



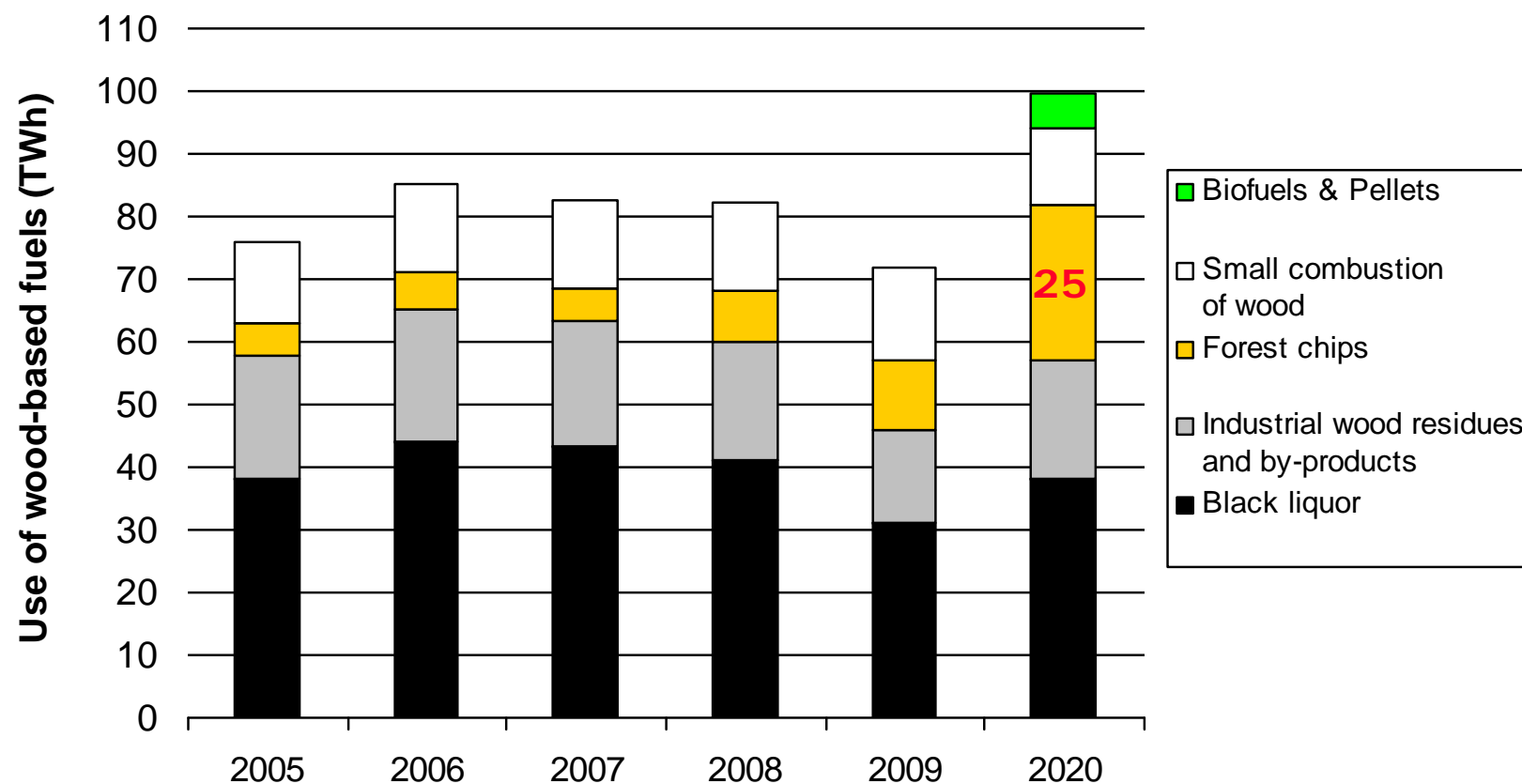
# Metsäteho

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## Improving the Cost-Efficiency of Small-diameter Energy Wood Harvesting from Early Thinnings in Finland

Kalle Kärhä, Aaron Petty & Heikki Pajuoja Metsäteho Oy  
Tore Högnäs, Metsähallitus  
Arto Mutikainen, TTS Research

## Use of Wood-based Fuels 2005–2009 in Finland, and Target for 2020



Sources: Pekkarinen 2010, Statistics Finland 2010

Logging Residues



Small-diameter Wood



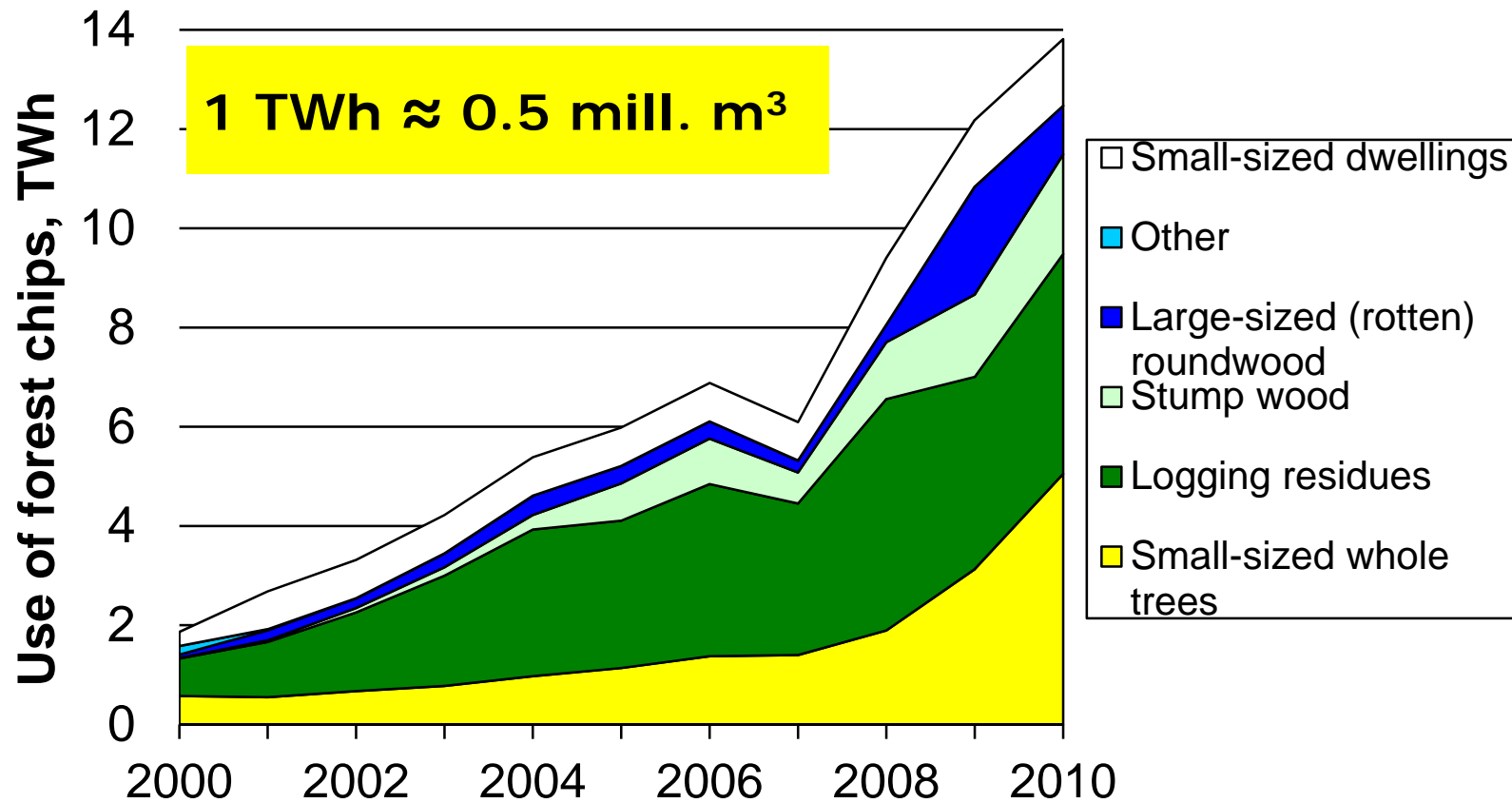
Stumps



Large-sized (rotten)  
Roundwood

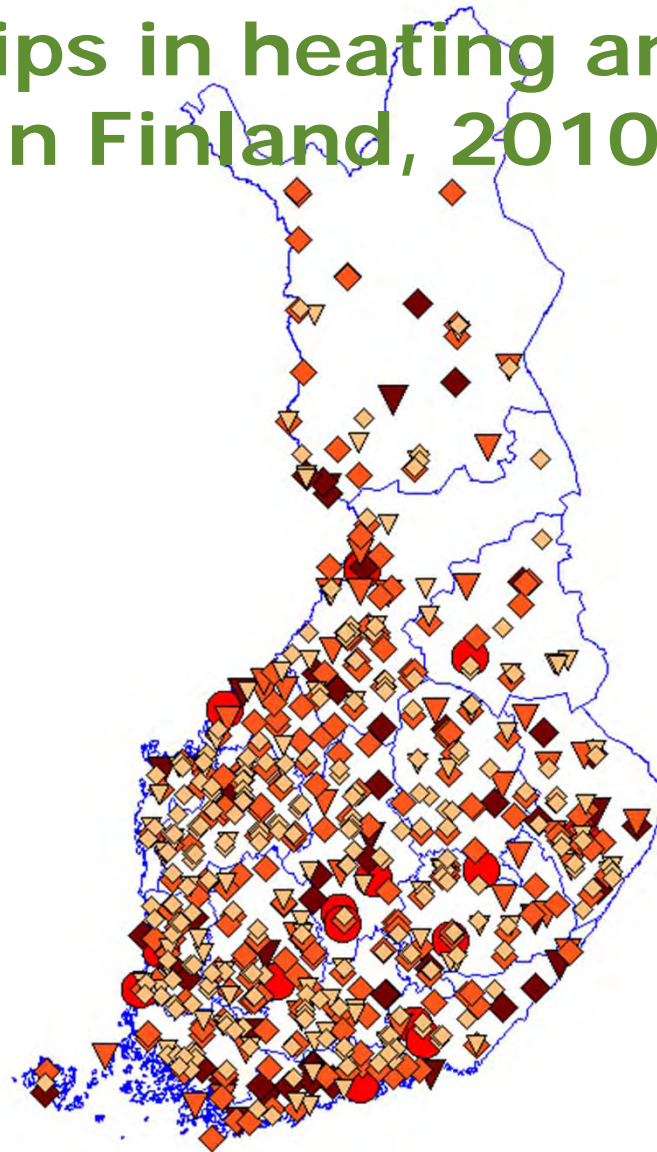
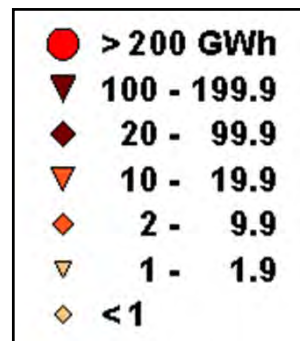


# Use of Forest Chips 2000–2010 in Finland

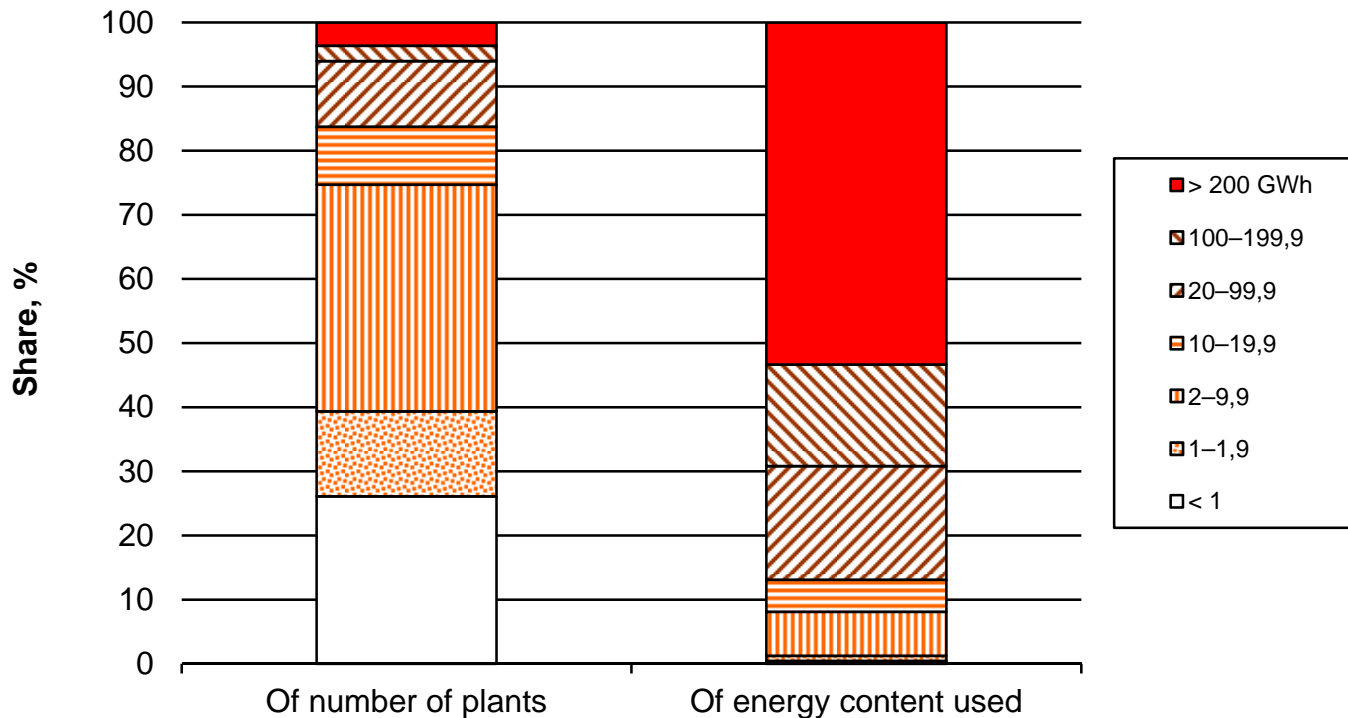


Source: Ylitalo 2011

# Use of forest chips in heating and power plants in Finland, 2010

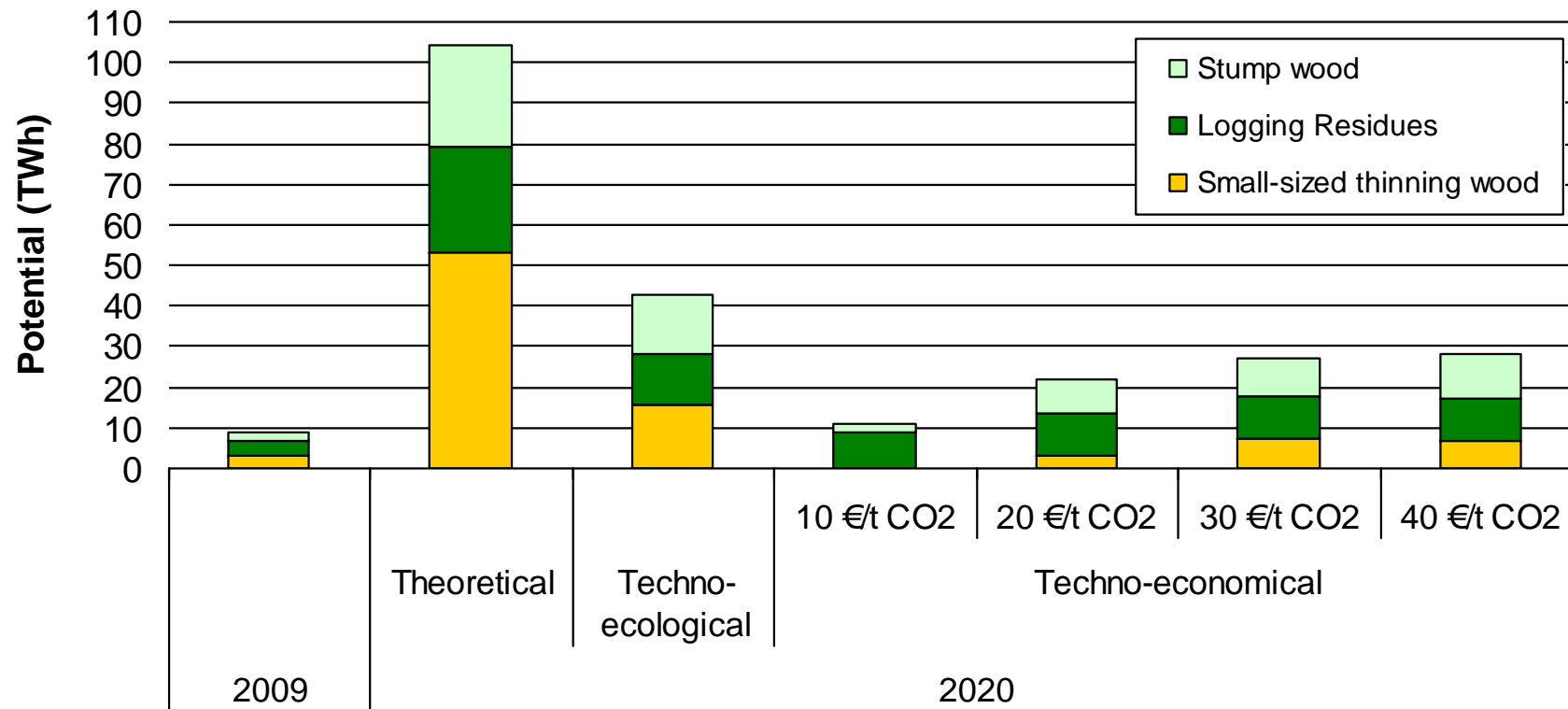


# Use of forest chips in heating and power plants in Finland, 2010



Source: Ylitälo 2011

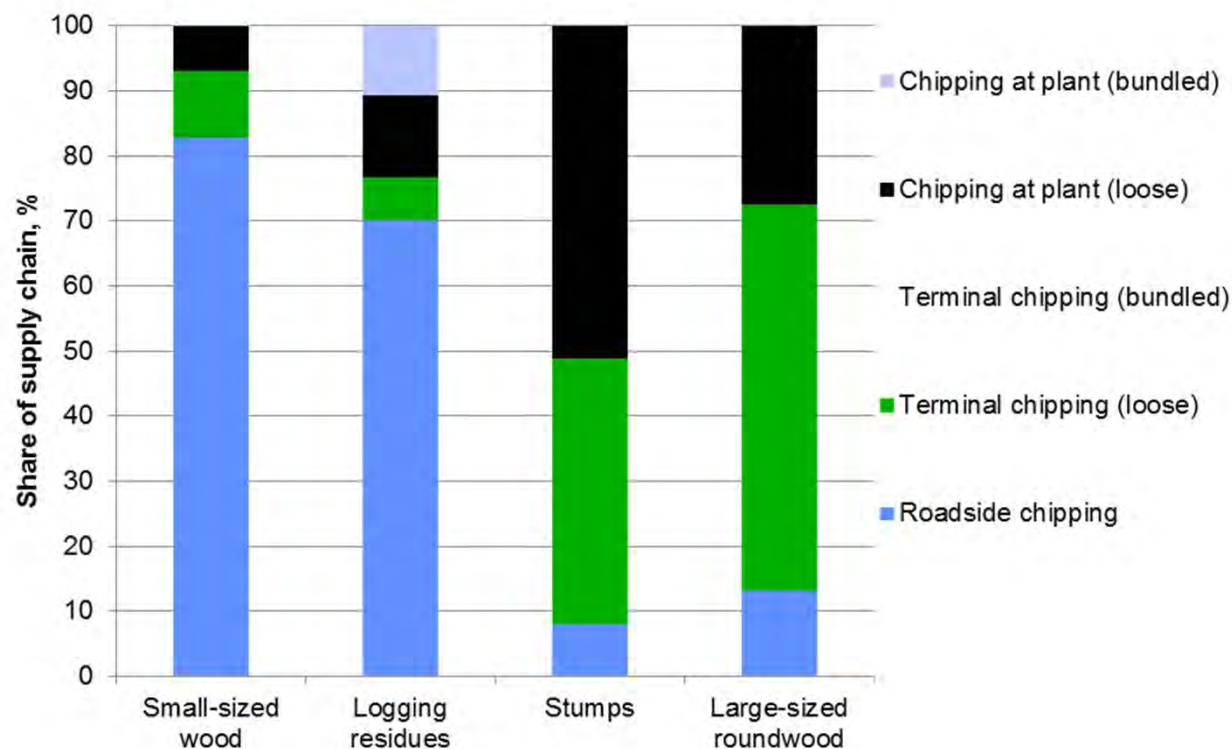
# Use of Forest Chips vs. Potentials in Finland



*Domestic industrial roundwood cuttings were 57 mill. m<sup>3</sup> and the subsidy for chips from small-diameter thinning wood from young stands 4 €/MWh.*

*Sources: Kärhä et al. 2009, Ylitalo 2010*

# Supply Chains of Forest Chips 2010 in Finland



Source: Kärhä 2011





# Harvesting Methods of Small-sized Thinning Wood

## Optional Harvesting Methods for Young Stands

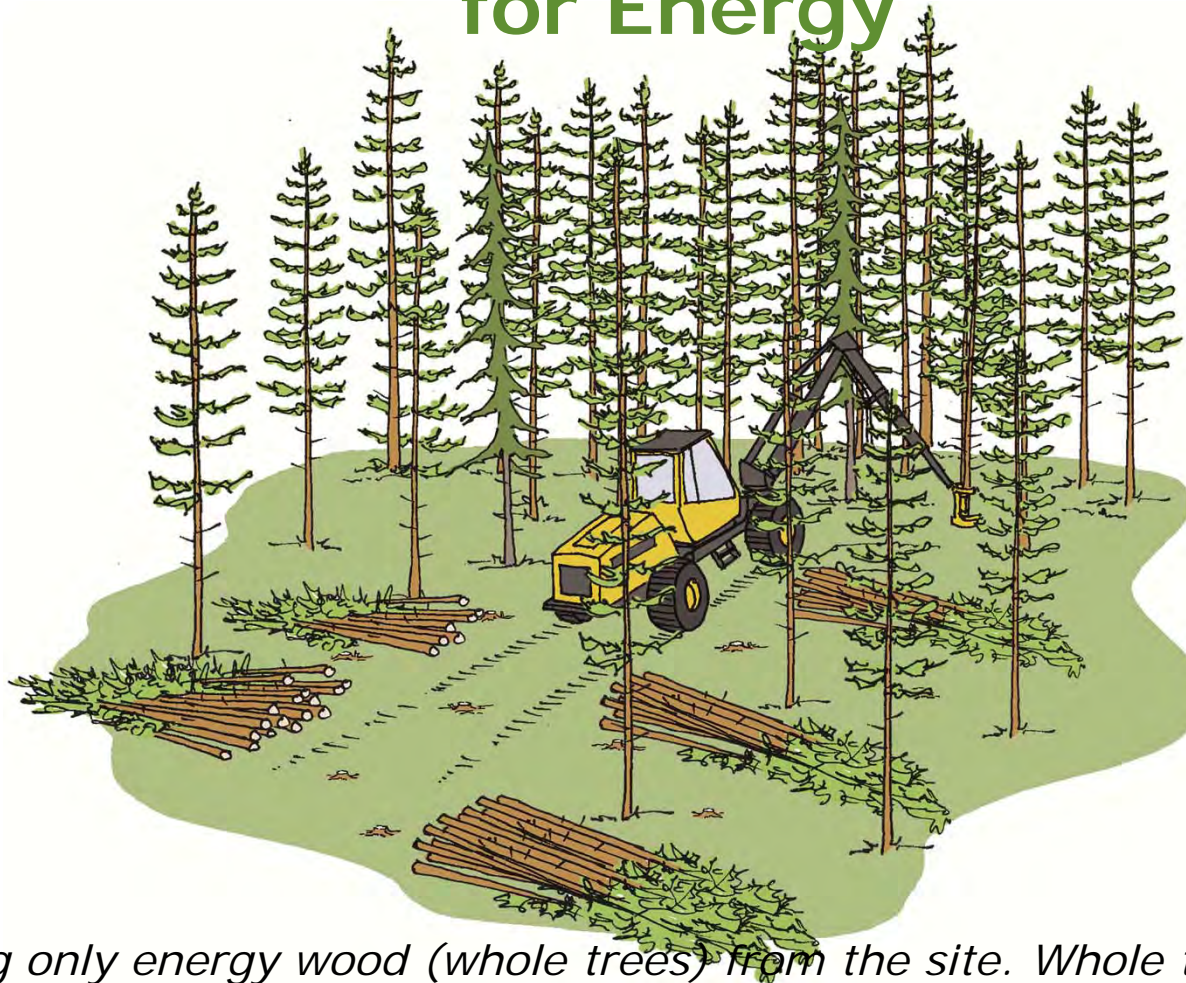
### **I) Separate Wood Harvesting Methods:**

- Separate harvesting of roundwood (i.e. pulpwood) with single tree cutting
- Separate harvesting of roundwood (i.e. pulpwood) with multi-stem handling
- Separate harvesting of energy wood (whole trees)
- Separate harvesting of energy wood (delimbed stemwood).

### **II) Integrated Wood Harvesting Methods:**

- Integrated harvesting of roundwood (i.e. pulpwood) and energy wood (i.e. whole trees)
- Integrated harvesting of roundwood (i.e. pulpwood) and energy wood (i.e. delimbed stemwood).

## Separate Harvesting of Whole Trees for Energy



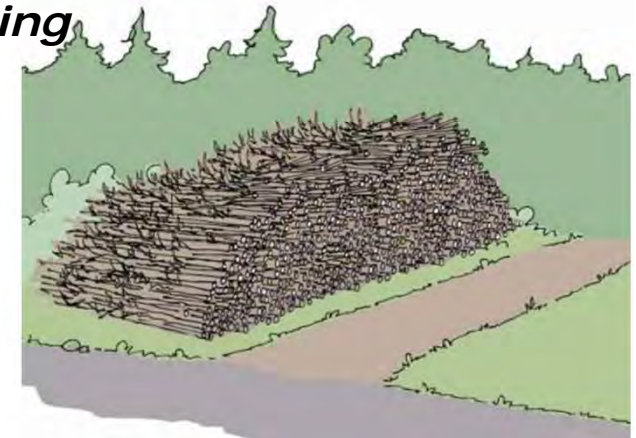
*Harvesting only energy wood (whole trees) from the site. Whole trees are bucked for the length of forest haulage.*

*Drawing: Juha Varhi*

# Separate Harvesting of Whole Trees for Energy



*Crane Scale Measuring*



Improving the ...FORMEC 2011

*Drawings: Juha Varhi*

# Crane Scale Measuring Devices

- LoadMaster Multi Forest
- Ponsse LoadOptimazer
- Bluescale XW 50L
- Tamtron TBS 200
- Valmet
- John Deere



## Separate Harvesting of Whole Trees for Energy

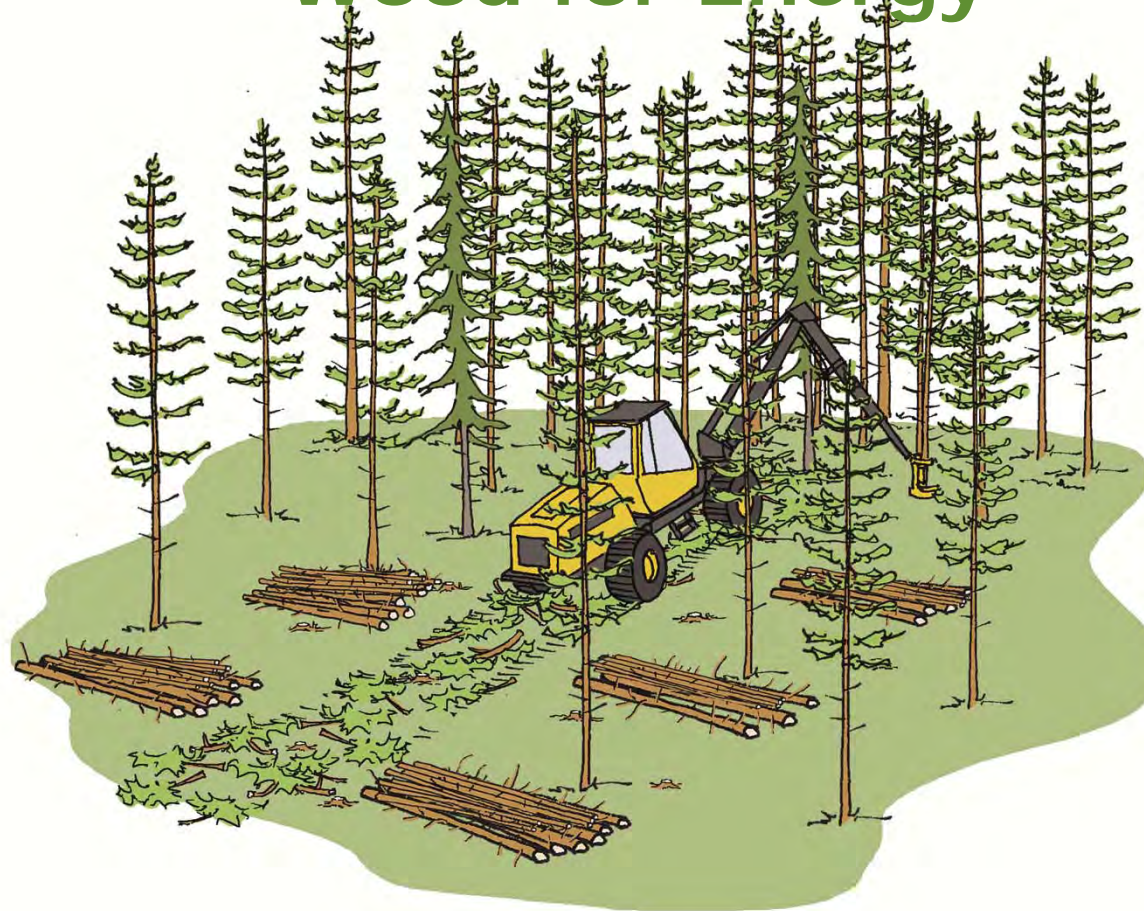


- Recovering also energy wood from stand.
- **High removals.**
- **Multiple-tree handling.**
- Stem processing as little as possible.
- High cutting productivity.
- **Low cutting costs.**



- **Small load size** in forest haulage.
- **High forwarding costs.**
- Careful selection of harvesting sites (**e.g. spruce-dominated stands, infertile soils, and terrains with poor carrying capacity** are problematic).
- **Burning of pulpwood.**

## Separate Harvesting of Delimbedstem Wood for Energy



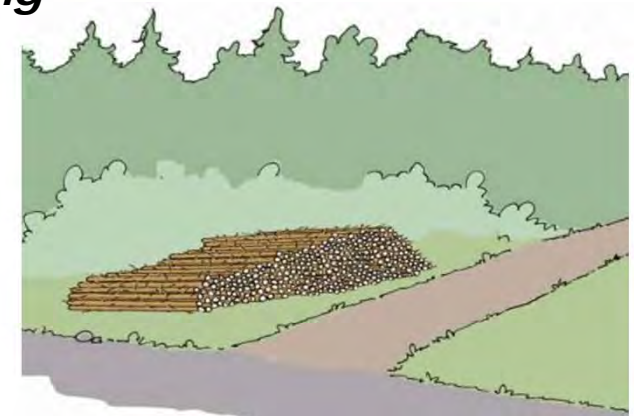
*Harvesting only energy wood (delimbed stemwood) from the site. Trees harvested are delimbed and bucked for the length of forest haulage.*

*Drawing: Juha Varhi*

## Separate Harvesting of Delimbed Stemwood for Energy



*Crane Scale Measuring*



*Drawings: Juha Varhi*



## Separate Harvesting of Delimbed Stemwood for Energy

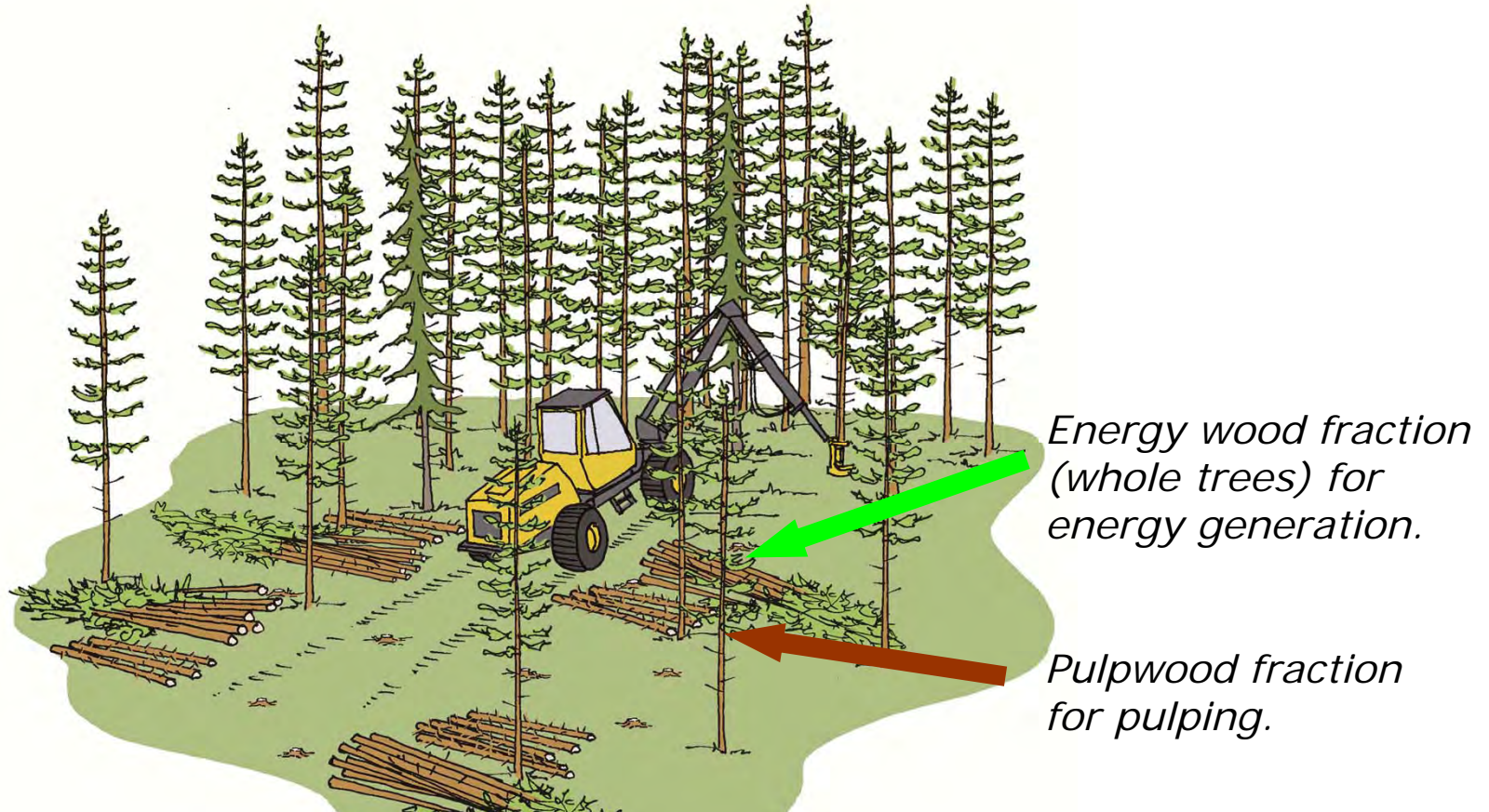


- Multiple-tree processing.
- Larger load size than with whole trees.
- **Low forwarding costs.**
- **No risk for nutrient loss.**
- Spruce-dominated stands, infertile soils, and terrains with poor carrying capacity.
- **High-quality fuel chips, i.e. higher price for chips.**
- Timber truck optional for road transportation.
- **Optional crushing at the plant.**



- No recovering all possible energy wood fraction.
- **Lower removals** than in whole-tree harvesting.
- Felling heads in cutting.
- Lower cutting productivity than with whole trees.
- **Higher cutting and harvesting costs** than with whole trees.
- **Burning of pulpwood.**

# Integrated Harvesting of Pulpwood and Energy Wood (Whole Trees)



*Industrial roundwood and energy wood (whole trees) harvested from the logging area are stacked in the cutting phase into two separate piles.*

*Drawing: Juha Varhi*

# Energy Wood, Softwood Pulpwood and Hardwood Pulpwood Stacked into Separate Piles

*Softwood Pulpwood*

*Hardwood Pulpwood*

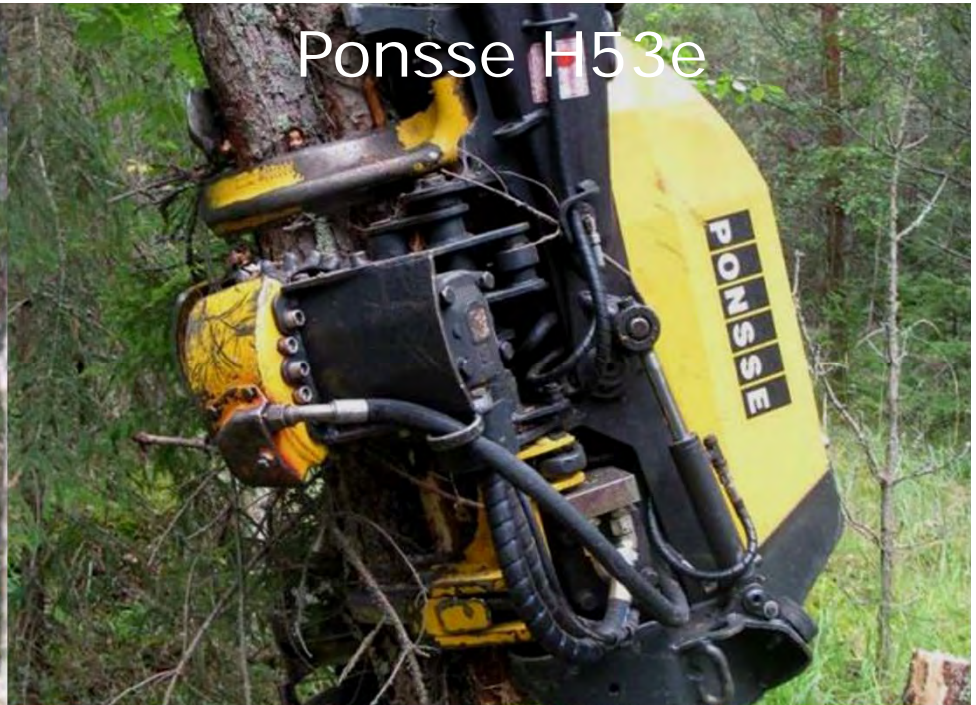
*Energy Wood  
(Whole Trees)*

# Multiple-tree Processed Softwood Pulpwood



Moipu 400ES

> > MTH  
> > Feeding



Ponsse H53e

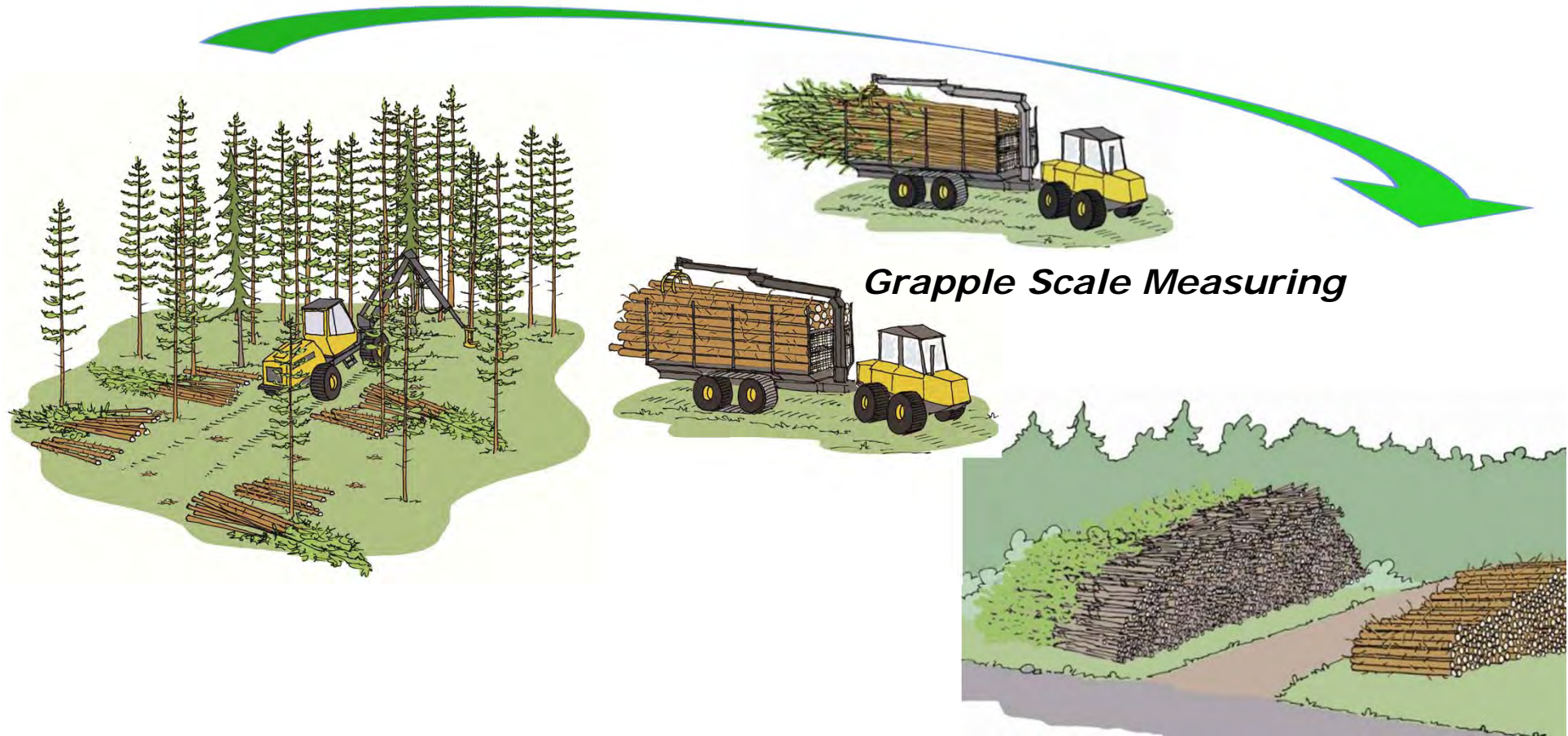


John Deere H412



Timberjack H754

# Integrated Harvesting of Pulpwood and Energy Wood (Whole Trees)



Drawings: Juha Varhi

## Integrated Harvesting of Pulpwood and Energy Wood (Whole Trees)

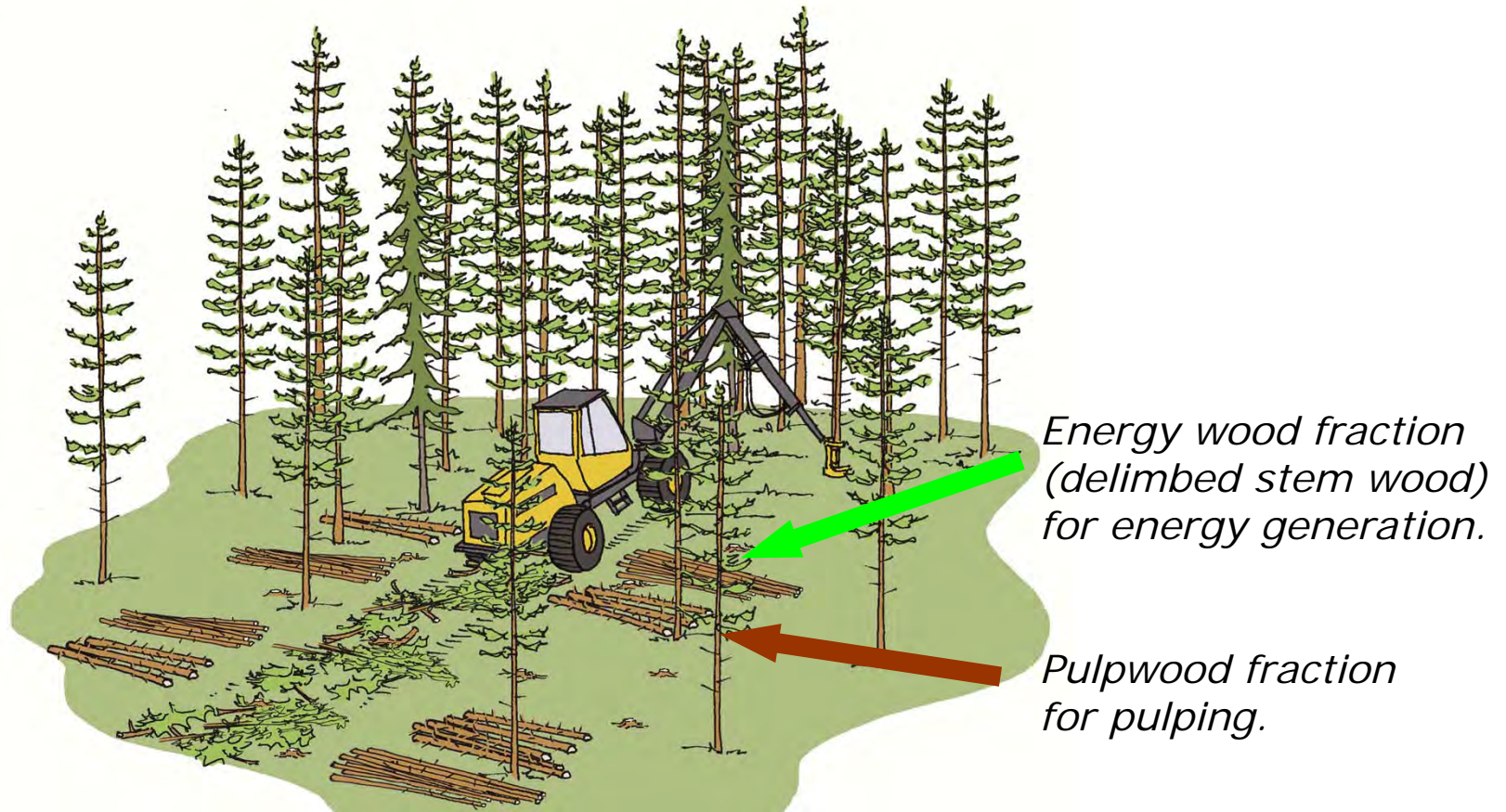


- **High total removals.**
- Multiple-tree handling.
- Cutting productivity almost at the same level than in whole-tree cutting.
- **Low cutting costs.**
- **Flexibility** (changes in top diameter of pulpwood poles).
- **Good quality of multi-stem processed pulpwood.**
- **No burning of pulpwood.**



- Felling heads in cutting.
- Small load size with whole trees.
- **High forwarding costs with whole-tree fraction.**
- Careful selection of harvesting sites (e.g. **spruce-dominated stands, infertile soils, and terrains with poor carrying capacity** are problematic).

# Integrated Harvesting of Pulpwood and Energy Wood (Delimbed Stemwood)

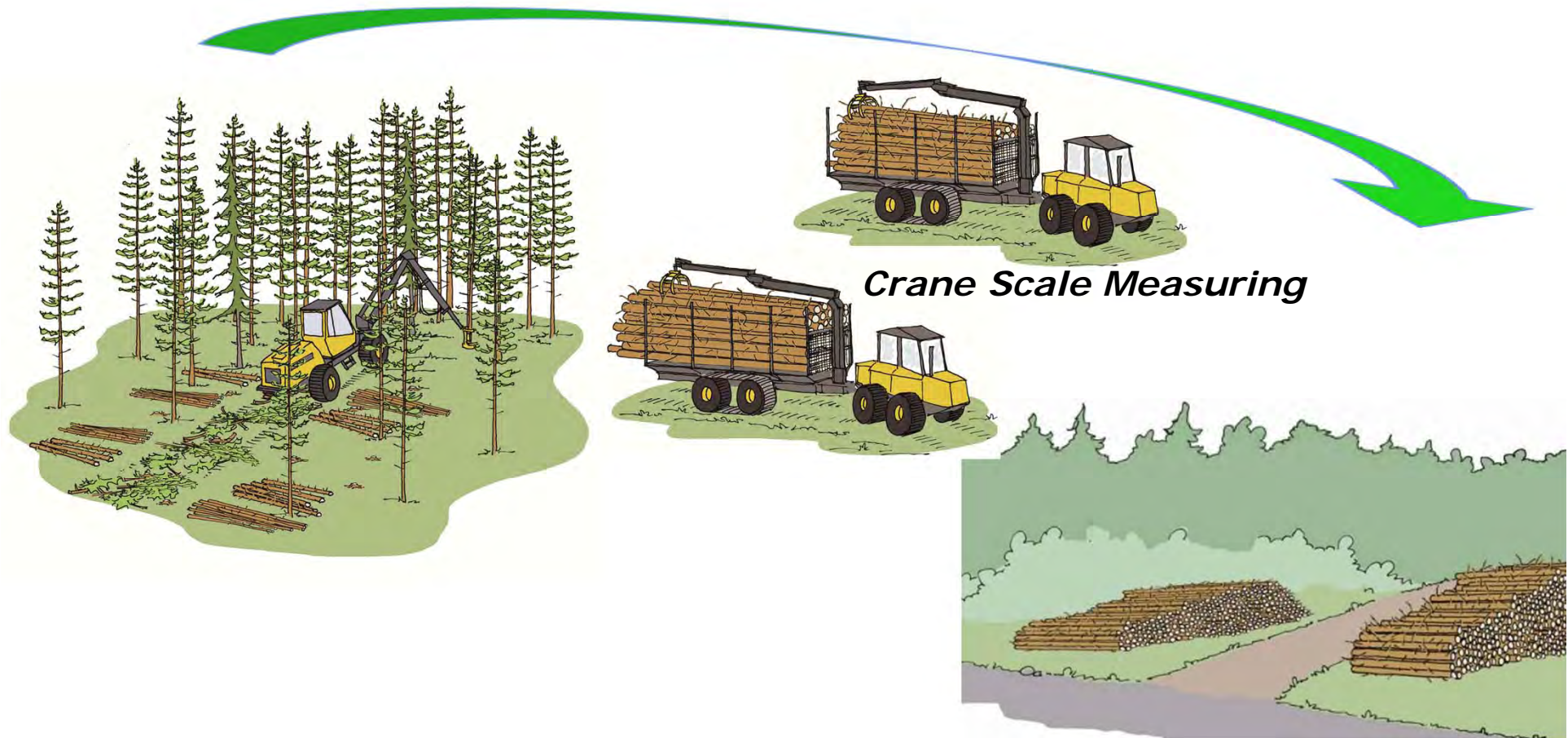


*Industrial roundwood and energy wood (delimbed stemwood) harvested from the logging area are stacked in the cutting phase into two separate piles.*

*Drawing: Juha Varhi*



# Integrated Harvesting of Pulpwood and Energy Wood (Delimbed Stemwood)



*Crane Scale Measuring*

*Drawings: Juha Varhi*

## Integrated Harvesting of Pulpwood and Energy Wood (Delimbed Stemwood)

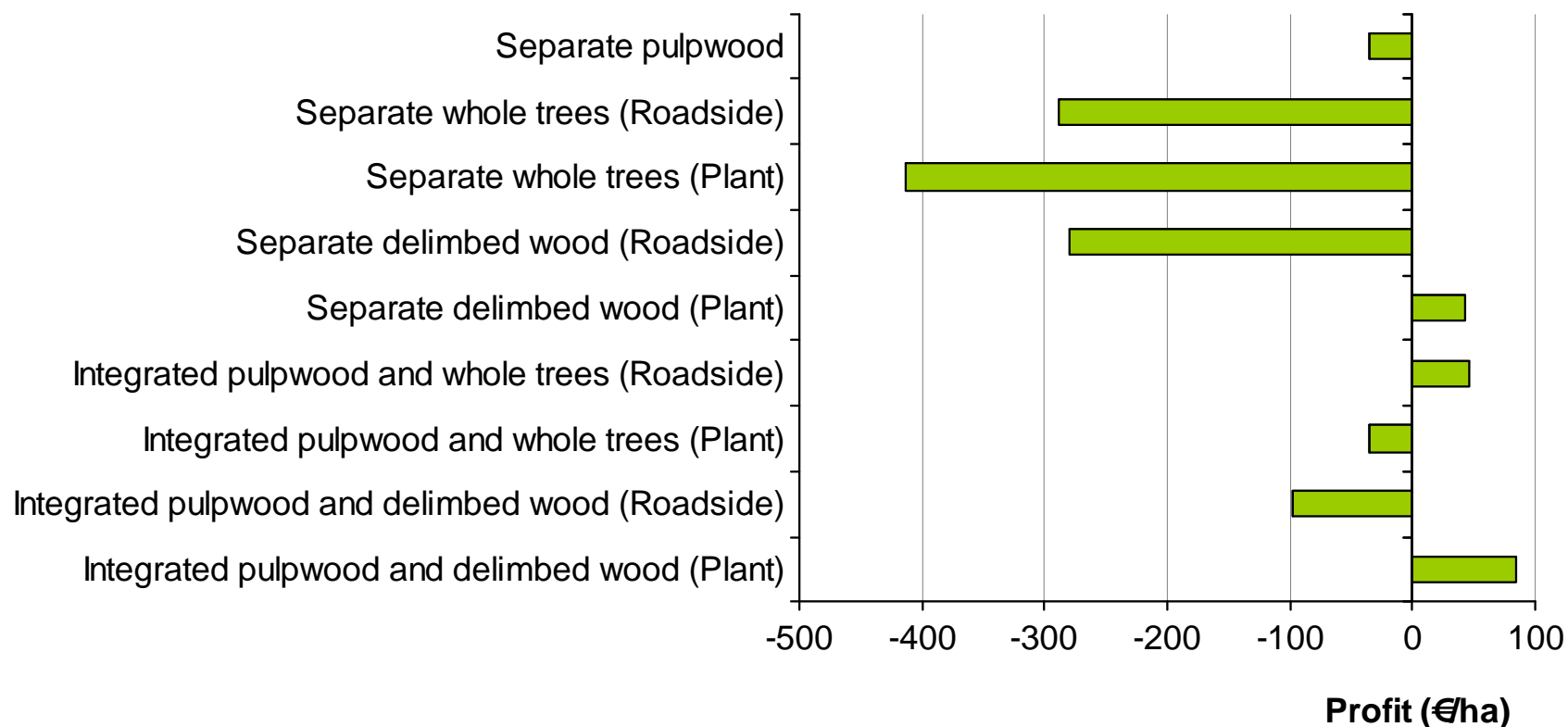
- Multiple-tree processing.
- **Low forwarding costs.**
- Quality of multi-stem processed pulpwood.
- No risk for nutrient loss.
- **Spruce stands, infertile soils, and terrains with poor carrying capacity.**
- **High-quality fuel chips, i.e. higher price for chips.**
- Timber truck optional.
- Optional crushing at the plant.
- **No burning of pulpwood.**



- No recovering all possible energy wood fraction.
- **Lower total removals.**
- Felling heads in cutting.
- Lower cutting productivity.
- **Higher cutting and harvesting costs.**

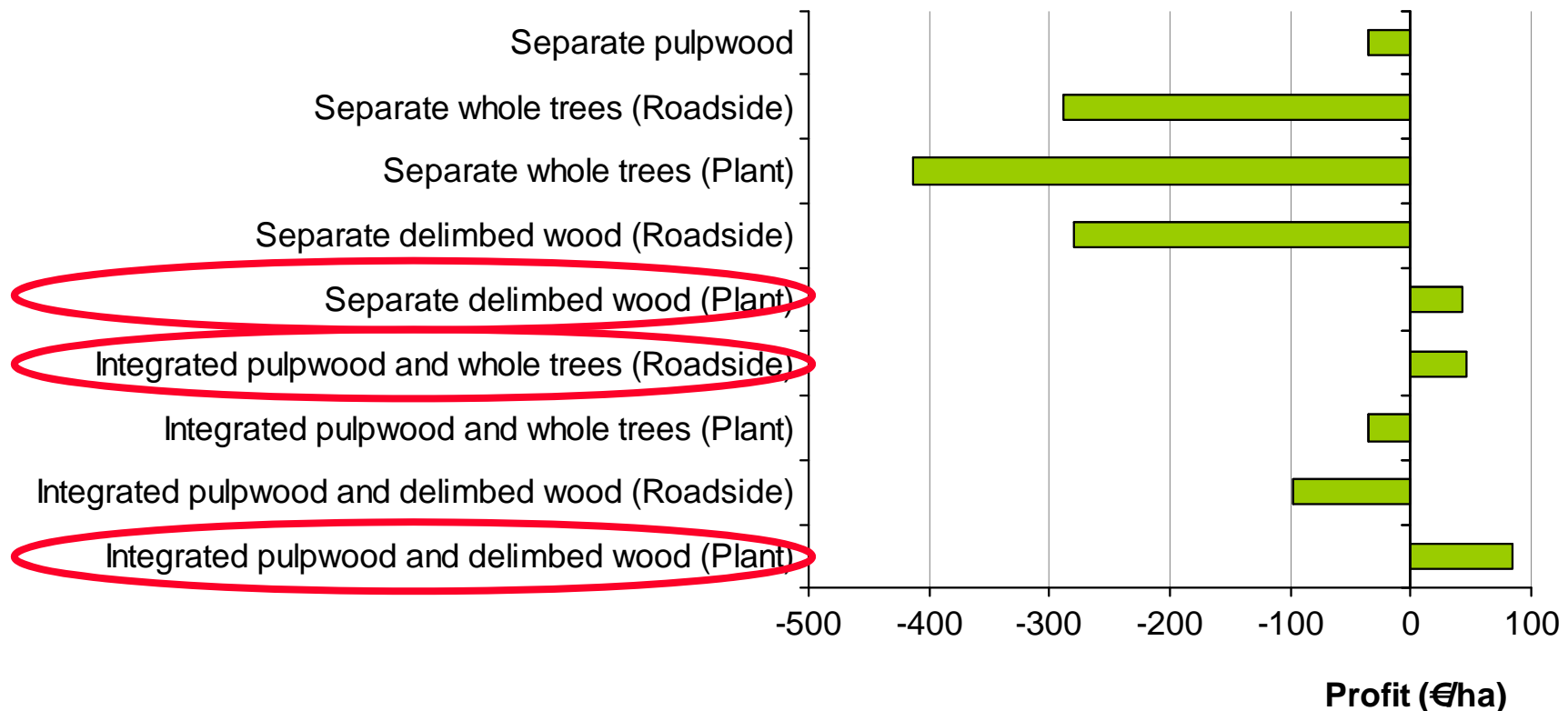
## The Best Method?

*One cost calculation...*

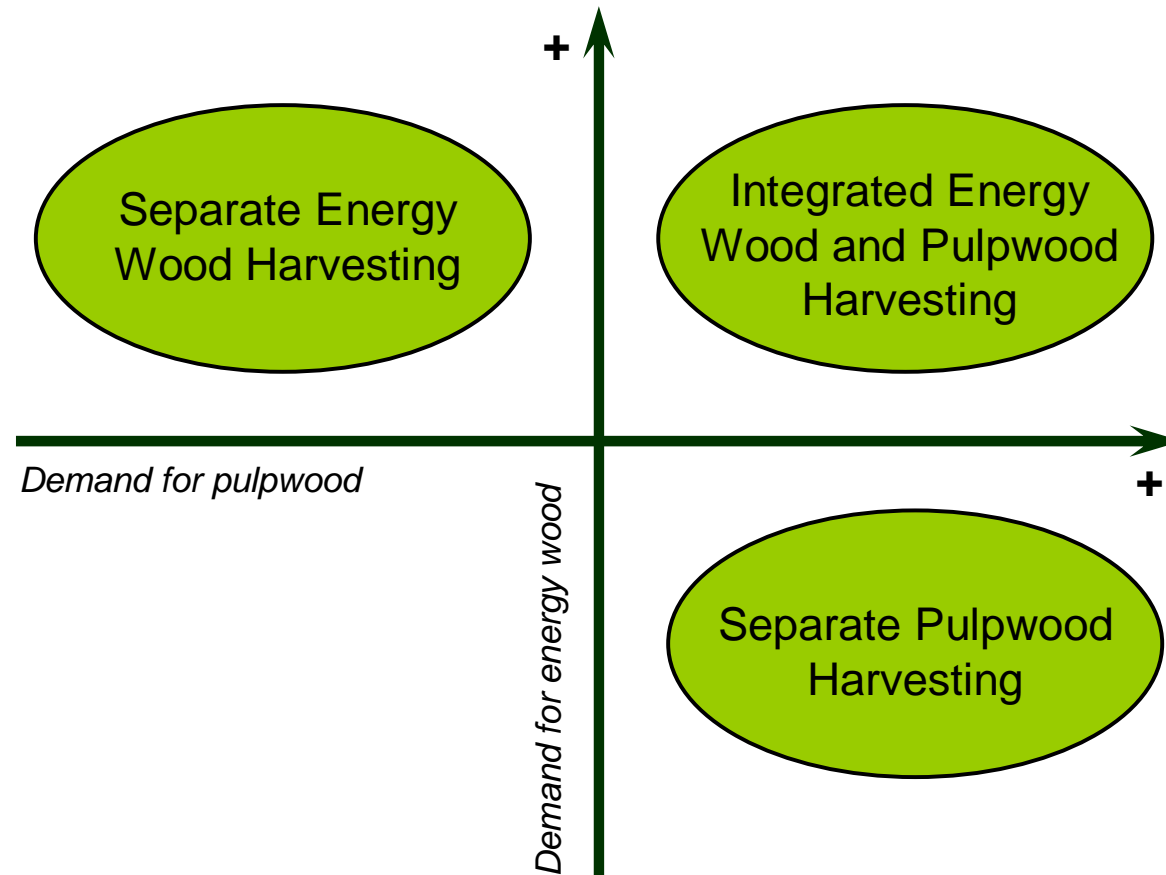


## The Best Method?

*One cost calculation...*

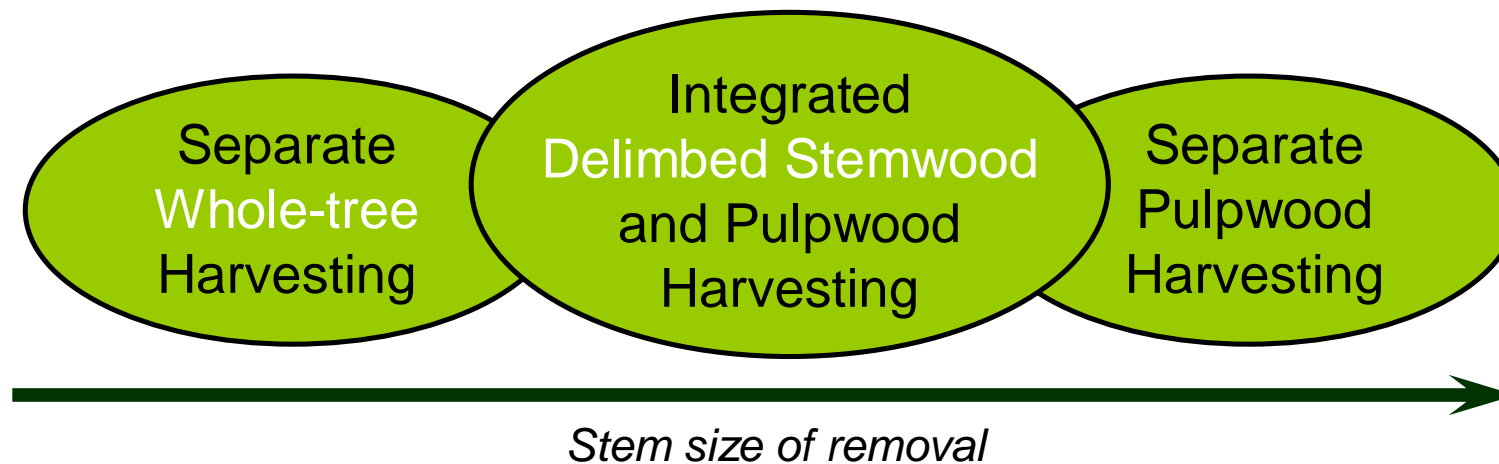


# Impacts of Market Situation on Selection of Harvesting Method



Source: Kärhä & Mutikainen 2009

# Impacts of Harvesting Conditions on Selection of Harvesting Method



Source: Kärhä 2010



# Metsäteho

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***Thank you!***

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