



From Tradition to Innovation

Developing a Smart Trolleybus System

Verkehrsbetriebe Biel



Transports publics bernois

Emanuel Hadjikan

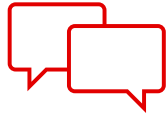
Project Manager & Electric Engineer

About

Biel/Bienne



~50k
inhabitants



DE / FR
Switzerland's largest bilingual city.



Watch Maker City
Swiss Watch Metropolis



About

Verkehrsbetriebe Biel (VB/TPB)



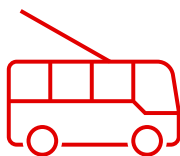
~250
employees



8 / 3
urban / regional bus lines



~ 16'000'000
passengers per year



since 1940
Trolleybus operation



About

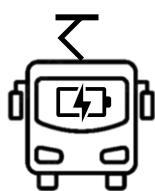
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TROLLEY
18M



B-TROLLEY
18M



E-BUS
18M



DIESEL
12M / 18M

1

e-bus line

1

trolleybus line

2

b-trolleybus
lines

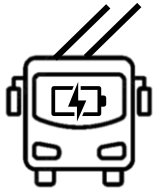
4

diesel bus
lines

- **Experience with many technologies** (trolley, battery-trolley, e-bus)
- **High operational reserve necessary**
- **Low operational efficiency**

Fleet Strategy

Urban Network



Lines 1-13

60 vehicles

BATTERY-TROLLEYBUS

12M – 18M – 24M

- 100% Trolleybus Operation by 2030
- Line network adapted to customer demand and electrification
- Full electrification with only 2.5km of additional overhead lines
- Conversion of OppCharge e-busses to battery-trolleybuses
- Introduction of double-articulated busses

Regional Network



Lines 11, 70, 71

6 vehicles

E-BUS DEPOTCHARGE

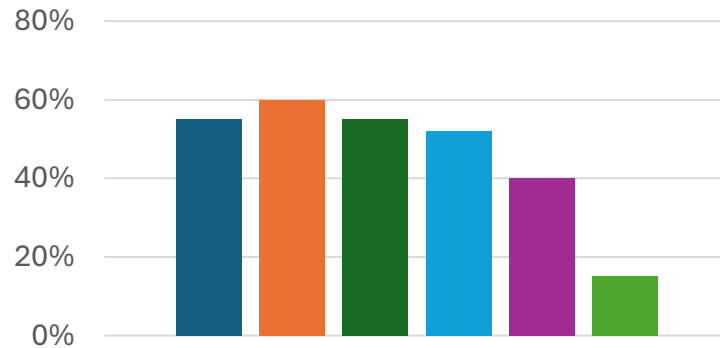
12M

- Electrification after 2030
- Mixed operation with urban lines where required
- dependence on depot location

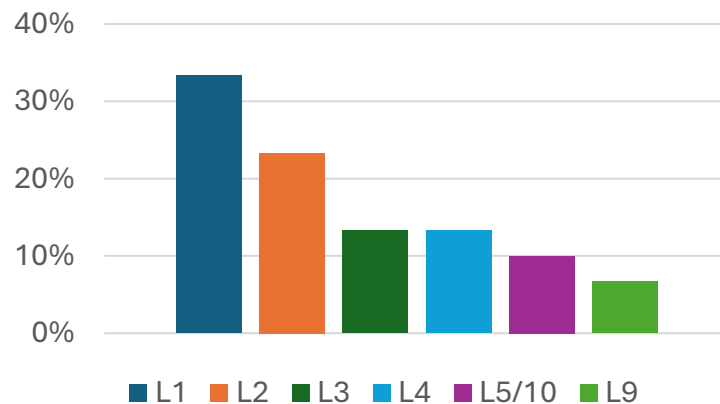
Innovation

Battery Modelling Concept

Overhead Operation per Line
18m Trolleybus



Annual Operation Time
18m Trolleybus



Our Approach

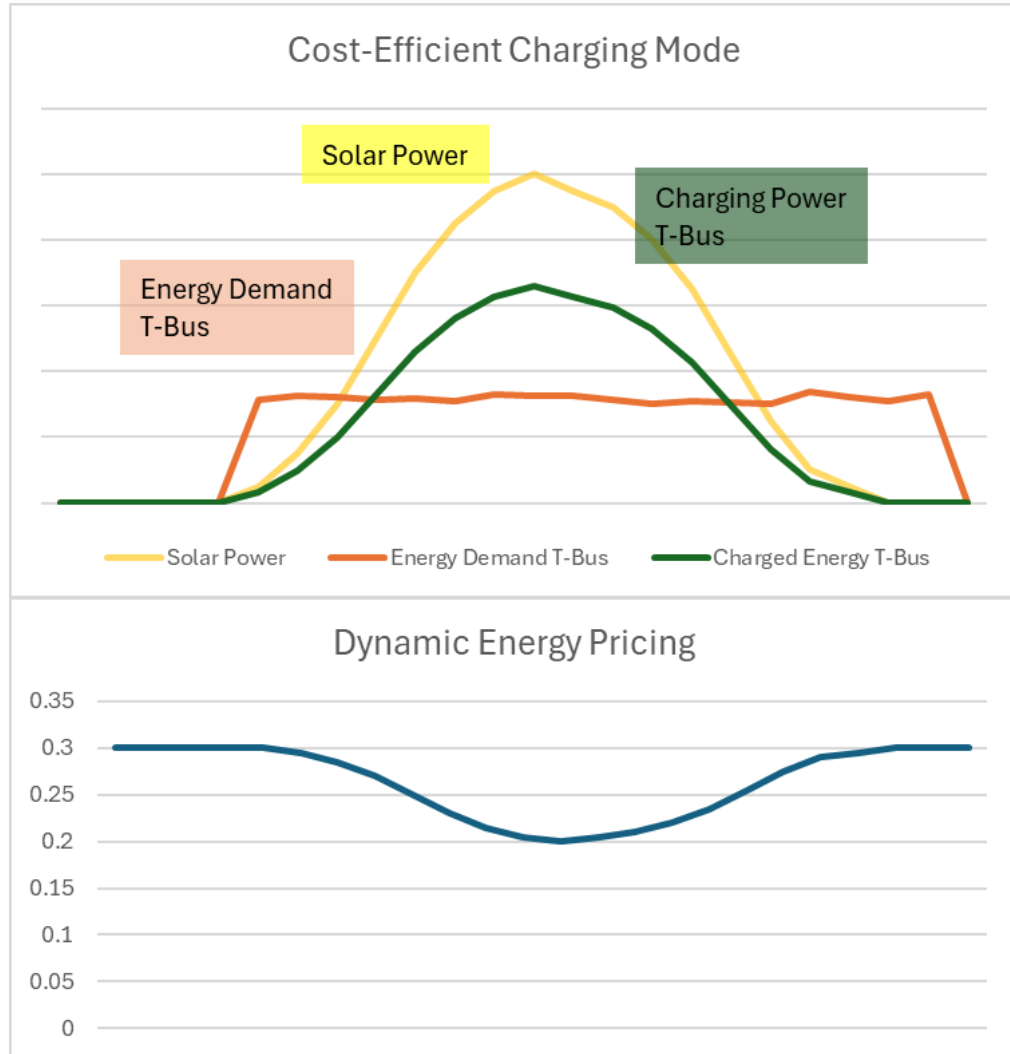
1. Determining the operating environments
2. Selection of the required battery size and type to achieve the desired service life
3. Economic efficiency calculation
4. Selection of battery modules

Advantages

- Battery-saving: High charging time at high Annual Operation Time
- Battery lifespan of up to 20 years expected
- Choice of battery types is less restricted (LTO, NMC, LFP available)
- Flexible application options (depending on battery type)
- Same battery module for all bus sizes (12m, 18m, 24m)

Innovation

Dynamic Charging Concept



Daytime

- Lower Energy costs
- Use of local (in-house) solar power
- Ideal for the introduction of dynamic electricity rates



Location /
Line

- Balanced use of rectifier stations
- Optimized energy procurement (line-specific)
- Lower overall grid charges

Conclusion

- The battery trolleybus has great potential - but needs political acceptance
- Low operating costs (energy, personnel, space) with a greater impact than increased investment costs
- Risk-resistant in technological developments
- Modern trolleybus systems as a basis for mobility concepts of the future
- The trolleybus is very resource efficient
 - Small batteries with a very long service life
 - Long lifetime of the infrastructure (catenary, rectifier, transformer...)

