

# TECHNOLOGY INVESTMENT: STAYING THE COURSE

- A sustained commitment to research has led to an ever-growing portfolio of DENSO products
- The innovative reapplication of core technologies in new ways and in new fields has been the catalyst for DENSO's growth

## EXPERTISE IN ALL KEY AUTOMOTIVE FIELDS

Since DENSO was founded, the emerging needs of automakers, society and car users have consistently guided our decisions on investment and research into new technologies. These decisions have resulted in an independent knowledge base in all the key automotive technology fields, allowing us to rapidly respond to shifts in any area of the industry.

Enduring relationships with automakers and DENSO's foresight have played a vital role in our ability to respond to future market needs. Joint research and product development programs with automakers have also spawned a raft of groundbreaking products—from advanced engine management systems to cutting-edge components for hybrid electric vehicles (HEVs).

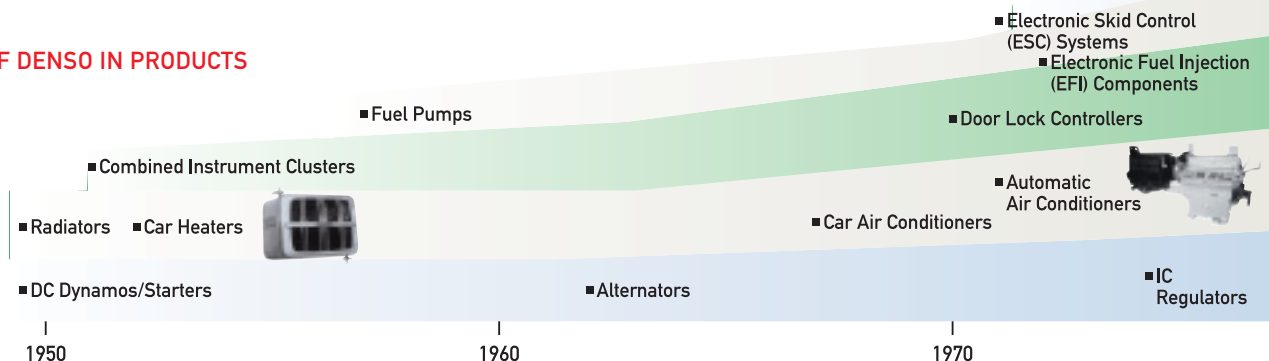
Underpinned by our bold management decisions, we have channeled our resources into three main areas that anticipated emerging needs: climate control technology, automotive electronics, and communications technology. Beyond paying dividends in the form of new technologies or products, our sustained and long-term commitment to research in these areas has directly led to new business opportunities and products in related fields. We believe our strength across these core technological areas represents a clear DENSO difference that our rivals find hard to emulate.

### A KEY REVENUE STREAM:

#### CLIMATE CONTROL TECHNOLOGY

DENSO's current strength in car air conditioning products was born out of heat exchange technology used in early car radiator components. In the 1950s, when household air conditioners were still a luxury, the market for car air conditioners was given scant attention by automotive component suppliers and automakers alike.

## THE HISTORY OF DENSO IN PRODUCTS



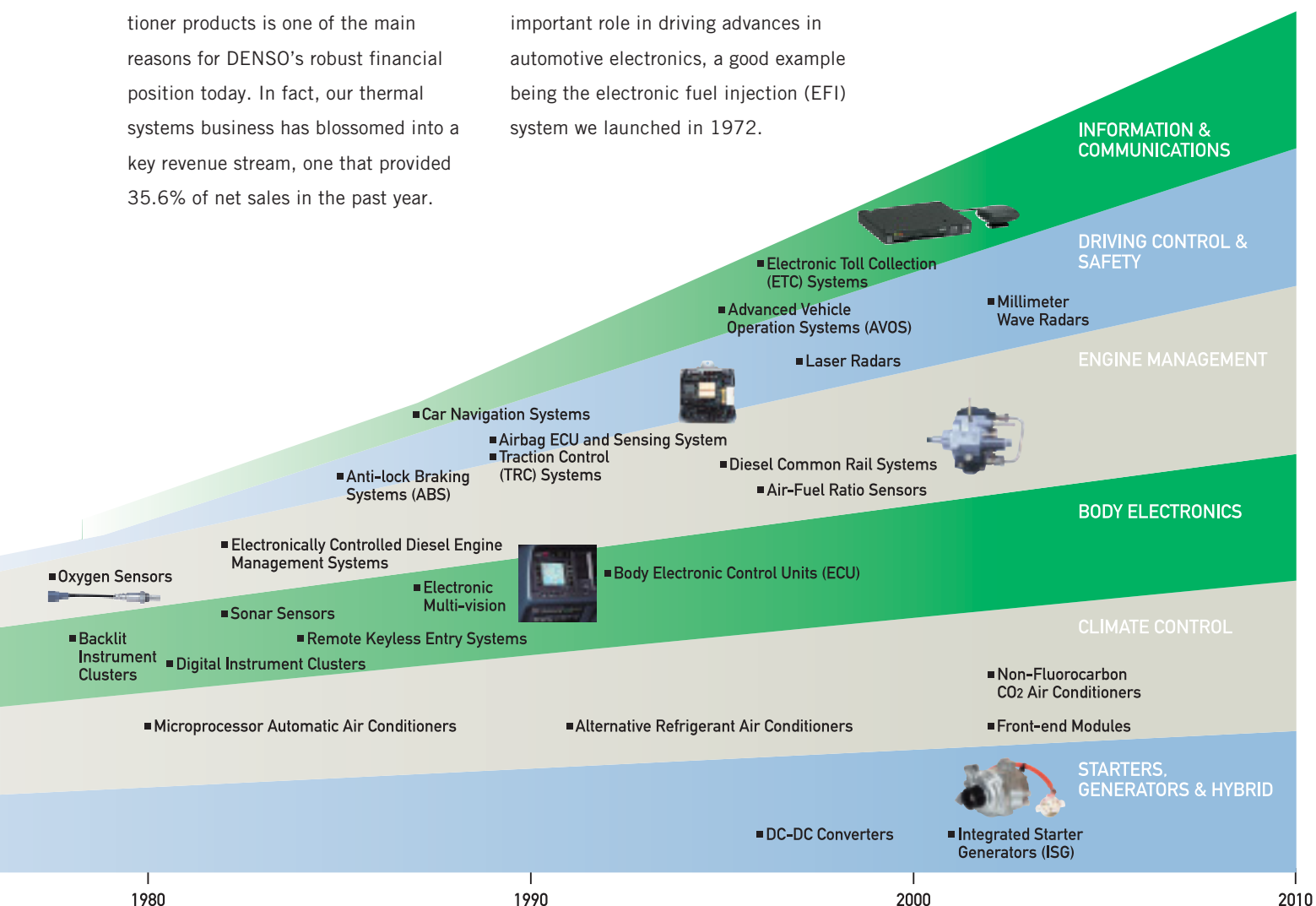
DENSO, however, made a conscious decision early on to start an independent development program, based on the belief that air conditioners would soon become an indispensable option in cars. This move has been vindicated: as times have changed, consumers have wanted more from the automobile than just a means of getting around, with growing demands for better safety and improved cabin comfort. Thanks to our climate control technology, passengers and drivers now enjoy more in-car comfort, while the success of our car air conditioner products is one of the main reasons for DENSO's robust financial position today. In fact, our thermal systems business has blossomed into a key revenue stream, one that provided 35.6% of net sales in the past year.

**THE CATALYST FOR CHANGE:**

**AUTOMOTIVE ELECTRONICS**

At DENSO, we realized early on that electronics would be fundamental to the future of the automobile, prompting us to establish an IC Research Laboratory in 1968. This step allowed us to take a pioneering lead in the development of automotive electronics. More than three decades of work in this field has resulted in semiconductors becoming one of our core technologies, and has directly led to a raft of groundbreaking products. These products have subsequently played an important role in driving advances in automotive electronics, a good example being the electronic fuel injection (EFI) system we launched in 1972.

This groundbreaking success was the starting point for the development of a range of engine management-related products that control the whole powertrain process, from air induction through combustion and exhaust. These products showcase how we applied our expertise in automotive electronics to respond to stricter emissions regulations and calls for more efficient engines.



## DATA COMMUNICATIONS MODULE



Our know-how in automotive electronics has also been harnessed and applied to climate control components, helping to improve cabin comfort. We achieved a major leap forward in this area in 1971, with the launch of an air conditioning system that automatically controlled cabin temperature in accordance with manual switch instructions—something we take for granted today, but a pioneering development at the time. This system was one of the first steps in an ongoing R&D program that led most recently to the development of a four-seat independent air conditioning system in 2002. Without a doubt, our dominant position in car electronics has been founded on this kind of relentless development and innovation.

### ***TRANSFORMING THE CAR ITSELF: COMMUNICATIONS TECHNOLOGY***

DENSO entered the communications field at the same time it moved into automotive electronics. Initial research focused on developing radio technology to create communications systems

specifically designed for the car. Results were soon in coming with the launch of our first car transceiver in 1973. And in 1985, following the deregulation of the telecommunications industry in Japan, we used this knowledge to begin the development of car and mobile phones. This investment gave us the technology and expertise to become a player in the nascent market for intelligent transport systems (ITS) and telematics products. During the past year, our efforts in this area have culminated in the launch of a data communications module for Toyota's G-BOOK telematics system, which offers users high-speed seamless Internet connectivity while on the move. With this kind of product, DENSO is driving the pace of change in the industry as the car increasingly becomes a mobile terminal integrated into information networks.

DENSO was also among the first in the industry to start development of car navigation systems in the 1980s, achieving a pioneering success in 1987 with the launch of a car navigation system using digitized map data stored in on-board CD-ROMs. Car navigation systems are rapidly becoming highly advanced information and communication terminals offering a range of new services for car users. Not surprisingly, DENSO is at the forefront of this revolution too.

## FUSING DENSO TECHNOLOGIES IN INNOVATIVE WAYS

DENSO has grown in tandem with its technological capabilities. This is no coincidence—the innovative reapplication of core technologies in new ways and in new fields has been the catalyst for our growth. Now, as the pace of change in our business environment accelerates and product categories merge at an even faster speed, DENSO is being asked to raise its game to new heights to create the kind of groundbreaking products that society and automakers need. We believe that fusing core technologies in exciting new ways is the key to our future growth. Here we outline just two examples:

### ***ENGINE/AIR CONDITIONER PARALLEL CONTROL***

One example of how we are merging core technologies is a new air conditioner compressor launched in 2001. Until the launch of this component, compressors had been designed to shut down briefly during acceleration to reduce the load on the engine. This eliminated any drag on engine performance, but it also meant the air conditioner stopped functioning

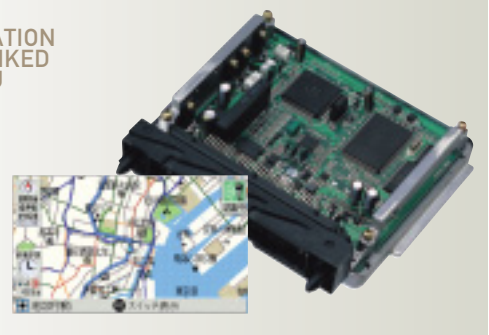
for a time, leading to deterioration in cabin comfort. DENSO's latest compressor solves this problem—compressor drive torque is more carefully controlled to match car speed without requiring a total shutdown. This ensures the air conditioner keeps running and optimum cabin comfort is maintained. Only our depth of expertise in both climate control technology and engine management systems in automotive electronics made this proprietary innovation possible.

### ***CAR NAVIGATION SYSTEM-LINKED ENGINE ECU***

Another example is an engine electronic control unit (ECU) that uses information gleaned from car navigation systems to make appropriate adjustments to the

car's gears when road conditions change; braking into a corner for instance. This brings enhancements to both drivability and safety. At DENSO though, we believe this represents only the first step in the evolution of car navigation systems and their combination with other automotive systems. In fact, we are currently developing products that channel car navigation system data into safety and air conditioning systems to improve protection, drivability and comfort for car users. One example is a control unit for a new adaptive front lighting system (AFS). This system monitors steering angle and vehicle speed while turning and redirect headlamps individually, thereby ensuring a full, well-lit view for safer driving at night while cornering. By linking the AFS control unit to the navigation system, the control unit will make highly accurate headlight adjustments in anticipation of road conditions ahead.

CAR NAVIGATION SYSTEM-LINKED ENGINE ECU



AIR CONDITIONER COMPRESSOR WITH PARALLEL CONTROL FUNCTIONS

