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Freight Rail Efficiency Improvement Through Operational Coordination

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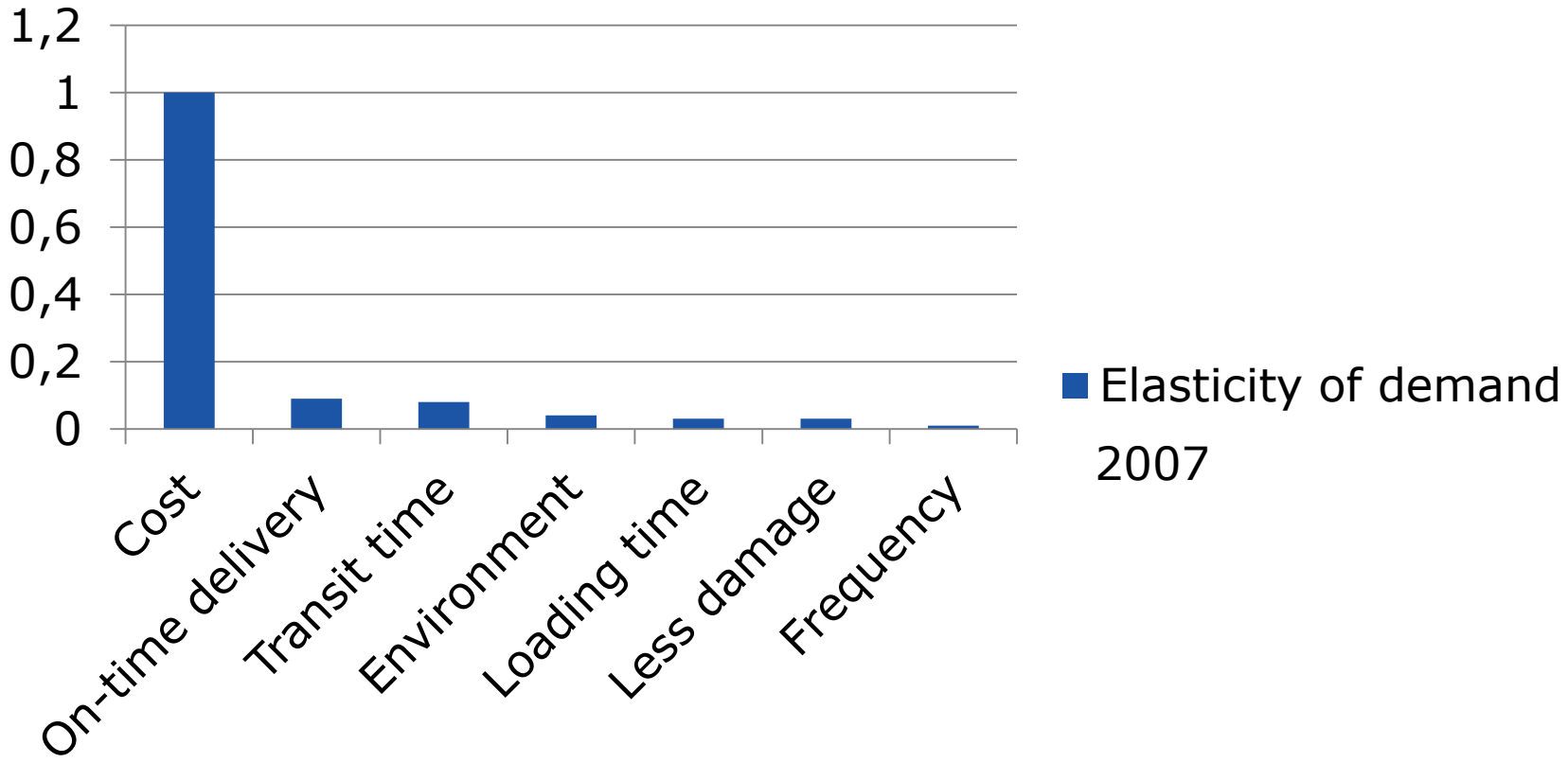
2011-10-05

Main Topics

- Traffic trends
- Capacity bottlenecks
- Infrastructure improvement plans
- Limiting technical standards
- Recommended best practice

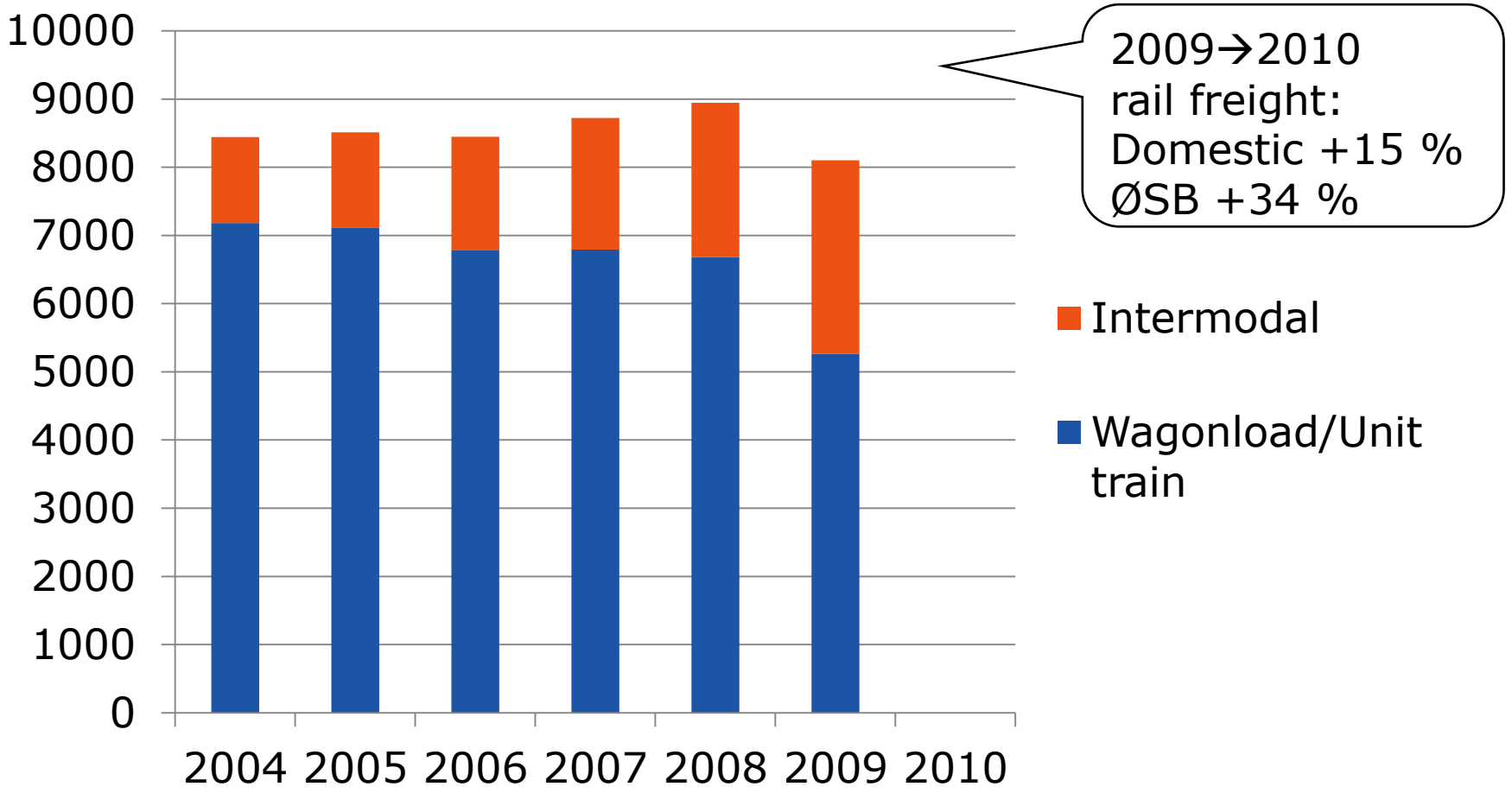
Shippers' Priorities

Elasticity of demand indexed by cost



Swedish Cross-border Rail Freight

Tonnage excluding iron ore (1000 tons)



Direct Rail Freight Relations 2011

o/w = one way
r/t = round trip

- Intermodal trains

Oslo A–ØSB–Rotterdam RSC r/t	2/wk	Bring Frigo
Katrineholm–ØSB–Herne WW r/t	5/wk	van Dieren Maritime
Nässjö–ØSB–Herne WW r/t	3/wk	van Dieren Maritime
Göteborg G–ØSB–Herne WW r/t	5/wk	van Dieren Maritime
Helsingborg–ØSB–Herne WW r/t	4/wk	van Dieren Maritime/KV
Malmö–ØSB–Taulov r/t	7/wk	Hupac
Malmö–ØSB–Hannover Leinetor r/t	6/wk	LKW Walter
Malmö–ØSB–Herne WW r/t	6/wk	TX Logistik
Malmö–ØSB–Krefeld r/t	6/wk	LKW Walter
Taulov–Hamburg Billwerder r/t	3/wk	Kombiverkehr
Taulov–Busto Arsizio G r/t	10/wk	Hupac
Taulov–Verona QE r/t	5/wk	Hupac
Padborg–Hall–Verona QE r/t	2/wk	TX Logistik
Padborg–Verona QE r/t (direct)	2/wk	TX Logistik

Direct Rail Freight Relations 2011

o/w = one way
r/t = round trip

- Wagonload trains

Borlänge–TS–Seddin o/w	6/wk	Green Cargo
Malmö–ØSB–Fredericia r/t	5/wk	Green Cargo
Malmö–ØSB–Maschen r/t	27/wk	Green Cargo
Malmö–TS–Seddin o/w	5/wk	Green Cargo
Trelleborg–TR–Domodossola r/t	1/wk	Nordisk Transport Rail
Trelleborg–TR–Treviso r/t	2/wk	Nordisk Transport Rail
Maschen–ST–Malmö o/w	3/wk	Green Cargo
Seddin–ST–Malmö o/w	12/wk	Green Cargo

- Unit trains

Älmhult–ØSB–Gent Z r/t	12/wk	Volvo
Göteborg A–ØSB–Hannover Lin. r/t	5/wk	Volvo
Malmö–ØSB–Maschen r/t	12/wk	Scandfibre Logistics
Malmö–ØSB–Dortmund O/S r/t	19/wk	Scandfibre Logistics

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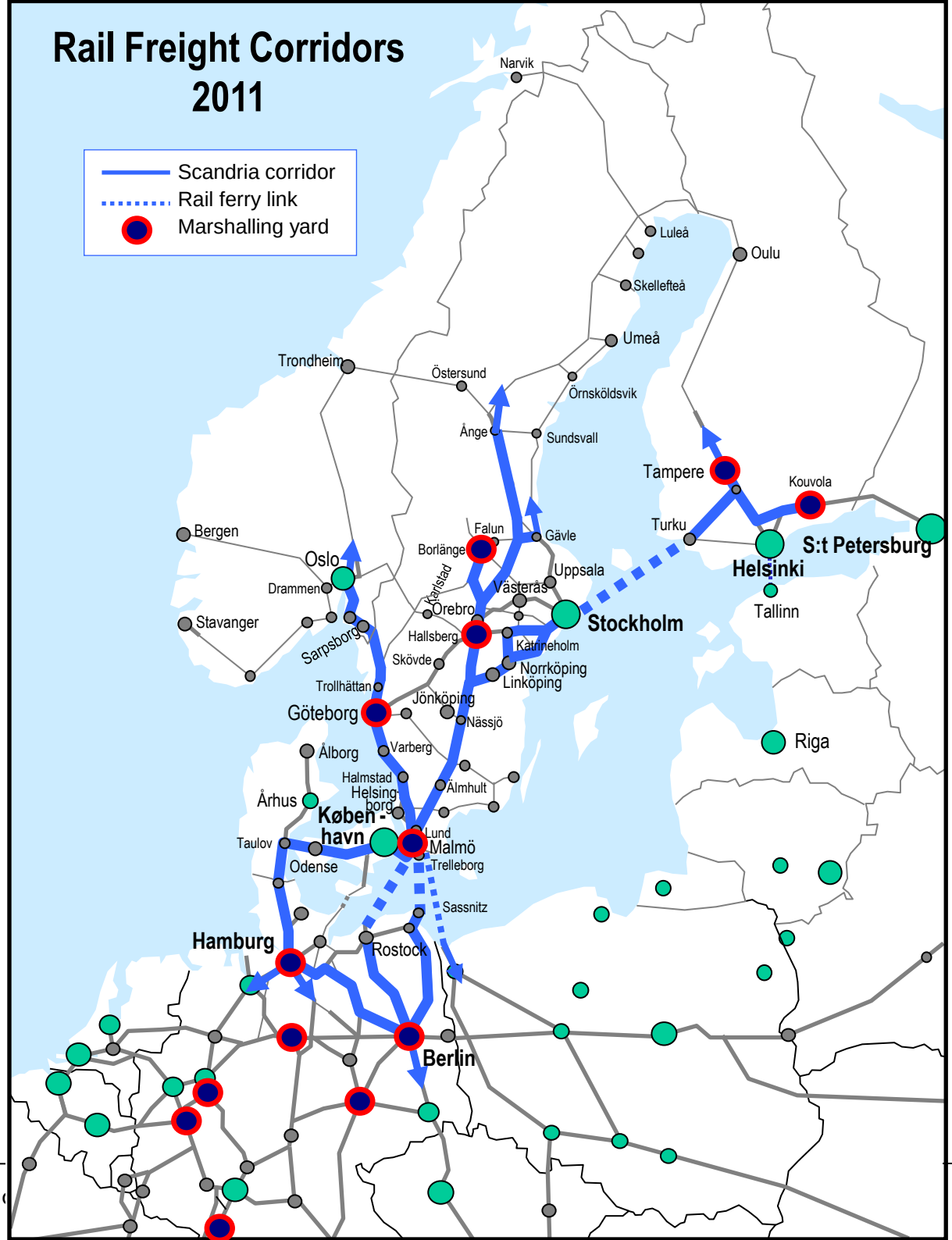
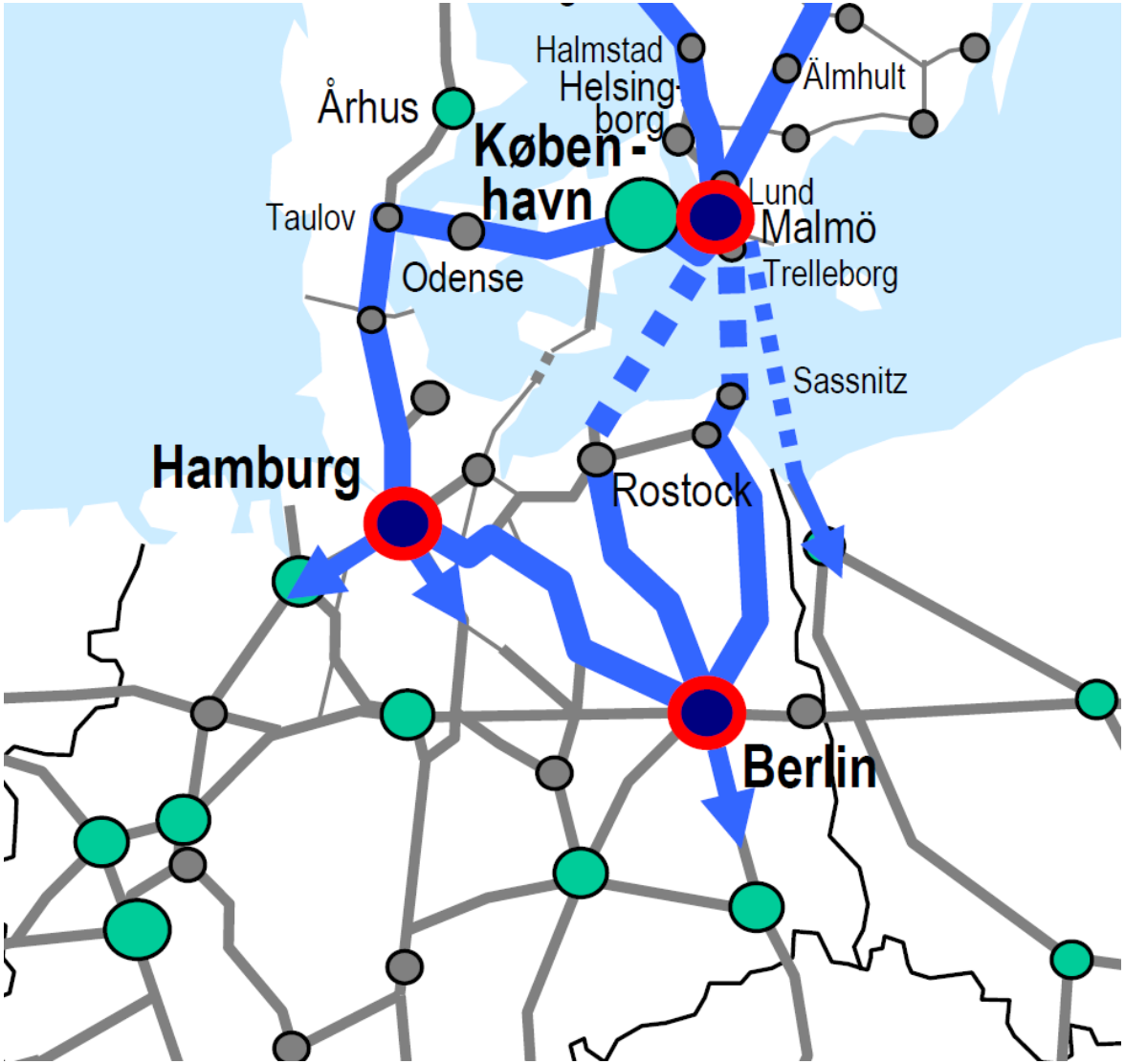
Rail Freight Corridors 2011



Rail Freight Corridors in 2011

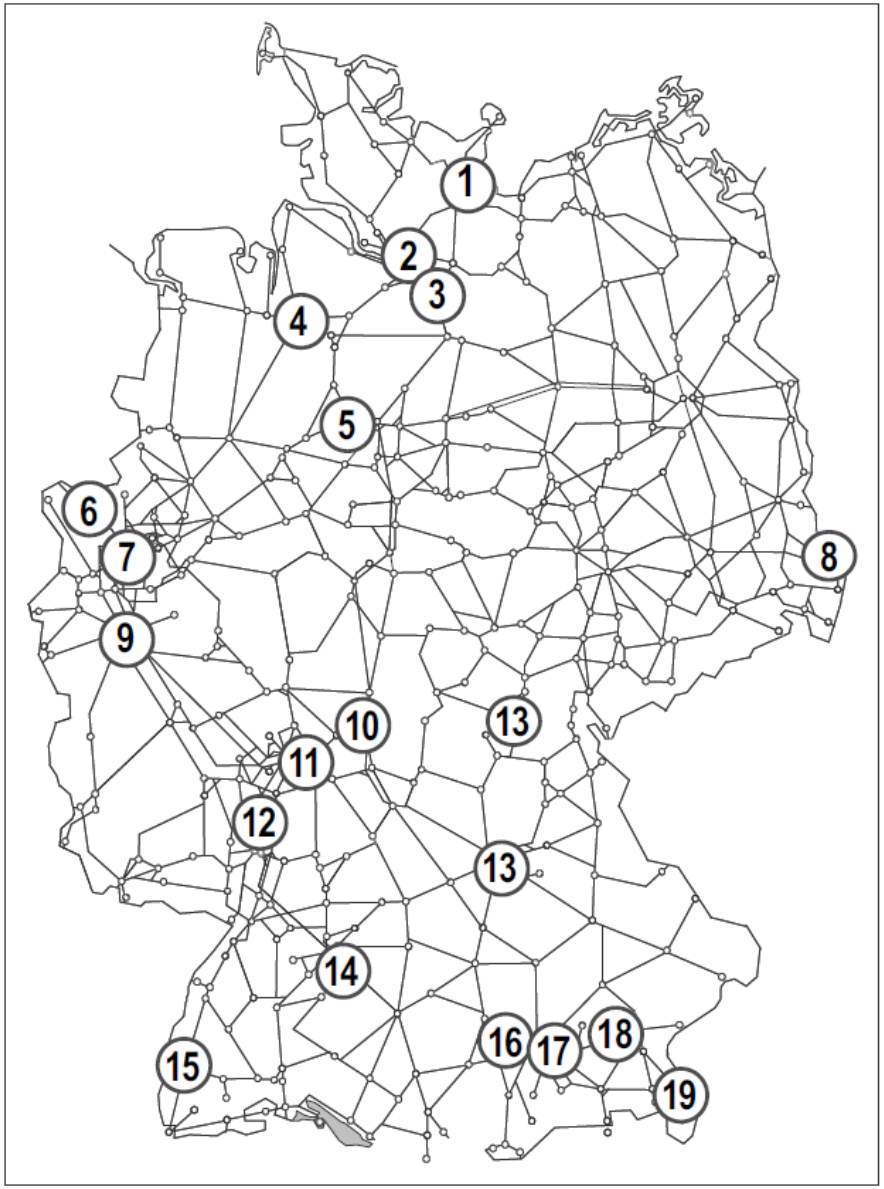
<u>Freight train paths/day in each direction:</u>
Via Taulov 48

Via Rostock 3 (large)
Via Sassnitz 4



Germany: Capacity Bottlenecks in 2006

	Engpassbereiche
1	Bad Schwartau–Lübeck-Kücknitz ✓
2	Knoten Hamburg
3	Stelle–Lüneburg
4	Knoten Bremen
5	Seelze–Minden
6	Emmerich–Oberhausen
7	Düsseldorf–Duisburg
8	Hoyerswerda–Horka–Grenze/PL
9	Knoten Köln
10	Fulda–Frankfurt am Main
11	Knoten Frankfurt am Main
12	Rhein/Main–Rhein/Neckar
13	Nürnberg–Fürth–Leipzig
14	Stuttgart–Ulm
15	Karlsruhe–Basel
16	Augsburg–München
17	Knoten München
18	München–Mühldorf
19	Salzburg–Freilassing



Map: BMVBS

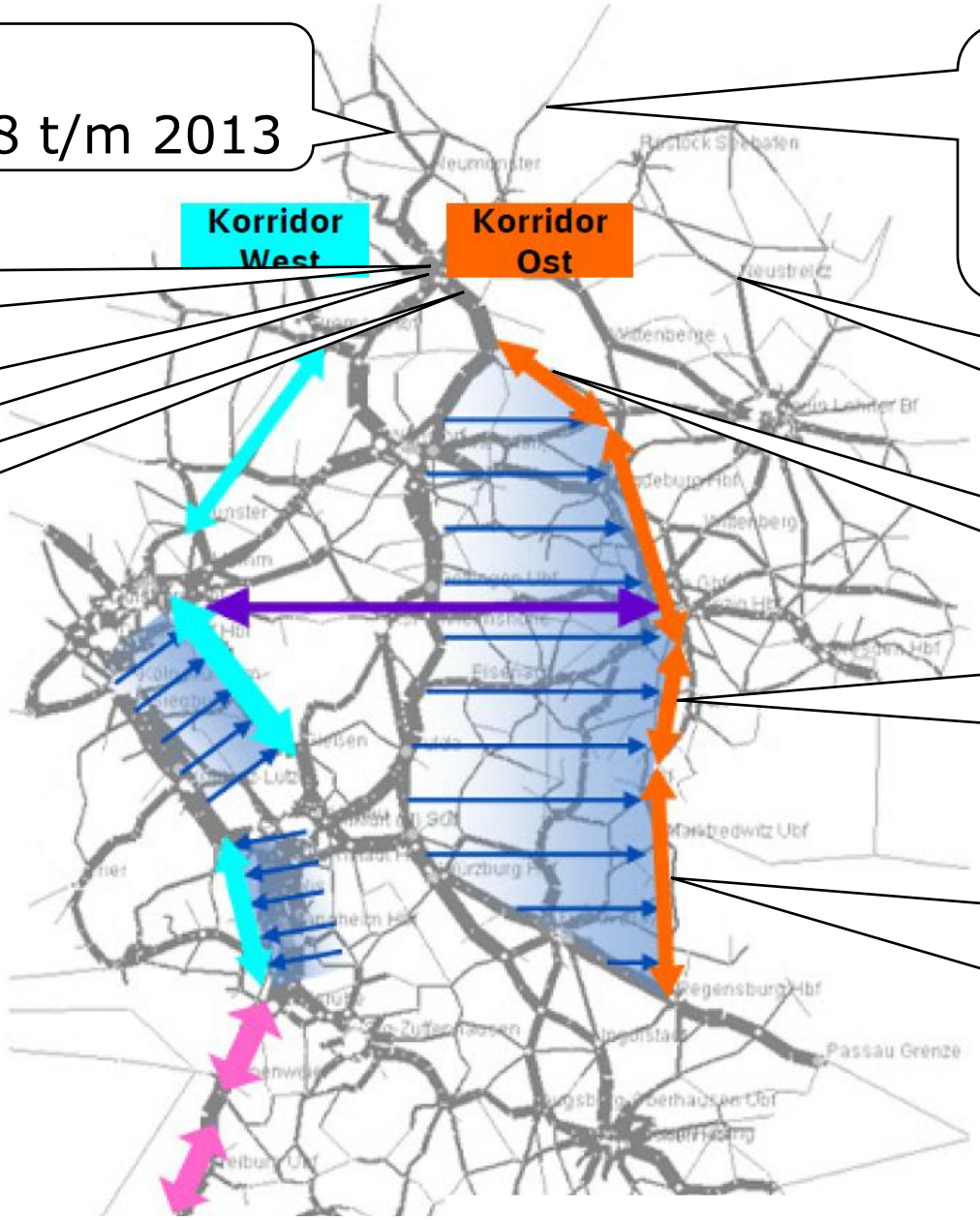
Germany: Capacity Expansions

Rendsburg
22.5 t/axle, 8 t/m 2013

Ahrensburg-
Hamburg TT

Hamburg
shorter blocks

Stelle-Lüneburg
TT 2015



Puttgarden-
(Fehmarnsund)-
Bad Schwartau
E 2020, DT 2027

Rostock-Berlin
25 t/axle 2013

Uelzen-Stendal
DT ≈2017

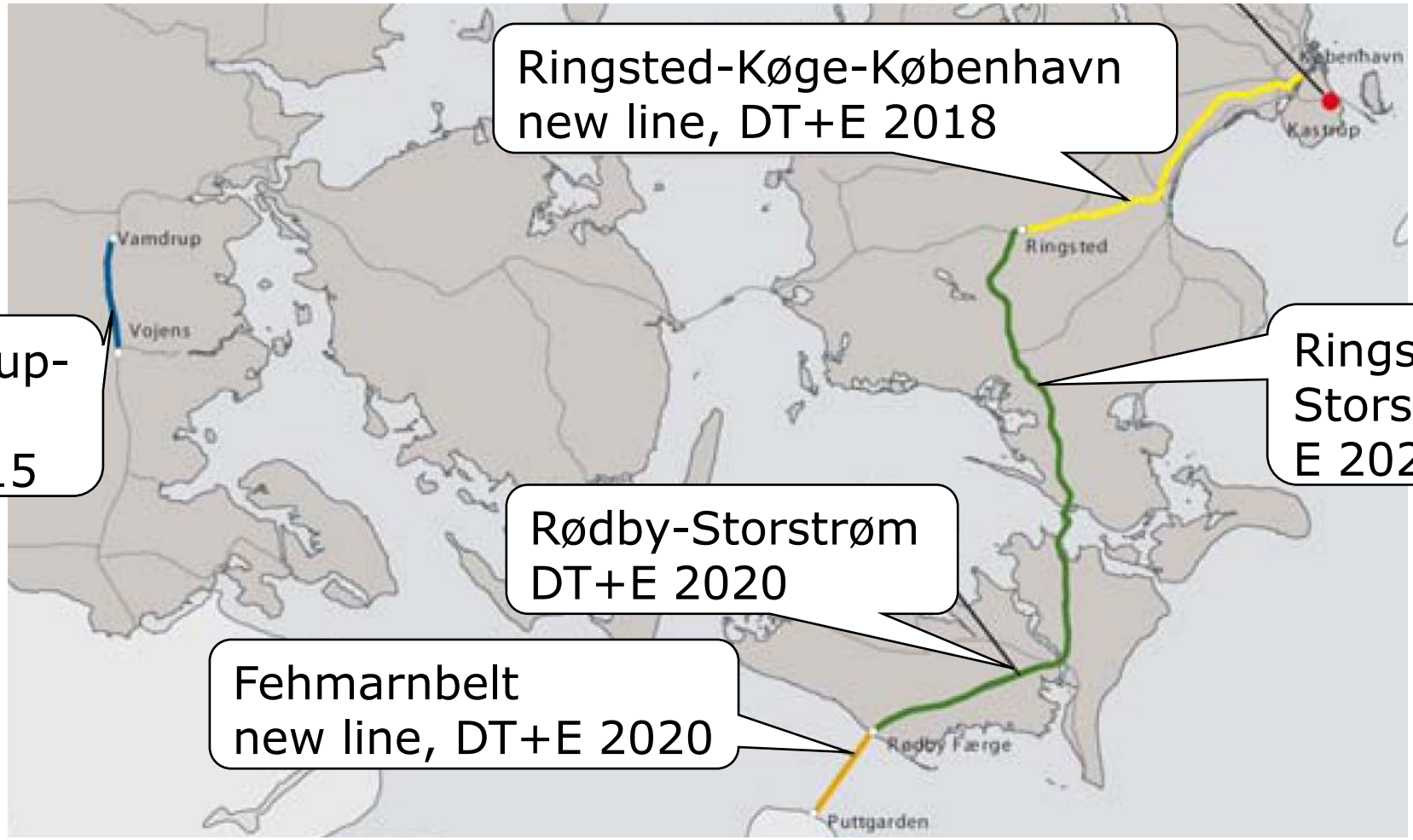
Hof-
Reichenbach
E 2013

Reichenbach-
Marktredwitz-
Regensburg
E ≈2019

Map: DB Netze

E = electrification
DT = double track
TT = triple track

Denmark: Capacity Expansions



Map: TM

DT = double track
E = electrification

Sweden: Capacity Bottlenecks in 2011 and Expansions

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Västeraspby-Härnösand
U, sidings 2012-08-01

Kilafors-Söderhamn
U, CTC, siding 2016

Sundsvall-Gävle
sidings 2011-2014, ≈2021

Kilafors-Holmsveden
siding ≈2021

Stockholm
QT 2017

Trollhättan-Göteborg
DT 2012

Hallsberg-Degerön
siding ≈2013

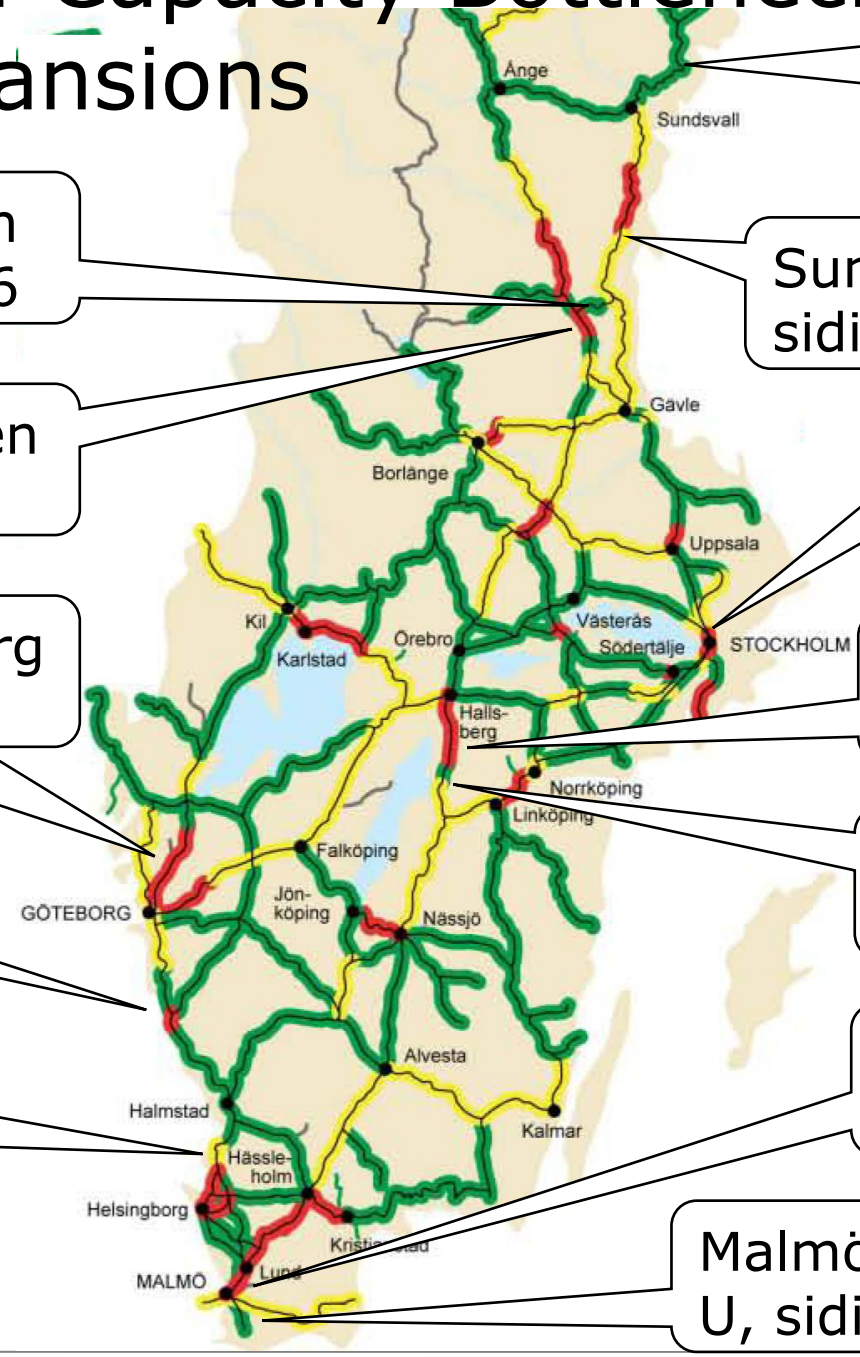
Varberg
DT ≈2021

Motala-Fågelsta
DT 2012

Hallandsåsen
DT, tunnel 2015

Flackarp-Arlöv
QT 2018

Malmö-Trelleborg
U, siding 2015



DT = double track
QT = quadruple track
U = upgrade

Map: TRV

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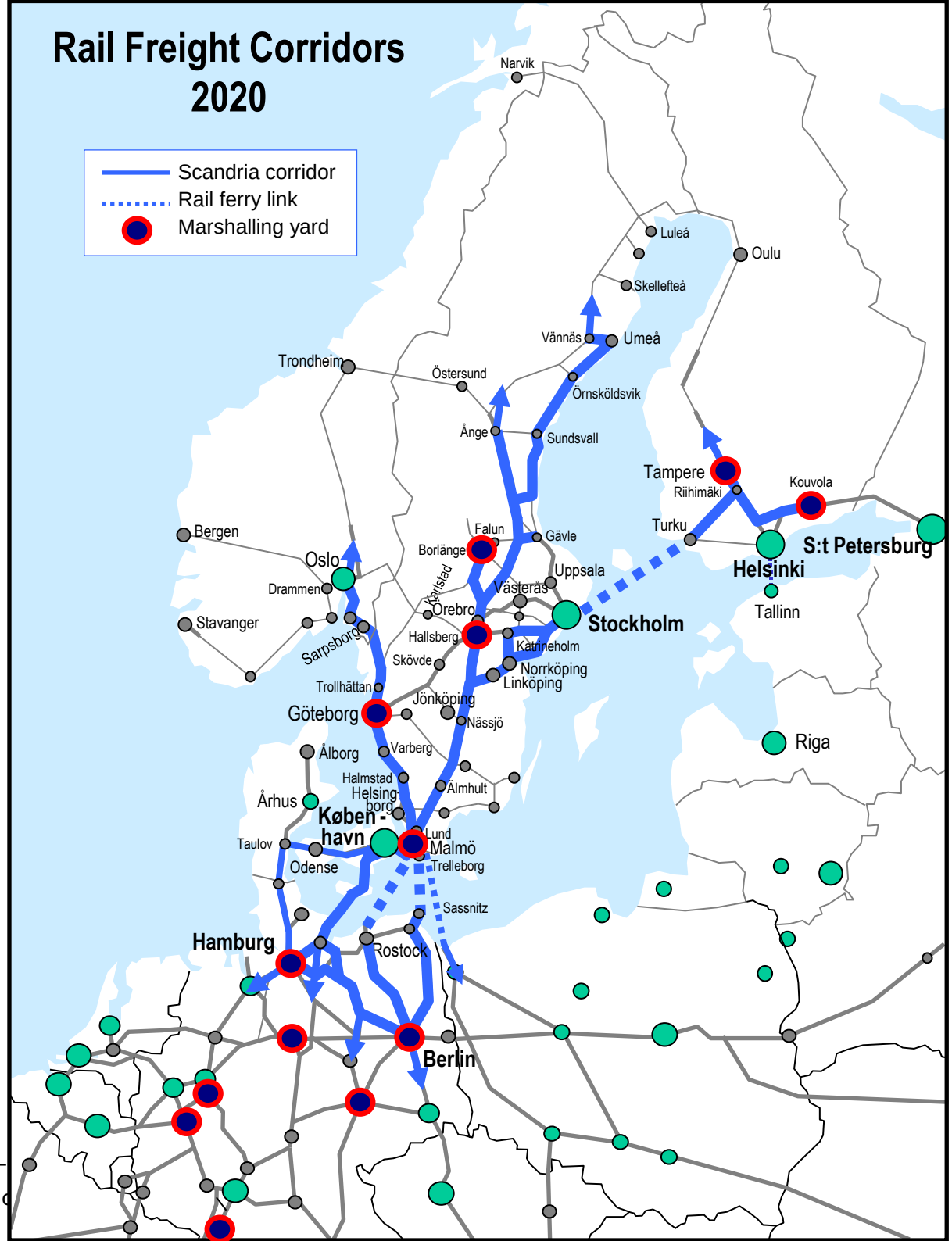
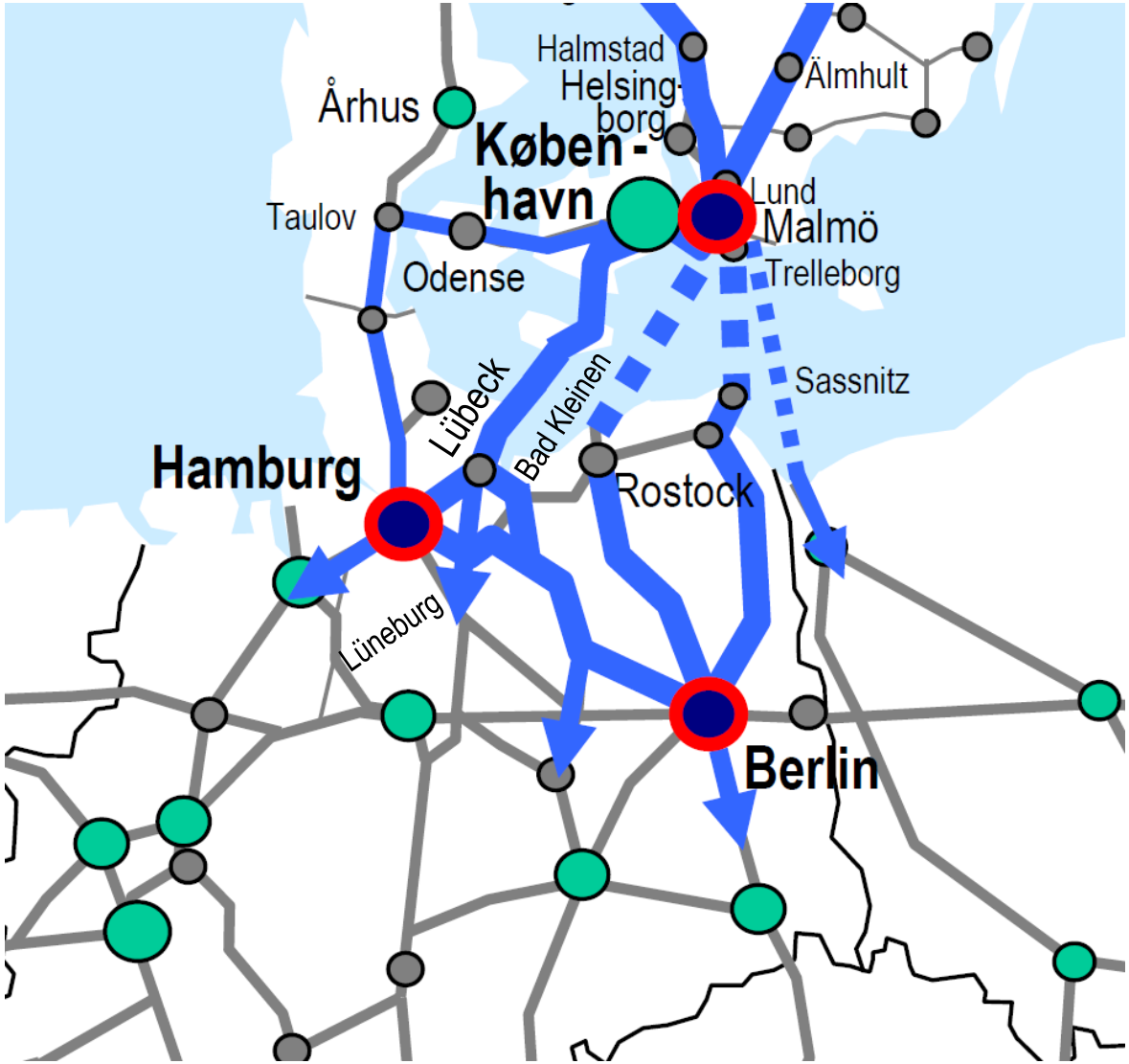
Rail Freight Corridors 2020



Rail Freight Corridors from 2020

<u>Freight train paths/day in each direction:</u>
Via Taulov 48
Via Fehmarnbelt <u>also</u> 48



<u>Possible improvements:</u>

Shortest routes, electrification needed

- Lübeck-Lüneburg
- Lübeck-Bad Kleinen

Connection needed

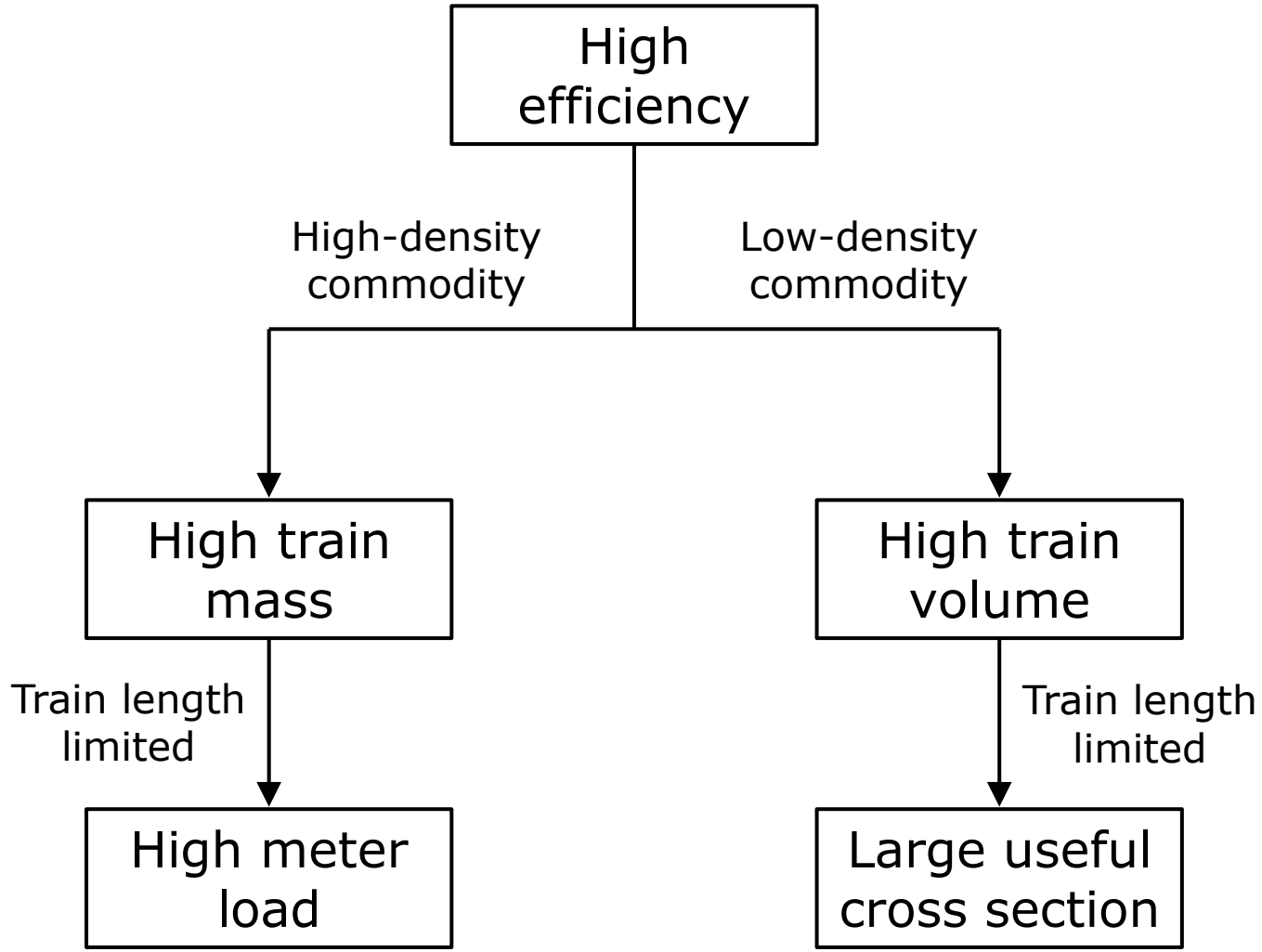
- Bad Kleinen

Rail Freight Policy

EU 2011:

- Transfer 30 % of road freight to rail and sea by 2030,
- and transfer 50 % by 2050.

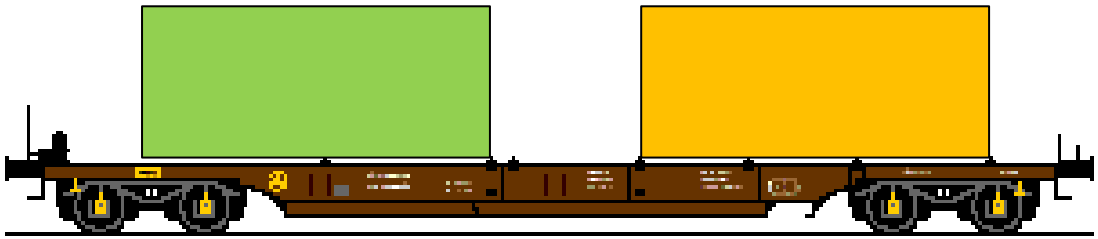
Operational Goals



Today's Actual Meter Loads

- Common commodities

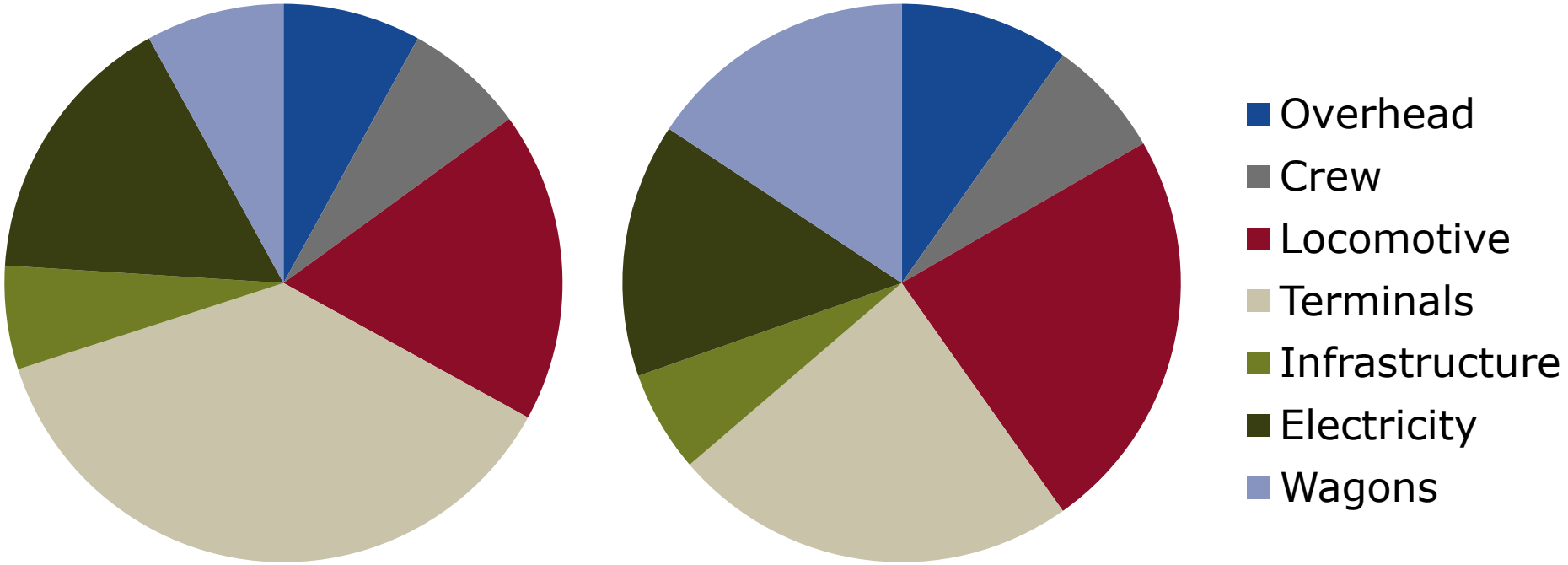
  - intermodal trains: 2.0 to 2.5 tons/m



  - paper in Habbins wagons: 3.9 tons/m

Rail Freight Costs (Flodén 2011)

Medium-cost scenario **High-cost scenario**



- Independent of train size: overhead, crew
- Incremental: locomotive(s)
- Less than proportional to train size: terminals, infrastructure
- Approx. proportional to train size: electricity, wagons

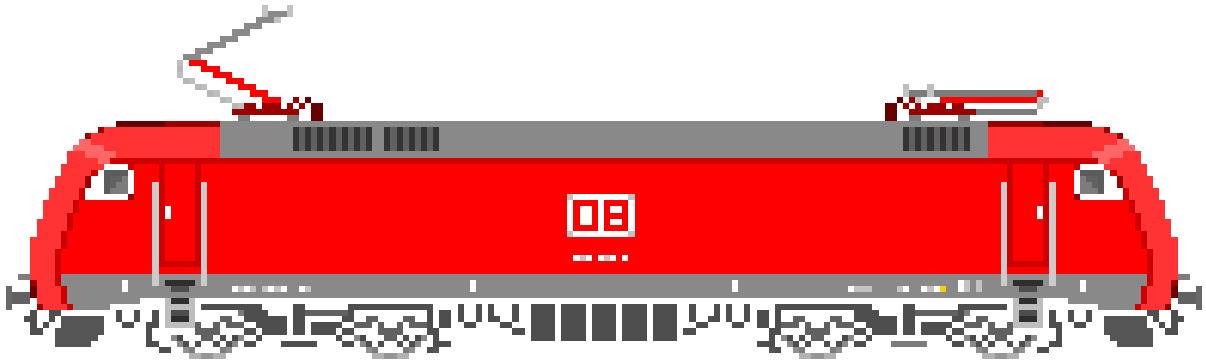
∴ Large trains, utilizing each locomotive fully, minimize cost per load unit.

Train Tonnage Limitations

- Ratings for modern locomotive (84 tons, 5600 kW)

  - on 10 to 12.5 ‰ gradient: ≈ 2400 – 2600 tons

  - on 16.5 ‰ gradient: 1600 – 1700 tons (Storebælt)



Sample Operating Scenarios

Assumptions (medium term): Train lengths, gradients, locomotives given.

	Corresponding meter load			
	1 loco		2 locos	
Gradient	17 ‰	10 – 12 ‰	17 ‰	10 – 12 ‰
Tonnage rating	1700 tons	2500 tons	3400 tons	5000 tons
Train length 700 m	2.4 tons/m	3.6 tons/m	4.9 tons/m	7.1 tons/m
Train length 800 m	2.1 tons/m	3.1 tons/m	4.2 tons/m	6.2 tons/m

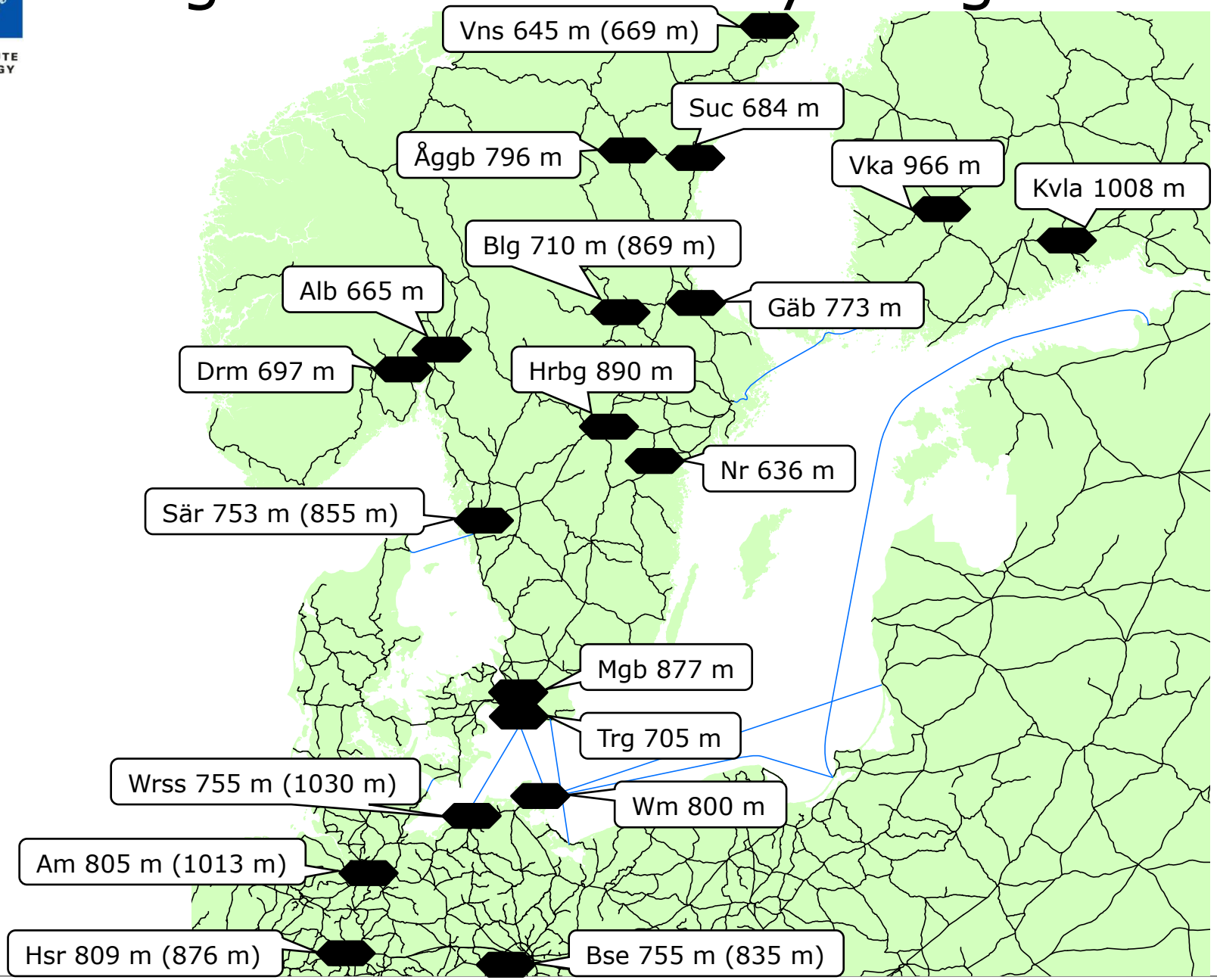
To achieve high system utilization

∴Intermodal trains: 1 locomotive, (2–2.5)→≈3 tons/m

∴Paper trains: 2 locomotives, (3.9)→≈6 tons/m

… but how?

Long Tracks of Railway Freight Yards

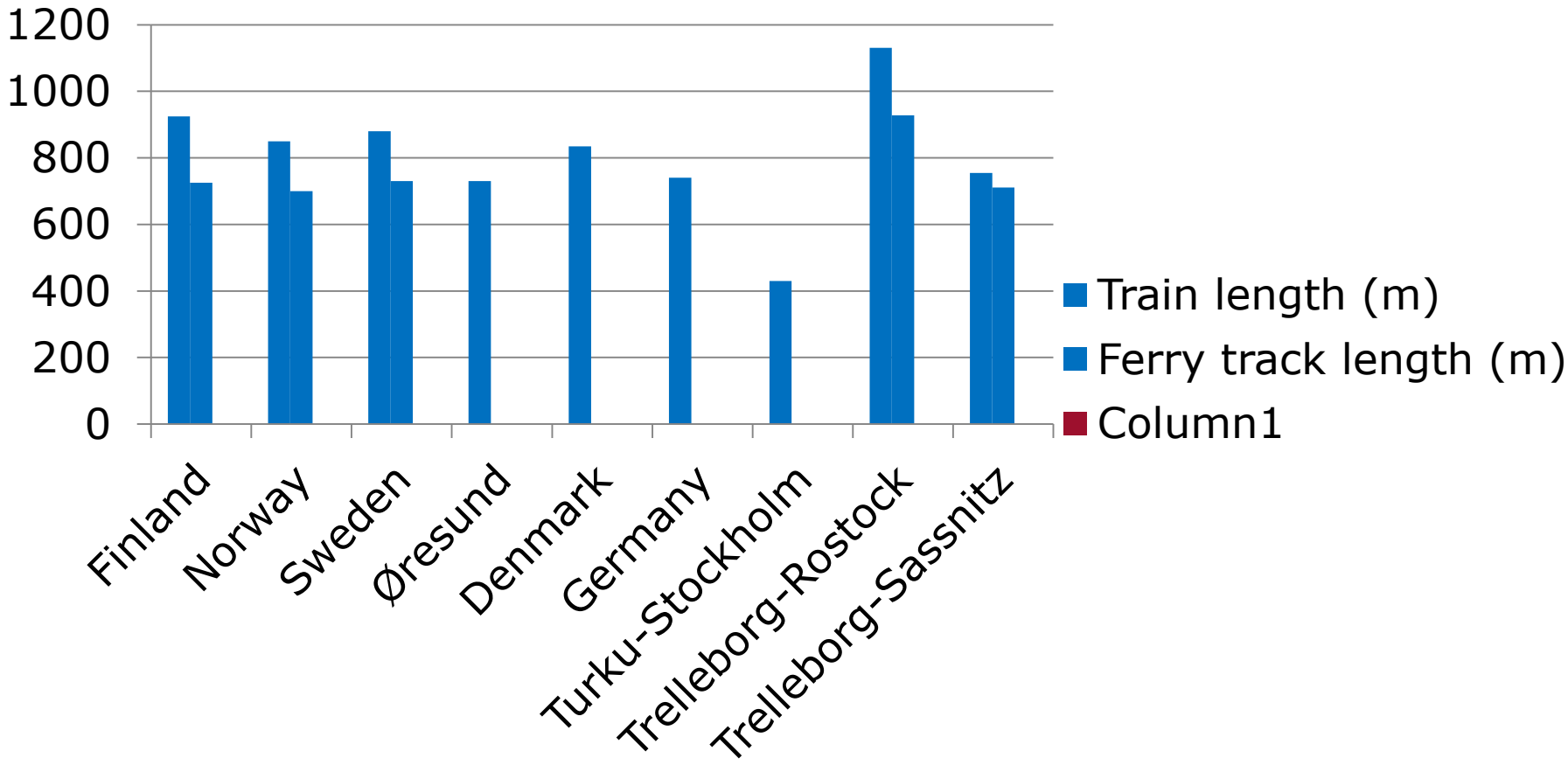


Note: Track lengths shown are electrified receiving or departure tracks (others).

Map: KTH

Present Corridor Standards

Train length w.r.t. brakes, ferry track length (m)



Development: Train length Padborg-Hamburg 835 m planned for 2011.

Present Corridor Standards

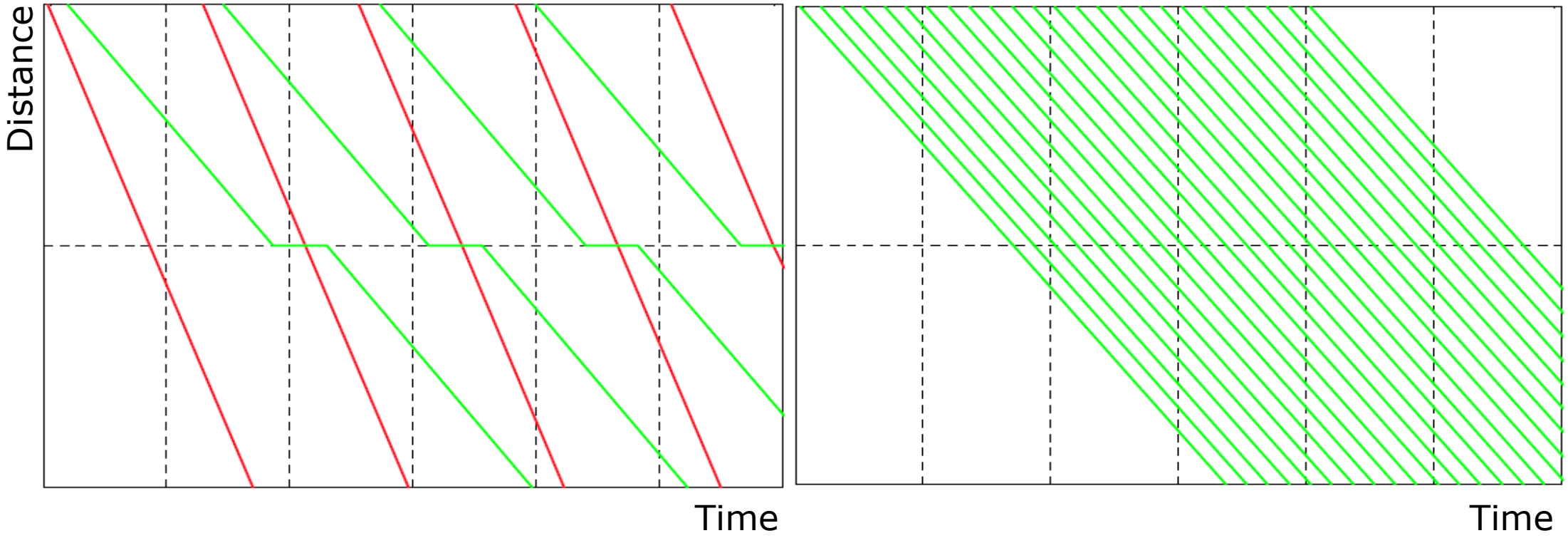
Freight train speed vs. length (Denmark)

Speed (km/h)	Train length (m)
100	835
120	600

Limited by braking performance and signal distance.

The Role of Speed

Mixed traffic consumes available capacity ...



... while homogenous traffic at uniform speed can run at high frequency.

Speed vs. Load Rating of Wagons

ABCDE markings, example (Shimmnss)

	A	B	C	D	E
S	38,7 t	50,5 t	60,5 t	68,5 t	78,5 t
SS	38,7 t	50,5 t	58,5 t		

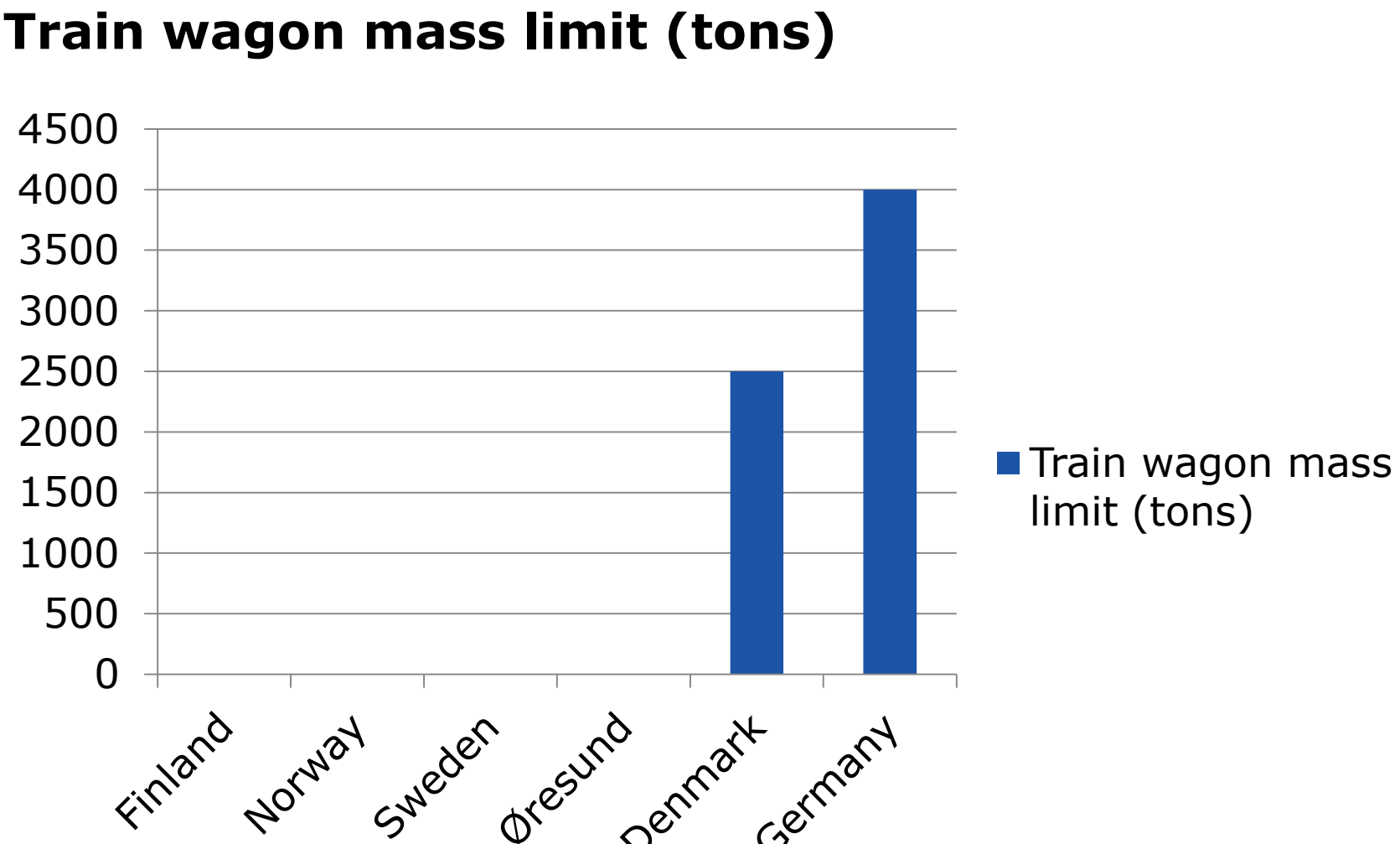
Legend

Track axle load limit: A=16 t, B=18 t, C=20 t, D=22.5 t, E=25 t

Wagon speed limit: S=100 km/h, SS=120 km/h

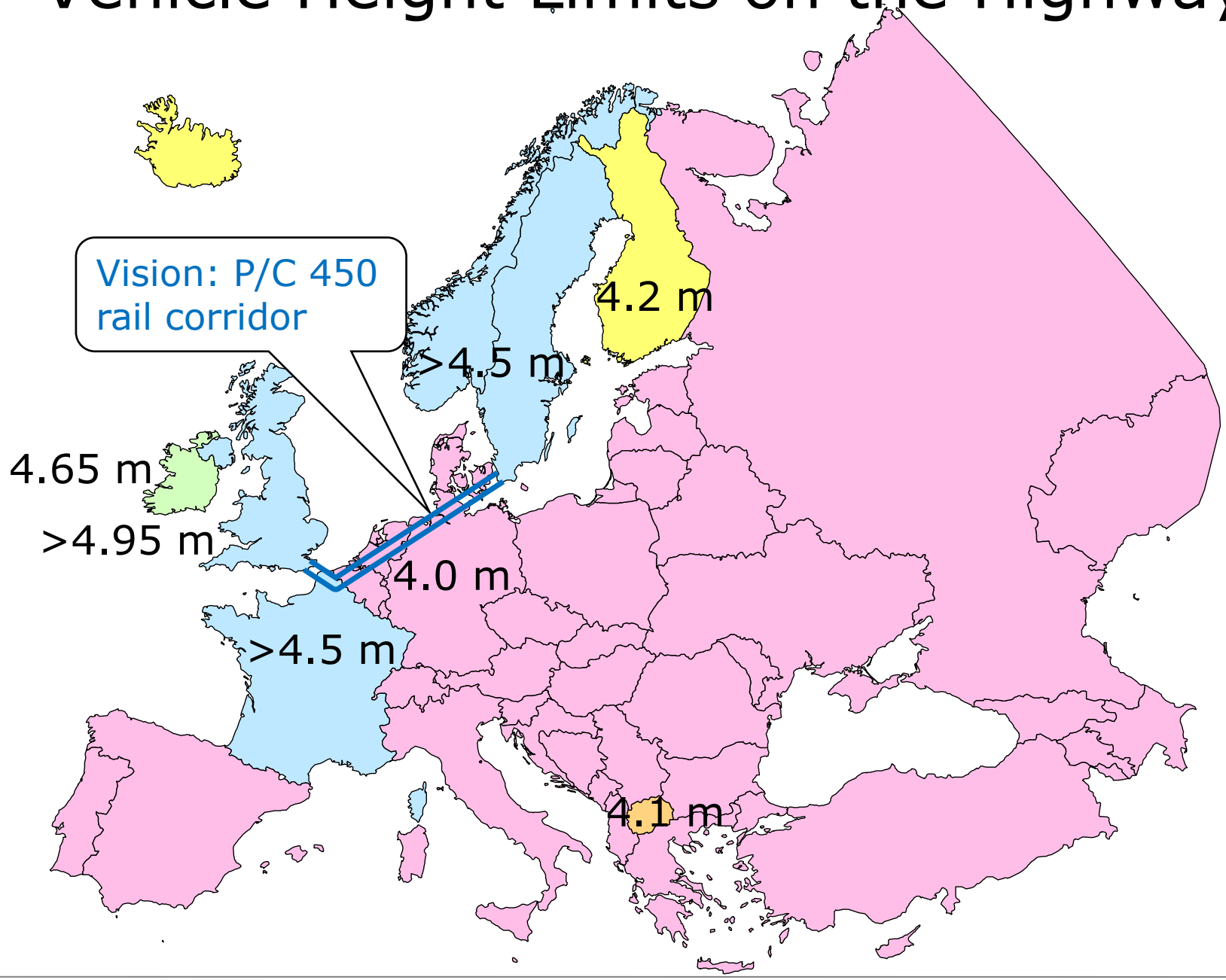
Wagon load limit: t

Present Corridor Standards



Note: Limits for screw couplers. Higher values for automatic couplers.
Tractive effort of 0.60 MN corresponds to ≈5200 tons on 10 ‰

Vehicle Height Limits on the Highway



Railway Intermodal Gauges

Interunit 2009 (modified)

Fran-Scan Hi-cube Intermodal Corridor G2, P/C 450 (proposed)

P450

P432

P422

P410

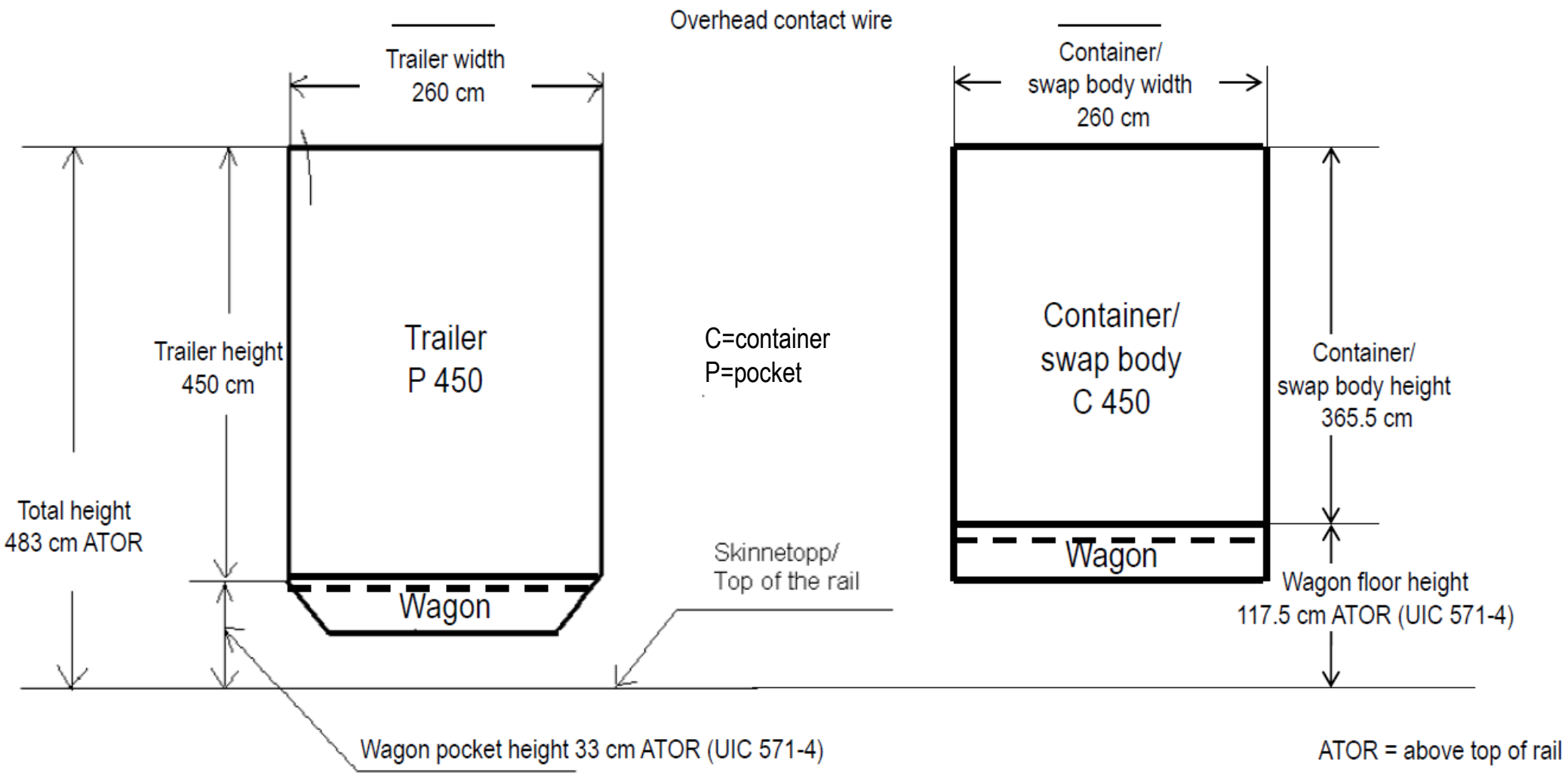
P400

P380

P359

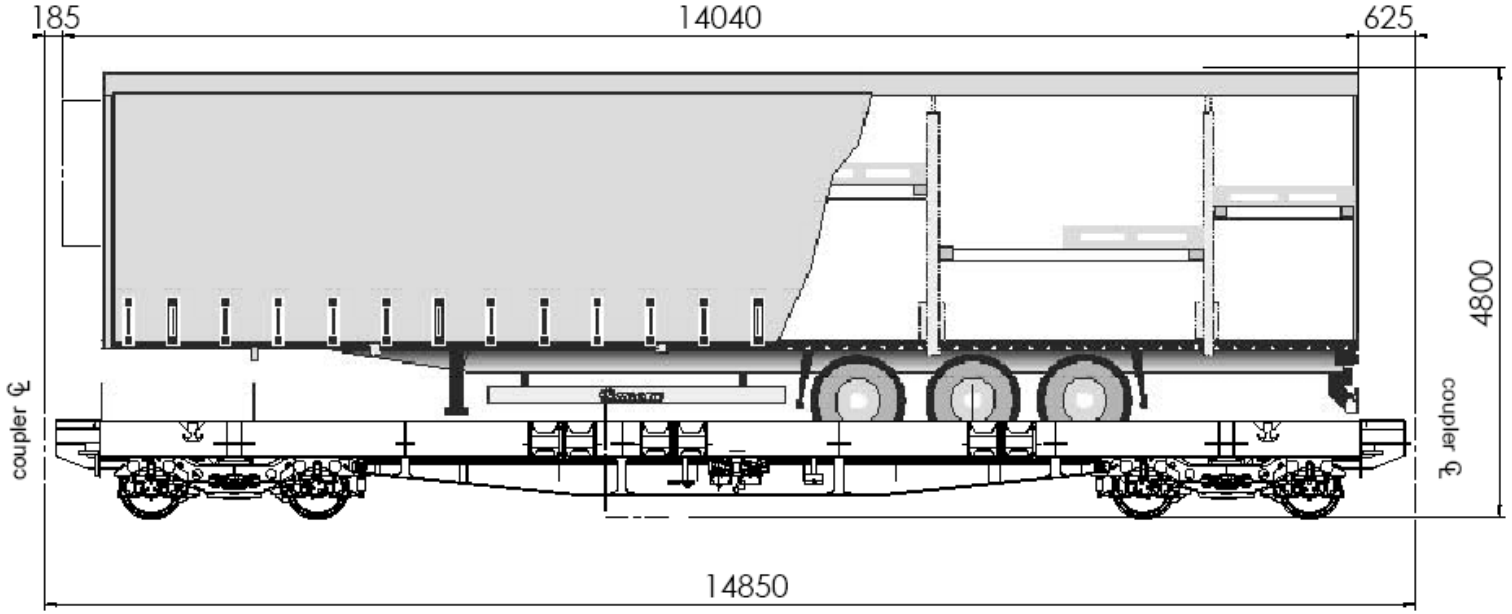
No code

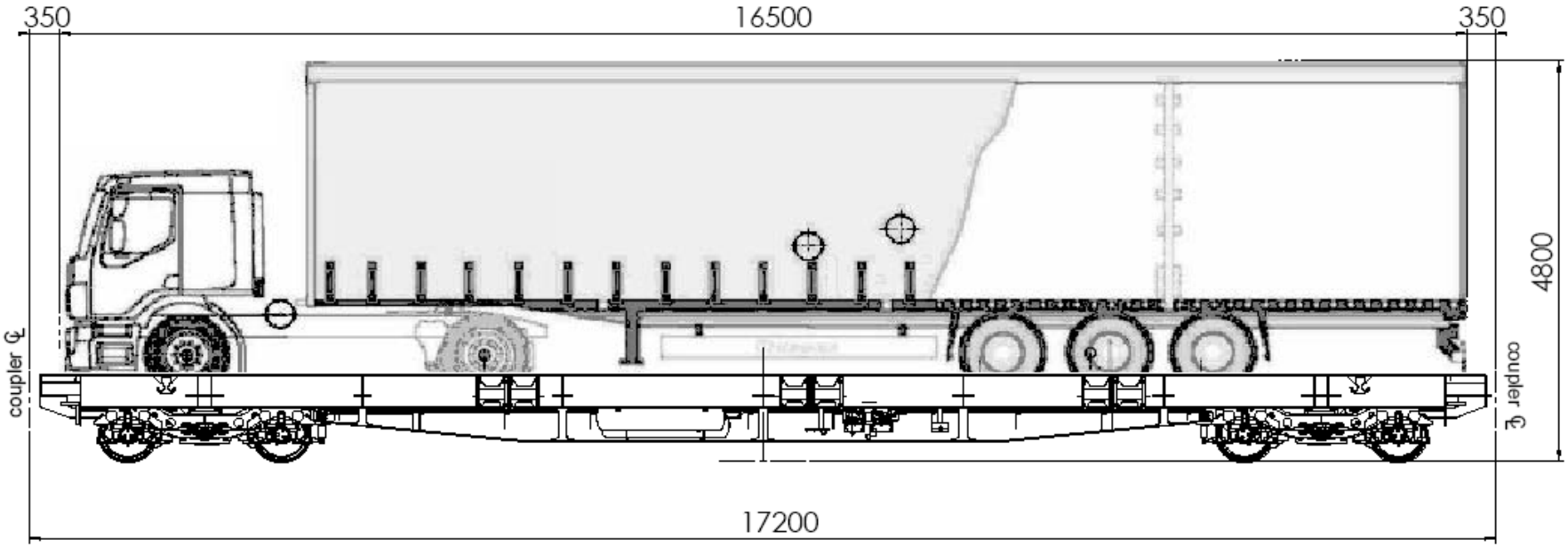
UIC Intermodal Gauge P/C 450



Alternative Use of P/C 450: Ro-Ro

Trailer Train





Other Loads: House Sections and Lumber

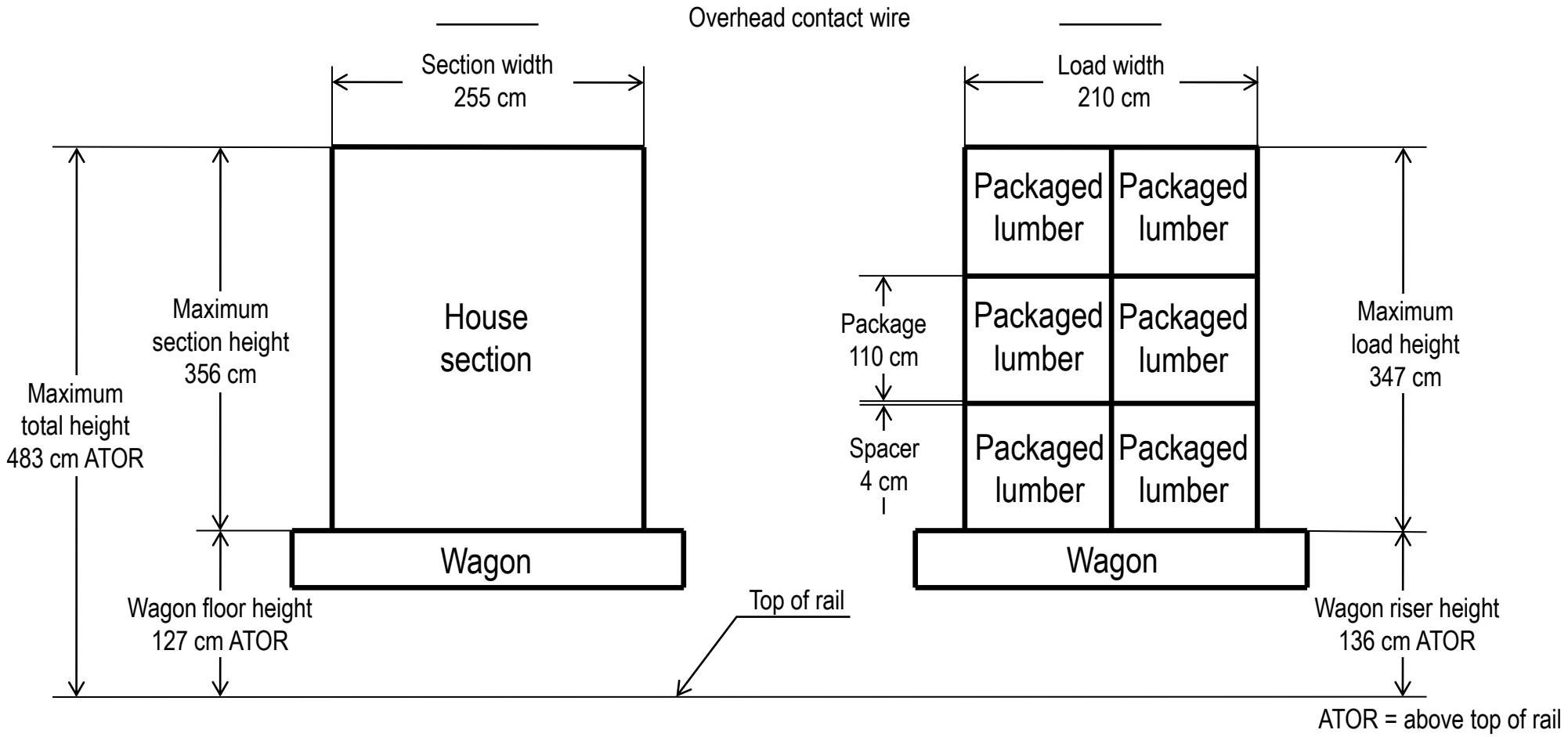
Bengt Dahlberg

Felix Hubertsson

1268 mm floor height, Rs

1336 mm riser height, Kbps

Forest Products in Gauge P/C 450



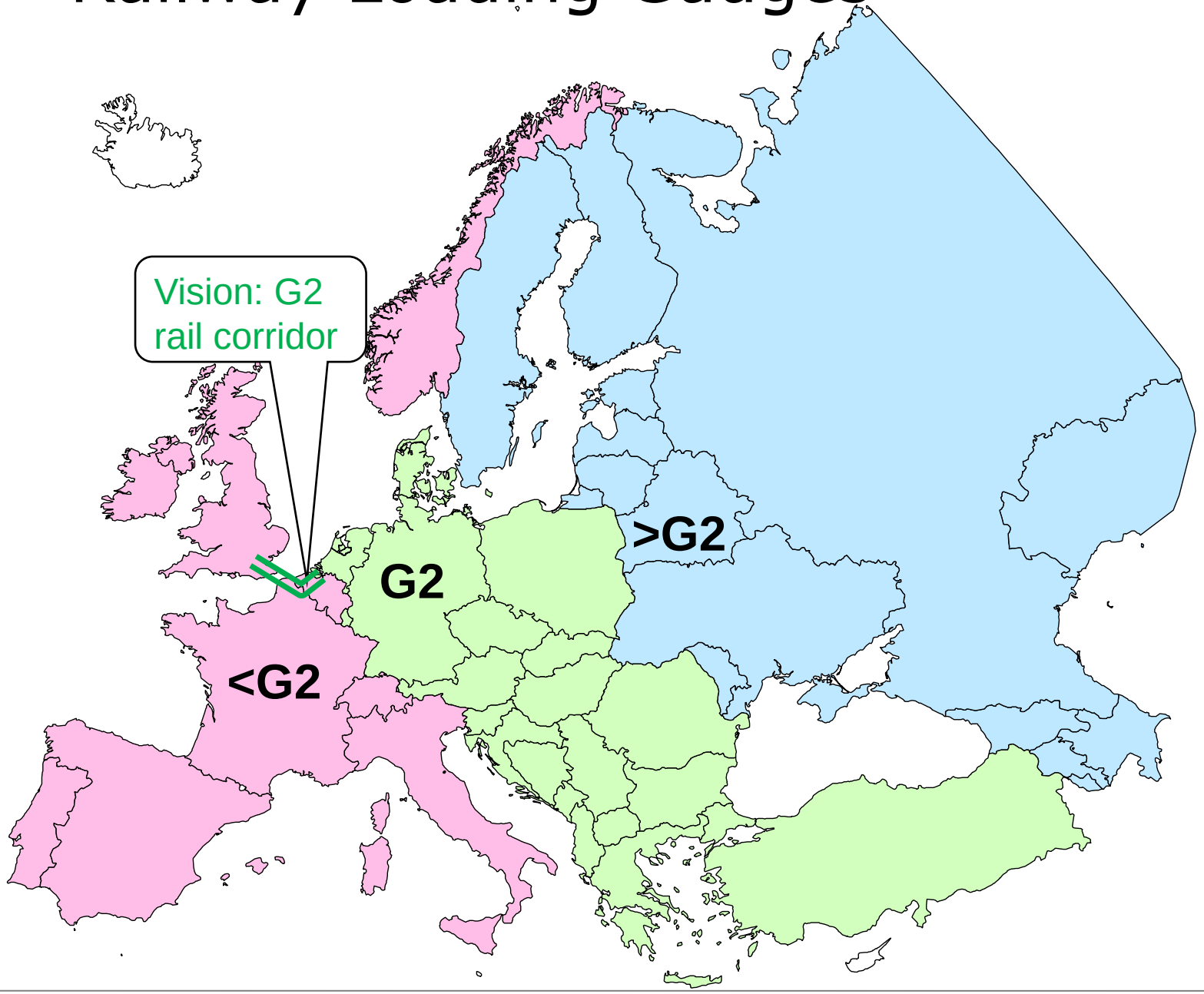
∴ Lumber can be stacked 1 package higher (+50%) in intermodal gauge P/C 450 than in P/C 400.

Vertical Clearance Requirements

- OHL construction tolerance: 30 mm
- Contact line dynamic movement: 50 mm
- Electrical minimum clearance (EBO, VDE 0115-1):
  - 25 kV 220 mm
  - 15 kV 150 mm
  - 3 kV 50 mm
  - 1.5 kV 35 mm
- Vehicle dynamic movement (TSI): 50 mm
- Track ballast tamping allowance: 50 mm

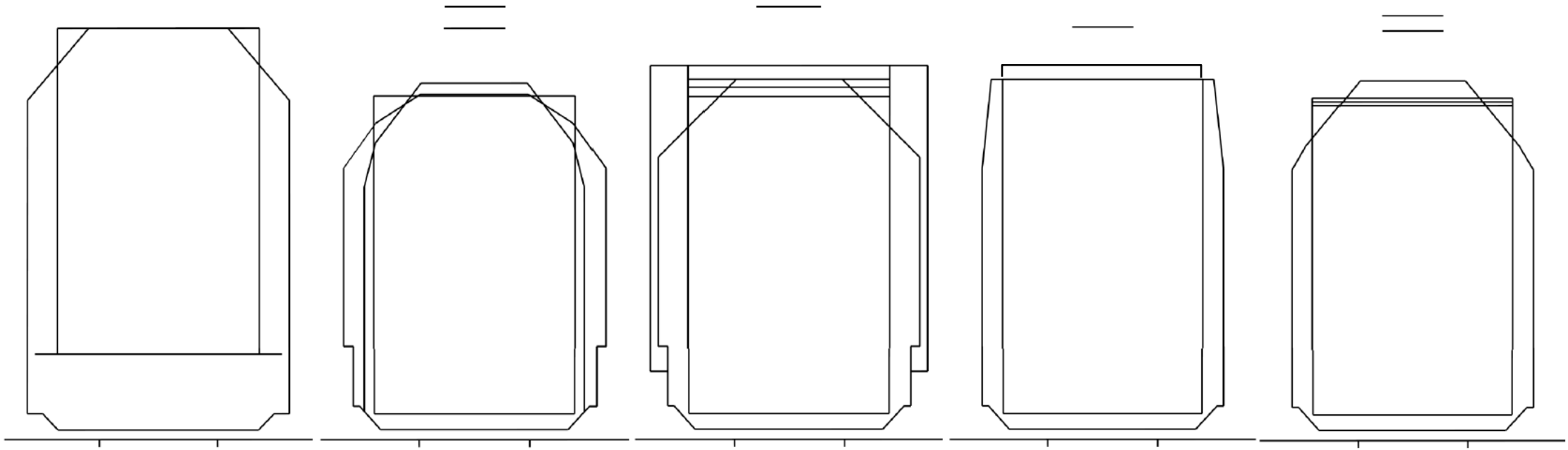
⇒**Total clearance 215 mm to 400 mm needed to OHL.**
(Normal OHL height: 5.3 – 5.5 m ATOR)

Railway Loading Gauges



Present Corridor Standards

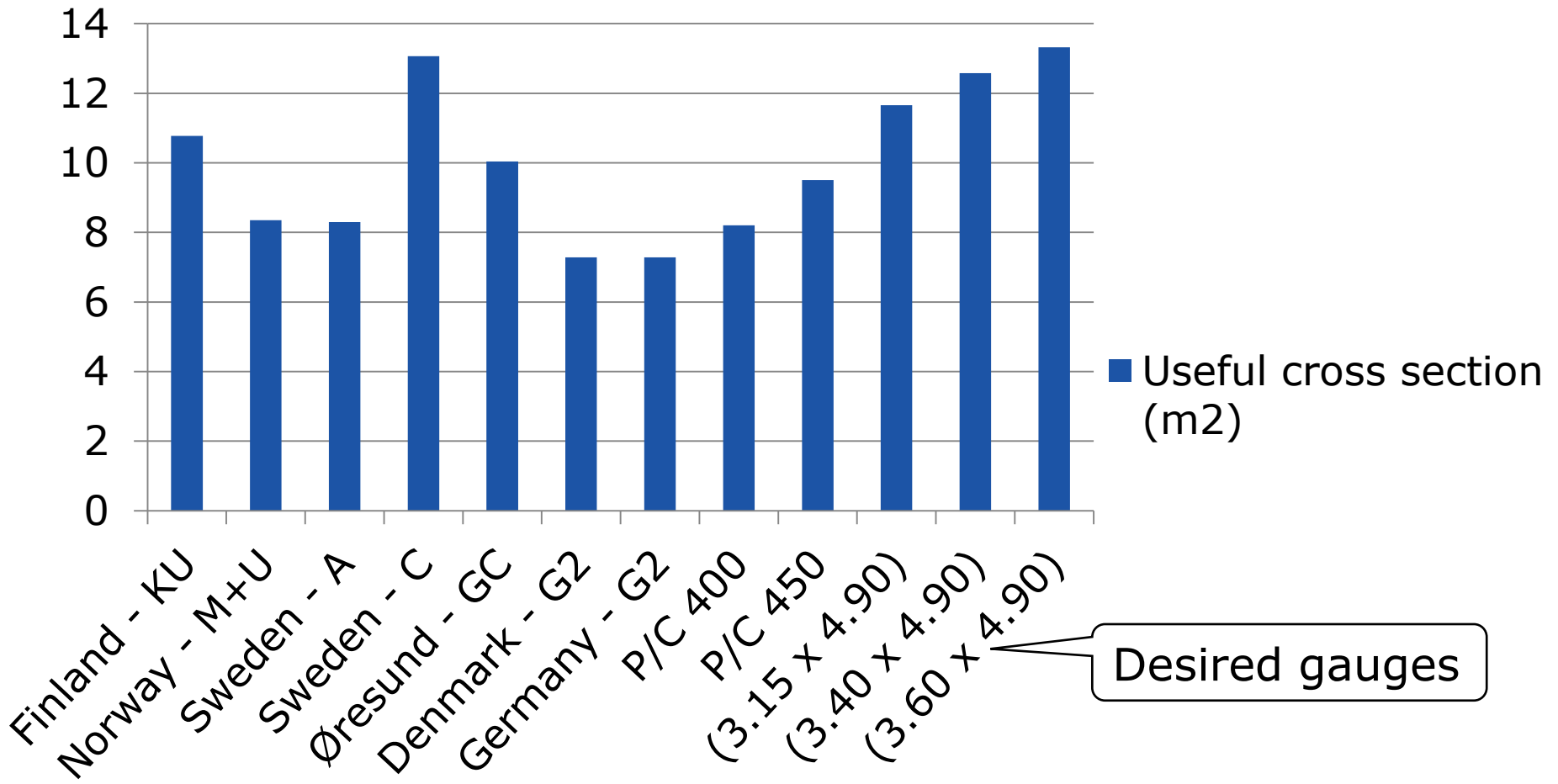
Loading gauges and intermodal gauges



Finland	Norway	Sweden	Øresund	Denmark
KU	M, U	A, C	UIC GC	Germany
P/C 497	P/C 410	P/C 450	P/C 450	G2
		P/C 432		P/C 410
		P/C 422		P/C 405
		P/C 410		P/C 400

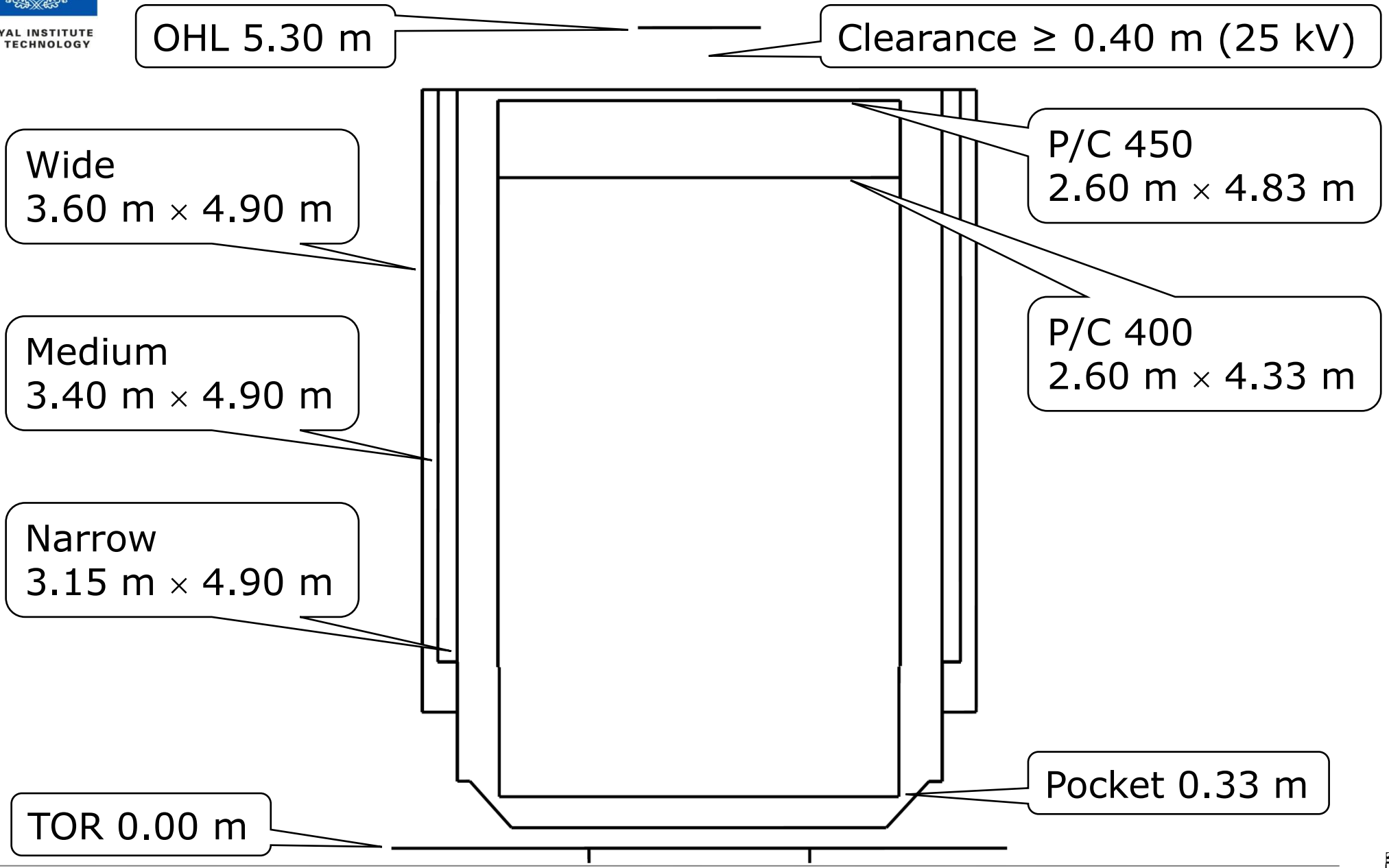
Present Corridor Standards

Loading gauge or intermodal gauge useful cross section (m^2)



Note: Largest inscribed rectangular section above floor height 1.2 m or above container mounts 1.175 m ATOR.

Desired Loading and Intermodal Gauges



Opportunities of a Large Gauge

Kockums Industrier

133 m^3 volume, Hiqqrrs-vw wagon

Kockums Industrier

148 m^3 volume, SECU container

Opportunities of a Large Gauge

Frederik Tellerup

5 seats across, X53 unit

Michael Nilsson

3.45 m width, X55 unit

Opportunities of a Large Gauge

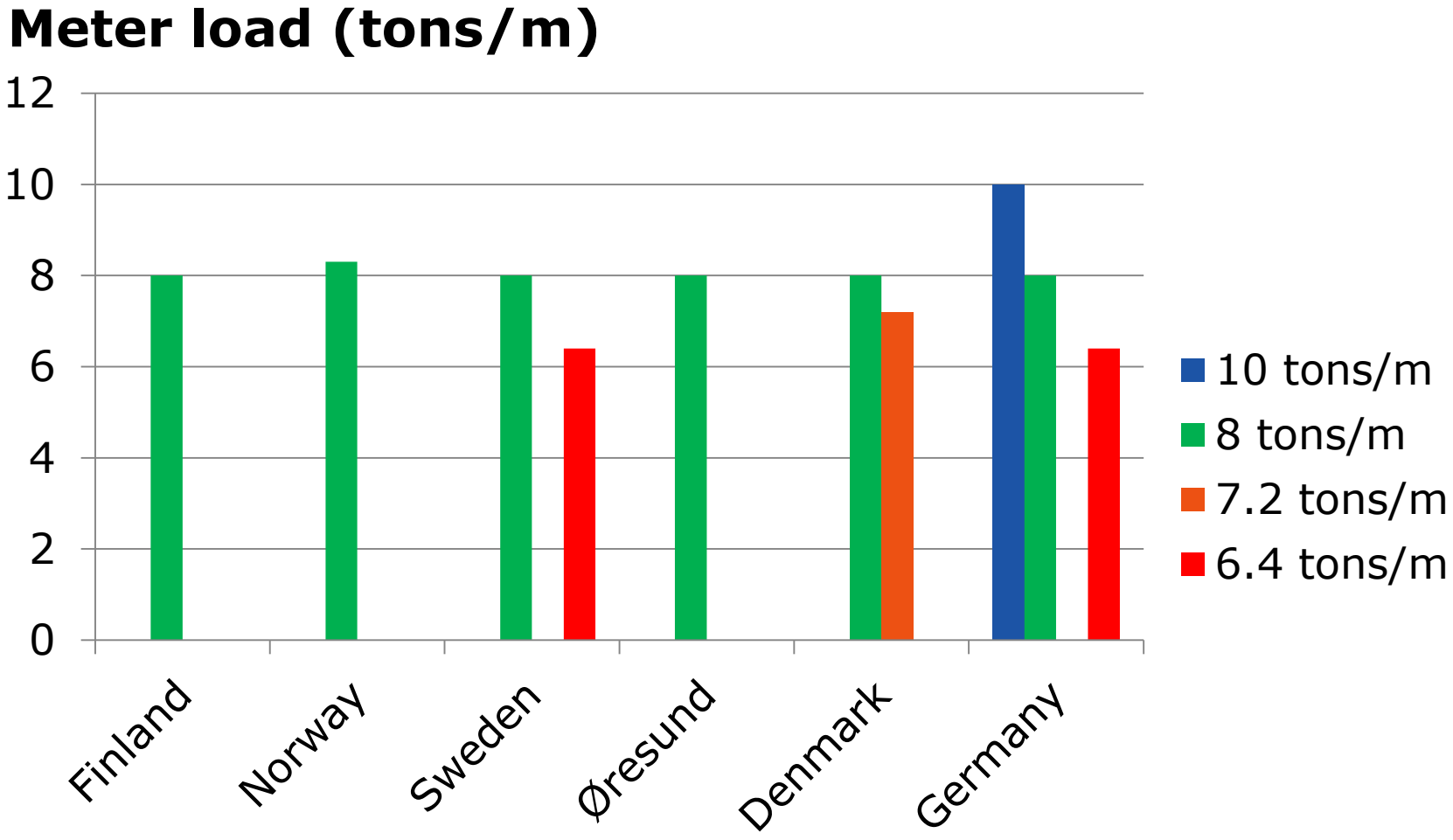
Robert Schwandl

6 seats across, SA unit

Robert Schwandl

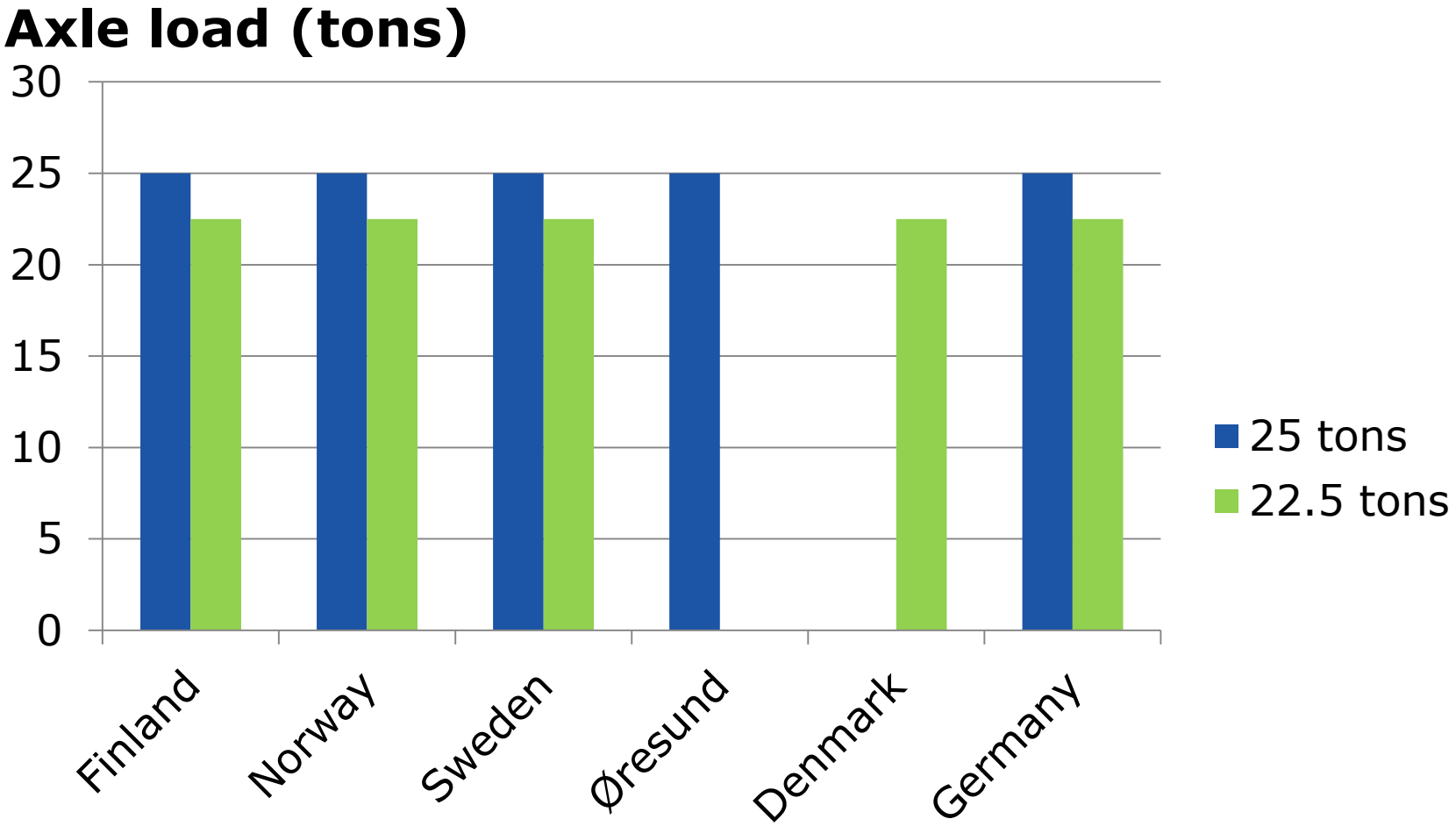
3.60 m width, SA unit

Present Corridor Standards



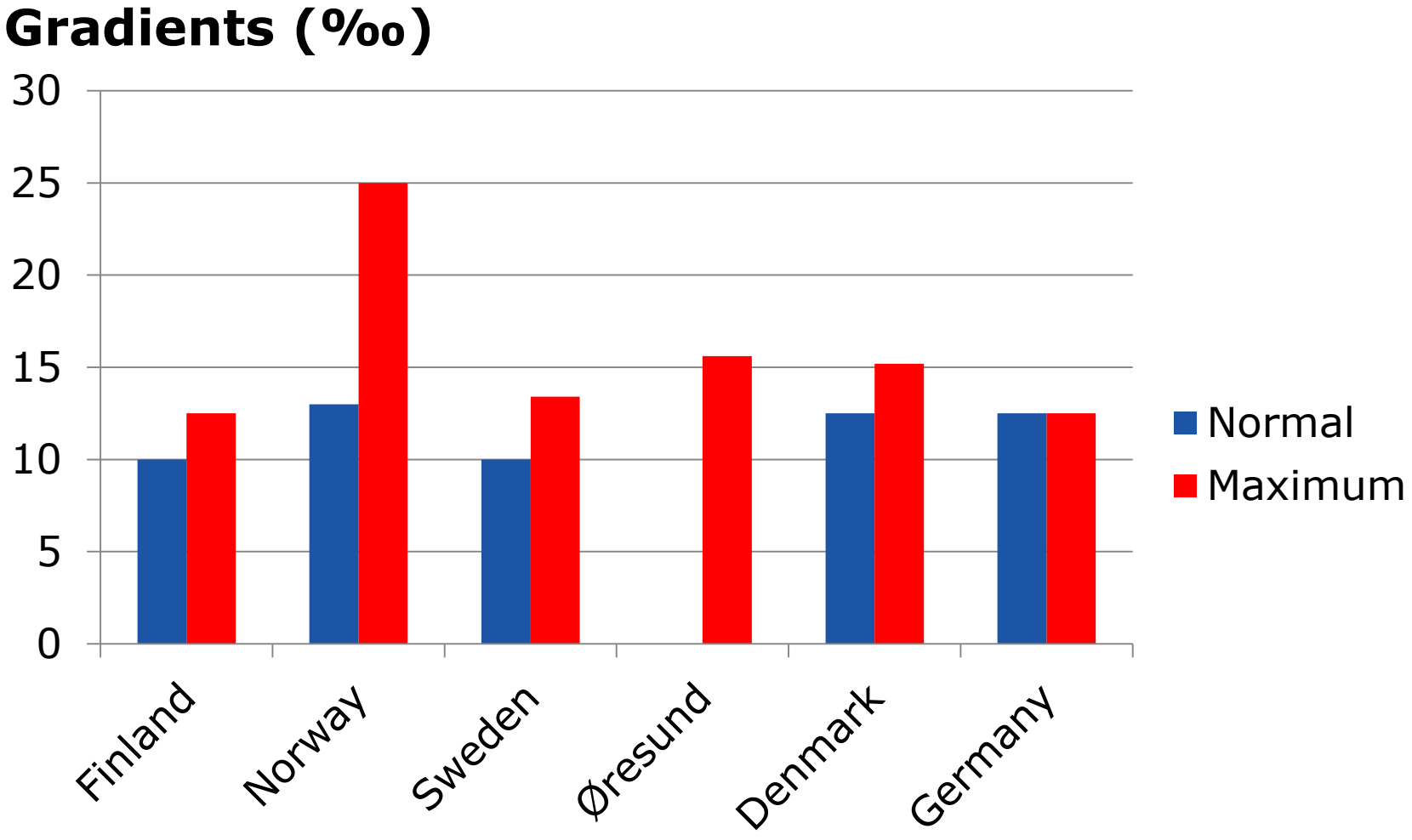
Development: New/upgraded lines in Sweden are planned for 10 tons/m.

Present Corridor Standards



Development: New/upgraded lines in Sweden are planned for 30 tons.

Present Corridor Standards



Recommended Best Practice

• Freight train speed		120 km/h (day), 100 km/h (night)
• Train length	-Head end loco	730 m (P), 835 m (5GP), 880 m (G)
	-Rear end brake	1440 m (P), 1650 m (5GP), 1740 m (G)
	-Distributed locos	1440 m+730 m (P), 1740 m+880 m (G)
• Wagon mass	-Head end loco	≈ 5200 tons on 10 ‰ (screw couplers)
	-Distributed locos	≈ 5200 tons+5200 tons (screw couplers)
• Distant signals		≈ 1200 m
• Loading gauges		3.15 m, 3.40 m, 3.60 m×4.90 m ”flat top”
• Intermodal gauges		2.60 m×4.33 m, 2.60 m×4.83 m (P/C 450)
• Meter load		≥ 8.3 tons/m (4×25 tons/12 m)
• Axle load		≥ 25 tons
• Gradient		≤ 12.5 ‰
• Wagon brake ratio		≥ 80 % (≥ SS)
• Screw coupler strengths		0.85 MN, 1.02 MN, 1.35 MN

Main Points

- Transportation demand is increasing.
- New links and capacity improvements are planned.
- The shippers' main priority is cost.
- High technical standards can raise efficiency and lower cost.
- When upgrading or building new, use recommended best practice.

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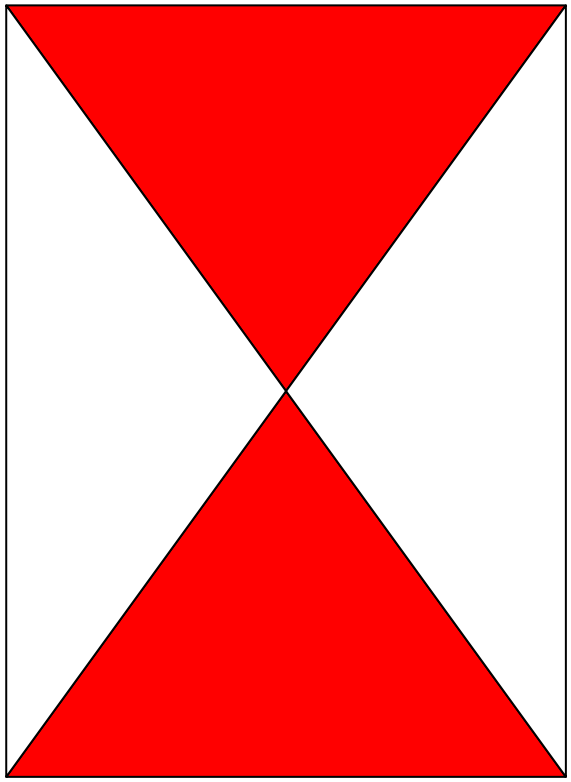

Thank you!