

Technology Innovations For Future Mobility

2015 International Forum Korea on Advances in Mechanical Engineering

Sep. 17th, 2015

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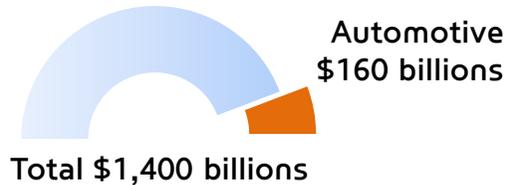
Introduction
Of Auto Industry
In Korea

- The most representative key industry and important economic sectors by revenue
- 11.6% of Sales, 13% of Export, 7.3% of Direct/Indirect employment

Economy

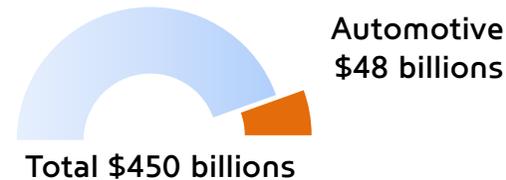
- Total Sales of Manufacturing

Industry
11.6 %



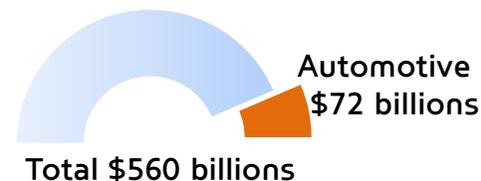
- Value added of Manufacturing

Industry
11.1 %



- Total Export

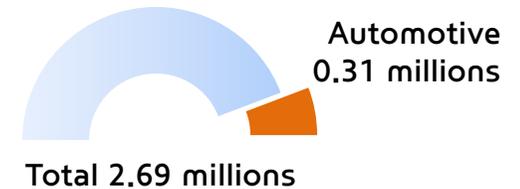
13 %



Job Creation

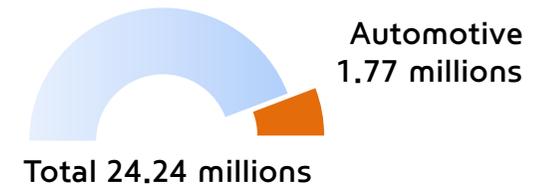
- Direct employee in Manufacturing

11.4 %



- Direct/Indirect in Total employee

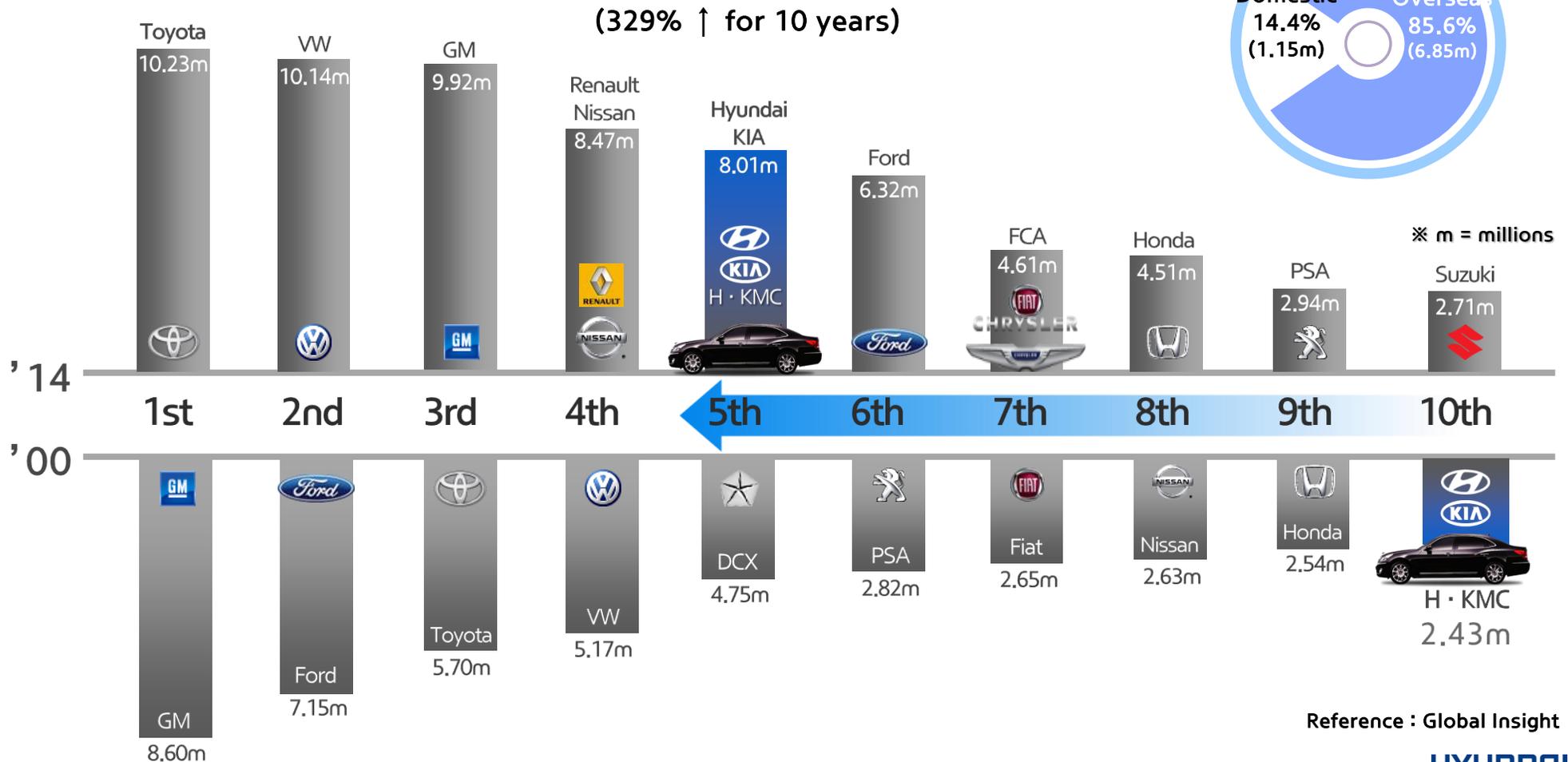
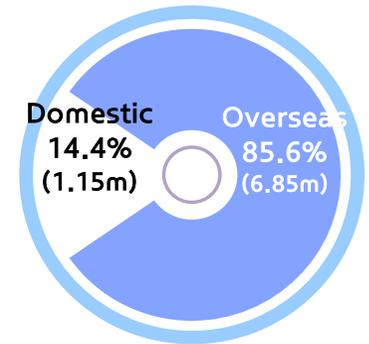
7.3 %



2014 Sales 8.01 millions, Globally the 5th Largest company

2014 Profit : \$7 billions (Hyundai) / \$2 billions (Kia)

Global Sales (2014)

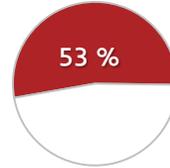
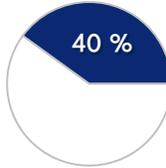


Reference : Global Insight

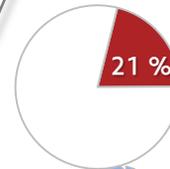
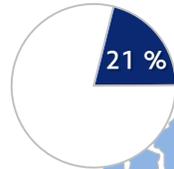
Global Network (Production)

32 Production facilities in 9 nations

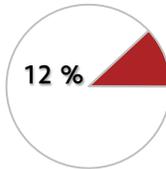
Korea



China



The United States



Russia



Czech Republic



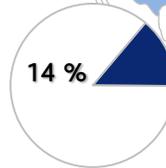
Slovakia



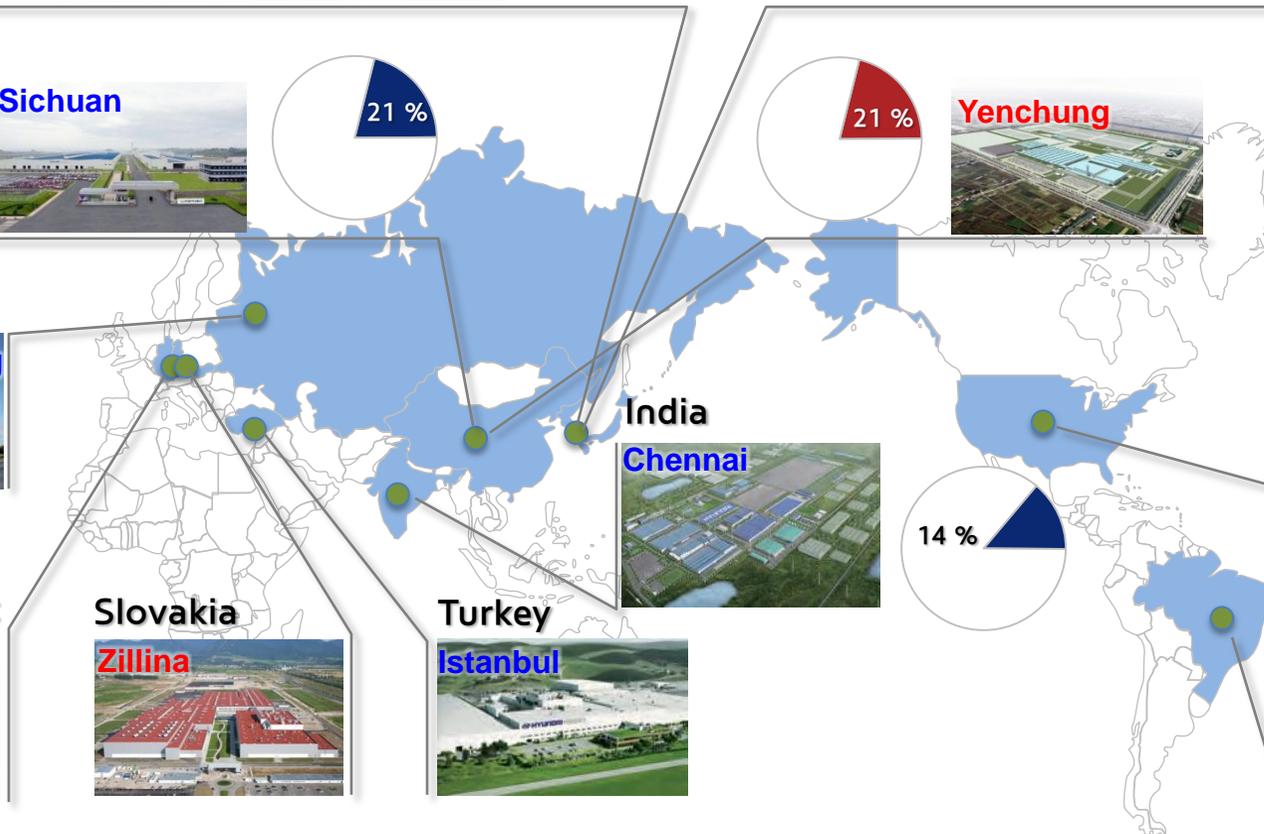
Turkey



India



Brazil



13 R&D Centers in 6 nations : > 12,000 engineer

Europe Design Center
(Russelsheim, HMC)



Europe Design Center
(Frankfurt, Kia)



China Research
Center



CARI (Uiwang)



Namyang Research Center



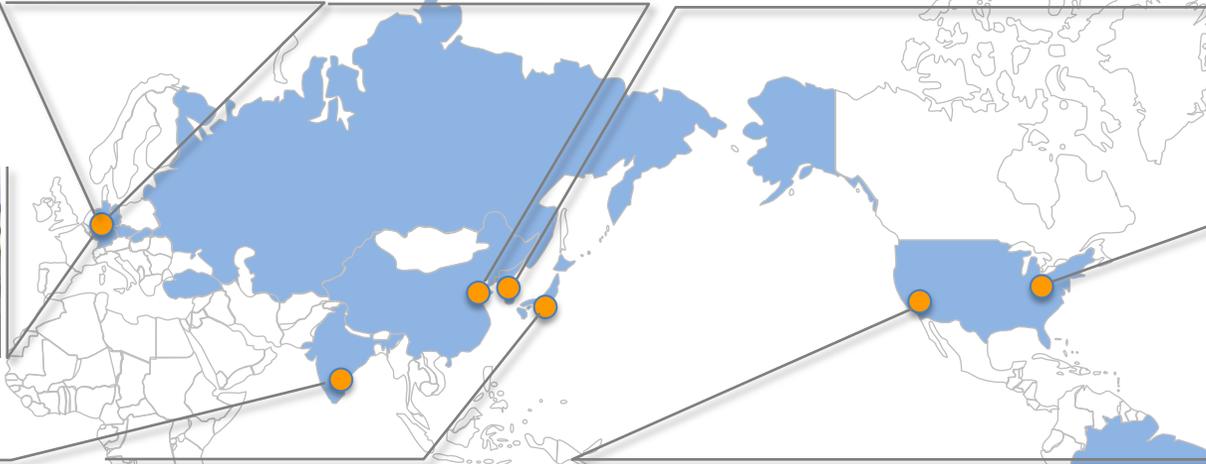
Eco Technology Center
(Mabook)



HMETC (Russelsheim)



HATCI (Ann Arbor)



India
Research Center



Japan
Research Center



HATCI (Irvine)



California
Proving Ground



California Design
Center (Irvine)



2 Technology Innovations

Voices of Customers & Societies



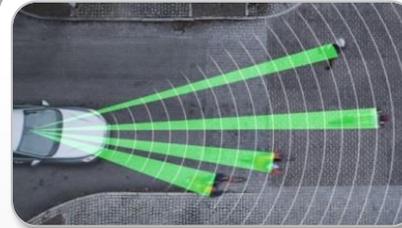
Environment

- Global Warming
- Green House Gas
- Fuel Efficiency
- Eco-Friendly Vehicles
 - HEV, PHEV, EV, FCEV



Energy

- Energy Independence
- Renewable Energy
- Depletion of Fossil Fuel



Safety

- Advanced Driver Assist System
- Autonomous Vehicle
- V2X



Convenience

- UX
- IoT / 5G
- Virtual/Augment Reality
- HealthCare
- Artificial Intelligence

Future Automotive Technology Key words

1 Green car

2 Smart Car

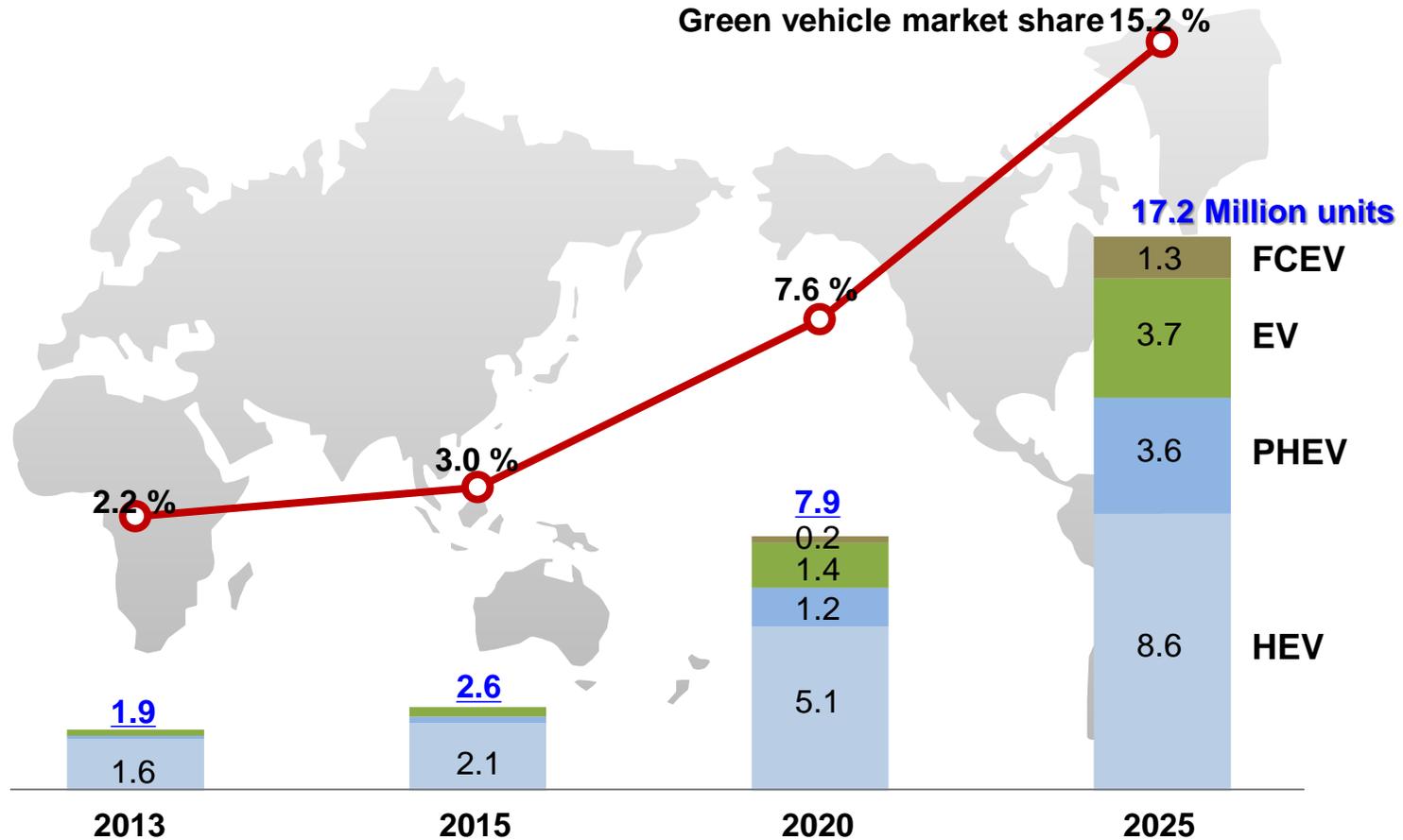


1. Green car

2. Smart Car

1.90 Million units (2.2 %) in 2013

➔ Expected to grow up to 17 Million units (15.2 %) in 2025



* Source : HIS, Fuji economy

22 models of Environmentally Friendly Vehicle Line up by 2020

HEV	PHEV	EV	FCEV
12	6	2	2

3rd

'16 ~ '20

Next generation green vehicles
Full Line-up of green cars

'11.5
Sonata/K5
HEV



'13. 1
Tucson
FCEV



'14. 4
Soul
EV



'15
Sonata/K5
PHEV



2nd

'11 ~ '15

Mass Production

Sonata HEV (2011), Tucson iX35 FCEV (2013)
Soul EV (2014), Sonata PHEV (2015)

1st

'00 ~ '10

Fleet Demonstration & Validation

Issues for Mass Production : Driving Range, Cost, Charging

Longer Driving Range

● High Energy Battery

- Advanced Li-ion Battery
: High Ni (Cathode), Si (Anode)
- Beyond Li-ion batteries
: All Solid State, Metal-Air, Li-S



● SiC / GaN Power Devices (WBG)

- Fuel Efficiency 5 ~ 10 %
- Downsizing 40 % ↓



Cost Reduction

● Battery

- Electrode Material Optimization
: LCO, NCA → NCM (Cathode)

● Motor

- Rare Earth Materials ↓ in Magnet



Fast & Convenient Charging

● High Power Battery

- Design Optimization
: Thinner Electrode & Separator
- Finer Active Material



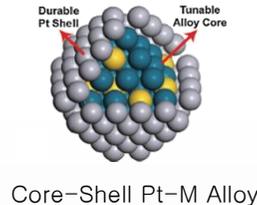
● Inductive Charging

Issues for commercialization – Cost, System Optimization

Cost Reduction

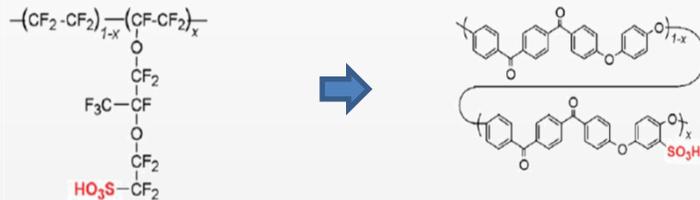
● Catalyst

- Reduction of Platinum
- : Core-Shell Pt-Metal alloy
- Non-Platinum catalyst



● Membrane

- Fluorinated membrane (Nafion)
- Hydrocarbon Membrane



● H2 Storage

- 700 bar Compressed H₂ System
- H₂ Storage Material w/ Low Pressure (~100 bar)
- : LiBH₄/MgH₂, 2LiNH₂/MgH₂, Mg(BH₄)₂

System Optimization

● Why Optimum System?

- Durability, Additional CR, Less Investment

● System Optimization

- Modular Design similar to Engine
- Less Plumbing & Wire
- Optimum System Operation
- Elimination of Redundant Components : Humidifier, H₂ Blower, Sensors

Power Density (kW/L)

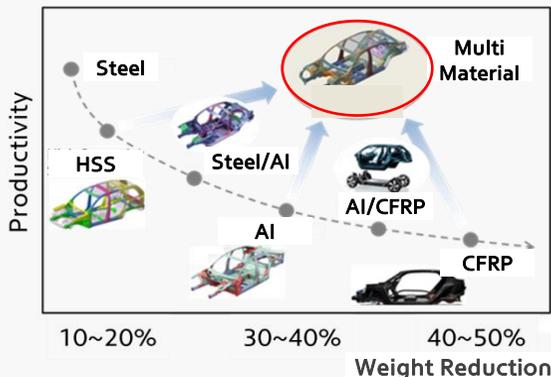


Improving the Fuel Economy with Lightweight Materials and Novel Nanotechnology

Lightweight Materials

“Reducing vehicle’s weight by 150kg
Increase fuel efficiency by 3.8%”

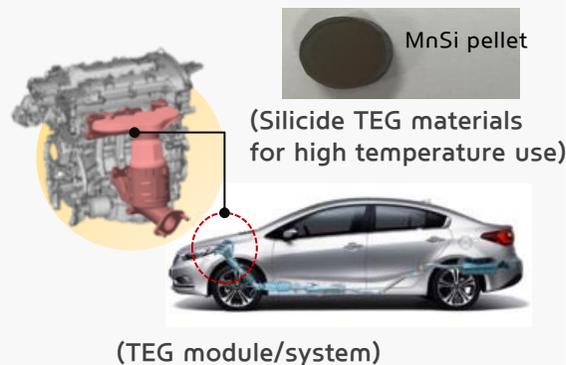
- **New alloy design using ICME†**
 - High mechanical property with lower cost
- **Fiber reinforced plastics**
 - Cost reduction of CFRP
 - Low density materials [SRC ‡]
- **Multi-Material Weight Reduction**
 - Steel, Al, CFRP, Plastic
 - Joining, anti-corrosion



Energy Harvesting

“Energy regeneration of solar and waste heat energy”

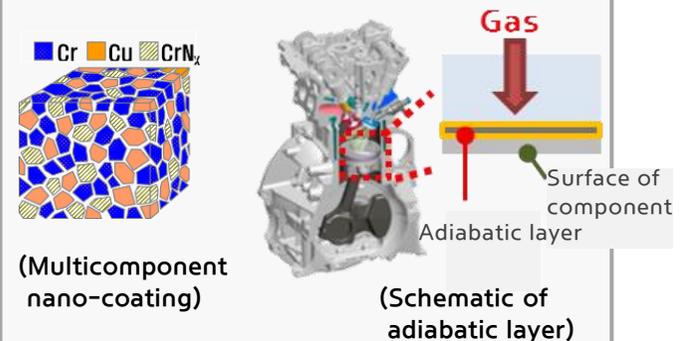
- **Solar Cell**
 - α -si (6% ↑), perovskite (15% ↑)
- **Energy Conversion Technology**
 - Thermoelectric materials and system (10 % F.E. ↑ with 1kW generation)
 - triboelectric, piezoelectric, etc



Nanotechnology

“Functional nano-materials
Increase fuel efficiency by 9%”

- **Low Friction Coating (Engine)**
 - Multicomponent nano-coating : friction coefficient (50% ↓) at H.T.
 - PECVD, ALD
- **Thermal Management Materials**
 - Adiabatic layer : Aero-gel, GSV
 - Nano fluid Coolant



† ICME : Integrated computational materials engineering

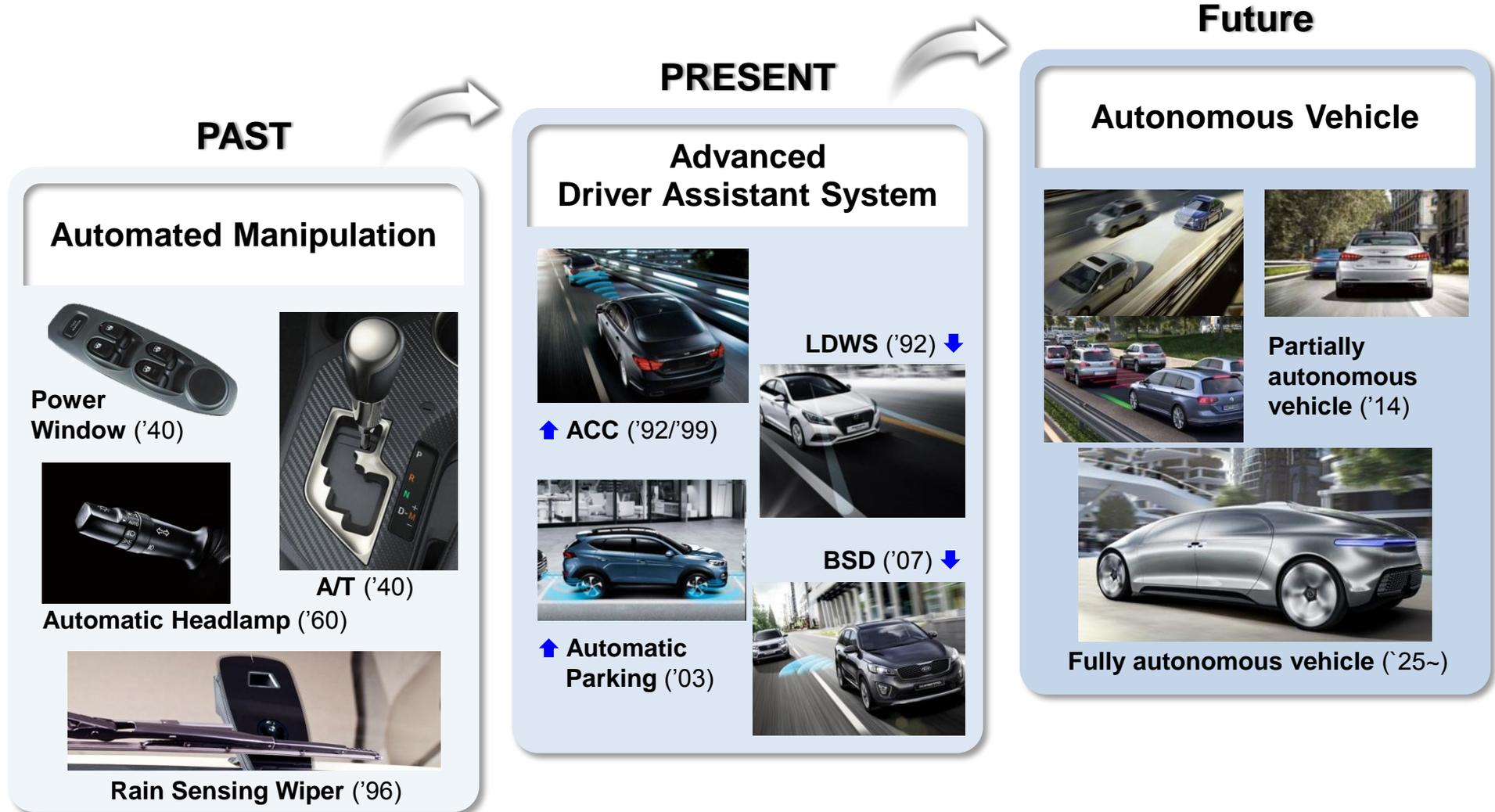
‡ SRC : Self reinforced composite



1. Green car
2. Smart Car

Roadmap of the Intelligent Vehicle Technologies

Continuously developed for Convenience and Safety



Advanced Driver Assistant Systems(ADAS) are developed to automate/adapt/enhance vehicle systems for safety and better driving experience

Longitudinal ADAS

Adaptive Cruise Control

Adjusting the speed to maintain safe distance from vehicles ahead



Autonomous Emergency Braking

When collision is imminent, emergency braking applied to avoid collision or to mitigate its effect



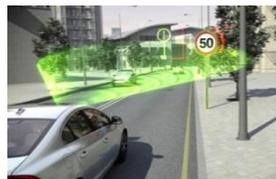
High Beam Assist

When detecting oncoming / ahead vehicles, dipping the headlights



Traffic Sign Recognition

Recognizing traffic signs
- Speed limit, overtaking



Lateral ADAS

Lane Keeping Assist System

Steering system to ensure the vehicle stays in its lane



Automatic Parking

Detecting free space, maneuvering the vehicle into parking slot



Lane Change Assist (or BSD)

Detecting other vehicles located or approaching to the blind zone



Rear Cross Traffic Alert

Detecting crossing vehicles for reverse maneuver



Automotive companies are developing their own autonomous vehicles with different concepts

Autonomous vehicle technologies developing

Commercialization



“Highly safe vehicle”

- Highway autonomous driving (` 13)
- Smart technologies for Green car (` 15, R-car)



- ▶ Highway driving assist (` 15)
- ▷ Traffic jam assist (` 18)

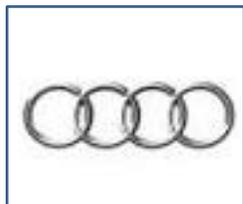


“The most intelligent vehicle”

- 100km driving with commercial system (` 13)
- Concept car (CES ` 15)



- ▶ Highway driving assist, Traffic jam assist (` 13)
- ▷ Highway autonomous driving (` 19)



“Feeling of freedom & fun of driving”

- Audi piloted driving concept
550 miles driving



- ▶ Traffic jam assist (` 16)
- ▷ Highway autonomous driving (` 17)



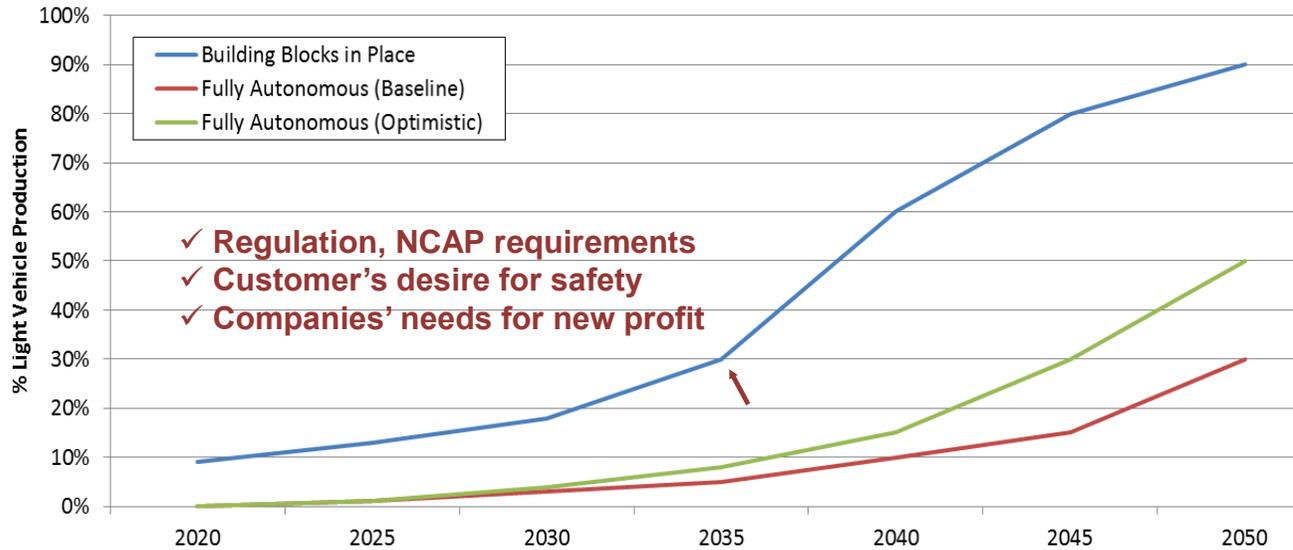
“Driverless taxi”

- The most famous automated car
- Experimental sensors and vehicle



- ▷ Driverless car (` 20)

Autonomous driving will be in market as the improved ADAS features After 2035, Half of the newly produced vehicles will be highly autonomous



Many issues to be resolved for commercialization

- System cost
- Reliability
- Regulation

- Strategy analytics

✓ Sales forecast

- Boston consulting



HDA ('16)
90 M, \$1,600



TJA ('17)
110 M, \$1,300



Valet Parking ('17)
120 M, \$500



HDA+Lane change ('18)
320 M, \$1,300



Urban AD ('22)
620 M, \$2,300



Full AD ('25)
380 M, \$2,700

Building Blocks in Place = vehicles with smart technologies, but not fully autonomous (level 1~3)

3 Conclusions

Implementing high safety, new HMI and eco-friendly technologies on Hyundai Tucson Fuel Cell Electric Vehicle (FCEV)

- ➔ *High safety features : Partial Autonomous Driving, Traffic Jam Assist, Emergency Stop System, Narrow Path Assistance*
- ➔ *HMI : Augmented Reality HUD, New Concept of AVN & Central Control Panel*
- ➔ *Eco-friendly technologies : Transparent Solar Panel Roof, Bio-based Plastic Interior Trim*

✓ Solar Panel Roof

Ventilating cabin air and charging a 12V battery using 40W translucent solar panel sunroof



✓ AR HUD

Displaying driving information with 50 inch size on windshield at 7.5 m front from a driver's view point



✓ Central Control Panel

Minimizing driver's distraction while driving by controlling the hemispherical touch pad without looking at it



✓ Bio-Plastic Interior Trim

Reducing CO₂ by applying bio based materials in interior trims



✓ Fuel Cell System

Up to 600 km driving range with the 100 kW fuel cell system and the 24 kW high voltage battery



Traffic Jam Assist

Narrow Path Assist

■ To Society and Customers



Emission,



% Accident
Rate,



Pleasure

Green and Pleasure based on Safety!





Thank you