TECHNISCHE UNIVERSITÄT DRESDEN

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Lowland Cable Yarder in Four Different Process Variants

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DRESDEN concept
Exzellenz aus Wissenschaft und Kultur

Outline

- Background
- Specific description of the lowland cable yarder
- Study area
- Preliminary results of field studies
    - Ergonomics
    - Productivity
    - Machine costs
    - Catenary sag
- Outlook: Possible harvesting systems
- Summary

Background

- Forest on wet (T4) or watery land (T5) account for 12 % of European forest area
- Driving on those soils is not recommended due to irreversible soil disturbances or simply it‘s impossible
- The importance of those problematic sites will increase with shorter freezing periods and warmer winter
- In consequence, large forest areas will be taken out of management additionally

Approach

- Felling operations might be possible by motor-manual work or mechanized work with driving only once on the sites
- Yarding operations might be possible with cable yarders
- No cable yarding technology existing for short logs

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Machine Specification of Lowland Cable Yarder

- Yarding of short logs in bundles
- Hover transport of logs without touching the ground
- Acting without saddle trees up to 350 m

- Skyline up to 16.0 m height
- Mechanical dead-end tower

Picture: Engler, 2015

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Machine Specification of Lowland Cable Yarder

- Mechanical dead-end tower, of 16.0 m height
- Carriage with 2 winches with synthetic fiber ropes
- Easy choker system for stacks

Picture: Engler/ Pilz, 2015

Video

Study Area

	Lübben 1 Brandenburg, Germany		**Lübben 2 Brandenburg, Germany**		**Daubaner Wald Sachsen, Germany**
Tree species	*Pinus*		*Alnus*		*Pinus*
Cable lines	2		2		1
Max yarding distance [m]	$_{T2}$160	$_{T1}$180	$_{T1}$250	$_{T2}$320	220
Felling operations	Harvester		Chainsaw		Harvester
Log distribution (stack)	at cable line		between lines		at cable line
Methodology	Element time study		Time study; day notes		Time study; day notes

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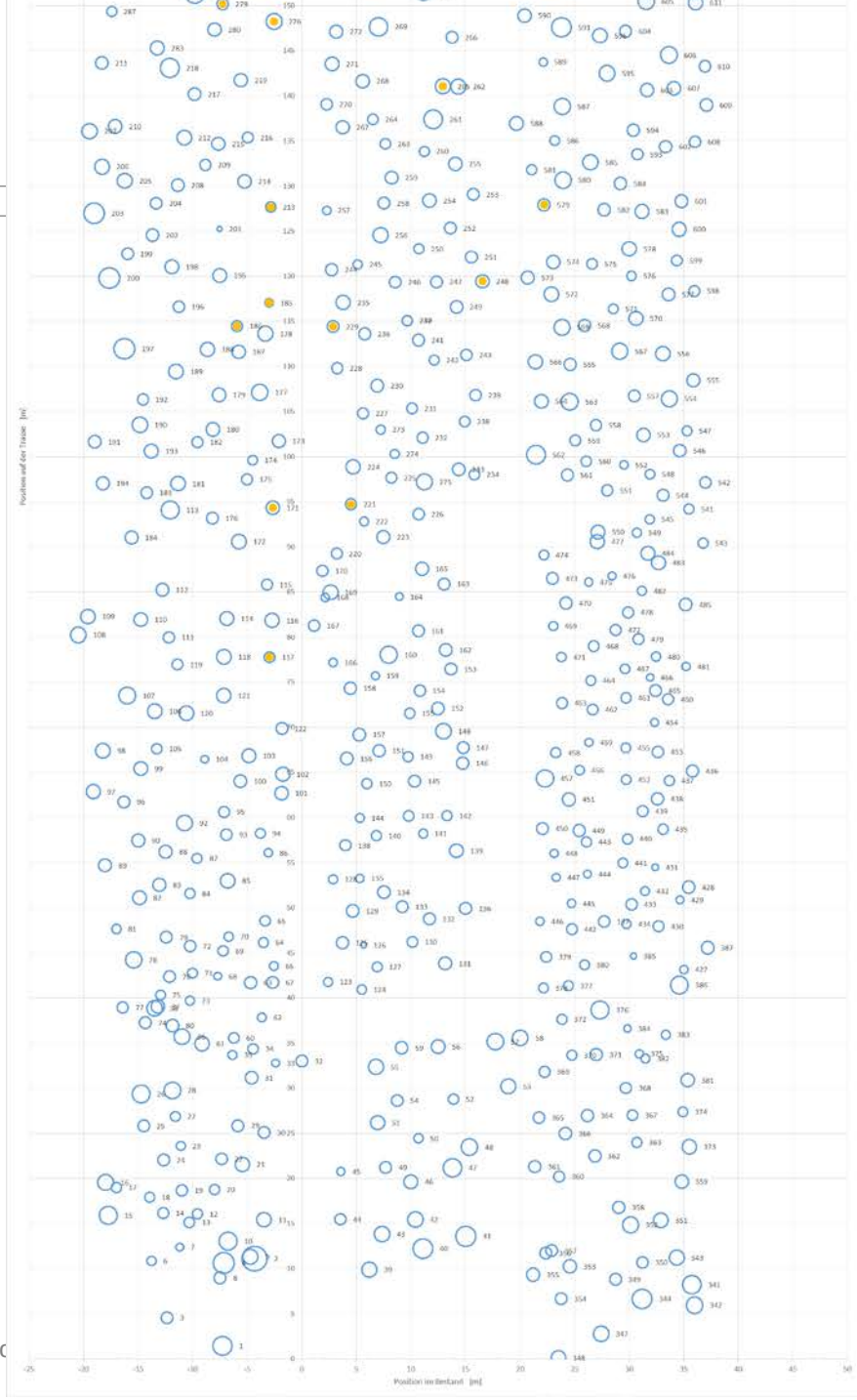
Methodology

- Single tree
  - Position: Distance; angle from cable line
  - DBH
  - Damage
- Traverse line of cable line
- Mean diameter and # of logs per stack

- Element time study



Pre-Results Ergonomics

- OWAS studies are currently running*
- First results tend to show short, but large stress levels
  - Approx. 80 % of low degree of stresses

    (1) straight back
    (1) both arms below shoulder level
    (2) standing on two straight legs
    (1) < 10 kg load

  - Approx. 20 % of high degree of stresses

    (2) or (4) bent or bent and twisted back
    (1) both arms below shoulder level
    (4) or (6) squatting or kneeling
    (2) 10 – 20 kg load

* Data from Pilz, 2015; Picture: Engler, 2015

Pre-Results Productivity, Only Yarding**

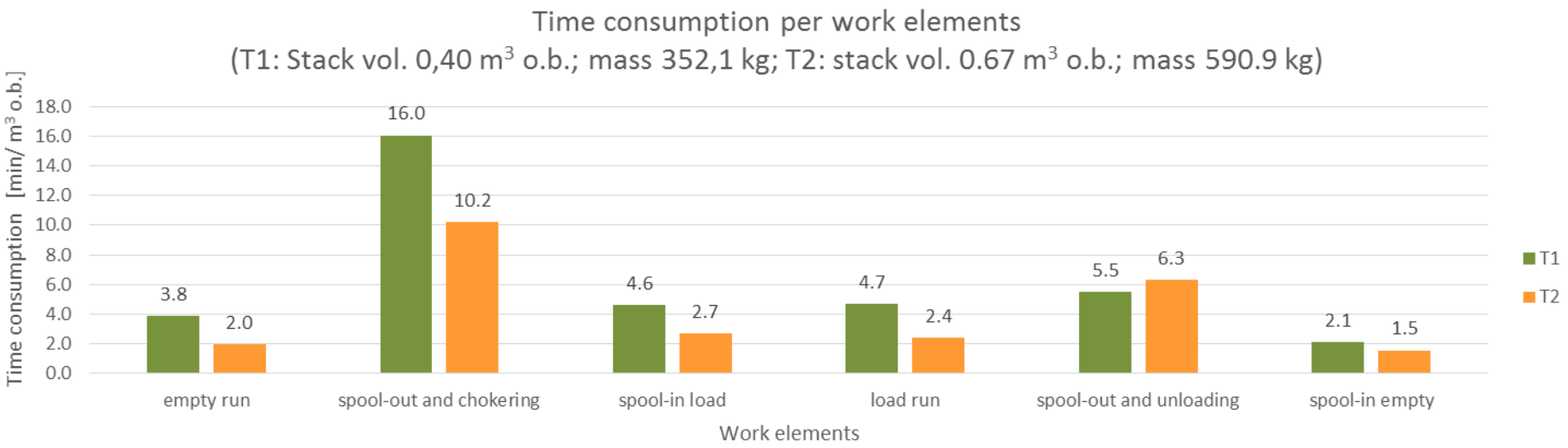
	Lübben 1 Brandenburg, Germany	Lübben 2 Brandenburg, Germany	Daubaner Wald Sachsen, Germany
# cycles	61	68	63
Max yarding distance [m]	$_{T2}$160 $_{T1}$180	$_{T1}$250 $_{T2}$320	220
Log diameter* [cm o.b.]	13.3	17.7	24.4
Log volume* [m^3]	0.0432	0.0778	0.1871
Volume/ cycle* [m^3/ cycle]	0.4304	0.5347	0.7853
Cycle time* [min/ cycle]	7.67	7.40	5.86
Productivity* [m^3/ pmh_0]	3.35	4.30	8.32

* arithmetic mean
Data Lübben 1: Engler, 2015

** logs were piled at cable line; lateral yarding was excluded from calculations
Data Lübben 2 and Daubaner Wald: Pilz, 2015

Time Demand for Elemets

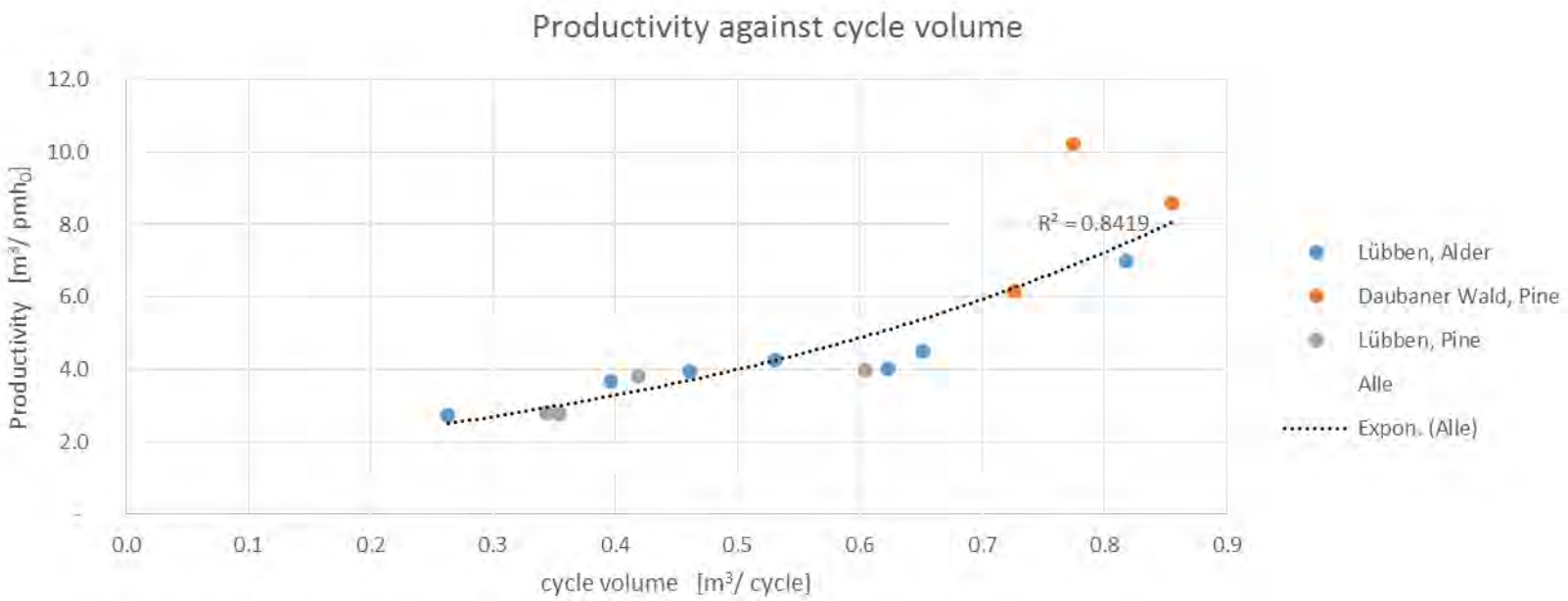
- Empty run shares 7.8 – 10.5 %, and load run shares 9.5 – 12.7 % of total productive time
- Spooling-out and chokering is time demanding, 40.7 – 43.6 %, – adequate stacks required
- Influence of driving distance on system productivity seems to be minor



Data Lübben 1: Engler, 2015

Cycle Volume and Productivity

- Carried volume per cycle is strongly correlated with productivity
- It seems to be a larger influence factor than yarding distance
- Max carrying capacity is 1 t, about 1 m^3



Data Lübben 1: Engler, 2015 Data Lübben 2 and Daubaner Wald: Pilz, 2015

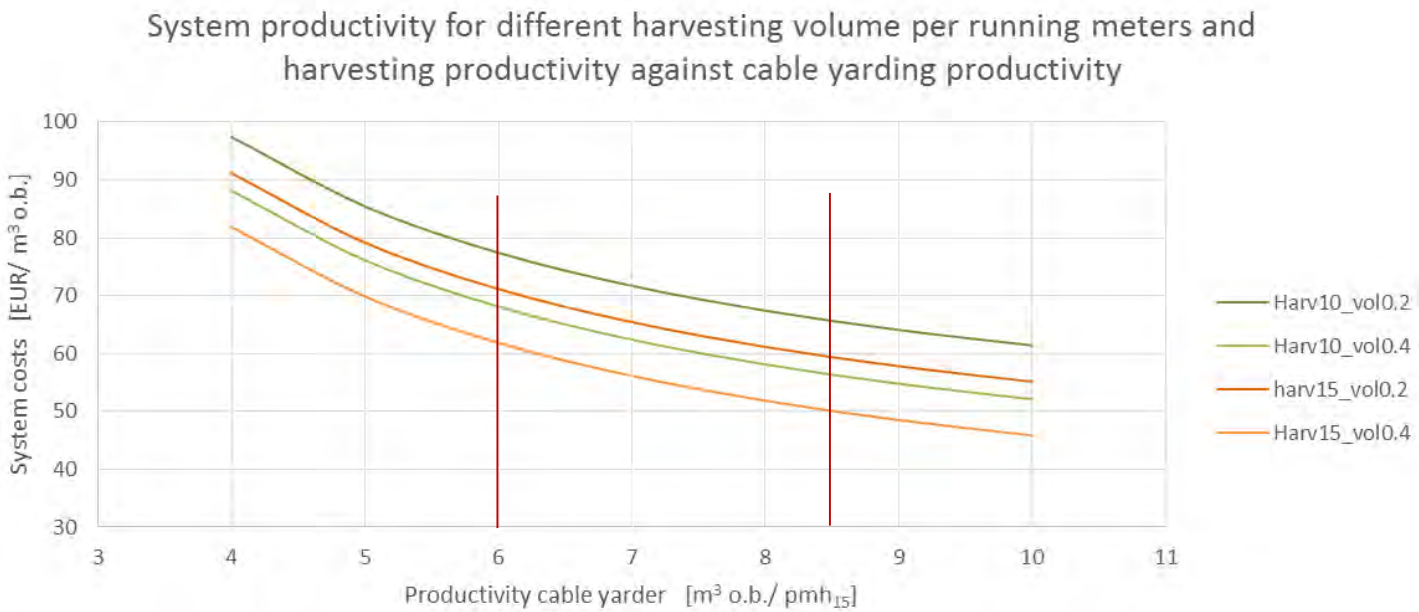
Pre-Cost Calculation

Description	
Acquisition costs	230,000 Euro
Amortization	17,000 pmh_{15} / 15 years
Fuel consumption	5 l/ pmh_{15}
Fuel costs	1.4 Euro/ l
Interest rate	8.0 %
Operator costs per person	31.0 Euro/ pmh_{15}
∑ Material costs	82.1 Euro/ pmh_{15}
∑ Personnel costs	62.0 Euro/ pmh_{15}
∑ Operation costs	144.1 Euro/ pmh_{15}

Cost calculation according to KWF

Pre-Cost Calculation

- System costs vary depending on
  - The productivity and cost of the harvester (188.1 EUR/ pmh_{15})
  - The productivity of the cable yarder itself
  - Volume of harvested biomass per running meter
- Costs in a range between 50.0 to 75.0 EUR/ m^3 o.b. seems to be realistic



Catenary Sag

- At the maximum catenary sag the distance to the ground was still approx. 15 m at a yarding distance of 180 m

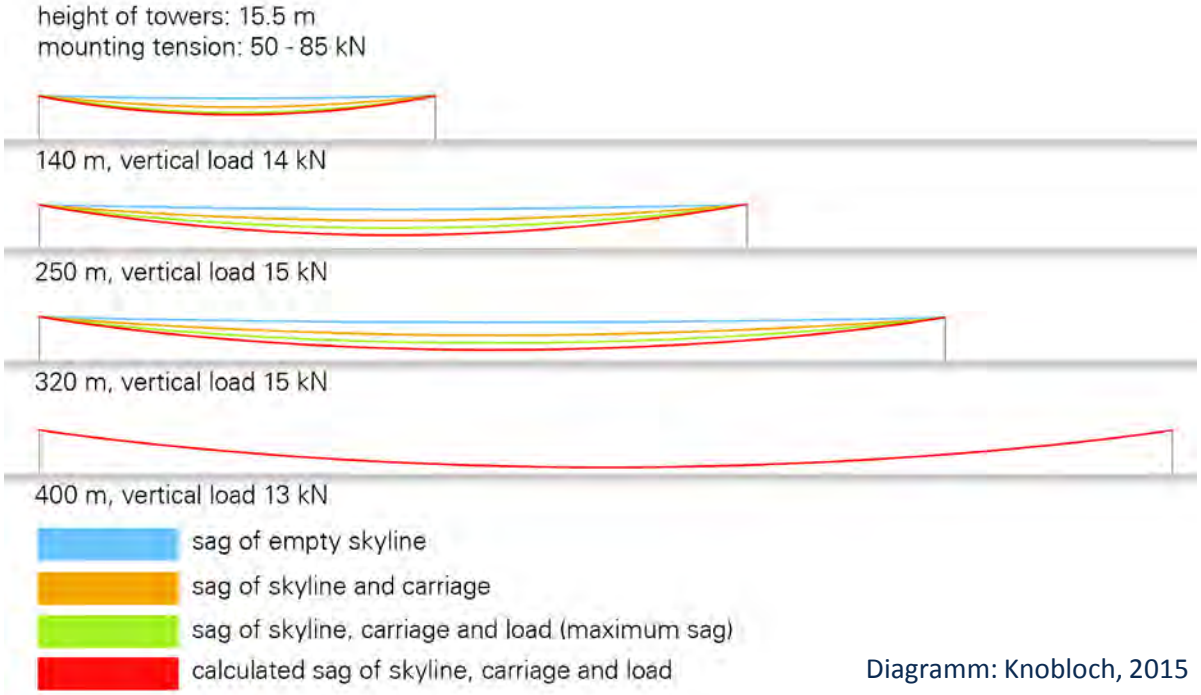
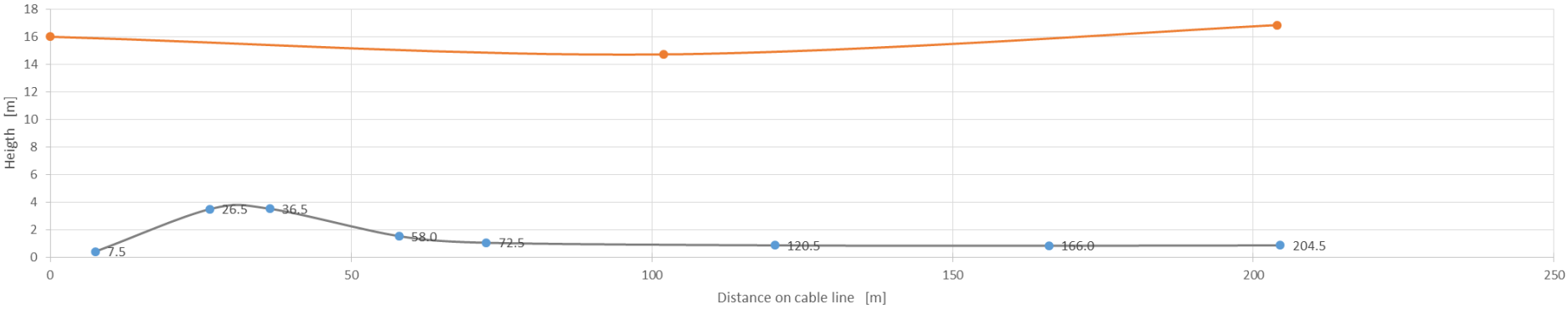


Diagramm: Knobloch, 2015



Outlook: Possible harvesting systems

stand characteristis

good for harvester | not for harvester

soil characteristics

T3: sensible, but in limits trafficable

T4 or T5: not trafficable

1 Processing: harvester Hauling: harvester Yarding: flat lift	2 Processing: Chainsaw Hauling: tractor Yarding: flat lift
4 Processing: portal harvester Hauling: portal harvester Yarding: flat lift	3 Processing: Chainsaw Hauling: flat lift Yarding: flat lift

Diagramm: Erler, 2015

Outlook

soil characteristics

T3: sensible, but in limits trafficable

T4 or T5: not trafficable

4 Processing: portal harvester
Hauling: portal harvester
Yarding: flat lift

3 Processing: Chainsaw
Hauling: flat lift
Yarding: flat lift

Diagramm: Erler, 2015

Summary

- The lowland cable yarder ‚flat lift‘ works fine (!)

- Technology enables forest work on forest land where access was prior impossible (or only with irreversible damage)

- Soil damages are limited to a minimum
- Avoiding of tree damages by short logs
- Yarding can be combined with standard harvester processing, due to short logs
- Short log yarding is in line with forest certification schemes

- Productivity is in range of 5 – 8 m^3/ pmh_0
- Costs range about 50.0 to 75.0 EUR/ pmh_{15} incl. setting up and dismounting the towers and the skyline

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References