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V2X value and business opportunity

30th September 2021

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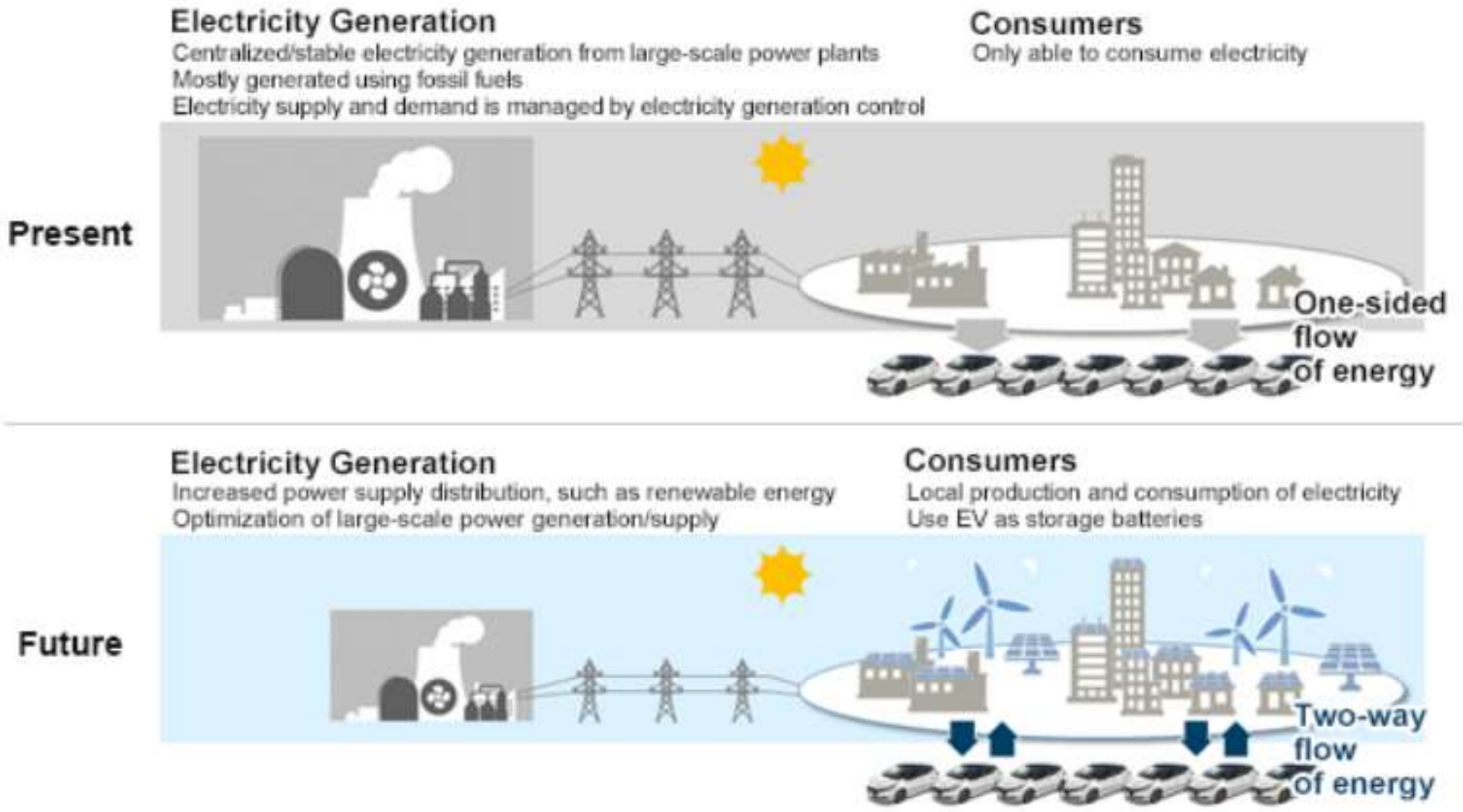

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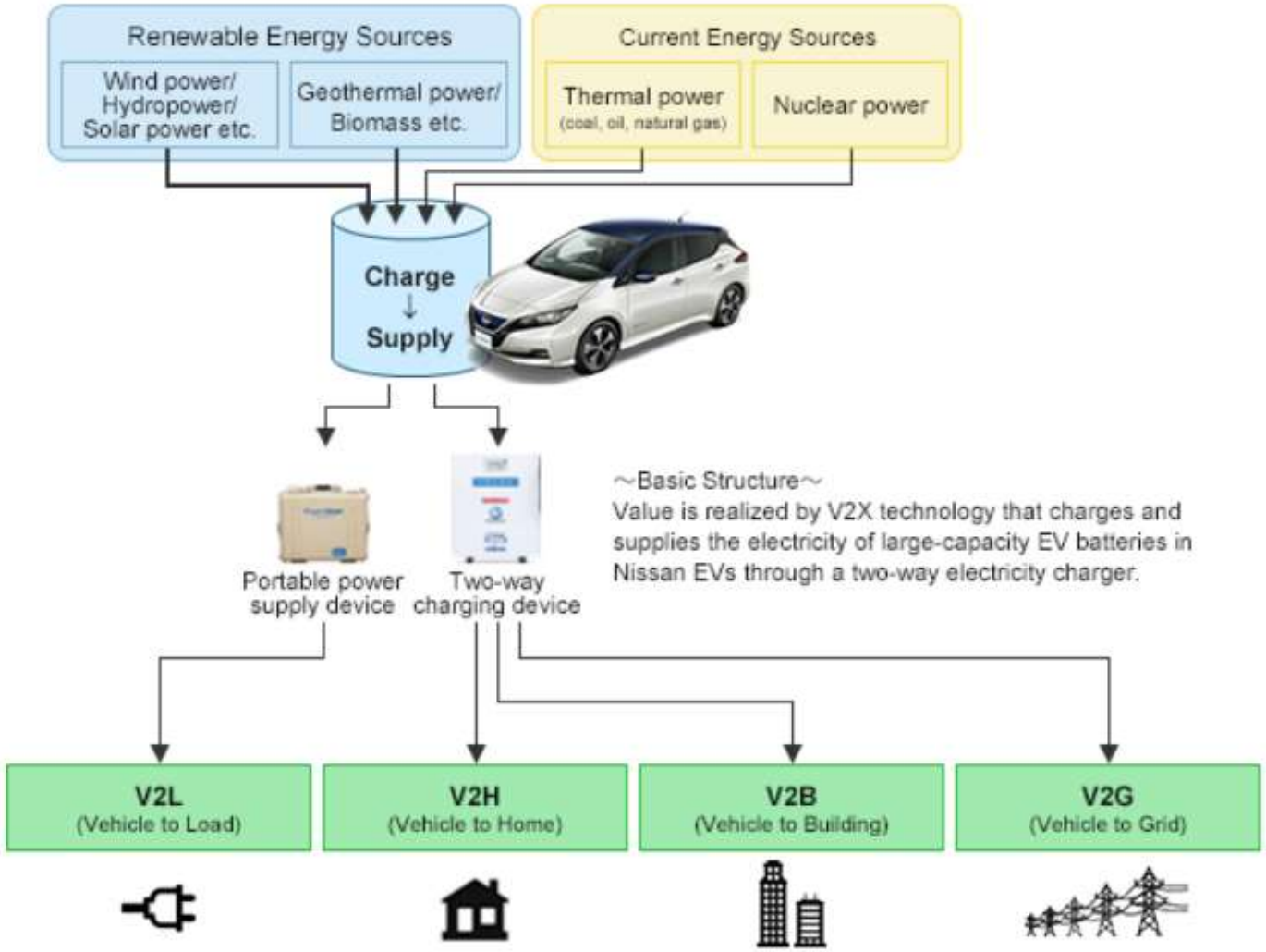
Nissan Energy Share

- By utilizing (sharing) the electricity stored in Nissan EVs in many ways, Nissan is bringing a new value to everyday lifestyles. And that value is created through V2X technology (V2L, V2H, V2B, V2G).



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Major Nissan Energy Share demonstration activities

Major Nissan Energy Share demonstration activities

2012 — V2H *1

Able to supply electricity stored in a Nissan Leaf battery to a home.

2014 — V2B

Lowered electricity costs by lowering peak electricity consumption in buildings.
(at the Nissan Motors Advanced Technology Center)

2014 — V2G

Participated in V2G demonstration project by US DOD to verify the benefits from the large-scale V2G. (DOD/LAAFB/Various other companies)

2016 — V2B

Participated in charging/discharging demonstration with the goal of adjusting frequency (Enel/two others)

2017 — V2B, Smart charging

Participated in virtual power plant (VPP) construction demonstration project by Kansai Electric Power and Sumitomo Electric

2018 — V2H(G), Smart charging

Participated in demonstration of stabilizing electricity supply and demand balance on Maui, Hawaii, by storing solar power during the day and wind power at night (NEDO, Hitachi)

2018 — V2G

Electricity charging/discharging demonstration with the goal of levelling electricity consumption. (ENEL/Nissan Europe)

2018 — V2G

Participated in a demonstration to stabilize the variation (supply and demand balance) in the amount of electricity supply generated by Kyushu Electric Power's solar power generator.

2018 — V2G

Participated in a demonstration to reduce electricity costs by lowering peak electricity consumption in buildings (Fermata Energy).

2018 — V2G

Participated in a demonstration to stabilize the variation (supply and demand balance) in the amount of electricity supply generated by Tohoku Electric Power's wind power generator.

2019 — V2B

Participated in a demonstration to verify the peak shift of electricity consumption and CO2 reduction in a building utilizing EVs, solar power generators and fixed storage batteries from NTT West/NTT Smile Energy.

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V2X benefits and values streams

For customer

- Peak shaving
- Efficient use of RE
- Use of “TOU”, “Dynamic pricing”
- Resilience

For power company

For TSO

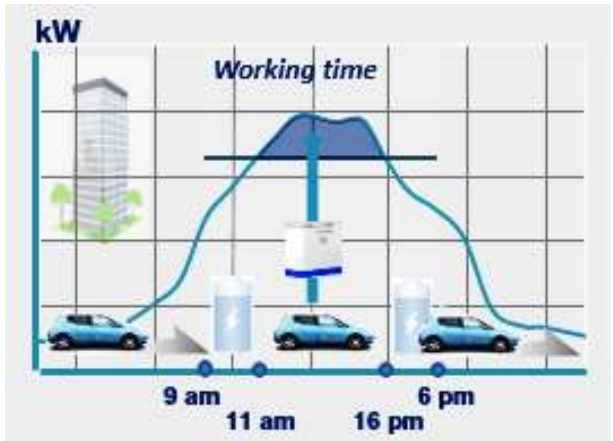
- kWh（energy market)
- kW　(capacity market)
- ΔkW（real time balancing market)

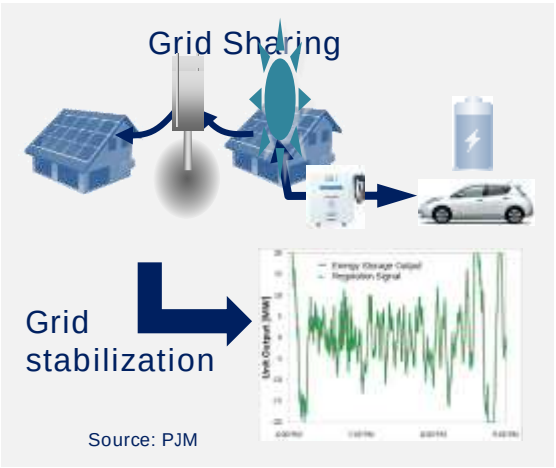
For DNO/DSO

- Congestion avoidance

For electricity retailer

- Imbalance avoidance





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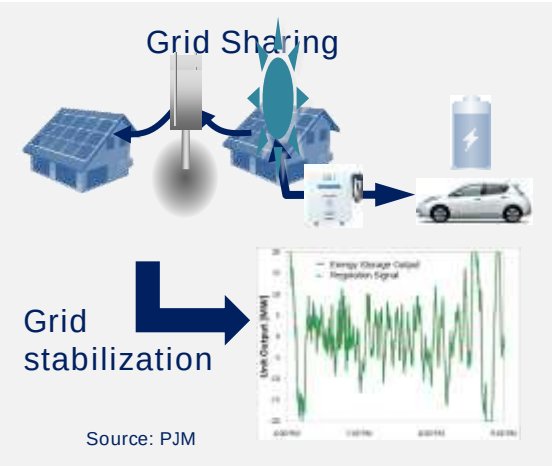

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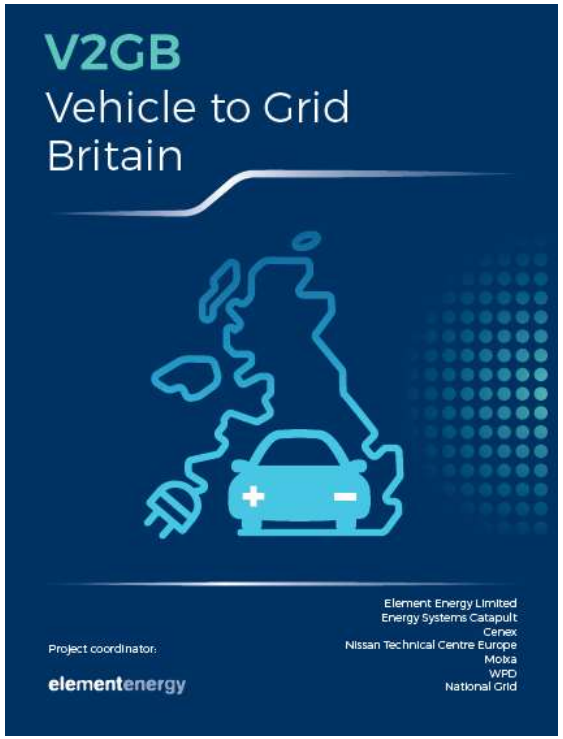
V2GB: The project to assess the viability of V2G business in Great Britain



Project members

elementenergy, CATAPULT Energy Systems, cenex, moixa, NISSAN, nationalgrid, WESTERN POWER DISTRIBUTION

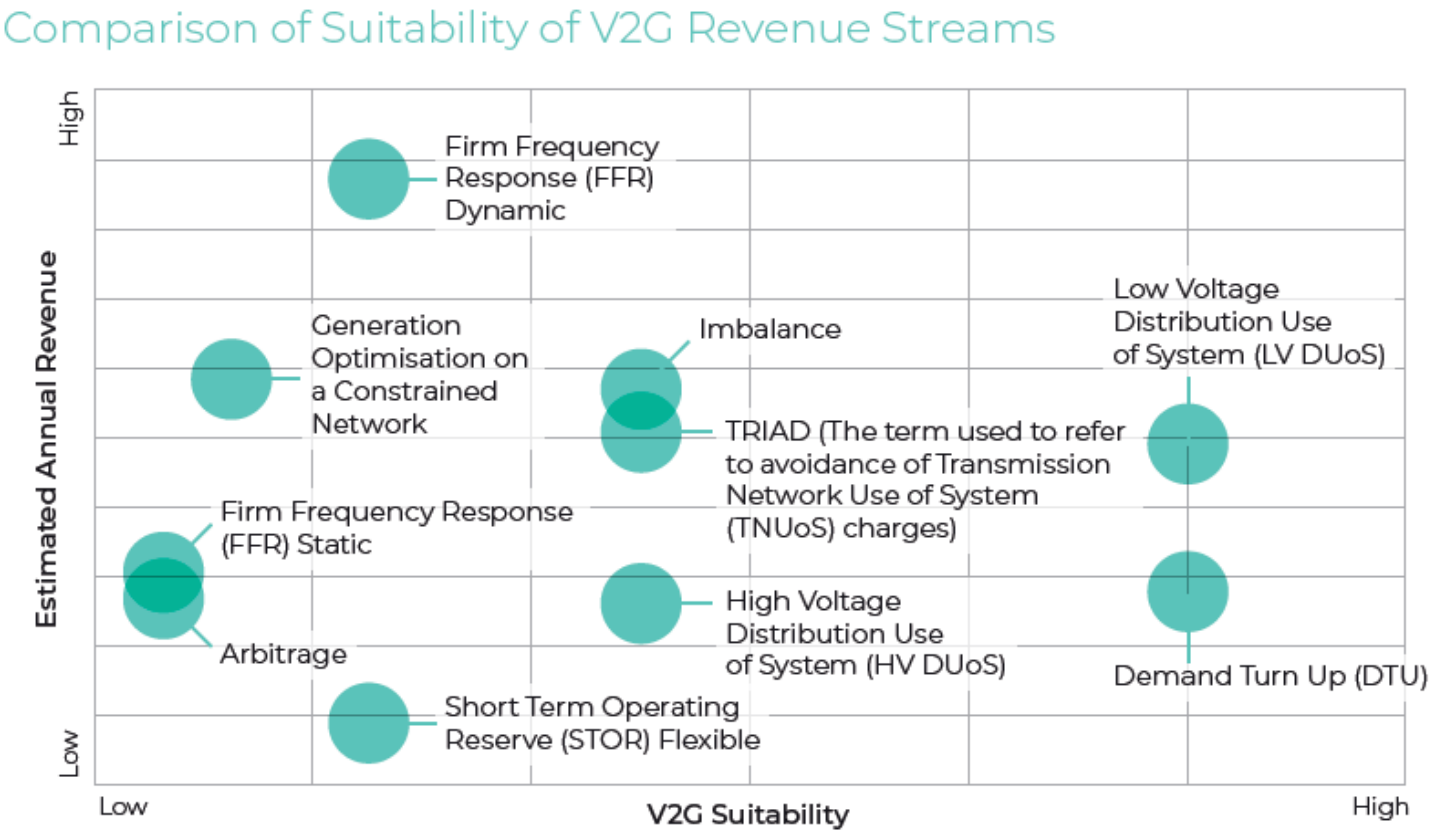


Figure 14: Comparison of Suitability of Top 10 V2G Revenue Streams

Source: V2GB（Vehicle to Grid Britain）Public Repor（t 2019）,
http://www.element-energy.co.uk/wordpress/wp-content/uploads/2019 /06 /V2GB-Public-Report.pdf

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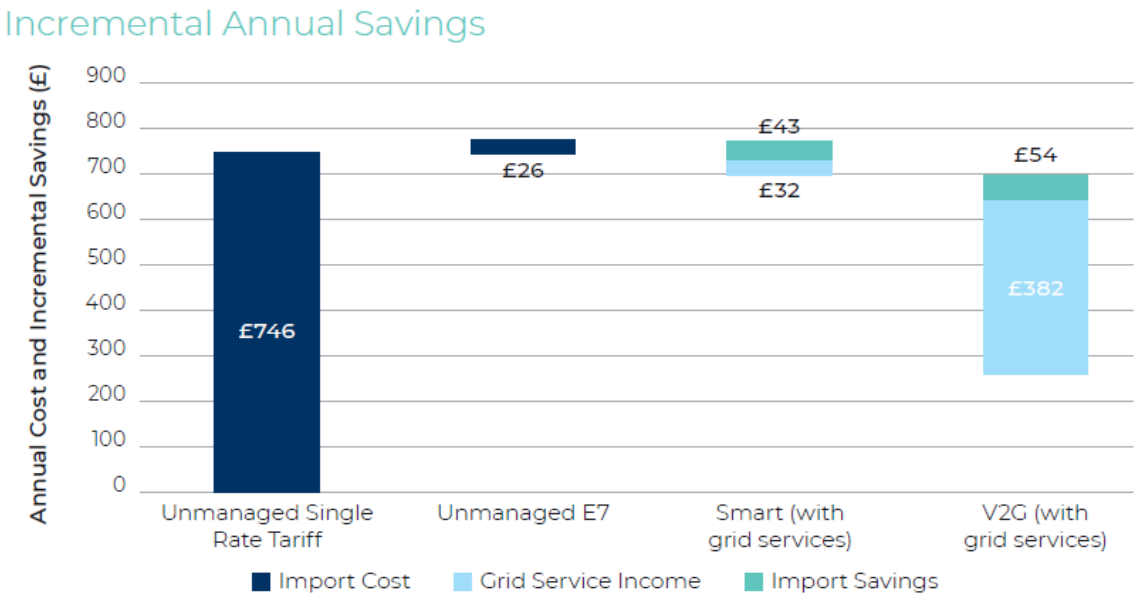
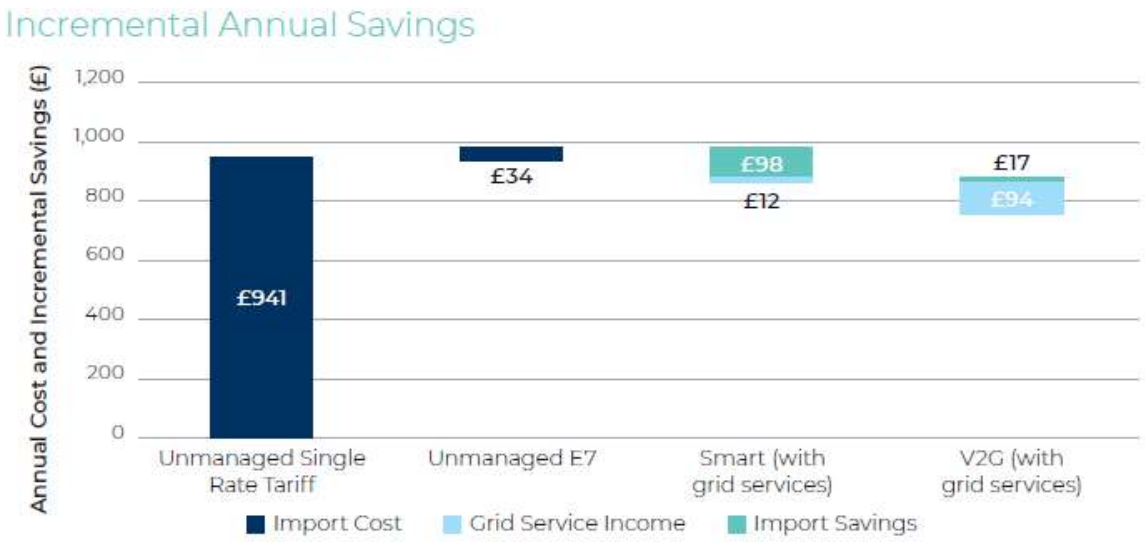
Findings from V2GB

- 7kW V2G charger could capture annual revenues of around £436 (in case of high plug in rate: 75% of time plugged in)
- The plug-in rate is a key driver for value captured from V2G. (average: around 30% of time plugged in)
- Nearly all of this value would be from providing services to the System Operator (SO), mainly FFR.



High Plug-in rate incremental saving with grid services



Base case incremental savings with grid services

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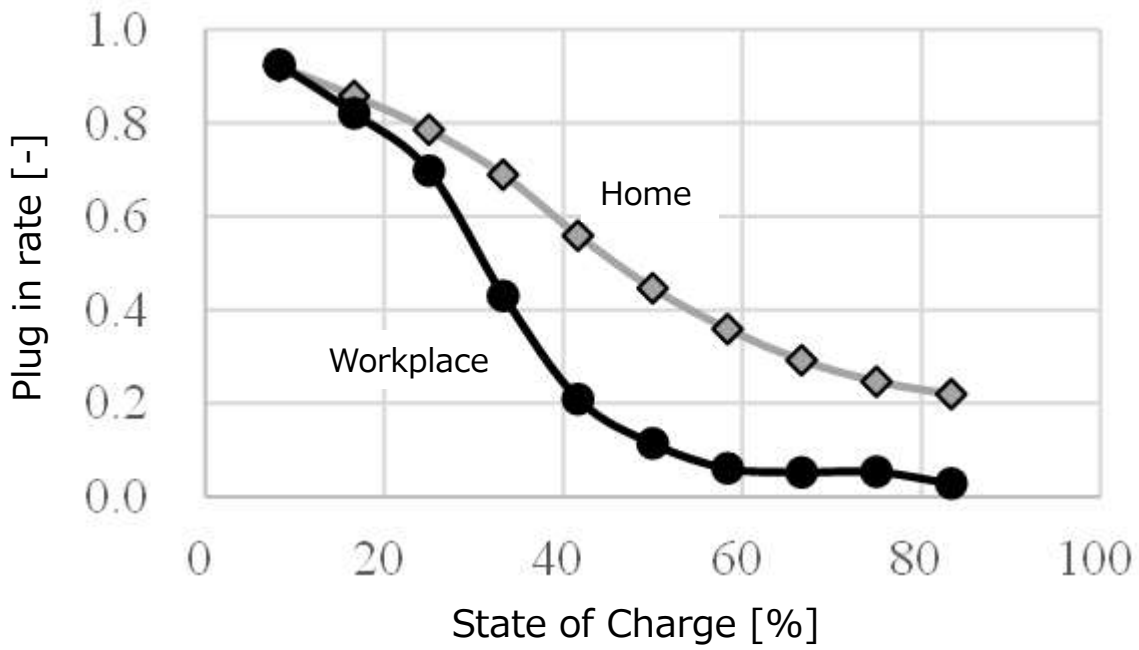
Plug in rate : from the LEAF telematics data (in Japan, 2015 – 2016 24kWh)

■ Charge point definition:

If a charging event with a normal charging output occurs at a place defined as home or workplace, that place was defined as having a normal charger.

■ Plug in rate definition:

$$\text{Plug in rate} = \frac{\text{Number of times charging event occurred}}{\text{Number of parking times at the place with normal chargers defined above}}$$



Source:
Suzuki, K., Kobayashi, Y., Murai, K., & Ikezoe, K. (2020). Impact of EV Charging on Power System with High Penetration of EVs: Simulation and Quantitative Analysis Based on Real World Usage Data (No. 2020-01-0531). SAE Technical Paper.

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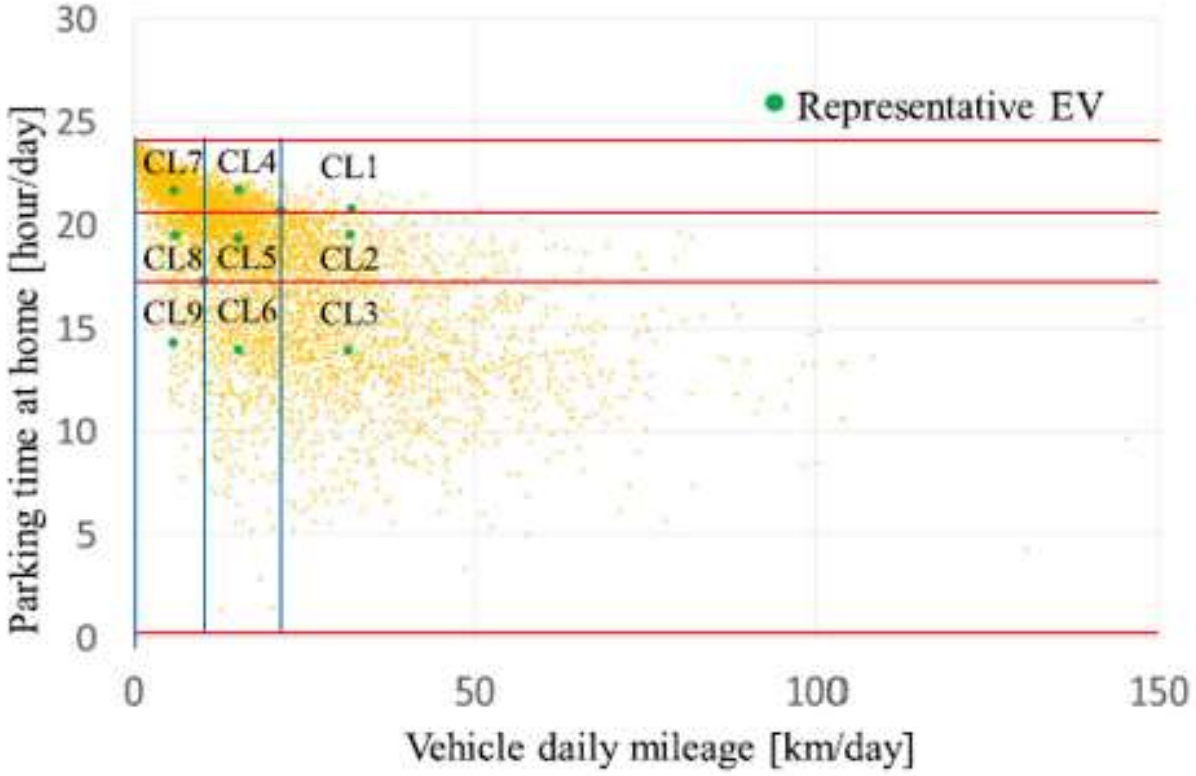
Evaluation of the “Efficient Use of RE” in Residential Houses

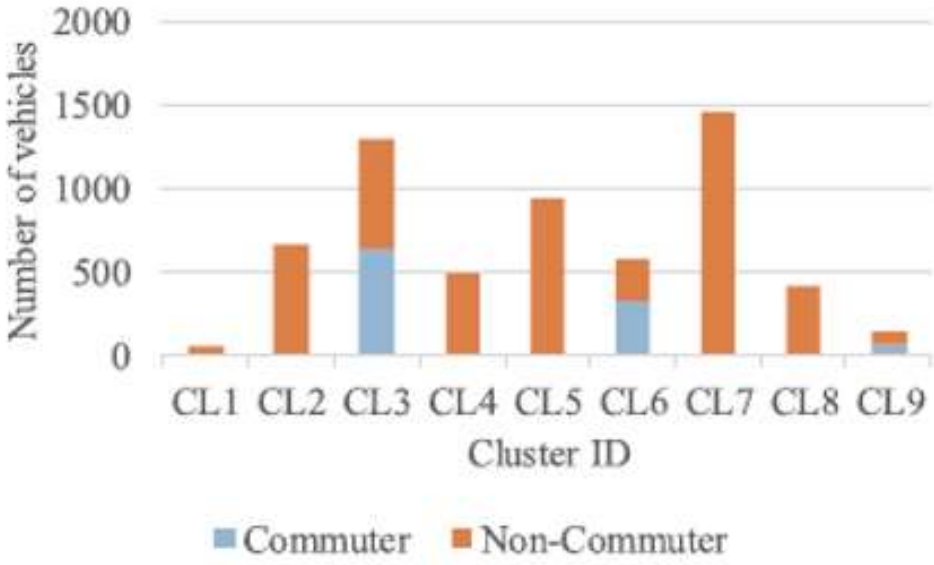
Joint research with University of Tokyo

- In order to estimate the efficient use of RE at home, EV usage patterns were necessary as input data
- Actual telematics data* of Nissan LEAF were used for this simulation and they were divided into 9 clusters

*(Jan. 1, 2015 ~ Dec. 31, 2016 in Japan)



EV clusters and representative EVs



Number of EVs belonging to the nine clusters

Source:
Iwafune, Y., Ogimoto, K., Kobayashi, Y., & Murai, K. (2020). Driving simulator for electric vehicles using the Markov chain Monte Carlo method and evaluation of the demand response effect in residential houses. IEEE Access, 8, 47654-47663.

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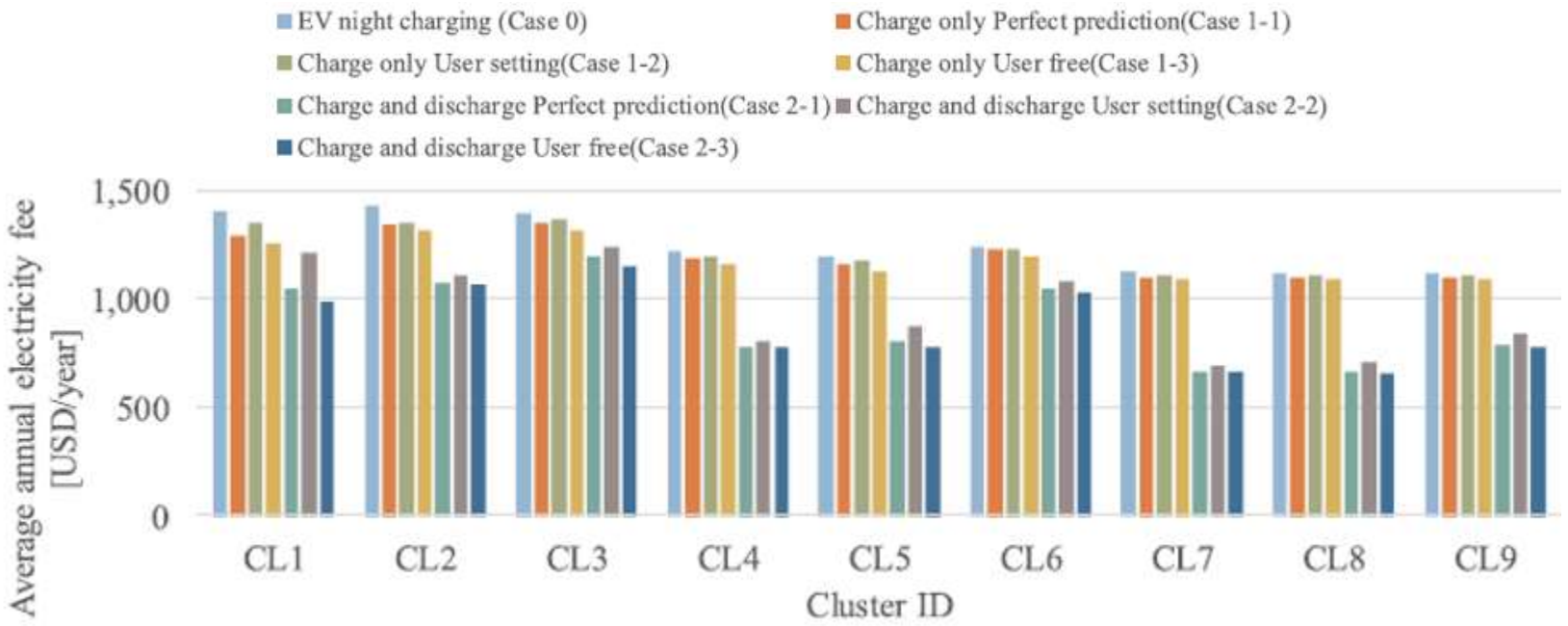
Finding from the analysis of “Efficient Use of RE” in residential houses

- Charge and discharge control with roof top PV makes a profit of 209 ~ 463 dollars per year compared to the base case (EV night charging).
- We found that 40kWh EV batteries can be operated economically by determining the operation schedule without forecasting or planning.



EV battery operation results (10-home average of annual electricity fee)

Parameter	Value
Electricity price	Purchase price at home: 18/33 US cents/kWh (nighttime 23:00–7:00/other time 7:00–23:00) Selling price: 8 US cents/kWh Purchase price at CSs: 50 US cents/kWh
Demand and PV generation profile	8760 h measurement data in 10 all-electric houses (PV generation 5000–6200 kWh/y, demand other than hot water supply 6100–8400 kWh/y)
EV	Battery capacity: 40 kWh Charge and discharge capacity: 3 kW SOC lower limit: 20 kWh at V2H periods in user-free case and 8 kWh in other cases EV fleet efficiency: 7 km/kWh Battery charge and discharge efficiency: 90% each

Parameter setting

Source:
Iwafune, Y., Ogimoto, K., Kobayashi, Y., & Murai, K. (2020). Driving simulator for electric vehicles using the Markov chain Monte Carlo method and evaluation of the demand response effect in residential houses. IEEE Access, 8, 47654-47663.

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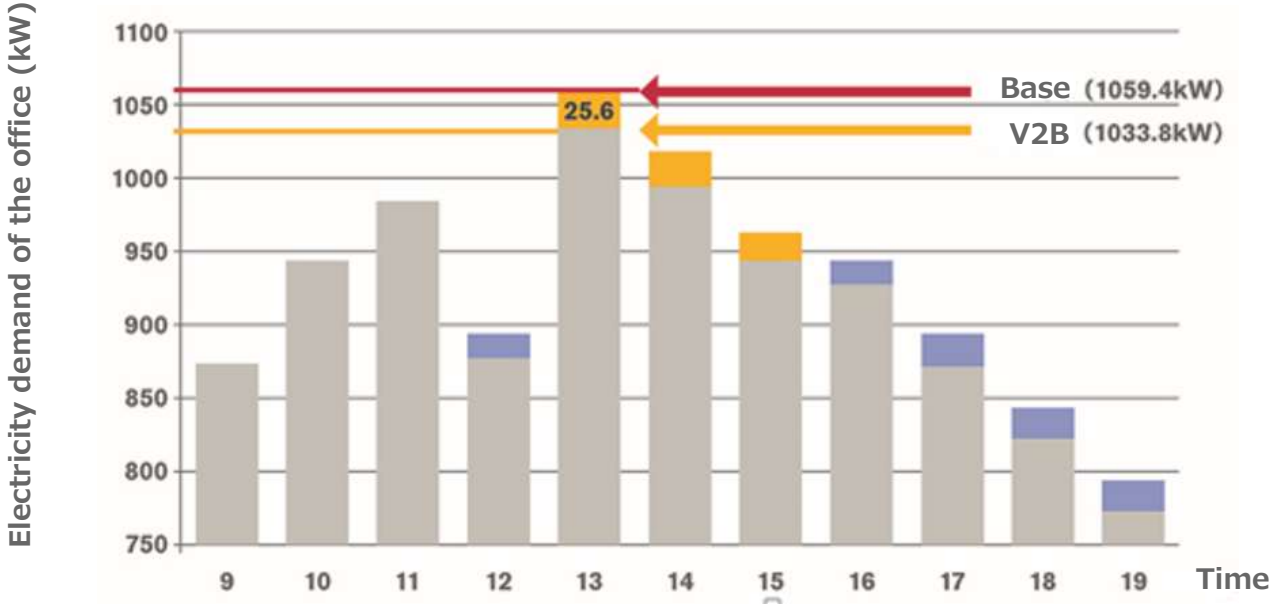
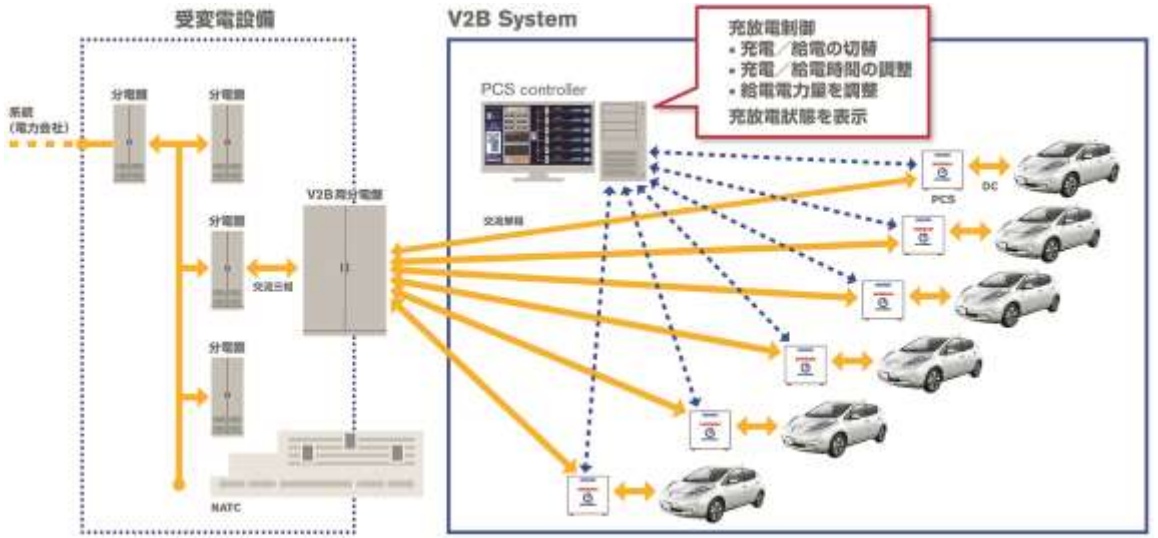
V2B (Vehicle to Building) demonstration in NATC*

*Nissan advanced technology center (in Japan)

- V2B with the six Nissan LEAFs made the peak power of the building reduced by 25.6kW
- According to estimates with current electricity rate, this could save 500,000 yen annually. (641€/EV/year 1€=130¥)

Source:
https://global.nissannews.com/ja-JP/releases/131129-01-j?source=nng&query=building





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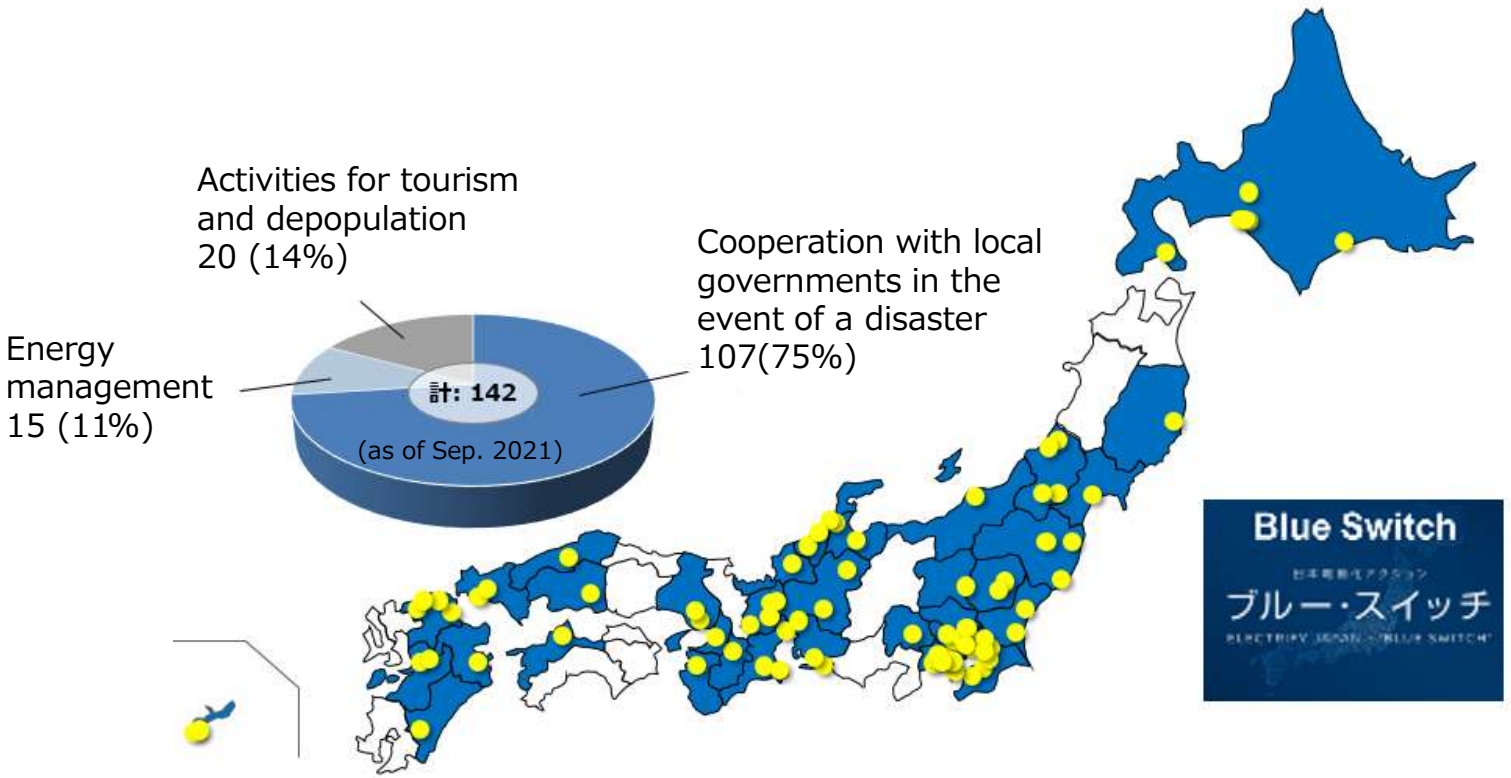
Nissan Blue Switch

Source: Blue Switch Fact File
https://ev2.nissan.co.jp/BLUESWITCH/book/html5.html#page=1
Translated by presenter

- Nissan is promoting the "Blue Switch", a Japanese electrification action that tackles social changes and solutions to regional issues through the spread of electric vehicles (EVs).
- The project unlocks the energy stored in car batteries to help people hit by earthquakes, typhoons or other emergencies



A Nissan LEAF plugs directly into a power converter for makeshift evacuation centers needing light and cooking facilities

Source: https://global.nissanstories.com/en/releases/nissan-blue-switch

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Contribution to national power system

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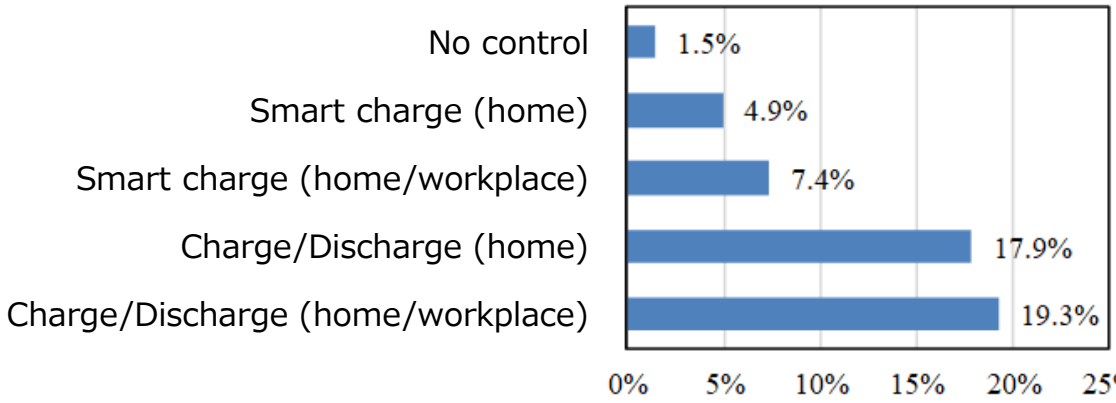
Estimation of contribution to national power systems

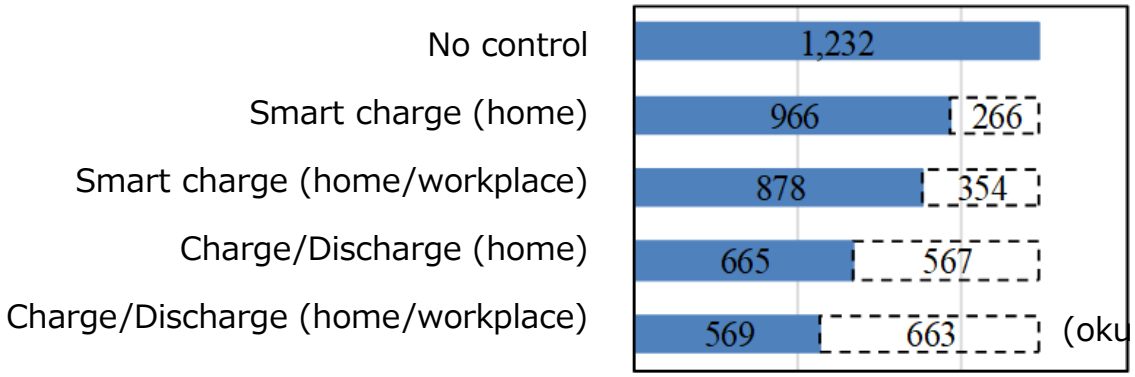
Source: 荻本和彦，岩船由美子ほか：EV の実走行データに基づくデマンドレスポンス効果の定量的評価（II），エネルギー資源学会，第35 回エネルギーシステム・経済・環境コンファレンス発表（2019） in Japanese

- Through joint research with the University of Tokyo, V2X contribution to the national power systems were estimated.
- Calculation model _Minimizes operating costs (fuel cost + start / stop cost) under various constraints such as supply and demand balance, load frequency control (LFC) constraints, and interconnection line constraints.
- Result: V2X can reduce RE curtailment by 19.3% and reduce operating costs of power generation by 66.3 billion yen.

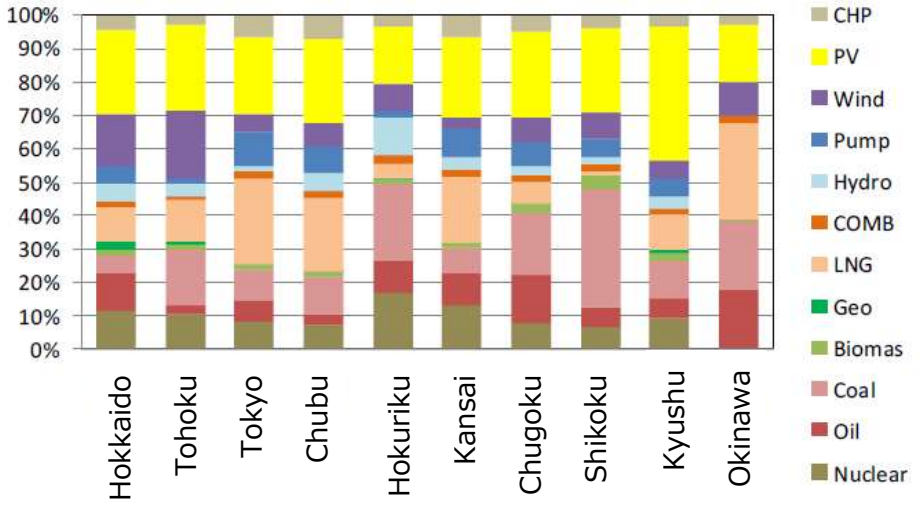
510 Million Euro（1€ = 130¥）



Reduced ratio of RE curtailment (vs. no-EV case)

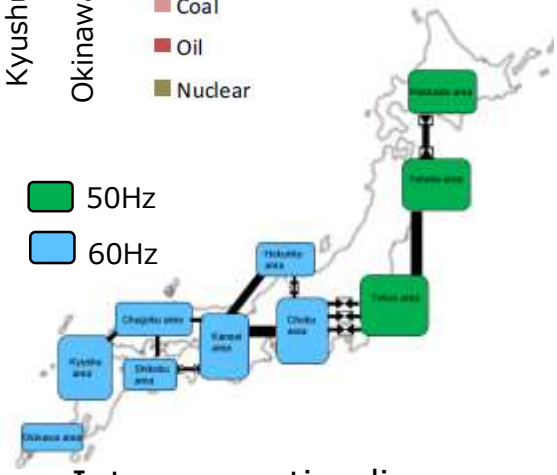


Reduction of operating cost



Mixture of power sources
(2030 assumptions for simulation)

Simulation conditions of EV	
EV ratio	16% of private vehicle (8,96 Million)
EV usage pattern	from LEAF actual data 10 clusters defined



Interconnection line

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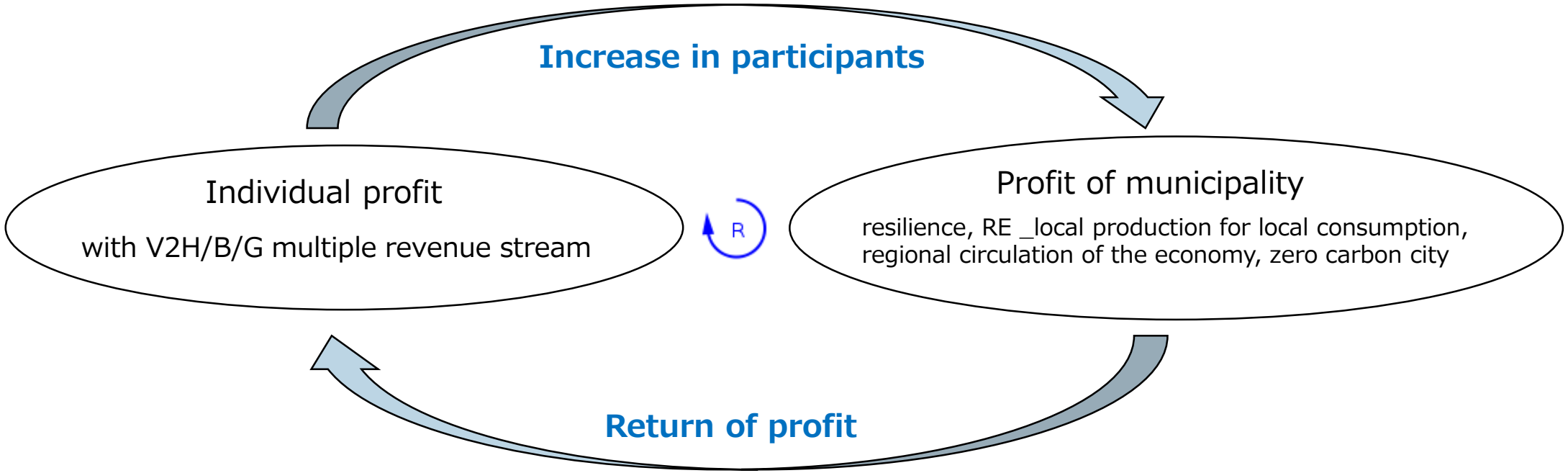
The pass to the sustainable business

- Increase the number of V2X participants by the novel business model with V2H/B/G multiple revenue stream
- By increasing participants who can make profits individually, the profits of the local municipality will increase
- By returning the profits of municipality, the number of participants who will make a profit will increase
- This positive reinforcement loop will lead the V2X business sustainable



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Thank You !
For Your Attention

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