

# Electric Power Steering Systems

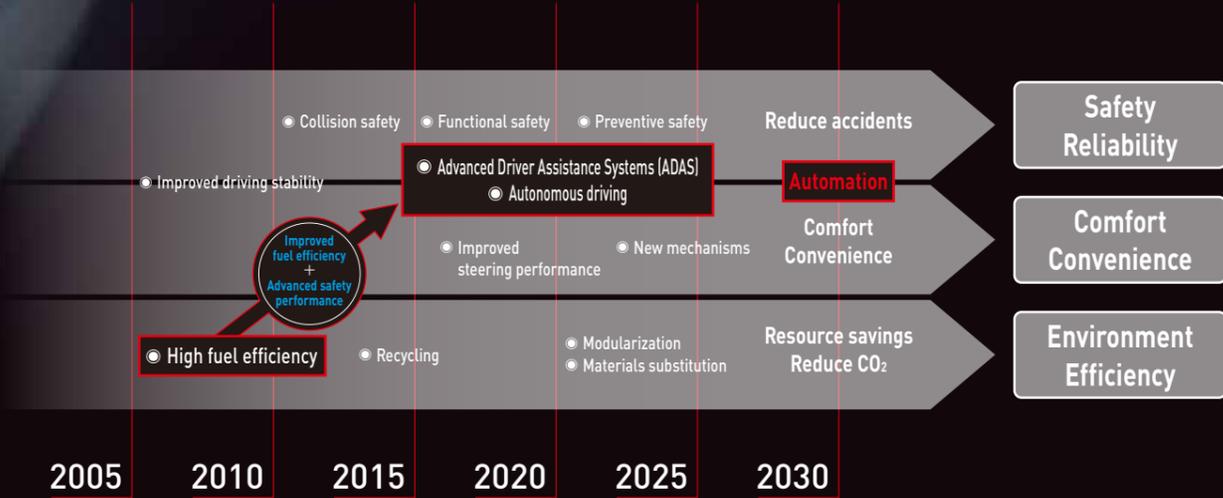




**Our goal is sensational driving experiences – JTEKT  
Offering Greater Peace of Mind with Advanced Driver Assistance Systems  
that Enable Experiencing Steering Feel**

"Driving," "Cornering" and "Stopping."  
Of the three basic vehicle performance functions, our forte is "Cornering."  
Committed to producing superior steering equipment,  
JTEKT developed the world's first electric power steering (EPS) system in 1988.  
Today, our products hold No. 1 market share around the globe.

**Electric Power Steering Systems**



# ADAS

Advanced Driver Assistance Systems

## Advancements in ADAS Technologies

In the near future, transformations will occur not in the vehicle society, but in the way we live as well

Thanks to higher computer processing capabilities and more accurate, inexpensive peripheral recognition sensors such as onboard radar and cameras, modern-day vehicles can detect the periphery and driving conditions with high precision. Accordingly, the practical application of active safety is advancing, perhaps best represented by collision avoidance braking.

Additionally, driver assistance systems openly using EPS control, such as automatic parking systems and lane departure warning / lane-keeping support systems, are contributing to the reduction of traffic accidents and the number of related fatalities. These systems are gradually becoming compulsory and are the focus of NCAP\* ratings. As a result, their widespread use is anticipated.

In regards to enhancing Advanced Driver Assistance Systems (ADAS), the potential for further advancements from the current Level 2-3 status to fully autonomous driving systems that take over driver operation may be feasible with the expansion of applicable roads predicted for the future. Such technologies will not only transform the way we drive, but also how we live as well.

\* NCAP (New Car Assessment Program)

A public vehicle collision test that involves crashing new cars and assessing the passenger safety level.

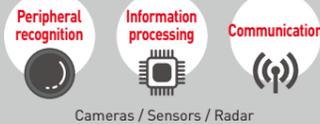
# ADAS

Advanced Driver Assistance Systems

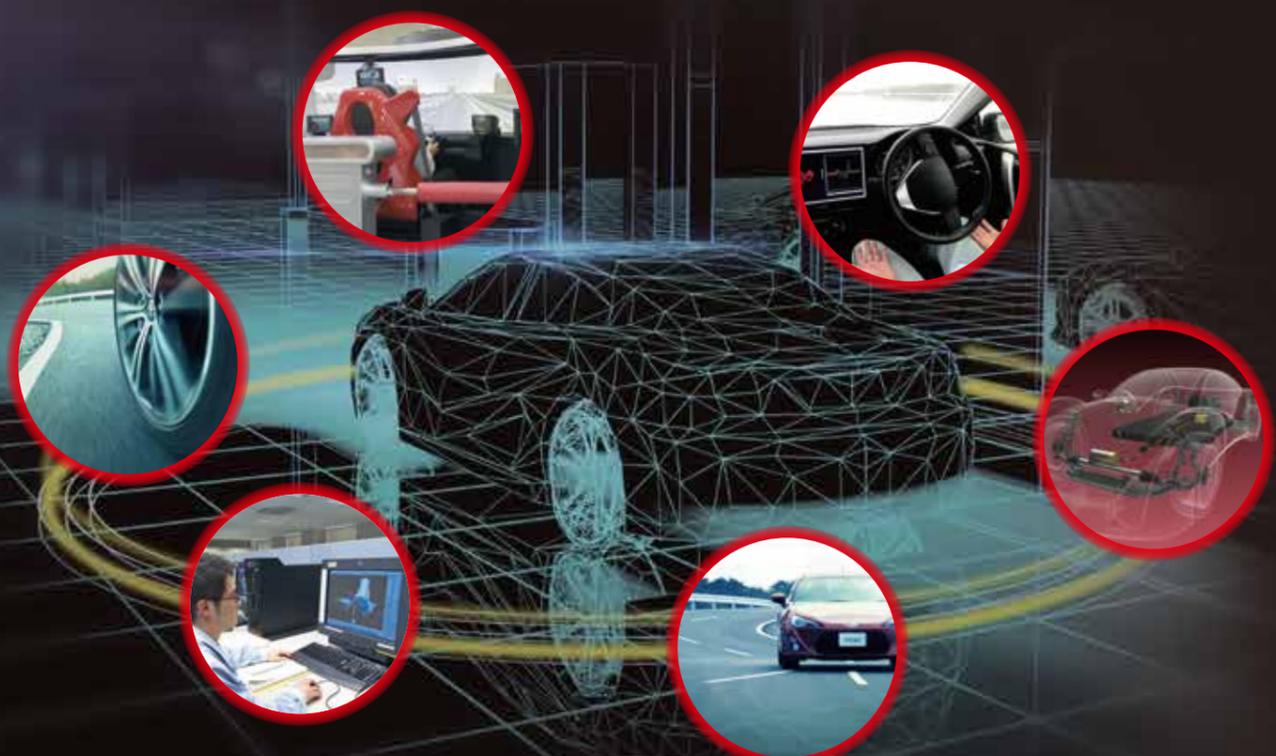


Technologies with advanced diversification / integration

Additional car functions



Three basic vehicle functions



# SBW

Steer-by-Wire

## The Evolution of Steering Systems

Autonomous driving level	Level 2	Level 3	Level 4	Level 5
	Driver's initiative		System initiative	
Driver's role (example)	Monitoring the driving environment	Reading: OK * Operation by driver when necessary	Sleeping: OK * Vehicle is controlled by system in order to minimize risk at the time of an emergency	Driver not required

Steering system	Passenger vehicle	<p>SBW</p> <p>Clutch</p> <p>Vehicle centralized ECU</p> <p>(w/clutch)</p> <p>(No-link)</p>		
	Large vehicle	<p>Steering actuator + Hydraulic power steering</p> <p>Hydraulic power source</p>		
Method to achieve autonomous driving level (JTEKT safety concept)	Software backup (JFOPS 2)	Hardware redundancy (JFOPS 3)	Complete hardware redundancy including power supply (JFOPS 4)	

JFOPS JTEKT Fail-Operational System

JTEKT concept of safety is defined from 0 to 4.

What is redundancy? By duplicating (making redundant) systems for functions required to have high reliability, safety is secured by the remaining functions even if a component of the system fails (redundant design).

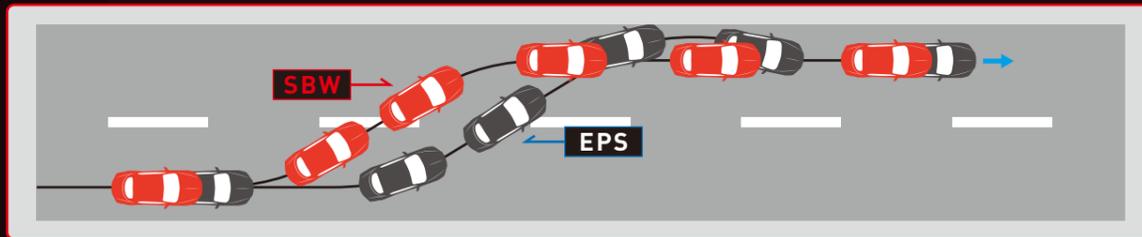
## Merits of Steer-by-Wire

### Freedom in communication between the driver and system during ADAS operation (able to freely control both steering wheel and tires)

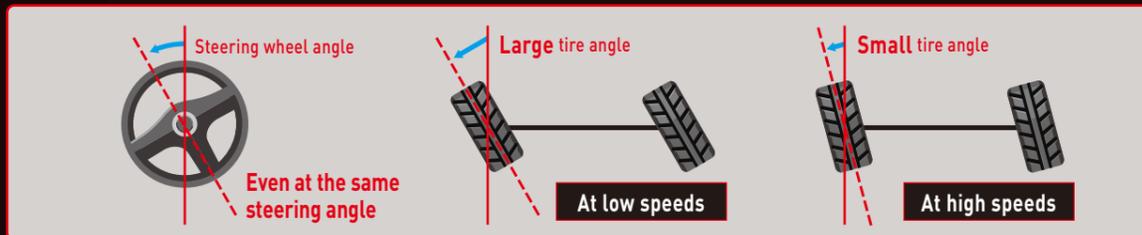
1. If collision avoidance operation is necessary, not only the steering wheel, but also the tire angle can be controlled appropriately
2. Changes in vehicle orientation are reflected in steering wheel movement, providing steering sensation

### Achieving ideal steering properties

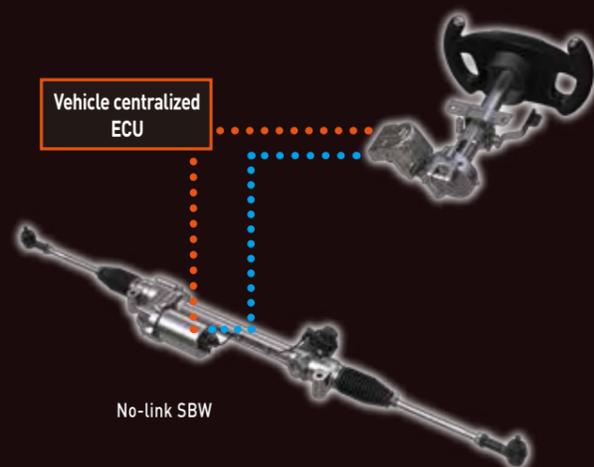
1. Improved vehicle response / traceability / stability when changing lanes



2. Improved handling at low speeds, improved driving stability at high speeds



3. Conveys the necessary information from the road surface while blocking out disturbance, thus alleviating driver fatigue



### No-link SBW enables freedom of layout and contributes to expanding the vehicle interior space

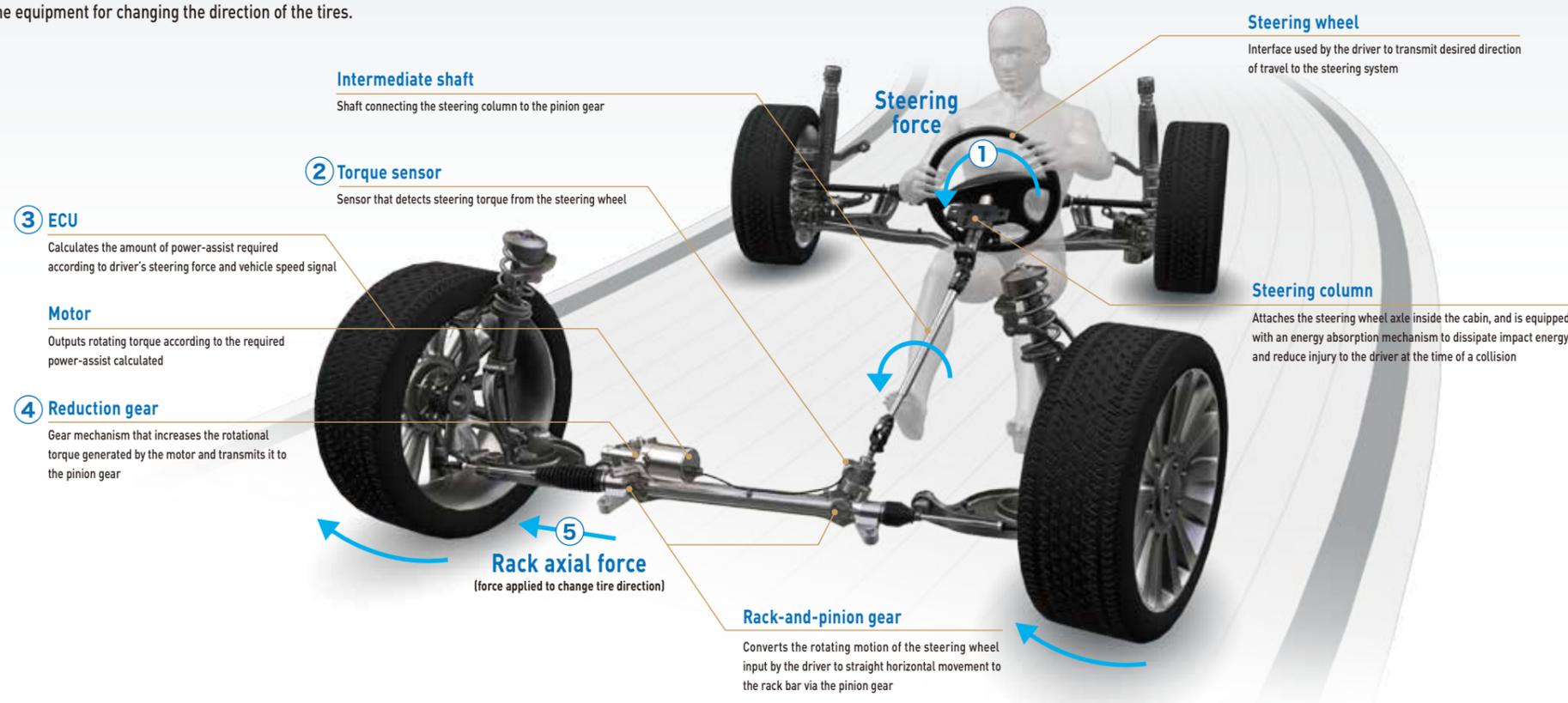
JTEKT responds to market demand as a steering system supplier supporting a safe and exciting vehicle society

# A Confident, Relaxing Driving Experience... That's what our steering systems provide

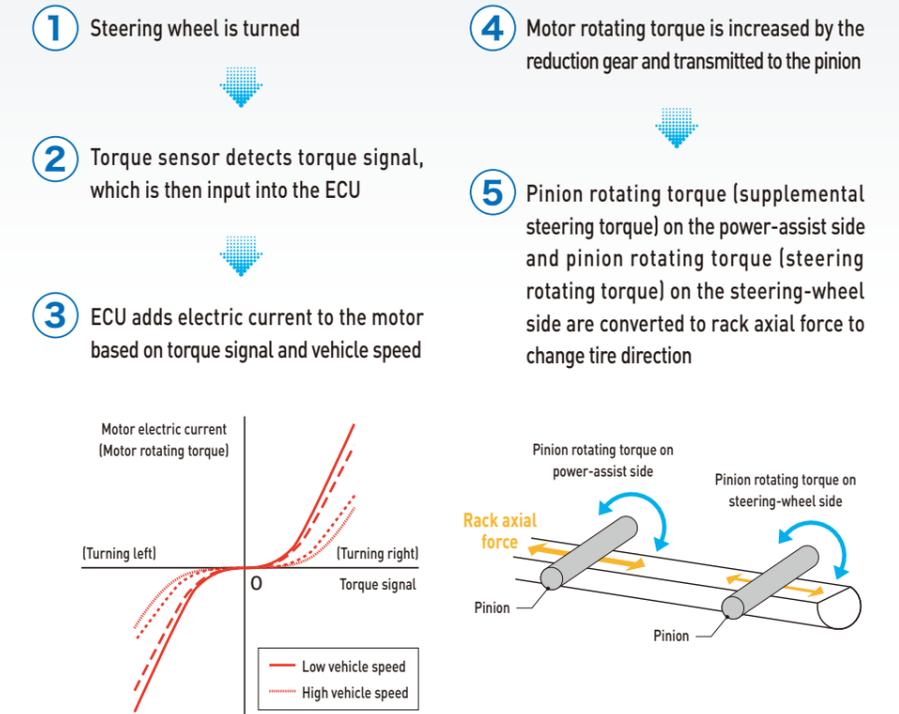
JTEKT products not only realize steering performance matching vehicle requirements (e.g., body, suspension, tires, brakes and drive-train), our steering systems act as a human-machine interface where the driver's intentions are delivered to the vehicle and supplemental / accurate information is transmitted back to the driver, making it possible for the driver to feel "happier," "safer" and "more comfortable" when driving the vehicle.

## Steering System Configuration example : DP-EPS

Definition of steering system: Components used to control (steer) the direction a vehicle is moving; in short, the equipment for changing the direction of the tires.



## Basic steering operation example : DP-EPS



## Standard System Proposal

Vehicle segment		UA/A B C D E F SUV/P-UP							
		UA/A	B	C	D	E	F	SUV/P-UP	
Steering system	Column-assist	C-EPS	Recommended			Application range			
		Rack-assist	P-EPS	Recommended			Application range		
	Rack-assist	DP-EPS	Application range			Recommended			
		RP-EPS	Application range			Recommended			
H-EPS		Application range							

JTEKT EPS systems are compatible for most automobiles, from small vehicles to large SUVs

## System Features by Type

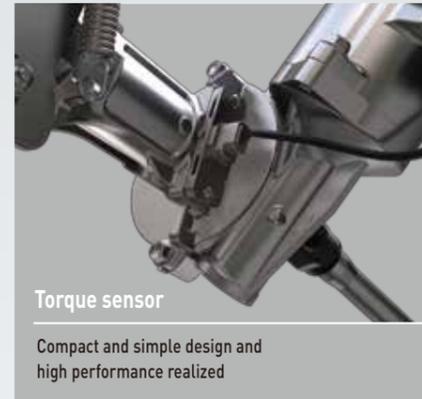
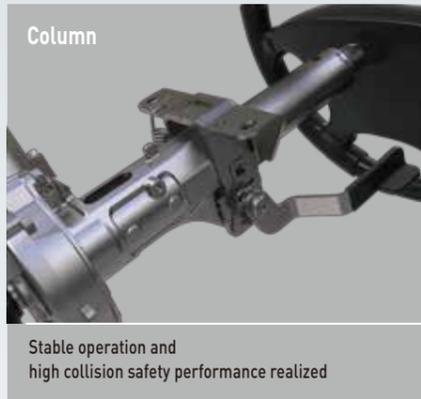
Column-assist	Rack-assist
<p>Since the motor and ECU are inside the cabin, waterproofing is not required and there is no influence on engine and transmission layout</p>	<p>Excellent steering performance as the result of minimal friction between the time of turning the steering wheel and start of rack movement</p>
<p>Optimum steering system for compact vehicles with small rack force</p>	<p>Optimum steering system for medium- to large-sized vehicles that require better steering performance</p>

# C-EPS<sup>®</sup>

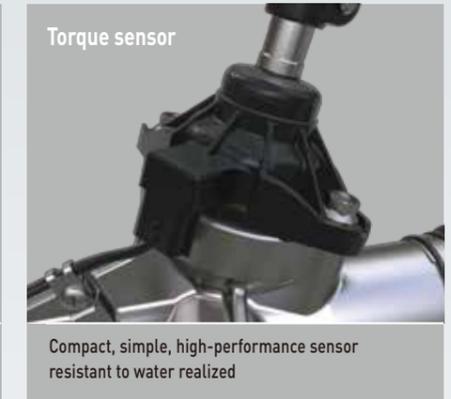
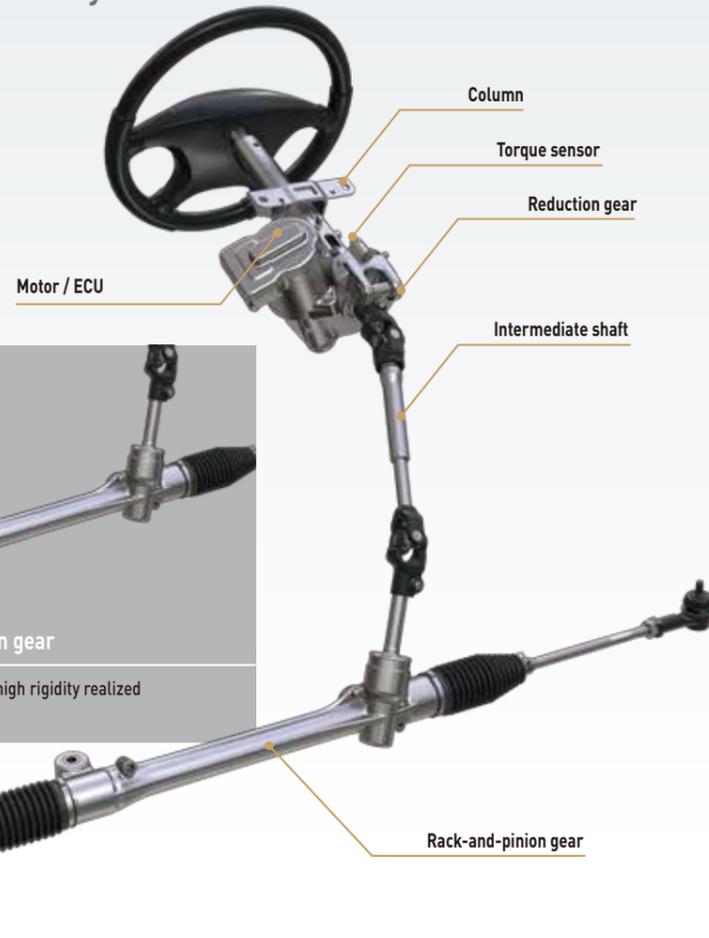
- Ideal for compact vehicles with small engine compartment: power-assist unit is located in the steering column
- Introduced as the world's first EPS in 1988
- Superior safety, comfort and environmental performance based on technologies and experience accumulated since its introduction

# DP-EPS<sup>®</sup>

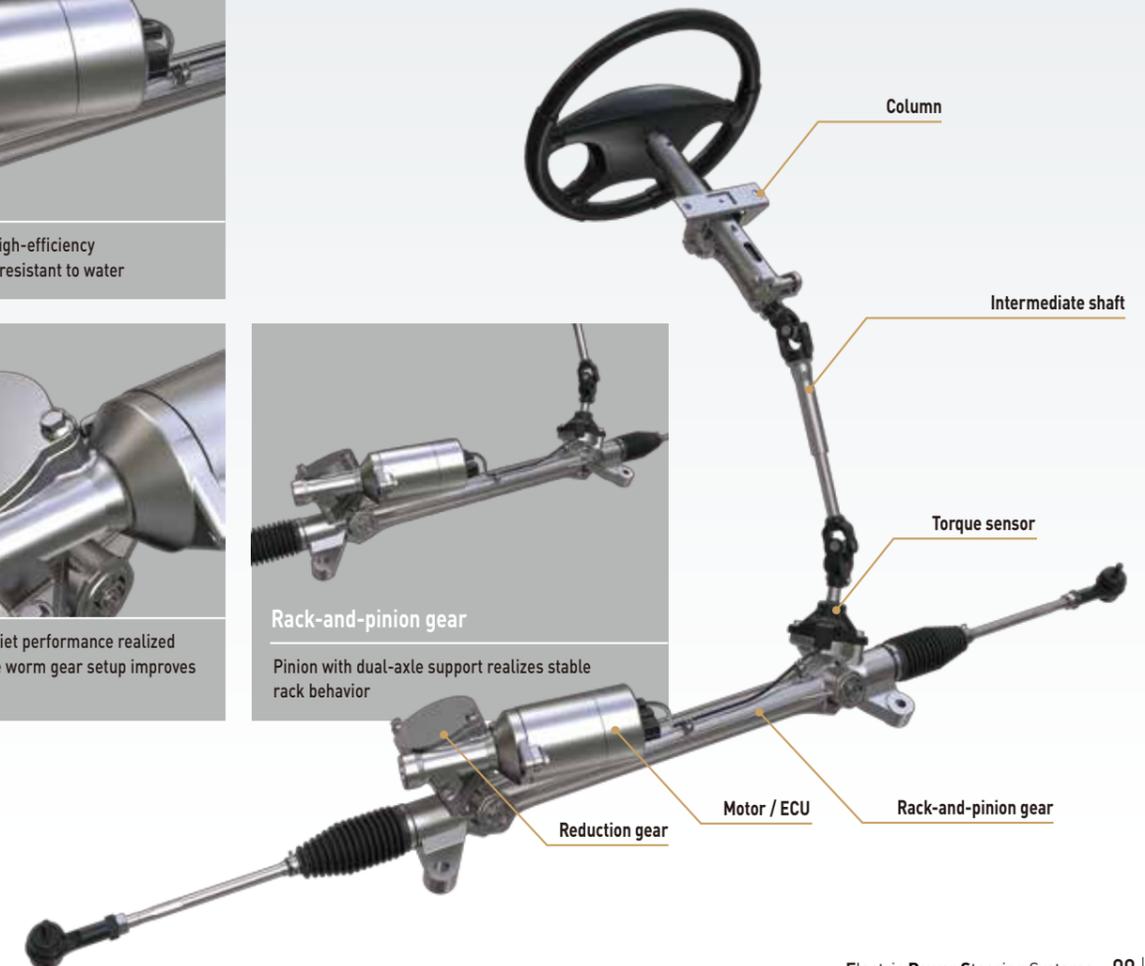
- Rack-assist realizes excellent steering feel with high rigidity and superior dynamic performance
- System structure with flexible mounting freedom realized by separating the assist unit from the steering wheel axle
- Enhanced degree of freedom in specific stroke on the steering-wheel side realized by adopting an optimal design to reinforce the assist unit
- System with excellent safety, comfort and environmental performance realized through the application of proven technologies



## C-EPS system

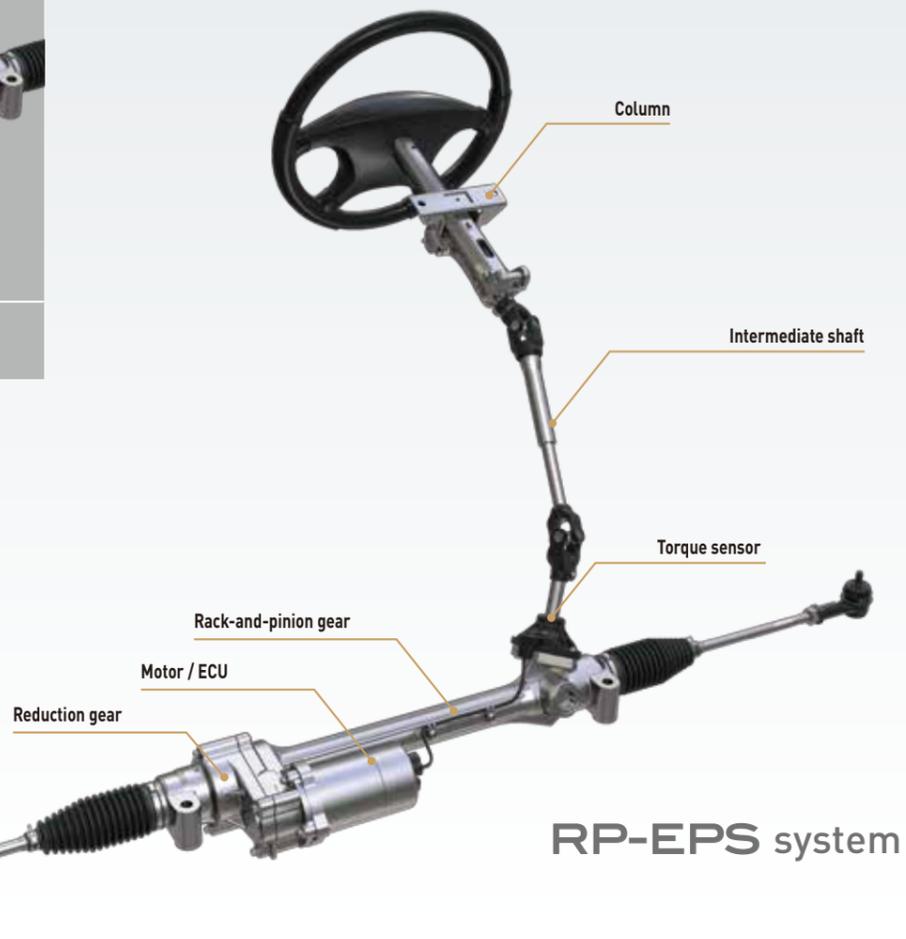
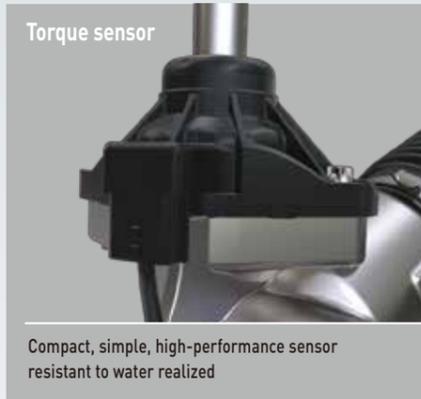


## DP-EPS system



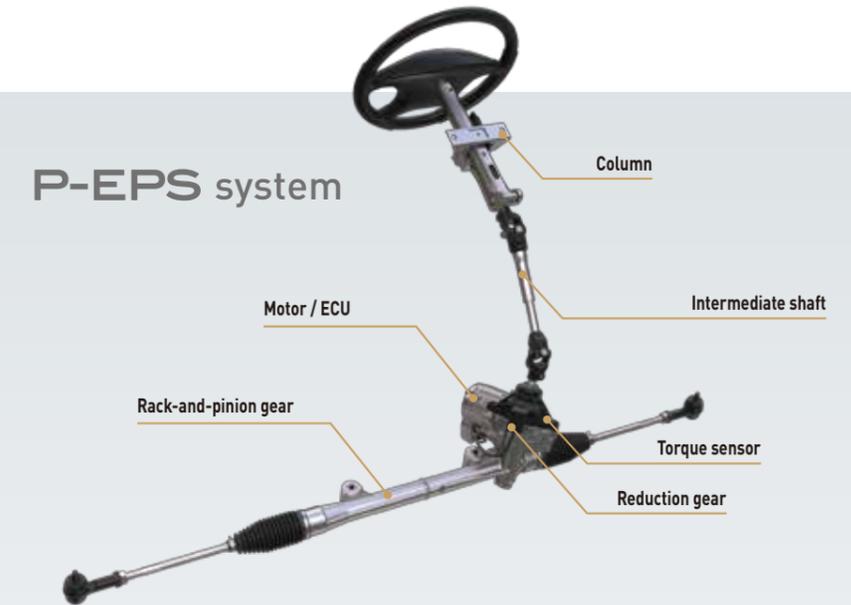
# RP-EPS®

- Rack-assist realizes excellent steering feel with high rigidity and superior dynamic performance
- Easier installation realized with adoption of high-output, compact reduction gear
- System with excellent safety, comfort and environmental performance realized through the application of proven technologies



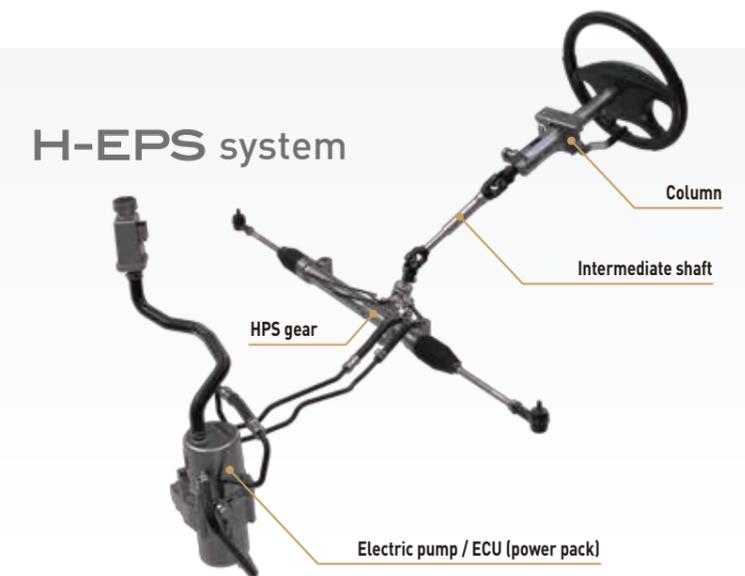
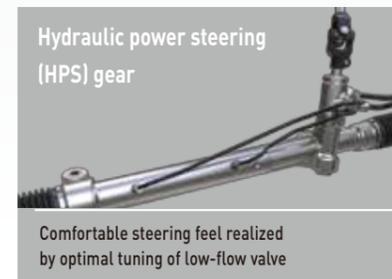
# P-EPS®

- Small / compact system adopted in response the engine room environment
- System with excellent safety, comfort and environmental performance realized through the application of proven technologies

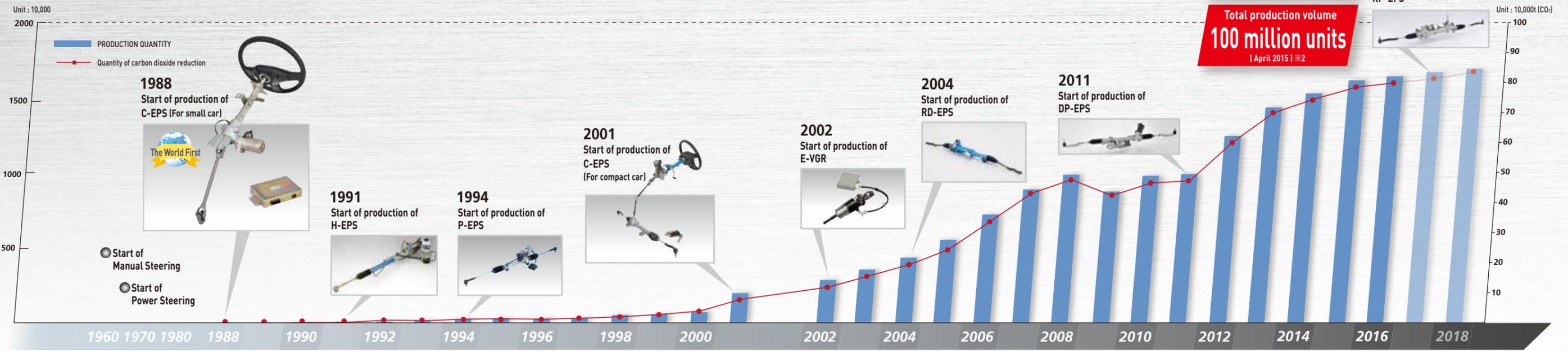


# H-EPS®

- Excellent safety, comfort and environmental performance realized using an energy-saving hydraulic power steering system equipped with an electric pump
- Extremely flexible installation and ability to use for EV driving realized by adopting an independent electric pump
- Excellent steering feel and improved fuel efficiency realized through optimum discharge setting (MAP) and special valve tuning

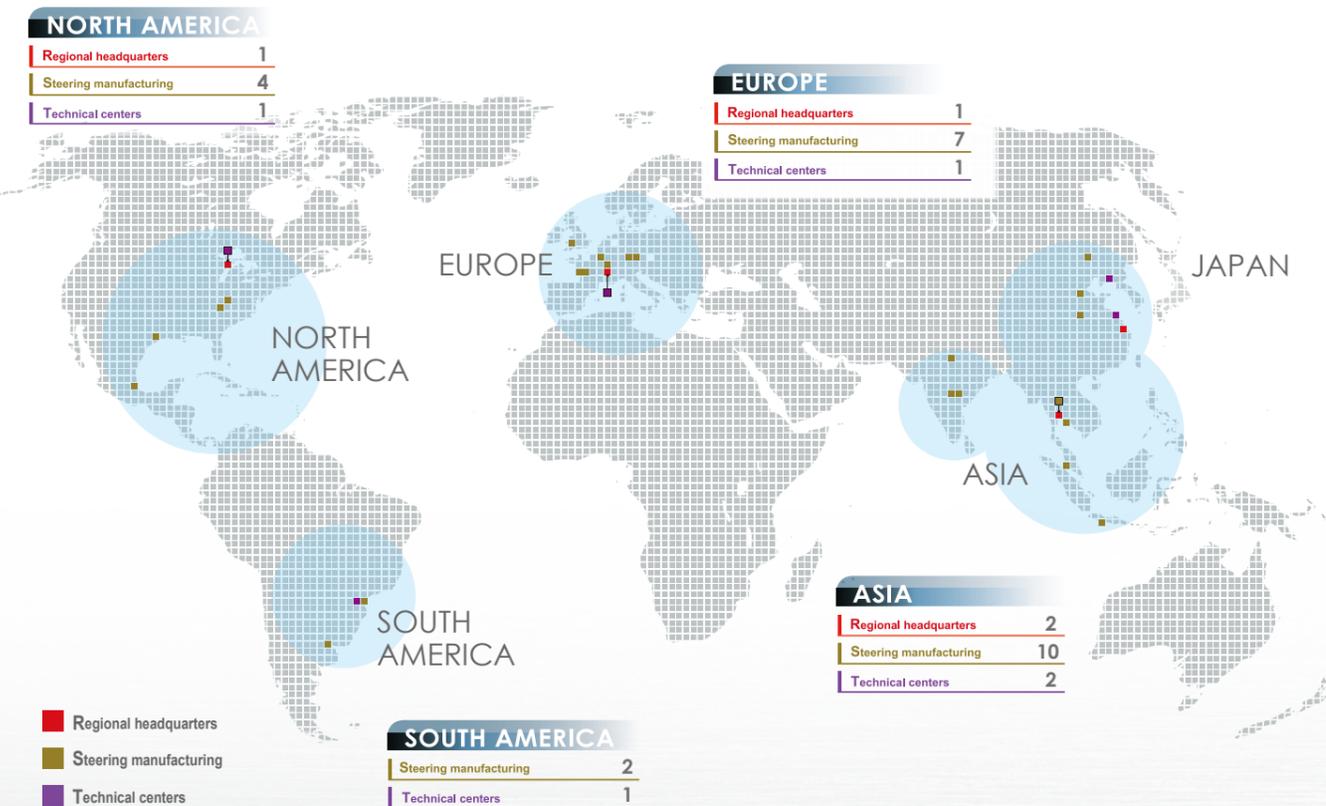


# One out of every three vehicles in the world is equipped with JTEKT electric power steering (EPS)



## Safer, More Reliable Power Steering Systems to Customers Worldwide

### GLOBAL NETWORK



## Advanced Research & Development Facilities for Producing Next-generation EPS Systems

JTEKT R&D centers exchange information around the world, enabling the company to accurately understand market demand and provide the newest / best / optimal systems to meet the diversified needs of our customers.



## Proving Ground Enables Testing / Evaluations Simulating Roads Worldwide

Fully utilizing our knowledge as a world-leading systems supplier, JTEKT conducts driving evaluations and analyses of products installed in vehicles. We exhaustively pursue the highest standards in product safety and operation on a test course capable of simulating various road and weather conditions around the world. As a total systems supplier, our highest value is to provide our customers with products that deliver outstanding performance and the best quality that help to make automobiles that are more than just fun to drive.



Proving Ground	Site area	Course area	Combined circuit length	Dynamics pad area	Facilities
Iga Proving Ground	500,000m <sup>2</sup>	170,000m <sup>2</sup>	2,200m	54,000m <sup>2</sup>	Straight-line track, Winding track, Fording track, Dynamics pad, Noise evaluation track
Iry JTEKT European Proving Ground	125,000m <sup>2</sup>	59,000m <sup>2</sup>	-	43,000m <sup>2</sup>	Straight-line track, Dynamics pad, Low friction track, Noise and vibration evaluation track



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