Measurement of wood energy assortments in Sweden

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Increasing consumption of wood energy assortments – now approx 10 milj m^3 per year

Roundwood **Small trees** **Tops and branches**

~~*Logging residues*~~

A new measurement law in 2015

- Will include all assortments, also energy, but only when sold from the forest owner.
- Only ”evaluated” methods and equipment may be used
- Measuring companies must have internal control and show that accuracy requirements are fulfilled

This triggers more focus on the development of techniques and methods for measurement of energy assortments

Organisation of timber measurement in Sweden

Government – Timber Measurement Act

↓

National Board of Forestry – measurement regulations

Operational organisations (private sector)

National board of sellers and buyers

SDC — Timber accountancy

Regional boards of sellers and buyers

Syd
Qbera
Nord — Timber measurement associations

Two of SDCs departments

Control of timber measurement (VMK)
- Monitors the quality of timber measurement
- Authorises of timber measurement companies
- Approves measurement equipment

Development of timber measurement (VMU)
- Development projects of national interest
- Measurement instructions

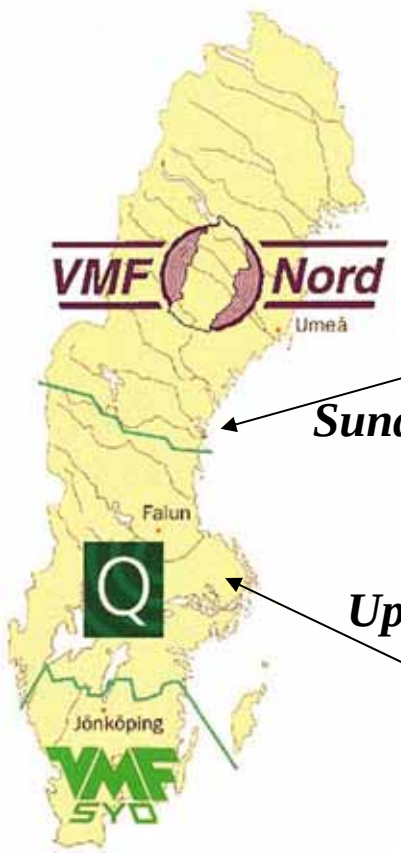
Organisation of wood measurement in Sweden

Three regional Timber Measurement Associations

VMF Nord
Umeå
280 Employees

VMF Qbera
Falun
375 Employees

VMF Syd
Jönköping
315 Employees



Four closely collaborating, private, non-profit companies.

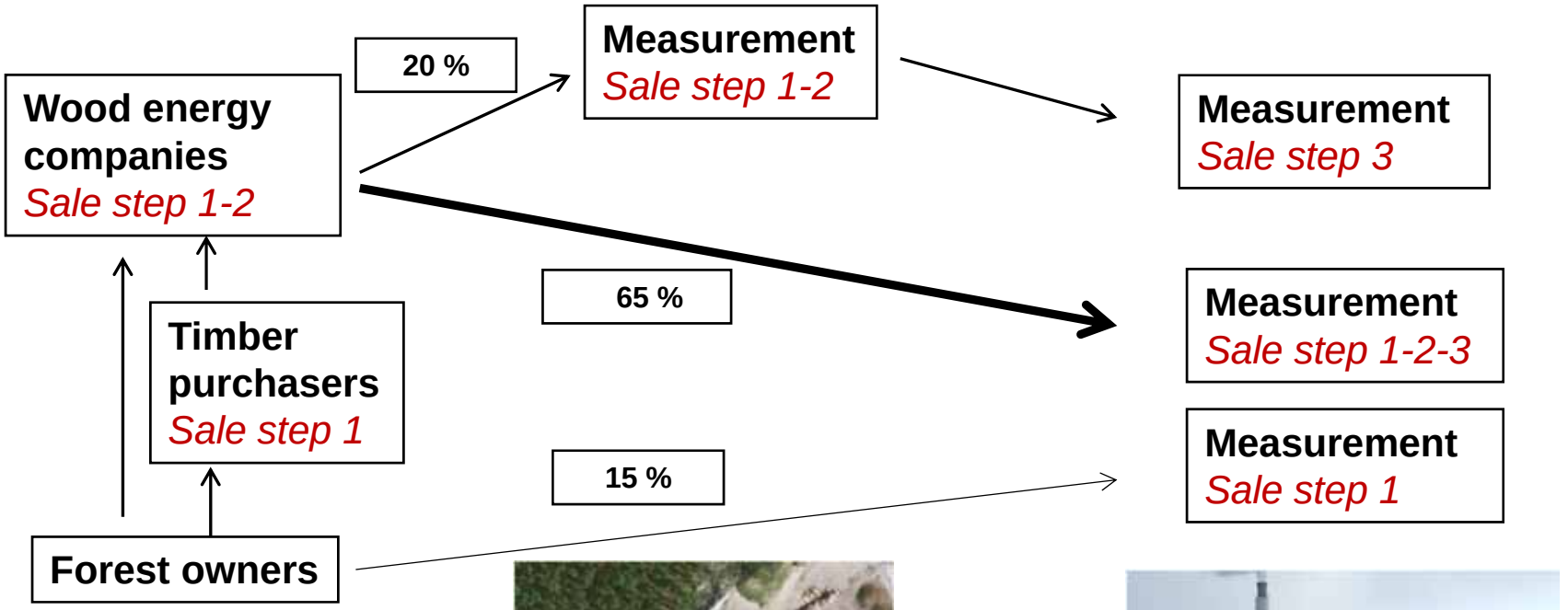
SDC – the IT company for the Swedish forestry sector, 115 employees

VMU and VMK, two of SDC´s departments

Wood energy from the forest
Approx 10 milj m³

Wood energy terminals
Approx 250

Consumers
100-200 heating plants, 20-30 pulp mills etc



Assortments / measurement method / trading units

Roundwood

Pile measure-ment (stack measurement)	*Weight + conv.factor*
m^3sub	**m^3sub**

Small trees, tops and branches, recycled wood

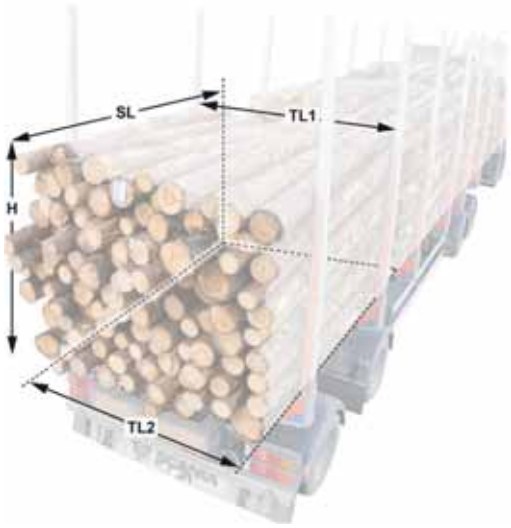
Weight	*Weight + moisture content from chipped sample piles*
ton	**Dry ton or MWh**

Chipped materials

Loose volume	*Weight + moisture content*
m^3loose	**Dry ton or MWh**

Most roundwood for energy is measured as manual measurement of piles on trucks

Volume under bark: Length x Width x Height x Estimated wood volume percent



Four alternatives:

1. Timber Measurement Association at ”equipped” measurement station
2. Remote measurement using cameras
3. Measurement by truck drivers
4. Weight scaling, conversion to volume

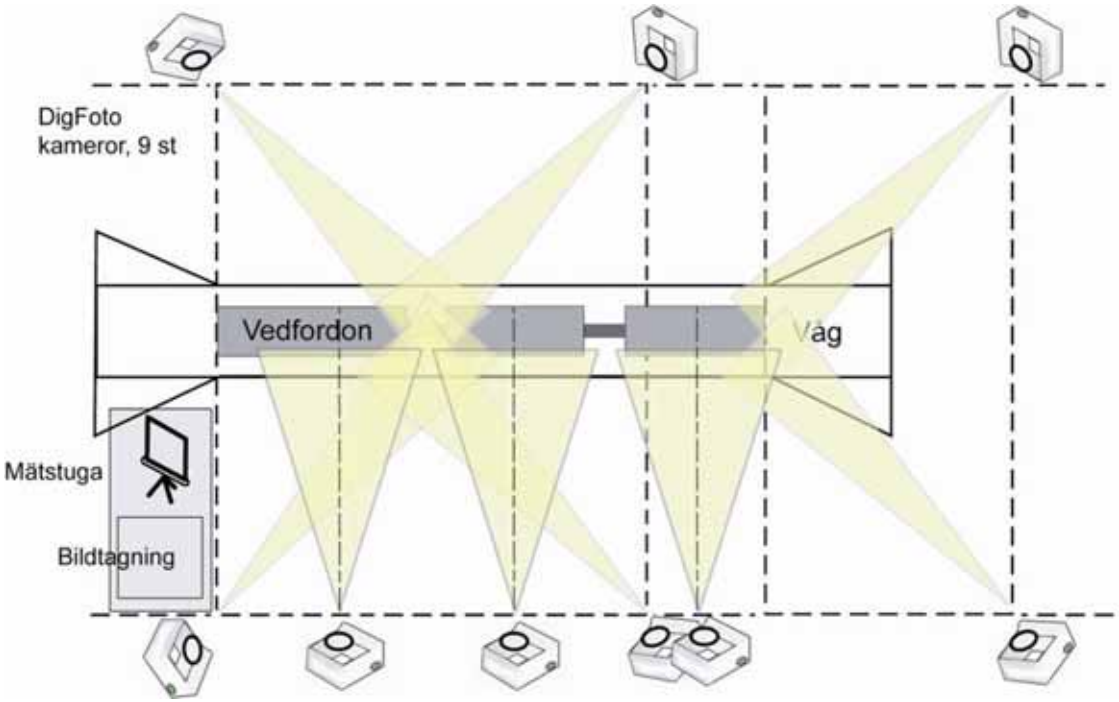
Control (check scaling) of pile measurement is done as log-by-log measurement

Remote measurement using cameras – installation at SCA's terminal in Sundsvall

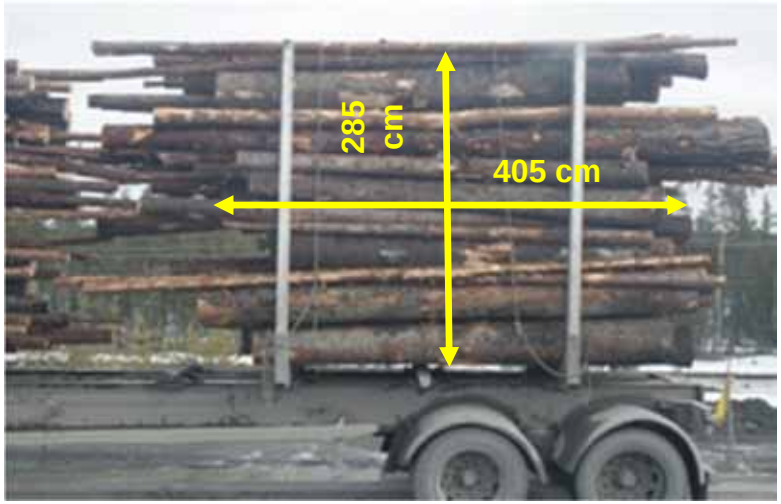
- Cameras for measurement of log length and pile height
- Cameras to see end faces of the piles, for id-marking, quality etc

All cameras can be used to determine solid volume percent, species etc

Remote measurement – example with nine cameras



Three cameras for height and log length.



Six cameras for pile end faces. Used for estimation of wood volume percentage, rot, marking etc.

The driver and the scaler

The driver

All photos displayed on a screen.

The driver approves quality of the photos.

He is informed if there is a sample for log-by-log measurement.

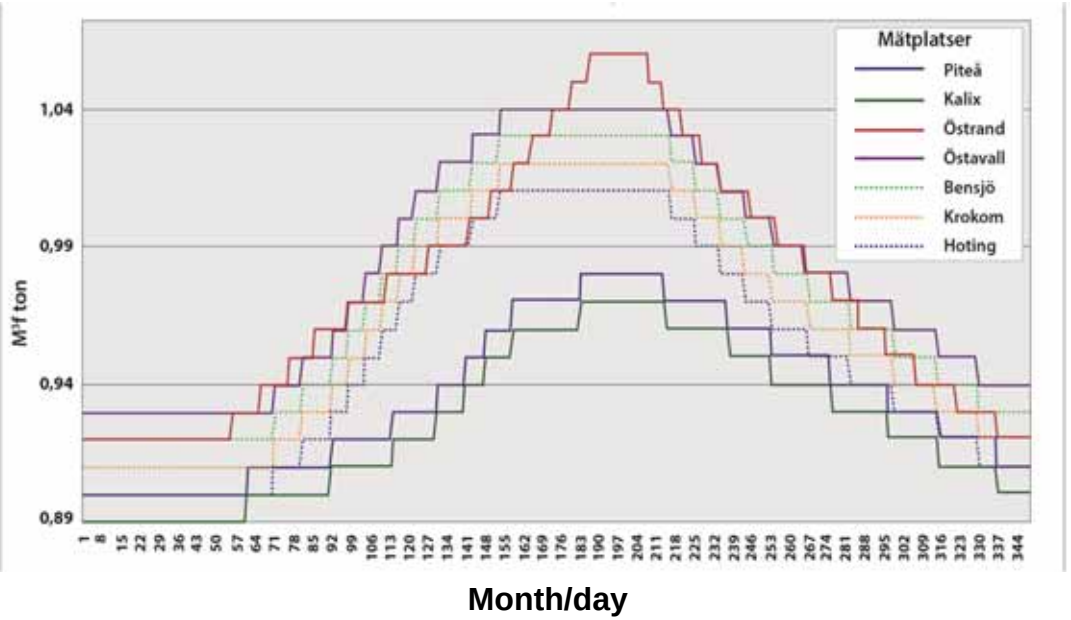
The scaler

Measurement on the screen.

Can be done from another place or at another time.

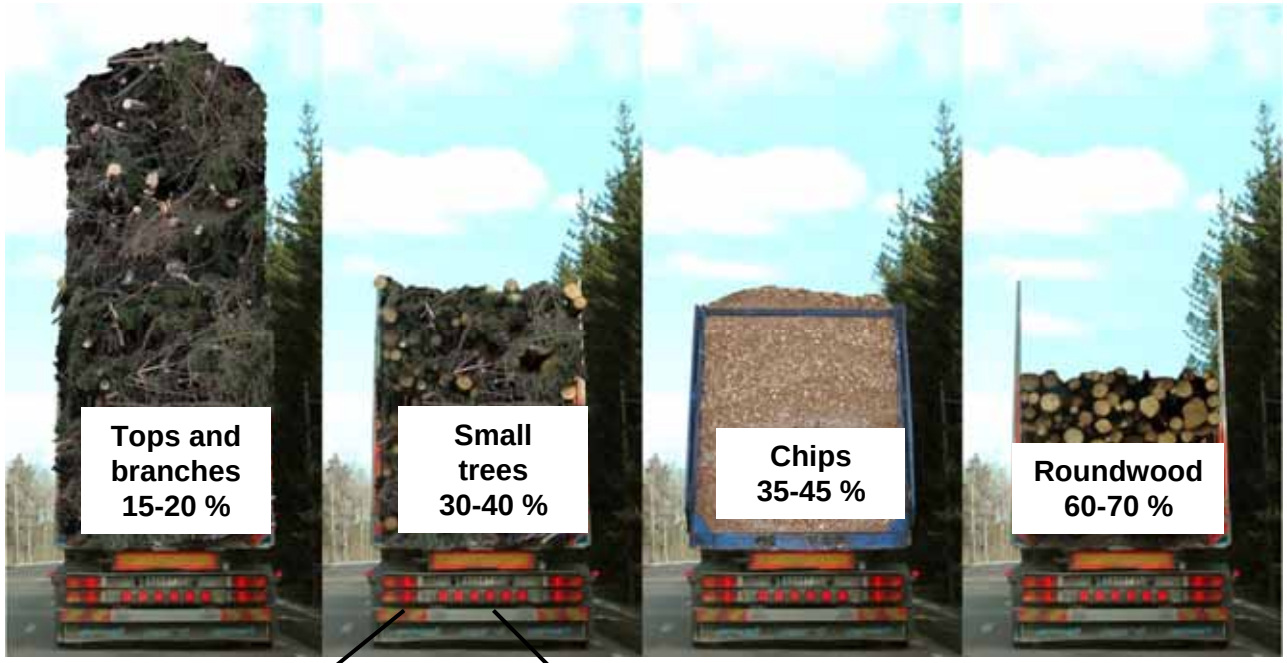
Measurement by truck drivers

Daily conversion factors weight/volume, So far only used for pulpwood



Both alternatives often less accurate compared to trained scalers

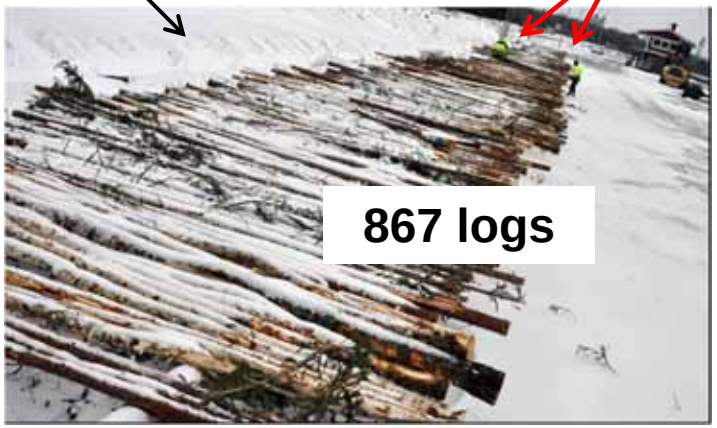
- Roundwood: solid volume
- Chips: loose volume
- Small trees or tops and branches: no volume



Pile measurement

Control measurement

Two scalers!



Energy assortments – we need weight scaling - always and everywhere

We need to follow Finland and North America

Photo © LoadMaster, Cool-ManOy

Photo © TamtronOy

Photo © John Deere Oy

Photo © PonsseOy

FPInnovations
FERIC

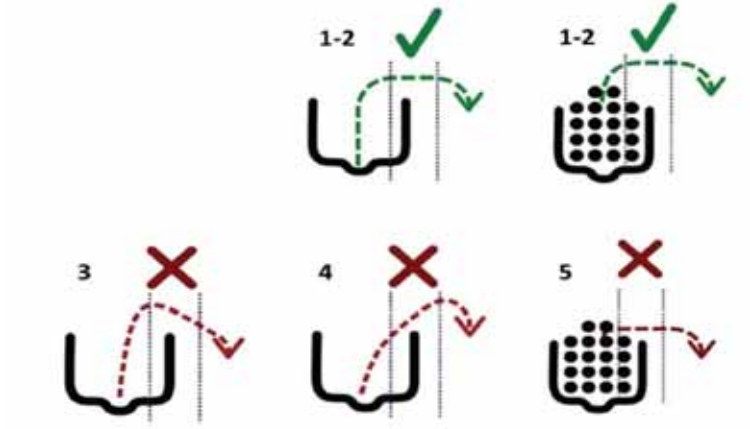
Accuracy of Log Truck Onboard Weigh Scales

Peter Dyson

Weight scaling – ongoing studies in Sweden

Grapple weighing in forwarders or timber trucks

Influence of the operator?



Dynamic weighing

Sensitivity tests

Purchase of tops and branches by dry tons. Guesstimate of moisture content using cameras, chipped samples for MC determination

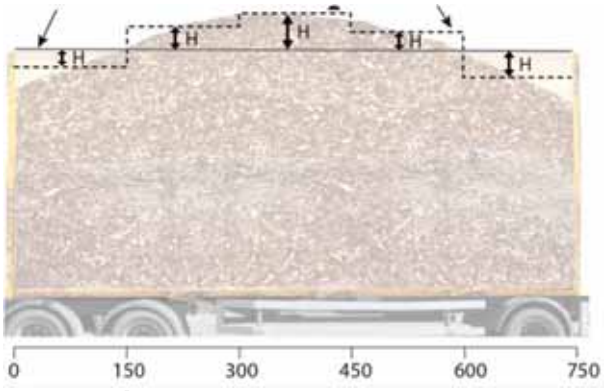
Chipped forest fuel

- Roundwood
- Whole trees
- Tops and branches
- Stumps
- Energy forest
- Bark
- Saw dust
- Recycled wood

Which trading unit? Volume (m^3 loose volume in containers) or dry tons or energy content (MWh)?

Measured when delivered in containers on trucks or railroad

Measurement of loose volume might be phased out and replaced by dry tons



Today´s manual measurement. Height per section.

Problems

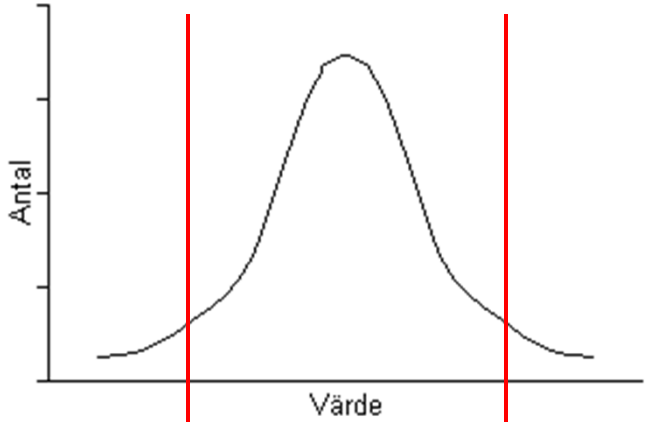
- Easy measurement but difficult to perform controls
- A trading unit that depends on:
  1. Transport distance
  2. Chipping equipment

Control: Laser measurement at many points

Dry tons or MWh requires determination of moisture content

Which measurement accuracy will we have given prerequisites like:

- Sampling method
- Number of samples
- Size of a sample
- Assortment
- Chipping equipment
- Method when loading/transporting
- Season (time of the year)



Measurement accuracy a result of statistical analyses

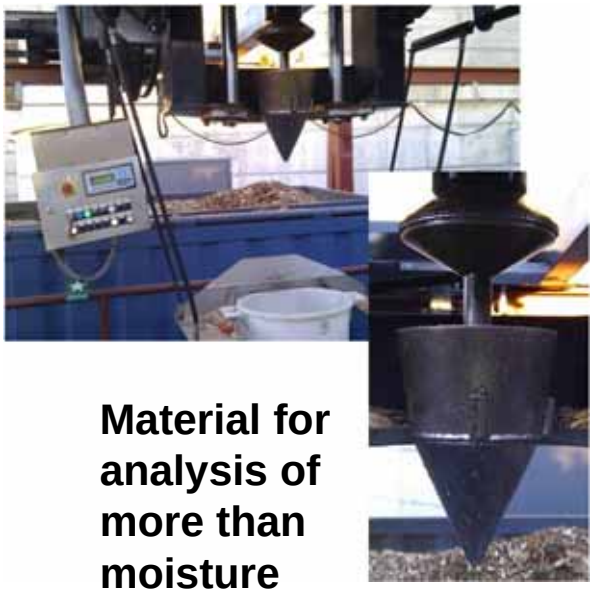
Sampling for moisture content - the key to dry tons or MWh

Manual sampling at scaling station

Near Infra Red NIR probe

Result directly

Mechanical probe



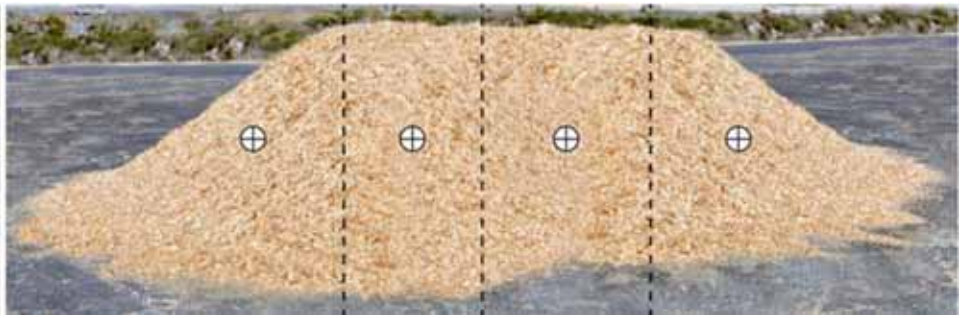
Material for analysis of more than moisture

or after off-loading

Manual sampling most common

Manual sampling at a measurement station. Use a correct shovel.

Sampling after off-loading. Commonly done by the drivers, or by the personnel at the heating plants.



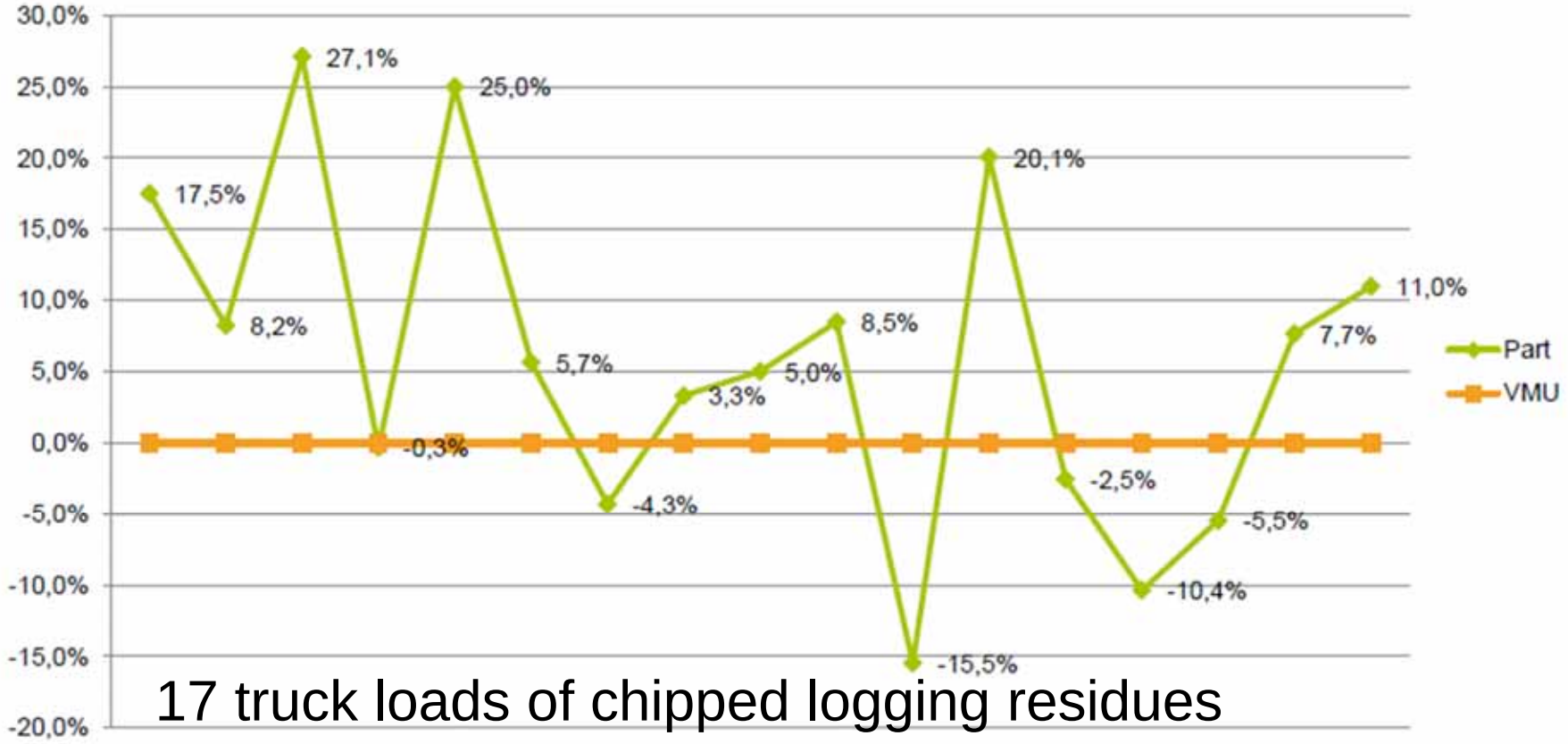
An example of a field laboratory for MC-analyses

- A mobile container with drying ovens
- Installed at a couple of small measurement stations

Example on the result of bad samling

- VMU = 20 well distributed MC samples
- Part = sampling by the driver

Deviation in quantity (dry tons)



17 truck loads of chipped logging residues

Measurement accuracy (dry weight) for a contract, given a certain sampling, chipped logging residues

Number of sampled trucks	Samples per truck		Number of trucks in the same contract				
		container	1	2	5	10	20
		Mean error for the contract %					
1	3	4,5	5,5	7,1	7,9	8,1	8,3
	6	3,4	4,1	6,1	7,0	7,3	7,4
	10	2,9	3,4	5,6	6,6	6,9	7,1
2	3	-	-	3,9	5,2	5,6	5,8
	6	-	-	2,9	4,5	4,9	5,1
	10	-	-	2,4	4,2	4,7	4,9
5	3	-	-	-	2,4	3,2	3,5
	6	-	-	-	1,8	2,7	3,1
	10	-	-	-	1,5	2,5	2,9
10	3	-	-	-	-	1,7	2,2
	6	-	-	-	-	1,3	1,9
	10	-	-	-	-	1,1	1,8
20	3	-	-	-	-	-	1,2
	6	-	-	-	-	-	0,9
	10	-	-	-	-	-	0,7
			will not fulfill accuracy demands				
			will fulfill accuracy demands with 95 % probability				
			will fulfill accuracy demands with 99 % probability				

Measurement of chipped materials four ”scenarios”

Loose volume
m^3loose

Big station
- Measurement bridge
- Control on site
- Quality can be assessed

Small site without facilities
- ”Measure” when loading
- Pass control site when sampled
- No quality assessment

Weight + moisture content
Dry tons or MWh

Big station with MC-equipment
Alt. for MC sampling:
1. NIR probe
2. Mechanical probe
3. Measurement bridge

Other equipment:
- Lab for MC samples
- Weight scale

Small site without facilities
- MC samples after off - loading
- Samples transported to MC-lab
- Weighing using crane or in-built load cells

Basic demands for loose volume
- ”Pre-measured” containers
- Control using special equipment

Basic demands for weight + MC content
- Approved weighing
- Control MC samples after off-loading

The future,

Well, in 1984 the Swedish Timber Measurement Council declared:

”*All energy assortments should be measured and traded based on their dry weight*”

That might come in the future!

Pulpwood or roundwood for energy: Two main areas for development

Measurement in photos

Krokom

Should be cheaper

Small measurement stations can be open 24/7

Automatic measurement - Mabema

Braviken

Should be better and quicker

Big measurement stations, maybe also for sawlogs

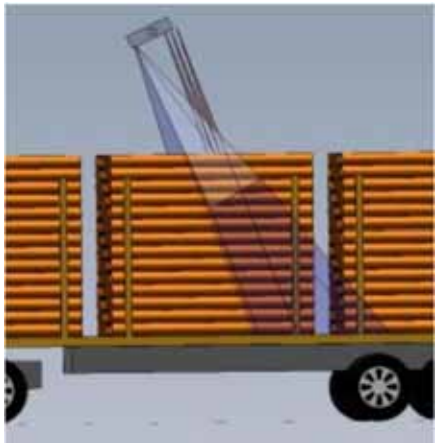
Finland has Modus and AVM-stations

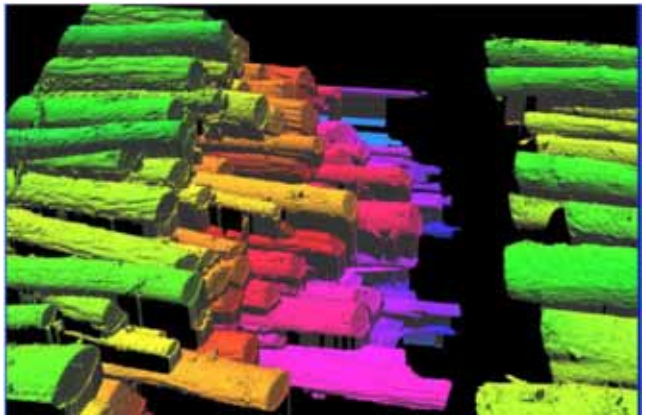
Automatic measurement of piles on trucks

- **Laser triangulation (like in a log scanner)**
- **Developed by Mabema in Linköping**

Our biggest development project

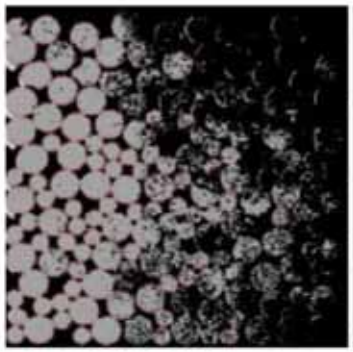
Laser triangulation for solid volume



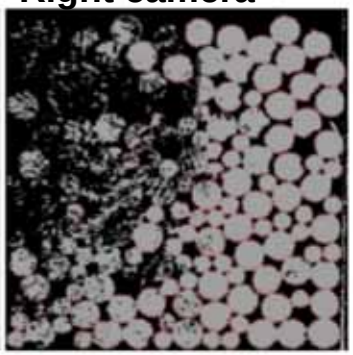


Cameras from three sides and from a certain angle for description of pile end face. In total six sets of cameras and lasers.

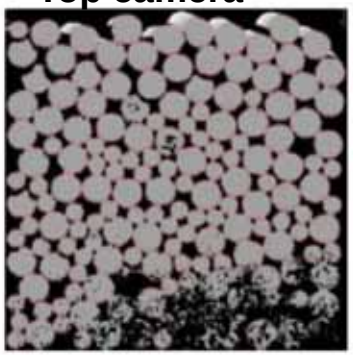
Left camera



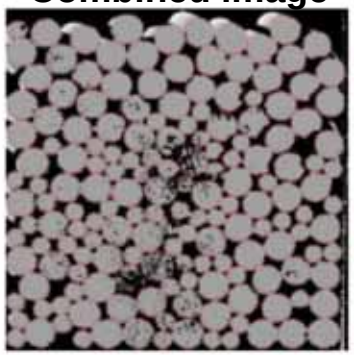
Right camera



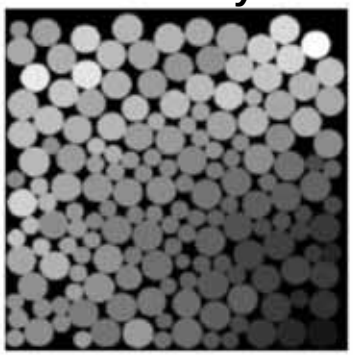
Top camera



Combined image



After analysis



Accuracy goal: standard deviation per pile < 6 %

The situation in 5-10 years?

Measurement in photos

- Many of the smaller measurement stations, incl wood energy terminals
- Also at bigger measurement stations for prolonged opening hours

Automatic pile measurement

- Many of the pulpmills
- Some sawmills (eg mills sawing standard lengths)

The four alternativs to measure wood volume under bark

TMA at ”equipped” measurement station

Positive	*Negative*
Well trained personnel	High cost
Can be TMA	Limited opening hours

Remote measurement using cameras

Positive	*Negative*
Well trained personnel	Risk for slightly reduced accuracy
Low cost	Width of truck (pile length) cannot be measured
Can be TMA	
Flexible opening hours, can be 24/7	

Measurement by truck drivers

Positive	*Negative*
Low cost	Less accurate
No need for meas.station	Individual differences
	Difficult to organise control

Weight scaling, conversion to volume

Positive	*Negative*
Weight ”for free” when loading	Low accuracy for conversion factors
	Much log-by-log measurement for conversion accuracy and/or controll
	Lack of control procedures for crane weight

Moisture content measurement with NIR-probe

The probe can be freely positioned within the container

Five installations in Sweden - more will probably follow

Mechanical probe for MC-sampling

- Three (old) installations in Sweden
- Press down to wanted depth, filled when turning back