Trains on Less Infrastructure

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Introduction

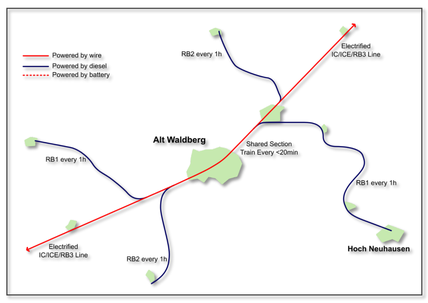
Rail Systems (light rail & heavy rail) can provide

- A large transport capacity in a small of space
- With a good overall environmental footprint

A major concern is the cost of the infrastructure, they are often not economically viable.

Can we use modern technologies to reduce infrastructure cost?

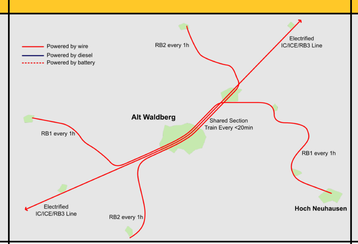
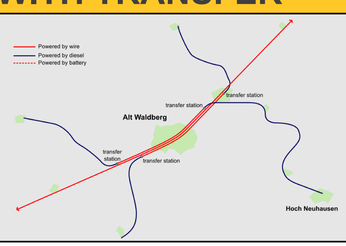
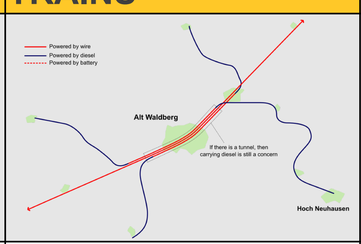
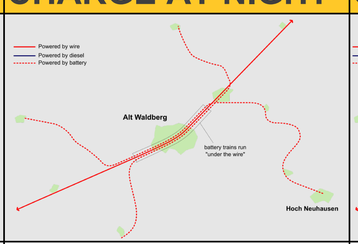
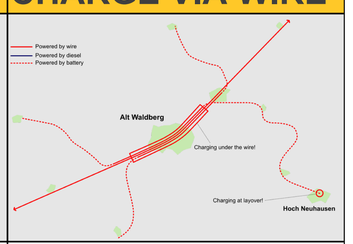
BEMU – A Motivating Example



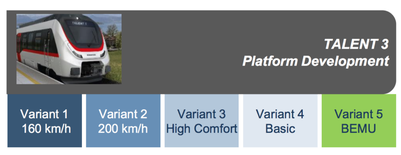
Consider the electrification of railways around the fictitious city of "Alt Waldberg", to illustrate common infrastructural, technological, economical & environmental trade-offs:

- Electrified main-line runs through city
- Non-electrified lines cover the region
- Those lines have little service (1 per hour)
- The shared city section has a lot of service

Possible Options for *Alt Waldberg*

	OPTION 1: ELECTRIFICATION	OPTION 2: DIESEL-ONLY TRAINS	OPTION 3: EMU & DMU TRAINS, WITH TRANSFER	OPTION 4: DUAL-MODE TRAINS	OPTION 5: BATTERY TRAIN, CHARGE AT NIGHT	OPTION 6: BEMU TRAIN, CHARGE VIA WIRE
Powered by wire / Powered by diesel / Powered by battery						
Noise and emission	++	- - (emissions/noise even under wire)	- (emissions and noise in diesel sections)	- (emissions and noise in diesel sections)	++	++
Infrastructure cost	very high	low	low	low	low	low
Vehicle cost	low	low (4.5M€)	low-medium	high	very high	medium-high (6-7M€)
Operating cost	low	high	high for diesel sections	high	low-medium	low
Issues	-infrastructure = $$$ -poor cost-benefit -issue: stacked freight	-diesels may be dis-allowed, e.g. city-tunnel -non-standardized fleet	-transfers are very unattractive -non-standardized fleet	-trains are complex, expensive & heavy -non-standardized fleet	-big batteries are expensive & heavy -increases infra cost	-few examples in operation

"Bombardier Primove" on Talent 3



BOMBARDIER TALENT 3

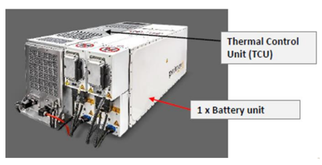
3rd gen. of the "Talent" regional train platform

- Maximum speeds: 160-200km/h
- Length: 3-12 cars per train

THE BEMU VERSION

The BEMU version of the Talent 3 is one possible configuration of the platform

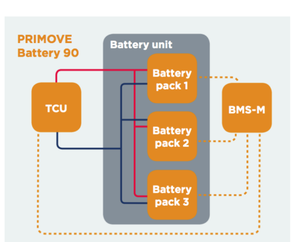
- It grew from research funded by BMVI
- uses the "Bombardier Primove System", developed primarily for trams and buses



"PRIMOVE SYSTEM" ON TALENT 3

"Primove" is Bombardier's vehicle battery system

- 4 Primove units on roof, 7.5t, 300 kWh total
- 440 kWh possible with additional units
- **Range**: 40km, but up to 100 km is possible



THE PILOT PROJECT

BMVI Research is built around a pilot project:

- It requires 40 km of range
- Up to 160km/h under wire, 120km/h on battery
- DoD is 40% with 50% Catenary-free operation

BEMU shows possibility reducing cost for overhead infrastructure. But *What if We Remove the Rails?*

ART – Autonomous-rail Rapid Transit

ART is a rail-less system for public transport that follows markings on the road by scanning them, developed by **CRCC** (China Railway Construction Corporation Ltd).

SPECIFICATIONS	
Dimensions (m)	↔2.65 ↕3.4 31.6
Energy per km	4kWh/km
Battery Capacity	170 kWh (Li-Titanate Bat.)
Charging Method	Pantograph 30s for 3-5 km 10 mins for 25km
Max. Speed	Up to 70km/hour
Life Cycle	25 years
Turning Radius	15m minimum
Incline	Up to 13%

BENEFITS

- Low emission, construction and maintenance cost
- Short construction time
- Flexible operations in changing traffic conditions

LIMITATIONS

- **Cost concerns**: road/rail CAPEX vs OPEX; lifetime of buses vs trams
- **How smart is it?** Test drive was still manually driven.
- **Sharing Lanes:** Should trams run on dedicated lanes?

CONCLUSION

New technology can reduce infrastructure costs and may make trains more viable:

1) **BEMUs** like the **Bombardier Talent 3** allow extending electrified rail systems into non-electrified territory
   — *the technology is realistic, but the impact may not be very large*
2) **ART** promises tram systems without overhead lines and without rails
   — *the potential impact is high, but there's uncertainty whether the system can live up to its promises*

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