



V2G GLOBAL ROADTRIP: AROUND THE WORLD IN 50 PROJECTS

Lessons learned
from fifty
international
vehicle-to-grid
projects.

An Everoze & EVConsult
report jointly commissioned
by UK Power Networks
and Innovate UK

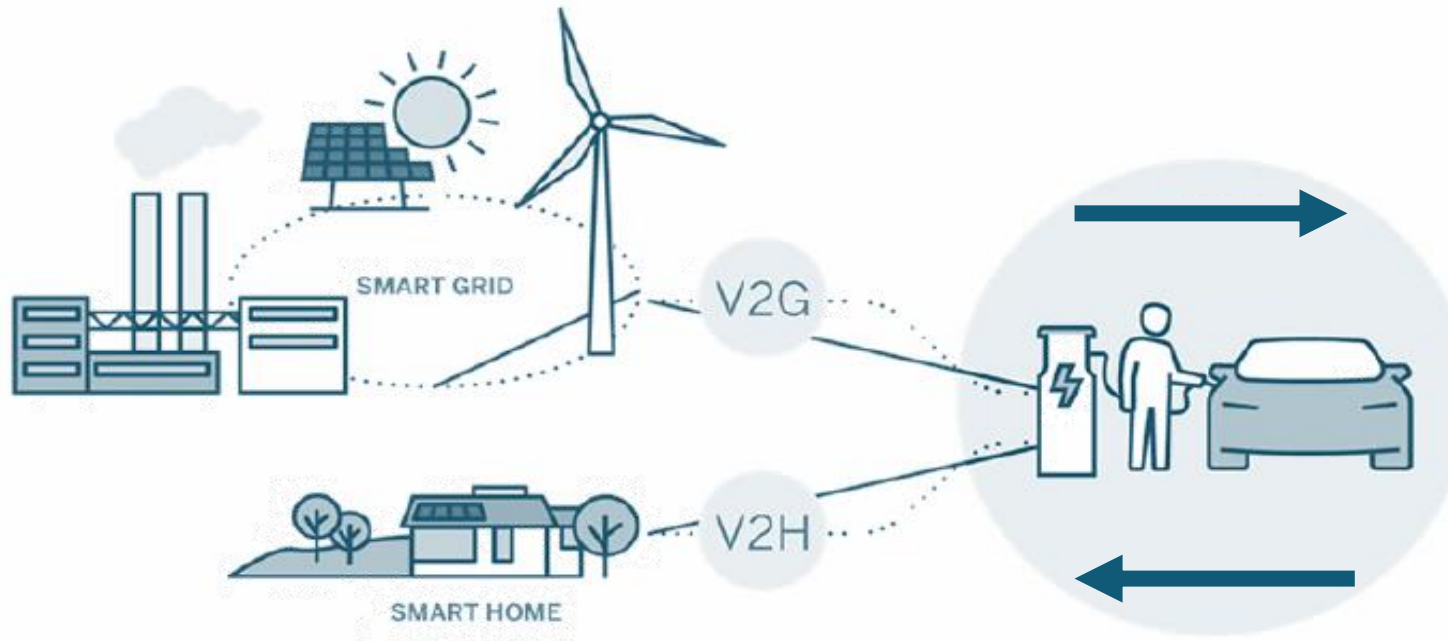
October 2018

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VEHICLE-TO-GRID (V2G)

Connecting the worlds of energy & mobility

Making the EV an integral part of the future (decarbonised) grid



SMART CHARGING or '**V1G**':
CONTROLLING RATE AT
WHICH CAR IS CHARGED

VEHICLE TO GRID or '**V2G**' -
TWO WAY FLOW OF POWER TO
AND FROM THE VEHICLE





PART 1: MAPPING OUT OUR JOURNEY



PART 2: STOP-OFFS ON THE WAY



PART 3: OUR JOURNAL



CHAPTER 1

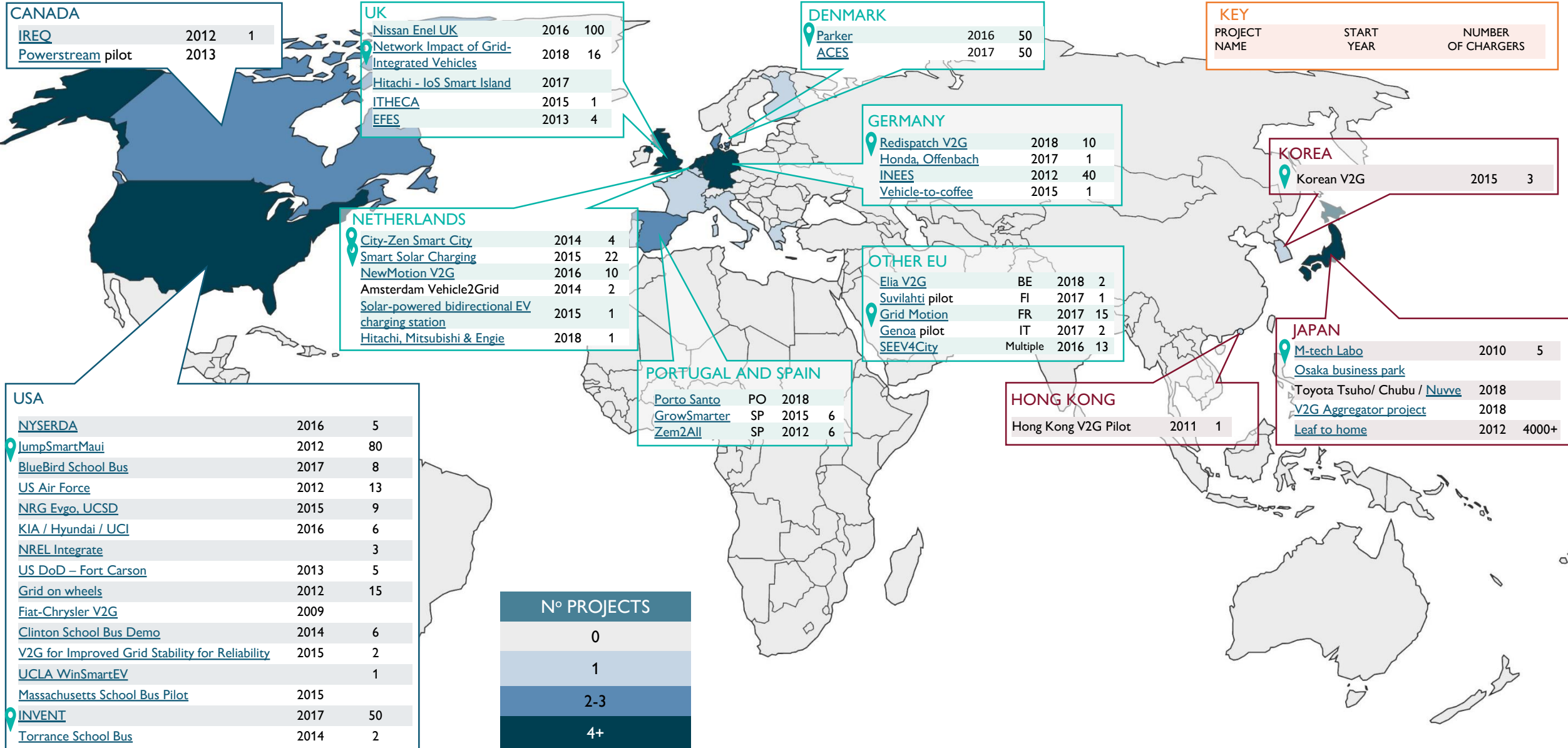
MAPPING OUT OUR JOURNEY

Every good roadtrip begins with a plan. What projects are out there? We survey the literature and contact contact leading experts to form a definitive list.





THE V2G MAP OF THE WORLD



CHAPTER 2

STOP-OFFS ON THE WAY

Right, so we're off! Time to see the must-see landmark projects! We shortlist 3 showcase projects and marvel at what's been achieved, taking Dashboard Snapshots along the way.



2016-18

PARKER

Landmark commercial deployment of V2G in Danish frequency response market – engaging multiple fleets, vehicles & locations.

Project sought to test ability of electric vehicles to provide grid services using real world fleets. Identified and addressed barriers to commercialisation. Compared capability of different cars. Follows from Edison and Nikola projects. Linked to ACES project on Bornholm.

PARTNERS

DTU Elektro/PowerLabDK (Project lead), NUVVE (Aggregator), Nissan, Groupe PSA, Mitsubishi Motors (Car OEMs), Inseco (Other), Frederiksberg Forsyning (Host and Fleet), Enel (Charger), Mitsubishi Corp (Tech)

PROJECT FOCUS

1. COMMERCIAL
2. TECHNICAL
3. SOCIAL

PROJECTS VALUE DKK 14,731,471 (financed by Forsell)

SERVICE PROVISION

BENEFICIARY

SERVICE

V2G?

WHEN TO ACT

TRIGGERING ACTION

RESPONSE SPEED

DURATION OF SERVICE

STATUS

TSO

Frequency containment
V2G
Pre-fault
Grid frequency
< 10 seconds
Up to 30 mins
Proven

DSO

Constraint management
V2G
Post-fault
Backoffice control signal
< 3-5 minutes
1-4 hours
Researched

TPI

Trading on day-ahead / Intraday
V2G
Price differential
Bid / offer accepted
< 15 minutes
15 min blocks
Researched

READINESS LEVEL



SERVICE	5	1	1
TECHNOLOGY	9	Commercially available	
MARKET	H	Main Daily Market is FCR-N in DK2. Project accessed market through Energinet participation, & now have commercial contracts with customers. Key regulatory barriers identified include i) grid connection pre-qualification process poorly defined for this asset, particularly given likelihood of different cars & chargers and need to assess performance at aggregated level ii) high cost of settlement meters iii) high energy tariffs and taxes, including double counting	

"We are celebrating our second full year of providing frequency response to the Danish TSO"

- Marc Trahand, nuve

PROJECT WEBPAGE

CUSTOMER SNAPSHOT

PLUG-IN TIME

0hrs

24hrs

SEGMENT

COMMERCIAL

CHARGING LOCATION

WORK (UTILITY)

24/7 service provided to Energinet. Utility vehicles used by Frederiksberg Forsyning during day and parked overnight and weekends. Other locations include municipalities, commercial companies and ports.

CHARGE POINT

50 units
ENEL 10kW DC charger

VEHICLE

Nissan LEAF 30kWh, 10x
Nissan E-NV200 24 kWh & Mitsubishi Outlander 12kWh

Mobility-as-service offer – a fee per month which provides charger and maintenance and tools to manage charging. V2G is used to reduce charging cost for consumers, with FR revenues reducing costs paid. Roll out limited by high taxes on EVs (no. of EVs went down in Denmark in 2017)

CUSTOMER OFFER



Monthly fee which includes charger

OPERATIONAL SNAPSHOT

BATTERY USAGE FOR V2G: 30% to 95%

USER BEHAVIOUR

Every fleet is different.

Customers have access to app on phone to indicate what state of charge they would need at what point in the day.

Some users don't want to use the app, so then a schedule is put in for them.

Important to understand customer schedule.

ARCHITECTURE

App informs Nuvve of drivers' preferences and charge required. This resource is then matched to grid and market signals to provide service.

For V2G CHAdeMO protocol is being used.

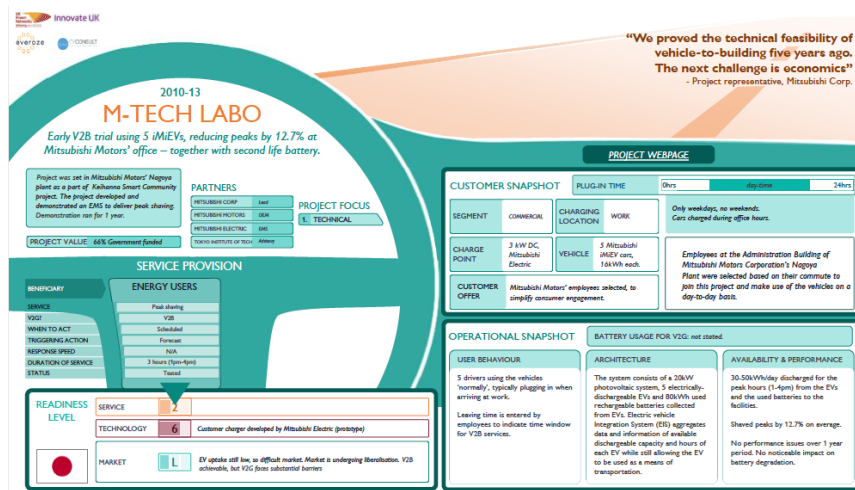
AVAILABILITY & PERFORMANCE

Different vehicles tested and show different performance levels. Technical barriers included:

- long duration freq. bias – service required often exceeded kWh capacity requiring lower kW bids
- two way energy loss - (discharging at power levels lower than the rating of the charging equipment can result in low efficiency and high losses. Efficiency of 90%+ expected in future.
- battery degradation impact (see INVENT slide for further details)

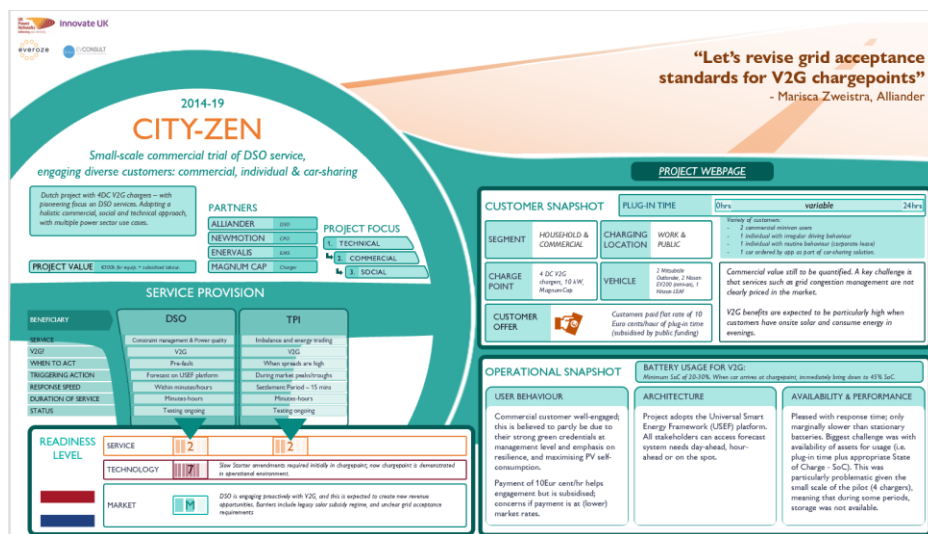


M-TECH LABO



- Vehicle-to-Building (V2B) trial for behind-the-meter services
- Building energy peak shaving proven with electric cars and 2nd life batteries
- No noticeable impact on battery degradation.

“We proved the technical feasibility of vehicle-to-building five years ago. The next challenge is economics”
-Project representative, Mitsubishi Corp.



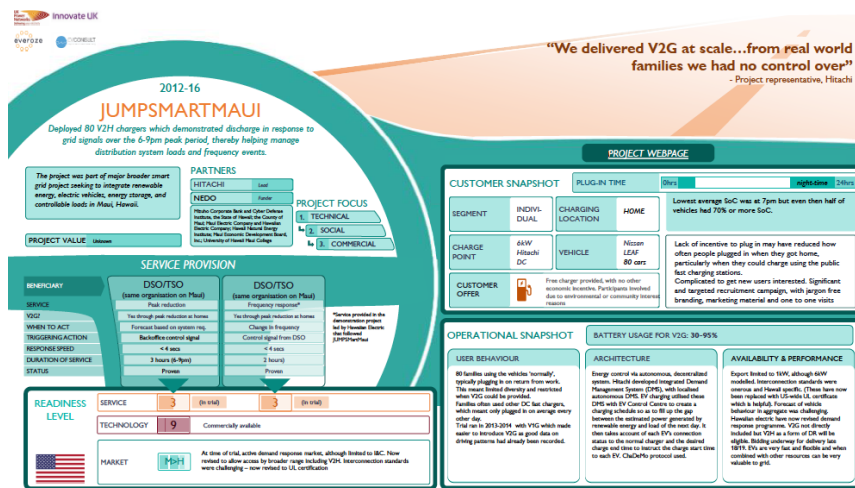
“Let’s revise grid acceptance standards for V2G chargepoints”

- Marisca Zweistra, Alliander

- Introduced ‘slow start’ to chargers to help overcome issues with voltage inrush (implications of this for speed of response)
- V2G can help increase local consumption of solar (charging on excess in day and exporting at night)
- DSO services not priced effectively in the market



JUMPSmartMAUI

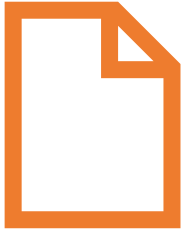


**“We delivered V2G at scale...
from real world families we had
no control over”**

- Project representative, Hitachi

- Successful in reducing in peaks on system
- Export limited to 1kW, due to regulations although 6kW charger capacity
- Single user group (families) meant limited diversity and restricted when V2G could be provided (just evenings)
- No incentive provided to users, which may have reduced how often people plugged in at home.

*This time away has prompted some reflection.
We log what we've learned – and the
implications for the UK.*





LESSONS

FOR NETWORK OPERATORS



1. ADAPT INTERCONNECTION STANDARDS & PROCESSES

It takes 6 months to connect a V2G charger in the UK
NPG project



2. CLARIFY THE VALUE OF DSO SERVICES

A key challenge is that services such as grid management are not clearly priced in the market
City-zen project



3. DESIGN SERVICE SPECIFICATIONS WITH V2G IN MIND

Speed of response, duration and availability all need to be carefully considered
Parker project



LESSONS

FOR INDUSTRY



4. MATURE THE HARDWARE

High cost and performance issues with chargers

Cited by many project



5. TARGET SERVICES WHERE V2G ADDS VALUE

i.e. (1) where export is required (2) locations with surplus solar capacity; (3) markets with high peak pricing or charges; and/or (4) for longer duration services

Report conclusion



6. SEGMENT USER BEHAVIOUR

We had 80 families using the vehicles ‘normally’, typically plugging in on return from work. This limited diversity and restricted when V2G could be provided

JumpSmartMaui Project



LESSONS

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FOR INDUSTRY



4. MATURE THE HARDWARE



5. TARGET SERVICES WHERE V2G ADDS VALUE



6. SEGMENT USER BEHAVIOUR

FOR GOVERNMENT

Support and enable

CURRENTLY, COMMERCIAL V2G OFFERS AVAILABLE IN:



“We are celebrating our second full year of providing frequency response to the Danish TSO”

- Marc Trahand, nuve

DENMARK, UK & US

V2G surge: EDF Energy and Nuvve to install 1,500 smart EV chargers



CREDIT: EDF Energy

Two companies team up to offer EDF Energy's business customers V2G chargers aimed at providing 15MW of additional energy storage capacity

Commercial V2G rollout in UK

- Innovate UK projects -

THANKS FOR LISTENING

REPORT AVAILABLE AT:

<http://everoze.com/app/uploads/2018/10/UKPN001-S-01-H-V2G-global-review-compressed.pdf>



BIG THANKS TO OUR CONTRIBUTORS

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