
HESS

Welcome

First electric buses

1940 Trolleybuses for Biel and Basel

Over decades the APU was a diesel generator

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But new emissions regulations for APUs resulted in:

- higher complexity due to exhaust aftertreatment systems
- more space requirements
- higher weight
- higher cost

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At the same time, battery solutions have become more attractive:

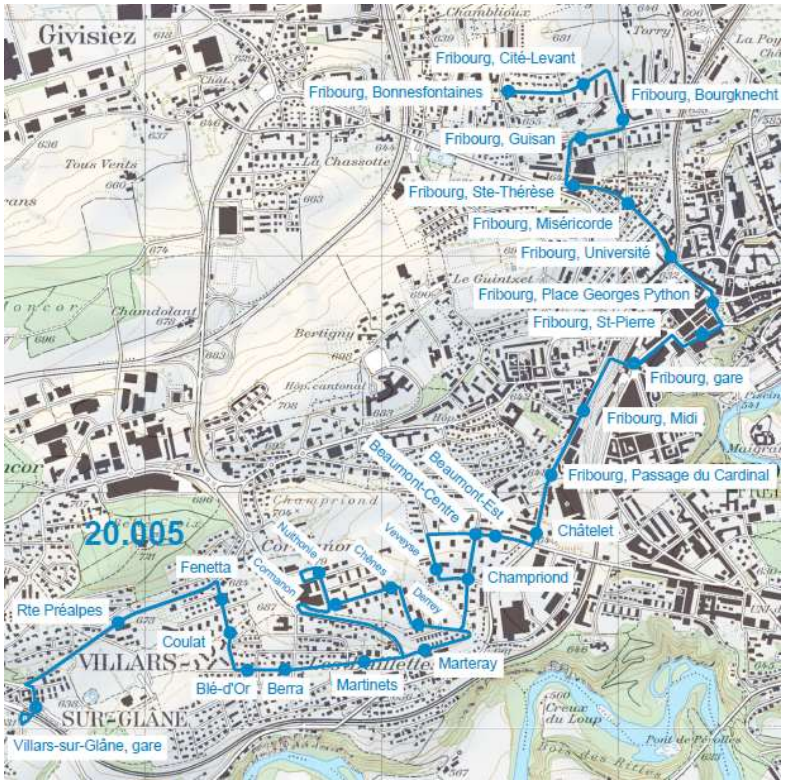
- more powerful
- less expensive
- more space-saving
- easier to integrate
- complementary to the existing electric drive and the existing overhead line

2017 Game changer: Poject SwissTrolley® *plus*

- Dynamic Charging
- LTO battery 60kWh
- VBZ, BFH and ETHZ as research partners

=> approx. 0,4 kWh/Passanger

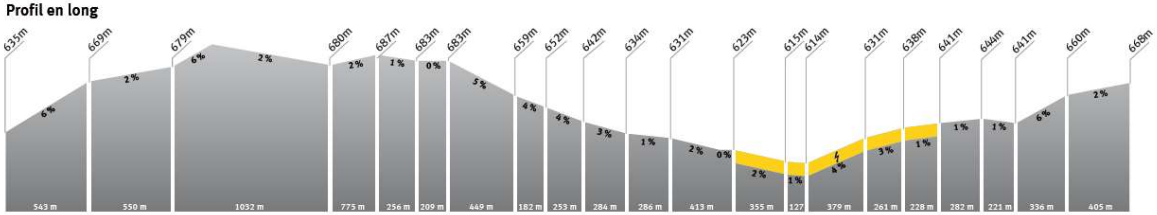
Analyse of the line datas:

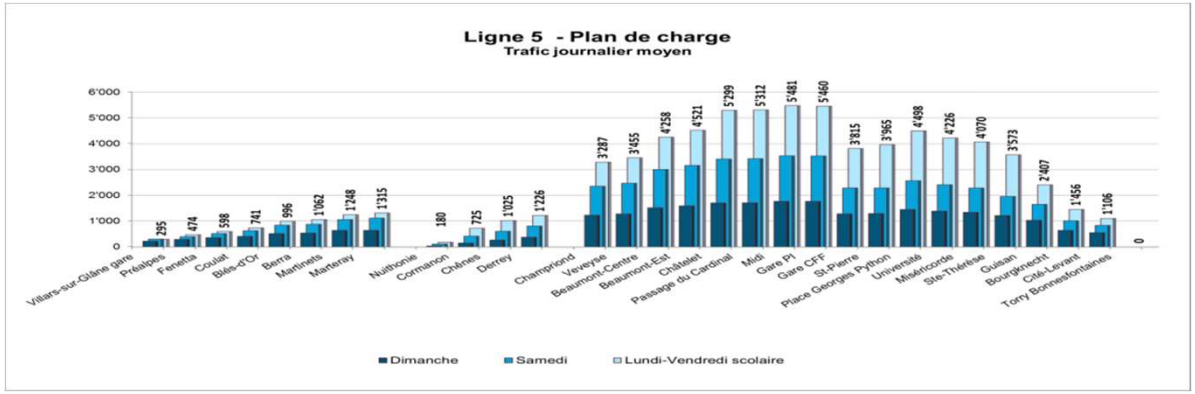


20.005 Villars-sur-Glâne gare–Fribourg gare–Torry (Ligne 5)

	65003	65001	65001	65007	65005	65003	65009	65005	65009	65003
Villars-sur-Glâne, gare		11 5 36	13 5 37		11 5 51	13 5 52			13 6 06	13 6 07
Villars-sur-Glâne,Rte Préalpes		5 37	5 38		5 52	5 53			6 07	6 08
Villars-sur-Glâne, Fenetta		5 38	5 39		5 53	5 54			6 08	6 09
Villars-sur-Glâne, Coulat		5 38	5 39		5 53	5 54			6 08	6 09
Villars-sur-Glâne, Blés-d'Or		5 39	5 40		5 54	5 55			6 09	6 10
Villars-sur-Glâne, Berra		5 39	5 40		5 54	5 55			6 09	6 10
Villars-sur-Glâne, Martinets		11 5 40	5 41		11 5 55	5 56			6 10	6 11
Villars-sur-Glâne, Nuithonie	10 5 43	12 5 43		10 5 58	12 5 58		12 6 06	13 6 13	13 6 13	
Villars-sur-Glâne, Cormanon	5 43	5 43	5 43	5 58	5 58	5 58	6 06	6 13		6 13
Villars-sur-Glâne, Chênes	5 44	5 44	5 44	5 59	5 59	5 59	6 07	6 14		6 14
Villars-sur-Glâne, Derrey	5 45	5 45	13 5 45	6 00	6 00	6 00	6 08	6 15		6 15
Villars-sur-Glâne, Marteray										
Fribourg, Champriond	5 47	5 47	14 5 47	6 02	6 02	6 02	6 10	6 17		6 17
Fribourg, Beaumont-Centre	5 47	5 47	5 47	6 02	6 02	6 02	6 10	6 17		6 17
Fribourg, Châtelet	5 48	5 48	5 48	6 03	6 03	6 03	6 11	6 18		6 18
Fribourg, Passage du Cardinal	5 48	5 48	5 48	6 03	6 03	6 03	6 11	6 18		6 18
Fribourg, Midi	5 49	5 49	5 49	6 04	6 04	6 04	6 12	6 19		6 19
Fribourg, gare CFF	5 53	5 53	5 53	6 08	6 08	6 08	6 16	6 23		6 23
Fribourg, St-Pierre	5 55	5 55	5 55	6 10	6 10	6 10	6 18	6 25		6 25
Fribourg, Miséricorde	5 58	5 58	5 58	6 13	6 13	6 13	6 21	6 28		6 28
Fribourg, Guisan	5 59	5 59	5 59	6 14	6 14	6 14	6 22	6 29		6 29
Fribourg, Bourgknecht	6 00	6 00	6 00	6 15	6 15	6 15	6 23	6 30		6 30
Fribourg, Cité-Levant	6 01	6 01	6 01	6 16	6 16	6 16	6 24	6 31		6 31
Fribourg, Bonnesfontaines ○	10 6 02	12 6 02	14 6 02	10 6 17	12 6 17	13 6 17	12 6 25	13 6 32		10 6 32

Profil en long





Revival of trolleybuses thanks to batteries

City	units	lenght
Bernmobil	14 + Options	24.7m
Bernmobil	14 + Options	18,7m
Zürich	9	18,7m
Luzern	5	24,7m
Lausanne	12 + Options	24.7m
Lausanne	14 + Options	18,7m
St Gallen	11 + Options	24,7m
St Gallen	6 + Options	18,7m
Freiburg	10 + Options	18.7m
Salzburg	15 +7 + Options	18,7m
Lyon	34 + Options	18,7m

2017 Game changer – Project lighTram®*19 TOSA*

- Static Charging with 400/600kW
- LTO battery 60kWh
- TPG, ABB, Hitachi
  as research partners

=> approx. 0,4 kWh/Passanger

2018 Game changer – lighTram®*19 OPP*

- Static Charging with 450kW
- NMC battery 150kWh
- Bernmobil as research partner

=> approx. 1,1 kWh/Passanger

Batteries allow the quick electrification of bus fleets

- Less noise in the cities
- Less noise for the passengers
- Higher energy efficiency
- Less CO2 emissions
- Attractive passanger concepts
- Allows multiaxle drives
- Less Maintenance costs
  (except battery replacement)

Brisbane Metro

Milestone

Challenges with batteries in public transport

Actor	Topic	Positive	Negative	Pain-Points
Federal and local policy makers	Awareness Willingness to change Willingness to finance Adjustments of laws	+ + + +		Standardizing requirements (e.g. fire safety, certificates of origin)
Federal and local public administration	Adjustments to regulations		-	Fear of critisme due to changes Fear of critisme due to bad battery image Maintaining false subsidies incentives (e.g. mineral oil tax refund)
Operators	Willingness to change Know-how Cost level	+ +	- - -	Fear of technology change Afraid of the battery and high voltage Counter-financing by the local public ad.
Popullation	Image of batteries		--	The public knows too little about the origin of resources, behavior in fire, life cycle applications

Challenges with batteries in public transport

Actor	Topic	Positive	Negative	Pain-Points
Universities	Motivation Technical know-how Life-Cycle know-how	+ + +	 -	Knowledge of everyday behavior of batteries over several years (vibrations, winter temperatures, humidity)
Supply Chain	Know-how Sustainability Cost level Comittment to life-cycle	 +	- - -	Missing established exchange of innovations Missing certified origin and CO2 footprint Missing certiefied Recycling Missing standardizing battery life time warranty considerations. Warranty conditions should be clear and practically implementable to all parties (cell manufacturer, battery manufacturer, vehicle manufacturer, vehicle operator)

As a bus manufacturer, we are inspired by the possibilities that batteries make possible.

We are happy to discuss solutions and ideas.

Thank you !