PASSENGER CAR POWERTRAIN FOR VOLTAGES >800V

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Funded by the European Union

HiVEP

Project Key Data

HIVEP - **H**i**gh-V**oltage fast-charging **E**fficient electric vehicle **P**owertrains

HORIZON-CL5-2024-D5-01-02 - Integration and testing of next generation post-800V electric powertrains (2ZERO Partnership)

Research & Innovation Action

Grant agreement ID: 101192720

Start date: 1 February 2025

End date: 31 July 2028

Duration: 42 months

Total cost: € 4 983 920,75

Funded by the European Union

www.hivep.eu

https://cordis.europa.eu/project/id/101192720

HiVEP Consortium

FEV

Coventry University

UNIVERSITY OF SURREY

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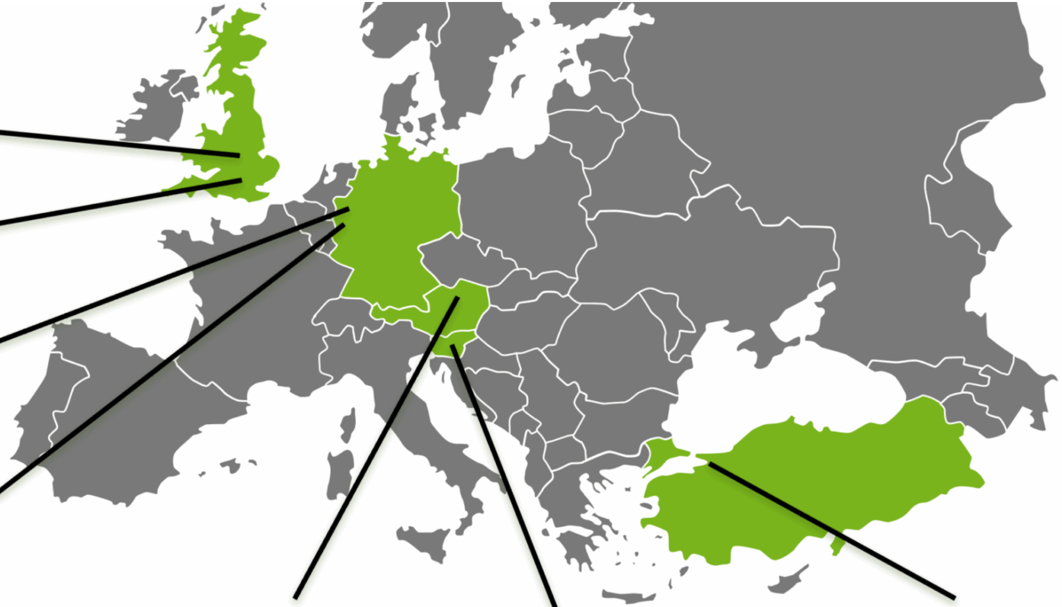

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FEV fka

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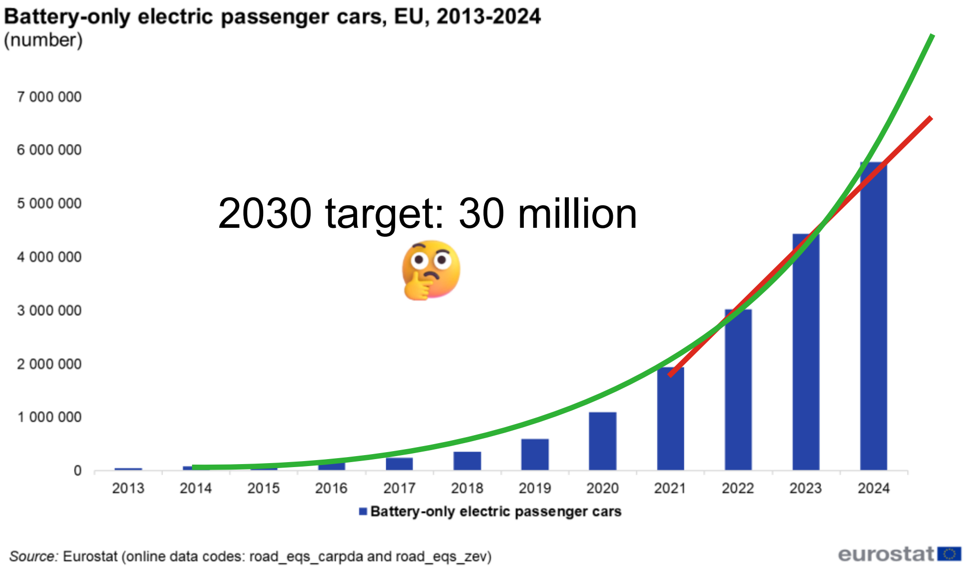
Togg

FEV

Challenges

User concerns impede BEV adoption at scale

- Charging time
- Range
- Cost



Dependency on critical raw materials

- E.g., Rare-Earth magnets

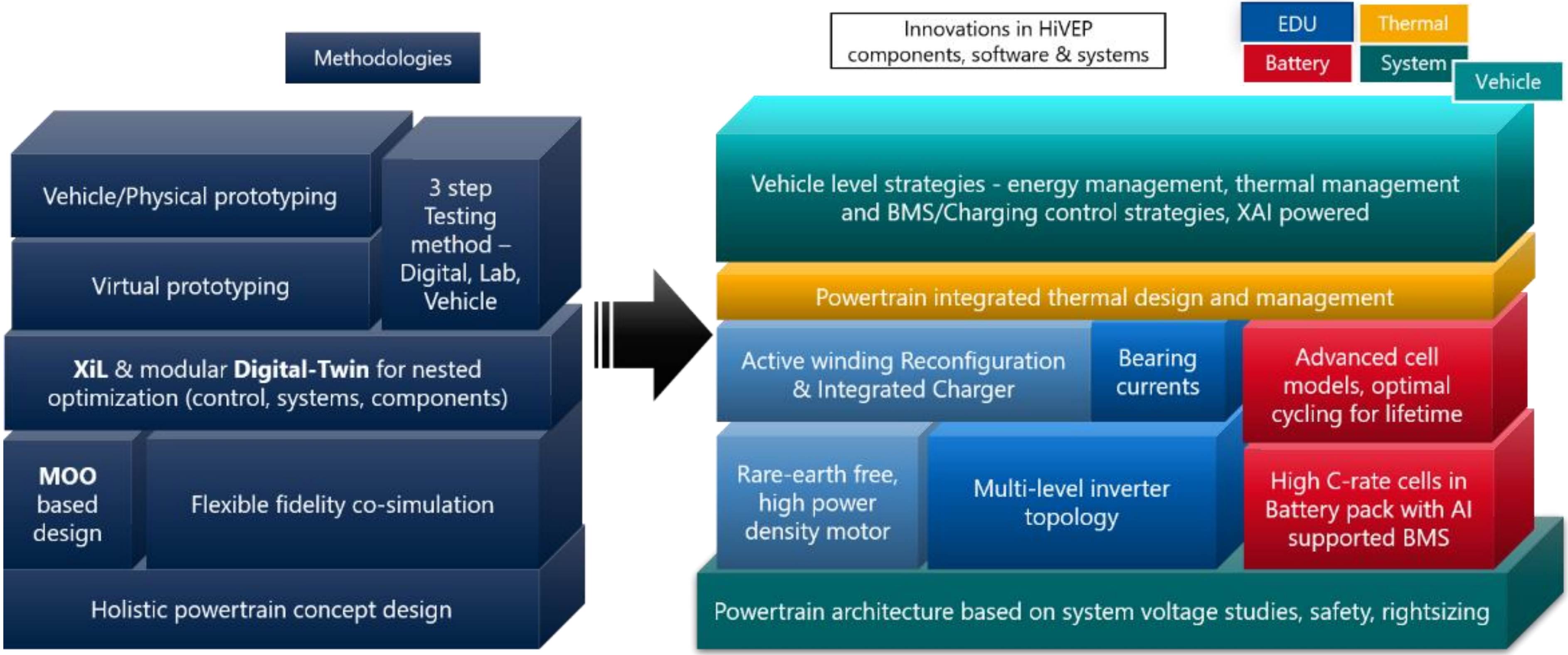
Efficiency and thermal constraints

- E.g., range affected by wintery conditions

HiVEP Goals

- Develop next-generation post-800V EV powertrains (≈950–1200 V) for mass-market C-segment vehicles, enabling higher efficiency and faster charging.
- Achieve ultra-fast charging (<10 minutes 10-80% SoC) using advanced batteries, BMS, and compatible charging architectures.
- Increased powertrain efficiency through approx. 25–26% reduction in losses, due to innovations in electric motors, multi-stage inverters and thermal management
- Reduce costs by ~20% at powertrain and component level via modular designs, integrated functions (e.g. i-charger), and scalable power
- Increase driving range (~20%+) without increasing battery size, leveraging efficiency gains and advanced energy management.
- Enhance sustainability and resource efficiency, including rare-earth-free motor designs, reduced material use, and circular economy approaches.
- Real-life demonstration of all technologies integrated in vehicle

HiVEP Methodology & Innovations

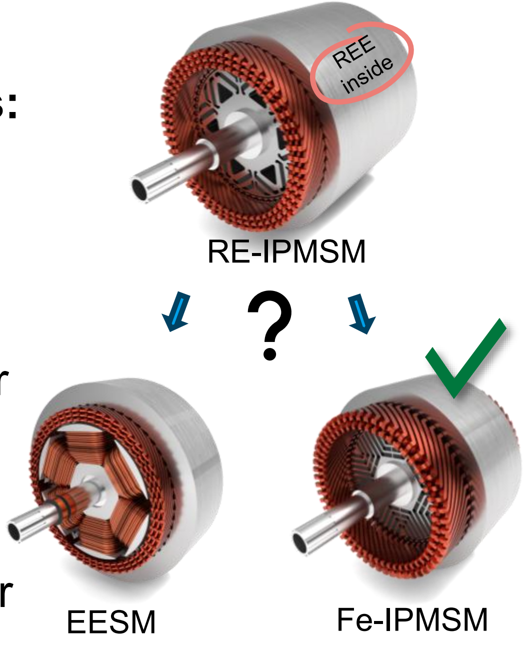


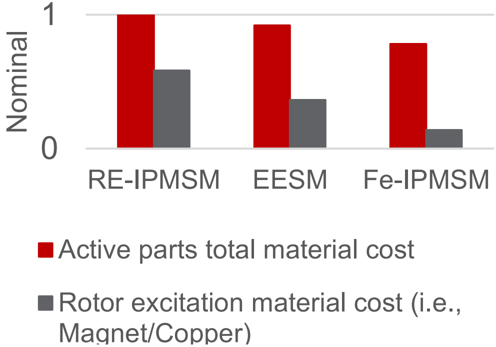
Electric Machine Innovation: Rare-Earth-Free Rotor

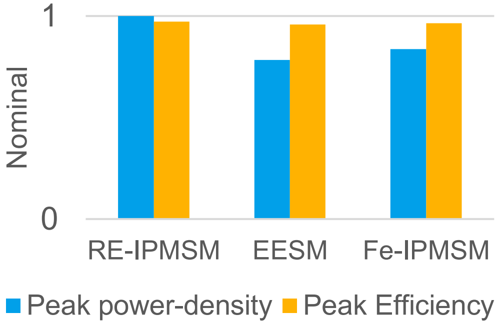
Base: PMSM w interior RE magnets (RE-IPMSM)

Rare-earth-free rotor options:

- Efficiency ↓
- Performance ↓
- EESM: Externally excited synchronous machine
- Fe-IPMSM: PMSM w/ interior ferrite magnets
  - Least cost (target: -20%)
  - AWR (Active winding reconfiguration) to recover performance & efficiency



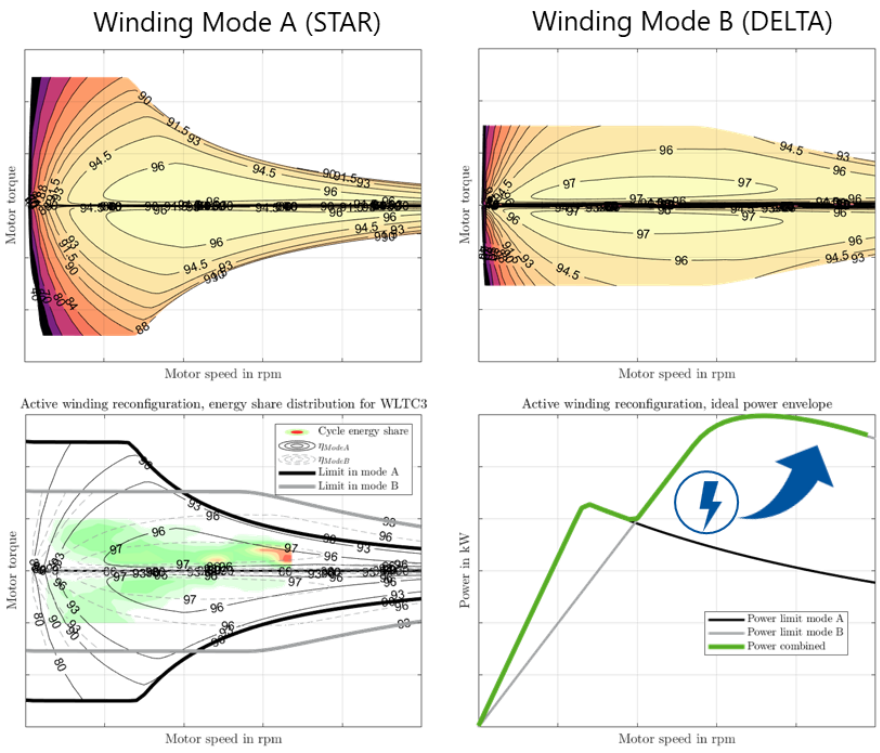




Electric Machine Innovation: Active Winding Reconfiguration

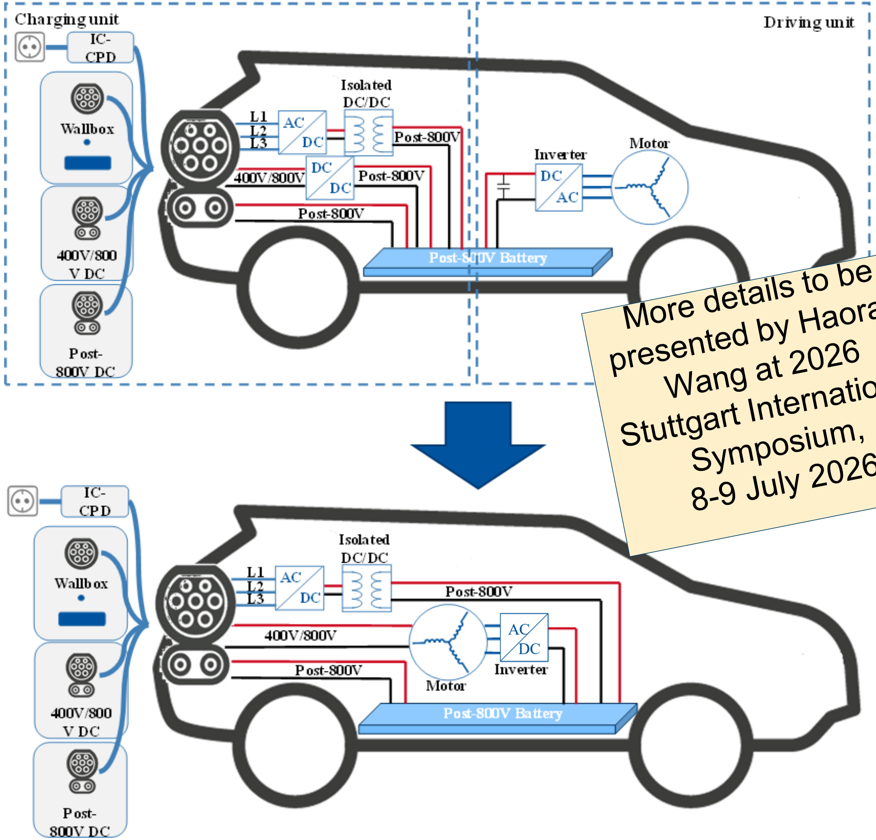
Active Winding Reconfiguration

- Switching between star and delta
- Two motors in one
  - Low speed, high torque
  - High speed, higher power
  - Efficiency sweet spot adjusted to operating points
- Facilitates “Right-Sizing”
- Helps closing/reducing performance and efficiency gaps of Fe-IMPMSM to RE-IMPMSM



Multilevel-Inverter w/ I-Charger

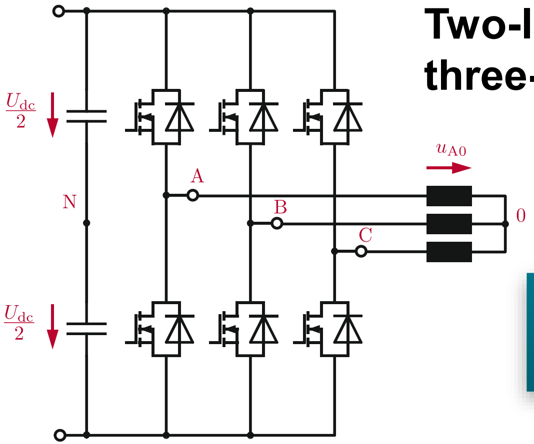
- Task: boost DC from 400 V to post-800V voltage
- Standard systems have separate DC-DC power electronics
- Solution: HiVEP I-charger
  - integrates motor windings and inverter
  - Saves on PE switches and inductive components
  - Controls eliminate charging-induced torque during charging and, hence, mechanical stress on park brake



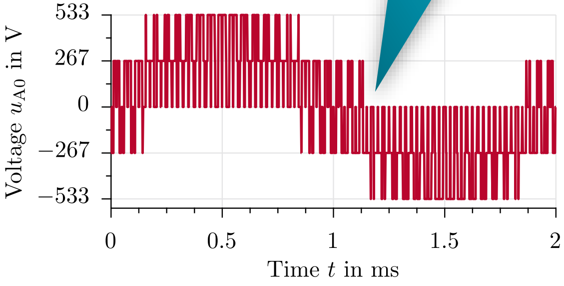
More details to be presented by Haoran Wang at 2026 Stuttgart International Symposium, 8-9 July 2026

Multilevel-Inverter Topology

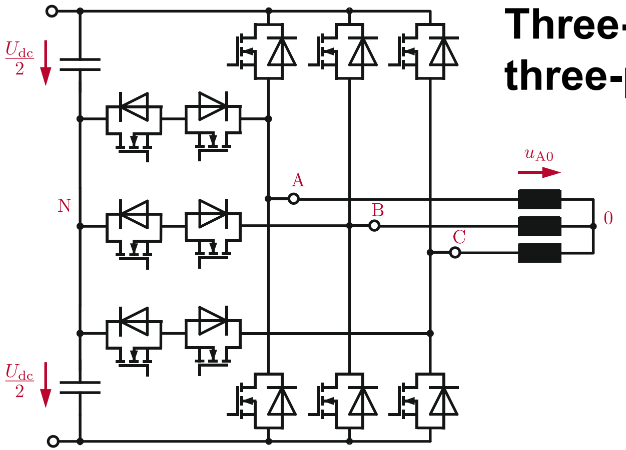
Two-level three-phase inverter

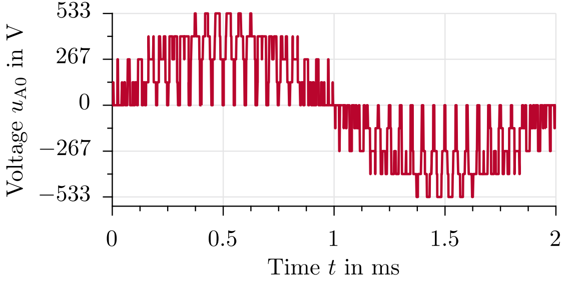


Voltage across the inductor shows five levels for a two-level inverter



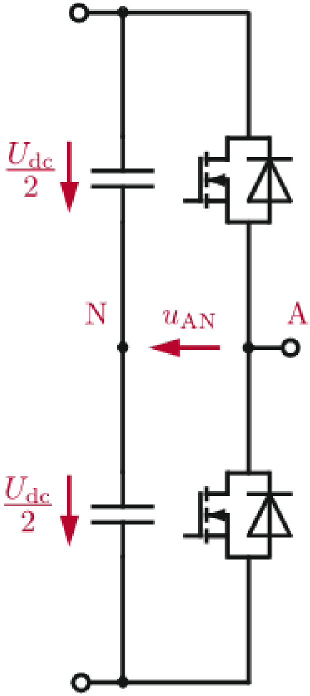
Three-level three-phase inverter



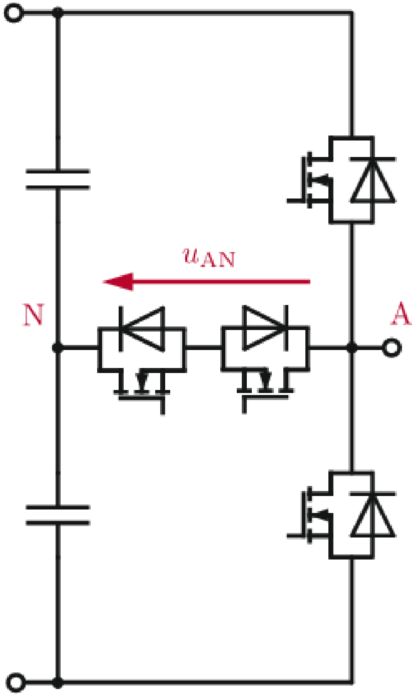


Source: Evaluation of Multi-Level Inverter Topologies for Electrical Traction Drives, Annegret Wörndle, Aachen Automotive Colloquium 2024, 9 October 2024.

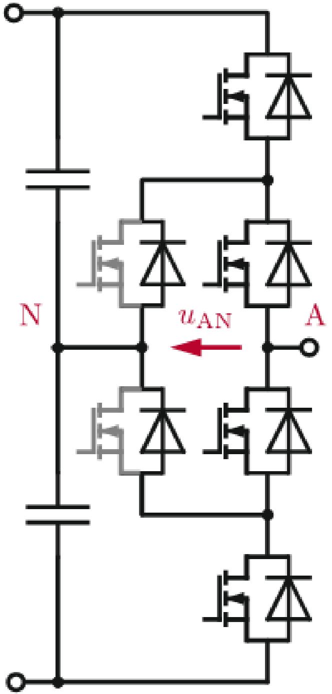
Multilevel-Inverter Topology



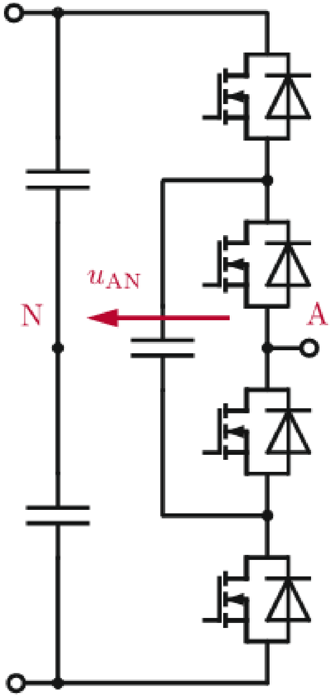
Two-level
topology



Three-level
T-type topology



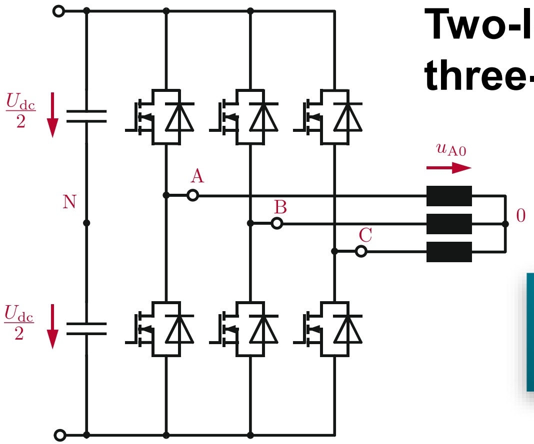
Three-level
active neutral point clamped
(ANPC) topology



Three-level
flying capacitor
(FC) topology

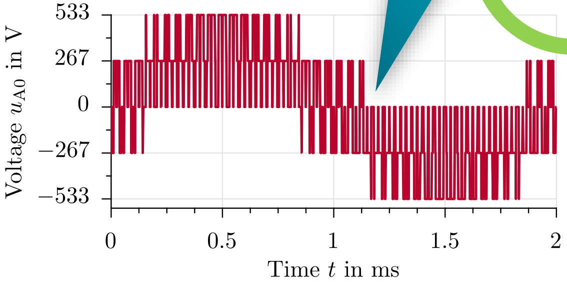
Source: Evaluation of Multi-Level Inverter Topologies for Electrical Traction Drives, Annegret Wörndle, Aachen Automotive Colloquium 2024, 9 October 2024.

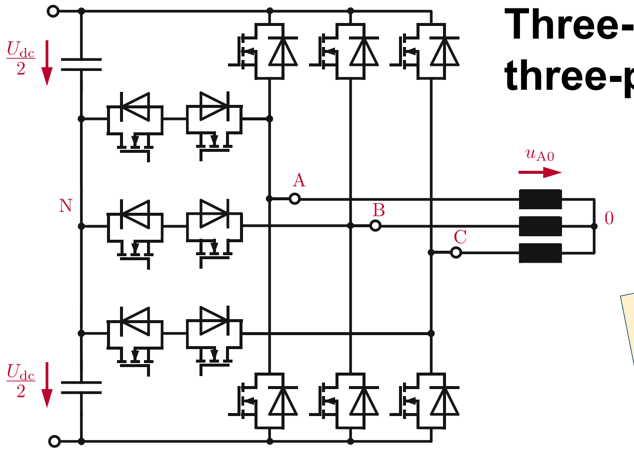
Multilevel-Inverter Topology



Two-level three-phase inverter

Voltage across the inductor shows five levels for a two-level inverter

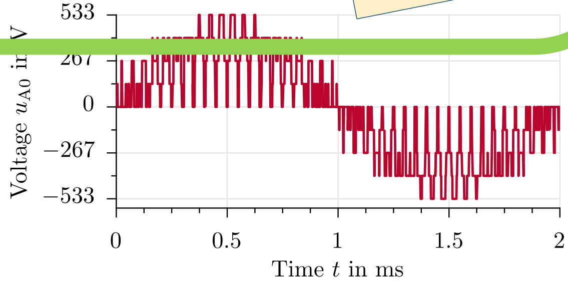




Three-level three-phase inverter

kV-level, thermal mgt. ⇒ use SiC, not GaN

T-type



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Conclusion

HiVEP develops next-gen BEV technology for mass-market vehicles with

- Reduced dependency on critical materials (REE) and reduced cost
- Increased efficiency and range by
  - 3L SiC inverter
  - Voltage > 800 V → lower currents and losses
  - Holistically integrated energy and thermal management
  - Sweet-spot matching by active-winding-reconfiguration e-motor
- Charging time below 10 min … and more …

Technologies integrated in Togg T10X donor vehicle, demonstrated real-life

Industry partners validate pathway to industrialisation

Project will continue for about two more years

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