Developing biomass supply systems for forested marginal lands in Sweden

Raul Fernandez-Lacruz (PhD student) and Dan Bergström
Department of Forest Biomaterials and Technology
Swedish University of Agricultural Sciences, Umeå, Sweden
raul.fernandez@slu.se, dan.bergstrom@slu.se

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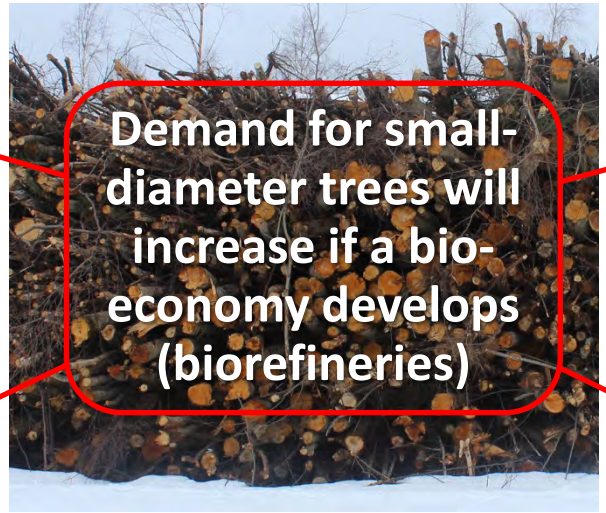
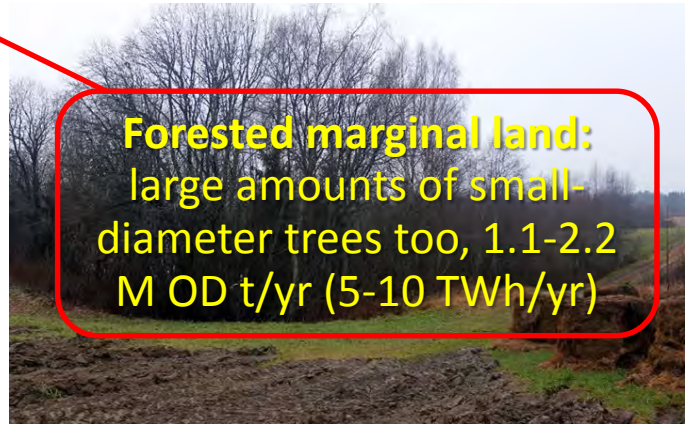
Introduction



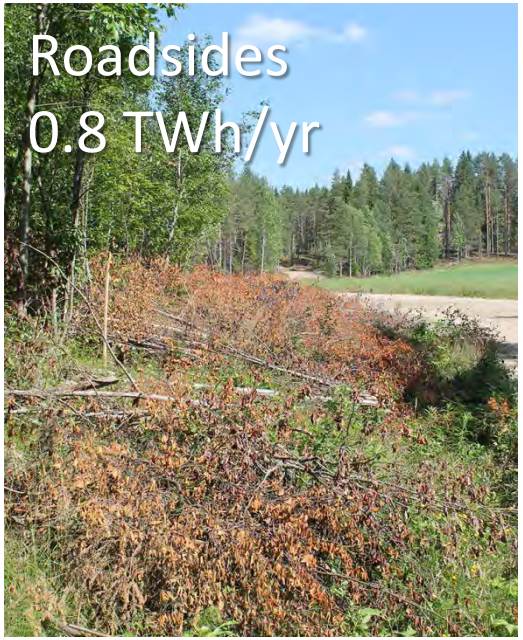
Energy plants
Pulp mills

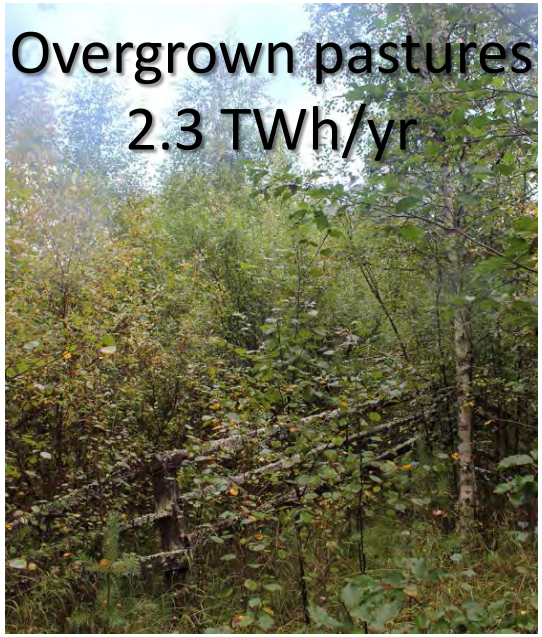


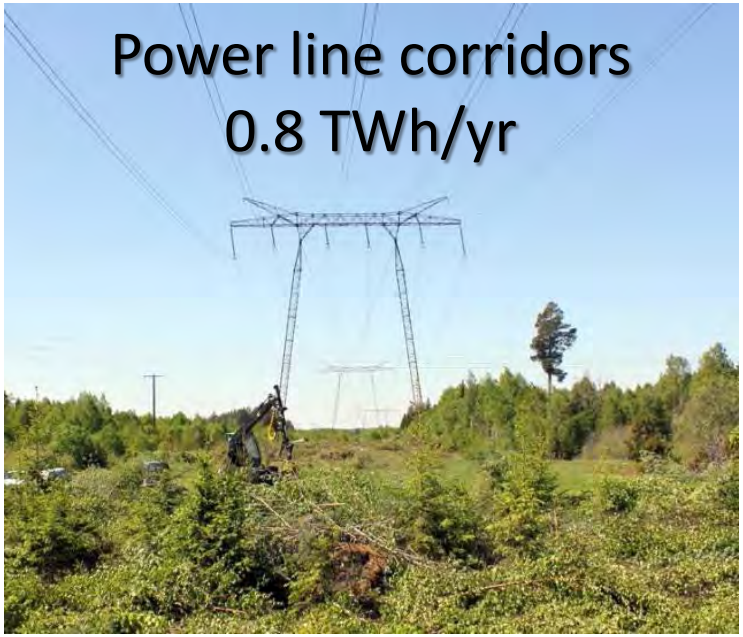
Primary forest biomass for wood chips in Sweden

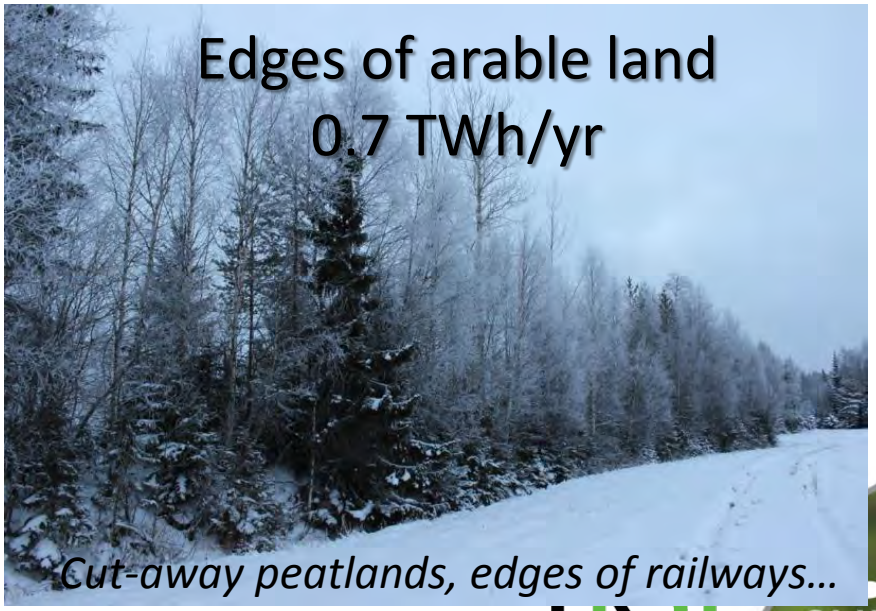
- Stumps, 0.3 TWh
- Small-diameter (whole, undelimbed) trees, 2.3 TWh
- Roundwood, 6.9 TWh
- Logging residues (tops and branches), 10.6 TWh

Introduction









(potentials from Emanuelsson et al. 2014. Nationwide harvest of small trees and bushes – potential, opportunities and obstacles)

Introduction

Harvests of marginal lands VS. energy thinnings in young dense forests:

= Heterogeneous and small tree sizes;

= High stock densities;

= Simmilar, existing, techniques (accummulating harvester/felling heads);

= High harvesting and transport costs.

☺ Sometimes, higher productivities and volumes (work as in clear-cut);

☺ Easy accesible from existing road networks;

☺ Land must be cleared anyway, regularly;

☹ Stand area small;

☹ Scattered in the landscape;

☹ Work safety regulations;

☹ Large variation amongst marginal lands (case to case);

Aim of the study

1. Characterize typical sorts of marginal land in northern Sweden;
2. Study the productivity of conventional & innovative systems on these lands;
3. Compare the cost of wood fuel delivery using different supply systems.

M&M: Inventory

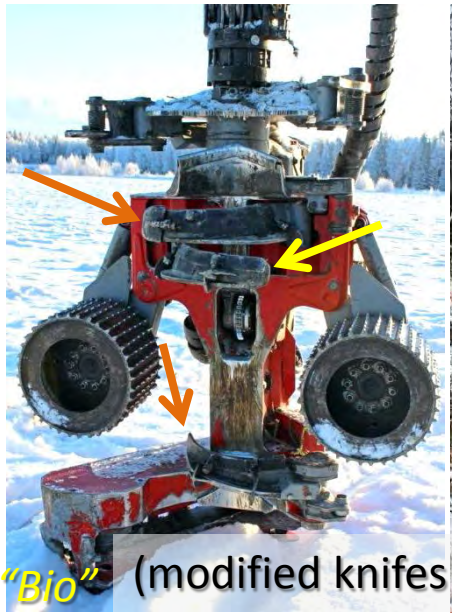
50 km around Umeå, four types of predominantly marginal lands: farmland, edge areas and peri-urban sites.

More biomass-rich!

Stand	A	B	C	D
Type of marginal land	**Industrial site**	**Edges of arable land**	**Arable land**	**Roadside**
Typical stand size (ha)	1	0.5	4	Up to road length
Density (all trees/ha)	16 446	20 105	4 341	2 450
Mean DBH (cm)	7.0	10.6	14.9	14.9
Mean height (m)	8.4	8.7	12.9	11.1
Mean stem volume (dm^3)	23	54	140	128
Biomass (OD t/ha)	52.5	97.0	70.6	38.2
Volume whole tree (m^3/ha)	123	199	134	91
Tree species % (alder:birch:spruce:willow:pine)	100:0:0:0:0	10:49:32:4:5	20:73:6:0:1	0:41:0:0:59
Forwarding distance (m)	206	196	180	0
Driving conditions (GYL)	2.1.1.	3.1.1.	3.1.1.	1.1.1.

Bearing capacity (G) limited during periods of high ground moisture (spring when snow and ground frost is melting)

M&M: Harvesting systems



(modified knifes for rough-delimbing)

M&M: Harvesting systems, terrain transport

(Gullberg, T. 1997. Time consumption model for off-road extraction of shortwood)

M&M: Comminution and road transport systems

A

+

B

+

Transport from the forest to the power plant for comminution

C

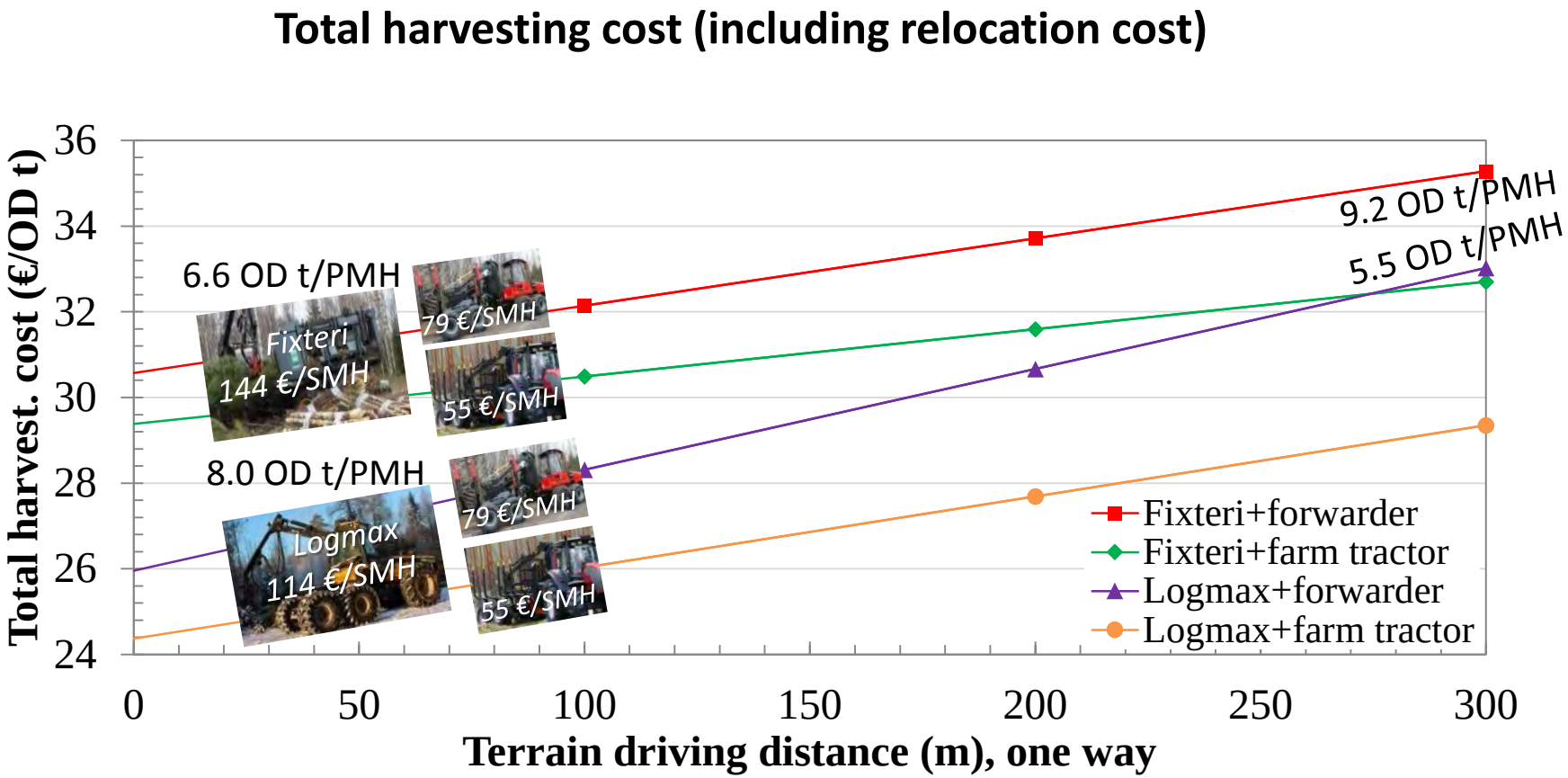
+

Chipping at the forest roadside and transport of chips to power plant

(Bergström D., Di Fulvio F. 2014. Comparison of the cost and energy efficiencies of present and future biomass supply systems for young dense forests)

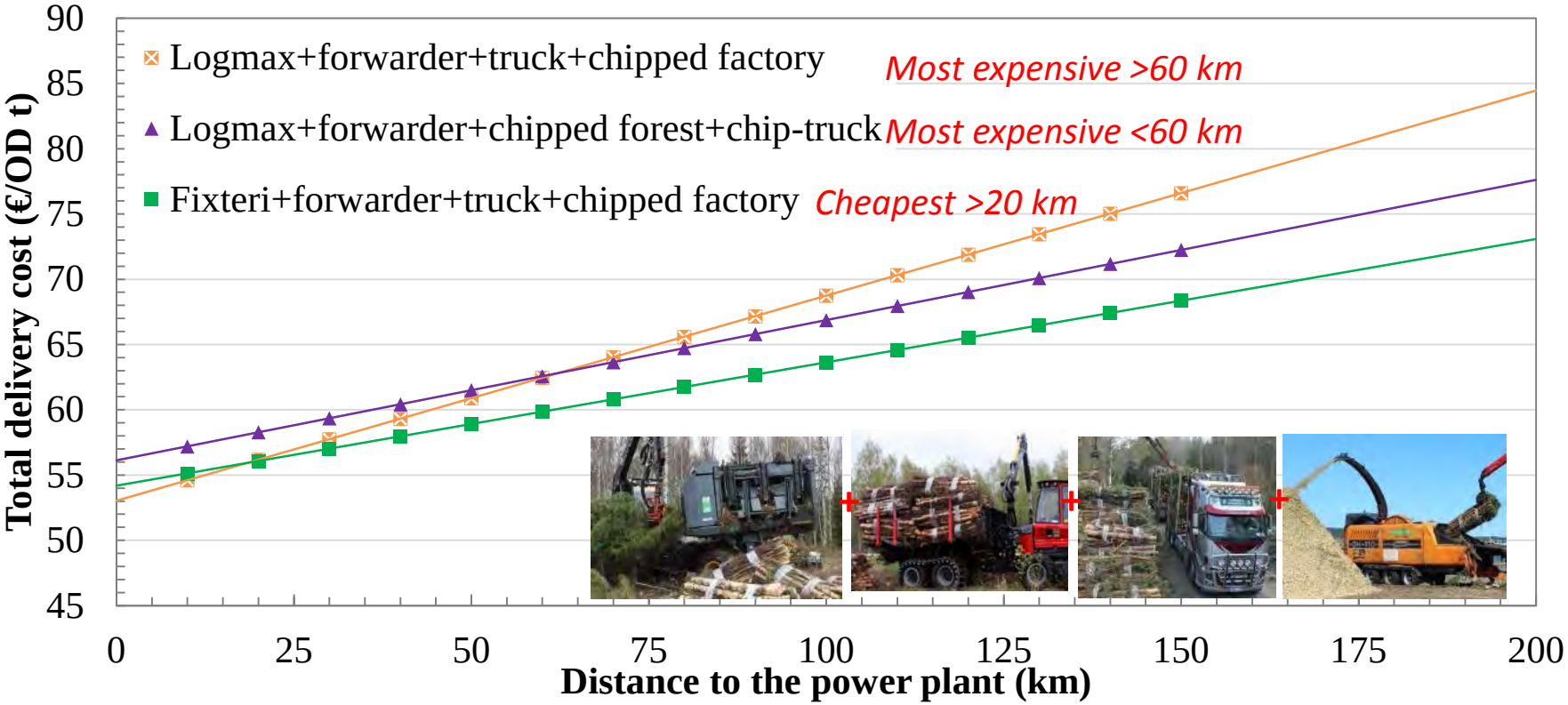
Results

Based on productivity and biomass concentration on overgrown arable land (4 ha, 70.6 OD t/ha, DBH 14.9 cm, stem volume 140 dm^3). Equivalent productivity Logmax.



Results

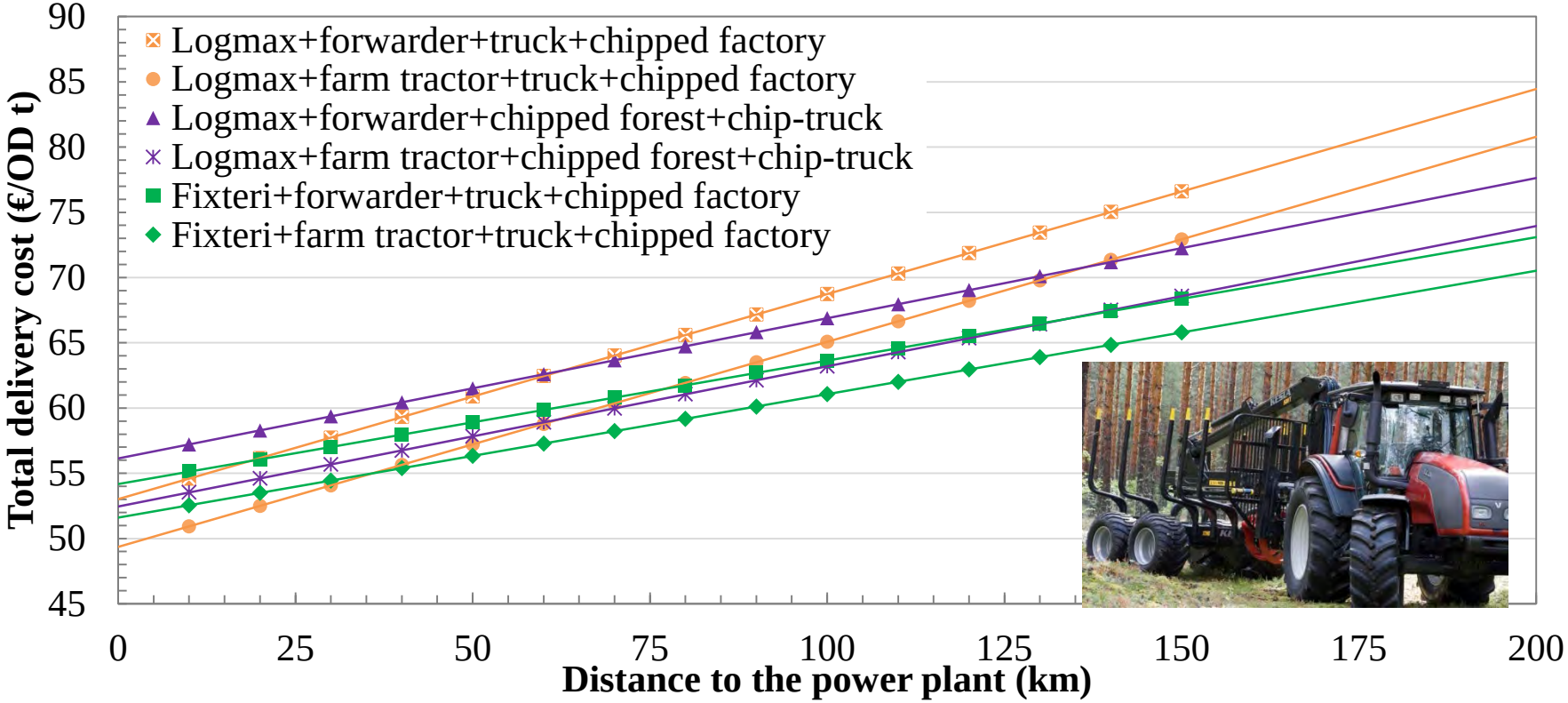
Total delivery cost of wood chips, 3 supply systems
(chipping cost at power plant included, in order to allow comparisons)



Bundler system most cost-effective alternative! (7%-5% comp. lower at 100 km)

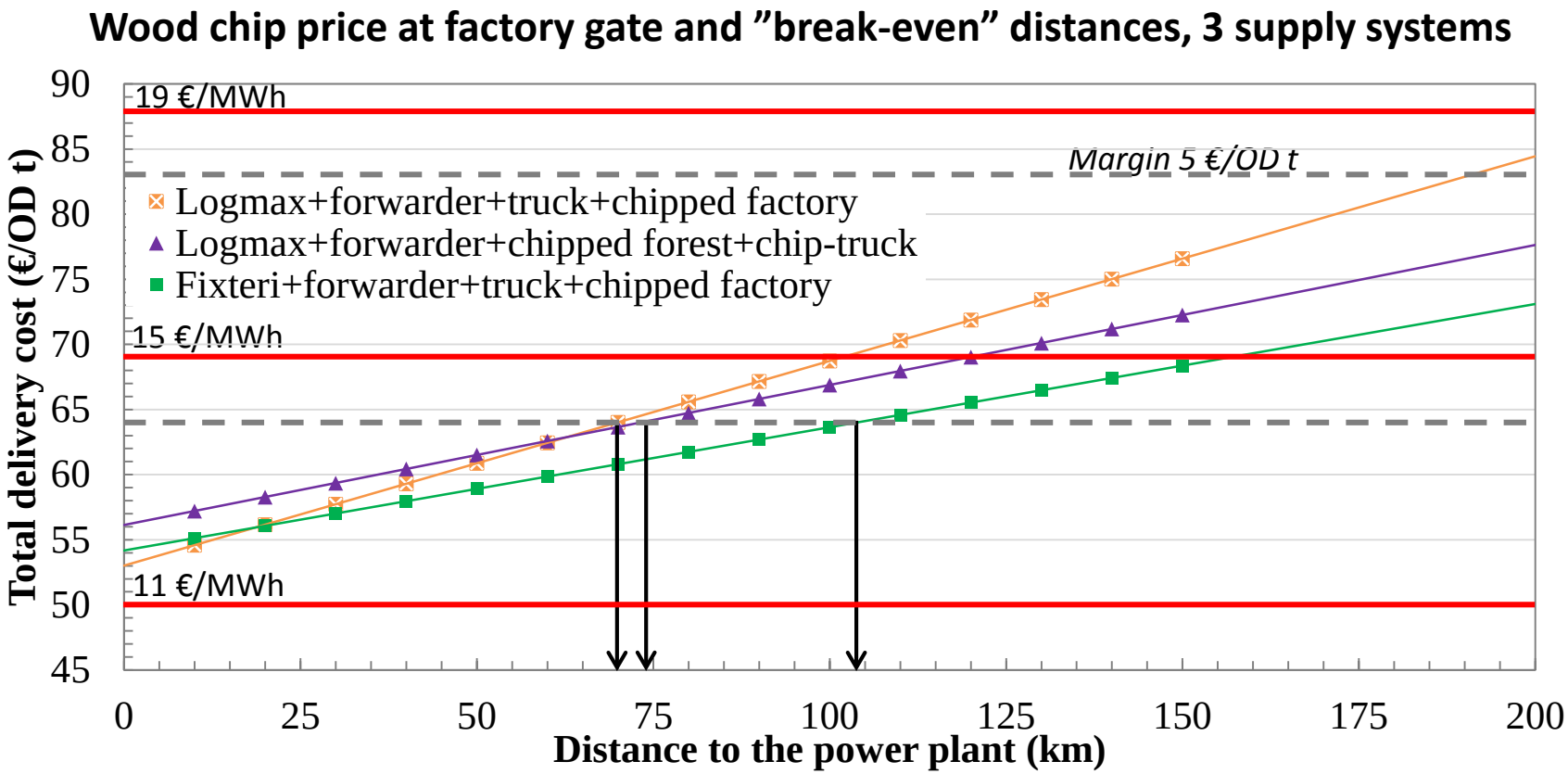
Results

Total delivery cost of wood chips, 6 supply systems
(chipping cost at power plant included, in order to allow comparisons)



For all systems, using a farm tractor, cost could be reduced by 4-5% (low operational cost)

Discussion



→ Assuming a high price, the 3 alternatives were profitable with a large margin;

→ If price fall from a high to a medium level, the bundle-harvester system can still deliver the biomass far away from the forest;

→ Low prices at industry gate can put at risk supply chains that have required years to set up;

Discussion and Conclusion

→ Analyses with the farm tractor based on assumptions, to be verified in the field;

→ Limited use of forest machines if bearing capacity decreases; better winter!

→ The case study marginal land: lower costs than the equivalent biomass harvesting of a dense first thinning→ Higher concentration of biomass, work as in clear-cutting and relatively large tree size (more typical pulpwood sizes!);

→ Higher costs in other marginal land with smaller tree sizes, sites and longer terrain driving distances. Conditions can vary greatly, difficult to generalize for all!;

→ More expensive harvest but savings during transportation and comminution at the factory/terminal by large-scale chippers, rather than at the forest roadside; Handling bundles easier than tree sections or logging residues;

→ Integrated transportation of bundles and roundwood (same timber trucks).

→ Further development and integration of harvesting marginal land with conventional forest land can decrease the delivery costs of small-diameter trees!

Thanks for your attention!

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Energimyndigheten

Raul Fernandez-Lacruz (PhD student) and Dan Bergström

Department of Forest Biomaterials and Technology

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