



英飞凌功率半导体技术助力零碳能源应用
南京，2022年8月



Table of contents

1	Background	3
2	Infineon's solutions enable the green energy and higher efficiency	7
3	Infieon's Advanced Technology	26
4	Infineon is Continously enabling Decarbonization	27

Table of contents

1	Background	3
2	Infineon's solutions enable the green energy and higher efficiency	7
3	Infieon's Advanced Technology	26
4	Infineon is Continously enabling Decarbonization	27

节能解决方案对于帮助解决日益增长的全球人口的能源需求日益重要



到2030年¹...



85.5亿

全球人口总数

348.6亿吨CO₂
全球碳排放总量



12.65 亿吨油当量

世界能源消费总量



如今三分之二的温室气体排放都来自能源行业。

电力已占据全球能源需求近三分之一。

能源效率正在成为全球实现气候目标的重要杠杆。

1) 联合国；国际能源署 (IEA)

微电子为应对全球宏观趋势和社会挑战发挥重要作用



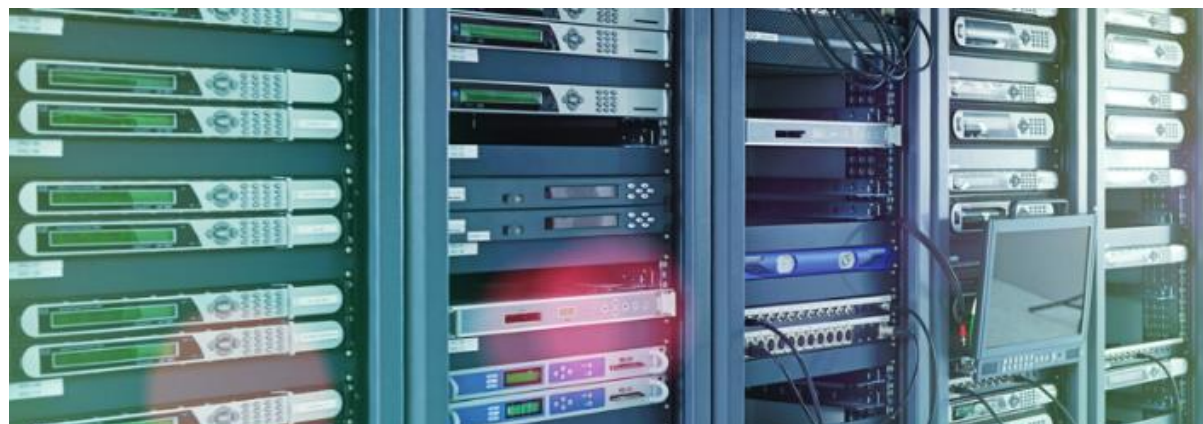
人口和社会变迁



气候变化和资源稀缺



城市化



数字化转型

英飞凌所开发的技术能帮助优化整个电能产业链的能量效率

探索如何让绿色能源成为现实

www.infineon.com/green-energy

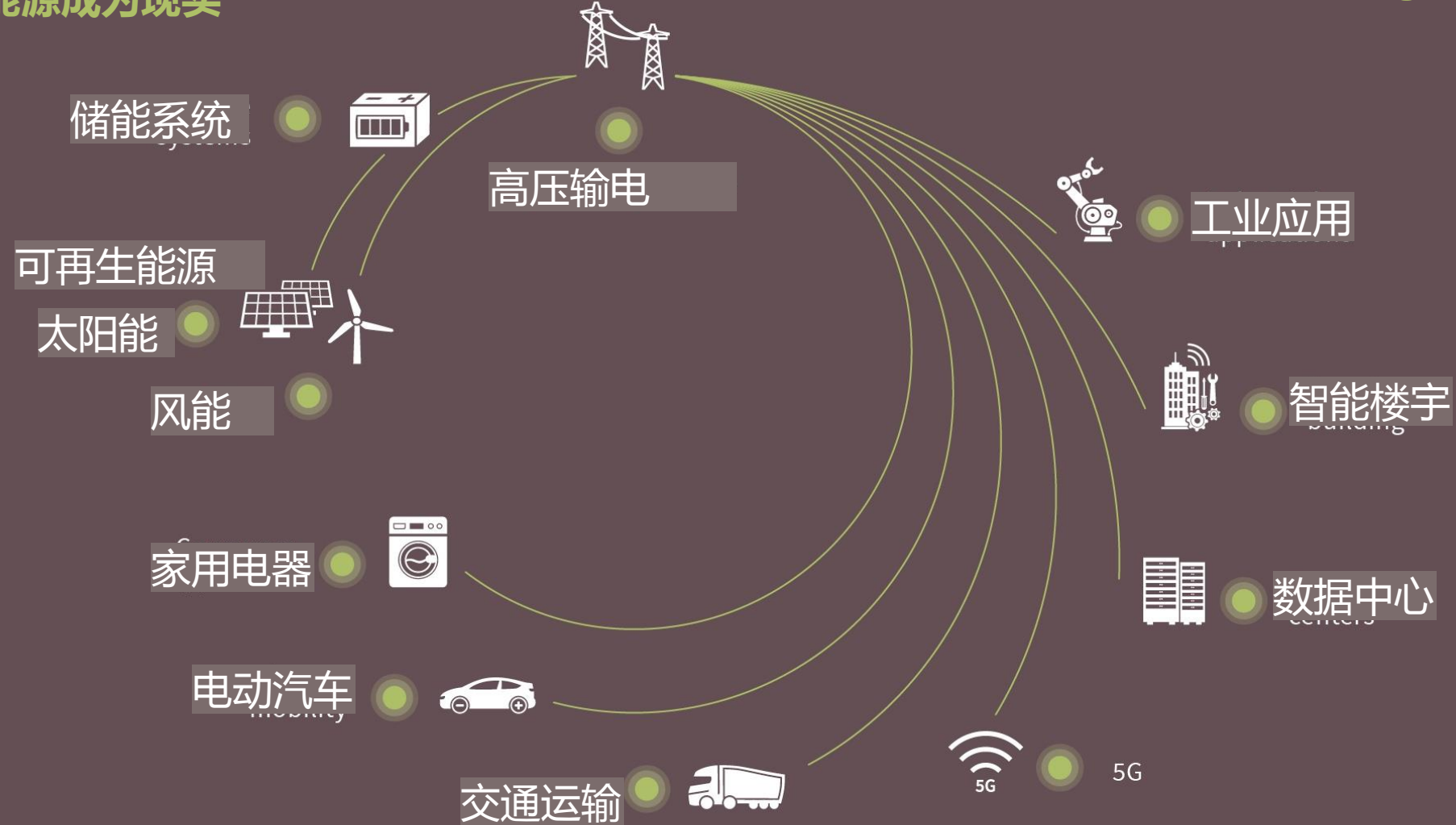
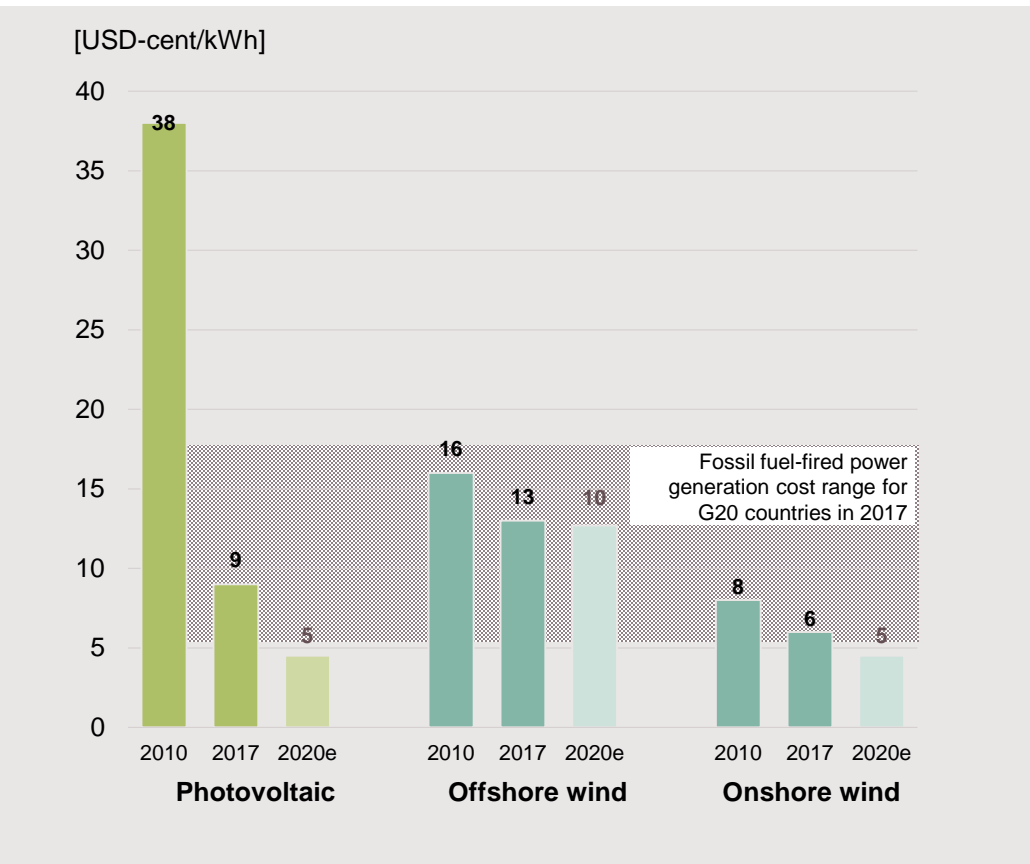


Table of contents

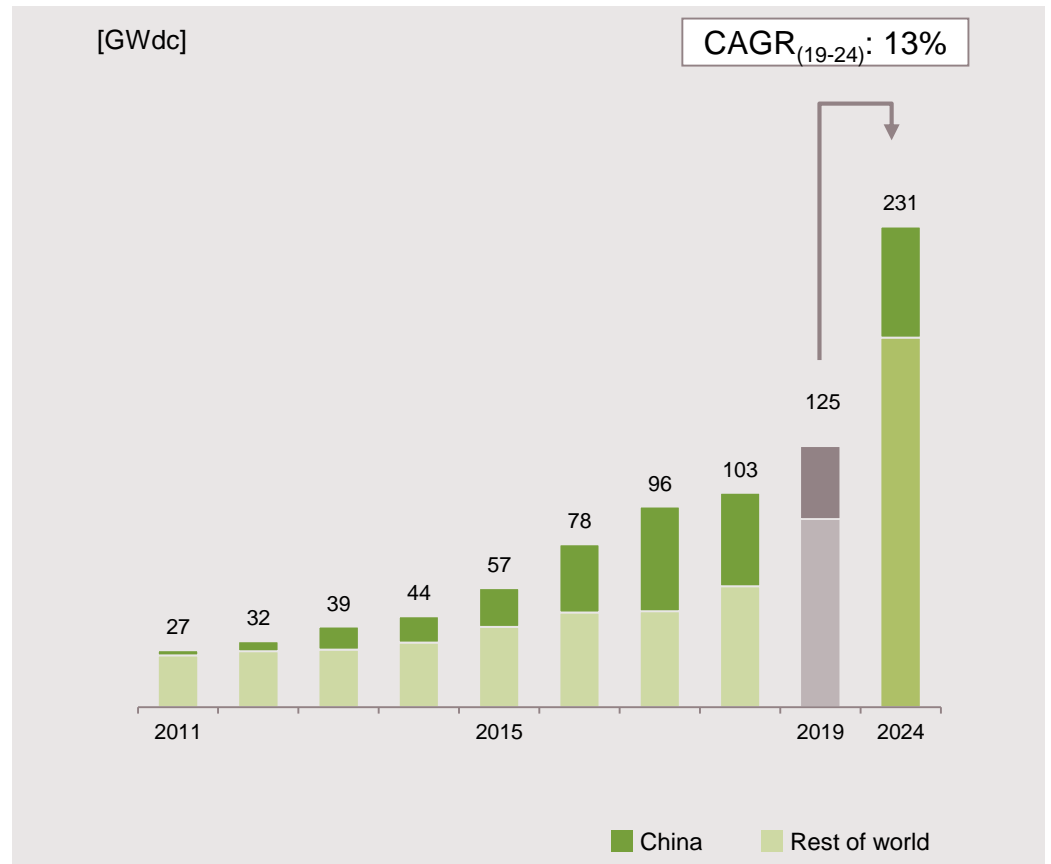
1	Background	3
2	Infineon's solutions enable the green energy and higher efficiency	7
3	Infieon's Advanced Technology	26
4	Infineon is Continously enabling Decarbonization	27

Renewables reach cost parity: besides China, India and RoW will also drive growth

Development of levelized cost of electricity (LCoE)¹⁾

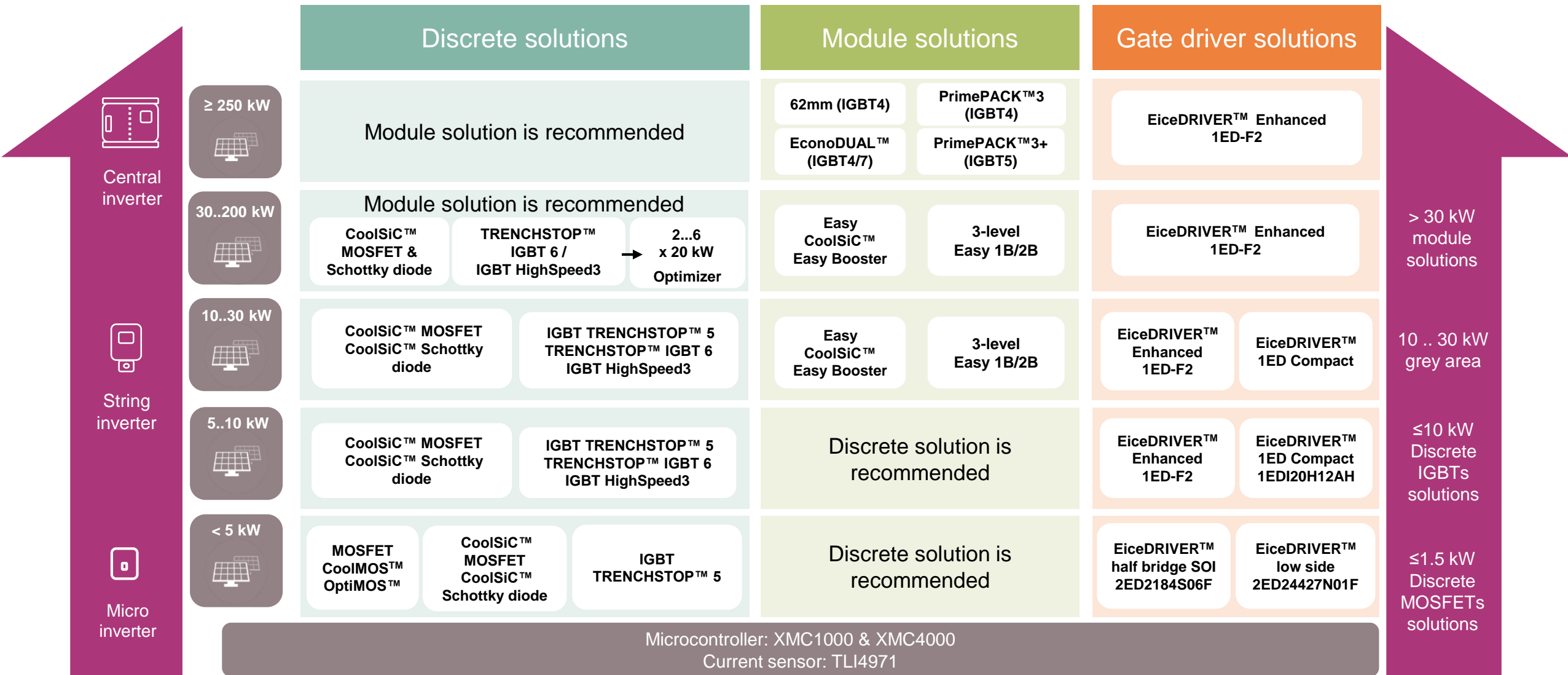


Global PV installations by region

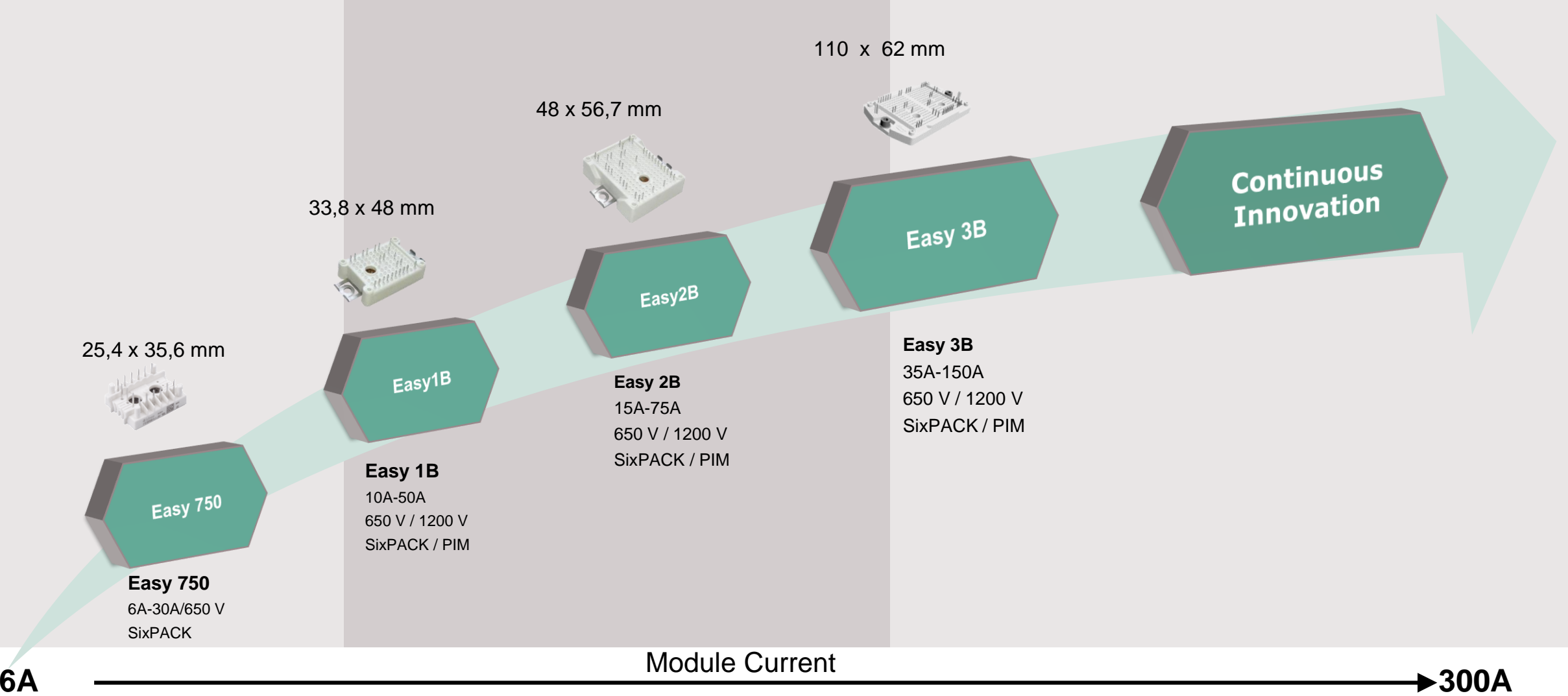


Source:
 1) IRENA – Renewable Power Generation Costs in 2019
 2) IHS, "PV Installations Tracker – Q4 2020 – January 2021 update"

Infineon's power solution positioning for solar application



LMP Product Lineup: Easy Modules



Easy 3B – Module mechanical concept

Benefits

- › Equally distribution of forces
 - 5 areas for equally force sharing

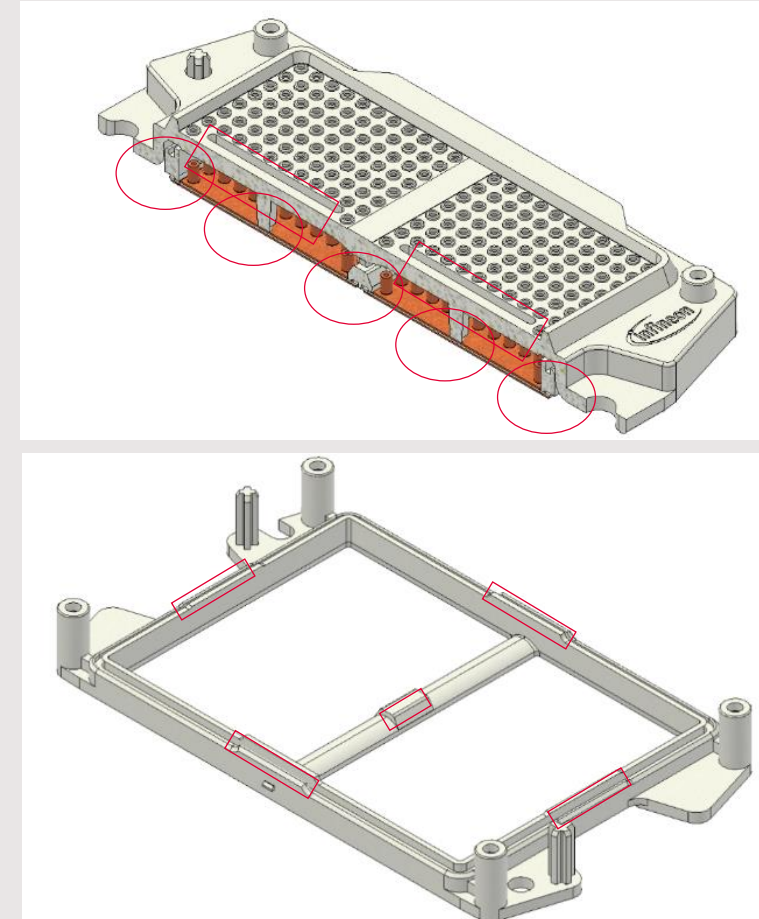
- › Two bow compensators
 - Force transfer due to outer frame

- › Spring effect
 - To guarantee a defined pressing force after mounting



Highly defined pressing force
Lower R_{th}
No risk of DCB crack

Hold – Down Concept



PrimePACK™ with IGBT5 and .XT



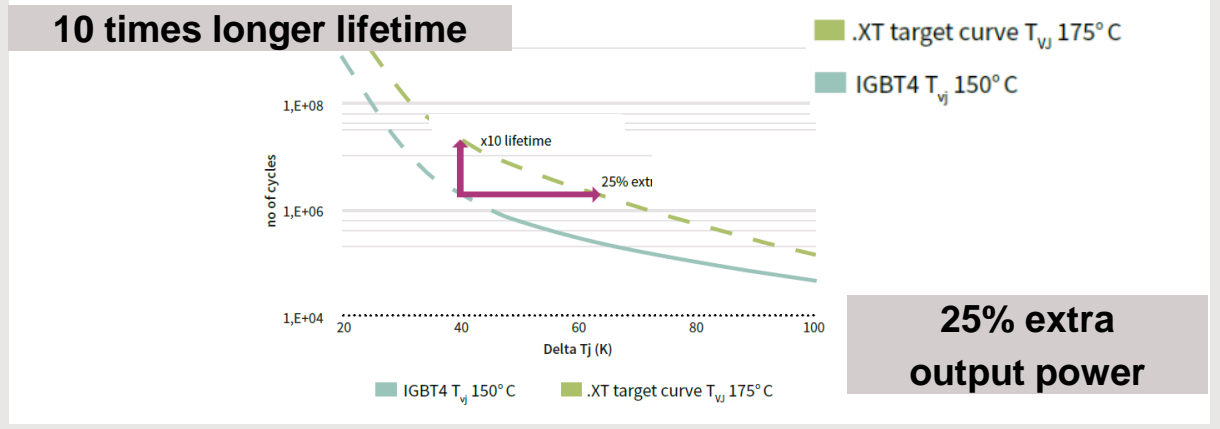
Features

- > Latest chip technology: IGBT5
 - Increased operation temperature $T_{vjop} = 175\text{ °C}$
 - Reduced die thickness
- > New Interconnection Technology: .XT
 - Increased power cycling and thermal cycling capabilities

Benefits

- > Increasing power density by 25% or achieving 10 times longer lifetime
- > Reducing total losses by up to 20%
- > Reducing cooling effort and heat sink

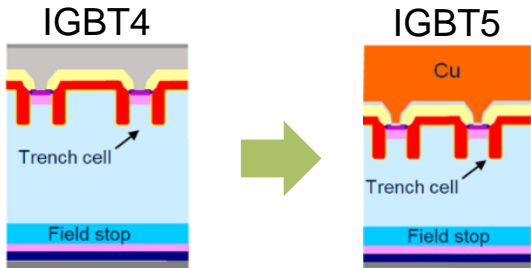
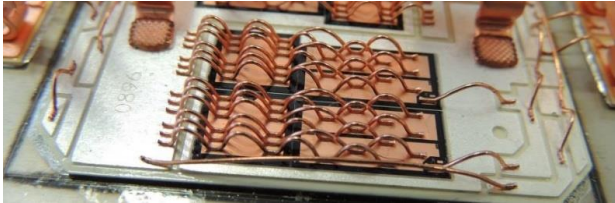
Improved/flexible performance



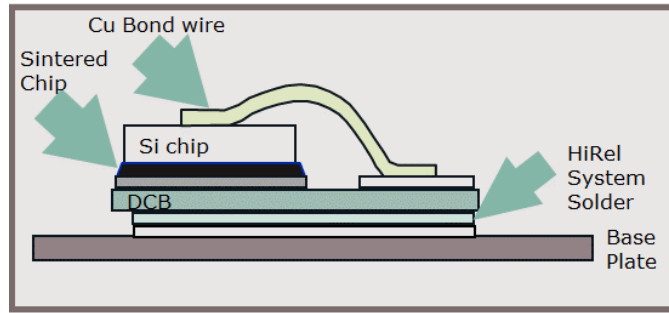
Key applications

Being at the heart of wind turbines – PrimePACK™ with IGBT5 and .XT technology

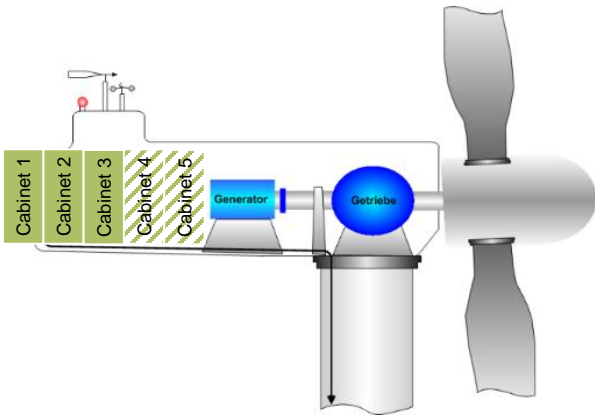
IGBT5 chip technology



.XT joining technology



PrimePACK™ module



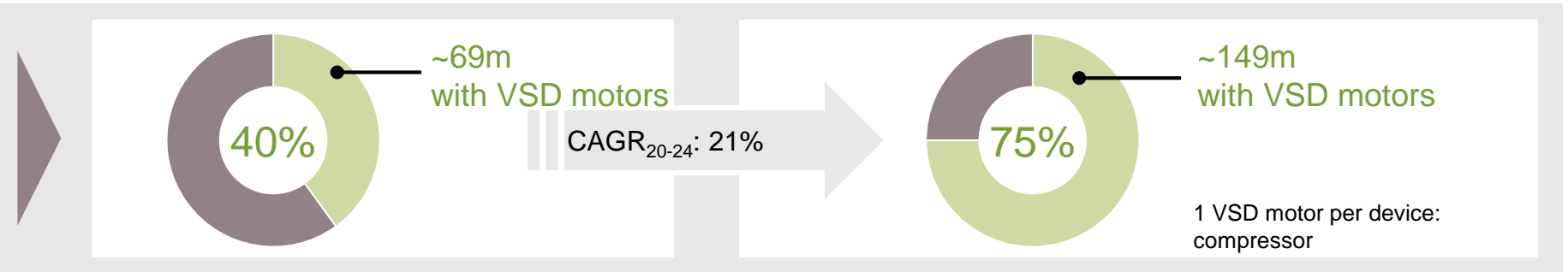
- › high reliability and robustness, esp. for off-shore wind turbines
- › long lifetime
- › power cycling capabilities increased by factor of 10
- › high power density: using IGBT5 and .XT power modules, with the same number of cabinets about 30% more electrical power increase feasible
- › excellent system efficiency

Infineon products are used in HVDC projects around the world



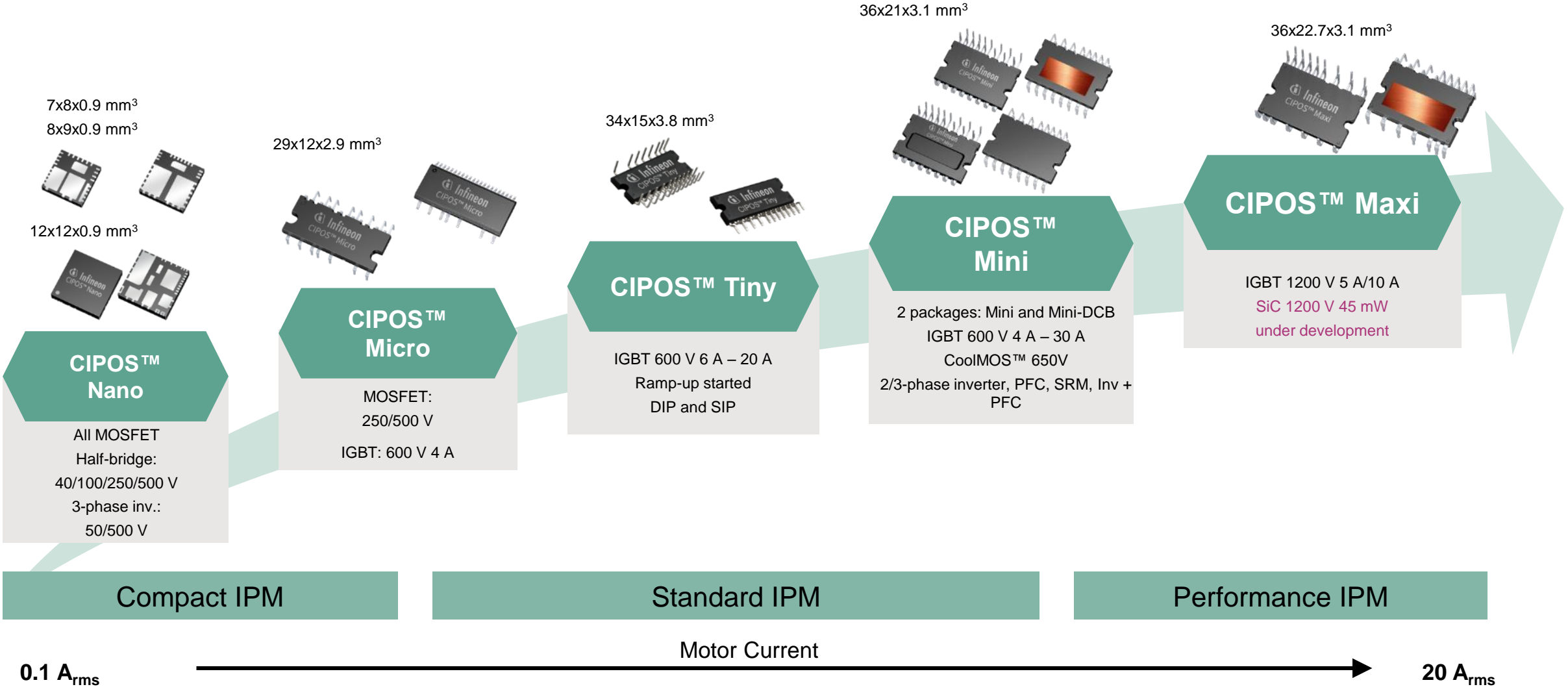
Infineon helps building HVDC systems, which contribute to save 14% transmission losses
Comparison of HVAC and HVDC system with 150 km cable length

Inverterization is driving the global demand for power semiconductors for the next years

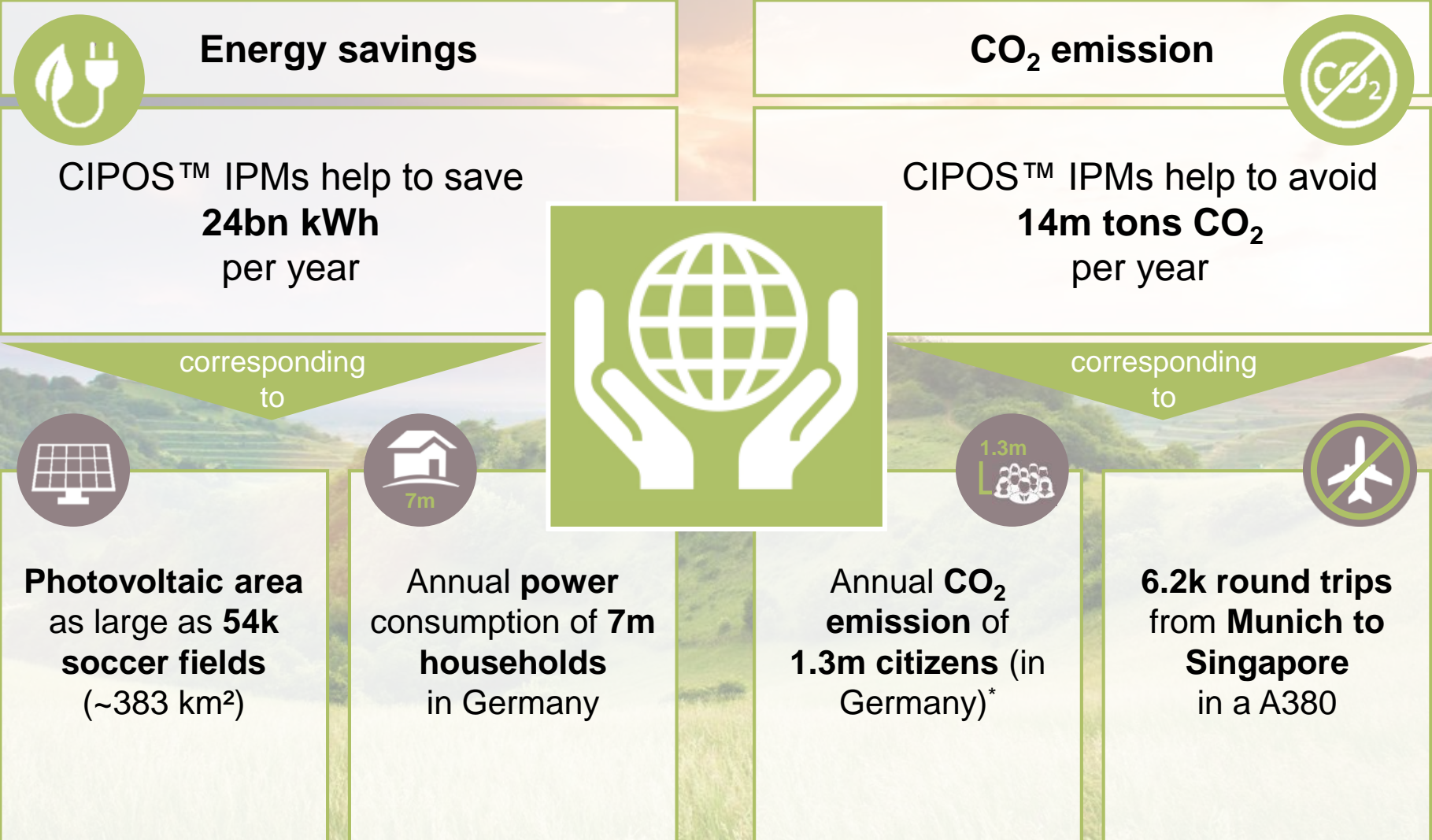


Source: Omdia, "Major Home Appliance Market Report", November 2020

Molded IPM portfolio for broad application coverage

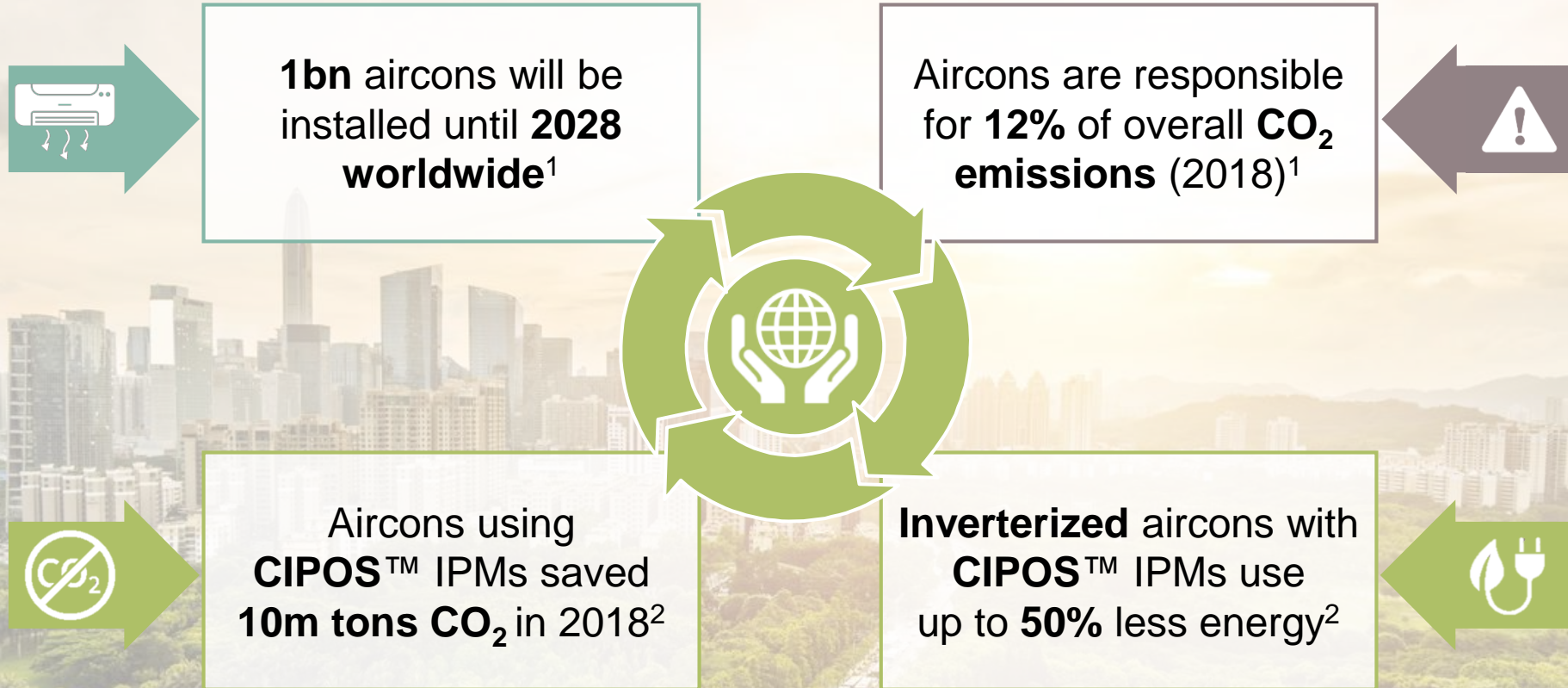


Infineon's CIPOS™ IPMs contribute to a greener society



Note: Energy savings (year 2018) were calculated by comparing inverterized motors with non-inverterized motors; *total CO₂ emission incl. industry, infrastructure, private consumption etc.

The growing demand for air-conditioning poses a global environmental challenge



Energy-efficient air-conditioning using CIPOS™ IPMs contributes to a greener society

1. [The Economist](#), "The cost of cool: Air-conditioners do great good, but at a high environmental cost", 25.08.2018
2. Energy savings were calculated by comparing inverterized motors with non-inverterized motors

Due to the extensive power module portfolio Infineon can address the whole range of drives applications

Under Review

	Servo drives	Low-power drives*	Mid- and high-power drives
	<p>370 W 75 kW</p>	<p>370 W 500 kW</p>	<p>500 kW 10 MW</p>
Requirements	<ul style="list-style-type: none"> › high positioning accuracy › fast response with no overshoot › high reliability 	<ul style="list-style-type: none"> › performance and reliability › safety features › good price/performance ratio 	<ul style="list-style-type: none"> › safety › durability › high reliability and low downtime
Key applications	<ul style="list-style-type: none"> › robotics › material handling › machine tools 	<ul style="list-style-type: none"> › pumps and fans › process automation › cranes › marine drives 	<ul style="list-style-type: none"> › oil & gas industry › chemical industry (e.g. air compressors) › cement mills
Infineon products	<ul style="list-style-type: none"> › CIPOS™ IPM › Easy 1B › Easy 2B › CoolSiC™ Discretos 	<ul style="list-style-type: none"> › iMOTION™ › CIPOS™ IPM › EasyPACK™ › EconoPACK™ 	<ul style="list-style-type: none"> › PrimePACK™ › IHM › IHV

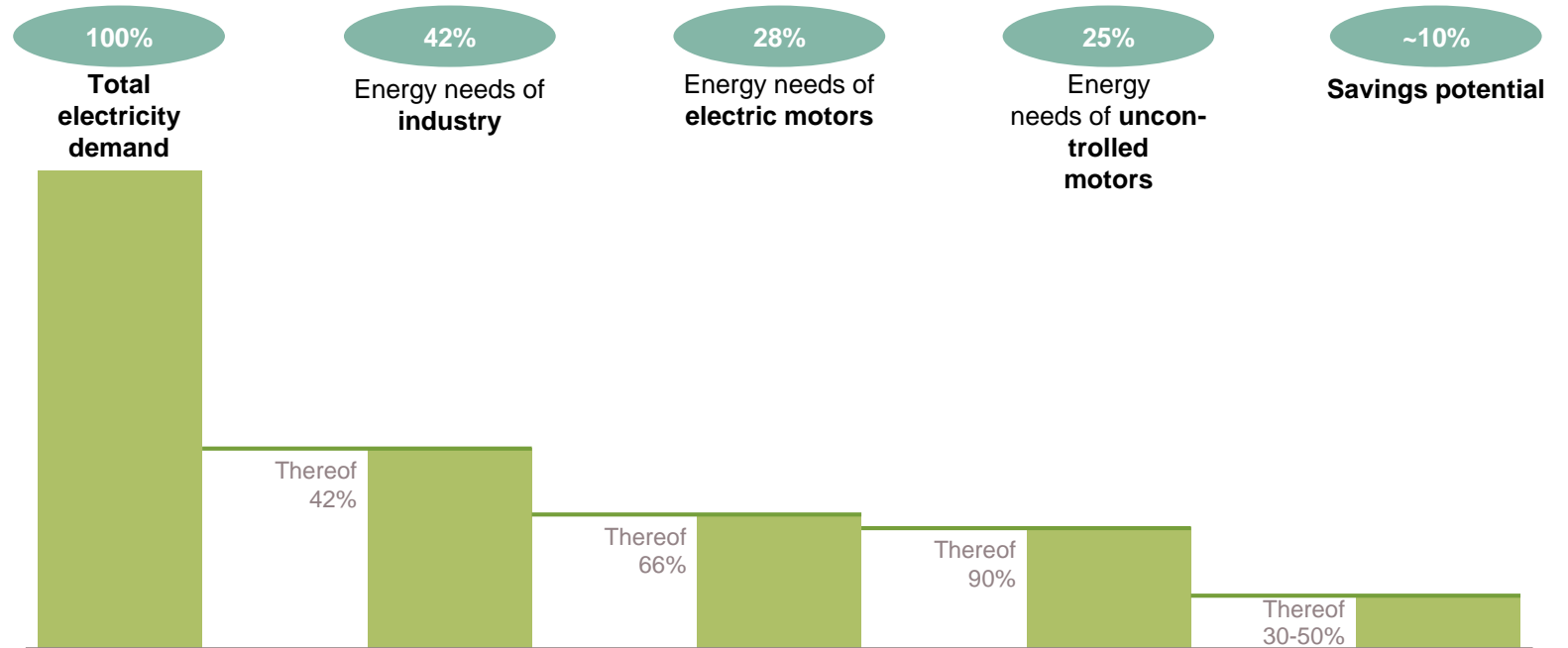
*Low-power drives include compact drives, standard drives, premium drives and brushed DC drives.

Huge savings possible by smarter control to enable more efficient applications



Savings potential of VSD

as a percentage of worldwide electricity consumption

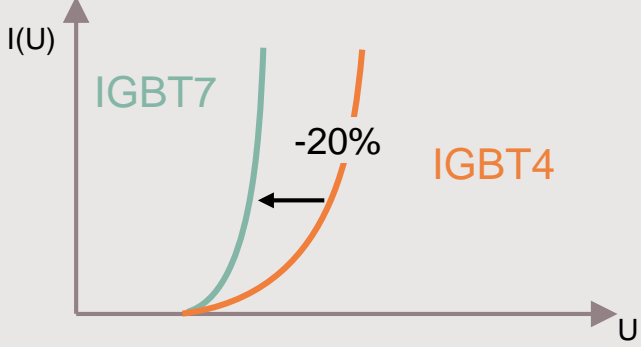


The savings potential equals that of 220 nuclear power plants or 3bn tons of CO₂ annually!

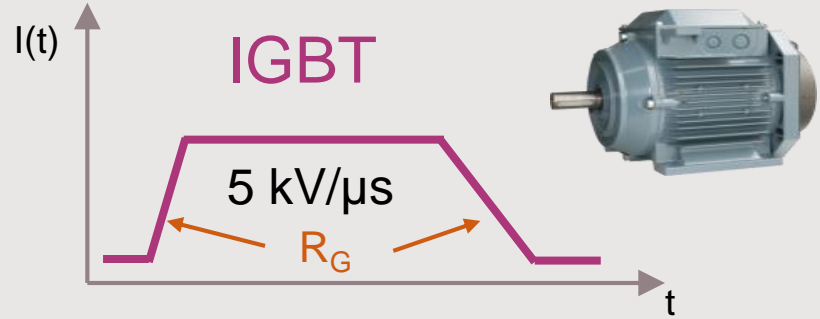
Source: ABB, 2013

TRENCHSTOP™ IGBT7 Technical Advantages

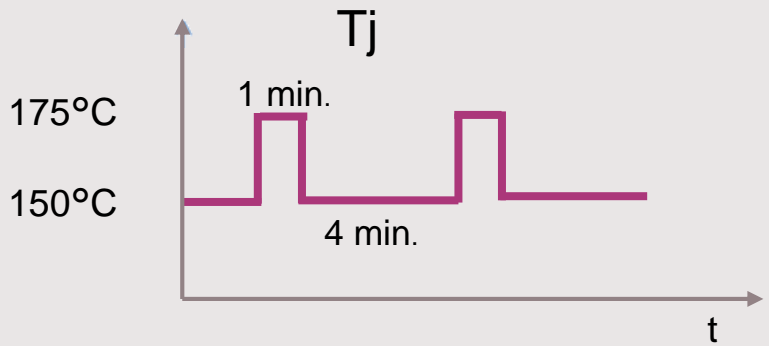
Much Lower Conduction Loss $V_{ce,sat}$



Controllable dv/dt to meet motor control application



175°C operation temperature for overloading



Drives

Energy storage

CAV

Why should you choose IGBT7?



One to one replacement to IGBT4 with benefits like lower losses, higher robustness and longer lifetime



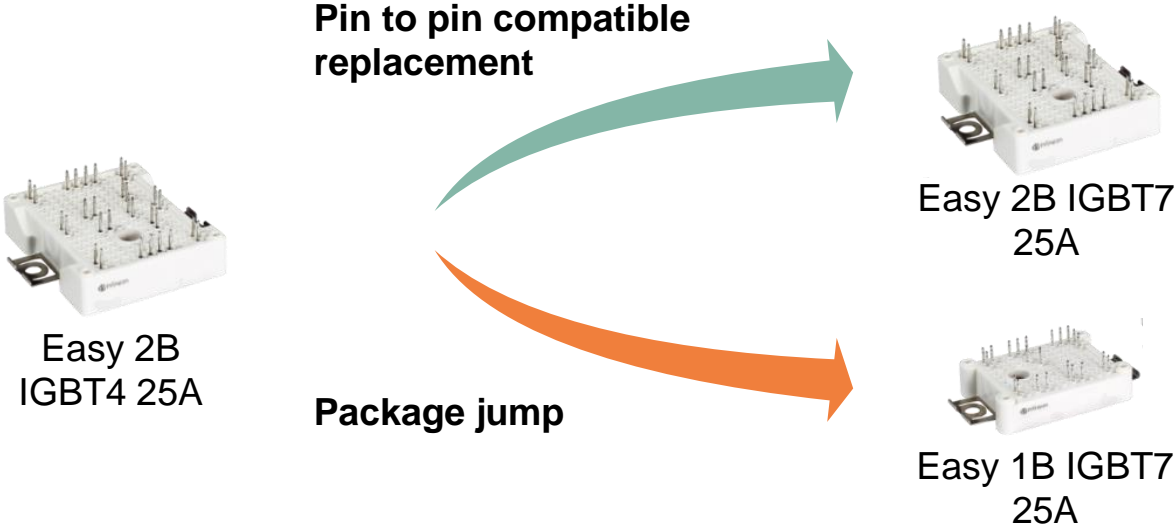
More compact design through reduced frame size with higher performance (exchange Easy2B → Easy1B)



Hit sweet spot in drives by tailored features > system cost saving for the customer (heat sink, smaller EMC filter)

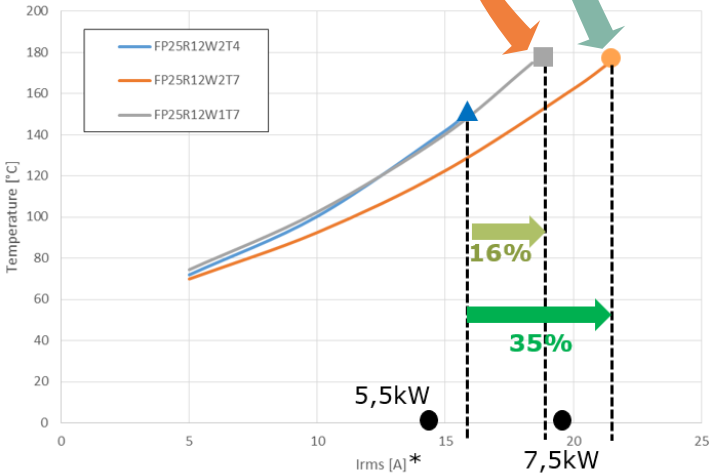
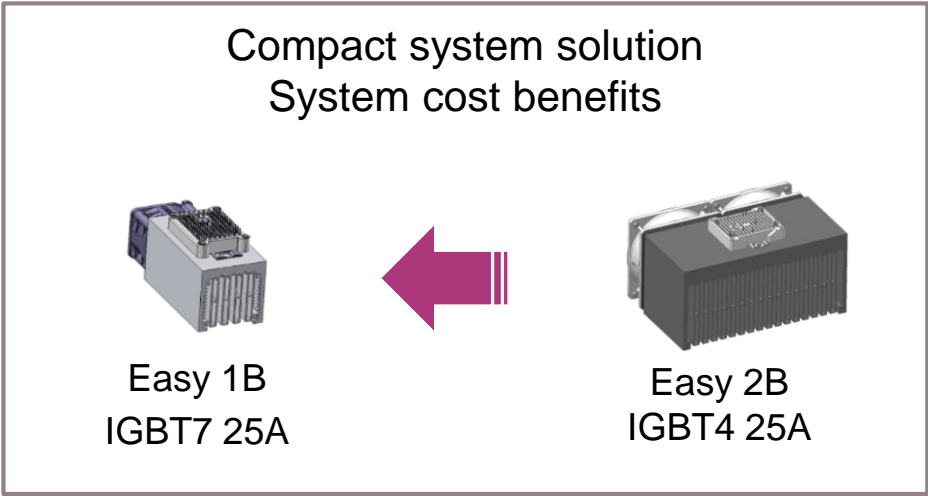
1) e.g. UPS Riello, Solaredge, Arcelik, Prima Elektro

Higher power density and frame size jump

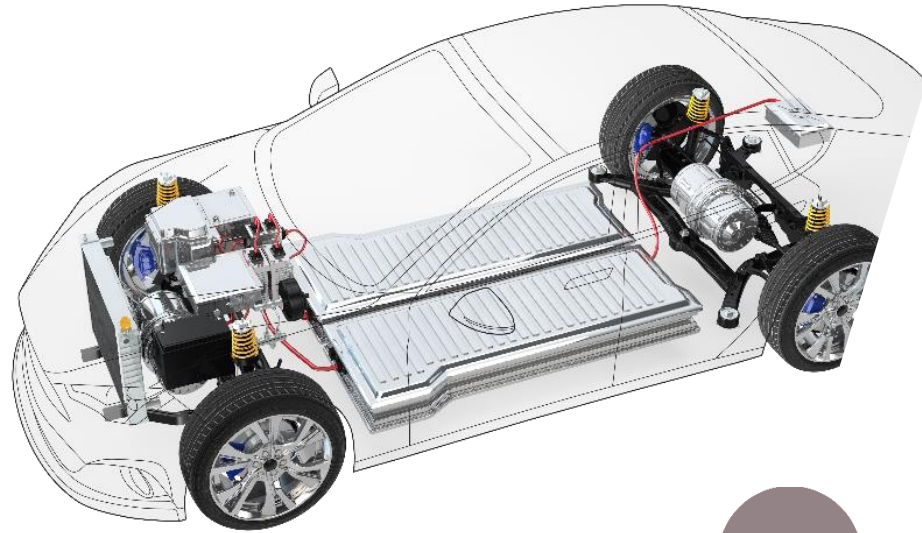


35% more current with same system cooling. Power class jump is possible.

Compact system design can be realized, also 16% more output power can be achieved.

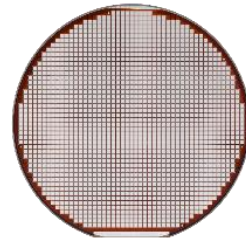
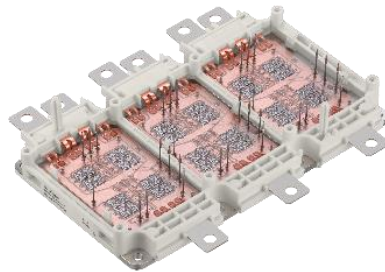


CoolSiC™ Module, Bare Die & Discrete enable longer drive range in e-Mobility Main Inverter



Reduced battery size, less cooling effort, lower cost in passive components, longer drive range, are a few of the benefits embracing SiC based solutions in electric drive train. In 800V system, SiC based main inverter can achieve appr. 7% more range vs. its Si counterpart. OEMs adopt topologies where SiC is used in the main inverter with rear wheel drive while Si-based secondary inverter in front wheel drive, achieving good balance between efficiency & cost.

SiC



Advantages of SiC

- › Increasing battery utilization by 5-10%
- › Higher power density for system size reductions of up to 50%
- › Lower conduction losses in light load condition and lower switching losses compared to Si IGBTs
- › IFX CoolSiC™ offers superior performance without jeopardizing quality

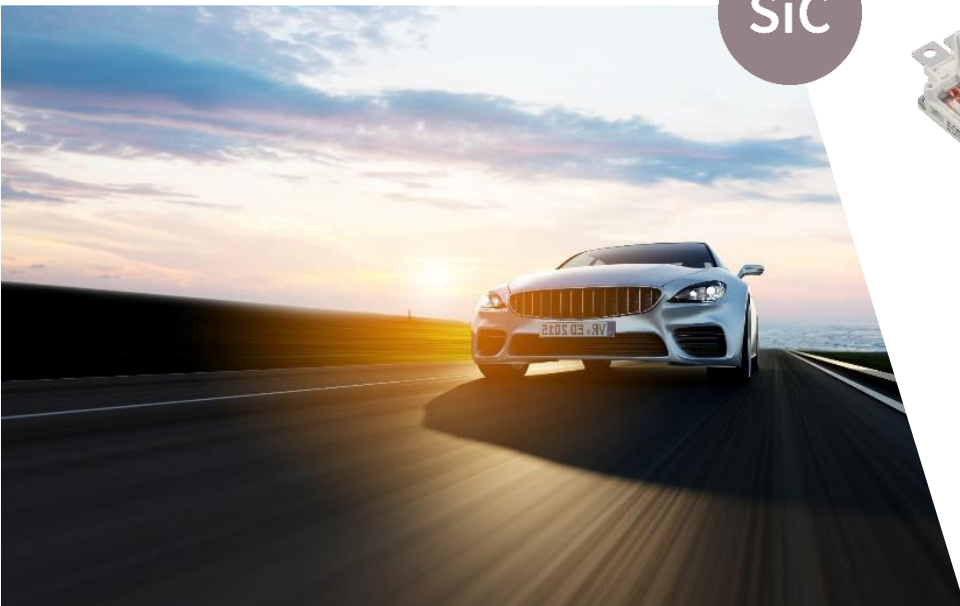
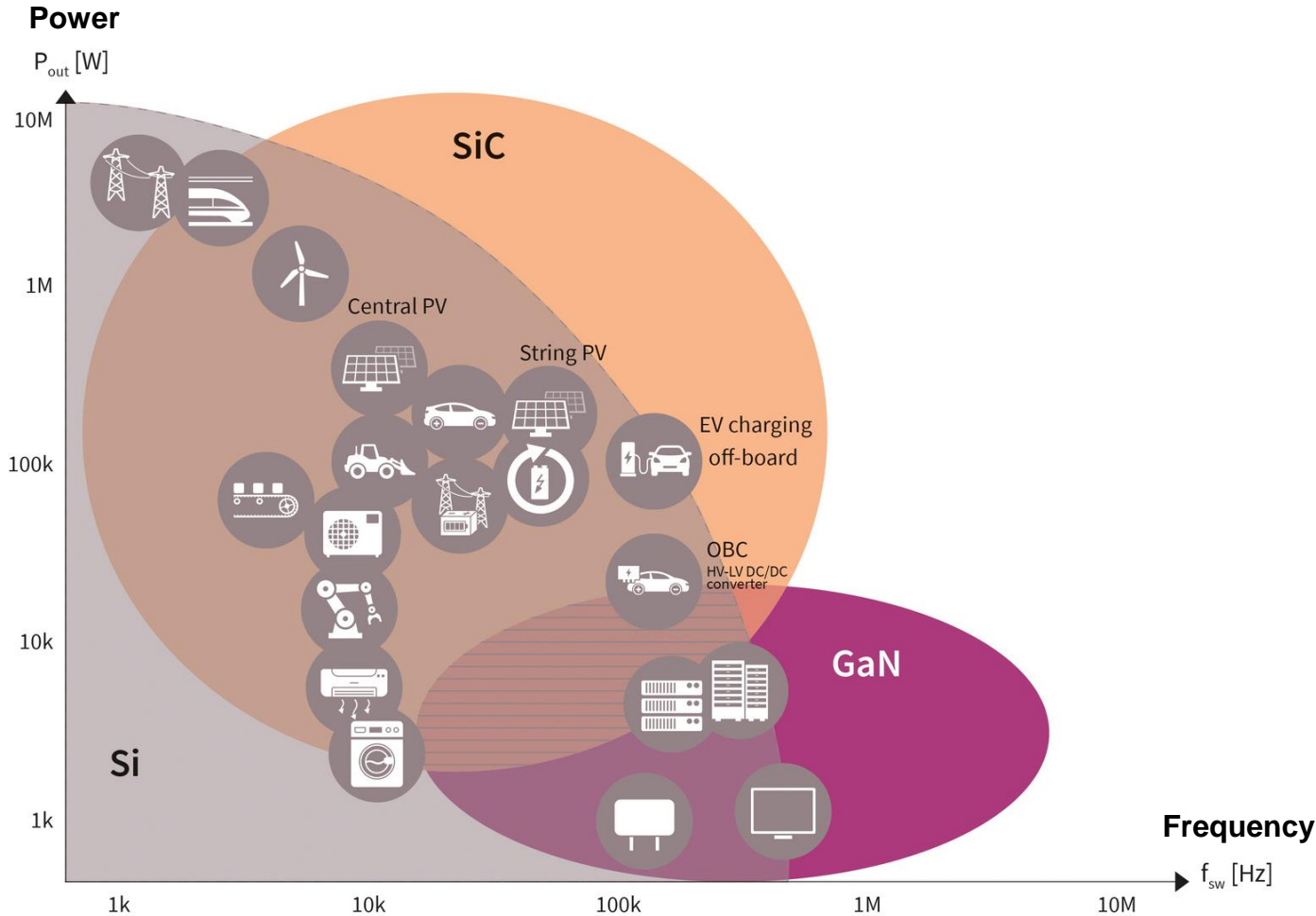


Table of contents

1	Background	3
2	Infineon's solutions enable the green energy and higher efficiency	7
3	Infieon's Advanced Technology	26
4	Infineon is Continously enabling Decarbonization	27

Leveraging full potential based on the power ratings and switching frequency required by the application

Comparison of technologies



Si

- › Si remains the mainstream technology
- › Targeting 25 V – 6.5 kV
- › Suitable from low to high power

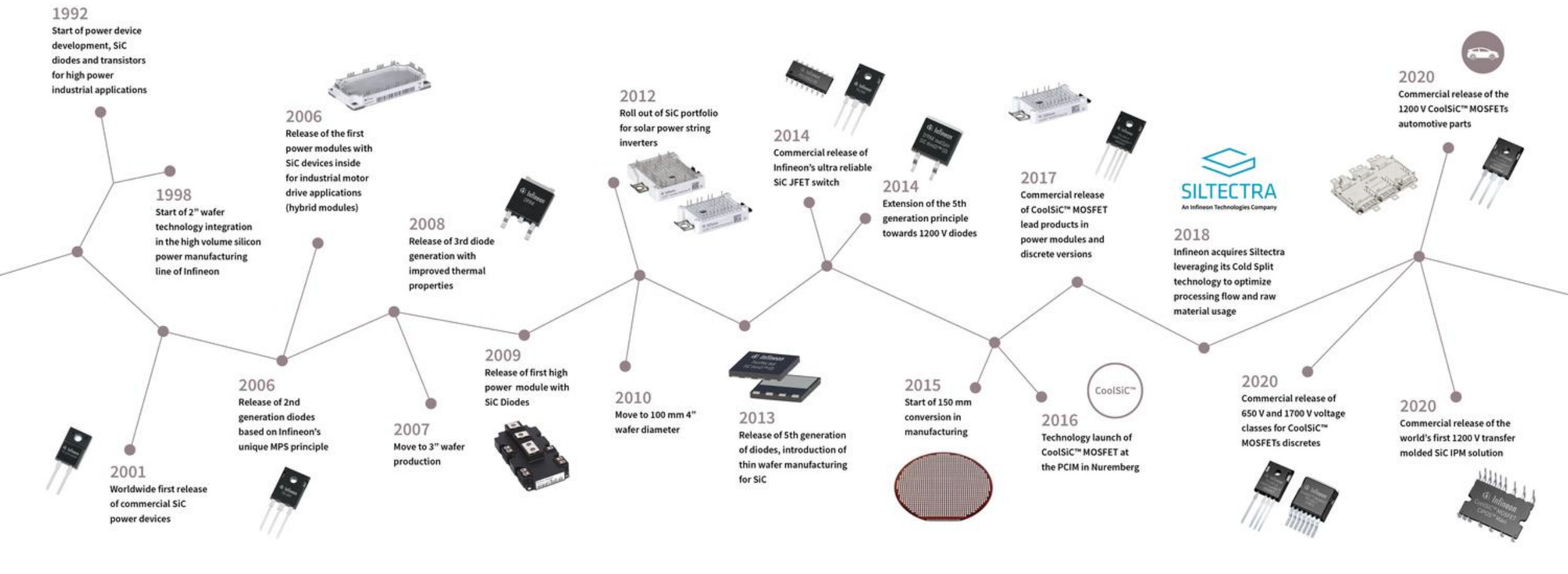
SiC

- › SiC complements Si in many applications and enables new solutions
- › Targeting 650 V – 3.3 kV
- › High power – high switching frequency

GaN

- › GaN enables new horizons in power supply applications and audio fidelity
- › Targeting 80 V – 600 V
- › Medium power – highest switching frequency

Infineon has 20 years of field experience with SiC



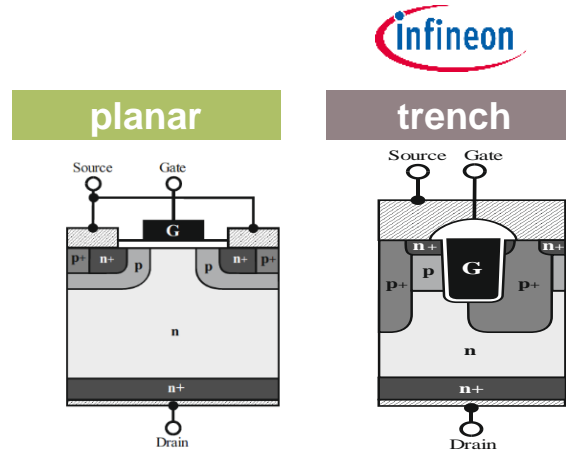
Four key success factors: Infineon well positioned to defend its leadership in power semis also in SiC



1. Substrate



2. Device



3. Module

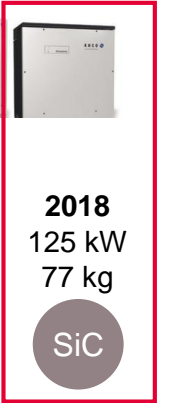


4. System



Courtesy: Kaco and pv magazine

2008	2011	2016	2018
100 kW	50 kW	50 kW	125 kW
1129 kg	151 kg	70 kg	77 kg



- > multi-year SiC wafer supply agreement
- > acquisition of SILTECTRA™

- > trench-based architecture
- > 150 mm conversion completed

- > expertise from industrial heritage
- > high-volume manufacturing

- > deep application and system know-how
- > Product-to-System

SiC will add significant value to a broad variety of systems across applications

(Selected) SiC benefits



Photovoltaics

- > Smaller and lighter systems
- > Lower cost



EV charging

- > Reduced charging times
- > Low loss at high voltages



eMobility

- > Higher efficiency
- > Better power density



Traction

- > Reduced power losses
- > Less weight and space



UPS/ SMPS¹

- > Reduced power losses
- > Reduced cooling efforts



Drives

- > Reduced energy usage
- > Reduced footprint



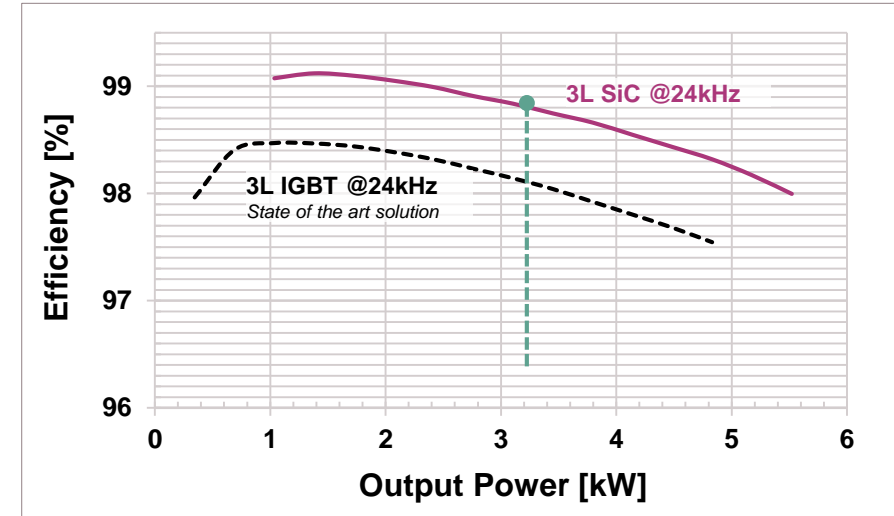
Note: 1) UPS = uninterruptible power supply; SMPS = Switched-mode power supply

SiC MOSFET: higher conversion efficiency allows improvement of system costs

Higher conversion efficiency

Lower conduction and switching losses lead to

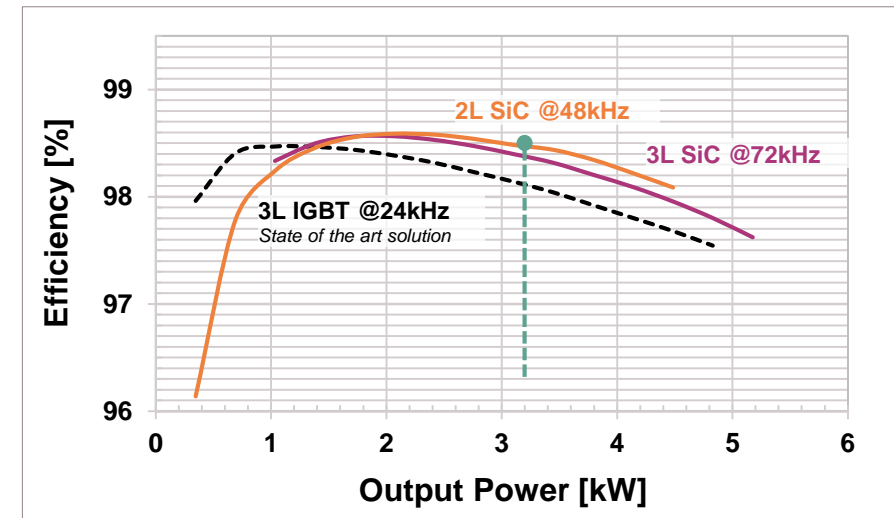
- › Higher conversion efficiency at same switching frequency
- › Higher output power for a given frame size



Effect on system costs

SiC devices enable

- › Increased switching frequencies to shrink magnetic components
- › Reduced power circuit complexity by using simpler topologies, e.g. 2L instead of 3L

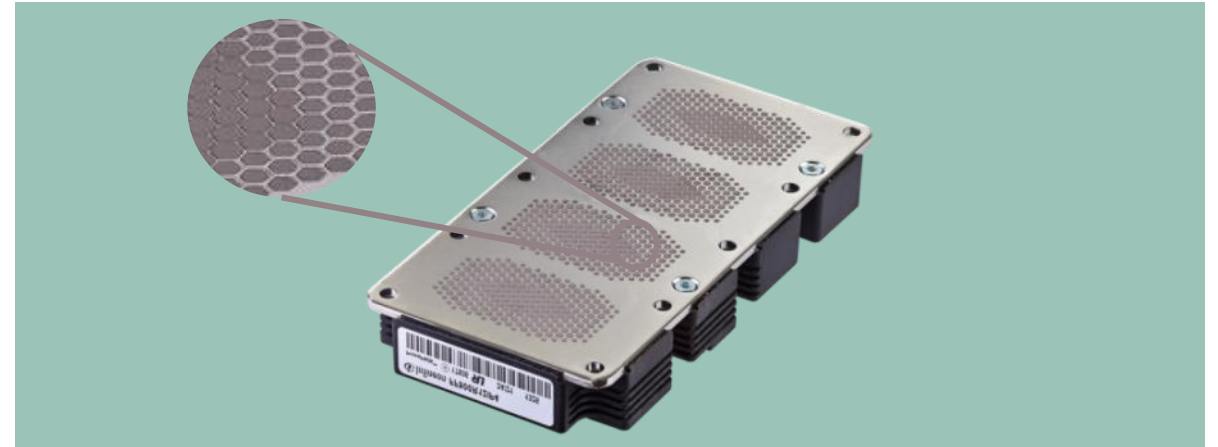


Thermal challenges

- › Efficient cooling solutions are needed in power electronics to enable high power density
- › Common silicone-based solutions do not meet increasing requirements of reliability and lifetime and are inconvenient to handle

TIM solution

- › New concept of pre-applying thermal interface material (TIM) directly onto the module
- › Infineon took ownership over this process previously performed by customers
- › TIM is screen-printed to the base plate. The particular pattern and placement optimizes heat transfer
- › Specially developed and optimized for our power modules and demanding applications
- › TIM is free of silicone and out-performs the general purpose materials



Benefits

- › Modules ready to use decreasing time and complexity during assembly and mounting
- › Easy to handle - no liquid components
- › Simplified maintenance
- › Increased heat transfer allows higher power and power density
- › Increased lifetime and system reliability

Thermo-mechanical challenges

- › Power cycling results in huge mechanical and thermal stress to the components inside our power modules
- › This can lead to material fatigue and wear

.XT solution

- › .XT is a set of interconnection technologies developed to enhance most critical connections within power modules. The holistic approach covers:
 - Copper bond wires
 - New chip surface structures
 - Sintering of IGBT and diodes
 - Improved system soldering



Benefits

- › Increased system reliability regarding thermal- and power cycling capabilities
- › Enables junction temperatures of up to 175 °C
- › Increases the lifetime by a factor of 10 compared to today's standard modules

Key applications





Features

- › Modular approach, scalable power range on one platform
- › New package design
- › High power density by optimized mechanical construction
- › Robust against harsh environments
- › High isolation voltage of 10.4 kV
- › Low inductive module design

Benefits

- › Reduced system-, maintenance- and lifecycle cost
- › Single module geometry supports simplified design-in process
- › Long lifetime and high reliability for applications operating under harsh environmental conditions
- › Prepared for upcoming new interconnection technologies and semiconductor generations
- › High power platform offering scalability and flexibility designed for paralleling of multiple modules

Key applications



Table of contents

1	Background	3
2	Infineon's solutions enable the green energy and higher efficiency	7
3	Infieon's Advanced Technology	26
4	Infineon is Continously enabling Decarbonization	27

我们的产品创新结合高效生产是应对气候变化的关键

帮助减排超过5,400万吨二氧化碳



二氧化碳排放*
约161万吨
二氧化碳当量

比率约为1:35



二氧化碳减排¹
约5,600万吨
二氧化碳当量


净生态效益：二氧化碳减排超过5,400万吨

* 碳排放量（二氧化碳当量）增加可能主要是因为在计算时首次考虑了生产服务提供商的碳排放。


我们创造的净生态效益相当于……



一座1,874 km²光伏电厂的碳减排量。



欧洲约9,000万人口的平均年用电总量。



5万趟从慕尼黑飞往新加坡的空客A380满员航班。

英飞凌的贡献



是排名第一的可再生能源发电用
半导体供应商



帮助整个电能产业链提高能源效率，
降低电损。



用我们的产品帮助减排超过5,400万
吨二氧化碳。



到2030年实现碳中和，到2025年实现二氧
化碳排放量减少70%（范畴1和范畴2排
放）。

让绿色能源成为现实 – 英飞凌的技术进步如何帮助提高能源效率



大力发展太阳能发电和风电

可再生且清洁。 英飞凌在充分利用太阳能和风能的无限潜力方面，起到了至关重要的作用。我们的半导体解决方案可提高风电和光伏系统设计的能效并实现小型化，从而助力风电和光伏发电与传统能源并驾齐驱。



优化能流、降低损耗

稳定且可靠。 英飞凌的半导体助力以最高效的方式实现能源传输、配送和储存。降低损耗对于优化全球能流进而满足日益增长的能源需求至关重要。



增效节能

智能且高效。 英飞凌提供的传感器、单片机和功率半导体为社会生活的各个领域带来了可持续的创新高效电源管理解决方案：交通、工业、通信和生活。英飞凌的系统级解决方案可以平衡电力输入和输出，从而实现增效节能。

为了未来的品质生活，减少碳排放和提高能源利用效率是全世界的共同使命。

作为业界领先的功率半导体供应商，英飞凌助力优化当今和未来整个电能产业链：交通、工业、通信和生活的能源效率。

让绿色能源成为现实



Part of your life. Part of tomorrow.