



SBB CFF FFS

SBB experience

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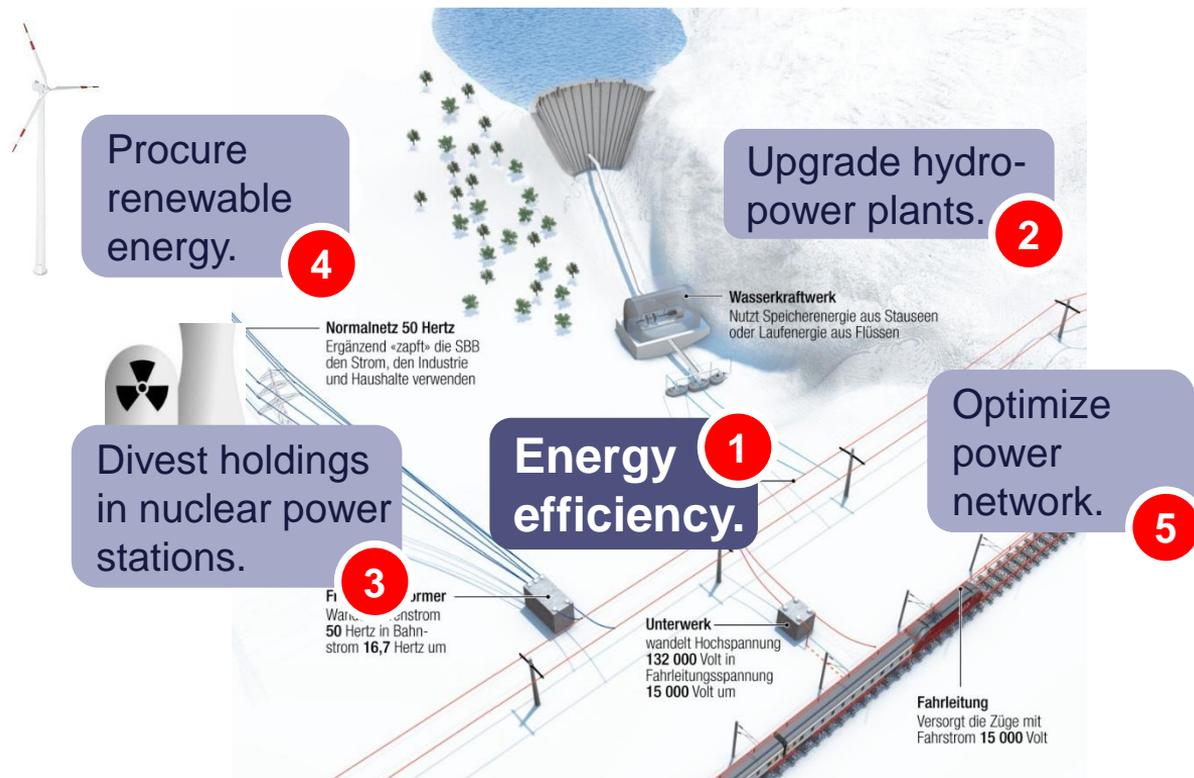


Agenda.

1. SBB Ambition 2040 «100% renewable energy».
2. Areas of action.
3. Replacing diesel traction: dual-engine, hybrid and full electric.

SBB's energy strategy incl. efficiency and renewable energy.

- Energy efficiency: goal likely to be achieved by 2025.
- Focus should be extended to include renewable energy.
- Steering committee asked for possible ambition 2040.



Ambition 2040: «SBB to use 100% renewable energy!»

- ✓ All energy that is consumed by SBB comes from renewable sources, this includes energy used by shunting vehicles and infrastructure assets.
- ✓ Reduction of specific energy use by another 10% compared to 2030:
 - Passenger traffic ≈ 63 Wh/Person-km
 - Cargo ≈ 33 Wh/Net ton-km

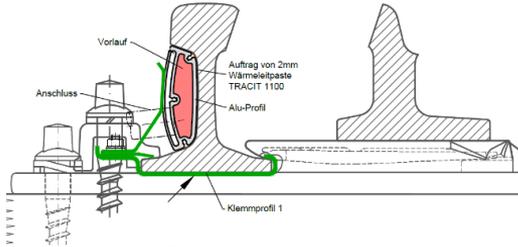


Areas of action.

Area of action	Description
Heating	Replacing of fossil fuel heating systems in buildings and stationary assets by renewable energies.
Diesel generators	Operating of emergency generators with e.g. supercapacitors and hydrogen battery, salt batteries; on rolling stock with biodiesel or synthetic diesel.
Switch heating (gas)	Replacing switch point heating's from natural gas / Propene to electric (mainly 16.7 Hz), water heated systems.
Road & special vehicles	Electric vehicles and fuel cells (usage of renewable energies).
Energy purchase & CO2 compensation	Purchase of renewable energy (e.g. biogas); Compensation of non-renewable energies by certificates (guarantees of origin for electricity).
Diesel traction	Replacement purchase for thermal vehicles e.g. by two-engine, battery or hydrogen.



Stationary systems and assets.



→ Geothermal switch point heating

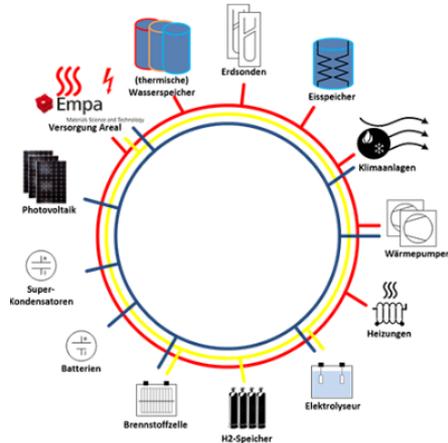


→ 2nd life batteries (Lithium Ion Battery)



→ Emergency generator (technology salt battery)

→ Energy Hub



→ PV self production & feeding into the 16.7 Hz grid



Replacing diesel traction.

- 99.8% electrified grid but still using around 11 Mio. liter Diesel, **mainly for shunting vehicles.**
- SBB strategy:
 - Concept studies.
 - Establishing knowledge on hydrogen.
 - Proof of options and technologies (hybrid, batteries, H₂, etc.).
 - Developing of a TCO-Tool to proof replacements on a economical view.
- Preparing details for the next procurements (proof of technologies and options as well as possibilities)

Dual-engine -

Maintenance train Gotthard Base Tunnel.



- Specification and procurement for the maintenance train for Gotthard and Ceneri Base Tunnel (licensed ETCS Level II).
- 30 special vehicles, in which 13 are powered by a dual-engine (electrical/diesel).
- Trains can be divided into individual sections, serving on different construction sites.
- Tunnel entrance and exit electrically, maintenance powered by diesel.
- Diesel fuel savings per train of 11'800 l/yr. (corresponds to a reduction of CO₂ emissions by 36.4 t/yr.).



Hybrid -

Alstom H3 Hybrid.

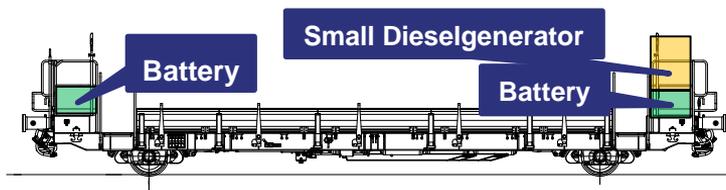


- Operating in Regional Cargo Production (shunting).
- 3 H3 units in operation, procurement of additional 12 units.
- A 350 kW generator and a 350 kW battery (P_{tot} 700 kW)
- The substitution of an Am843 leads to diesel fuel savings per train of 66'100 l/yr. (corresponds to a reduction of CO₂ emissions by 206.1 t/yr.)



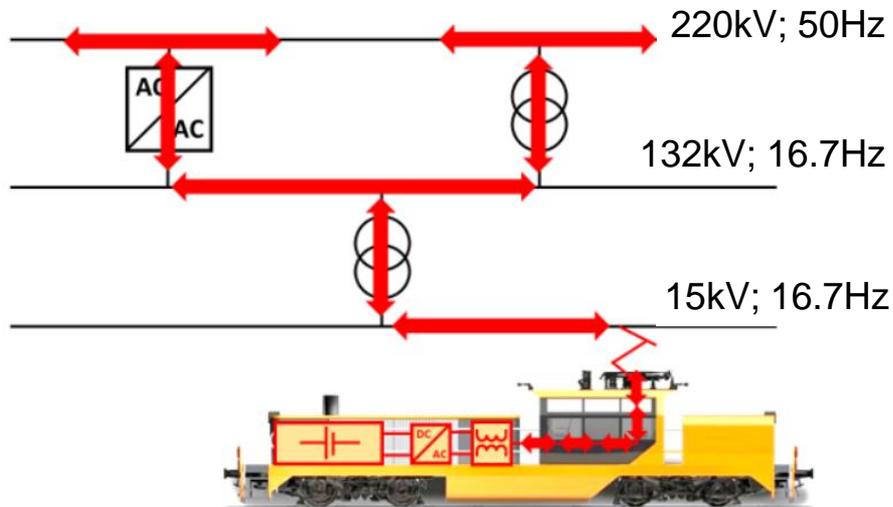
Hybrid prototype - Construction wagon (flat wagon Xs_tief).

- For prototyping SBB decided to go for a Hybrid solution but the goal is battery-only.
- Diesel generator at optimal efficiency point to charge the battery.
- Autonomy at battery-only 23h + diesel generator 14h (@ 70% load).
- Online monitoring for SoC, SoH, system information.
- Sodium-Nickel-Battery which is 100% recyclable, no fire and explosion risks, very insensitive for cold (-25°C) and hot (+60°C) temperatures.
- Lifetime up to 20 years (guarantee for 15 years)
- LCC is positive!



Full electric - Shunting tractor Tm3.

→ Prototyping: fully replacing diesel on shunting tractor Tm3 by battery system.



- Lead-acid battery.
- Back-up times:
 - 20 km with load of 200 tons
 - 60 km without load
- Proof of concept for bidirectional charge.



Thank you!