

Moisture management, energy density & fuel quality in forest fuel supply chains

IEA Bioenergy Multi-Task Conference
Vancouver, August 2009

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JOENSUU SCIENCE PARK



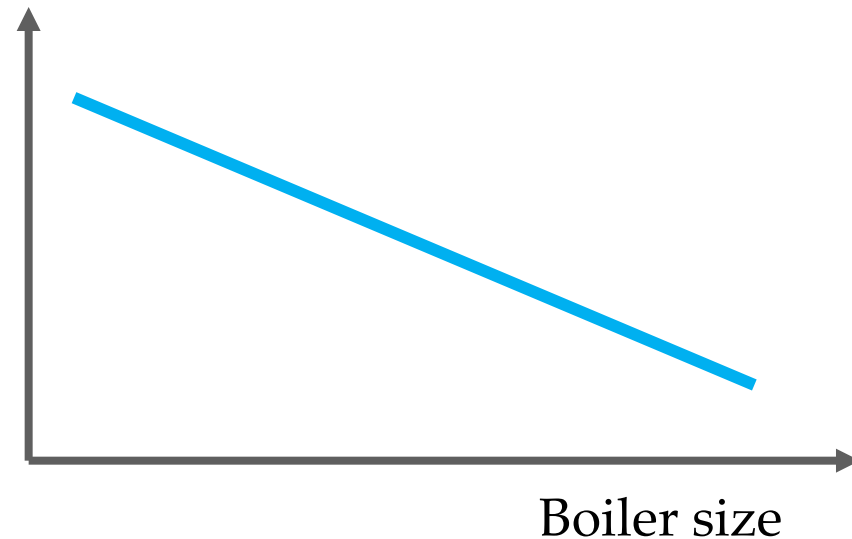
- **Client = Energy Plant sets the requirements for the fuel!**
 - plant is designed to certain type of fuel
 - fuel quality should meet the specifications and be stable, or at least predictable



Quality as a restriction



Quality
requirement



Moisture

- The main quality factor
- Energy content
- Logistic costs, usability in winter

Energy density

- Cost factor in logistics
- Strongly linked to moisture content

Cleanness (stones, ash)

- Increasing problem (stumps, recycled wood...)



FUEL:

ENERGY DENSITY:

	MWh/m ³	MWh/1000 kg
Loose full trees, pine 46% MC	0,37	2,6
Chipped full trees, pine 46% MC	0,74	2,6
Bundled spruce logging residues, 46% MC	0,92	2,6
Black liquor (70% DM)		3,3
Pellets	3,1	4,8
Hard coal		7,1
Light fuel oil	10,0	11,9

Particle size (sticks!)

- Assorted chips <--> hog fuel with sticks

Chlorine (Cl) content...

- (S/Cl ratio > 4)

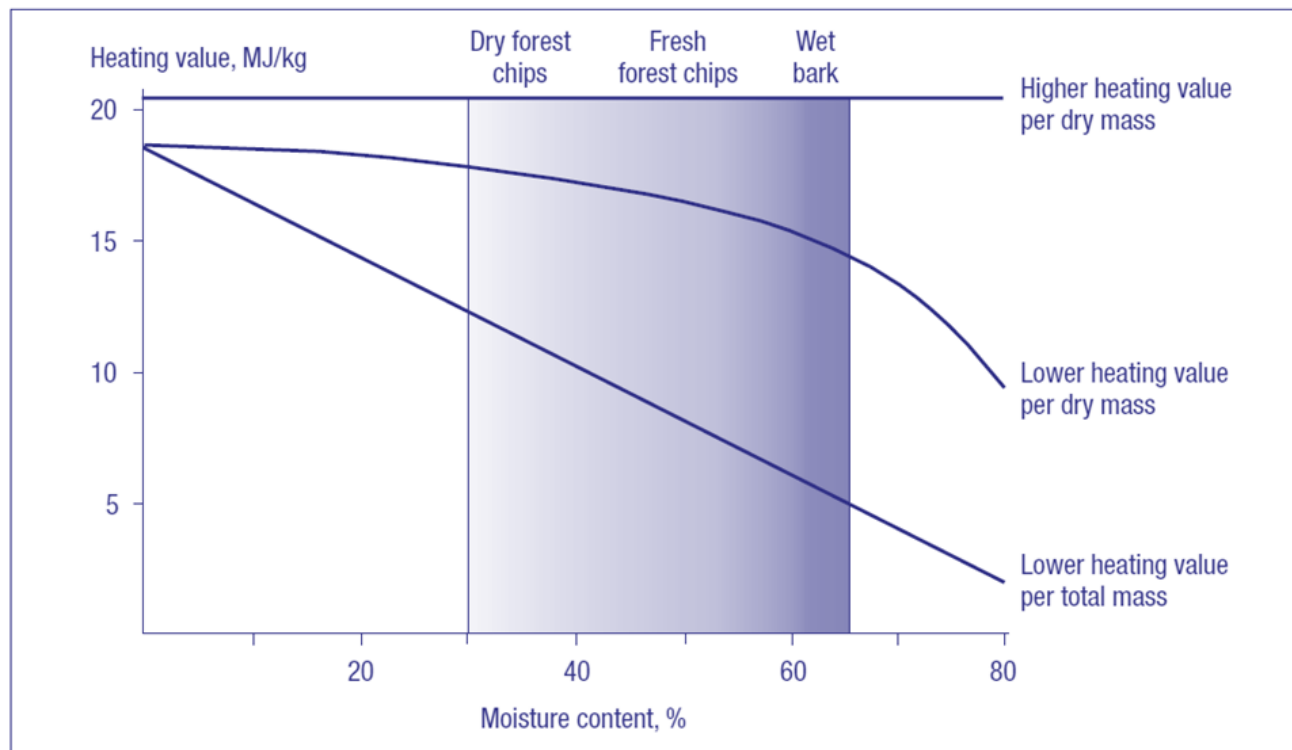


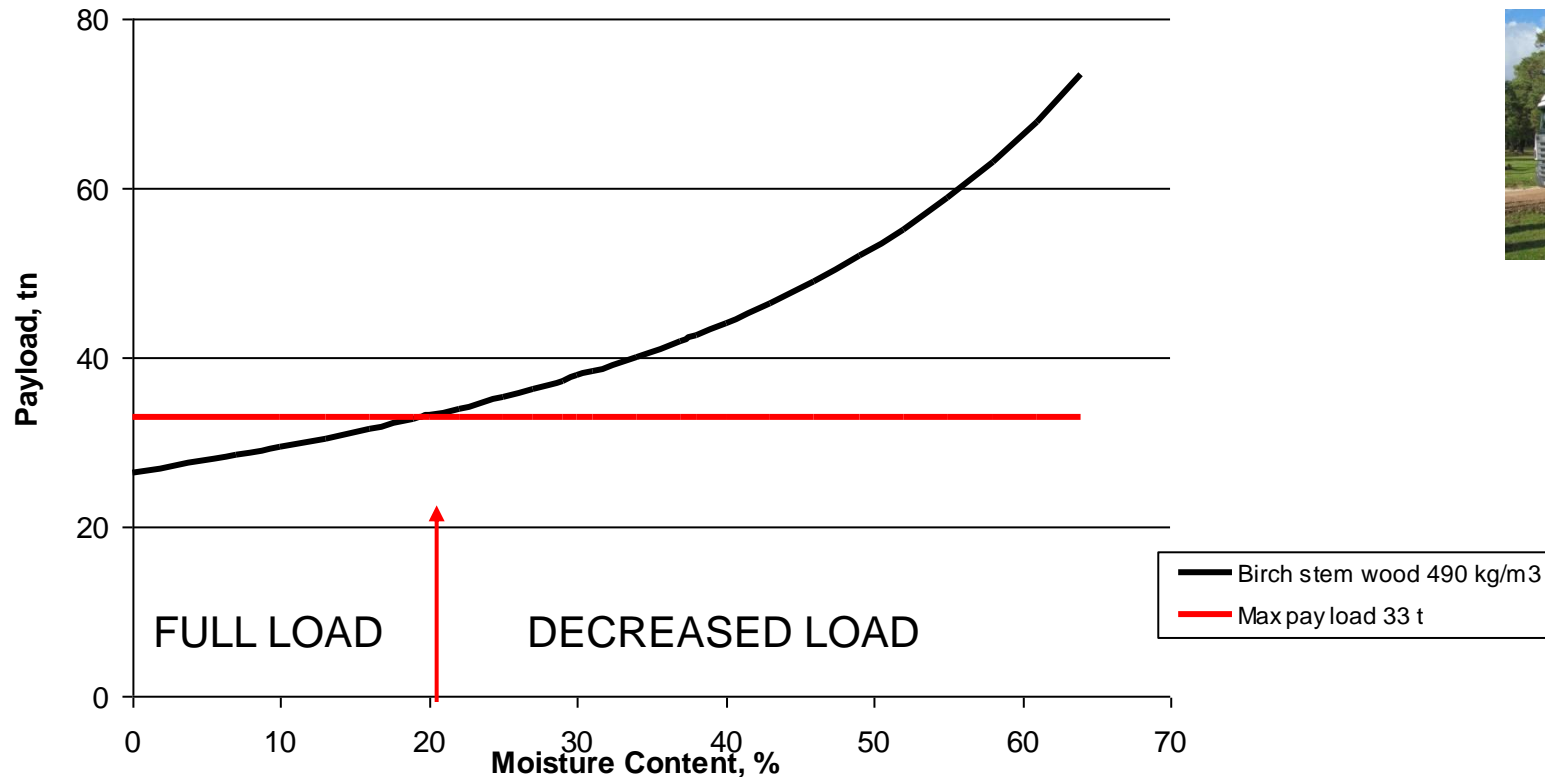
Figure 54. The effect of moisture content on the effective heating value of wood.

(Hakkila 2004)

- **Small plants:** Weight of a standard volume sample is measured, sample is dried in micro wave oven.
- **Big plants:** Scaling of truck + moisture sample analysis in laboratory
- Every load!



Moisture (MC) reduces the payload
Truck volume 135 m³, tree density 490 kg/m³



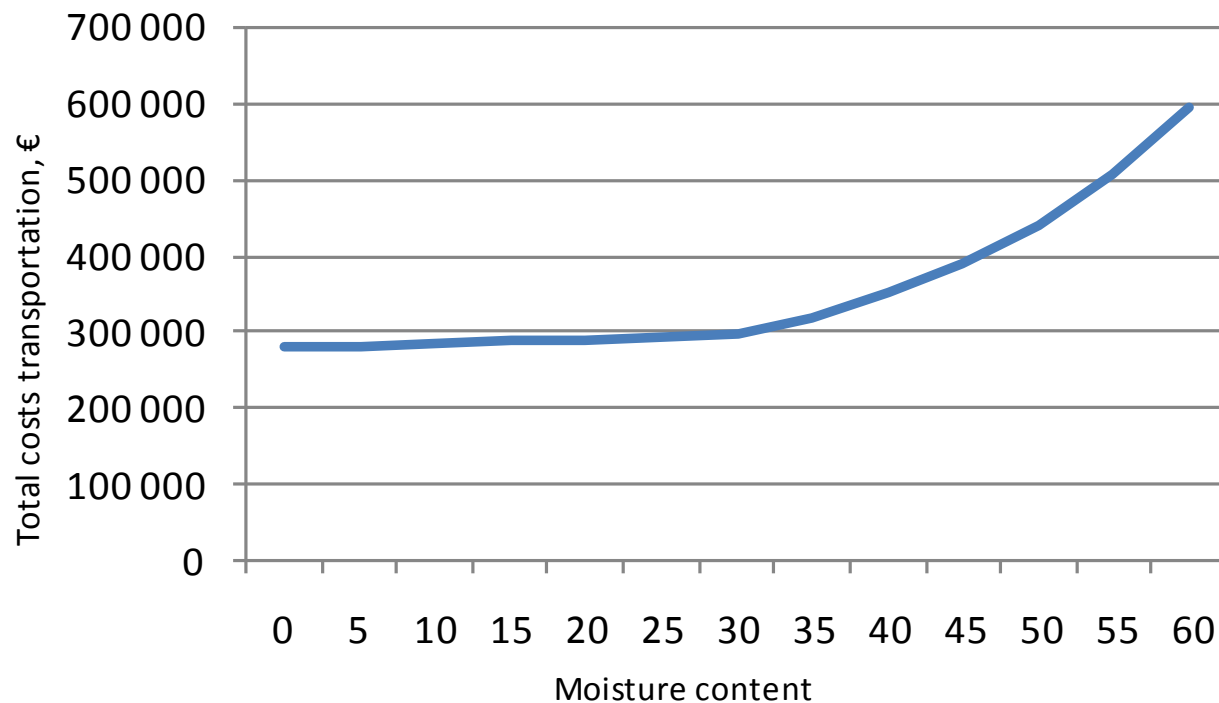
Variation in maximum truck load:

at 20% MC = 54 m³(solid) = 137 MWh

at 49% MC = 34 m³(solid) = 83 MWh

Total transportation costs by moisture content

Case energy plant: Chip demand 170 000 MWh/year

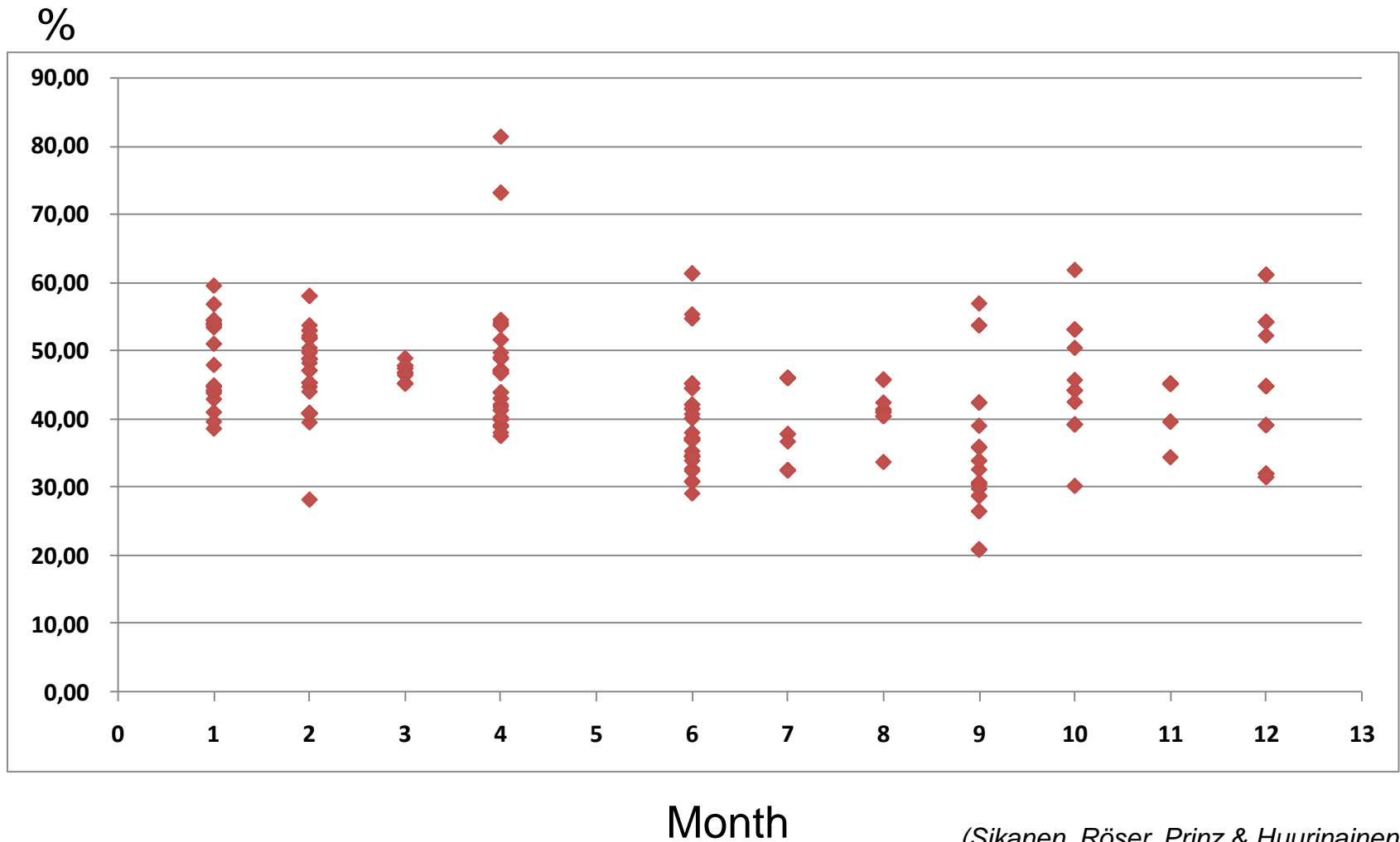


Average transportation distance: 75 km

Chip truck: max pay load 33 tons, total mass 60 t

(Sikanen, Röser, Prinz & Huurinainen 2009)

*Contractor example in the year 2008:
Large actual variation in moisture content!*



(Sikanen, Röser, Prinz & Huurinainen 2009)

Reducing moisture should be the goal in every step in the supply chain



- 1-3 weeks seasoning, when possible (brown chips = lower nutrient loss)
- High, large piles in open space, "ventilation" under the pile
- Storing unchipped; moist chips start composting
- Covering of piles, moisture reduction potential 4-15 %
- Debarking of stemwood?
- Active drying at plant or terminals?
- Avoid unnecessary storing:
 - biomass losses
 - re-moisturing
 - fire risk
 - health risk (fungi, microbia)



- Better efficiency by better monitoring of moisture!
- Quality-based deliveries, demand at the plant as a driving force
- Technology development, best/improved practises
- Information system from forest to the boiler:
 - Estimation of moisture at roadside storage, control by cheap and accurate field measurements
 - Cheap and accurate measuring system and remote control for wood fuel terminals
 - On-line measurement at the plant (boiler optimisation)
- Bottlenecks:
 - Lack of standardization of data
 - Lack of system integration (interfaces)
 - Lack of commercialized technology and services
 - Lack of serious attitude?





Not to mention metal particles like steel bars, bicycles



- Sand, gravel, stones and other impurities cause use breaks, damages and increased maintenance costs:
 - Chippers, crushers
 - Conveyors, feeding screws, silos
 - Grate problems, degradation of grate sand in fluidized bed boilers...
- **Problem:**
 - The extra costs of low quality are not known → the quality has no value.
- Quality aspects should affect more on:
 - practises in and design of supply chains
 - technology development

- **Cleanness is difficult to maintain:**

- driving over residues
- skidder instead of forwarder
- careless loading of forwarder
- careless roadside storing and loading
- storing and loading of chips in roadside storage or in terminal on unclean surface vs. roadside chipping

- The increasing use of stumps is a major challenge for technology



Thank you for
your attention!