

leti
cea tech



GaN ON SILICON TECHNOLOGY: A NEW ERA OF ENERGY CONVERSION

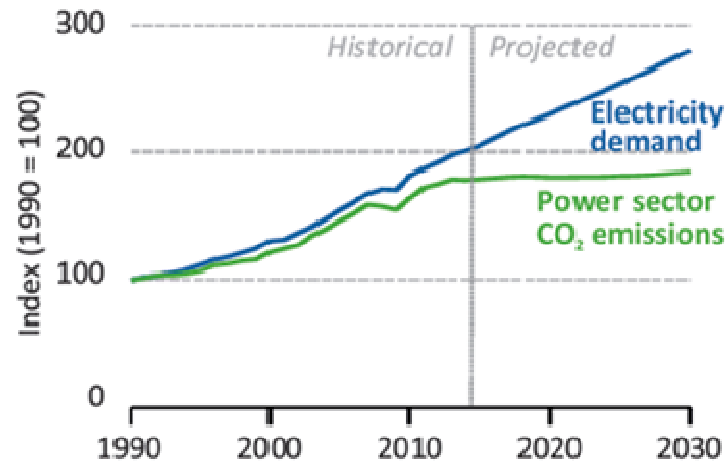
Thierry Bouchet - Director Technical Marketing Strategy, Power Electronics

MORE FOR LESS

MORE Power  for LESS environmental foot-print



Growth in world electricity demand and related CO₂ emissions



+50%



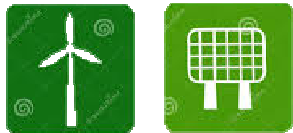
Source: World Energy Outlook Special Briefing for COP21 (2015).

SOLUTION: IMPROVE SYSTEM ENERGY EFFICIENCY

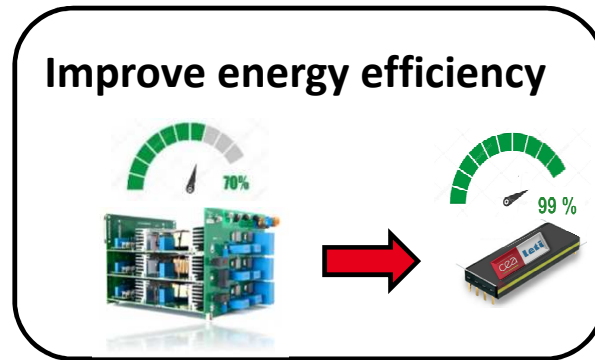
Building, automation, lighting



Renewable energy



Improve energy efficiency



Electrical transportation modes



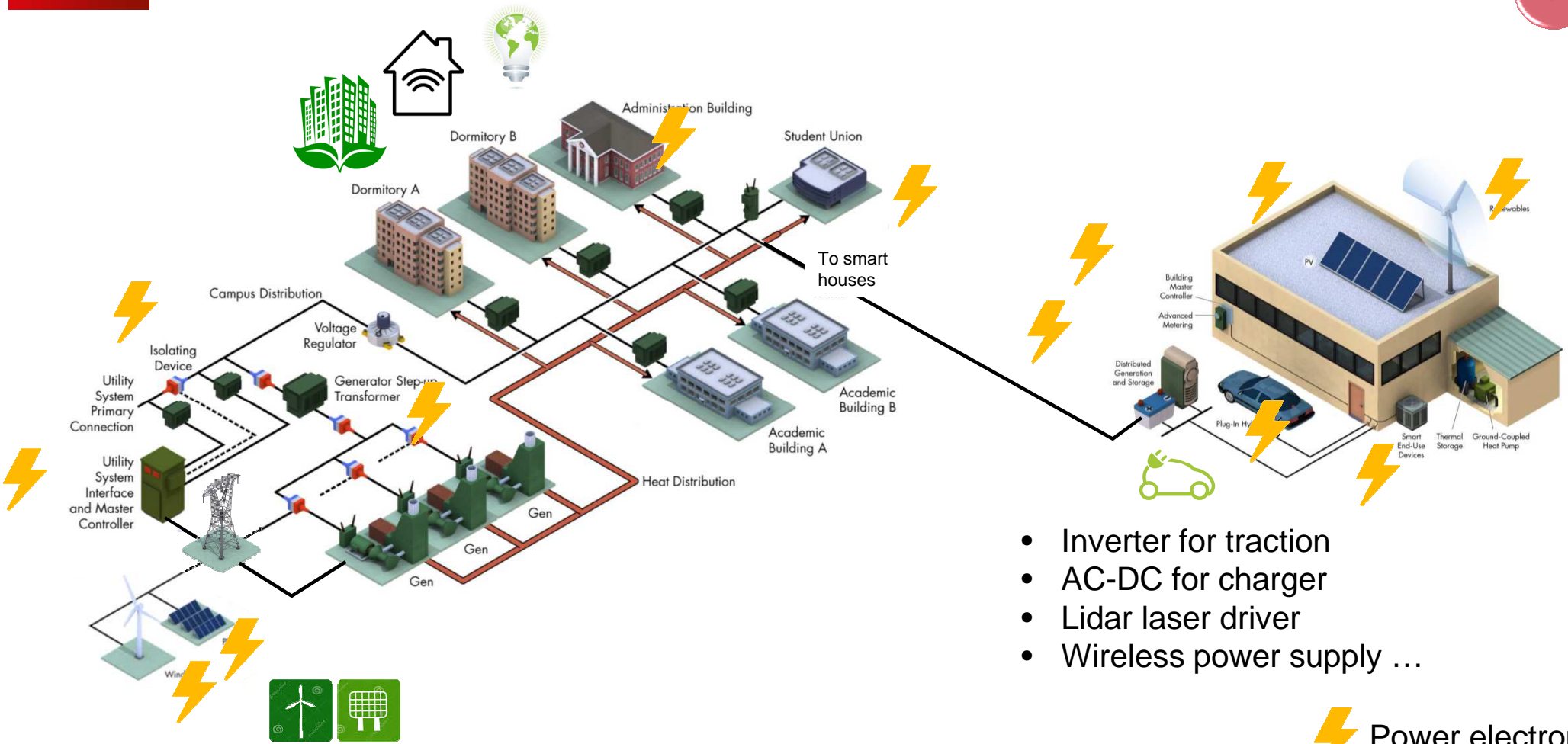
Frequency
Power density
Integrated functions



GaN/Si
CMOS
200mm

FROM GENERATION TO DISTRIBUTION AND CONSUMPTION WBG KEY ENABLERS

More Efficient
GaN/Si
Cheaper
Smaller & Lighter



- Inverter for traction
- AC-DC for charger
- Lidar laser driver
- Wireless power supply ...

Power electronic

WHICH TECHNOLOGY FOR WHICH APPLICATION

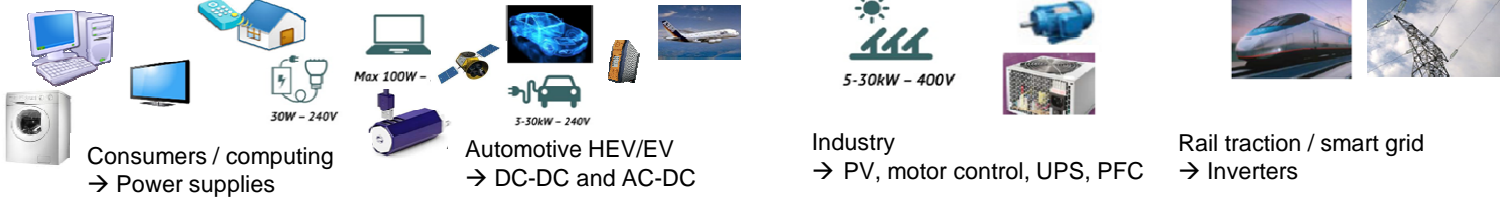


DISTRIBUTION > 1kW

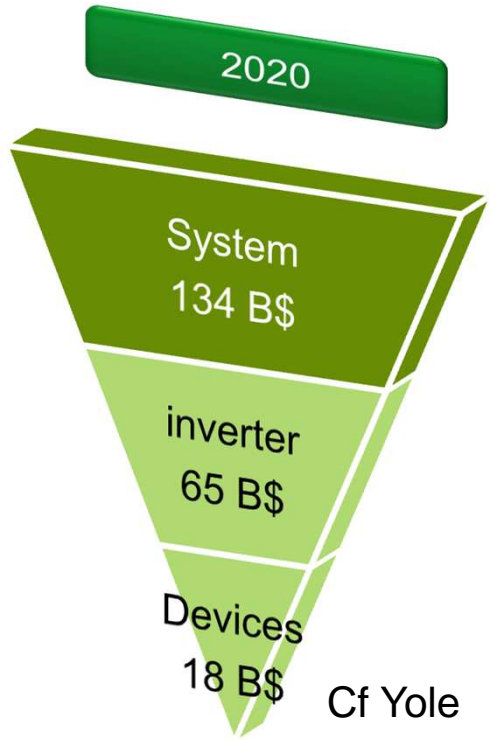
Power supply <1kW

Power converter > 1kW

30V 600V 1200V 6kV



Silicon GaN/Si SiC

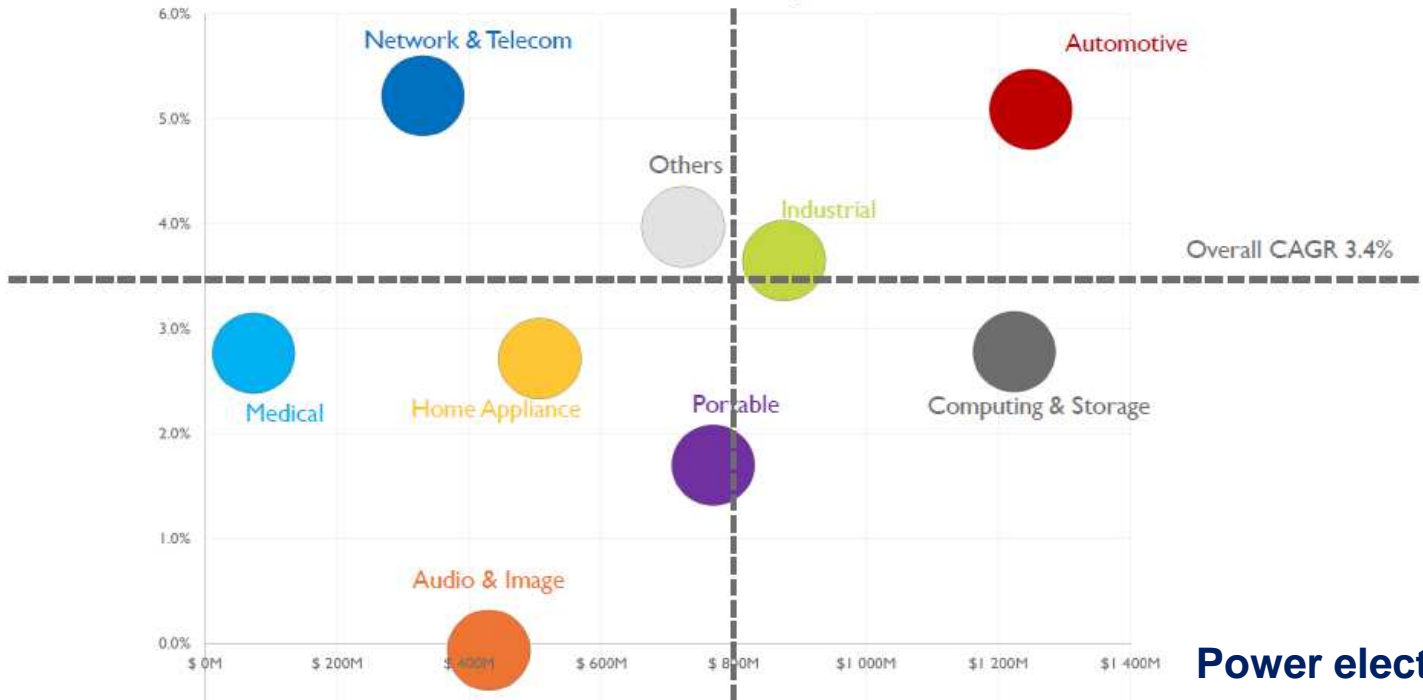


MAIN MARKET DRIVERS



Growth

Market size and evolution comparison



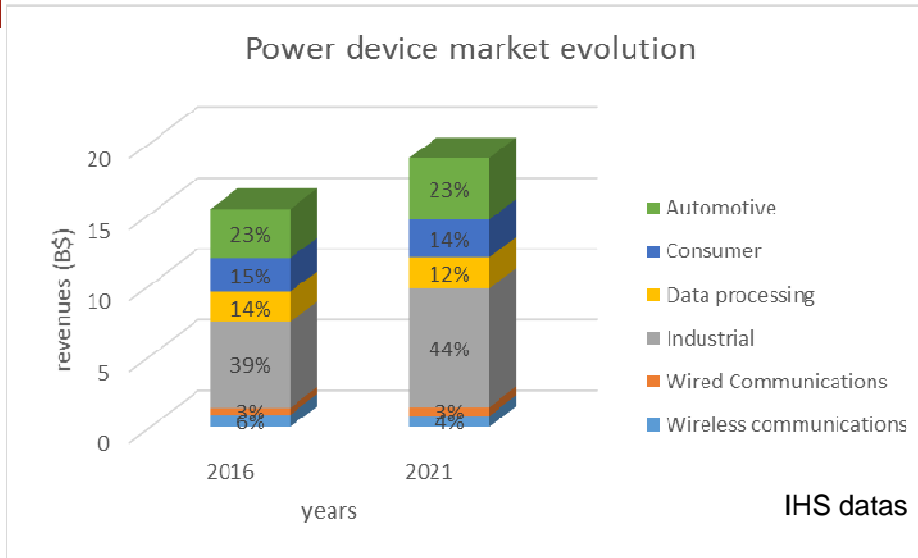
Hybrid & EV = 14 Munits in 2021 (cf Yole)



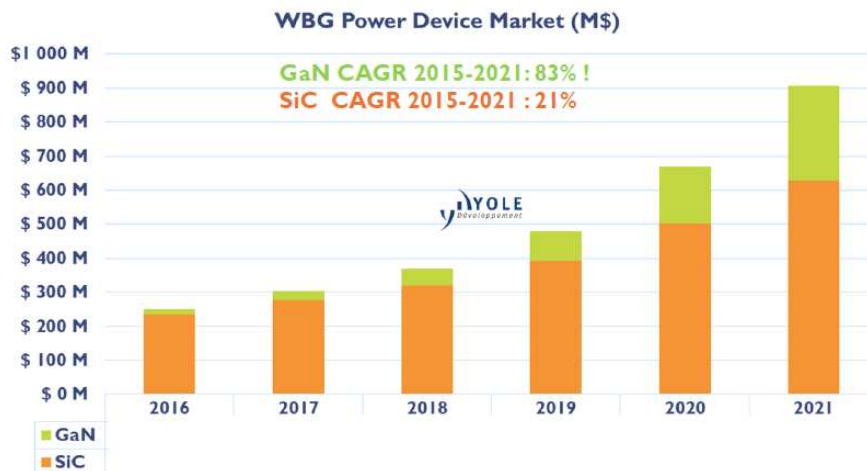
Power electronic revenue

Automotive & industry are the main power electronic drivers (cf YOLE)

POWER DEVICE AND WBG MARKET EVOLUTION

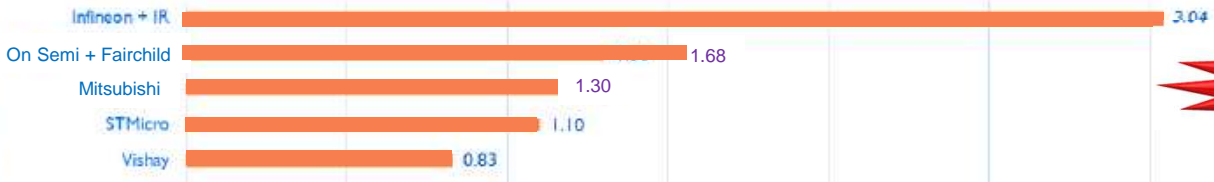
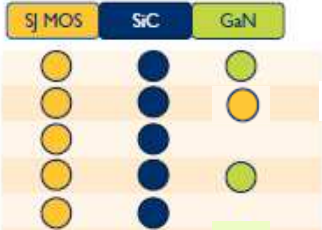


Dynamic market +3% vs. semiconductor growth
 CAGR > 5% (IHS & Yole) for the next 5 years (HEV/EV)



WBG market is still small (<2% of device activity in 2016)
 But very dynamic (CAGR > 80% for GaN)

GaN/SI POWER DEVICE MANUFACTURERS



TOP 5
(cf Yole)

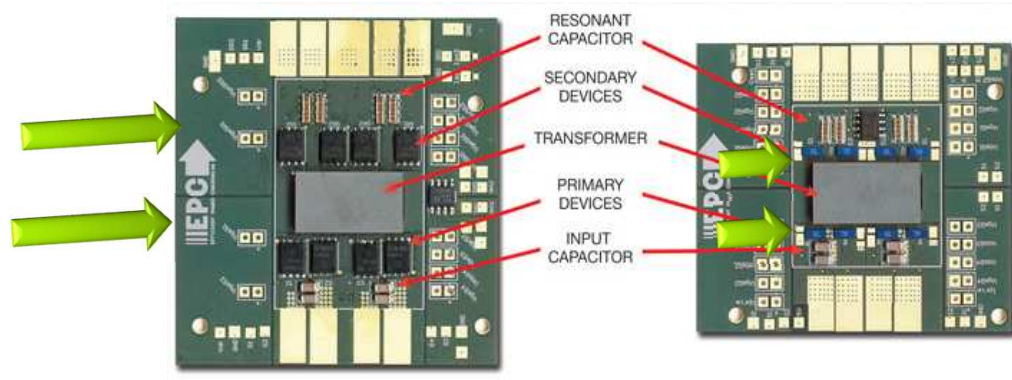
Acteur GaN	tension	maturité	catégorie	Substrat
transpherm	650 V	commercial	fabless	6"
ST	650 V 650V, 1200V	R&D R&D	IDM IDM	6" 8"
VisiC	650 V	commercial	fabless	6"
Panasonic	650 V	commercial	IDM	6"
GaN Systems	650 V	commercial	fabless	6"
Infineon	650 V	R&D	IDM	6"
IPEC	400 V	R&D	fabless	6"
dialog	650 V	R&D	fabless	6"
TEXAS INSTRUMENTS	650 V	R&D	fabless	6"
EXAGAN	650 V	R&D	fabless	8"
tsmc	100 V 650 V	commercial	fondeur	6"

Fabless working with TSMC foundry

LARGE BENEFITS MEAN GaN SYSTEM APPROACH



Replace Si devices by GaN
= Low benefits



Thinking at system level
with GaN capabilities
= Large benefits

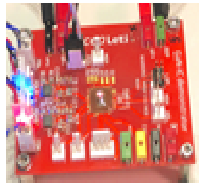


GaN vs Si
= 20 times smaller!

LETI POWER AT MINATEC CAMPUS: FROM TECHNOLOGY TO SYSTEMS



Circuit & GaN IC



Electrical characterization



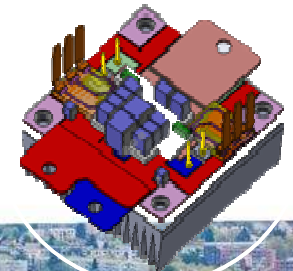
200 mm GaN epitaxy tool



GaN device technology on 200 mm CMOS line

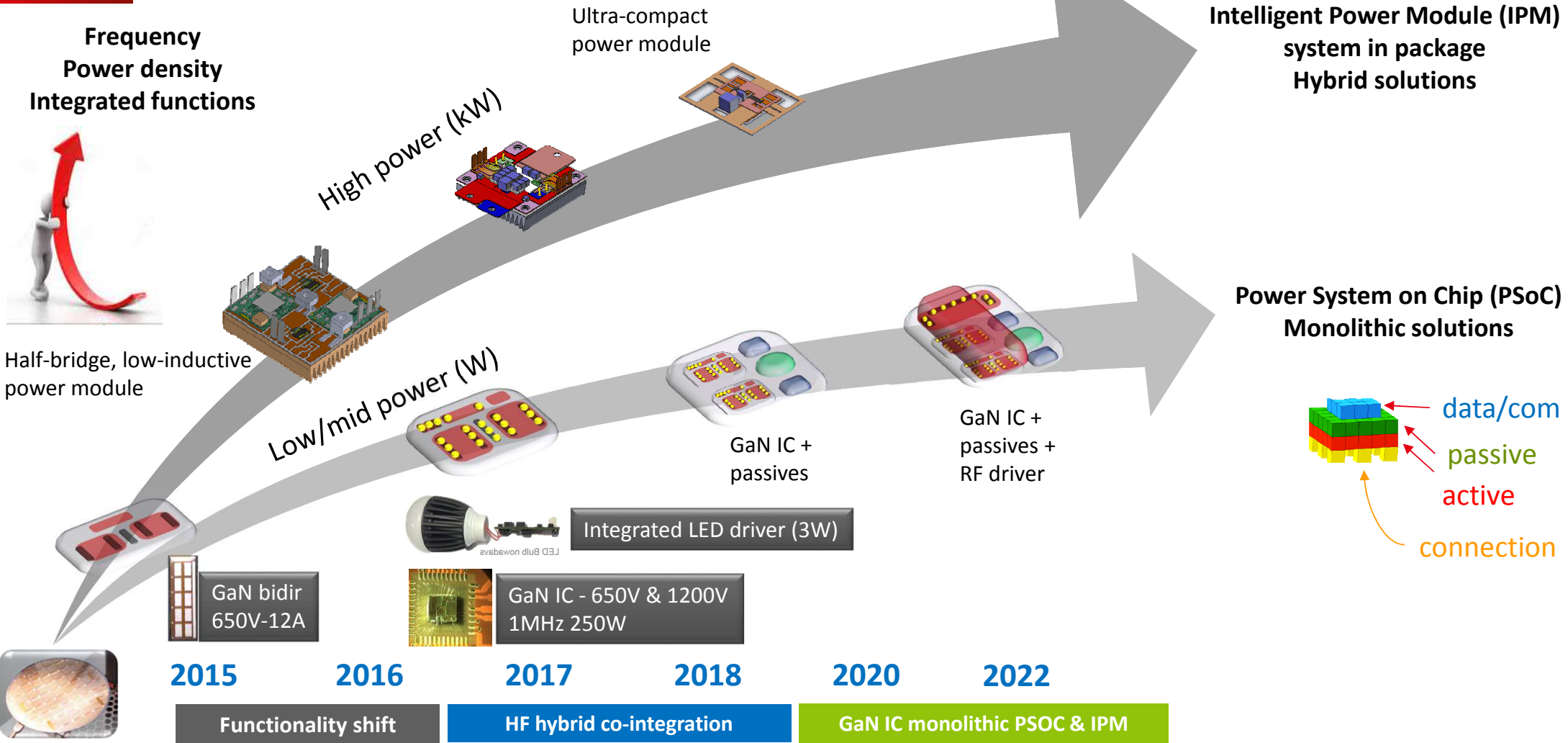


Packaging & power module





LETI GaN POWER ROAD MAP AND DEMONSTRATORS

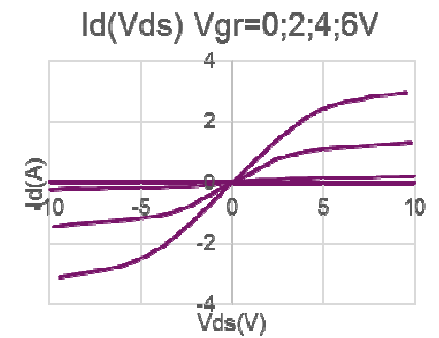
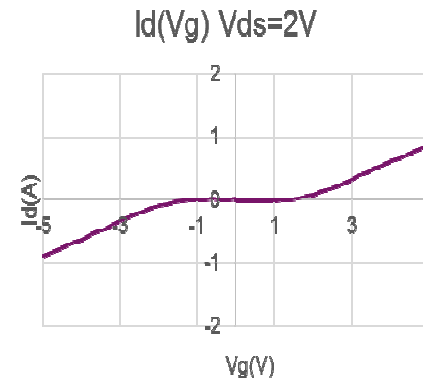
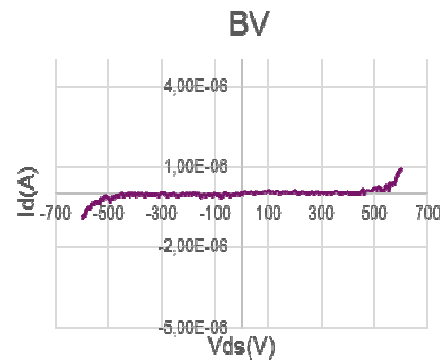
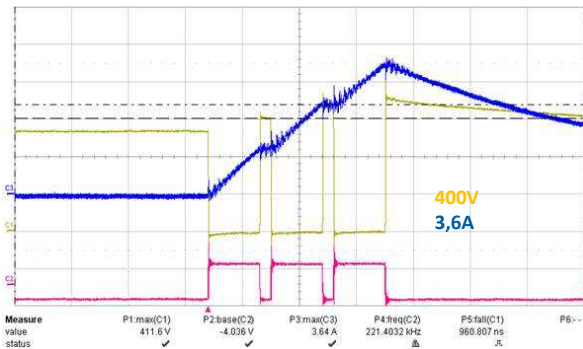
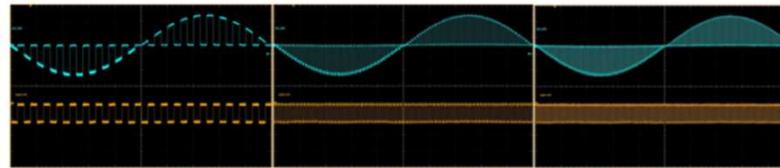
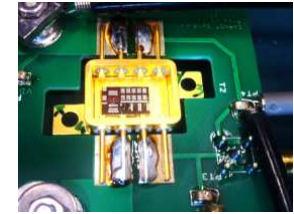
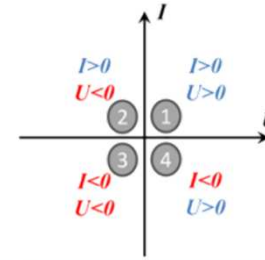
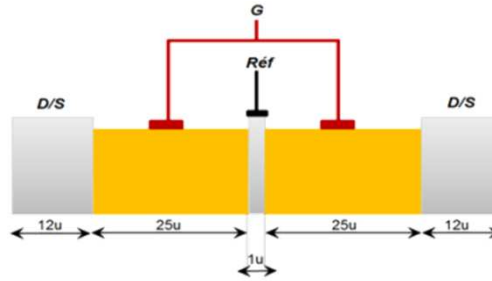




FUNCTIONALITY SHIFT: MONOLITHIC BIDIRECTIONAL TRANSISTOR 600V / 12A

Functionality shift

- ➔ 1MHz switching-up
- ➔ Withstand voltage up to 400V
- ➔ Turn on time : 13ns
- ➔ Current IDS 3,6 A
- ➔ No current collapse

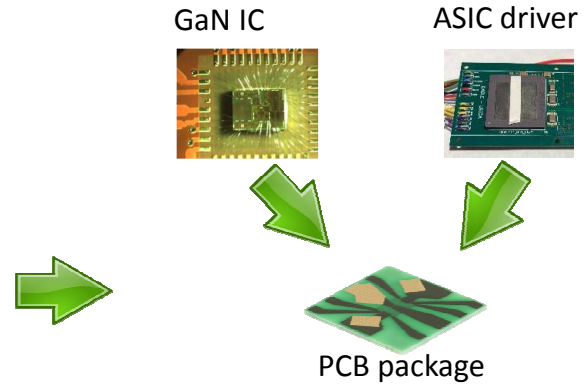
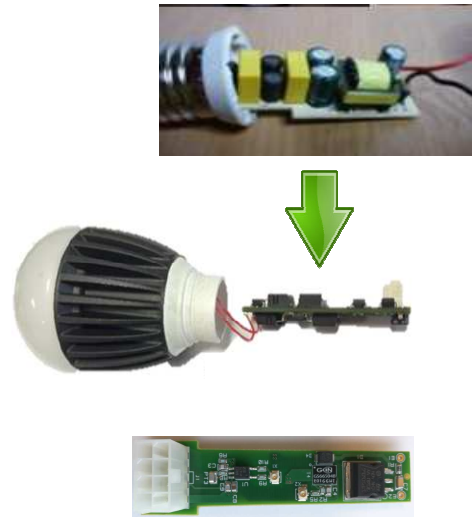
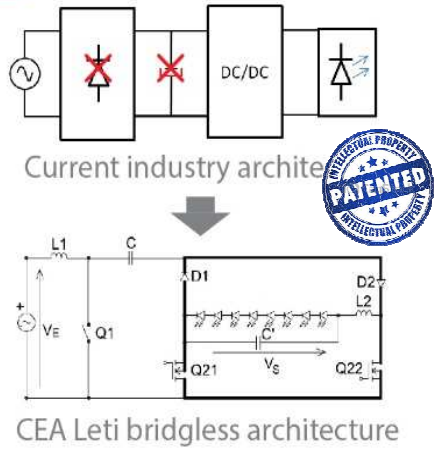




SYSTEM INTEGRATION WITH GaN/Si : HF GaN DRIVER FOR LED

HF hybrid co-integration
GaN IC monolithic PSOC & IPM

- High-performance and integrated 1MHz LED driver (presented at APEC 2017 USA)



Smaller : more integrated (divided by 2)
Reliable: No electrochemical capacity
Higher efficient: >90% efficiency gain



EXAGAN: A LETI STARTUP (SINCE 2014)



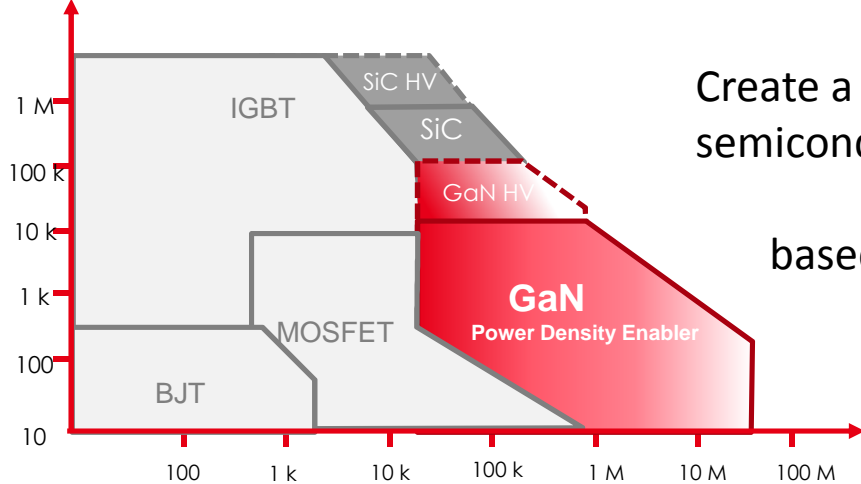
- Spinoff from Leti and Soitec
- Headquartered in Grenoble (Minatec)
- Power transistors 650/1200 V
- Proprietary G-FET™ 200 mm technology for full CMOS fab compatibility



Accelerate your systems roadmap toward 99%+ energy efficiency,

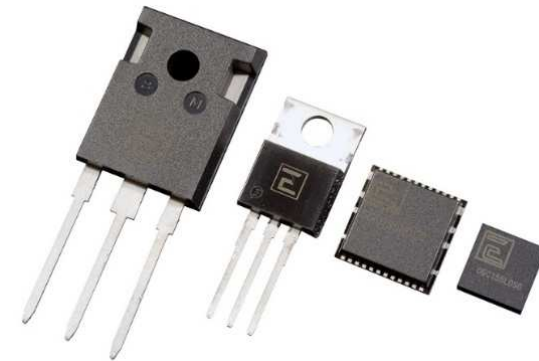
with faster, cheaper and cleaner GaN based power conversion solutions

Power By Application (W)



Create a new global leader in power semiconductor with a startup approach,

based upon a unique GaN/Si technology and robust fablight supply chain

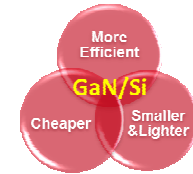




LETI DEVELOP TECHNOLOGIES TO INCREASE ENERGY EFFICIENCY WITH MORE INTEGRATED CONVERTERS AT LOWER COST




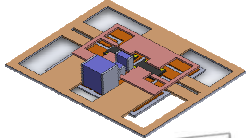
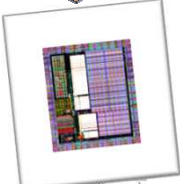
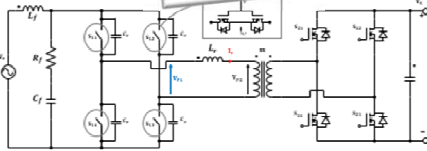
To respond to the main challenges



Functionality shift

HF hybrid co-integration

GaN IC monolithic PSOC & IPM

- GaN/Si bidirectional transistor 
- 3D power module with integrated passives and drivers 
- Driver for GaN/Si devices, PSiP 
- High-frequency design: DAB, soft switching, resonant & matrix converters 
- GaN IC 