

# Quantum Cascade Lasers - Market Share Analysis, Industry Trends & Statistics, Growth Forecasts (2024 - 2029)

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## Abstracts

The Quantum Cascade Lasers Market size is estimated at USD 415.36 billion in 2024, and is expected to reach USD 514.28 billion by 2029, growing at a CAGR of 4.40% during the forecast period (2024-2029).

One of the significant advantages of QCLs is their ability to cover a wide range of wavelengths, from the mid-infrared to the terahertz region. This versatility allows precise control over the laser emission, making them suitable for various applications like gas sensing, molecular spectroscopy, and even detecting explosives and drugs. The ability to tune the wavelength range of QCLs opens new possibilities for scientific research and practical applications.

### Key Highlights

Quantum cascade lasers exhibit high output power, enabling them to deliver intense and focused beams. This characteristic makes QCLs well-suited for long-range remote sensing applications, such as LIDAR (Light Detection and Ranging), where the laser beam needs to travel significant distances. In addition, the high output power of QCLs allows for efficient and accurate measurements in various spectroscopic techniques, ensuring reliable results in scientific research and industrial applications.

Quantum Cascade Lasers (QCLs) have various applications in precision medical activities due to their unique properties. QCLs are compact, semiconductor-based lasers operating in the mid-infrared and terahertz regions of the electromagnetic spectrum. They offer high-resolution spectroscopy, precise control of emission wavelengths, and high-power output. The Quantum Cascade Lasers (QCLs) laser

market is expected to expand significantly over the coming years due to the rise in hospitals and the adoption of new technologies in medical settings worldwide.

Quantum Cascade Lasers (QCLs) have extensive applications in gas sensing and chemical detection in the military and defense sectors. The unique properties of QCLs, such as their mid-infrared emission range and high sensitivity, make them well-suited for identifying and quantifying various gases and chemicals.

According to a report by SIPRI, military expenditures in North America reached more than USD 900 billion in 2022. East Asia spent almost USD 400 billion that year, with Central and Western Europe spending the third highest. This is expected to propel market growth.

The high up-front associated costs of Quantum Cascade Lasers (QCLs) can vary depending on various factors, including the specific QCL design, manufacturing processes, wavelength range, power output, and desired performance characteristics. At the same time, it is challenging to provide an exact figure for the up-front costs of QCLs due to the variability.

With their high-frequency capabilities, QCLs can be employed in the development of advanced wireless communication systems, such as millimeter-wave and terahertz communication. These systems have the potential to provide ultra-fast, high-capacity wireless data transfer, opening up new possibilities for telecommunications networks. With the rising penetration of 5G, the penetration of 5G smartphones is also growing, which is estimated to rev the expansion of the studied market.

## Quantum Cascade Lasers Market Trends

### Industrial End-User Industry to Hold Significant Market Share

QCLs are broadly used in industrial applications due to their high power and brightness, broad wavelength coverage, long-term stability, rapid pulse generation, compactness, solid-state nature, and increased sensitivity and selectivity for gas sensing. QCLs are suitable for industrial environmental monitoring. They help detect and analyze trace gases and pollutants due to their great sensitivity, preciseness, and selectivity. Possibilities exist in areas where QCL-based sensors and systems can improve efficiency, compliance, and environmental sustainability, such as gas sensing, industrial process control, emissions monitoring, and air quality monitoring.

QCLs monitor air quality in industrial zones. QCL-based sensors can detect and calculate a variety of air pollutants, including particulate case, ozone, nitrogen dioxide, carbon monoxide, and volatile organic compounds. These sensors give constant, real-time data that can be used to examine air quality, identify pollution sources, and perform targeted mitigation actions.

The emergence of Industry 4.0 has garnered widespread interest among industrialists and process automation industries in the industrial Internet of Things (IIoT) concept. Additionally, a notable rise in demand for industrial environmental monitoring has led to a global boost in the extractive quantum cascade lasers market. The ongoing trend of Industry 4.0 in different sectors has resulted in a considerable surge in the adoption of process automation technologies, especially in emerging economies like China, India, Australia, and South Korea.

The growing manufacturing sector in several regions globally is likely to aid the market's growth. For instance, China experienced significant growth in its manufacturing sector due to technological advancements, infrastructure development, skilled labor, government policies, and initiatives. According to the National Bureau of Statistics of China, China's industrial production increased by about 4.6% in 2023 compared to 2022.

The increase in automation in various industries is anticipated to augment the adoption of quantum cascade lasers in factory settings. For instance, according to the IFR forecasts, the global adoption is expected to increase to around 518,000 industrial robots operational across factories all around the globe by 2024. Australia/Asia was the region with the most installed units; an estimated 266,000 units were fitted in 2020 alone. It is estimated that by 2024, industrial robot installations in Asia/Australia will reach 370,000 units. Also, according to IFR, industrial robot shipments are projected to rise significantly in the coming years, surpassing the peak in 2022 when around 453,000 industrial robots were shipped globally.

### Asia Pacific Expected to Witness Significant Growth

China's healthcare and medical sectors are experiencing significant growth, with an increasing focus on advanced diagnostics and treatment. QCLs are used in medical applications such as breath analysis, non-invasive glucose monitoring, and molecular spectroscopy for disease detection and monitoring. The demand for QCLs in these

areas is expected to rise as the healthcare sector expands.

China has been facing an increasing burden of cardiovascular diseases, including heart attack, stroke, coronary artery disease, heart failure, and other conditions, due to dietary & lifestyle changes, rapid urbanization, and industrialization.

In May 2023, using data from 2,025 hospitals in China, researchers found that air pollution raises the risk of irregular heartbeat. The study included 190,115 patients with acute onset of symptomatic arrhythmia, including atrial fibrillation, atrial flutter, premature beat, and supraventricular tachycardia (a heart condition that causes abnormally fast heart rate). Exposure to air pollution was determined to be linked to an increased risk of irregular heartbeat in an extensive study of 322 Chinese cities.

Japan is rapidly moving toward "Society 5.0", thus introducing the fifth chapter to the four major stages of human development in this new ultra-smart society. All things are connected through IoT technology, and all technologies are getting integrated, dramatically improving the quality of life.

Moreover, key sectors coming under this strategy are manufacturing (USD 77.8 million), infrastructure (USD 643.2 million), nursing and medical (USD 55 million), and agriculture (USD 66.2 million). Such expansion in the manufacturing industry further propels the studied market growth.

The demand for QCLs is likely to propel the Japanese ICT sector owing to the country's investment in the ICT sector. For instance, SoftBank, one of the world's leading telecommunications investment holding companies, recently announced plans to build a large data center in the Japanese city of Hokkaido in 2023. The new data center, which is expected to have a capacity of 40 to 60 million square feet (USD 266 to 400 million), is expected to be one of the largest data centers in Japan.

The government of South Korea has declared its intention to augment tax incentives associated with research and development and facility investment in the semiconductor industry. This move aims to encourage companies in the sector to invest a minimum of KRW 340 trillion by 2026.

Furthermore, the government plans to establish a semiconductor engineer training center by 2022 to provide over 150,000 experts for the next decade. These measures are intended to assist South Korean companies in elevating their share in the global non-memory chip market from 3% to 10% by 2030. Such initiatives will drive the industry's

growth and create significant demand for QCLs in automation and control systems.

## Quantum Cascade Lasers Industry Overview

The quantum cascade laser market is characterized by its varied landscape, which includes global corporations and small and medium-sized businesses. Key participants in this market encompass Hamamatsu Photonics KK, Thorlabs Inc., Adtech Optics Inc., Mirsense SAS, and Leonardo Drs Inc. These companies are engaging in strategies like forming partnerships and pursuing acquisitions to bolster their product line and secure a lasting competitive edge.

January 2024 - Thorlabs and IRsweep entered a Licensing and Technology Transfer Agreement (TTA) to extend the Mid-IR spectral sensing platform developed into new applications. Thorlabs will take advantage of IRsweep's patented QCL-based DFM-Comb spectroscopy instruments to create a high-performance sensing platform that combines the power of conventional broadband spectrum with the flexibility of tunable laser spectrum into a single device. This new tool will allow Thorlabs to provide a powerful solution for various applications, such as gas detection, environmental monitoring, and chemical analysis.

October 2023 - Block Engineering released its next generation of compact quantum cascade lasers. The new QCLs claim to offer a six-fold increase in laser power, orders of magnitude better thermal and temporal stability, and minimal electronics with unique pulse design capabilities. The company's sQCL is a compact laser module that can be tuned across a 2-3 micron wavelength range within a more significant 5.4 to 12.8 micron span.

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