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## Potential of innovation and inventions

Inventions that gain commercial acceptance become innovations. Within the forest technology sector, the competitiveness of new or improved equipment in harvesting and extraction of forest biomass greatly depends on satisfying some basic conditions. They must:

- reduce or mitigate impact on the soil (compaction, rutting, soil displacement), residual trees and atmosphere;
- reach higher productivity than state of the art equipment;
- reduce consumption of fossil fuels and improve the energy balance of the forest biomass;
- reduce the negative impact on operator's working environment (ergonomic, health and safety of forest workers); and
- increase the value of the forest biomass and the profitability of forest contractors.

The implementation potential of new products as well as their probability and the desirability of adoption was assessed with a Delphi survey, a tool of futures studies. The Delphi survey is a technique for gathering data from a panel of experts within their domain of expertise. It is a repetitive process during which the

experts are allowed to revise their opinions based on the responses of the other experts in the panel. The aim is that at the end of the process consensus is reached.

As expected, some innovations that are already used in other sectors were deemed to have more potential than others to be adopted in harvesting and extraction of forest biomass. "Hybrid electric power system", "Self-operating machines", and "Ultra-low emission engines" are thought to have the greatest potential for use. The directive concerning low emission engines is promoting the introduction and development of this technology also in the forest energy sector.



In terms of probability of adoption of equipment that have not yet been commercialized, “Automated loading of biomass harwarders”, “Open forest street map”, “Hybrid chipper” and “Machine vision” are thought to have the greatest probability of becoming commercially accepted. Open forest street map is a digital forest road network available online to the contactors without or with only a small fee in order to support the phase of operational and strategic planning of forest biomass supply, round wood supply and other branches of forestry logistics. They are also thought to be the most desirable inventions. Additionally, the inventions that are thought to be those most probably adopted and have the highest commercial potential are also the ones that are furthest developed, and might for example already have prototypes.



Hybrid chipper by Kesla Oy. Photo: Luke.

However, a number of barriers to adopting these technologies exist. Some barriers are cultural, e.g. acceptance might depend on ways of doing harvesting and the ownership of the forest. Other barriers are more technical, while yet others revolve around the need for more test results to show that there would be benefits from adopting the inventions. The barriers need to be taken into account in product development. For example, it might not be useful to market machine vision to harvesting companies, if the forest owner wants to decide themselves which trees to harvest.

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