



# Expanding our leadership in Power Systems

Power Roadshow  
Paris, 27 – 28 November 2023



# Agenda and speakers

## Agenda

- 1** Overview

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- 2** Division PSS (incl. GaN)

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- 3** Division GIP (incl. SiC)

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- 4** Q&A

## Speakers



**Adam White**  
Division President PSS

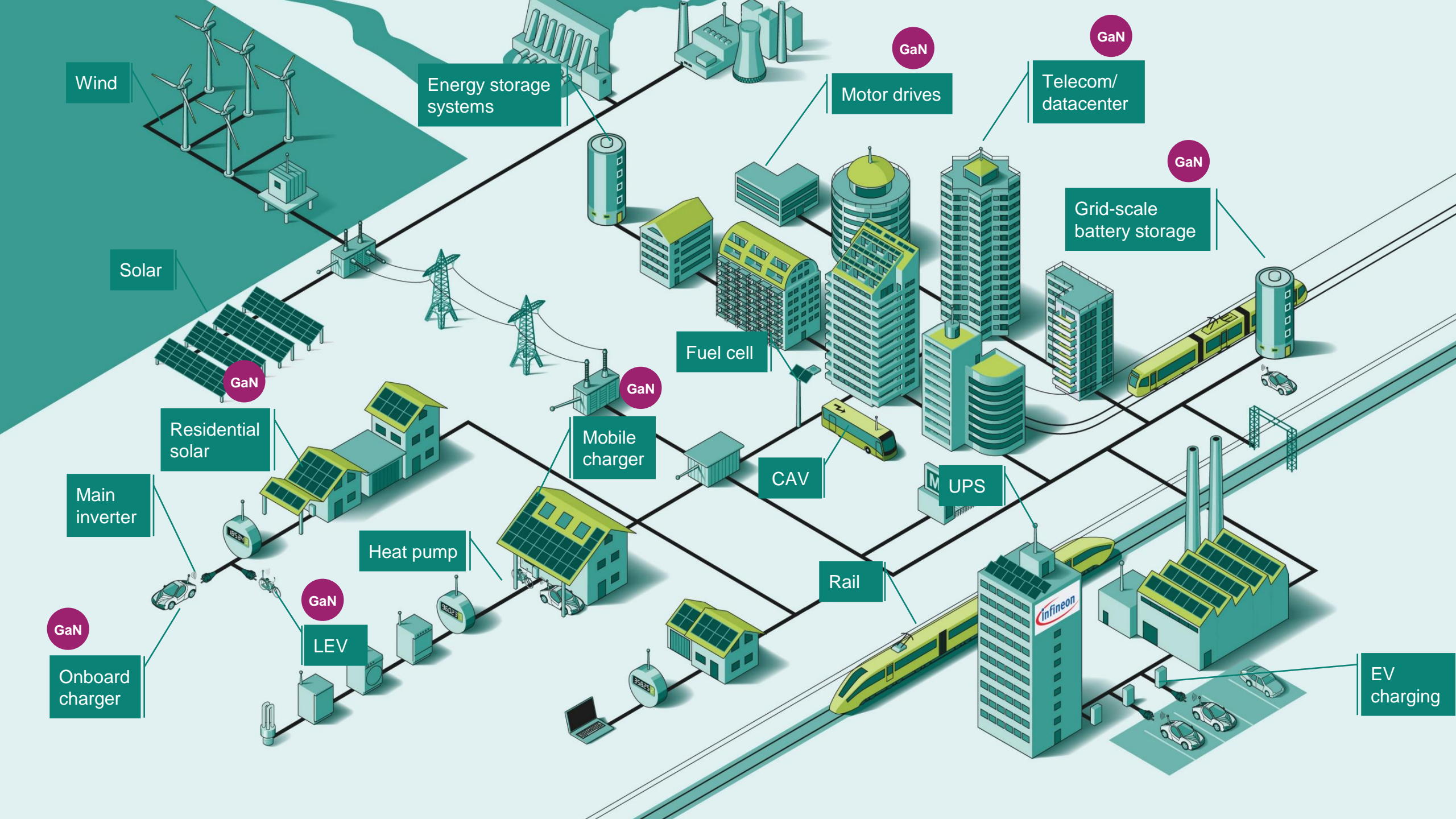


**Dr. Peter Wawer**  
Division President GIP

# Expanding our leadership in Power Systems

- AI becomes a strong growth driver
- GaN: reinforcing global leadership in Power Systems
- Enable green energy
- Leader in SiC modules





# Power & Sensor Systems



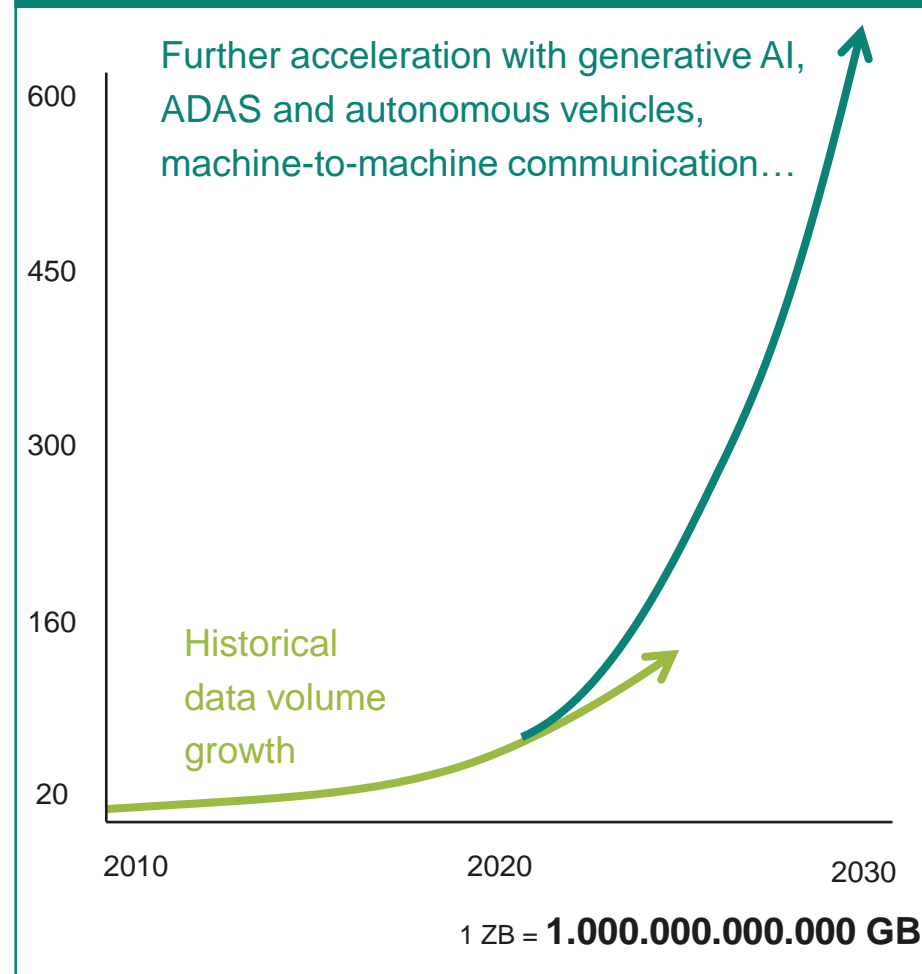
# Exponential growth in global data by 2030

## Drivers of data generation

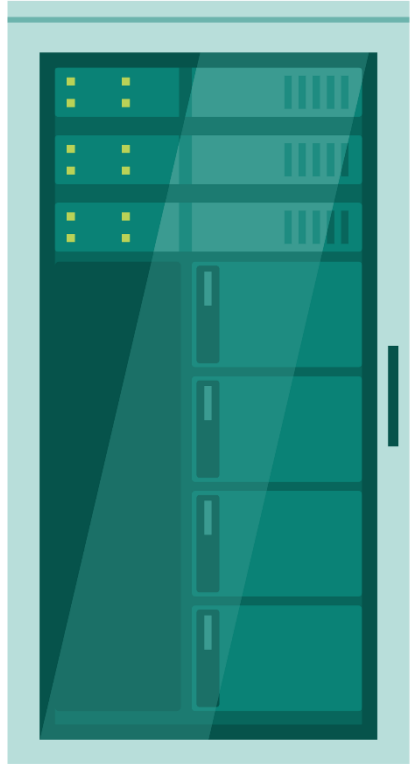
- **146-fold increase of data** volume is expected between 2010-2025 – total of 175 zettabyte (ZB) by 2025
- **Further acceleration** in data volume growth with expected **30% CAGR by 2030**
- **Key drivers** are generative AI, ADAS and autonomous vehicles, AI Factory Automation, ...
- **97%** of the data is stored without active use

Sources: Statista, NCTA - The Internet & Television Association; Thrive Global; IDC White Paper; UBS; Infineon estimate

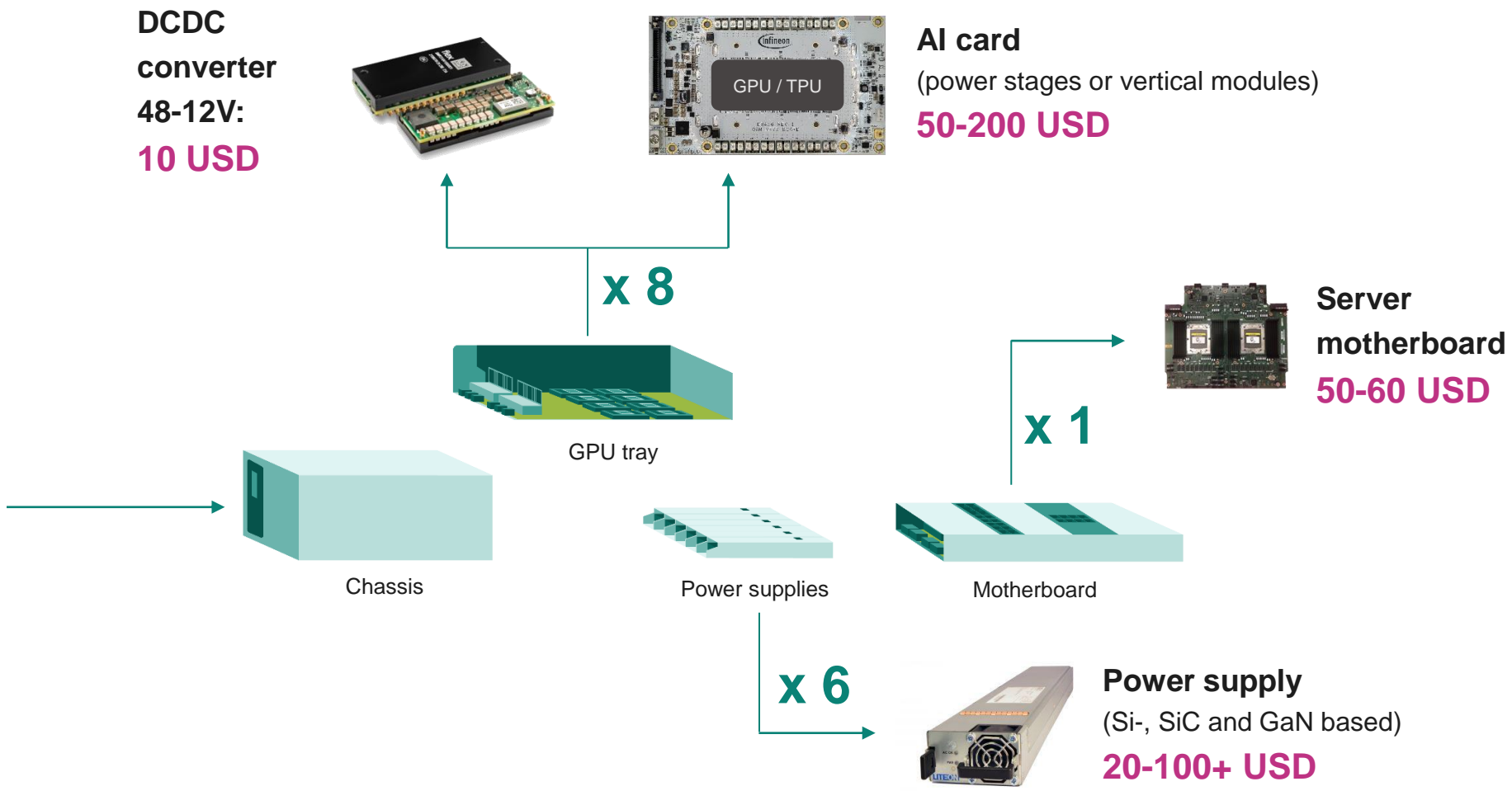
## Data volume in zettabyte (per year)



# Average Infineon BOM per AI server about 850 to 1800 USD



**1 Server rack includes  
4 AI servers**

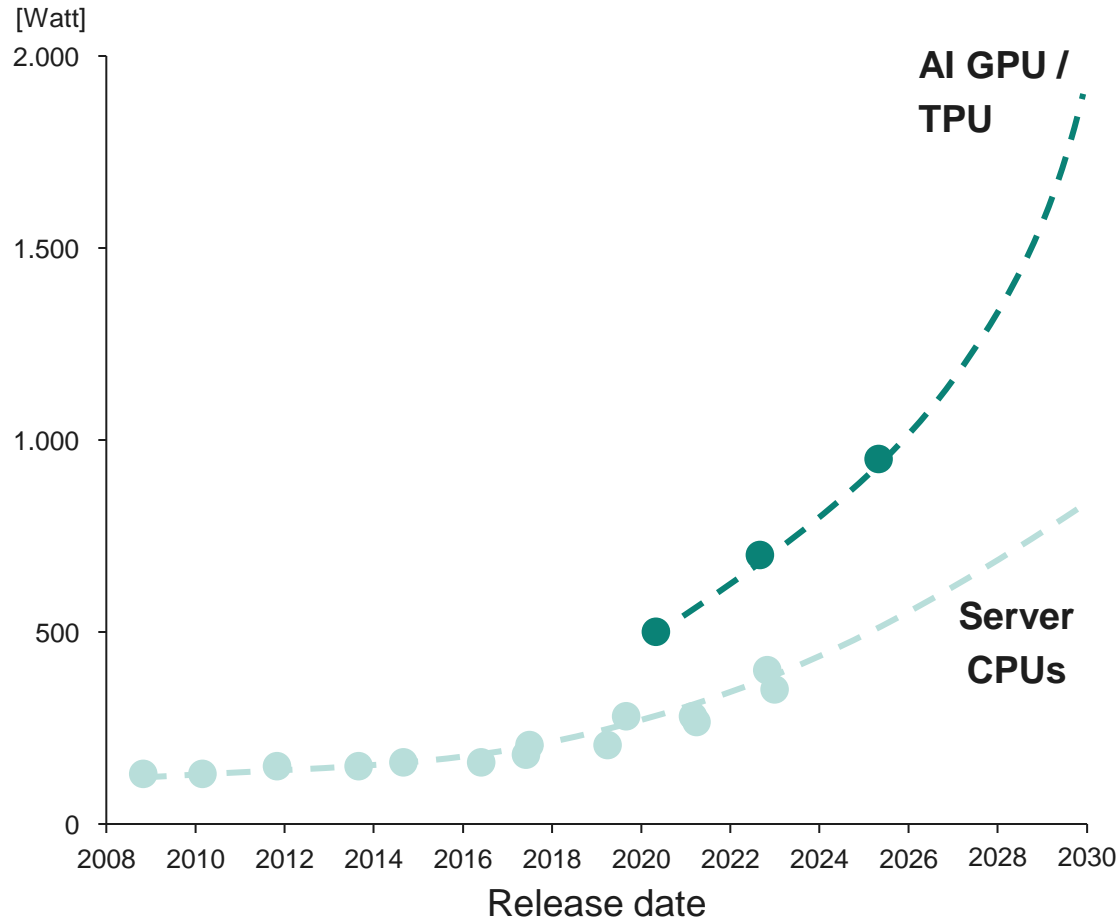


**USD** = potential Infineon content per AI server

# AI enabled systems demand higher power that further increase semiconductor content



## x86 and ARM-based processor electricity demand



**AI Training GPU / TPU**

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Unit CAGR<sup>1</sup> >40%  
Avg. BOM CAGR<sup>1</sup> >10 %

**Other Servers**

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Unit CAGR<sup>1,2</sup> 6%  
BOM CAGR<sup>1,2</sup> <10%

**Semiconductor SAM CAGR<sup>1</sup>**

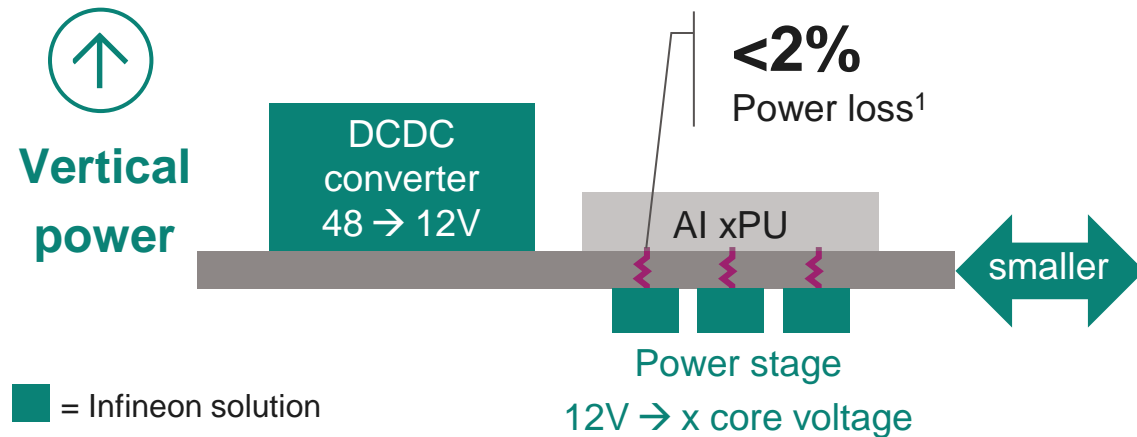
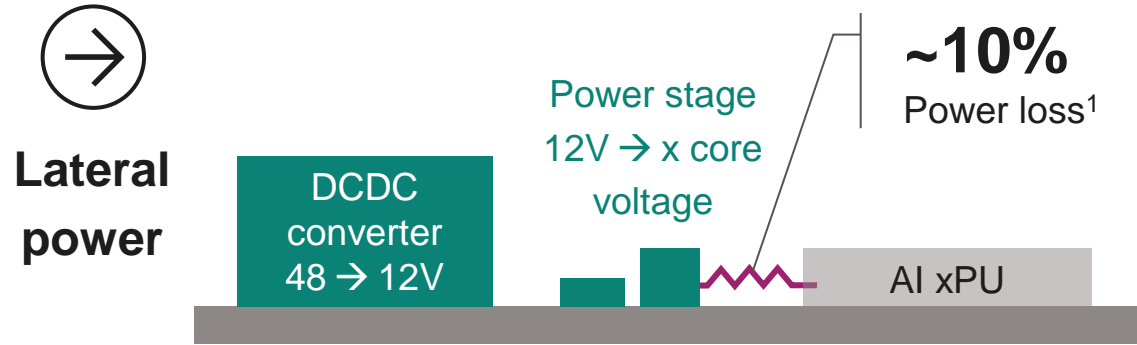
**>50%**

**~15%**

Source: Company information; Infineon analysis    1 CAGR 2023-2027 in Infineon relevant market    2 Incl. AI inference



# 48V architecture combined with Infineon's vertical power solutions delivers best-in-class total cost of ownership



■ = Infineon solution

Source: Infineon calculation 1 Power delivery loss in % of xPU power

## Customer benefits of vertical power delivery



**Increase power density** via smaller size to enable further increase in compute power



**Reduce power losses by >7MW** for an average data center (100,000 CPU nodes)

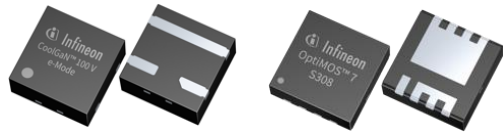


**>12% total cost of ownership saving** compared to lateral power delivery networks

# Infineon improves current existing solutions at all fronts to increase power efficiency

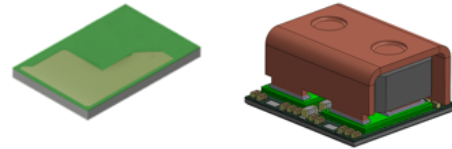
## Levers to increase power efficiency

### Power semiconductor



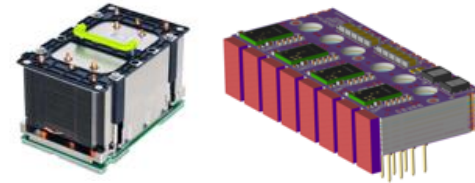
- Silicon, SiC and GaN technologies
- Analog/mixed signal

### Advanced packaging



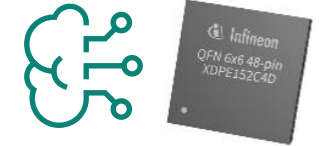
- Chip embedding
- Modules
- Integrated magnetics

### System architecture



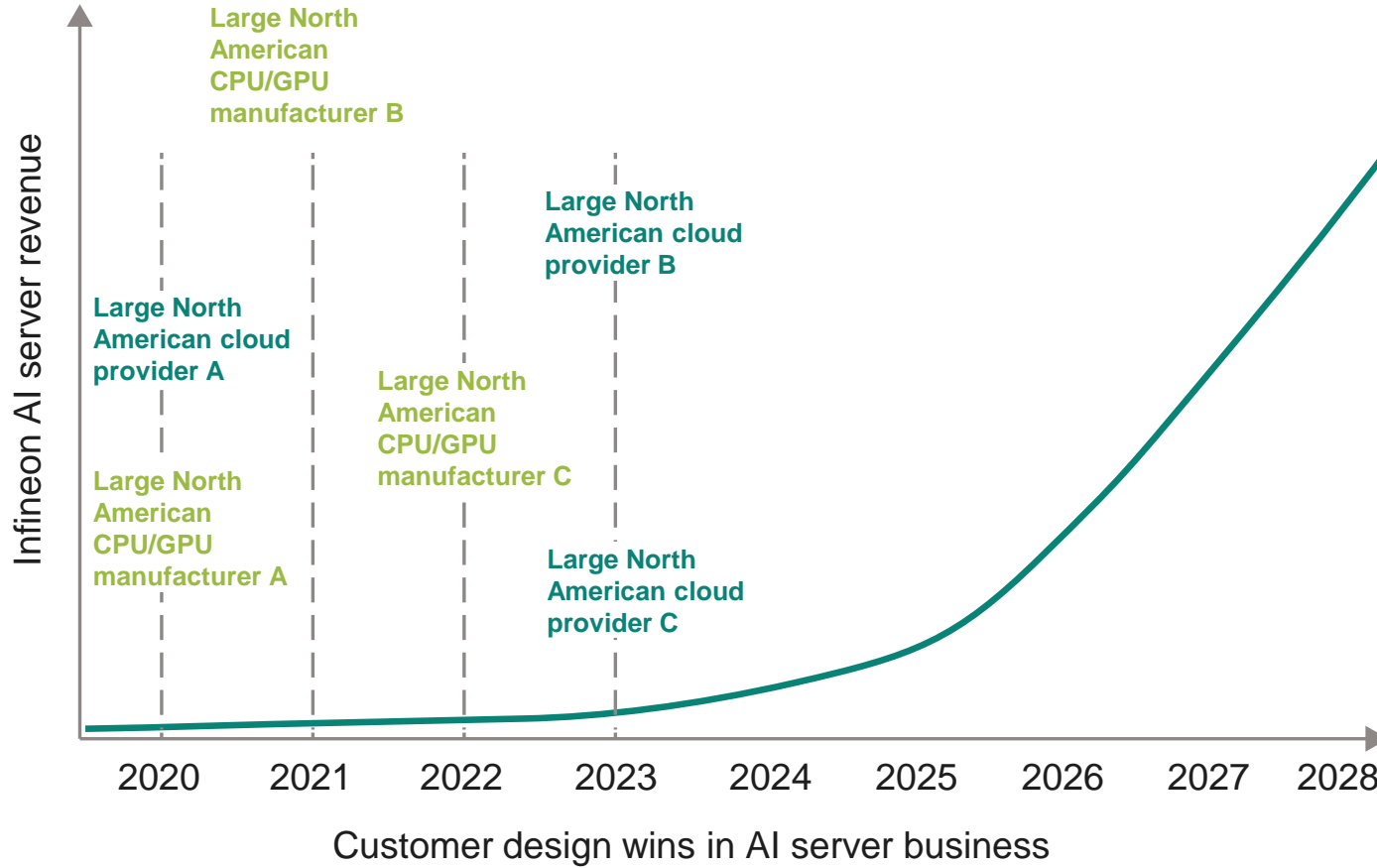
- Novel 48V → 12V converter topologies
- Vertical power delivery
- Scalable architecture
- Magnetics

### Smart control & software



- Hyper-transient digital controller
- Hotswap/e-fuse controller
- Point-of-load

# AI will be a strong driver of revenue increase for Infineon's server business



In FY24 AI revenue in our server business is expected to be a low triple digit million amount

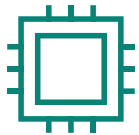
Revenue CAGR FY24-29

**> 50%**

# Infineon completes acquisition of GaN Systems on Oct 24<sup>th</sup> 2023, becoming a leading GaN power house



## Strengthening GaN portfolio, reinforcing global leadership in Power Systems



Addressing fast-growth applications with **highly complementary strengths** in IP, application understanding, customer access and project pipeline



Significant **roadmap acceleration** through unmatched R&D resources and application expertise



**Leadership in Power Systems** through mastery of all relevant power technologies – Si, SiC, GaN

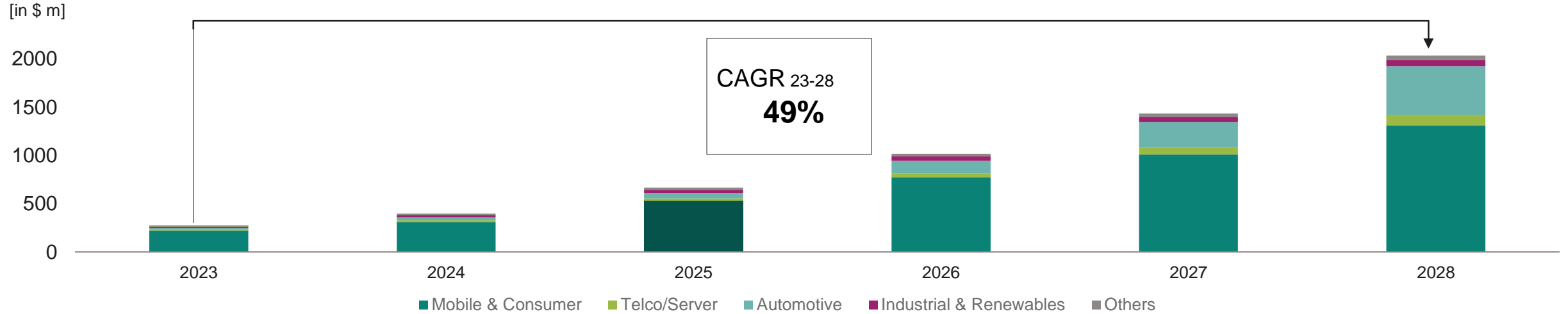
# Infineon's GaN business fully set up to support leadership in Power Systems



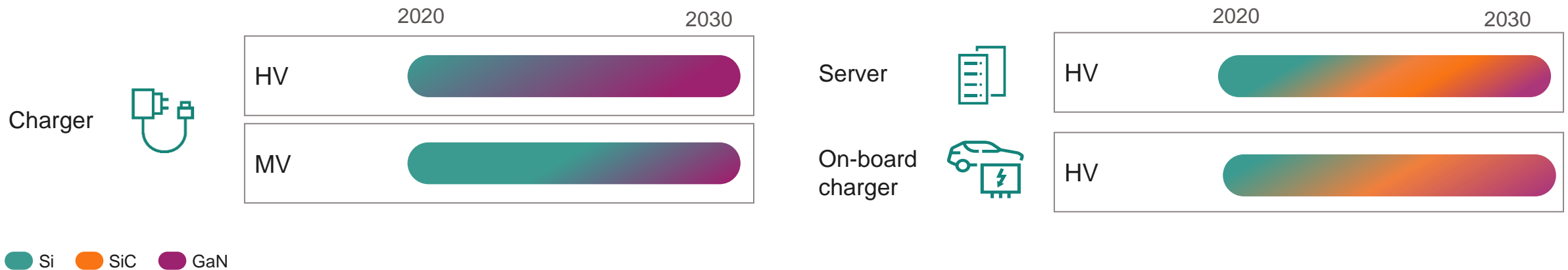
- Full focus of all Infineon GaN activities in one dedicated Business Line
- More than 350 patent families
- After the acquisition the GaN Systems product portfolio increased by a factor of 2. Products are ranging from 100 V to 650 V
- About 450 GaN experts are serving more than 2000 active GaN customers
- Dual-site in-house production ready for 200 millimeter combined with strong foundry partnerships

Design opportunity  
pipeline for  
GaN power in focus  
applications of more  
**than €3bn**

# GaN is an immense market opportunity covering key power applications



## GaN expected to be the preferred technology in several PSS core portfolio applications by 2030

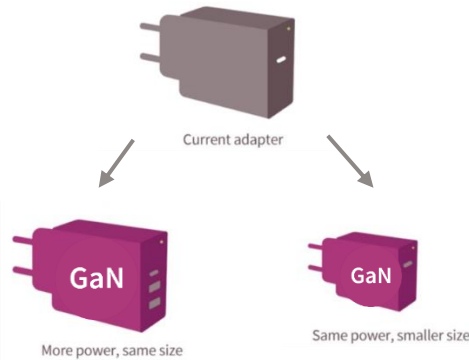


GaN for power market: Source: Yole Intelligence SiC/GaN Compound Semiconductor Market Monitor | Q3 2023 Database. October 2023

# Reducing CO<sub>2</sub> and saving resources with Infineon's GaN solutions

## Mobile charger

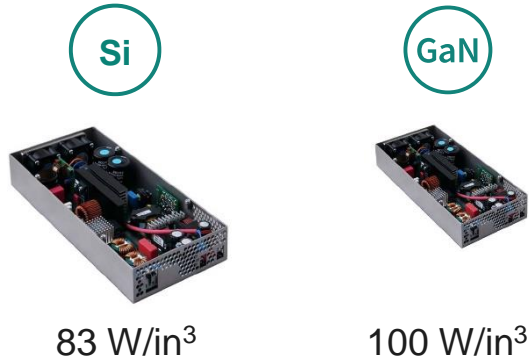
Saving resources with highly efficient GaN chargers



**2x** less size & weight

## Switched mode power supply

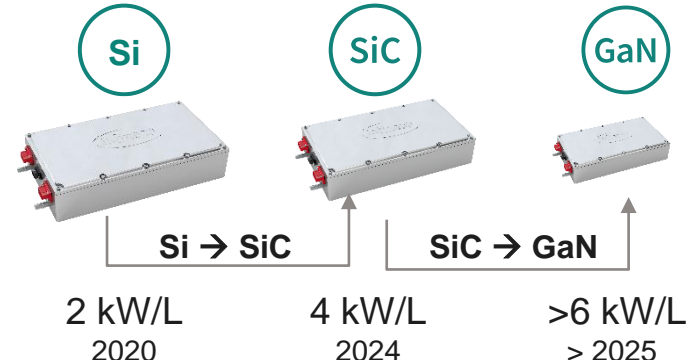
Reaching highest efficiency and power density with GaN power supplies



**2x** less size & weight

## On-board charger

Increasing efficiency and power density with GaN On-board chargers



**3x** less size & weight

Value proposition

Product examples

- **10 USD BOM**  
(2 GaN power transistors + 10 Si MOSFETs and 1 controller IC)
- Customers: **Anker plus 50 other projects in Asia and North America**

- **75 USD BOM**  
(4 GaN power transistors + 4 SiC diodes, 40 Si MOSFETs, 8 gate driver ICs and 1 CoolSET™)
- Customers: **40 projects with leading electronic manufacturers in Asia, Europe and North America**

- **More than 100 USD BOM**  
(18 GaN power transistors + 16 digital isolators, 5 current sensors and 1 controller IC)
- Customers: **25 projects with leading electric car manufacturers in Asia, Europe and North America**

# Green Industrial Power





# GIP – undisputed power systems leadership in the green, industrial space – mastering all required key materials



- » Reliable multi sourcing of raw materials
- » World-scale fabs



- » Application understanding
- » Packaging know-how and hybridization competence

## Leadership in Power Systems across all materials and technologies

### Silicon

Diode – MOSFET – IGBT – Driver – Controller



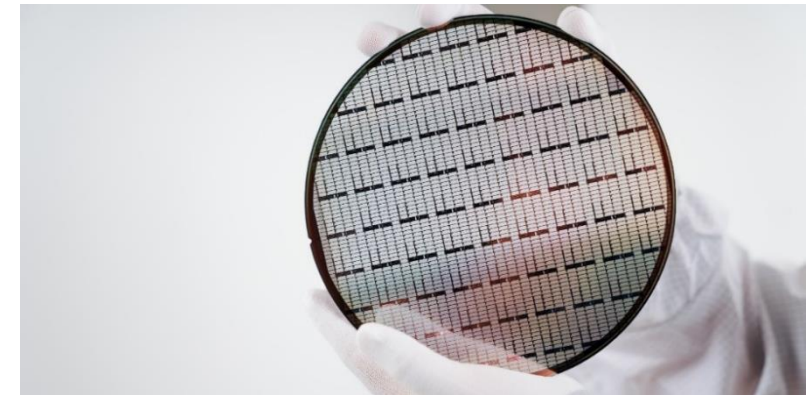
### Silicon carbide

Diode – MOSFET



### Gallium nitride

HEMT – Driver



# GIP specific-markets showing accelerated growth – enabling green energy and driving decarbonization

## Key facts

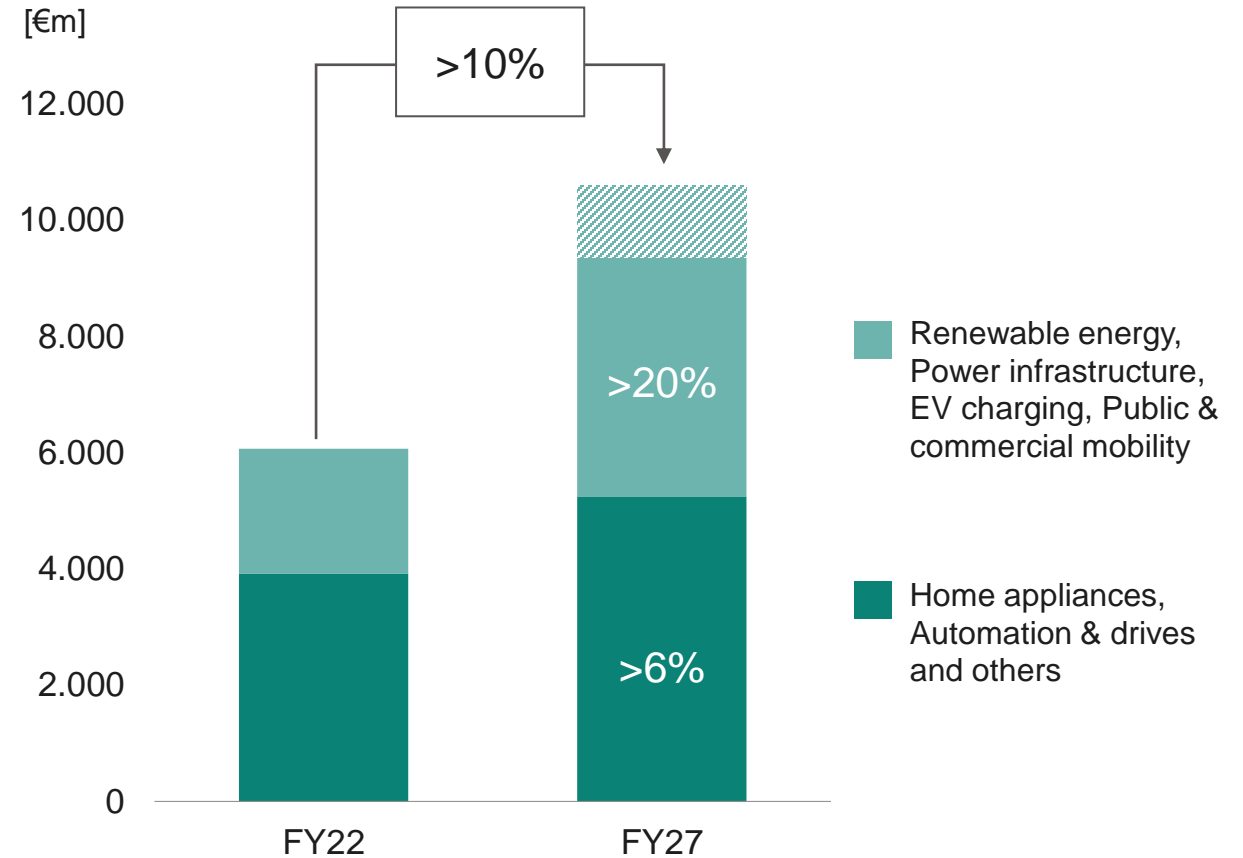


– The **acceleration of the energy transition** drives GIP markets

– **SiC** penetration accelerates

– **SiC** is a key point of **differentiation** and drives GIP **profitability**

## Total addressable market

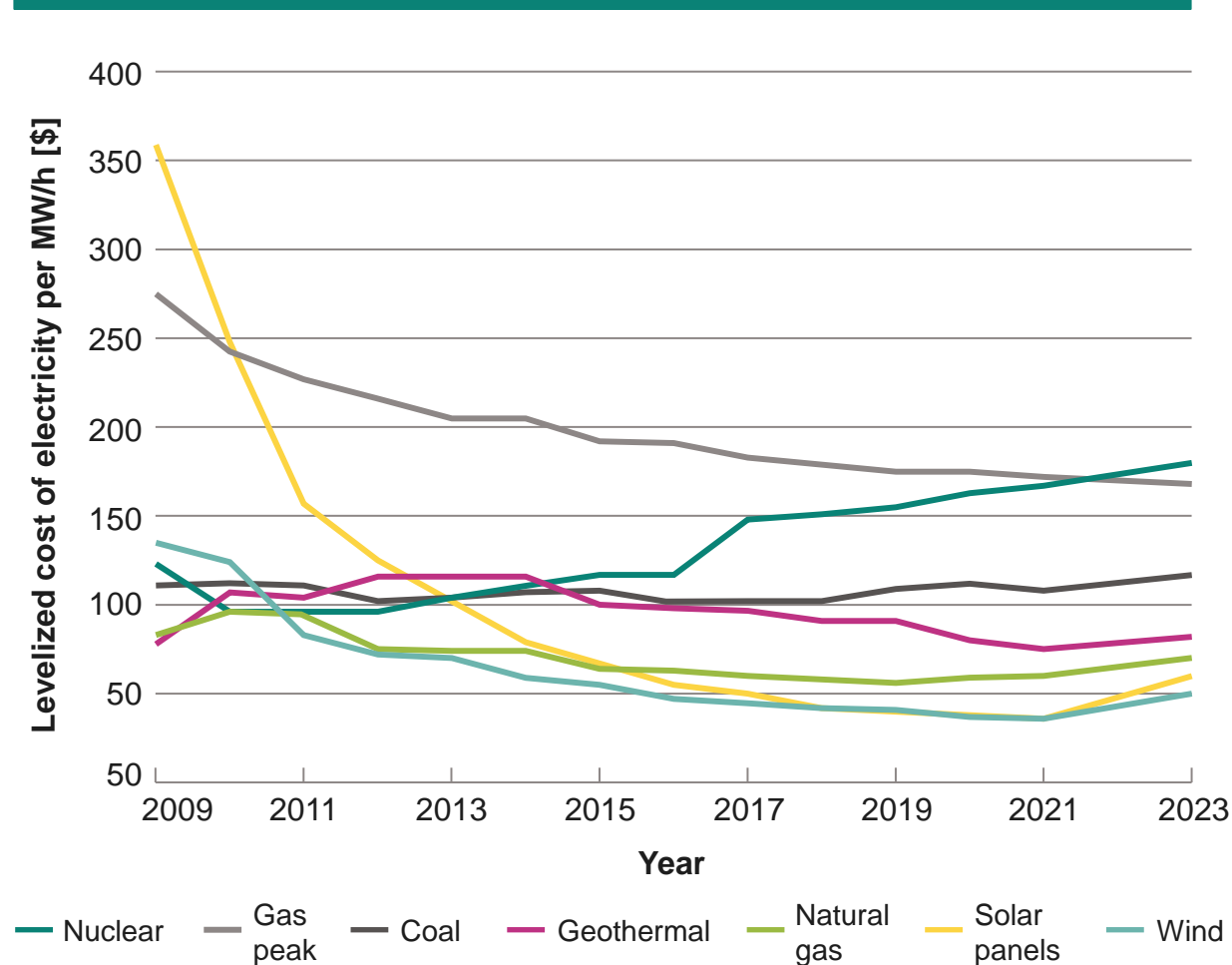


Infineon analysis

x% CAGR FY22–27e

# Decarbonization pays off – renewable energies have become the cheapest source of electricity

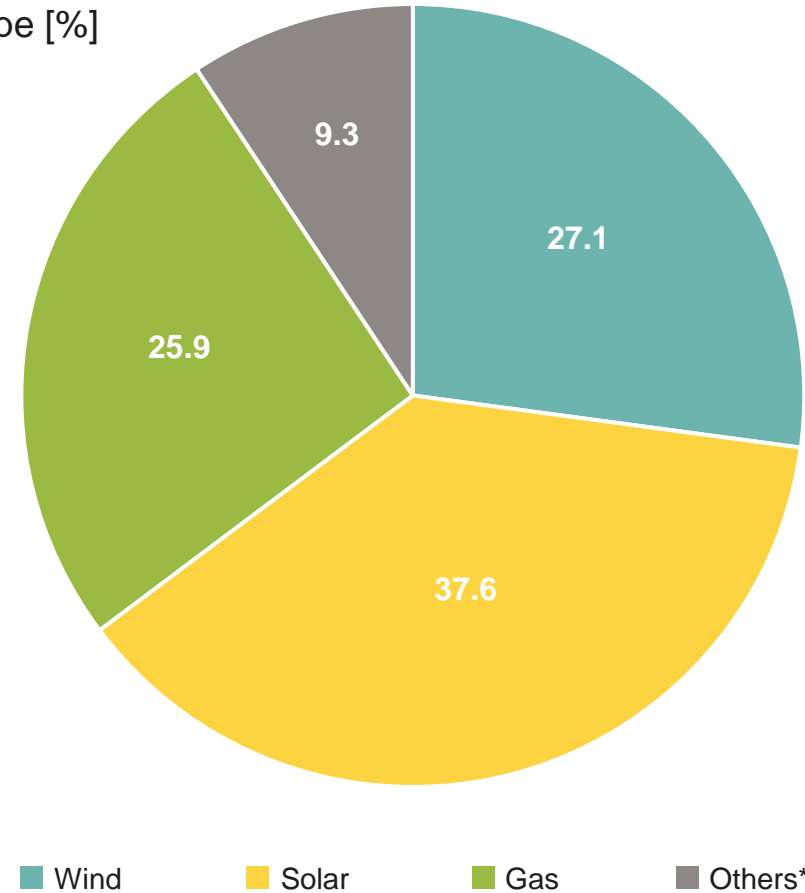
## Trend of electricity cost



Source: Lazard, „LCOE“, April 2023

## Electricity generation additions in US 2022 – total 24.7 GW

By fuel type [%]



Source: S&P Global Market Intelligence

# Energy generation – getting more out of photovoltaic with advanced semiconductors



## We make solar inverters smaller, lighter and more powerful

CoolSiC™ MOSFETs allow for higher currents and reduced heat loss, enabling higher power density and smaller form factors for inverters, massively reducing cost in USD per watt-peak



**2008**  
90 W/kg  
 $\eta_{\max}$  97.1%



**2011**  
330 W/kg  
 $\eta_{\max}$  97.8%



**2016**  
710 W/kg  
 $\eta_{\max}$  98.5%

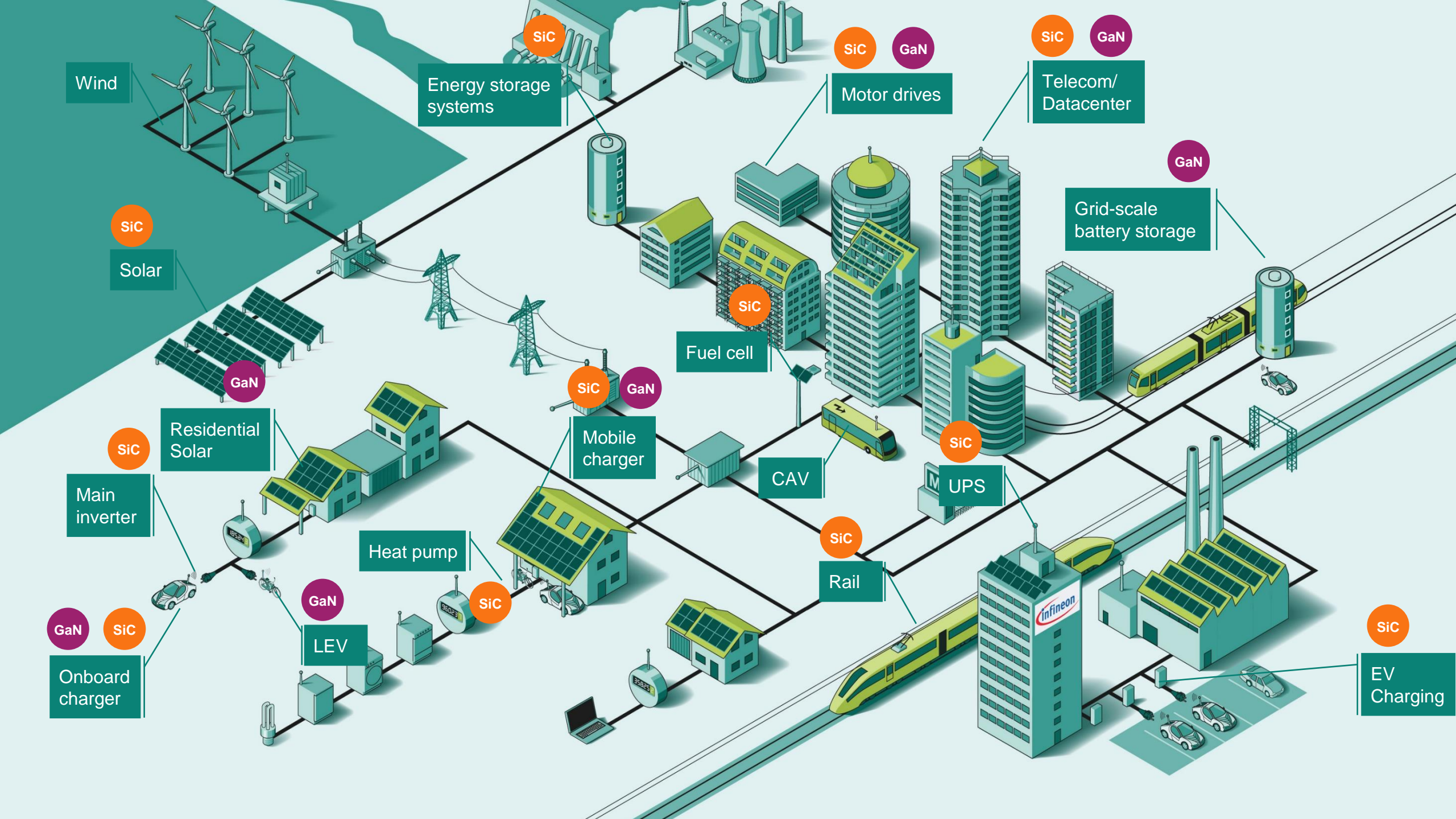


**2020**  
~2100 W/kg  
 $\eta_{\max}$  99.2%



**2023**  
~3000 W/kg  
 $\eta_{\max}$  99%

Courtesy: Kaco new energy GmbH, Sungrow



Wind

Energy storage systems

Motor drives

Telecom/  
Datacenter

SiC

Solar

GaN

Residential Solar

SiC

Main inverter

Heat pump

GaN

LEV

SiC

Onboard charger

GaN

SiC

SiC

Mobile charger

GaN

Fuel cell

SiC

CAV

UPS

SiC

Rail

SiC

GaN

Grid-scale battery storage

SiC

EV Charging

Infineon

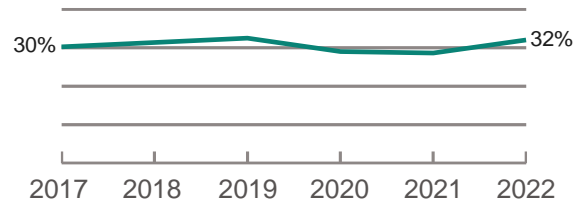
# Infineon has a consistent track record as a leading IGBT provider with unmatched competitiveness



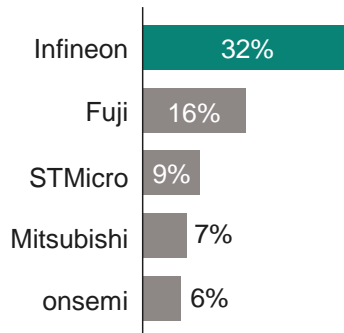
## Discrete IGBTs

Total market in 2022: **\$2.5 bn** (+14% vs. 2021)

### Market share development



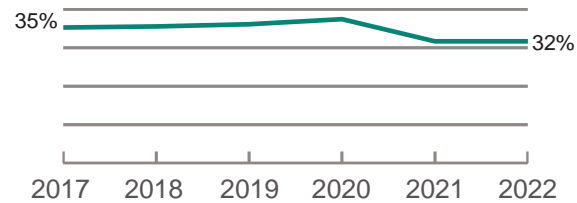
### Market share 2022



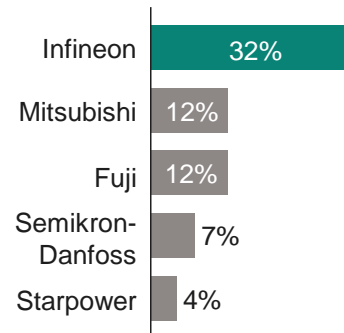
## IGBT modules<sup>1</sup>

Total market in 2022: **\$4.4 bn** (+2% vs. 2021)

### Market share development



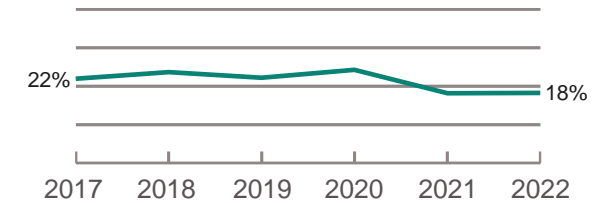
### Market share 2022



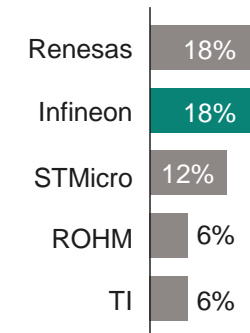
## Gate driver ICs

Total market in 2022: **\$2.1 bn** (+16% vs. 2021)

### Market share development

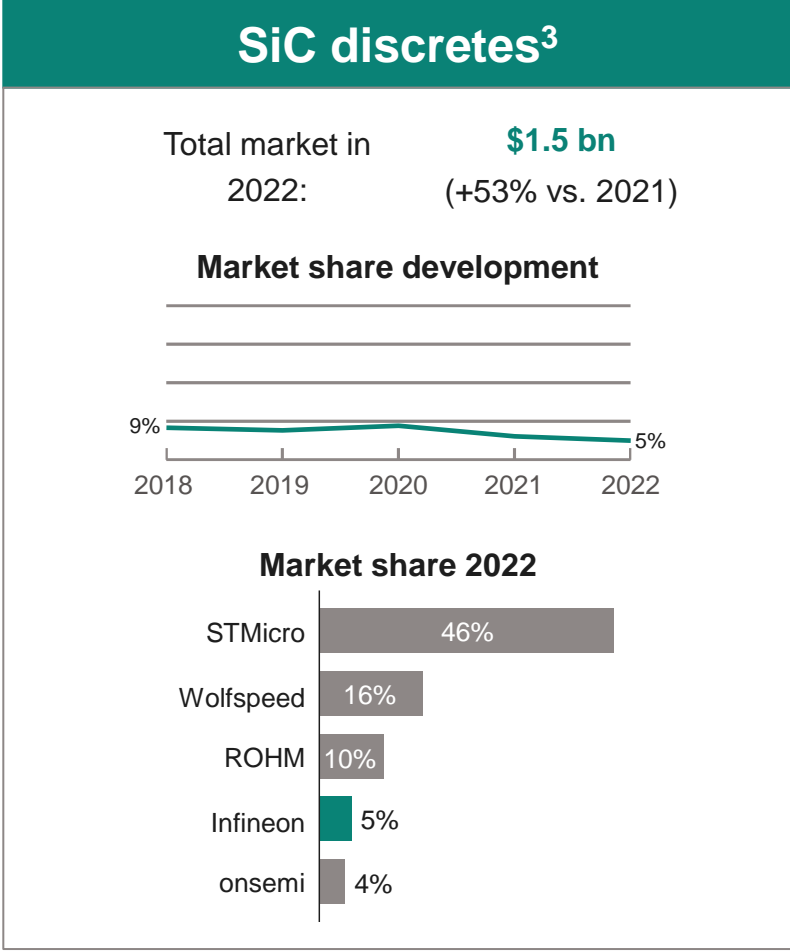
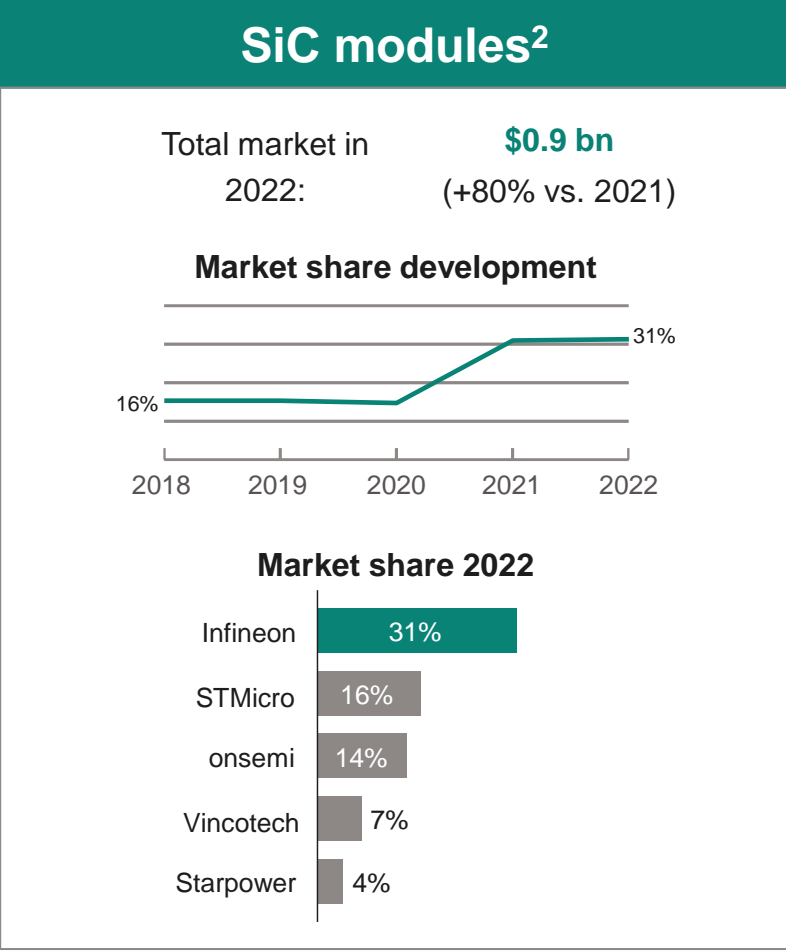
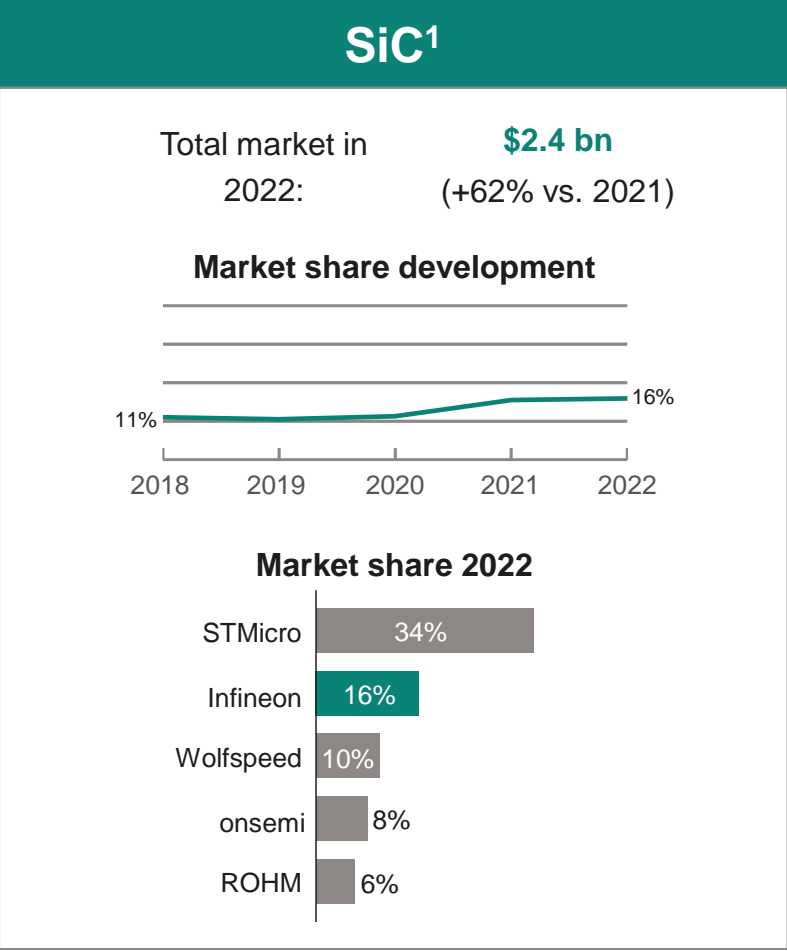


### Market share 2022



<sup>1</sup> Including standard (non-integrated) IGBT modules and power integrated modules (PIM)/CIB  
 Source: Based on or includes content supplied by Omdia, "Power Semiconductor Market Share Database 2022", Final Version V2 September 2023.  
 Results are not an endorsement of Infineon Technologies AG. Any reliance on these results is at the third party's own risk.

# Leading position in SiC modules, the fastest growing business



<sup>1</sup> Including SiC Rectifiers, SiC Power MOSFETs, SiC Hybrid Modules and SiC Full Modules | <sup>2</sup> Including SiC Hybrid Modules and SiC Full Modules | <sup>3</sup> Including SiC Rectifiers and SiC Power MOSFETs  
 Source: Based on or includes content supplied by Omdia, "Power Semiconductor Market Share Database 2022", Final Version V2 September 2023. Results are not an endorsement of Infineon Technologies AG. Any reliance on these results is at the third party's own risk

# Infineon has industry's most compelling SiC offering



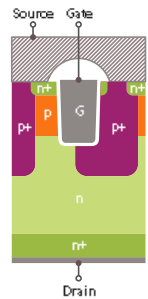
## SiC raw material supply + Cold Split technology

- More than 5 qualified SiC wafer and boule suppliers
- Increased productivity through Cold Split
- 200mm conversion project on track



## Superior trench technology

- 30% more chips per wafer than planar
- Unmatched reliability with zero field returns



## Packaging portfolio

- Best-in-class in-house packaging solutions
- New .XT technology for highest power density

## Deep system understanding

- Decades of experience
- Broadest portfolio: off-the-shelf plus customized solutions

## Customer trust and relationship



More than  
**3,600 active customers**  
being served





# CoolSiC™ – another great example for Infineon's quality leadership



## Defects per million (dpm) for GIP SiC products

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Data based on more than 23 million SiC power switches sold

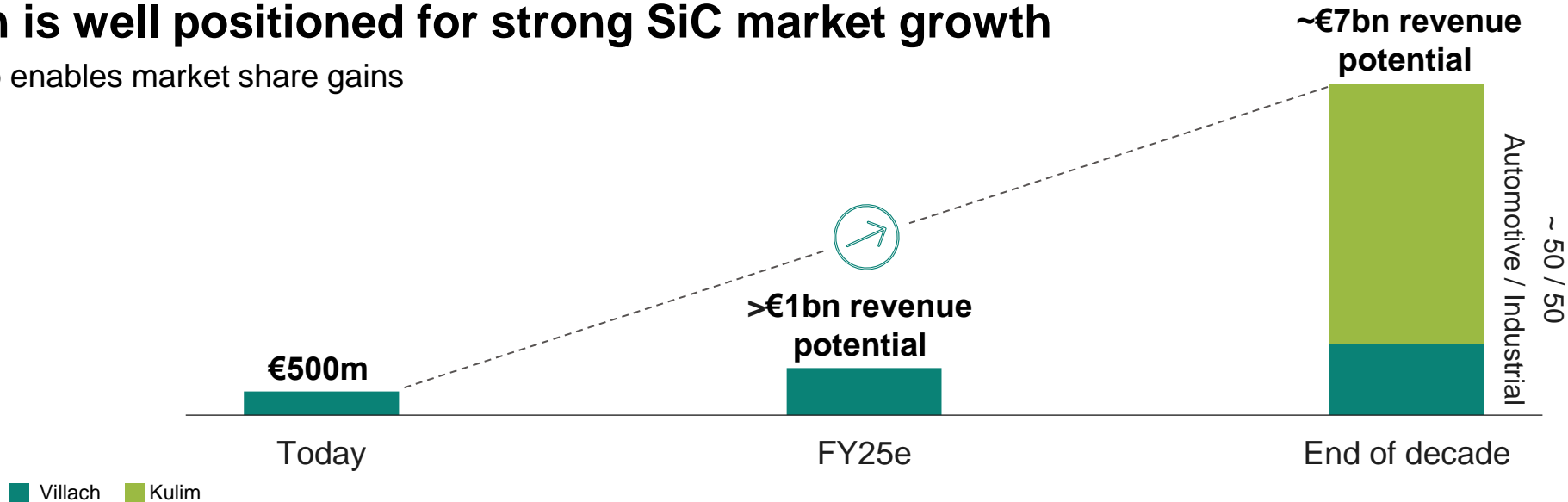
- Infineon's SiC power switches never caused any „spill“ or severe incident on customer side
- The product returns for SiC are even below silicon based power switches, a very mature technology.
- This counts for discrete devices as well as for power modules
- Infineon CoolSiC™ provides the same or even better quality level as silicon to our customers

# 30% market share target in SiC by end of decade underpinned by significant capacity expansion



## Infineon is well positioned for strong SiC market growth



Steep ramp enables market share gains







# Huge potential along entire green energy chain until 2030 according to IEA Net Zero scenario






## Generation

	Photovoltaic	<b>+4,600 GW</b>
	Wind power	<b>+1,900 GW</b>

## Infrastructure

	Grid network	<b>\$600bn annual investments</b>
	Grid storage	<b>+900 GW</b>
	EV charging	<b>+185m chargers (public and private)</b>
	Electrolysis	<b>+560 GW (pipeline: 170-365 GW)</b>

## Consumption

	Heat pump	<b>+420m units</b>
	H <sub>2</sub> Fuel cell <sup>1</sup>	<b>+200k FC EV +200k FC Trucks</b>
	eAviation   eMarine	

Note: Based on Net Zero Scenario (IEA) | Source: IEA, 1 Internal Analysis

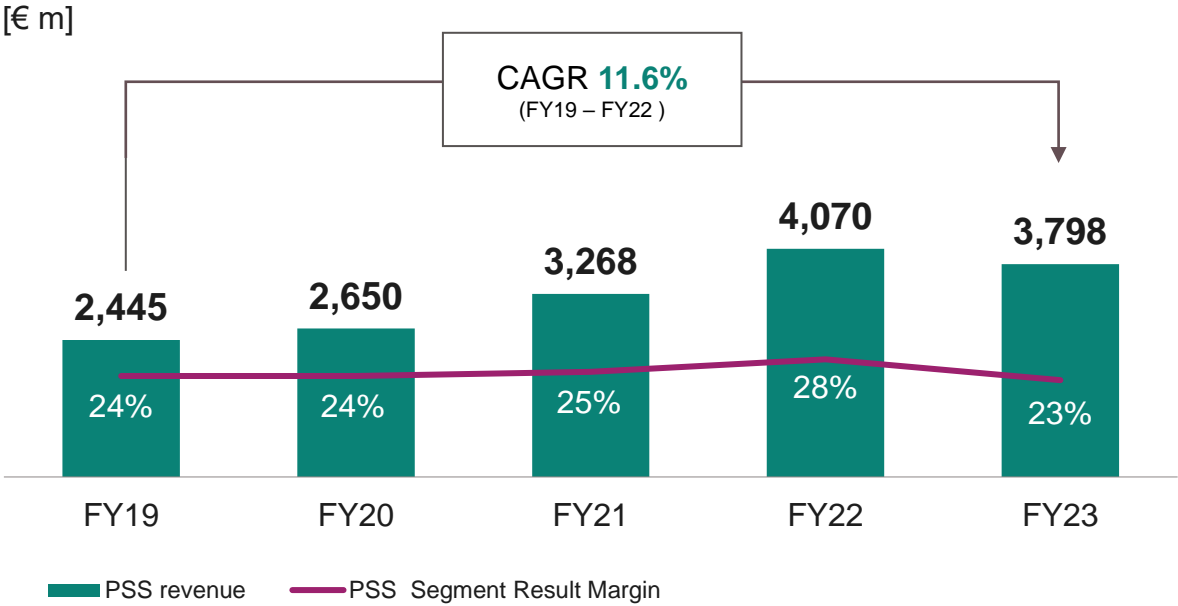
# Questions & answers



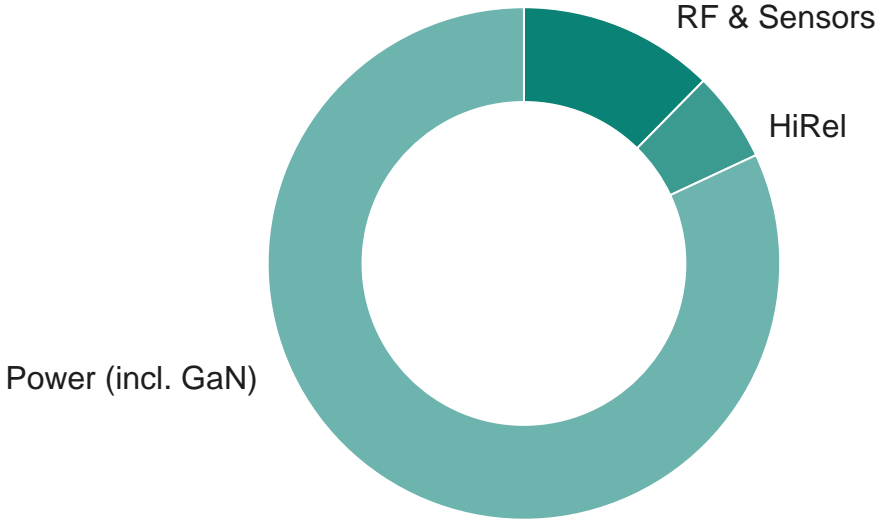
# Appendix

# PSS at a glance

## PSS revenue and Segment Result Margin



## FY23 revenue split by product group



## Key customers


# In PSS weakness in most verticals to persist with expected improvement during the course of CY 2024

## Applications

% of FY23 segment revenue<sup>1</sup>



**~15%**  
Computing



**~10%**  
Communications



**~7%**  
Smartphones



**~24%**  
Consumer



**~35%**  
Industrial

## Market Outlook for CY24



- Server weakness continues in 1<sup>st</sup> half CY24. In 2<sup>nd</sup> half market could return to growth. Server market growth benefits from AI opportunities due to increasing semi content
- PC market shipments are expected to recover in course of CY24, but still expected to remain below pre-pandemic levels



- Total telco capex is forecasted to be flattish and slightly negative in wireless
- Demand in 1<sup>st</sup> half CY24 expected to be weak with some upside potential in 2<sup>nd</sup> half



- In CY24 YoY growth in smartphone shipments expected. Recovery should increase momentum in 2<sup>nd</sup> half



- Weak macro environment and related inventory digestion expected to persist in 1<sup>st</sup> half CY24. Return to growth possible in the 2<sup>nd</sup> half

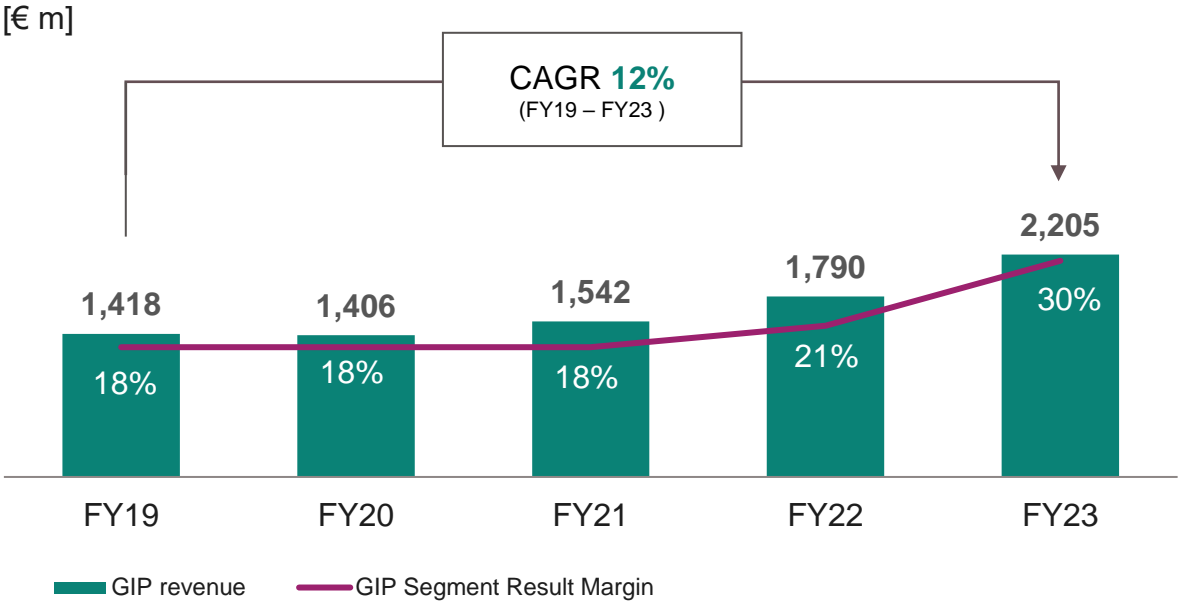


- Flattish YoY development expected as weakness in residential solar and automotive markets occurred towards end of CY23. This leads to a reduction in growth prospects

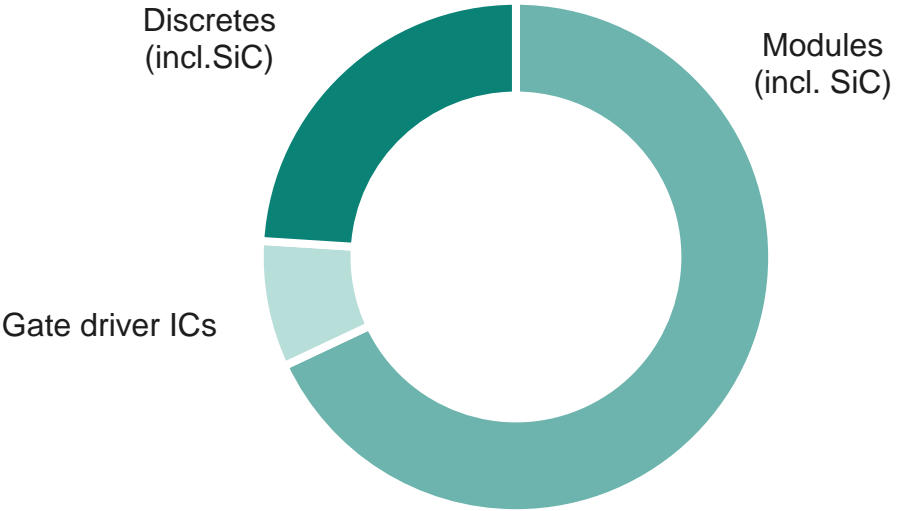
<sup>1</sup> Does not sum up to 100% due to other applications not shown here

# GIP at a glance

## GIP revenue and Segment Result Margin



## FY23 revenue split by product group



## Key customers





# Positive outlook in Green & Efficient Energy applications and moderate growth in Drives confirm positive GIP market outlook

## Applications

% of FY23 segment revenue<sup>1</sup>



**~26%**  
Renewable  
Energy  
Generation



**~11%**  
Power  
Infrastructure



**~12%**  
Transportation



**~28%**  
Automation  
& Drives



**~11%**  
Heating,  
Ventilation,  
Air condition



**~6%**  
Home  
Appliance

<sup>1</sup> Does not sum up to 100% due to other applications not shown here

## Market outlook for CY24



- Photovoltaic installations continue to grow supported by demand for green hydrogen
- Growth in wind installations mainly relies on onshore projects (85% onshore, 15% offshore)



- Growth in EV charging infrastructure is further fueled by government programs
- Grid requirements for expansion, modernization and flexibility drive growth in Transmission & Distribution as well as storage solutions



- Rail transportation units expected to grow high single digits
- E-bus outpacing EV adoption rate and rapid improvement in economics of e-trucks



- Market research expects to enter a period of adjustment with drives demand bottoming in H2 CY24
- Global diversification of manufacturing operations support midterm growth

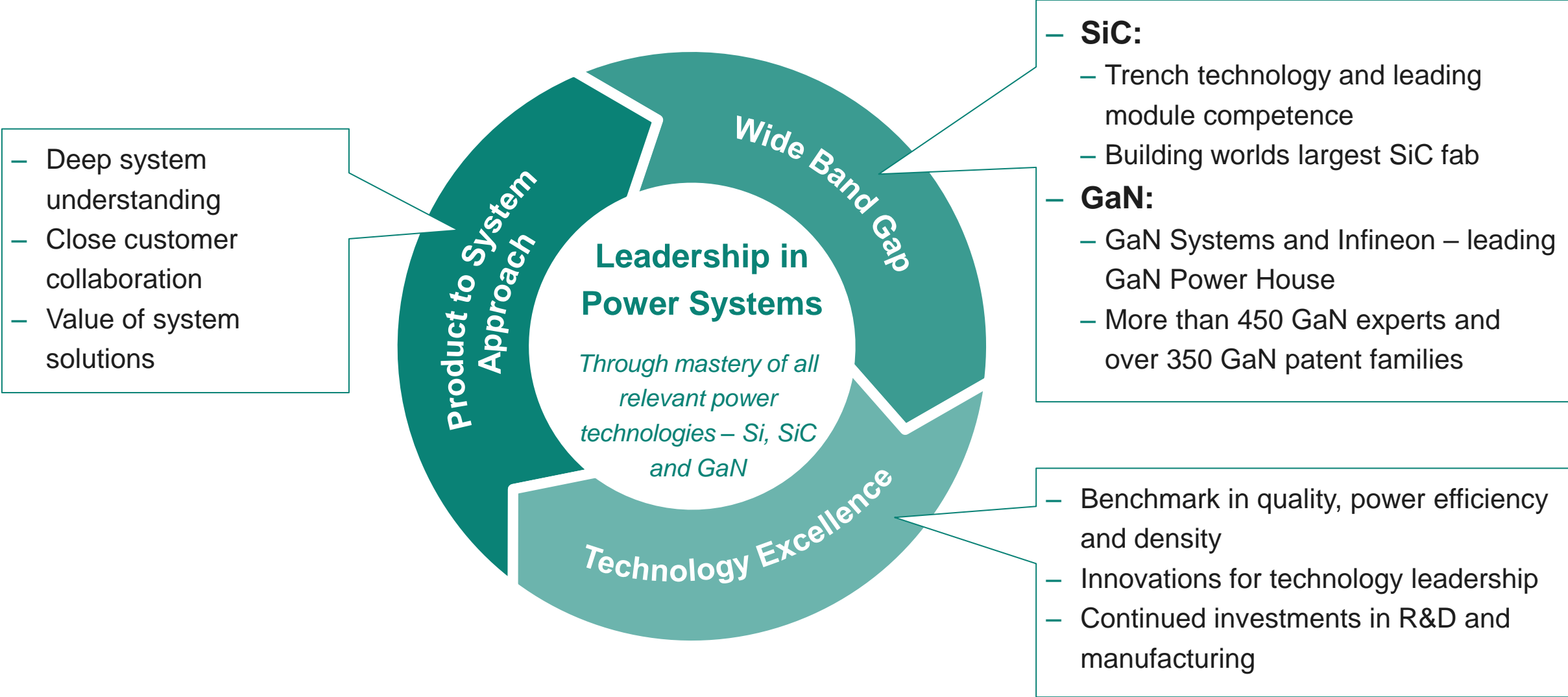


- Steady residential and commercial demand growth for air condition expected, government support for the housing in China would be an additional stimulus
- Focused policies in several countries support heat pump demand



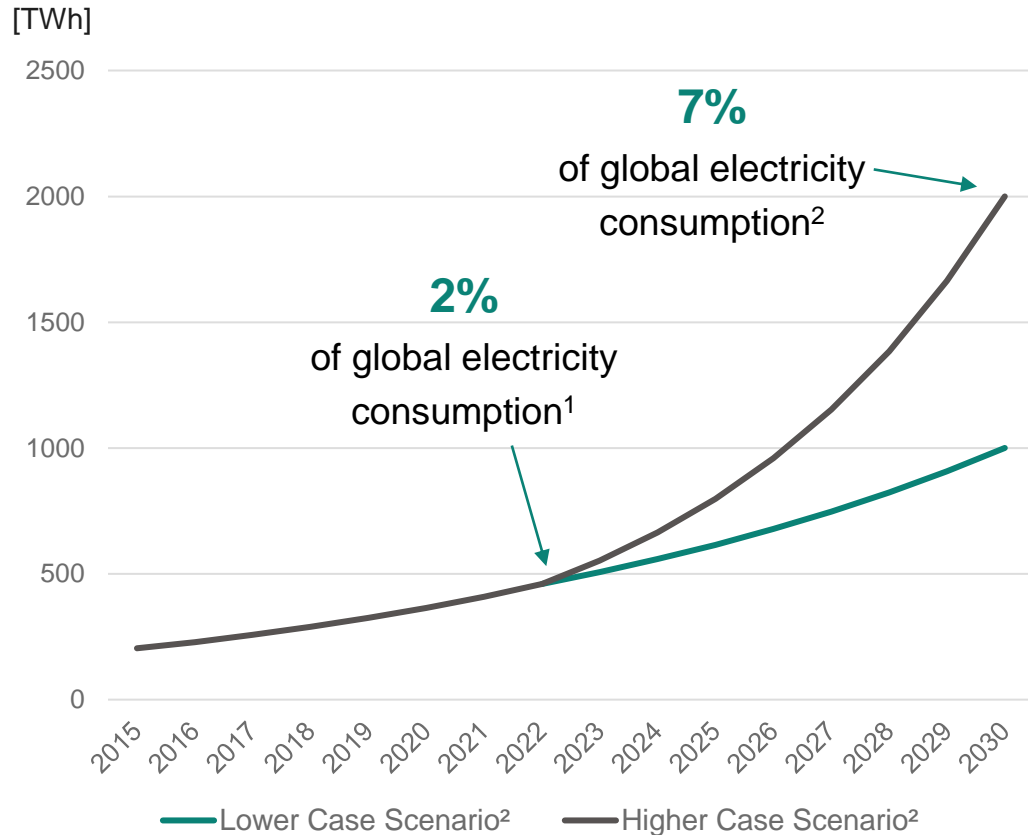
- Limited visibility for a recovery overall
- Green shoots in selected areas such as smart appliances

# Expanding our leadership in Power Systems



# AI accelerates power demand in data centers, increasing the need for energy efficient solutions

## Projected electricity consumption of data centers<sup>1,2</sup>



1 IEA; including crypto mining energy use – 2015-2022

2 Infineon assumption and calculation

3 McKinsey

Data centers' share of global final electricity demand was 2% in 2022<sup>1</sup>.

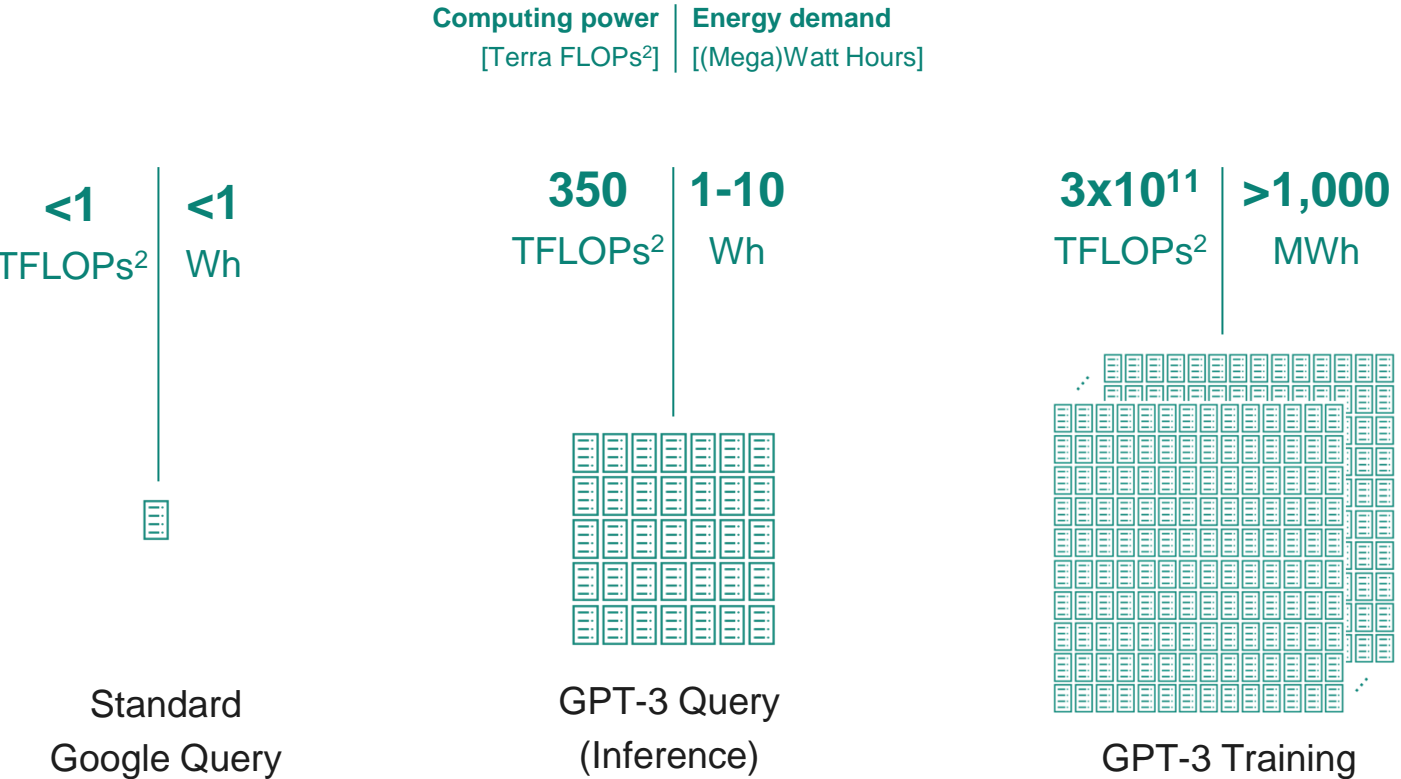
Example US: power consumption per Data Center is forecasted to grow by some 10% a year until 2030<sup>3</sup>.



Global energy saving potential per year if all data centers worldwide would use Infineon products: **48.3TWh<sup>2</sup>**  
( $\approx$  10bn USD electricity cost savings and 34.2 million metric tons CO<sub>2</sub> equivalent)

# Generative AI exponentially increases electricity demand

## Computing power and electricity demand in generative AI vs. a Google<sup>1</sup> query



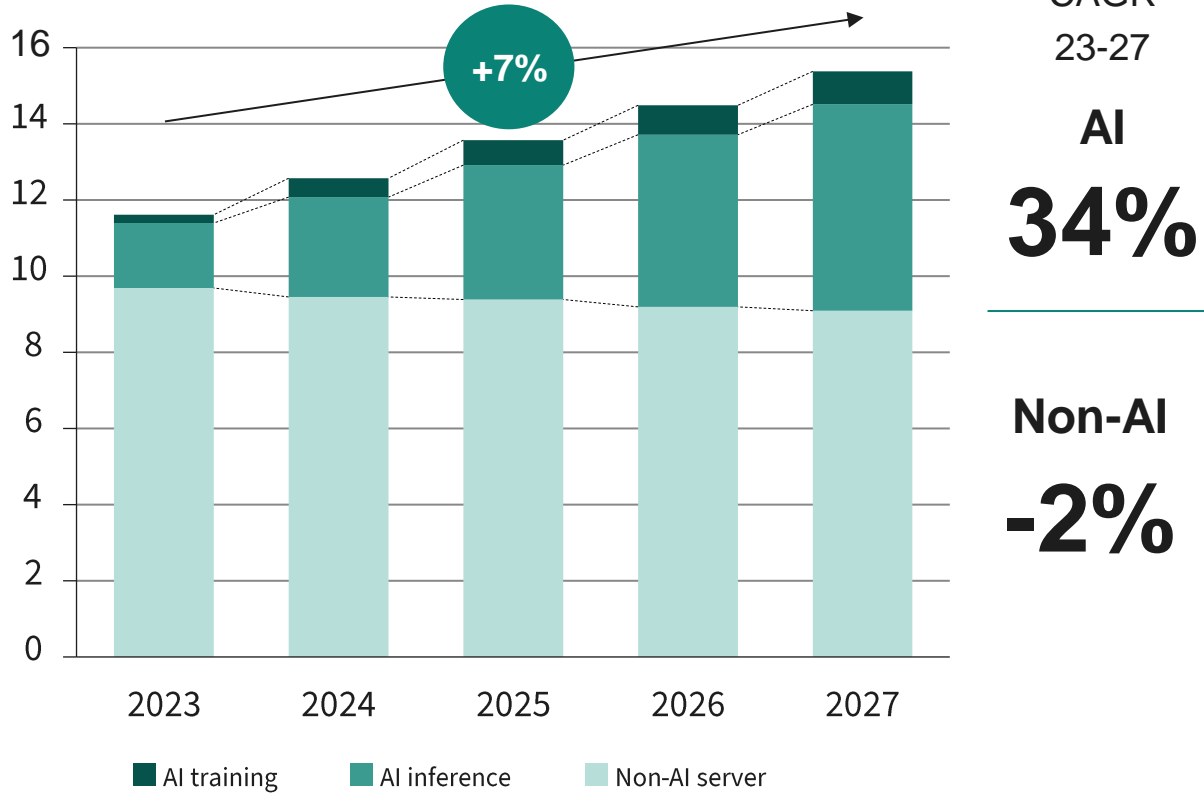
Power supply of an existing data center is limited in the medium term

Source: Company information; Statista 1 Google BERT algorithm 2 (Tera=10<sup>12</sup>) Floating Point Operations Per Second

# AI use cases drive substantial growth in server and AI cards

## Annual server shipments by workload type

[million units]



Surge in the server market will be driven by AI use cases

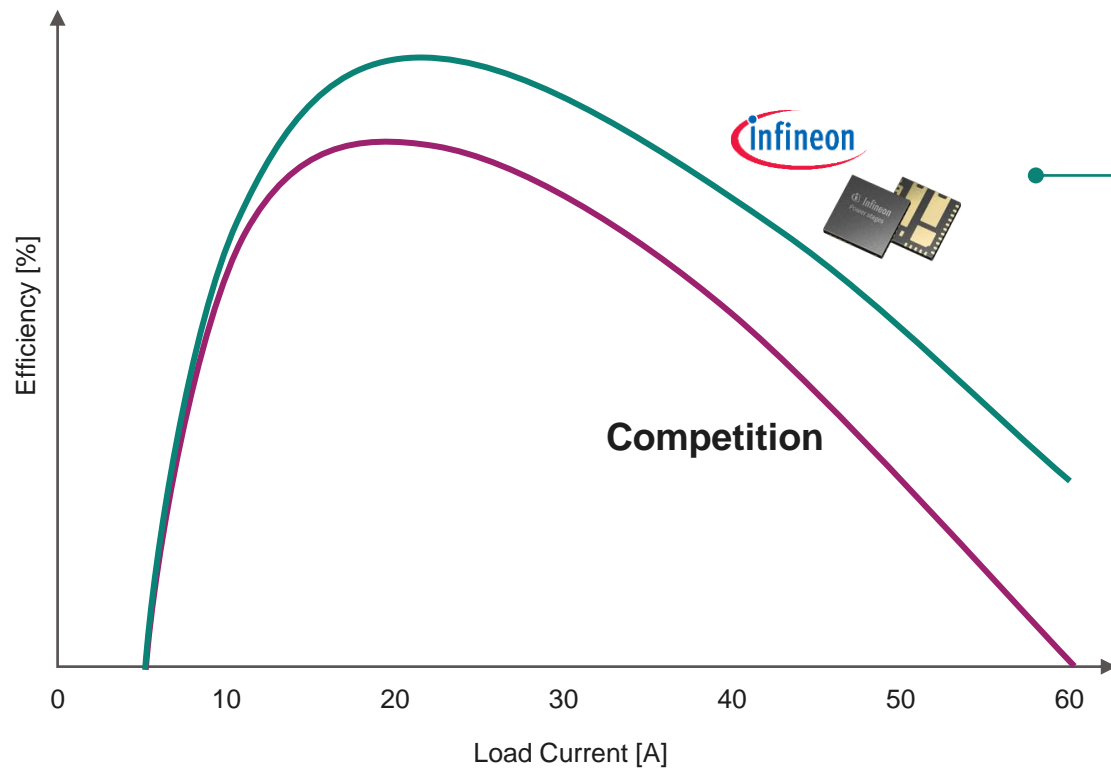
Today's AI training servers contain up to 8 AI cards, leading to 3x higher energy demand compared to traditional servers

The typical Infineon BOM content for an AI training server is up to ~15-20x higher (~850-1800 USD) compared to a traditional server (~65-80 USD)

Sources: Based on or includes content supplied by Omdia, "Long Range Server Forecast 2H23". Results are not an endorsement of Infineon Technologies AG. Any reliance on these results is at the third party's own risk; J.P. Morgan – assumptions for AI training share; Infineon analysis

# Leadership in server power is based on best-in-class performance in power stages

## Efficiency benchmark high current power stages



## Infineon's high current power stage



PQFN package with OptiMOS™ MOSFETs

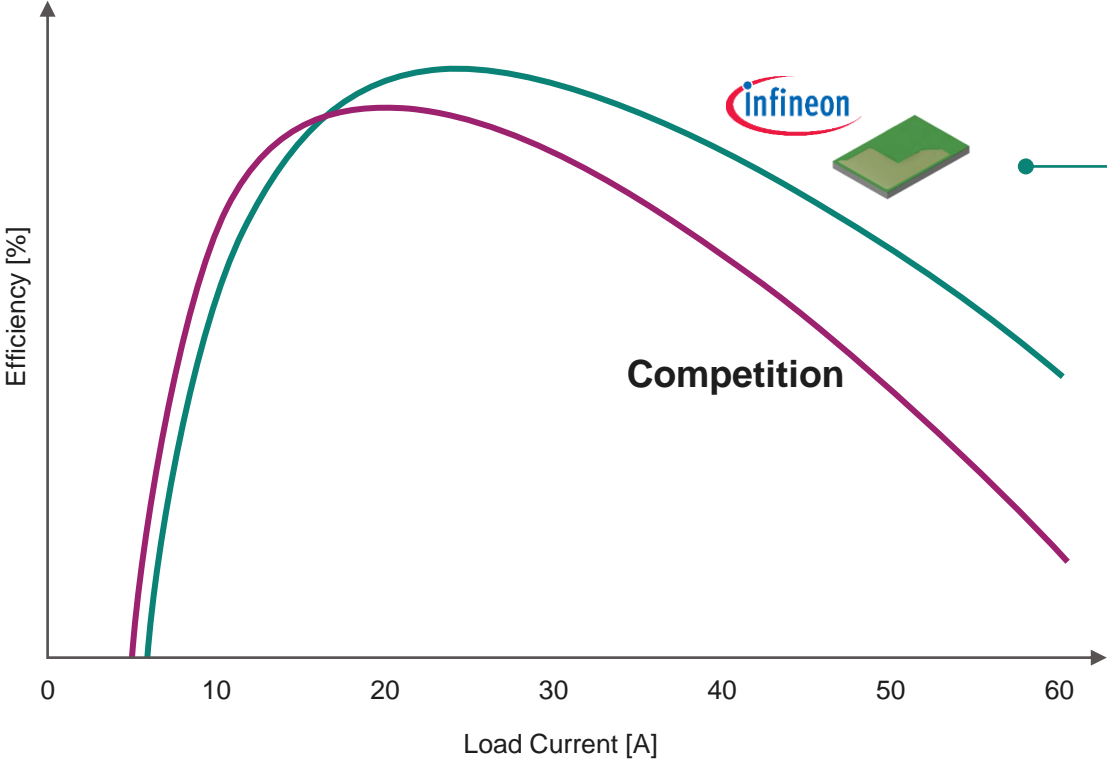


~15% higher power density vs. competition

Source: Infineon measurement

# Chip embedding enables highest power density

## Efficiency benchmark high density power stage



**Infineon's high density power stage**

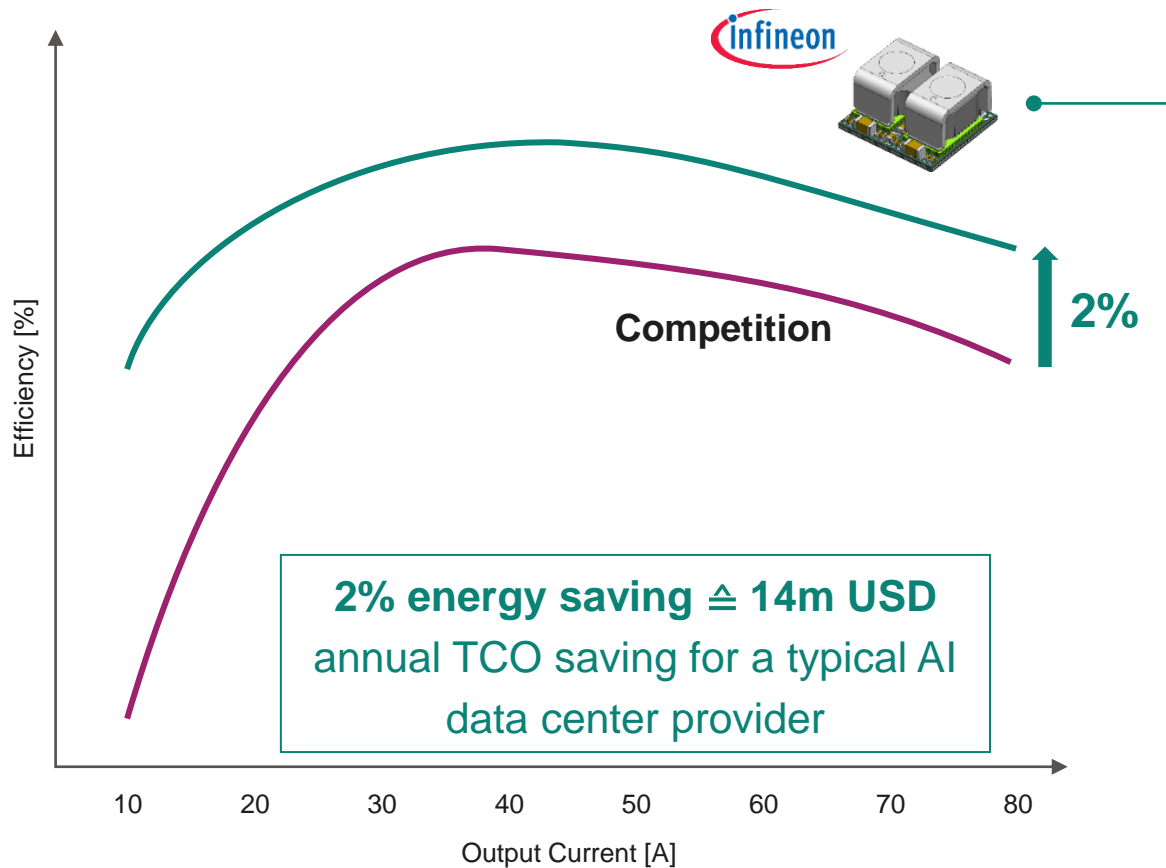
Chip embedding package with OptiMOS™ MOSFETs

~30% higher power density vs. competition

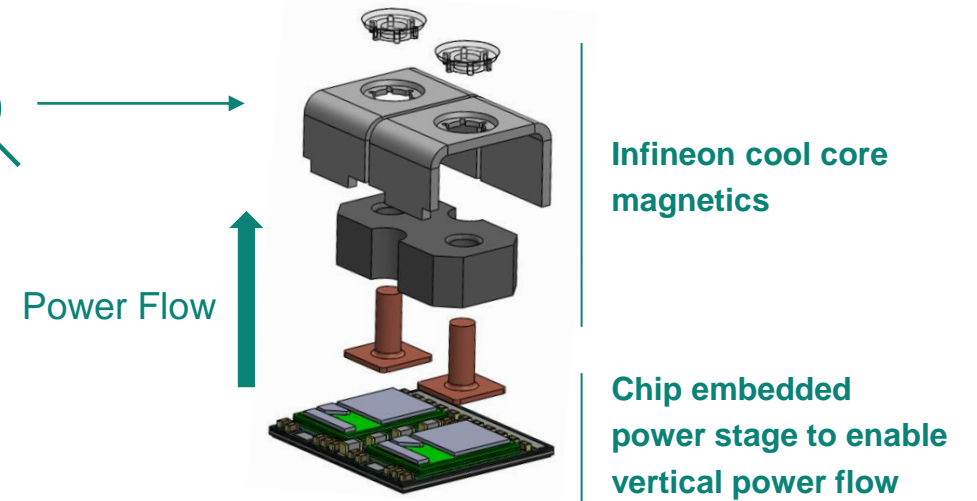
Source: Infineon measurement

# Best-in-class power density and quality through vertical power delivery solutions

## Efficiency benchmark power modules for AI



## Infineon's vertical power modules



- Novel inductor topology
- System IP
- Best-in-class electrical and thermal efficiency

Source: Infineon measurement and calculation



# We power greener AI, shaping the future with our solutions

*Technology can help us  
save the planet!*

**34.2 million**

metric tons

**CO<sub>2</sub> equivalent**

could be saved by using Infineon  
products in all data centers.



Sources: Infineon assumption and calculation (2022); [IEA](#)

## We master all...



**System innovation** with leading companies



Industry-leading **system and innovation expertise**



Best-in-class in **efficiency** and **lowest cost of ownership**

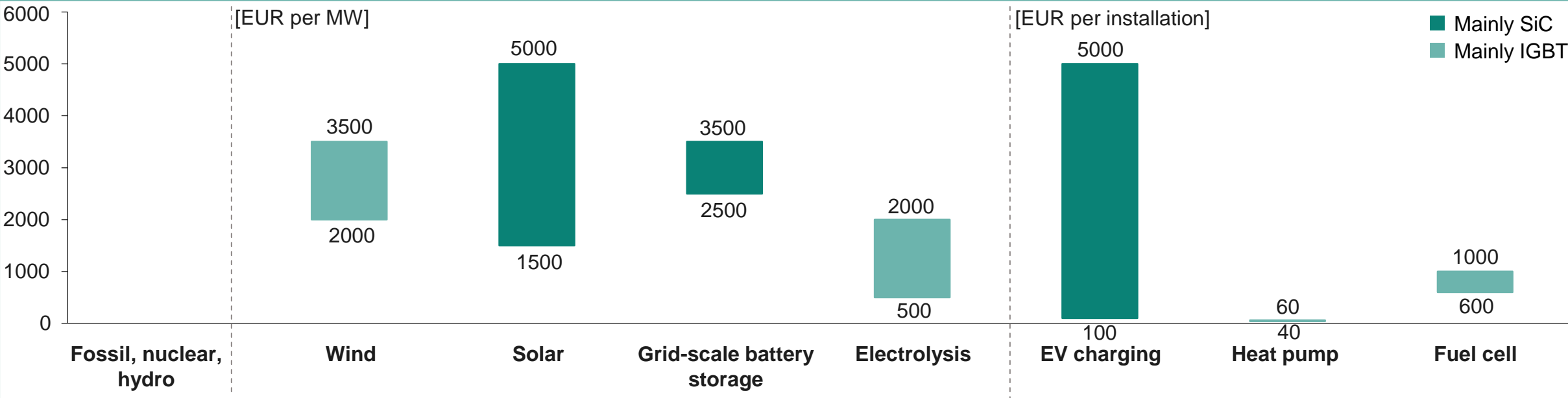


Full control of quality and supply- through **vertically integrated manufacturing flow**

Infineon is in a pole position to  
further grow market share!

# Green energy generation provides large business opportunities

## Power semiconductor content by application



<b>Additions in 2022<sup>1)</sup></b>	<b>74<sup>[GW]</sup></b>	<b>220<sup>[GW]</sup></b>	<b>12<sup>[GW]</sup></b>	<b>&lt;1<sup>[GW]</sup></b>	<b>~6m<sup>[inst.]</sup></b>	<b>22m<sup>[inst.]</sup></b>	<b>5k<sup>[inst.]</sup></b>
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<b>CAGR 2023 – 30</b>	<b>16%</b>	<b>23%</b>	<b>56%</b>	<b>92%<sup>2)</sup></b>	<b>31%</b>	<b>16%</b>	<b>42%</b>
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1) IEA: Net Zero by 2050 – A Roadmap for the Global Energy Sector. May 2021; Sector Tracking reports September 2022; internal Analysis  
 2) Based on 270 GW pipeline (midpoint), >100% based on NZE requirements of 560GW

# Adam White, Division President Power & Sensor Systems



## Adam White

was born in the United Kingdom in 1974.

He holds a Diploma in Engineering, Electronic and Electrical Engineering with Industrial, BEng (Hons) DIS from University of Loughborough, United Kingdom.

### 1996 – 2010

Various R&D, Operations, Marketing, Sales and Management positions, International Rectifier

### 2010 – 2015

Executive Officer & SVP Worldwide Sales<sup>1</sup>, International Rectifier

### 2015 – 2022

Chief Marketing Officer<sup>1</sup> of Power & Sensor Systems Division, Infineon

(Adam White became a part of Infineon 2015 in light of the acquisition of International Rectifier)

### Since 2022

Division President Power & Sensor Systems, Infineon



## Dr. Peter Wawer

was born in Berlin, Germany, in 1967.

He holds a Diploma in Electrical Engineering from the Technical University in Berlin where he also received his PhD.

He joined Infineon (Siemens AG until 1999) in 1997.

### 1997 – 2008

Various positions  
at Infineon

### 2008 – 2011

Senior VP Technology  
at Q-Cells SE

### 2011

Senior VP Technology  
and Production at Q-  
Cells SE in Bitterfeld,  
Germany

### 2012

Member of the  
Management Board  
of the Power  
& Sensor Division  
(Power Management  
& Multimarket Division  
at that time)

### Since 2016

Division President  
Industrial Power  
Control

# Disclaimer

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## Disclaimer

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