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Welcome to the best practice workshop

DECARBONISATION OF WORK TRAINS

Proposed by the UIC Energy efficiency and CO_2 Emissions Sector

Organised by the Sector's Chairpersons:

Bart Van der Spiegel, Infrabel,
Gerald Olde Monnikhof, ProRail.
Philippe Stefanos, UIC

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DECARBONISATION OF WORK TRAINS

- The meeting will be recorded.
- Please remain on **mute** while the speaker is active.
- Please keep your **camera off** while the speaker is active.

- Please write **questions in the chat**.

Workshop timeline

10 h **Infrastructure Managers challenges and solutions**

- ProRail
- Trafikverket
- Ricardo
- SBB

Questions - Discussion

11 h **Suppliers challenges and solutions**

- Plasser & Theuer
- Vossloh
- Strukton

Questions - Discussion

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PRORAIL

Working towards a sustainable future

Reinout Wissenburg
Manager Strategic Sustainability

Decarbonisation of work trains – March 18th, 2021

Decarbonisation of the Dutch railway sector

PARIS2015
UN CLIMATE CHANGE CONFERENCE
COP21·CMP11

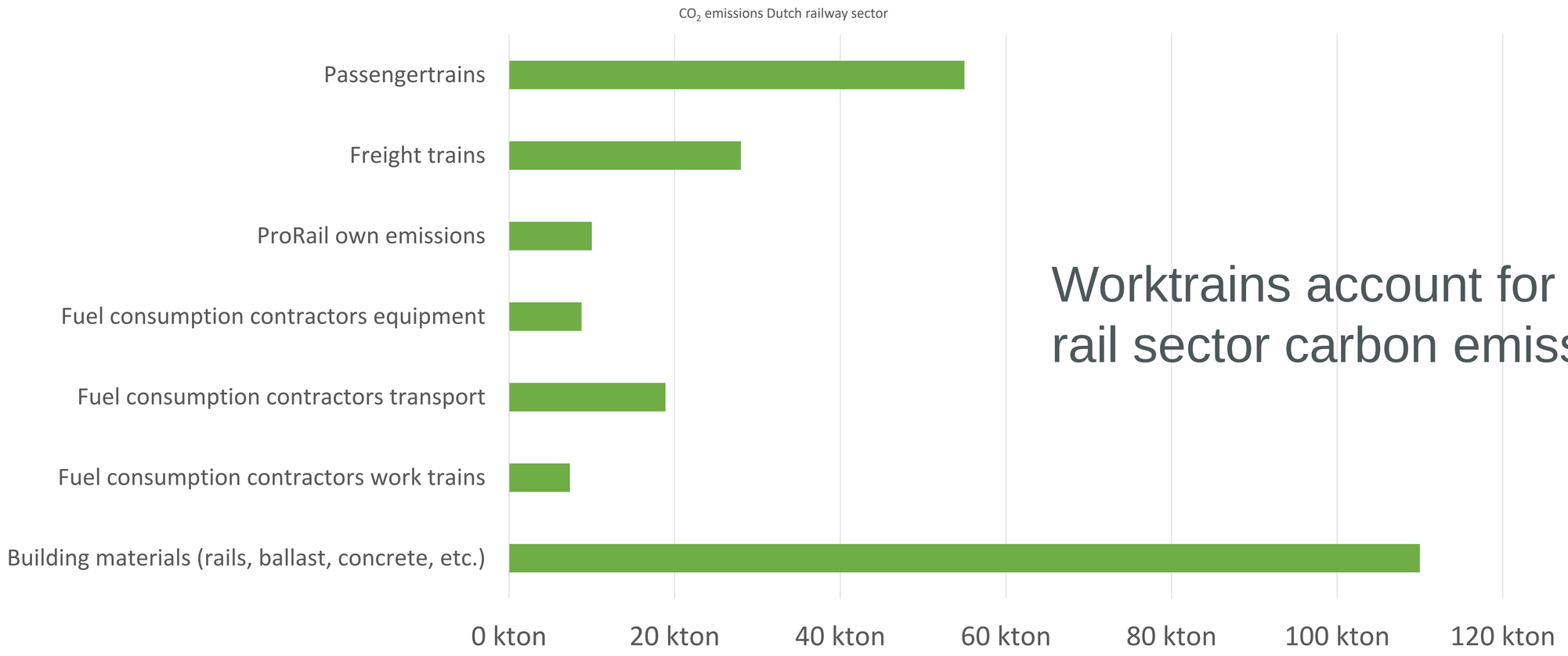
Carbon neutral railway sector
in 2050, aiming for 2040

Roadmap ProRail
Sustainability with four tracks

ProRail

Verbindt. Verbetert. Verduurzaamt.

Carbon break-down of the Dutch railway sector



Worktrains account for 3% of rail sector carbon emissions

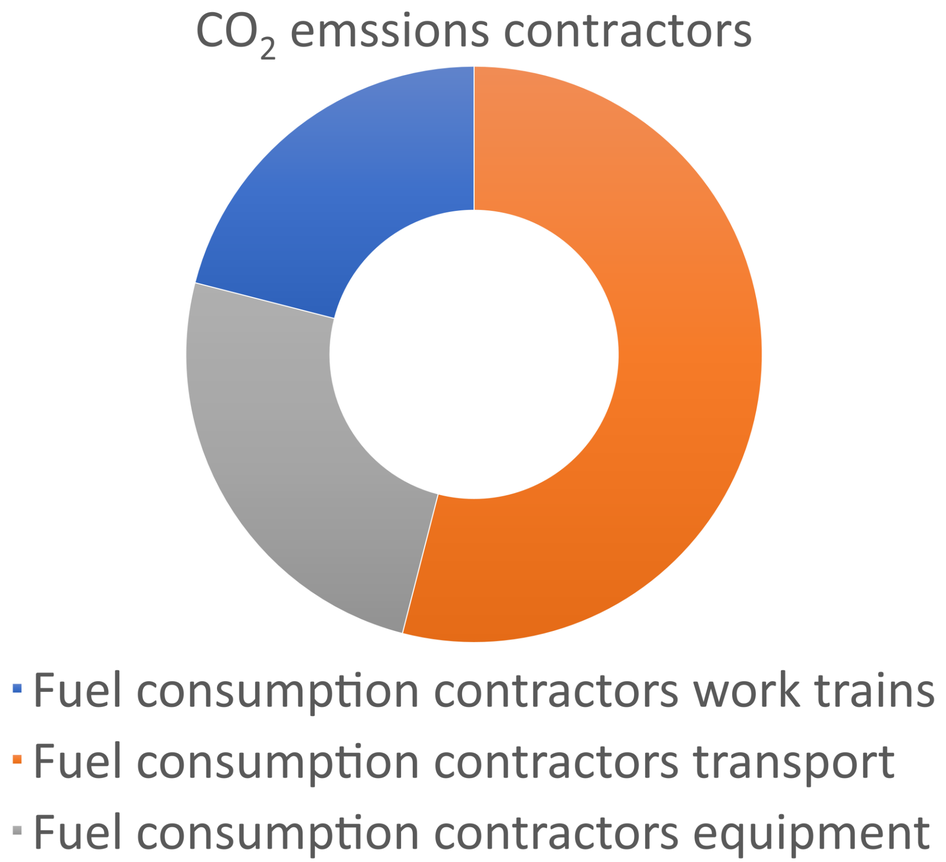
ProRail

Verbindt. Verbetert. Verduurzaamt.

Rail-related carbon emissions from contractors

But this is 20% of the carbon emissions related to our contractors.

We focus our efforts on the building site, tackling this full chart



Tackling carbon from contractors

Transport to the building site

Non-mobile machinery

Work trains

‘Easy’ – focus on criteria in tender processes

‘Challenging’ – focus on market cooperation and innovation

Learn from zero carbon bus deployment

Challenges to tackle to decarbonise work trains

Financial

- Long life span of typical 35+ years
- Carbon strategy and investments are misaligned

Dutch

- Admission can be problematic
- Dutch infrastructure is not always suitable (1,5 kV)

Market

- International deployment of trains
- Single tender gives incentive for short term reductions

Technological

- Large trains have the biggest emissions
- Few proven alternatives

- Clear ambition
- Agreed replacement calender
- European partnership

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TRAFIKVERKET

The infrastructure sector climate transition

Håkan Johansson

Coordinator climate mitigation

hakan.johansson@trafikverket.se

Road and rail sector

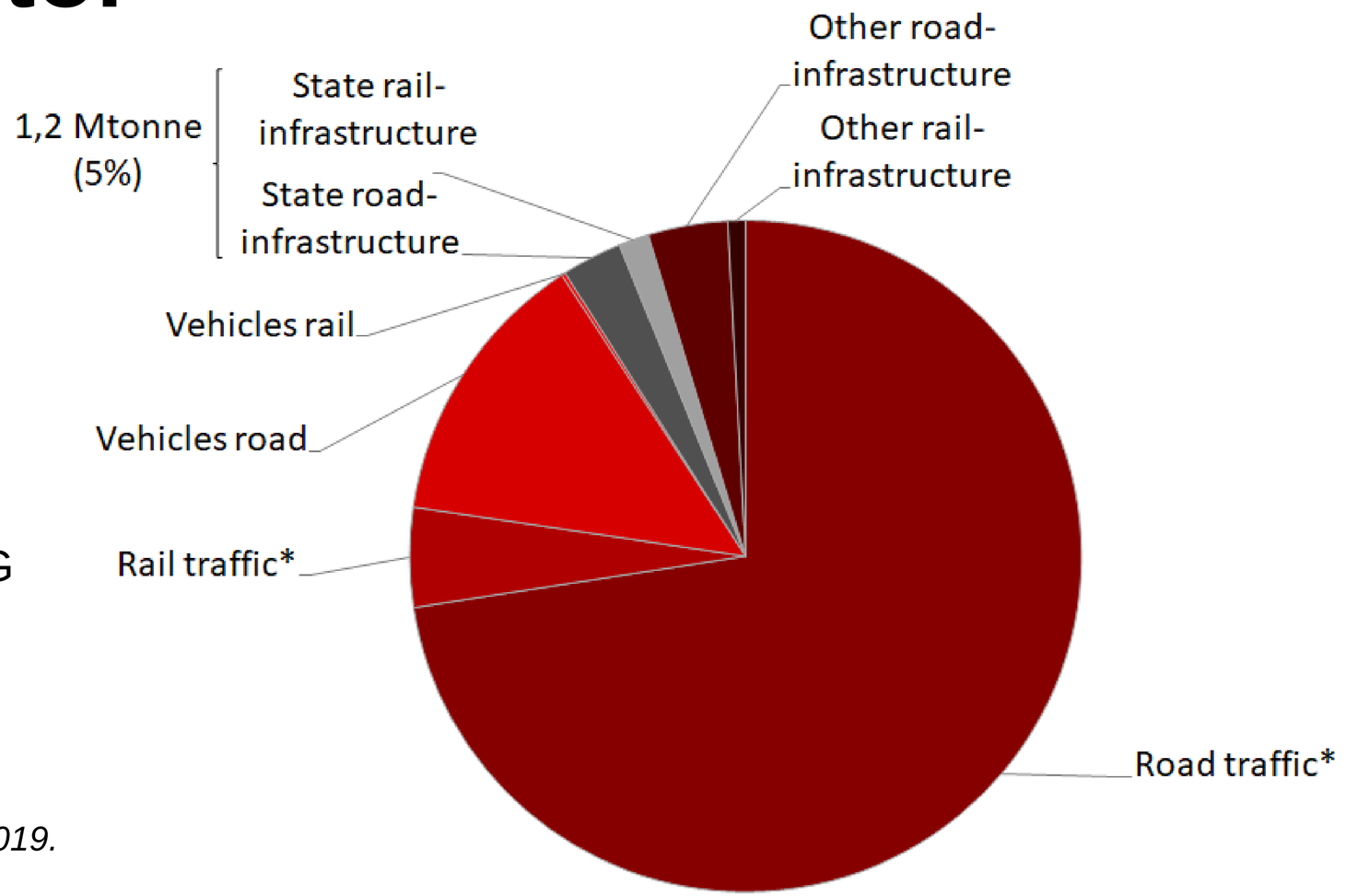
in Sweden

Lifecycle emissions

(consumption based emissions)

27 million tonnes CO2e per year 2015

State own infrastructure 5 percent of GHG



Based on Liljeström C. (2018) and Liljeström et.al. 2019.

** incl. fuel production*

Swedish Transport Administration

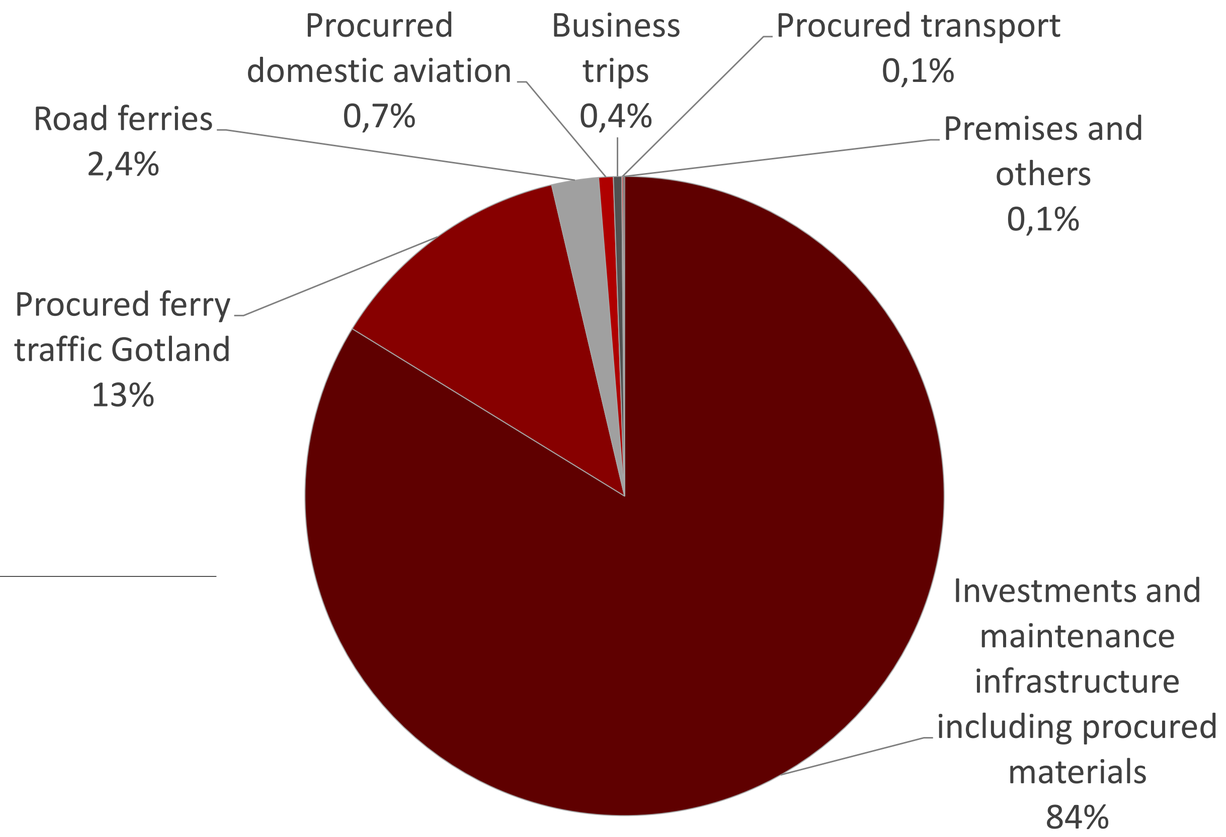
Average annual emissions:

(consumption based)

1,4 million tonnes CO2e per year

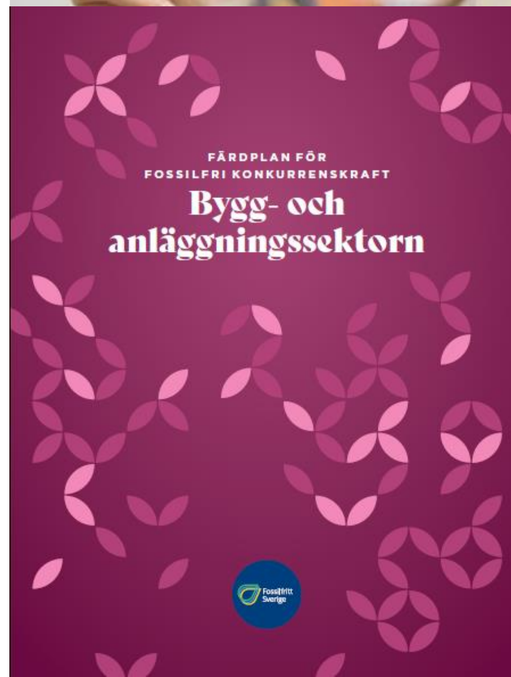
Of which 1,2 million tonnes

own infrastracture

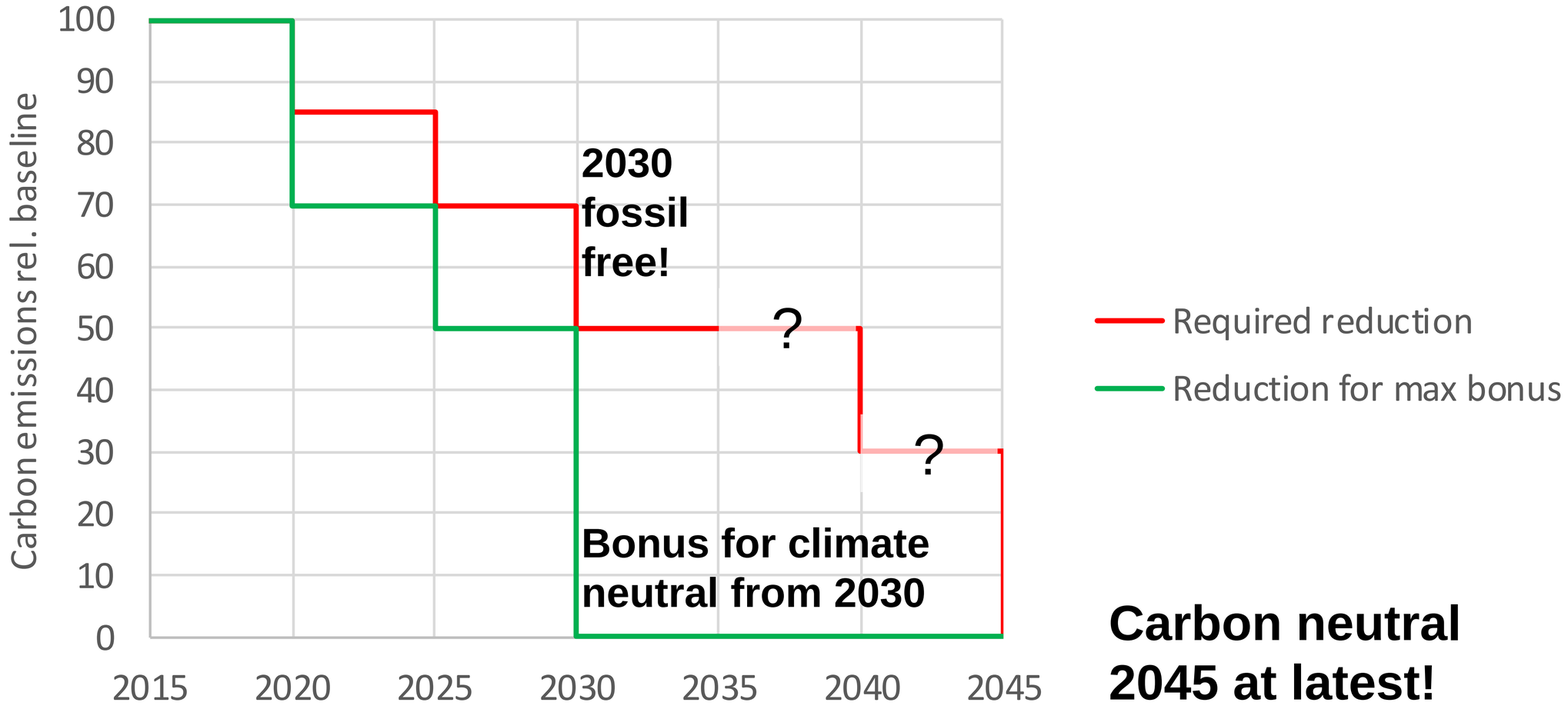


From goals to action

- Staring point – the goal in the Climate act decided by the Parliament Sweden shall not have any net emissions of GHG emissions 2045.
- The Transport Administration set a long-term goal for 2045 and intermediate goals for 2020, 2025 and 2030.
- Impact assessment together with industry showed the goals could be achieved at no or low extra cost.
- Implementation of carbon calculator – Klimatkalkyl from 2015.
- Goals implemented in procurement of construction, maintenance and materials from 2016.



Goals towards carbon neutrality



Carbon neutral 2045 at latest!

Requirements

Investments ≥50 MSEK

- Required reduction of GHG emissions compared to defined baseline with Klimatkalkyl
- Bonus for larger reductions (1 SEK/kg CO2e).
- Required climate declaration and EPD in end of project.

Investments <50 MSEK reinvestments and maintenance

- Requirements on maximum GHG emissions for some designed material with high GHG emissions: reinforcement steel, cement, concrete, asphalt and renewable fuels in metropolitan areas.
- Bonus for renewable fuels outside metropolitan areas
- Required EPD in end of project (also for construction steel).

Maintenance – pavement contracts

- Bonus for pavement lower emissions than baseline

Procurement of railway materials

- Requirements on maximum GHG emissions
- Bonus for larger reductions
- Required EPD
- Sleepers, rails, switches,…...

Procurements of transport of railway materials

- Requirements and bonus on g/tonnekm on road
- Requirements on renewable fuel and use of electric trains

10 SEK ≈ 1 Euro

In general penalty if requirements not met

Requirements in procurement of planning, design and building

Investment measure ≥ 50MSEK / €5M

Requirement on consultant to present measures in the planning phase, Climate calculation

Quantitative requirement on consultant or turnkey (design) contract, Climate calculation

Quantitative requirement on construction contract, Climate calculation

Climate declaration and EPD to control compliance of requirements to reduce GHG emissions

Measurement selection study

Planning phase

Design phase

Building phase

Requirements in design and building 2016-
investment projects ≥50 MSEK

- Transport Administration defines a baseline for the project using Klimatkalkyl (referring to emission levels year 2015).
- In the procurement a requirement is given to reduce the GHG emissions with x percent compared to the baseline. On average:

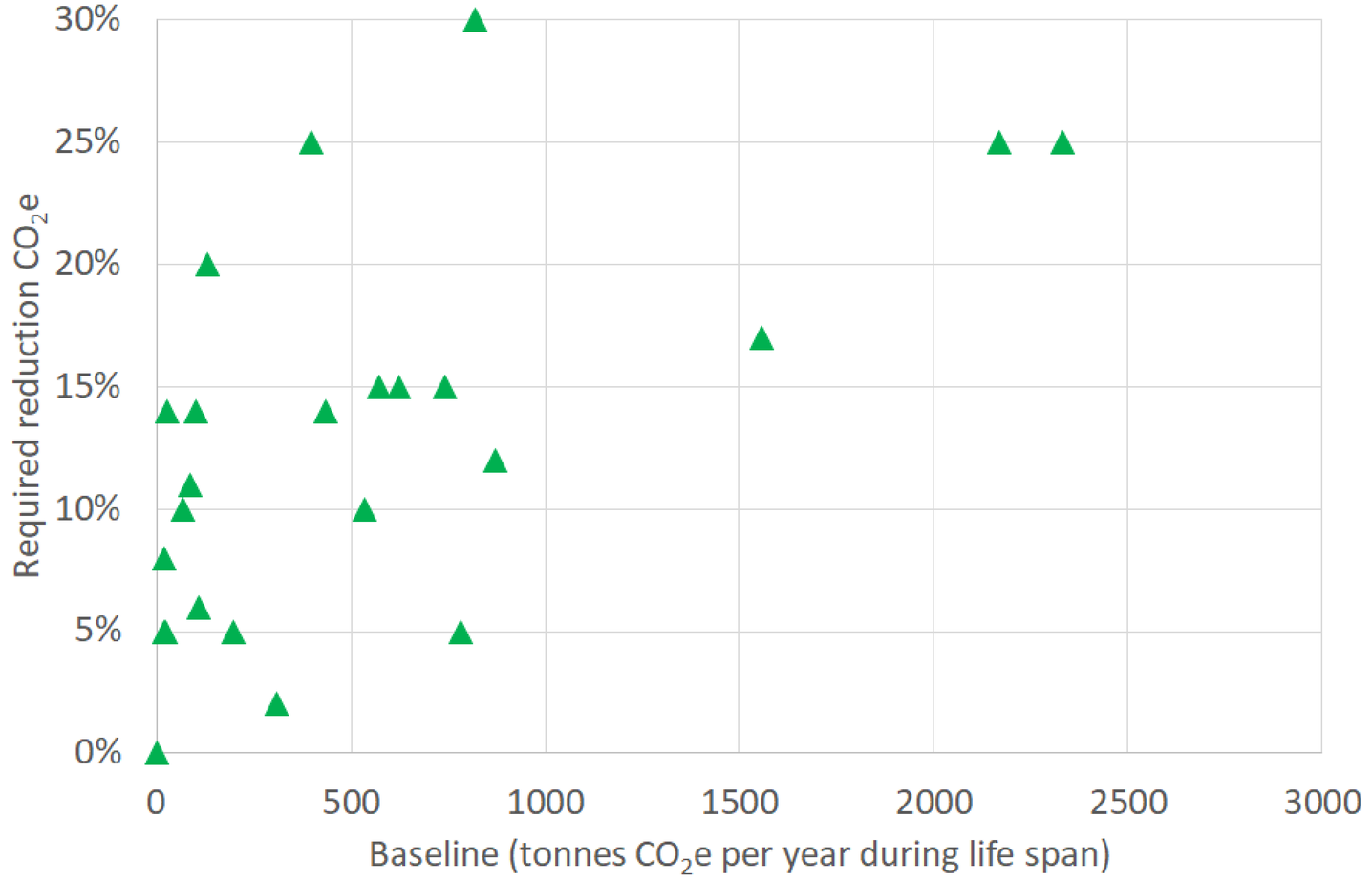
  - 15 percent reduction by 2020 compared to 2015
  - 30 percent reduction by 2025 compared to 2015
  - 50 percent reduction by 2030 compared to 2015 + fossil free fuels

- If significant change of scope of works, the baseline will be updated. The percentage reduction requirement will however be retained.

Requirements in design and building 2016-
investment projects ≥50 MSEK

- At the end of the project, the contractor must demonstrate that the requirement has been achieved through a climate declaration.
- Performance of project specific materials has to be demonstrated through EPD. Always the case for concrete, reinforcement steel, construction steel and fuels.
- Bonus model presented in procurement for larger GHG reduction than required. Bonus paid at climate declaration (1 SEK/kg CO2e). In 2030 bonus is paid for up to 100 percent reduction (from requirement on 50 percent).
- Penalty if requirements not met (2 SEK/kg CO2e).

Requirements in procurement of investment projects
larger than 50 MSEK (€5M) procured 2018-2020



18 percent
reduction on average

Note this is required reduction!

Bonus for larger reductions!

Challenges towards climate neutrality

Climate neutral products and energy:

- Concrete
- Steel
- Asphalt
- Biofuels
- …

Transformation of trucks, locomotives (outside overhead contact line) and machines to electricity

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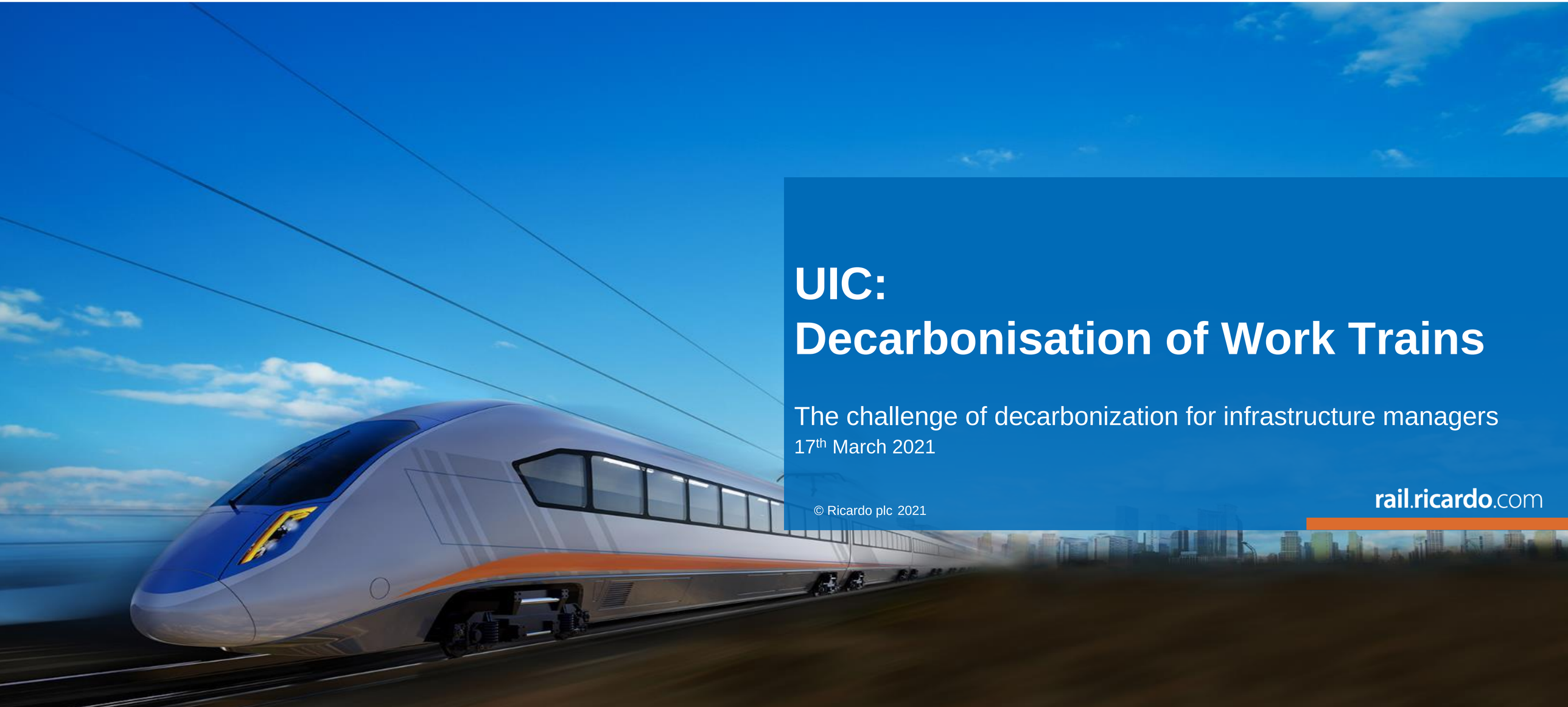
RICARDO

The challenge of decarbonisation for infrastructure managers

18th March 2021

Creating a world
fit for the future



UIC:
Decarbonisation of Work Trains

The challenge of decarbonization for infrastructure managers

17th March 2021

rail.ricardo.com

Contents

- **Situation and Objectives**
- Technology Landscape for Sustainable Traction
- Procurement Landscape for Sustainability
- Concluding Statements

Situation and Objectives for this Workshop

Situation

- Network Rail aim to deliver net zero carbon emissions by 2050
- For traction the TDNS defines a clear roadmap to deliver - based on current known technologies

Complication

- Work trains must operate without electrical power from infrastructure
- Technology is moving at pace across all transport sectors
- Optimum solutions require an integrated approach
- Sustainability has many dimensions
- ***All of these factors make timely and optimised investment decisions challenging***

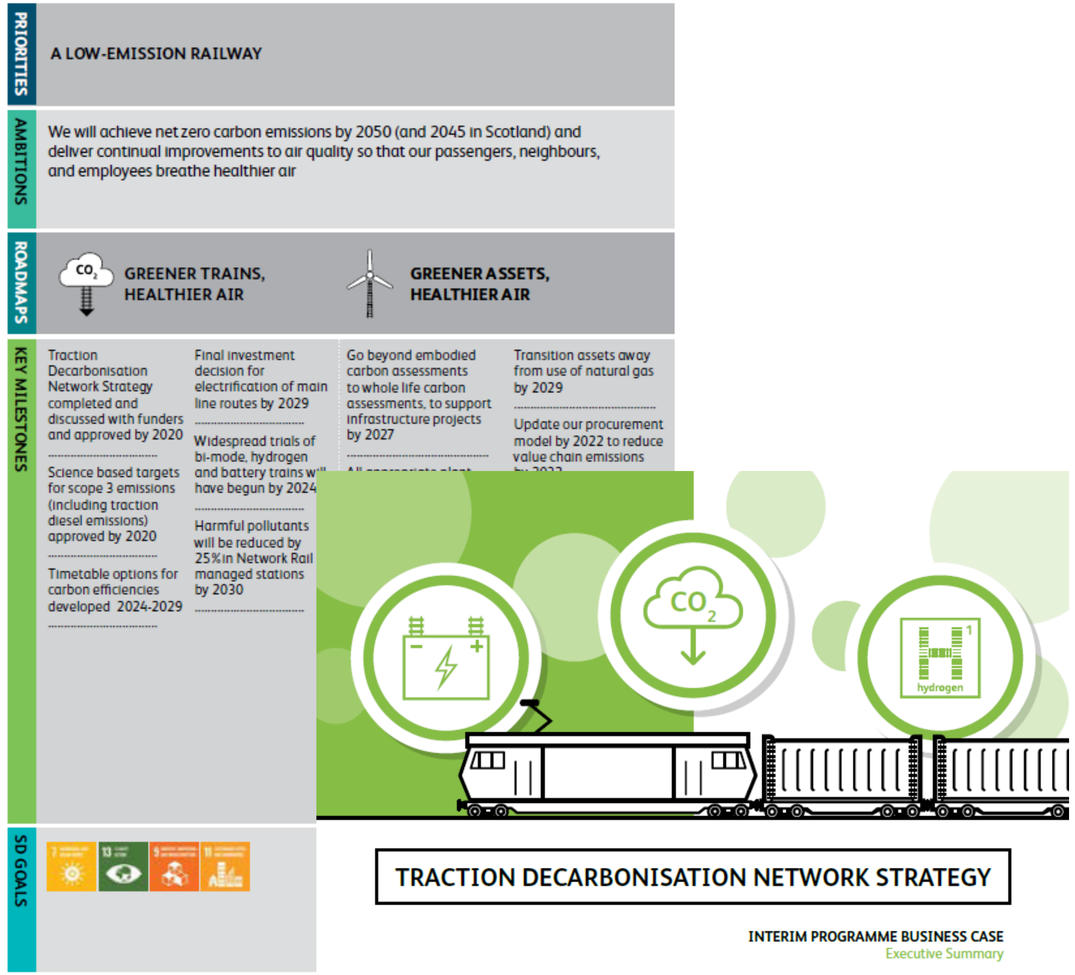
Objectives for Today

- Understand the priorities for Network Rail & Infrastructure Managers in upgrading or procuring sustainable work trains
- Share insights from cross-sector experience in sustainable technology solutions
- Outline the key requirements and challenges for the supply chain to deliver sustainable solutions

Environmental Sustainability: Low Carbon Traction & Power Options

Objective: What is success for Network Rail?

- How do Network Rail ensure all possible routes to reduce emissions for non-electric traction and power are catered for in procurement without risk of omitting key technologies/solutions
  - What is the outlook and the risks for short, medium and long term solutions?
    - What is the interaction between these?



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Potential routes to clean vehicle traction

Well to Wheel (WTW)

Well to Tank (WTT)

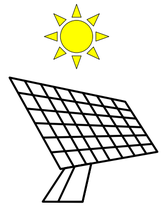
Tank to Wheel (TTW)

Impacts

Renewable Source

Energy Vector

Traction System



Electricity

Hydrogen

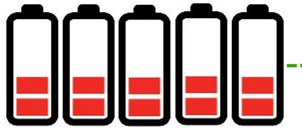
e-H_2/CH_4

Syn Fuels

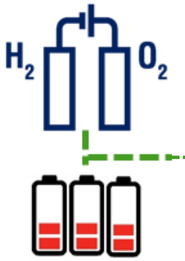
Waste to Power

Hydrocarbon

Bio-refinery

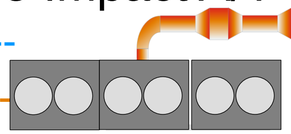


Battery / Electric

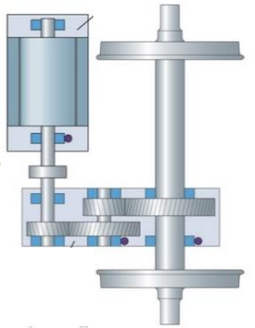


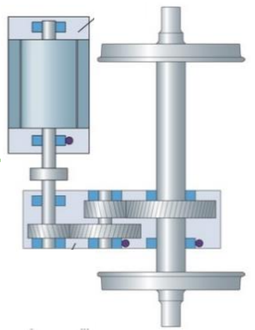
H_2 Fuel Cell

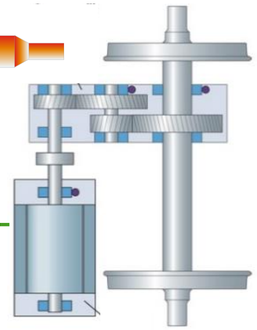
Zero Impact A/T



Thermal Hybrid





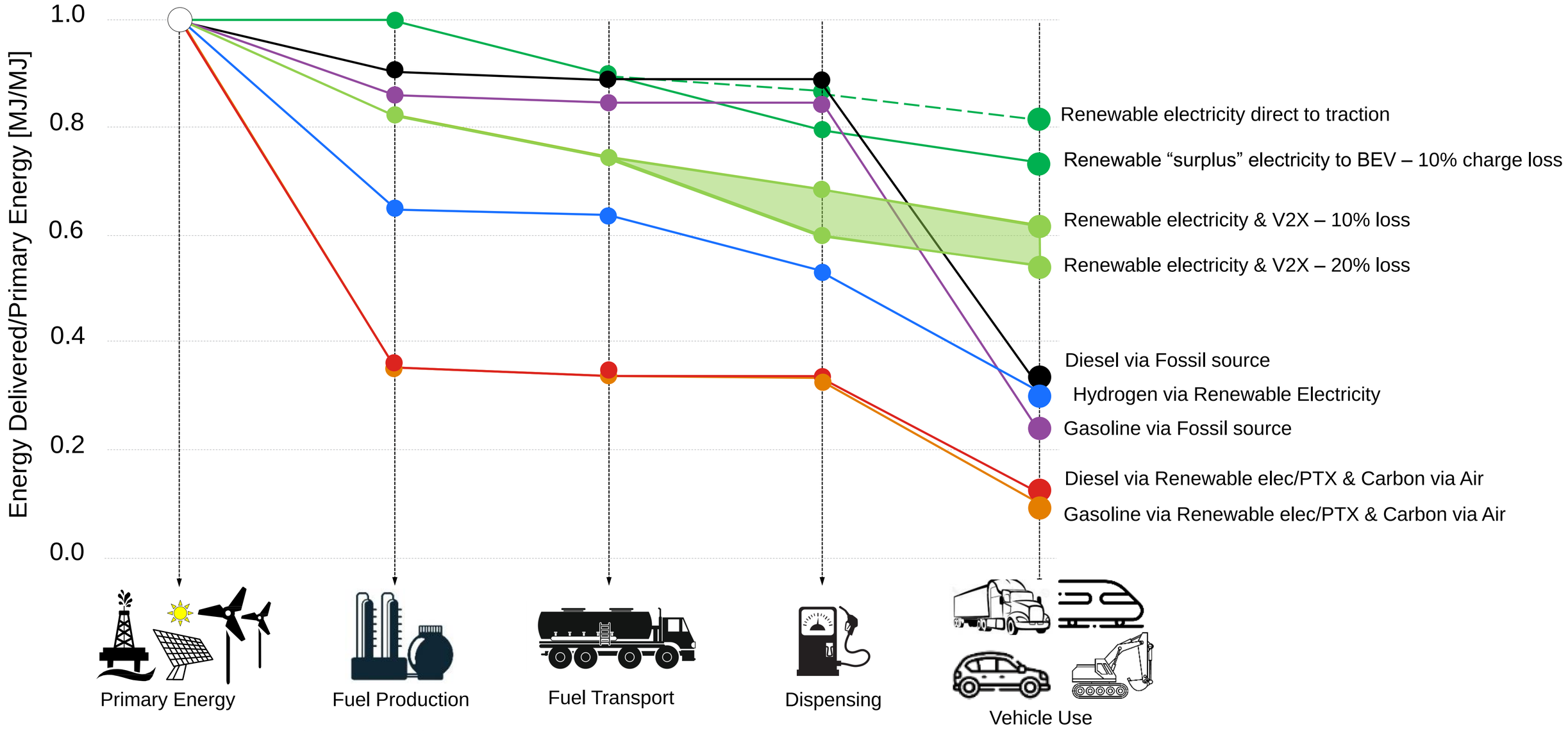


- Network Electrification
- Zero tailpipe emissions
- Battery manufacture/recycling
- Mass market re-charging
- “Green” Hydrogen economics
- Hydrogen infrastructure
- On-board Hydrogen storage
- PTX efficiency & economics
- Biomass/waste availability
- Clean Air Zones/ICE bans
- Existing infrastructures

Source: Ricardo Analysis

Overall energy efficiency of alternative energy/fuel options must be considered

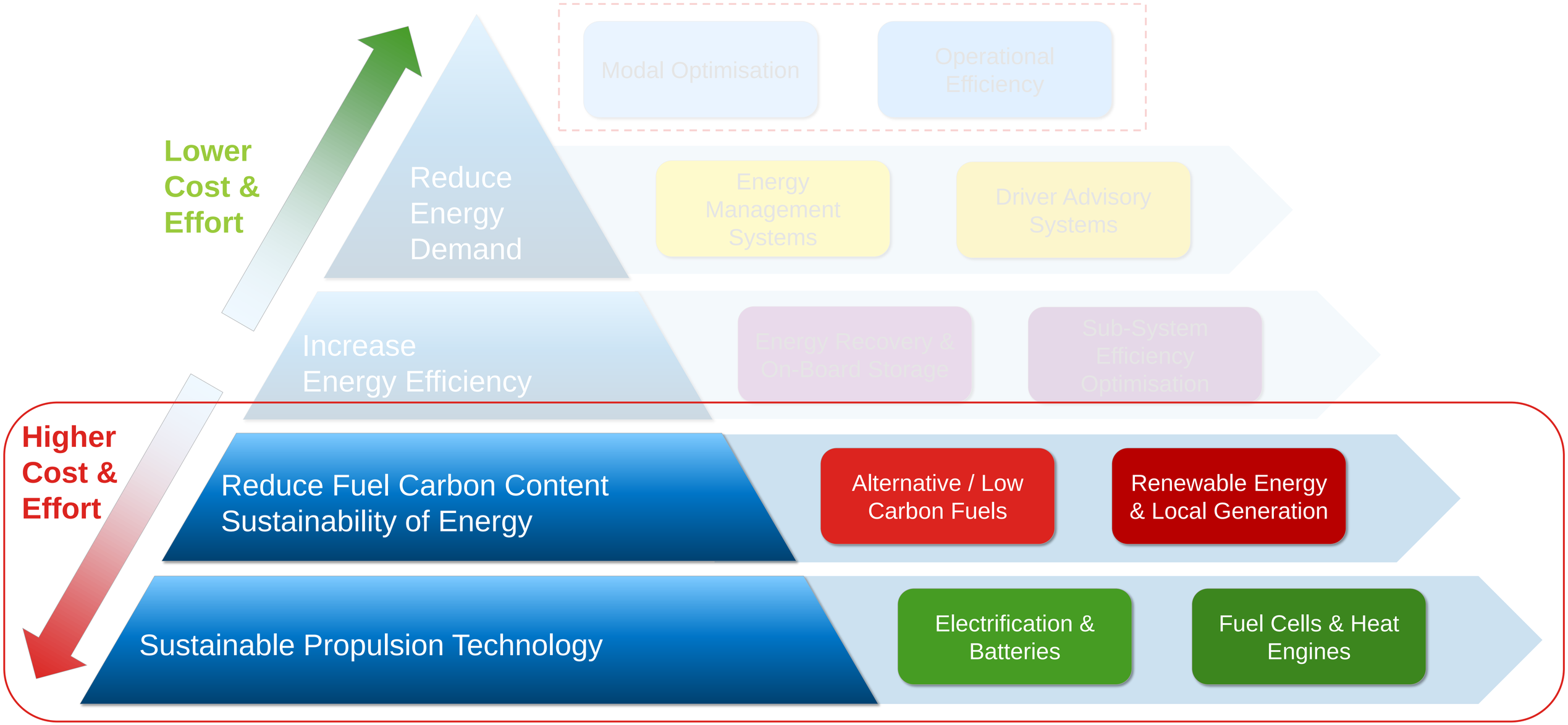
There will be limited available zero emission/renewable energy for future demand



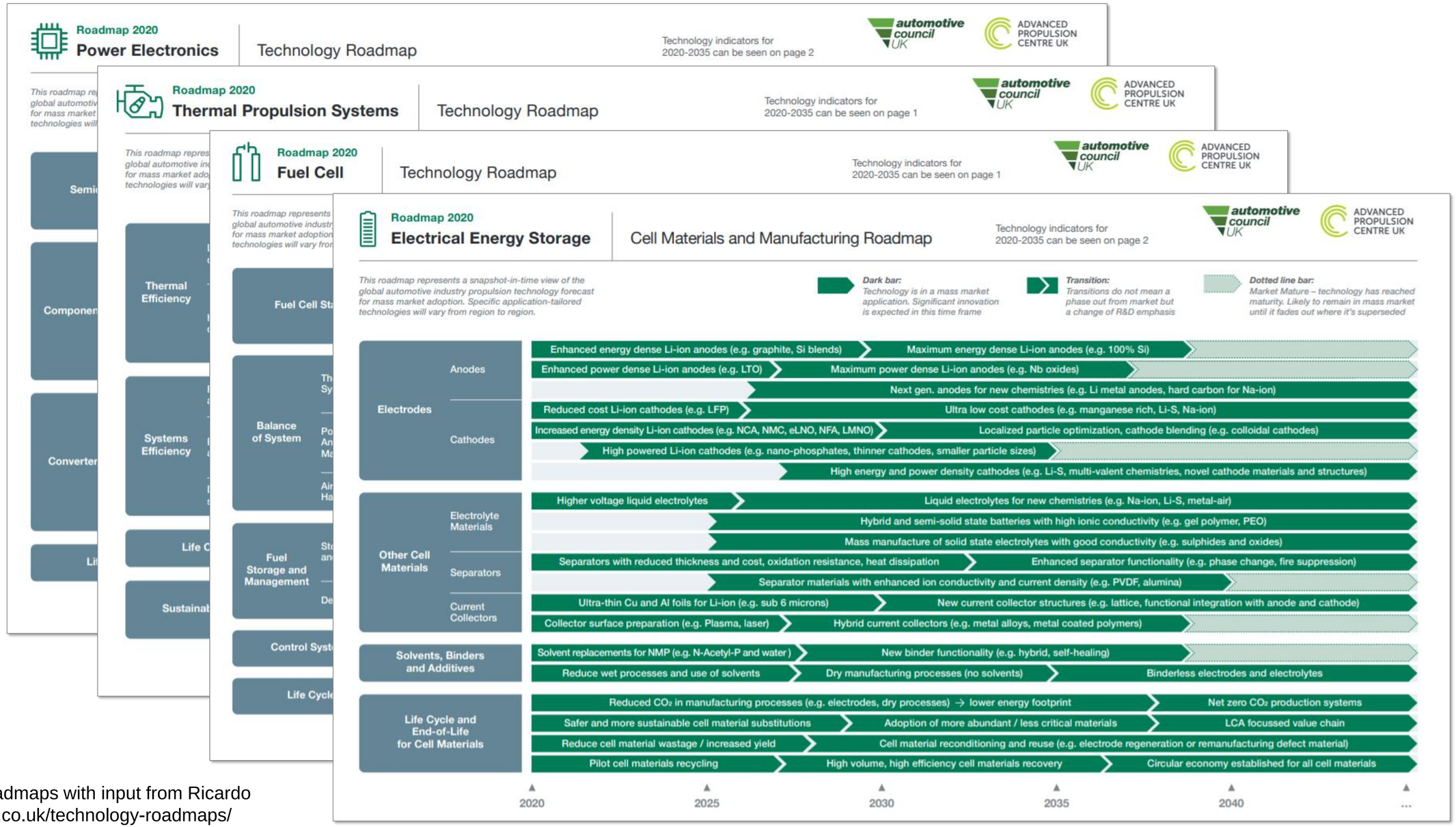
Source: The Road to Sustainable Fuels for Zero Emissions Mobility – Shell/OVK

Hierarchy of De-Carbonisation Strategies for Propulsion

Assessment of cost/benefit ratio drives focus on reducing energy demand



Technology Roadmaps: Requires cross-sector knowledge to develop roadmaps & technology



Source: APC UK Roadmaps with input from Ricardo
https://www.apcuk.co.uk/technology-roadmaps/

Technology Roadmaps: So how might things change by 2035?

BATTERY STORAGE

		2020	2025	2030	2035
Pack Indicators	Transient Discharge Power Density (W/kg)	715	825	945	1070
	Charge Acceptance (Continuous C Rate)	1.5	2.5	3.5	4
	Gravimetric Pack Energy Density (Wh/kg)	185	210	240	275
	Volumetric Pack Energy Density (Wh/l)	470	540	640	720
	Pack Cost ($/kWh)	125	97	77	63

3x Charge Rate
+50% Energy Density
~50% Cost Reduction

FUEL CELL

		2020	2025	2035
Heavy Duty Vehicles	$/kW (System)	455	195	80
	$/kW (Stack)	285	115	40
	System Efficiency* (%)	60	65	70
	Stack Durability (Hrs)	15,000	22,000	30,000
Hydrogen Storage Tank[2]	Onboard Hydrogen Storage Cost ($/kg of H2)	470	365	200

+10% Efficiency
2x Durability
~80% Cost Reduction

Source: APC UK Roadmaps with input from Ricardo
https://www.apcuk.co.uk/technology-roadmaps/

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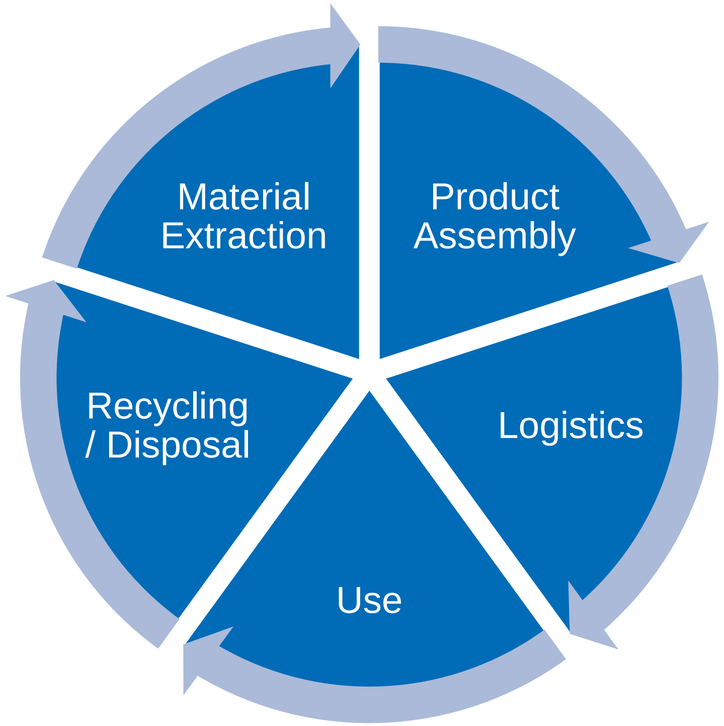
New Considerations for Procurement: A Changing Landscape

Life Cycle Assessment



Circularity

Life Cycle Thinking

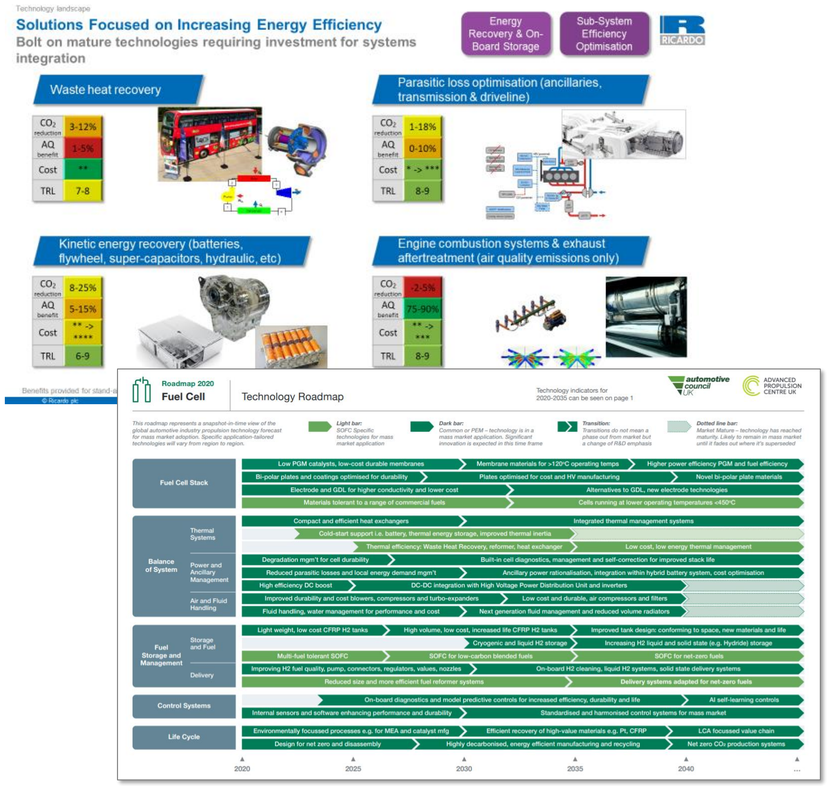
How Can LCA and Circularity Support Sustainable Procurement Strategy & Decisions?

Micro-Level Decision Support

Product-related questions

Upgrade vs New?

Macro-Level Decision Support



Informing and developing policy

Environmental Accounting

Company social reporting

TCFD (Taskforce for Climate-related Financial Disclosure)

Contents

Concluding Statements

- Decarbonisation is the disruptive force re-shaping all transport sectors
  - *Tools such as Life Cycle Analysis will support procurement decisions*
- Procurement must grow as a team process
  - *There are many potential solutions and technologies, pathways are complex, fragmented and the outcome uncertain*
- There will be evolutionary and revolutionary technologies, from across many sectors
  - *Maturity rates of solutions and technologies will differ and are not set*
  - *Retain ongoing evaluation of available and future solutions*
- Good evidence based tools and information are available to support decisions
  - *It may be more appropriate to "make do and mend" now and delay a new build procurement as the technology landscape becomes more clear*

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SBB

Decarbonisation of work trains

Marco Meier, Ueli Kramer

UIC Decarbonisation of work trains

18.03.2021

Marco Meier, Ueli Kramer

Important facts first

General

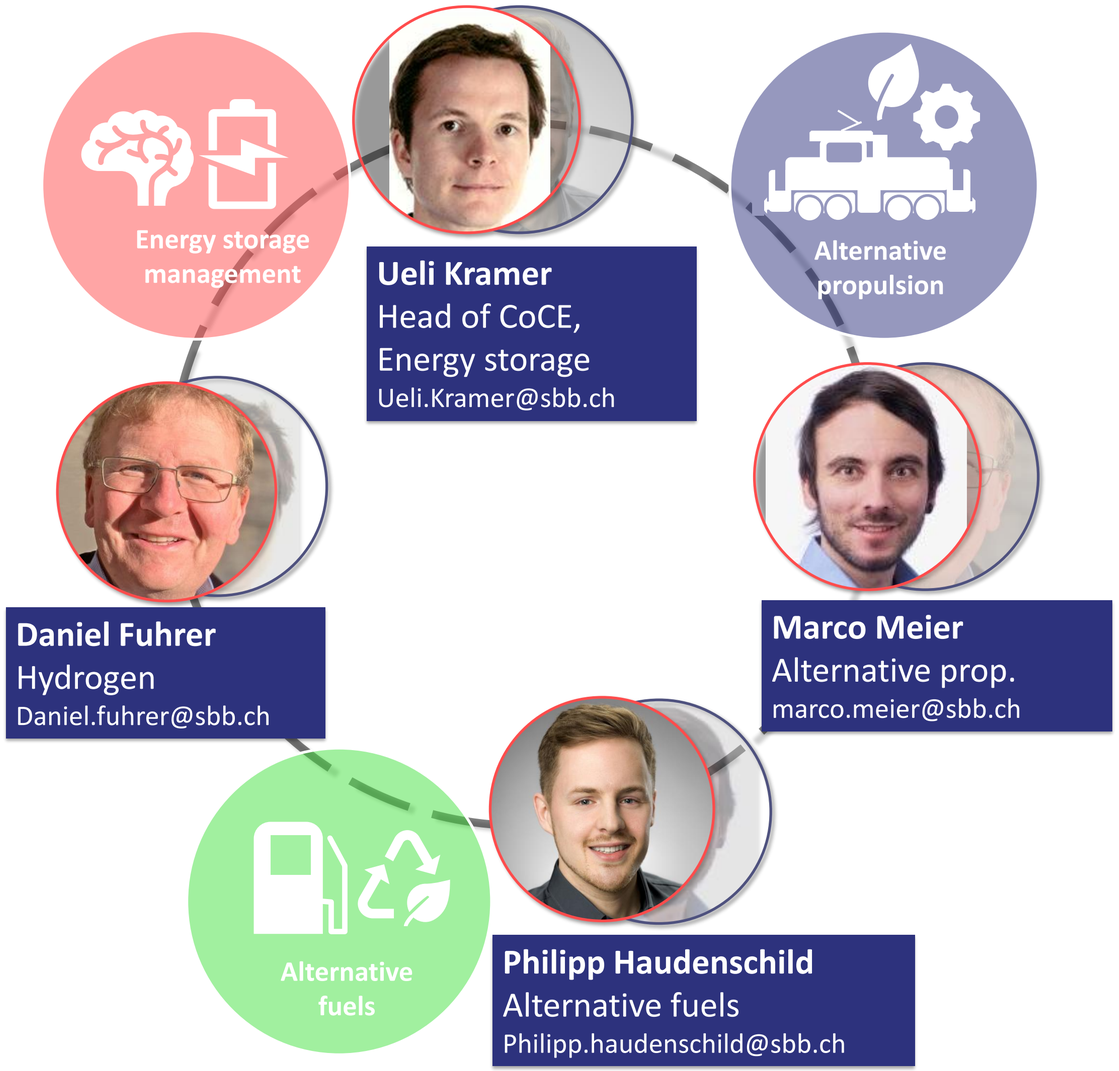
- → **Zero GHG emissions 2040, compensation** fee from **2030**
- → **Pre-chain will be included** (~ 10x GHGeq emissions compared to direct emissions)
- → **New procurements must use renewable energy** (instead of fossil fuels)
- → **Renewable diesel fuels are last choice!** (noise, LCC, smell, health)
- → **We do not follow hypes! (H2 only if battery is not possible)**

Important facts first

Work trains…

- account for **~20% of diesel demand** (total: 11 Mio l/a)
- **Diverse fleet**: >250 vehicles and 14 types
- **4 types** (75% of vehicles) account for **~96%** of the **fuel demand**
- The **largest fleet** (124 vehicles) will be **replaced 2029-2036**
- **Preferred solution** for this **biaxial light work train: battery-catenary-hybrid**

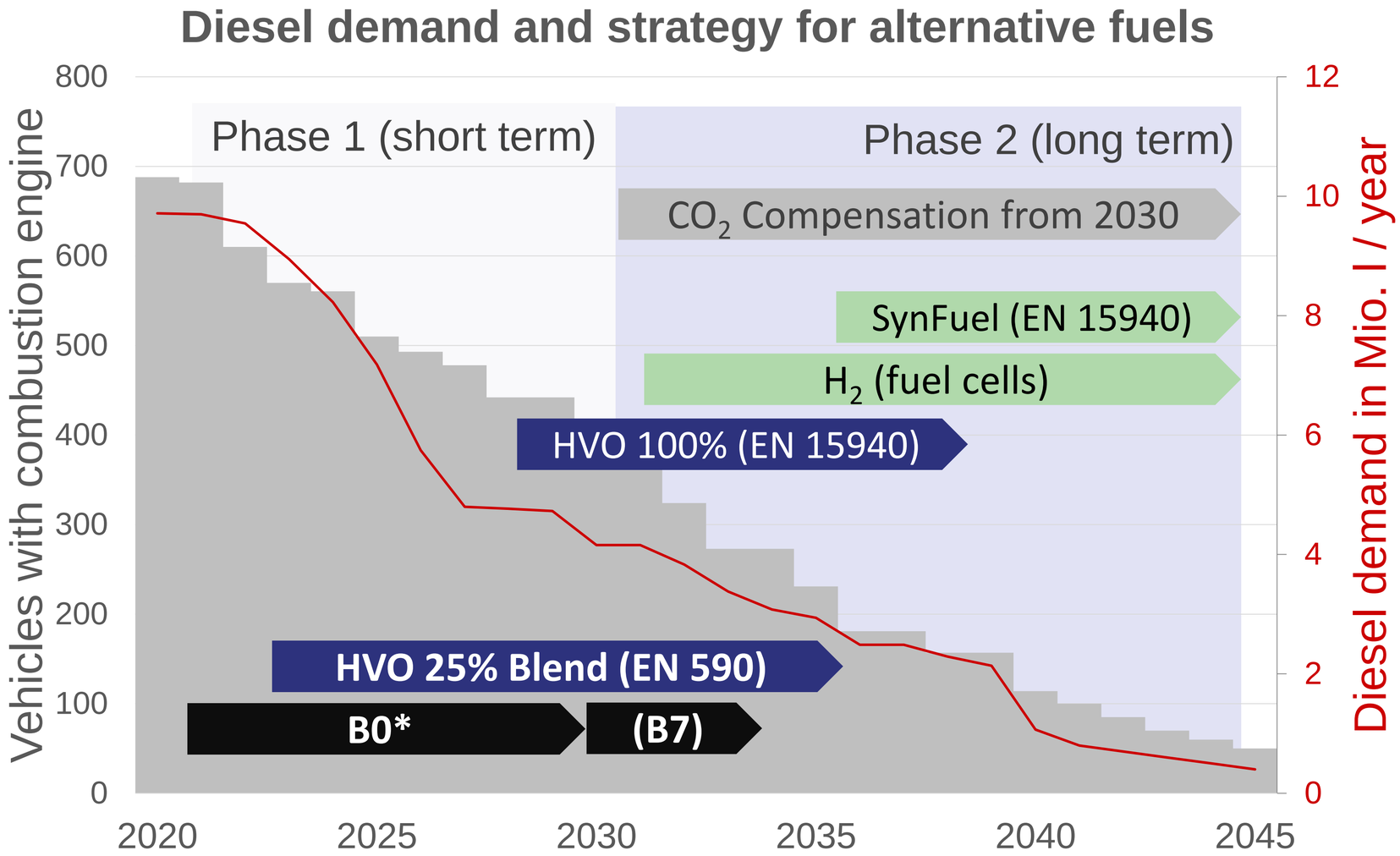
CoC Energy storage - with and for all divisions.



What we do:

- Neutral technology assessments (technoeconomic, ecology).
- Pilot projects & implementation
- Support line organisation as technical specialists

Alternative fuels are last choice

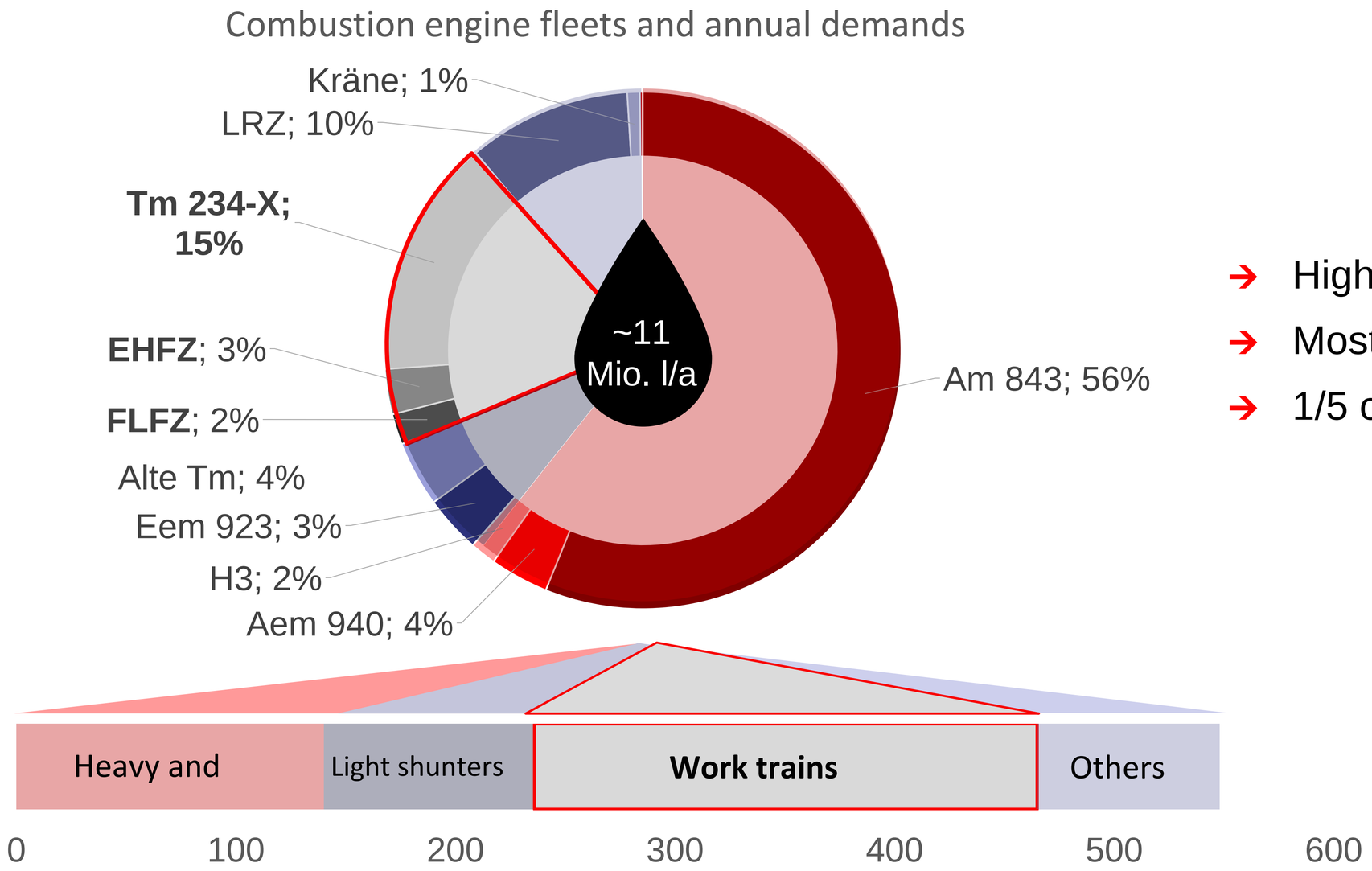


*limited availability expected, B7 is standard in central Europe

Current state H_2:

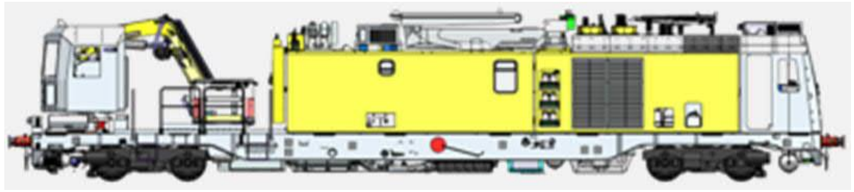
- Niche use: Only where battery-electric solution is not feasible
- Synfuel/HVO might replace H2 in general

Work trains and total diesel demand of SBB



- Highest number of vehicles
- Most diverse category
- 1/5 of annual diesel demand

Current work train fleet (owned by SBB)



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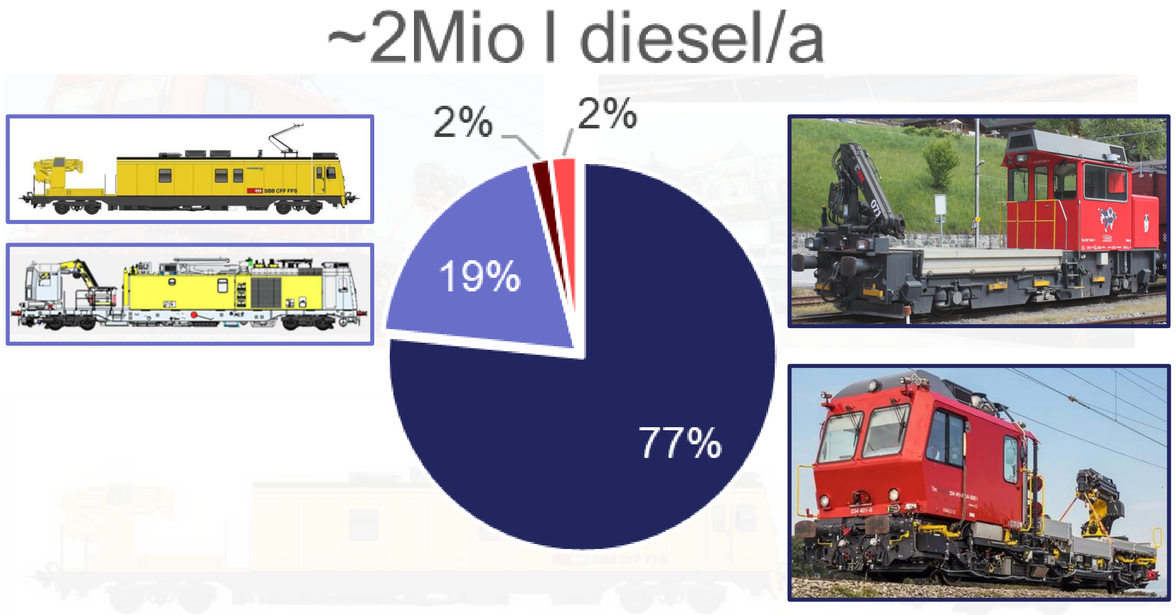
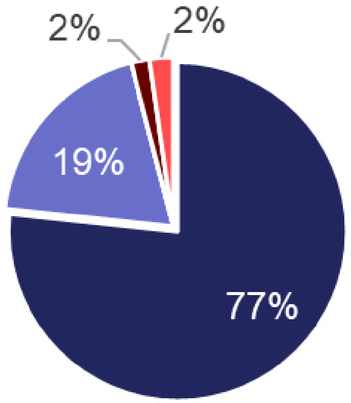


Windows of opportunity

~2Mio l diesel/a



New procurement

Light biaxial work trains

EOL: 2029-2036; 124 pcs.

Mid-life refit

Light biaxial work trains

4-axle work trains

~2028-2030; 13 pcs

~2032-2034; 24 pcs

~2034-36; 11 pcs

2021

2030

2040

Replacement of Tm 234-1/2/3 (biaxial light work train)

Tm 234-1/2/3

Dieselhydraulic

EOL: 2029-2036;
124 pcs.

can a biaxial work train be electrified?

Helbling Tm 234-4

Dieselhydraulic

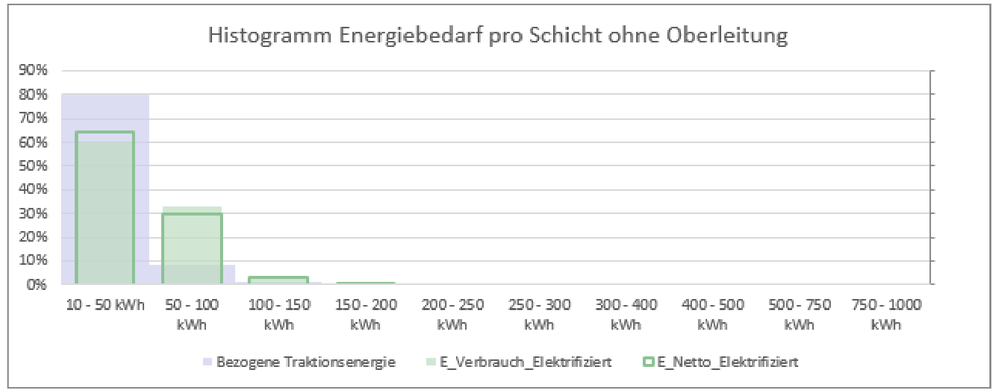
V_max: 100 km/h

P: 520+130 kW

F_start: >100kN

m_max: 40t

Yes, it can be electrified!



Elaborated solutions

- **Full electric**
  - Battery
  - **Battery-Catenary hybrid**
  - Fuel cell 100/200 kW
    - 350/700 bar H2 storage
    - Metal hydride storage
  - Energy tender
    - Battery
    - 350/700 bar H2 storage
    - Metal hydride storage
- **Electro-hydraulic**
  - Battery
  - Fuel cell 100/200 kW
    - Metal hydride storage
    - 350/700 bar H2 storage
  - Battery + diesel range expander
  - H2 combustion engine
    - Metal hydride storage
    - 350/700 bar H2 storage
  - Energy tender
    - Battery
    - Metal hydride storage

Conclusion today

- ➔ **Feasibility** for full electrification is **given**
- ➔ Techno-economically best solution: **battery-pantograph hybride**

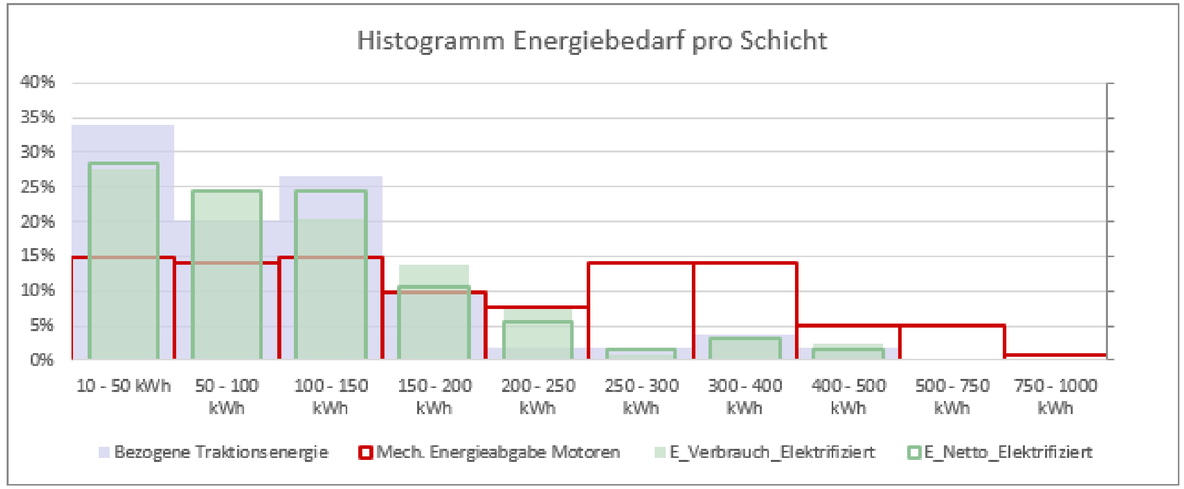
Requirements engineering

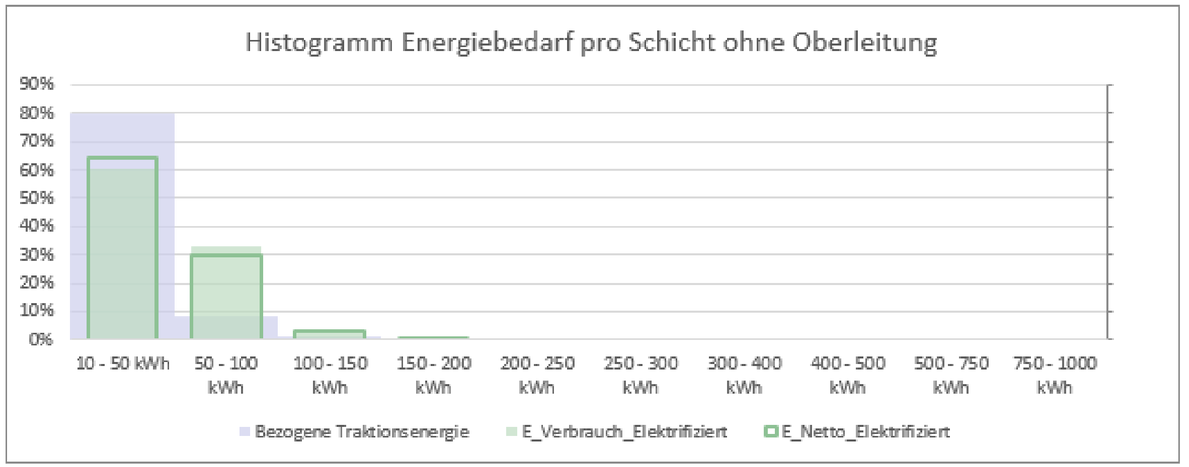
Key components for electrification

- Proper data concept
- Identification of most demanding cases
- Optimisation of current processes
- **Energy efficiency!** (Recuperation, Compressor, Cabine climatisation/HVAC)

Focus on customer needs of stakeholders

- Driver: Fleet homogenisation
- Minimum LCC
- Focus on operational environment
- Facts >> «feelings»





Wrap up

- New procurements must use **renewable energy** (instead of fossil fuels)
- Renewable diesel **fuels** are **last choice!** (noise, LCC, smell, health)
- We do not follow hypes! **(H2 only if battery is not possible)**
- The **largest fleet** (124 vehicles) will be **replaced 2029-2036**
- **Preferred solution** for this **biaxial light work train: battery-catenary-hybrid**

Thank you – Merci beaucoup – Grazie mille – Vielen Dank

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INTERNATIONAL UNION
OF RAILWAYS

BREAK

Break

Restarting at 11h05

Online workshops coming up next:

- 12 May 2021 – 10:00-12:00
  Hydrogen trains
- 19 May 2021 – 10:00-12:00
  Battery trains

Call for speakers is open, contact stefanos@uic.org

INTERNATIONAL UNION
OF RAILWAYS

TRIPLE F

Fossil Free Future of Track Work Machinery

Matthias Landgraf, Bernhard Antony
Graz University of Technology, Plasser & Theurer

UIC Workshop, 18.3.2021

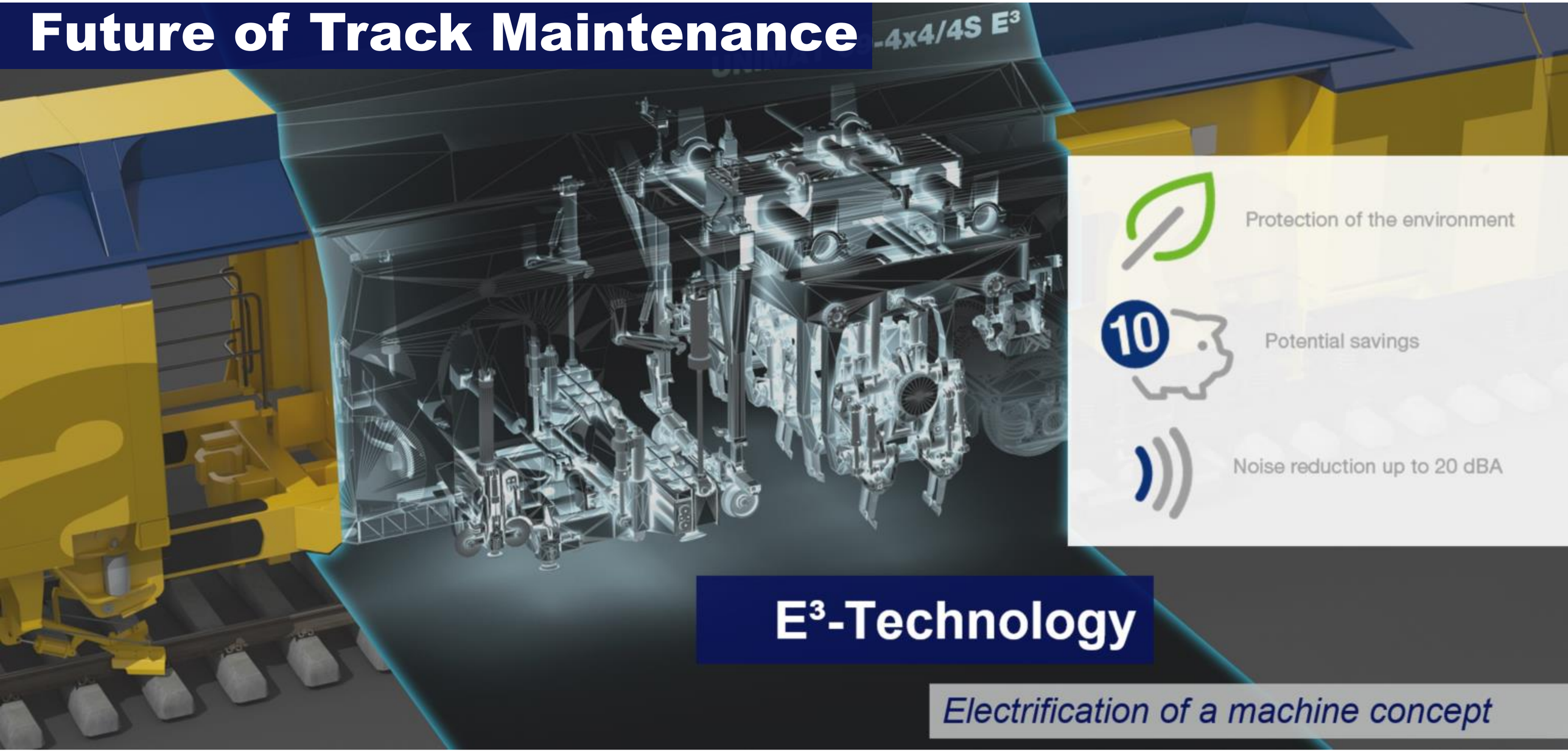
Motivation

Economic

Ecologic

Ergonomic

Future of Track Maintenance



Advantages – Tamping unit with electric vibration shaft drive

- ✓ Economic as it reduces energy costs
- ✓ Ecologic as the E³ technology enables pollutant emissions to be lowered and allows fossil fuels to be reduced
- ✓ Economic, ecologic and ergonomic thanks to noise reduction → the machine can be used in urban areas and tunnels
- ✓ Highest tamping quality in tracks and turnouts (Plasser & Theurer tamping technology with guaranteed process safety)

Full-electric : P&T UNIMAT 09-4x4/4s E3 (2017)

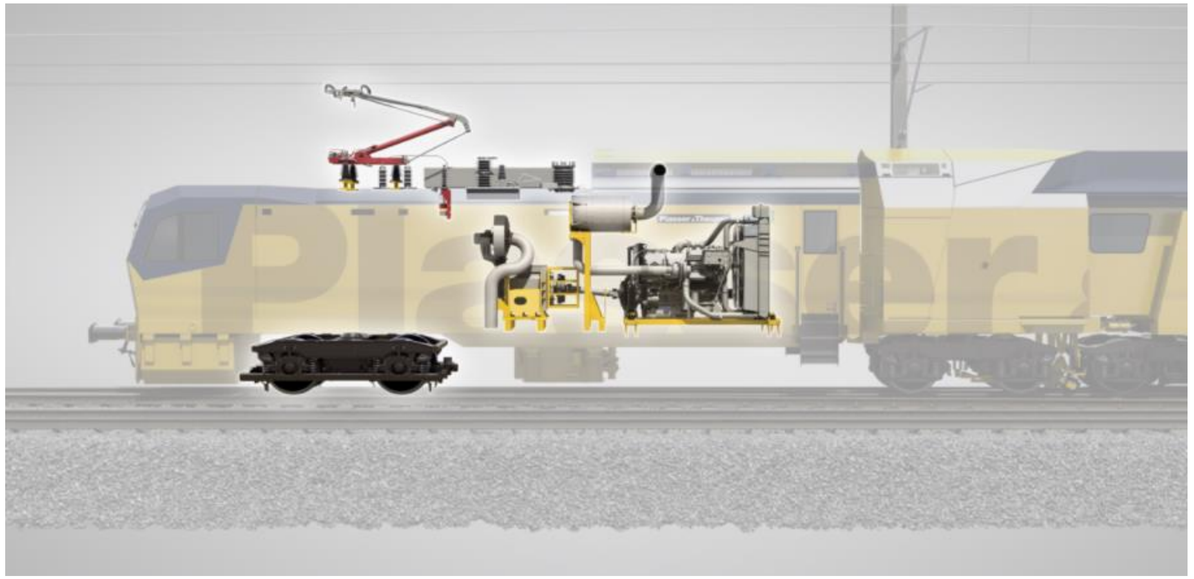
Tamping machine with full-electric drive

Overview

- Diesel and Electric (Overhead Line) drive
- Speed up to 100 km/h self-propelled (infinitely adjustable)
- Modular design (Easier homologation)
- Tamping unit with electric vibration shaft

Powertrain

Catenary	• 15 kV power is transferred through the transformer and inverter to 200 kW electric motors on the bogies
Diesel Drive	• 597 kW • Diesel engine is connected to an asynchronous motor to drive the electric bogies
Other	• Savings up to €135 per work hour • 20 dB noise reduction



Source: Plasser & Theurer

Diesel-Electric: P&T HTW 100 E3 (2017)

Hybrid motor tower car for maintenance and catenary inspection with three-part lifting platform

Overview

- Diesel and battery drive
- Speed up to 100 km/h
- 77,6 tons / 19,5 tons axle load
- Up to 12h of battery operation

Details

Battery	• 154 kWh Li-Ion • Charged externally, via diesel engine or braking energy recovery system
Other	• Hydrodynamic • Equipped with 480 kW Diesel Engine • Pantograph used for machine earthing (safety)
Example Of Use	• New Rail Link through the Alps (Ceneri Tunnel, Switzerland)

Source: Plasser & Theurer

Economic

Ecologic

Ergonomic

Project Goals

1 Cross-Industry

- Alternative Fuels (AF)
  - Definition
  - Explanation and research trends
  - Summary
- Cross-Industry Trends
  - Challenges
  - Passenger vehicles
  - Heavy-duty on-road vehicle
  - NRMM – Construction machinery
  - Rail
  - Aviation
  - Maritime
- Consolidation and comparison

2 Rail Sector

- Potential Analysis
- Applications
  - General Application
    - Diesel
    - Fuel Cell | Catenary
    - Gaseous and Synthetic Fuels
  - Application and Innovation
    - Examples Railways Europe
    - Status Quo
- Limitations
  - Regulations
  - Action Plans | Incentives | Funding

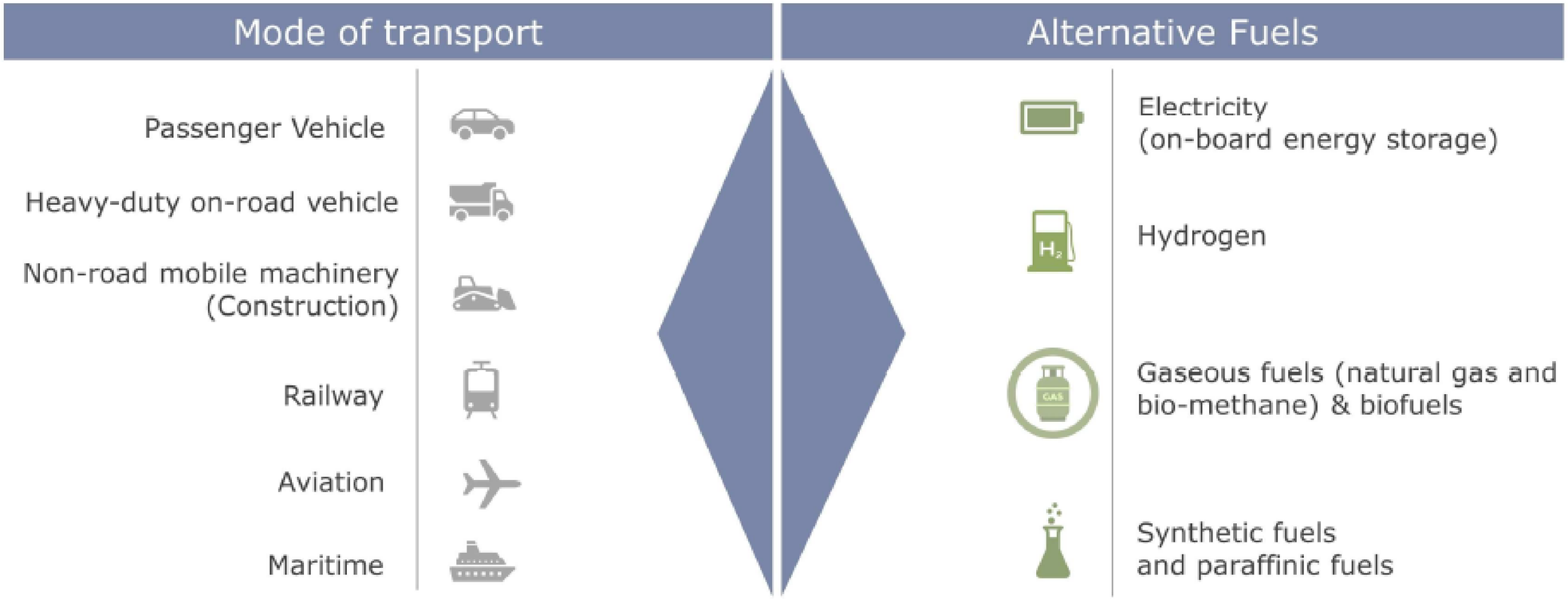
3 Track Machinery

- Comparative analysis
  - Trends Construction Machinery
  - Trends Track Work Machinery
- Calculation scenarios CalCAS
- Results

review | analyses | solutions

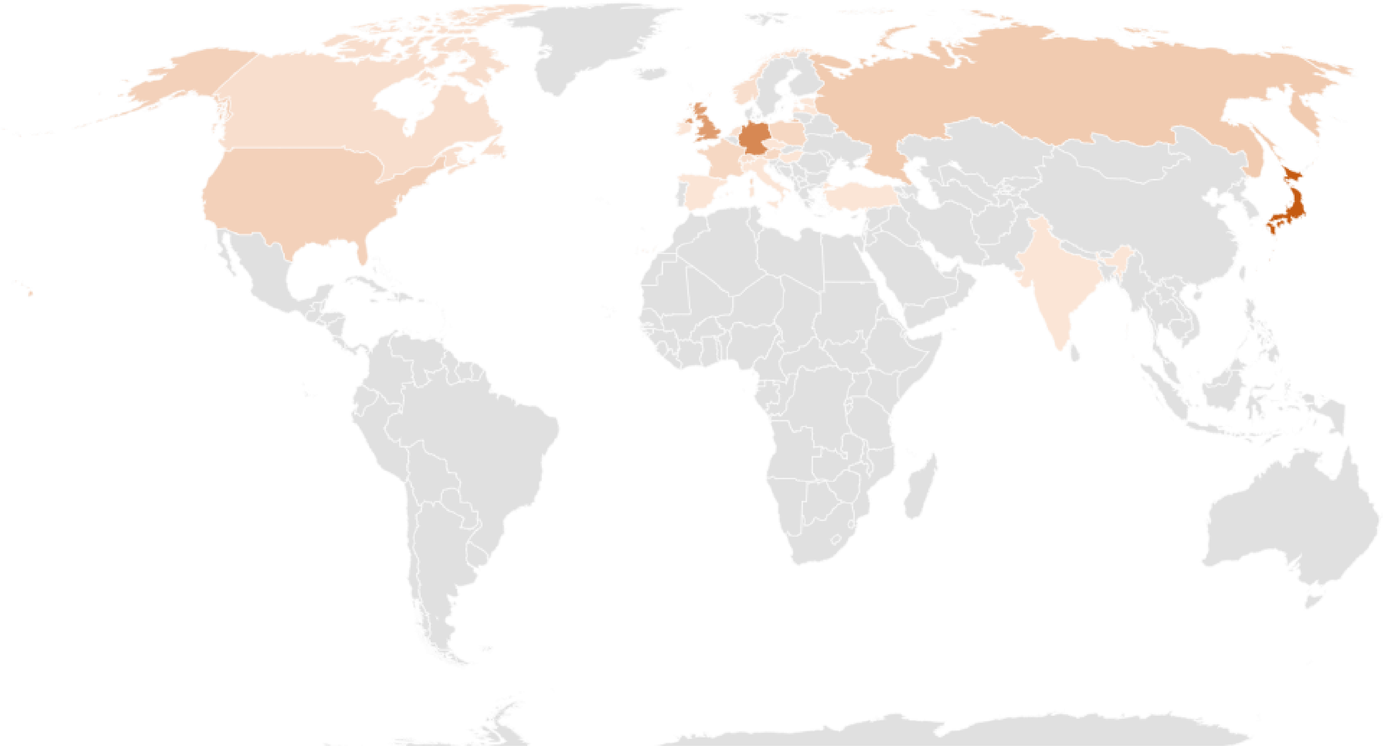
Cross-Industry Analysis and Railway Sector

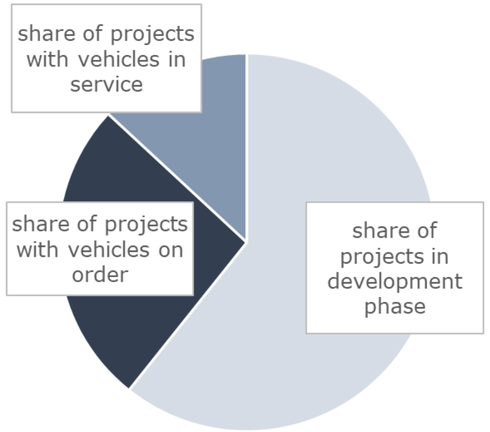
Cross-Industry Analysis | Scope

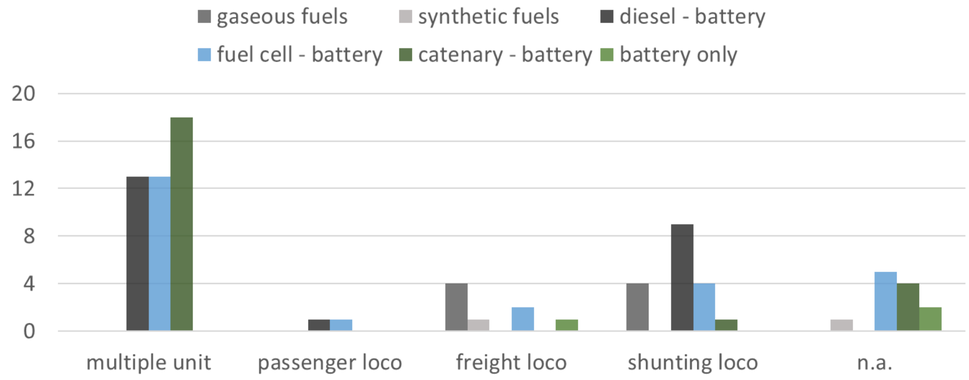


Deep-dive Rail Sector

On-going activities in rail sector in regard to alternative propulsion technologies
(except for diesel-catenary bi-mode solutions)







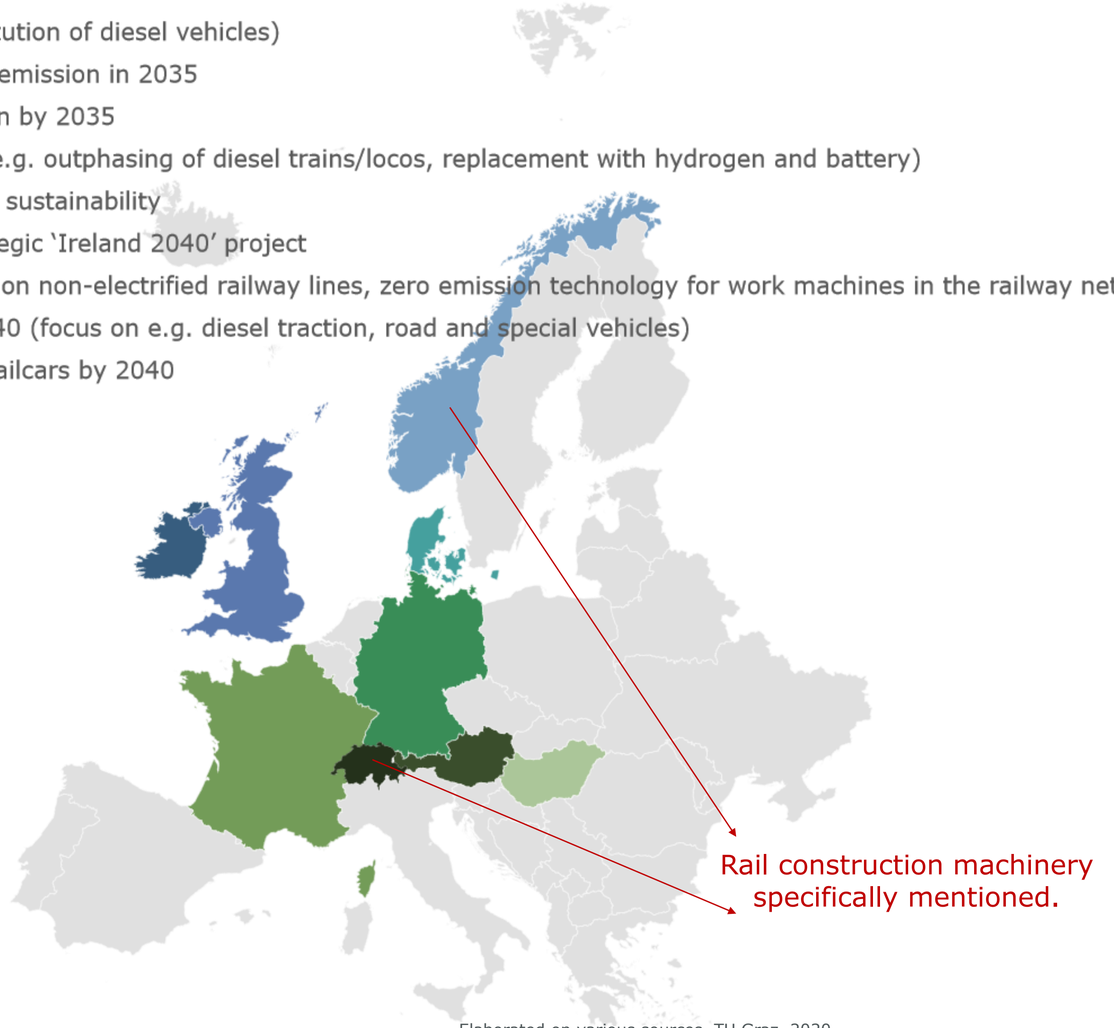
Elaborated on various sources,
TU Graz, 2020

Note: projects do not refer to the manufacturing country/OEMs involved (e.g. Chinese manufacturer CRRC has cooperated with the German federal railways), they refer to the project applying country.

Political incentives

Excerpt of Climate Targets in European Rail Sector

- ÖBB Climate Protection Strategy 2030 (e.g. substitution of diesel vehicles)
- Regional Dutch trains could be operated with zero-emission in 2035
- Decarbonisation plans: elimination of diesel traction by 2035
- German federal railway: carbon neutral by 2050 (e.g. outphasing of diesel trains/locos, replacement with hydrogen and battery)
- Battery-electric train procurement aiming for more sustainability
- Introduction of hybrid trains as a response to strategic 'Ireland 2040' project
- Achieve climate goals (e.g. by replacing fossil fuel on non-electrified railway lines, zero emission technology for work machines in the railway network)
- Entire SBB will only use renewable energies by 2040 (focus on e.g. diesel traction, road and special vehicles)
- Goal of the British government: replace all diesel railcars by 2040



Elaborated on various sources, TU Graz, 2020

Prießnitz, Martina, and Thomas Gerstenmayer. 'The End of Fossil Fuels ÖBB Personenverkehr AG'. The End of Fossil Fuels, UIC Workshop Zürich, 2019.
Zasiadko, Mykola. Two Dutch Provinces Want to Shift to Zero-Emission Trains by 2035. 2018, https://www.railtech.com/rolling-stock/2018/11/06/two-dutch-provinces-want-to-shift-to-zero-emission-trains-by-2035/.
Smith, Kevin. 'Do Hydrogen and Battery Trains Mean the End for Diesel Traction?' International Railway Journal, vol. 60, no. 4, 2020, pp. 18–21.
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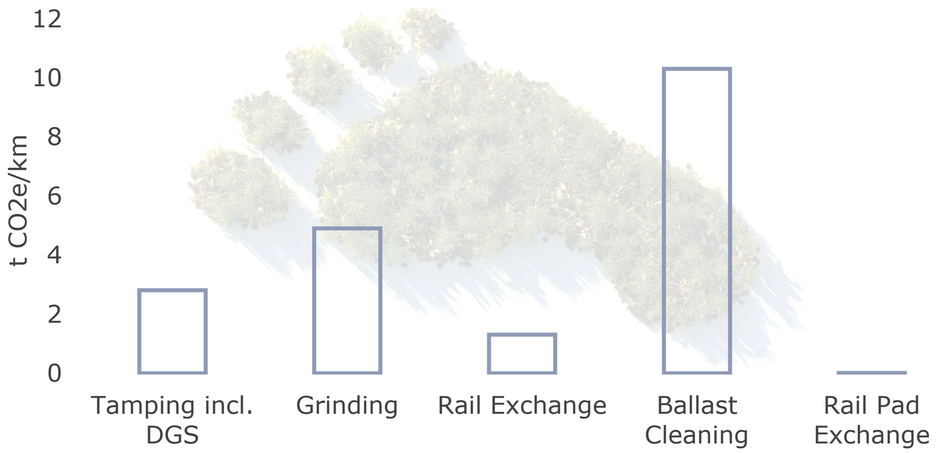
Oommen, Stephen. 'The Norwegian Railway Reform'. The End of Fossil Fuels, UIC Workshop Zürich, 2019.
Kramer, Ueli. 'Center of Competence - Energy Storage'. The End of Fossil Fuels, UIC Workshop Zürich, 2019.
N.N. 'Alstom/Eversholt: Wasserstoff-Zug Für UK'. Der Eisenbahningenieur, no. 7, 2018.

Track Work Machinery

Potential of mitigation

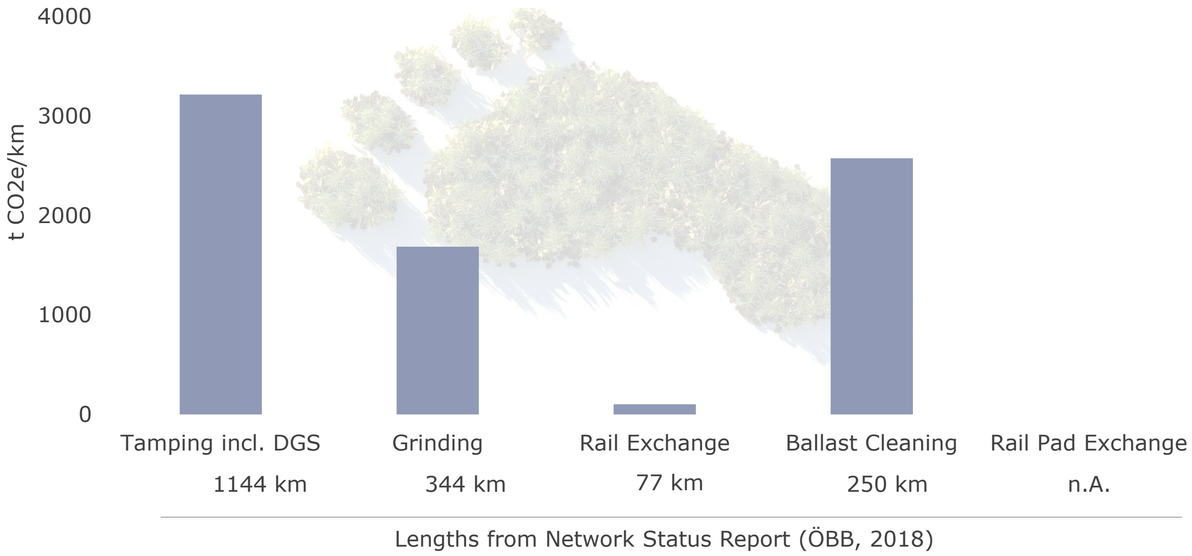
Greenhouse gas emissions associated to several track maintenance and renewal measures.

Impacts per km



Includes transport, fuel consumption, material transport and production.

Netwide ÖBB



Lengths from Network Status Report (ÖBB, 2018)

For Austrian Federal Railways (ÖBB Infrastruktur AG), depicted track maintenance amount to 9,600 t CO2e/yr.

Evaluated machinery

Calculation of power consumption via TMC MCO

USP 2000
Ballast regulation

MFS 120
Material logistics

09-4x4/4S
Universal Tamping

GAF LAE
Structure Conversation

EM 100 VT
Measuring

DGS 90 N
Stabilisation

Assumption of power consumption

URM 700
Ballast cleaning

RM 85
Catenary inspection

APT 1500 RL
Welding machine

MTW 100
Catenary inspection

AHM 800 R
Formation Rehabilitation

SUZ 500
Track (Re)Laying

Scenario calculation and analyses

Input data

Type of battery and fuel cell
(to choose from list),
charging time, shift length, …

Technical data

Density of battery type,
DoD (Depth of Discharge),
Energy capacity and density of hydrogen,
weight and size of hydrogen storage;
Machine data: working speed, fuel cons., …

Calculation

Machine-type specific Electric energy demand
Capacity
Connection power

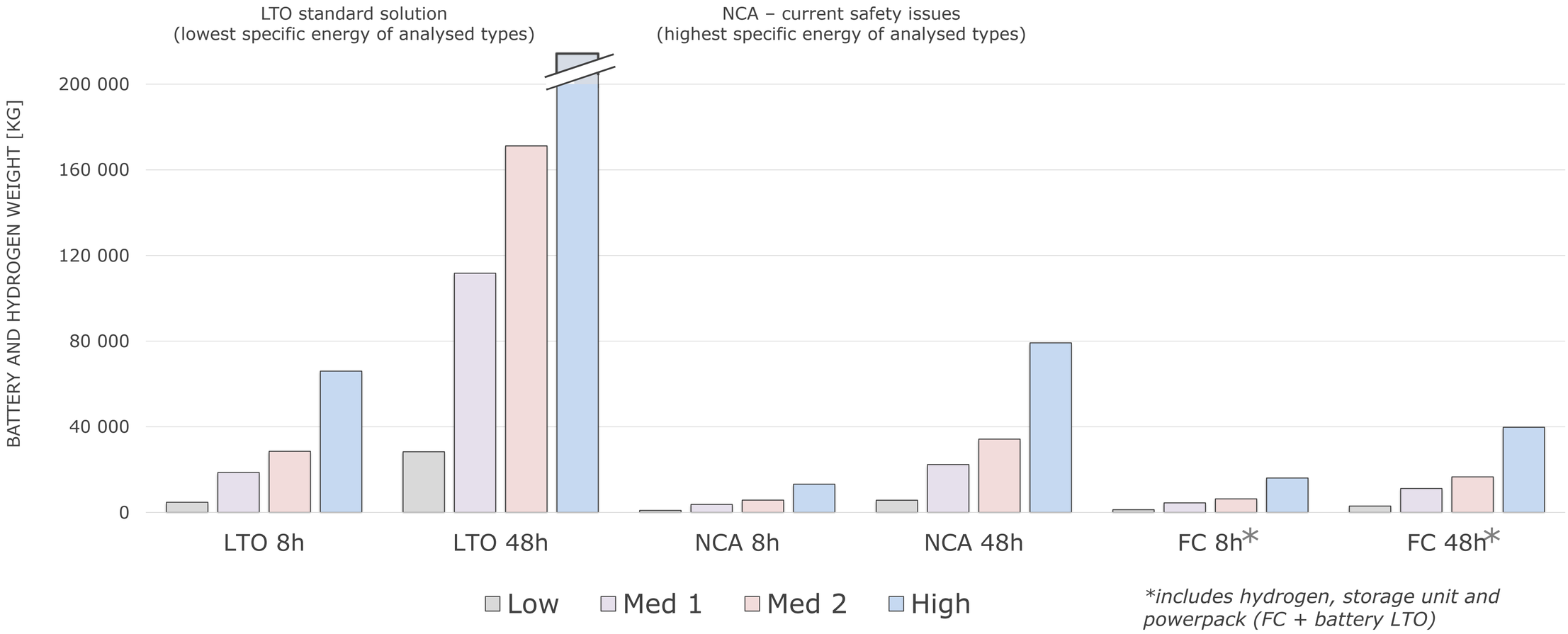
Results

Weight, volume of battery type
or fuel cell and hydrogen (incl. storage)
based on shift length and specific
machine data.

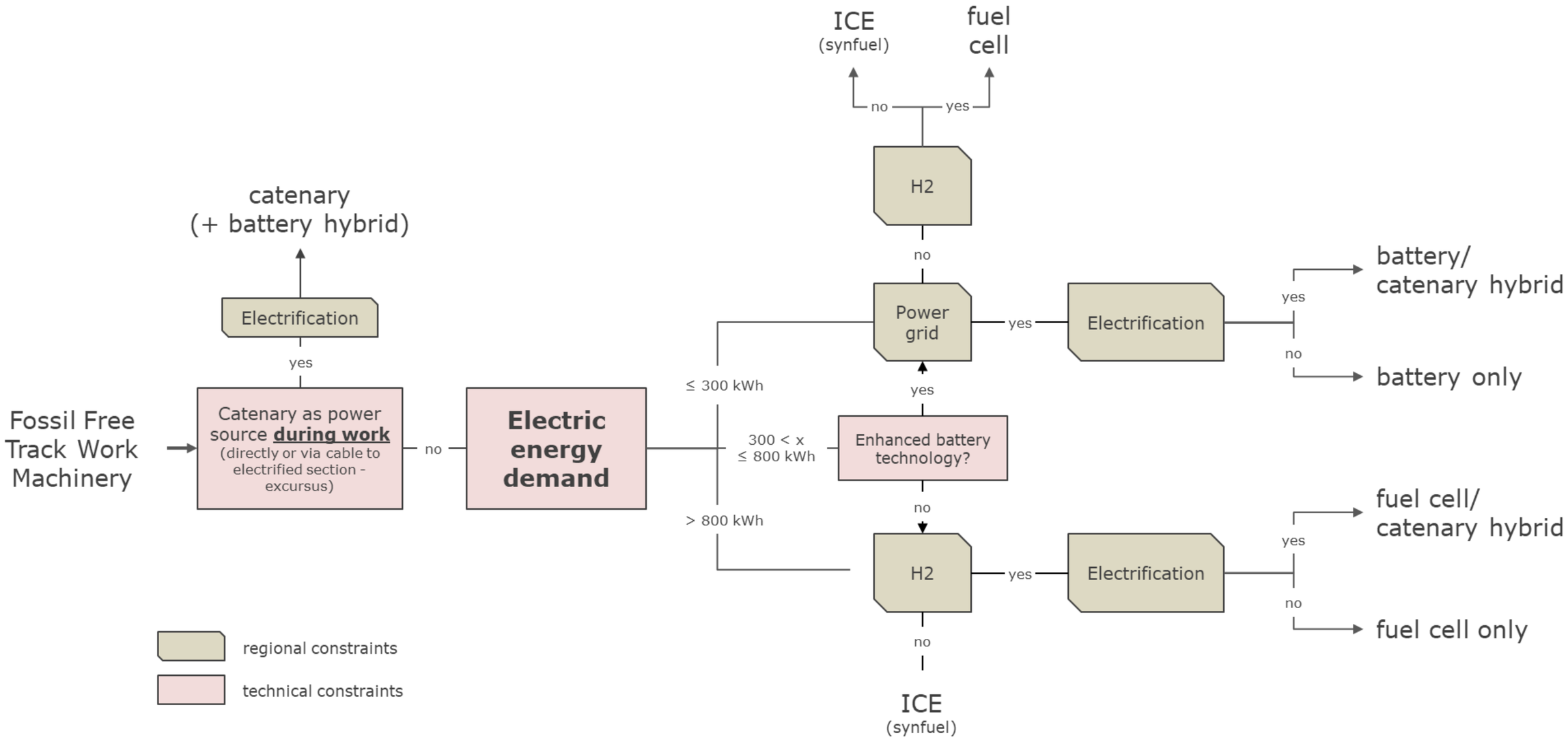
Calculation of
Comparison for
Alternative
Solutions

CalCAS

Result for cluster based on electric energy demand of machinery



Decision Tree



Results

- Catenary should be used whenever possible for track works (problems with safety and flexibility).
- Hybrid solutions are preferable whenever electrification is available (catenary for transfer).
- Electric energy demands of > 300kWh per shift complicates and
  > 800 kWh hinders use of battery-electric systems.
- Up to now, production of Synfuels is too energy-intensive to essentially reduce carbon emissions.
- Mobile refilling and recharging will be key as infrastructure (connection power or hydrogen stations) will not be available in every region.
- Demands for specific machines vary enormously based on construction type (continuous/ discontinuous work modes, shift lengths, …).

Remarks

- Values are based on available technologies, not prospective future developments.
- Electric energy demand is calculated via current diesel consumption.

?

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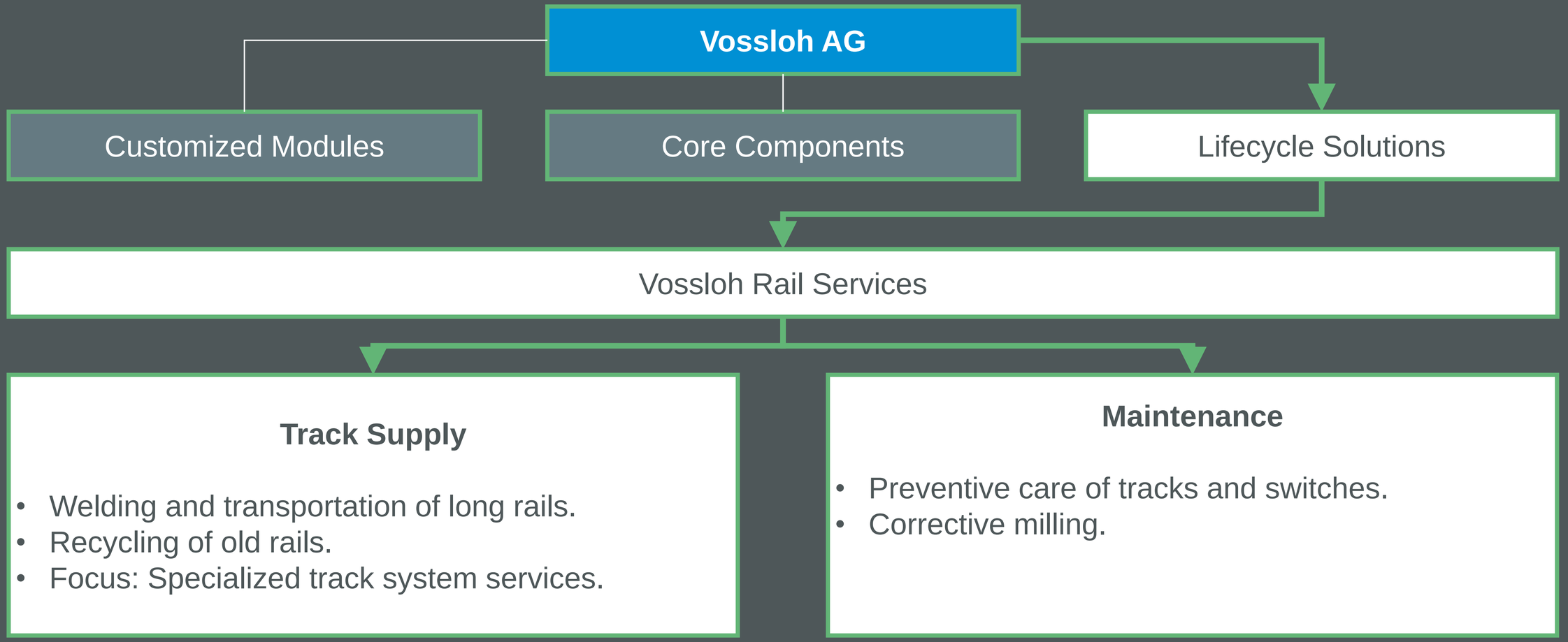
DECARBONISATION OF WORK TRAINS VOSSLOH

Topics

- Vossloh as a company
- Our approach and sustainability objectives
- Current status and objectives
- Advantages of our approaches
- Machines that we develop and build
- Other machines in use and challenges
- Support from network operators
- Planning for the future

Vossloh as a company

Who we are



Our approach for sustainability

Extending the lifecycle of the rail

Grinding (preventive) → Milling (corrective) → Rail exchange (last step) → Extending the lifecycle of the rail.

Our approach to reduce emissions

1. Grinding to prevent defects as rail care.
2. Milling to eliminate defects that have arisen.
3. Smart maintenance to perform only necessary work.
4. Electrification of machines responsible for rail maintenance.

Current status and objectives

Current status	Leads to
Purchase of 100% green electricity VRS-wide.	CO2-neutrality by the year 2030.
Certifications according to DIN ISO 50001 and 14001.	Energy and environmental management.
Fulfil European environmental requirements.	Various standards with very different requirements.
Fulfil special requirements and certifications of ProRail	Monitoring, Reduction, Communication, Participation
Consider initiatives for further improvement.	Further electrification of our machines and operating equipment.

Advantages of our approach

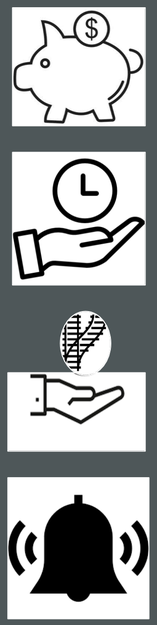
Smart Maintenance

Sense

- Collect data
- Monitor condition

See

- Process data
- Visualise status
- Definition of necessary steps
- Control machines



Solve

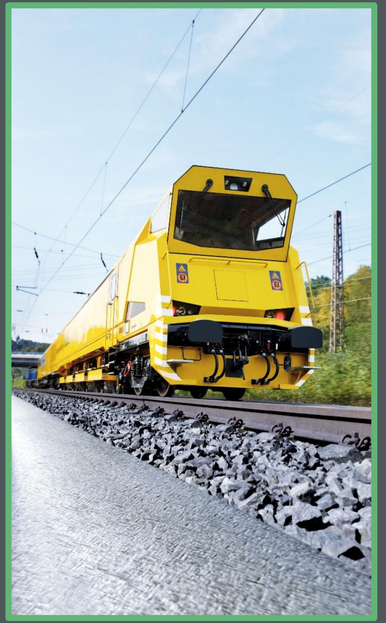
- -60% inspection costs compared to manueal measurement.
- -80% planning effort 3-12 months on the fly.
- +100% extended service life resource-saving.
- 100% transparency of track condition.
- Monitor condition

→ Reducing emissions!

Minimize complexity – maximize output

Advantages and challenges

Grinding and milling



- Preventive approach to prevent rail failures and increase the life cycle.
- Smart Maintenance. Train ist also diagnostic vehicle to monitor rail condition.
- Grinding without rail closure.

Challenges to carbon neutrality

- Routes without power supply.
- Conversion of vehicles not developed in-house not worthwhile.
- Performance of purely electric machines partly insufficient.
- Battery capacity problematic for long work shifts.
- No uniform requirements in Europe.

Machines that we develop and build

Overview

- Permanent development of machine portfolio.
- Development of digital monitoring and planning tools.
- Sensor and control system engineering.
- CAD, CAE, programming.

We are a manufactory and build machines demand oriented and more sustainable.

Smart Maintenance

Multi Purpose Milling (MPM)

High Performance Milling (HPM)

High-Speed-Grinding-City (HSG)

High-Speed-Grinding-2

Possibility to make changes here in future.

Support from network operators

What would help us

- Incentive and motivation for electrification must increase.
- Advantages for CO2-neutral working machines in tenders.
- Increased use of maintenance to extend lifecycle.
- Commission condition-based maintenance.
- Uniform environmental regulation.
- Uniform requirements for certification.

Then we can focus more on environment and energy than we already do.

Planning for the future

Further optimization and changes with Hybrid HSG-Cities

- Further electrification to machinery and equipment

- Hybrid-HSG-Cities planned for 2021.Plug-in-hybrid with the possibility of using only electricity.

- Less exhaust fumes → better air for the operators.
- No handling of fuel.
- Noise reduction
- Customer has the choice, can determine their own footprint.

What else can we do to improve the area of working trains?

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OF RAILWAYS

STRUKTON

Accelerate transitions

Cees Steendijk
Business Development Energy transition

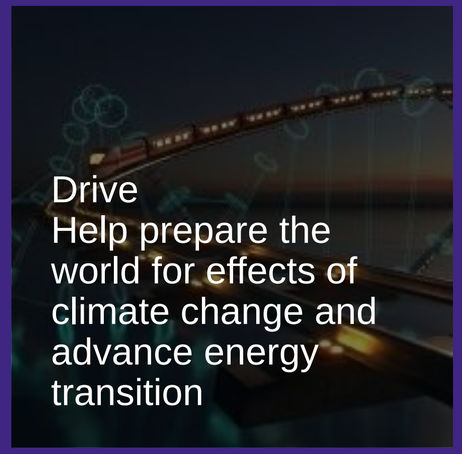
Decarbonisation of worklocomotives

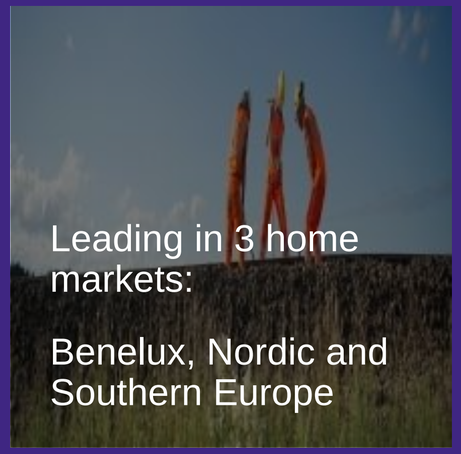
Accelerate transitions

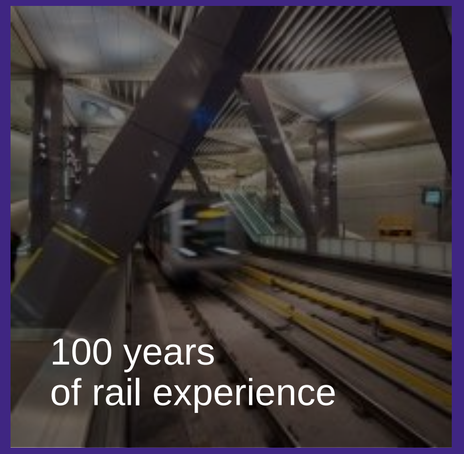
Cees Steendijk
Business Development Energytransition

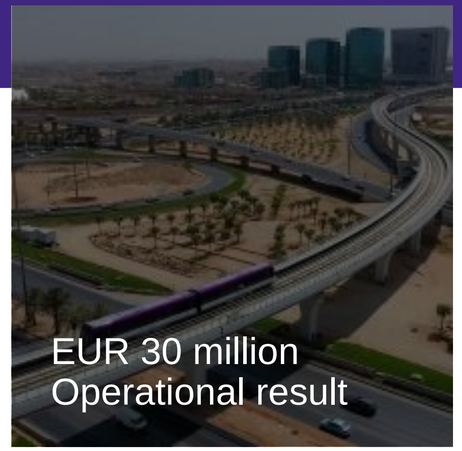
Strukton

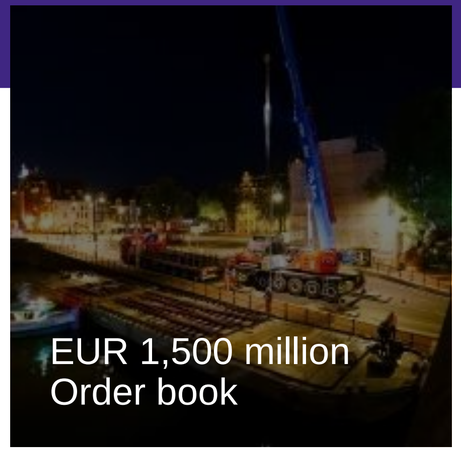
Key figures of Strukton Rail

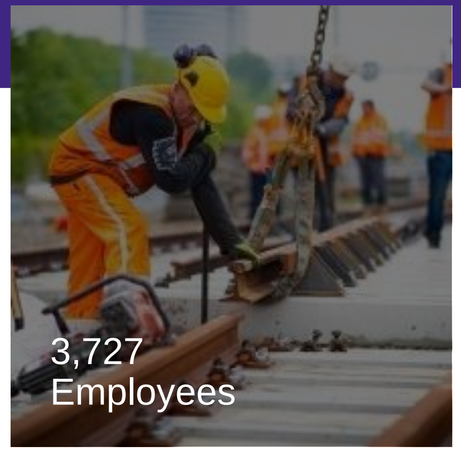


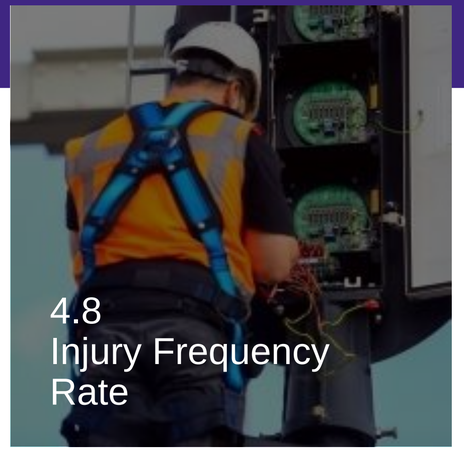


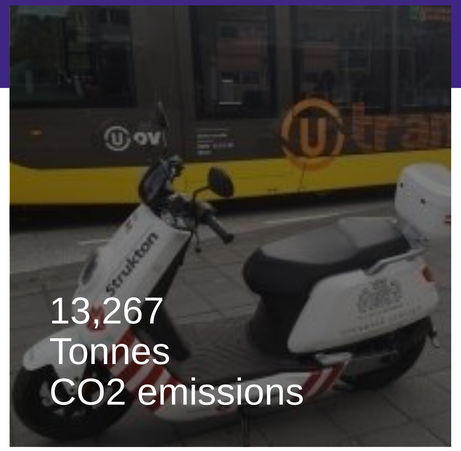












Focus on Sustainability

DRZMHDVRSNLLR

Power Supply

Capacity

Rolling Stock

Noise & Vibrations

Transitions and circularity are not new for us

Coal

Former NS3000, bought from NS in 1926 to build “miljoenenlijn”

Diesel

Electric (2019/2021)

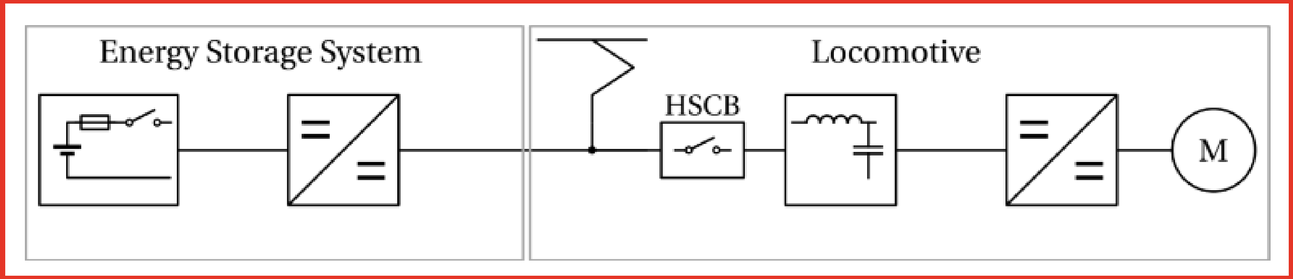
Electric locs (1824, 1736, 1740, 1756) reused as Worklocomotives

- CO2 Emissions reduction
- Second life (Rebuilt technically at Strukton’s workplace in Zutphen)
- No diesellocs on electrified routes anymore
- Using battery on non-electrified tracks
- Railway renovations and maintenance operations
- Transport equipment and materials
- Powered by wind energy (100% Green)
- Healthier for the employees

GPS and monitoring

- In-house knowledge for converting locomotives to battery-powered trains
- Engineered by Strukton Rail engineers (power electronics)
- Developed Monitorsystem
- Optimised Energy Storage system

And with Energy Storage (variants)



- 1500V supply via existing E-loc connection
- In-house Converter technology

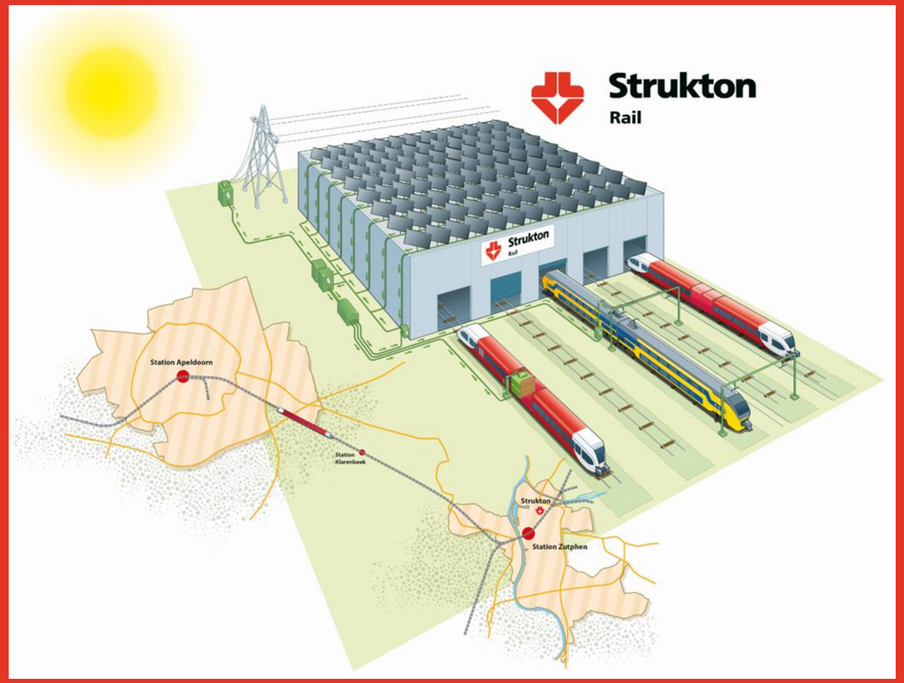
- Carriage variant with workroom upstairs

Legenda:

- Batterij
- Besturing
- Meetstation (Remote)
- Spoelen
- Schakelaars

Challenges

- Regulations
- Financing Energy Storage
- Few incentives for sustainable worktrains from the market



More information

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Online workshops coming up next:

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  Hydrogen trains
- 19 May 2021 – 10:00-12:00
  Battery trains

Call for speakers is open, contact stefanos@uic.org

Thank you for your attention.