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Kemera Supports and the Profitability of Small-Diameter Energy Wood Harvesting from Young Stands in Finland

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Abstract

In order to speed up the production of small-sized thinning wood chips in young stands, the Finnish State provides financial incentives for the production of small-diameter wood chips. Financial support is provided according to the Sustainable Silviculture Foundation Law (Kemera). Currently (Summer 2008), the Kemera support provides subsidies for small-sized wood chips in early thinnings 7–10 €/MWh maximum in typical harvesting conditions (whole-tree chip removal 40–70 m^3/ha, and average stem size of removal 10–40 dm^3). Metsäteho Oy undertook a study on the total production costs of small-sized thinning wood chips with and without the Kemera supports. The results gave a clear indication that small-sized wood chips cannot currently be produced without the Kemera supports from young stands with typical harvesting conditions. If operating without the Kemera supports, the average stem size of whole trees harvested must be greater than 80 dm^3, at the current price level of small-diameter wood chips in order for the harvesting of small-diameter energy wood from young stands to be economically profitable in Finland.

Keywords: Support policy, Costs, Small-diameter wood, Energy wood, Harvesting, Early thinnings.

1. Background

In Finland, 3.0 million m^3 (6.1 TWh) of forest chips were used in 2007 (Ylitalo 2008). Of this amount, 87% was used by energy plants and the remaining portion by small-sized dwellings (Ylitalo 2008). Only one quarter (0.7 million m^3) (1.4 TWh) of the total amount of commercial forest chips used for energy generation was produced from small-sized trees in young stands (Ylitalo 2008).

When harvesting small-sized thinning wood in young stands, the stem size harvested typically has a breast height diameter ($d_{1.3}$) of less than 10 cm, and the stems are harvested as whole trees (stem with branches) (e.g.

Kärhä 2006, Kärhä et al. 2006). In Finland, typical harvesting conditions in early thinnings may be described as where whole-tree chip removal is around 40–70 m^3/ha and the average stem size of removals in stands ranges between 10–40 dm^3 (Kärhä et al. 2006). It has been estimated that the stock of technically harvestable small-sized thinning wood in young stands is 3.5–7.0 million m^3 (7–14 TWh) annually (Hakkila 2004, Leino et al. 2007, Ranta et al. 2007, Laitila et al. 2008). In Finland, the annual use of forest chips for energy generation is to be increased 10 TWh (5 mill. m^3) by 2010, and 16–24 TWh (8–12 mill. m^3) by 2015 (Anon. 2003, 2008a). These goals presuppose that the harvesting volume of small-sized thinning wood is tripled, or even quadrupled, from the current harvesting volume.

In young stands, high harvesting costs, particularly cutting costs, are the primary problems in early thinnings. The small stem size, low removal per hectare and harvesting site, and dense undergrowth, result in low productivity and high cutting costs (e.g. Kärhä et al. 2005, Kärhä 2006, 2007a, Laitila 2008, Oikari et al. 2008). When producing whole-tree chips in young stands, the total supply chain costs are approximately 17–21 €/MWh. In the beginning of 2008, the mean price of forest chips at the plant was 14.4 €/MWh in Finland (Anon. 2008b). In order to speed up the production of small-sized wood chips in young stands, the Finnish State provides production subsidies for small-sized wood chips in early thinnings, according to the Sustainable Silviculture Foundation Law (Kemera) (Anon. 2007).

In Finland, two mechanized harvesting systems are used for small-diameter energy wood: 1) the traditional two-machine (harvester and forwarder) system, and 2) the harwarder system (i.e. the same machine performs both cutting and forest haulage to the roadside) (Kärhä 2006). At the present, there are close to 200 small harvesters (weight <13 tons) and harvesters for thinnings (weight 13–15 tons) cutting small-diameter thinning wood in Finland (Kärhä 2007b). In addition, there are around 50 energy wood harwarders in early thinnings.

Metsäteho Oy undertook a study on the total production costs of small-sized thinning wood chips with and without the Kemera supports. This seminar paper introduces the Kemera support system for energy wood harvesting in early thinnings in Finland, and presents the effect of the Kemera supports on the profitability of whole-tree chip procurement.

2. Kemera support system

The Kemera support is paid only for young forests owned by non-industrial private forest owners (Anon. 2007, 2008c). The Kemera support is paid for both the non-industrial private forest owner's own work, as well as for contracted work. The area, to be eligible for the support must be greater than 1 hectare (Anon. 2007, 2008c). A principal element in the Kemera support system is that supports provided are restricted to be given only once throughout a stands rotation cycle (Anon. 2007, 2008c). There are currently four support instruments offered for young stands in the Kemera support system:

1) Support for thinning young stands,
2) Support for small-sized wood harvesting,
3) Support for chipping, and
4) Support drawing up a work clarification (Anon. 2008c).

Support for thinning young stands:

- The support is paid for thinning operations of the stands second development class.
- Removal of trees at stump diameter (d_0) greater than 4 cm must be over 1,000 trees per hectare.
- The average $d_{1.3}$ of remaining trees has to be less than 16 cm after thinning operations.
- After the thinning operation, the height of dominate trees cannot exceed 14 m in Scots pine (*Pinus sylvestris* L.) and Norway spruce (*Picea abies* (L.) Karst.) dominated stands, and no more than 15 m in broadleaf stands. If wood is used for energy generation, the height may be increased.
- The density of remaining production trees must be 700–1,400 trees/ha according to tree species after a thinning operation. If the initial stand is dense and there is a risk in damaging remaining trees, the density of remaining trees may be 2,000 trees/ha maximum.
- There is no immediate need for industrial roundwood harvesting (i.e. first thinning) after a thinning operation, and the support is not paid for the pre-clearance operation of a first thinning.
- The amount of support provided depends on the Kemera support zone (Fig. 1, Table 1).
- If the forest owner has no valid forestry plan, the support will be lowered by 10%.
- The grantee of the support is a non-industrial private forest owner.

Support for small-sized wood harvesting:

- The support is paid for:
  i) wood which comes from the tending of young stands.
  ii) when energy wood removal is more than 20 m^3.
  iii) when wood is to be used for energy generation.
- The amount of the support is 7 €/m^3 (3.5 €/m^3 for bunching operation, and 3.5 €/m^3 for forest haulage).
- The grantee of the support is a non-industrial private forest owner.

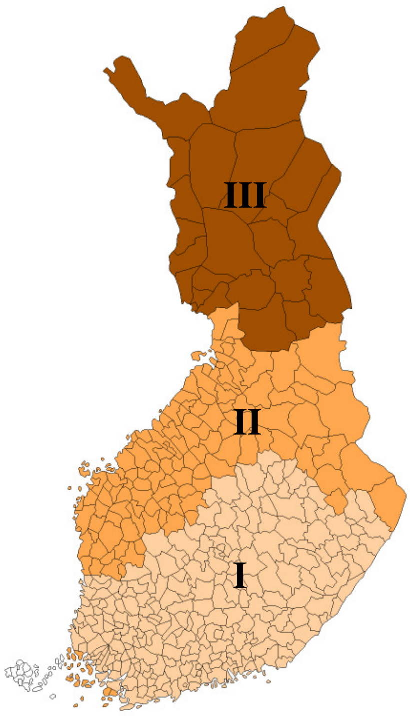

Figure 1. The Kemera support zones I–III in Finland. © Affecto Finland Oy, L7507/08.

Table 1. The amount of support for thinning young stands by the Kemera support zone and party completing the work.

	Support zone		
	I	II	III
	Support, €/ha		
Forest owner conducts own work	135	162	189
Work is conducted by paid labor	210.5	252.6	294.7

Support for chipping:

- Support is paid to the supplier of wood chips (e.g. energy wood procurement organization, chipping machine entrepreneur, heat entrepreneur, local forest management association) after the energy plant has received wood chips, paid in full.
- The amount of the support is 1.7 €/loose m^3 (4.25 €/m^3).

Support for drawing up work clarification:

- The Kemera supports for thinning young stands and small-sized wood harvesting are paid only after a work contract has been completed based on the application submitted to the forestry centre. The application must include clarification of a work contract.
- The support for work contract clarification may be paid if work is verified by someone other than the forest owner (e.g. officer of local forest management association or forestry centre).
- If the tending area in a young stand is greater than 2.6 ha, the support is 78 € + 16.5 €/ha. If the area is less than 2.6 ha, the support is 46.5 €/ha.
- If small-sized wood is to be used for energy generation, an additional energy wood harvesting support of 4.6 €/ha is applicable.
- Support for the clarification of chipping work is 0.1 €/loose m^3 (0.25 €/m^3).

When assuming that:

- A non-industrial private forest owner has a valid forestry plan.
- The forest owner does not carry out work activities.
- Work activities are conducted according to guidelines.
- Size of stand is 3.0 ha.
- Whole-tree removal is 50 m^3/ha (150 m^3/stand) (cf. Kärhä 2006).

Then the maximum total support is 2,498–2,750 €/stand depending on the support zone (Table 2). The largest support instruments are the supports for small-sized wood harvesting, the support for thinning young stands, and the support for chipping (Table 2). In confirming work clarifications, the level of support provided is smaller. The maximum total support per harvested cubic meter is around 17–18 € (8–9 €/MWh).

3. Cost calculations

When drawing up the total production costs of small-sized whole-tree chips with and without the Kemera supports, the following cost factors were applied:

- Stumpage price: 4.0 €/m^3
- Cutting costs: 48.1 €/m^3 (5 dm^3) … 5.2 €/m^3 (80 dm^3)
- Forwarding costs (250 m): 6.0 €/m^3 … 5.6 €/m^3
- Chipping costs: 7.5 €/m^3
- Road transportation costs: 4.0 €/m^3 (20 km) … 7.7 €/m^3 (120 km)
- Overheads: 2.5 €/m^3.

Table 2. The calculation of the maximum Kemera support for the stand by the support zone (cf. Fig. 1).

Kemera instrument	Support zone		
	I	II	III
	€/stand		
Support for thinning young stand	632	758	884
Support for small-sized wood harvesting	1,050	1,050	1,050
Support for chipping	638	638	638
Support for drawing up a work clarification			
- Basic support	128	128	128
- Added support for small-sized wood harvesting	14	14	14
- Added support for chipping	38	38	38
TOTAL			
- €/stand	2,498	2,624	2,750
- €/ha	833	875	917
- €/m^3	16.7	17.5	18.3
- €/MWh	8.3	8.8	9.2

4. Results

4.1. Profitability without the Kemera supports

When calculating the total production costs for whole-tree chips, it was noted that production costs were relatively high, 35–43 €/m^3 (17.5–21.5 €/MWh) in average harvesting conditions (average size of removed whole trees: 20–30 dm^3) of young stands compared to the average price of forest chips at the gate of energy plants (14.4 €/MWh) (Fig. 2).

The results indicated that whole-tree chips from early thinnings with typical harvesting conditions cannot currently be produced in an economically profitable manner without the Kemera supports. If operating without the Kemera supports, the average stem size of whole trees harvested must be around 80 dm^3 with relatively short road transportation distances, assuming that stumpage price is 4 €/m^3 (Fig. 2).

4.2. Profitability with the Kemera supports

When including the total maximum Kemera supports (Table 2) for the production costs of whole-tree chips (Fig. 2), the production of whole-tree chips was also economically viable in young stands where the average stem size of removal was less than the average (20–30 dm^3) (Fig. 3). In the large-sized young stands (i.e. the average size of removal 40–60 dm^3), the production of wood chips from early thinnings appeared to be relatively profitable. However, it must be noted that the Kemera support cannot be provided for these types of stands, because of the remaining large-sized tress in the stand after a thinning operation.

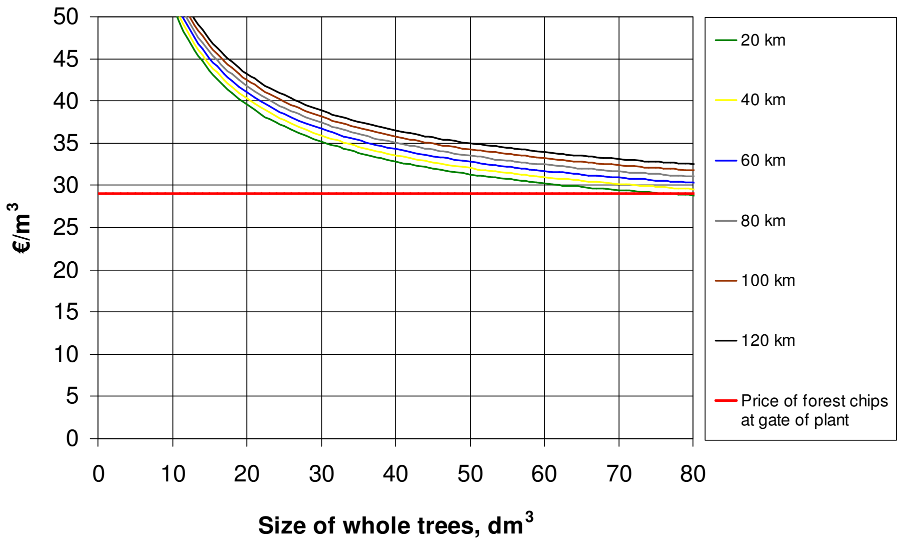

Figure 2. Total production costs of whole-tree chips as a function of the size of whole trees harvested from early thinnings, as well as the average price of forest chips (14.4 €/MWh) in the beginning of 2008 in Finland.

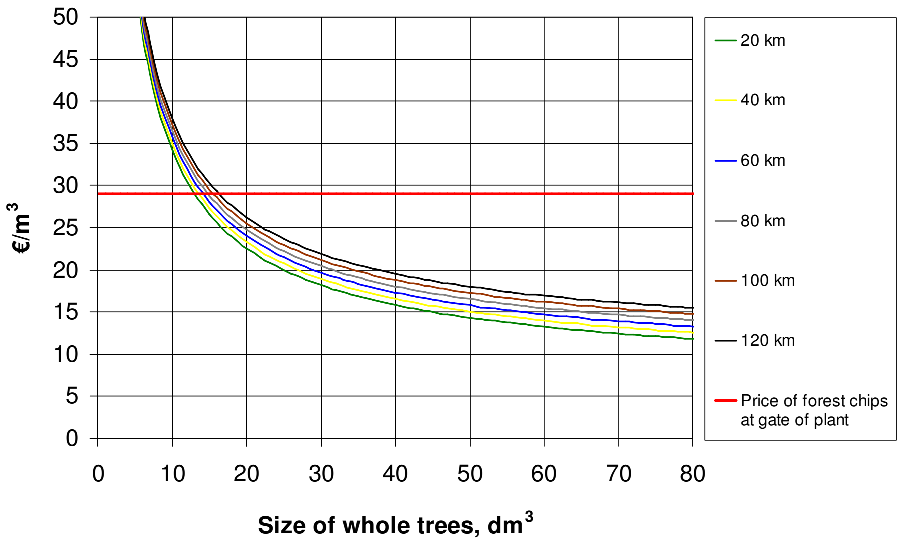

Figure 3. Total supply chain costs of whole-tree chips in early thinnings when including the Kemera supports of 17 €/m^3 (8.5 €/MWh) for production costs (see Fig. 2).

5. Discussion and conclusions

The cost calculations illustrated that small-sized wood chips (whole-tree chips) cannot currently be produced without the Kemera supports from young stands with typical harvesting conditions. When operating without the Kemera supports, the average stem size of whole trees harvested must be greater than 80 dm^3, at the current price level of small-diameter wood chips in order for harvesting of small-diameter energy wood from young stands to be economically profitable in Finland. When the average stem size of whole trees is approximately 80 dm^3, the stand is typically a small-diameter first-thinning stand for industrial roundwood (pulpwood) harvesting in Finland.

Also, the results indicated that small-sized thinning wood can be harvested from relatively poor harvesting conditions (the average size of whole trees 15–20 dm^3) with the Kemera supports. State authorities justify the levels of Kemera supports by stating the aim of the Kemera support system, which is to encourage recovery of small-diameter thinning wood for energy generation, which also includes harvesting poor quality sites.

There are several ongoing discussions that the Kemera support system would direct pulpwood for energy generation instead of pulping. Currently, there hasn't been research which has studied the amount of industrial roundwood (i.e. pulpwood) being allocated for energy generation within the Kemera system. Furthermore, it should be noted that guidelines determine very clearly that the average $d_{1.3}$ of remaining trees must be less than 16 cm after a thinning operation, which eliminates wood harvesting operations for energy generation from relatively large-sized early thinnings with the Kemera supports (Anon. 2008c).

The production support (Kemera) for wood chips from small-diameter thinning wood is required today, as high harvesting costs hinder the profitability. In the future, the level of Kemera supports will be lower, as funding levels provided from the State are not likely to increase, even with increasing levels of non-industrial private forest owners applying for the support. In looking at future prices, the price of forest chips will likely increase and improve the competitiveness of small-sized chip production from young stands with lower levels of Kemera supports. Increased development in supply chain and harvesting efficiency will likely increase the profitability of harvesting small-diameter wood and should be encouraged.

On the other hand, the production costs of small-sized wood chips in early thinnings will increase in the future when harvesting operations are expanded to include smaller and poorer quality sites, (i.e. less removals, more difficult terrain, and longer forwarding distances) which means increased cost pressures on the supply costs of small-diameter wood chips (Kärhä 2007c).

When discussing the Kemera supports, it must be noted that they play a very important role in Finland, so that young stands are managed in a way that promotes healthy silvicultural conditions. Without the Kemera support system, it can be estimated that there would be greater occurrences of untended young stands in Finland. In Sweden, for instance, where there is no similar support system for young stands, such as Finland's Kemera system, there are currently significant silvicultural problems with their young, dense and small-diameter stands (Nordfjell et al. 2008).

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