Powertrain Technology 2025 and Beyond

Emissions and Fuel Economy

- Technology / Cost
- Regulation
- Customer Mindset

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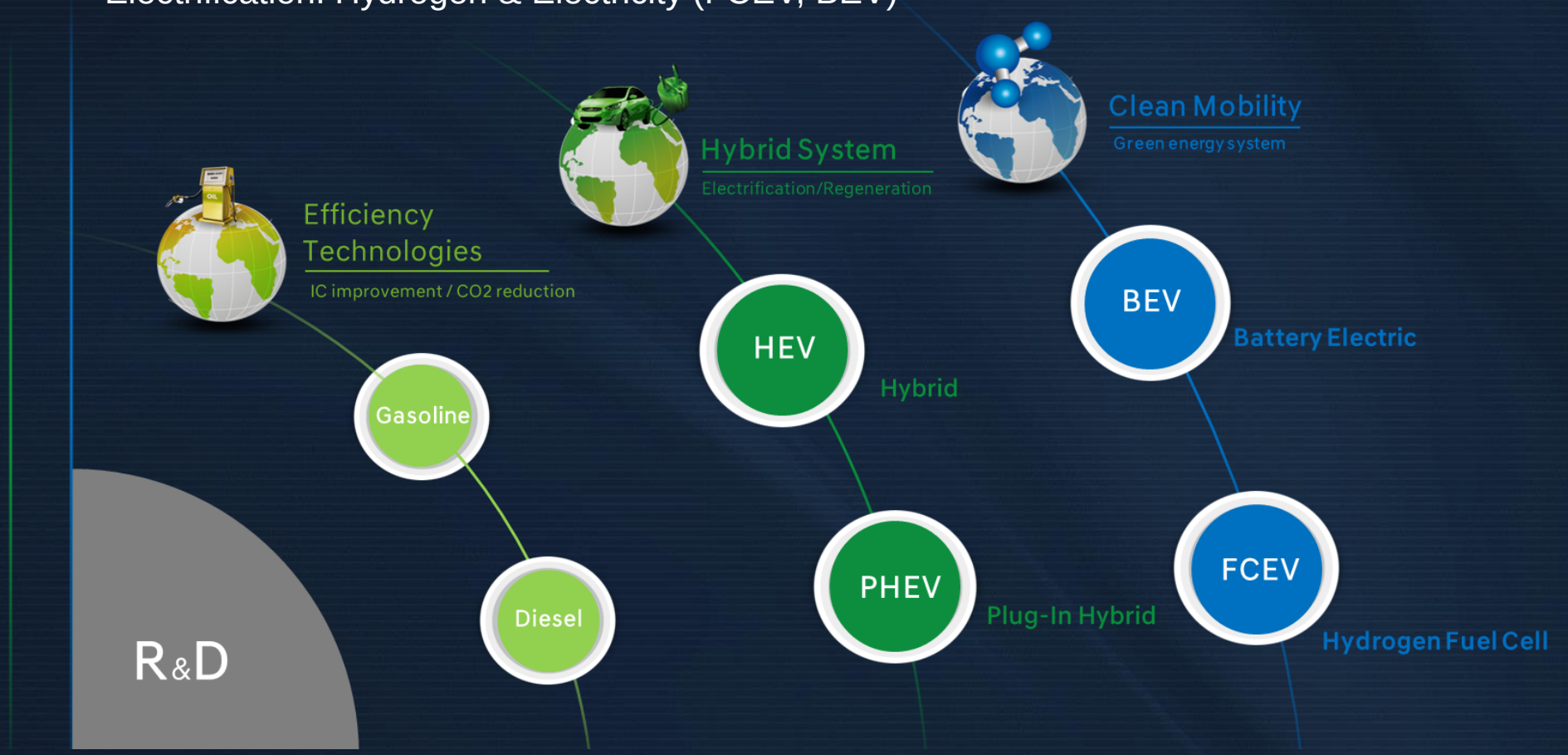
The Technology :

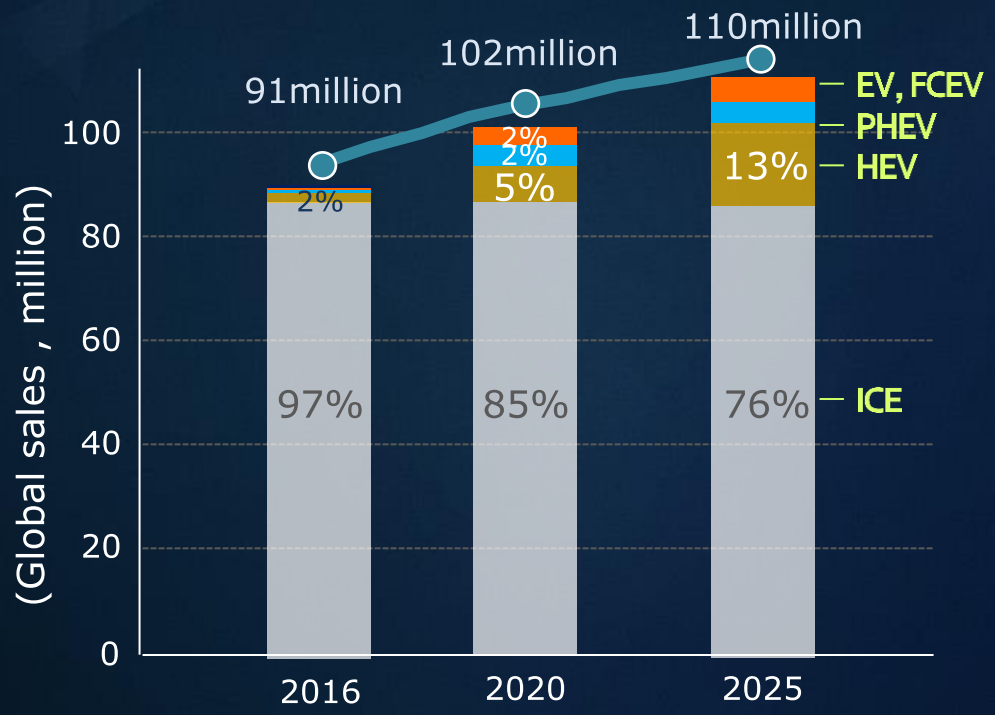
- Fuel Economy Improvement (New Engine & Transmission Technologies and Weight Reduction)
- Hybridization: Combustion + Electrification (HEV, Plug-in HEV)
- Electrification: Hydrogen & Electricity (FCEV, BEV)



ICE: Internal Combustion Engine; HEV: Hybrid Electric Vehicle; PHEV: Plug-In Hybrid Electric Vehicle; BEV: Battery Electric Vehicle; FCEV: Fuel Cell Electric Vehicle

Powertrain outlook

- ICEs ; the dominate propulsion system in 2025 (continued through 2040)
- Hybridization and electrification tied to the ICE
  - Increased electric range - Reduced system cost
- ADAS Technologies integrated in PT systems



source : Media coverage (IHS, Roland Berger, Frost & Sullivan, KPMG, FEV, Valeo, Nikkei …)

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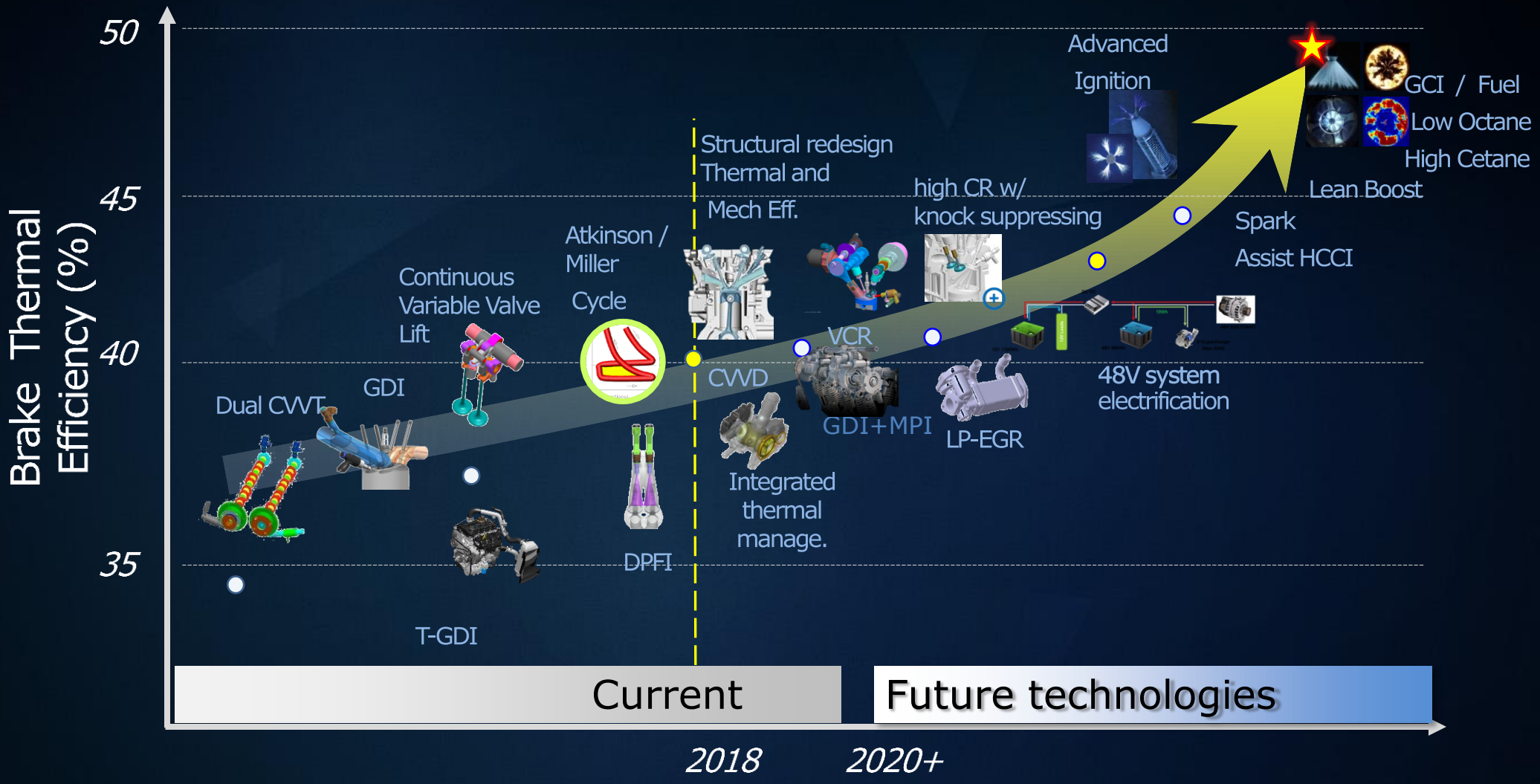
I.C.E. Technology Road Map



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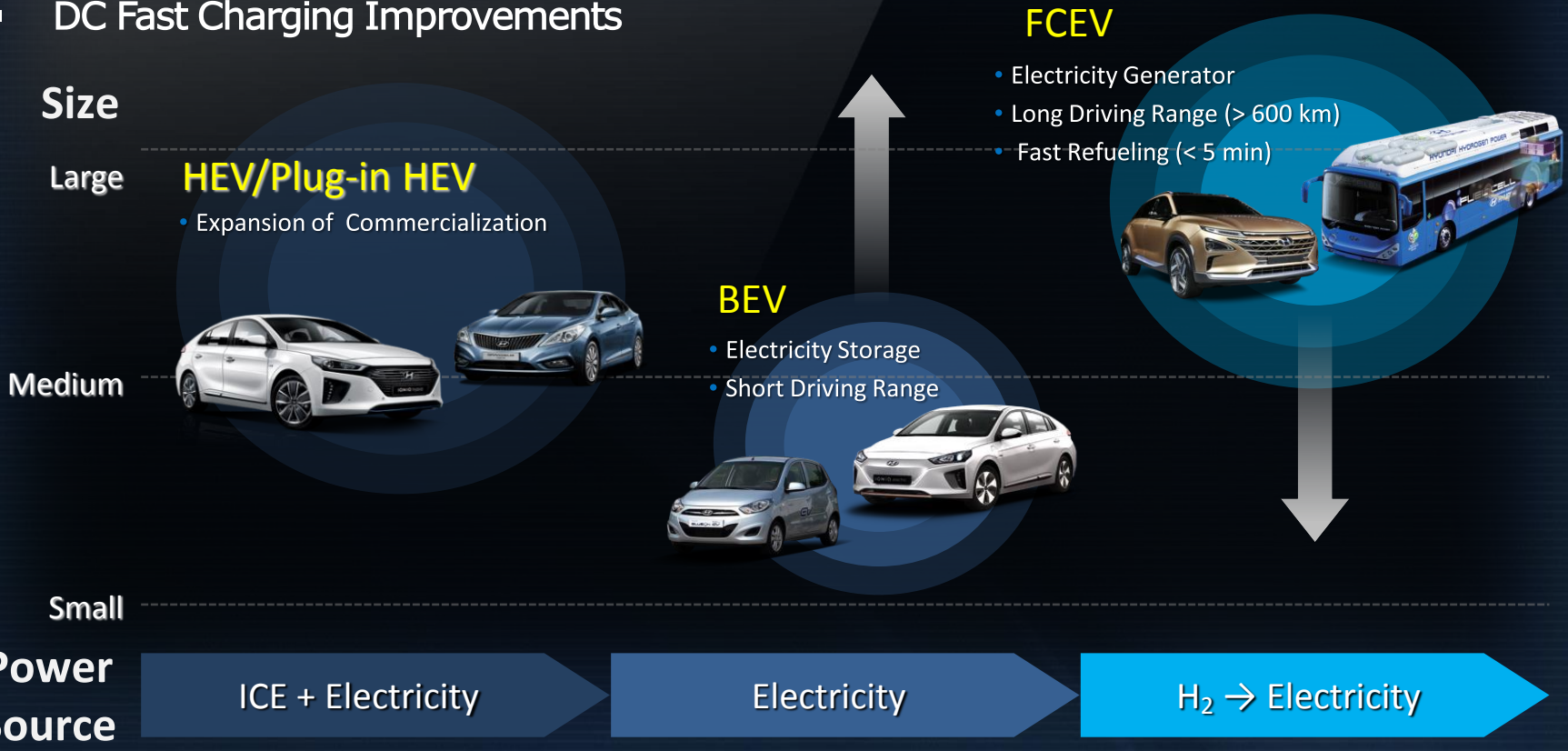
Eco Vehicles (HEV /PHEV/BEV/FCEV)

Continued slow growth with improvements in Cost structure / Charging Times /Infrastructure

- Manufacturing advancements
- Volume increases ($⬇)
- DC Fast Charging Improvements



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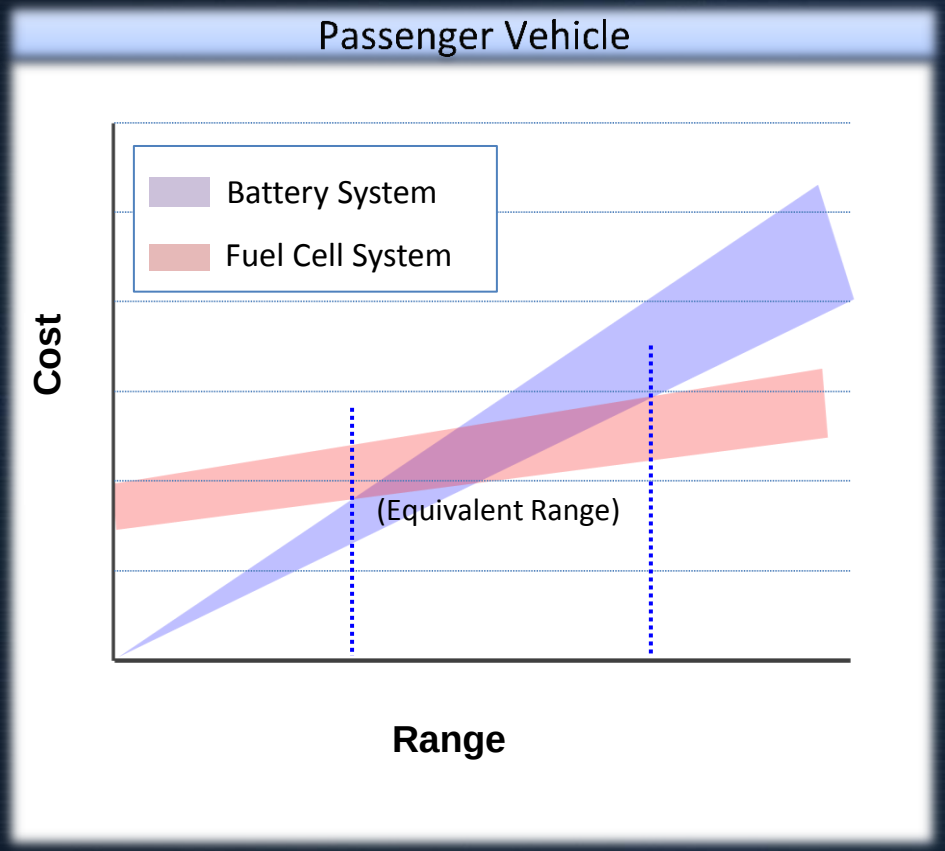
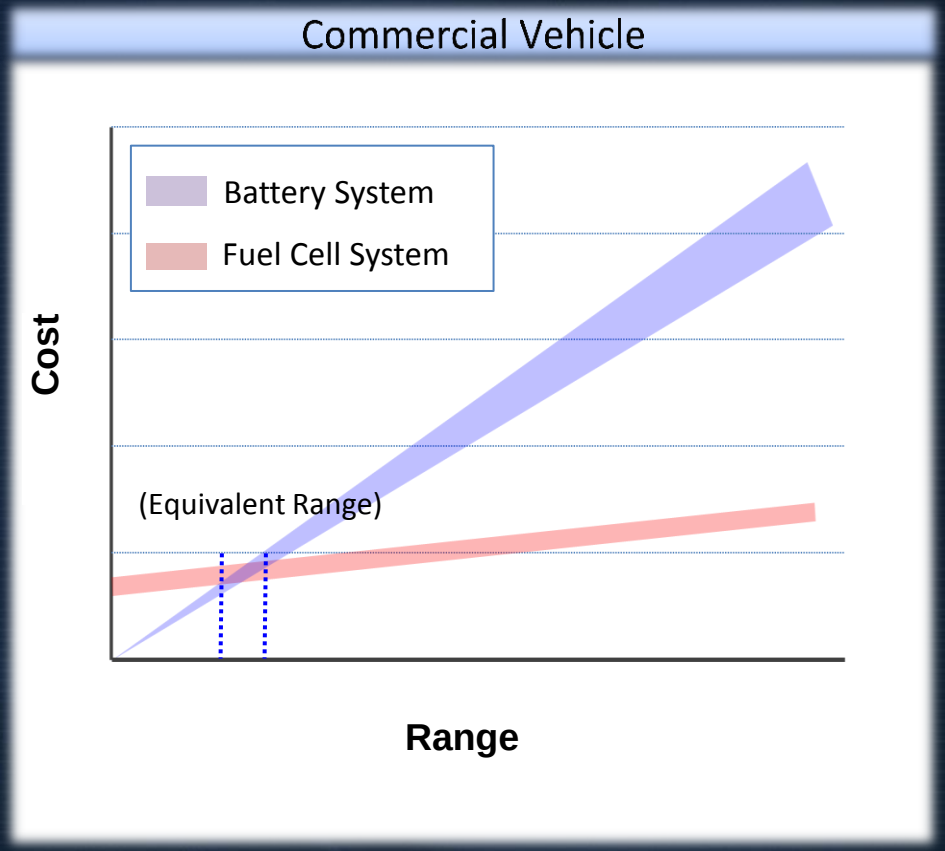
Battery Electric vs. FCEVs

- 2 Technologies each with Strategic Benefits: Depending on application





HMG Next-gen. Eco Vehicle Development

- 4- technologies in mass production (HEV/PHEV/EV/FCEV)
- Expanding to 38 models by 2025

  Continuing technology development to lead next-gen. Eco vehicle market

HEV	PHEV	EV	FCEV
13	9	14	2

* Including Hyundai Motors and Kia Motors

“State” of Battery Electric Vehicles

		IONIQ EV	KONA EV
High Voltage Battery	Capacity (kWh)	28	**64**
	Rated voltage (V)	360	**356**
	Current capacity (Ah)	78	**180**
	Output (kW)	98	**170**
	DC Charging	170A / 65kW	**200A/ 75kW**
	Energy density (Wh/kg)	104.9	**141.3**
	Cooling system	Air cooling	Water cooling
Driving range (mile)		**124**	**258**
Efficiency (MPGe)		136	**120**

		IONIQ	KONA
Charge	**AC Level 2** (KW AC)	6.6	7.2
	DC Fast (Max kW /Amp)	65 kW 170 A	75 kW 200 A
Charging Time	**Normal**	4h 20m	**9h 35m**
	QUICK (80% SOC)	23m (100 Miles)	**54m (200 Miles)**

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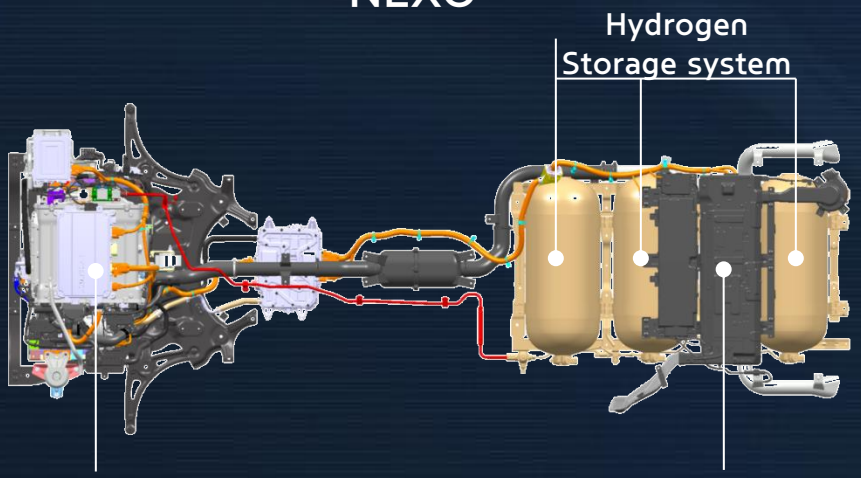
NEXO Fuel Cell -

- Develop 2nd generation Powertrain-Fuel Cell (2019 M.Y)
- Only SUV on the Market (Unique and Specific FCEV platform)
- Range of 380 Miles (61 MPGe)
- Developed for the entire US Market (cold ambient capable to -30 Deg C)

NEXO

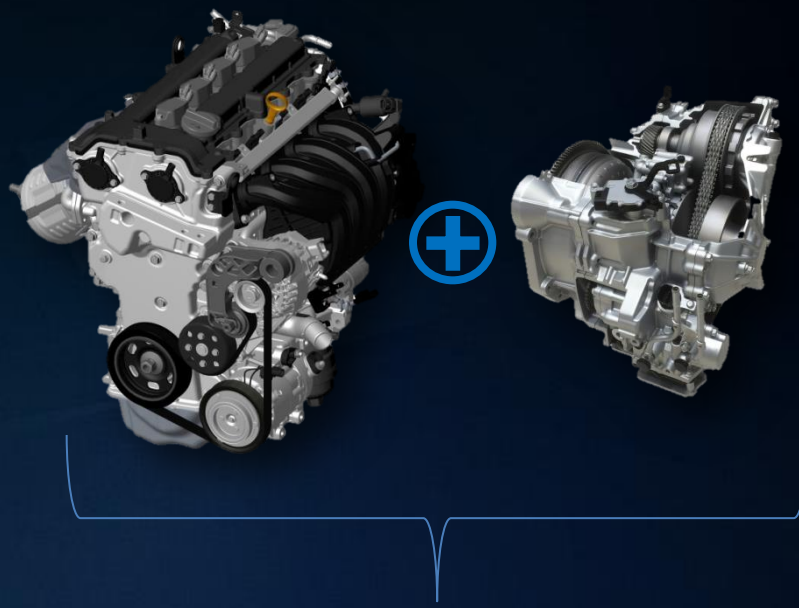


	NEXO
Fuel Cell Power	95kW
Battery	40kW
Max. Power	120 kW
Max. Torque	394 Nm
Motor System	Permanent magnet 120kW
H_2 Container	6.4 kg. @ 700 Mpa (bar)
Fuel Economy	61MPGe (Combined)
Driving Range	380miles (17")
Acceleration (0 → 62 mph)	9.2s (17")
Max. Speed	110mph (17")

ADAS "Intellectual Propulsion Controls"

Fuel Economy/Driveability

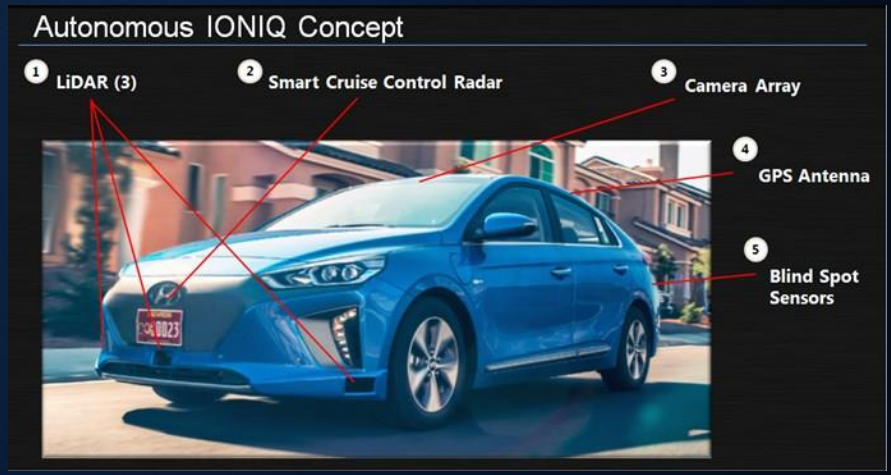
- Powertrain Integration and controls



- Intellectual Propulsion Controls (Optimized with ADAS)

  Forward looking **Powertrain control logic.**
  - Seeking out
  - Learning
  - Adapting
  - Integrating vehicle systems
  - Provides feedback and makes decisions

  Based on the surrounding environment & drivers intentions enables optimized Fuel Efficiency and Driving Performance



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Powertrain trend beyond 2025

Trend:

- ICEs continue to Dominate but with increased levels of Electrification
- HEVs & BEVs will reduce in Cost and BEVs in charging times
- ADAS systems will enhancements PT Integration and Efficiencies

Conclusion:

- Technology is not the issue: US Consumer attitudes and interest is the challenge
  - US sales for ECO Vehicles is less than 3% of total sales in 2017
  - 6 – 8 % expected by 2025 (therefore over 90% Non Eco vehicle sales expected)

Support : Incentives , Increased infrastructure and Consumer Education

- Incentives for Consumer purchases (Tax incentives, Fee Bates, HOV lanes …)
- Expanded Infrastructure: Fast Charging stations, H2 stations
- Education Campaigns: inform consumers of the short term and long term benefits of Eco vehicles (not only Financial but also Societal Benefits)

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