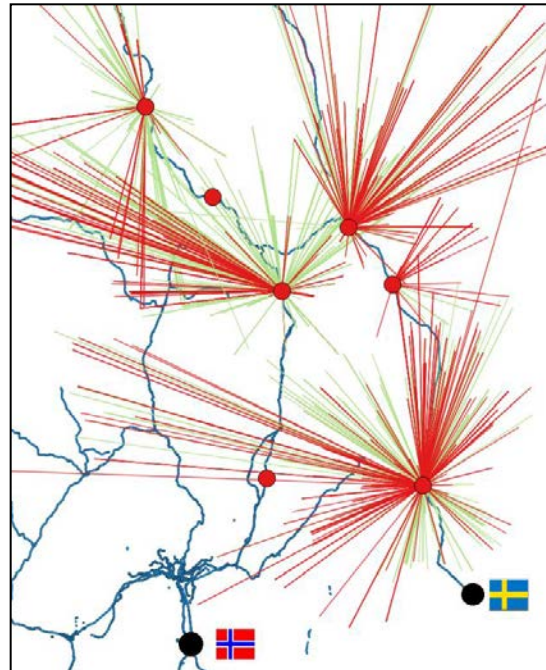


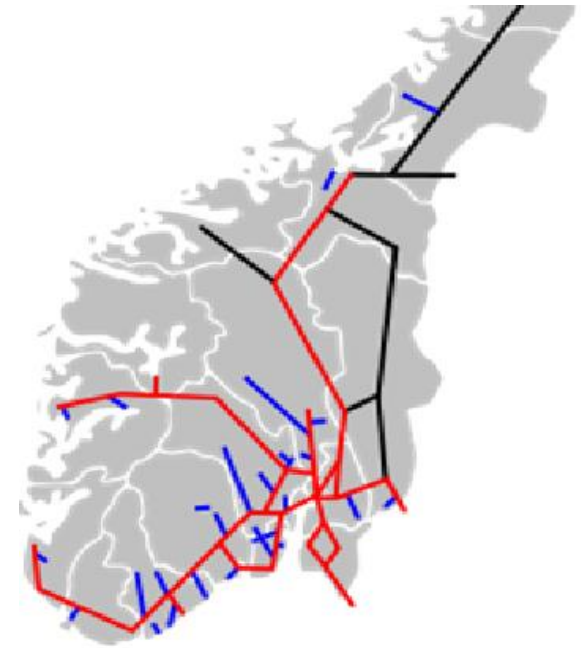
Modeling multimodal transport in Norwegian wood supply





Background

Restructuring of pulp mill capacity

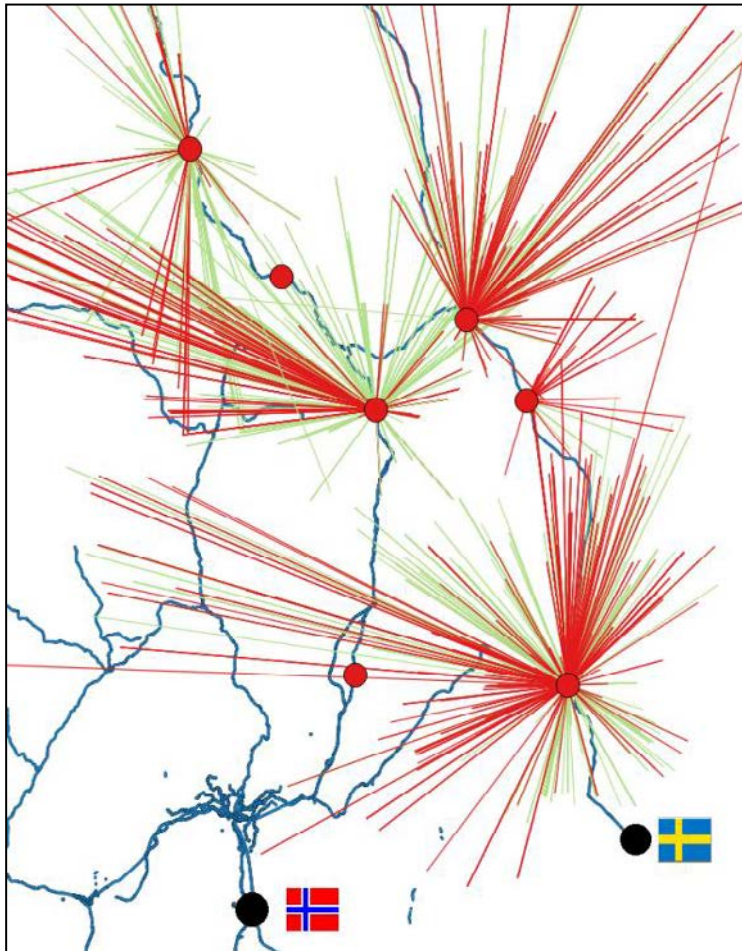
Limited rail electrification



spruce pulpwood 
pine + spruce pulpwood 

 electric
 diesel

Objective & models



Compare cost levels for varying levels of

- terminal capacity
- demand and electrification

between optimal wood flow solutions
using simple transport problem in Excel*

Model 0: $\min \sum \text{truck} + \text{rail costs}$
...+ terminal-specific costs added after optimization

Model 1: $\min \sum \text{truck} + \text{terminal} + \text{rail costs}$

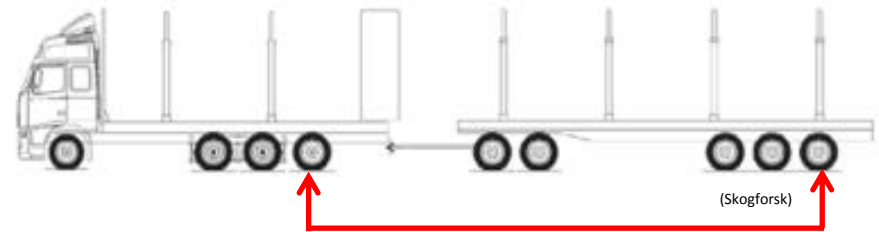
given restrictions:

- annual supply per area (45 w/pine, spruce)
- annual demand per market (2 w/pine, spruce)
- terminal transshipment restrictions
- terminal capacity restriction (m^3/yr)

For an annual transport volume of 1,4 million m^3 pulpwood

Truck transport: area-specific max GVW

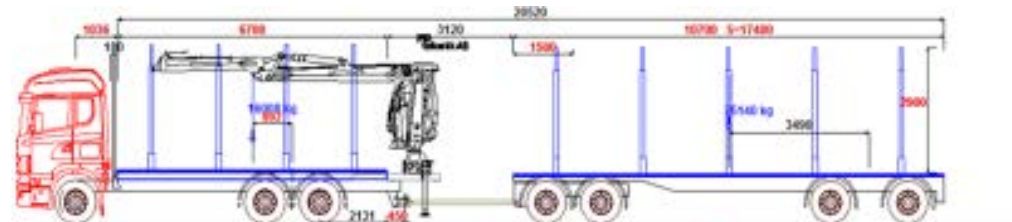
74t \Rightarrow 49t load



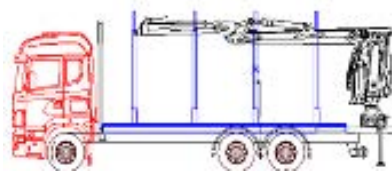
60t \Rightarrow 38t load

56t \Rightarrow 34t load

50t \Rightarrow 28t load

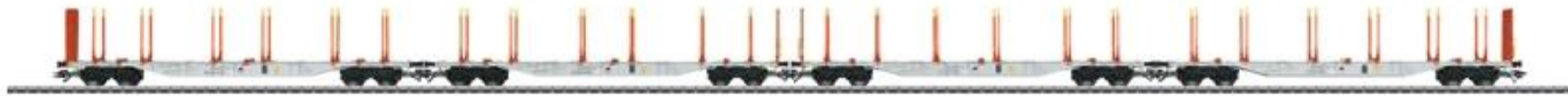


(D. Skjølaas)

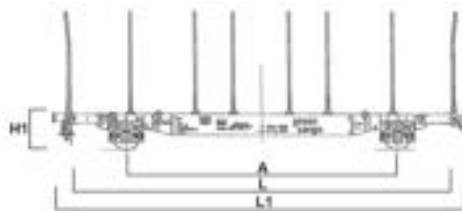


Rail transport : market-specific train configurations

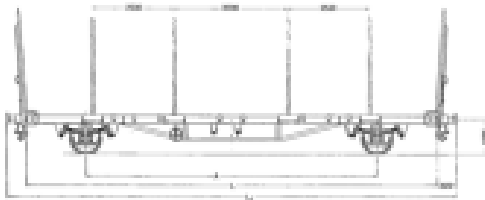
domestic $\approx 800-1100 \text{ m}^3/\text{train}$ export $\approx 1700 \text{ m}^3/\text{train}$



sgns wagons (3,4 t/meter)



laaps wagons (2,7 t/m)



Inps wagons (2,5 t/m)

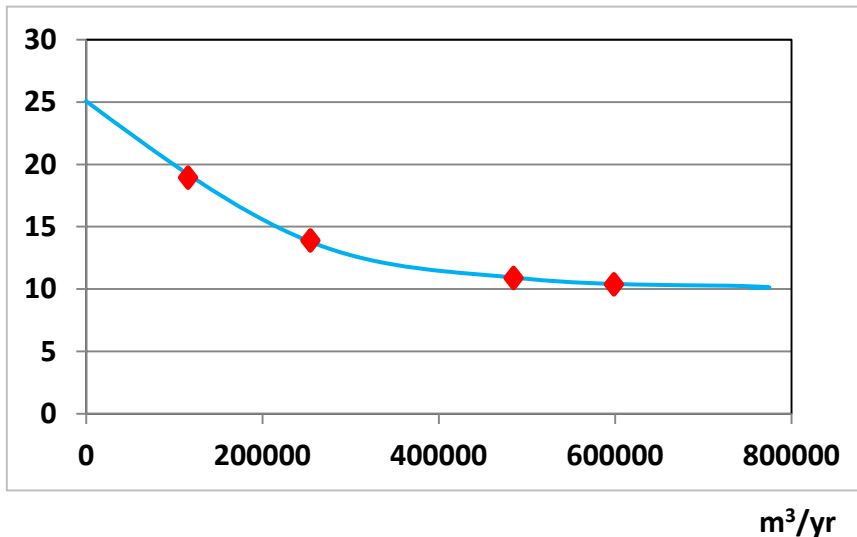
Cost functions

Truck transport: NOK/m³= fixed + variable (km)

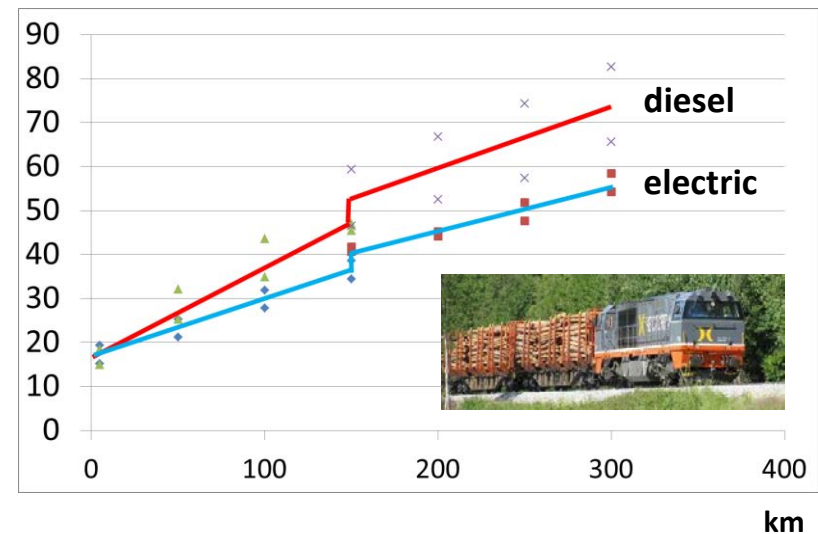
Max GVW	50 t	56 t	60 t
fixed NOK/m ³	26	24	22
variable NOK/m ³ km	0,72	0,67	0,62



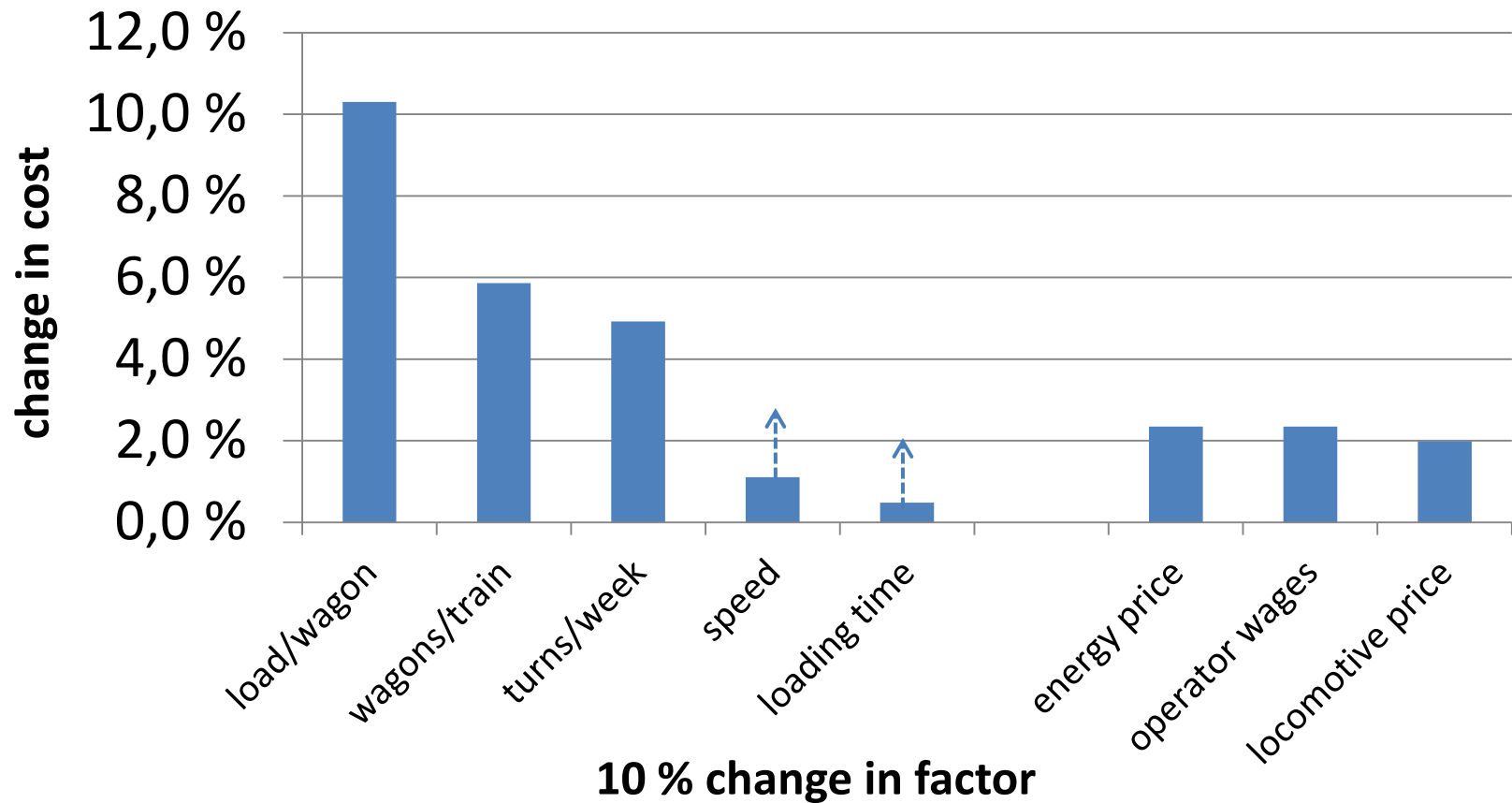
Terminal handling: NOK/m³



Rail transport: NOK/m³

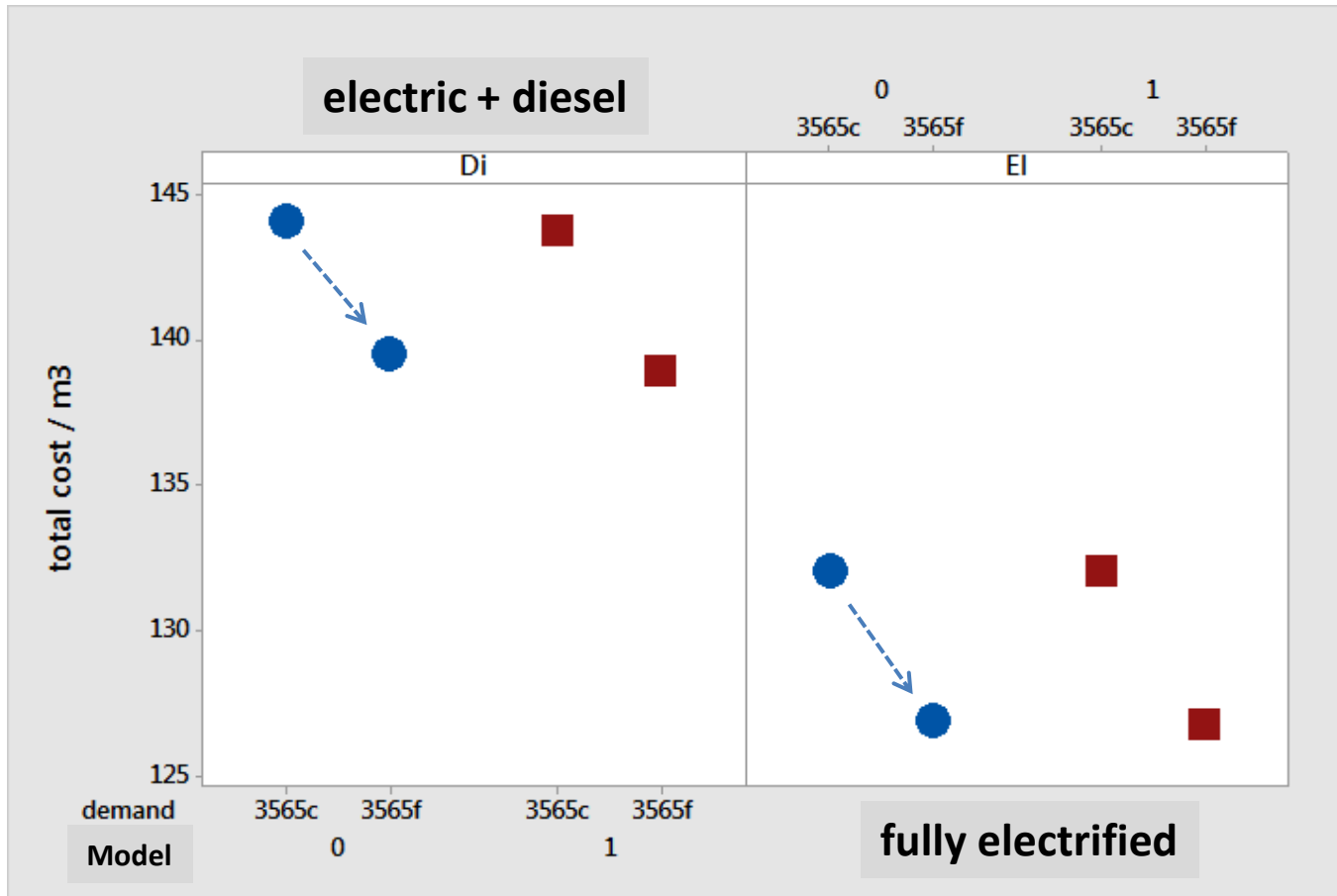


Ranking of factors influencing rail transport costs (NOK/m³)

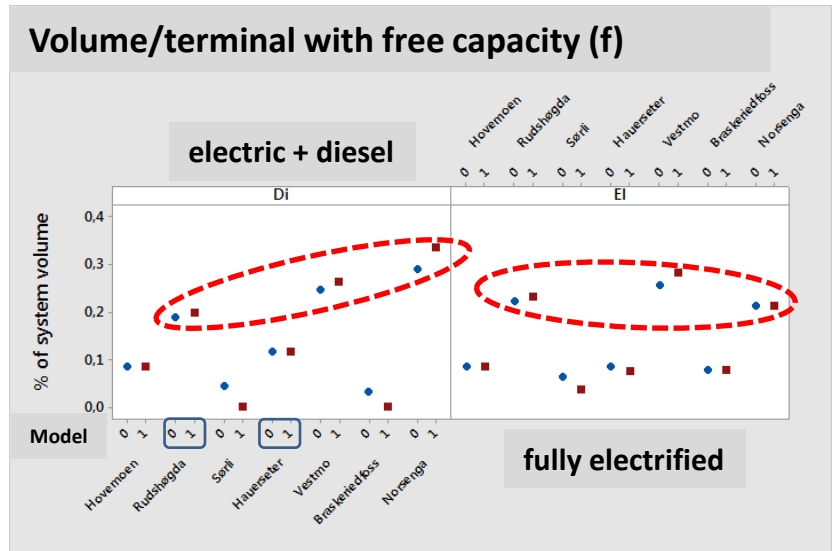
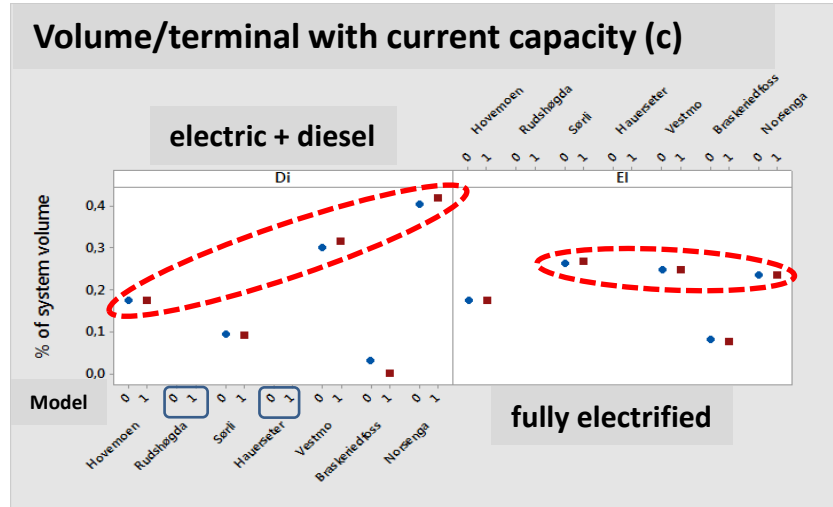
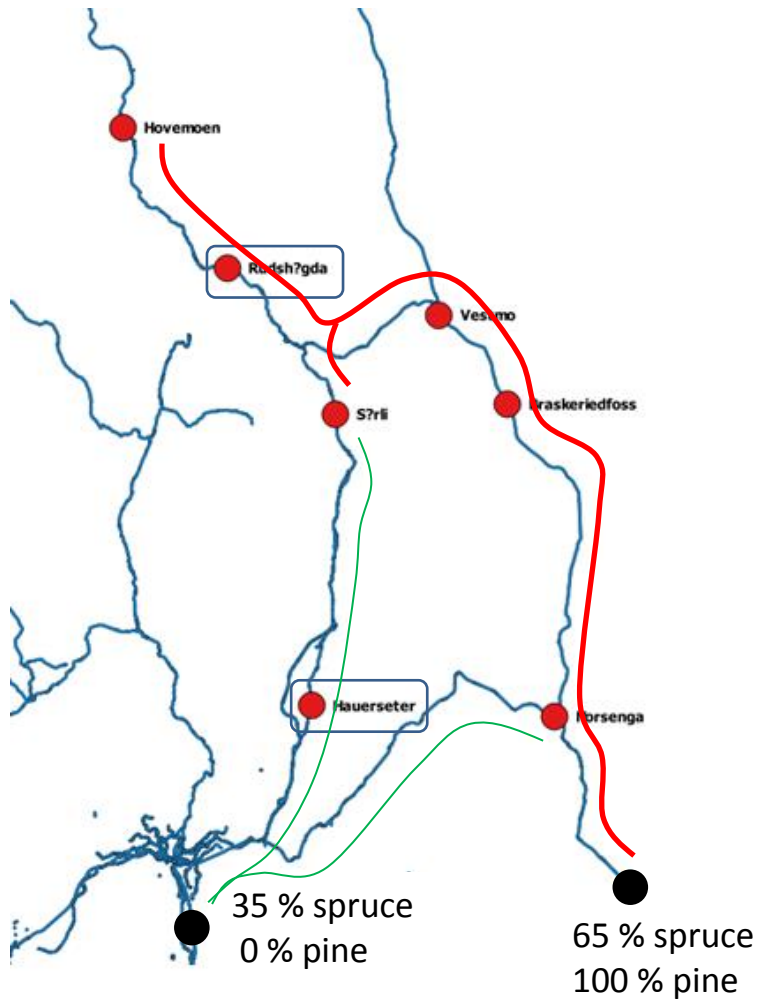


Cost comparisons with current demand

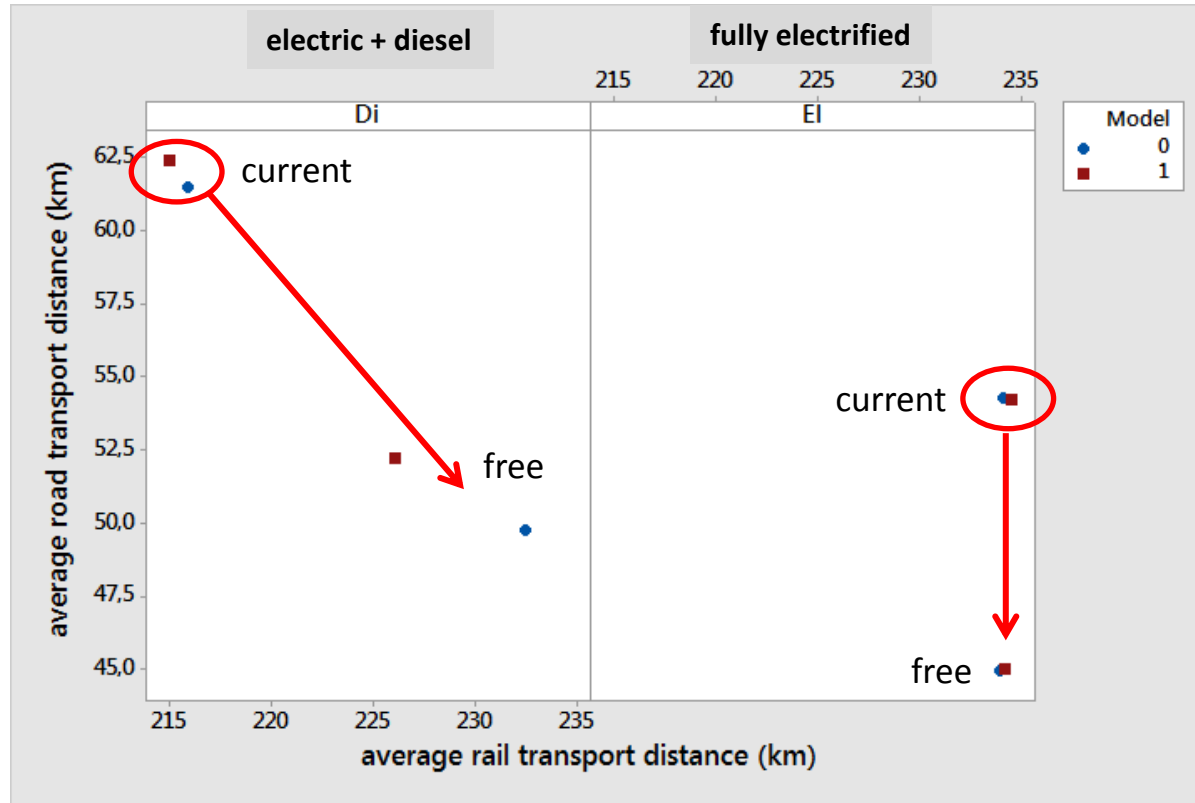
for current (35/65c) vs free (35/65f) terminal capacities



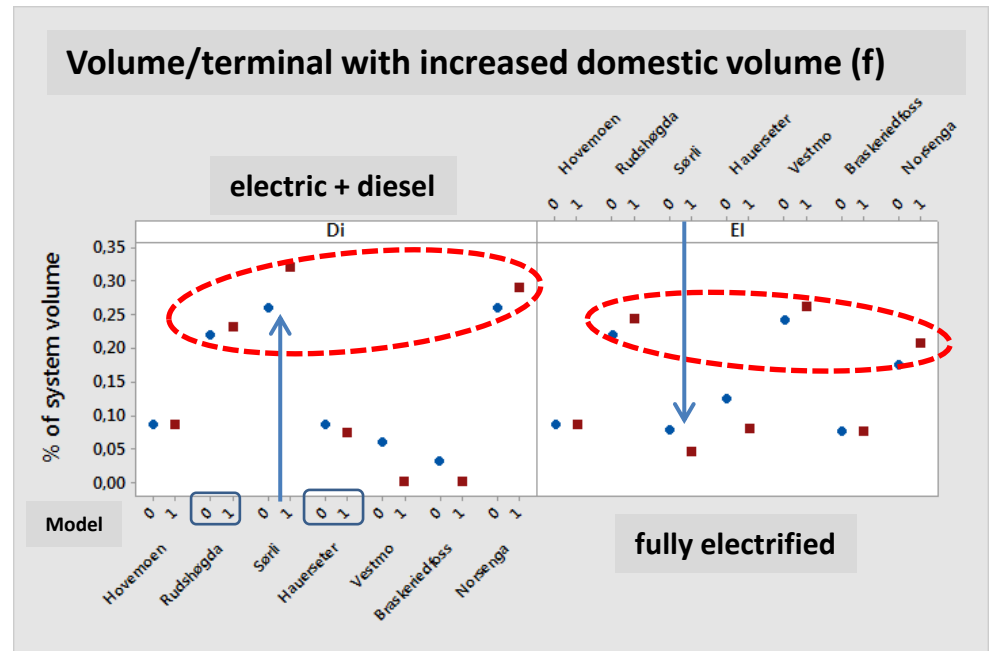
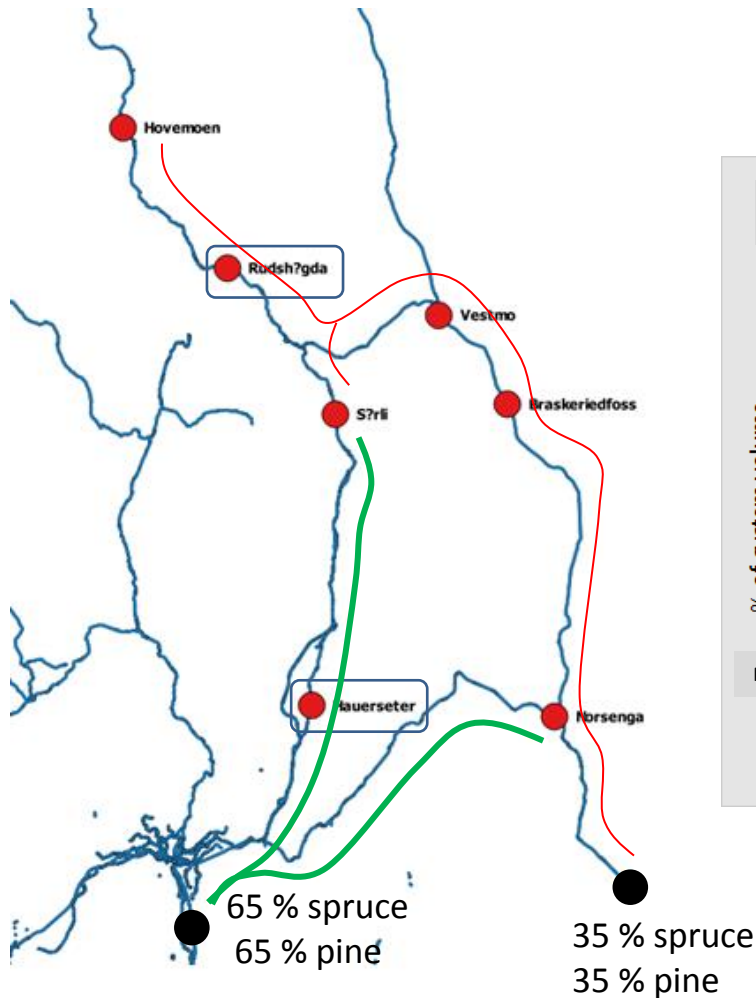
Solutions : Top three terminals with current demand



Solutions: Changes in average road and rail distance

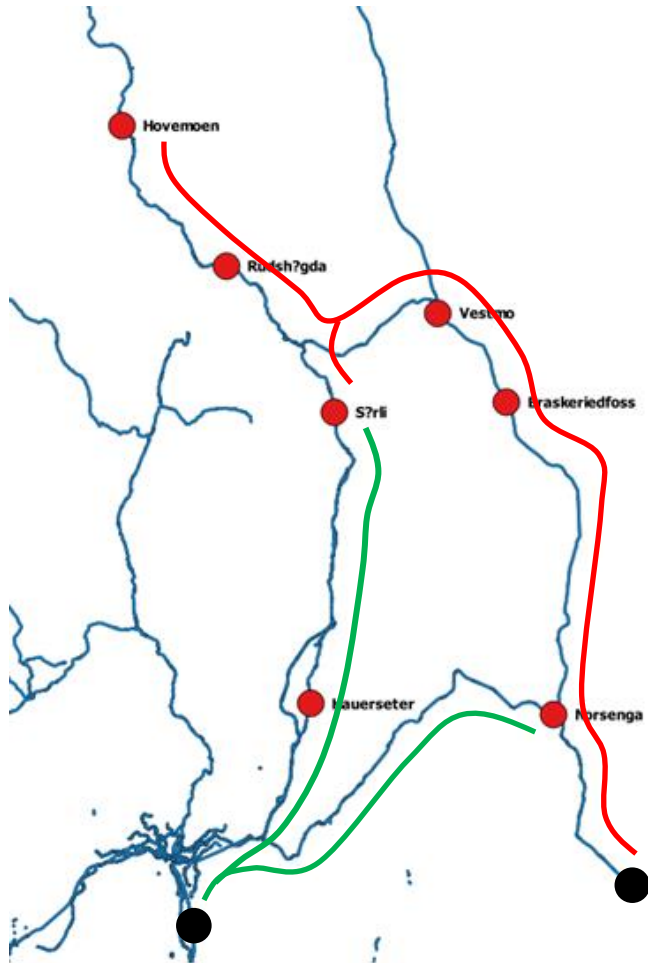


Solutions: Top three terminals with increased domestic demand



Market-specific cost development*

with current capacity/demand/electrification



		Costs (NOK/m ³)		
	Volume (1000 m ³)	w/ current flows	w/optimal flows	
			«own volumes»	«all-in»
Domestic	325'	132	132	↑ 139
Export	275'	149	143	↓ 103
Sum				122

*spruce pulpwood (sort 102)

In conclusion

*«It is always wise to look ahead,
but difficult to look
further than you can see»*

Winston Churchill