

# Delivery of sustainable supply of non-food biomass to support a resource-efficient Bioeconomy in Europe

## Discrete-event modeling of timber logistics

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# Discrete-event simulation as a study method

- **Efficient method in complex system analysis**
  - Systems with internal interactions, machine idling, stochasticity, several study scenarios
  - Cost/time efficient compared to real world piloting
- **Purpose-build models**
- **Visualization of the system simulations**
- **Various data sources and data-matrixes can be used**



”A simulation is the imitation of the operation of a real-world process or system over time” (Banks et al. 2010)

- **Challenges of timber logistics in the prevailing operation environment**
  - Many small roadside storages and wood assortment piles
    - In the case data 31% of all piles less than 10 m<sup>3</sup>
  - Number of transported wood assortments and mills are high
    - In total 25 different wood assortments
      - No of assortments in roadside storage: avg: 9, range: 2-12
    - 12 delivery facilities
      - eight saw mills, two pulp mills and two train loading terminals
- **Study was conducted to Metsäkolmio Ltd under the S2Biom project**



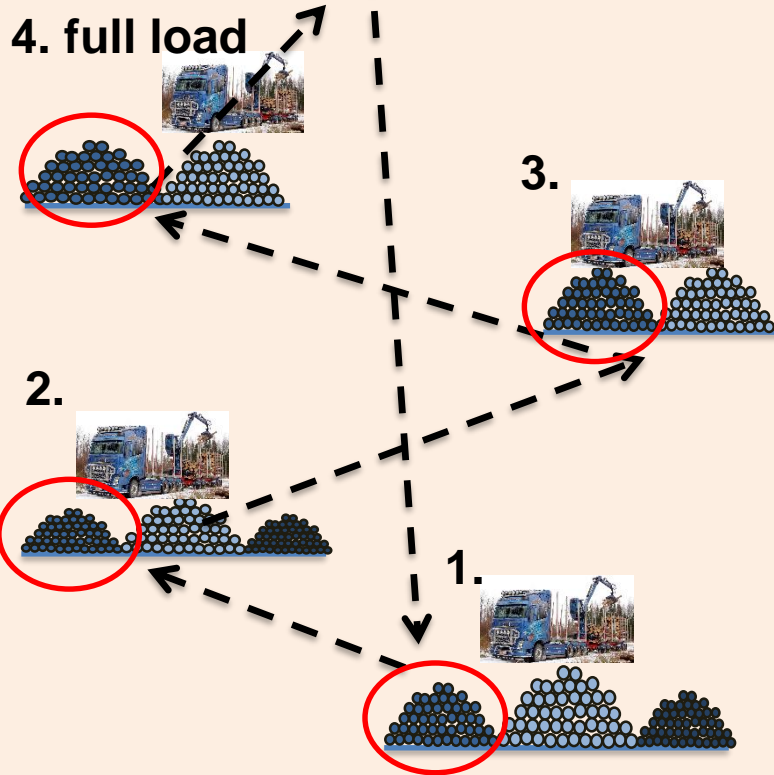
# Objectives of the study

- **Reveal the economy and operation potential of**
  - a) multi-assortment load model
  - b) bigger timber trucks,  
in prevailing operation environment

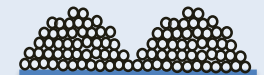
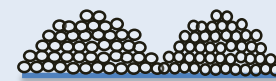


# Scenarios for the transport methods

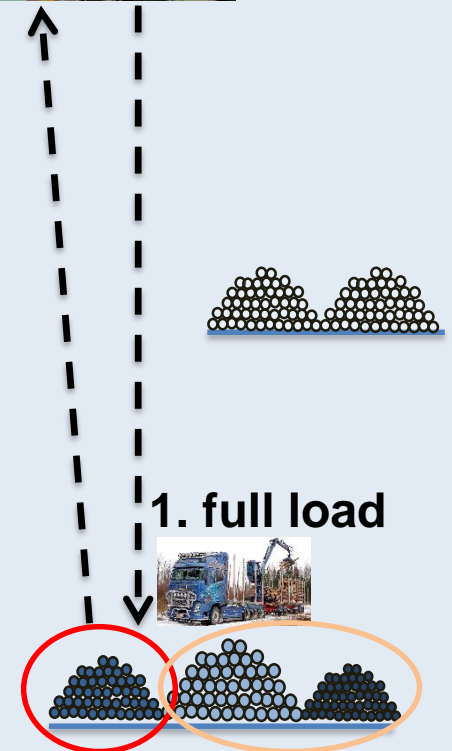
## Single-assortment load method



## Multi-assortment load method



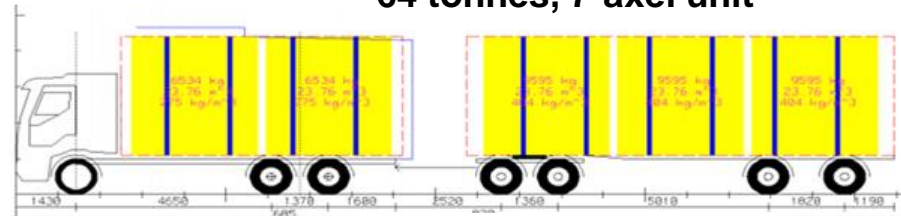
8 delivery places had an option for multi-assortment transports



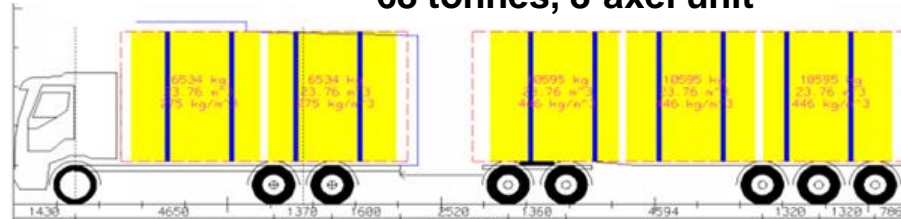
# Scenarios for the sizes of timber trucks

Consisted in  
study scenarios

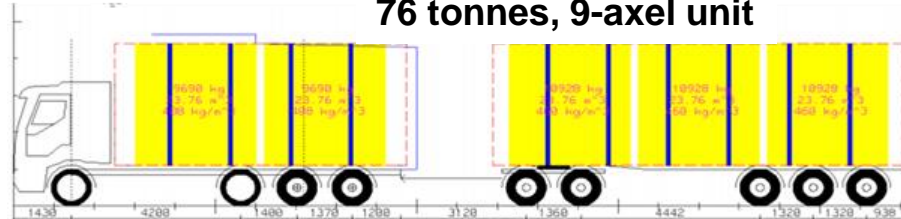
### 64 tonnes, 7-axel unit



### 68 tonnes, 8-axel unit



### 76 tonnes, 9-axel unit



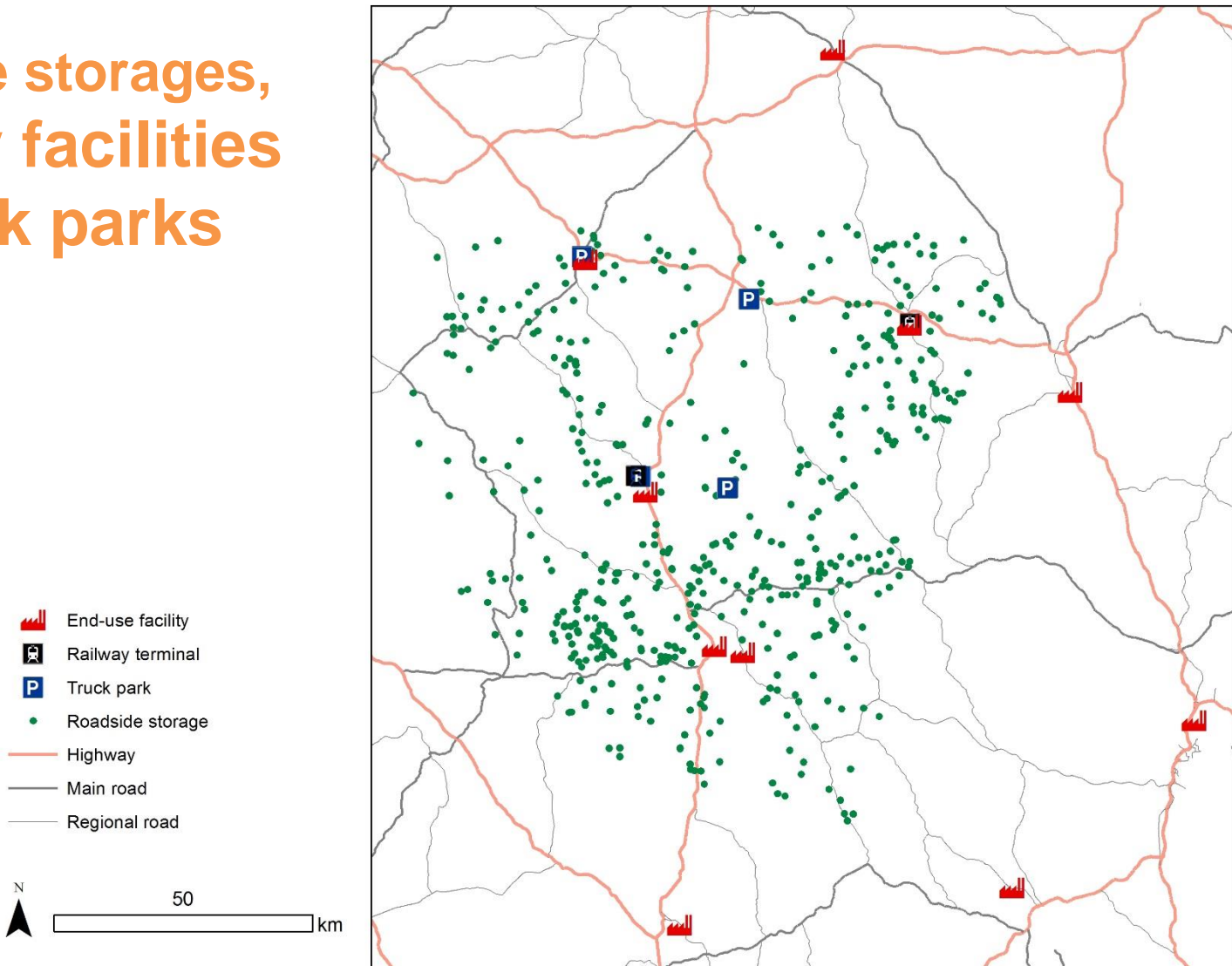
### 84 tonnes, 10-axel unit



To be studied... →

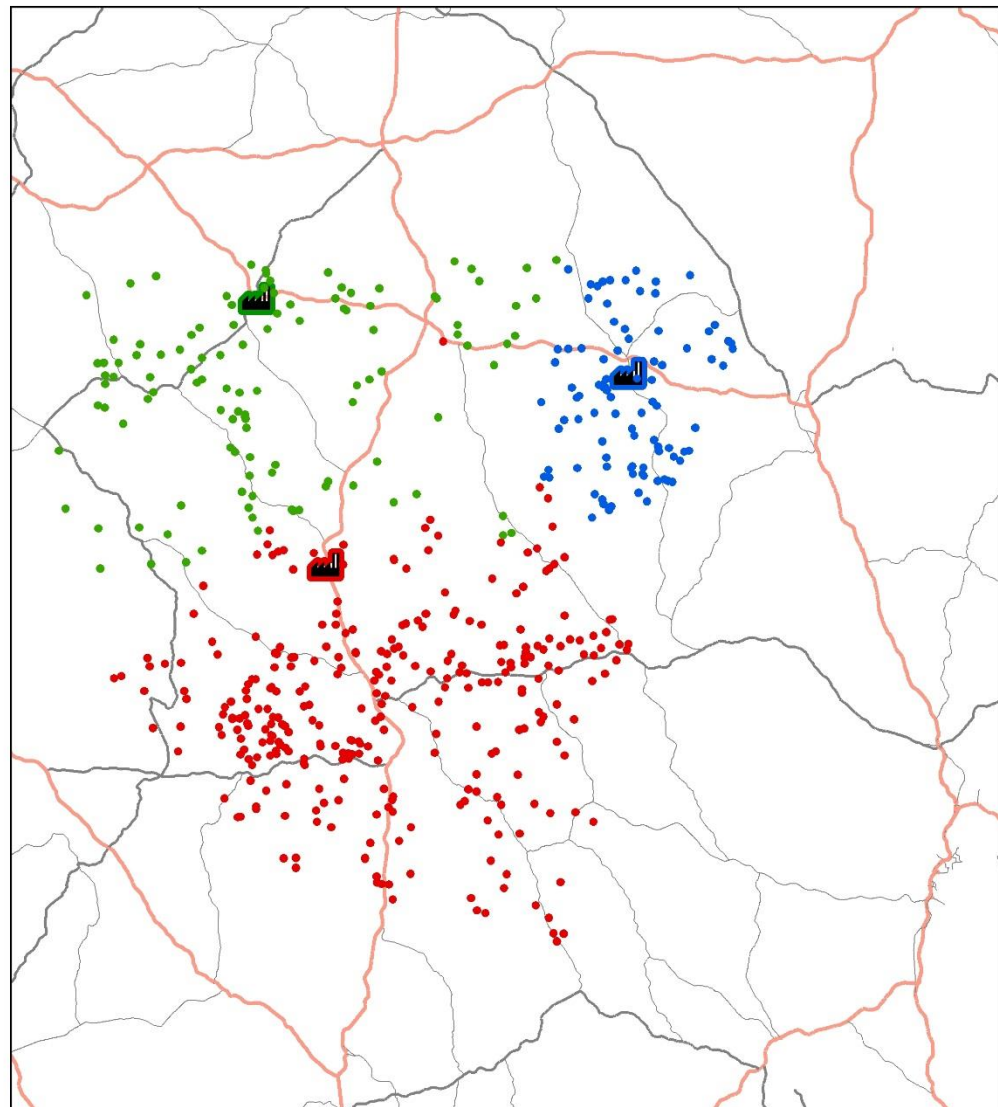
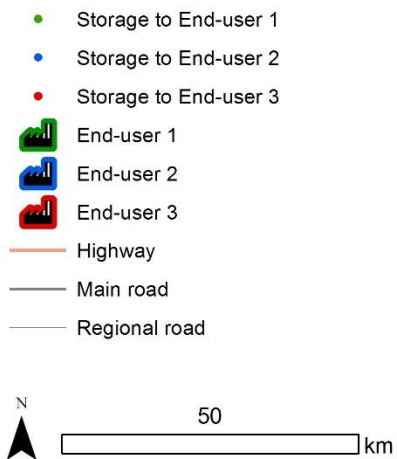
- **Roadside storage data**
  - co-ordinates, wood assortments, volumes, distances to delivery facilities and parks (by ArcGIS and Digi Road)
  - derived and recalculated from the earlier stand data
    - Area, storage size, assortment specifications from the customer
- **Characteristics of the operation environment/-model**
  - work-shifts, wood reception times, routing rules
  - time-element functions from Nurminen et al. 2007
- **Cost factors and values derived from the Finnish Transports and Logistics SKAL and the truck dealers**

# Roadside storages, delivery facilities and truck parks



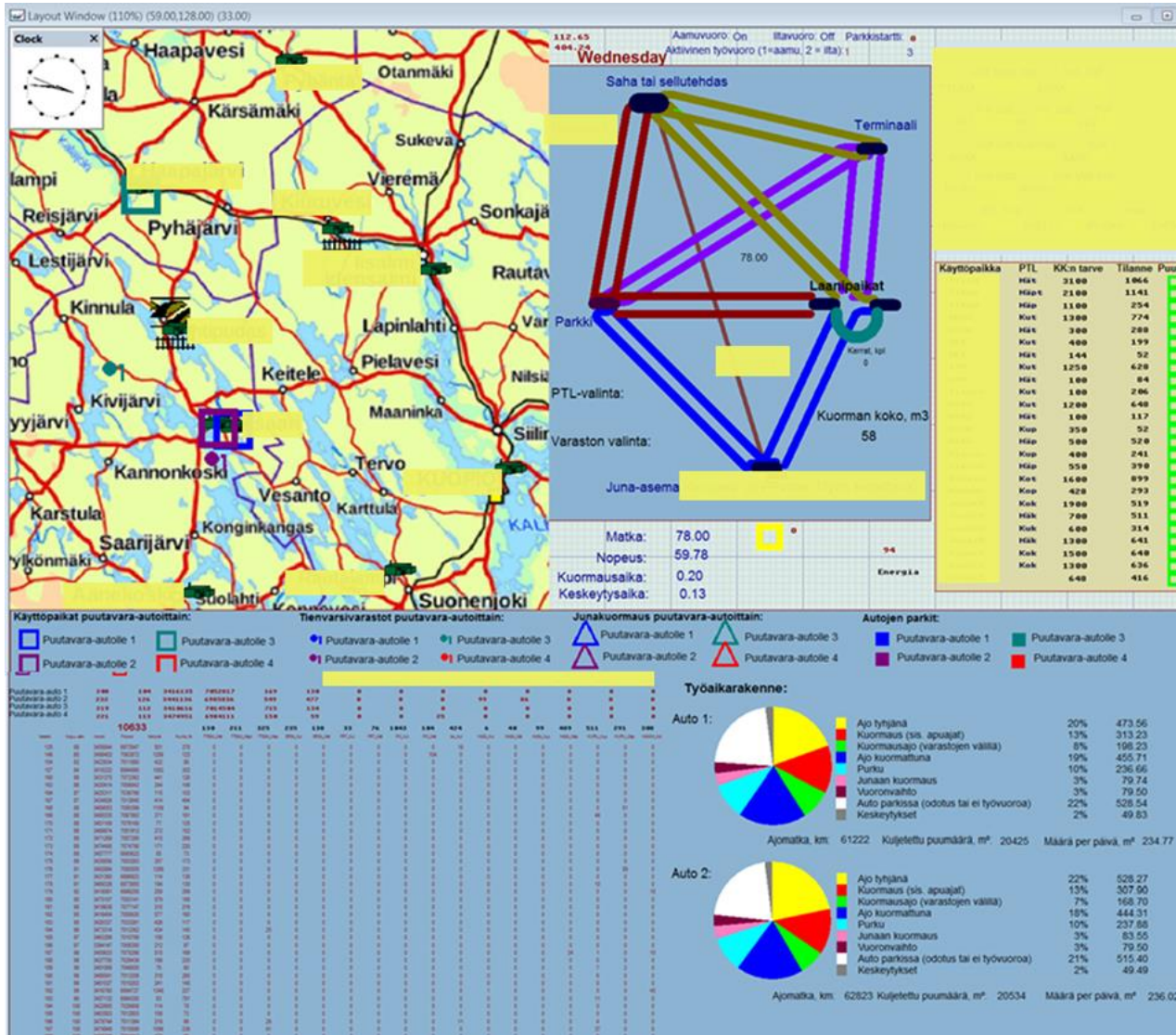


# Roadside storages and sawmills of pine sawnwood

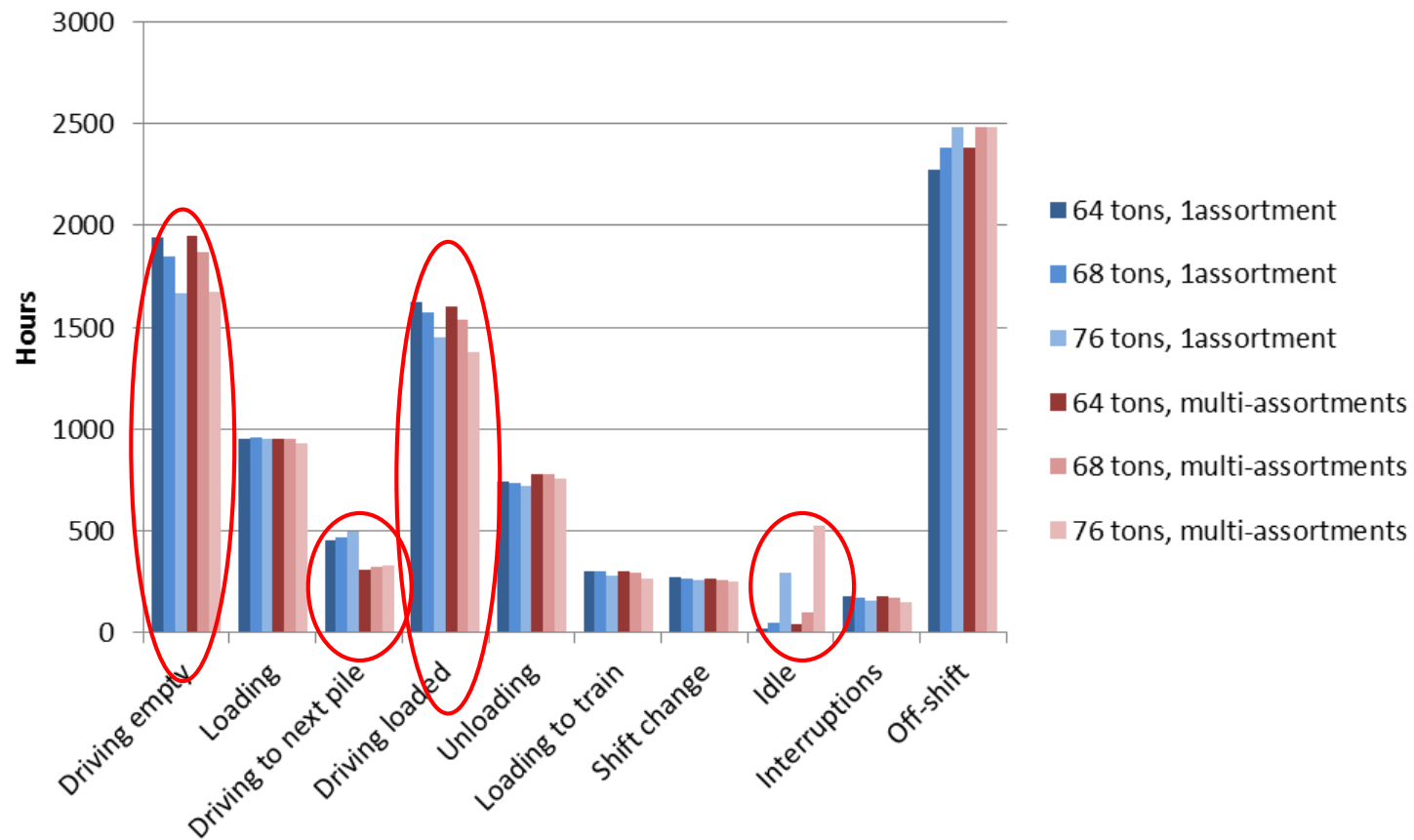




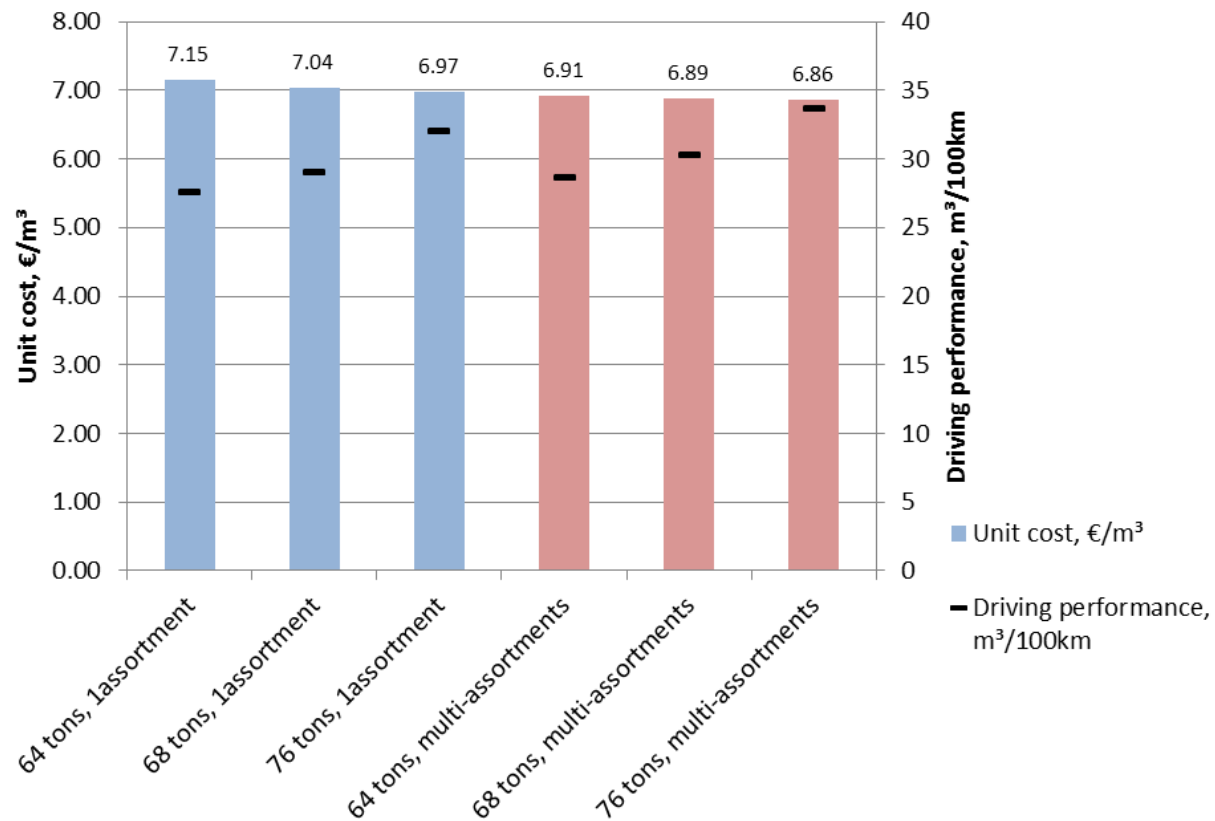
# Witness simulation environment



## Work element comparison



## Unit cost comparison, €/m<sup>3</sup>



- **Multi-assortment load method resulted 1.6–3.3 % lower unit costs compared to single-assortment load method**
- **Bigger truck size decreased transporting costs 1.5 % and 2.5 % while comparing 64 tonne truck to 68 and 76 tonne trucks in single-assortment scenarios**
  - 0.4 and 0.8 % lower costs in multi-assortment scenarios, respectively
- **Reasons for the low cost-benefit of the bigger trucks**
  - 76 tonne trucks' capacity was not in full use (idling time)
  - Bigger trucks have higher investment and variable costs
  - Small pile size is not favorable for the trucks with big load space
- **Fixed load volumes were used for each wood assortment**
  - 48, 51 and 58m<sup>3</sup> for 64, 68 and 76 tonne trucks

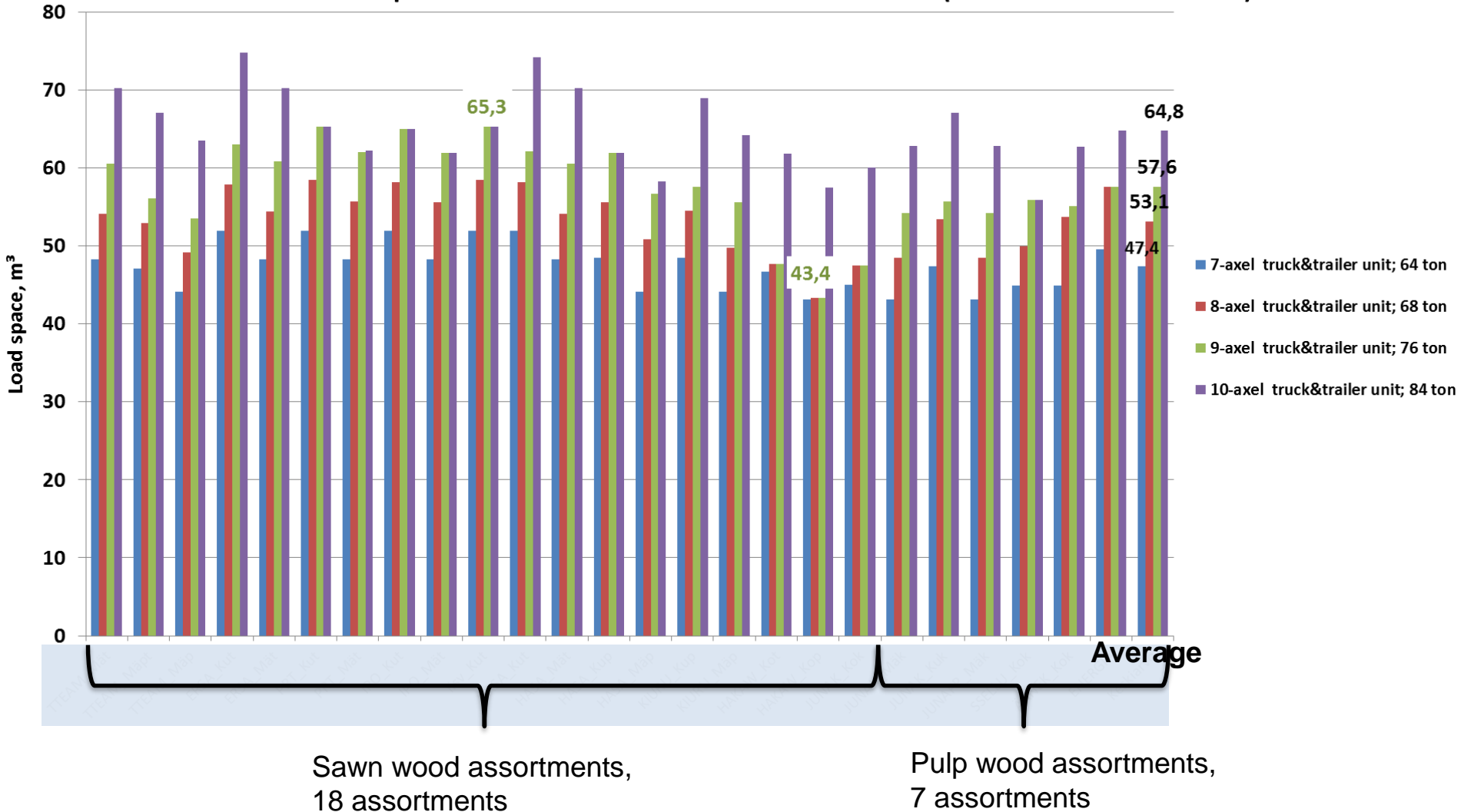
- **The developed model can be used to analyze the effect of different logistical concepts and operation models on e.g.**
  - transport costs
  - transported volumes
  - utilization rates of capacities
- **The model can be extended to other geographical regions and timber supply environments**
- **Special interest in**
  - the use of terminals as a part of timber supply
  - new operation models for trucks with varying sizes
  - the influence of routing rules, no. of assortments, RS storage size etc. on cost-efficiency

- **The impact of different operating environment for each truck size**
  - The size of roadside storage, the size of wood assortment piles
  - The number of wood assortments
  - An option to use terminals and high capacity trucks for shuttle transports form terminals to mills
    - 84 ton and 104 ton trucks as example
- **Impact of the amount of available road side storages**
  - In the case, in average 18,000 m<sup>3</sup> of timber was buffered in roadside storages (70-80 storages, bit less than use of one month)
  - High amount of capital is tied to storages
  - Efficient routing of trucks is easier with higher amount of available roadside storages



# Volume variation of load spaces

Maximum load spaces in m<sup>3</sup> for each assortment - Mid-winter (crane included - 3.5 tons)



Thank you!

**Boreal green bioeconomy**

