



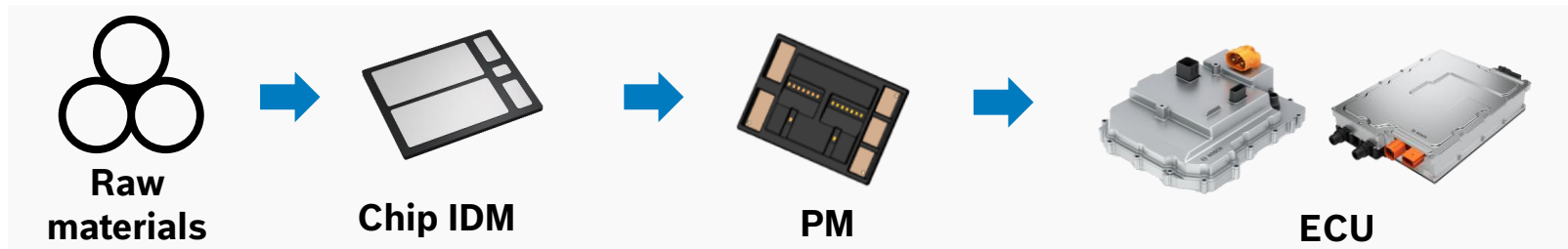
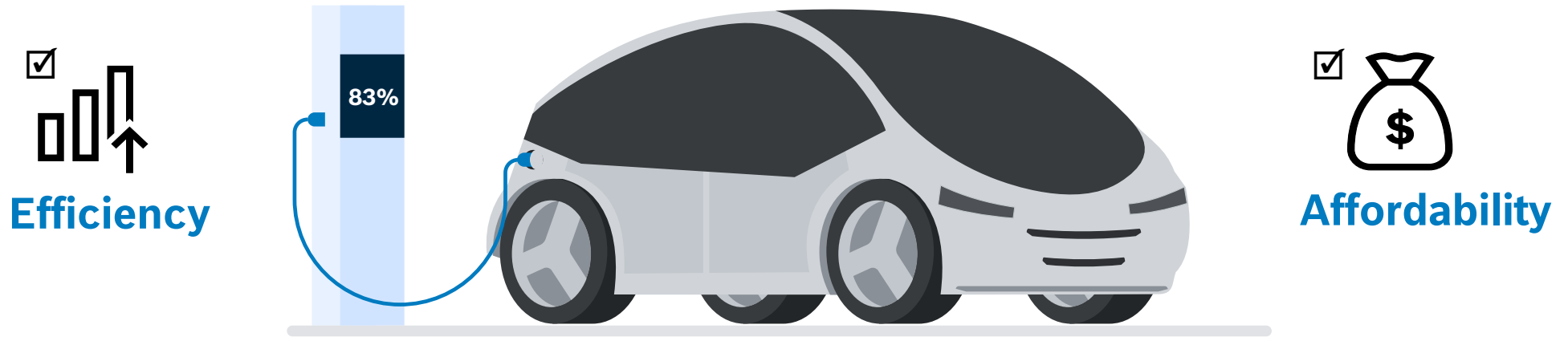
The Role of SiC in E-Mobility

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The Role of SiC in E-Mobility

How to make e-mobility efficient and affordable?



Close collaboration along the value chain required to achieve high yield and low costs.

The Role of SiC in E-Mobility

Raw Materials and Technologies

- **Improvement of defect density**
 - Pacemaker: China
- **SiC substrate availability**
 - No bottle neck expected
- **Laser splitting**
 - Reduce loss of material, in-house CMP
 - Chance: Ultra thin devices
- **Splitting-bonding**
 - Improved performance through highly doped poly-SiC
 - Chance: Supply chain robustness

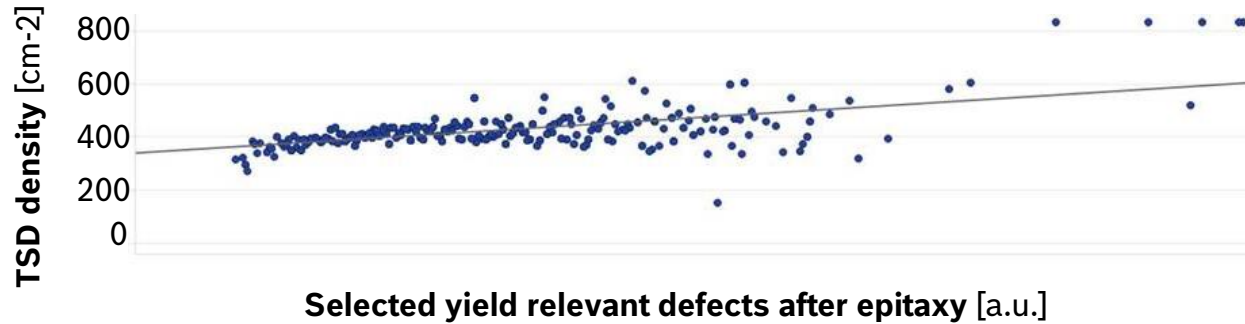


Transition to 200 mm is a good entry point to make benefit of advanced wafering technologies.

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Raw Material to Chip

Raw wafer defect density directly impacts chip yield



- **Device processing** and **yield feedback** is crucial for crystal growth companies to **improve** processes.
- Multiple **partnerships accelerate** learning cycles due to various feedback from different device types.
- **Raw wafer** and **epitaxy** process **need to be adapted** to each other.

Bosch Approach



Understand
Correlations



Support
Suppliers in process improvement

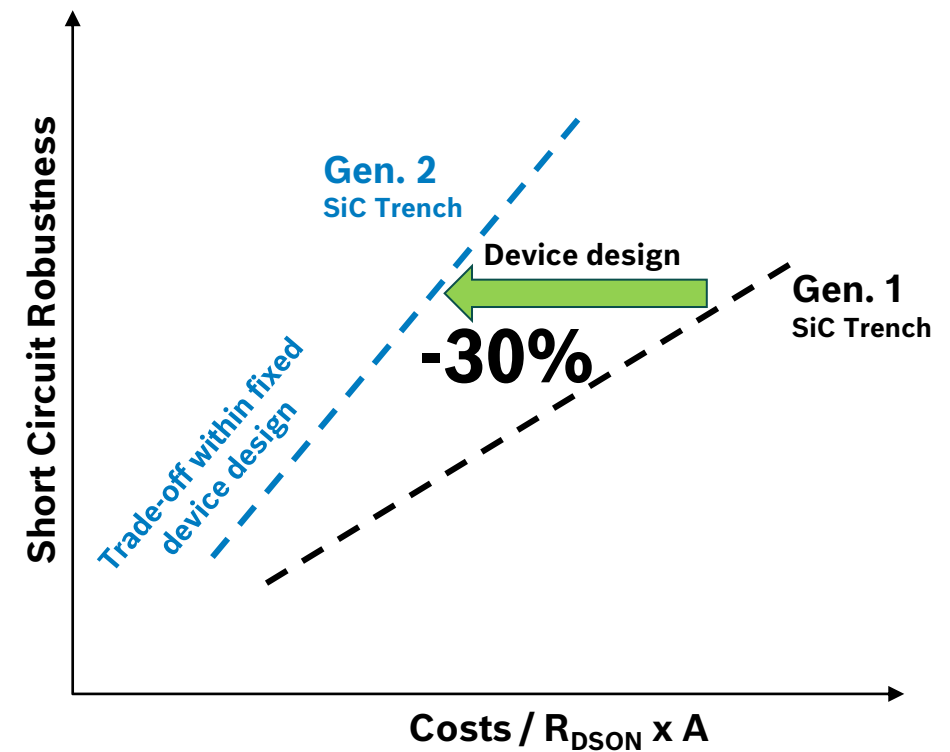
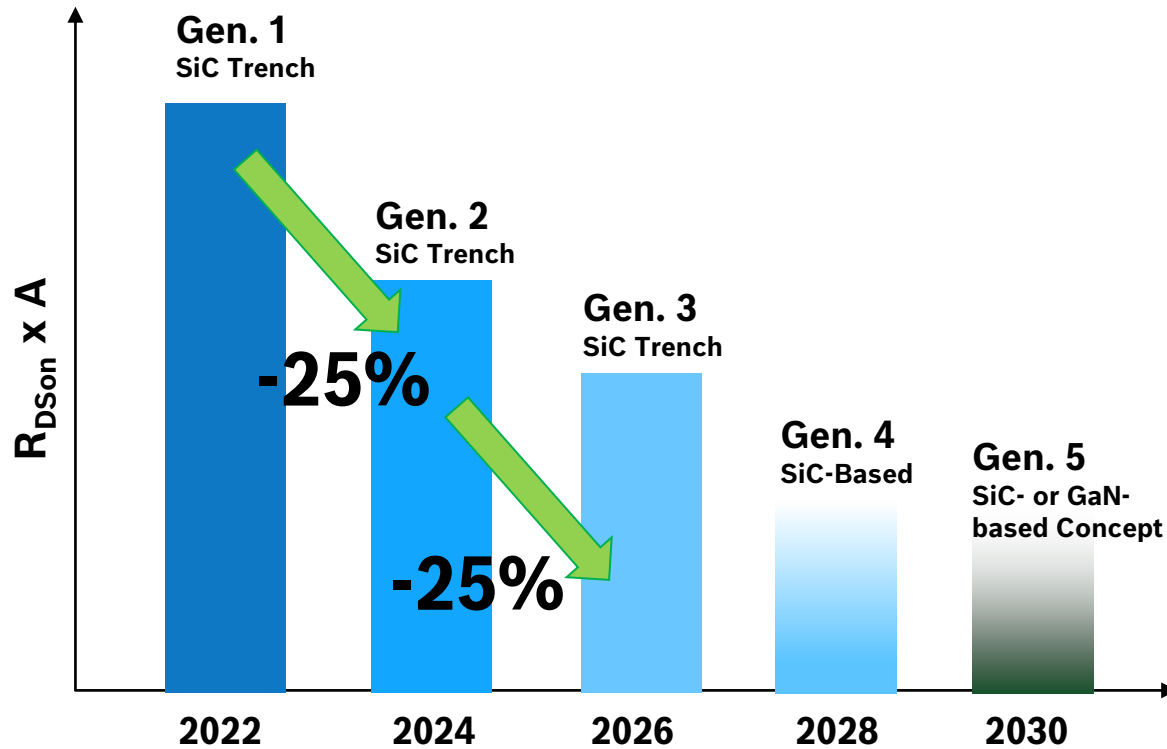


Reflect
Benchmarking

Raw material suppliers need device production data feedback loop to improve their products.

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Modern SiC trench-MOS driving performance & robustness



Bosch is focusing on **trench** device for gen 1-3.

Focus not just on $R_{DS(on)}$, but also on robustness/switching performance and efficiency (WLTP).

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Chip to Power Module



Best reliability

- **Interface** between **die** and **power module** is the **key**
- One-hand dealing with solution and **avoiding “blame-game”**



Holistic optimization

- Fulfilling **requirements** as joint task at all levels
- Transparent **cost trade-off** for best compromise on AIT
- **Optimization** of transistor enabled by **power module** and periphery **innovations**

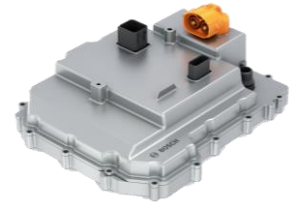


Fast time to-market

- Fastest **adoption** of innovation at all levels
- Best **risk management** with in-house simultaneous engineering

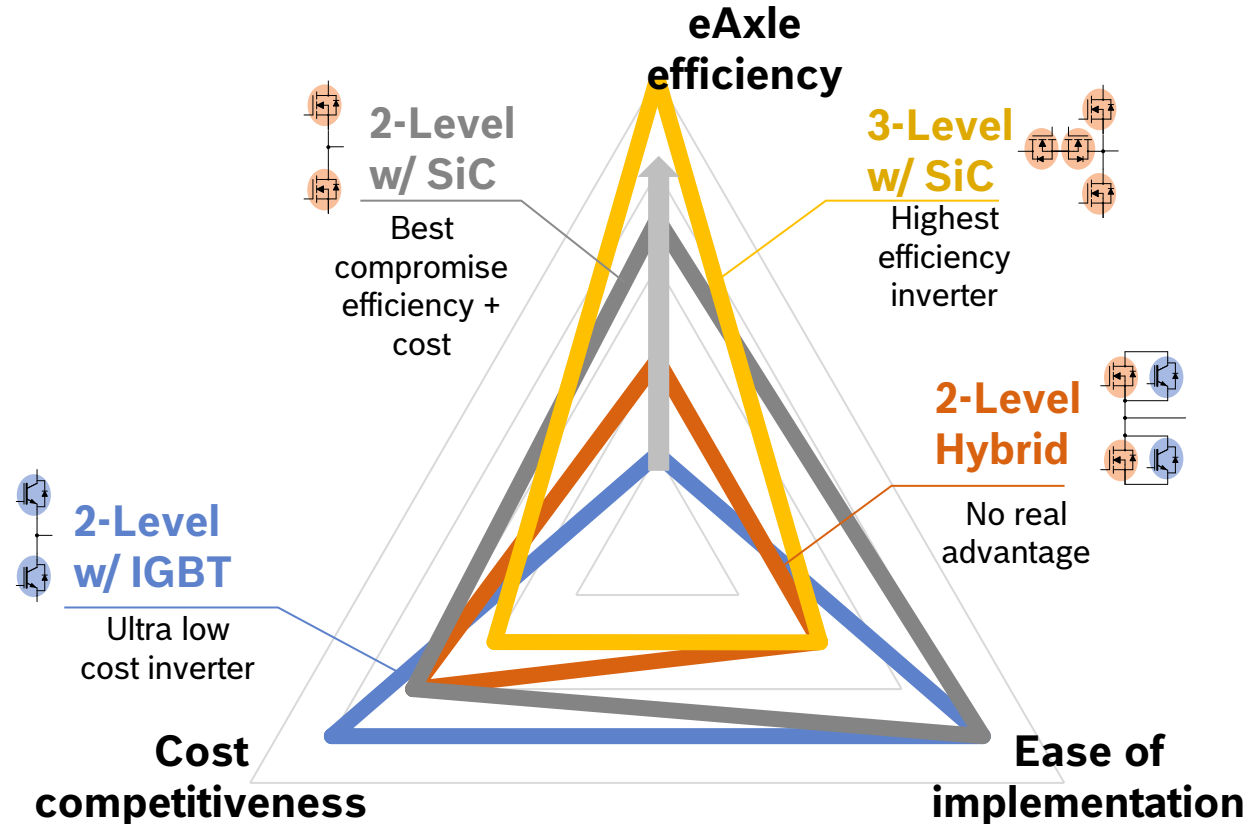
Important to have **chip** and **power module** in **one hand** due to critical interface.

The Role of SiC in E-Mobility Traction Inverter Topologies



At least **6% higher efficiency** with adoption of **SiC in 2-Level** topology

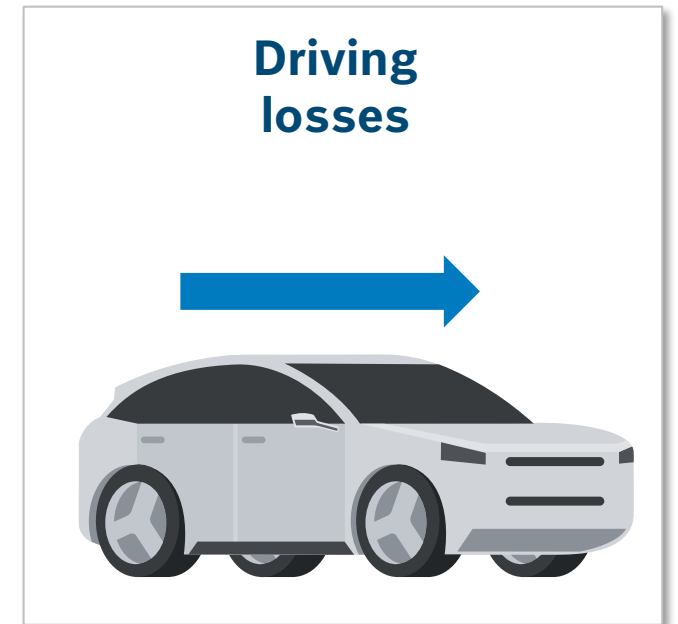
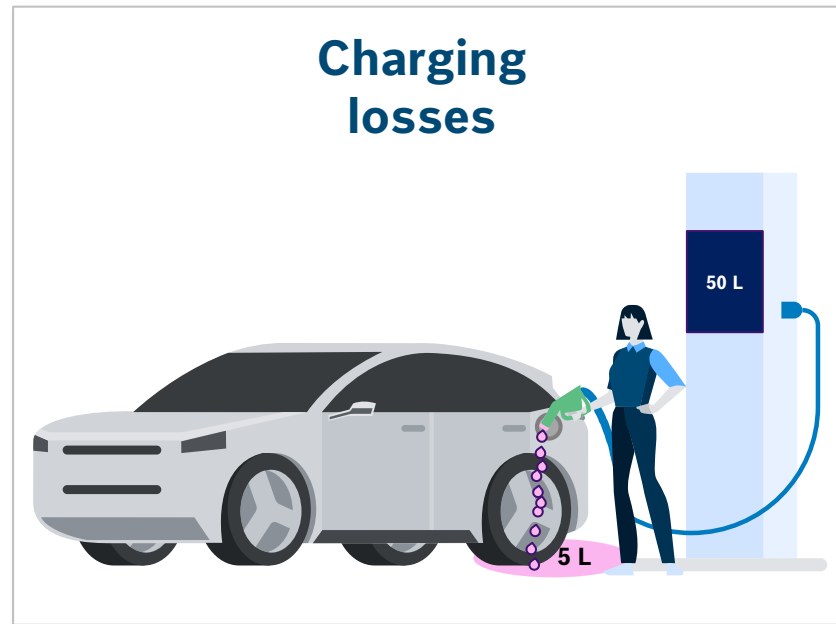
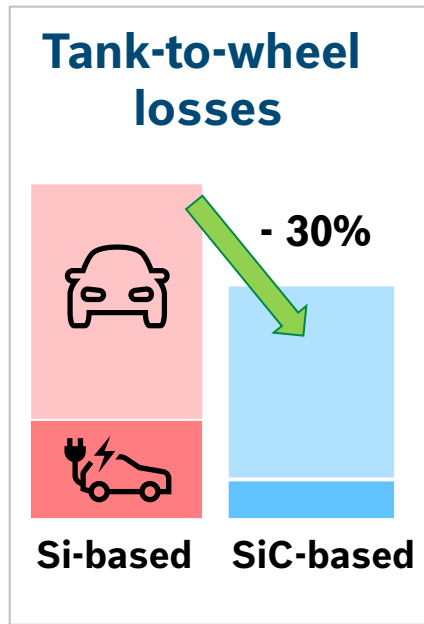
Multilevel topology with **SiC** may be the **next step** by further reducing switching losses and electric machine losses



SiC alongside new topologies remains the cornerstone towards higher electric axle efficiency.

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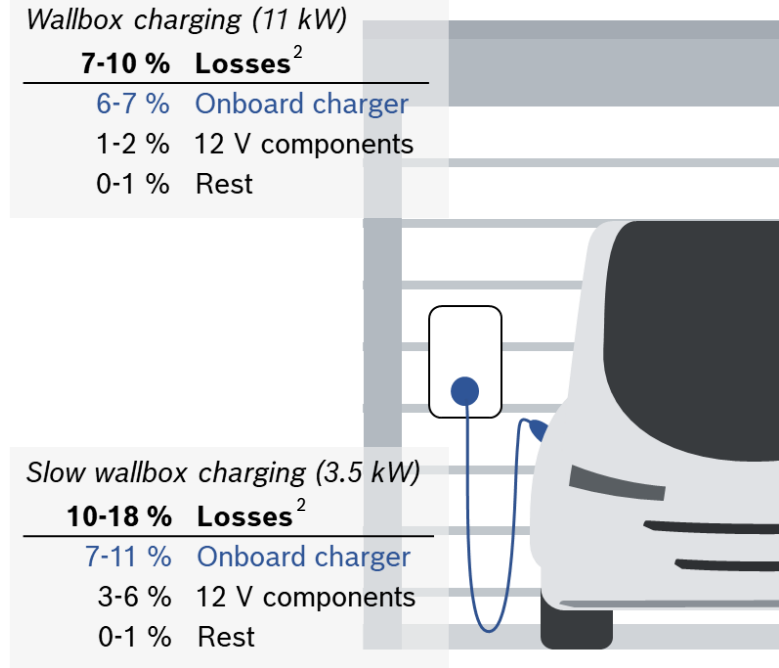
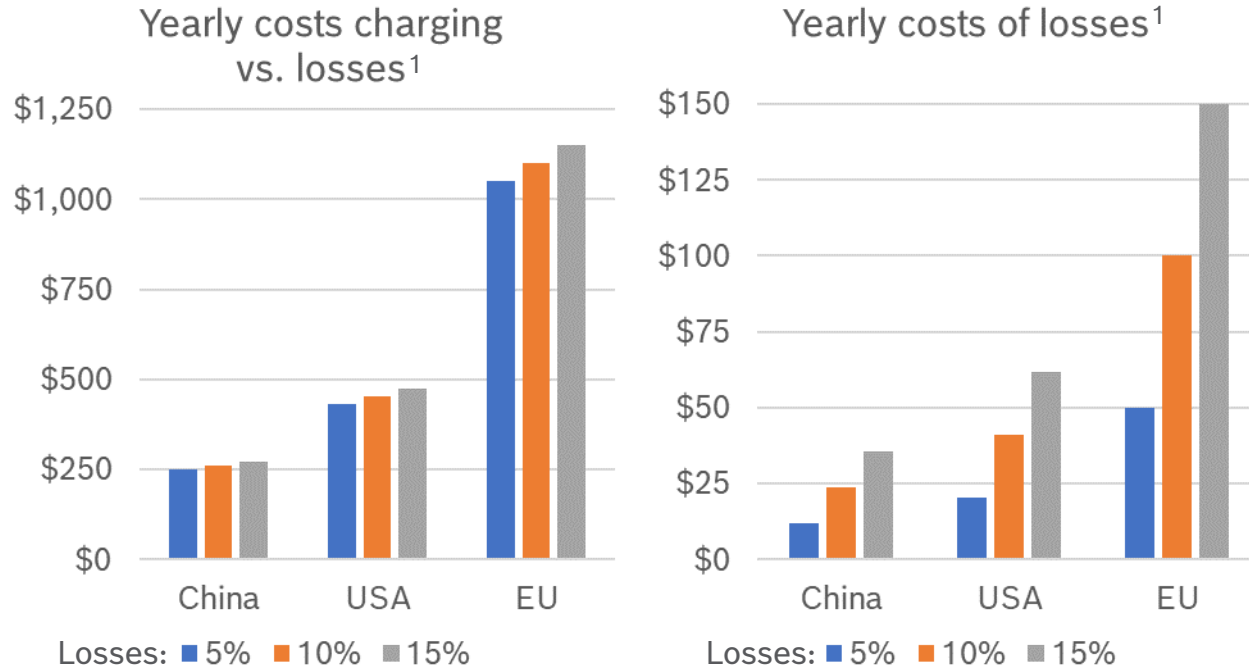
How much are end users willing to pay for charging losses?



Nobody talks about charging losses, what if end customers start to worry?

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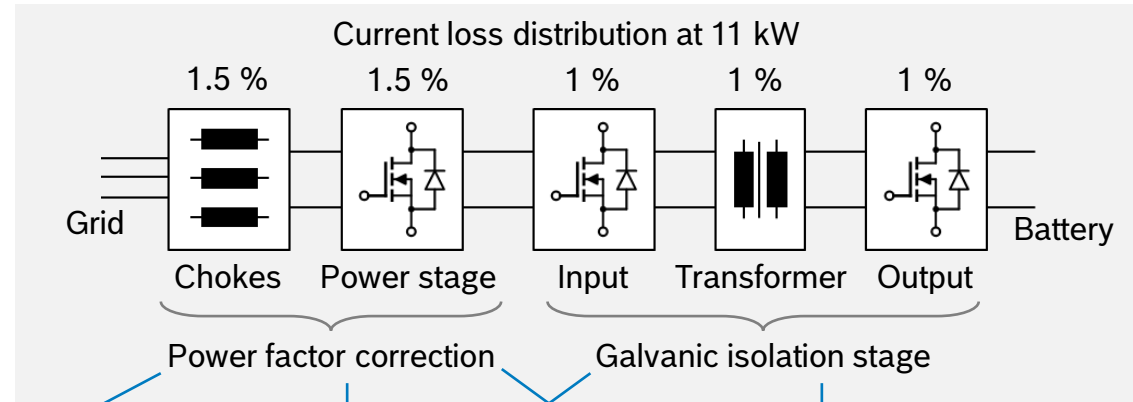
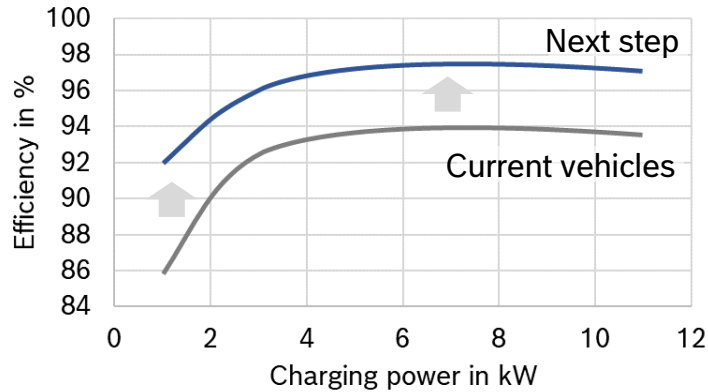
End users may worry about paying for charging losses



Power conversion efficiency and standby consumption are the main leverages for loss and cost savings.

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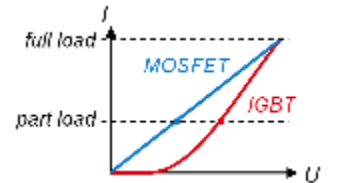
The way to more efficiency in charging



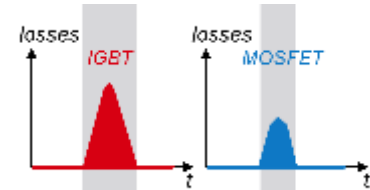
Leverage for
**efficiency
improvement**



New topologies
e.g. multi-level
variants



Resistive characteristic
of SiC reduces **part
load** losses



Better **switching performance** of SiC
allows for **optimization of passives**
via higher switching frequency

Pushing SiC performance alongside new topologies brings higher charging efficiencies.

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Conclusions

1 Affordability

Grasping SiC substrates is crucial for realizing cost-effective chips that unlock peak efficiency of EVs.

2 Efficiency

SiC alongside new topologies remains the cornerstone towards higher electric axle efficiency.

3 User Experience

End users watch cost of ownership, reducing losses in driving and charging gain importance.

