The impact of GaN in BEV, providing a major step towards net-zero by 2050

Simon Stacey – COO

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Cambridge GaN Devices at a Glance

A fabless semiconductor company designing, developing and commercialising **energy-efficient GaN-based power devices and ICs**

Operating from
5
Locations

Innovation
95+
Patent applications

Employees
~60
> 300% growth (2020– 2024)

Knowledge

Academic excellence and industry expertise combined

Innovation

Innovative power solutions that help protect the environment

Sustainability

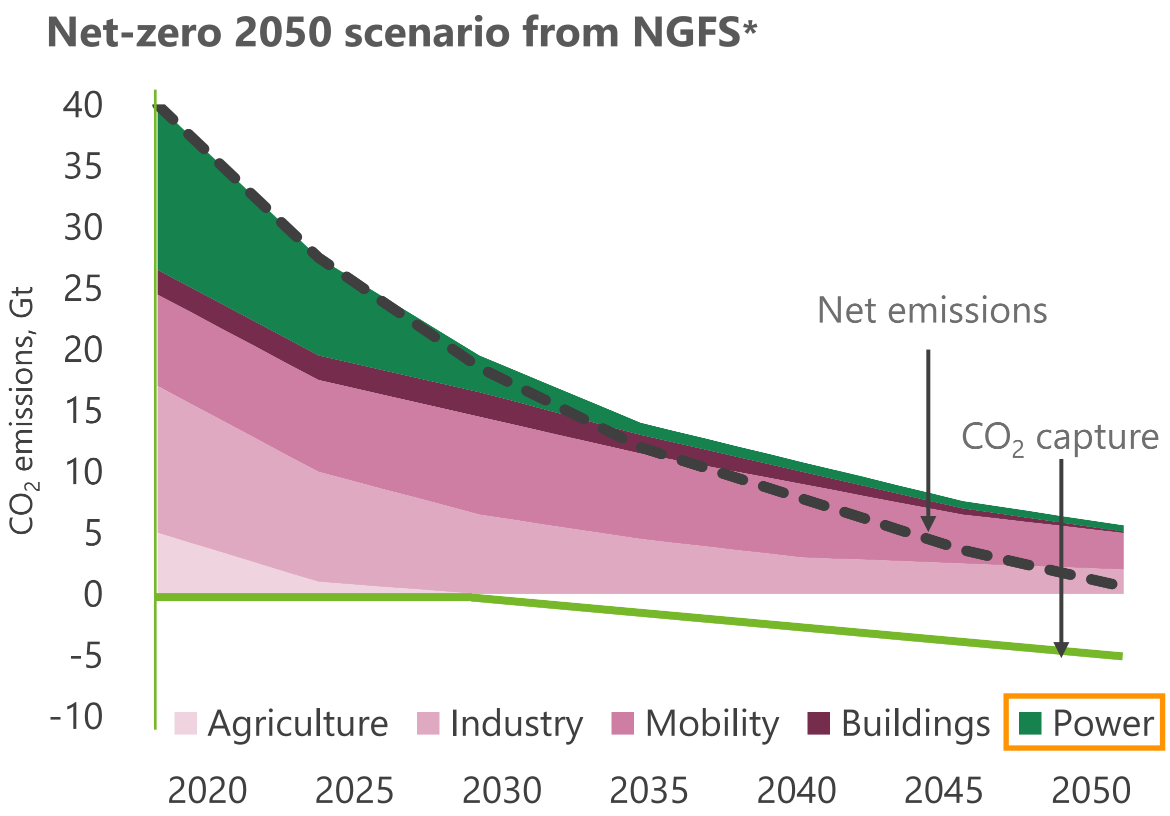
Eco-compatible products and business measures (**ESG**)

Collaboration

Cooperation, empowerment, respect, listening to customers, employees and partners

The World Must Go for Net-zero

Drastically Reduce Emissions Plus Removal



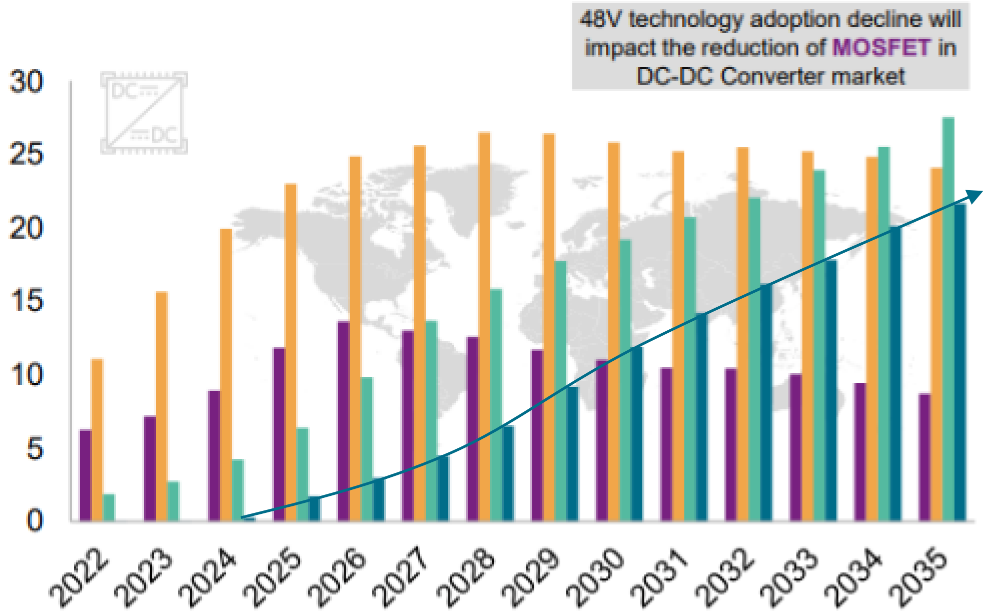
Sources: *Network for Greening the Financial System –
CGD elaboration from McKinsey 2022 Net-zero transition report

GaN will make an impact in Automotive, mainly in BEV

OBC and DCDC will see GaN catching up on SiC and Si, growing at much faster rate

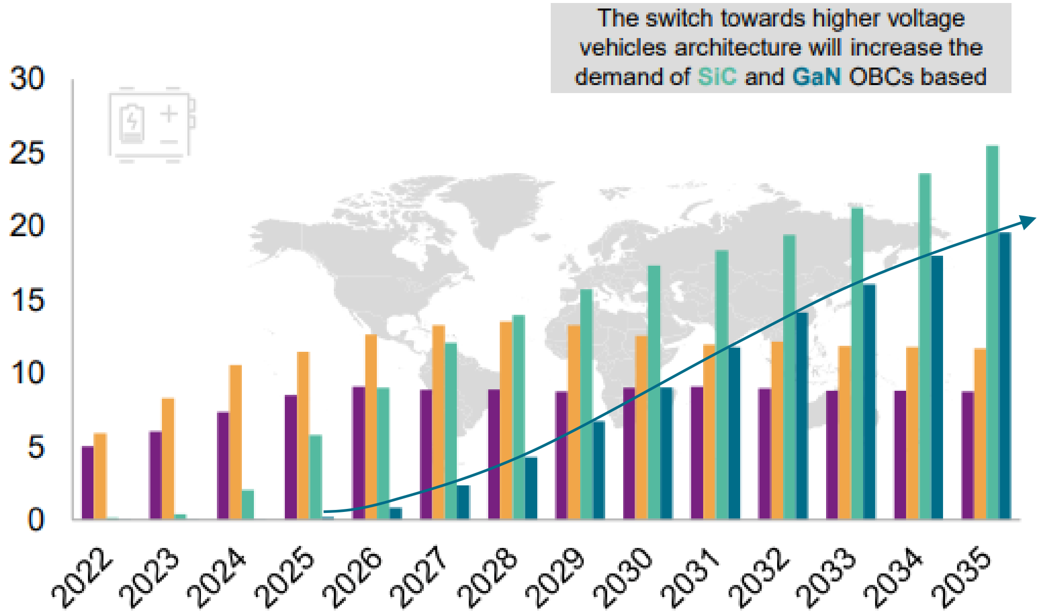
DC-DC Converter (million units)

Component volumes 2022 - 2035



On-board Charger (million units)

Component volumes 2022 - 2035

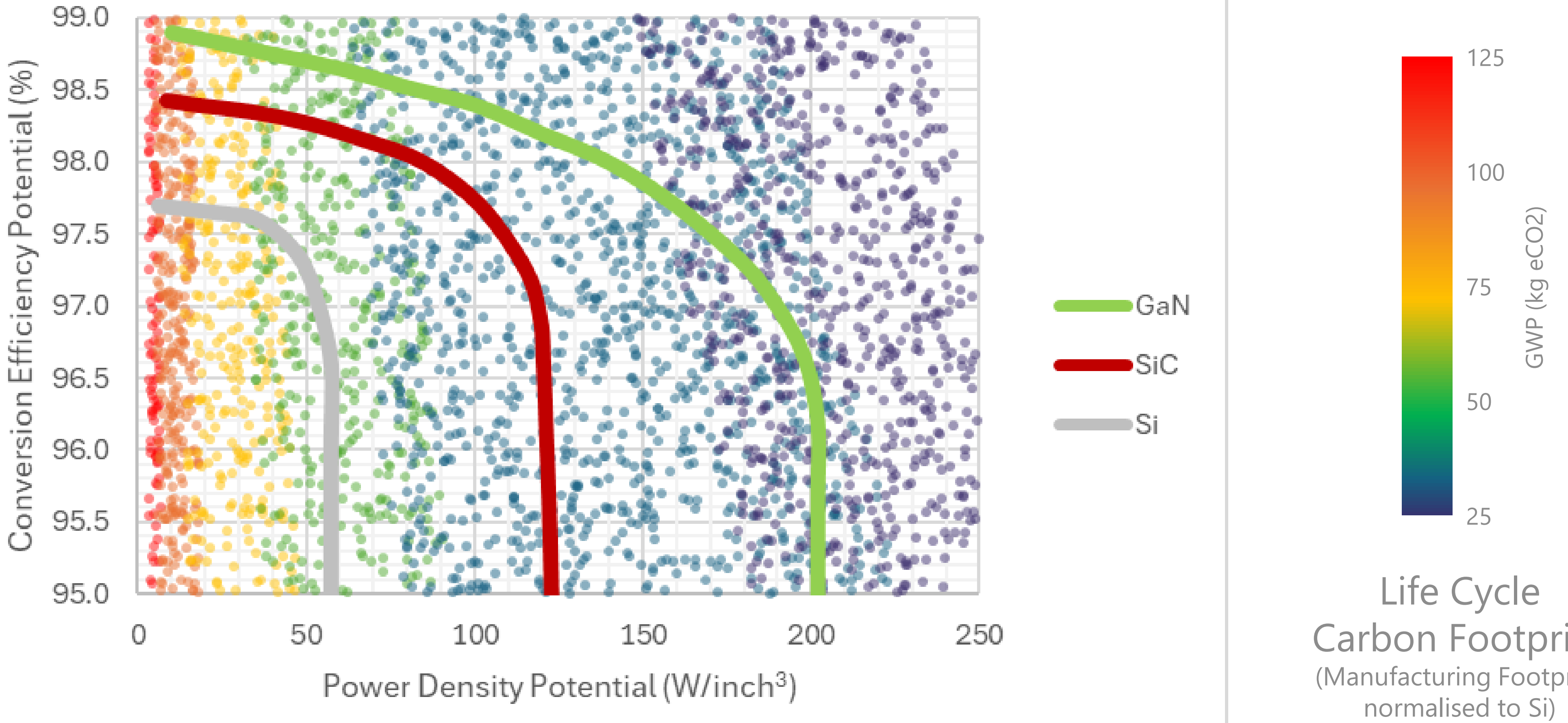


MOSFET IGBT Silicon Carbide (SiC) GaN

Source: SP Global, Automotive Power Electronics Roadmap, Oct 2023

EVs to Deliver Low Environmental Impact

GaN Enables Highest Efficiencies, Highest Power Densities and Lowest Carbon Footprint



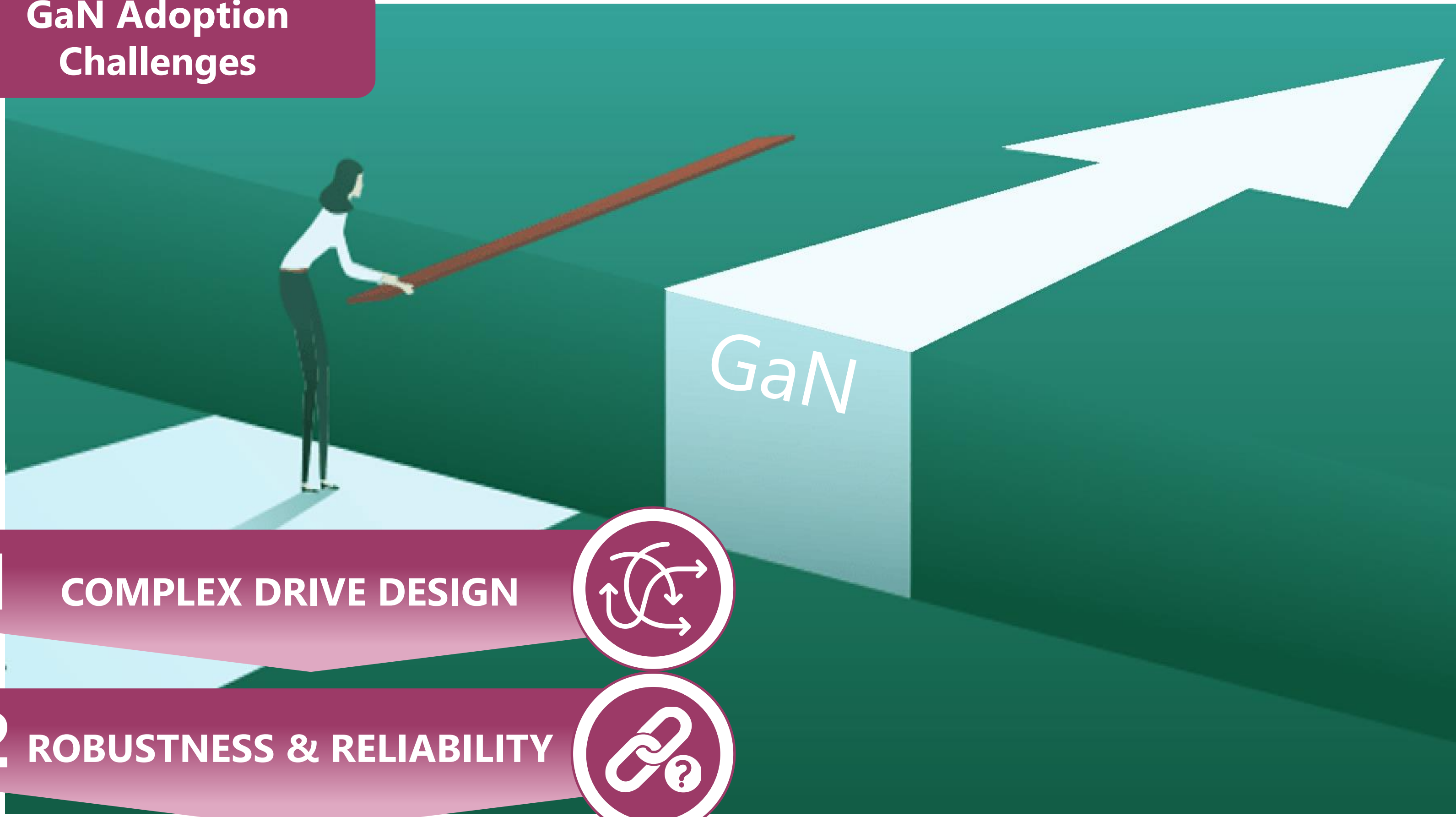
Life Cycle Carbon Footprint
(Manufacturing Footprint normalised to Si)

Source: Adapted by CGD based on plots from Infineon and PESL/ETH Zurich

However…

There are Barriers to GaN Adoption in High Power and Automotive Applications

GaN Adoption Challenges



1 COMPLEX DRIVE DESIGN

2 ROBUSTNESS & RELIABILITY

Complex Drive Design

Extra components required to drive vs MOSFETs

Complex RC network drive circuit required

Expensive gate drivers

Robustness and Reliability

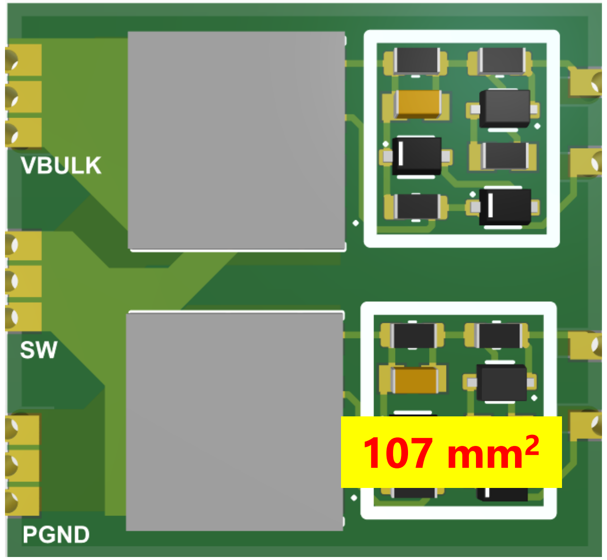
Concerns around gate robustness

Not enough reliability data

ICeGaN® Runs with Any MOSFET & IGBT Driver

Smaller Driving Circuits, Bigger Copper Area, and Lower BoM Cost

Half-bridge with discrete e-Mode GaN

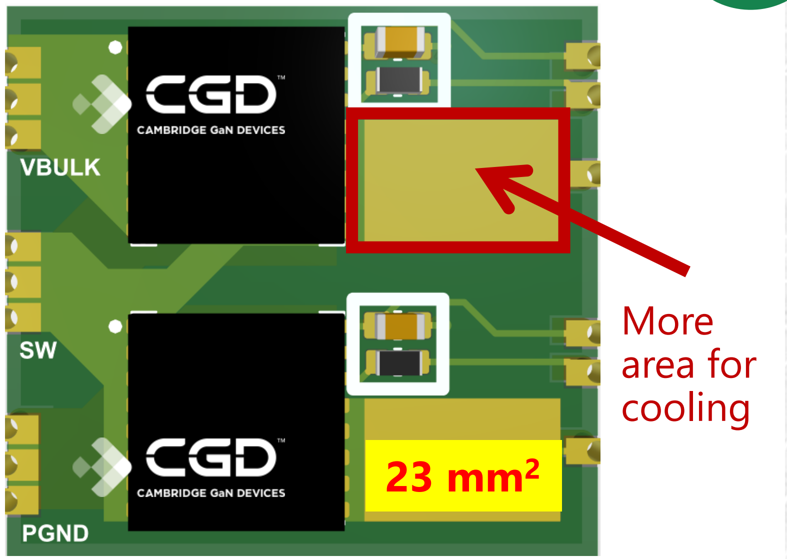


- Driving components: 16
- Area of driving circuits: 107 mm²

~5x smaller PCB space

4x fewer components

Half-bridge with ICeGaN



- Driving components: 4
- Area of driving circuits: 23 mm²

Larger cooling area → lower operating temperature → higher efficiency & reliability

ICeGaN® Addresses the Challenge of Robustness

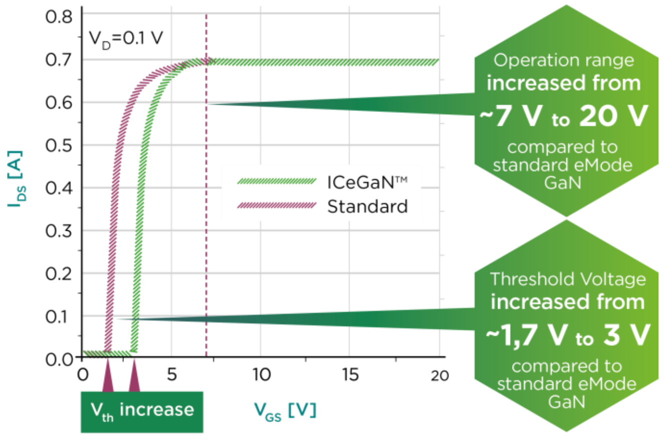
Extreme robustness with gate under dynamic voltage

Technology	25 °C	150 °C
ICeGaN	84 V	92 V
Si IGBT	80 V	80 V
SiC MOSFET	70 V	70 V
Std e-Mode GaN	24 V	25 V

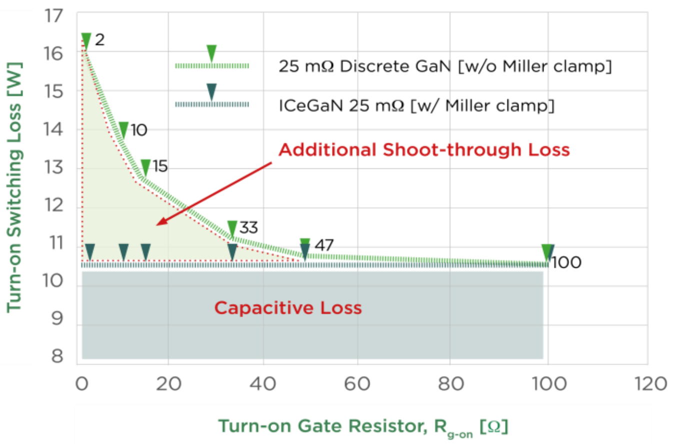
CPES Center for Power Electronics Systems

B. Wang et al "Exceptional Gate Overvoltage Robustness in P-Gate GaN HEMT with Integrated Circuit Interface", APEC 2024

High threshold voltage for di/dt noise immunity



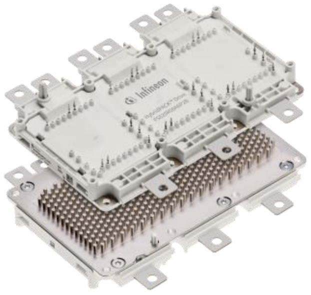
dv/dt Immunity No signs of shoot through



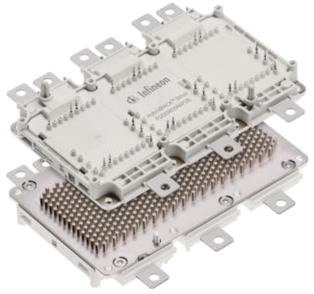
ICeGaN has been designed STARTING FROM RELIABILITY

ICeGaN® for Traction Inverters – Top System Performance

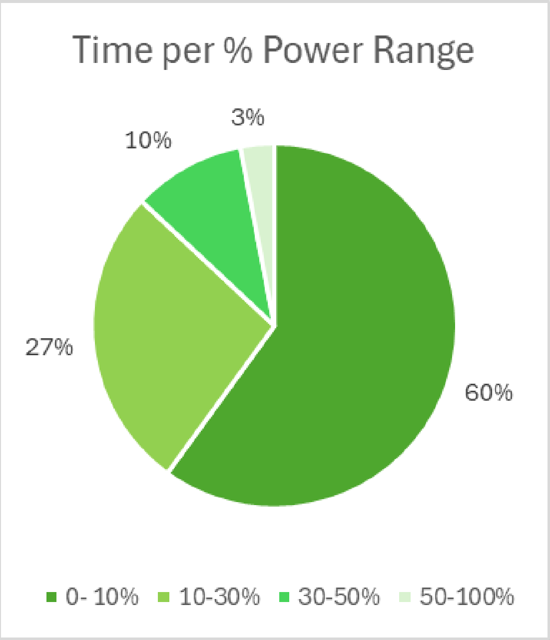
CGD CAMBRIDGE GaN DEVICES



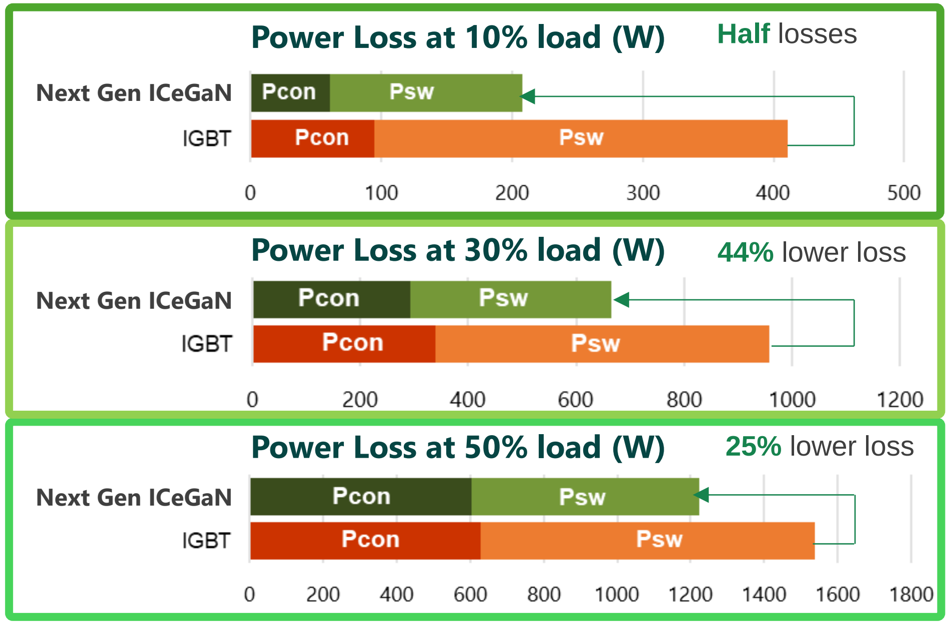
Si IGBT or SiC MOSFET



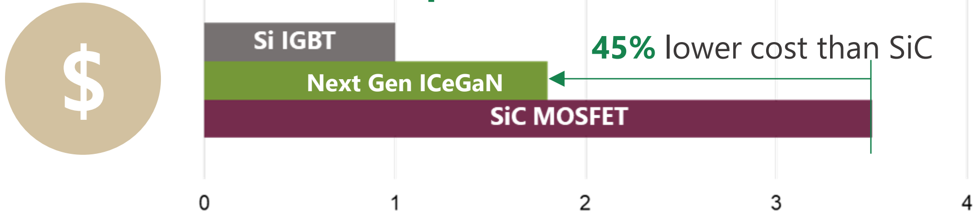
Next Gen ICeGaN



Inverter Performance



Die cost estimation (normalized) for 400V/150kW power module



Main Inverter system analysis assumptions:

1. V_{DC} = 400 V, SVPWM, Cos(phi) = 0.85, m = 0.8, F_{SW} = 10kHz
2. Next Gen ICeGaN spec: Vds = 650 V, Ids = 850A. ICeGaN: Ron,125C = 10mΩ
3. Si IGBT for benchmark – Infineon HyridPack Drive module FS820R08A6P2B
4. SiC: 650V/800A, Rdson = 3 mΩ

Summary and Conclusions

- GaN HEMTs are the present and the future of Power Conversion, achieving Efficiencies, Power Densities and Sustainability Potential beyond other technologies
- Robust GaN solutions exploit the monolithic integration opportunities offered by lateral GaN technologies…as realised by **CGD** with ICeGaN®
- Implementation of Robust Chip Architectures make the Reliability of GaN the same, or better, than incumbent Si and SiC technologies
- Economies of Scale and System Level integration opportunities make ICeGaN® the technology of choice for all market segments

Dare to innovate differently

CGD™

CAMBRIDGE GaN DEVICES