



# What it takes to make it real : Opportunities and challenges moving to 1500V architectures

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**Bodo's  
Wide Bandgap  
Event 2024**

*Making WBG Designs Happen*

***sic***

# 1500V DC-LINK ARCHITECTURE IS ESSENTIAL TO SOLVE THE NEED FOR MORE POWER



**RENEWABLE ENERGY**



**ENERGY STORAGE**



**MEGA-WATT FAST CHARGING**

*“The transition to renewable energy sources, coupled with economic growth, will cause electricity demand to solar - increasing by 40% from 2020 to 2030, and doubling by 2050”*

Source: [McKinsey](#)

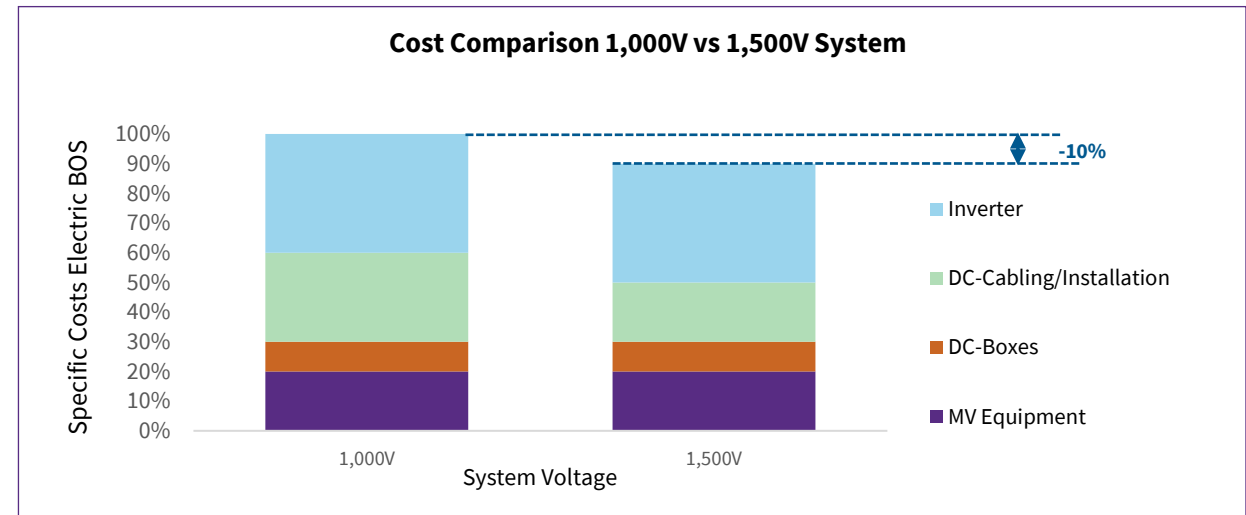
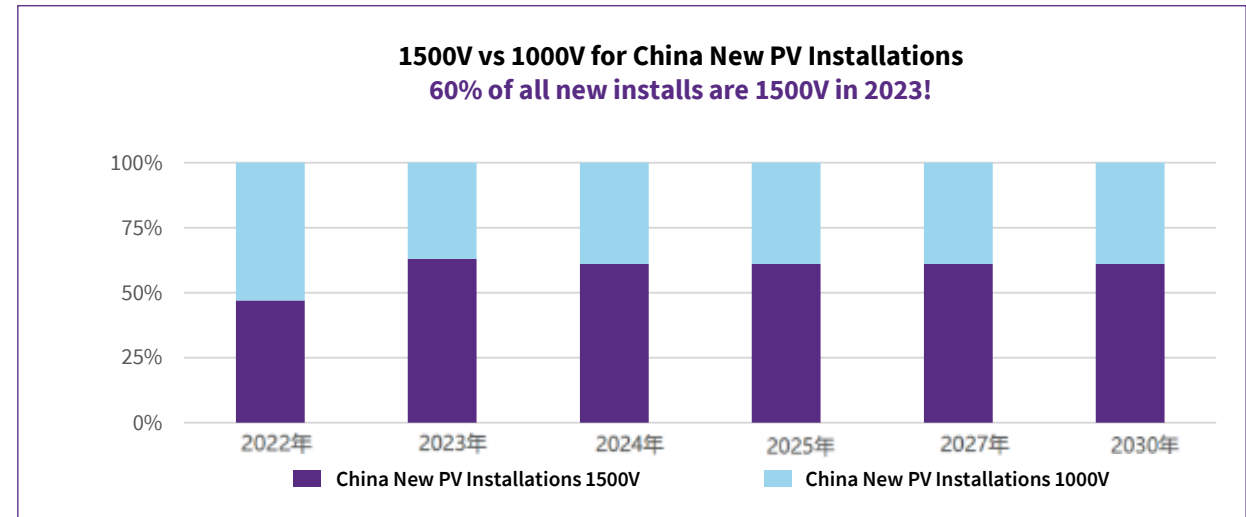
# 1500V SYSTEMS HAVE BECOME THE DESIGN STANDARD FOR RENEWABLES

## Benefits

- Reduced system and installation cost
- Infrastructure savings
- End-to-end efficiency improvements
- Less PV strings and AC/DC-cabling

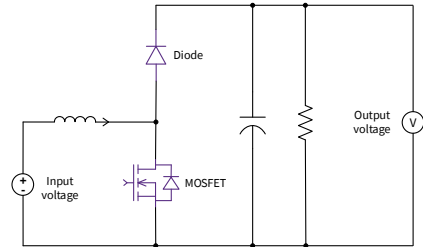
## Challenges

- Topology selection and trade-offs
- Semiconductor selection at required Vds and performance

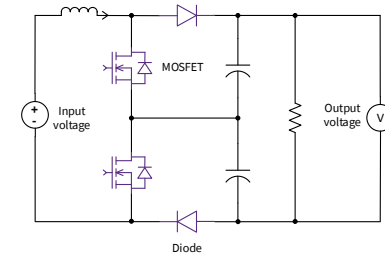


# 350KW 1500V MPPT STAGE: SILICON CARBIDE 2L VS SILICON CARBIDE 3L

2-level Boost Converter



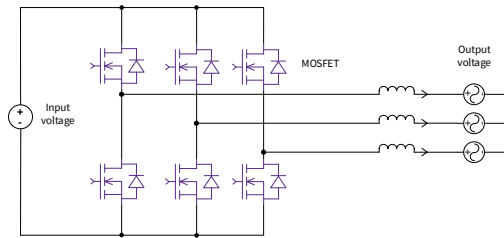
3-level Boost Converter



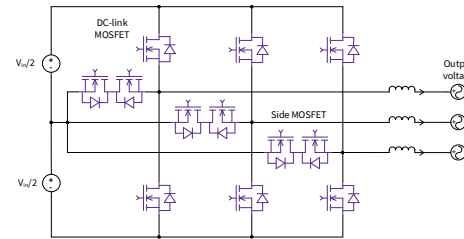
	2-level Silicon Carbide at 2kV Discrete	2-level Silicon Carbide at 2.3kV Module	3-level Silicon Carbide	All 3-level silicon IGBT Module
30KW/ CHANNEL	<ul style="list-style-type: none"> <li>• TO247 FET</li> <li>• TO247 diode</li> </ul>	<ul style="list-style-type: none"> <li>• 2.3kV Wolfpack booster</li> </ul>	<ul style="list-style-type: none"> <li>• TO247 FET</li> <li>• TO247 diode</li> </ul>	<ul style="list-style-type: none"> <li>• IGBT Module</li> </ul>
SWITCHING FREQUENCY	<ul style="list-style-type: none"> <li>• 32kHz</li> </ul>	<ul style="list-style-type: none"> <li>• 32KHz</li> </ul>	<ul style="list-style-type: none"> <li>• 48kHz</li> </ul>	<ul style="list-style-type: none"> <li>• <b>18kHz</b></li> </ul>
POWER DENSITY	<ul style="list-style-type: none"> <li>• 1.25X</li> </ul>	<ul style="list-style-type: none"> <li>• 1.4X</li> </ul>	<ul style="list-style-type: none"> <li>• 1.1X</li> </ul>	<ul style="list-style-type: none"> <li>• 1X</li> </ul>
EFFICIENCY	<ul style="list-style-type: none"> <li>• 99.6%</li> </ul>	<ul style="list-style-type: none"> <li>• 99.65%</li> </ul>	<ul style="list-style-type: none"> <li>• 99.38%</li> </ul>	<ul style="list-style-type: none"> <li>• 99.1%</li> </ul>
TOTAL POWER BOM COST	<ul style="list-style-type: none"> <li>• 82%</li> </ul>	<ul style="list-style-type: none"> <li>• 104%</li> </ul>	<ul style="list-style-type: none"> <li>• <b>75%</b></li> </ul>	<ul style="list-style-type: none"> <li>• 100%</li> </ul>
ADVANTAGES	<ul style="list-style-type: none"> <li>• Fewer devices, high efficiency, better FIT rate; Simple control</li> </ul>		<ul style="list-style-type: none"> <li>• Half of voltage rating devices, Lower switching loss</li> <li>• High frequency, High power density, Lower cost</li> </ul>	
DISADVANTAGES	<ul style="list-style-type: none"> <li>• Large voltage stress, High switching loss</li> <li>• Restricted switching fq, Large current ripple</li> </ul>		<ul style="list-style-type: none"> <li>• More power device/More device loss</li> <li>• Lower efficiency, Complex control circuits</li> </ul>	

# 1500 V POWER CONVERSION SYSTEM INVERTERS: 2-LEVEL OR 3-LEVEL

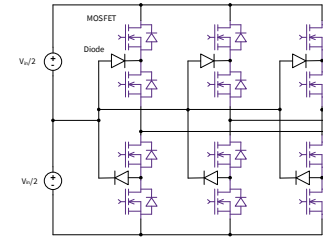
Three ways to use silicon carbide to improve efficiency and reduce system losses



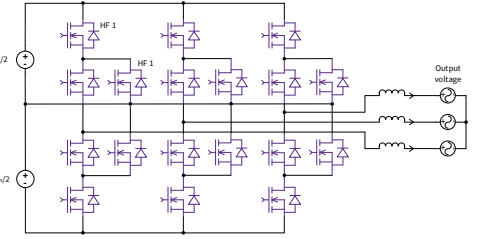
**2-Level, 6-Switch Half-Bridge**



**T-Type Circuit**



**I-NPC/A-NPC Circuit**



**HOW**

- 2300V SiC WolfPACK Power Module

**PROS**

- Fewer components
- Simpler control
- Longer system lifetime

**CONS**

- High voltage stress
- Requires >2kV device
- Higher harmonics

- 2300 SiC Wolfpack Power Module
- 1200V SiC MOSFETs

- Low voltage stress
- Low switching losses
- Low harmonics

- More components
- Require >2kV device for DC-LINK
- Higher complexity control makes the circuit more sensitive to parasitic effects

- 1200V SiC MOSFETS
- 1200V SiC Diode

- Low voltage stress
- Low switching losses
- Low harmonics

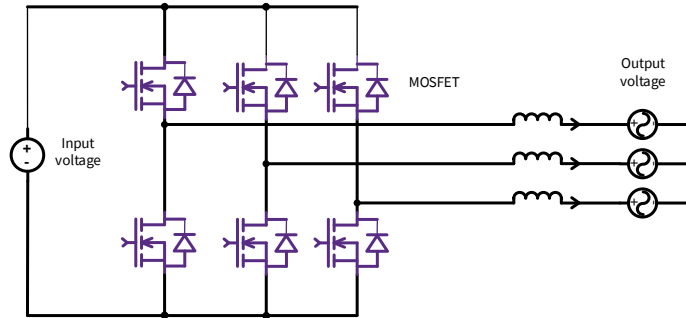
- More components
- Higher complexity control makes the circuit more sensitive to parasitic effects

# 2300V ENABLES SIMPLE 2-LEVEL SYSTEM, HIGHER FREQUENCY, LOWER LOSSES

DC-AC mode- 250kw with liquid cooling design

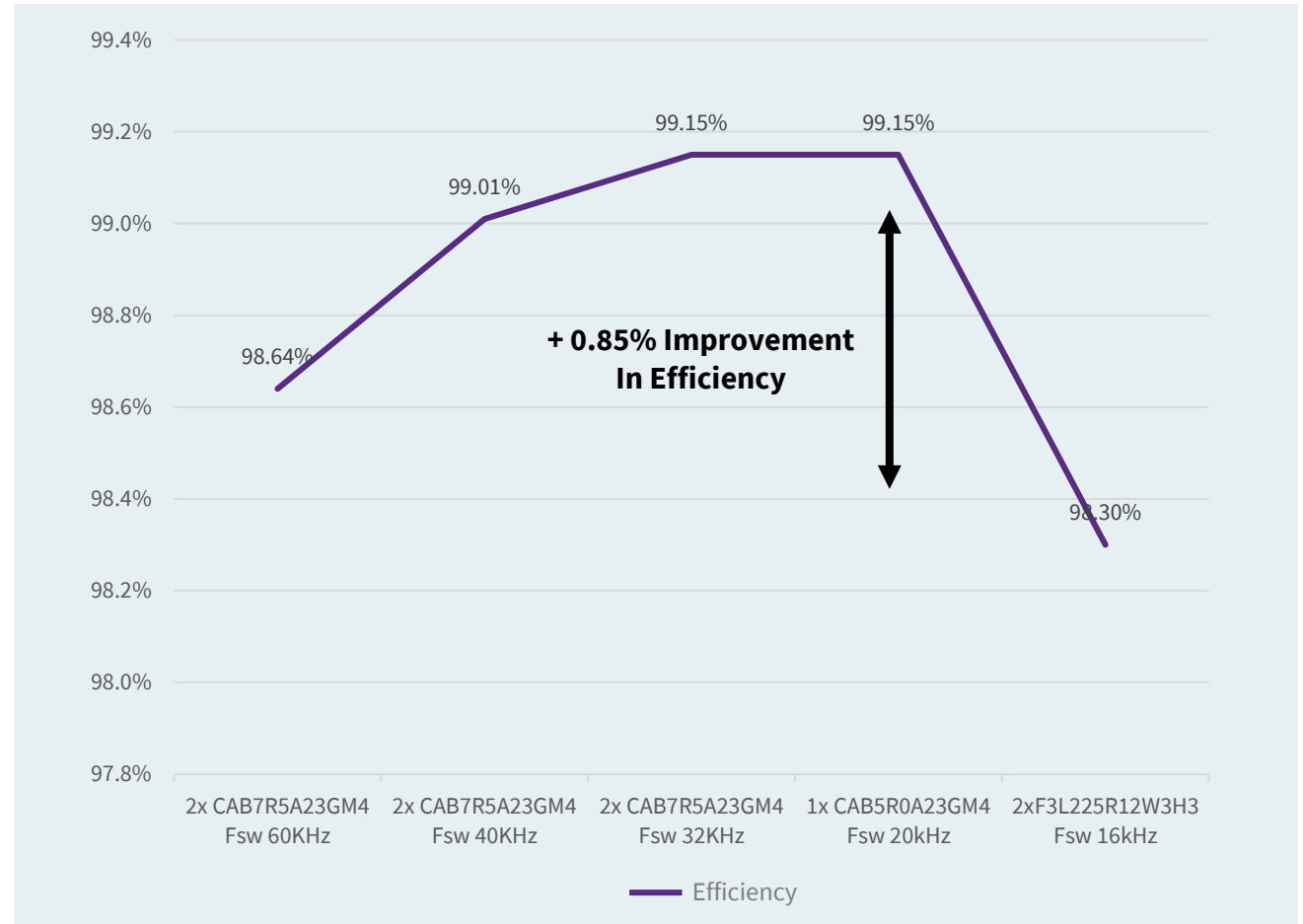
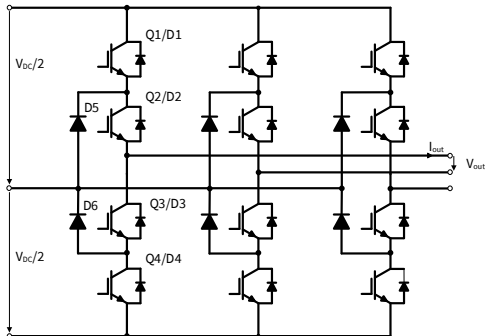
## Devices (2.3KV SIC Module):

CAB5R0A23GM4\*3/CAB7R5A 23GM4\*6



## Devices (IGBT Module):

F3L225R12W3H3\*6



# ENABLING RELIABLE GRID-SCALE ENERGY STORAGE

- Grid-ready flexible inverter covering a wide range of power and voltage levels delivering industry-leading efficiency and power density
- Low maintenance and service needs
- Easily mass produced to rapidly deploy a solution on a global scale



***“By utilizing silicon carbide in our revolutionary ‘M’ inverter, EPC Power is creating a paradigm shift in technology and energy capacity”***

– Devin Dilley, Chief Product Officer at EPC Power

# WOLFSPEED SILICON CARBIDE POWER SCALABILITY FOR SOLAR & ENERGY STORAGE

Product for all power scaling

## Discrete Advantages:

- Maximize design flexibility
- Minimize total BOM cost

## Module Advantages:

- Maximize power density
- Simplify layout and assembly
- Minimize assembly costs & component counts
- The industries widest full Silicon Carbide module portfolio
- Industry standard & Silicon Carbide optimized footprints

