

## **THE FUTURE DIRECTION OF THE ELECTRIFIED VEHICLE - UTILIZING OF BIG DATA -**

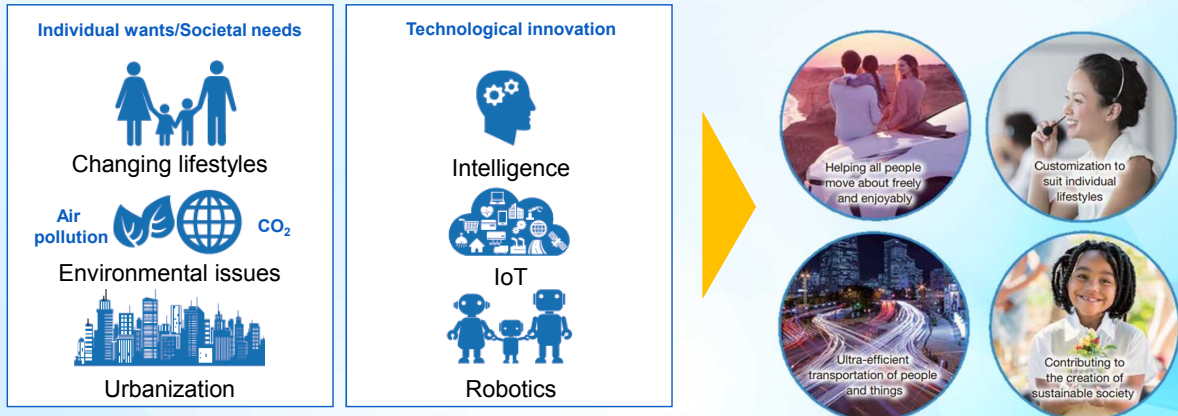


Shizuo Abe  
Toyota Motor Corporation

## Due to changing lifestyles and technological innovation...

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- ◆ Customer needs are ever-diversifying
- ◆ Society and industry are largely changing



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## Moving to provide new value to customers

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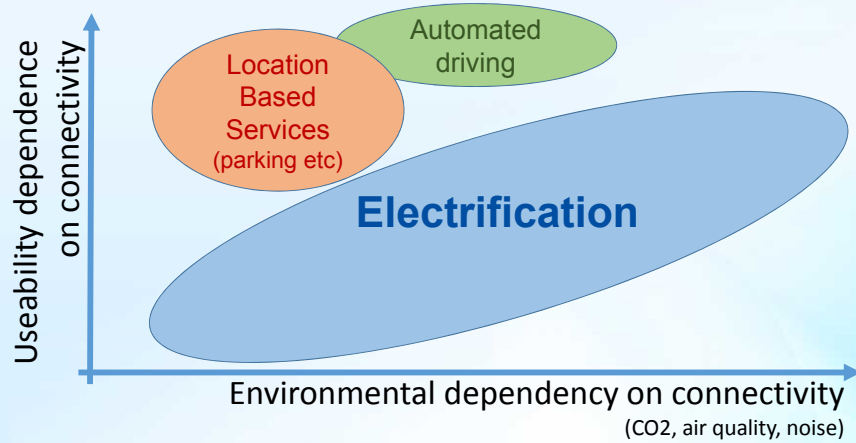


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## Image of connectivity impact (examples)

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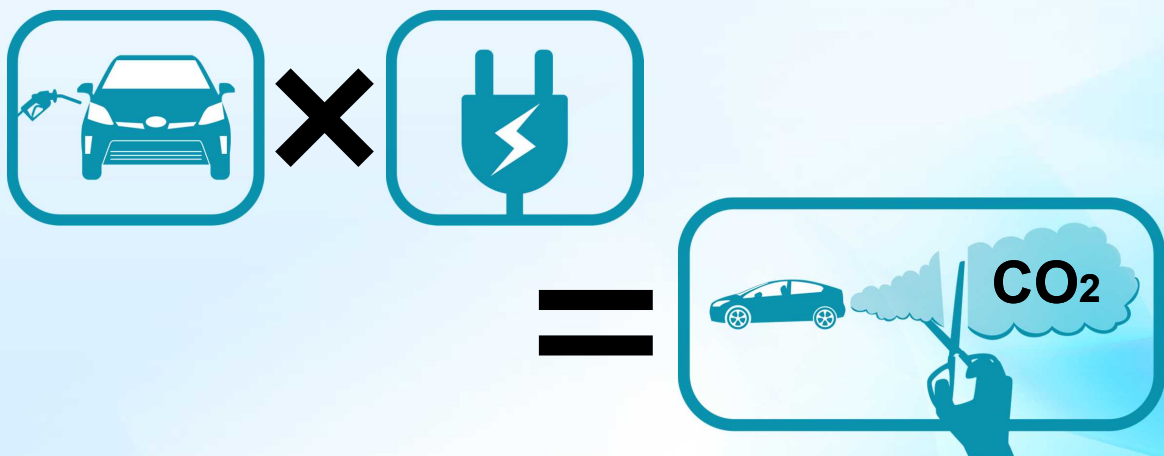
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## To reduce CO<sub>2</sub> emissions...

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### Vehicle electrification is essential.



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## Electrification frontrunner Prius

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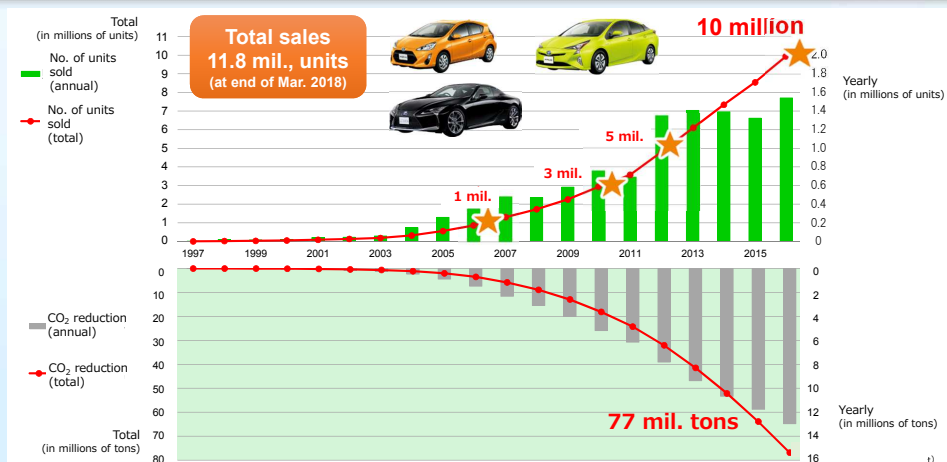
Prius has improved continuously its fuel efficiency

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## Toyota HEV sales & CO<sub>2</sub> reduction effect

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Total HEV sales reached 10 million units in January 2017.  
CO<sub>2</sub> reduction effect vs. to similar gasoline vehicles totals ~77 mil. tons

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Needs when it comes to cars are decided by...

## Customers & Markets

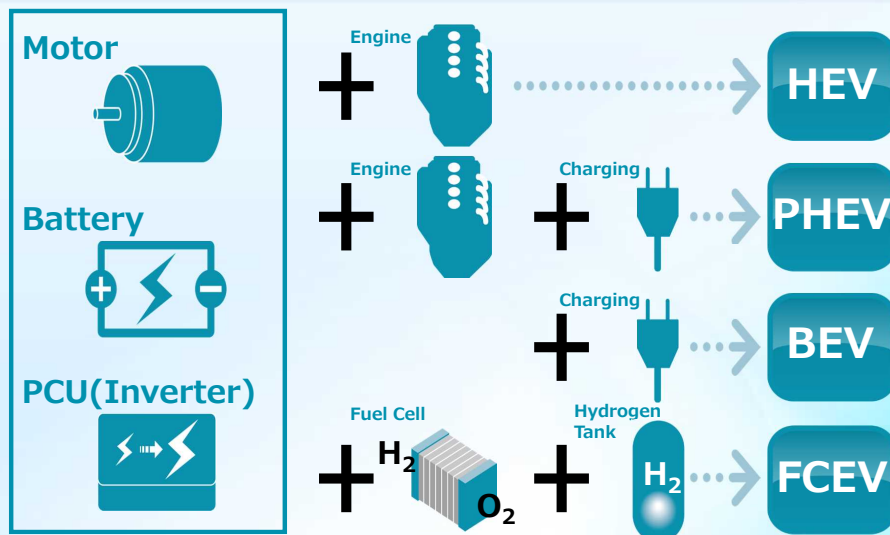


More than just one choice when it comes to electrified vehicle products

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## Core technologies and electrified vehicles

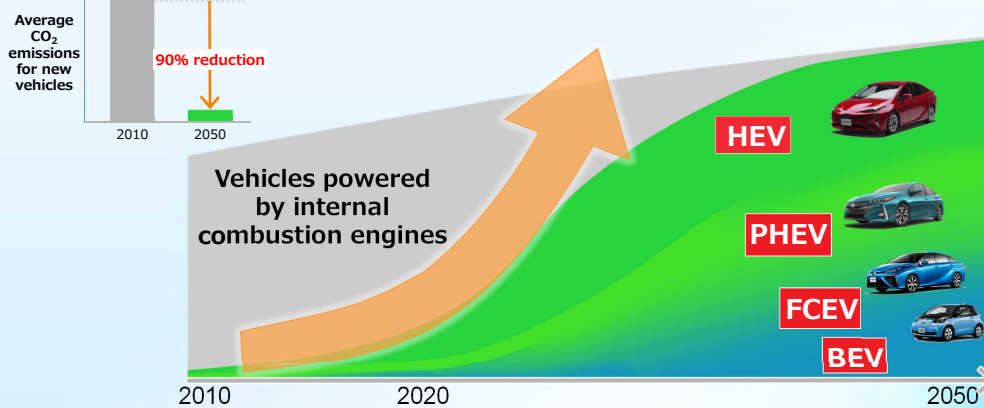


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## Powertrains for Toyota's Environmental Challenge 2050 <sup>10</sup>

Challenge 1: New-vehicle Zero CO<sub>2</sub> Emissions Challenge

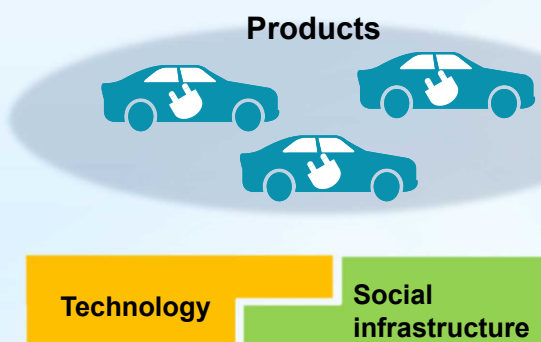


**Accelerate next-generation vehicle development  
toward 90% reduction in CO<sub>2</sub> emission**

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## Electrified vehicles and infrastructure needs <sup>11</sup>



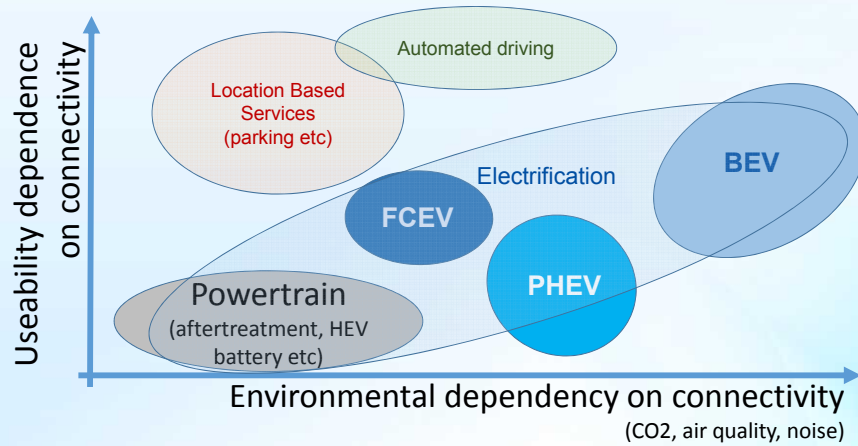
**All-encompassing approach to products, technology, social infrastructure**

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## Image of connectivity impact (examples)

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Some powertrains require connectivity to reach the full benefit for the environment

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## Challenges of vehicle electrification

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	HEV	PHEV	BEV	FCEV
Solution to Environmental Performance?	+	++	++	++
Cruising Range, Charging Time	++	?	?	++
Infrastructure	++	?	?	-
Cost / Affordability	++	?	?	-

PHEVs, BEVs and FCEVs promotion is key  
⇒ What is challenge for the expansion?

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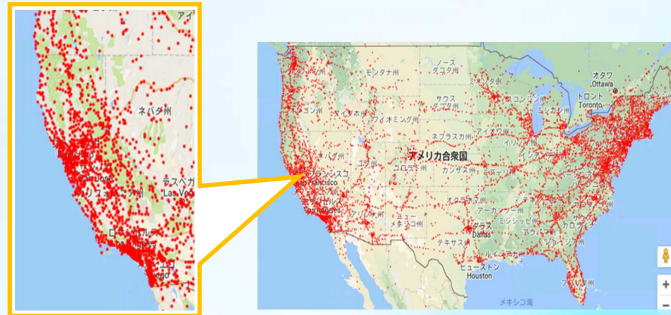
## Considering Toyota data - environmental performance

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### Toyota Data

Vehicle	Prius PHV (12MY~)
Vehicle Volume	About 2,187 units
Period	2/2012~3/2017 (About 5years)
Total VMT	72,415,756mile (1.17Billion km)
Ave. annual VMT	15,031mile (24.2thousand km)
Total Charging	1,642,185
Charging per day	1.12 times

### Parking spots for each vehicles trip ends



Actual vehicle data were used for the evaluation of PHEV/BEV market acceptance

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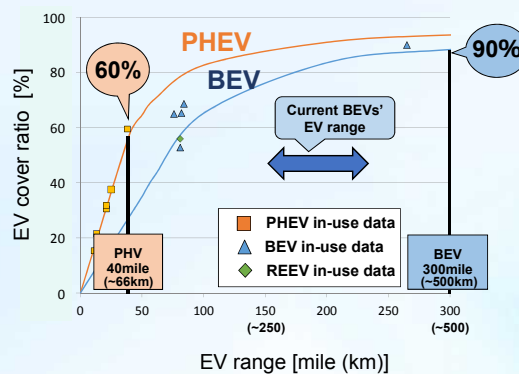
## Considering Toyota data - environmental performance

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### EV Cover Ratio of PHEV and BEV

#### Simulation Prerequisite

- Driving pattern: **Prius PHV Driving Data**
- Annual VMT: **15,000mile (24,000km)**
- Charging: **3.3 kW**



	TYPE	eVMT[mile]
Toyota Prius	PHEV	2,304
Honda Accord	PHEV	3,246
Ford C-Max	PHEV	4,574
Ford Fusion	PHEV	4,776
Chevrolet Volt	PHEV	8,924
BMW i3	BEVx	8,387
BMW i3	BEV	7,916
Ford Forcus Electric	BEV	9,741
Honda Fit	BEV	9,789
Nissan Leaf	BEV	10,294
Tesla Model S	BEV	13,494

Ref.: ACC MTR Staff report

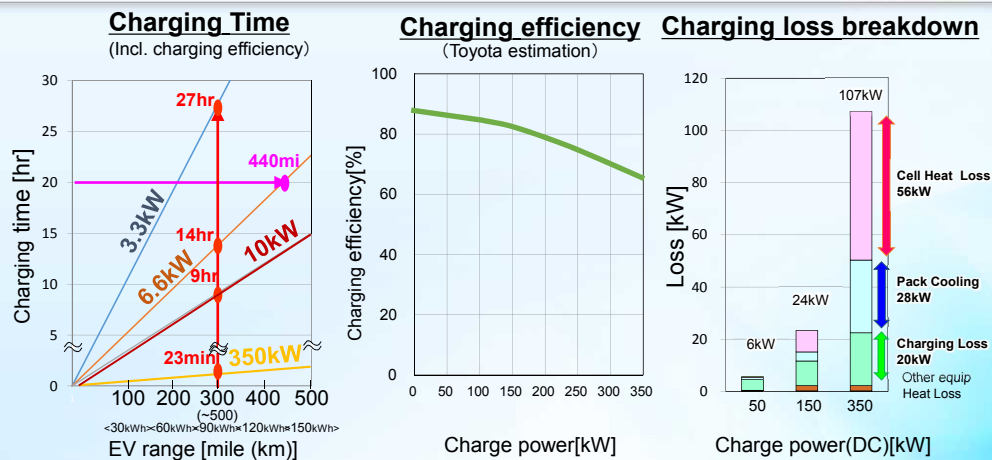
Toyota aims to achieve 60% EV cover ratio for future PHEV.  
→ cost and convenience for PHEV(66km) and BEV(500km) to be compared

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## Charging time and efficiency

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Advanced fast charging with 350kW power is still slower than liquid refueling and efficiency drops, thus it is not appropriate for standard usage

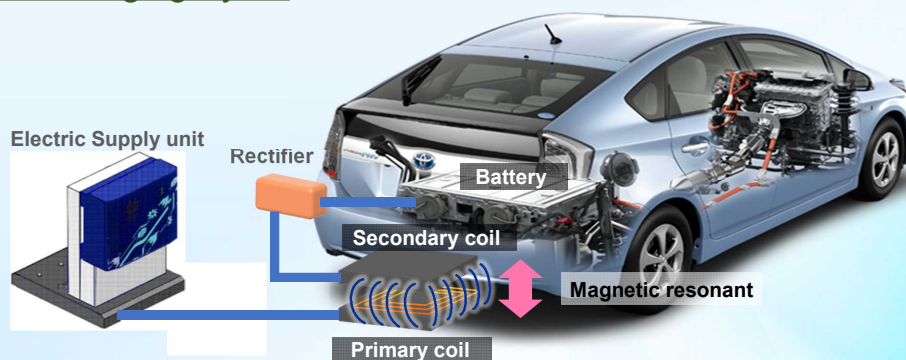
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## PHEV/BEV further Improvement

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### Wireless Charging System



Wireless charging brings more convenience than ICEs.  
It is a solution to secure PHEV CO<sub>2</sub> performance

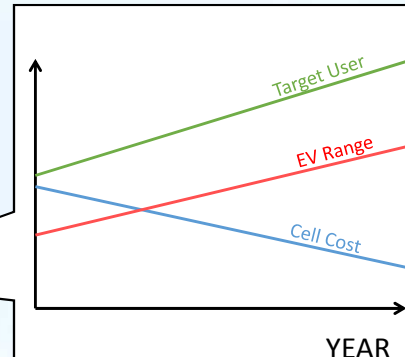
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## Challenges of vehicle electrification

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	HEV	PHEV	BEV	FCEV
Solution to Env. Performance	+	++	++	++
Cruising Range, Charging Time	++	++	-	++
Infrastructure	++	++	Depends on the cell cost	-
Cost / Affordability	++	+		-



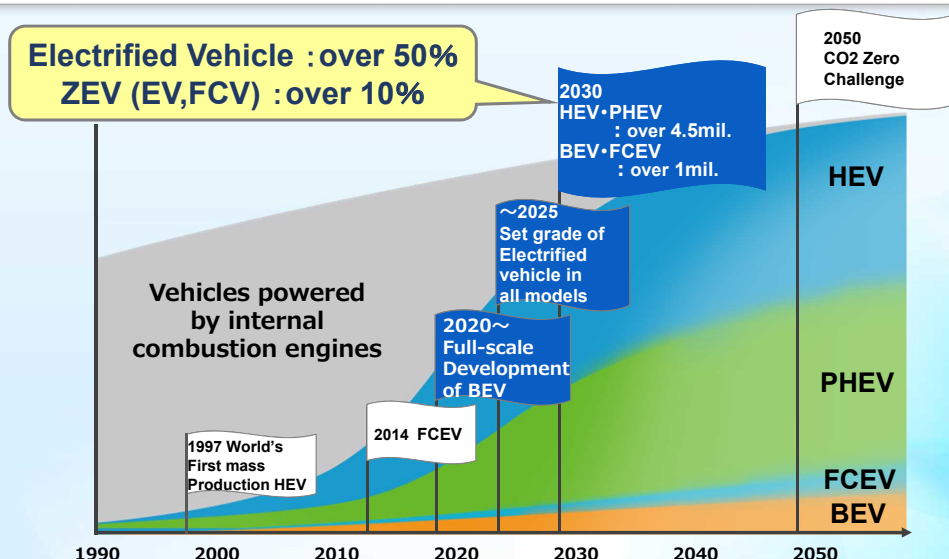
- In current circumstances, PHEV has merits over BEV for user and business
- For BEVs improvement of battery and charging convenience is essential.
- Toyota is working on the most suitable solution for each market/customer.
- HEV, PHEV, BEV and FCEV will have a different important in each market.

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## Milestone of vehicle electrification

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## BEV requires large capacity battery

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HEV



Prius (Li-ion battery)

BEV



BEV (example)

0.75kWh < Battery capacity > 40kWh

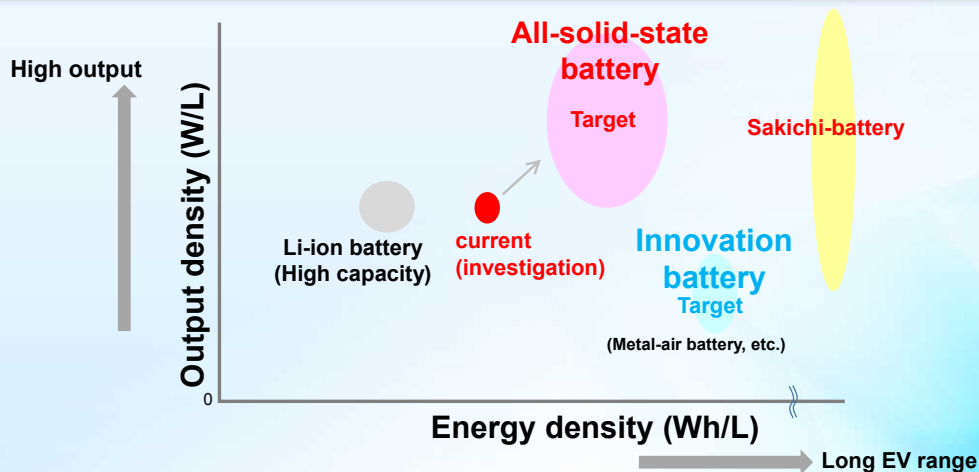
Battery supply for BEV production will become a challenge

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## Next generation battery development

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Development of next generation battery is key to spread electrified vehicles

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## For the purpose of problem-solving of BEV

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Development · Production of “High performance Battery”  
by collaboration of both companies



Realization and stable  
supply of number one  
automotive battery in the  
industry

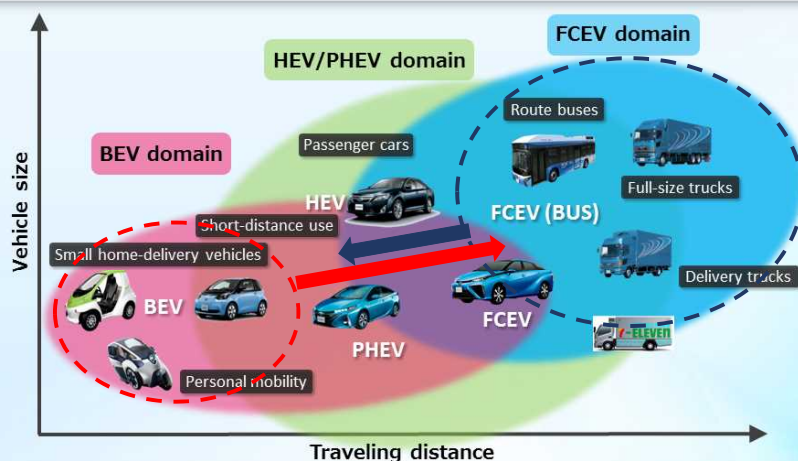
Contribution to spread  
electrified vehicles of  
automobile manufacturers  
around the world

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## Categorization of electrified vehicles from now (image of popularization)

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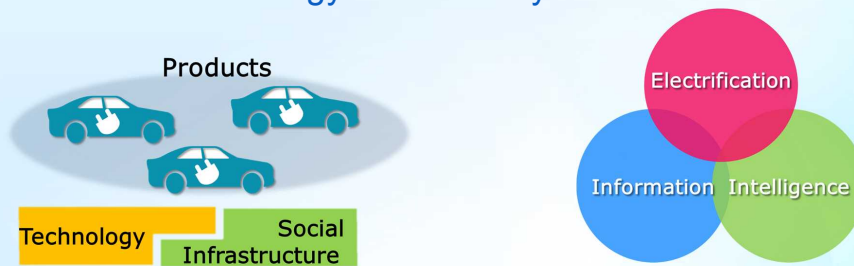
Diversification of HEVs, PHEVs, BEVs, and FCEVs becoming more important

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## Summary

- Toyota is developing all essential technologies for the next generation environmental vehicle development like PHEV/BEV/FCEV based on its HEVs as core technology.
- Improvement of battery and charging technology is important for spreading of BEVs and PHEVs. For battery a breakthrough like solid state or similar technology is necessary.



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Thank you very much for your kind attention !

*TODAY for TOMORROW*

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