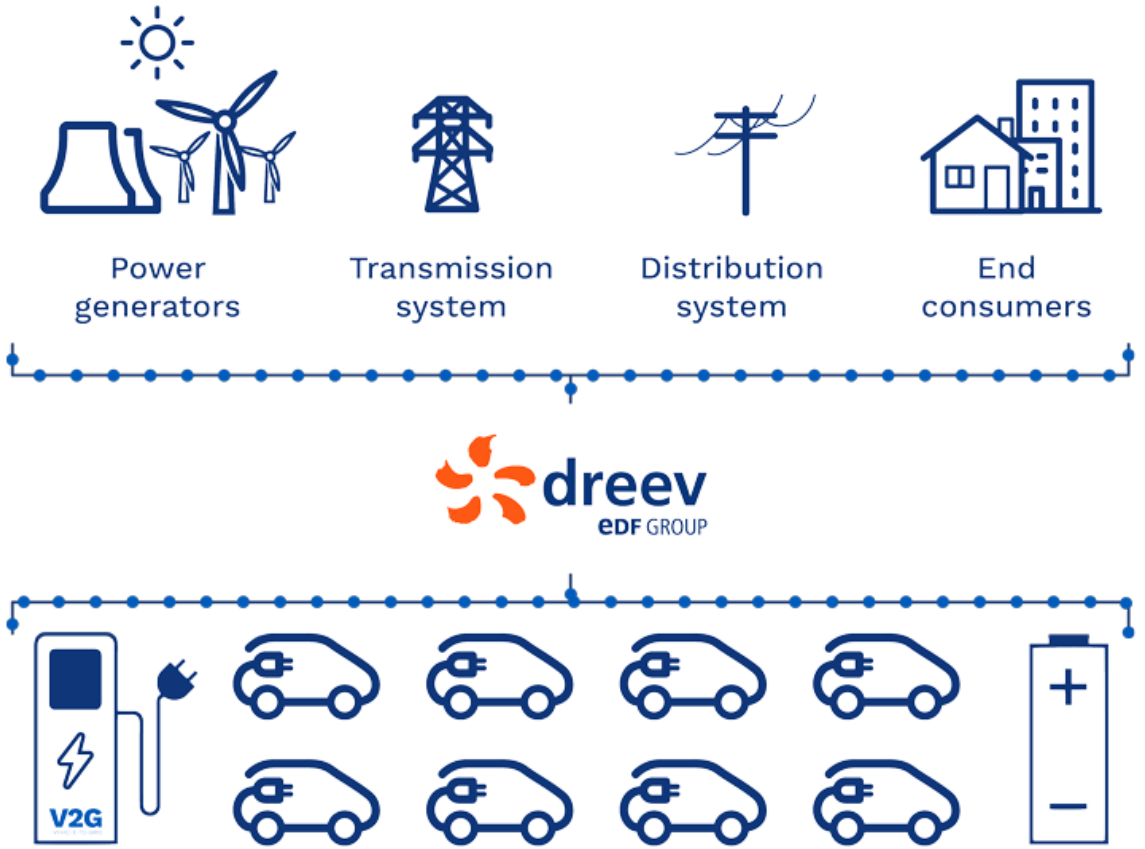
SMART EV CHARGING

What is V2G?

The energy stored in EV batteries can power a building, a neighborhood and even support the entire electric system!

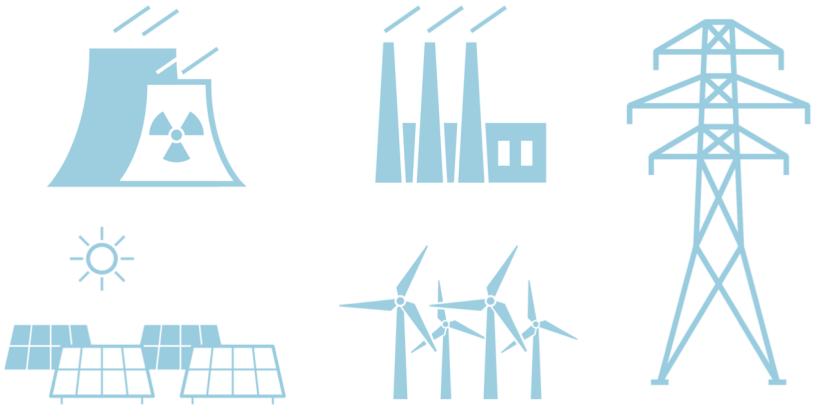
These grid-integrated vehicles become an active and essential part of the electric grid, they help integrate more renewables and enable to bridge the gap between energy and transportation

With V2G technology, each EV makes a difference!



V2G Markets

Transmission System



Frequency regulation, voltage control

Distribution System

Transformer upgrade deferral, congestion management

Behind the Meter

Peak shaving, tariff optimisation, arbitrage, emergency back-up

Unlocking the Value

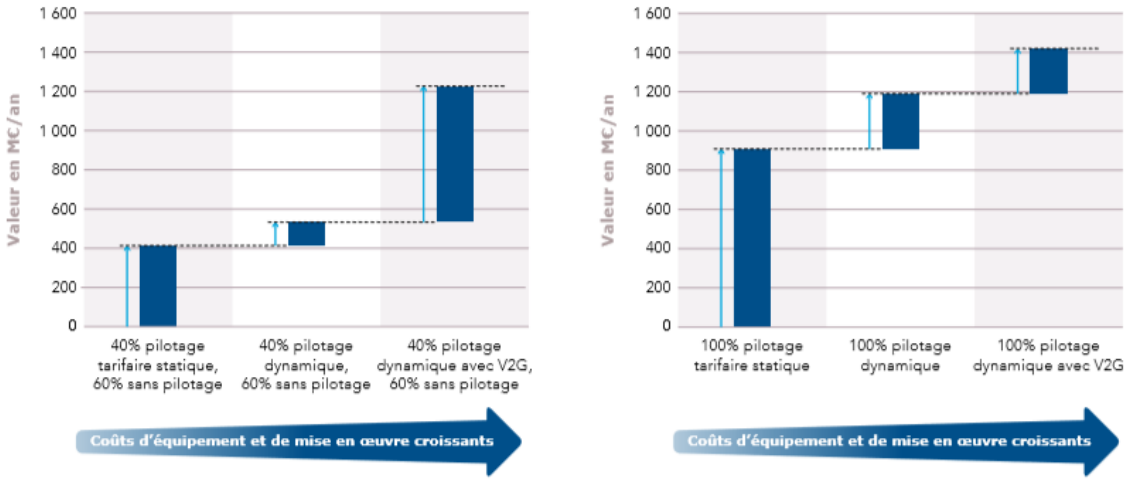
Why is V2G and Smart Charging Important?

V2G value could be worth £3.5Bn/year in UK by 2040
(source: Innovate UK)

Scenario		Energy system benefit (£bn/yr) Smart Charger	V2G
Burning platform	(assumes 50% participating vehicles)	0.1	0.15
Stepping stone	(assumes 50% participating vehicles)	0.5	1.4
Future survival	(assumes 80% participating vehicles)	1.1	3.5

EV flexibility is > €1Bn/year market in France
(source: RTE)

Figure 18. Gisement de valeur associée au pilotage dans le scénario *Crescendo* haut (variantes sur le développement du pilotage de la recharge, comparées à une situation sans aucun pilotage de la recharge)



Key Behind-the-meter V2G Services

Behind-the-meter value from V2G can be defined in **three broad types of services**:

Demand Response :

- Responding to events of **national peak demand** by reducing site load
- Tarif usually in $/kW-year

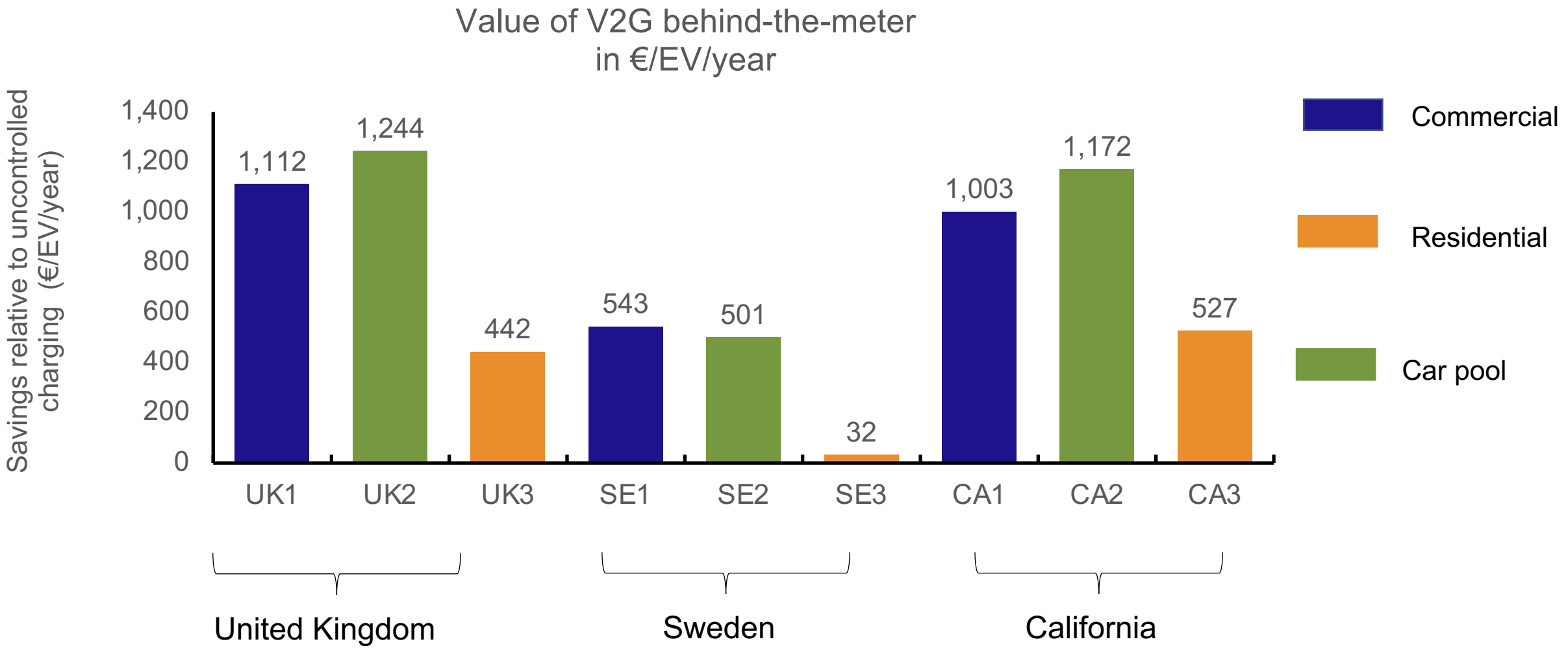
Time-of-Use (TOU):

- **Optimising** the variable (non-fixed) components of energy prices:
  - Energy (spot) prices
  - Distribution use of system charges
  - Capacity market supplier charges
- Tarif and charges applied in $/kWh

Demand Charge Management:

- **Mitigating** a site's maximum demand
- Tarif usually in $/kW-month

V2G Value - Analysis



Passing the V2G Value to Customers

- Your EV batteries work for you:
  you have to be rewarded for that!
- Keep control of your charge (in km)
  and plan your next trips at any moment
  with our Dreev mobile application
- An emergency?
  Our 10 kW V2G charger ensures a quick
  and flexible charge

Better points
Choice/override, reward and enhance their EV experience not hinder their use

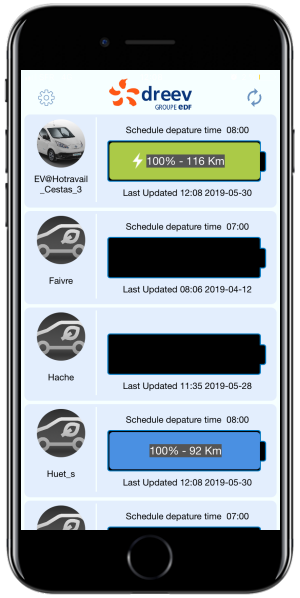
Drive, plug, we do the rest!

1 **Plug your car when parked**

2 **Schedule your next trips**

3 **The car is charged according to your preferences**

4 **Get a V2G Reward, Reduce your TCO!**



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Barriers to Mass V2G Adoption are starting to coming down

1. Gaps in the Regulatory Frameworks
2. Immature Industry Standards
3. Hardware Infrastructure and vehicle availability

V2G is Happening

Worlds First Commercial V2G Fleet

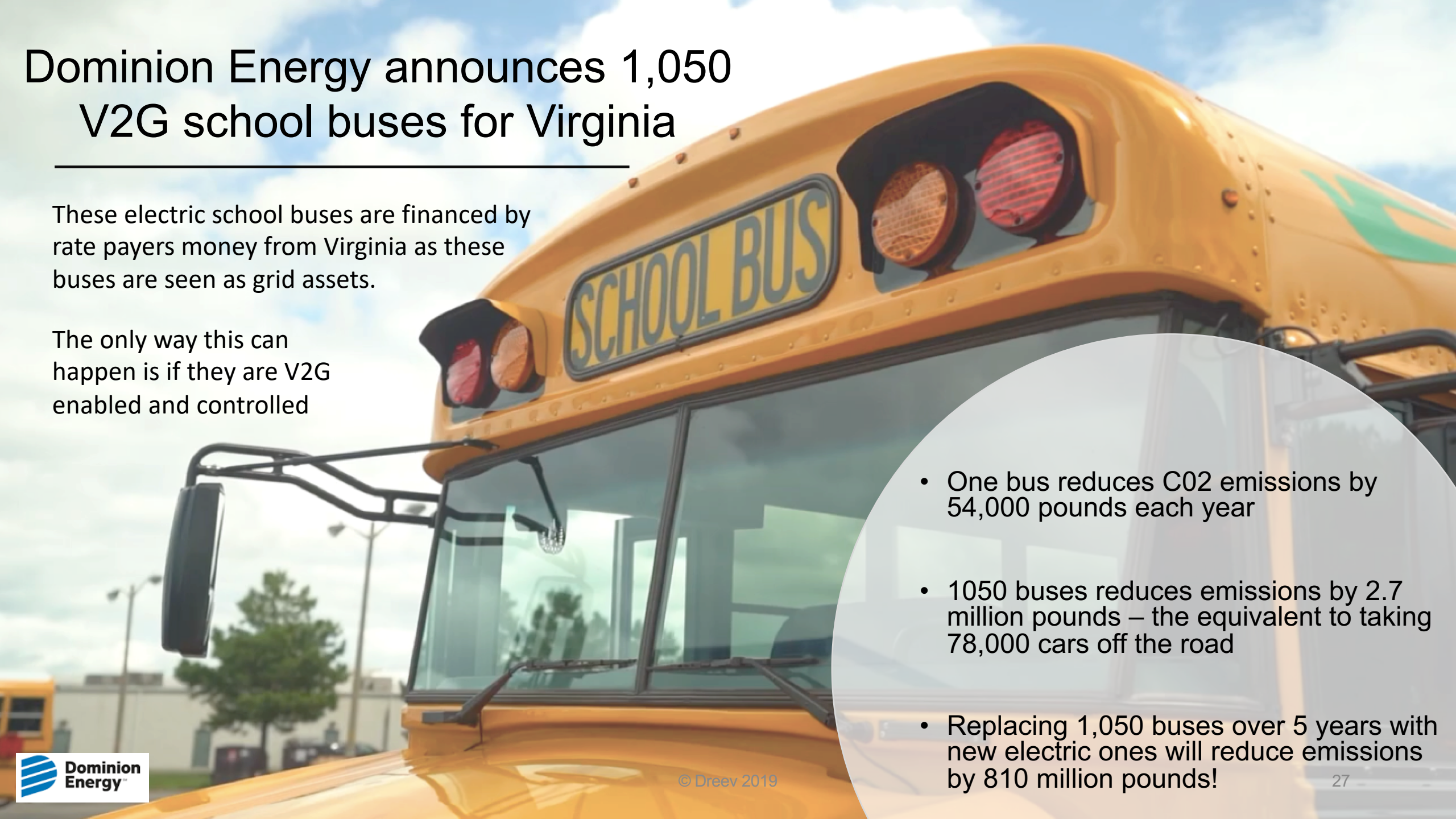
Real drivers, supporting renewable adoption, and lowering their TOC everyday with V2G

Each vehicle is generating **€1,860** of market participation revenue since Sept 2016

Dominion Energy announces 1,050 V2G school buses for Virginia

These electric school buses are financed by rate payers money from Virginia as these buses are seen as grid assets.

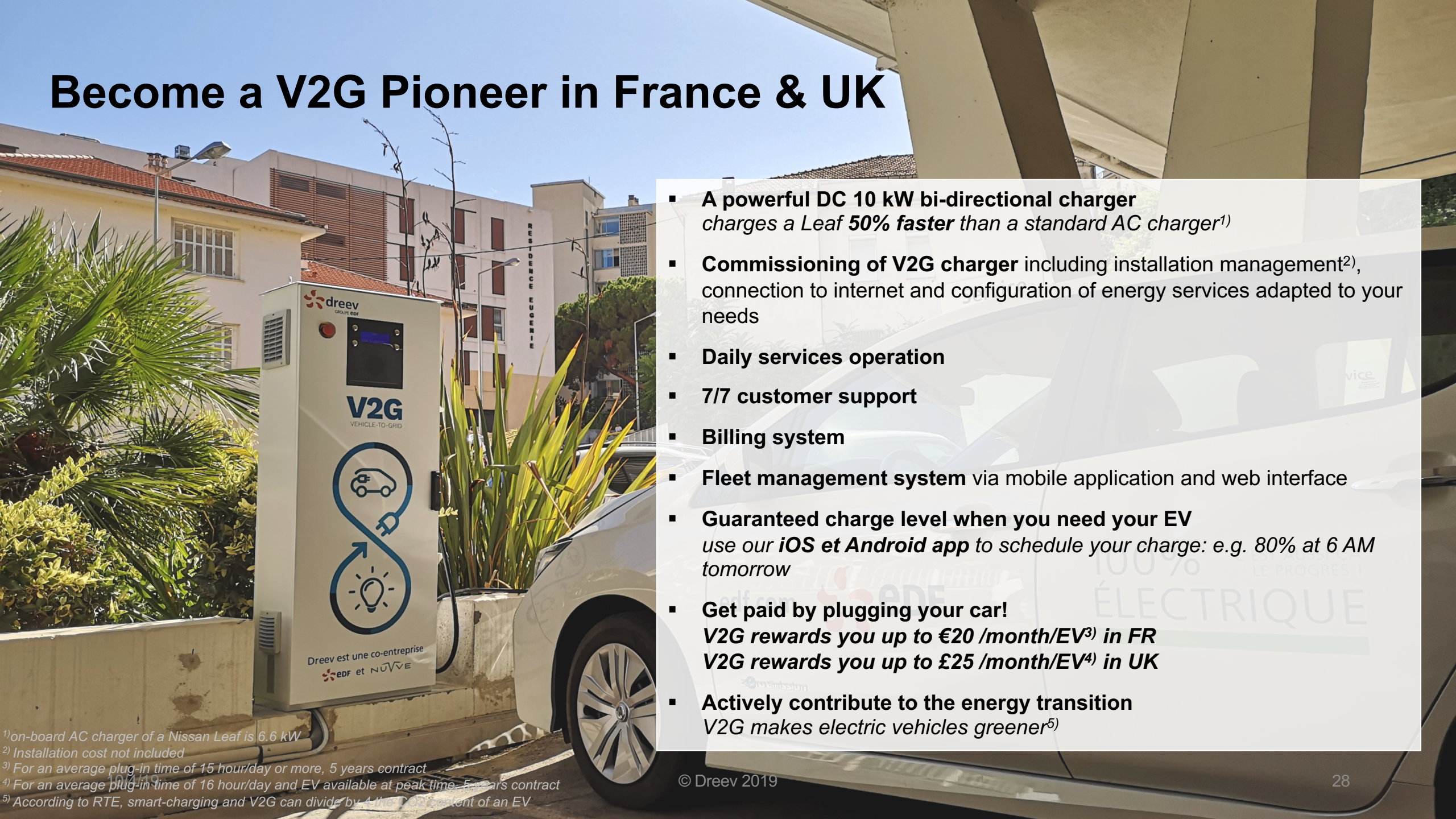
The only way this can happen is if they are V2G enabled and controlled



- One bus reduces C02 emissions by 54,000 pounds each year
- 1050 buses reduces emissions by 2.7 million pounds – the equivalent to taking 78,000 cars off the road
- Replacing 1,050 buses over 5 years with new electric ones will reduce emissions by 810 million pounds!

Dominion Energy

Become a V2G Pioneer in France & UK

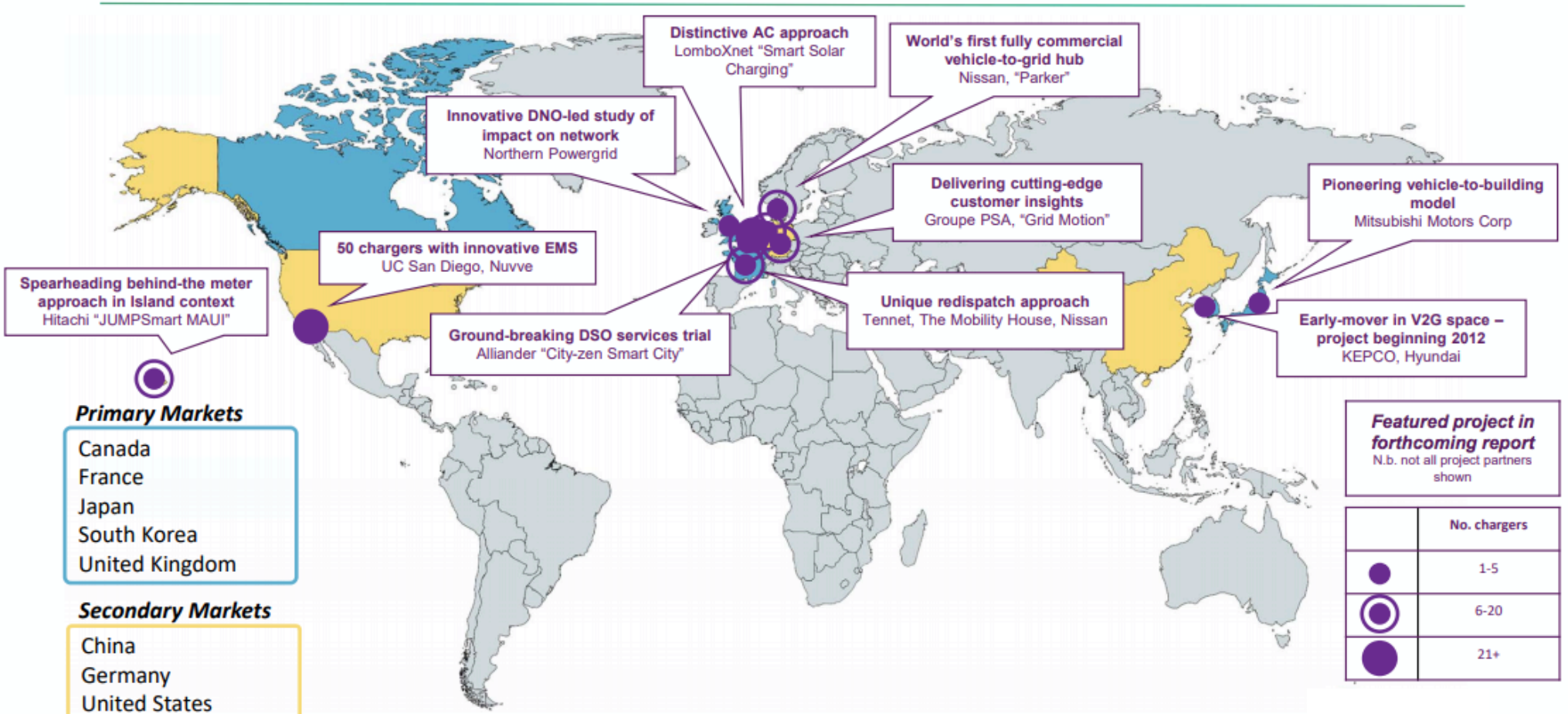


- **A powerful DC 10 kW bi-directional charger**
  *charges a Leaf **50% faster** than a standard AC charger[1)]*
- **Commissioning of V2G charger** including installation management[2)], connection to internet and configuration of energy services adapted to your needs
- **Daily services operation**
- **7/7 customer support**
- **Billing system**
- **Fleet management system** via mobile application and web interface
- **Guaranteed charge level when you need your EV**
  *use our **iOS et Android app** to schedule your charge: e.g. 80% at 6 AM tomorrow*
- **Get paid by plugging your car!**
  V2G rewards you up to €20 /month/EV[3)] in FR
  V2G rewards you up to £25 /month/EV[4)] in UK
- **Actively contribute to the energy transition**
  V2G makes electric vehicles greener[5)]

[1)] on-board AC charger of a Nissan Leaf is 6.6 kW
[2)] Installation cost not included
[3)] For an average plug-in time of 15 hour/day or more, 5 years contract
[4)] For an average plug-in time of 16 hour/day and EV available at peak time, 5 years contract
[5)] According to RTE, smart-charging and V2G can divide by 4 the CO2 content of an EV

V2G is Active Globally

Innovate UK



Cenex V2G Market Study: www.cenex.co.uk/vehicle-to-grid/

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Thank You!

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