



Industrial Power Control Business Update

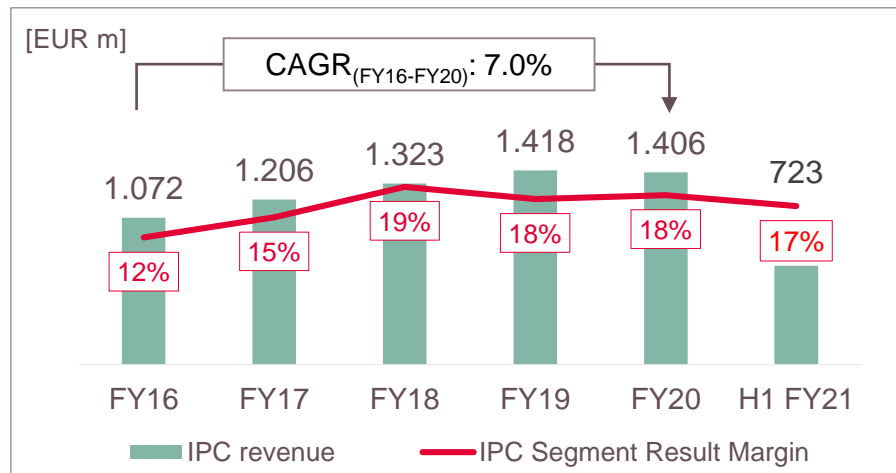
6 May 2021

Dr. Peter Wawer, Division President Industrial Power Control
Dr. Peter Friedrichs, Vice President Silicon Carbide

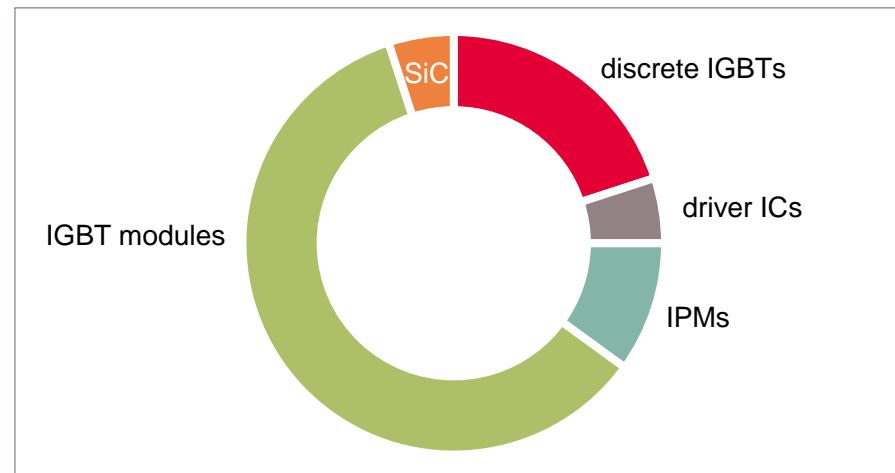


IPC at a glance

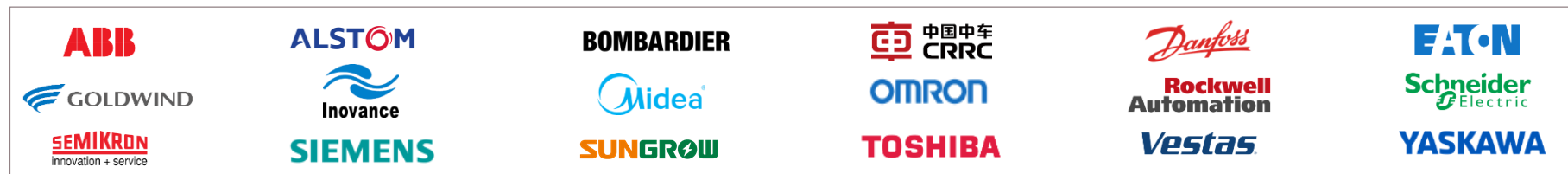
IPC revenue and Segment Result Margin









FY20 revenue split by product group



Key customers



Market outlook for IPC division's target applications

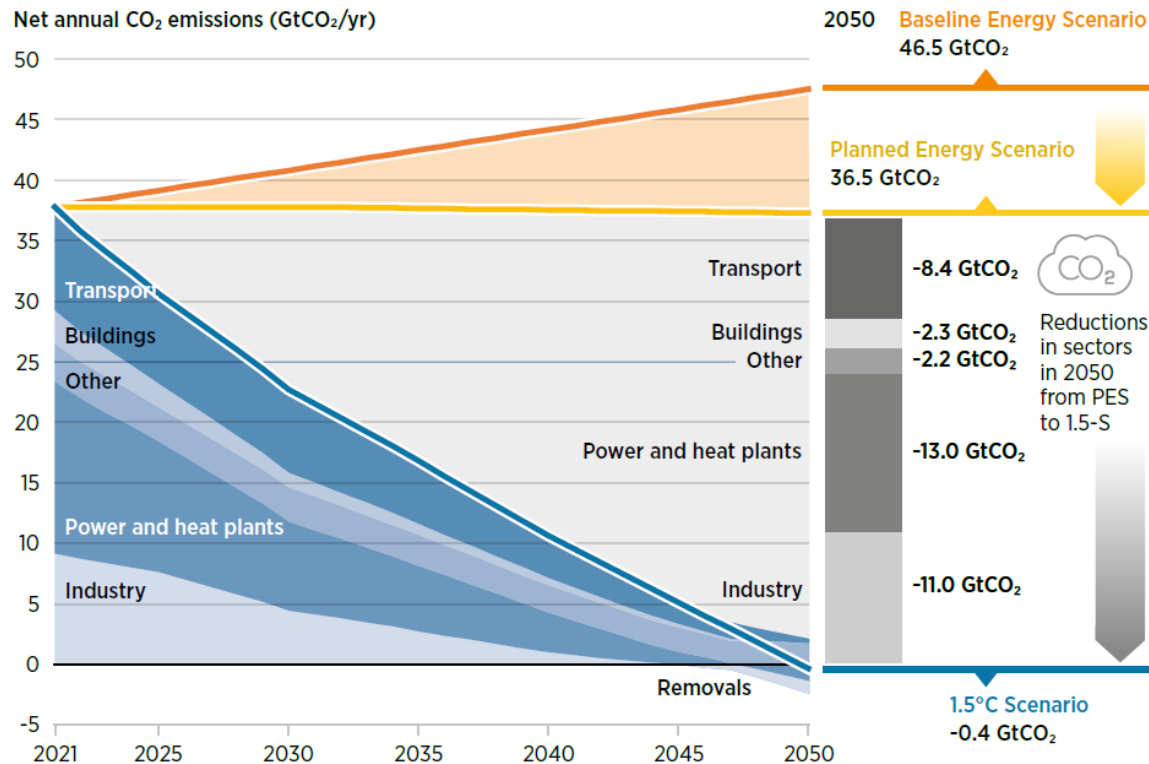
Applications (% of FY20 segment revenue)	Market Outlook for CY21	
<div>Automation and Drives</div> <div>~30%</div>		› Industrial Drives recovering in high single digits with demand growing mainly in GC region
<div>Renewables</div> <div>~24%</div>		› Wind: installations forecasted to increase to all-time-high › PV: market forecast continuously corrected upward
<div>Home appliance</div> <div>~16%</div>		› Catch-up of delayed purchases and energy efficiency incentive programs will drive growth
<div>Transportation</div> <div>~13%</div>		› Diminished COVID-related travel activities caused further push-out of construction of passenger trains and e-Busses
<div>Power Infrastructure</div> <div>~9%</div>		› Growing demand in EV charging infrastructure, Industrial UPS and energy storage systems › Delays in Transmission & Distribution projects
<div>Others</div> <div>8%</div>		› Growth driven by general market recovery



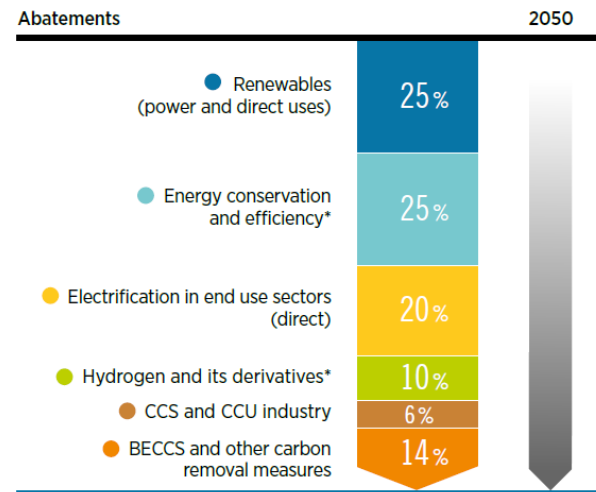
Clean energy



Infineon will profit from all CO₂ saving measures needed to reach the goals of the Paris Climate Agreement

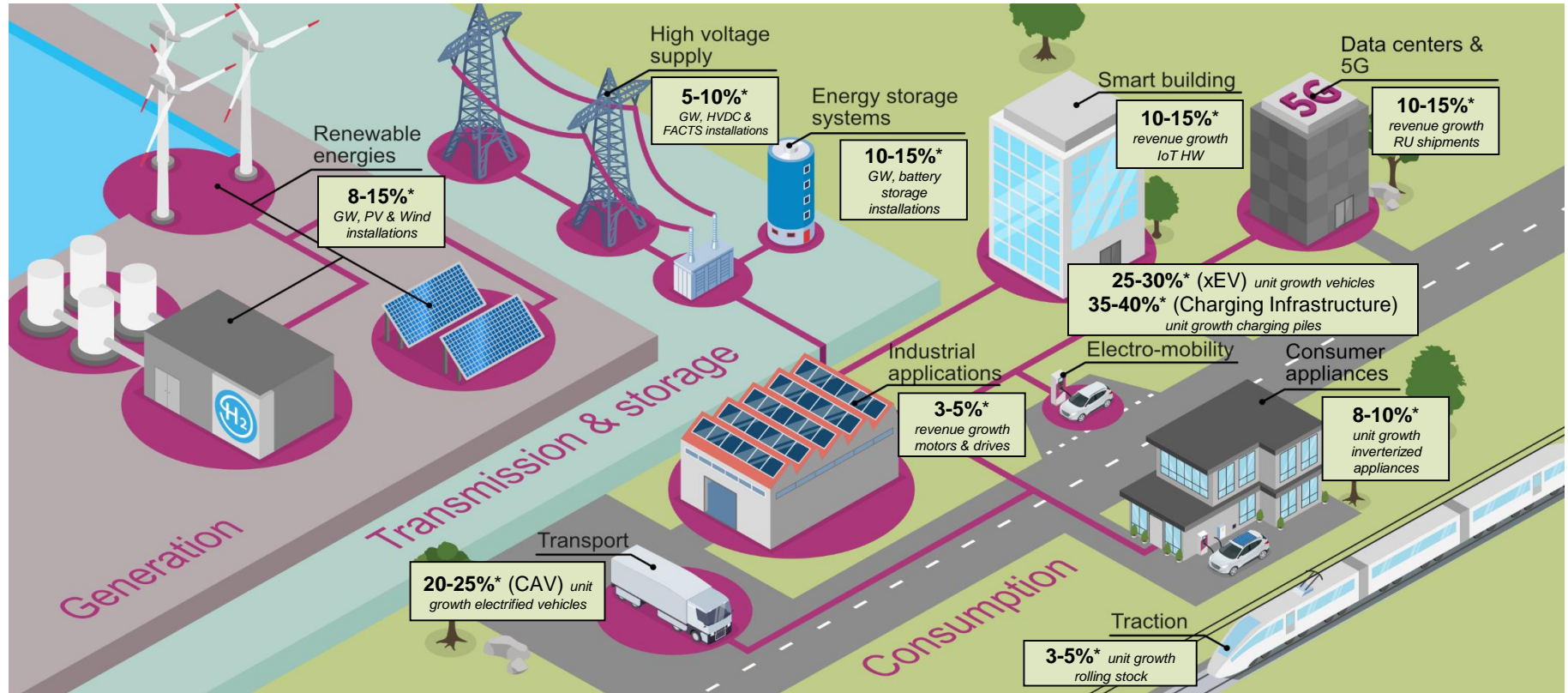


For the 1.5°C climate target, global CO₂ emissions need to drop to net zero by 2050



Source: IRENA, „World Energy Transitions Outlook, 1.5°C, Preview“

Along the energy conversion chain, Infineon develops technologies that are directly linked to megatrends



* CAGR 2020 – 2025

Infineon serves all applications in the field of renewable energy

Onshore



- › Application: Full Converter & Partial/DFIG* converter based wind turbine
- › Output: 1 MW – 6 MW
- › Power semi content: €2,000 - €3,250 per MW

Offshore



- › Application: Full Converter based wind turbine
- › Output: 3 MW – 14 MW
- › Power semi content: €3,250 - €3,500 per MW

HVDC**



- › Application: HVDC - VSC
- › Output: 100 MW – 4 GW
- › Power semi content: €5,200 - €18,000 per MW

String inverter



- › Application: residential, commercial and utility-scale PV plants
- › Output: 1 kW – 200 kW
- › Power semi content: €2,500 – €5,000 per MW

Central inverter

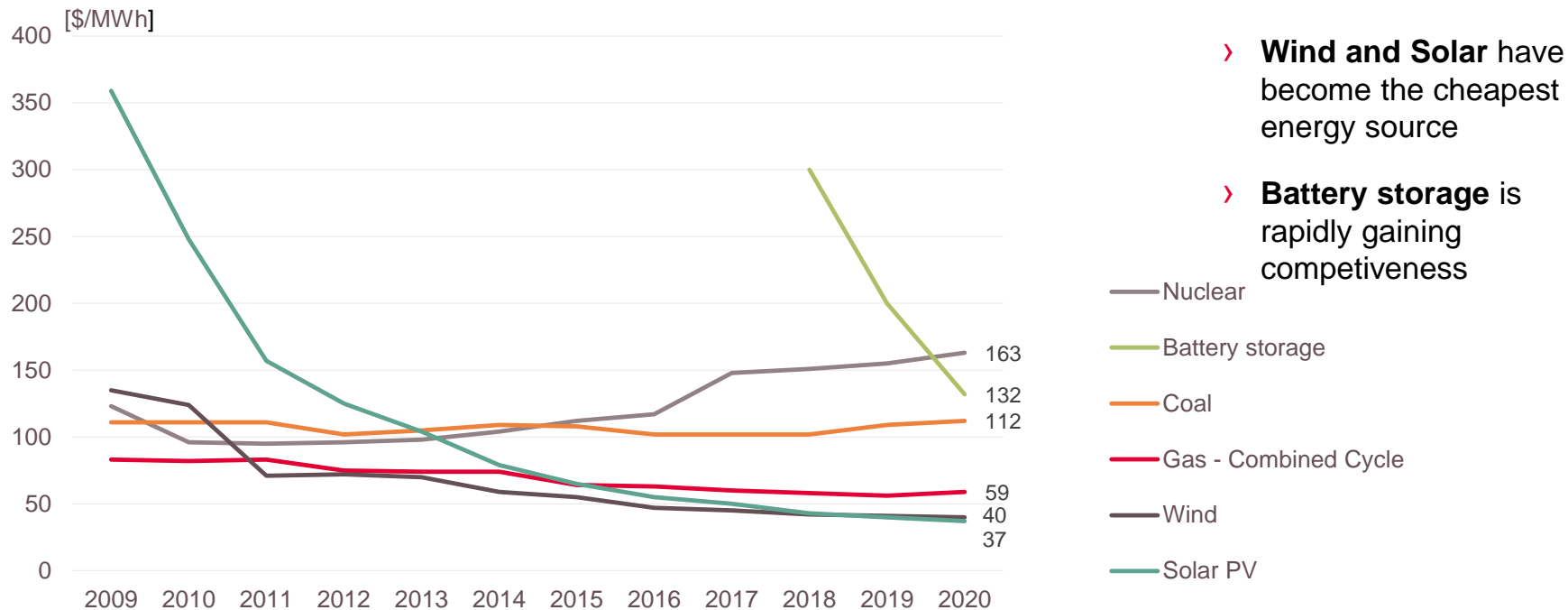


- › Application: utility-scale PV plants
- › Output: 600 kW – 1,250 kW
- › Power semi content: €2,000 – €3,000 per MW

* DFIG – Doubly fed induction generator ** HVDC - High-voltage direct current transmission

Renewables growth supported by constantly falling LCOE

Selected Historical Mean Unsubsidized Levelized Cost of Energy Values (LCOE)



› **Wind and Solar** have become the cheapest energy source

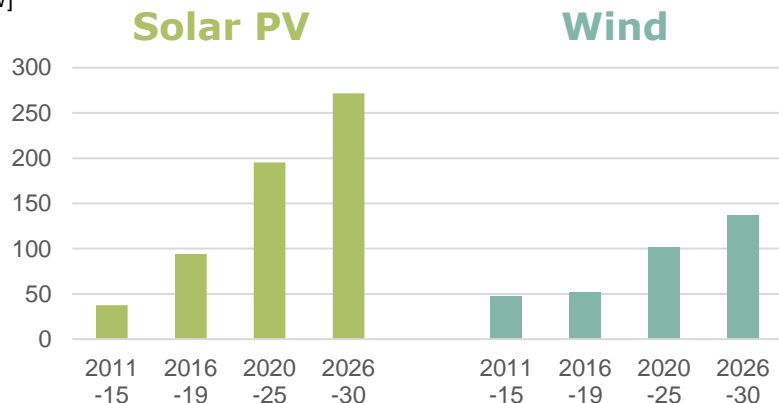
› **Battery storage** is rapidly gaining competitiveness

Source: Lazard: "Lazard's levelized cost of energy analysis – version 14.0"; Bloomberg: "BNEF Executive Factbook"

We are the #1 semiconductor enabler of renewable energies

Average annual solar PV and wind capacity additions

[GW]



Source: International Energy Agency: "World Energy Outlook 2020", Average annual solar PV and wind capacity additions in the Sustainable Development Scenario to 2030 p. 109

All leading renewable energy players are our customers*

PV inverter¹⁾

- 1 | Huawei
- 2 | Sungrow
- 3 | SMA
- 4 | Power Electr.
- 5 | Solar Edge
- 6 | ABB
- 7 | TMEIC
- 8 | Sineng Electric
- 9 | Growatt
- 10 | Ginlong

Wind²⁾

- | | |
|--------------------|---|
| ✓ 1 Vestas | ✓ |
| ✓ 2 SGRE | ✓ |
| ✓ 3 GE | ✓ |
| ✓ 4 Goldwind | ✓ |
| ✓ 5 Enercon | ✓ |
| ✓ 6 Nordex Group | ✓ |
| ✓ 7 Envision | ✓ |
| ✓ 8 Mingyang | ✓ |
| ✓ 9 United Power | ✓ |
| ✓ 10 Suzlon | ✓ |

* Infineon is serving the top-10 of each category but not necessarily as a sole supplier.

Source: 1) by shipped capacity in MW: based on or includes content supplied by IHS Markit, Technology Group: "PV Inverter Market Tracker – Q3 2020". October 2020.

2) WoodmacKenzie: "Wind Turbine OEM Market Share". November 2020

Enabling Technologies



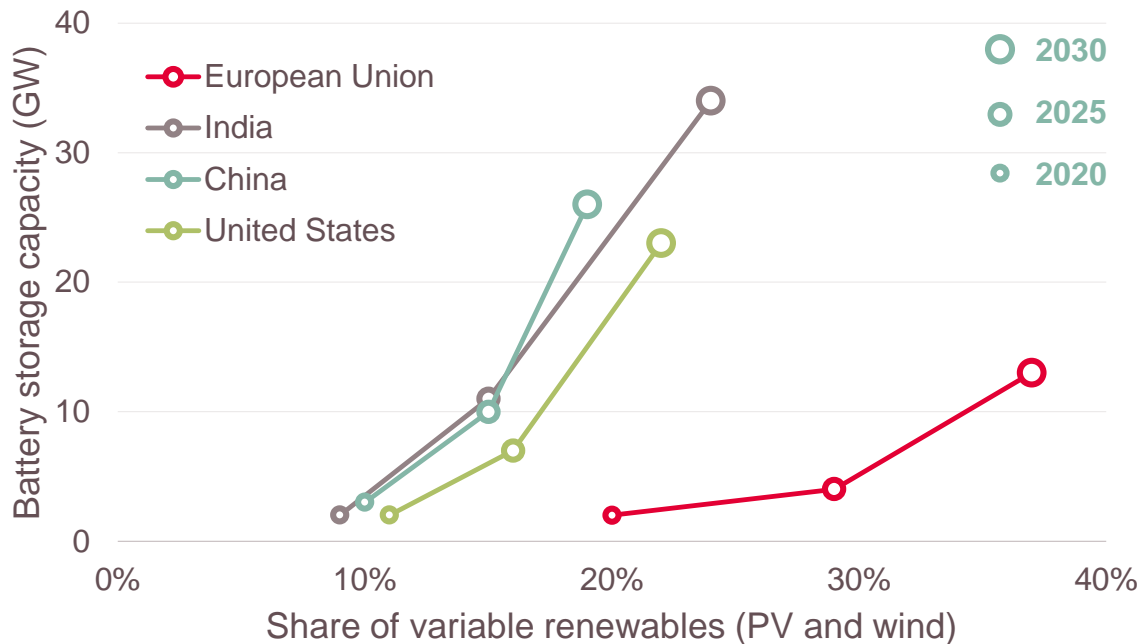
- > Reduces system size
- > Reduced power losses up to 50% compared to a traditional IGBT



- > Increased lifetime of power products
- > Highest reliability and performance

Energy storage is essential to further deploy decentral and renewable energy generation

Battery storage capacity and share of variable renewables¹⁾



Key drivers

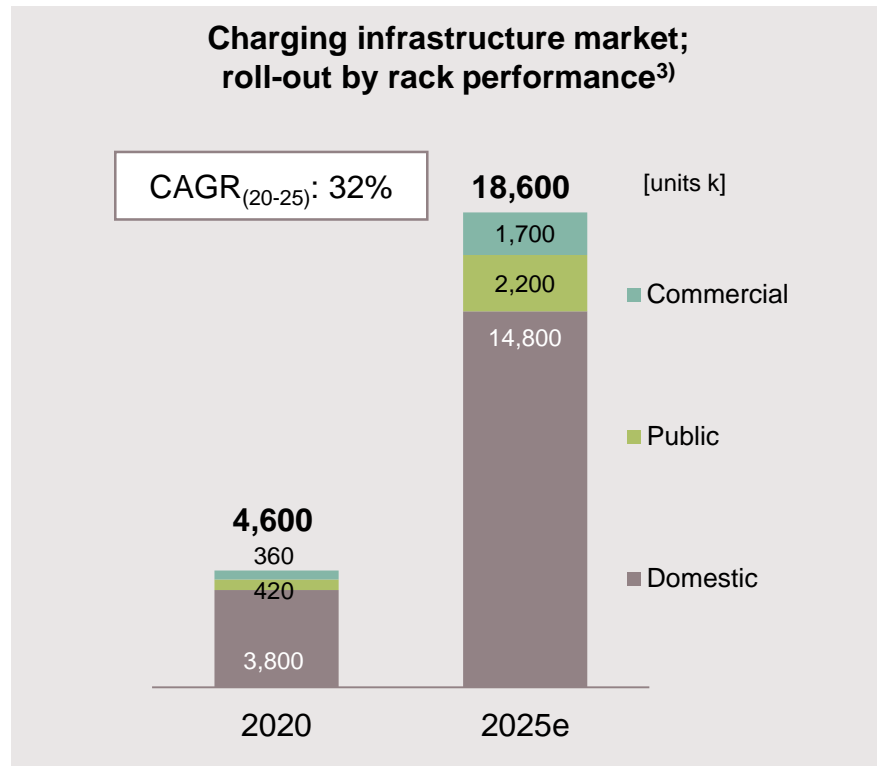
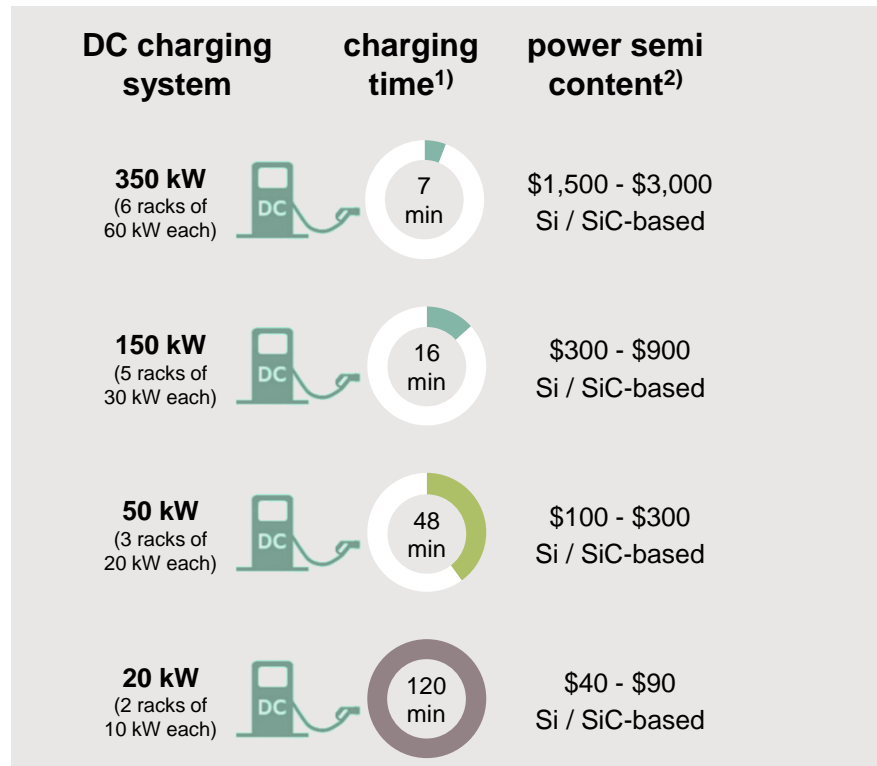
- › **Decentralization** of power generation
- › **Peak shaving** of energy generation and energy consumption
- › **Limited capacity** and flexibility of today's grids
- › **Reduction of standby cost** of fossil power plants

~€3,200 of power semiconductor content per MW of installed energy storage capacity²⁾

1) International Energy Agency: "World Energy Outlook 2020", p. 248; variable renewables consist of solar and wind energy.

2) Infineon estimate

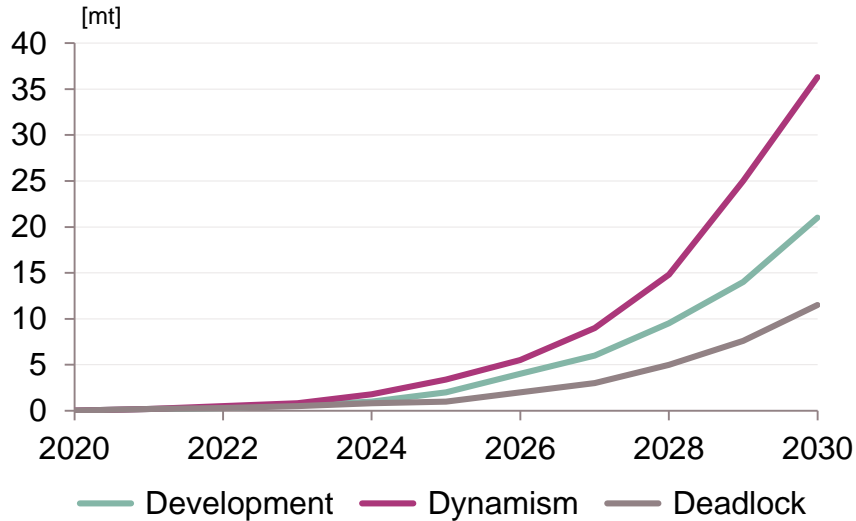
Growing penetration of electric vehicles will drive roll-out of charging infrastructure



1) Charging time for 200 km 2) Infineon estimates per charging pole 3) Based on or includes content supplied by IHS Markit Automotive: "EV Charging Infrastructure Forecast". April 2020
Subunit: A power electronic arrangement build from both active and passive components to convert AC input to dedicated DC output. Often referred to as "module".

Green hydrogen is bound to become an important pillar in decarbonization

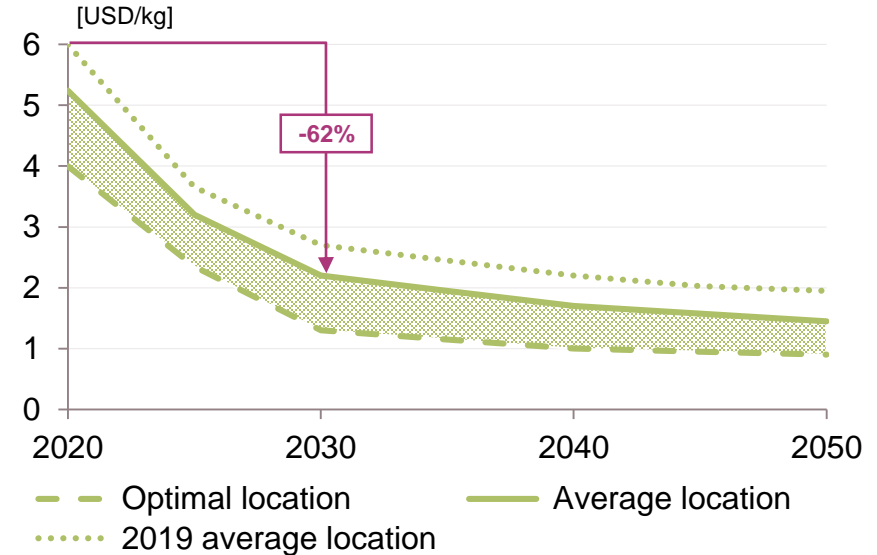
Demand scenarios for green hydrogen



- › **Cost reduction** - for the electrolyser and renewable energy
- › **Massive government support / regulation** – several governments ranging from Chile to China announced hydrogen strategies

Source: Barclays Research Estimates: „European Energy Services, Green H2“, 2021

Production cost of green hydrogen

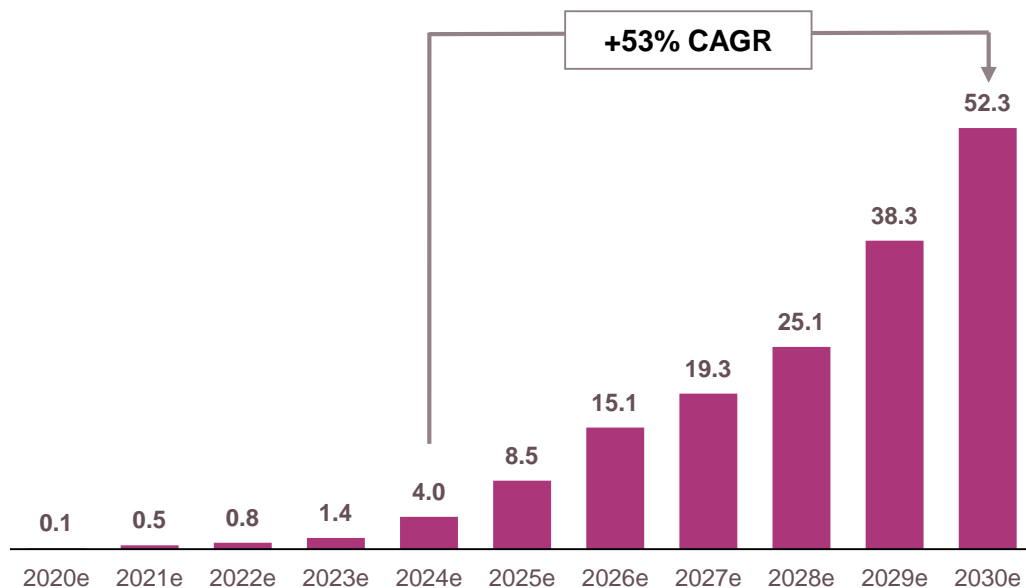


Source: Hydrogen council: “Hydrogen Insight”

Electrolyser require power semiconductors

2020-30e electrolyser installations (development scenario)

[GW]



Old technology with much room for improvement

- › **Cost reduction for the electrolyser** – economies of scale in module manufacturing and process technology
- › Several private initiatives are pushing H₂ e.g. the “Green Hydrogen Catapult”^{*} targets the deployment of **25 GW through 2026** of renewables-based hydrogen production, with a view to halve the current cost **to below \$2/kg.**

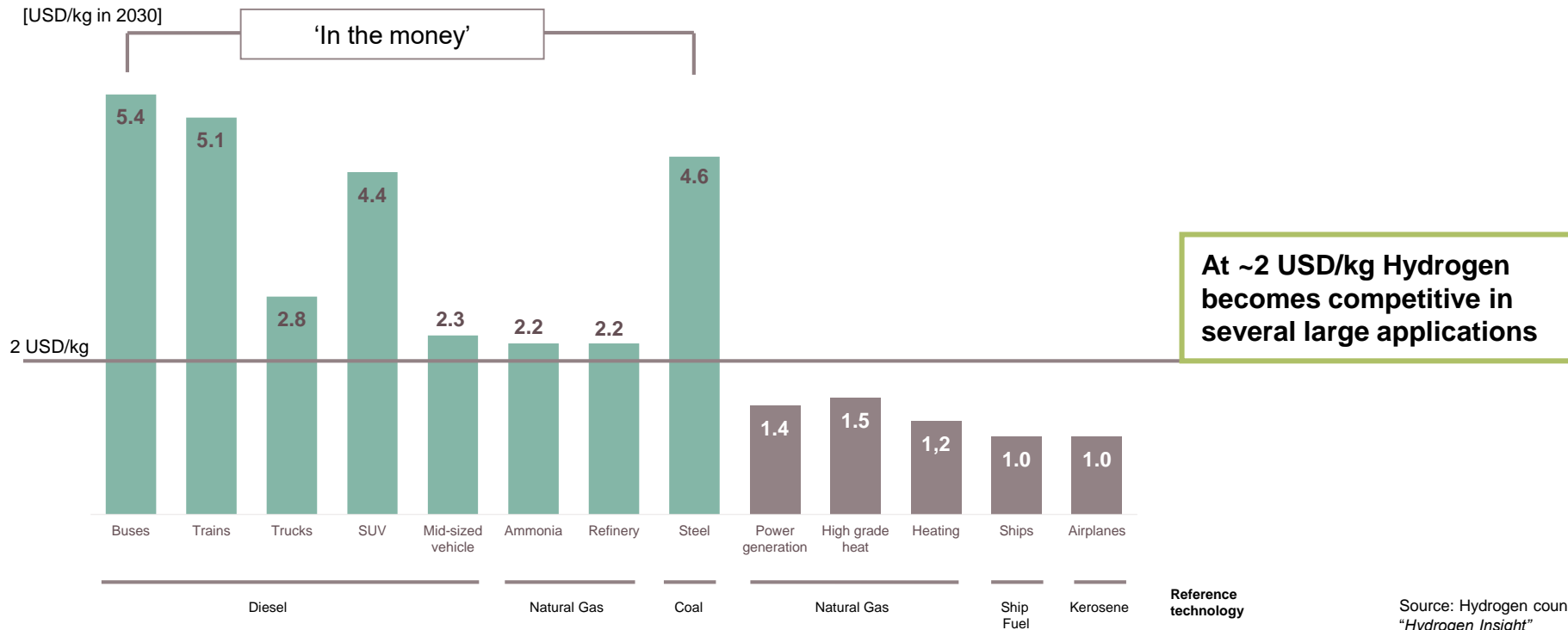
~€2,000 – €3,500 of power semiconductor content per MW of installed electrolyser capacity

Source: Barclays Research Estimates: „European Energy Services, Green H2: 150x bigger in 10 years”, 2021

^{*}Founding partners include: ACWA Power, CWP Renewables, Envision, Iberdrola, Ørsted, Snam, and Yara

Hydrogen as a substitute for fossil energy will become a feasible option

Required hydrogen production cost for breakeven with conventional solutions, with 100 USD/t CO₂e



Source: Hydrogen council:
"Hydrogen Insight"

There are further emerging applications developing which promise a positive environmental contribution and future business

E-Aviation



E-Marine



Hydrogen



CoolGaN™

CoolSiC™

Wide band gap materials

SiC MOSFET has reached the tipping point for a variety of applications



Photovoltaic

- › reduction of system cost
- › reduction of system size



EV charging

- › faster charging cycles



IPS/UPS

- › higher efficiency,
- › reduced total cost of ownership

tipping point reached



eMobility

- › higher reach per charge
- › more compact main inverter



Traction

- › lower system cost
- › higher seat capacity



Drives

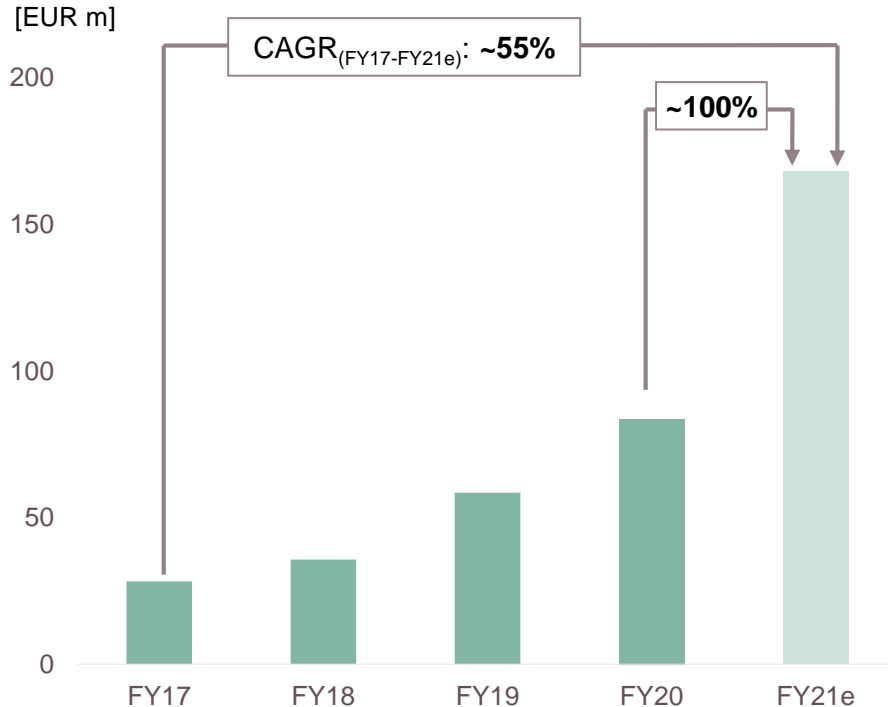
- › reduced system size
- › reduced total cost of ownership

future tipping points

Raised forecast - Doubling the revenue in FY21

More than half of the incremental growth contributed by automotive

Industrial and automotive applications driving the growth






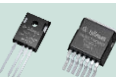
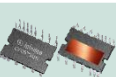





~200 different CoolSiC™ products

~3,000 total active customers including distribution



Strong CoolSiC™ portfolio expansion: by packages and by voltages

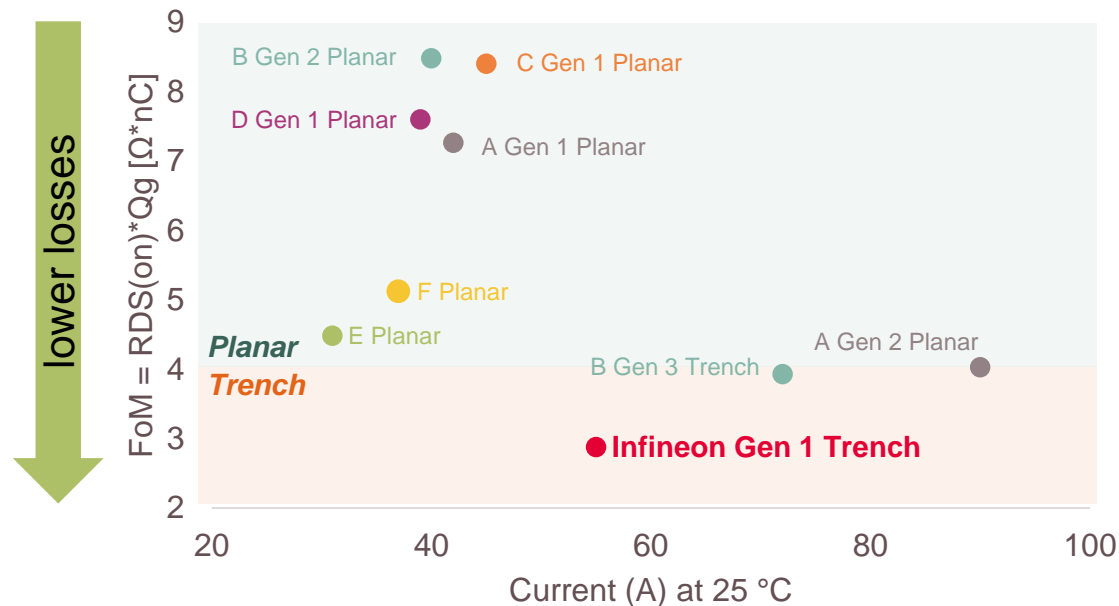
Broadest and best-in-class SiC portfolio

package options voltages	Industrial						Automotive grade			
	CoolSiC™ Diode	CoolSiC™ Hybrid		CoolSiC™ MOSFET			CoolSiC™ Diode	CoolSiC™ Hybrid	CoolSiC™ MOSFET	
	Discrete	Discrete	Module	Discrete	IPM	Module	Discrete	Discrete	Discrete	Module
										
600 V										
650 V										
1200 V										
1700 V										
Continuous expansion of portfolio										

Second generation (2nd Gen.) CoolSiC™ Trench MOSFET will increase the addressable market

1st Gen. with lowest losses is the leading technology today

2nd Gen. will expand the lead



- › 2nd Gen. CoolSiC™ Trench MOSFET is in advanced development phase
- › Enhanced power handling capability by 25% – 30%
- › Enhanced safe operating area without compromising quality
- › Enabling SiC in further high volume applications

2nd Gen. CoolSiC™ Trench MOSFET will significantly enlarge the market size for SiC MOSFETs

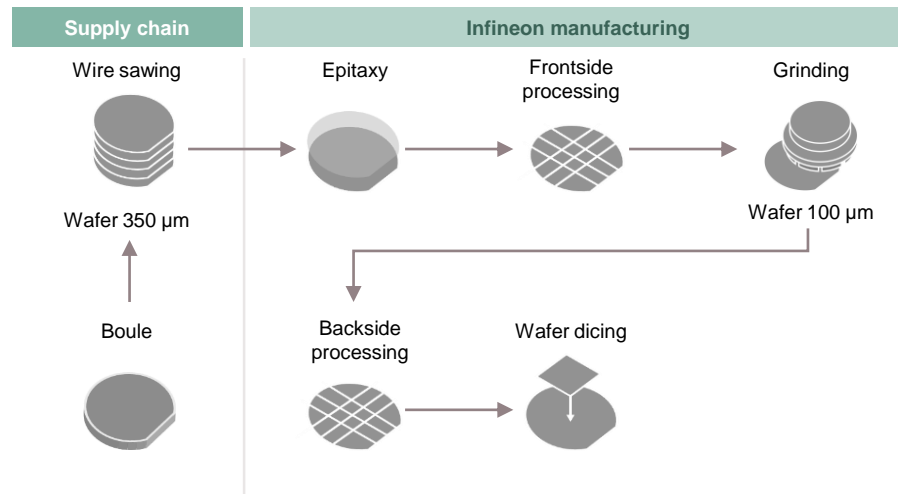
Source: SystemPlus Consulting: "SiC Transistor Comparison 2020". November 2020

Traditional wire sawing wastes ~3/4 of the raw material

Current status of SiC device manufacturing

The supplier cuts the boule into 350 μm thick wafers thereby losing almost half of the material as kerf. The resulting wafers are processed and ground to ~100 μm before finishing them. Thereby losing another half of the material.

→ ~3/4 of raw material lost

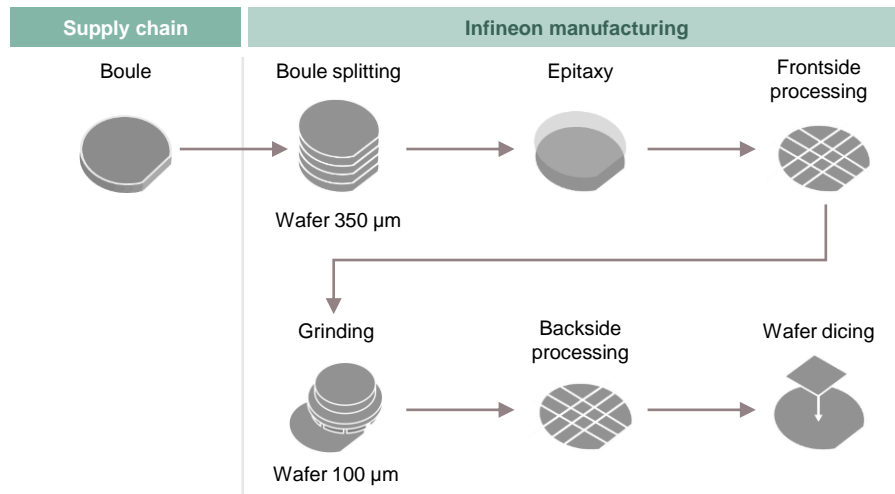


The kerf and grinding consume ~75% of the raw material

Phase 1: boule splitting in volume prod. starting FY22

We source boules and use our splitting technology to cut it into wafers. The process is kerf-free and therefore losses are minimal. The resulting 350 μm thick wafers are processed according to the current process flow.

→ Raw material losses reduced by half



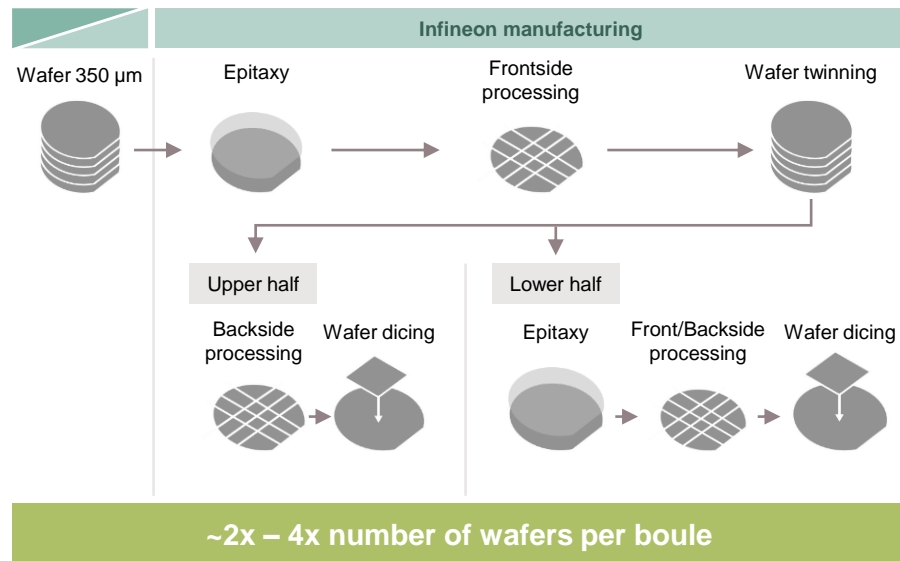
~2x number of wafers per boule compared to wire sawing

Boule splitting plus wafer twinning or advanced boule splitting quadruples output out of a given boule

Phase 2: wafer twinning

The starting material are either wafer from the phase 1 boule splitting process or sourced wafer. The 350 μm thick wafer is processed and instead of grinding it down to 100 μm the lower part is split off and processed again.

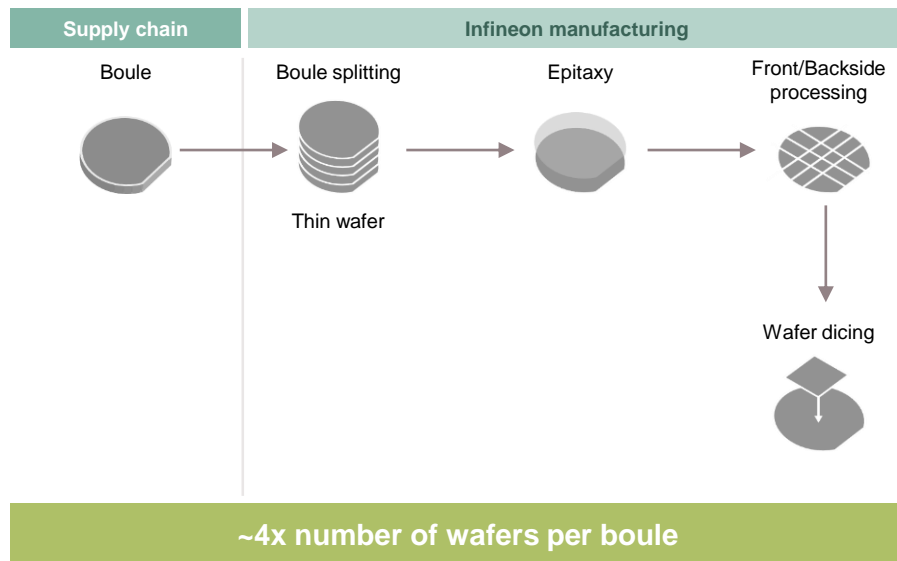
→ Combining boule and wafer twinning → minimal raw material losses



Phase 3: advanced boule splitting

The advanced boule splitting results in thin wafers that can be processed directly.

→ Most efficient process with minimal raw material losses



Infineon is ready to support and shape the growing SiC device market

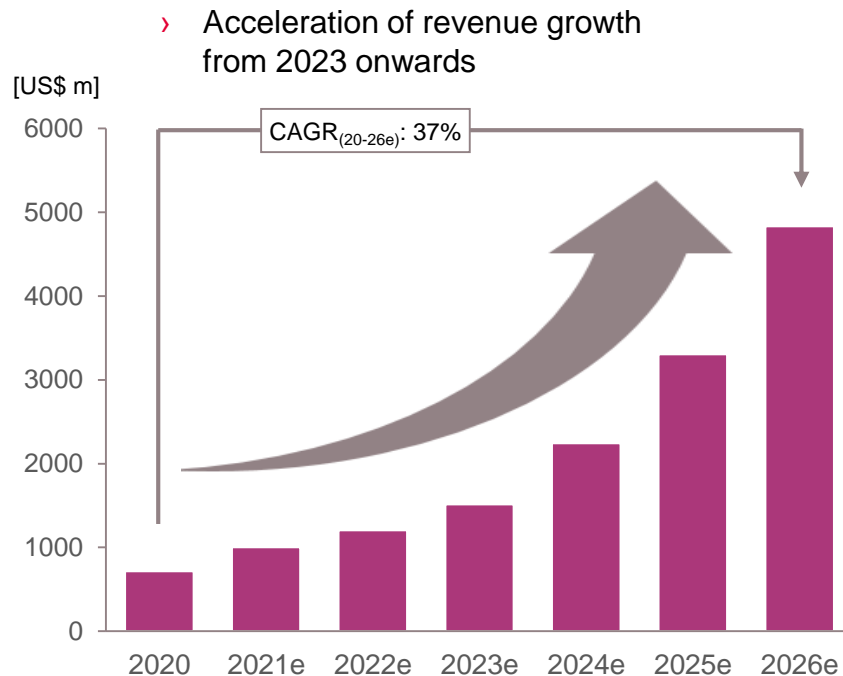
Today

- › Infineon is winning market share
- › Leading Infineon technology with 1st Gen. CoolSiC™ Trench MOSFET
- › Already broad, fast growing portfolio
- › System expertise and customer access

Strategic projects to support growth

- › 2nd Gen. CoolSiC™ Trench MOSFET
- › Cold Split: boule and wafer
- › Manufacturing lines already capable of processing 200 mm diameter
- › SiC raw wafer and boule supply diversified with multiple providers, e.g. Cree, GTAT and Showa Denko

SiC device market size



Source: Yole Développement: "Compound Semiconductor Quarterly Market Monitor, Module 1, Q1 2021"

GaN technology getting out of a niche

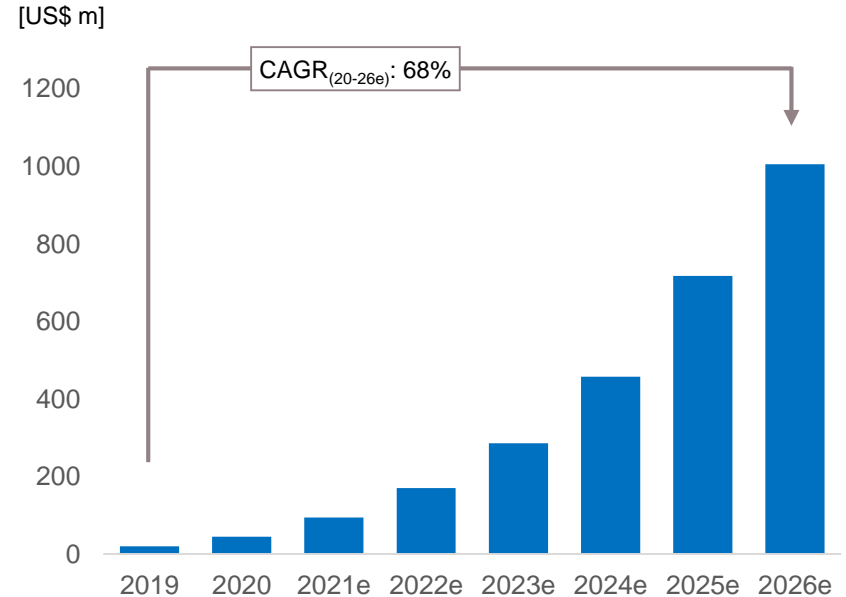
Infineon well positioned offering broad portfolio

Focus applications



GaN device market size

› Exponential growth projected



Source: Yole Développement: "Compound Semiconductor Quarterly Market Monitor, Module 1, Q1 2021"

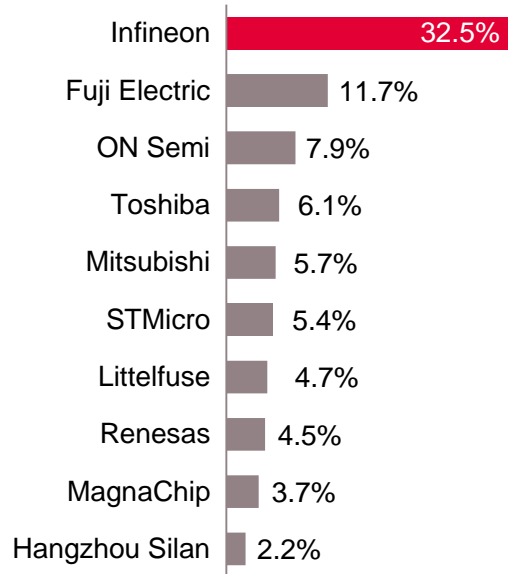


Part of your life. Part of tomorrow.

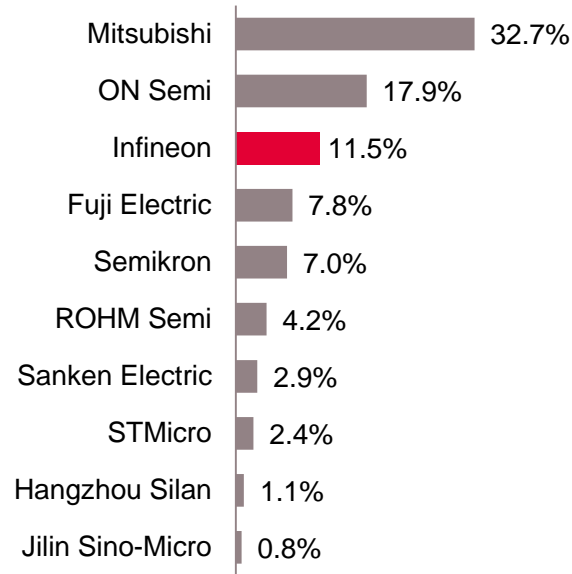
Clear leader in discrete IGBTs and IGBT modules; fostering position in IPMs



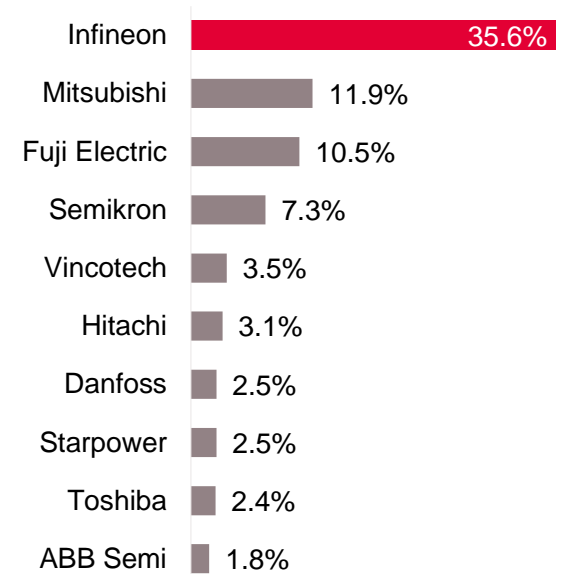
Discrete IGBTs 2019 total market: \$1.44bn



IPMs 2019 total market: \$1.59bn



IGBT modules¹⁾ 2019 total market: \$3.31bn



¹⁾ Including standard (non-integrated) IGBT modules and power integrated modules (PIMs) / converter inverter brake (CIB) modules
Based on or includes research from Omdia: "Power Semiconductor Market Share Database 2020". September 2020

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