



Jernbane-  
direktoratet

**Conceptual appraisal:**  
Increased utilization of ERTMS by ATO  
(Automatic Train Operation)

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# Why a Conceptual appraisal?

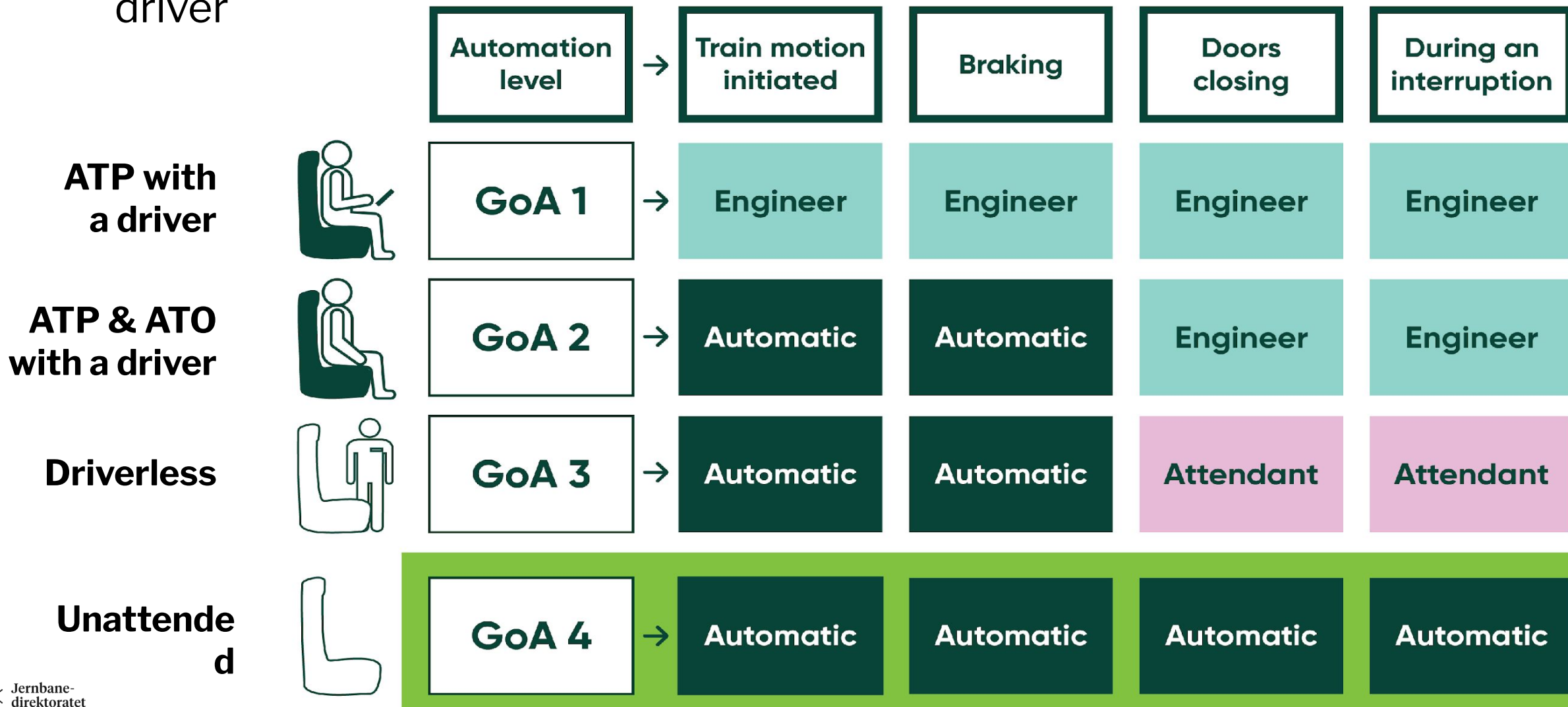
- Major investment in ERTMS L2 nationwide between 2024-2034
- Explore possibilities of further utilisation of the ERTMS
- Investigate if ATO is suitable for Norwegian conditions
- Investigate which problems and needs that can be met by investing in ATO in addition to ERTMS

The Norwegian project model

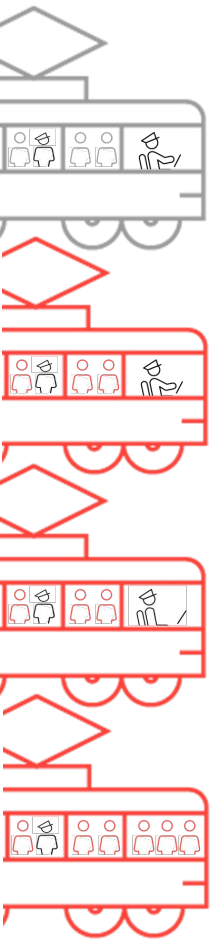


# What is ATO – Automatic train operation?

Computers gradually take over tasks performed manually by driver



# Conceptual alternatives:



Baseline

A

Driver assistance

B

Automatic driving

C

Driverless

**Driver assistance**

with C-DAS over ETCS L2

**Automatic driving**

GoA2 over ETCS L2  
with driver present

**Driverless** operation in  
GoA3/4 over ETCS L2.  
3 variants with different  
scope

# ATO-equipment for infrastructure and trains

TMS - Traffic Management System

Realtime traffic information and operational timetable

A

~~C-DAS infrastructure~~

A B C

ATO infrastructure

GSM-R/FRMCS  
Standard interface  
TSI CCS (FFFIS)

Automatic driving according to an optimized plan

Driver advice according to an optimized plan

A

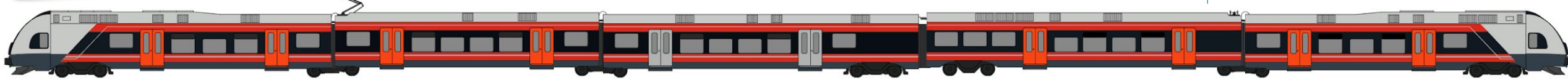
C-DAS on board equipment

The train's ETCS computer and driving control computer

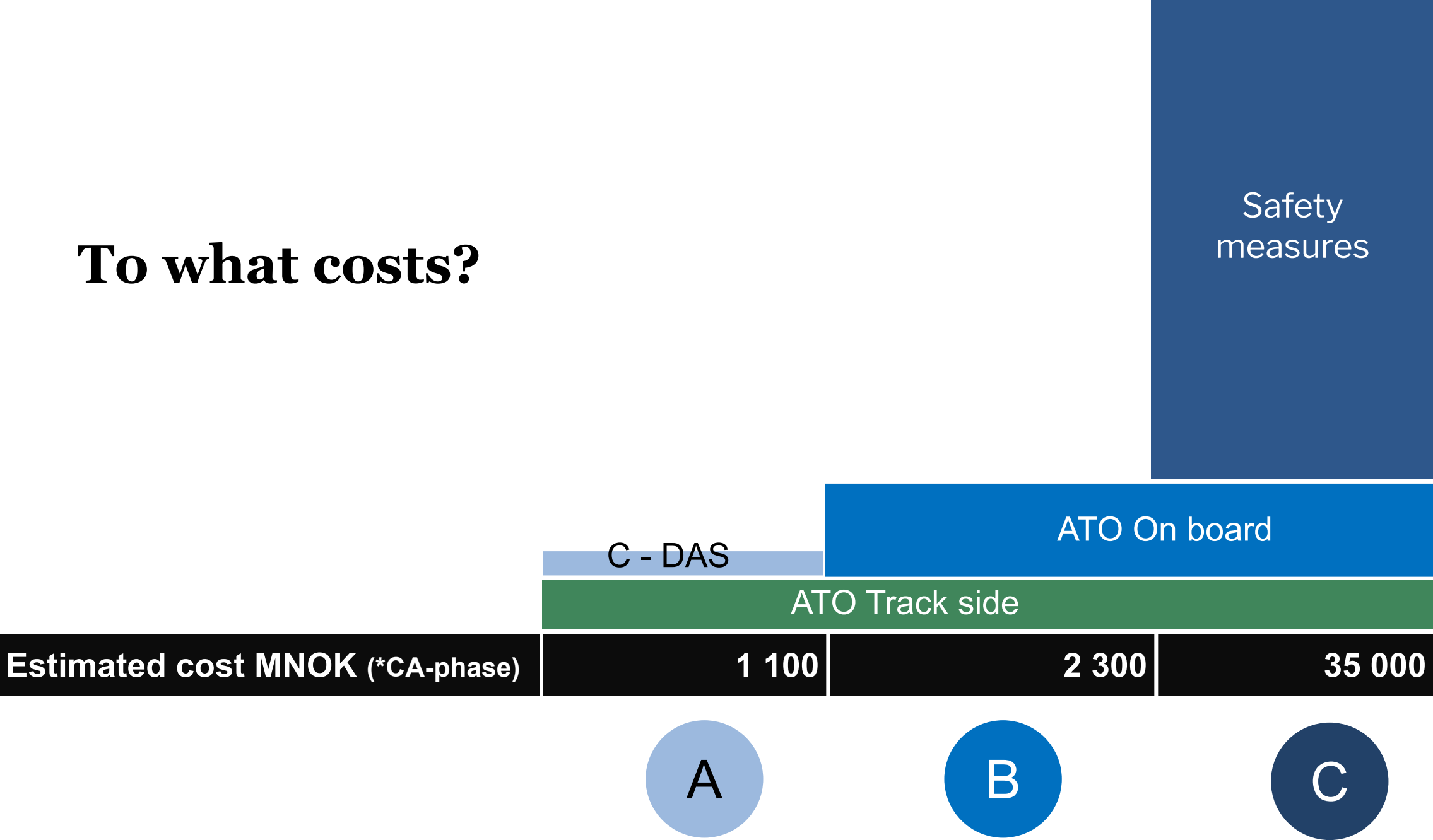


B C

ATO on board equipment



# To what costs?





# Findings from the analysis: Identified benefits

- Energy optimized and time optimized driving profiles simulated for each concept
- Significant reduction in delay (@time optimized profile)

Concept	0 Baseline ETCS L2	A C-DAS	B ATO GoA2	C ATO GoA 3/4
Total reduced delay - <b>Passenger trains</b> (Oslo-area)	1,19/1,08 min = 0%	17 – 22%	19 - 24%	23 – 27%
Total Reduced delay - <b>Freight trains</b> (24h average)	0,48 min = 0%	27%	-	33%

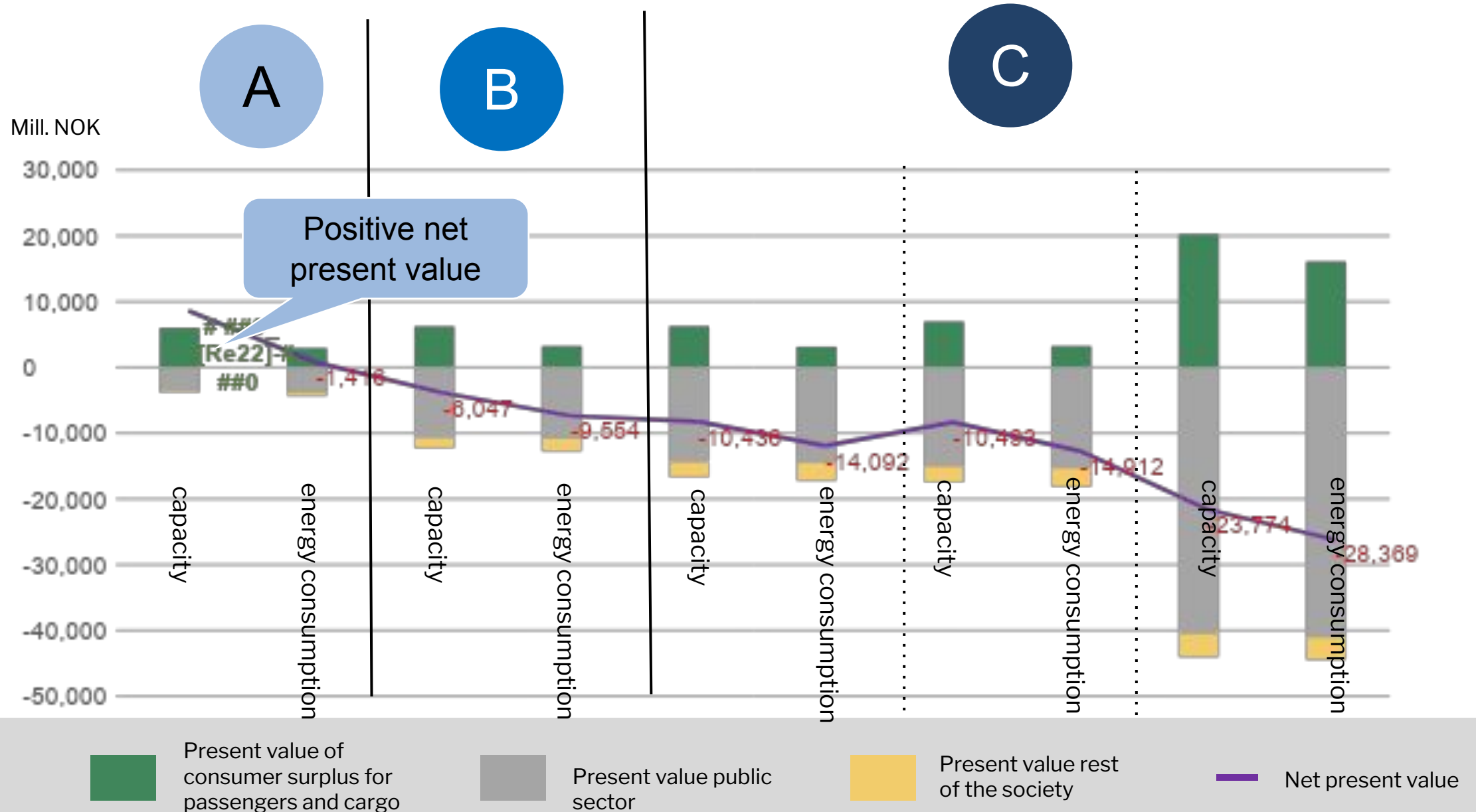
- Small reduction in headway (@time optimized profile)
  - The Oslo tunnel: Highly optimized already with 120s headway and 24 trains/hour rush
  - GoA2 is potentially gaining <4s, giving maximum one single timeslot
- Energy consumption reduced with ~2% (@energy optimized profile)

# Other findings from the analysis

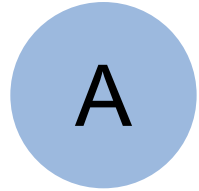
## Observations and limitations

- Very few systematic measures of Norwegian driving profiles
  - Lacking reference data
- Exploiting the full potential requires optimized timetables
  - Operational timetables with resolution down to a second
- Important with training programs focusing on continuous improvement

# Cost benefit analyses



# Our recommendation



- Concept A - Driver assistance is recommended for further planning
- The concept is viewed as a first step towards utilizing automatic train operations
- The appraisal recommends that the next phase awaits further experience of ERTMS deployment before start-up



**Thank you for your attention!**