

**Attracting Tomorrow**



**TDK IR Event**

**Factory Tours and  
Business Strategy  
Meeting 2024**

**TDK Corporation**  
IR&SR Group  
November 26, 2024

# Overview of Sensor Business

**Takao Tsutsui**

**Vice President,**

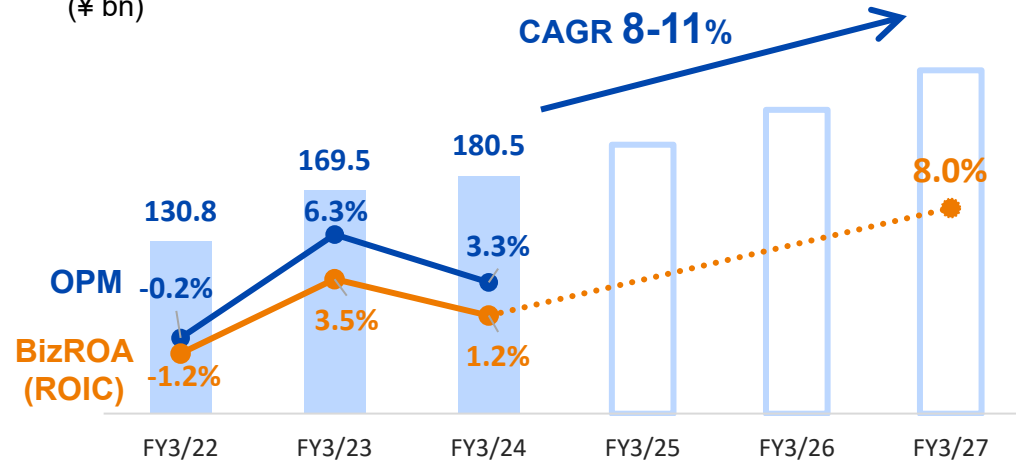
**CEO, Sensor Systems Business Company**

# Sensor Application Products business strategy

- Based on the strategic concept of “Create different and Connect,” we have created new solution and achieved large market shares in focus markets.

## Targets for net sales and BizROA(ROIC)

(¥ bn)



## Major products estimated market share



### Strategies

- Establish a “market-in” business approach, which captures market/customer needs to achieve “First-to-Market,” and a “concept-out” approach, which provides solutions based on concepts
- Expand collaboration with technology leaders and game changers that drive the industry forward
- Optimize the internal resources by transformation of organization structure

### Opportunities

- Increased demand for sensors due to the utilization of AI
- Increased business opportunities due to electrification of vehicles
- Establishment of top position leveraging the cooperative relationships of existing and new businesses

### Competitive advantage

- TMR technology derived from long accumulated magnetic and thin-film technologies
- Temperature sensors with top share in the automotive market
- Our unique production methods, materials and processes technologies
- MEMS design technology and magnetic circuit design technology
- IC design capabilities of ICSense and InvenSense, including expertise of sensor characteristics
- Product development capabilities by combining sensors and software

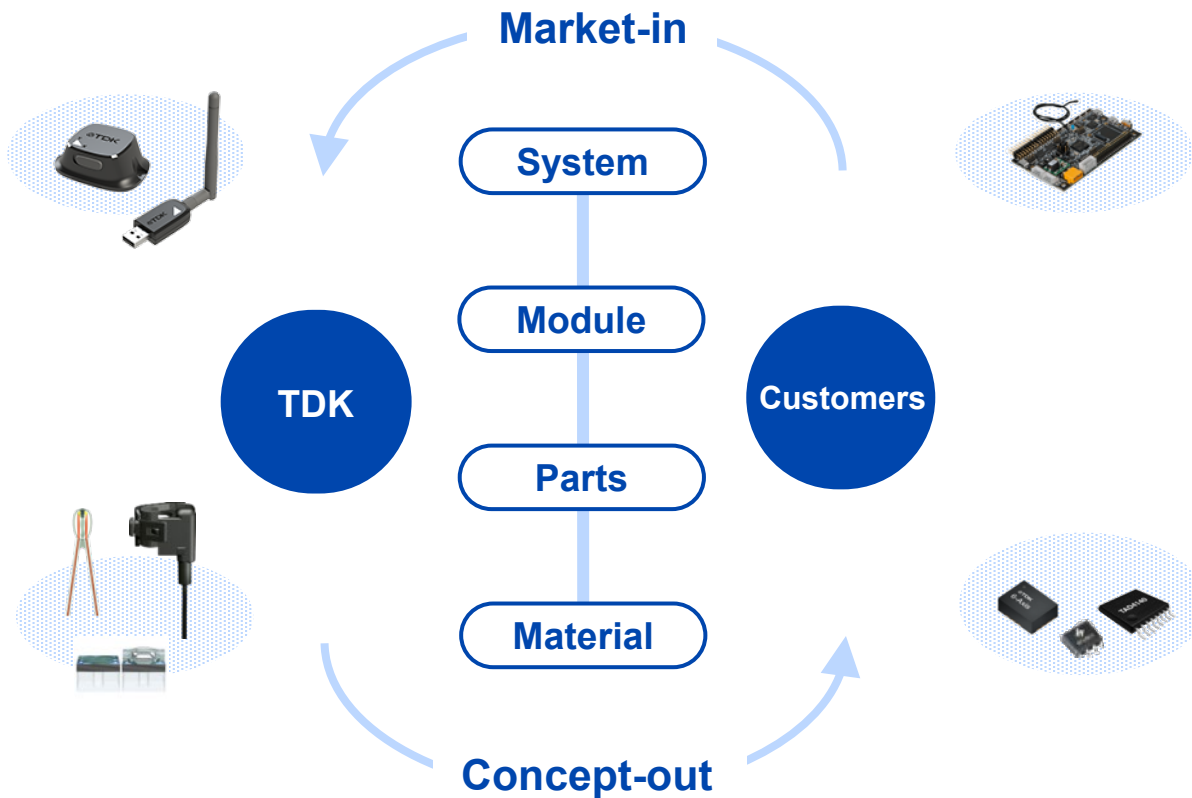
# Sensor Application Products | Positioning and Capex

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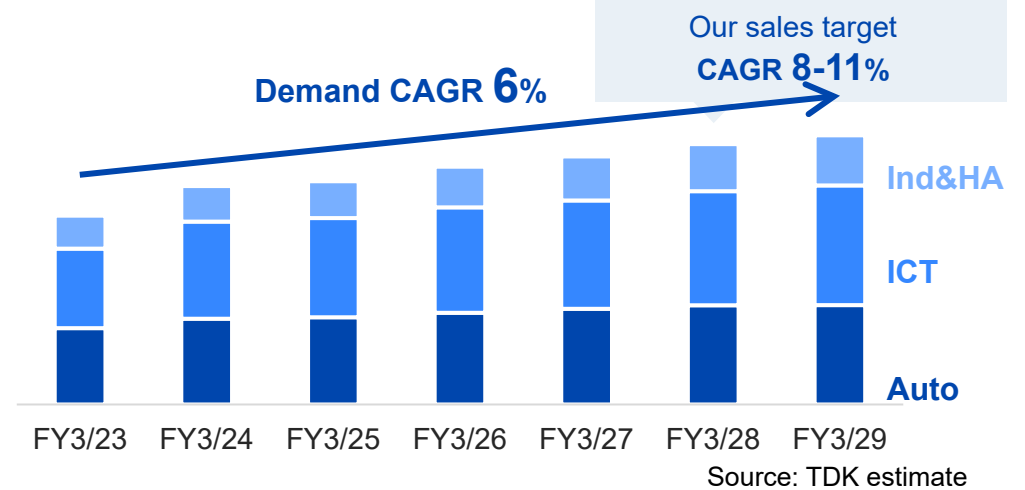


- Strengthen investments in key products and high quality products, by capturing DX and EX trends.

## Strategic position



## Sensor demand estimate by industry



## Investments for sensor capacity investment

Opening of Hungary factory  
(Temp. sensor for Auto/Ind&HA)



Temperature sensor factory  
in Hungary

ATF factory expansion  
(TMR sensor for ICT/Auto)



TMR sensor factory  
in Nagano

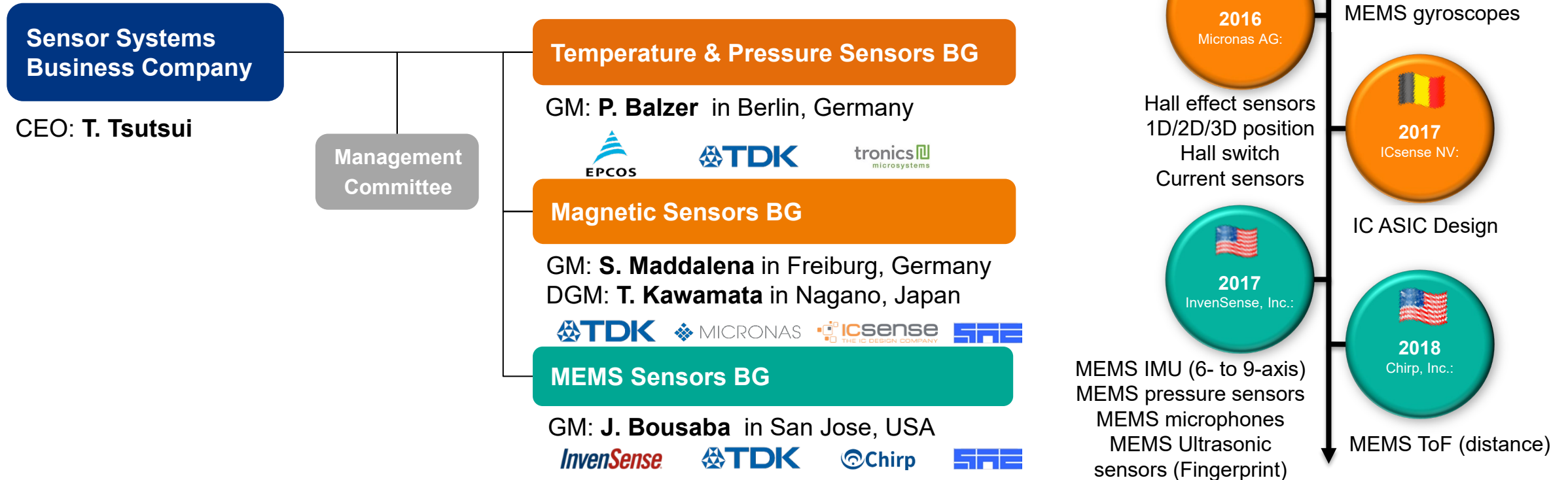
# Transition of TDK's Sensor Business

- **TDK's sensor business portfolio**

Temp, Pressure, TMR Sensors and MEMS Microphone

- **Since 2016, expanded sensor business portfolio through M&A**

The Sensor Systems Business Company (SSBC) was established in 2017. The role of SSBC is to anticipate customer needs and provide comprehensive solutions, not just individual products.



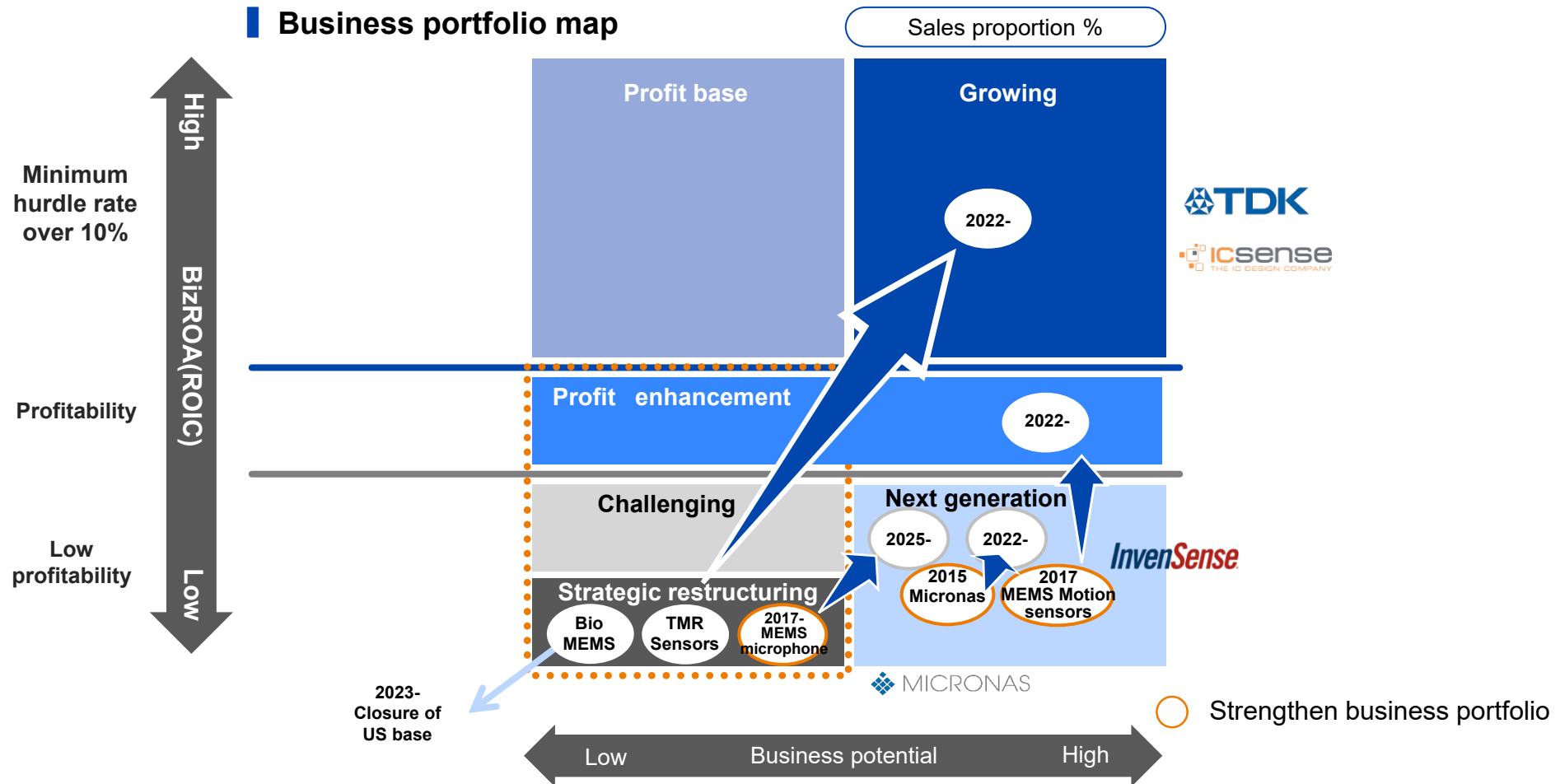
\*Chirp: It remains as a brand, but the company merges into InvenSense

# Enhancing business portfolio management

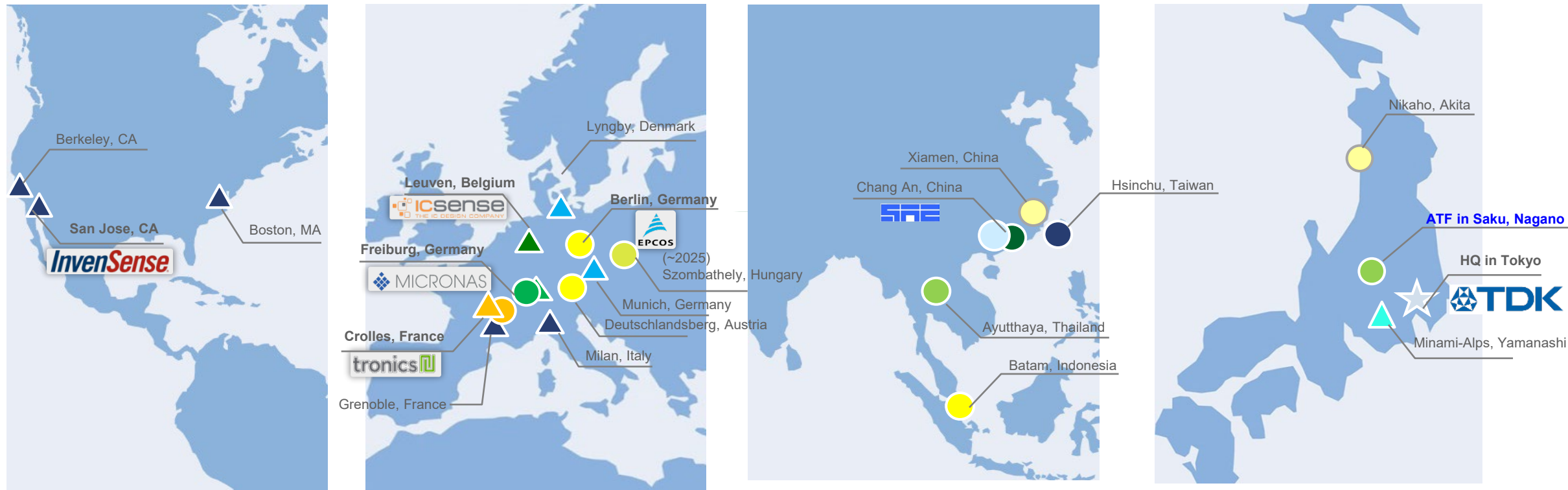
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- Applied magnetic and thin film technologies and developed the TMR sensor business
- Generated synergies by adding to portfolio and achieved turnaround through sales expansion



# SSBC Manufacturing & R&D Location Map

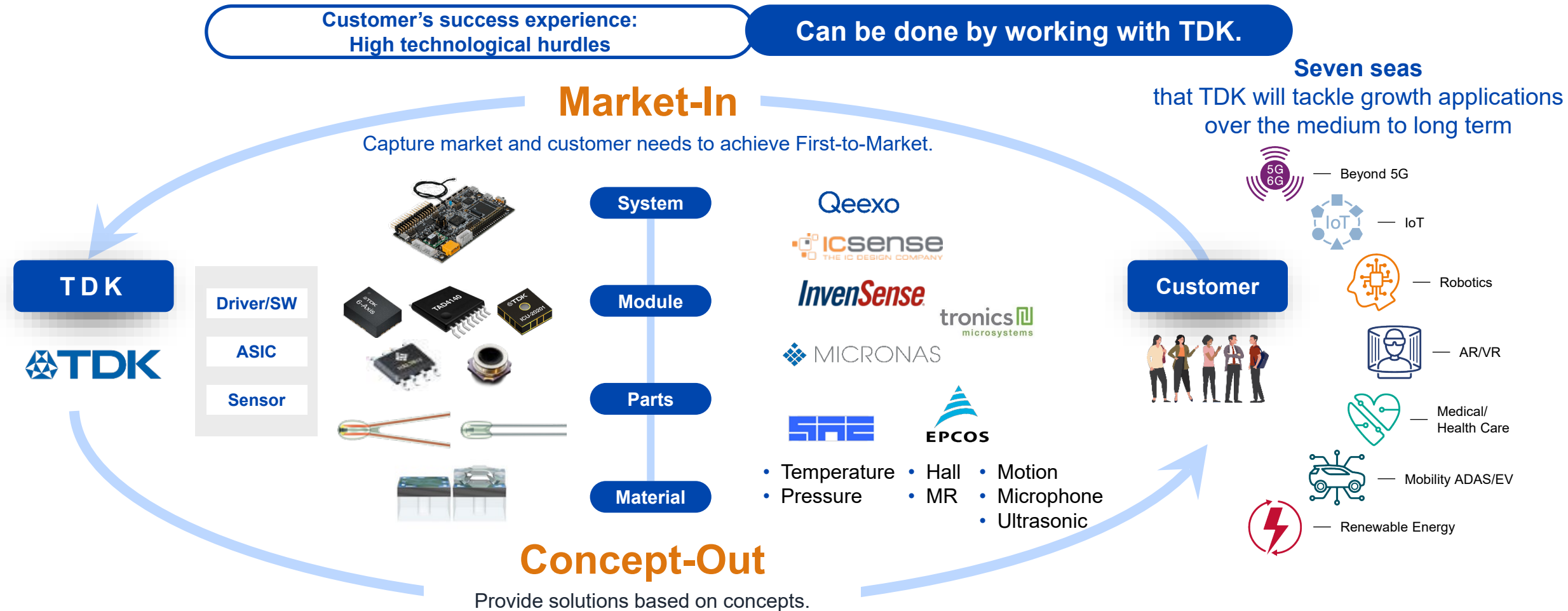


BG	Entity
Temperature & Pressure Sensors BG	TDK  , TDK Sensors  , Tronics  
Magnetic Sensors BG	TDK  , TDK-Micronas   ICSense  SAE 
MEMS Sensors BG	TDK  , SAE  , TDK Electronics  , InvenSense  

-  SSBC HQ
-  Manufacturing
-  R&D

# Accelerate transformation of SSBC

- Transition to an operational structure based on market axes for business expansion.





ICT



# Growth of Sensor Business: ICT, Industry

- The use of AI / the increase of sensors for a comfortable life.

## Present

### TMR sensor

Optical image stabilization (OIS)  
Auto Focus (AF)  
Motor Positioning

### MEMS microphone

Voice control  
Noise cancellation

### Magnetic sensors

eCompass

### MEMS 6-axis IMU

Screen tilt  
Phone movement tracking  
Indoor navigation  
Spatial audio  
Controller movement  
Head movement



## Future

### Small mobility



### Hobby / Sports



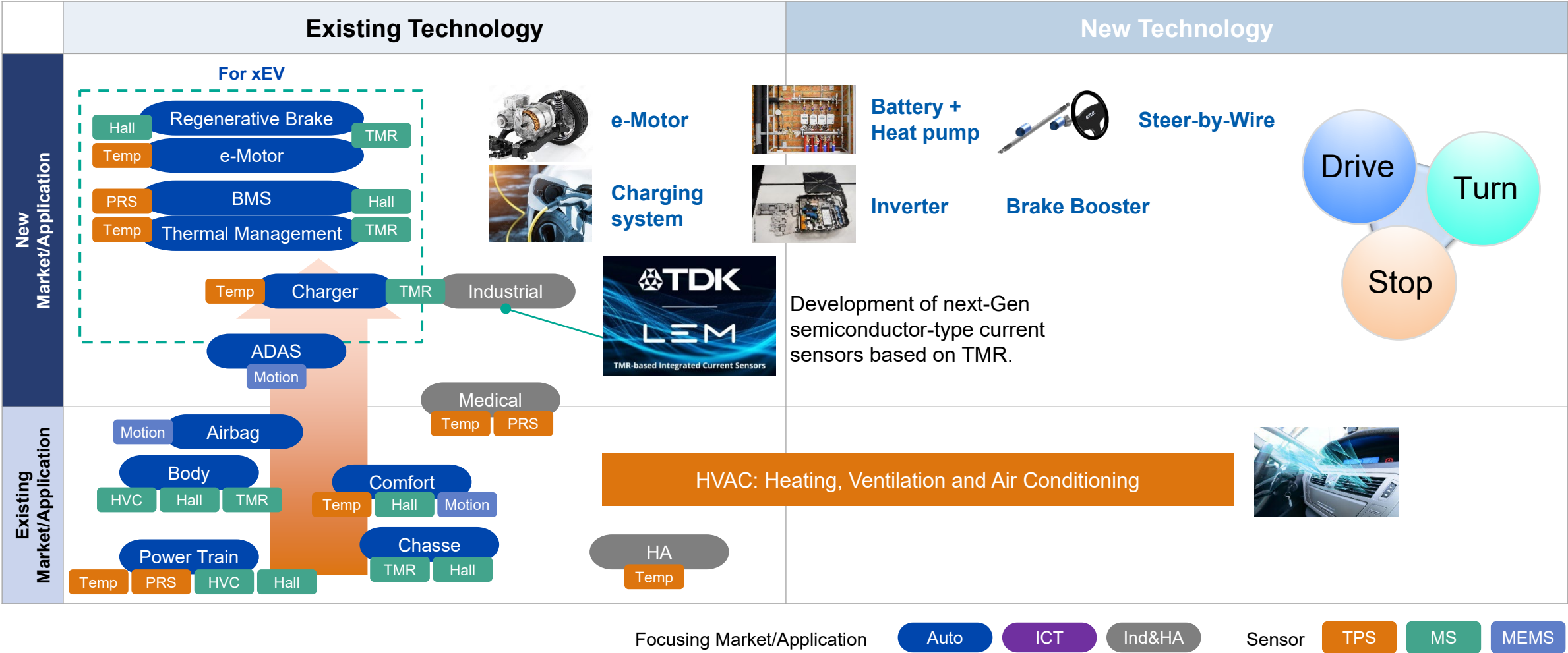
### Robotics



### Esports

# Sensor Business Strategy: Market/Application Landscape

Automotive



e-Motor



Charging system



TDK LEM  
TMR-based Integrated Current Sensors

 Battery + Heat pump  Steer-by-Wire  Inverter  Brake Booster  Drive Turn Stop  Development of next-Gen semiconductor-type current sensors based on TMR. || Existing Market/Application | Motion  Airbag  Body  HVC  Hall  TMR  Power Train  Temp  PRS  HVC  Hall  Comfort  Temp  Hall  Motion  Chasse  TMR  Hall  Medical  Temp  PRS  HA  Temp  HVAC: Heating, Ventilation and Air Conditioning |  |

Focusing Market/Application

Auto

ICT

Ind&HA

Sensor

TPS

MS

MEMS

# Growth of Sensor Business: Automotive

- Increase in the number of sensors due to electrification, electrification, and autonomous driving.

## ICE

### Temperature sensors

HVAC  
Powertrain  
Outside air temp  
...

### Pressure sensors

Powertrain  
...



### MEMS 6-axis IMU

Airbag

### TMR Angle switch

Power steering

### Hall switch

Gear position  
Window lift  
Buckle switch  
...

Drive

Turn

Stop

## xEV

### Temperature sensors

+ Battery pack  
Thermal management  
...

### Current sensors

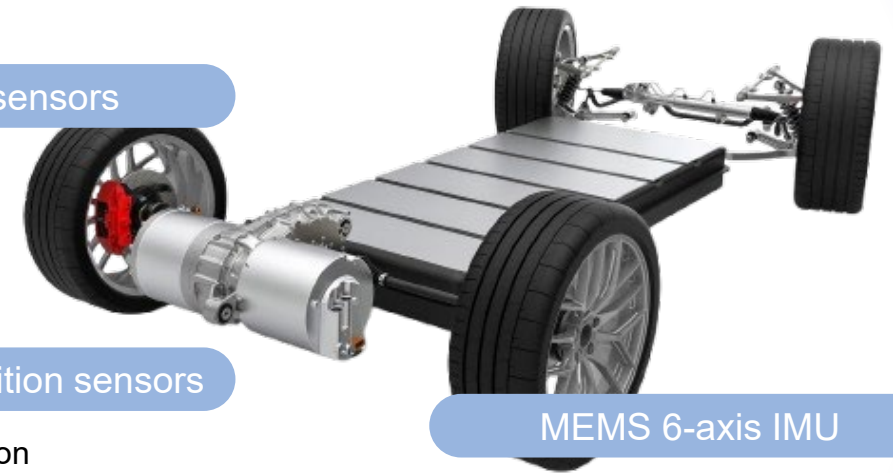
Charging EV  
Vehicle Electrification

### Pressure sensors

+ Battery cooling  
Thermal management  
...

### Speed and position sensors

E-axle motor position  
Bending lights  
Active pedal  
Drive-by-Wire  
Speed sensor  
...






### MEMS 6-axis IMU

+ ADAS image stabilization  
Dead reckoning  
Shock detection  
Adaptive headlight  
...

# NTC/PRS BOM comparison for ICE, HEV, PHEV, and BEV.

Drive



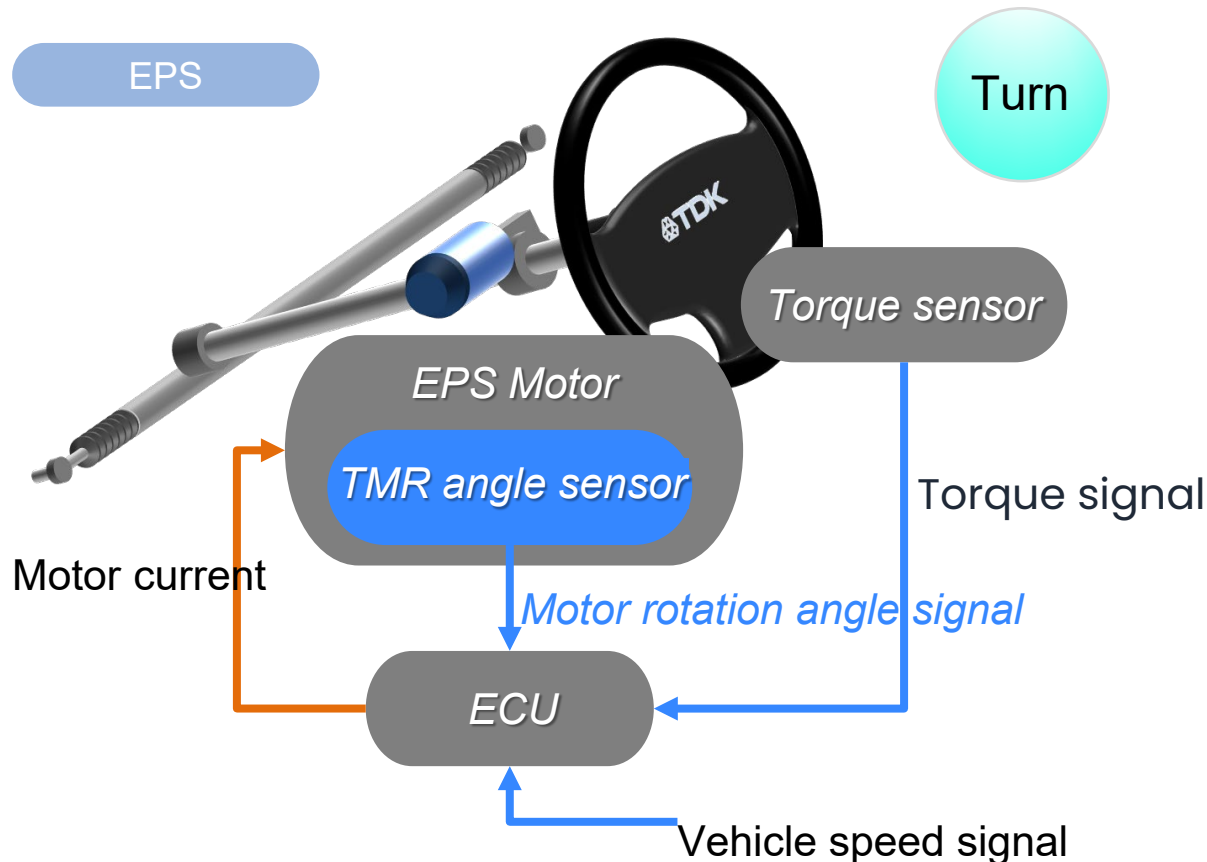
		ICE		FHEV		PHEV		BEV	
		PRS	NTC	PRS	NTC	PRS	NTC	PRS	NTC
Fuel	Fuel supply		1		1		1		
	Tank control				1		1		
	Leakage control** (incl. vapor control)		1		1-2		1-2		
Exhaust	Particle filter control		1		1		1		
	Crankcase venting		1		1		1		
Cabin heated surfaces		2		2		2		4	
ICE Management		7		7		7			
HVAC		3	1	3	2	3	2	3	4
HVAC /Battery	Liquid battery cooling and heating				Under evaluation		Under evaluation	3-7	1
	Battery pack			1		1		1	Under evaluation
EV Power	E-motor			1	1	1	1	1	1 - 2
	Inverter			0 - 1		1		1	
Charging	Junction box / Vehicle connector					1		1	
	OBC / DC/DC converter					1		1	
Ø BOM sensor value		12	5	14 - 15	8-9	17	8-9	15 - 19	6-7

Source: TDK estimates

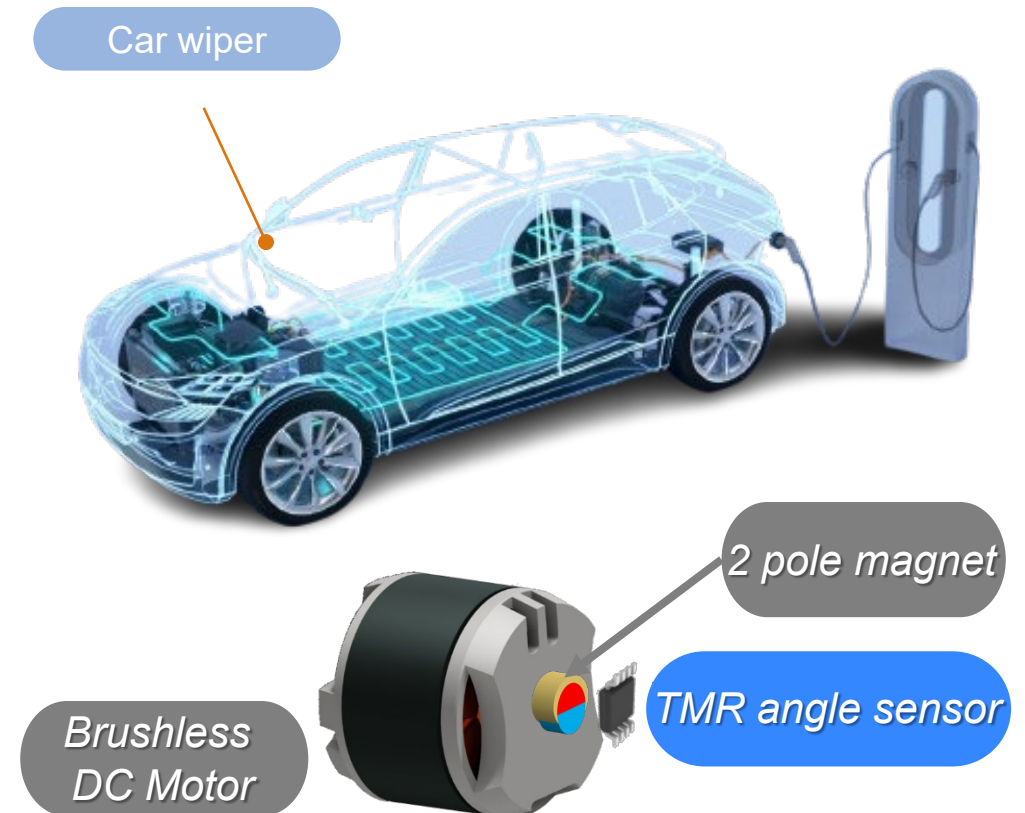


# TMR Angle Sensor for EPS & Wiper

- Top-class angular accuracy in the magnetic sensor industry
- High-reliability design that excels in environmental resistance and maintains performance over the long-term
- Productization of high output, high precision, and high stability in a compact package

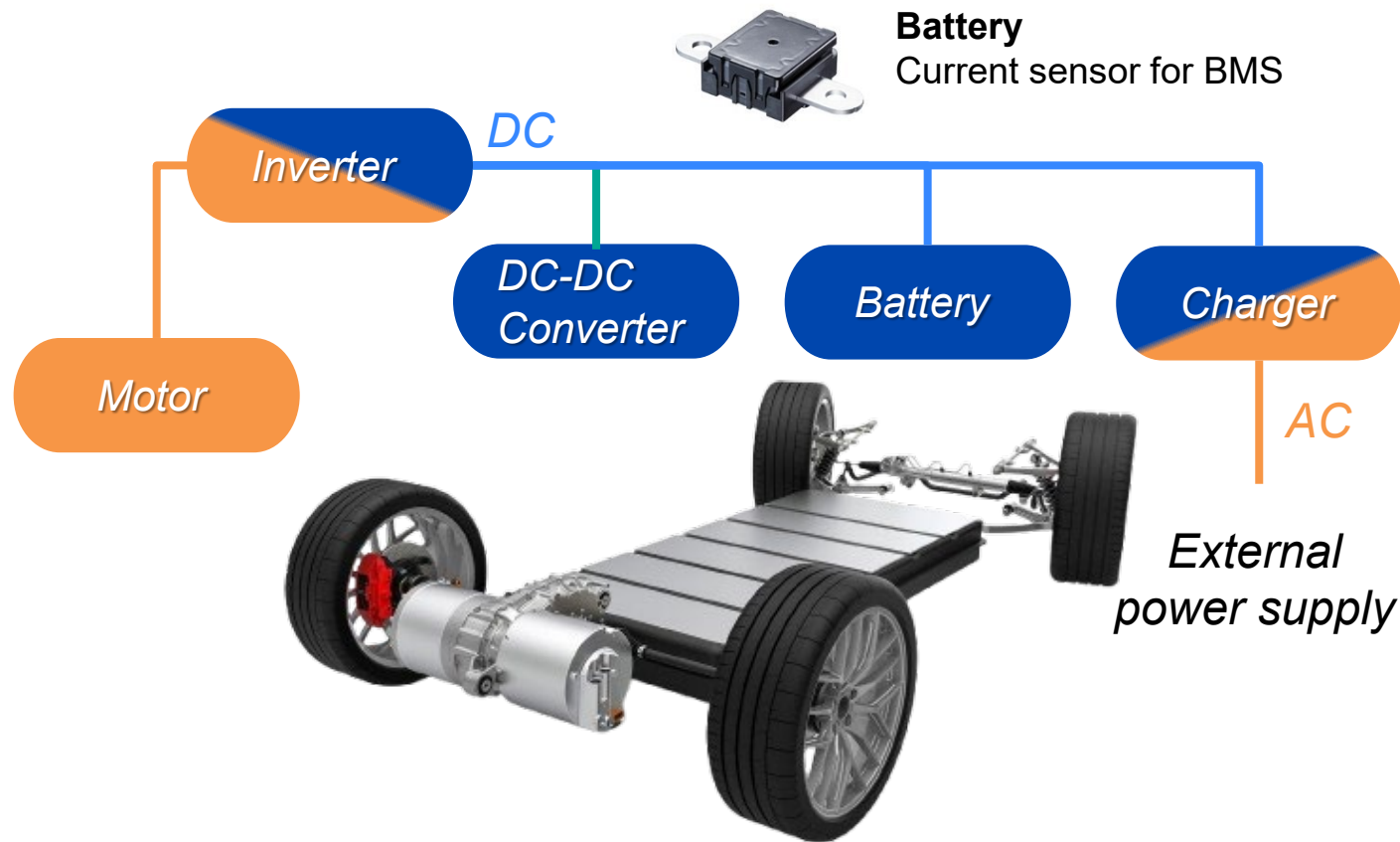


※EPS : Electric Power Steering



# Current Sensor

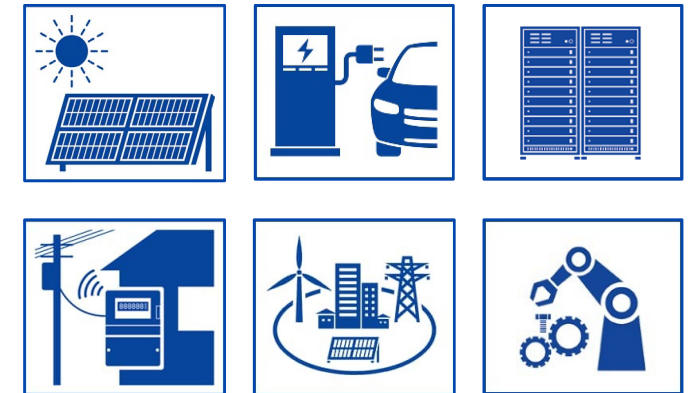
- Expansion into industrial equipment through partnerships



**Charger**  
Overcurrent detection

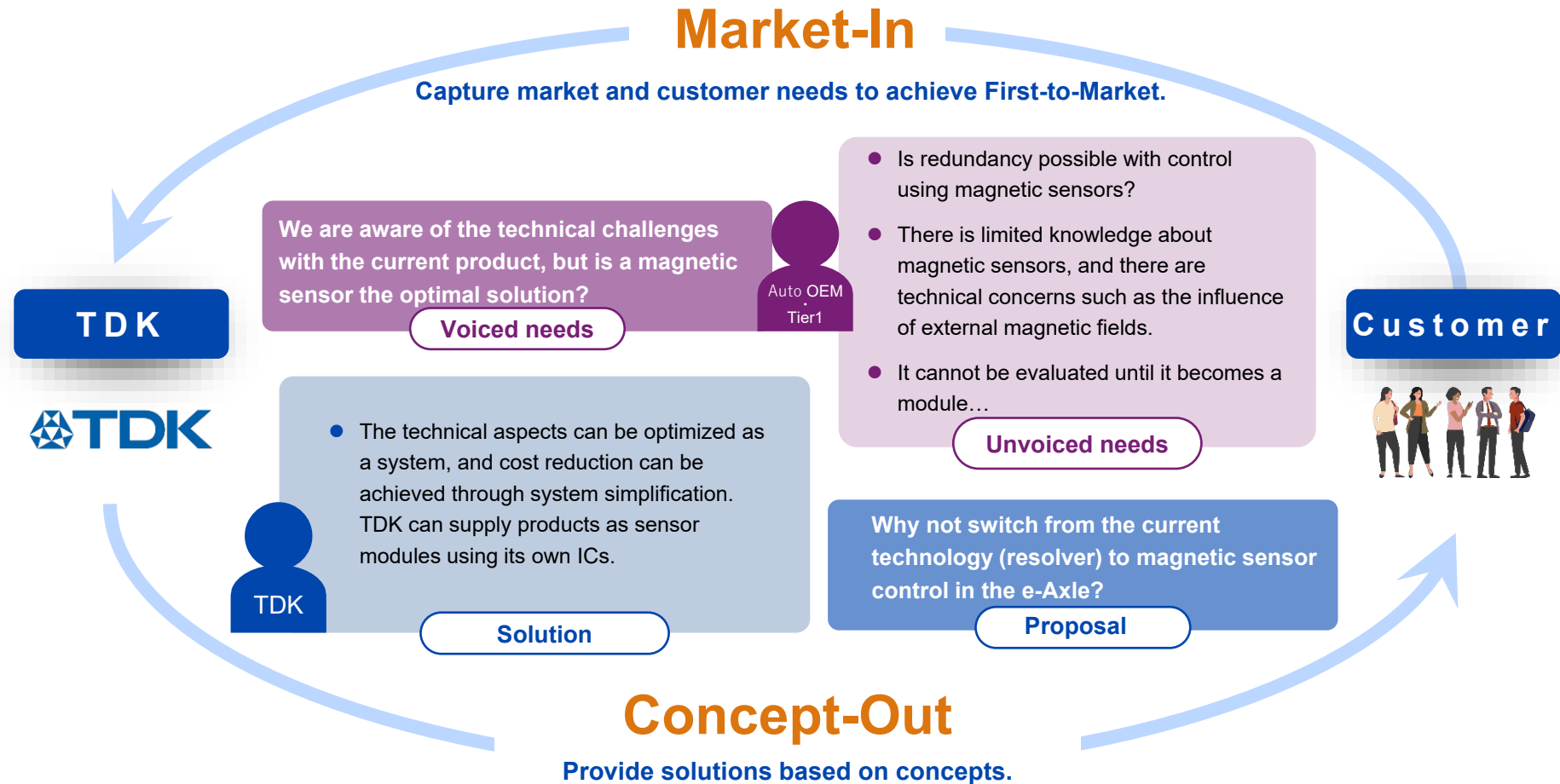


Partnership with a leading current sensor company for automotive and industrial machinery applications



# Concept-Out of sensor system solutions

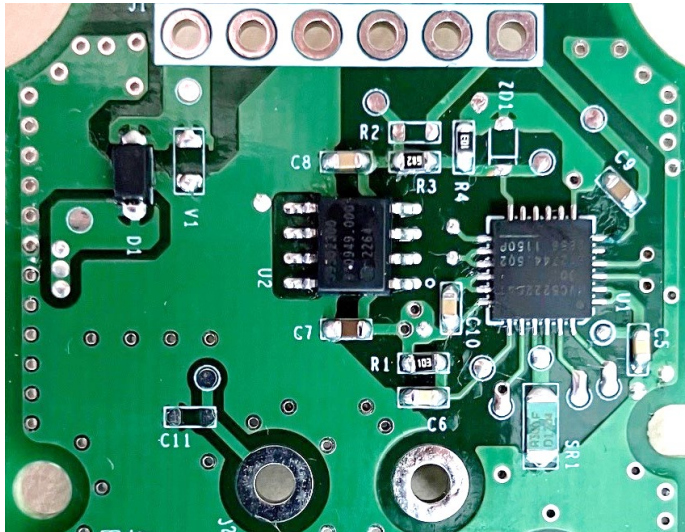
- Propose the optimal solution as a TMR sensor system based on the technical expertise developed in automotive EPS and brakes.





# Proposal of a solution: Smart Actuator

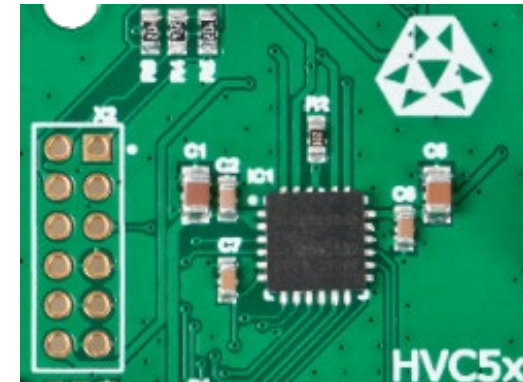
Today (HVC + Hall Sensor)



Application: Thermal management

Function: Pressure control

HVC + TMR Sensor Integration



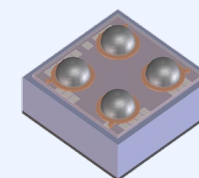
- ✓ Downsizing
  - ✓ Lower cost
  - ✓ Freedom of design
- ⇒ higher value for TDK

- New position sensor : Sensor fusion at system level

## SmartMotion × TMR Compass

### High performance 6-axis IMU sensor

- ✓ Balanced gyro design
- ✓ Low power consumption
- ✓ Low noise
- ✓ Firmware and On-chip embedded system control software (IMU + Compass)



### TMR e-compass

- ✓ Ultra low power consumption
- ✓ High accuracy and low noise
- ✓ Robust on external magnetic shock

### Application of indoor navigation system using magnetic field mapping

- ✓ Integration with navigation software technology
- ✓ Expansion into application software



### VENUE

Indoor positioning solution being developed by TDK group company Trusted Positioning (Calgary, Canada)

### Wearable device

- Geofencing
- Pedestrian route tracker



### Small mobility, Automotive

- Pedestrian navigation
- Route tracker
- Dead reckoning



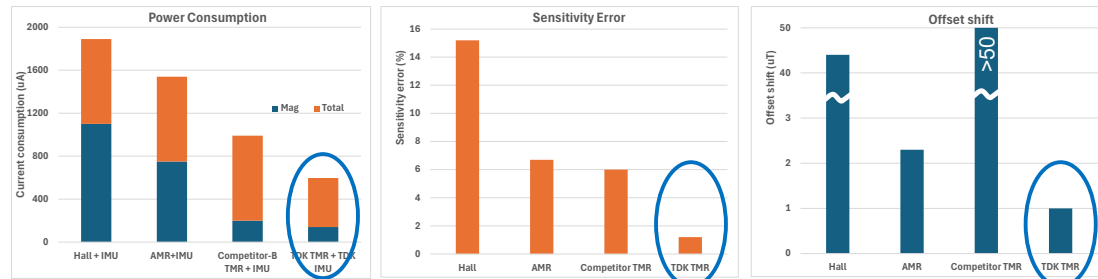
# Position Sensor - Sensor System Solution

## Position sensor concept

- TMR magnetometer & 6-axis IMU
- Sensor system integration into one system
  - Sensor fusion algorithm
  - Integration with positioning software

## Kotozukuri and success experience of customers

- System-level optimization as a solution through the integration of sensors and software.



### TDK TMR & INVN IMU

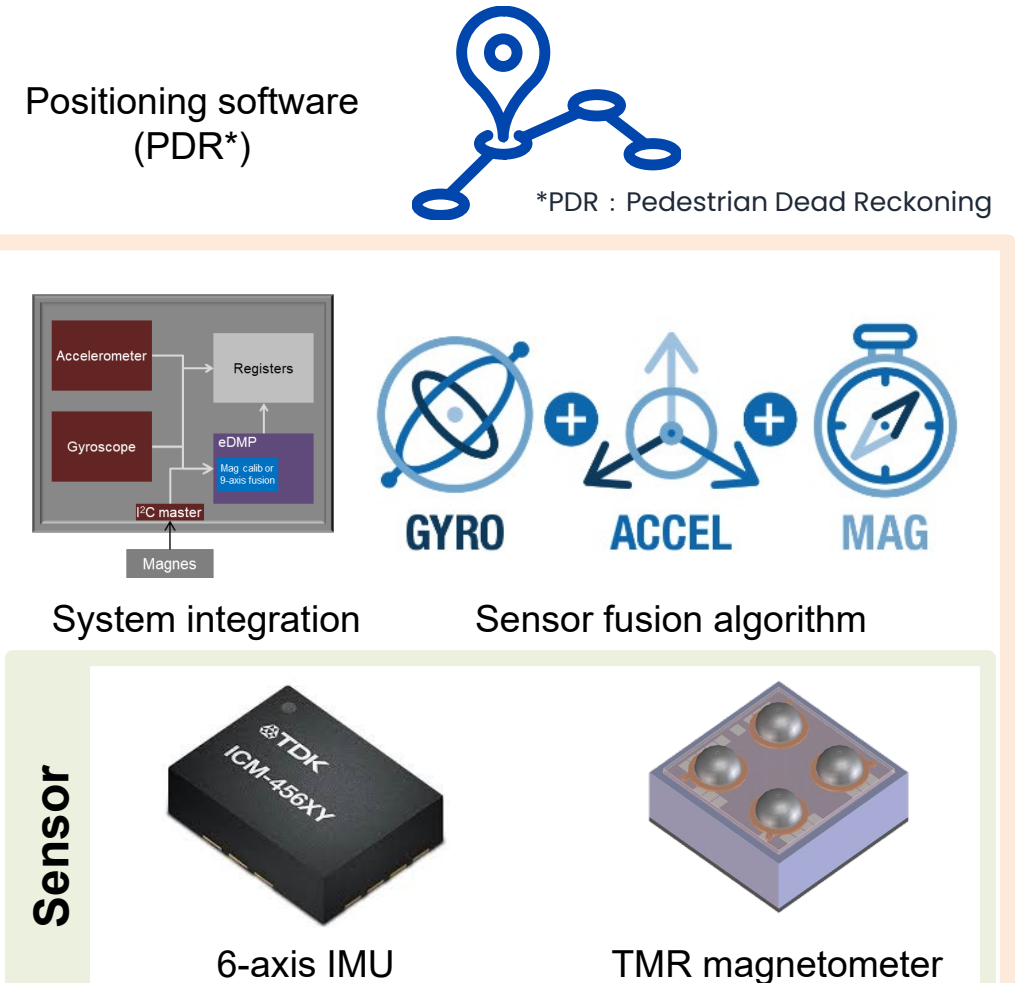
- ✓ Lowest power consumption

### TDK TMR magnetometer

- ✓ Lowest sensitivity error and offset variation

## Position sensor system

### 9-axis sensor





# TMR vs AMR Magnetometer for PDR

## ■ TMR vs AMR

- 20 mins PDR-only, 1200m distance travelled
- 9-axis solution with AMR Mag: Large tolerance (~30 degree heading drift)
- 9-axis solution with TMR Mag: Small tolerance (<10 degree heading drift)

Reference



9-axis PDR (AMR Mag)



9-axis PDR (**TMR Mag**)

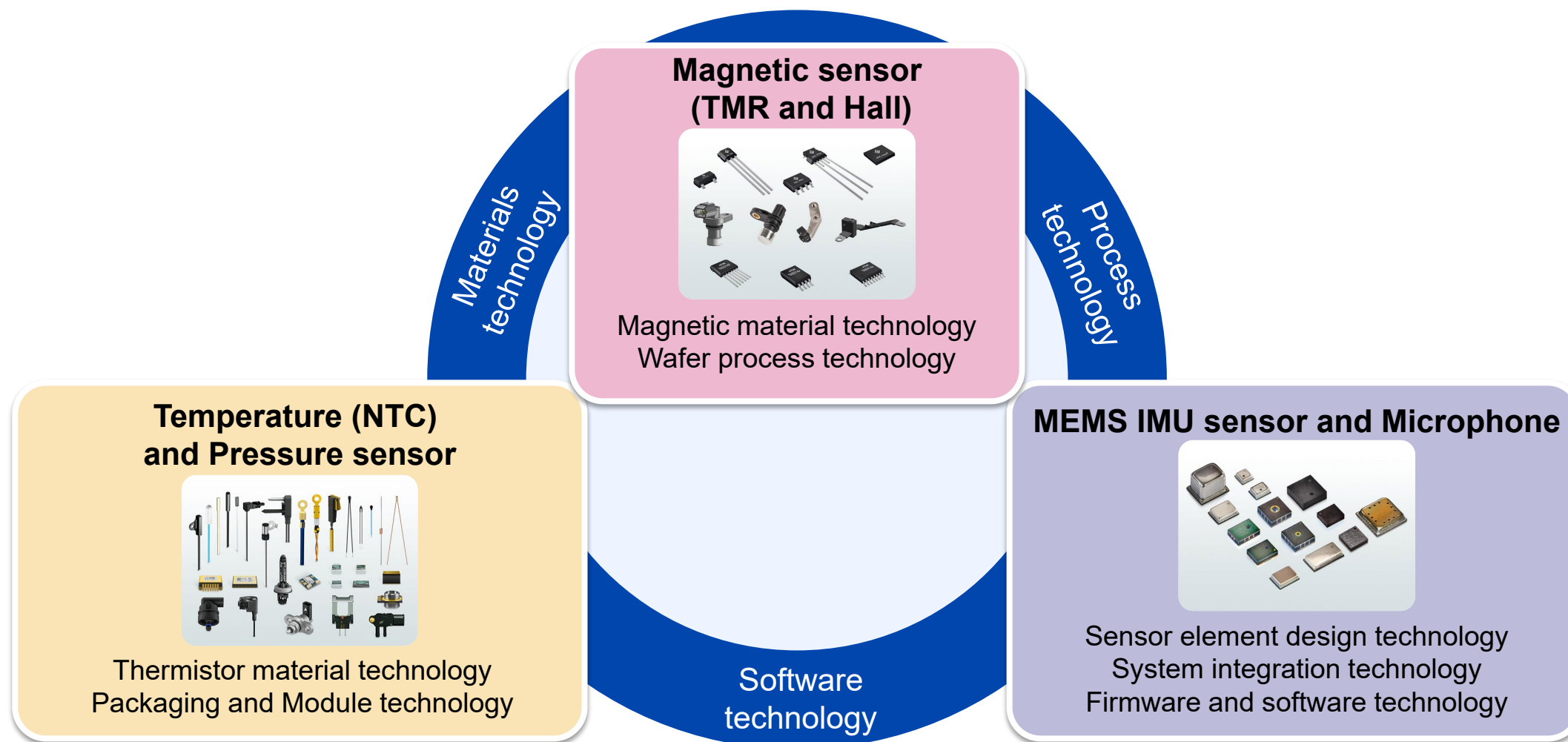


PDR : Pedestrian Dead Reckoning

It is used to measure the distance and direction of a pedestrian's movement using sensors, allowing for position estimation even in areas where GPS signals are unavailable.

# Beyond TMR, Beyond "Sensor"

- Exploit core competence of TDK SSBC business group  
Market creation by — materials, process, and software technologies —



# Overview of Energy Business

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**Vice President,**

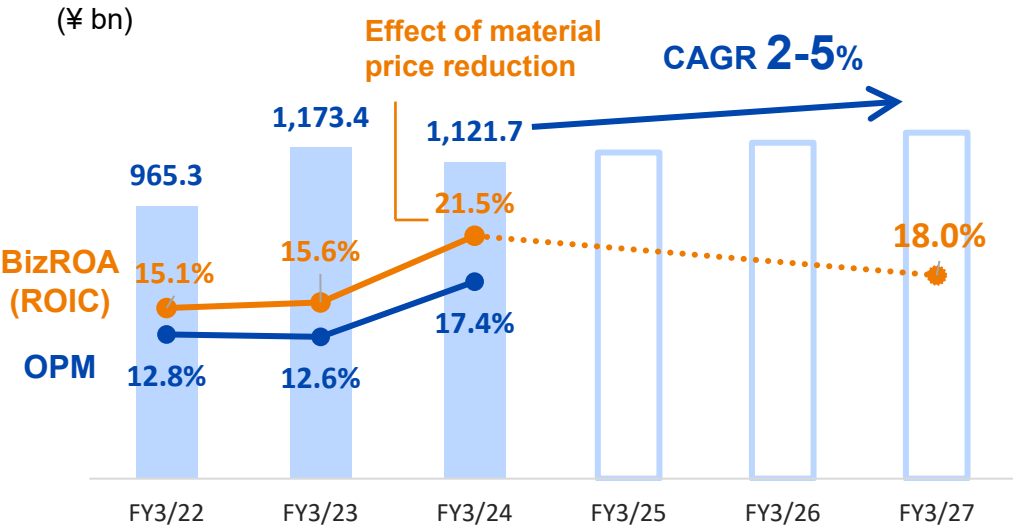
**CEO, Energy Solutions Business Company**

# Energy Solutions Business Company

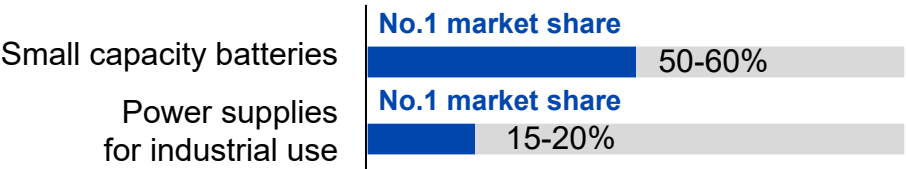
## business strategy

- Pursue excellence in energy products and technologies through relentless technological innovation and empower people in their daily lives.

### Targets for net sales and BizROA(ROIC)



### Major products estimated market share



Strategies	<ul style="list-style-type: none"><li>• Maintain and enhance top position in the market for small capacity batteries by continuous development of cutting-edge technologies.</li><li>• Establish the top position in the medium capacity battery market as a supplier.</li><li>• Further enhance market competitiveness by strengthening differentiation technologies and cost competitiveness</li></ul>
Opportunities	<ul style="list-style-type: none"><li>• Further expansion of applications requiring high-performance rechargeable batteries</li><li>• A boost in the high-end smartphone market due to the expansion of high-function devices, such as foldable smartphones and AI smartphones</li><li>• Increased added-value in LIB due to Si anodes and other new differentiation technologies</li><li>• Expansion of the storage battery market and demand for related devices due to the accelerated introduction of renewable energy (rechargeable battery and industrial power supply businesses)</li><li>• Local demand increase in growth markets such as India</li></ul>
Competitive advantage	<ul style="list-style-type: none"><li>• Ability to develop cutting-edge technologies as a technology leader in the industry</li><li>• Capability of management transformation based on “Capability to envision the future” and “Capability to execute”</li><li>• High-reliability mass production technology, thorough safety risk management</li><li>• Cost optimization technology and production engineering technology capabilities</li><li>• Broad customer base and long-term partnerships</li></ul>

# Small Capacity Batteries Strategies



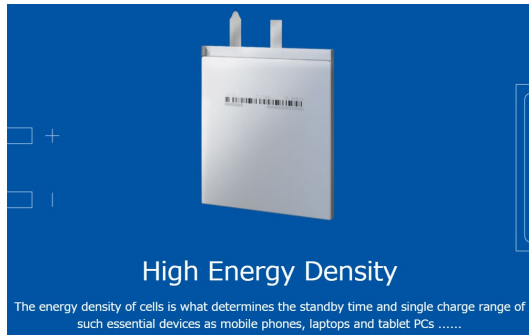
# Small Capacity Batteries Strategies

## 1. Offer new value through innovative technologies and enhance user experience

- Provide the most suitable technology to meet the needs of our customers
- Strengthen our technological superiority through continuous R&D investment



### High Energy Density



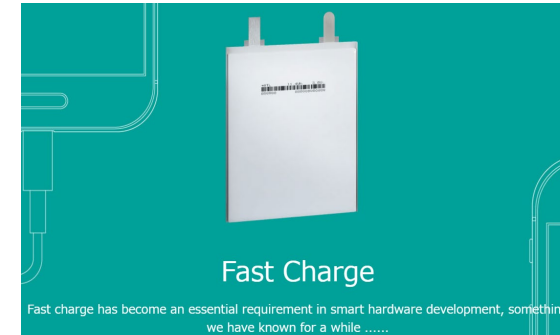
Materials  
technology

Stacking  
technology

Packaging  
technology

- Miniaturization, thinning
- Higher Energy density

### Fast Charge



Stacking  
technology

MTW technology

- Ultra fast charge

### Arbitrary Shaped Cell



Stacking  
technology

Packaging  
technology

- Miniaturization, thinning
- Higher Energy density

### Long cycle / Safety



Stacking  
technology

MTW technology

Materials  
technology

Packaging  
technology

- Long life
- Enhanced safety

# Small Capacity Batteries Strategies

## 2. Implement a China Plus One strategy in view of geopolitical risks

- Start up of new plant in India, gradual expand production capacity
- Implement flexible measures in response to changes in the business environment

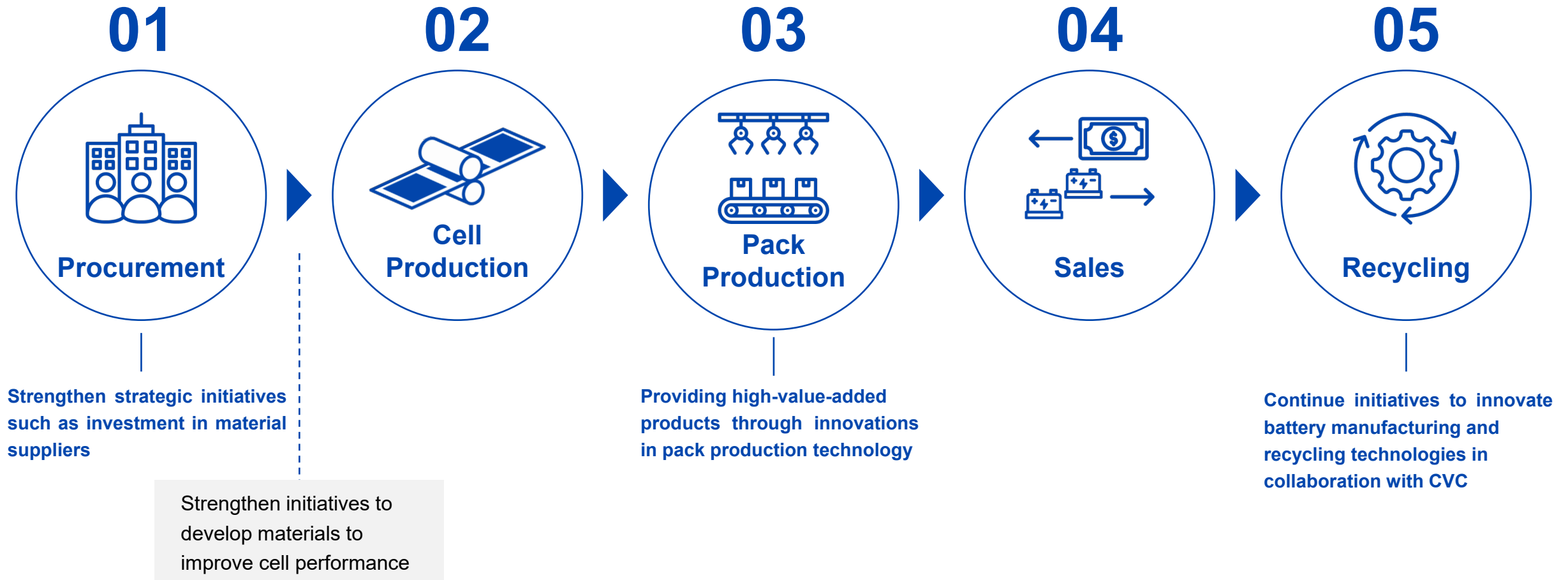
### India new factory overview



Phase 1 construction progress

# Small Capacity Batteries Strategies

## 3. Maximize business value by strengthening the value chain



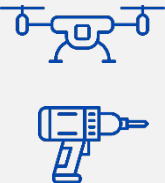


# Medium Capacity Batteries Strategies

# Medium Capacity Batteries Strategies

## 1. Superior Customer Service

- Propose and deliver products and technologies that meet customer needs from a wide range of resources (materials, designs, processes)

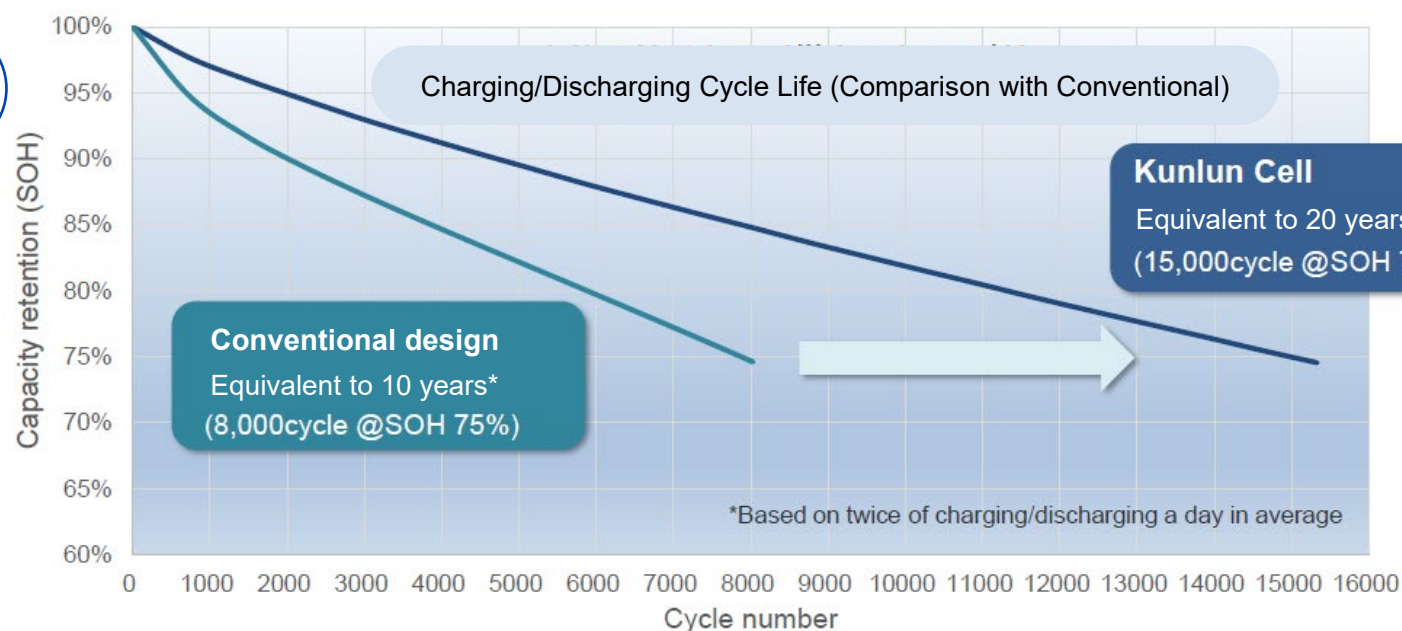
 <b>ESS*</b>	<ul style="list-style-type: none"><li>Acquire global top share for Residential Energy Storage System</li><li>Enhance “<b>safety and long life</b>”</li><li>Expand small capacity commercial and industrial ESS and uninterruptible power supply (UPS)</li></ul>
 <b>Electric motorcycles</b>	<ul style="list-style-type: none"><li>Strengthen initiatives toward expansion of Asian and EU markets in addition to the Chinese market</li><li>Optimization performance, safety and cost through product design tailored to customer needs</li></ul>
 <b>Power device products**</b>	<ul style="list-style-type: none"><li>For drone applications: Maintain top share by leveraging <b>high-power, high-energy density pouch cells</b></li><li>For power tool applications: Aim to expand share by leveraging <b>high power products</b></li></ul>

\*ESS=Energy Storage System \*\* Power device products= Drone, Power Tool, Cleaner, etc

## 2. Technology Advancement

- Continued technological innovation that further enhance customer value (High performance, long life, high quality, high reliability)
- Differentiating technologies for ESS (example)
  - Ultra long-life achieved by newly developed graphite and electrolyte
  - Long cyclelife of up to 15,000 cycles (Equivalent to 20 years, > SOH 75%)

Ultra Long-life Lithium-Ion Secondary Battery Cell  
(Residential / Industrial ESS)





# Medium Capacity Batteries Strategies

## 3. Operational excellence

- Achieve outstanding Q(Quality), C(Cost), D(Delivery) by launching a new plant

### Quality

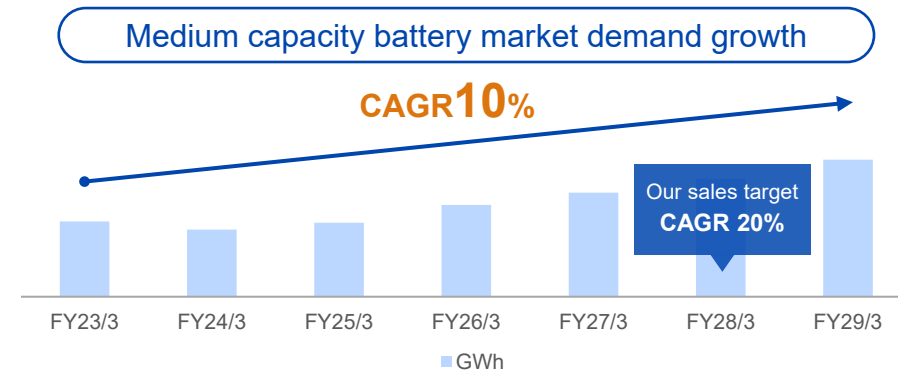
- Long life, high durability cells
- Latest technology facilities achieve a high level of quality
- Highly reliable BMS, pack integration design technology

### Cost

- Achieve high cost competitiveness through economies of scale and production technology
- Improve value by long-life products for customers

### Delivery

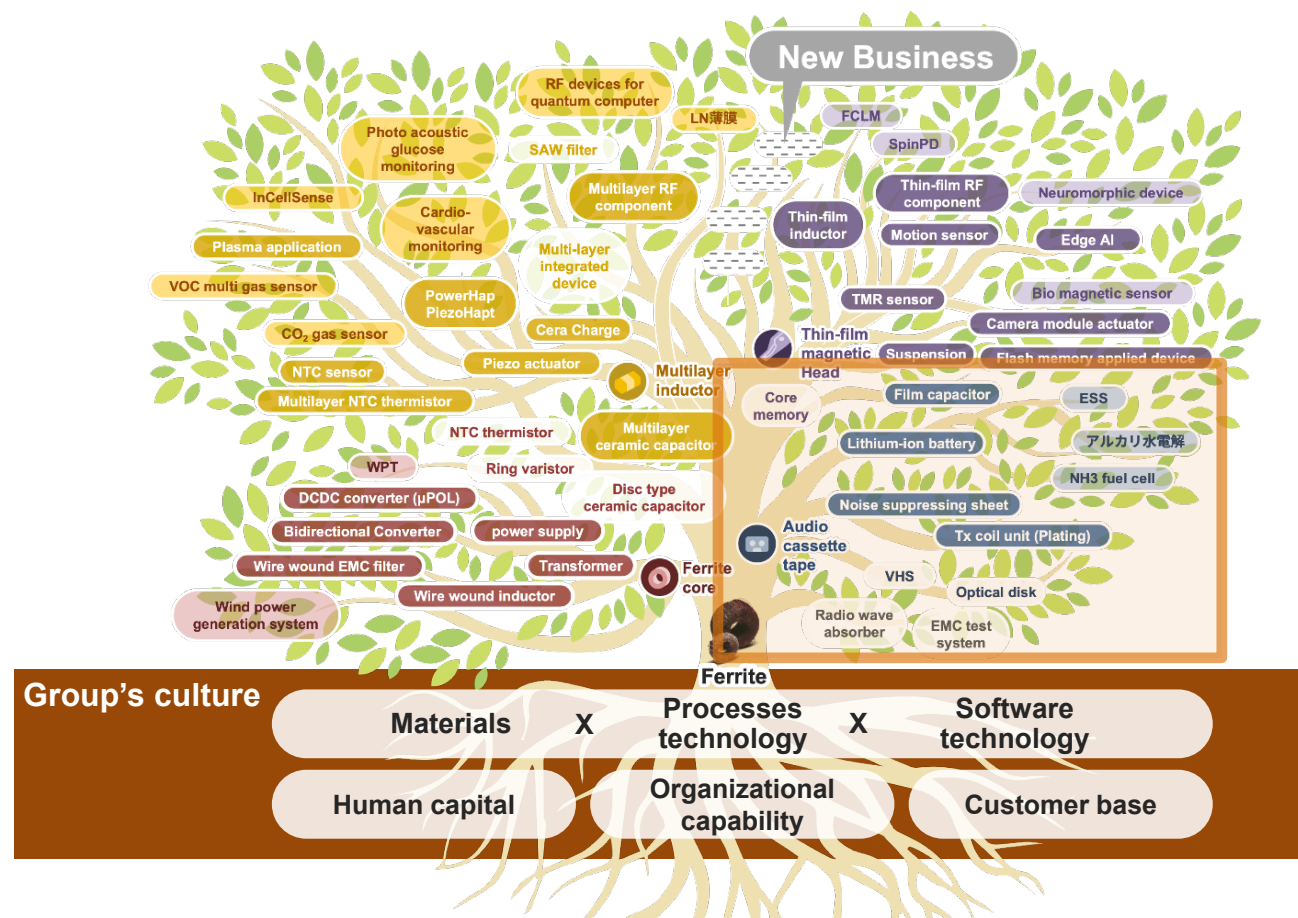
- Realize time to market through vertical start-up know-how from development to large-scale production
- Close customer support tailored to region base



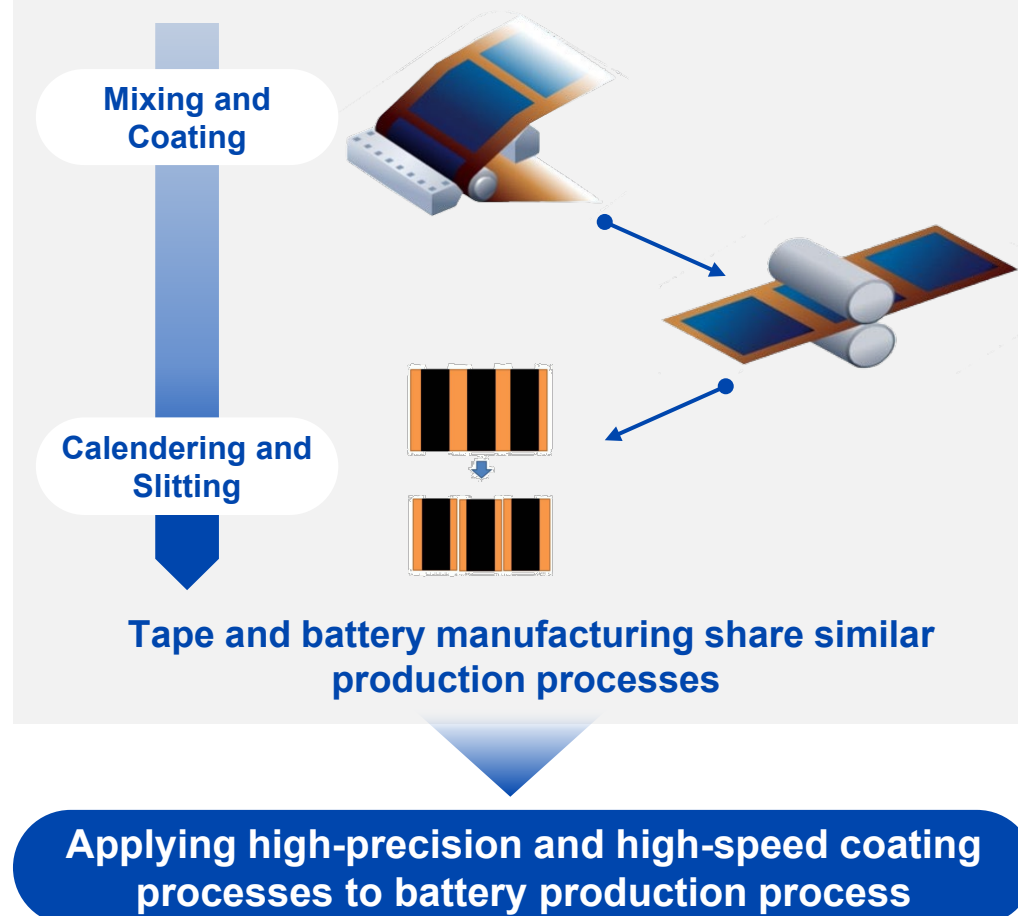
# Evolving the Ferrite Tree

- Applying Roll to Roll coating technology to the battery manufacturing process

## Future Ferrite Tree



## Expanding magnetic tape manufacturing technology into electrode production technology





# Cautionary statements with respect to forward-looking statements

This material contains forward-looking statements, including projections, plans, policies, management strategies, targets, schedules, understandings, and evaluations about TDK, or its group companies (TDK Group). These forward-looking statements are based on the current forecasts, estimates, assumptions, plans, beliefs, and evaluations of the TDK Group in light of the information currently available to it, and contain known and unknown risks, uncertainties, and other factors. The TDK Group therefore wishes to caution readers that, being subject to risks, uncertainties, and other factors, the TDK Group's actual results, performance, achievements, or financial position could be materially different from any future results, performance, achievements, or financial position expressed or implied by these forward-looking statements, and the TDK Group undertakes no obligation to publicly update or revise any forward-looking statements after the issue of this material except as provided for in laws and ordinances.

The electronics markets in which the TDK Group operates are highly susceptible to rapid changes, risks, uncertainties, and other factors that can have significant effects on the TDK Group including, but not limited to, shifts in technology, fluctuations in demand, prices, interest and foreign exchange rates, and changes in economic environments, conditions of competition, laws and regulations. Also, since the purpose of these materials is only to give readers a general outline of business performance, many numerical values are shown in units of a billion JPY. Because original values, which are managed in units of a million JPY, are rounded off, the totals, differences, etc. shown in these materials may appear inaccurate. If detailed figures are necessary, please refer to our financial statements and supplementary materials.

