



Optimal biomass truck load size and work models for loading of loose biomasses



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Metsäteho is a limited company owned by the leading forest industry organisations and companies of Finland and is specialized on research and development (R&D) work and projects.

Metsäteho supports the development of its shareholders' wood procurement and wood production operations as well as improves the operating preconditions for wood supply.

Work is based on active networking. The core role consists of analysing R&D needs and new possibilities, compiling research consortiums, implementing their work and supporting the development of the results.

Primary areas of activity include: R&D projects, consultancy services, seminars and other communication activities.

HARVESTIA



KOSKITUKKI



METSÄHALLITUS



Metsäteollisuus

POLKKY



TORNATOR



VARPO



Efficient Wood Supply Vision 2025 - poster



Efficient Wood Supply Vision in Finland 2025
Created by Metsäteho Ltd.

Development goal in Finland 2025

Wood supply to produce added value to the value chain while being 30% more cost-efficient than today.

Objectives

- To underline the objectives of wood procurement and wood production as well as goals for R&D.
- To create the basis for future R&D operations and preparation of research programs.
- To define future preconditions and development needs of wood supply, procurement and logistics operations.

New technology in a key role

- Sensor technology, automation and robotics
- Forest machine and truck data
- More efficient mobile networks (4G and 5G)
- Storing and analysing capacity of data
- Analysing methods of Big Data
- Data ecosystems and platform economy
- Virtual and added reality
- New power sources and fuels in forest machines and trucks



Megatrends behind the vision in forest industry



R&D focus areas 2018 - 2025

- Data ecosystems and decision support systems
- Sustainability in value chains
- Work safety, well-being and know-how
- Resource and energy efficiency
- Long-distance transport systems
- Increasing wood production

See more detailed presentation:
<http://www.metsateho.fi/briefly-in-english/>



- Stratistics supports the development of its downstream: seed procurement and seed production operations** as well as improves the operating procedures for seed supply.
- Work is based on active networking.** The core team consists of existing R&D needs and new positions, sampling research consortiums, implementing their work and supporting the development of the results.
- Primary areas of activity include:** R&D projects, consultancy services, seminars and other communication activities.



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http://www.metsateho.fi/wp-content/uploads/Tehokas-puuhuolto_2025_EN_Efficient_Wood_Supply.pdf

Back to the topic...

Proportions of forest biomass use in Finland in 2016

Logging residues 2.5 Mm³ (34%)



Small-sized trees 3.9 Mm³ (52%)



Stumps 0.8 Mm³ (10%)



Large-sized decayed wood 0.3 Mm³ (4%)

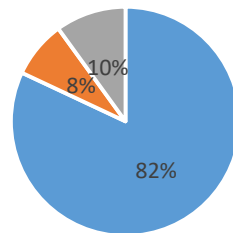


Source: Luonnonvarakeskus
2017

Proportions of comminution places of biomasses in forest biomass supply chains in 2016

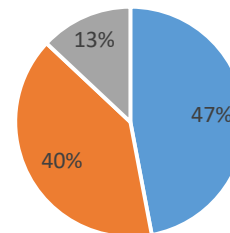
Source: Strandström 2017

Logging residues



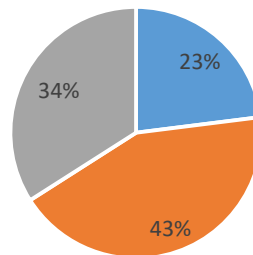
■ Roadside chipping ■ Terminal chipping ■ Plant crushing

Small-sized whole trees



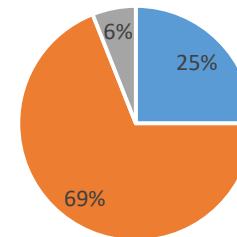
■ Roadside chipping ■ Terminal chipping ■ Plant crushing

Stumps



■ Road side crushing ■ Terminal crushing ■ Plant crushing

Large-sized decayed wood



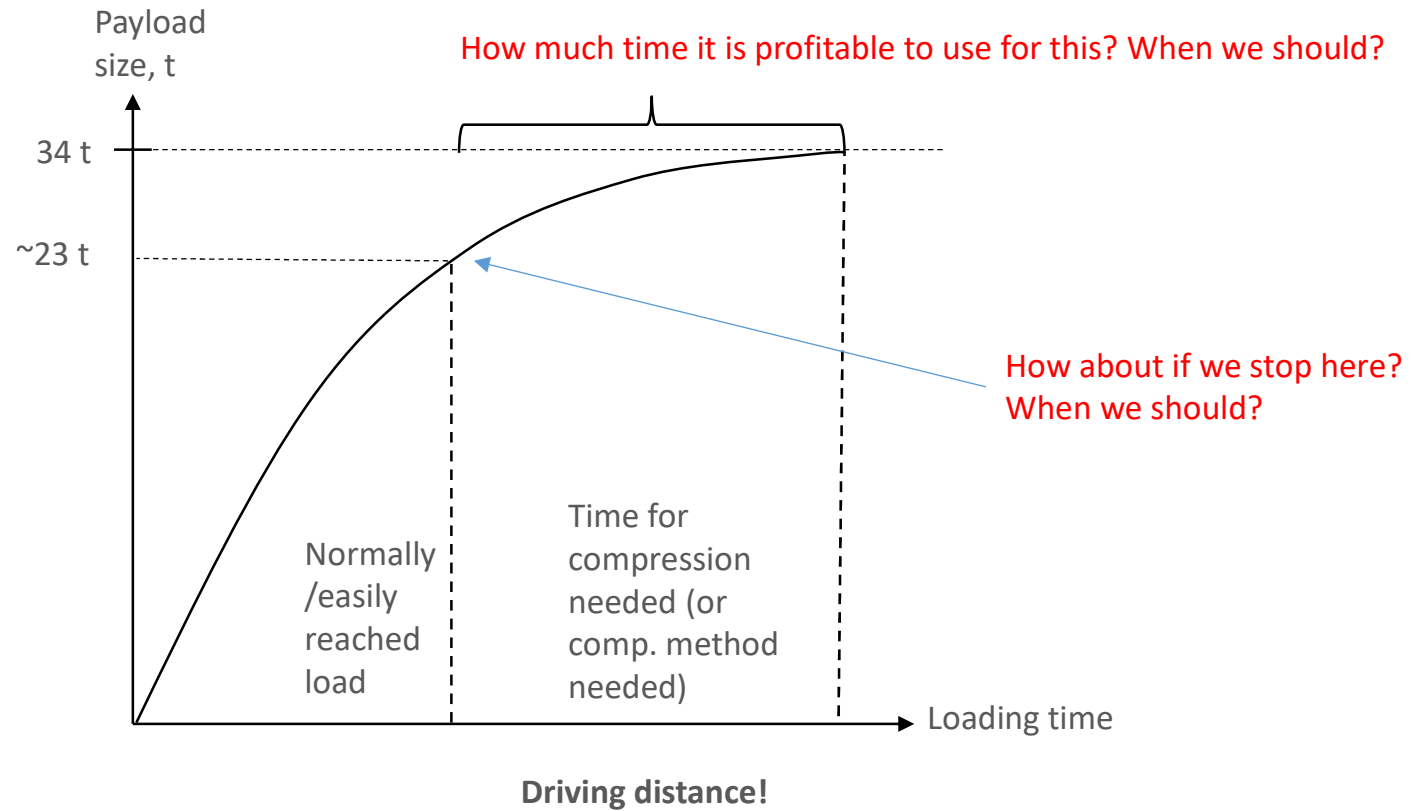
■ Roadside chipping ■ Terminal chipping ■ Plant crushing

Truck transport of uncomminuted material



- In Finnish conditions allowed total weight of a typical bioenergy truck is 64 tons and the volume of load space is about 160 m³.
- Weight of empty truck is about 31 tons. Typical payload size with stumps or logging residues is under **25** tons and the maximum load **33** tons is not reached often. What to do?

Loading of loose biomass

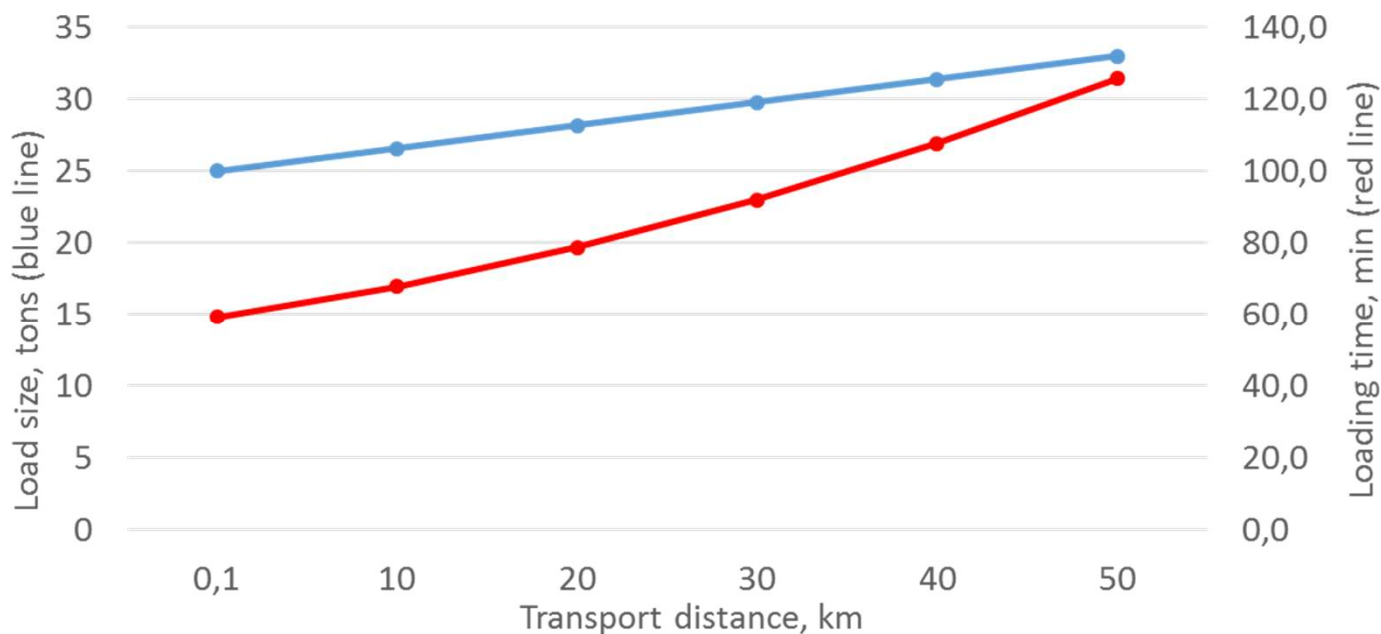


Objectives of the study

- calculate optimal payload size on different transport distances for logging residues
- describe productive work models for loading of truck with loose biomass materials



Optimal load size and transport distance in connection to loading time



- Blue line indicates the optimal load size when loading time is consumed according to loading time curve (red line). For example, if the transport distance is 30 km, the payload should be 30 tons at least.
- If it takes shorter time to load, the transport distance could be shorter and vice versa.

Discussion 1

- For over 50 km transport distances the load space should be full loaded by 64 ton trucks.
- The driving distance versus driving time optimization is very much dependent on the loading time.
- The loading time curve was based on the data of the work method study loads and did not differ much of the previous time consumptions of loading of biomasses.
- To reach 33 ton payload is very time consuming task if the material is dry, under 35 % precipitation. For this reason, work methods and techniques to compress the load are needed in addition to normal work procedures.

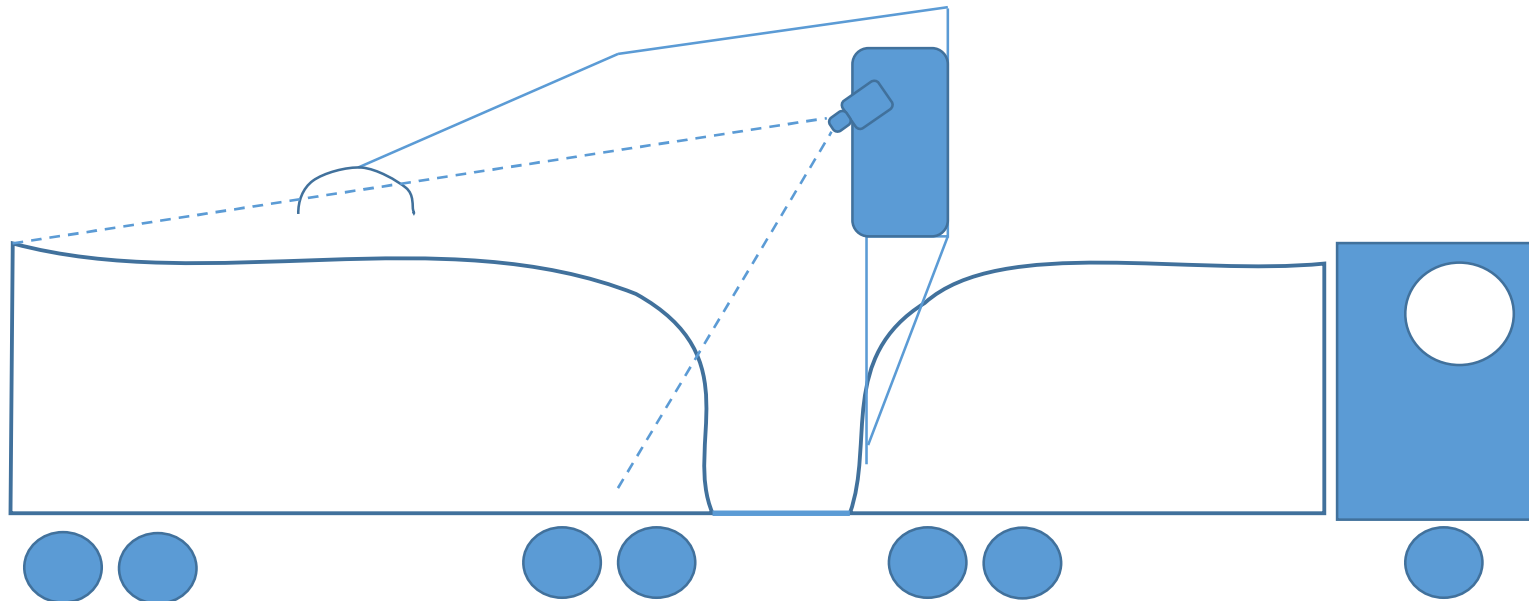
Work models for bioenergy truck loading

in other words

**Work movements and tricks to compress
the load**

Time study

- Loading of trucks was filmed from the loader cabin point of view.
- Payload sizes were collected from bridge scales.
- Totally 12 different biomass truck drivers participated the study.



Study loads

	Loads	Mean, kg	Min, kg	Max, kg	St. Dev., kg
Stumps	12	24068	17500	32200	4374
Logging residues	11	22197	17580	27820	3125

Work models

- Four different kinds of work models were recognized of the study material:

Work model for loading of

1. small sized stump material
2. normal sized stump material
3. middle sized stump load in a short loading time
4. logging residues

Discussion 2

- Material size proved to be important factor in stump loading work models -> for this reason, two of the models were based on material size.
- In logging residue loading, compressing movements are even more important compared to stump material: **press, squeeze and turn.**
- The drivers aimed to make "compressed bundles" of the tares by making different kinds of movements with the grapple in the pile and in the load space. Therefore, the most effective way to improve loose logging residue loading would be a grapple that would densify and bundle a single tare during the lifting phase to the load space.

Literature

- Ovaskainen, H. & Lundberg, H. 2016. Optimal biomass truck load size and work models for loading of loose biomasses. Metsäteho's slide series 3b/2016. 48 p.
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