Climate and Environmental Impacts of High-Speed Rail

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Photo: Leif-Harald Ruud

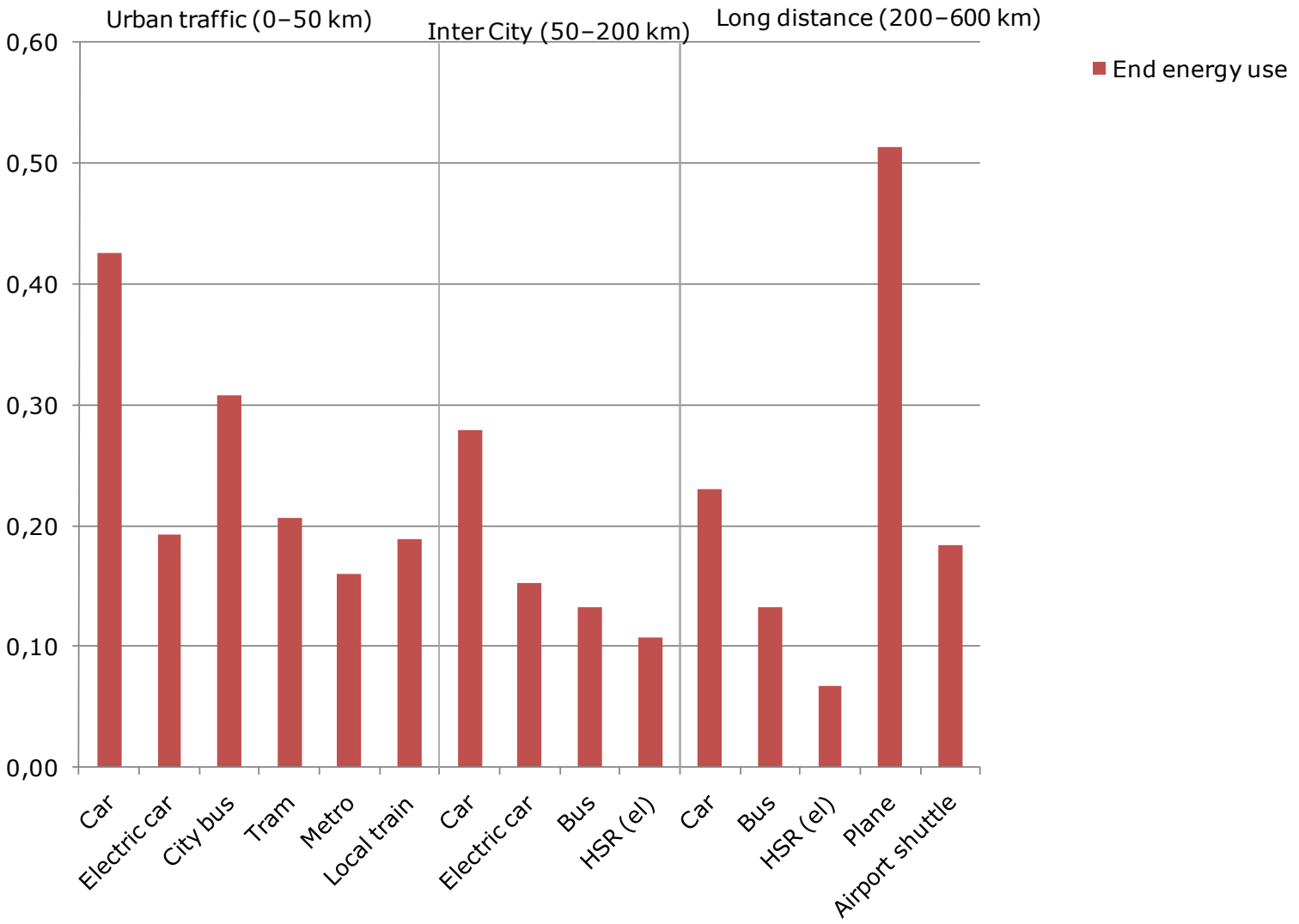
First: Why railways – from an environmental point of view?

- All transport modes have environmental impacts
- More rail transport is good for the environment if it leads to less use of transport modes with higher environmental impacts
- It means: More rail transport is not a goal in itself
- Different goals: We want to use the railway *in order to reduce* environmental impacts, while others want to increase the mobility. That's a challenge

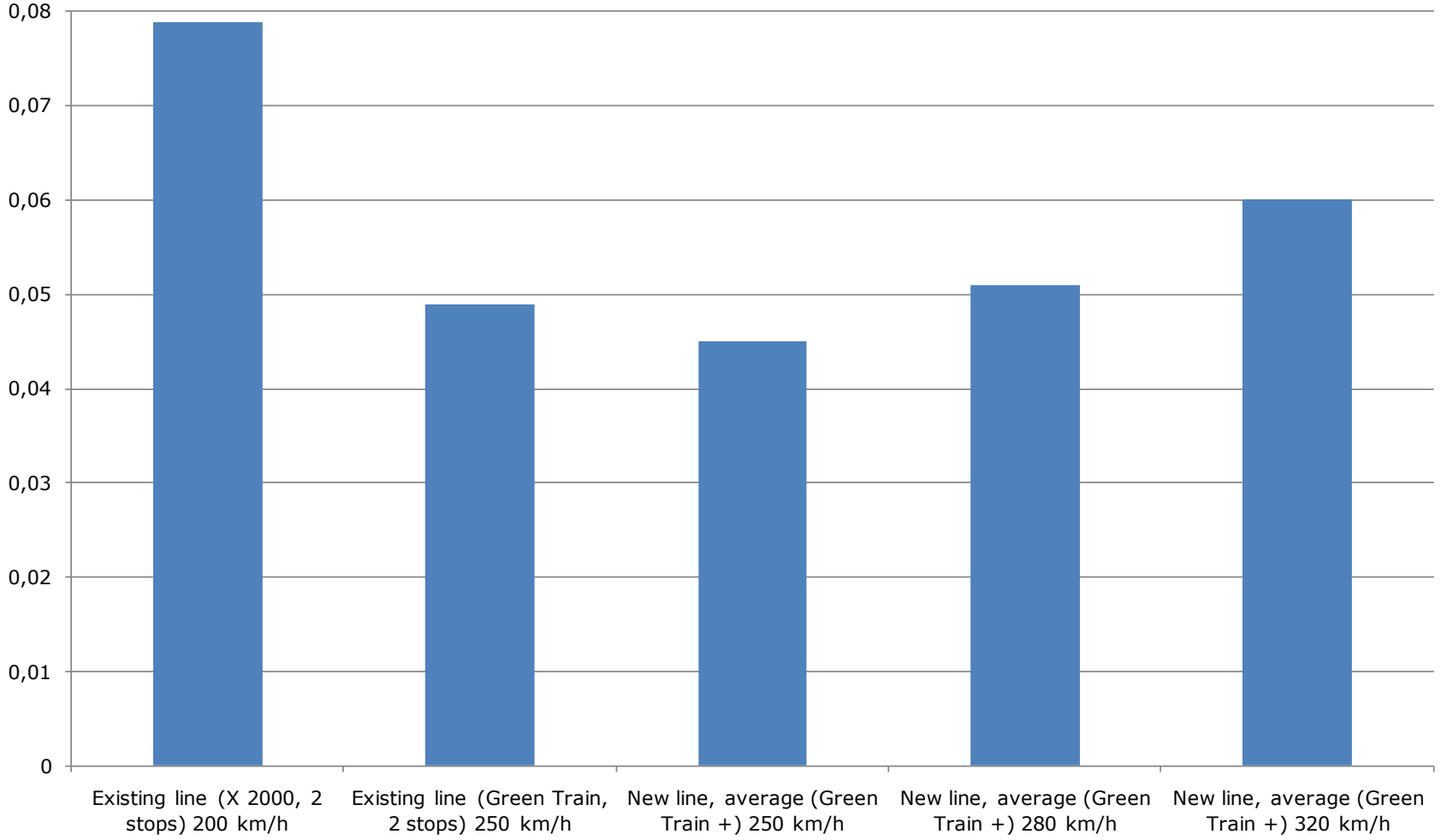
About this lecture

- To describe the environmental impacts of high-speed rail (HSR), we have to know the impacts of other transport modes too
- Main source: The report ”Energy and climate impacts of modern transportation” (2008)
  - Comparing rail, road and air traffic
  - Life cycle perspective (100 years, 2020 and 2030)
  - End energy use + indirect energy use
  - Vehicles + infrastructure
  - Assumptions on shifts in modal split and overall traffic trends
- Additional slides about the impacts on natural environment

End energy use, 2020 (kWh/pass.km)



End energy use, different speeds (kWh/pass.km)



”Green Train +” means Green Train with extra low aerodynamic drag

Source: Lukaszewicz, Piotr and Evert Andersson (2009): *Green Train energy consumption – Estimations on high-speed rail operations.* KTH. Stockholm

Energy production

- Losses in the railway power system is included in end energy use
- Indirect energy use includes losses in energy production and public transmission / distribution
- Electricity: European mix is assumed to be the long time marginal -> 0,25 kgCO_2/kWh in 2020 (quite lower than today) and 0,10 kgCO_2/kWh in 2030
- Fuel: 90% fossile fuel mixed with 10% biofuel i 2020 and 15% biofuel in 2030

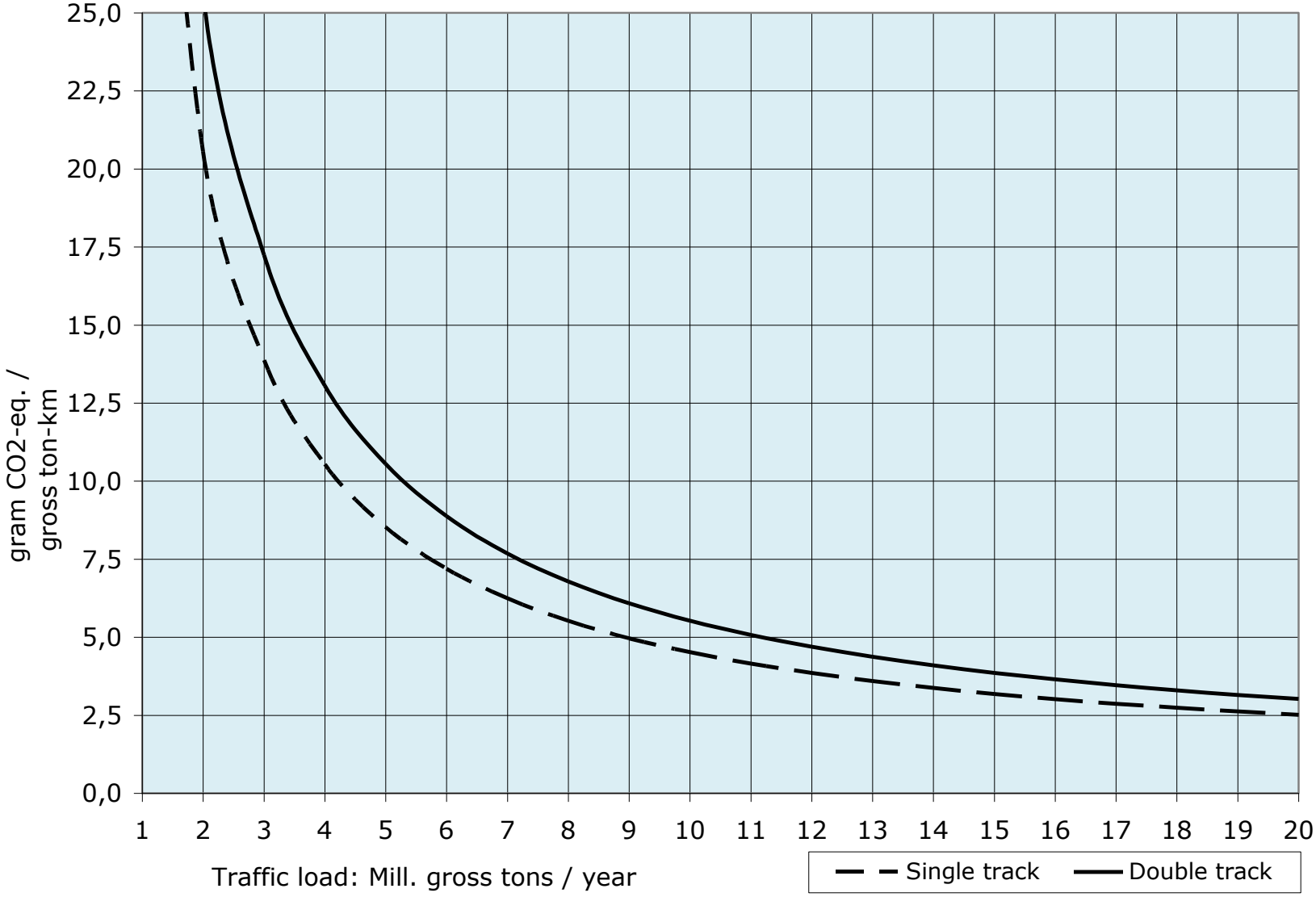
Infrastructure – The hardest part of a life cycle study!

- Norwegian conditions: Makes it difficult to use studies for other countries
- Long lifetime: At least 100 years
- How to allocate the environmental impacts on different types of transportation (passengers versus fright)?
- How do the impacts change when the traffic load varies? It is necessary to identify which impacts are depending on traffic volume and which are not
- Some assumptions:
  - HSR, double and single track for 250 km/h: 37% tunnel, 9% bridge
  - Highway, two–four laned: 5–10% tunnel, 2–5% bridge

Infrastructure: Some results

- Building highways and HSR:
  About the same energy and climate impacts per kilometre
  - HSR, double track: 4100 $kgCO_{2eq.}$/metre
  - Highway, four laned: 3600 $kgCO_{2eq.}$/metre
- Over the lifetime: Four laned highways have higher impacts than double track HSR
- But, higher traffic load on highways means a lower impacts per pass.km than for HSR

Climate impacts depending on traffic load



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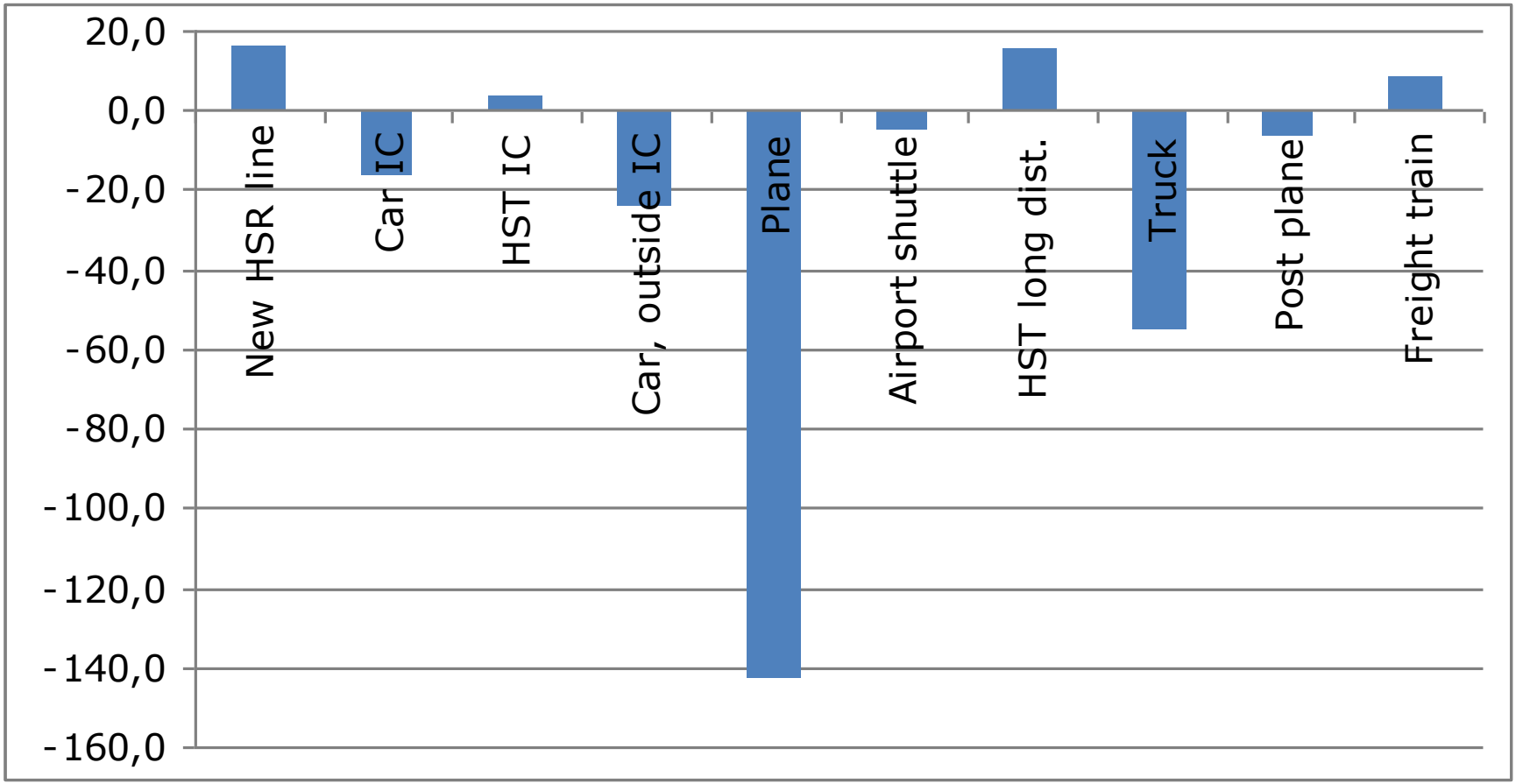
Shift in modal split etc.

- Important assumption: HSR is a part of a policy to reduce the transport sector's environmetal impacts. It means: HSR in combination with other measures
- Two scenarios for Gardermoen–Lillehammer–Trondheim (changes in relation to a situation without HSR):
  - Plane -> HSR: 70% or 90%
  - Car -> HSR: Depending on travelling distance and distance to nearest station: 4–25% or 7–40%
  - Car -> HSR (IC area): 16% or 32% in corridor
  - Truck -> freight train: 40% of long distance road transport
- Additionally changes as a result of induced traffic (positive and negative)

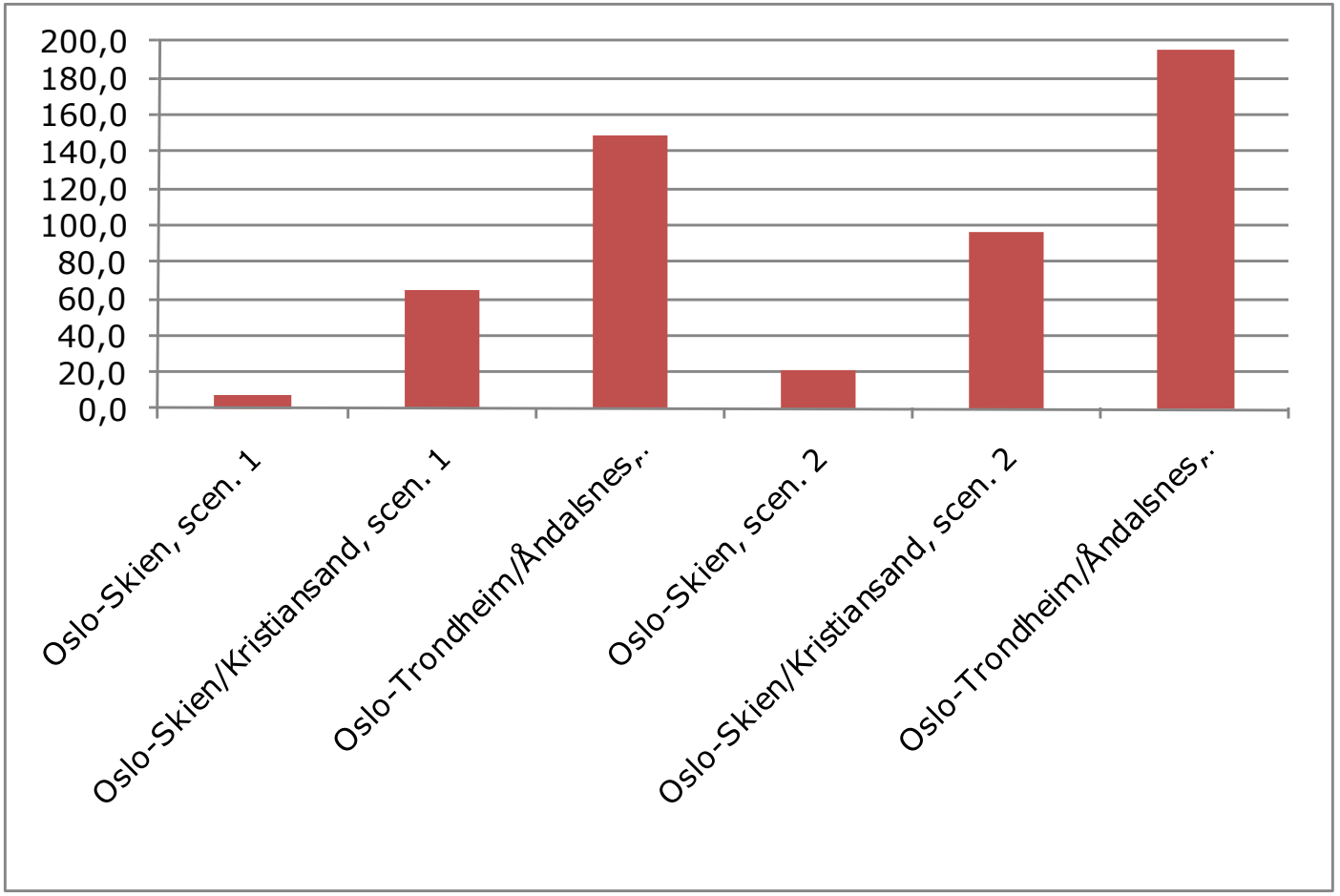
Result for Oslo–Lillehammer–Trondheim

Scenario 2, 1000 t CO_{2eq} / year, average (mix of 2020 and 2030)



CO_2 reductions for two corridors

1000 t CO_{2eq} / year, average (mix of 2020 and 2030)



Impacts on the natural environment (1)

- Building new infrastructure has significant impacts on the natural environment in many ways:
  - Encroachment on vulnerable areas, barriers, landfills etc.
- For HSR in Norway, a high share of line distances will be tunnel (about 40% Oslo–Lillehammer–Trondheim, and more between east and west)
- Unlike in many other countries, HSR in Norway will partly be built to replace existing lines (e.g. a new line Gardermoen–Lillehammer–Trondheim)
- A high share of line distances in tunnel will reduce the barriers and can lead to positive local effects if the existing line is closed and brought back to nature

Impacts on the natural environment (2)

- It is easier to avoid nature conflicts by planning and building new lines over longer distances, compared with building ”step by step”
- In a policy for reducing the transport sector’s environmetal impacts, it is important that new HSR lines are built *instead of* new highways and airport extensions
- This will limit the total impacts on the natural environment and also avoid induced road and air traffic
- Can HSR, with ”town centre stations”, contribute to a less sprawling land use locally (because it is attractive to live and work near the stations)?

Some conclusions (1)

- The environmental impacts of transportation is huge
- The official goal of preventing a temperature rise of more than two degrees have to change the way of thinking
- The HSR policy must be a part of a bigger policy and be combined with other measures, e.g. higher CO_2 taxes and limits on airport and road capacity
- The economic and environmental impacts of building new railways makes long term planning necessary. Railway lines being built today, have to fit into a future HSR network
- Investments in HSR should contribute to improvements for the rail freight traffic

Some conclusions (2)

- The passenger traffic on HSR lines between regions could be lower in Norway than in more urban countries. This makes it easier for freight trains to use the same lines
- This and other factors suggest that HSR lines should be constructed for moderate speed levels (250–300 km/h)
- It is hard to stop the population's desire for more mobility. Public money spent on rail can not automatically be used on other climate measures
- In the main transport corridors in southern Norway and to/from Sweden, it would be better to invest in a high-capacity HSR network, rather than continue to strengthen the more energy intensive and environmentally harmful transport modes

We have a choice …

Photo: Leif-Harald Ruud

More information:
http://naturvernforbundet.no/samferdsel