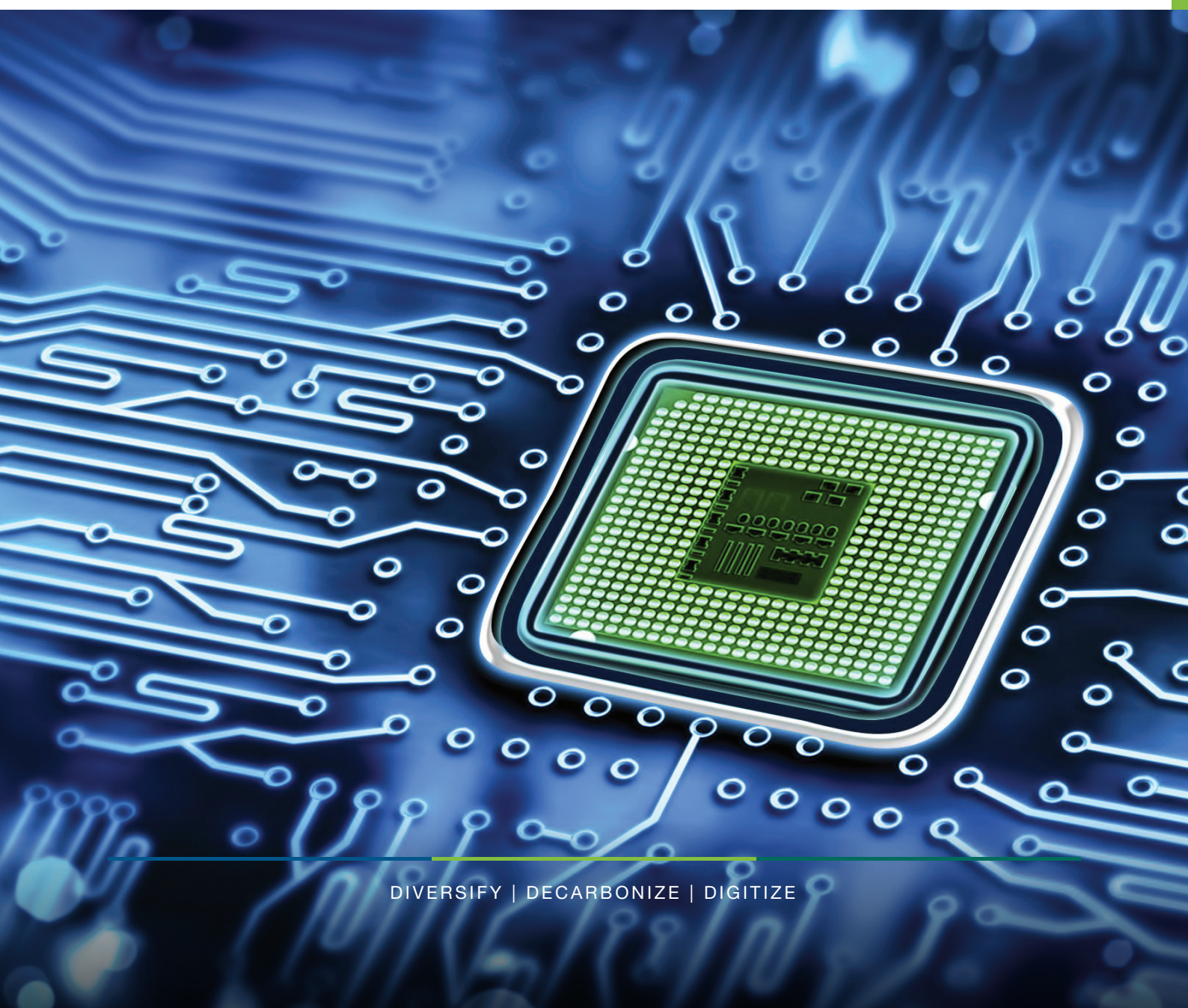
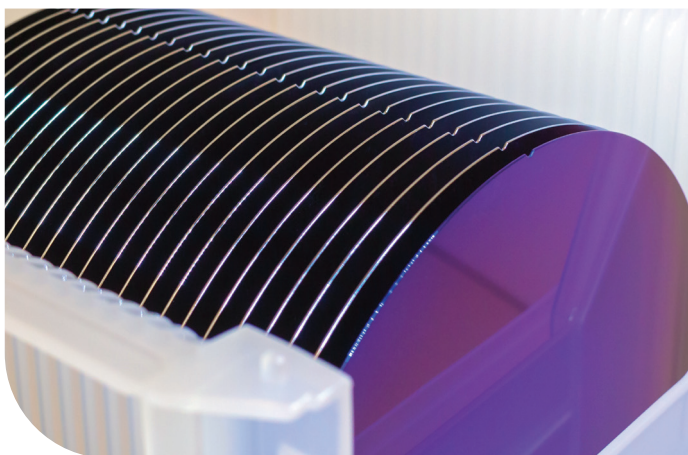


Atomac™ AtoStar™ Lined Valves Support the Drive to Digitization

Delivering ultra-pure process quality
for superior semiconductors



Atomac AtoStar lined valves help to maintain semiconductor quality in drive to digitization



Semiconductor manufacturing is booming because computer chips are the essential components in integrated circuits for a new era of smart consumer products and industrial equipment.

Everything from phones and home appliances to electric cars depends on semiconductors. So does the continued success of global corporations across industries. Many organizations are optimizing operations by connecting equipment with internet of things (IoT) sensors and controls through digital networks to cloud-based systems. The combined technologies monitor processes, analyze historical and real-time data, and predict changing conditions.

Semiconductors don't just make these digitization initiatives possible. They're what create opportunities for companies to significantly enhance efficiency and increase productivity and profitability.

Ensuring that semiconductors function with high reliability requires a level of quality control (QC) throughout the value chain that's unmatched in other process industries.

Semiconductors are extremely thin layers of silicone built under ultra-clean conditions. That's why the makers of semiconductors — and the chemical companies that supply their raw materials — rely on flow control solutions that enable them to meet the highest purity requirements.

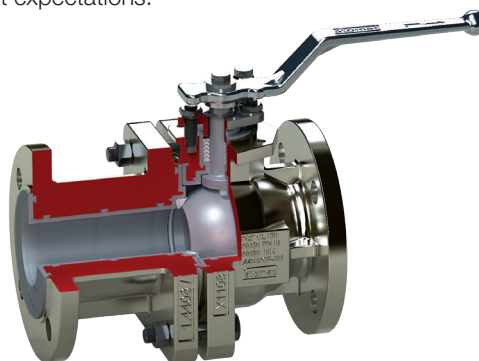
Proven valves for advanced manufacturing

And that's why successful companies count on Atomac AtoStar lined ball and check valves from Flowserve to control the flow of chemicals used to clean and etch semiconductor components. These valves also are used to manufacture and transport the chemicals used to make these components.

Atomac AtoStar valves are lined with perfluoroalkoxy (PFA) copolymer resin, which is impervious to virtually all chemicals and solvents.

With Flowserve as your partner, semiconductor manufacturers, their chemical suppliers and the original equipment manufacturers (OEMs) of chemical tanks and tank trucks can be assured that no impurities enter process fluids from the Atomac AtoStar ball valves. Likewise, the PFA coating of all the internal valve components and surfaces prevents chemical interaction that could corrode the valve body material and release contaminants from the base material into the process fluid.

And, as semiconductor companies race to expand existing plant capacity and construct new manufacturing facilities, Flowserve can help them and their chemical suppliers to complete projects on time with valve lead times that meet market expectations.



Atomac AtoStar PFA-lined stainless steel ball valves meet the purity standards required in semiconductor manufacturing, as well as the manufacturing and transportation of the chemicals used by the semiconductor industry.

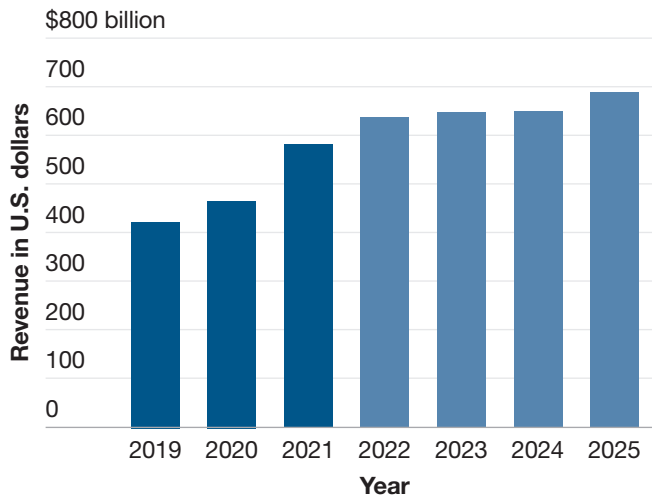
The global semiconductor boom

Global semiconductor sales reached \$500 billion in 2021 — a 25% increase over the previous year. That’s also an industry record for total sales and units shipped.ⁱ And there’s more growth to come.

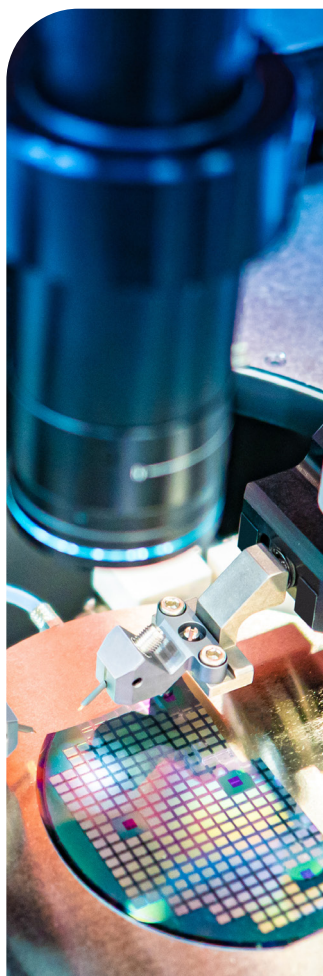
Semiconductor sales are projected to reach \$692.5 billion by 2025 and go as high as \$1 trillion.ⁱⁱ That’s bigger than the global fast-food industry.ⁱⁱⁱ

Semiconductors are critical to equipment and systems that digitize processes to enhance efficiency and minimize energy consumption and costs. As companies focus on their energy transition initiatives to switch to cleaner and renewable power sources and shrink their carbon footprints, they will continue to drive demand for faster and more capable semiconductors.

Global semiconductor industry revenue



Note: 2022 and beyond are forecasts.
Source: Gartner



Driving semiconductor growth: Adoption of smart devices

Semiconductors are highly valued, so manufacturing facilities must be built quickly along with the chemical supply chain to support them.

Gartner estimates that chip industry optimism drove record levels of capital expenditures of at least \$146 billion in 2021. That’s more than double the industry spending five years prior.^{iv}

Capital investment from the three largest semiconductor manufacturers will exceed \$200 billion from 2021 to 2023;^v governments have committed hundreds of billions of dollars more.

Chipmakers substantially ramped up production to meet high demand for consumer products. Adoption of 5G smartphone and IoT devices capable of connecting to the fastest networks available is a major driver of semiconductor demand. So is the continued strength of the worldwide personal computer market and the rapid shift of business computing to cloud services housed in large-scale data centers.

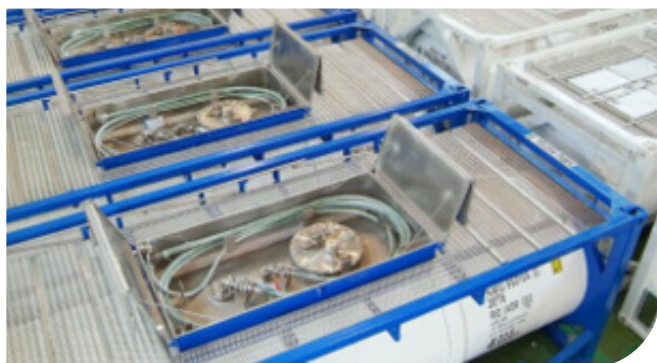
New demand also comes from the automotive sector in addition to the influx of IoT devices for businesses and industries.

Some of the new semiconductor plants will be located in traditional manufacturing clusters in Asia and the Pacific region. However, they more often than not will be built in the United States, Israel and Europe — a deliberate localization effort to increase chip production closer to the next step in the supply chain.^{vi} For example, the CHIPS for America Act for fiscal year 2021 authorized \$52 billion to support the expansion of semiconductor manufacturing in the United States.

Flow control for semiconductor processes

Semiconductors are created by fabricating thin, round silicon wafers 154 to 305 mm (6 to 12 in.) in diameter. Finished wafers are about 15 mil (0.012 in.) thick. The latest advanced processes at the core of nanometer semiconductor manufacturing are ideal applications for our Atomac lined ball and check valves:

- **Cleaning** — Isopropyl alcohol (IPA) is commonly used in a variety of cleaning processes, including drying. Hydrogen peroxide (H₂O₂) plus hydrochloric acid (HCL) or sulfuric acid (H₂SO₄) are used for metal cleaning after various fabrication steps to remove leftover particles and trace contaminants that can interfere with the electrical circuits.
- **Etching** — Hydrofluoric (HF) acid and phosphoric acid (H₃PO₄) are used for etching oxide and nitride silicon.
- **Transportation and storage** — All of these liquid chemicals are shipped from suppliers to semiconductor fabrication facilities in tank trucks; they're then unloaded and stored in on-site tanks until needed.



To maintain purity, chemicals used in semiconductor manufacturing are often transported in specially designed tanks like this one, which includes Atomac AtoStar lined valves.

Ultra-pure standards compliance

Strict quality standards for semiconductors limit manufacturing contaminants; allowable amounts are so small that they're measured in parts per billion or parts per trillion. If the acids and solvents fail to meet requirements, the chip manufacturers' production volumes can be significantly reduced and costs can escalate. Chips can fail to meet performance requirements, too.

Enabling the semiconductor companies and their chemical suppliers to meet the standards calls for inner components and surfaces of Flowserve Atomac AtoStar valves to be absolutely

smooth, without any scratches or impurities, in order to prevent contaminants from entering the process chemicals.

Chemically inert lining

Flowserve Atomac AtoStar lined valves have supported the process industry for decades. Each Atomac AtoStar valve from Flowserve is lined with PFA resin, which neither reacts with the process chemicals nor allows the chemicals to interact with the metallic construction materials. PFA withstands high temperatures, and its frictionless qualities enable improved flow. This design meets the following unique requirements for semiconductor manufacturing processes, which typically are conducted in clean rooms:

- No lining burrs on the flow path
- No unevenness on the sealing surface
- No contamination or discoloration
- No cleaning or assembly of the valve with oil or grease

Atomac AtoStar lined ball valves

Atomac AtoStar lined ball valves are ideal for the highly corrosive, ultra-pure conditions required for semiconductor fabrication as well as the manufacturing of chemicals used therein.

Models

AS1

- DIN face-to-face and flanges
- Two-piece, full-port design
- ANSI B16:5

AS2

- ANSI long face-to-face and flanges
- Two-piece, full-port design
- ANSI B16:5

AS3

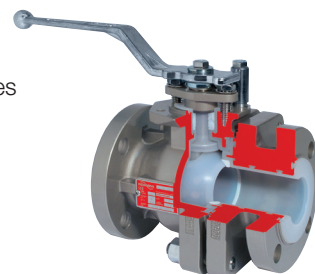
- ANSI short face-to-face and flanges
- Two-piece, reduced-port design
- ANSI B16:10

AS4

- ANSI short face-to-face and JIS flanges

AS5

- Japanese face-to-face and JIS flanges



Atomac AtoStar lined ball valves are available in five configurations. The Atomac AtoStar AS1 valve is shown (above).

Additional lined valves to support semiconductor manufacturing

In addition to Atomac AtoStar lined ball valves, Flowserve offers other lined valves available with ductile iron or stainless steel bodies to suit application requirements.

Durco® BTV-2000 lined butterfly valves



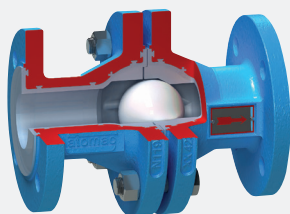
Durco BTV-2000 lined butterfly valves are ideal for highly corrosive applications.

With their triple-stem seal, Durco BTV-2000 lined butterfly valves provide reliable, leak-free service in a wide range of corrosive chemical applications. A compression spring keeps the dynamic pre-load force constant while energizing the various components of the triple-shaft seal design.

Conforming to ASME and available to DIN PN10 and PN16 requirements, they are available in lug (BTL), wafer (BTW) and long pattern (BTV-LP) designs. PTFE liners with PFA discs may be specified to 177°C (350°F).

Atomac ARV2 lined ball check valves

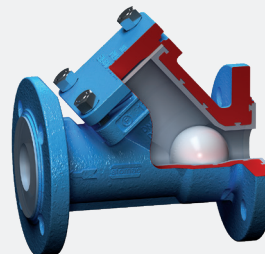
In highly corrosive applications, Atomac ARV2 lined check valves are a cost-effective alternative to swing check valves made from exotic alloys.



Fully PFA-lined Atomac ARV2 swing check valves are ideal for use in highly corrosive processes and can replace swing check valves made from exotic alloys due to the universal chemical resistance of the fluoropolymer lining.

These valves can be used in horizontal and vertical installations due to the special design of the hinge pin, which enables the disc to achieve a seal without support of any system pressure.

Atomac ARL lined 45° ball check valves

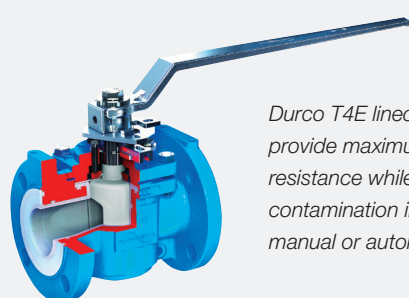


Atomac ARL lined ball check valves feature a solid PTFE ball and a full port design that minimizes pressure loss.

Atomac ARL ball check valves can be installed either vertically or horizontally and offer an unobstructed flow due to the fact that the ball is pushed into the 45° cavity.

They can handle moderate turbulence without liner damage and are ideal for horizontal pipe installations with low flow and back pressures.

Durco T4E lined plug valves



Durco T4E lined plug valves provide maximum corrosion resistance while eliminating product contamination in a cost-effective manual or automated package.

Durco T4E lined plug valves provide maximum corrosion resistance and prevent product contamination at a reasonable cost. This valve is designed for ANSI Class 150 and 300 as well as DIN Class PN16 and a maximum temperature of 204°C (399°F). A large sealing surface guarantees a bubble-tight shutoff.

A secondary dynamic self-adjusting, self-energized PFA reverse-lip diaphragm prevents stem leakage.

Leverage an expert partner to make your world better

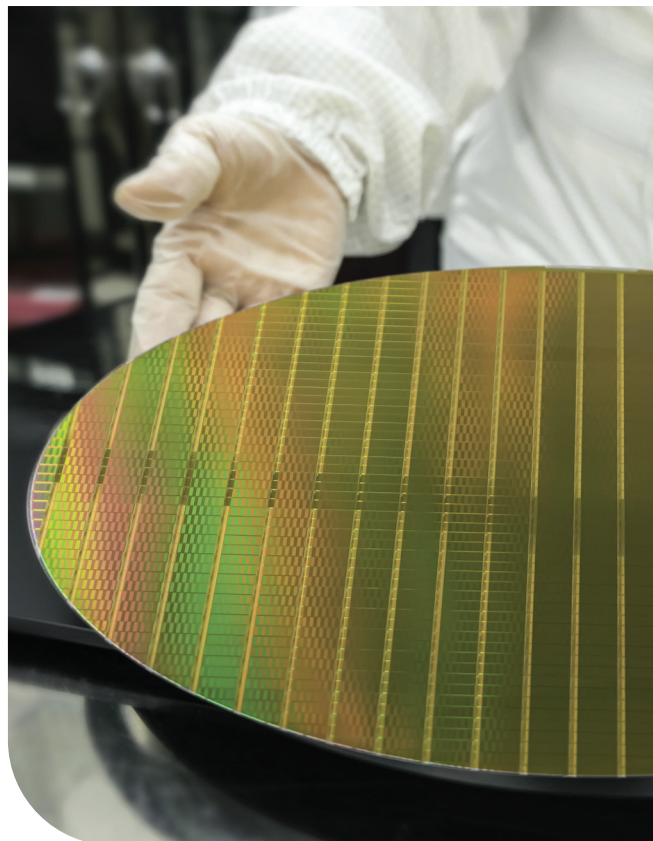
Semiconductors are the building blocks for today's popular consumer electronics devices. But they also form the foundation upon which companies are building the advanced systems they need to successfully complete their energy transition and digital transformation initiatives.

Flowserve is the ideal partner to help your organization maximize energy efficiency and minimize or eliminate greenhouse gas emissions that contribute to climate change. We also are uniquely capable of enabling your semiconductor manufacturing company and chemical supply company to keep ahead of the ever-increasing chip demand.

And, as more products and systems are digitized, Flowserve can provide the right flow control equipment to meet your timelines for projects to expand existing semiconductor fabrication plants or construct new chip foundries.

Throughout our history of more than 220 years, Flowserve has leveraged unmatched flow control expertise and global resources to support customers across industries during periods of significant change and growth. Today, we are decarbonizing, digitizing and diversifying our own operations and products to make the world better for everyone.

And, for semiconductor companies and their chemical suppliers, that means we're ready with extraordinary solutions that can make your world better, too.



- i Semiconductor Industry Association, "Global Semiconductor Sales Increase 23.5% Year-to-Year in November," January 3, 2022, <https://www.semiconductors.org/global-semiconductor-sales-increase-23-5-year-to-year-in-november-industry-establishes-annual-record-for-number-of-semiconductors-sold> (accessed January 28, 2022).
- ii Gartner, "Gartner Says Worldwide Semiconductor Revenue Grew 25.1% in 2021, Exceeding \$500 Billion For the First Time," January 19, 2022, <https://www.gartner.com/en/newsroom/press-releases/2022-01-19-gartner-says-worldwide-semiconductor-revenue-grew-25-point-one-percent-in-2021-exceeding-500-billion-for-the-first-time> (accessed January 28, 2022).
- iii Gartner, "Gartner Says Worldwide Semiconductor Revenue Grew 25.1% in 2021, Exceeding \$500 Billion For the First Time," January 19, 2022, <https://www.gartner.com/en/newsroom/press-releases/2022-01-19-gartner-says-worldwide-semiconductor-revenue-grew-25-point-one-percent-in-2021-exceeding-500-billion-for-the-first-time> (accessed January 28, 2022).
- iv Jiyoung Sohn and Meghan Bobrowsky, "For Chip Industry, Global Supply Crunch Pushes Next Target to \$1 Trillion," Wall Street Journal, January 30, 2022, <https://www.wsj.com/articles/for-chip-industry-global-supply-crunch-pushes-next-target-to-1-trillion-11643544005> (accessed February 1, 2022).
- v Deloitte, "2022 semiconductor industry outlook," January 17, 2022, <https://www2.deloitte.com/content/dam/Deloitte/us/Documents/technology-media-telecommunications/us-tmt-2022-semiconductor-outlook.pdf> (accessed January 28, 2022).
- vi Deloitte, "2022 semiconductor industry outlook," January 17, 2022, <https://www2.deloitte.com/content/dam/Deloitte/us/Documents/technology-media-telecommunications/us-tmt-2022-semiconductor-outlook.pdf> (accessed January 28, 2022).



Our commitment to energy transition

At Flowserve, our approach to energy transition begins and ends with our purpose: to make the world better for everyone. We understand that when we enable our customers to tackle climate change and address increasing energy demands through our innovative flow control solutions, we can make the world better — now and for generations to come.

Our approach is threefold. We are diversifying, decarbonizing and digitizing to support the global energy sector's transformation toward low-carbon sources.



DIVERSIFICATION

Our innovative portfolio of flow control solutions and services will support energy systems around the world to diversify the energy mix and adopt cleaner sources of energy.



DECARBONIZATION

We will support the reduction of energy-related CO₂ emissions across the mix of energy sources through our innovative portfolio of flow control solutions and services.



DIGITIZATION

We will enable improvements in efficiency, productivity, sustainability and safety of energy systems around the world through our digital solutions and services.

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VATA000415-00 (EN/A4) March 2022

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