

Possible Solutions For Zero Emission Railways

THE END OF FOSSIL FUELS IN THE RAILWAY SECTOR
UIC BEST PRACTICE WORKSHOP- ZÜRICH 13.11.2019



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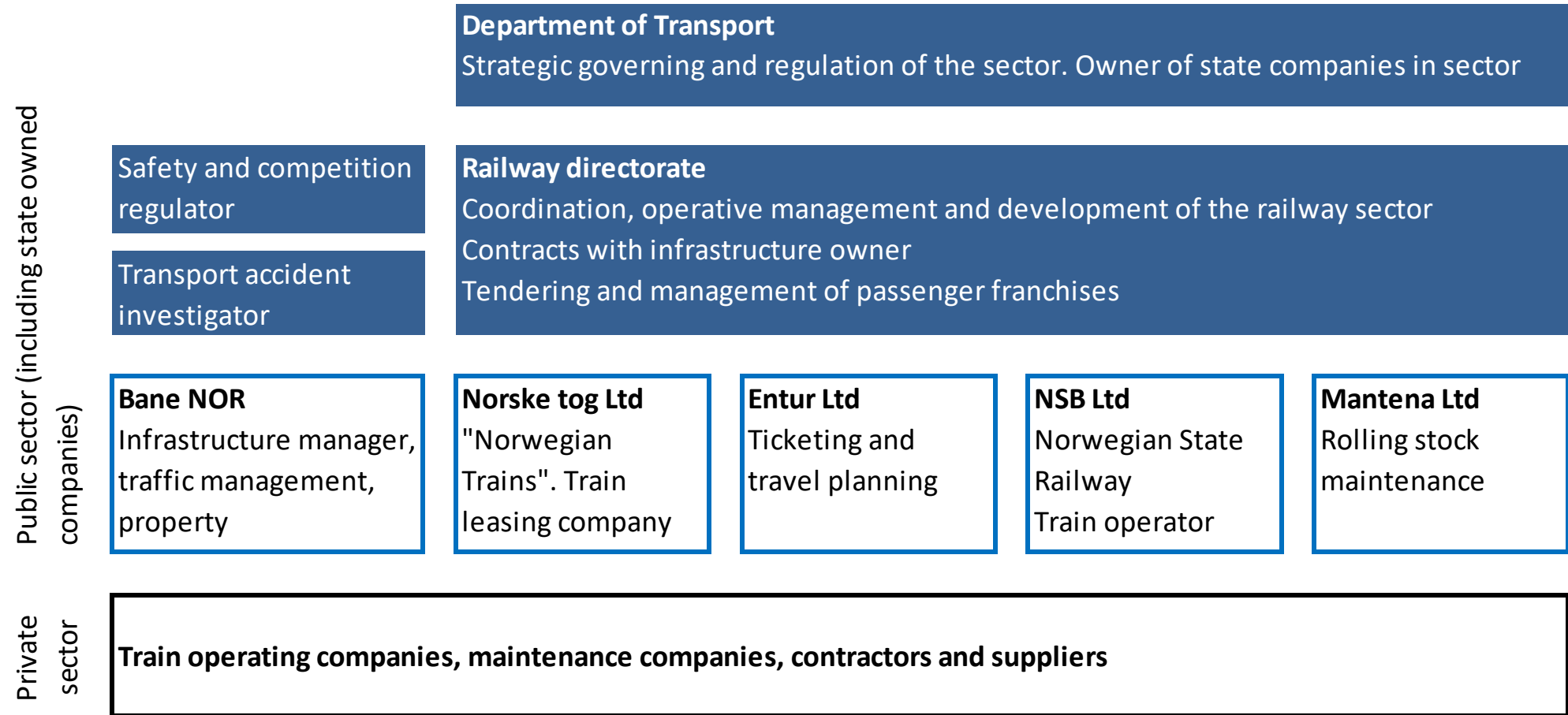
The Norwegian Railway Reform



«The Railway Directorate shall ensure that the railway sector is operated as efficiently, safely and environment friendly as possible for the good of passengers, freight transport and society in general»

«To initiate, develop and present proposals concerning the development of the railway and public transport system in light of the transport needs identified by the Directorate»

Norwegian railway sector from 2017



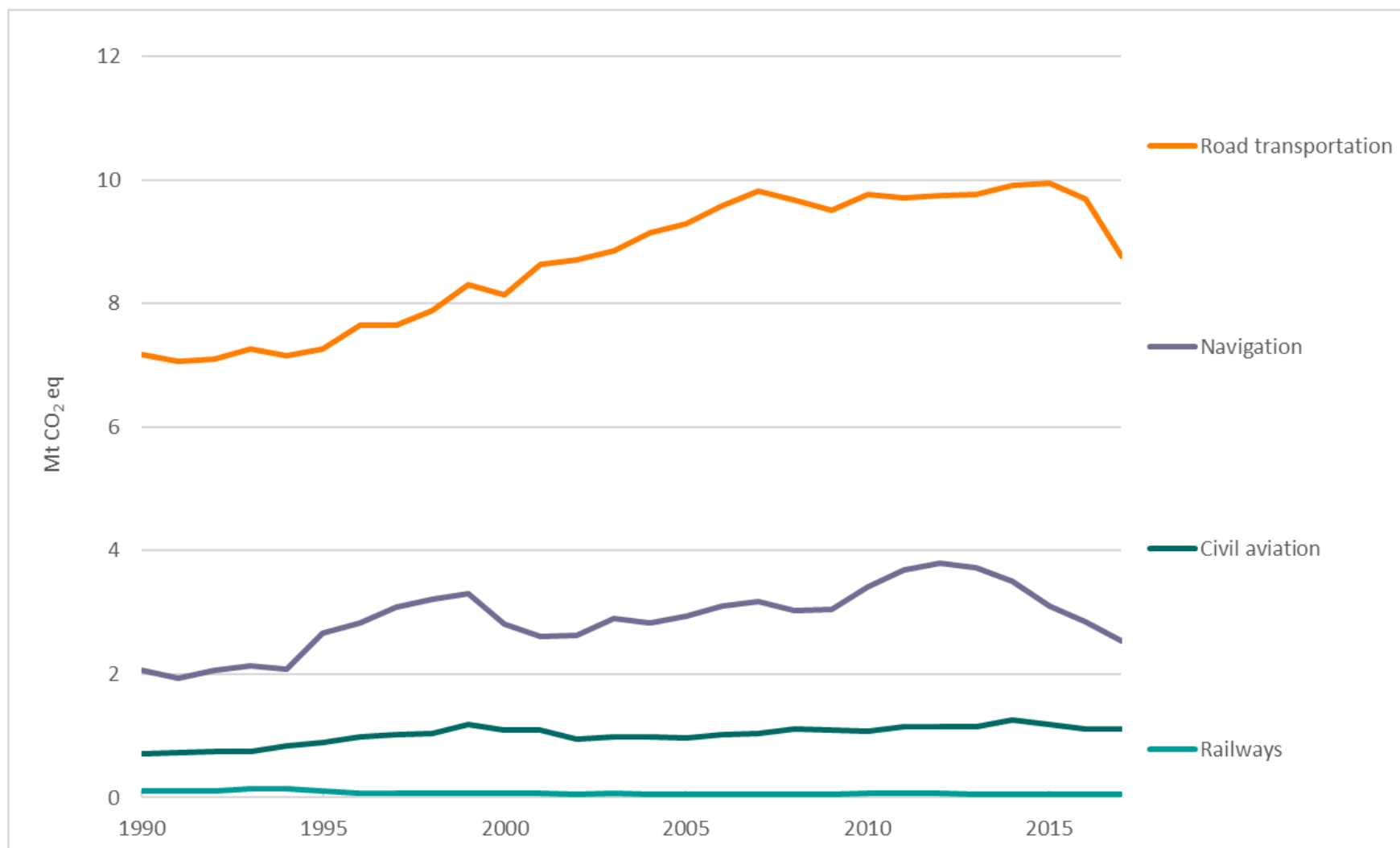


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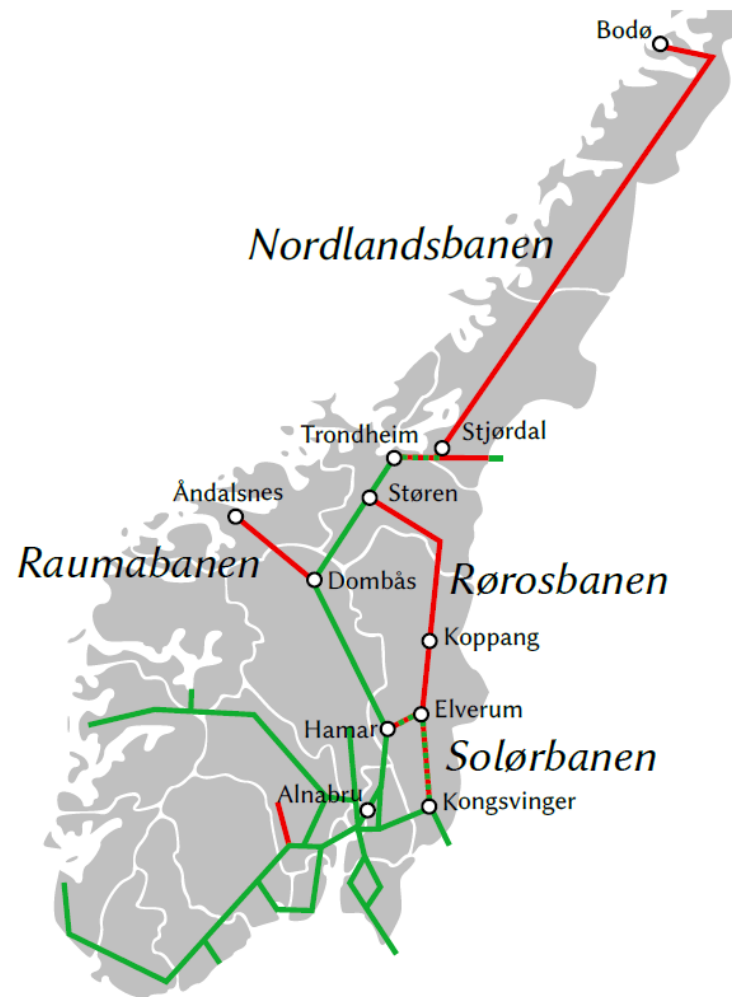


CO₂ emissions from the Transport sector in



Source: Statistics Norway/ Norwegian Environment Agency

Where are we aiming for zero emission solutions?



Solutions available for non-electrified lines

BOMBARDIER TALENT 3 ELEKTRISK TOG

Tyskland får snart sitt første batteritog

Neste år setter Deutsche Bahn et batteridrevet tog i prøvedrift i Tyskland.



12 SEPTEMBER 2018 NEWS

Austria's ÖBB and Siemens unveil battery-powered train prototype



ÖBB and Siemens develop battery-powered train prototype. Credit: www.siemens.com/press.

Hydrogen fuel cell trains to run on British railways from 2022



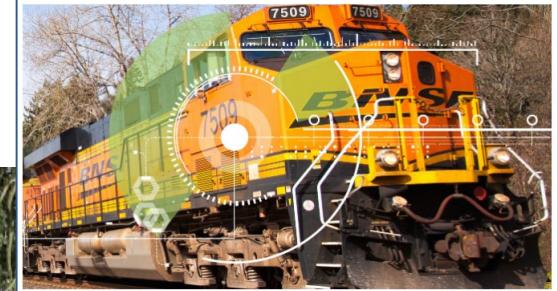
Germany launches world's first hydrogen-powered train

Two trains built by the French train maker Alstom are now operating on a 62 mile stretch of line in northern Germany

LOCOMOTIVES

Leading The Charge: Battery-Electric Locomotives Will Be Pushing US Freight Trains Further

Oct 24, 2018 by Chris Noon



Solutions for workshops - freight terminals- maintenance



Ambitions to achieve zero-emission solutions

- Paris agreement
- Norway's commitment to the 2030 goals
- Low emission society goals in 2050
- NTP 2018-2029
- Plan for fossil-free public transport in 2025
- Granavolden platform
- Letter of assignment

Some of the challenges facing the railway today

- Maintenance & reliability
- Innovation & new products
- Associated costs
- Durability
- Withstanding extreme conditions

Project NULLFIB

NULLFIB- Zero emission solutions for non-electrified tracks/lines (NULLutslippsløsninger For Ikke-elektrifiserte Baner)



Scope:

- New and future zero emission technology that could replace the use of fossil fuels on non-electrified railway lines.
- Opportunities to reduce investment and renewal of overhead lines at railway lines, railway stations, workshops and freight terminals ("last mile").
- Opportunities to deploy zero emission technology for railway vehicles / work machines used for fault correction, operation and maintenance of the rail network.

Main deliverables

- Revisjon of report ” *Analyse av alternative driftsformer for ikke- elektrifiserte baner*”. (SINTEF F27096, 2015)
- Proposal for a mandate to Department of Transport
- Proposal to National Transport Plan (NTP) for the period 2022-2033
- NULLFIB final report 31/12-2019, for the project objectives and in addition describe possibilities of administrative and economic transition from diesel to zero-emission technology.

Considering four alternatives

- Hydrogen
- Biogas
- Biodiesel
- Battery



Bodø, terminus of the Nordland line

Non-electrified lines

- 1395 km (approx. 1/3rd) of total 4150 km is non- electrified.
- Estimated cost for electrification for Nordland line would be approx. 1,4 Billion €.
- Diesel consumption for all lines per year is approx. 16 mill/litre
- Fuel consumption for a Cargo-train for example, Trondheim-Bodø is approx. 8000 litres (roundtrip).



Freight train passing mountain Saltfjellet on the Nordland line.

Hydrogen operation – assessment by the end of 2019

- The Norwegian Government Transport Committee has requested the Railway Directorate to investigate the possibility of a test project with hydrogen operation of railway vehicles.
- The directorate shall before end of 2019 assess the cost and feasibility of a pilot project.



Alstom hydrogen powered train

Feasibility study of battery operation

- Feasibility study of battery-operation for Nordlandsbanen (Trondheim – Bodø).
- Length 728km, 162 tunnels, 256 bridges, challenging operation conditions.
- Including the line from Rana mines to Mo I Rana.



Snow clearing on tracks on the mountain Saltfjellet on the Nordland line

Contributors



Electrification

Is it possible in a cost-effective way only to electrify sections of the line?



Preliminary findings

- There are safety challenges associated with hydrogen and biogas.
- There are challenges associated with the operating economy of the operators.
- The security challenges with gas in Norwegian railways probably give rise to investment needs that have previously been under-communicated if the solutions are implemented.
- Biodiesel is easy and accessible, but it is a question of whether it is right for the Railway to use this limited resource in the long run when technology provides alternatives.

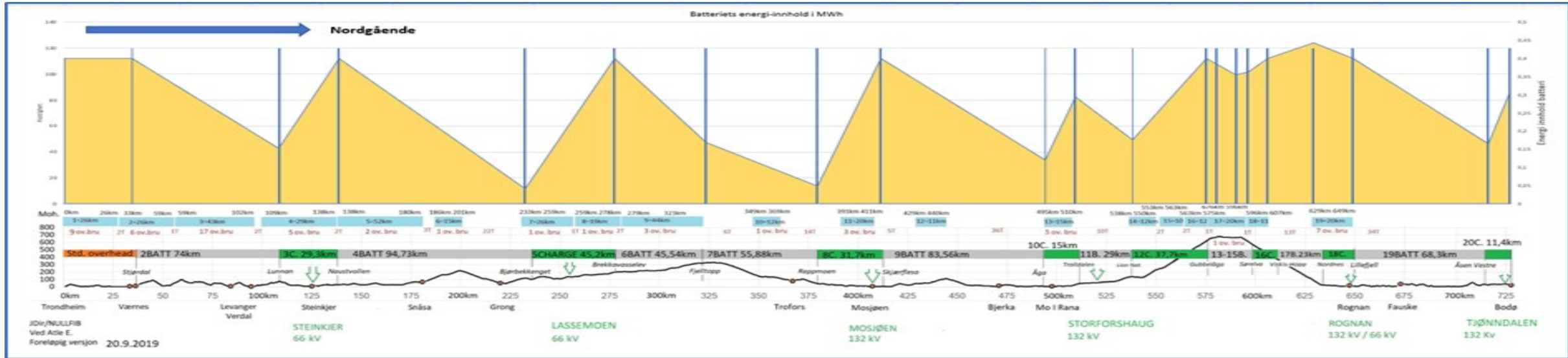


Preliminary findings

- Electrification only **219** kilometres compared to **695** kilometres.
- Only **5 %** of tunnels are affected. (162 tunnels in total)
- Cost reduction by **76%** compared to full electrification.
- Freight trains are dimensioned, we need **2.4** MWh of energy in the battery
- Batteries in trains and strategically located KL will provide approximately **17%** energy savings. (deceleration and descent energy)
- Grid connection is assessed and there is availability of energy along this line.

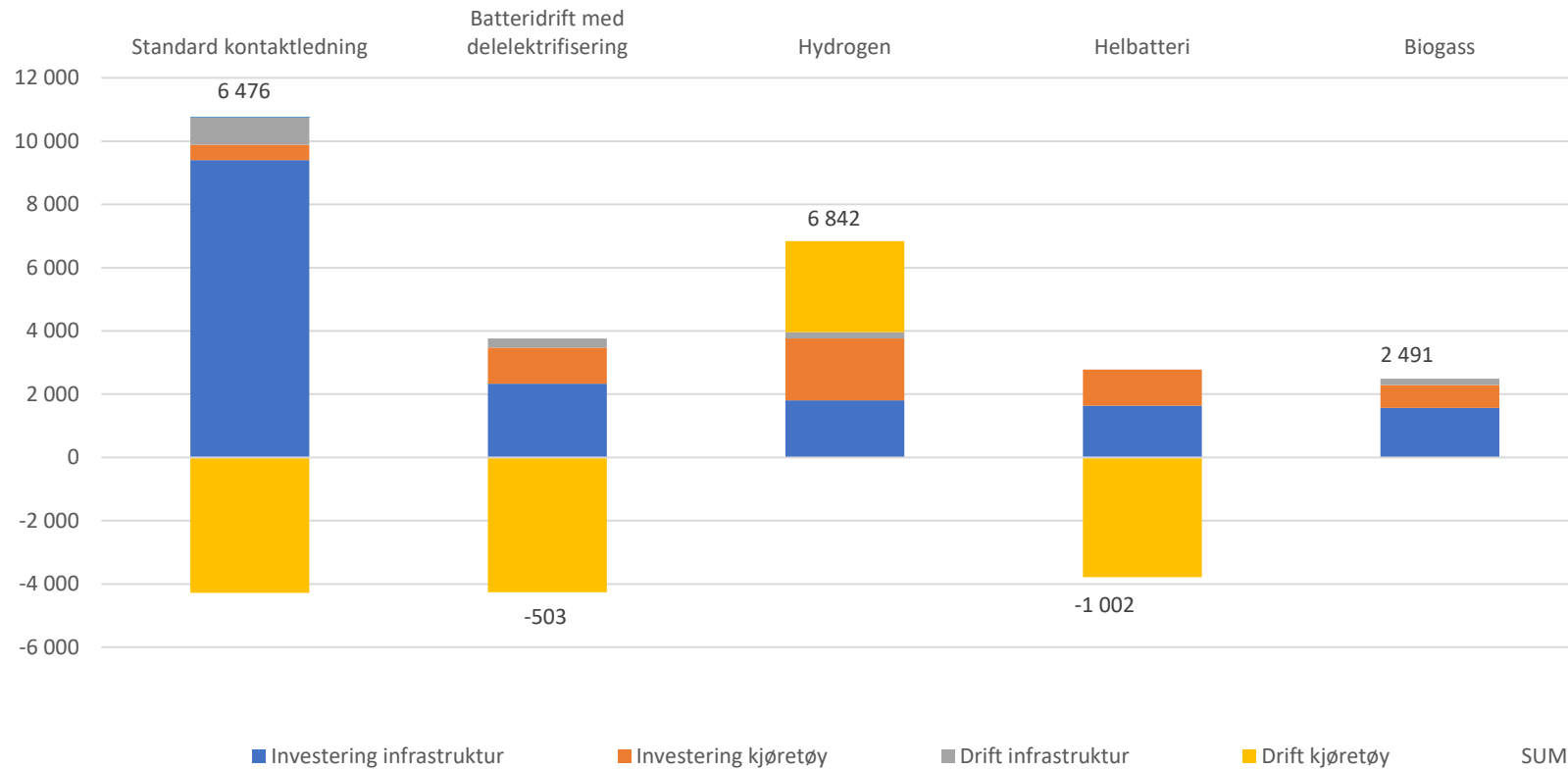


Horisontal profile – Nordland line

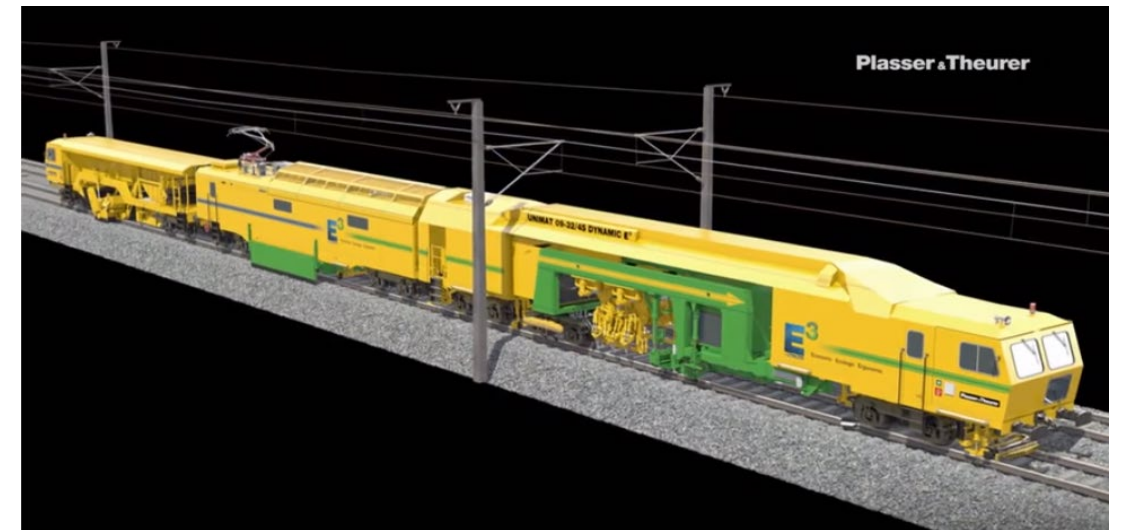
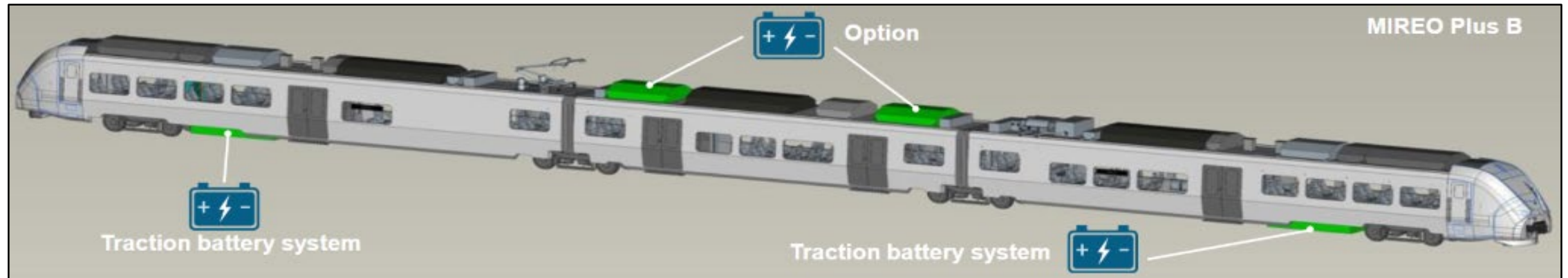


Cost effective analysis

Change in costs by introducing technology other than diesel / biodiesel for passenger transport and freight transport on the Nordlandsbanen Stjørdal-Bodø. Present values 75 years NOK 2019
million



What do the train manufacturers think?



Translated conclusion from SINTEF report (2019)

- SINTEF recommends that new, alternative solutions for zero emissions, such as fully-battery and hydrogen trains, as well as hybrids of these, are included when future operating concepts for remaining non-electrified lines in Norway and should be considered in more detail.

Availability of technology, for the evaluated concepts.

Driftsform	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2035	2040	2045	2050
Diesel	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
KL-anlegg	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Biodiesel	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Biogass	8	8	9	9	9	10	10	10	10	10	10	10	10	10	10
Helbatteri	8	9	10	10	10	10	10	10	10	10	10	10	10	10	10
Hurtiglading	5	6	7	8	9	10	10	10	10	10	10	10	10	10	10
Delelektrifisering	7	7	8	8	9	10	10	10	10	10	10	10	10	10	10
Hydrogen	3	5	7	8	9	10	10	10	10	10	10	10	10	10	10
H ₂ -hybrid	3	5	7	8	9	10	10	10	10	10	10	10	10	10	10

SINTEF expectation of regulation availability for the evaluated concepts.

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Thank you for your attention

...any comments or questions?

