



# Techday

Taiwan | 2023

OUR TECHNOLOGY STARTS WITH YOU



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**Techday**  
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# Power & Energy Management Solutions

**Francesco MUGGERI**

Vice President, Marketing & Applications  
Power Discrete & Analog, APAC  
STMicroelectronics



# Global challenges

Need to increase energy efficiency everywhere & support the use of renewable energy sources

Rising demand for and usage of electrical energy

> **30%** global electricity demand increase from 2020 to 2030

Decrease carbon emissions

**45%** CO<sub>2</sub> emission reduction from 2010 to 2030 to limit warming to 1.5 degrees C

Increase use of renewable energy

Electrical energy from renewal sources from ~**10%** in 2020 to ~**20%** in 2030

# Trends in sustainability

## Sustainability driven on all levels of society



### Nations

#### China

2030: Peak Carbon Emissions  
2060: Carbon Neutral

Europe & USA  
2050: Carbon Neutral



### Corporations

#### ST

2027 Carbon neutral  
Commitment

- 83% reduction in our PFCs emissions efficiency since 1994
- 51% renewable electricity.
- Participating in Apple clean energy program
- 27% direct & indirect emissions efficiency in 2021 vs 2020



### Individuals

Responsibility, awareness &  
actions

Awareness & Actions



# We are committed to be carbon neutral by 2027

**Amplifying the positive impact of our technology**  
**Accelerating our sustainability initiatives**

## Milestones



Carbon neutral by 2027\*

Compliance with the 1.5°C scenario by 2025  
– recognized by SBTi

Sourcing 100% renewable energy by 2027

Collaborative programs and partnerships for  
carbon neutrality throughout our ecosystems

**-83%** reduction in our PFCs emissions efficiency since 1994

**51%** renewable electricity. Participating in Apple clean energy program

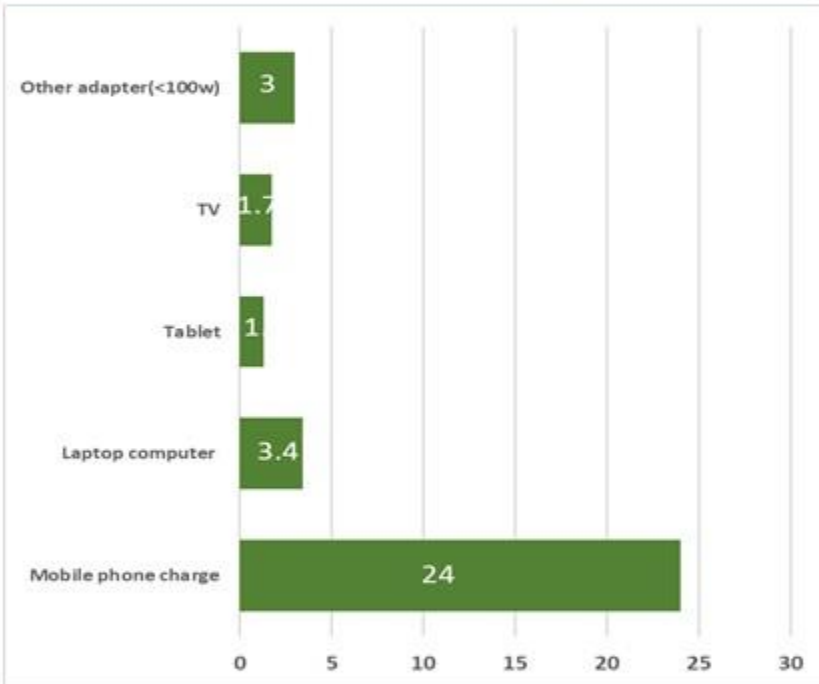
**-27%** direct and indirect emissions efficiency in 2021 vs 2020





# Global Energy: Impacts from Standby Power

Total Number of Equipment  
in Use Yr22 (Bn)



23,015 TWh:  
total worldwide electricity consumption  
(2020)

65mW current  
AVG standby  
power to  
**5mW**  
(Zero Standby  
Power)

we will get a  
total energy  
saving of  
**17.56  
TWh**

By reducing our energy consumption,  
we can reduce our carbon footprint

60mW/unit energy saving equals  
~ 3 standard nuclear plants



11.01 MMBOe

2.31 M tce



4.38 Tg CO<sub>2</sub>



tce: tonnes of coal equivalent, toe: tonnes of oil equivalent

MMBOe: Million Barrels of Oil Equivalent

Sources: Statista, EarthWeb, STMicroelectronics

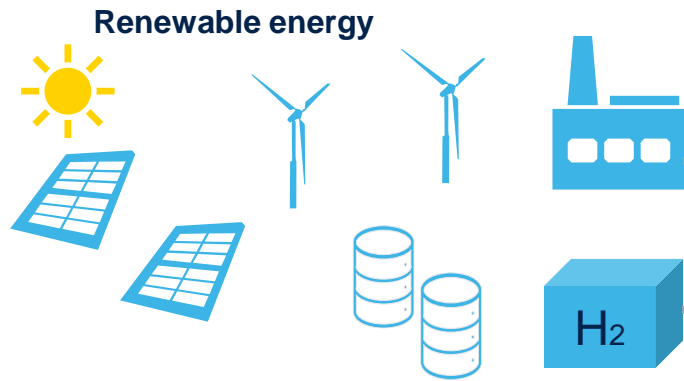


# Developing solutions for sustainability and efficiency

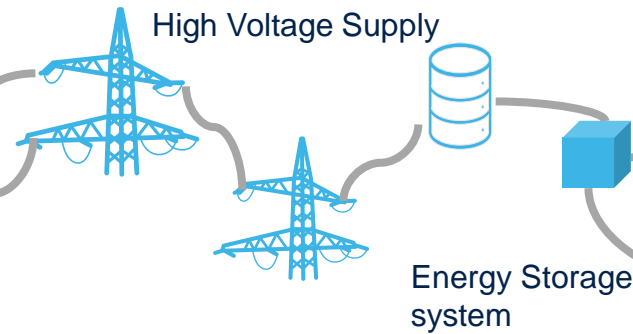


# Power & Energy: conversion chain

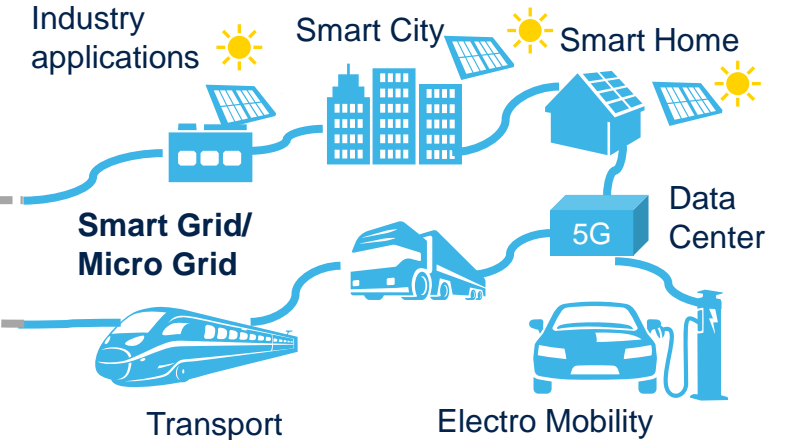
## Energy Generation



## Transmission/ Storage



## Consumption



## Centralized Energy Generation

- Solar: 19% CAGR (2022-27)<sup>1</sup>
- Wind : 13% CAGR (2022-27)<sup>1</sup>
- Energy Storage: ~30% CAGR (2022-30)<sup>2</sup>
- Energy Distribution

## Energy Distribution/Management

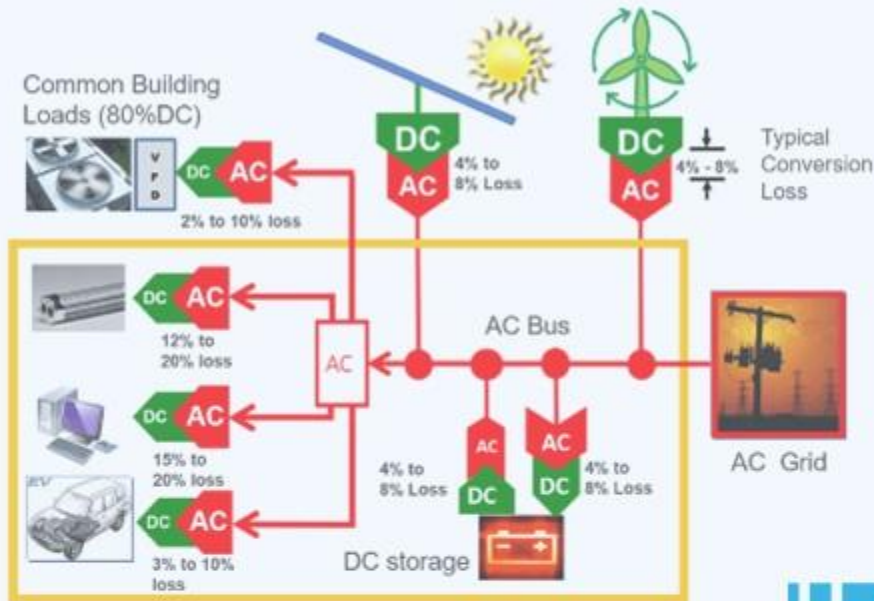
- Smart Grid: 19.1% CAGR (2021-26)<sup>3</sup>
- Energy storage
- Automated Energy Management: 12.67% CAGR (2022-27)<sup>4</sup>

## Distributed Energy Generation

- Smart Agriculture (Global CAGR 9.4%, 2023-28)<sup>5</sup>
- Manufacturing & Process Automation (CAGR 8% 2022-25)<sup>6</sup>
- NEV (China): 38.24% CAGR (2021-26)<sup>7</sup>
- Charging Pile: 44% CAGR (2022-25)<sup>8</sup>

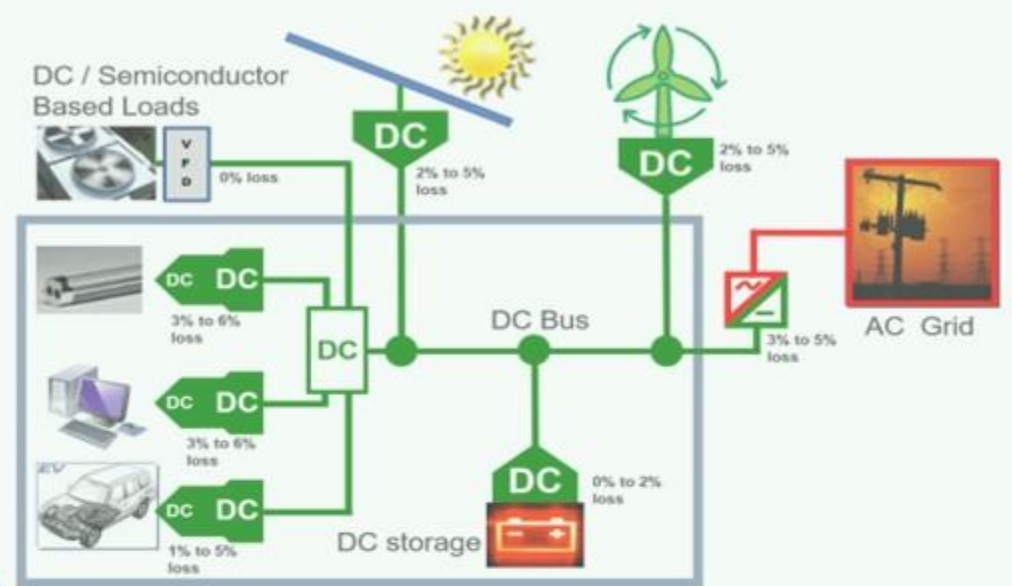


# New Microgrid Architectures beyond 2025



**AC Microgrid**

Improves  
8-15%  
Efficiency



**DC Microgrid**

CurrentCDS

Set as non-profit, open, independent foundation for promotion and adoption of DC microgrid.

Objective is to provide free access to IP, for safe and stable.

**DC-INDUSTRIE**  
ENERGIEWENDE TRIFFT INDUSTRIE 4.0

Funded by Germany Federal Government.

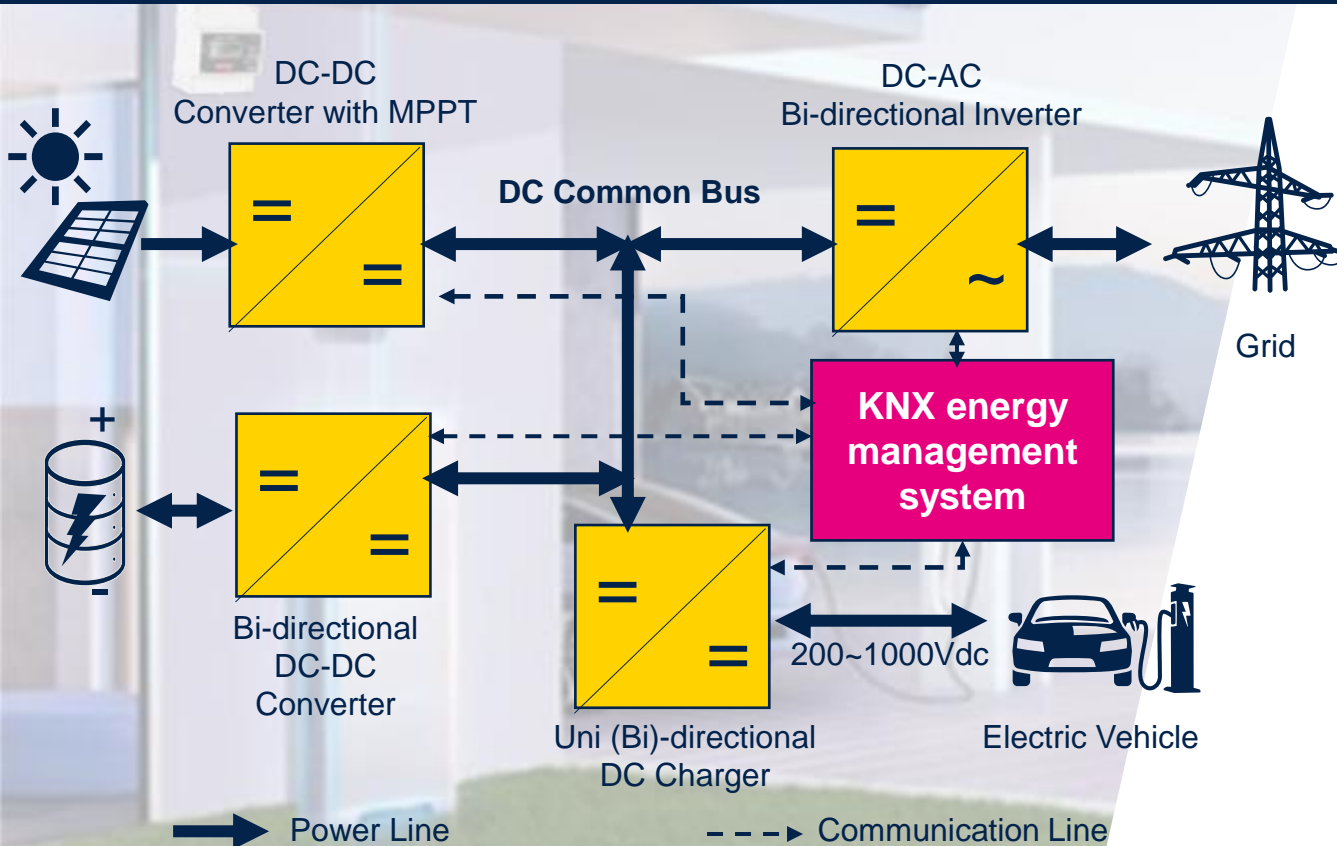
For safe and robust energy, supporting connection to the supply grid and maximum use of decentralized, regenerative energy.

# Enabling Microgrid with PV and ESS

Increase use of renewable energy

Increase your grid independence

lowering energy costs by up to 11% #



Trend #1

Integration of PV and Energy storage

Trend #2

Energy Storage for Resilience

Trend #3

PV powering households

# Source from [Rolls Royce](#): Use case I Germany Electric vehicle charging hub



# Enabling Microgrid:3-in-1 solution with PV, ESS and EV charging

30kW Three Phase Vienna Rectifier

PE.ED\_0002.20 (STDES-30KWVRECT)



PJM30

30kW Three Phase LLC Converter

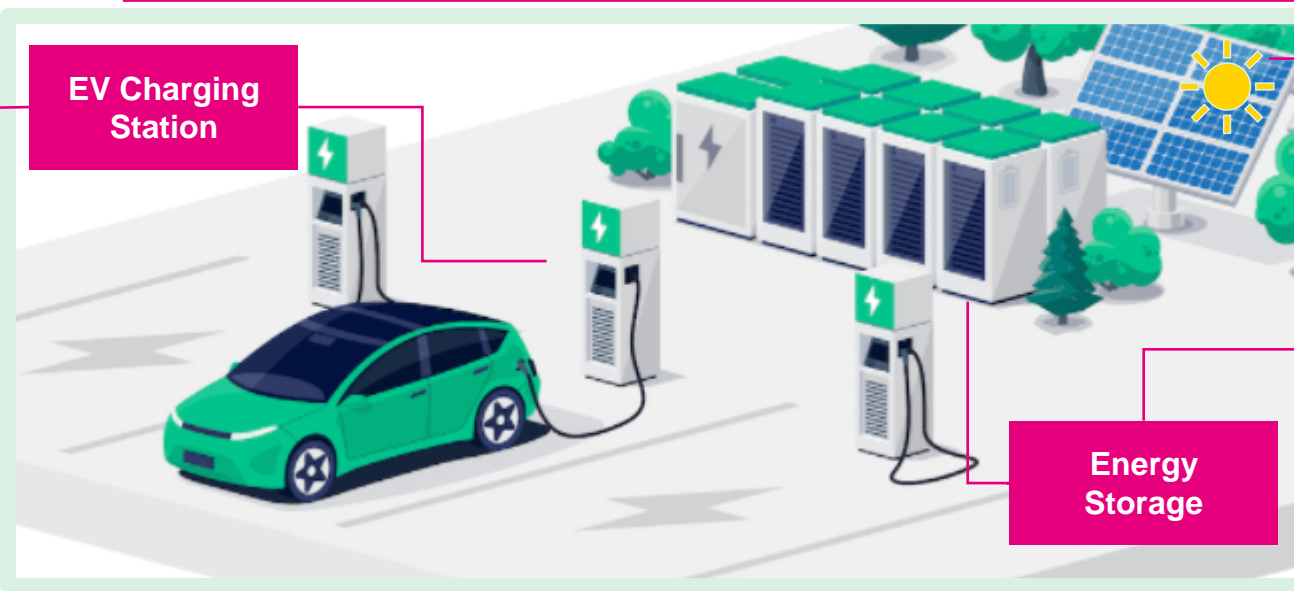
PE.ED\_ED\_0004.22



PJM30

PLC based 900W smart solar PV optimizer PE.SMW0031.22	STB500- Smart Solar Rapid Shutdown PE.SMW0006.20	AI based Solar Arc Fault Circuit Interrupter PE.SMW0036.23	40kW SiC Gen.3 Bi-directional DC/AC Inverter PE.ED_0007.22
 <div>PJM30</div>	 <div>PJM30</div>	 <div>PJM30</div> <div>NEW</div>	 <div>PJM10</div>

PV Inverter



6.6kW SiC Gen.2 bi-directional AC-DC for Energy Storage  
PE.EG\_0002.21



Bidirectional Totem-pole PFC  
PJM30

Functional CLLC

NEW

# Superior efficiency of 30kW EV charging unit empowered by SiC Gen 3

1

## 30kW Vienna PFC

**30kW Three Phase Vienna Rectifier for EVCS**

**Application key Specification:**

- Input AC voltage: Three phase 380VAC up to 480VAC with 47Hz or 60Hz
- Maximum input current: 25A/80°C
- DC output voltage: 800VDC, full load output power: 30kW, max efficiency: 96.5%
- Power Factor: >0.997
- DC output load regulation: from 25% to 100% load speed < 5ms
- EMI/EMC: EMI problem max. 20V/100kHz

**Key Products**

- SiC MOSFET: STC12000V100A100
- SiC MOSFET: STC12000V100A100
- SiC MOSFET: STC12000V100A100

**Key Benefits**

- Small size and low EMI/EMC problem max. 20V/100kHz
- High efficiency
- Low EMI/EMC

2

## 30kW 3-phase LLC

**30kW Three Phase LLC Converter for EVCS**

**Application key Specification:**

- Input AC voltage: Three phase 380VAC up to 480VAC with 47Hz or 60Hz
- Maximum input current: 25A/80°C
- DC output voltage: 800VDC, full load output power: 30kW, max efficiency: 96.5%
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**Key Products**

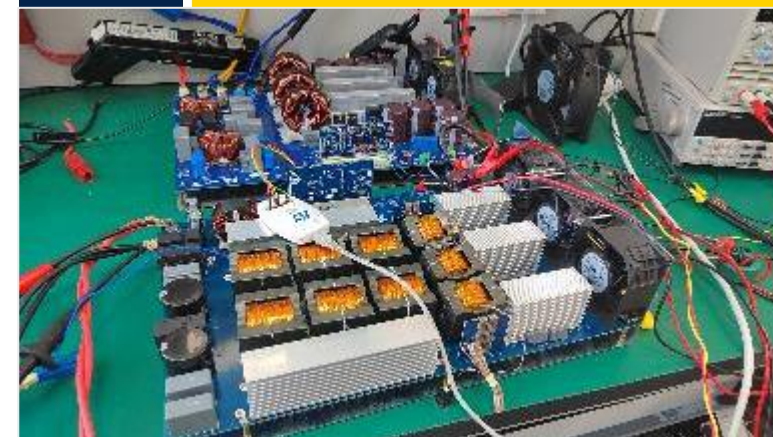
- SiC MOSFET: STC12000V100A100
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**Key Benefits**

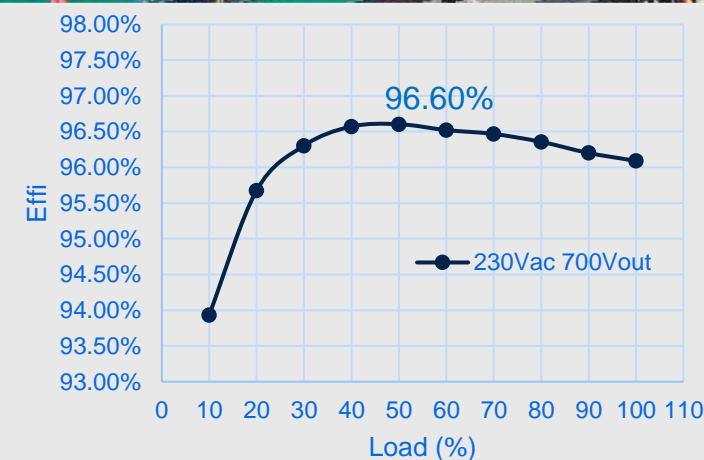
- Small size and low EMI/EMC problem max. 20V/100kHz
- High efficiency
- Low EMI/EMC

3

## Total Solution



Whole charging unit demonstrated efficiencies of 96.6%



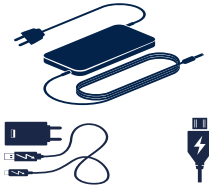


# Power & Energy

Product to system approach to create value for our customers

## Focus applications and key benefits

Power Supplies & Converters



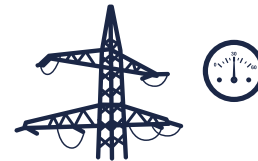
Energy Generation & storage



Lighting system & Controls

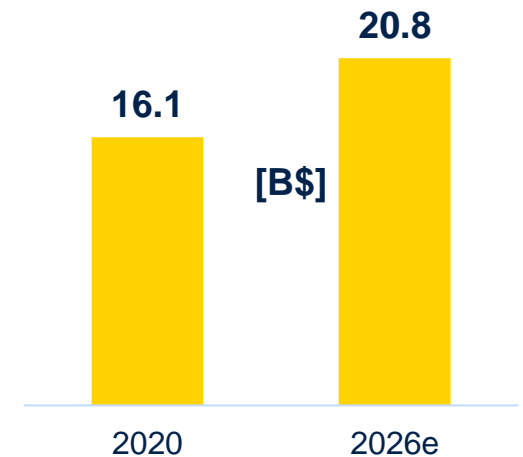


Metering & Powerline Communication



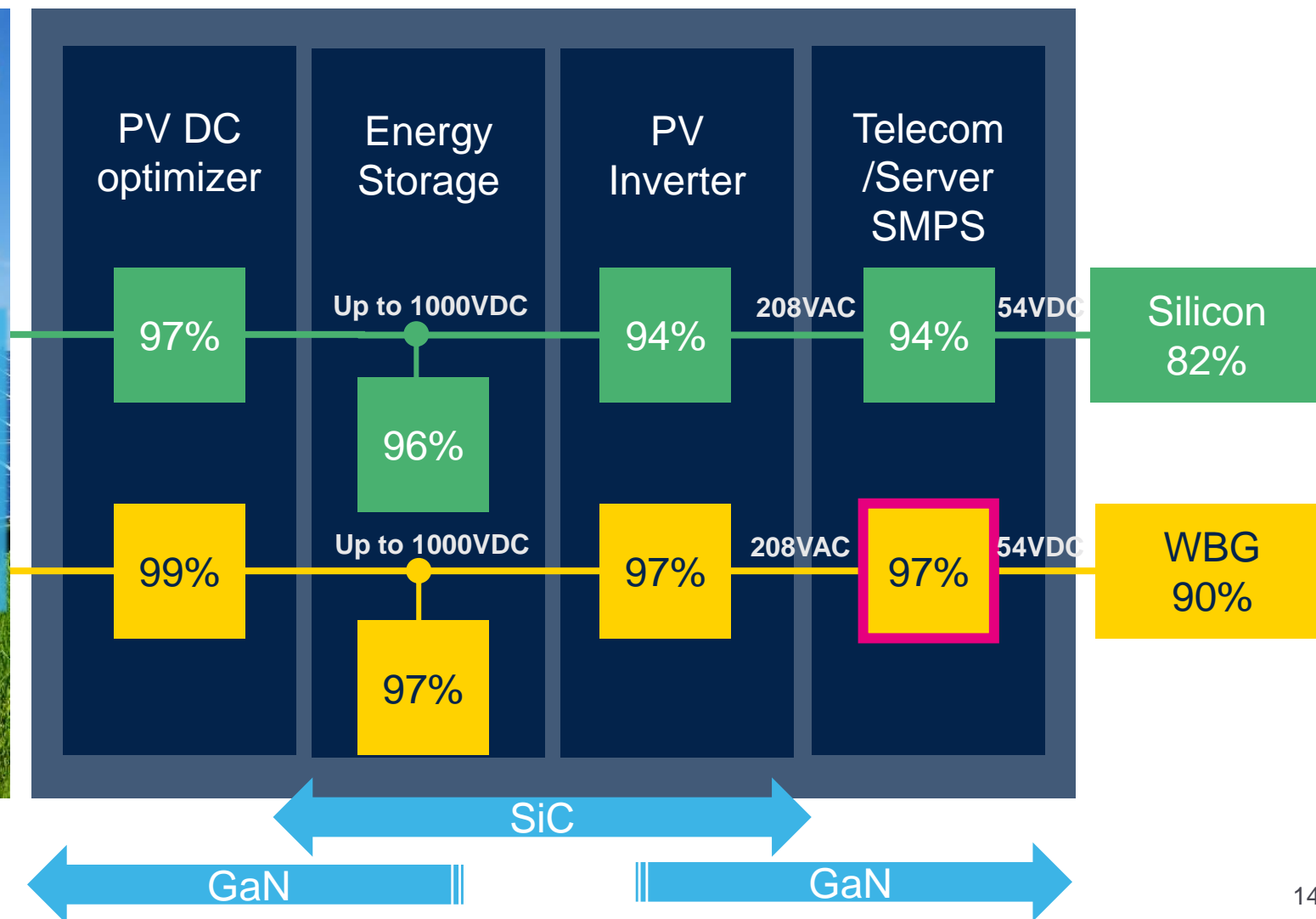
## Power & energy forecast

CAGR 11% - 2020-26



# Where our solutions are contributing...

WBG improves efficiency by 8% vs Silicon





# Leader in SiC MOSFET

## Focus applications



Power supply



UPS



Solar Inverter



Industrial Motors



EV Charger



Traction



OBC, DC-DC

## ST business perspective

>50%

Today market share automotive & industrial

>\$1B

SiC revenues in 2023

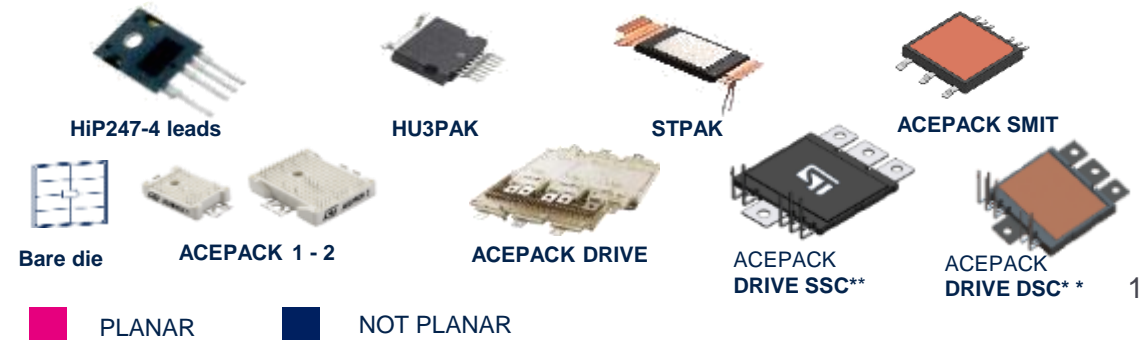
>115

projects in development

## Current offer and roadmap: from 650 to 2200 V

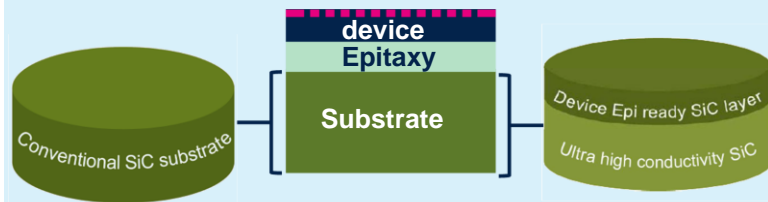
Gen1	Optimized <b>Ron</b> and <b>Tj</b> for <b>motor drive</b> applications	■
Gen2	Balanced <b>Ron</b> and <b>Qg</b> for industrial and automotive	■
Gen3	<b>Lower Ron</b> vs. Gen2 maximizing the driving range of EVs	■
SiC VHV*	<b>Very High Voltage SiC</b> 2200V Available in bare die option	■
Gen4*	<b>Lower Ron</b> vs. Gen3 tailored for traction inverter	■
Gen5**	Innovative <b>high power density technology</b> structure	■
MDSiC**	Radical innovation, outstanding Ron value at hot temperature and further Ron reduction vs. Gen5	■

## Advanced packaging



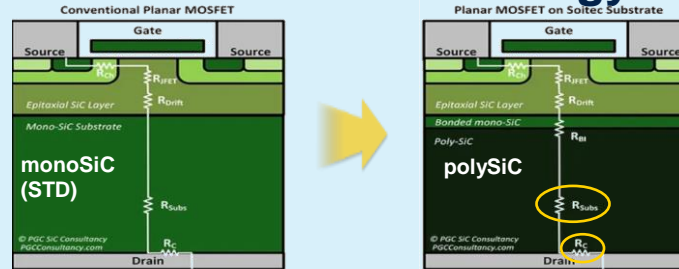
# SOITEC SmartSiC™ Process for SiC Substrates Manufacturing

## SmartSiC™ Technology



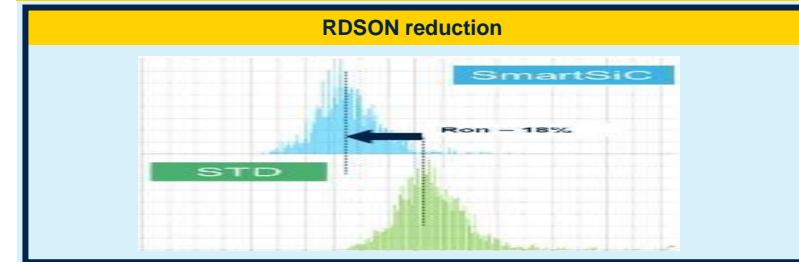
- Prime quality mono-SiC (single crystal) used as «donor»
- High-conductivity polycrystalline SiC used as «handle-wafer»
- Conductive bonding interface between mono- and poly-SiC, w/o any foreign material
- surface finishing including polishing and high temperature annealing to be epi-ready
- Donor wafer reuse ( $\geq 10$  x) for new process cycles

## Advantages of SmartSiC™ Technology



- **Substrate cost reduction**
  - $\geq 10$ x epi-ready SmartSiC wafers obtained from a single STD SiC substrate
- **Device feature size reduction / RDSon reduction**
  - highly doped p-SiC material leading to the reduction of RDSon
- **Copy & paste of MOSFET process flow**
- **Acceleration of the path to 200mm transition**
- **Facilitation of 300mm transition** (1<sup>st</sup> SiC sample substrates at 300mm availability in 2026)
- **Poly-SiC in house Manufacturing**
  - SmartSiC substr. adopting in house pSiC in H1'25

## SmartSiC™ Qualification Status



### HIGHLIGHTS






- **early validation** successfully completed (Jan '23):
  - RDSon reduction of 15% confirmed
  - Good reliability results at 500h
  - Dynamic behavior aligned to STD G3 technology
  - EWS yield in line with ST baseline

### PLAN

- **6" Technology Qualification Aug. 2024**
- **8" Technology Qualification Sept. 2024**
- **8" technology transfer to ST start Sept. 2024**

# Application benefits of silicon carbide

## Silicon carbide addresses energy efficiency in industrial & automotive applications

	<b>Electric Vehicles</b>	longer driving range and car weight reduction
	<b>Charging Station</b>	faster charging cycles
	<b>Power Supply for Server</b>	higher efficiency and reduced total cost of ownership
	<b>Industrial Drives</b>	compact design with reduced size and weight reduced total cost of ownership
	<b>Renewable Energy</b>	reduction of system size, weight and installation cost



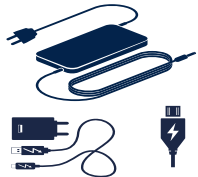
# Gallium Nitride

ST is aggressively pursuing GaN development

## Focus applications and key benefits

### Focus applications and key benefits

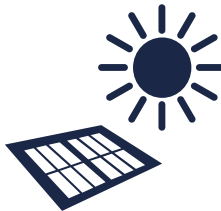
AC-DC adapter  
& Smartphone fast  
charger



Server power supply



Solar Energy  
Storage System



**4x**  
smaller  
vs Si

**3x**  
lighter

**50%**  
higher  
power  
density

**20%**  
lower  
 $P_{Loss}$

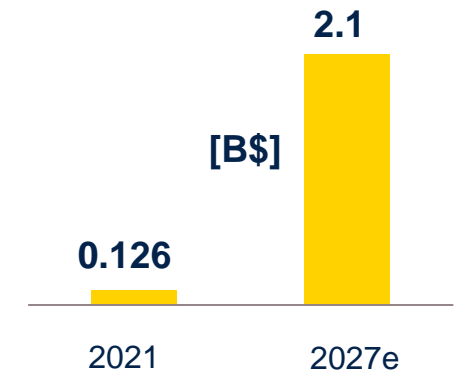
**3x**  
lighter

**2x**  
smaller &  
Fan-less



## GaN market

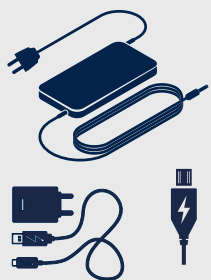
CAGR 59% 2021–2027





# Benefits of GaN Technology

## Adapter for tablet and notebook: fast charger



4x smaller

3x lighter

## Server power supply and Telecom Base station

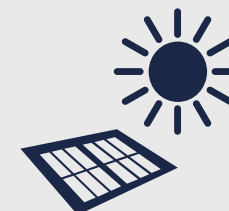


50%  
higher power density



20% lower  $P_{LOSS}$

## Solar ESS (Energy Storage System)



2x smaller

3x lighter

# ST GaN Products

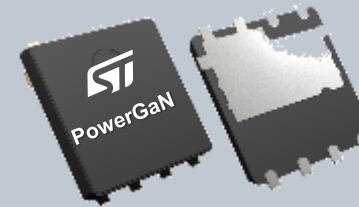
Discrete and High integration GaN embedded (SiP) provider

SiP

## PowerGaN

(Ron 16mΩ - 290mΩ)

Discrete



Up to KW

Server/Telecom/Data Center, Energy Storage, OBC

## MasterGaN

(Ron 150mΩ - 450mΩ)

+ Half Bridge Driver



30W – 320W

Phone/Laptop Charger/Adapter, Desktop, TV, Game Console Adapter

## VIPerGaN

(Ron 225mΩ - 450mΩ)

+ Flyback Controller



25W – 100W

Phone/Laptop Charger/Adapter, Server/Telecom/Data Center Standby Power



# Investing to support our customers

## 300 mm capacity expansion

**Crolles**



**Agrate**



**Doubling  
300 mm  
footprint by  
2025**

## Wide bandgap capacity expansion

**Catania – Silicon Carbide**



**Tours – Gallium Nitride**



**Expanding  
production  
capacity  
Internal  
vertical  
integration &  
external  
partnerships**



# STMicroelectronics and Sanan Optoelectronics to advance silicon carbide ecosystem in China



Corporate

## STMicroelectronics and Sanan Optoelectronics to advance Silicon Carbide ecosystem in China

- STMicroelectronics and Sanan Optoelectronics to create a Joint Venture (JV) for high-volume 200mm SiC device manufacturing
- JV will support rising demand for STMicroelectronics SiC devices in China for car electrification and industrial power and energy applications
- Sanan to build separately a 200mm SiC substrate manufacturing facility to fulfill the JV's needs



新闻稿

### 意法半导体携手三安光电，推进中国碳化硅生态系统发展

- 意法半导体和三安光电将成立一家合资制造厂，进行8英寸碳化硅(SiC)器件大规模量产
- 该合资厂将有助于满足中国汽车电气化、工业电力和能源等应用对意法半导体 SiC 器件日益增长的需求
- 三安光电还将单独建造一个8英寸 SiC 衬底制造厂，以满足该合资厂的衬底需求

2023年6月7日，中国—服务消费电子应用领域、全球领先的半导体公司意法半导体(STMicroelectronics，简称ST，纽约证券交易代码：STM)，和中国化合物半导体龙头企业(通磊LED、碳化硅、光通信、RF、传感器和微化器等产品)三安光电(上海证券交易代码：600703)今日宣布，双方已签署协议，将在中国重庆建立一个新的8英寸碳化硅器件合资制造厂。新的SiC制造厂计划于2025年第四季度开始生产，预计将于2028年全面落成。届时将更好地支持中国的汽车电气化、工业电力和能源等应用日益增长的需求。同时，三安光电将利用自有SiC衬底工艺，单独建造和运营一个新的8英寸SiC衬底制造厂，以满足该合资厂的衬底需求。

该合资厂将采用ST的SiC专利制造工艺技术，专注于为ST生产SiC器件，作为ST的专用晶圆代工厂以满足其中国客户的需求。

该合资厂全部建设总额预计达32亿美元，其中未来5年的资本支出约为24亿美元，资金来源包括来自意法半导体和三安光电的资金投入、来自重庆政府的支持以及由合资企业向外贷款。

三安光电首席执行官赵海宏表示：“该合资厂的成立将有力推动SiC器件在中国市场的广泛采用，作为一家国际知名的专业SiC晶圆代工服务公司，三安还将新建一个SiC衬底工厂，专门为新成立的合资厂提供SiC衬底。这是三安光电朝着成为SiC专业晶圆代工工厂这一目标迈出的重要一步。随着新合资厂的成立和新SiC衬底工厂的产能扩张，我们有信心三安将连续在SiC专业晶圆代工市场占据领先地位。”

意法半导体总裁兼首席执行官Jean-Marc Chery表示：“中国的汽车和工业领域正在朝着电气化加速前进。在这个市场上，ST已经成功拿下了许多客户项目。对ST来说，与中国本地的重要合作伙伴一起建立一个专门的晶圆厂，这将帮助我们以最有效的方式满足中国客户不断增长的需求。将三安光电未来的8英寸衬底制造厂、双方新成立的前端合资制造厂，以及ST在中国深圳现有的后端制造厂相结合，ST将有能力为我们的中国客户提供一个完全垂直整合的SiC价值链。此举将成为继ST在意大利和新加坡的持续重大投资外，进一步扩大其全球SiC制造业务的重要一步。新合资厂将助力ST实现到2030年取得60亿美元以上SiC营收这一目标。这一举措也与ST在2025-2027年实现200亿美元以上的营收目标以及我们之前向资本市场传达的相关财务目标相契合。”

该项目的完成仍需监管部门批准。



# Key takeaways

## Strong Commitment to leading the industrial & automotive market

ST focuses on key Industrial market segments – **Automotive, AI, Automation, Power & Energy, Motor Control, Security**

We offer a **very wide product portfolio** to facilitate adoption in customer designs and projects

ST provides you with **better power efficiency, smarter and more intelligent energy usage solutions** to address rising demand for renewable energies

## Powering our Customers Sustainable Innovation



# Our technology starts with You



Find out more at [www.st.com](http://www.st.com)

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