Main innovation types of forest biomass supply chains

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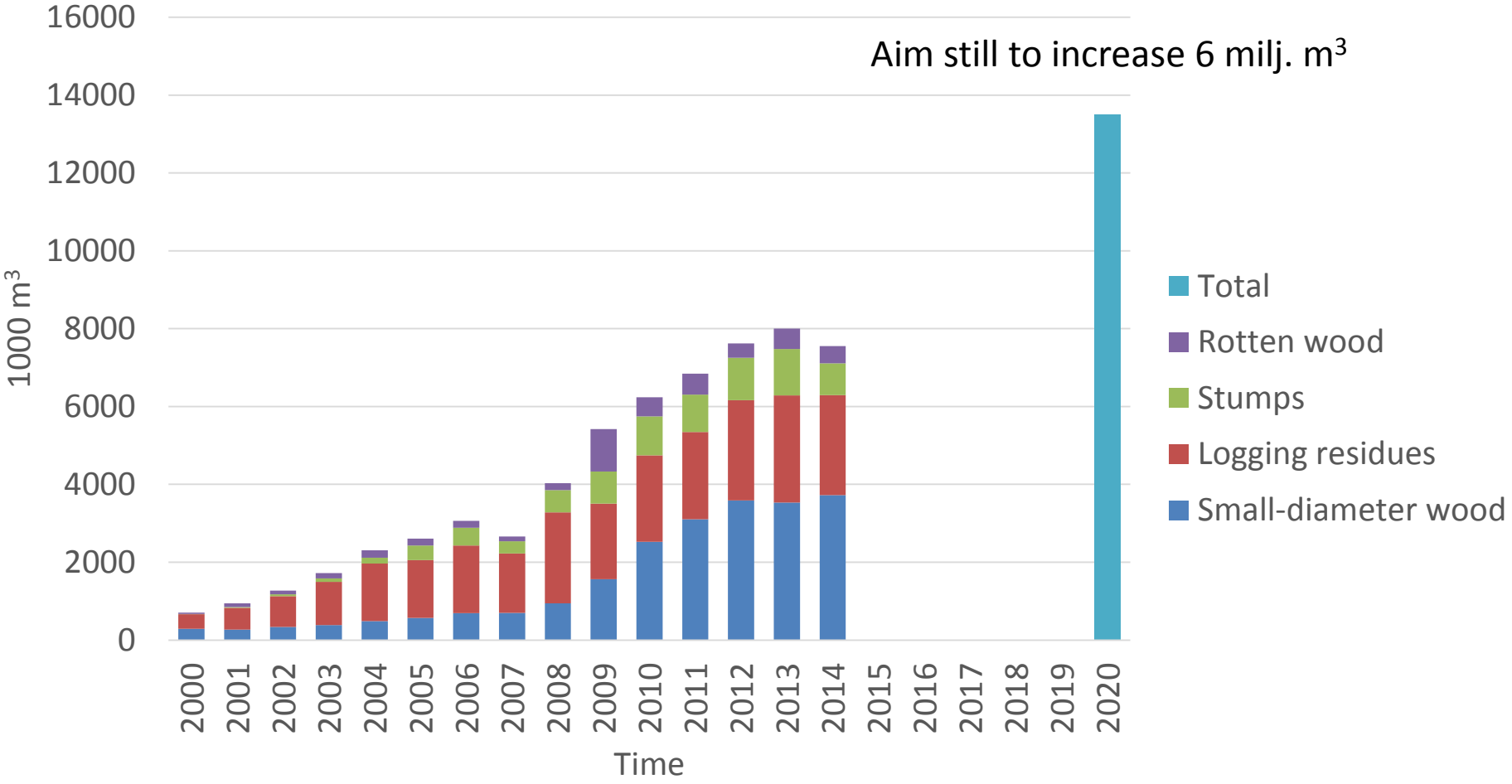
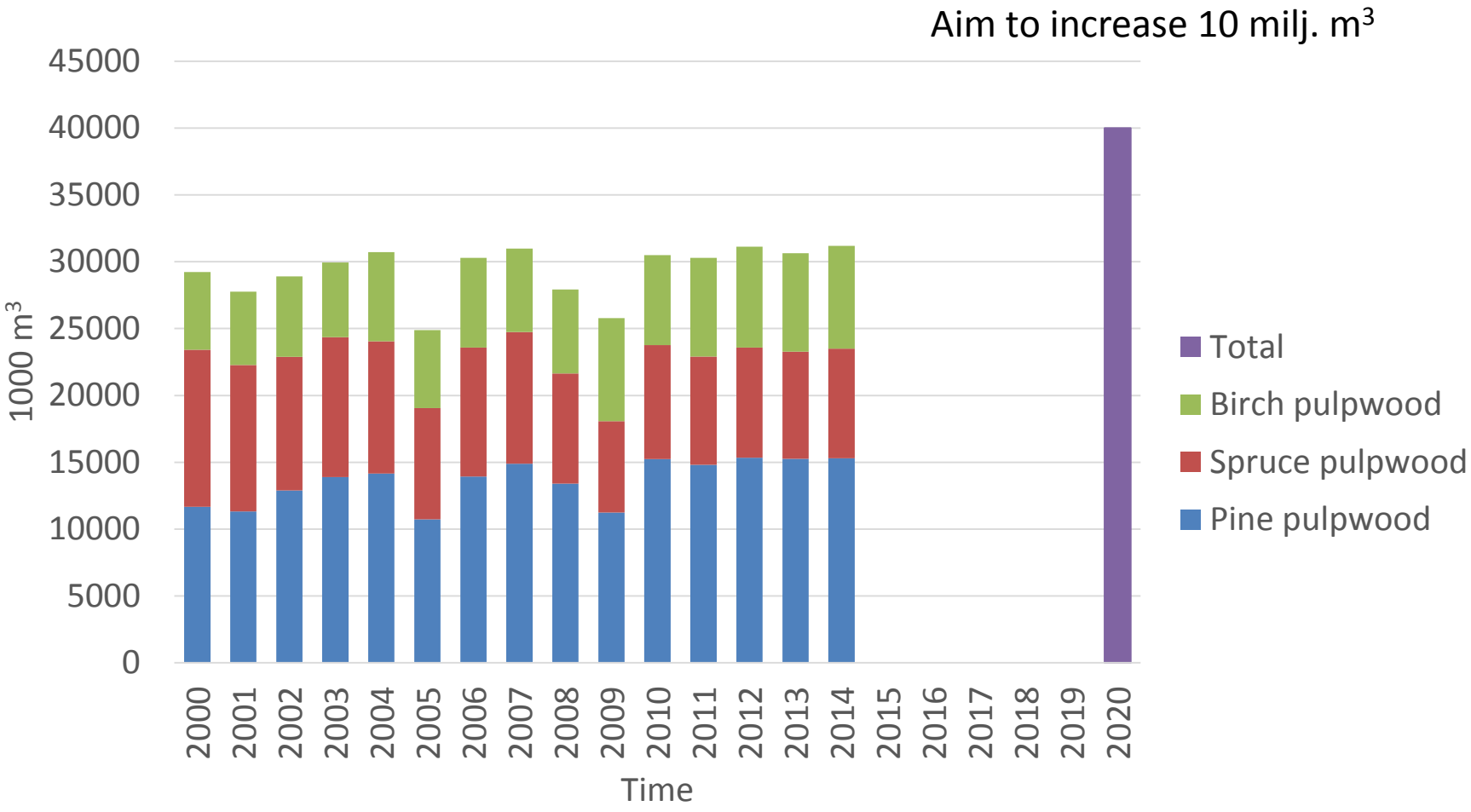
1. Background

Increasing use of small-diameter wood for energy in Finland



~half million small-diameter wood every year more

Increasing use for small-diameter wood for pulp in Finland



~half million pines from first thinnings every year more

Innovation types
for harvesting and supply chain of small-diameter wood

- **Incremental innovation** starting from single tree cutting to…
  - develop cutting heads of multi-tree handling…
    - to enable integrated cutting of small-diameter wood (pulp and energy wood)
    - delimbed stemwood cutting
    - whole tree cutting
- Productivity increase and unit cost decrease
  - Cost-efficient cutting of small-diameter wood
  - Possible energy use of delimbed wood
  - Potential stumpage price for forest owners?
- **Radical innovation** of bundling small-diameter wood has been developing too
- **Network innovation** (Karttunen 2015) to find out the most potential forest management methods and supply chains to produce small-diameter wood with the lowest total cost

http://www.ponsse.com/products/bioenergy/multi-stemming

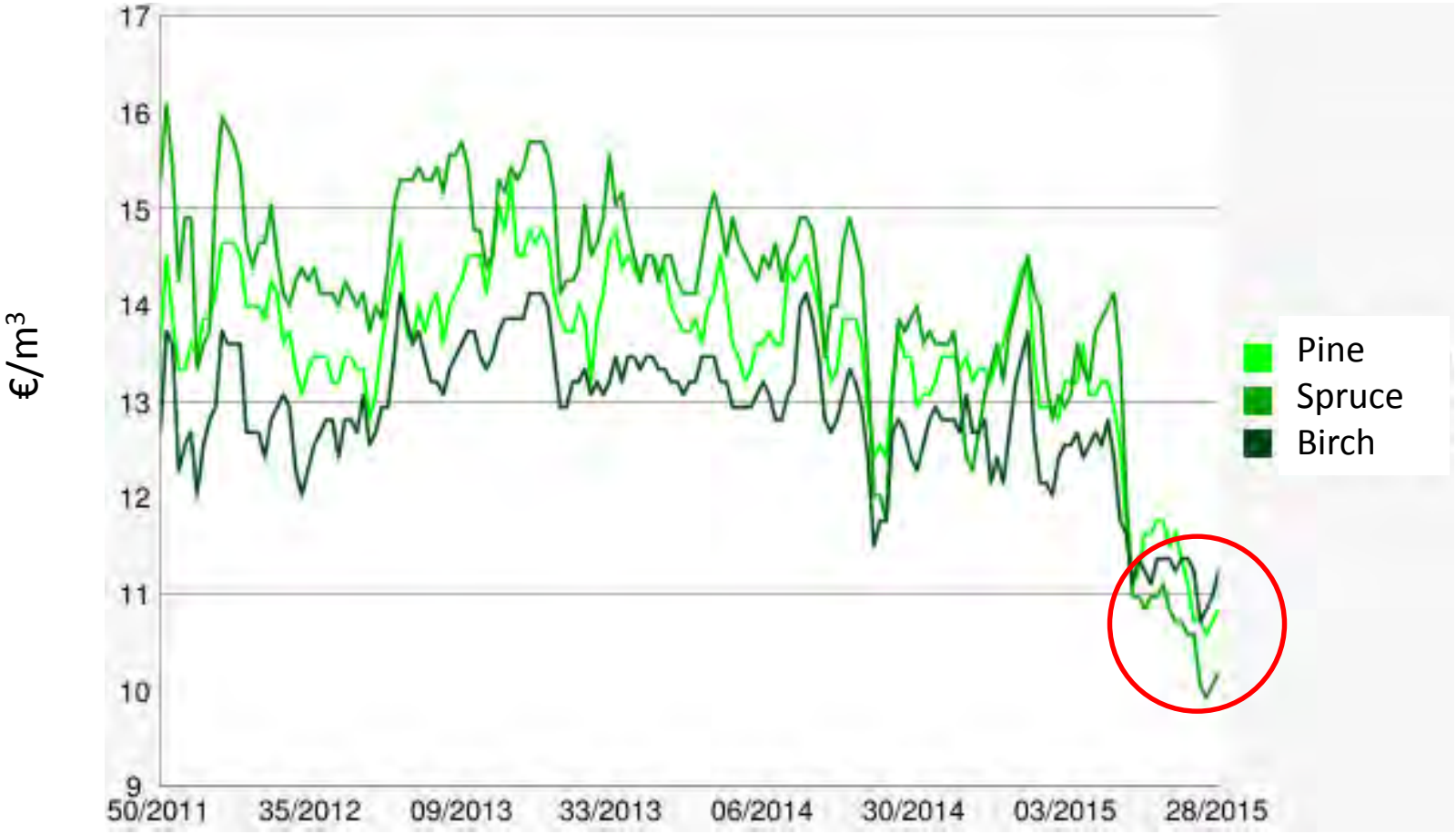
Radical innovation:
Fixteri FX15a baler

http://www.fixteri.fi/?q=en

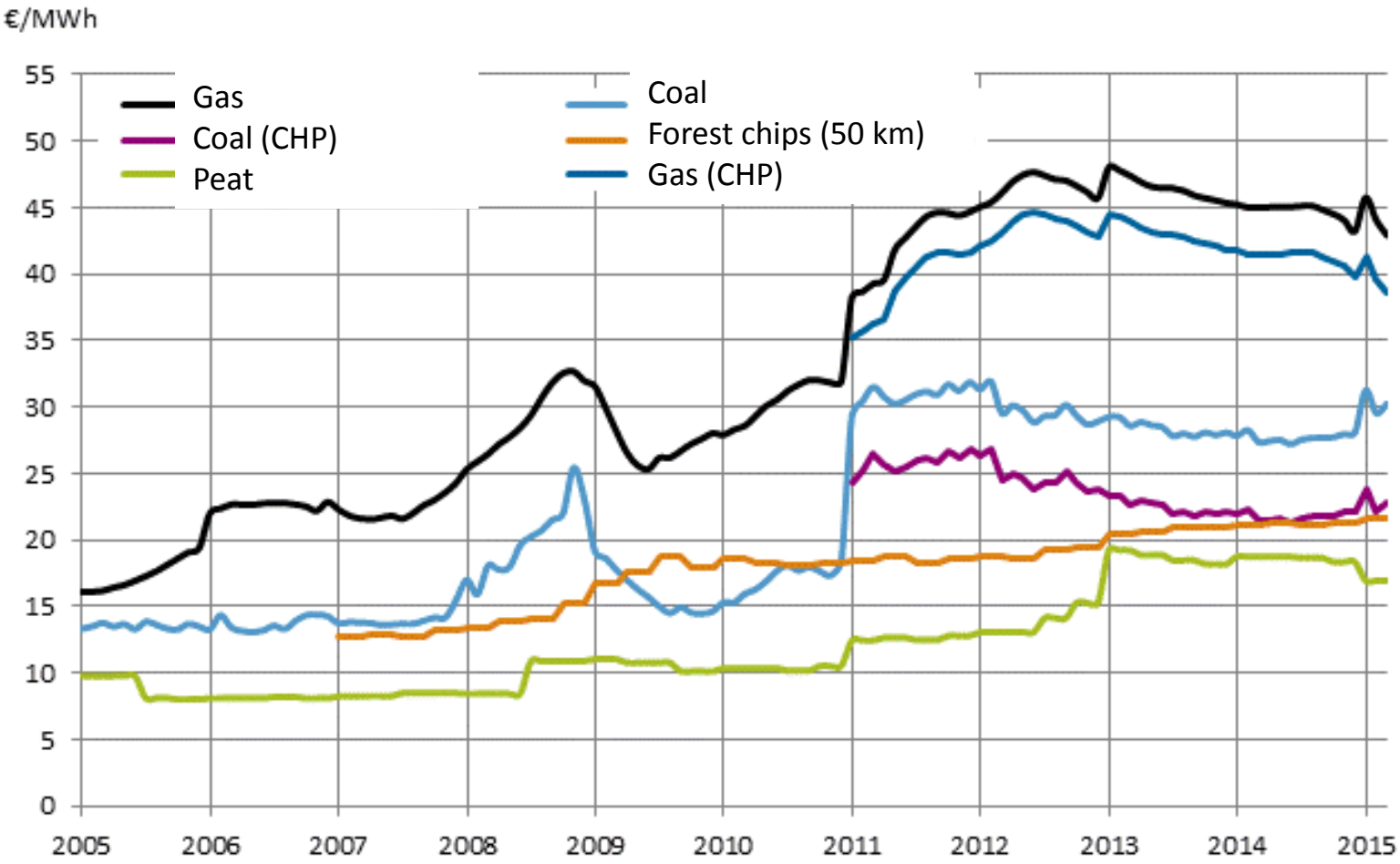
Stumpage price for forest owners

Pulp wood prices has decreased as well in long-term real prices as nominal prices in short-term (over supply / under demand). New subsidies enable same money either industrial or energy use, which has dropped pulp wood stumpage prices of first thinning!!!

Nominal stumpage price of pulp wood from first thinnings:

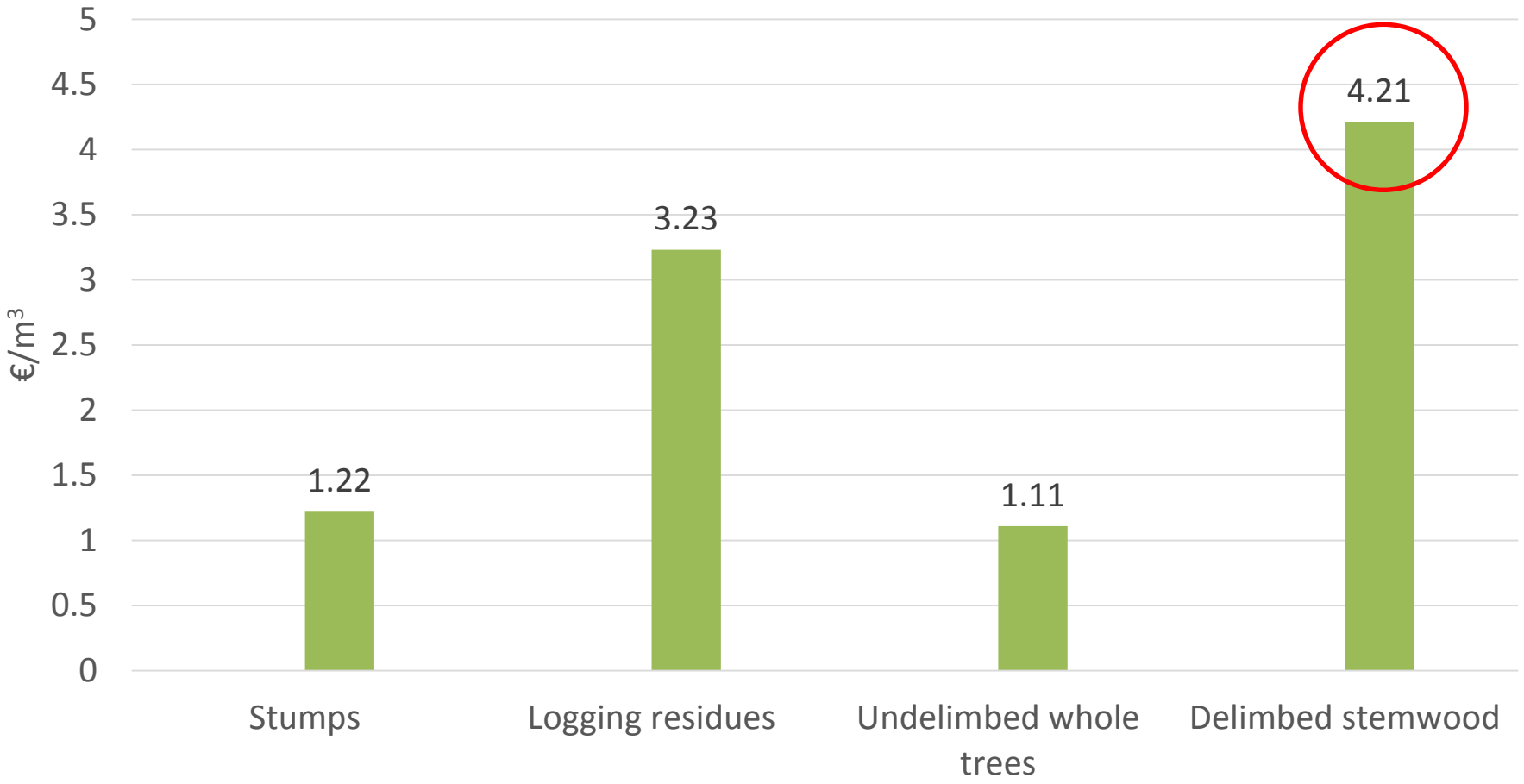


…but energy wood plant prices has been increasing when the use of foret fuel has increased (2014 average: 21.4 €/MWh)…



Forest chips

…but energy wood stumpage prices (2014) are not high



2. Material and methods

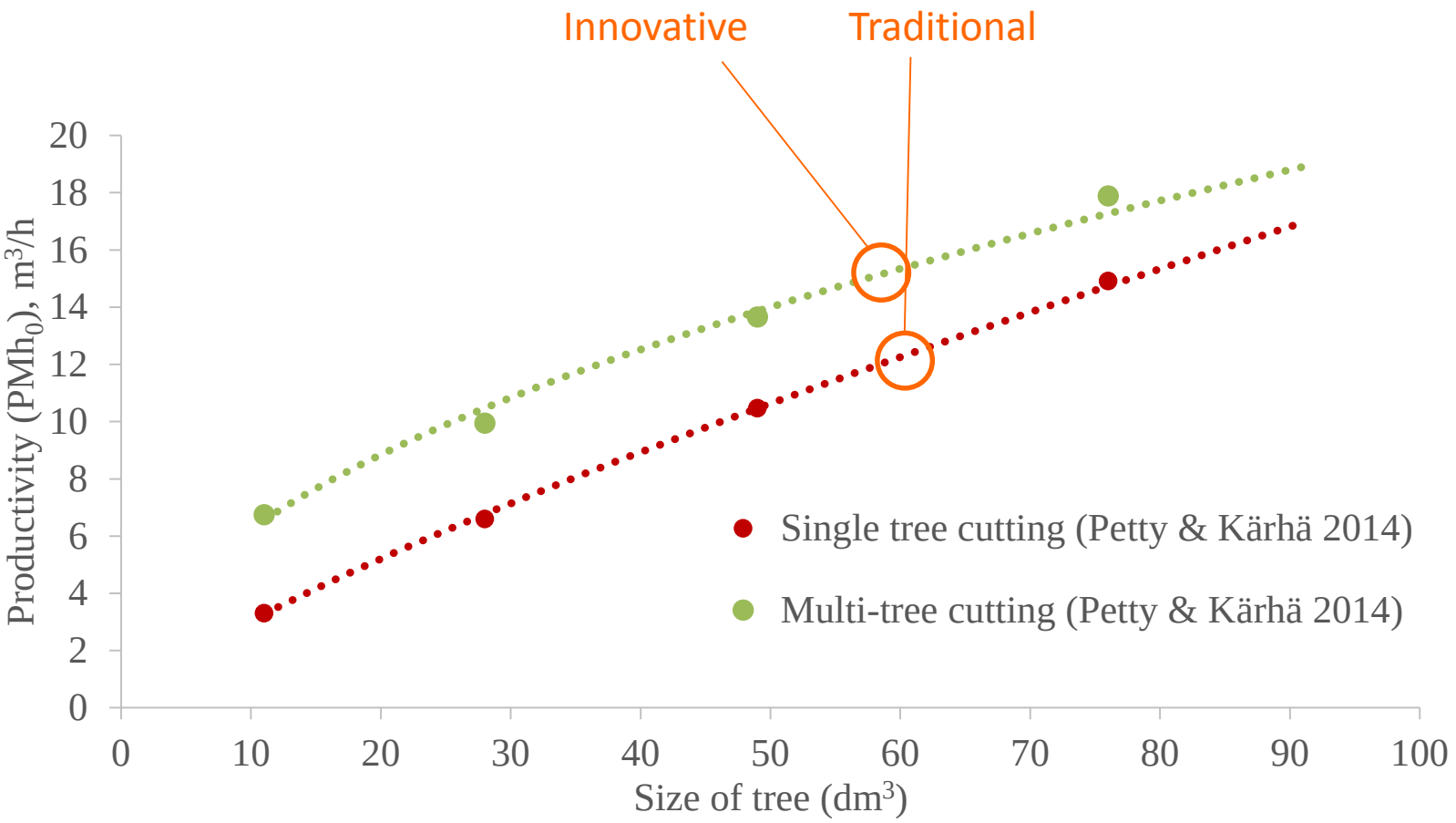
Cases: Harvesting and supply chain alternatives

- Each case compared ”traditional” pulp wood supply chain vs innovative energy wood supply chain
- Cases were based on early studies and chosen to compare the main innovation types:
  - **1. Case:** Traditional single tree cutting vs. innovative multi-tree cutting of small-diameter wood **“Incremental innovation”**
  - **2. Case:** Traditional multi-tree cutting vs. innovative bundling system of small-diameter wood **“Radical innovation”**
  - **3. Case:** Traditional density stand (2000 trees/ha) vs. innovative denser forest management (3000 trees/ha) and supply chain of small-diameter wood **“Network innovation”**

Follow the size of tree between the cases (~40 and/or ~60 dm^3)…

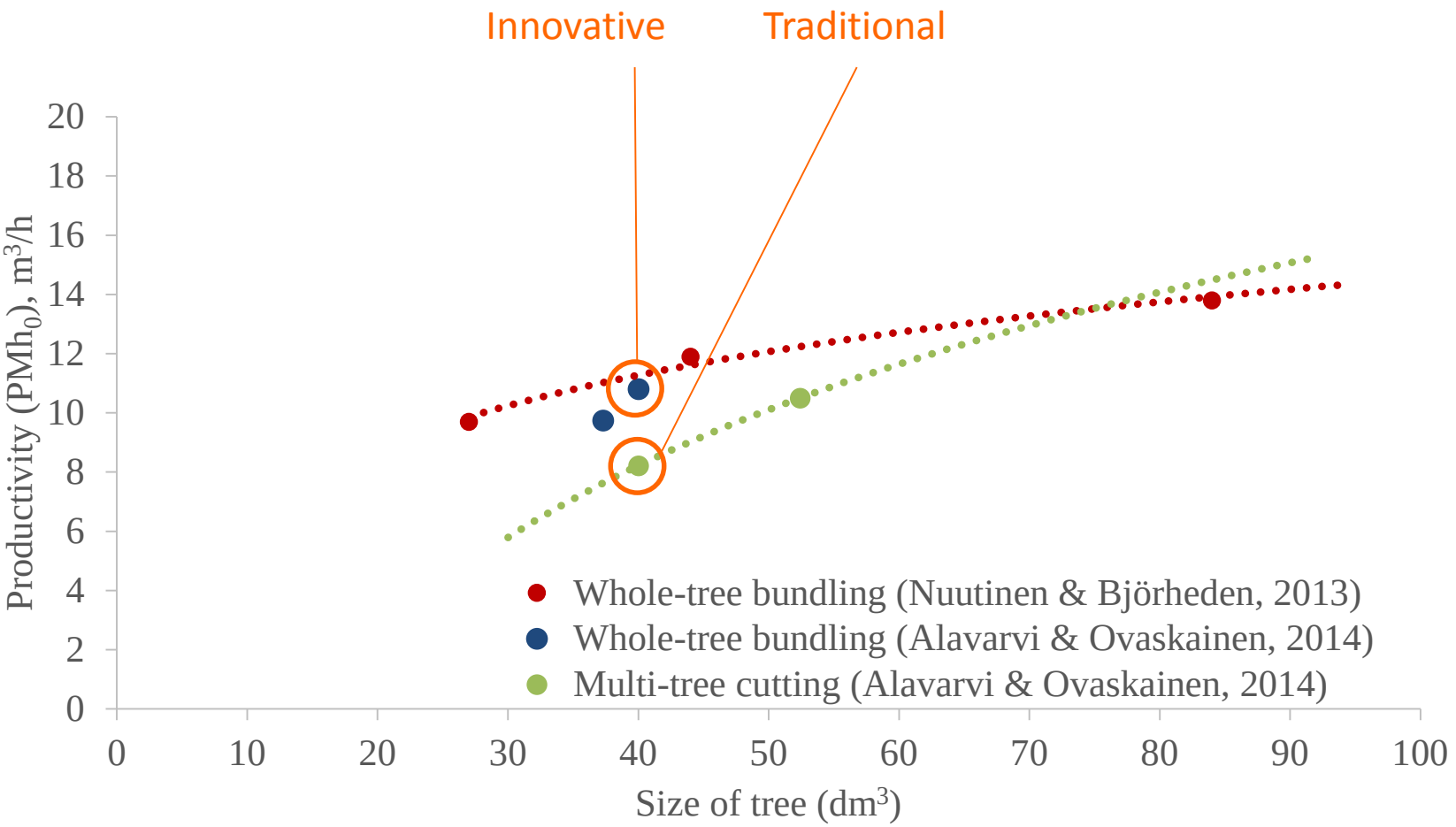
Cutting productivity comparison

1. Case: Traditional single tree cutting vs. innovative multi-tree cutting of small-diameter wood "Incremental innovation"



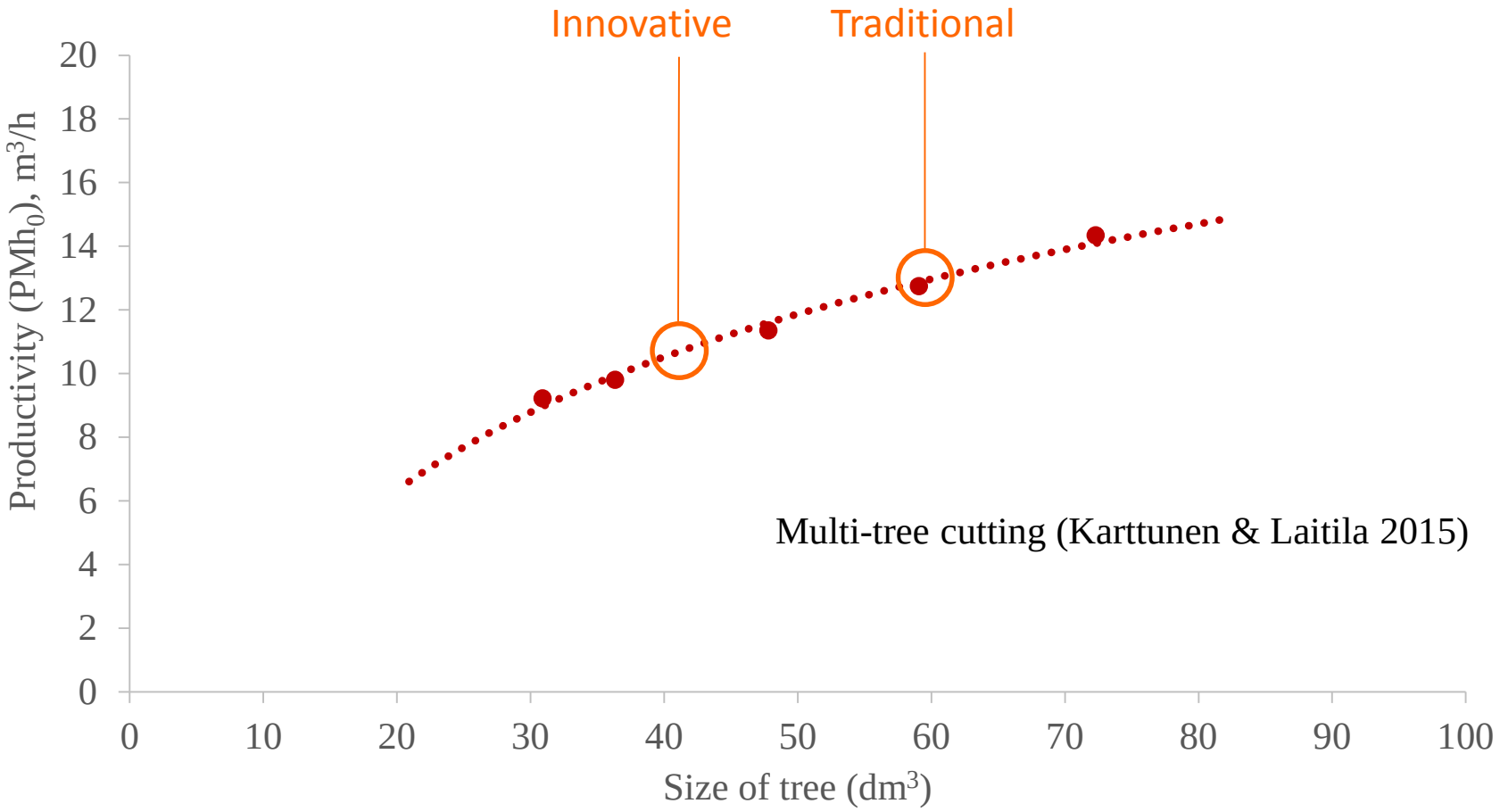
Cutting productivity comparison

2. Case: Traditional multi-tree cutting vs. innovative bundling system of small-diameter wood "Radical innovation"



Cutting productivity comparison

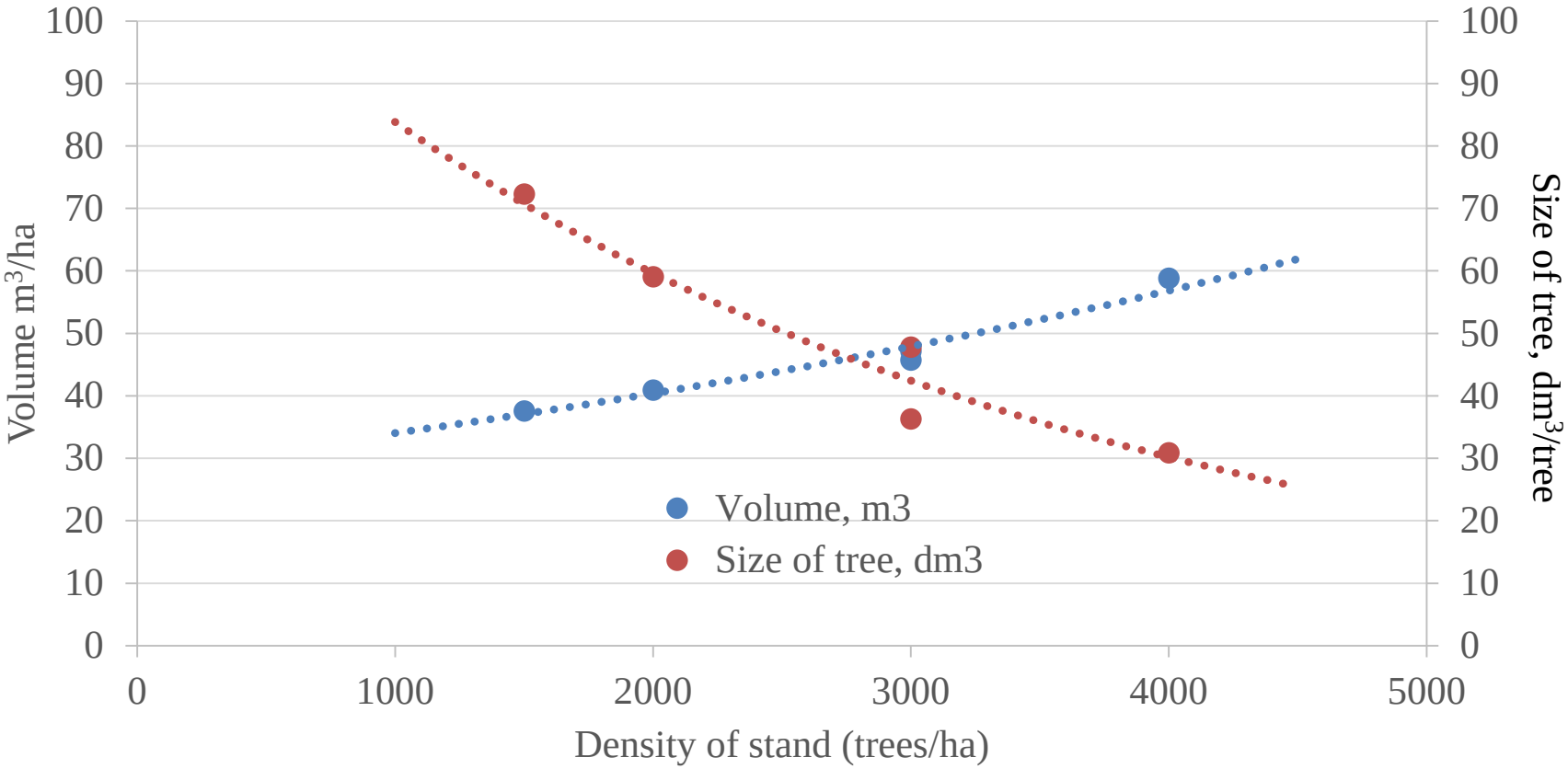
3. Case: Traditional density stand (2000 trees/ha) vs. innovative denser (3000 trees/ha) forest management and supply chain of small-diameter wood "Network innovation"



Density of stand before cutting (trees/ha): 3000 vs. 2000

More detailed information

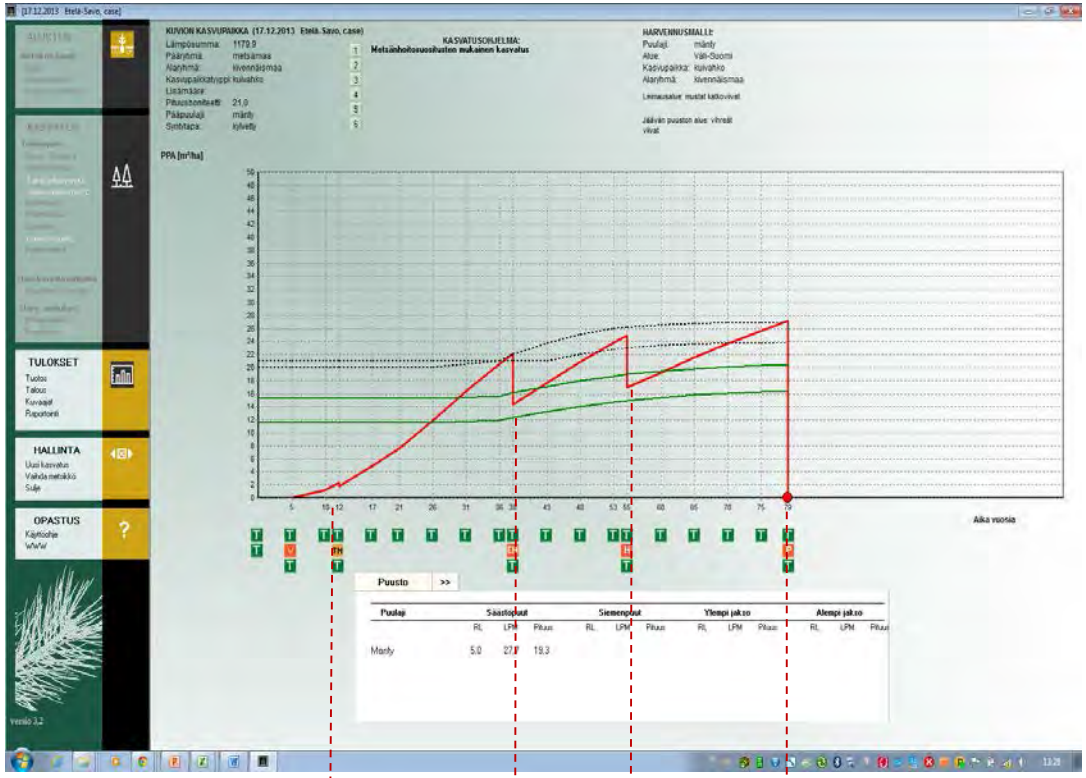
3. Case: Difference of volume and size of trees from first cutting in relation to density of stand (before first cutting)



More detailed information

3. Case: Forest management simulation

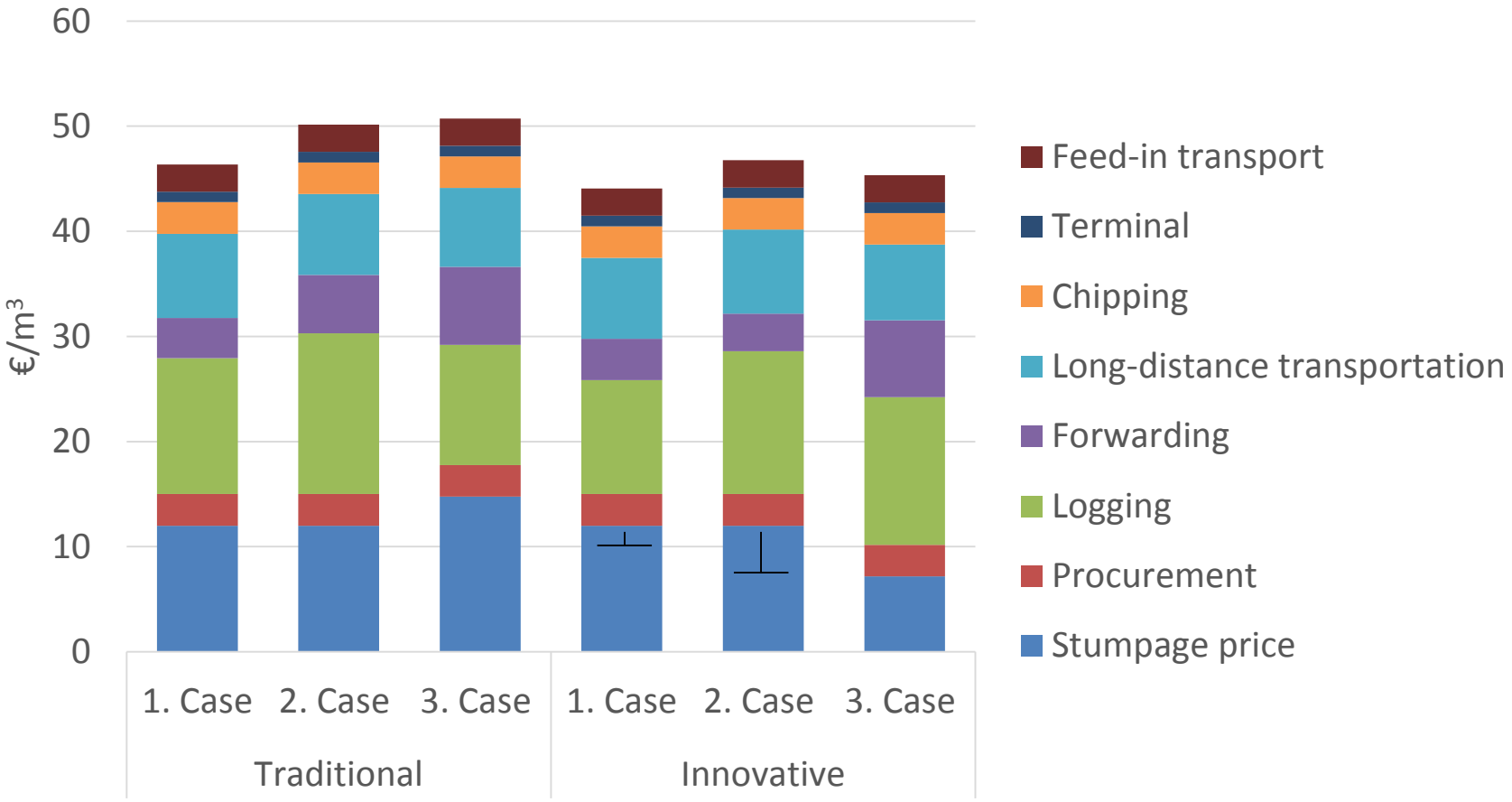
- This study focused on young stands representing typical Scots pine (Pinus sylvestris L.) stands in Finland
- Site type was the dryish and fresh heath sites and the density of trees was set to 2000 trees/ha (traditional baseline) and 3000 trees/ha (innovative)
- Forest stand simulator MOTTI was used in this study based on silvicultural recommendations to grow forest stand data



Discounting (3% interest rate) cutting incomes and silvicultural costs to the starting point of rotation (comparability) -> **Stumpage price of energy wood**

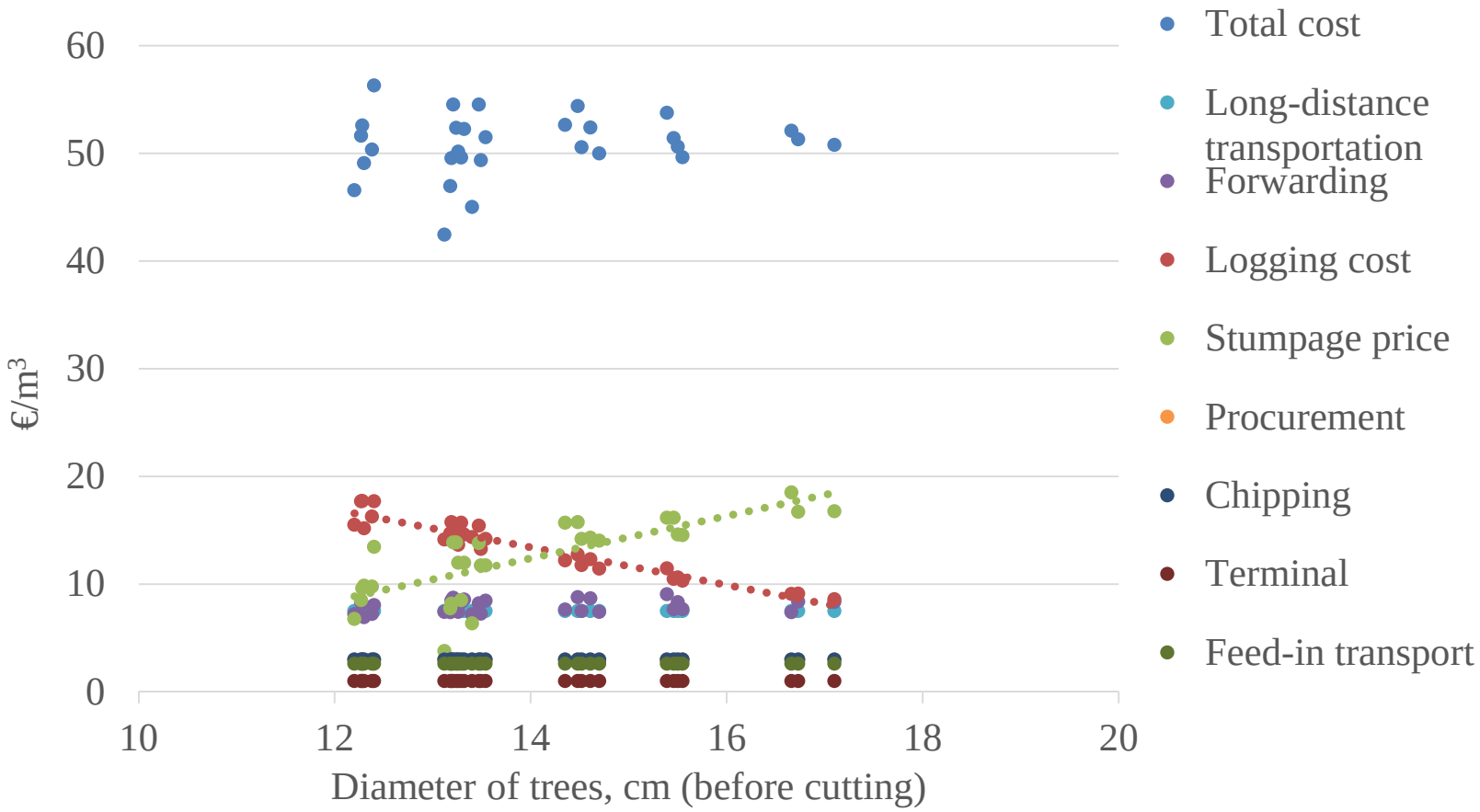
3. Results

Total cost of supply chains (€/m³)

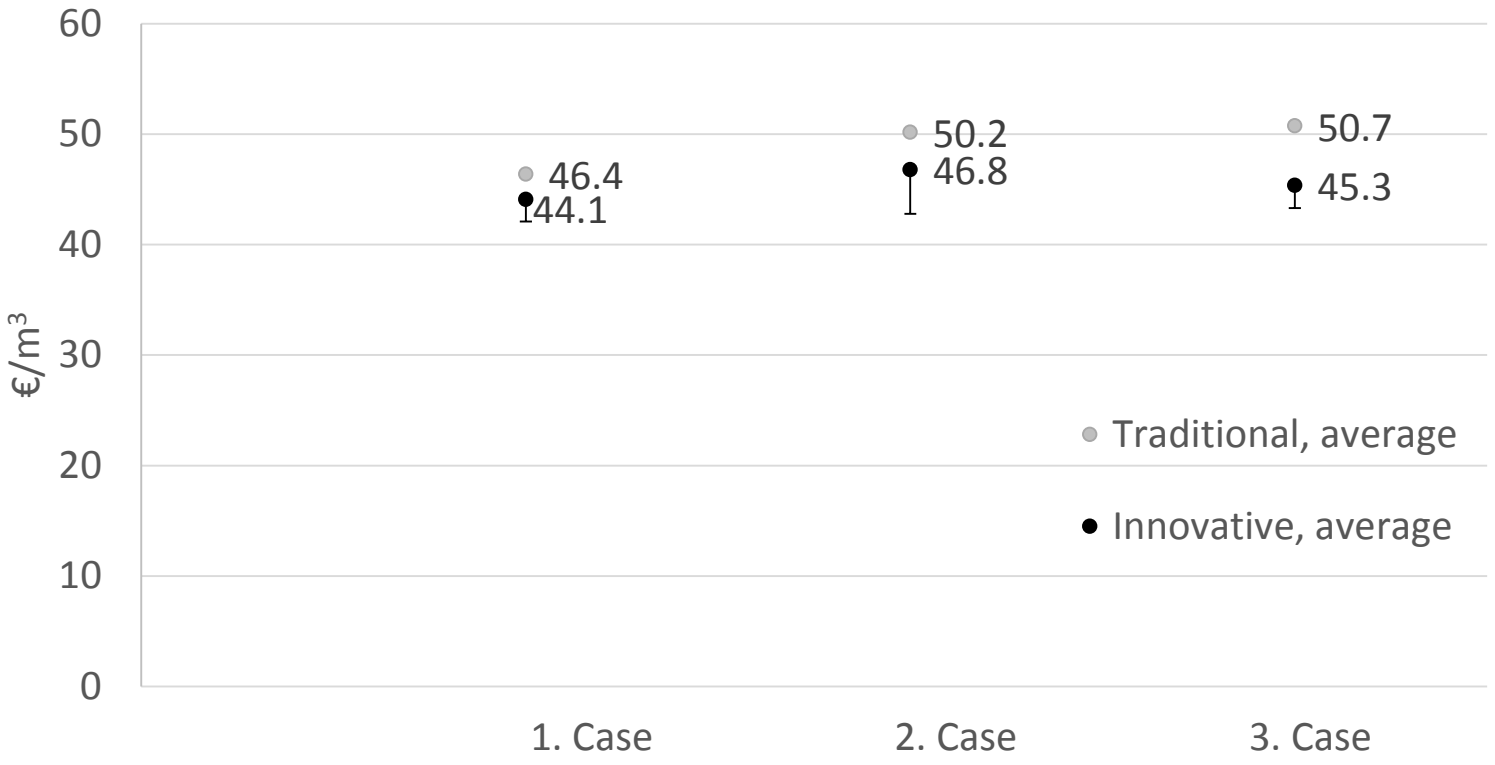


Total cost of supply chains

Case 3, Traditional: Logging cost and stumpage price are going different directions due to diameter of trees



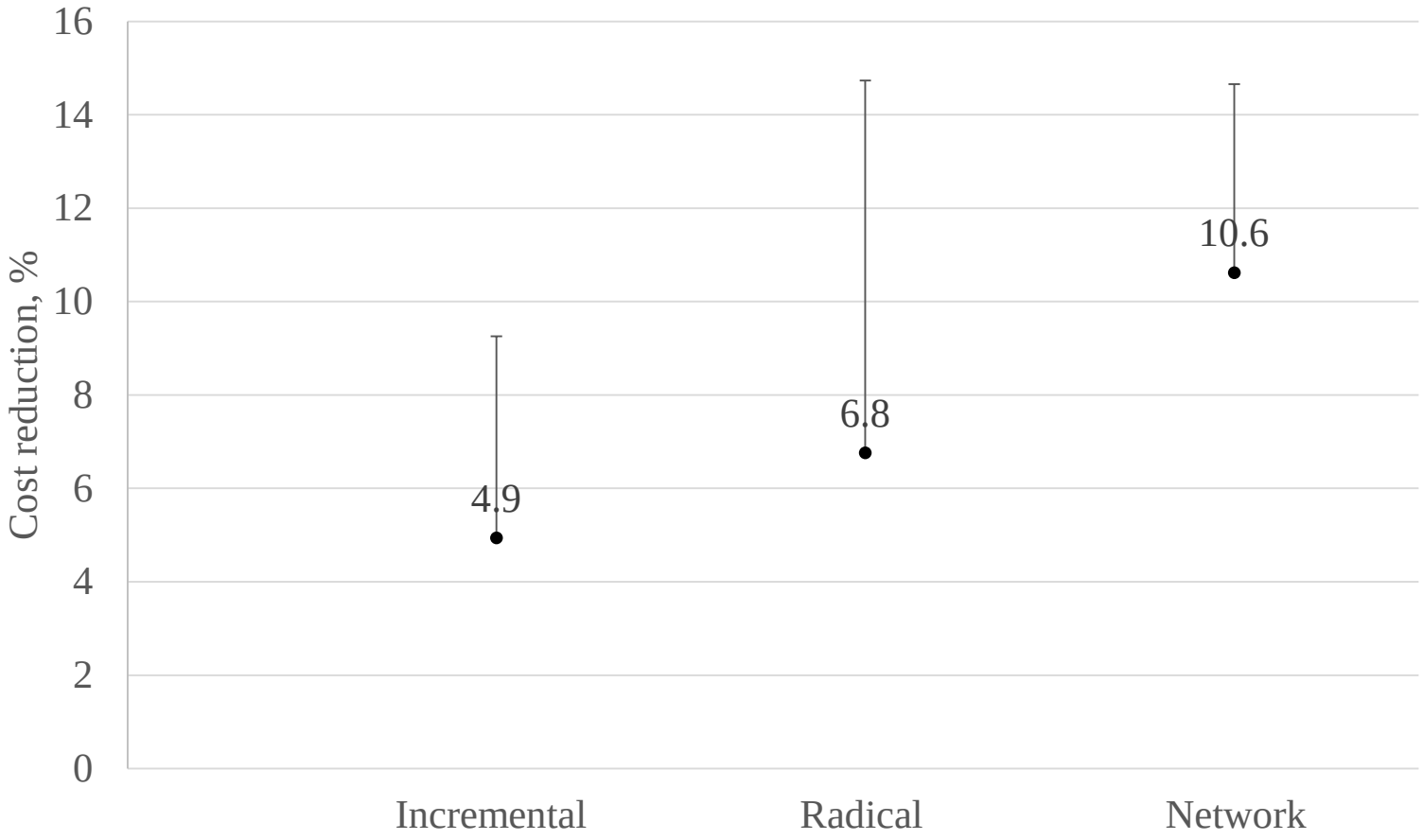
Total cost of supply chains (€/m^3)



Cost reduction (%)

$$Cost\ reduction\ (\%) = \frac{Cost_T - Cost_I}{Cost_T} * 100$$

$Cost_T$: Cost of traditional supply chain (€/unit)
$Cost_I$: Cost of innovative supply chain (€/unit)



Discussion

- Main innovation types of small-diameter supply chain were divided:
  - Incremental innovation (multi-tree handling machine)
  - Radical innovation (bundling machine)
  - Network innovation (forest management and supply chain combination)

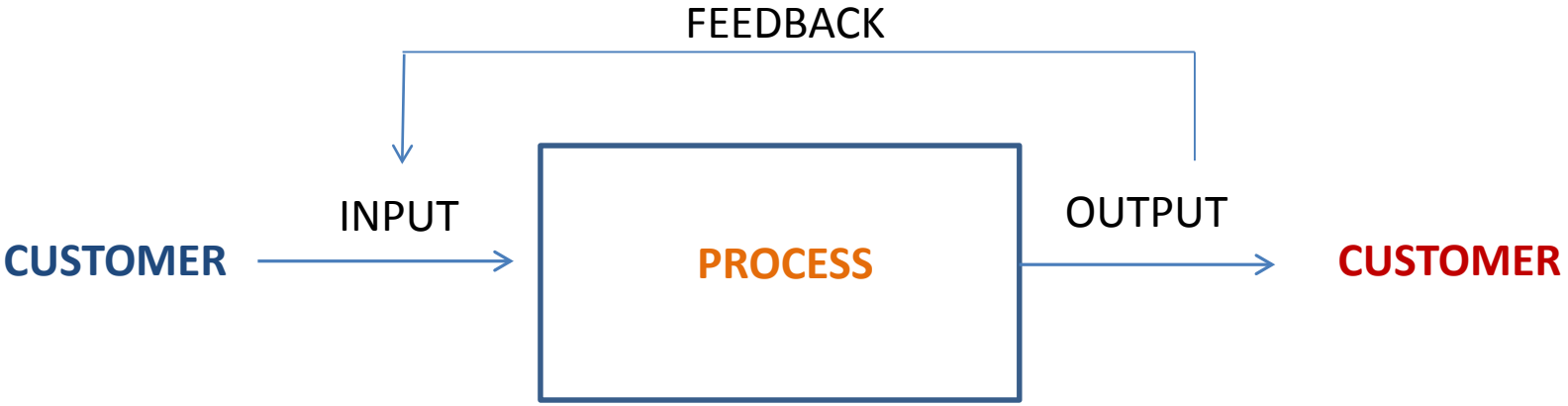
- The forest management alternatives to produce small-diameter energy wood and especially estimated stumpage prices have been missing in early studies of supply chains

- We found the stumpage price one of the most important cost factor of small-diameter wood (in addition logging cost), which cannot be left out of the study analysis of entire forest biomass supply chains

- **Cost reduction** of network innovation type was the highest
  - Highest average cost reduction **10.6%** (potential ~15%)

Conclusion

- It is not worth innovating only inside company´s own activities but opening the innovation process for the entire supply chain network is crucial
- Co-operative network innovation can be seen as an additional element for a company´s own innovation
- What does this mean in process innovation of small-diameter wood supply chains?
  - The best way to innovate is to create co-operative network between…
    - … Researchers, study projects and companies
    - … Science, developing and practice
    - … Forest owner (management), logistics and plant / final customer



More information…

Main innovation types of forest biomass supply chains can be access more closely:

Karttunen, K. 2015. Added-value innovation of forest biomass supply chains. 78 p. Dissertationes Forestales 186. http://dx.doi.org/10.14214/df.186

3. Case of forest management and supply chain analysis of small-diameter wood (as network innovation) can be access more closely:

K. Karttunen & J. Laitila (2015): Forest management regime options for integrated small-diameter wood harvesting and supply chain from young Scots pine (Pinus sylvestris L.) stands, International Journal of Forest Engineering, DOI:10.1080/14942119.2015.1083749

http://dx.doi.org/10.1080/14942119.2015.1083749

Thank you for your attention!

Metsäteho

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