

# Toyota's Leadership Perspectives

## Future Electrified technologies for India to make carbon neutral mobility

21<sup>th</sup> Oct. 2022

20<sup>th</sup> Edition of India GBC's Green Building congress 2022



**Raju Ketkale**

**Executive Vice President & Director**

**Toyota Kirloskar Motor Pvt. Ltd.**





TTI

Test Track

Eco Park

CBU Yard

Plant 2  
D22 Production  
( 59 sec)

Plant 1  
Innova & Fortuner Production  
(2.32 mintakt)

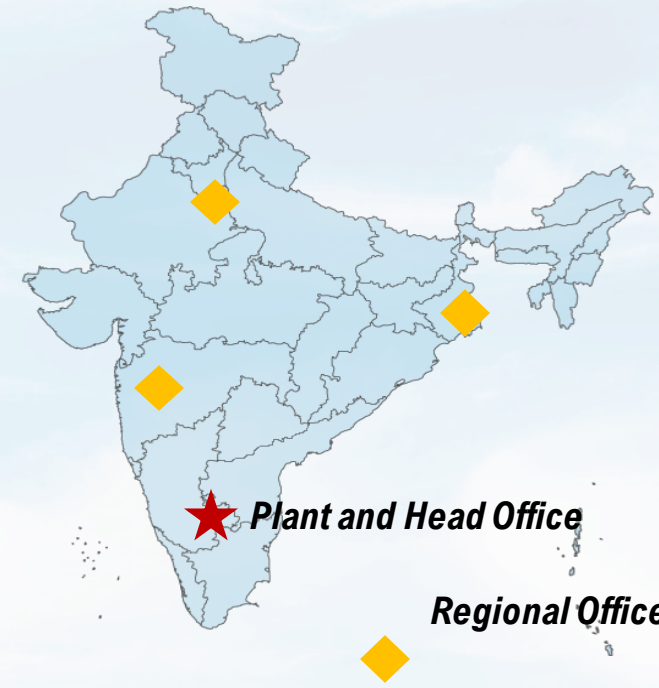
NMEC

Cricket Ground

Gurukul



SN.	Particulars	Details
1	Name	Toyota Kirloskar Motor Pvt. Ltd.
2	Date of Incorporation	6 <sup>th</sup> October 1997
3	Head Office	Bidadi, Karnataka
4	Paid-in Capital	Rs. 7 Billion
5	Ownership Profile	Toyota, Japan - <b>89%</b> & Kirloskar Group - <b>11%</b>
6	Employees	Approx. 6000 (Permanent) [As on Jun'22]
7	Area	432 Acres
8	Production Capacity	Plant 1 : 100k units/year Plant 2 : 200k units/year SKD Line : 3k units/year



### Plant 1

### Plant 2 ( Domestic & export market)

### SKD Line



*Innova*



*Urban Cruiser  
Hyryder*



*Camry*



*Lexus ES 300h*



*Fortuner*



*Grand Vitara*



*Hilux*

Supplier Base in India

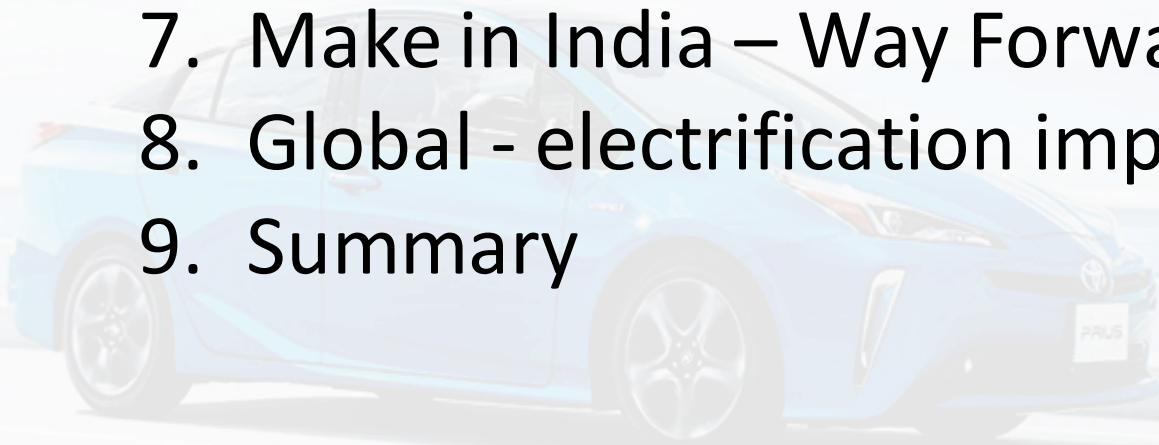
**191 Supplier**

Dealer Network in India

**435 outlets**

# Contents

1. **Background and Concept of Toyota Electrification**
2. Electrification Core Technology
3. Hybrid Electrical Vehicle
4. Fuel Cell Vehicle Technology
5. Toyota's Global experience of electrification
6. India Electrification perspective
7. Make in India – Way Forward
8. Global - electrification impact on society
9. Summary





1.1 Background – Requirement for future vehicles

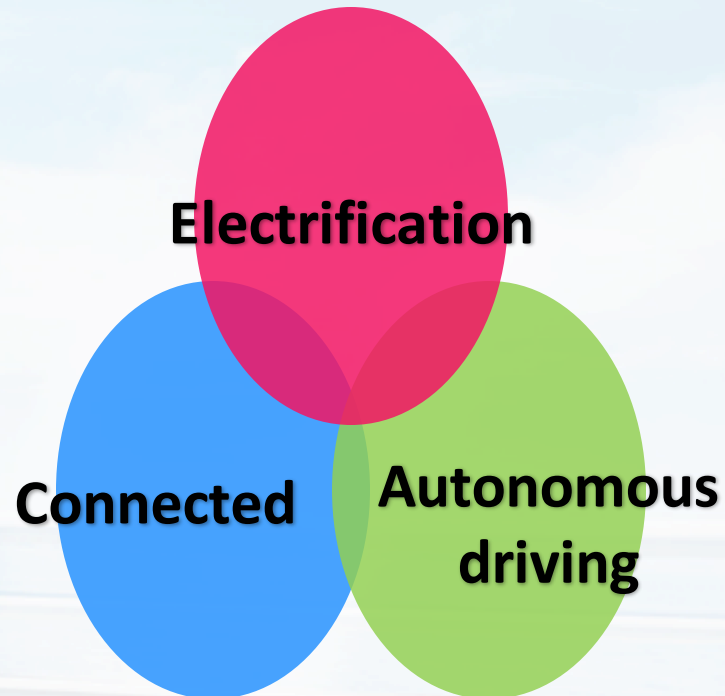
**Big transformation  
once in a century**

=

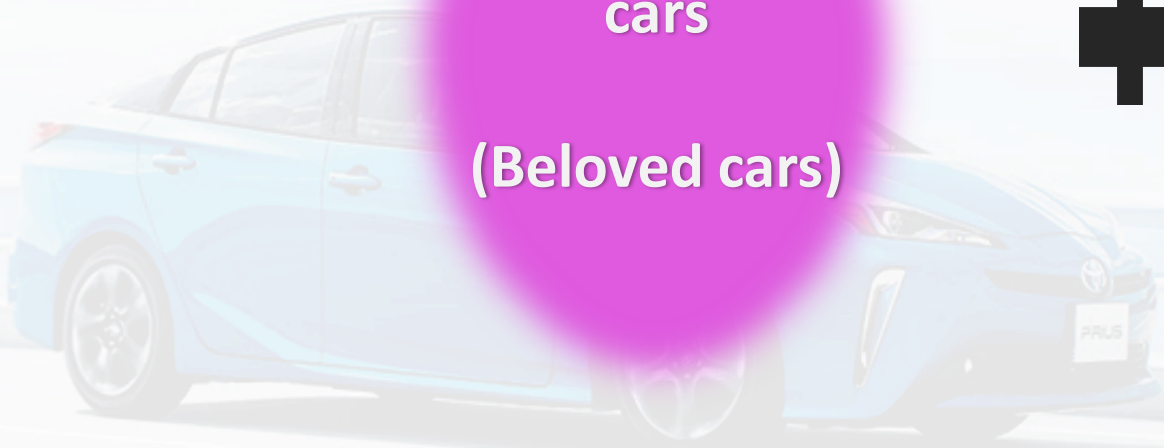
**Big opportunity for  
new value creation  
& business expansion**

Ever-better  
cars  
(Beloved cars)

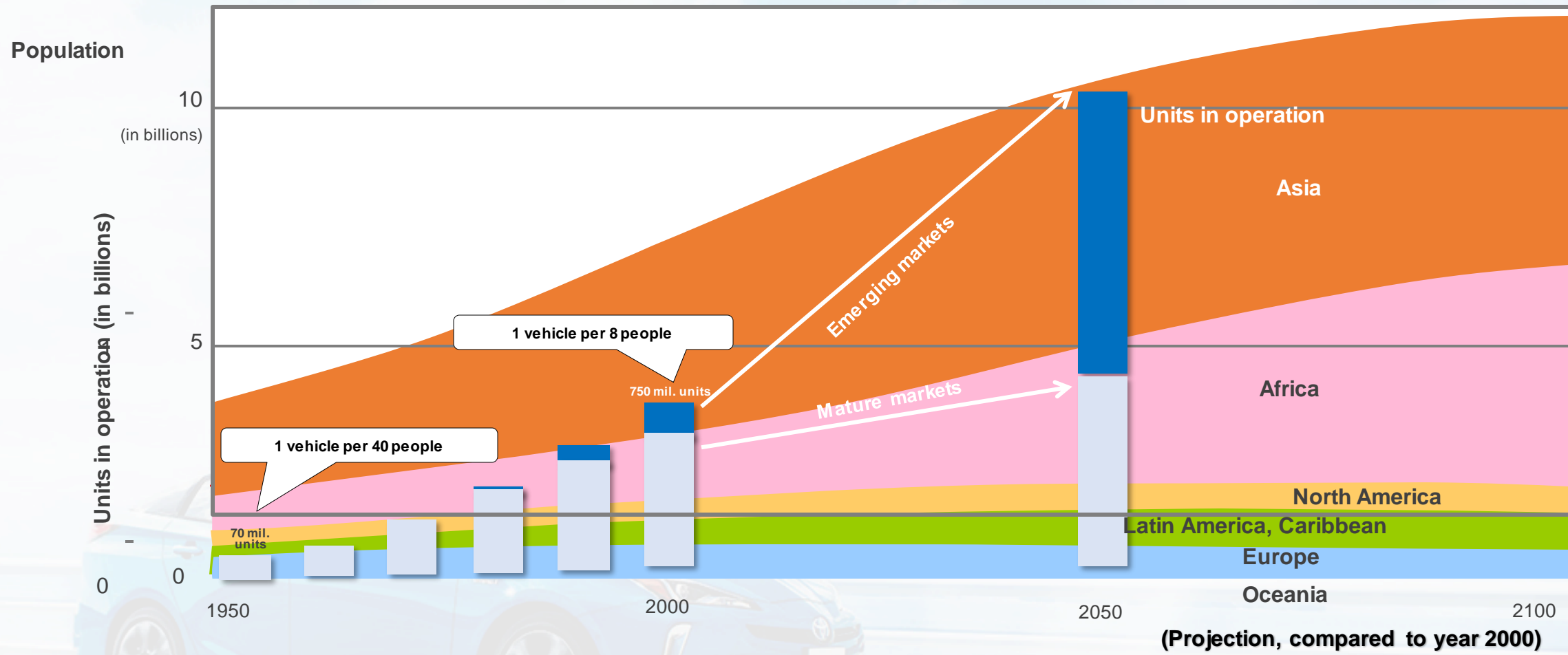
+



Strategic priority



# 1.2 Global Population Growth and Vehicle Units in Operation

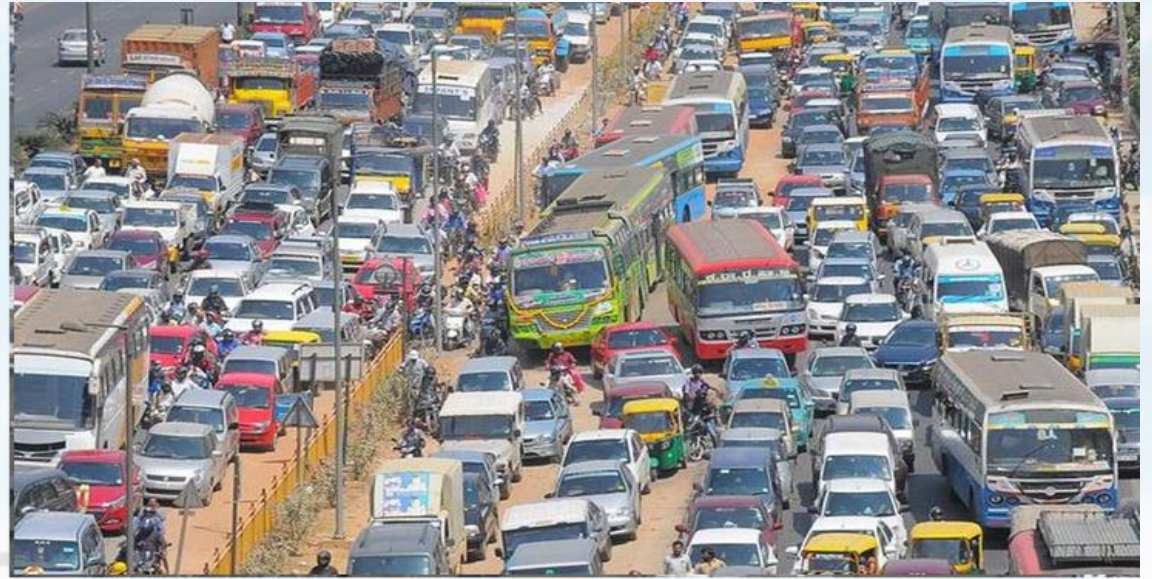


**Population and vehicle growth in emerging markets  
⇒ Units in operation to increase three-fold by 2050**

Sources: 1) United Nations Department of Economic and Social Affairs  
2) World Business Council for Sustainable Development



# 1.3 Global Issues : Energy Security, Pollution & Global Warming







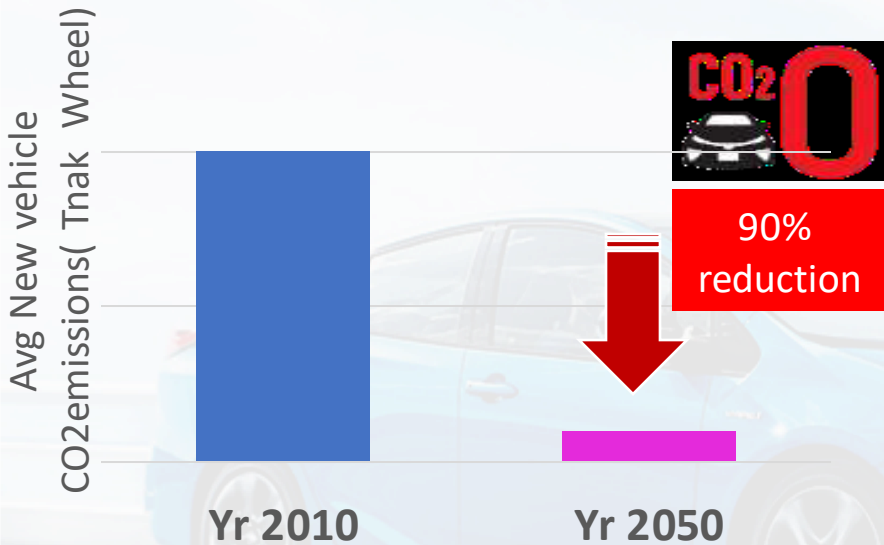


## Environmental Challenges 2050

Toyota's Strategy towards electrification.

### ➤ Product

#### New Vehicle Zero CO2 Emissions Challenge



90% reduction in new vehicle CO2 emissions by 2050

#### Toyota Fundamental Stance

Energy Conservation

Energy Diversification

When widely-used, eco-friendly cars can contribute to environmental protection

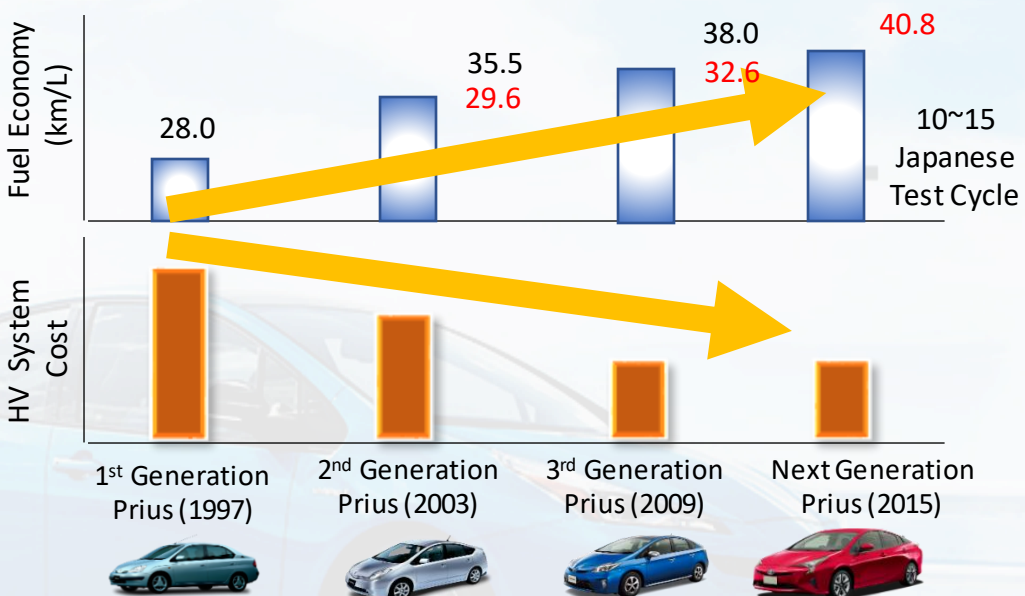
Responding to environmental issues while pursuing the Joy of Cars

+ Pursuing the Joy of Cars

## Environmental Challenges 2050

### ➤ Product

#### a. Raising Fuel economy & Reducing xEV system Costs



**Substantial increase in fuel economy and reductions in costs have been achieved**

#### b. Spread of xEV Vehicles



**Lineup of SHEV in all categories**

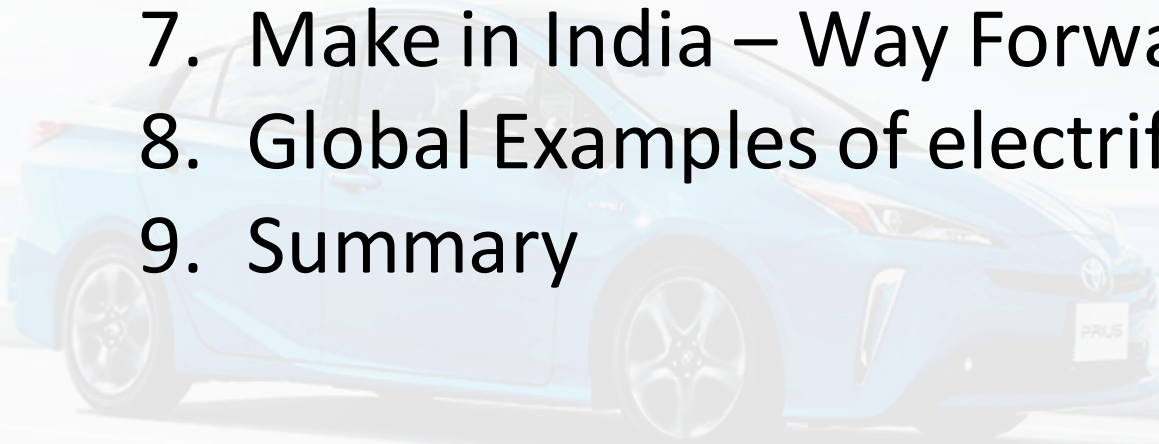
**What is Toyota Focus**





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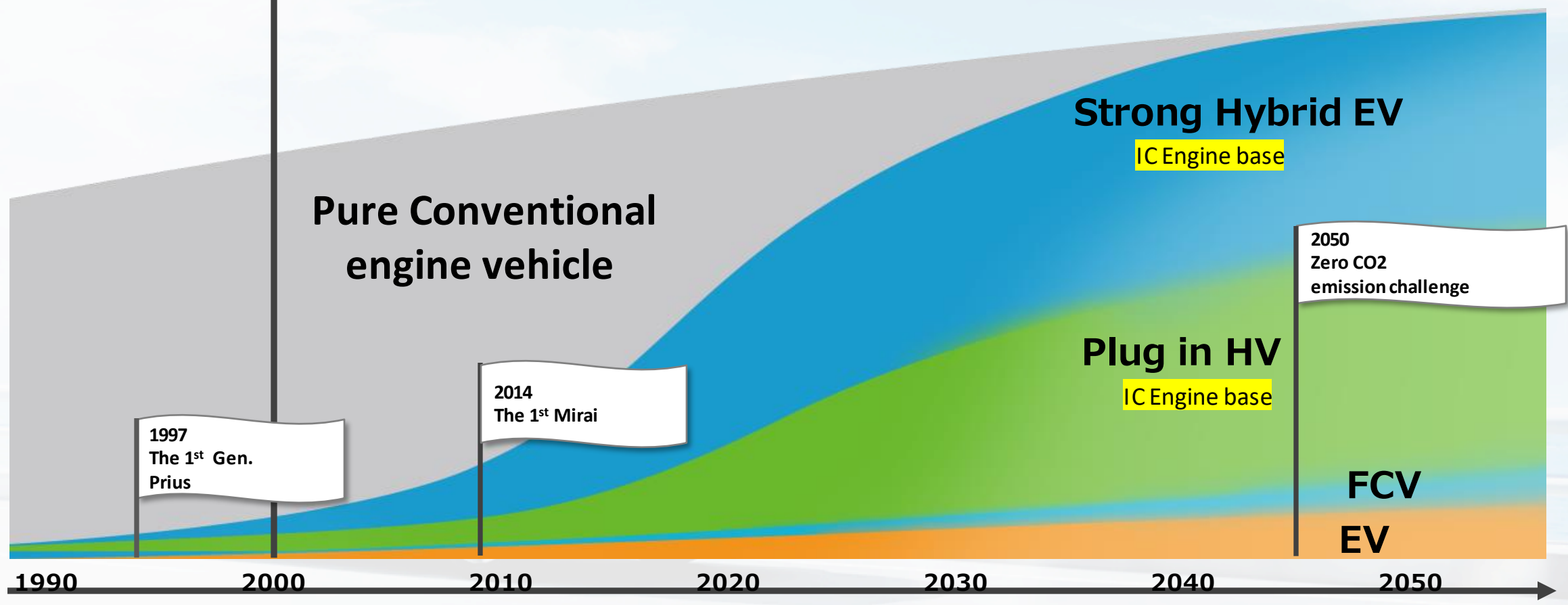
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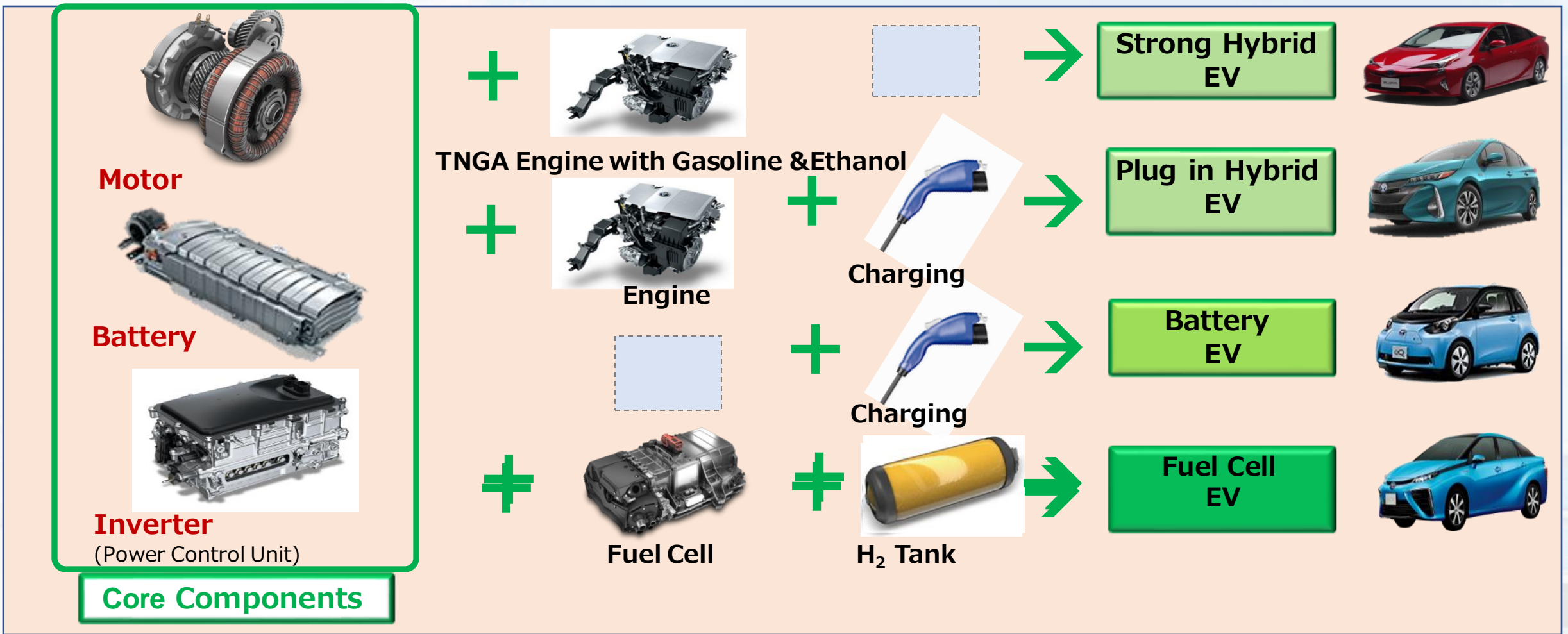
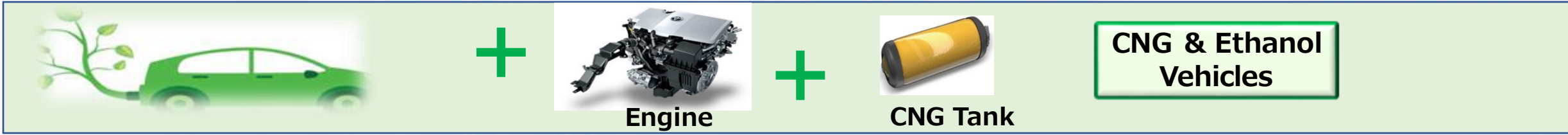
# 2.0 Vehicle electrification milestone

Confidential

- From 2020 Battery EV roll-out
- Around 2025 Electrified grades available for all Toyota/Lexus
- Around 2030 Electrified Vehicle > 5.5 million EV/FCV > 1.0 million





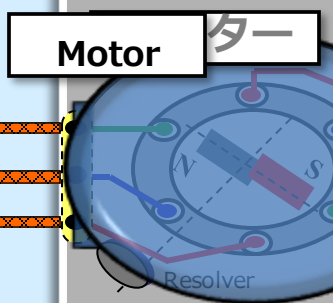
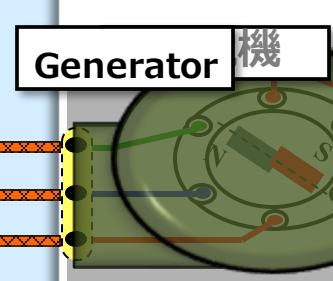
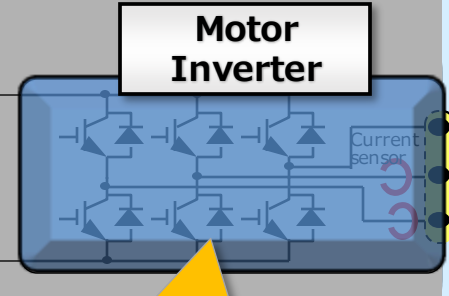
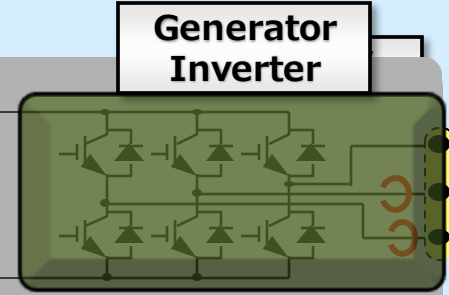
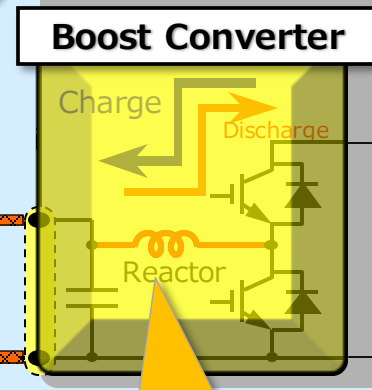
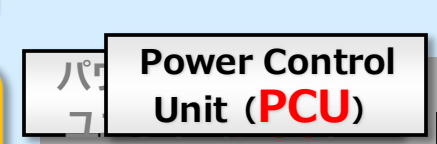
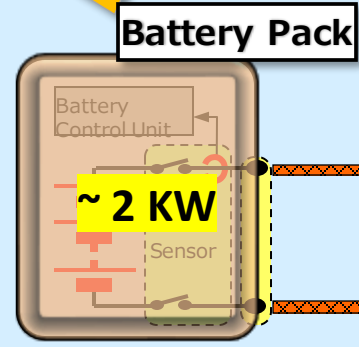


Electrification of IC Engines is low hanging fruit due to strong Eco system available

Toyota Strong Hybrid System operates at high voltage (up to 600V, Similar to EVs),

## 2<sup>nd</sup> ~ 4<sup>th</sup> Gen

Reduce no. of cells:  
Lower voltage  
Smaller size

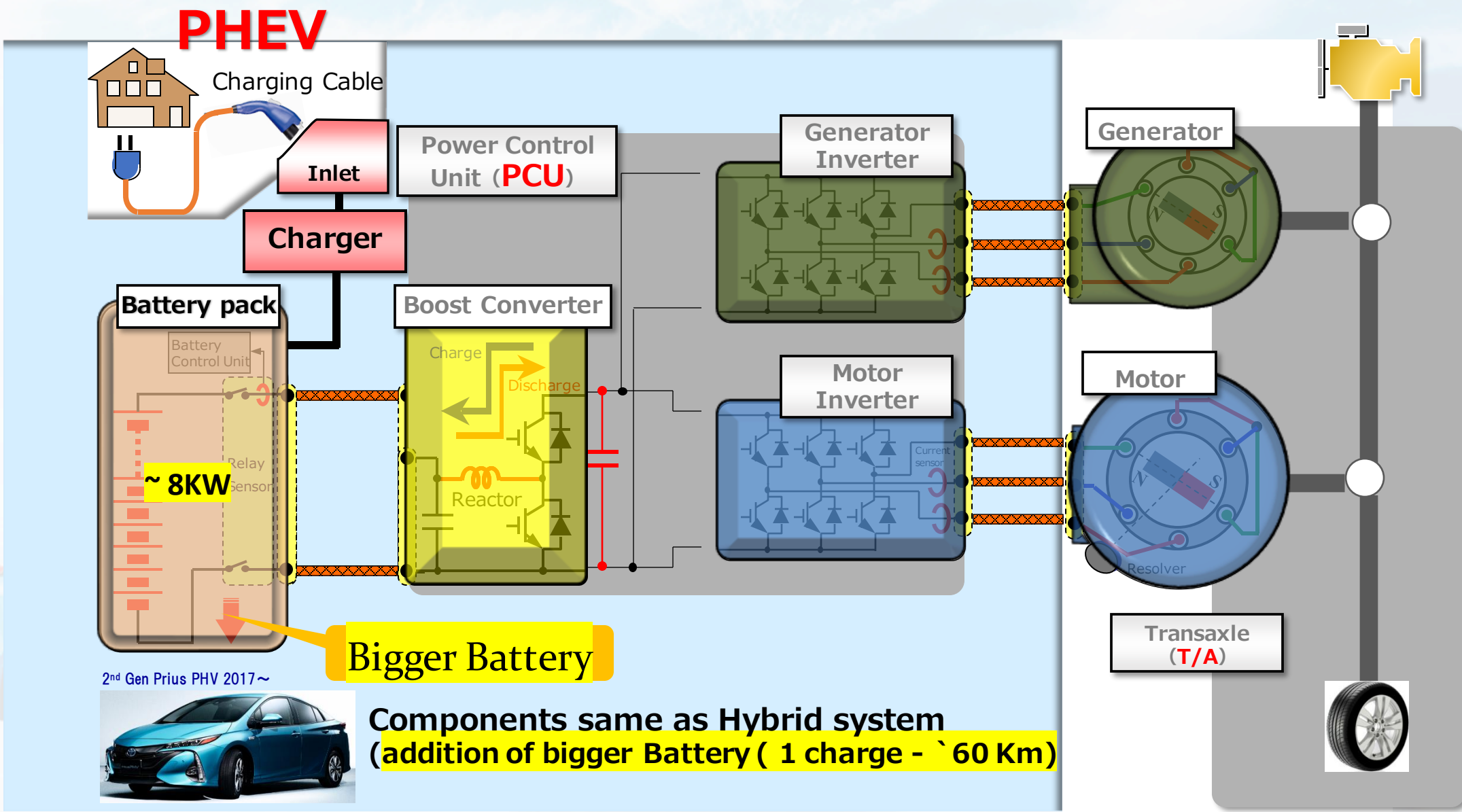


Voltage Boost upto 600V

Increase the motor voltage  
Size reduction (Current cap. Red.)

**( IN Hybrid EV -3 Core components cost from 3.5 ~ 4.5 lakh)**

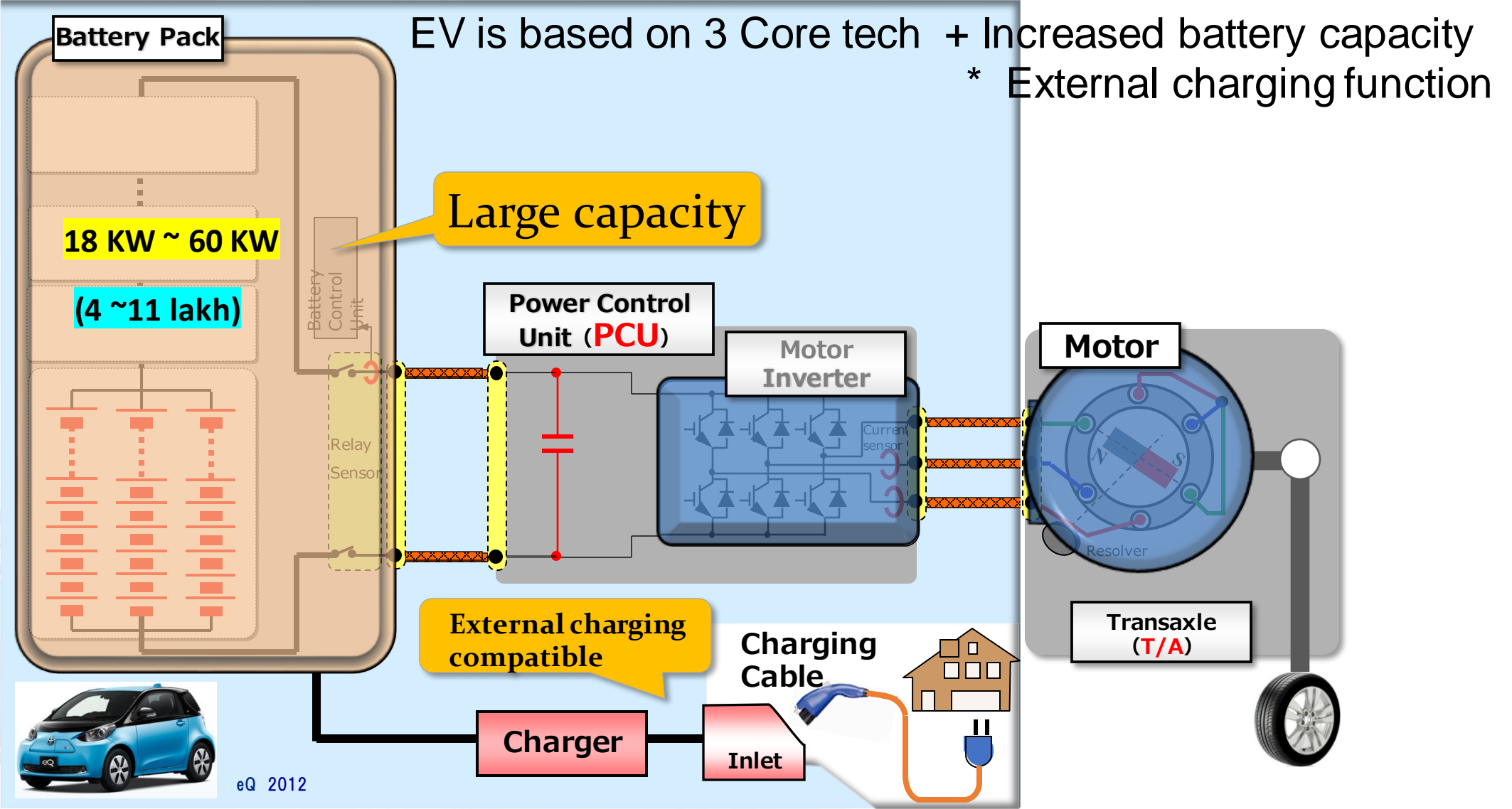
Core Technology of electric mobility is incorporated in Toyota Strong Hybrids



( IN PHEV 3 Core components cost from 5.0~ 5.5 lakh)



BEV

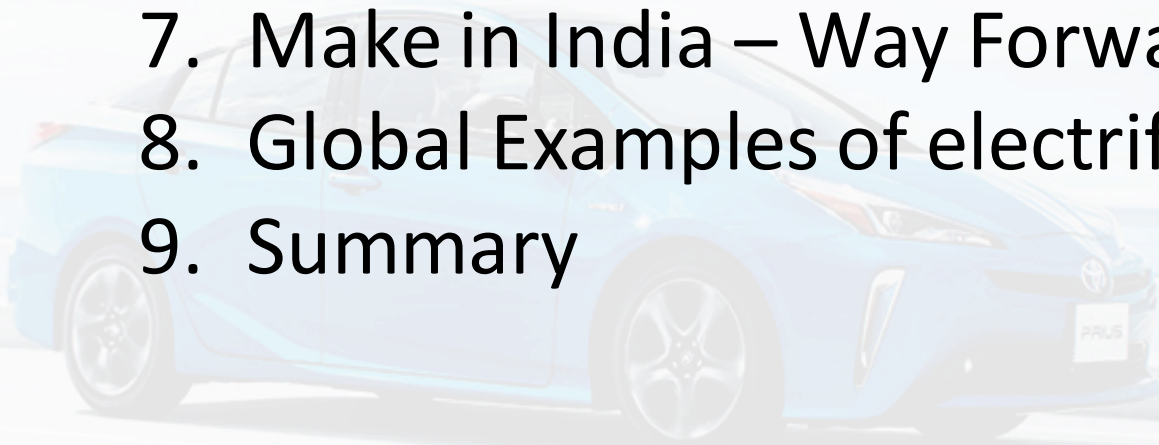


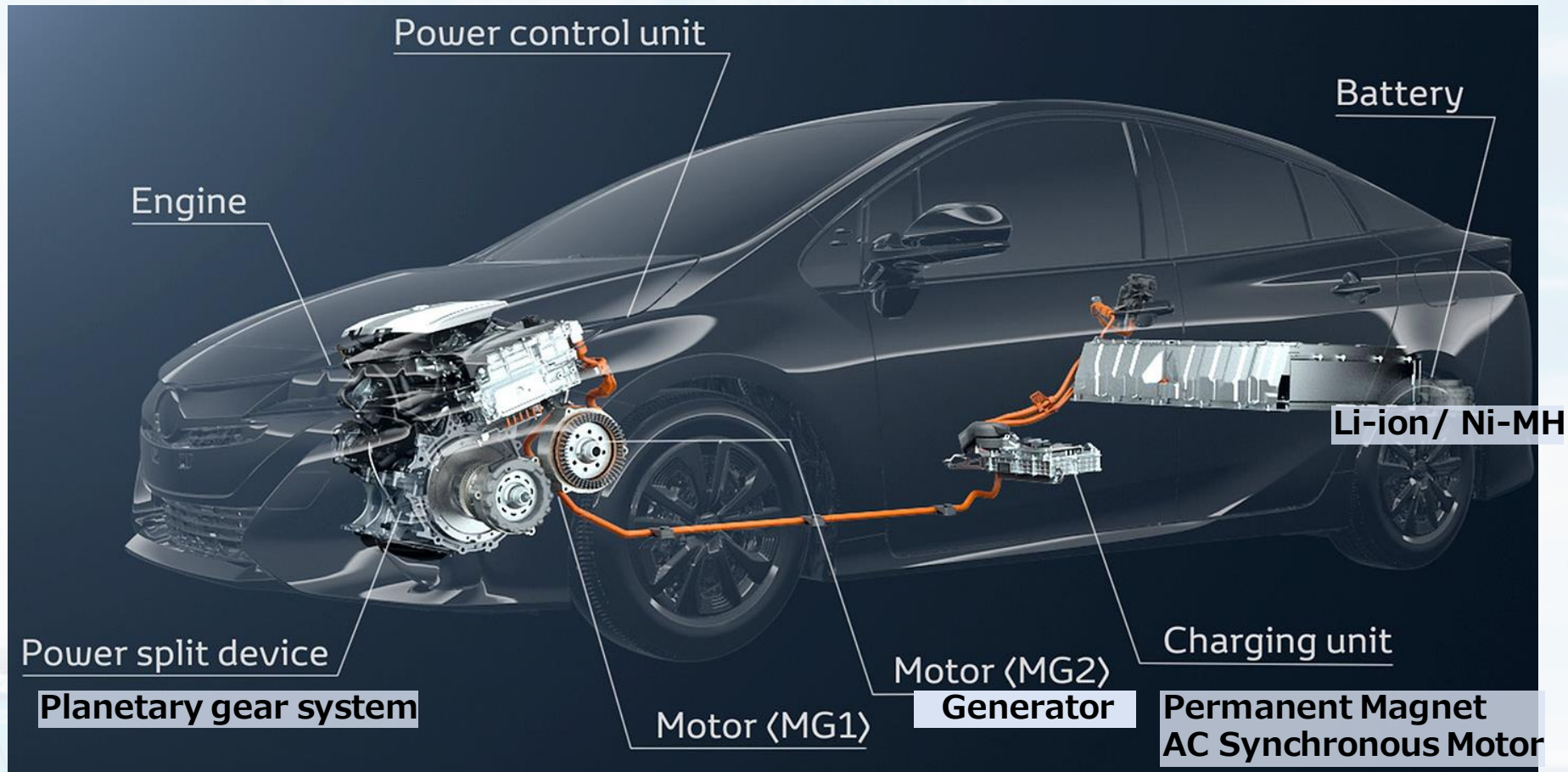
EV is based on 3 Core tech + Increased battery capacity  
\* External charging function

( IN BEV Core components cost from 4.5 ~ 10 lakh)

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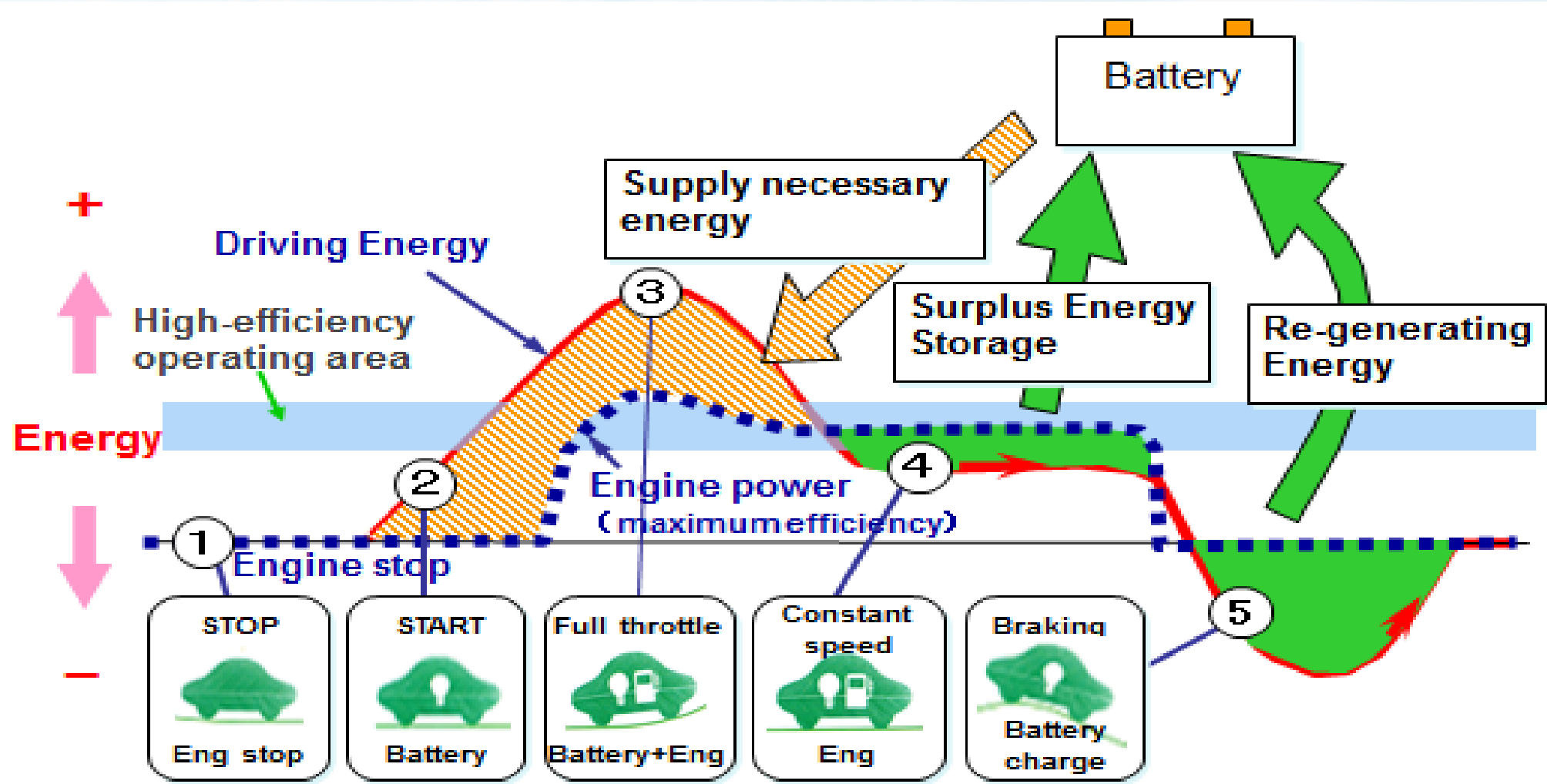




- HEV use same core components as EV (Battery, Motor, PCU)
- High performance: ~600V Motor & Generator; EV only drive mode
- High FE increase: >45%



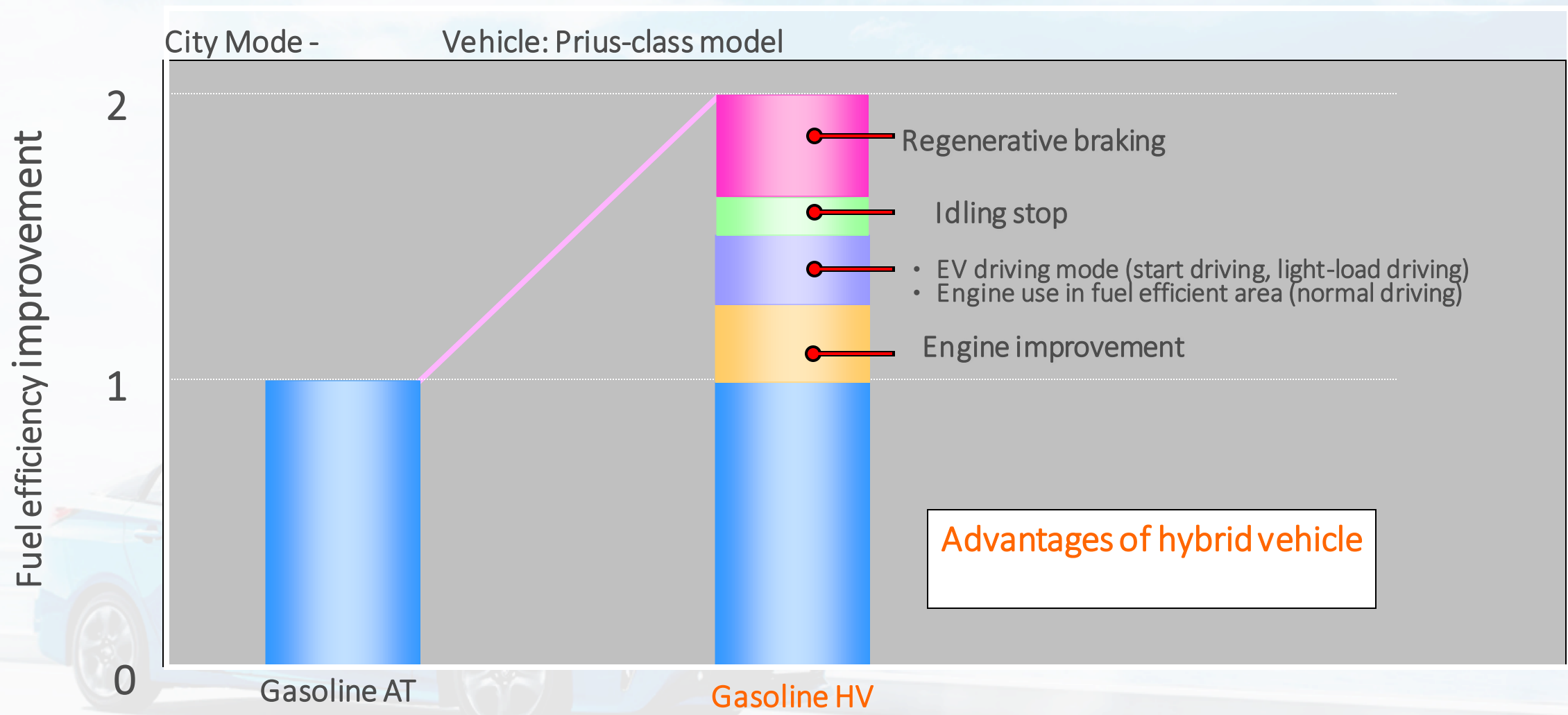
### 3.1 Energy management of Toyota's Strong Hybrid System (THS)



In SHEVs, battery supports engine for the less-efficiency operation area, and store energy for less energy consuming drive

### 3.2 Why Toyota's Hybrid System is fuel efficient

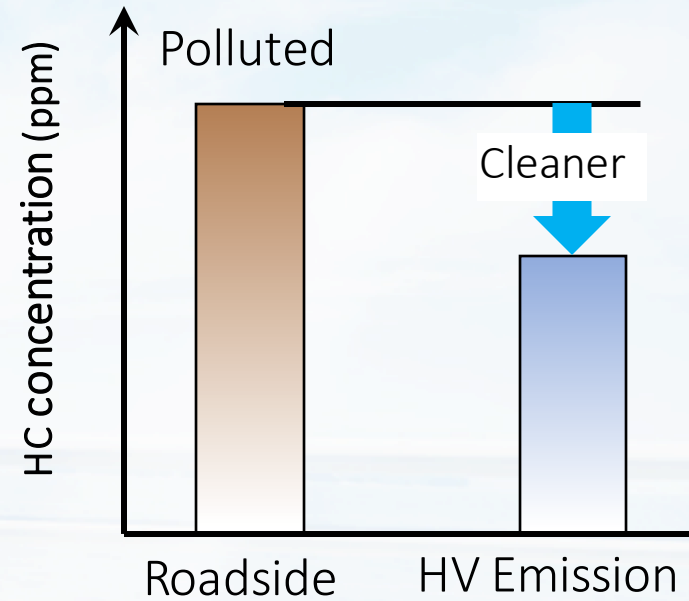
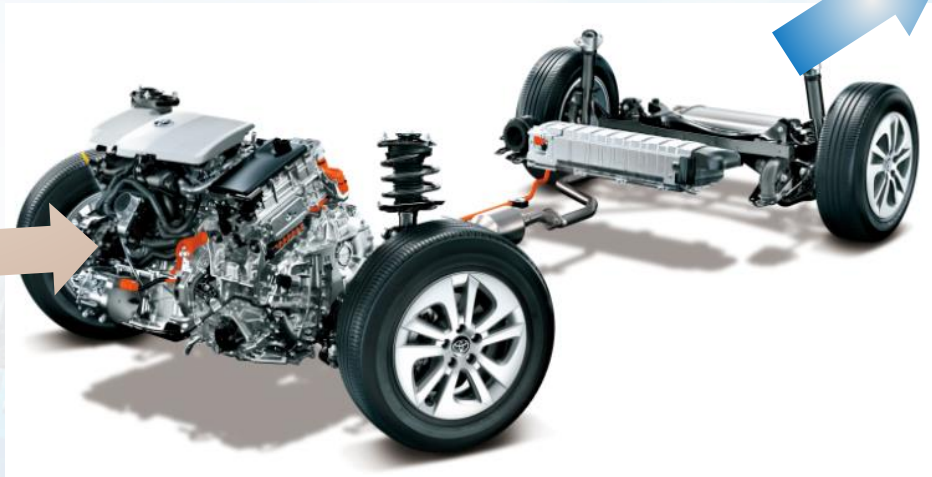
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Roadside  
HC Polluted Air

Cleaner Emission Gas  
★

The HC concentration of HV emission is lower than polluted roadside air!!



\*Concentration levels of HC in the air in urban areas is reduced.

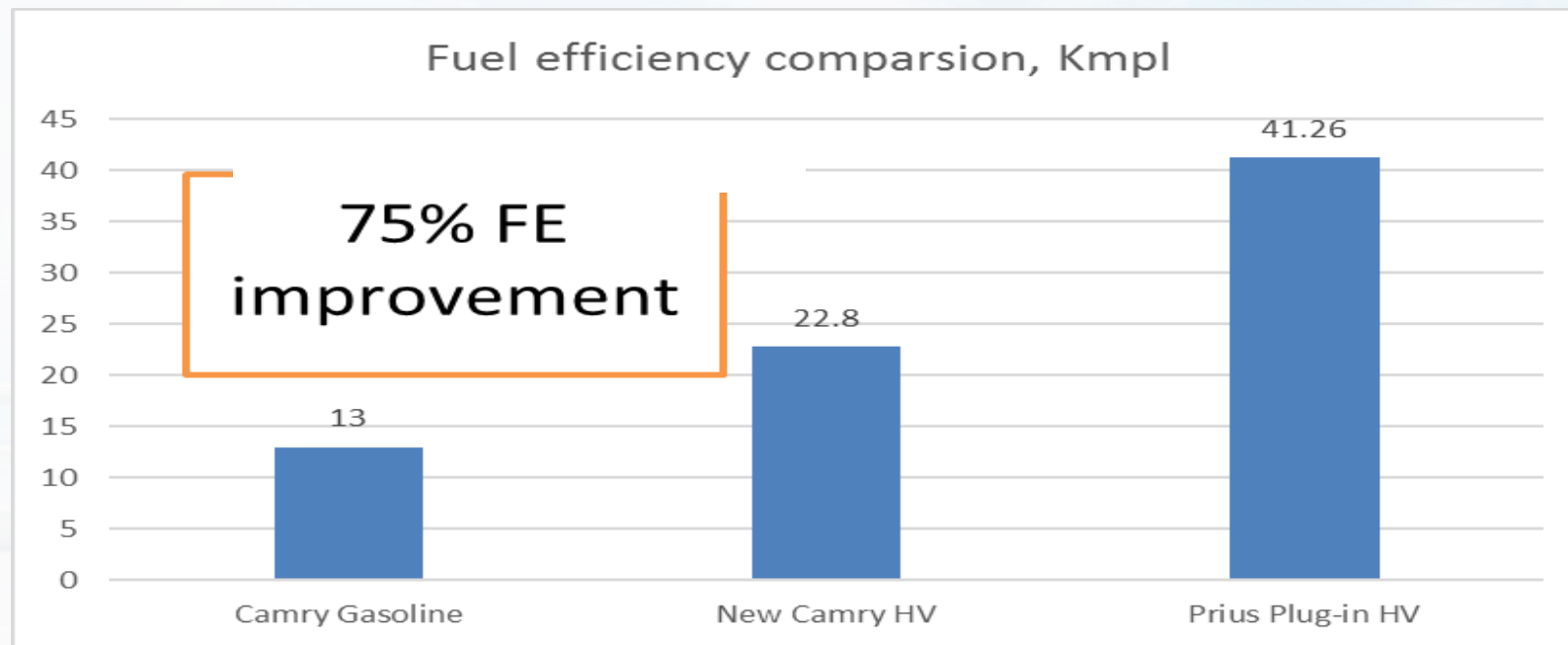
More Strong Hybrid Electric Vehicles will help improve vehicular air pollution



## NEW CAMRY HYBRID - EMISSION TEST VALUES SUMMARY

BS VI						
	CO, g/km	HC, g/km	NO <sub>x</sub> , g/km	NMHC,g/km	PM,g/km	PN(numbers/km)
Limits	1	0.1	0.06	0.068	0.0045	6 X10 <sup>11</sup>
Limits with DF	0.667	0.077	0.038	0.052	0.0045	6 X10 <sup>11</sup>
<b>Camry HV</b>	0.100	0.025	0.002	NA	NA	NA
% margin	<b>85</b>	<b>68</b>	<b>95</b>	NA	NA	NA

DF - Deterioration factor  
 CO - Carbon monoxide  
 HC - Hydro carbon  
 NOX - Nitrous Oxide  
 NMHC - Non methane hydro carbon  
 PM - Particulate matter  
 PN - Particle number  
 RDE - Real driving emissions



**Toyota HYRYDER  
 Strong Hybrid EV  
 is Made In India.**

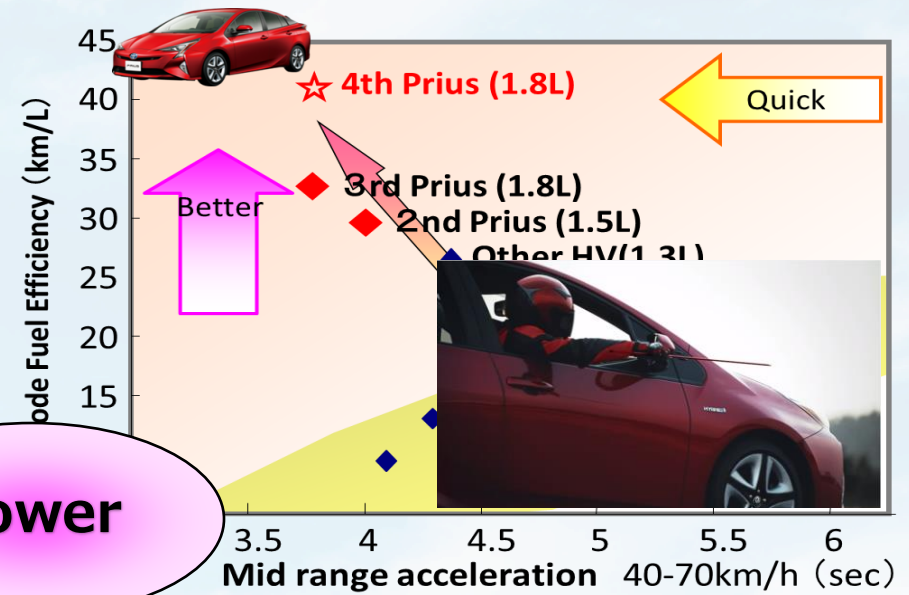
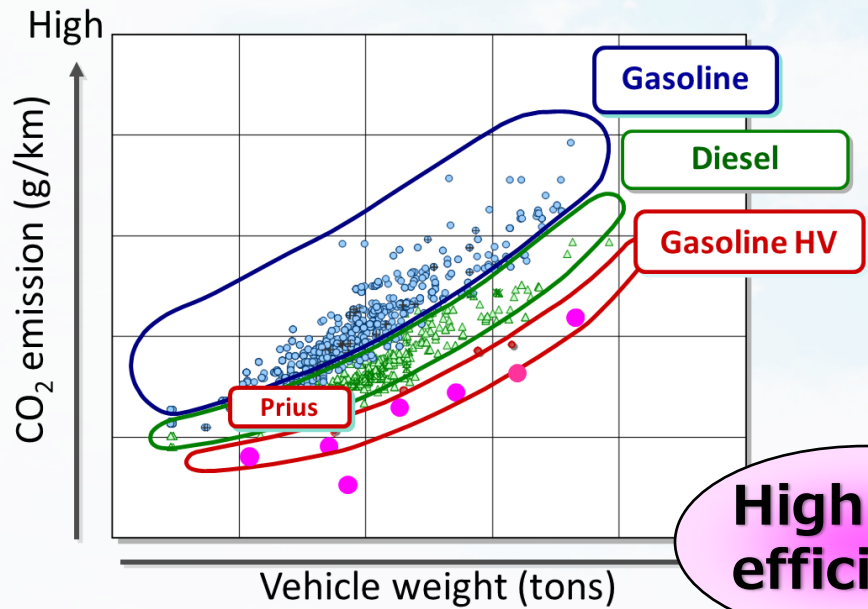
**Its emission is  
 1/10<sup>th</sup> of BS6  
 target.**

**Its CO2 emission  
 is even lower than  
 CAFÉ#2 target.**

# 3.5 Benefits of Toyota's SHEV

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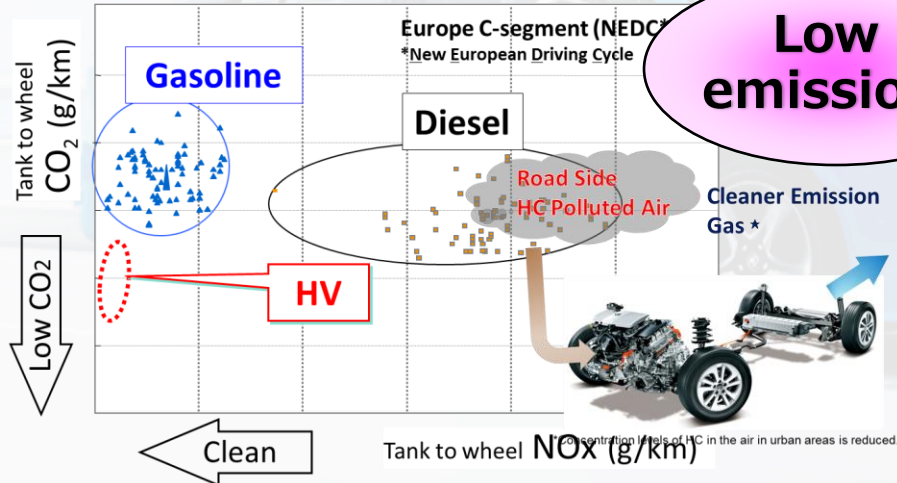


High fuel efficiency

Power

Low emissions

Quietness



\* JC08 Japanese test cycle

## The Higher Fuel Efficiency

# PRIUS



1st Gen  
(1997)

2nd Gen  
(2003)

3rd Gen  
(2009)

4th Gen  
(2015)

SHEV technology is significantly evolved (provides 30-48% improved fuel efficiency over ICE) and achieved low CO<sub>2</sub> emission



## □ Model : Urban Cruiser HYRYDER

- Urban Cruiser HYRYDER (Toyota) & Grand Vittara ( Suzuki)
- Mid Size B - SUV
- 1.5 Litre Engine ( Toyota Hybrid system)
- e-CVT, AT
- RHD & LHD

## □ Schedule

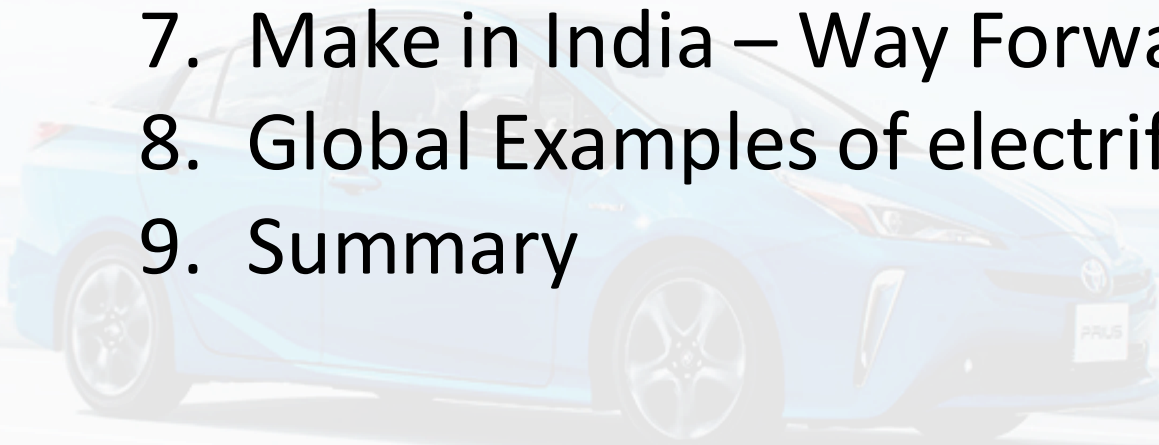
2021		2022		
Design Proto Trial (May'21)	Production Proto Trail (Nov'21)	Mass Production Proto Trail (Apr'22)	SOP- Aug'22 (Domestic)	SOP-Nov'22 (Export)
			Today	

Many used HVs are imported into Sri Lanka, Myanmar, Mongolia, as secondhand vehicles which shows long life of vehicles



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# 4.1 Core component Common use: Mirai FCV

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Electrification strategy  
for 3 components  
(Commonise w/Hybrid)

**FCV Unique Parts**

Fuel Cell Stack

High Pressure H<sub>2</sub> tank

**Motor**

Motor of Lexus



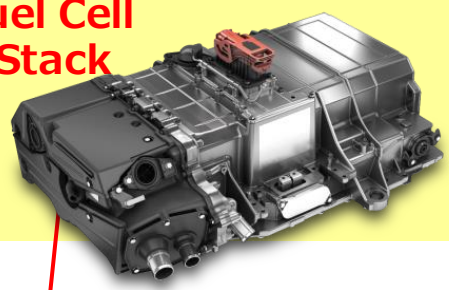
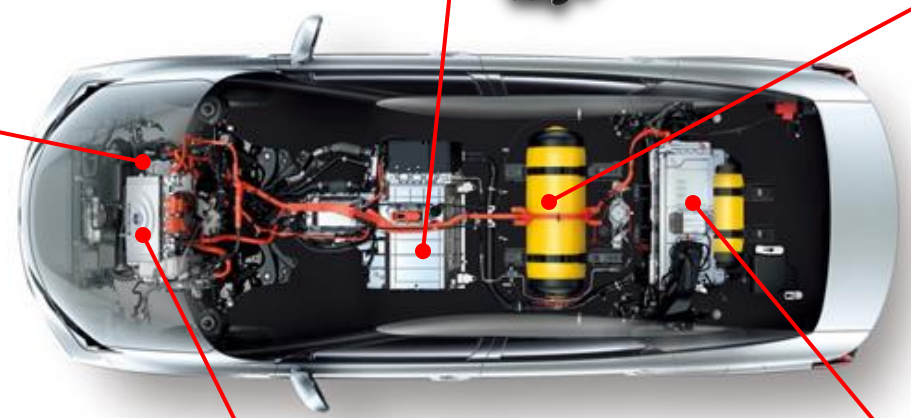
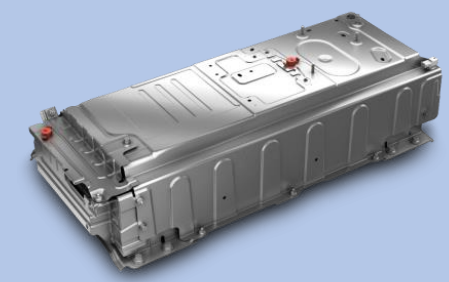
**PCU**

PCU of Lexus



**Battery**

Battery pack of Camry HV



# 4.2 Architecture of Mirai FCV & SORA FC Bus

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FC technology

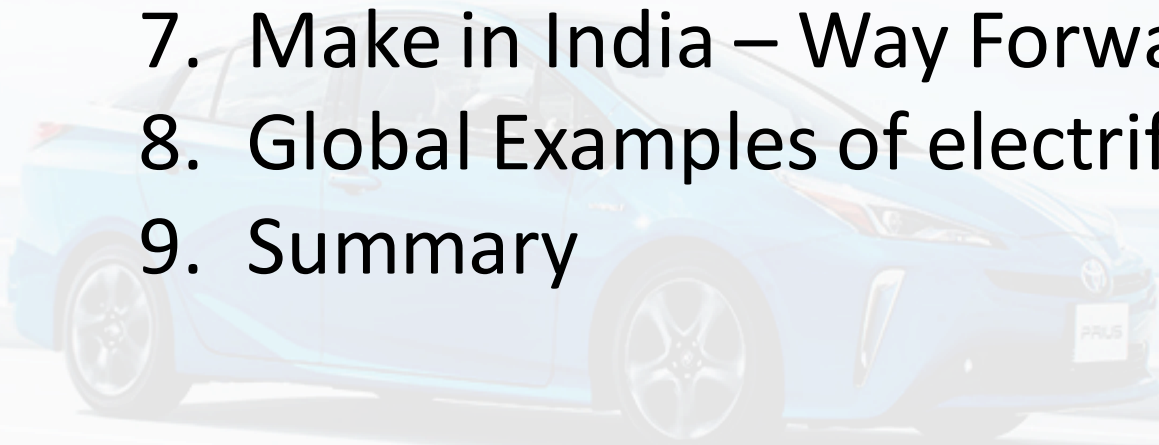


Electrified technology



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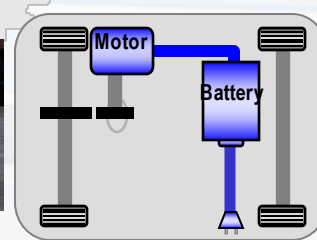
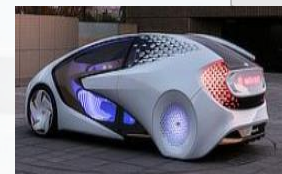
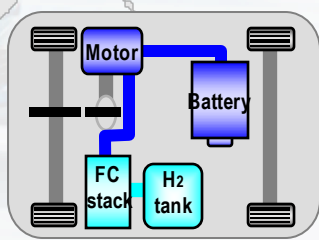
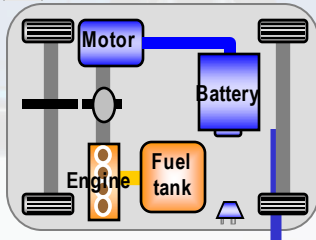
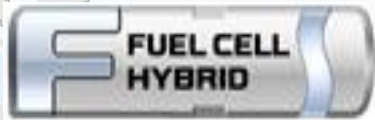
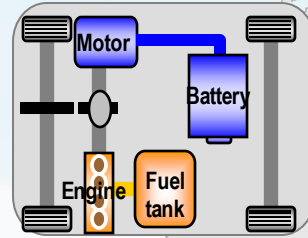
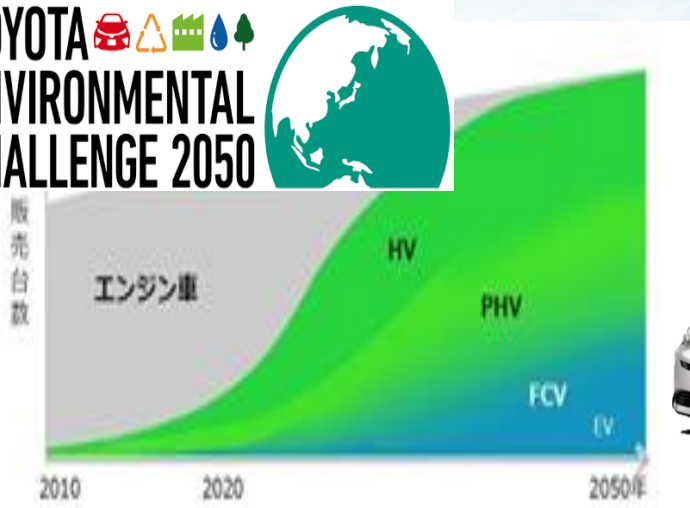
# 5.0 Development of hybrid technology

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Hybrid technology is a core technology and is also found in PHVs, EVs and FCVs

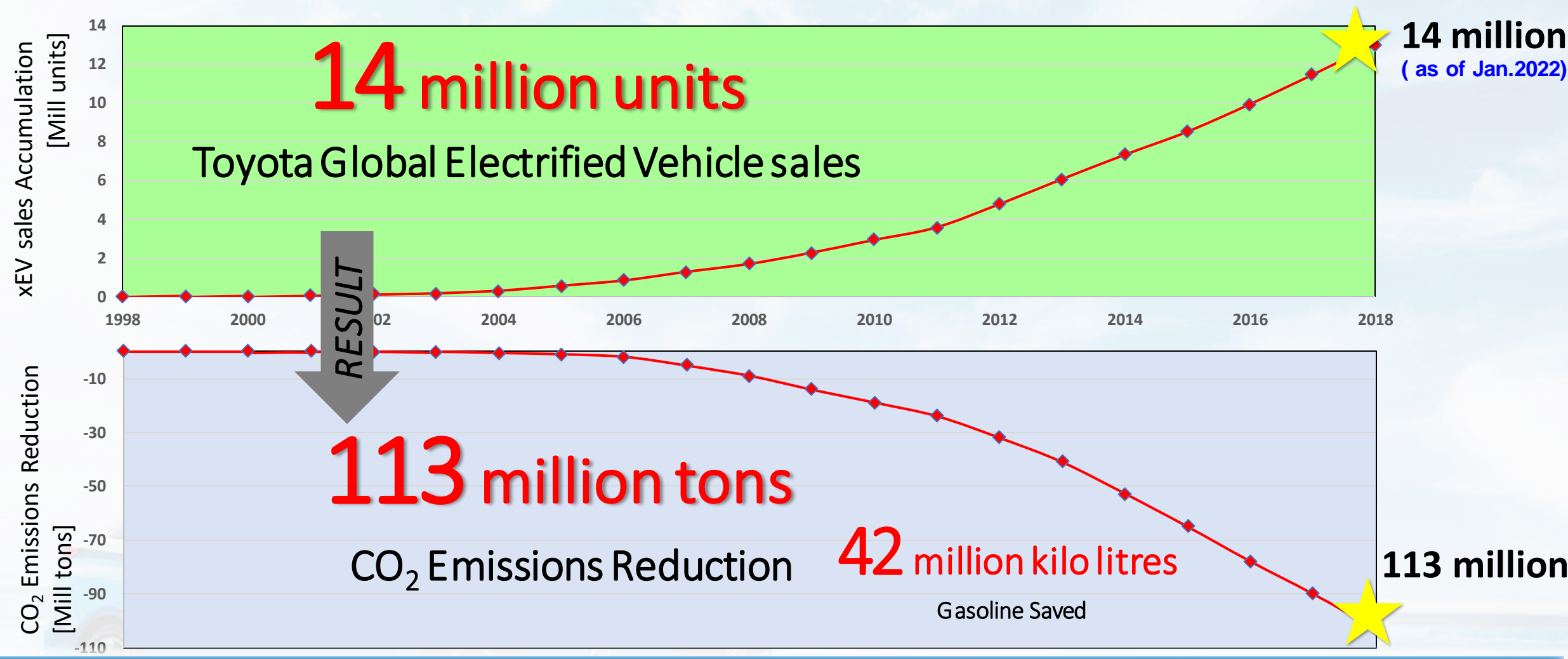
TOYOTA ENVIRONMENTAL CHALLENGE 2050



# 5.1 What Toyota Achieved

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SHEVs provides the opportunity to electrify efficient IC Engine and realize IMMEDIATE environmental benefits



~4,500 people in  
electrified vehicle  
development

Enormous accumulation  
of  
electrification technology  
& knowhow

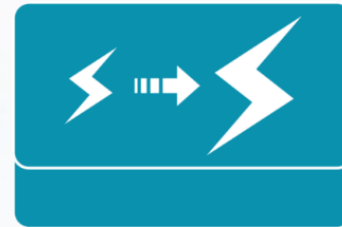
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Electric motors  
28 mil. units



Batteries  
14 mil. units

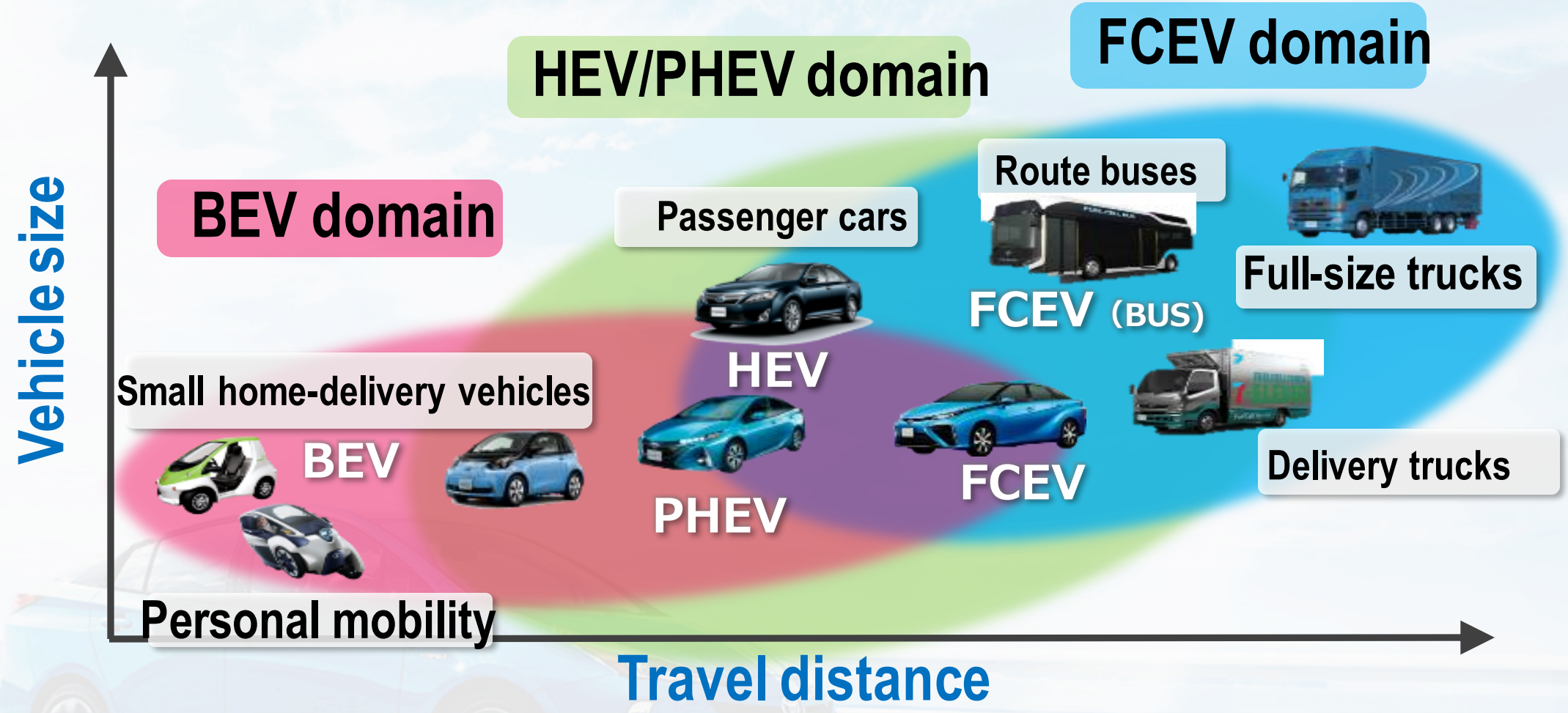


Inverters  
14 mil. units

Electronic  
control

Regenerative  
braking





Technology agnostic approach & Electrification of IC Engine is key for future mobility



**2<sup>nd</sup> LARGEST ECONOMY**



**LARGEST MANUFACTURING HUB**



**ENERGY INDEPENDENT**

(TRANSITION TO LOCALLY AVAILABLE  
LOW CARBON FUELS LIKE RE,BIO-FUEL ,HYDROGEN)

**India aims to be Largest Economy , Manufacturing hub and energy independent.**




**COP 26, Glasgow, 2021**  
Net zero by 2070

**Amrit kaal**  
Energy Transition and Climate  
Action by 2047


**Aatma Nirbhar Bharat**  
Energy independent by 2047

① **Alternate Fuels**


② **Electrification**

**CNG** 


- Increase the number of CNG Stations in India to **10,000 stations** by 2030
- Develop **CNG corridors** on major inter-city highways with CNG stations every 50 km

**Ethanol** 

- National Biofuel Policy targets Ethanol blending of 20% (**E20**) by 2025 & Govt. Advisory for FFV introduction
- Govt. has additionally allowed Ethanol from various feedstocks like Damaged food grains, maize etc.
- GST on Ethanol reduced to 5% & PLI benefits for FFV

**Hydrogen** 

- **'National Hydrogen Mission'** announced by Prime Minister in Nov'20
- "Green hydrogen policy" issued for easing green hydrogen production
- Pilot project under MNRE , IOCL for FC Bus & Car feasibility
- India's first green hydrogen fueling station pilot @ LEH

**BEV** 

- **FAME 2 Incentives** , 5% GST , Low road tax for faster BEV penetration & Investment for Faster charging infra expansion
- **PLI Scheme** - Implement high Import Duty on BEV components and incentivize for Localisation (Make in India)

India need to follow multiple pathways to become Energy Independent



## Reduction in Fossil Fuel



- In EY 2020-21 ethanol blending has helped to reduce/displace **26 million barrels** of gasoline.
- In EY 2024-25\* ethanol blending expected to help to reduce **86 million barrels** of gasoline.

## Reduction in Import Bill



- Ethanol Blending savings in last 8 years ~ **Rs. 41,500 Cr**
- In EY 2020-21 ethanol blending helped to reduce ~ **Rs. 10,000 Cr**
- With E20 blending, expected saving ~ **Rs. 30,000 Cr**

## Reduction in GHG emission



- Ethanol Blending in last 8 years reduced GHG emissions by **~27 lakh MT**
- With E20 blending, expected reduction in GHG Emission is **~10 million MT**
- E20 can **reduce PM 2.5 Emissions** up to 14% than Gasoline

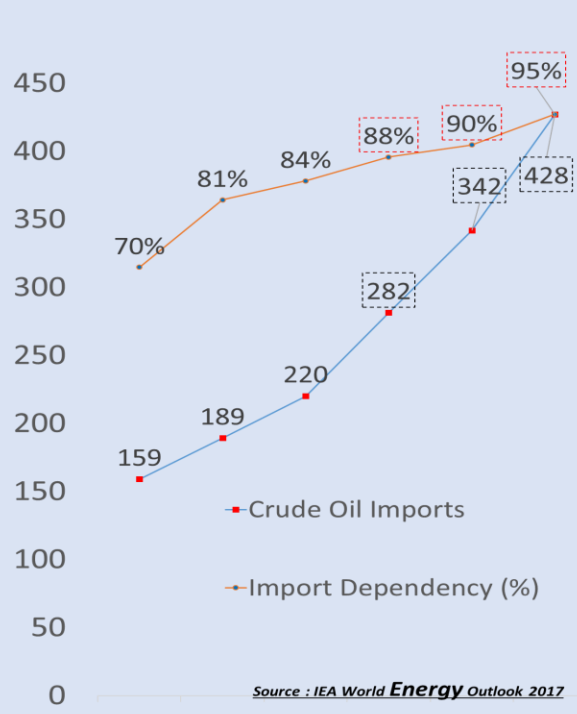
Source: <https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1831289> & Praj Industries

Ethanol not only reduces GHG emission but also India's import bill

## Fuel Imports

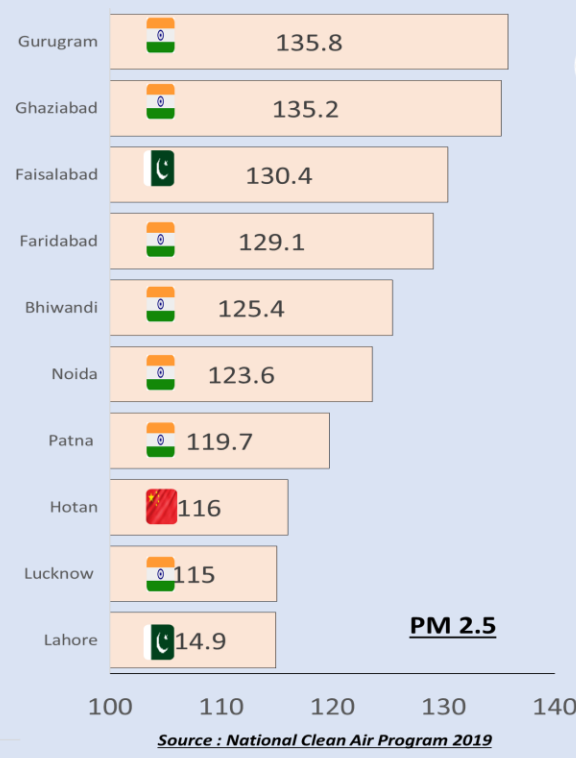
Fuel Import Projections

> 90% by 2030



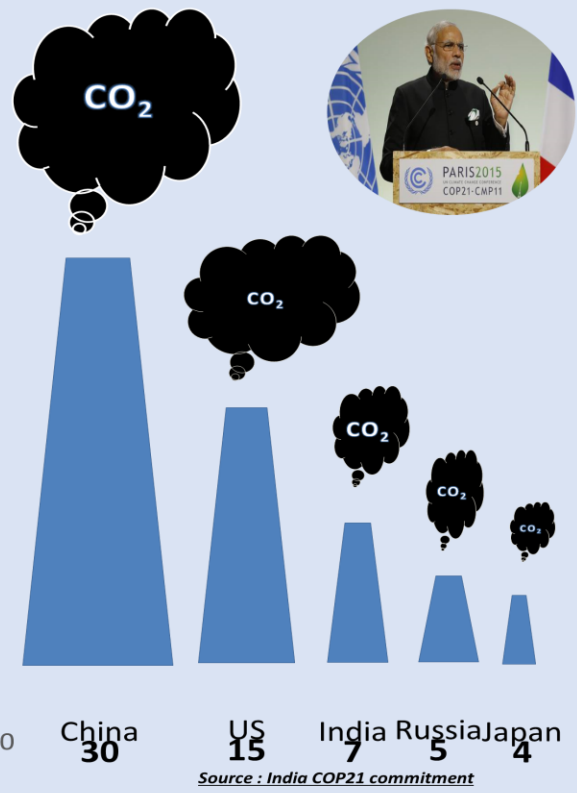
## Pollution

Top 7 cities in India



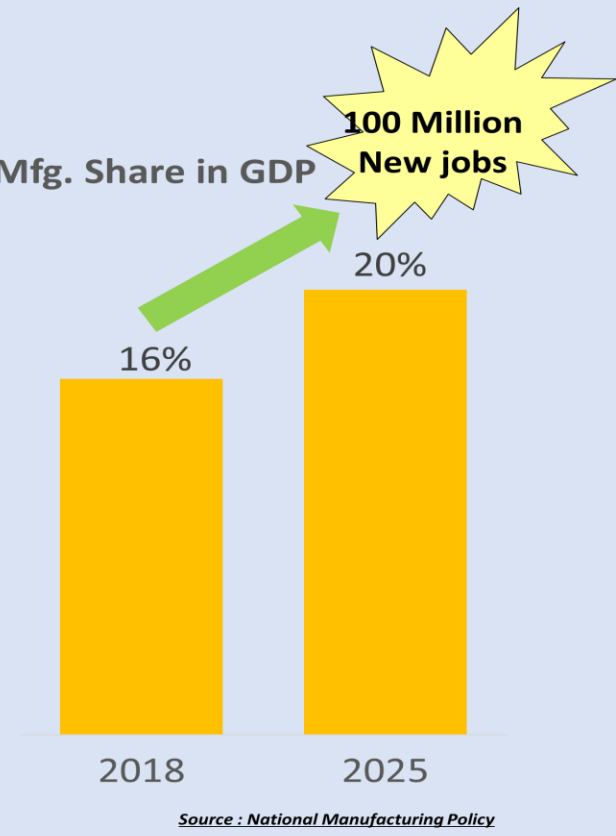
## CO<sub>2</sub> Reduction

3<sup>rd</sup> Largest



## Manufacturing Leadership

Mfg. Share in GDP



**Reduce oil imports 10% by 2022**

**20-30% reduction in air pollution by 2024**

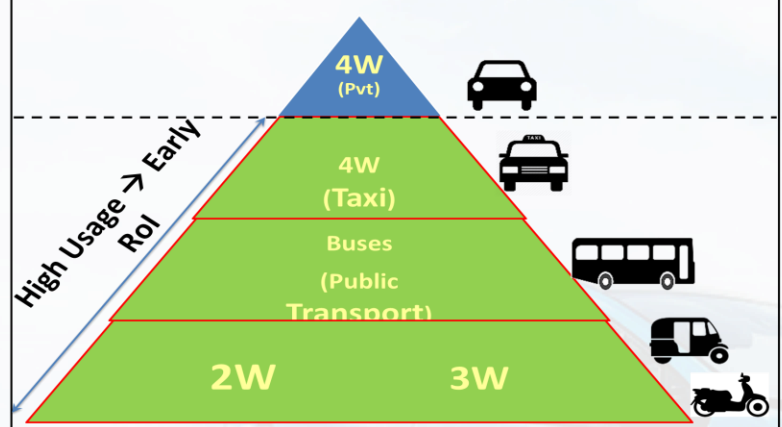
**35% emission reduction by 2030**

**Manufacturing and new jobs to increase**

**India has to move towards electrification with sustained manufacturing growth**

## EV Thinking

**Public transport on top priority**



India requires "affordable Mobility"

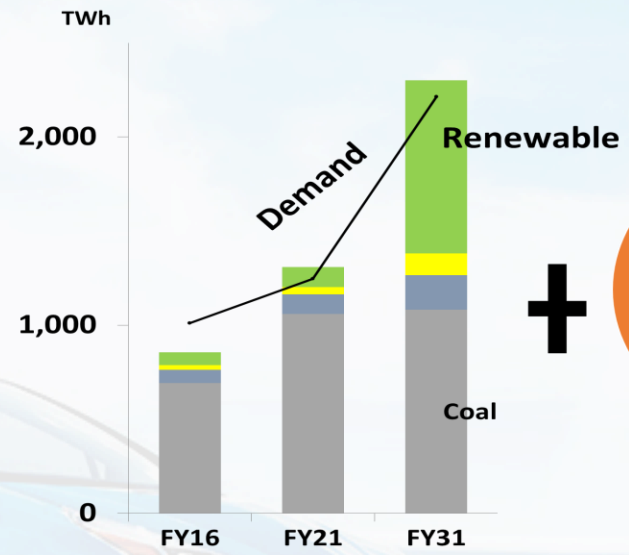
**FAME 2 Scheme to promote Public transport**

## Make in India

**National Mission for Transformative Mobility and Battery Storage**

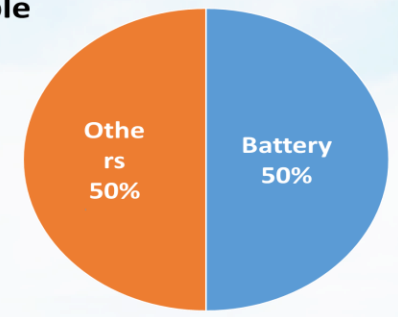
**Vision:** Implement 'GIGA' -Scale Integrated Cell & Battery Manufacturing Plants

### Renewable Energy

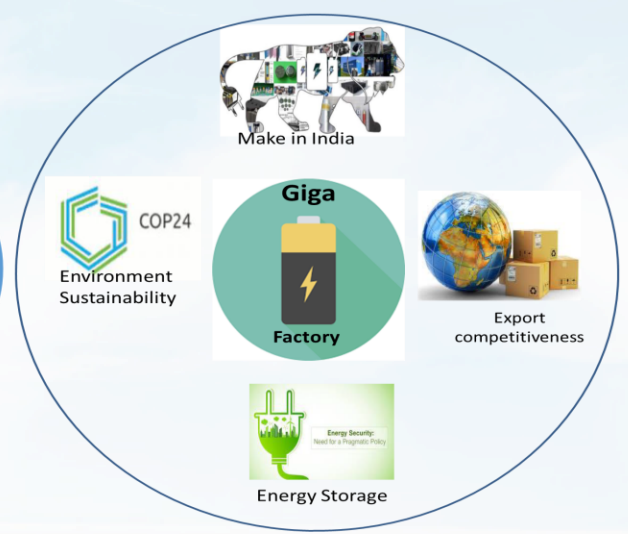


Electricity Generation: Coal → Renewable  
40% of electricity thru renewable sources

### EV cost Break up



Battery is 50% of vehicle cost



**Need Storage for Renewable energy**

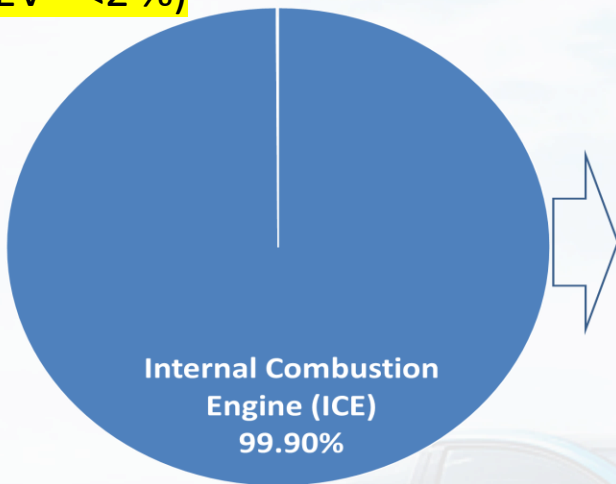
**Battery localization must for EV**

**Need 50 GW planned with ₹30,000 Cr investment**

**EV suitable for local pollution reduction. Shifting to renewable energy and battery manufacturing is key**

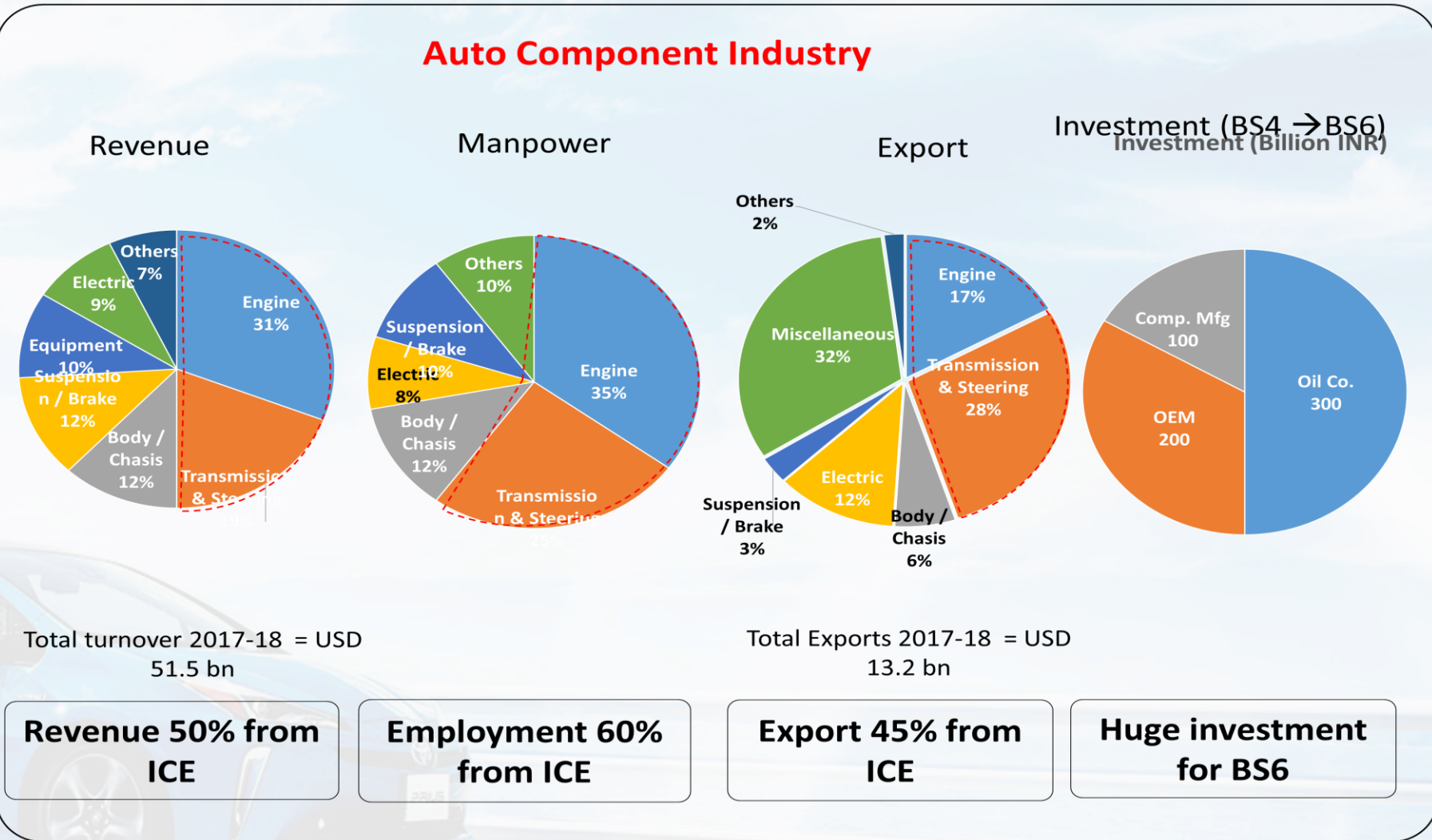
## Automotive Industry

BEV - <2 %



**99.90% ICE Vehicles sold**

## Auto Component Industry



Total turnover 2017-18 = USD 51.5 bn

**Revenue 50% from ICE**

Total Exports 2017-18 = USD 13.2 bn

**Employment 60% from ICE**

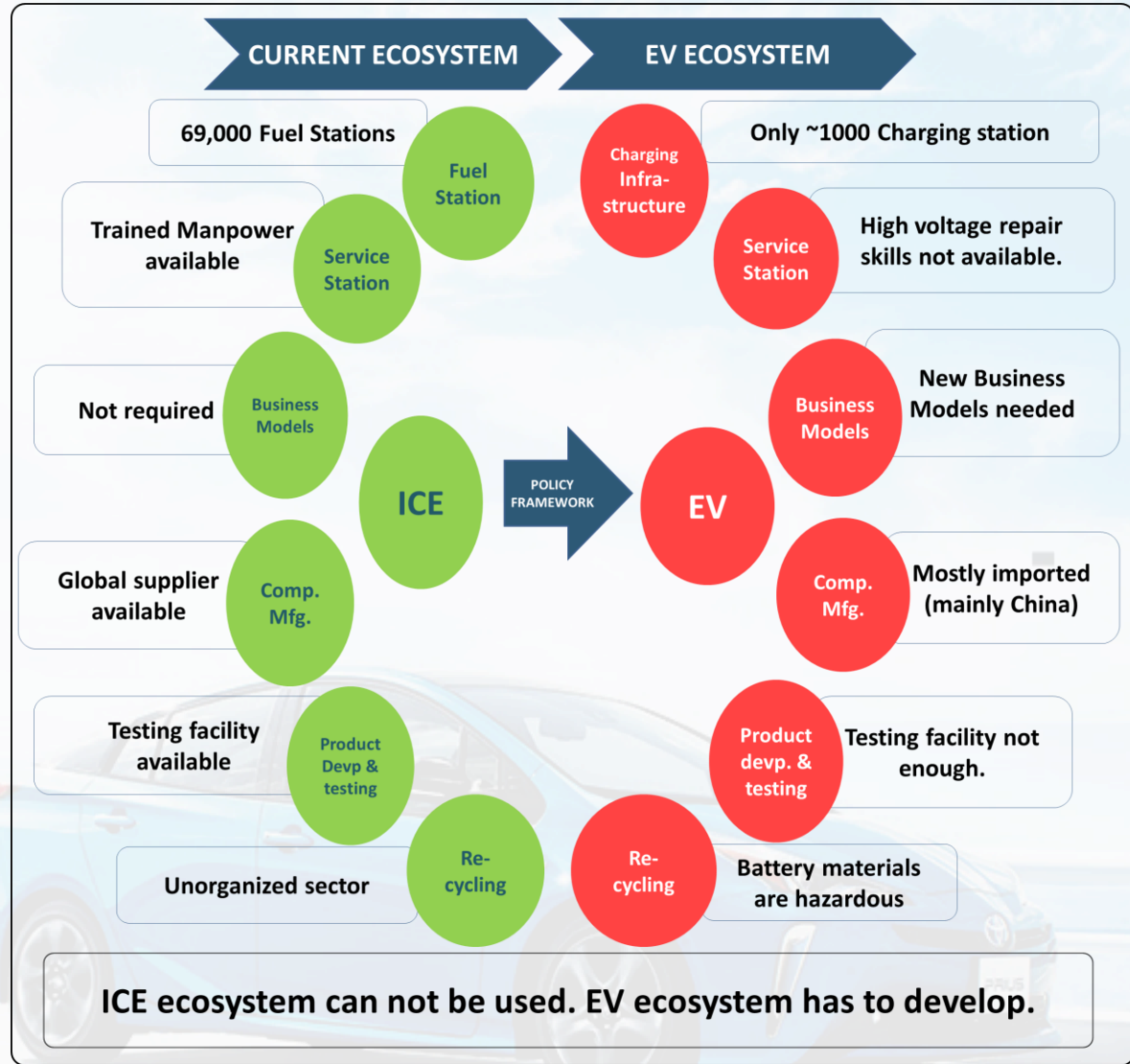
Total Exports 2017-18 = USD 13.2 bn

**Export 45% from ICE**

**Huge investment for BS6**

**Currently ICE vehicle and component manufacturing is backbone of Automotive Industry**





### EV Battery Localization Status

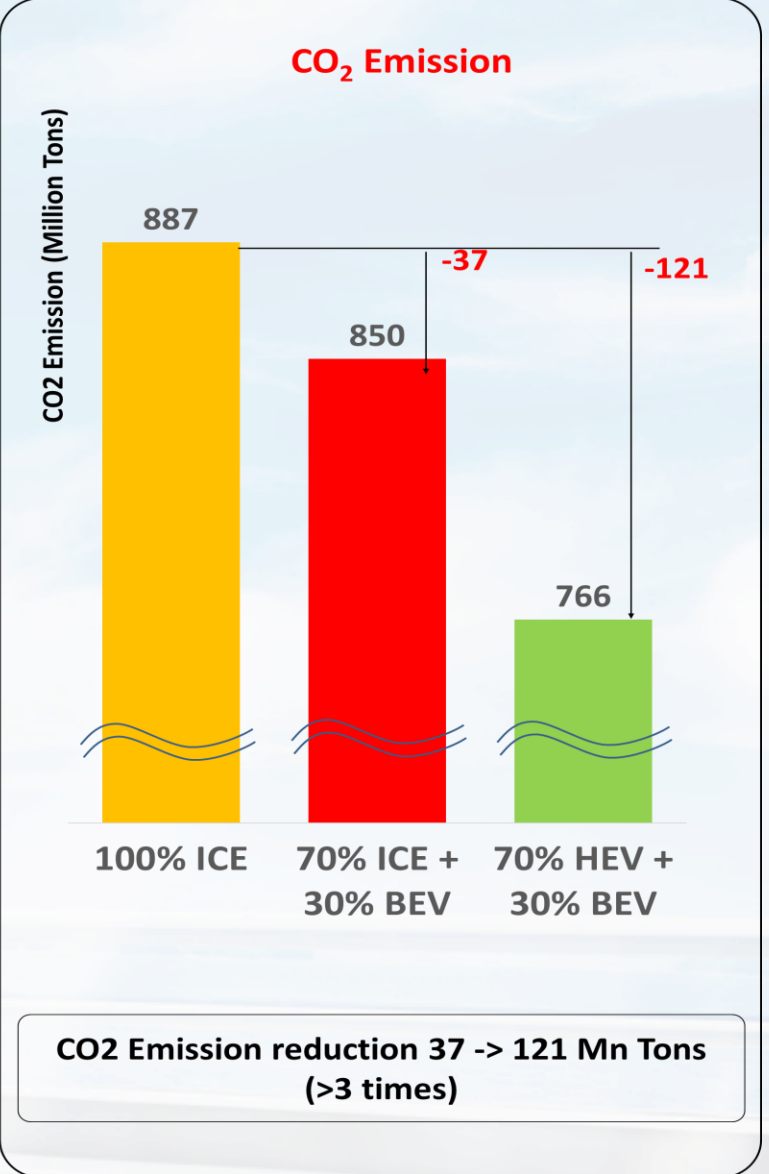
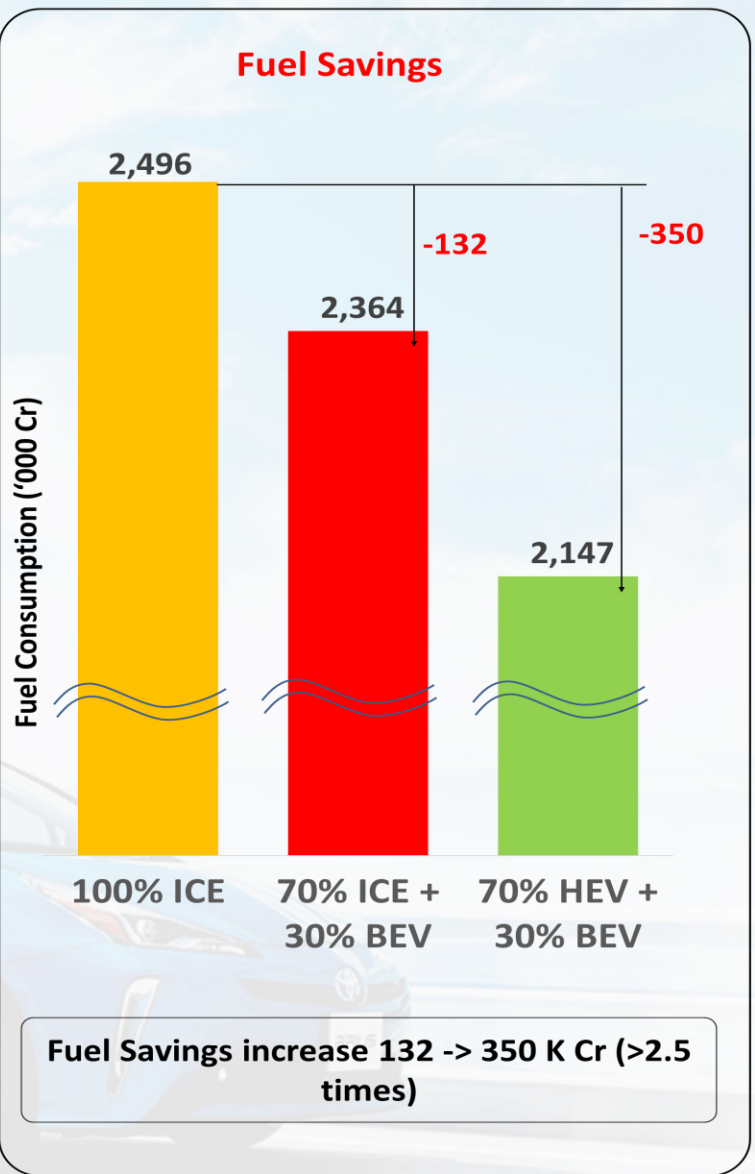
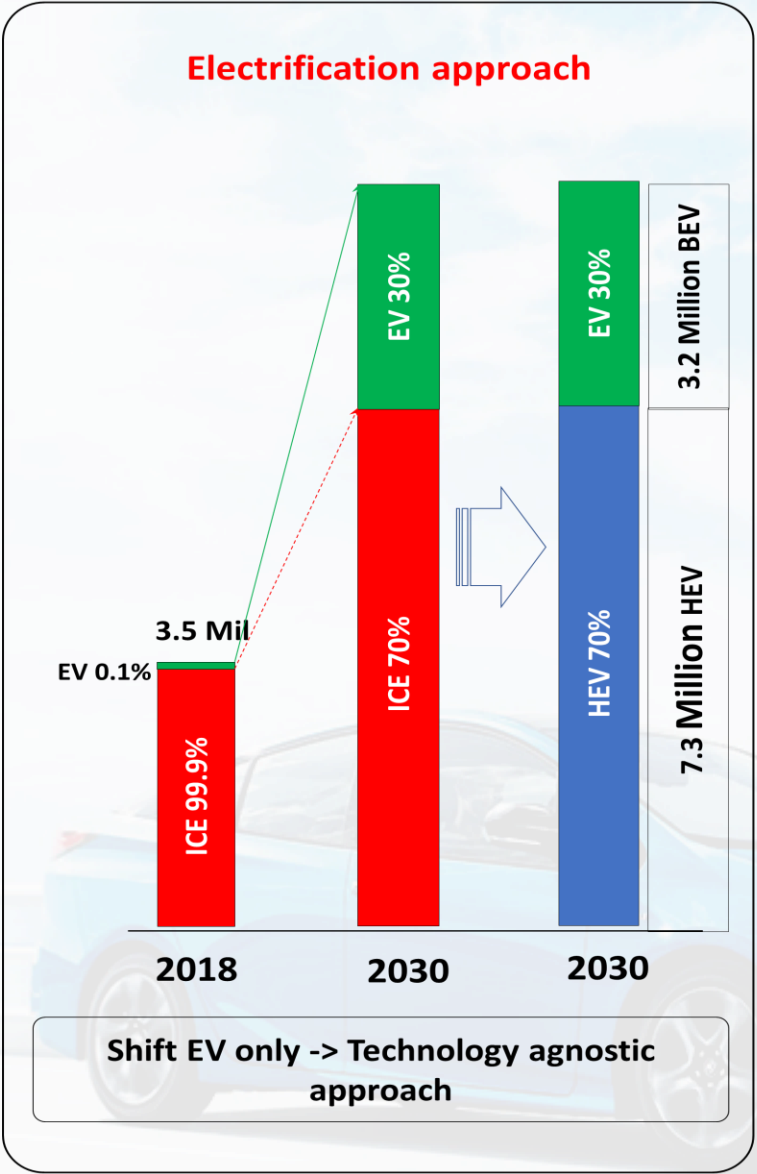
\* *NITI Aayog Report*

Capability for	China / US	India
	2018	2020
Raw material processing	✓	X
Separator manufacturing	✓	X
Cathode manufacturing	✓	X
Electrolyte manufacturing	✓	X
Anode manufacturing	✓	X
Cell manufacturing	✓	X
Pack manufacturing	✓	✓
Value chain captured	100%	<20%

**Need to import now**

- ❑ Will take 5 years min. lead time for Localization
- ❑ Raw material (~65%) continue to import.

**EV Ecosystem to develop from now onwards, need to shift towards Electrification without disruption**

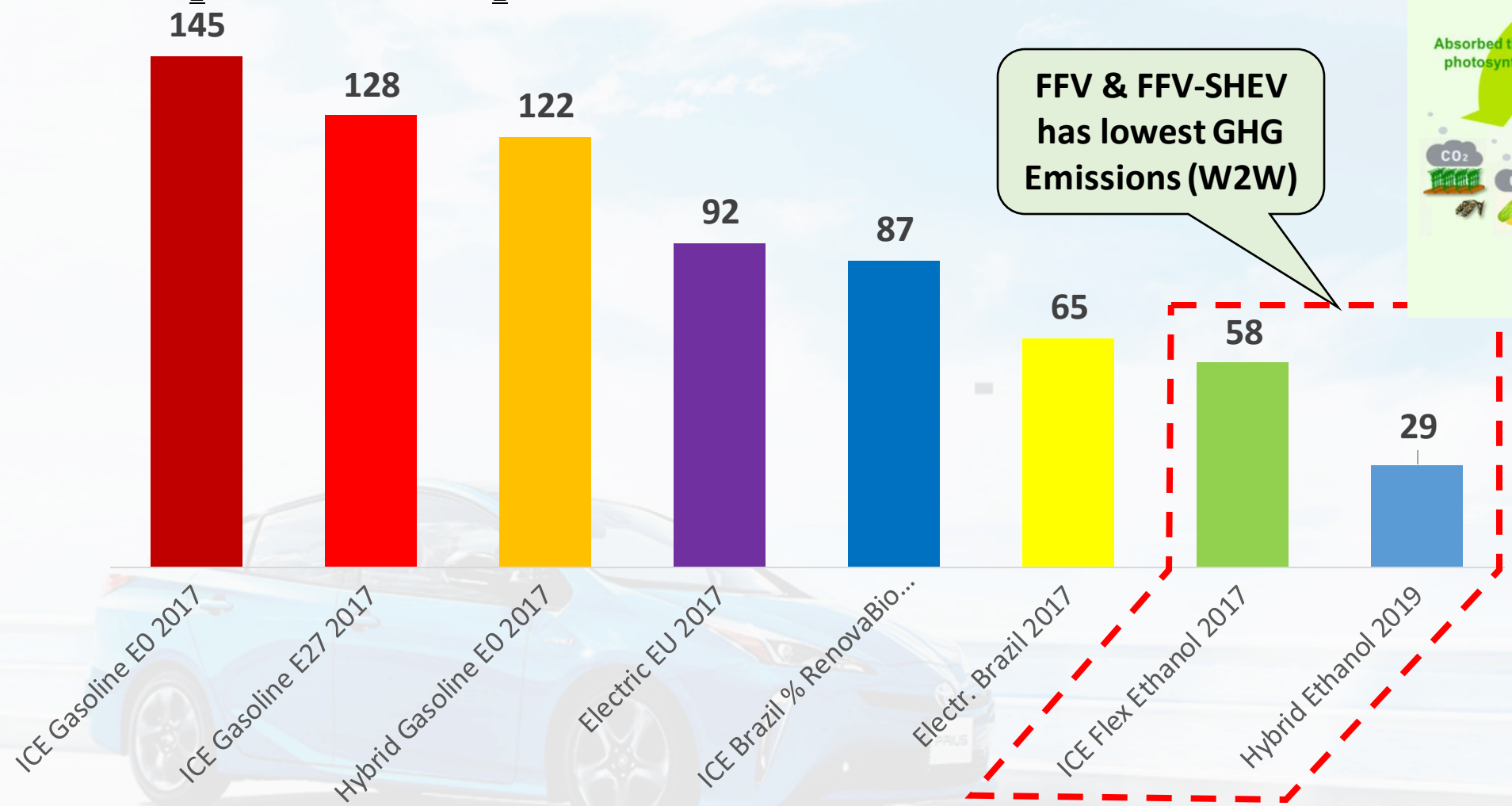


**Technology Agnostic approach will support achieving National objective without Disruption**

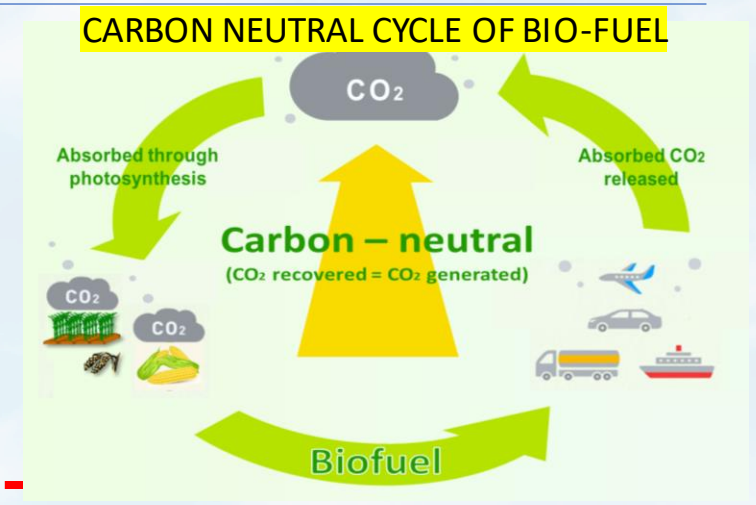
**New Initiative by Govt. of India**  
**- Electrification & Carbon Neutrality strategy through**  
**Alternative Bio Fuels**



## CO<sub>2</sub> Emissions (gCO<sub>2</sub>e/Km)



**FFV & FFV-SHEV has lowest GHG Emissions (W2W)**

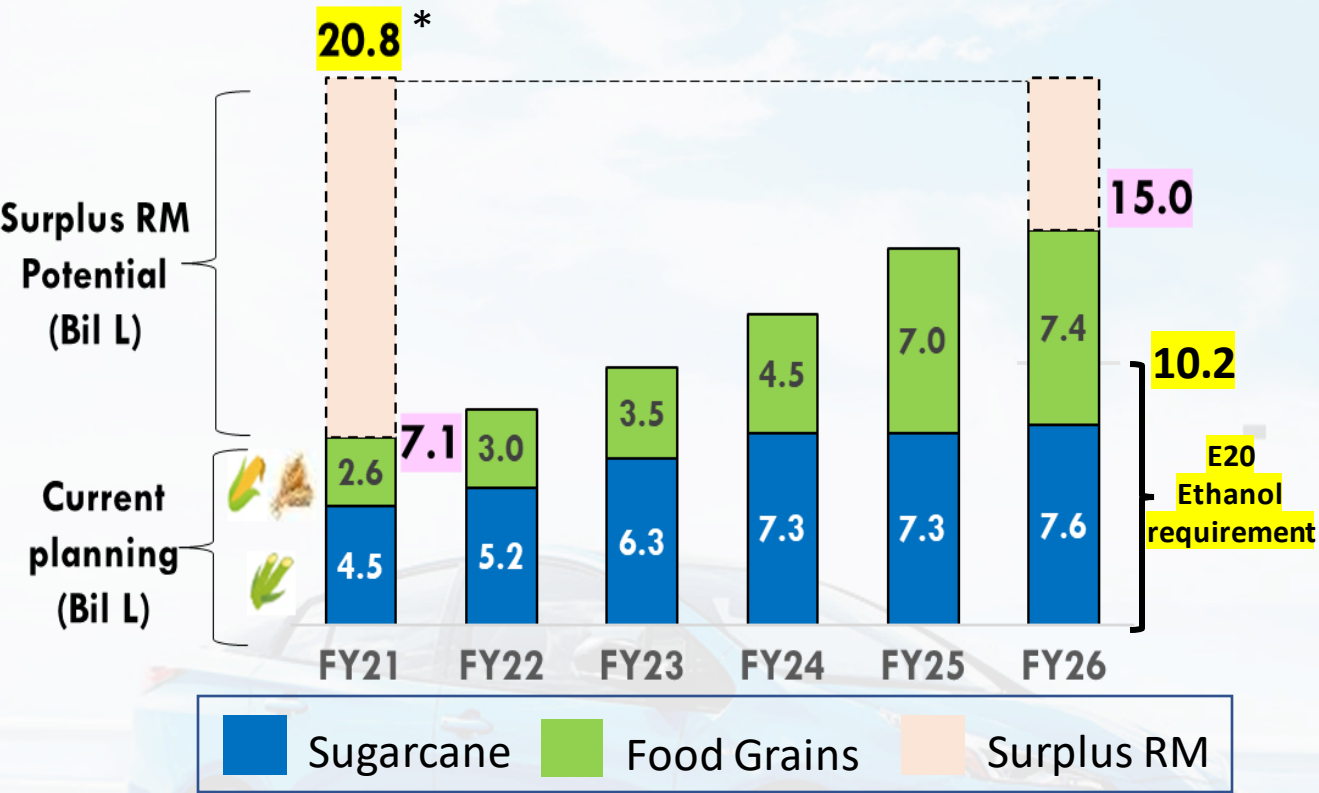


*Source: Datagro Brazil*

Brazil study shows FFV & FFV-SHEV technology is lowest carbon footprint  
IISc to conduct India Well to wheel study

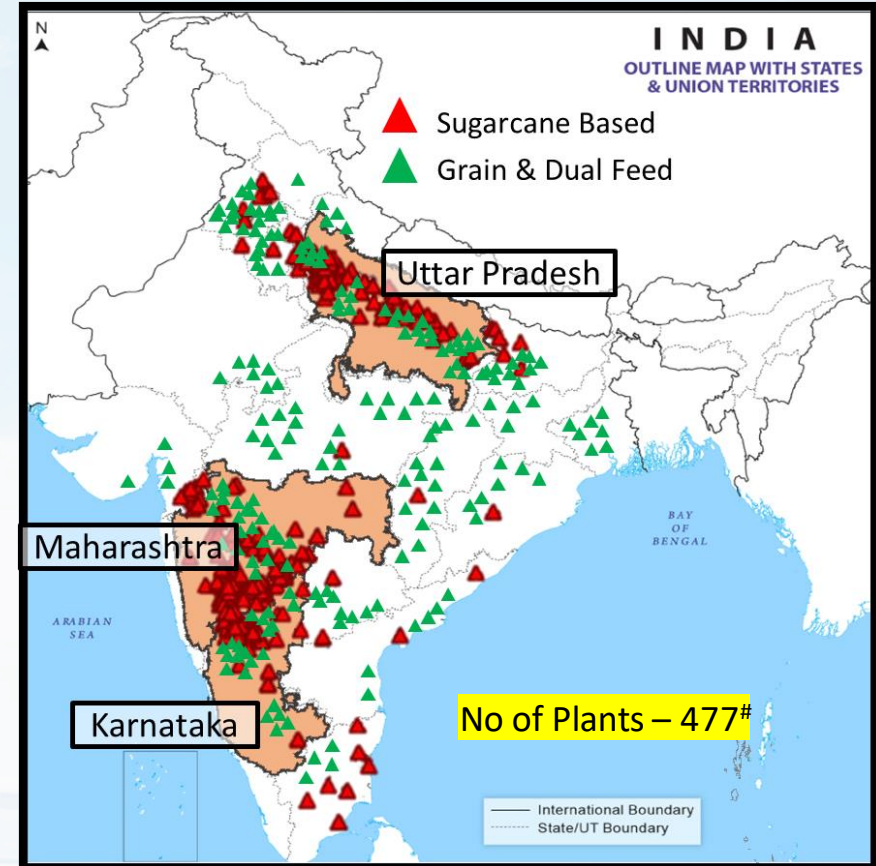


## 1G Feedstock



Enough 1G Raw Material availability

## Production - Approved Ethanol Plants by DPF



Production capacity enhancement

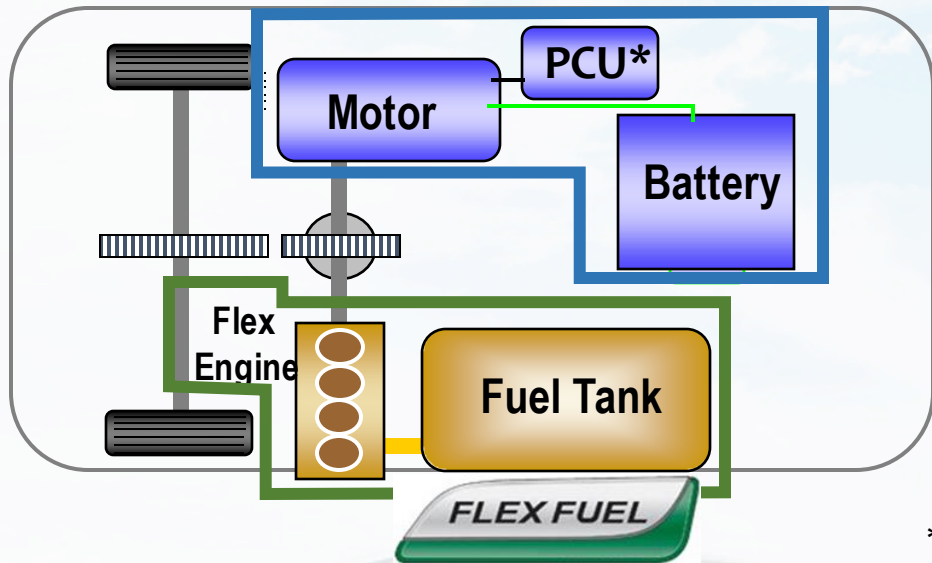
\* Calculation based on surplus Sugar & damaged food grains diverted for Ethanol Production by DPF

# Plants installation target by 2024

1G Ethanol will be surplus in India and can reduce more Gasoline with FFV introduction  
In Future, 2G Ethanol (Non food sources) can provide even bigger opportunities

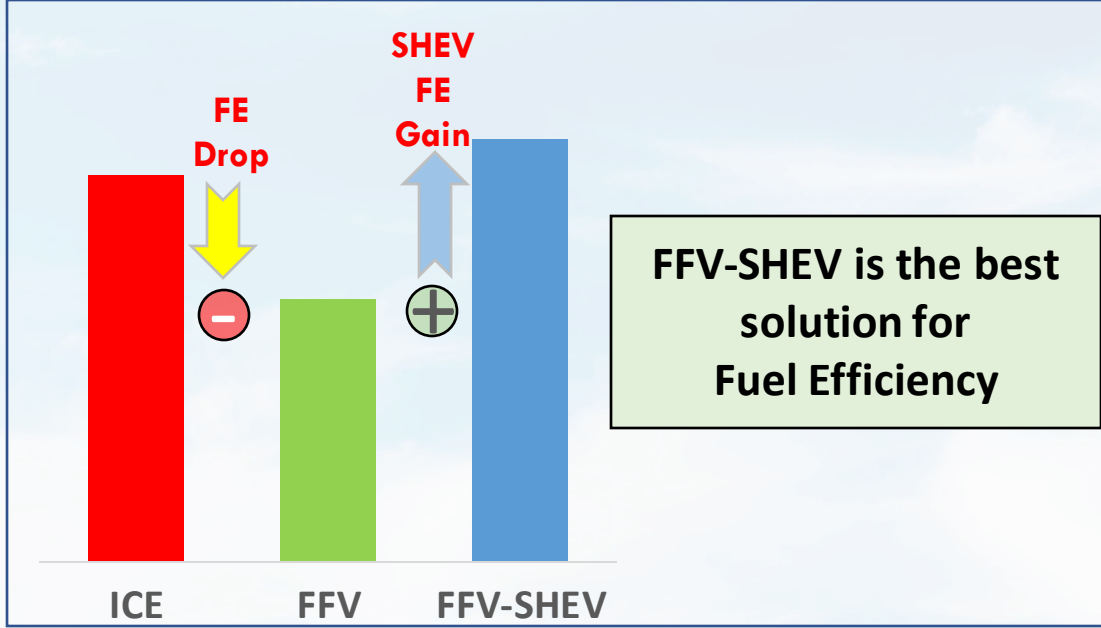
## Flex fuel Strong Hybrid Electric Vehicle Technology

## FFV-SHEV Fuel Efficiency (KM/L)



FFV-SHEV technology is a combination of “Biofuels & Electrification”

\*PCU- Power Control Unit



### Merits of FFV-SHEV



Higher Fuel Efficiency

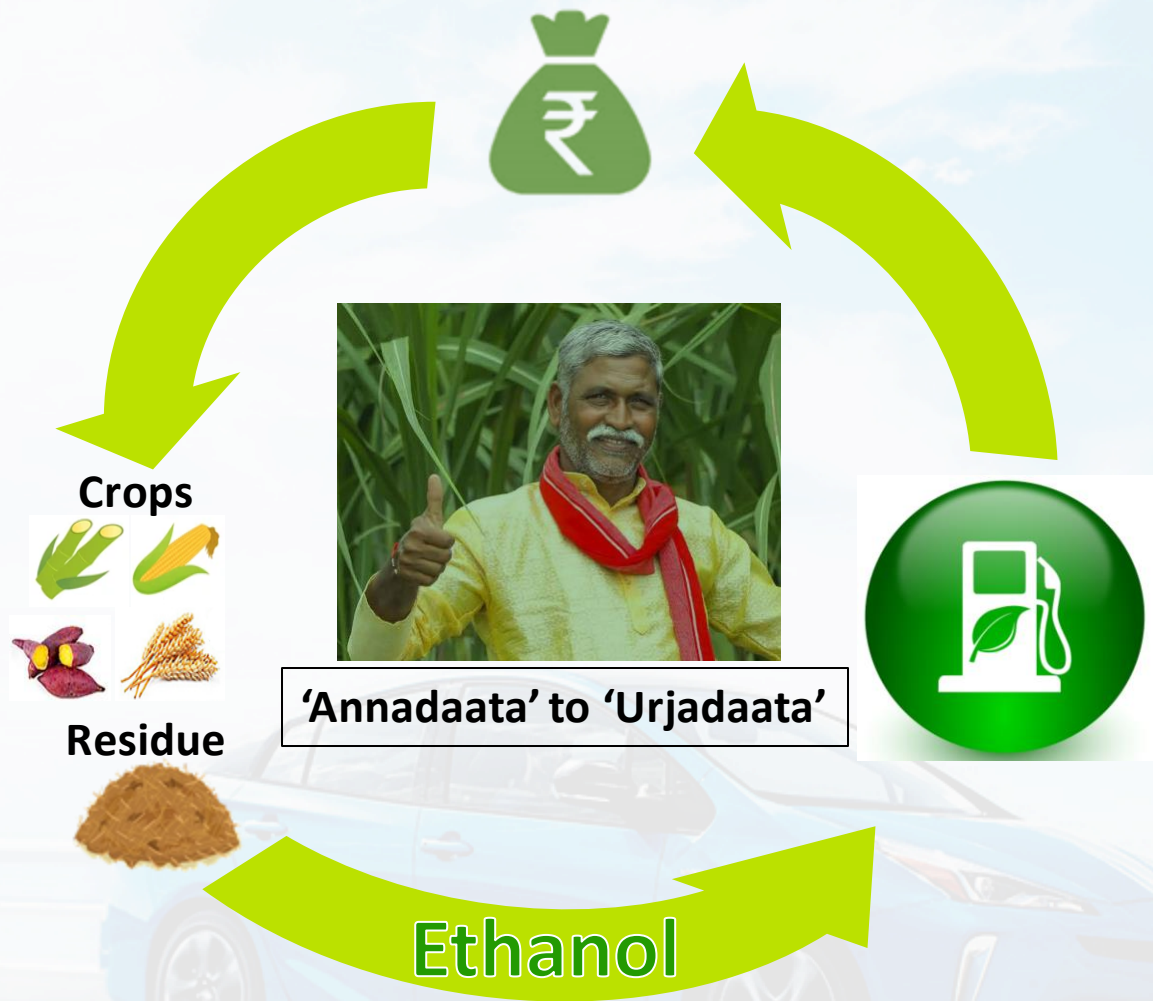


Lowest CO2 emission

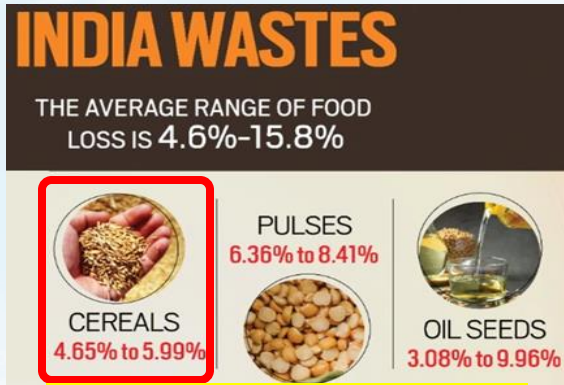


Promotes Electrification  
(Core EV parts like Motor/Battery/PCU)

Combination of Bio-fuel and Electrification can help to meet India's National Goals faster



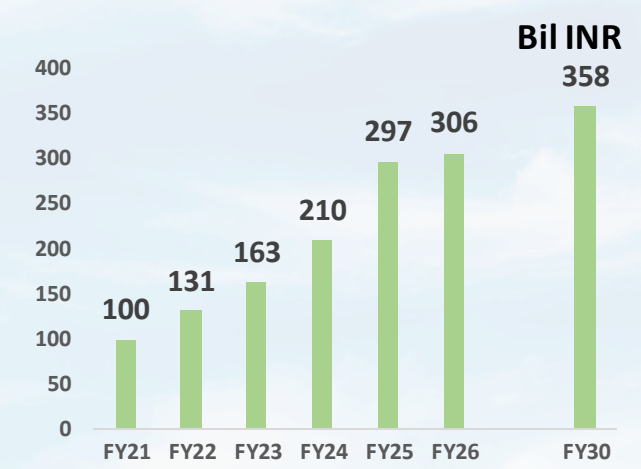
### Revenue to Government



**Wasted Food grains will be used for Ethanol production**

Source: <https://www.indiatoday.in/india/story/india-grows-more-food-wastes-more-while-more-go-hungry-1752107-2020-12-22>

### Income Growth to Agriculture Sector



Source: TKM Internal Calculation basis Govt. press release data <https://pib.gov.in/PressRelease/framePage.aspx?PRID=1831289>

### Agriculture Sector Scale Up



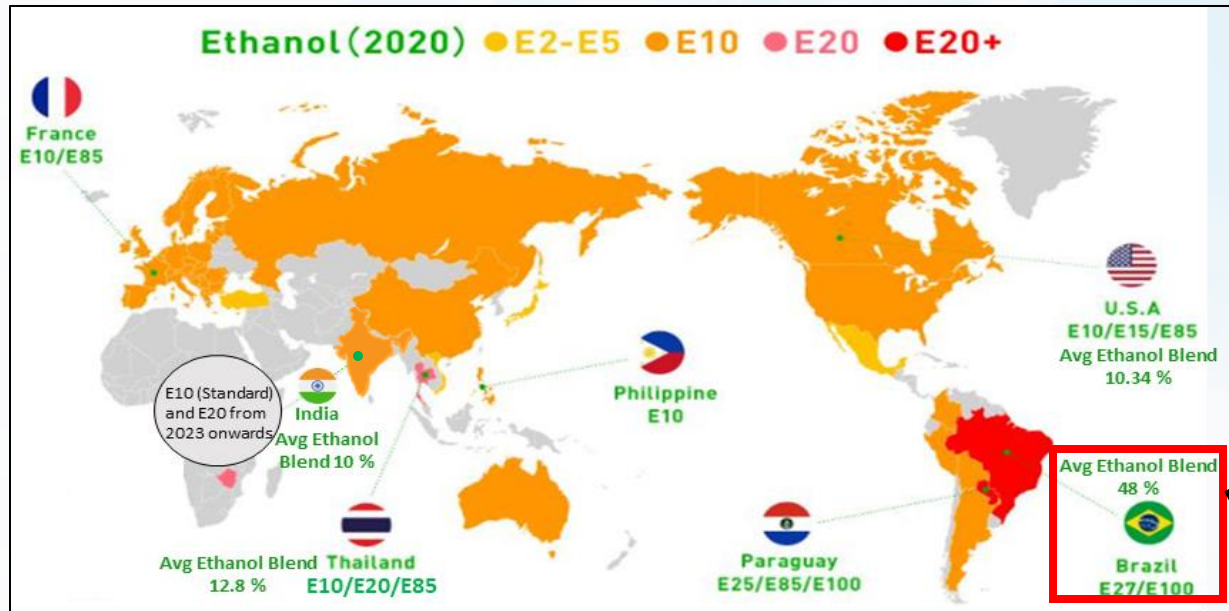
- Expansion of Ethanol RM crops growth
- Provide **Higher income** to farmers
- Development of Rural community & **Jobs creation (~ 327,000 Jobs\*)**
- Conversion of Agri residue to Ethanol
- Additional income** to farmers
- Reduce pollution** from residue burning

**Higher Ethanol usage → Higher Agricultural Growth**

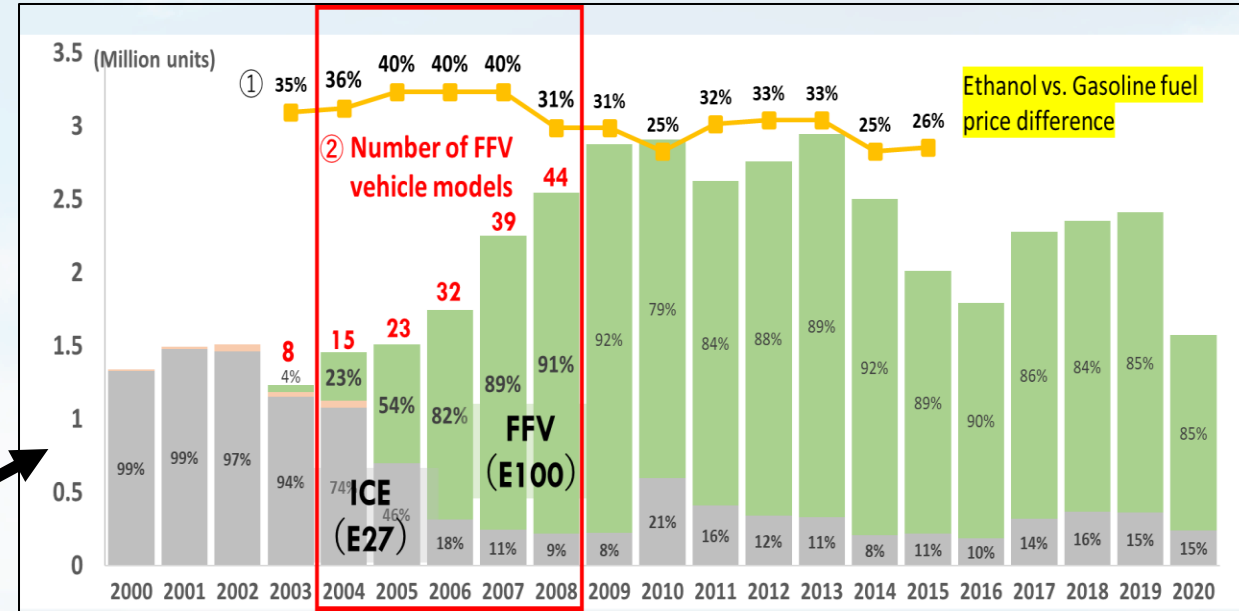
\*Ref: Industry Study –for E20 Milestone



## Global Usage of Ethanol



## Global Experience : Brazil FFV expansion



### Main reasons for the rapid expansion of FFV in Brazil:

**E100: 35% to 40% cheaper than gasoline price & Lower taxation for FFV**

**Increase in FFV vehicle models available in Market**

Ethanol is used as an Alternate Fuel globally. Brazil succeeded in achieving Higher Average Blend %

Brazil could quickly switch to Ethanol due to enough fuel availability at 35% lower cost



# 8.5 Electrification Strategy

Confidential

TOYOTA

## Technology Impact

★ Marginal ★★ Fair ★★★ Good ★★★★ Excellent

		HEV	PHEV	BEV	FCEV
National Objective	CO <sub>2</sub> impact (Well to Wheel)	★★ ~ 70 gm	★★ ~ 80 gm	★ ~ 90 gm	★★★★ Low
	Emission / Fuel saving (Tank to Wheel)	★★ - 40 ~ 50%	★★★★ -70 ~ 75%	★★★★ -100%	★★★★ -100%
	Incentive support	★★★★ (Less)	★★★★ (Medium)	★★ (Big)	★ (Very big)
	Manufacturing and Employment	★★★★ ICE + Core Comp	★★★★ ICE + Core Comp (3500)	★ Core Comp	★★ FC + Core Comp (2000)
Customer Acceptance	Cost (w.r.t ICE Model)	★★★★ (20 ~ 30%)	★★★★ (50%)	★★ (100%)	★ (200%)
	Range (Single Filling / Charge)	★★★★ (1000 km)	★★★★ (1000 km)	★ (200~500 km)	★★ (650 km)
	Fueling Time	★★★★ (3 min)	★★★★ (3 min)	★ (8 hrs / 1 hr)	★★ (5 min)
	Infra	★★★★ (Not required)	★★★ (Better)	★★ (Must)	★ (High cost)
Industry	ICE Investment Impact	★★★★ (Nil)	★★★★ (Nil)	★ (Big)	★ (Big)
	New Battery + Motor + Controllers	★★ (~ 2 kWh)	★★★★ (8 kWh)	★★★★ (~20 kWh)	★★ (~ 2 kWh)

HEV is most suitable for India from National / Customer/ Industry point of view

SHEV will use current ICE eco-system, increase customer acceptance & help achieve National objectives.

- 1. Electrification of IC Engine( Petrol) is top priority for country through Hybrids Electric Vehicle ( SHV & FFV+SHV) for protect ICE eco system, new technology & upskill.**
- 2. Self charging Hybrids vehicles runs >50 % time in city on EV mode, it dramatically helps reduce pollution without providing infrastructure of charging**
- 3. Cost reduction by creating sustainable local manufacturing of core components by aggregation of demand by fiscal & policy support to XEV ( GST, CAFÉ treatment etc)**
- 4. Ethanol is an Indigenous fuel which boosts agrarian economy ( Rural economy) & mass electrification.**
- 5. Combination of ethanol & electrification( FFV & SHV) can help India to achieve India's energy dependency faster**
- 6. Toyota strongly believe technology agnostic approach & country specific energy mix is sustainable & Toyota Launched pilot project of FCV( Mirai) & FFV – SHV( corolla) with iGovt. Of India.**

## S & T Alliance – S & T badge Manufactured product in TKM ( 200K)



## Management & Union joined hand - D22 Key Handover Ceremony



**With 4 Party Collaboration...We move forward together**

**Great Learning & experience as a whole Organization**

**Thank You**