Impacts of Higher Vehicles Weights on Timber and Chip Transportation in Finland

Research Overview

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Summary

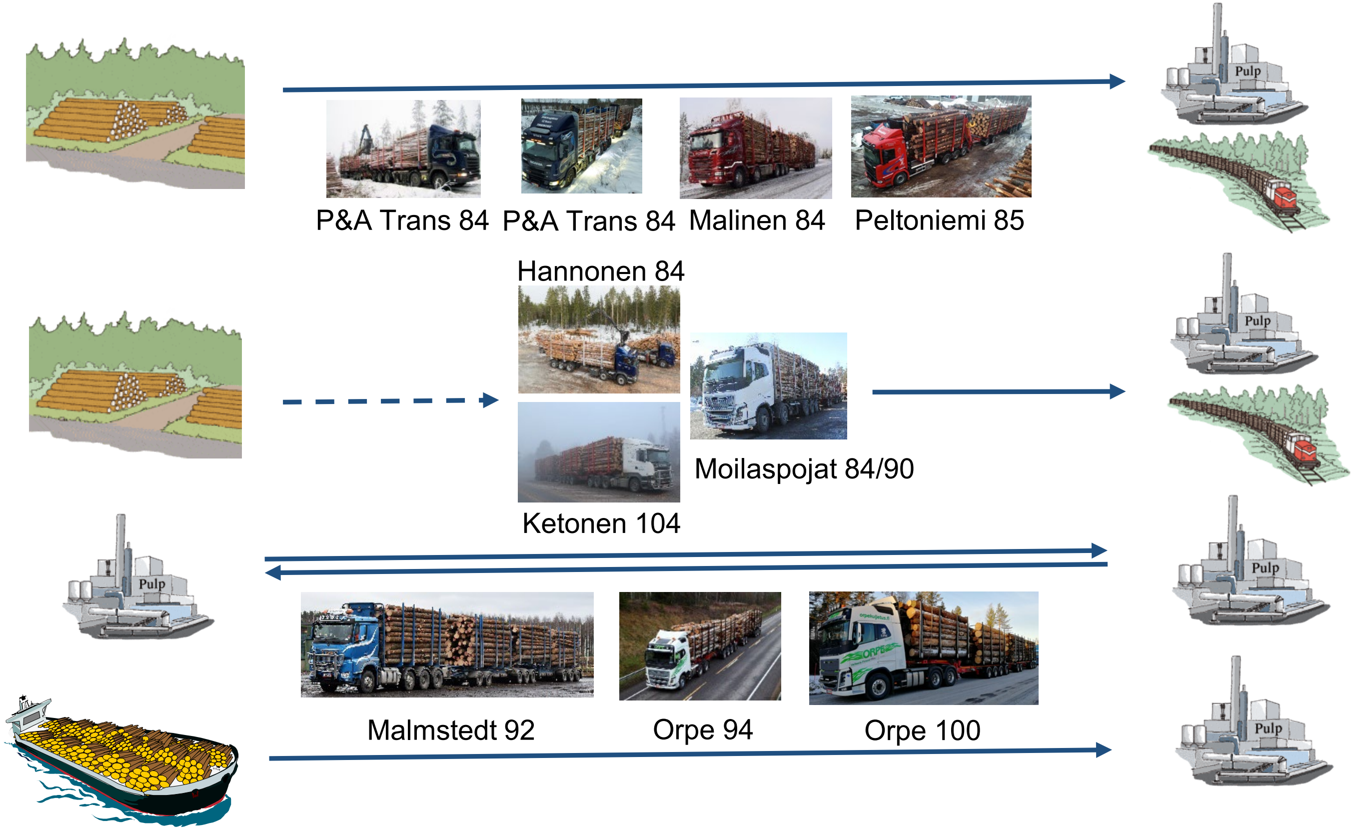
- The slides summarise the research findings on the effect of increased vehicle weights (>76 t) on the transportation of timber and chips. Most of the research material has been collected from the vehicle combinations that have participated in HCT trials in Finland. The total weight of the vehicles studied ranged from 84 to 104 tonnes.
- In Finland, HCT trucks would annually reduce
  - 84 000–206 000 loads of timber and 36 000–130 000 loads of chip transportation
  - 2–44 million € of timber transport costs (8–12 % per m^3 cost reduction in transport distance of 100–300 km)
  - 3–8 million litres of fuel consumption in timber transportation
  - 4–11 % fuel consumption per m^3 in timber transportation (depending on transport distance).
- According to road wear studies, it has been found that even the heaviest HCT trucks do not cause increased rutting on roads with thick pavements. However, further studies are required to assess the impact on roads with thin pavements, gravel roads, and bridges. The results from the latest road wear studies will be available by the end of 2023.
- According to the initial bridge wear study conducted in Finland, HCT trucks increase wear by a maximum of 10 %. However, for most 84-ton vehicles and short bridges, the wear on bridges is significantly lower. This research was solely based on calculations, and the results need to be confirmed through test loading for validation.
- Research results have not indicated any differences between HCT and normal trucks in terms of traffic safety.
- This research overview will be updated at the end of 2023 to include additional results from ongoing research (specifically related to the costs and fuel consumption of chip tranportation and road wear).

Contents

1. HCT Vehicle Combinations

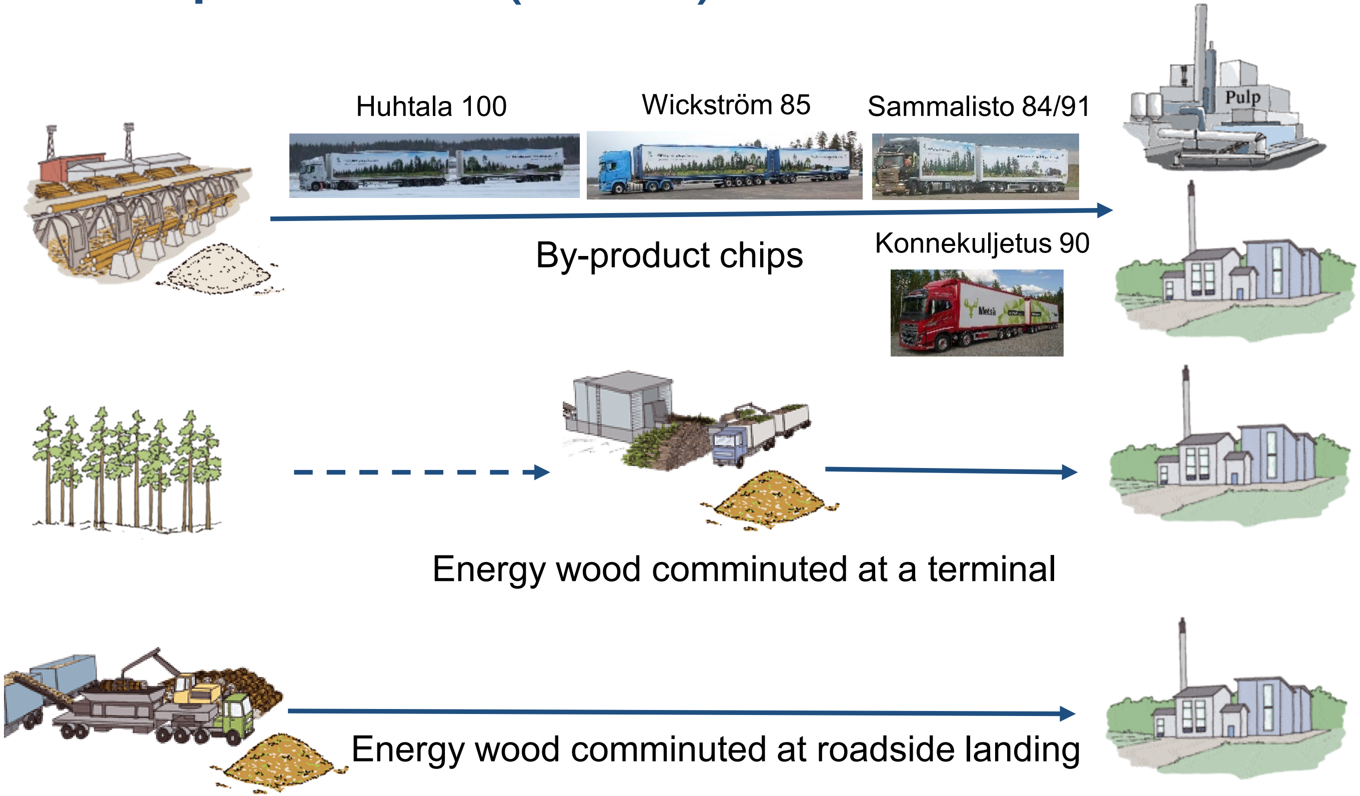
- HCT (High Capacity Transport) in Finland
  - More than 76 tons (the weight limits were raised in 2013)
  - More than 25,25 meters (in January 2019, the length limits were raised up to 34,50 meters)
  - Restricted transport routes determined in trial permits granted by Traficom
    - https://www.traficom.fi/fi/liikenne/tieliikenne/pidemmat-ja-raskaammat-hct-rekat
  - Trial truck are obligated to participate in HCT research
    - Further information on HCT trials and research results in timber and chip transportation available at www.metsateho.fi/hct.
- This slide report provides a summary of the results obtained from trials and research conducted between 2014 and 2023. More detailed information can be found in Metsäteho's report (Venäläinen & Poikela 2022), which was published in December 2022.
- Legislation on vehicle weights and dimensions
  - Road Traffic Act 729/2018 (114–117a§)
    - https://finlex.fi/fi/laki/ajantasa/2018/20180729 (in Finnish)
    - In addition, Traficom's supplementary regulations

HCT Timber Trucks (>76 t)



Photos: Jouko Peltoniemi Oy, Kari Malmstedt Oy, Metsä Group, Metsähallitus Forestry Ltd, Metsäteho, Oy, Orpe Kuljetus Oy

HCT Chip Trucks (>76 t)



Photos. Metsä Group, Metsäteho Oy, Koneurakointi Aki Sammalisto Oy

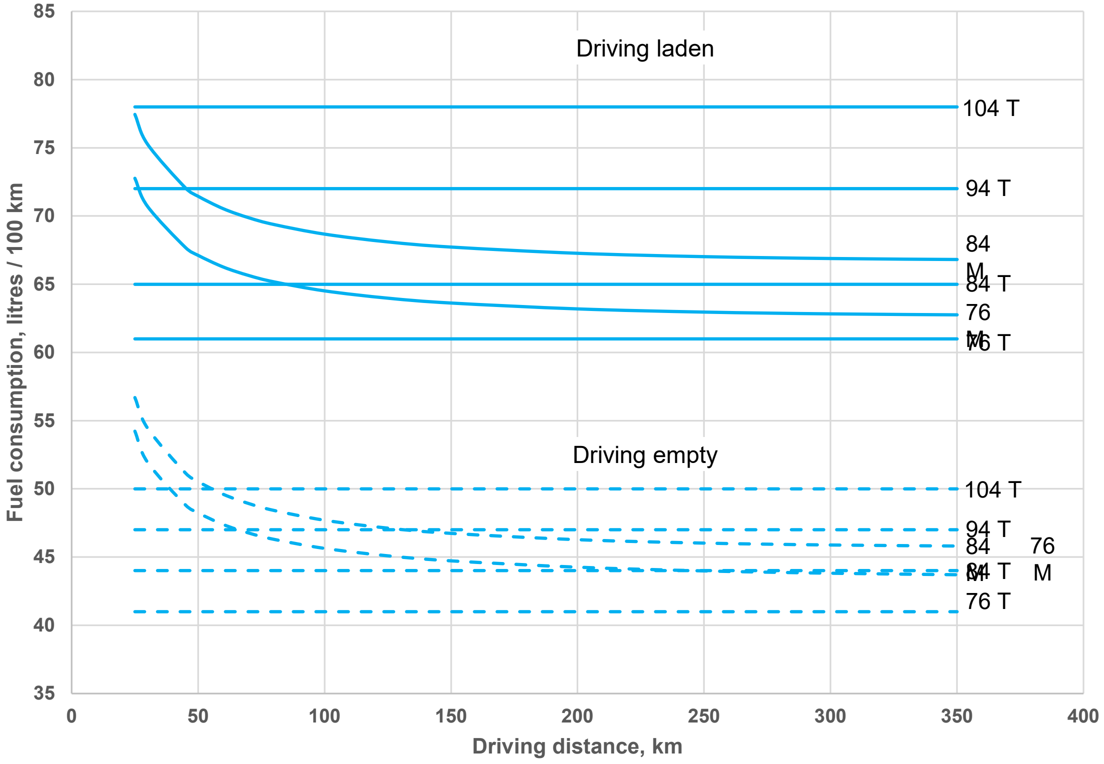
The Most Potential HCT Trucks

- Metsäteho Oy’s interview research (Venäläinen & Poikela 2021) for
  - Transport and forest companies
  - Manufacturers of trucks, trailers, and coupling equipment
- Interviewees’ experiences with HCT trucks and their views on the most potential solutions
  - The availability of various HCT trucks is crucial as it allows transport companies to choose the most suitable solutions for specific regions or routes, considering different weight requirements. This ensures flexibility and efficiency in the transportation industry.
    - Opinions on the most potential total weight of a truck combination varied among companies.
  - Most of the interviewees expressed satisfaction with the HCT trucks they were most familiar with. However, some interviewees suggested minor modifications to trial trucks or the introduction of new types of trailers.
  - The use of HCT trucks could be made more efficient by implementing new operating models (such as increasing utilisation of back-haulage and terminals suitable for HCT trucks).

2. Fuel Consumption and Emissions

- In Metsäteho's study (Venäläinen & Poikela 2022), fuel consumption data from HCT and control vehicles was collected along with data on
  - Route type (transport from forest/terminal)
  - Time of year
  - Payload
  - Vehicle properties and
  - Transport distance.
- The updated fuel consumption formulas for timber trucks emphasised the data collected from the newest trucks as well as results from other fuel consumption research. These formulas were designed to illustrate the typical changes in fuel consumption per truck weight class. Therefore, the formulas do not provide specific fuel consumption values for individual trucks involved in the research.
- Updated fuel consumption formulas for chip trucks will be published by the end of 2023.

Fuel Consumption Formulas (Timber trucks)



T = terminal truck
M = forest truck

Venäläinen & Poikela 2022

Fuel Consumption per Green Ton

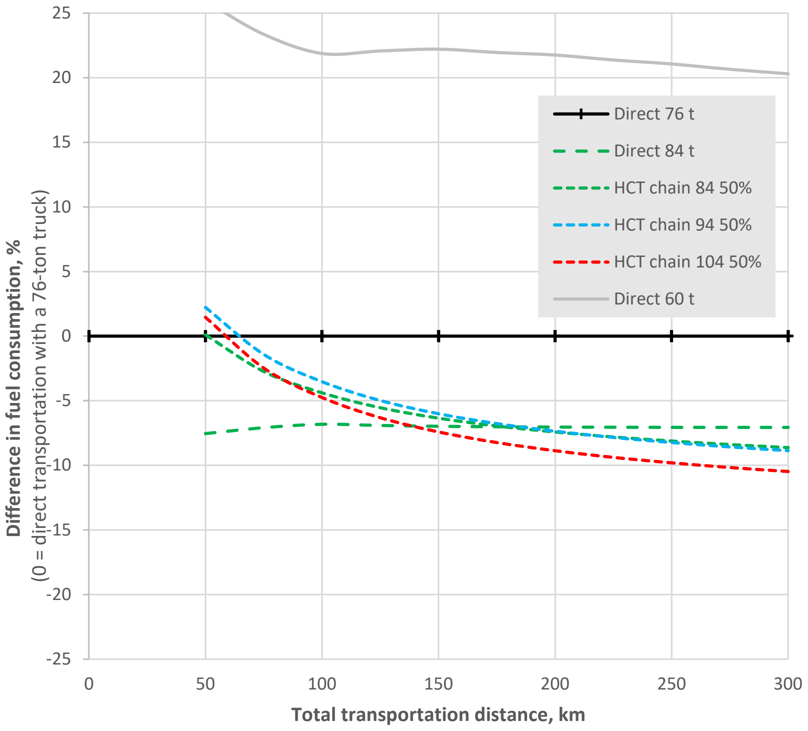
Difference to a 76-ton truck, driving distance of 100–300 km

Weight t	Difference %
84F	–6,8…–7,1
84T50 %	–4,4…–8,6
94T50 %	–3,5…–8,9
104T50 %	–4,7…–10,5

F=forest truck, T=terminal truck
Share of transferred load: 0 %, 50 % (reloading of the truck, but not the trailer), 100 %

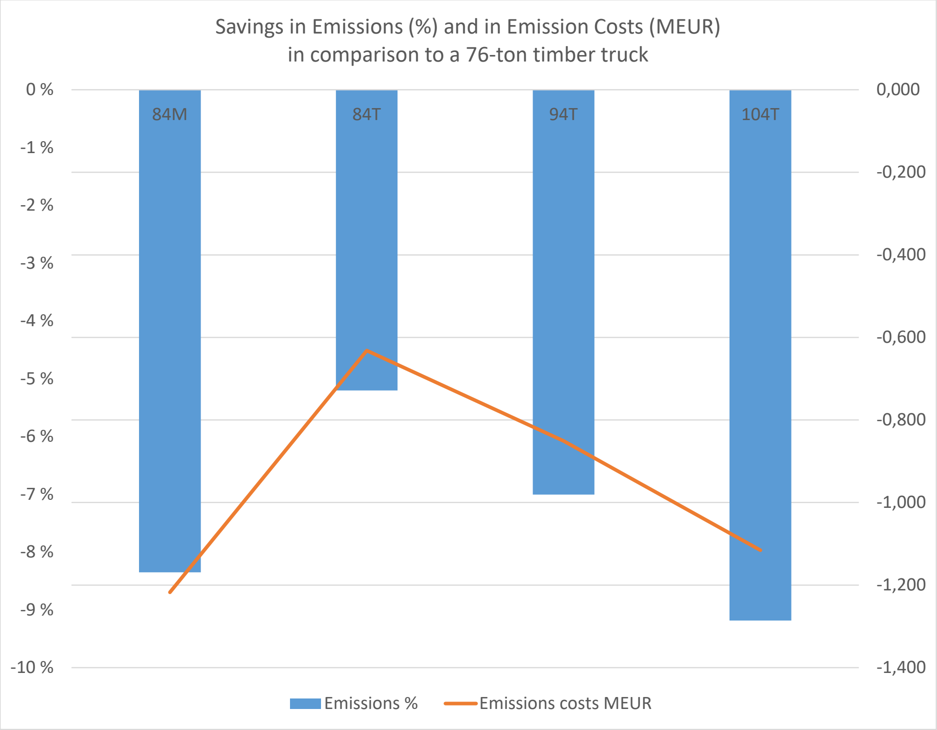
Venäläinen & Poikela 2022

Timber trucks (forest + HCT transport chain)



Emission Reduction Targets

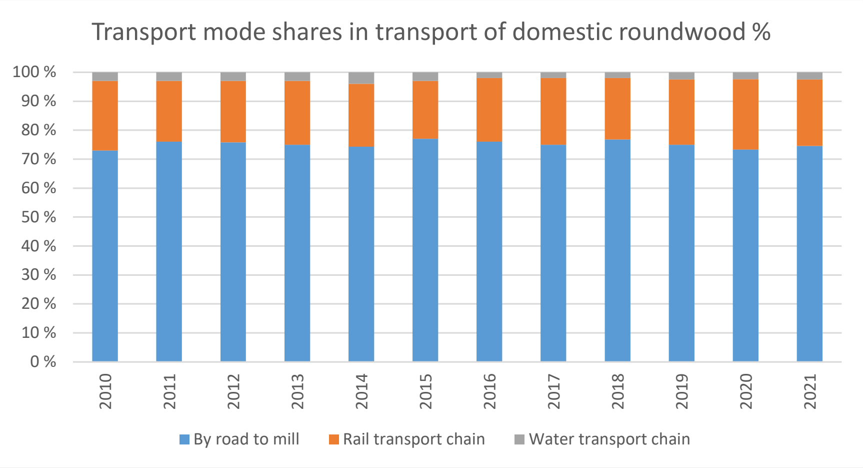
- The European Commission has proposed that Finland would be obligated to reduce its GHG emissions by 50 % (from 2005 to 2030).
- The graph illustrates the potential impacts of different vehicle combinations on CO_2 emission reductions, if considering only
  - Weight of vehicle combinations (in 2005, the maximum weight was 60 t)
  - Timber transport volume in 2021.



Venäläinen & Poikela 2022

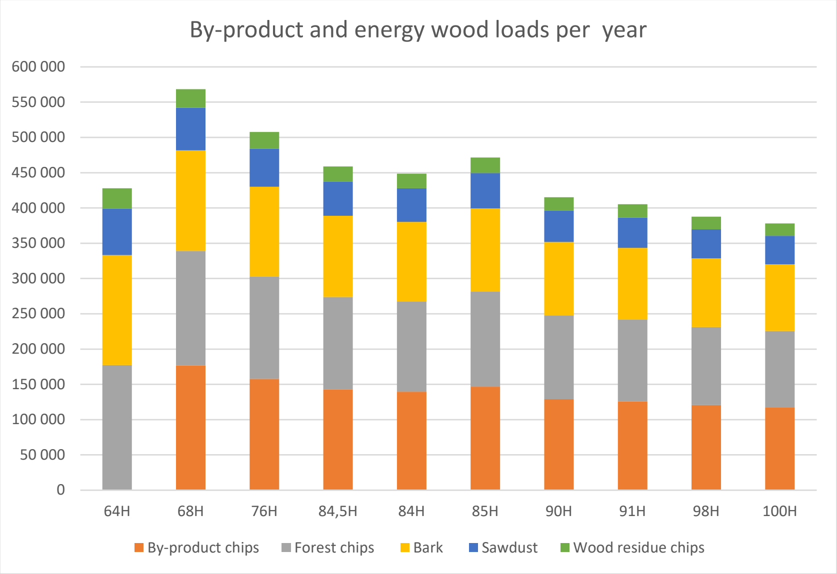
Impacts on the Use of Railway Transportation

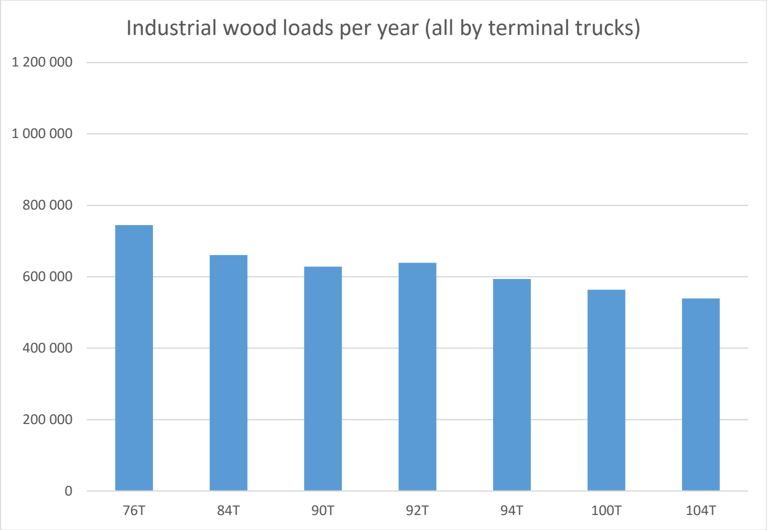
- The impacts of an 84-ton timber truck on the use of railway transportation was modelled in two studies (Lapp & Iikkanen 2017, Lapp et al. 2022).
  - The estimated decrease in timber transport 5–7 % depending on the area of operation of the HCT vehicle.
  - Decrease in railway transportation particularly on routes without direct railway connections
  - The estimated modal shift volume likely to be limited due to expected improvements also in competitiveness of railway transportation.
- The study did take into account the potential role of HCT vehicles in road leg transport to railway terminals.
- The increase in truck weights in 2013 did not result in changes in the share for rail transportation of timber (see the graph).



% transported m³
Metsäteho Oy in Natural Resources Institute Finland 2022

3. Transport and Cost Efficiency





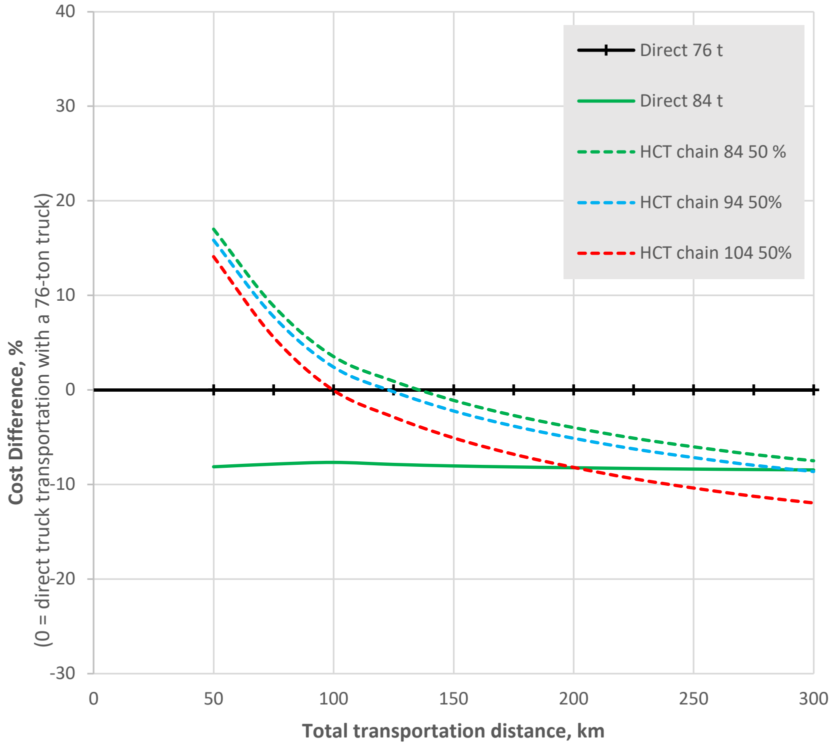
Venäläinen & Poikela 2022

Transport Cost Savings – Timber

Difference to a 76-ton truck
Driving distance of 100–300 km

Weight t	Difference %
84F	–7,7…–8,5
84T50 %	+3,5…–7,5
94T50 %	+2,4…–8,6
104T50 %	0…–11,9

F=forest truck, T=terminal truck
Share of transferred load: 0 %, 50 % (reloading of the truck, but not the trailer), 100 %



Cost benefits of terminal stages or back-haulage transportation have not been estimated

Venäläinen & Poikela 2022

Use of Swap Bodies at HCT Terminals

Hannonen's HCT truck
(Photo: Metsä Group)

Moilaspojat's HCT truck
(Photo: Metsähallitus Forestry Ltd)

4. Traffic Safety

- Traffic safety research on long trucks
  - Research conducted by the University of Oulu (Haataja et al. 2018, Pirnes et al. 2018, Strandström 2018, Tuutijärvi et al. 2018) addressed factors such as stability and manoeuvrability of vehicle combinations.
  - Aalto University's research (Heinonen 2017) covered areas such as driving speeds, overtaking HCT vehicles, and queues behind long trucks.
- Traffic safety research on heavy trucks
  - The University of Oulu´s (Pirnes et al. 2018) research examined breaking distance, stability, slipping and accelerations, and forces acting on coupling equipment.
  - Additionally, manufacturers have been monitoring possible cracks in couplings.
  - The currently available research has not identified any significant differences in traffic safety between heavier and standard trucks.

5. Road and Bridge Wear

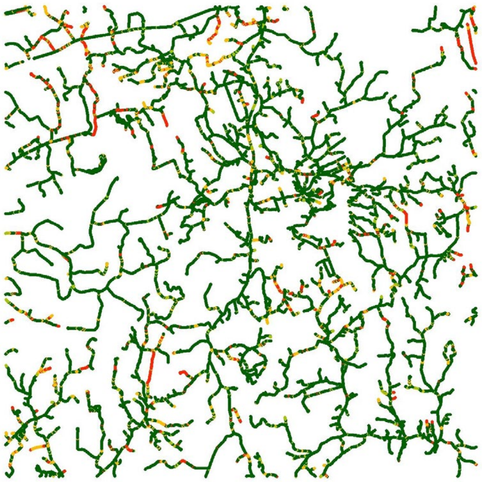
Results from the available research

State roads with thick pavement	State roads with thin pavement	Gravel roads (public and private)
No differences in rutting[1, 3]	Differences in rutting depending on the thickness the of pavement[1, 2, 3]	Somewhat contradictory results[2, 3]
	Ongoing study by the University of Tampere	Ongoing study by the University of Oulu
Ongoing Winter Premium project by University of Oulu and Finnish Meteorological Institute => Higher weight restrictions when road structure is frozen		

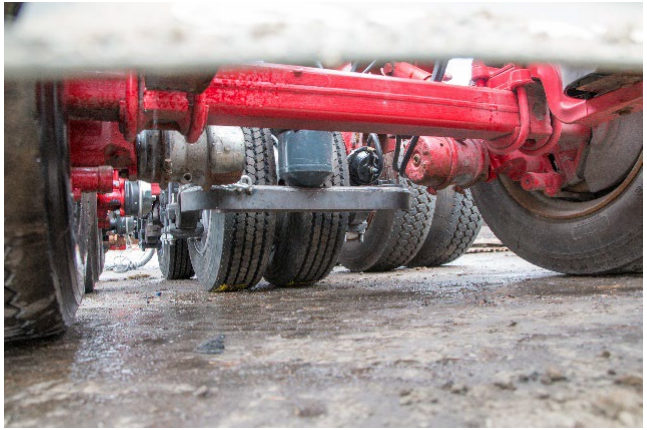
1=Vuorimies et al. 2018 2=Vuorimies et al. 2019 3=Pekkala 2018

Means to Reduce Road Wear
(Venäläinen & Poikela 2022)

- HCT corridors and terminals (see section 6)
- Gravel road trafficability classification tool (refer to the image at the top)
- Dynamic weight restrictions on roads
    - Such as Winter Premium
- Central Tire Inflation System, CTI
- AT Wheels’ new axcel solution (refer to the image at the bottom)



Arbonaut Oy



AT Wheels

Bridge Wear

- Bridge bearing capacity depends on (Sauna-aho et al. 2018, Kalliovalkama 2022)
  - Bridge length, cross-sectional dimensions
  - Properties of vehicle combinations (total mass and length, distance between axles and axle groups, mass of axle groups, and placement of the heaviest axles).
- Bridge wear calculations for HCT vehicles (Kalliovalkama 2022)
  - In most cases, HCT vehicles increased stress by more than 10 %
  - The level of stress depends on the placement of the heaviest axles in vehicle combinations
  - Differences from normal trucks were minimal with some 84-tonners and on short bridges
  - Test loading of selected bridges is necessary to further analyse the results from calculations.
    - For instance, possible reinforcements of bridges were not considered in the calculations.
- Bridge wear can be reduced, for example, by limiting the number of concurrent HCT vehicles on a bridge.

Calculative difference between HCT vehicles and standard trucks in bridge wear (regarding torque)

(Kalliovalkama 2022)

	Torque max		Torque min	
	Long Bridge	Short Bridge	Long Bridge	Short Bridge
T100	17,1 %	2,4 %	9,1 %	-10,6 %
H100	12,4 %	-4,4 %	1,7 %	2,9 %
T92	10,9 %	-1,4 %	0,3 %	-5,9 %
H91	18,4 %	9,0 %	11,6 %	8,1 %
T90	13,3 %	1,0 %	8,9 %	6,6 %
H90	14,2 %	-0,1 %	8,9 %	6,0 %
M85	9,2 %	-2,7 %	4,2 %	1,5 %
M84C	7,0 %	3,7 %	3,9 %	2,5 %
M84D	8,5 %	5,3 %	5,3 %	3,9 %
H84	4,6 %	-0,1 %	0,0 %	-1,9 %
T84	4,0 %	-5,9 %	3,8 %	2,5 %

6. HCT Corridors and Terminals

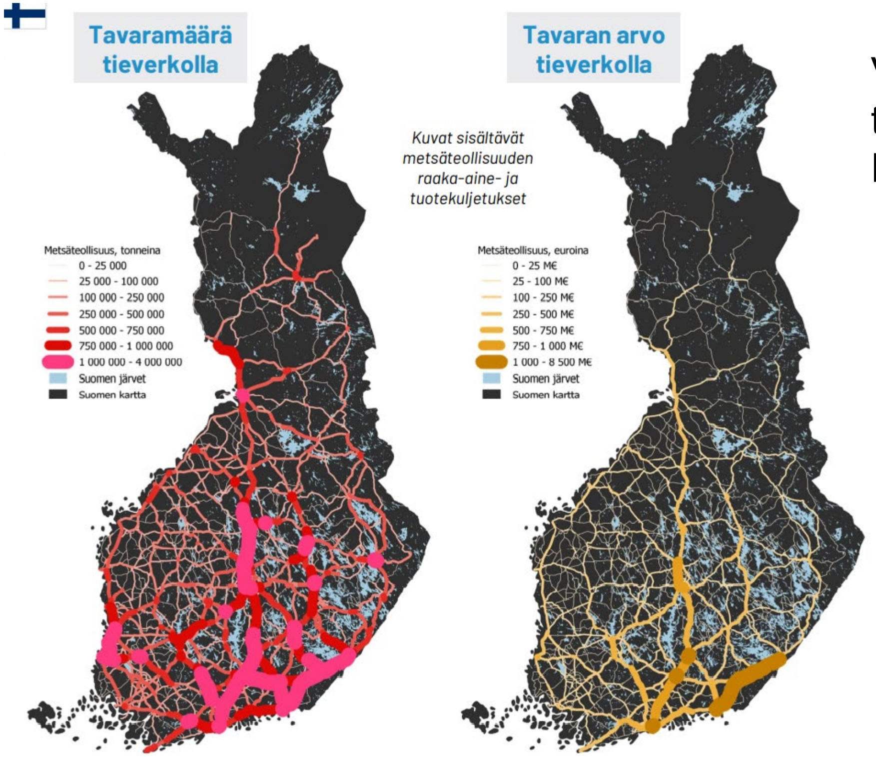
- Dedicated corridors would allow for the concentration of HCT vehicles on road connections that benefit the most from HCT vehicle traffic while minimising negative impacts.
- Bridges with weight restrictions do not necessarily hinder HCT transportation in a region. Possible solutions include:
  - Rearranging truck modules before crossing the bridge
  - Using detours
  - Planning HCT routes to avoid bridges.

Suggested Sections of HCT Corridors for Wood Transportation
1. Notable sites using industrial and energy wood
2. Notable industrial and energy wood terminals • Terminals for rail, waterborne, and road transportation
3. **Essential road connections between wood procurement areas and sites using wood** (see maps on the next slide)
4. Corridor types • Pulpwood transport from terminal to site of use • Log transport from terminal to site of use • Energy wood transport from terminal to site of use • Wood transport from forest to site of use • Exchange of wood between mills and terminals, back-hauling

Venäläinen 2017

Forest Industry’s Most Important Road Connections

Freight volume on the road network, Forestry, in tonnes



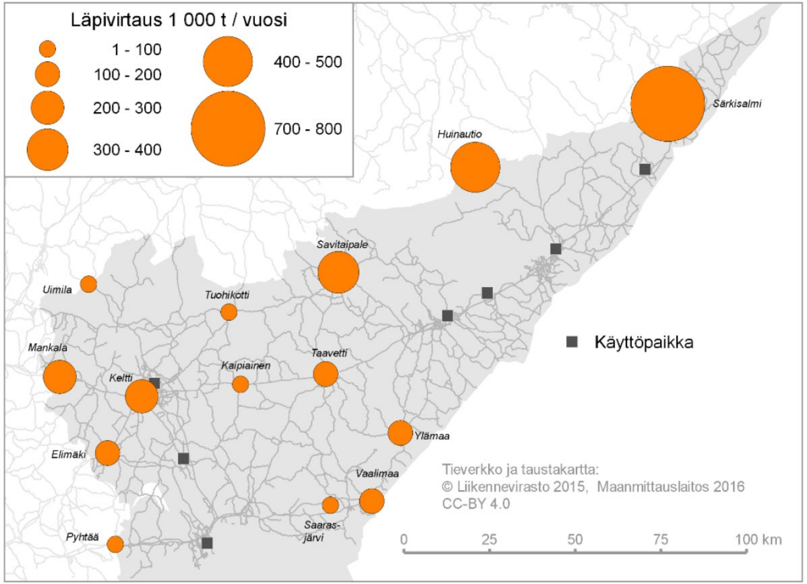
Value of freight on the road network Forestry, in Euros

Statistics Finland in Infra ry et al. 2022, statistical data is partly insufficient

HCT Terminals

- Terminals are needed for the transfer of timber from a forest truck to an HCT truck, including:
    - Actual road transportation terminals
    - Smaller loading areas for
        - Short-term storage of loaded trailers or swap bodies
        - Short or long-term storage of timber
        - Sufficient space for two articulated vehicles to facilitate load transfer.
- LUT University (Korpinen & Aalto 2017, Lappeenranta University of Technology 2017) has conducted simulations to determine the optimal locations for HCT terminals.

Annual volume (1 000 t/a)



Korpinen & Aalto 2017

7. Driver Shortage

- The demand for new timber truck drivers exceeds the number of newly graduated drivers (even without considering potential future increase in the need for drivers) (Strandström & Poikela 2020).
- Terminal-based timber logistics model
  - Offers greater flexibility in the utilisation of driver resources
  - In transport between terminals, drivers do not need to possess experiece in forest truck operations.

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