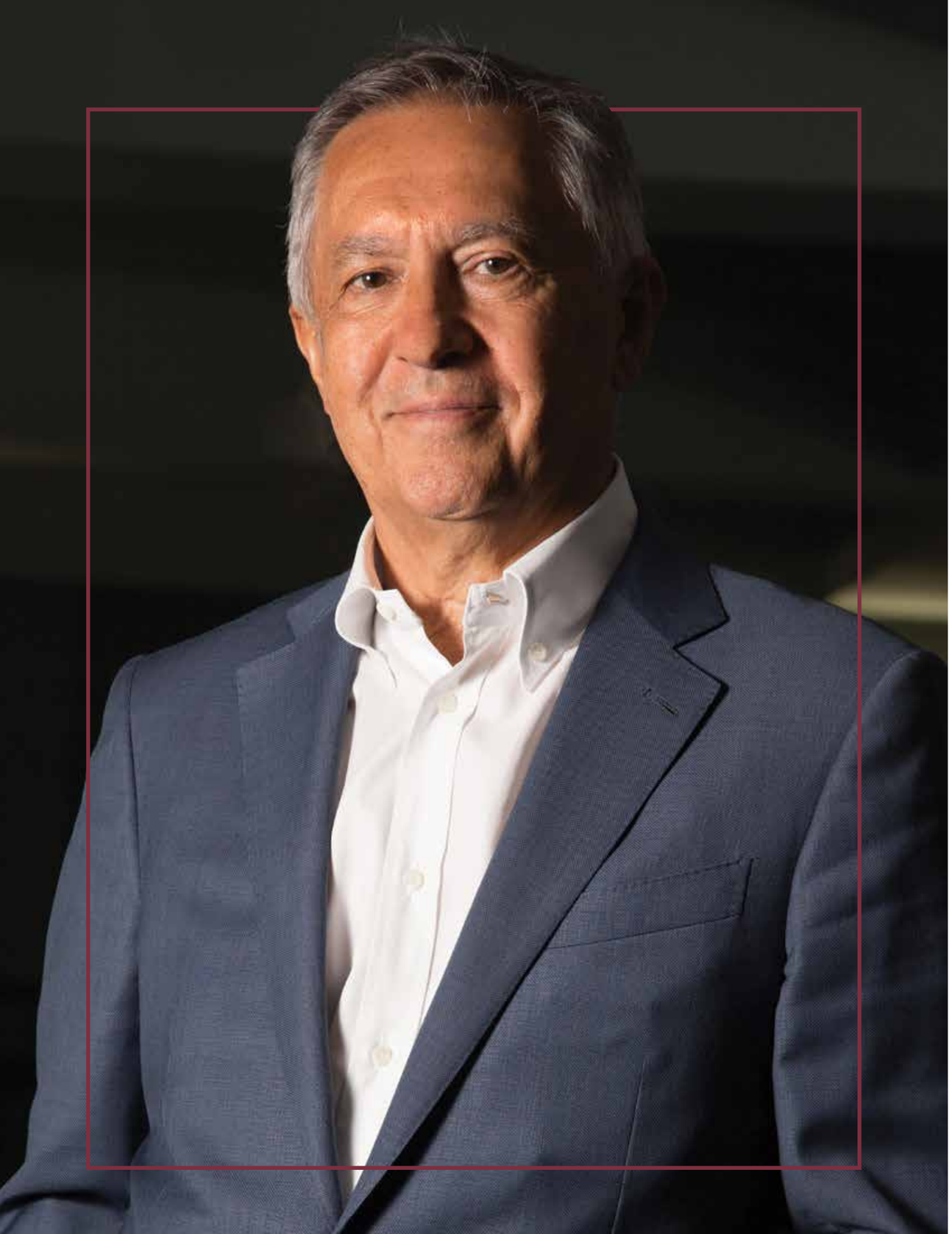


TECHNOLOGY
INDUSTRY

POWERING CHANGE

BY FRED YOUNG

Patrizio Vinciarelli

CEO / Vicor Corporation

"When in 1900 a Great Plains farmer held the reins of six large horses while plowing his wheat field, he controlled ... no more than 5 kW of animate power. A century later his great-grandson, sitting high above the ground in the air-conditioned comfort of his tractor cabin, controlled effortlessly more than 250 kW of diesel engine power," notes author Vaclav Smil, in his book Energy and Civilization: A History.

VICOR

$400 million Revenue | **1100** Employees | **Andover, Massachusetts** HQ | **NASDAQ: VICR** Stock

THOUGH WE ARE TAUGHT the history of civilization in terms of kings and queens, wars and invasions, cities founded and seas crossed - instead the smart money has noted that what really marks the pace and progress of development is energy use. Few companies are closer to the cutting edge of this development than Vicor.

The CEO and founder of Vicor, the high-performance power module company, Patrizio Vinciarelli, has been an important part of the exponential increase in power density during his professional career. His story began as a fellow in the theory group at Switzerland's famed CERN, center for research into elementary particles, in the mid-seventies.

And perhaps this huge research center in Geneva which focuses on the planet's tiniest particles could be seen as a suitable beginning for the career of a man who is focused laser-like on a single concept: power density.

Vinciarelli grew up in post-war Rome where he earned a doctorate in theoretical physics before heading for the US, CERN and back to the US. After growing frustrated with the academic milieu at top-tier universities such as Stanford and Princeton, he founded Vicor in 1981 with a vision of stepping up power system efficiency and density.

"Our lead in power density and current density has been expanding for four decades."

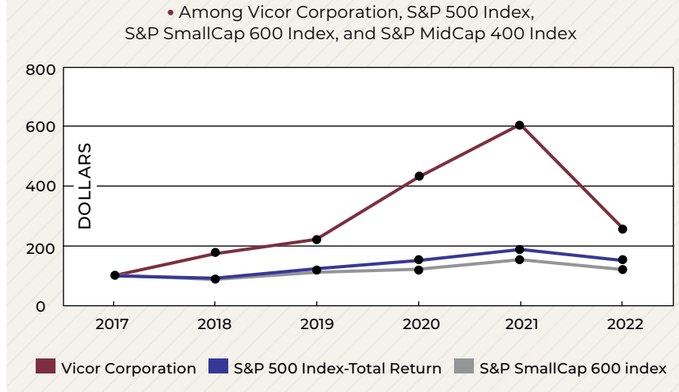
PATRIZIO VINCIARELLI
CEO / VICOR CORPORATION

"The opportunity that I saw from the beginning was to bring to the power system marketplace a power component methodology based on modular building blocks," Vinciarelli told CEO North America: "Something akin to the Lego blocks that kids play with ... back in '81, and to a large extent still today, the power industry lacked a power component methodology. Power systems were developed from the ground up without the power density, efficiency, and scalability that I saw as future market-drivers."

Where other companies saw systems which needed to be custom-built every time, Vicor would focus on modular components, standard building blocks which could be used across systems - enabling the creation of economies of scale, reducing cost and enabling superior performance.

"I think in the 40 years that have lapsed, the opportunity has become clear - but still today - Vicor is the only company with a power component methodology and the innovation necessary to drive superior power density. Since our founding, power density has changed from 1 watt per cubic inch to over 10000 watts per cubic inch," notes Vinciarelli. "These developments in power density anticipate emerging market opportunities such as artificial intelligence, which typically drives very high current densities, or automotive power systems which typically require very high power densities."

COMPARISON OF FIVE YEAR CUMULATIVE RETURN



THE RISE OF AI AND AUTOMOTIVE

Industry analysts estimate that AI requires 300% higher rack power than traditional data centers, leading to a massive search for efficiency gains in power distribution systems.

In 2018, computers consumed roughly 1-2% of the world's energy supply and in 2020 this rose to 4-6%, according to researchers at Penn University. At this rate it could grow to 8-21% by 2030.

In the case of AI, the computing demand of the neural networks used to train the systems is bottomless, but power it not.

Power optimization will become a global priority in order to unleash the power needed to meet the demands to support AI, machine learning and the massive data center growth. Power delivery is the limiting factor for AI progress.

Simultaneously, electric vehicle (EV) sales are booming, growing from just over 6 million cars to just over 10 million units between 2021 and 2022. They are expected to account for 50% of all car sales by 2030. And every major automotive OEM is scrambling to optimize their power delivery network to reduce range anxiety and power consumption.

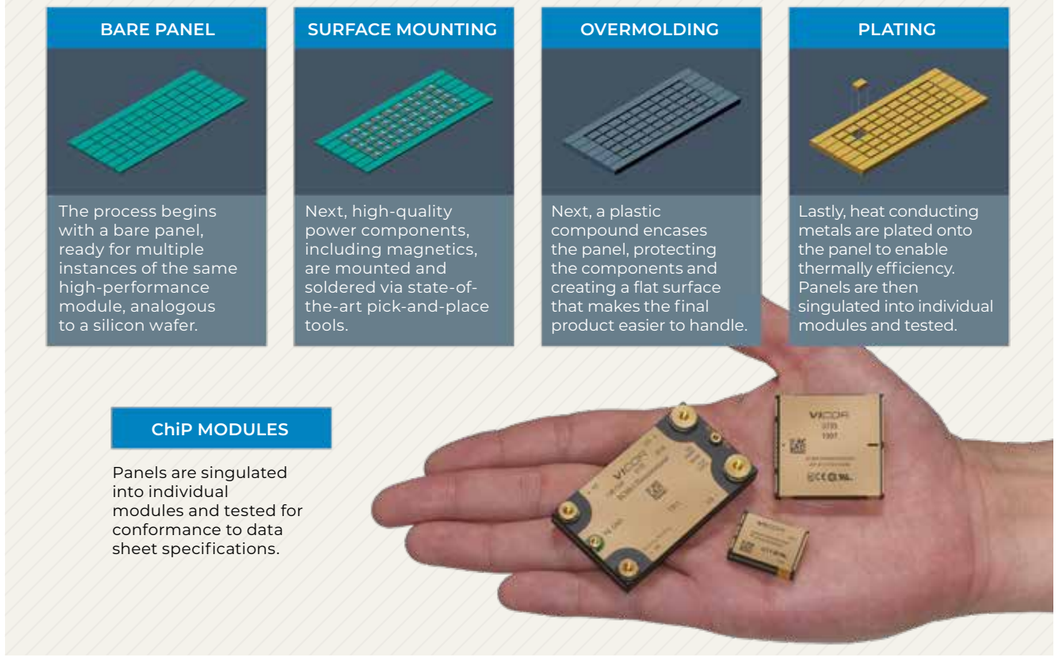
It is in these kinds of applications where Vicor's decades of expertise is designing the highest density power modules pays off.

"I think we are in a very unique position, developed through long term vision" adds Vinciarelli. "It is an enviable

"Our world's first ChiP (Converter housed in Package) foundry enables a unique capability to provide the highest power density for automotive applications or current density for AI applications, and do so with the lowest cost structure, in our fab in the USA."

PATRIZIO VINCIARELLI
CEO / VICOR CORPORATION

UNIQUE ChiP MANUFACTURING OPTIMIZES DENSITY, COST AND QUALITY



position due to a combination of critical factors. One critical factor has to do with our power conversion technology which has distinct performance advantages. As an example, we are working on a fast charger for EVs. The power conversion requirement is 150kW and the competitors alternative weighs about 22 kilograms to process those 150 kilowatts with relatively poor efficiency. A Vicor solution provides much better efficiency at a very small fraction of the weight, about 2.7 kilograms. This represents a nearly 8x weight reduction and substantial savings in power losses".

Efficiencies at this scale can have an impact on the range of EVs where a weight difference of nearly 20kg is significant.

A SEMICONDUCTOR-LIKE APPROACH TO MAKING POWER MODULES

Power converters are typically assembled using dedicated manufacturing set-ups that are unique to a particular type of converter. Vicor has, however, over the last 15 years created a production methodology similar to that of a wafer foundry, in which semiconductor circuits are printed onto blank silicon wafers.

There are many speed and quality benefits to a semiconductor approach for manufacturing. For Vicor the difference is that instead of using wafers it uses panels.

"We are opening the world's first vertically-integrated ChiP (Converter housed in Package) fab to prepare for escalating demand. In our foundry, we make a wide variety of power modules on a common substrate," explains Vinciarelli. "Through a variety of process steps which are primarily chemical in nature. That gives our foundry a unique capability, unique scalability and, before too long, unmatched cost-effectiveness in addressing power system needs."

The Vicor foundry is in the final stages of testing and is expected to drive profitability to new levels. The foundry is expected to give the company the capacity to generate above $1 billion a year in revenue.

"We expect in the next three to four years to fully realize that capacity," adds Vinciarelli. "Which would take us from $400 million in revenue in 2022 up to about $1 billion."

"We are opening the world's first vertically-integrated ChiP (Converter housed in Package) fab to prepare for escalating demand."

PATRIZIO VINCIARELLI
CEO / VICOR CORPORATION

PROFITING CLOSE TO HOME

Vicor gross revenues clocked in at $399 million in 2022 up 11% from 2021. Despite the satisfactory year-over-year result, the company is confident that new AI, data center and automotive solution will drive it to much higher revenues.

The company increased manufacturing floor space by 45% with its $100 million new foundry addition to meet coming demand.

With geopolitics creating turbulent headwinds for many electronics companies - dependent as they are on suppliers and manufacturing in Asia - Vicor's decision to invest in a US based vertically integrated advanced manufacturing facility is set to pay off.

"We have always believed that highly automated US manufacturing with vertical integration, close collaboration between product development, manufacturing processes and operations is key to synergistic value opportunities leveraging best-in-class products", says Vinciarelli. "This is one way we continue to be differentiated from our competitors."

"We are gearing up to support a billion dollars in revenues per year."

PATRIZIO VINCIARELLI
CEO / VICOR CORPORATION

Uniquely, Vicor manufacturing facilities are in the same city as its corporate headquarters, Andover Massachusetts, just a few miles down the road from MIT and a variety of world-class engineering institutions. Vicor has manufactured their power modules in USA for 42 years which has been a key to their leadership in powering innovation.

As the founder of Vicor, Vinciarelli has made the billionaire lists of major magazines. His over 200 patents in electronic conversion technology prove he has worked for that fortune.

But though numbers are interesting, civilization also advances through action.

Vicor has been collaborating with some of the world's more innovative companies like Doosan Mobility (hydrogen powered drones), Kodiak Robotics (autonomous trucking), HIRO (edge computing for brain surgery) and Ampaire (electric aviation). These are among many world changing innovations that Vicor enables.

The next couple of years are primed for a massive adoption of new technologies from AI to renewables to automotive electrification.

Vicor and Vinciarelli look determined to power that change.