SBB CFF FFS

The role of HVO in SBB’s decarbonisation strategy.

Fenja Feitsch
September 2023

Agenda

Introduction: SBB.

Background: Decarbonization on (and off) the rails at SBB and in the rail sector.

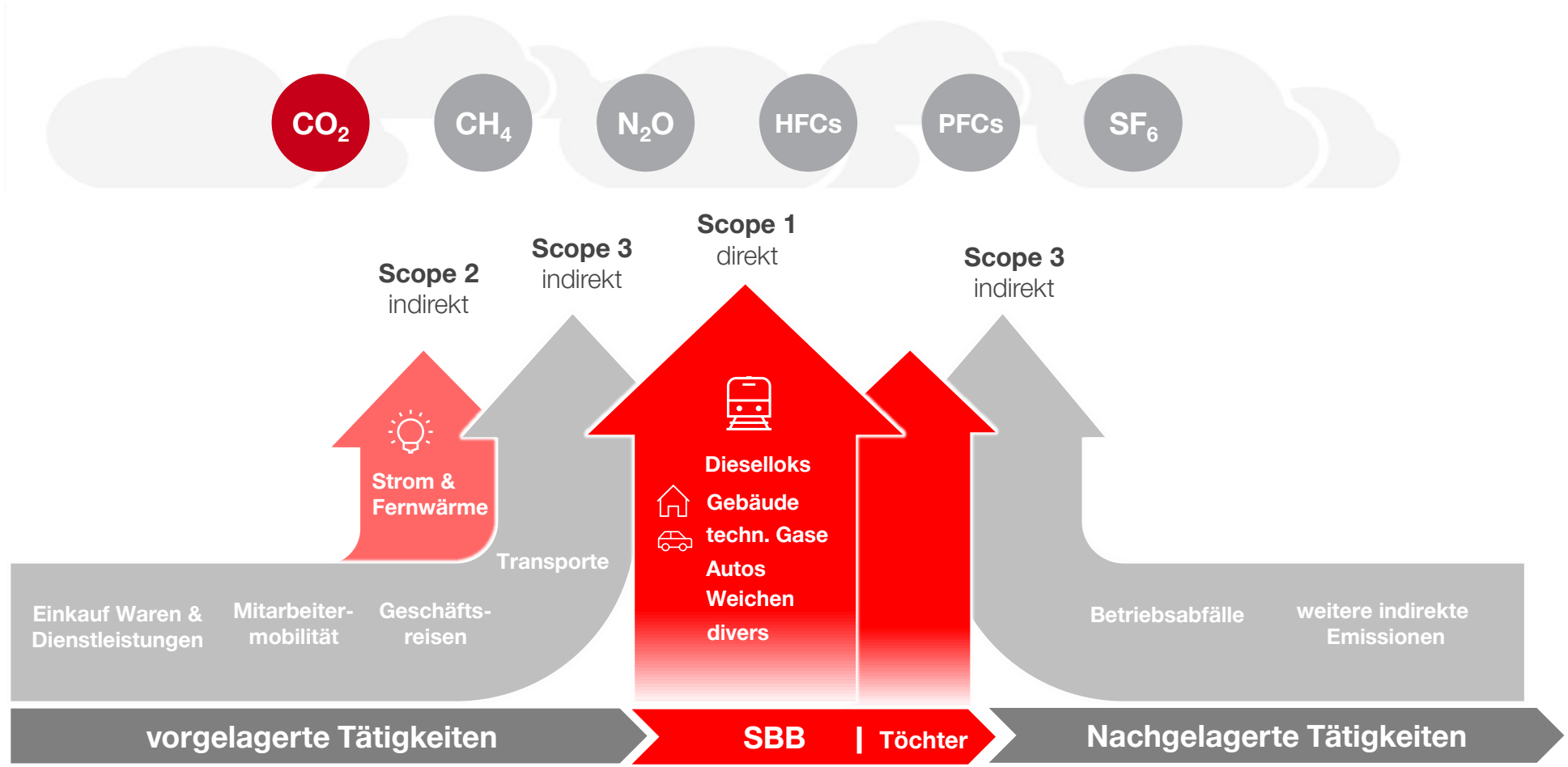
Challenges: Transition phase and electrification of diesel-powered rail vehicles

Alternative diesel fuels: Introduction

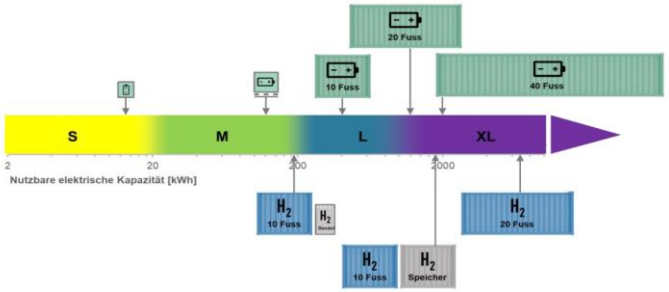
Presentation: **SBB - Center of Competence**
Energy Storage and Alternative Drive Systems

	Ueli Kramer	**Head of EAS / Special Energy Storage Systems** Team leader / design, technology evaluation, solution development, standards & specifications
	Marco Meier (Deputy)	**Specialist alternative drives / TechEco** Fleet strategy, track construction, technology assessment (LCC, TCO)
	Daniel Fuhrer	**Hydrogen Specialist / Senior Project Manager** Hydrogen specialist, testing, replacement of diesel generators, project management
	Steffen Wienands	**Specialist Battery Storage Systems** Battery safety, asset management, battery technologies, cycle economy capability
	Roger Kocher	**Specialist Vehicle Projects** Requirements management, project management, data acquisition, procurement support
	Maria Kaninia	**Data specialist energy storage systems** Data analysis and modeling, clarification of dimensioning issues, interfaces
	Blerim Emini	**Technical lead electrification construction sites** Needs assessment, support and interface with AEP/VU in electrification
	Philipp Haudenschild	**Specialist alternative fuels** Specialist alternative fuels (focus HVO), charging infrastructure, civil engineering (third parties)
	Fenja Feitsch	**Engineering intern from university** Measurement campaign (diesel-powered locomotive) for battery-electric successor

Background: CO_2 emissions of SBB



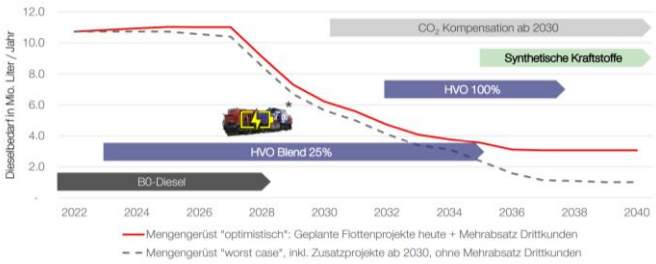
Background: Decarbonization on (and off) the rails at SBB and in the rail sector.



Comprehensive and technology-neutral **evaluation of energy storage solution**s related to diverse applications.

Holistic **support for the electrification** of the **working environment.**

Solution development, piloting and active **support until implementation.**



Implementation strategies and identification of challenges in dealing with energy storage.

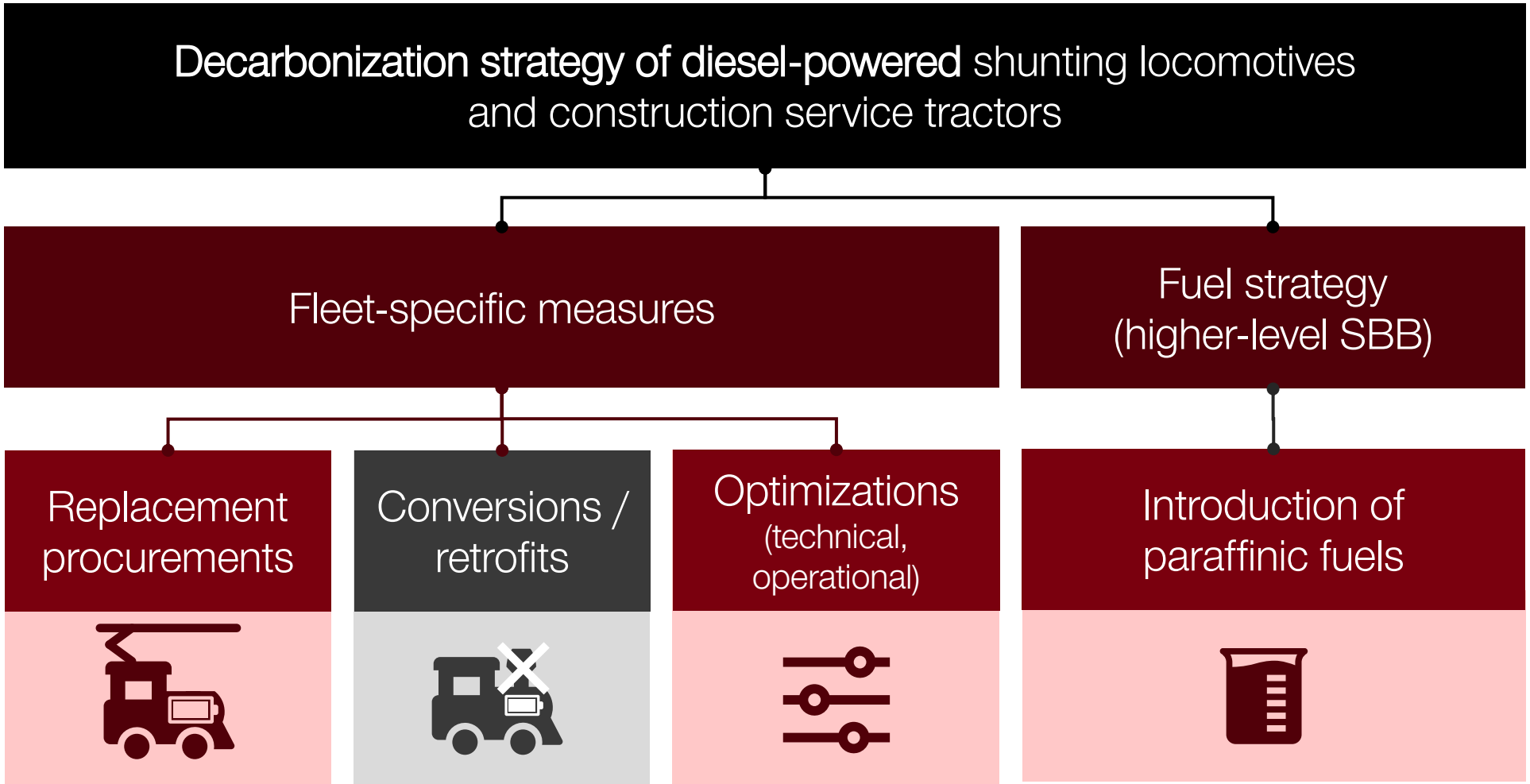
Demand analysis and scenario development for diverse work environments during the conversion to purely emission-free propulsion.

Training and technical/content support as well as facts and figures for different needs.

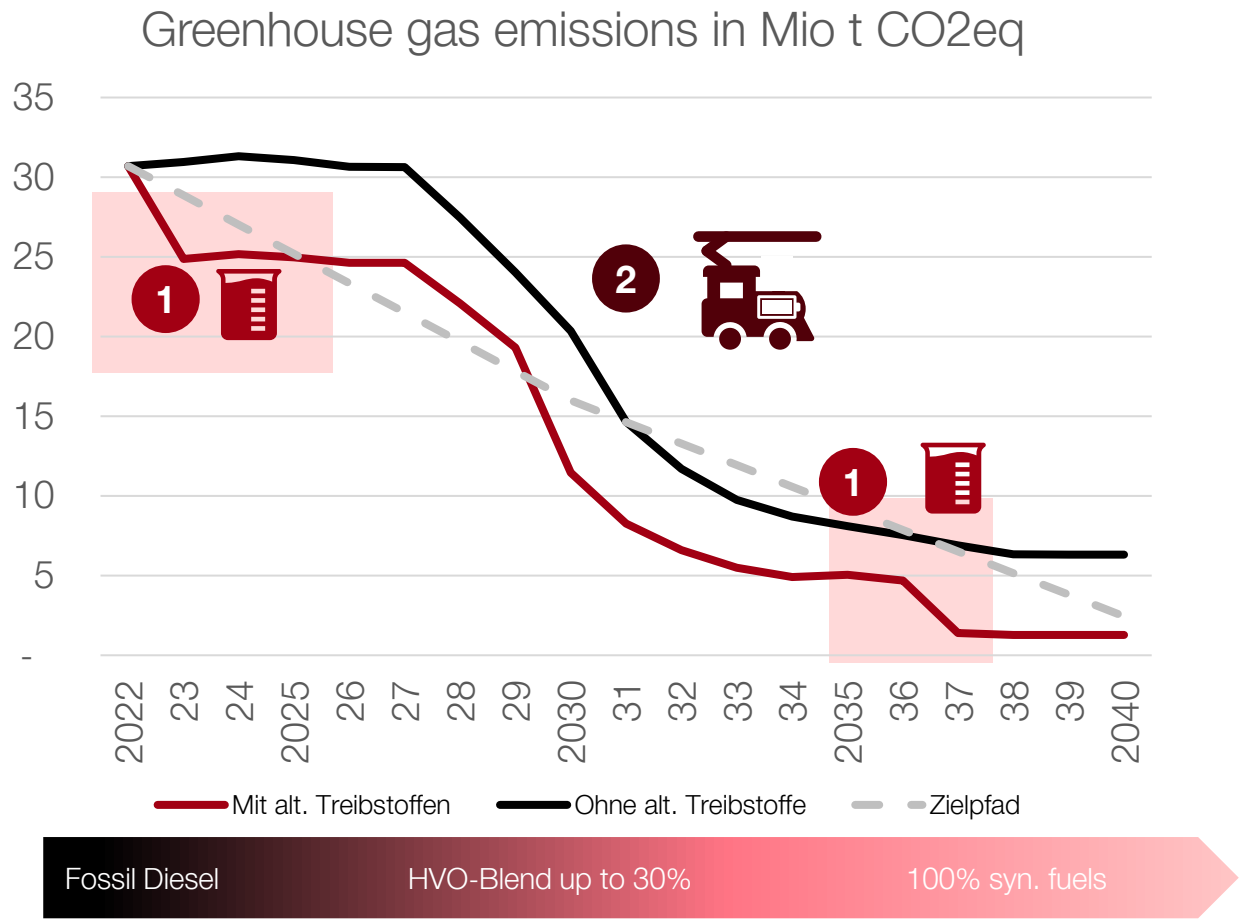
Challenges: Transition phase and electrification of diesel-powered rail vehicles

More than 40% of SBB's CO2 emissions come from diesel traction and construction site power supply.(12 Mio. l diesel / year)

Challenges: Transition phase and electrification of diesel-powered rail vehicles



Challenges: Transition phase and electrification of diesel-powered rail vehicles



Quantity structure today:

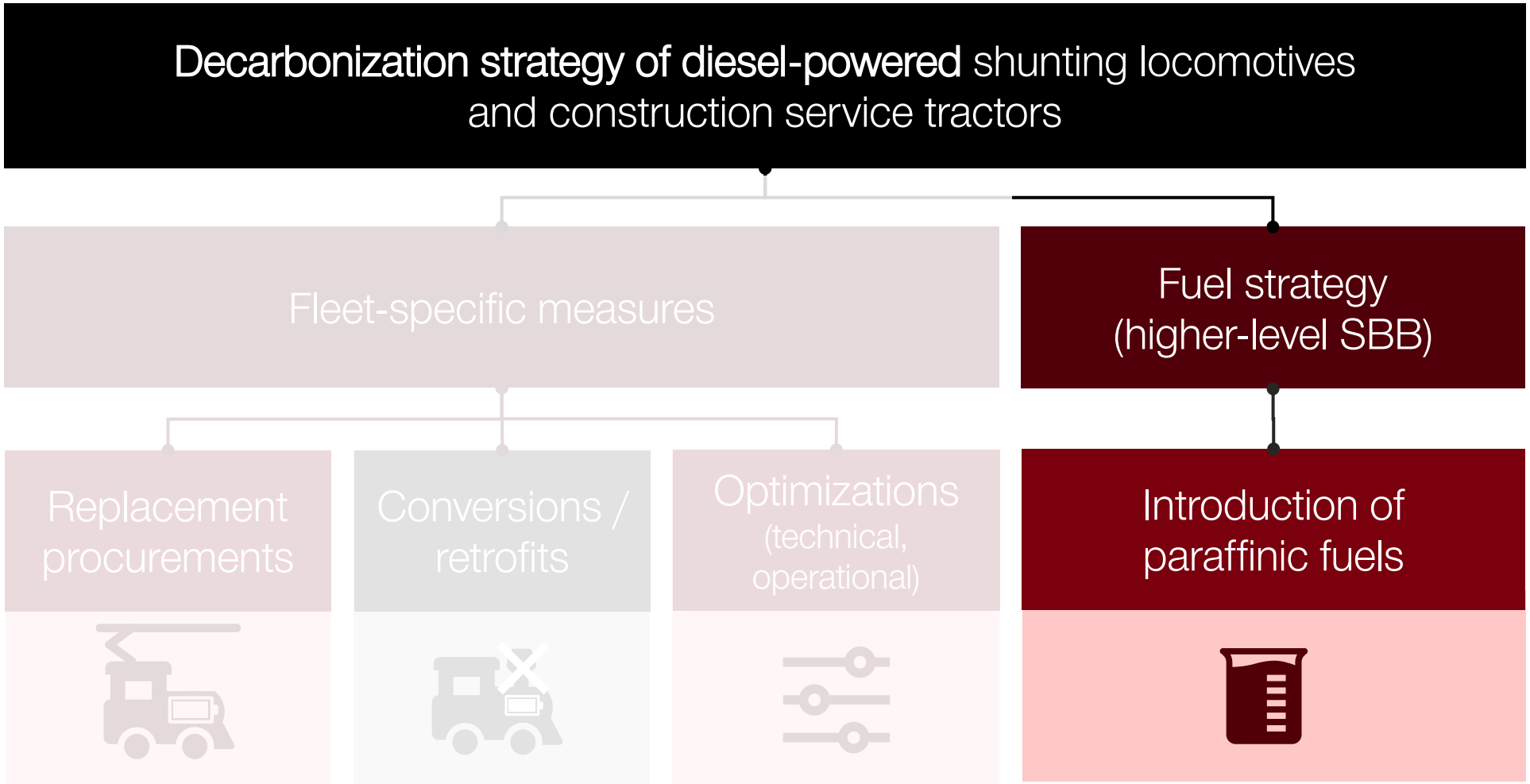
- Around 11 million liters of diesel per year for around 1,000 SBB diesel-powered rail vehicles (infrastructure, cargo, passenger transport)
- Responsible for around 30 Mio t CO2, which corresponds to 35-40% of SBB's CO2 emissions

Decarbonization in two steps:

1. Alternative diesel fuels as a transitional solution (HVO blend & e-fuels)

2. Electrification of the essential fleets through replacement procurement with battery-electric drive systems

Challenges: Transition phase and electrification of diesel-powered rail vehicles



HVO as alternative diesel fuel.

What exactly is HVO?

- **HVO is not a classic biodiesel** and stands for Hydrotreated Vegetable Oil and refers to **hydrotreated vegetable oil**.
- Today, **HVO is increasingly produced from waste fat and residual fractions.** These come, for example, from slaughterhouses, fisheries and the processing food industry, as well as from vegetable oil fractions that are not suitable for food production.
- Therefore, the terms "HVO" and "**hydrotreated vegetable oil" are no longer an accurate description** of the origin of the raw materials used.

HVO-Blend meets the previous standards for diesel engines.

No modification to refueling equipment necessary.

Why is HVO a good bridging technology?

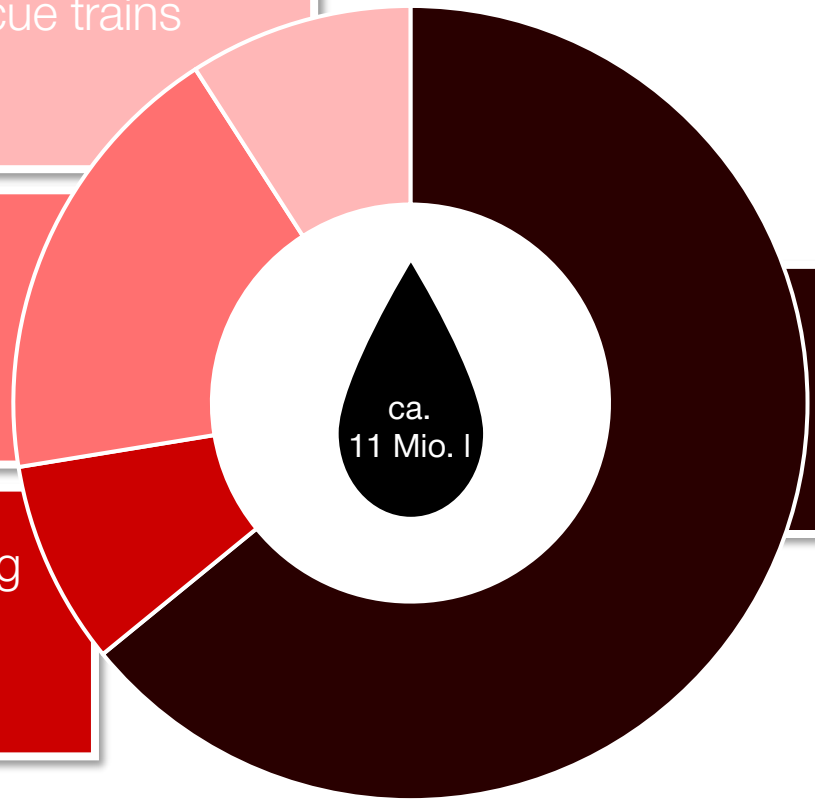
- HVO belongs to the paraffinic diesels (like SynFuels and e-Fuels) and is a pure hydrocarbon compound.
- HVO is a so-called **drop-in fuel**: it can be **used as an admixture (blend)** and **pure**
  - The **blend with up to 30% admixture to conventional diesel** meets the previous standards (EN 590) and can be used in all diesel engines.
  - **100% HVO complies with the EN 15940 fuel standard**, and many diesel engines - including those at SBB - have already been approved for it.

Transition phase: What do we still need diesel fuels for?

Firefighting and rescue trains
9 %

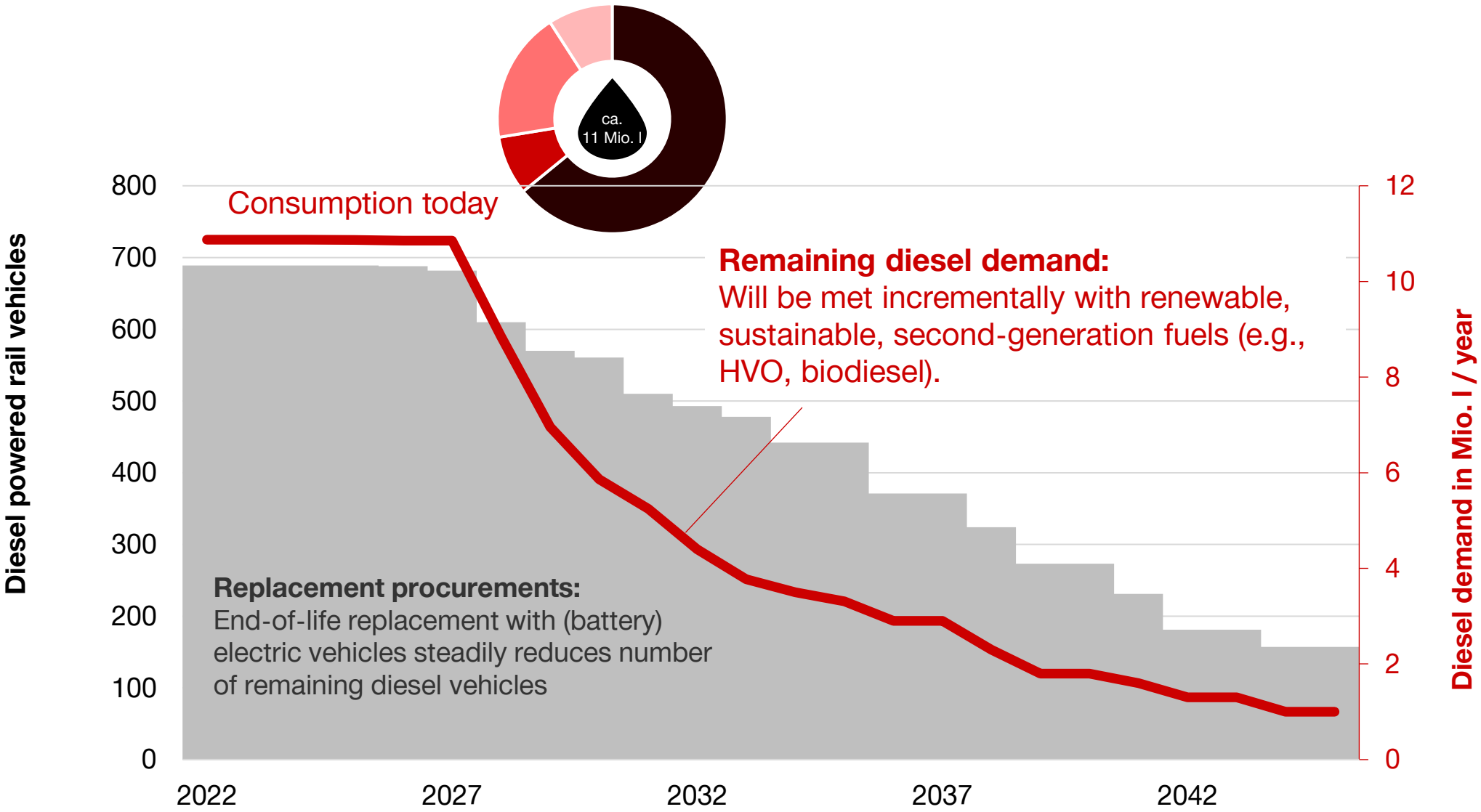
Construction sites
and maintenance
19 %

Small/medium shunting
Locomotives
8 %



Heavy shunting
locomotives
64%

Transitional phase: Challenging but supported by HVO



Alternative diesel fuels: Introduction in 4 steps.

Availability and price are the challenges. The market is evolving.

HVO-Blend (up to 30% HVO)

- From 2024 onwards
- Admixture to fossil diesel at all filling stations
- Suitable for all engines

HVO 100% (partial)

- Circa 2030
- Island operation of individual sub-fleets, parallel to HVO blend
- For younger engines after 1990

HVO 100%

- Circa 2035
- Prerequisite: All motors are EN15940 compliant.

SynFuels 100%

- Expected from 2040
- Potential successor to HVO, produced from renewables & CO2.
- Also complies with EN15940

Fossil Diesel — HVO-Blend up to 30% — 100% syn. fuels

HVO Blend ist currently the **best compromise.**

Criterion	Fossil diesel B0	Diesel B7 (7% FAME)	HVO Blend (±25% HVO)	HVO 100% R100	SynFuel R100	Hydrogen cH2
Feedstock	Crude oil	Crude oil & used cooking oil	Crude oil & organic waste, fats, residues	rg. waste, fats, esidues	CO_2, electricity und H_2	Electricity and water
Emissions operational	As usual	As usual	- 15% pollutant & particulate emissions	20% pollutant & articulate emissions	- 20% pollutant & particulate emissions	No local emissions
Sustainability	None, status quo	Very low, temporary solution	Little to Medium, Temporary solution	Medium to Good, Temporary solution	Medium to Good, Temporary solution	Very Good, If renewable
CO_{2eq}-reduction*	0%	Max. 5%	12 – 23 %	47 - 92%	Up to 99%	Up to 100%
Fields of attention: sustainability	Not sustainable, great potential for environmental pollution, raw material usually comes from politically unstable regions.	A lot of FAME from oil plants in circulation in Europe. Prefer used cooking oil, only then advantage over fossil diesel. Low CO_2 reduction because of low blending.	Ethical concerns about waste of animal origin. Manufacturers also offer non-sustainable HVO from oil plants (soya/palm oil). Limited resource "waste".	Ethical concerns about waste of animal origin. Manufacturers also offer non-sustainable HVO from oil plants (soya/palm oil). Limited resource "waste".	Requires CO_2 source, water, renewable electricity. Origin of CO_2 and electricity central. Always inferior to hydrogen. High energy input in production.	Origin of electricity is crucial. Must be renewable. More than 90% of the H_2 on the market is currently of fossil origin. High energy losses during refuelling/storage.
Availability & Price	Still unlimited, indicative price	Today's standard, cheaper, +3% additional consumption	Good, 0 to 5% additional costs, own mixing ratio can increase costs.	Limited to good, 0 to 10% extra cost	Experimental, very expensive	Small quantities, expensive
Changeover effort	none	Poor storability, risks for older engines, existing filling stations	Engine compatibility given also for third parties, existing filling stations	Partial approvals by engine manufacturers, low technical risk, existing filling stations	Partial approvals by engine manufacturers, low technical risk, existing filling stations	New vehicles and filling stations necessary

*Well-to-wheel assessment based on JEC Well-to-Tank report v5 2020 (https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/jec-well-tank-report-v5) and information from fuel suppliers.