**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.

**Possible Options for Alt Waldberg**

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Powered by wire</td>
<td>-</td>
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<tr>
<td>Powered by diesel</td>
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<tr>
<td>Powered by battery</td>
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<td>-</td>
<td>-</td>
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<td>-</td>
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<tr>
<td>Noise and emission</td>
<td>++</td>
<td>- (emissions/noise even under wire)</td>
<td>- (emissions and noise in diesel sections)</td>
<td>- (emissions and noise in diesel sections)</td>
<td>++</td>
</tr>
<tr>
<td>Infrastructure cost</td>
<td>very high</td>
<td>low</td>
<td>low</td>
<td>low</td>
<td>low</td>
</tr>
<tr>
<td>Vehicle cost</td>
<td>low</td>
<td>(4.5M€)</td>
<td>low-medium</td>
<td>high</td>
<td>very high</td>
</tr>
<tr>
<td>Operating cost</td>
<td>low</td>
<td>high</td>
<td>high for diesel sections</td>
<td>high</td>
<td>low-medium</td>
</tr>
<tr>
<td>Issues</td>
<td>infrastructure = $$$ poor cost-benefit</td>
<td>diesels may be disallowed, e.g. city-tunnel non-standardized fleet</td>
<td>big batteries are expensive &amp; heavy increases infra cost</td>
<td>few examples in operation</td>
<td></td>
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</tbody>
</table>

**”Bombardier Primove” on Talent 3**

**BOMBARDIER TALENT 3**

3rd gen. of the “Talent” regional train platform
- Maximum speeds: 160–200 km/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, 7.5ft, 300 kWh total
- 440 kWh possible with additional units
- Range: 40 km, 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 160 km/h under wire, 120 km/h on battery
- DoD is 40% with 50% Catenary-free operation

**ART – Autonomous-rail Rapid Transit**

**GOAL**

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 × 3.16
- Energy per km | 4 kWh/km
- Battery Capacity | 170 kWh (Li-Titanate Bat.)
- Charging Method | Pantograph
- Max. Speed | Up to 70 km/hour
- Life Cycle | 25 years
- Turning Radius | 15 m 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 trains
- 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

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

**Can we use modern technologies to reduce infrastructure cost?**