COMPRESSION POTENTIAL ”DOUPLING ENERGYWOOD LOAD SIZE”

Sustainable Bioenergy Solutions for Tomorrow (BEST) research program

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Background

- Comminution from roadside landings to terminals => higher
  - utilization rate of machinery
  - delivery reliability of energy

- Problem: low payloads on long distance transport
  → 9/2013 (60 t): 65-70 % of maximum capacity
  10/2013 → (64-76 t): down to 50 % of maximum capacity
  - The dryer material the lower payload

Target / Plan

- BEST-program concentrates on terminal-oriented solutions
  - ⇒ This sub-task focuses on finding cost-effective solutions to supply non- or low-refined raw material from road side landing to terminal
- Loose density on long-distance transport is normally 100-150 kg/i-m^3
  - Find potential density and solutions on 60-76 t trucks.
  - By compressing slash/stumps during loading
- Compressing must take place integrated on other work stages
  - Cutting/lifting, hauling, loading on truck

Compression study

Original idea by Sakari Mononen & Metsähallitus

- Proto 2011-2012
- Study unit 2012-2013

Study with final prototype

SLASH
- Moisture content 35 %

PINE STUMPS
- Moisture content 24 %

Results on practical conditions

UNCOMPRESSED SLASH

	Truck	Trailer	Both	
# of load cycles	30	78	108	
Loading	21	31	52	min
# of unload cycles	17	45	62	
Unloading	?	17	?	min
Total weight	24540	28300	52840	tn
Tare	18500	14040	32540	tn
Payload	6040	14260	**20300**	tn

UNCOMPRESSED STUMPS

	Truck	Trailer	Both	
Total weight	25060	29940	55000	tn
Tare	18400	14040	32440	tn
Payload	6660	15900	**22560**	tn

COMPRESSED SLASH

	Truck	Trailer	Both	
# of load cycles*	48	86	134	
# of bales**	23	33	56	
Loading	36	50	86	min
# of unload cycles	20	46	66	
Unloading	6	14	20	min
Total weight	25600	29780	55380	tn
Tare	18300	14020	32320	tn
Payload	7300	15760	**23060**	tn
Compression	20,9	10,5	13,6	%

COMPRESSED STUMPS

	Truck	Trailer	Both	
Total weight	25800	31280	57080	tn
Tare	18400	14040	32440	tn
Payload	7400	17240	**24640**	tn
Compression	11,1	8,4	9,2	%

* from road side pile to compression unit

** from compression unit to load space

Compression study conclusions

- Slash
  - Compression unit works technically as planned
  - No applicable / profitable without major modifications
    - Compression rate (13.6 %) far too low
    - Time consumption of loading increased much more (65 %) than load size

- Stumps
  - Tested compression unit is not suitable or even developable for stump-processing

Compression potential on trucks

# of axles			Total weight, tn			Tare weight, tn			Payload, tn			Height,	Load space, m^3			Kg/loose-m^3	
truck	trailer	both	truck	trailer	both	truck	trailer	both	truck	trailer	**both**	m	truck	trailer	both	truck	trailer
3	4	7	26	34	60	18,5	13,5	32,0	7,5	20,5	**28,0**	4,2	52	105	157	144	195
3	4	7	26	38	64	18,5	13,5	32,0	7,5	24,5	**32,0**	4,2	52	105	157	144	233
3	4	7	26	38	64	18,7	13,8	32,5	7,3	24,2	**31,5**	4,4	56	112	168	130	216
3	4	7	28	36	64	18,5	13,5	32,0	9,5	22,5	**32,0**	4,2	52	105	157	183	214
3	4	7	28	36	64	18,7	13,8	32,5	9,3	22,2	**31,5**	4,4	56	112	168	166	198
3	5	8	27	41	68	18,5	14,5	33,0	8,5	26,5	**35,0**	4,2	52	105	157	163	252
3	5	8	27	41	68	18,7	14,8	33,5	8,3	26,2	**34,5**	4,4	56	112	168	148	234
4	4	8	31,5	36,5	68	20,0	13,5	33,5	11,5	23,0	**34,5**	4,2	52	105	157	221	219
4	4	8	31,5	36,5	68	20,2	13,8	34,0	11,3	22,7	**34,0**	4,4	56	112	168	202	203
4	5	9	34	42	76	20,0	14,5	34,5	14,0	27,5	**41,5**	4,2	52	105	157	269	262
4	5	9	34	42	76	20,2	14,8	35,0	13,8	27,2	**41,0**	4,4	56	112	168	246	243
4	5	9	35	41	76	20,0	14,5	34,5	15,0	26,5	**41,5**	4,2	52	105	157	288	252
4	5	9	35	41	76	20,2	14,8	35,0	14,8	26,2	**41,0**	4,4	56	112	168	264	234
5	4	9	42	34	76	22,7	11,4	34,1	19,3	22,6	**41,9**	4,2	70	88	158	276	257
5	4	9	42	34	76	23,0	11,7	34,7	19,0	22,3	**41,3**	4,4	75	94	169	253	237

- On 60-64 t trucks' trailers payload often clearly under carrying capacity (typical loose density < 150 kg/loose-m^3)
- For both 68 and 76 t trucks there are combinations, where load space volume and carrying capacity are in balance and 34+ tonnes loads available when compressed

General findings 1

- Slash
  - Lot of loose and smaller particles that must not be dumped to landing (organic waste => energy wood)
    - ⇒ **Compression must take place on / above load space**
  - Varying portion of logs, tops and whole-trees that are hard to arrange tight on load space
    - ⇒ **Compression process should be able to crack at least thinnest objects (< 10 cm?)**
    - ⇒ **Longest stem parts (> 2,5 m) could also be cut on shorter parts**

General findings 2

- Stumps
  - Lot of debris that must be dumped to landing (if not left on site)
    - ⇒ **At least part of compression process should take place outside load space**
  - Long-shaped stump chunks very challenging to arrange tight on load space
    - ⇒ **Longest roots should be left on site (or broke to shorter parts during loading)**
  - At least dry pine stump chunks surprisingly easy to break on smaller pieces
    - ⇒ **Compression process could possibly be replaced by breaking chunks during loading**
    - ⇒ **Primary shredding with separate machinery might be too heavy and costly treatment**

General findings 3

- Energy wood trucks / load space
  - Carrying capacity and load space volume are not in balance between truck and trailer on typical combination (3-axle truck)
    - ⇒ **Trailers biomaterial should be compressed more than 60 % tighter (233 versus 144 kg/l-m3) to maximize total payload (32 t)**
    - ⇒ **Better balance and maximum benefits (>40 t) can be reached using modern 4-axle trucks for transporting compressed biomaterials**

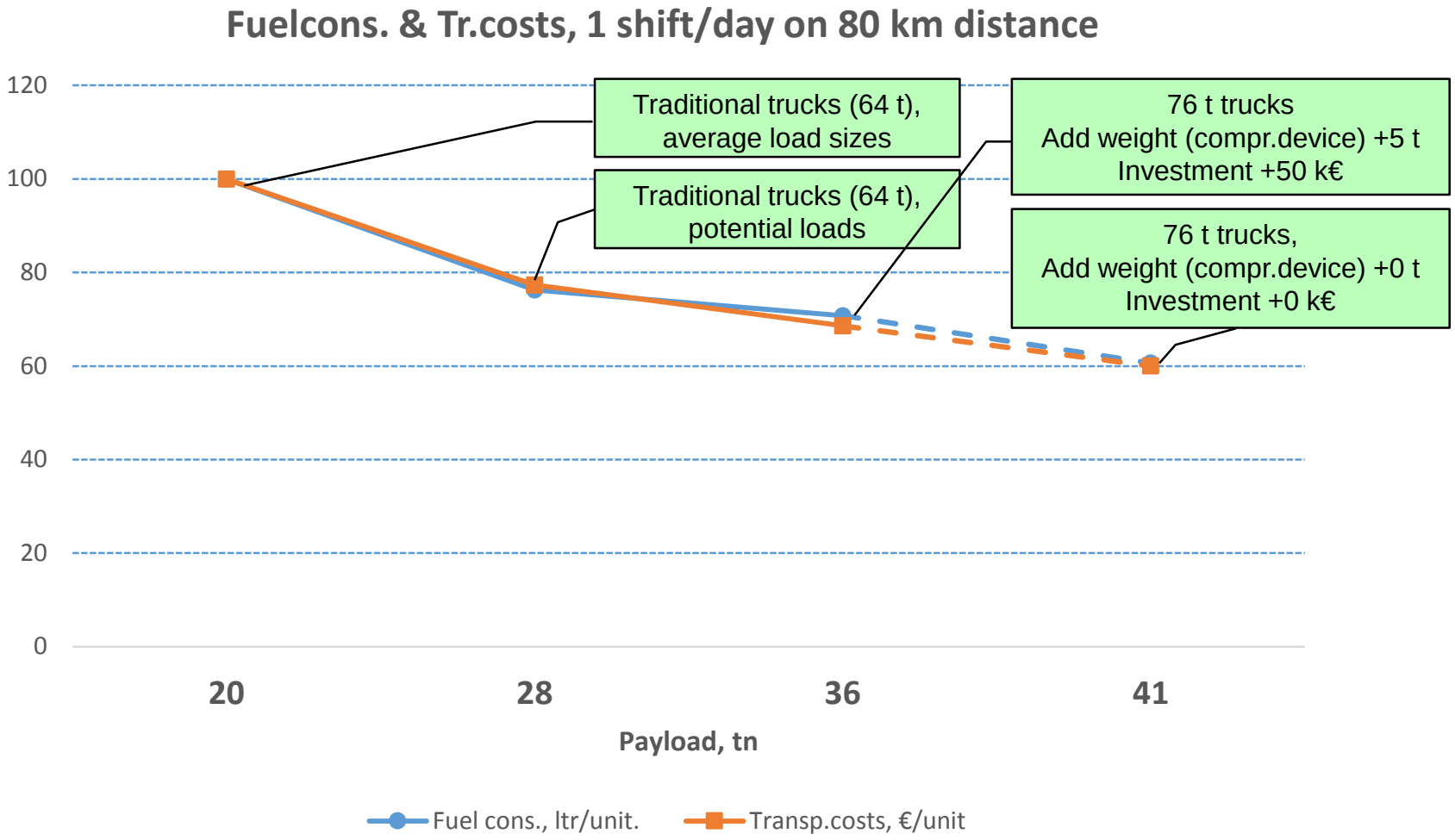
# of axles			Total weight, tn			Tare weight, tn			Payload, tn			Height,	Load space, m^3			Kg/loose-m^3	
truck	trailer	both	truck	trailer	both	truck	trailer	both	truck	trailer	**both**	m	truck	trailer	both	truck	trailer
3	4	7	26	38	64	18,5	13,5	32,0	7,5	24,5	**32,0**	4,2	52	105	157	144	233
4	5	9	34	42	76	20,2	14,8	35,0	13,8	27,2	**41,0**	4,4	56	112	168	246	243

  - Hydraulics in traditional telescopic trailers not powerful enough for longitudinal compression
  - Side structure sets limits for compression method and force especially in telescopic trailers
    - ⇒ **Trailers structure and hydraulics should be sized in line with compression needs**
    - ⇒ **Removable crossbars might be needed on top of sides to keep load space width on legal limit (2,5 m)**

General findings 4

- Energy wood loader / grabble
  - Heavy and long reaching loaders common in energy wood trucks
    - ⇒ **Backside of stump and slash piles still hard to reach (in contrast to roundwood piles)**
  - Often used as ”hammer” during loading, that stresses loader, load space sides and operator
    - ⇒ **Compression should be done in more controllable way (hydraulics, adjusted work model)**

Potential savings



Conclutions

- Compression methods for uncomminuted energy wood worth of studying
  - Potential savings are remarkable (20-30 %, or even more)

- Commercial solutions not yet available, mainly because
  - New weight limits were launched just year ago => It takes time that development processes start among manufacturers
  - Potential is higher than manufacturers have expected

Remarks

This study was part of the BEST-program launched originally by FIBIC and CLEEN together. The program was funded by TEKES.