



Bright ideas.
Sustainable change.

Zero-emissions passenger railway services

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Agenda

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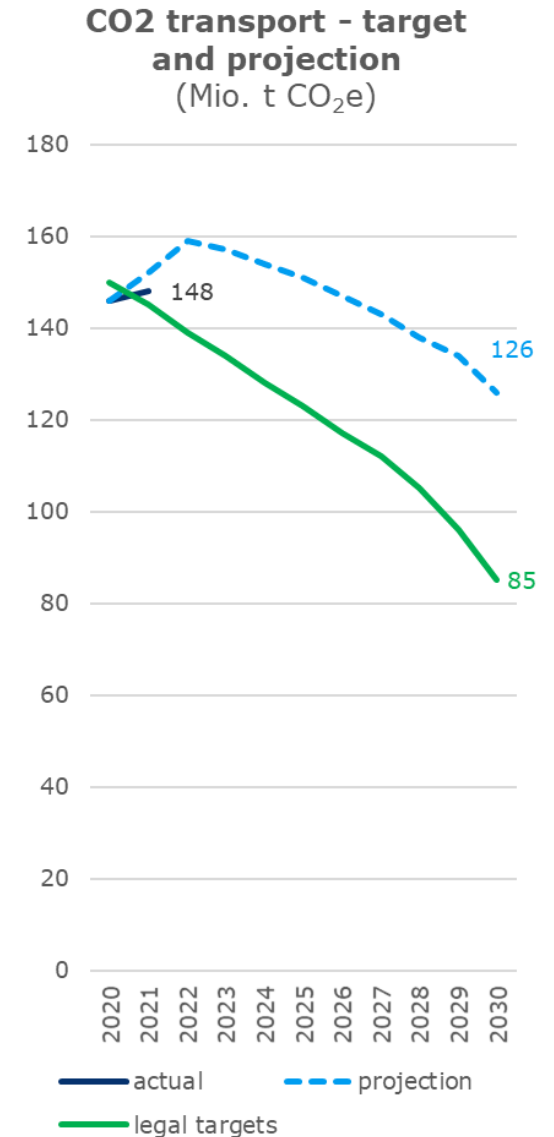
Can **HEMU compete** in the future?

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Objective & aim

- Reducing CO₂ emissions in the transport sector is a **major political target** in Germany
- Federal Government imposed a Climate Change Act ("Klimaschutzgesetz") → **reduction target** for CO₂e: **57%** until 2030
- Although most emissions come from cars, efforts to decarbonise regional rail services are growing
- We want to
 - give insight into current criteria of investment decision for zero-emission trains in Germany
 - show first results of market development regarding the competing technologies
 - outline market dynamics



BEMU

(Battery Electric Multiple Unit)

Power provided by electricity from catenary or on-board-battery

Battery recharged in electrified parts of the network or stations

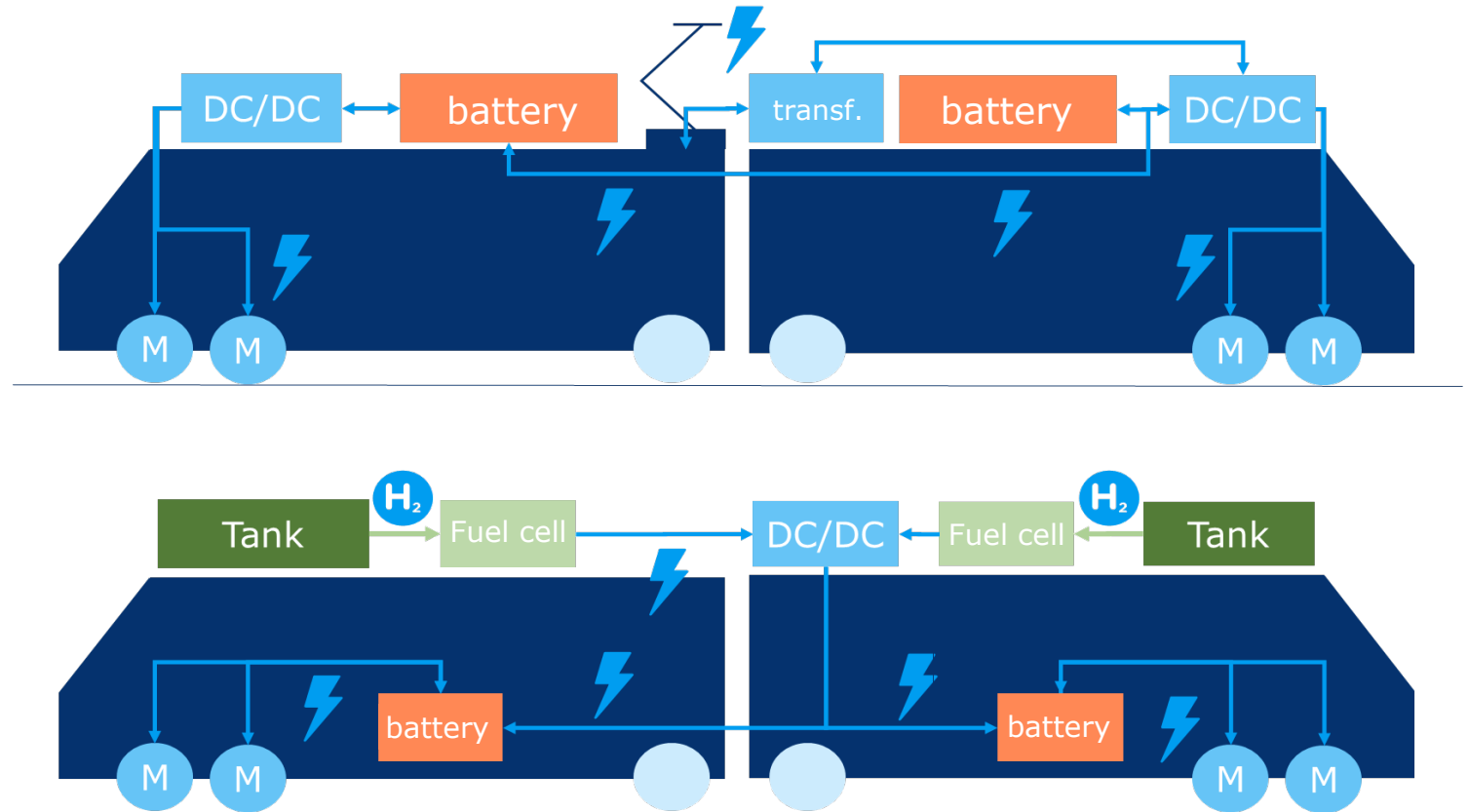
HEMU

(Hydrogen Electric Multiple Unit)

Power provided by electricity from fuel cell; battery for peak-load (acceleration)

State-of-the-art technologies for zero-emissions* rail services

* Precondition: green hydrogen or electricity production



Market overview on BEMU/HEMU orders in Germany

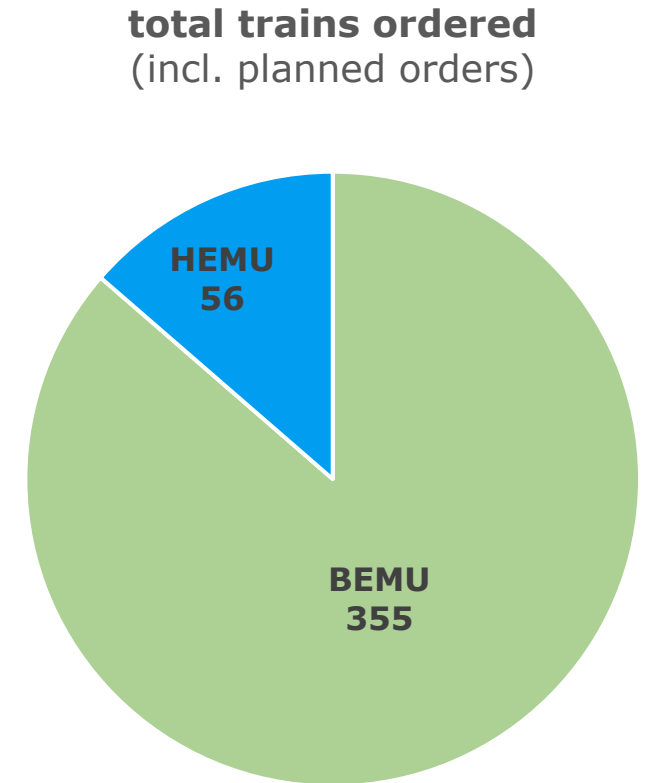
PTA	TOC	Technology	Rail Network	Fabricator, train type	Number	Operation from
LNVG	EVb	HEMU	Elbe-Weser	Alstom iLINT	14	6/2022
RMV	DB	HEMU	Taunus	Alstom iLINT	27	10/2022
NAH.SH	different TOC	BEMU	Landesweit	Stadler Flirt Akku	55	3/2023
NVBW	SWEG	BEMU	Ortenau, Hermann-Hesse-Bahn	Siemens Mireo +B	23	12/2023
BEG	Transdev	HEMU	Augsburg – Füssen ⁺	Siemens Mireo +H	1	6/2023
ZVMS	Transdev	BEMU	Leipzig – Chemnitz	Alstom Coradia Akku	11	9/2023
VBB	NEB	BEMU	Ostbrandenburg	Siemens Mireo +B	31	6/2024
VBB	NEB	HEMU	Heidekrautbahn	Siemens Mireo +H	7	9/2024
VRR, NWL	t.b.d.	BEMU	Niederrhein Münsterland	CAF Civity Akku	63	6/2025
ZV SPNV RP Nord	HLB	BEMU	Westerwaldbahn ⁺	t.b.d.	3	12/2025
ZV SPNV RP Nord	DB	HEMU	Rhein-Eiffel-Sieg ⁺	t.b.d.	3	12/2025
ZV SPNV RP Süd	DB	BEMU	Pfalznetz	Stadler Flirt Akku	44	12/2025
BEG	DB	HEMU	Linienstern Mühldorf	t.b.d.	approx. 4*	12/2025
NWL	t.b.d.	BEMU	RB68, RB76	CAF Civity Akku	10	12/2025
VMV	DB	BEMU	Warnow	Stadler Flirt Akku	14	12/2026
ZVNL	t.b.d.	BEMU	S-Bahn Leipzig	t.b.d.	approx. 16*	12/2026
NWL	t.b.d.	BEMU	Nördliches Münsterland	t.b.d.	approx. 60*	12/2028
VVO	t.b.d.	BEMU	Dieselnetz Ostsachsen	t.b.d.	approx. 25*	12/2028

⁺ = pilot project

* = current procurement

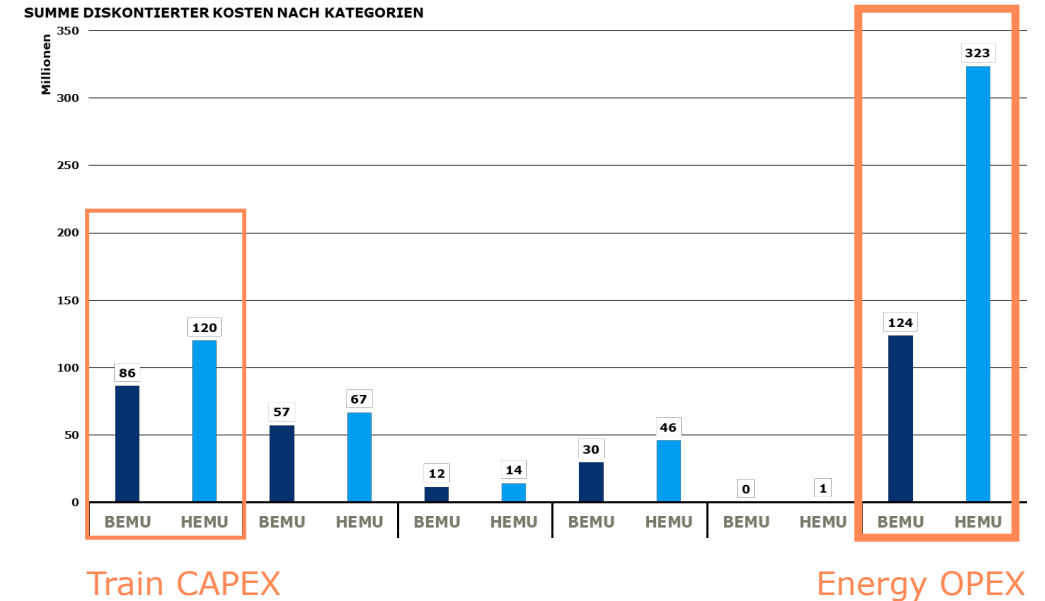
First conclusion: PTA strongly tend to BEMU technology

- From a total of >400 trains ordered (including planned orders), over **85%** are BEMU technology
- In cases of an open technology decision between BEMU and HEMU, **100%** BEMU was chosen
- Economical and technical assessments so far delivered the following results:
 - **Technical feasibility** depends on the network, particularly on the infrastructure pre-conditions
 - BEMU need parts of the network electrified
 - HEMU need fuel station(s)
 - Where **BEMU** are technical feasible, they are – in a life-cycle view – **less expensive** than HEMU (and usually DMU)



Reasons for preferring of BEMU (so far)

- **Main cost drivers for HEMU:**
 - CAPEX for the trains - to a lower extent
 - energy OPEX (hydrogen vs. electricity)
- **(Lacking) green hydrogen supply** in Germany: for HEMU projects, production capacities need to be established → monopoly market on the H₂ supply side
- Shrinking infrastructural advantage for HEMU due to
 - fast charging spots on stations
 - growing battery capacities
 - safety requirements for storage of H₂



Can HEMU compete in the future?

- Biggest **constraints for HEMU** to be an economical alternative to BEMU are
 - poor **energy conversion efficiency** – which is physically determined
 - high energy costs (OPEX): in Germany, **prices for electricity and hydrogen are coupled**, therefore a better HEMU-OPEX is improbable
- A game changer would be:
 - **Large-scale production and import** of green hydrogen would be able to decouple prices – in favour of H₂
 - A growing network of H₂ fuel stations would further bolster HEMU opportunities



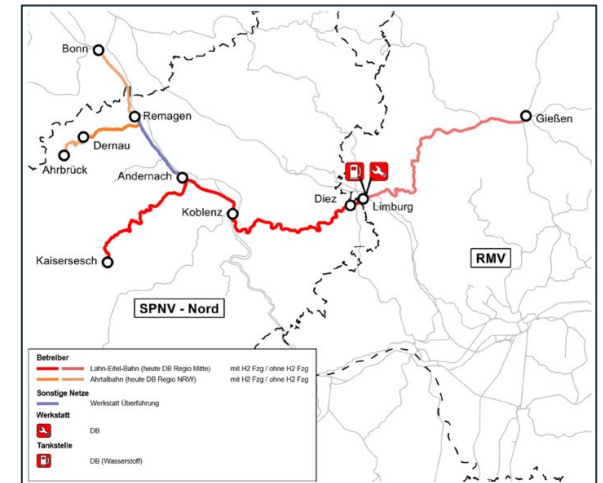
Conclusions

- We are on the verge of the **BEMU/HEMU age** in passenger transport
- When deciding on whether BEMU or HEMU is the favourable technology for current DMU networks,
 - **Assess local conditions**
 - Nowadays, **BEMU** seems to be the **superior** technology
 - **HEMU** has **huge potential** to follow-up in near future – or under special circumstances, e.g. growing wind power capacities in Finland
- And yes, there will be some problems with the trains in the beginning...
- We look forward to the developments in Northrhine-Palatine, where BEMU and HEMU will be measured within the **only joint pilot project** from ~2026 on – with Ramboll's support



Im Taunus verkehren seit einigen Wochen Wasserstoffzüge. Auf die neue Antriebsart werden große Hoffnungen gesetzt, doch von Anfang an zeigen sich Schwierigkeiten.

[News article on current problems of HEMU operation in Taunus \(source: FAZ.net\)](#)



[Network for the pilot operation of HEMU in Northrhine-Palatine \(source: DB Regio\)](#)

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