



Workshop
on National Wood Resource
Balances
30th March – 1st April 2008



Conversion factors

**A necessity for an accurate estimation
of wood consumption by industries**

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Existing conversion factors

Conversion factors are necessary for estimation of wood inputted in industrial processes used for wood final products (sawn timber, pulp and panels, processed wood fuel).

Conversion factors yet exists but:

- **There is important variations from a country to another**
- **Variations inside countries and processes**
- **Use of existing conversion factors leads to under estimate industrial wood consumption Need of improvement of existing conversion factors by country and process, defined with verified data**

Page : 2



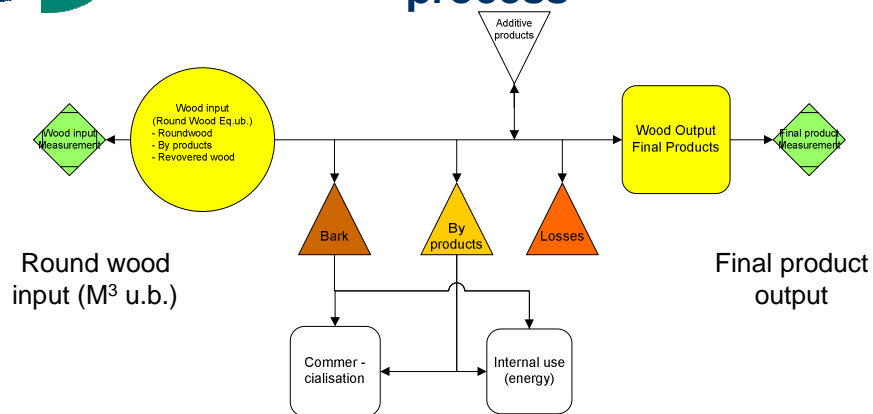
Compilation of existing conversion factors

		FAO 1979	EFSOS 2000	M.Fonseca (p.c.) 2005	EPF 2008	Finland (p.c.)	France (p.c.)
wood	Softwood	1.32 - 2.39	1.42 - 2.1	1.99		1.83	1.5 - 1.9
	Hardwood	1.44 - 2.55	1.4 - 3.52	1.95		2.32	1.7 - 2.30
er/Ply	Veneer		1.2 - 3.1	1.59			
	Plywood	1.63 - 2.94	1.5 - 3.1	2.02		1.8 - 1.9	
is	Particle board	1.1 - 2.2	1.2 - 1.8	1.32	1.53		1.2
	OSB			1.7	2.07		1.5
	Hardboard	1.98 - 3.01		2.16			
	MDF		1.5 - 3.3	1.73	1.86		1.9
	Insulation board	0.63 - 0.91		0.66			
Mechanical	Mechanical	2.4 - 3.27	2.16 - 2.9	2.68		2.72 - 3.18	2.4
	Semi mechanical	2.04 - 3.30	2.2 - 3.2	2.78		2.5 - 3.26	2.6
Sulfate	Sulfate	3.68 - 5.64		4.9		4.26 - 4.73	4.6
	Sulfite	4.65 - 6.24	4.48 - 6.4				4.6

Page : 3



Typical flow of an industrial wood process



$$\text{Conversion factor} = \frac{\text{Roundwood input u.b.}}{\text{Finalproductoutput}}$$

Round wood input u.b. = cubic meter under bark equivalent to round wood
Final product output = unit depends on product and process

Page : 4



Definitions

Round wood inputs

Product outputs

What ?	
<ul style="list-style-type: none"> • Round wood • Chips • Recovered wood 	<ul style="list-style-type: none"> • Final product • By-products
How ?	
<ul style="list-style-type: none"> • Volume over bark • Volume under bark • Fresh weight • Air dry weight 	<ul style="list-style-type: none"> • Volume • Surface • Air dry weight • Absolute dry weight
Where ?	
<ul style="list-style-type: none"> • In forest • At road side • On mill yard • At the entrance of the process 	<ul style="list-style-type: none"> • At mill

Page : 5



Units

Final product : cubic meter
square meter
tonnes

Input wood : cubic meter over bark/under bark (saw log)
green tonnes, air dry tonnes (pulp wood,
chips, recovered wood)

**Construction of a conversion matrix for transformation
of different wood measurements into others :**

- Bark factor
- Humidity
- Dryness
- Specific gravity

Page : 6



Conversions factors between units of measurements

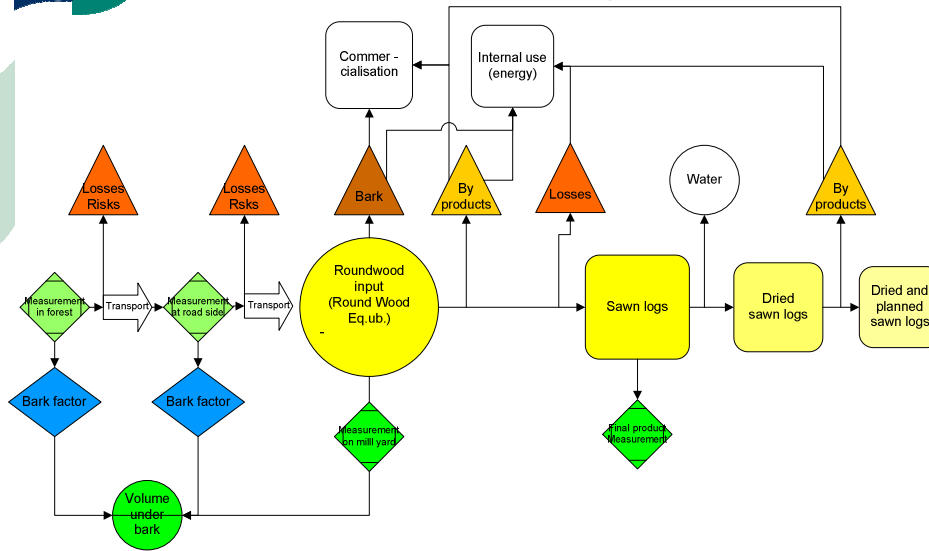
Construction of a conversion matrix for
transformation of different wood
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Page : 7



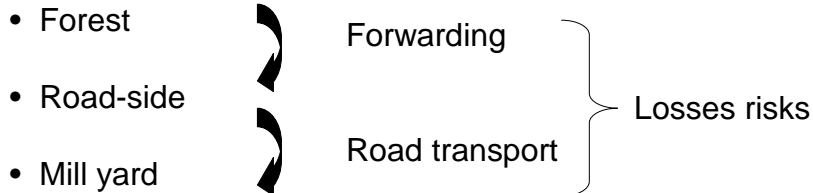
Saw mill industry



Page : 8



Location of logs volume measurement



Losses risks due to :

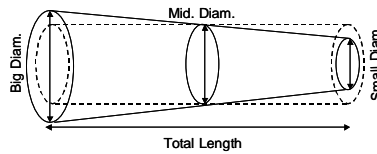
- logs forgotten in forest or at road side
- slashing for cull elimination

Page : 9



Logs volume measurement

Log is assumed as a cylinder

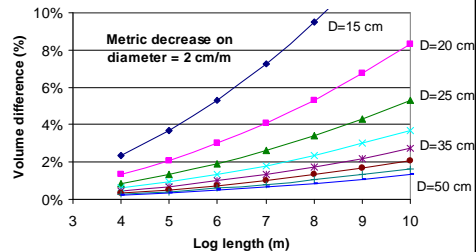
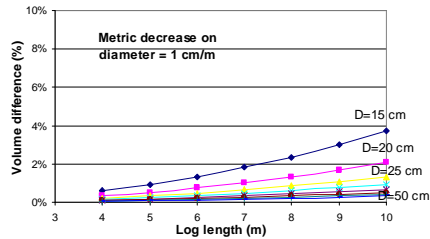


Cylinder volume \leq log volume

$$\text{Difference} = \frac{\text{length} \times (\text{big diam} - \text{small diam})^2}{12}$$

Page : 10

Logs volume measurement



Difference increases with :

- Log length
- Difference between big and small diameter

Log volume measurement

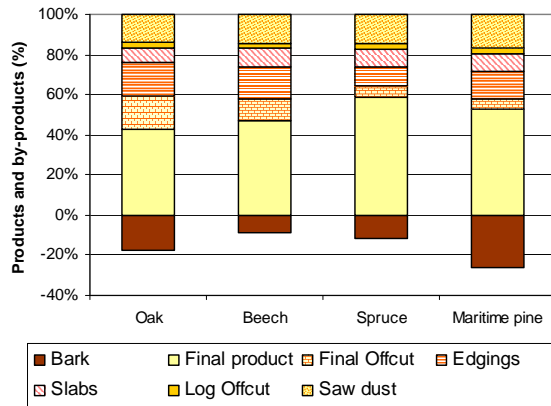
Due to different specifications of the saw mill, the log volume measurement can lead to an under evaluation of volume.

Example of some French and German sawmills :

- Length is rounded to the 1m or 50cm inferior
- Diameter is rounded to the 1cm or 2cm inferior

These rounding leads to an under estimation of **3 to 5 %** of the real volume.

Recovery rate : Species variations



- Large variation of recovery rate due to quality degree asked to final product
- Bark factor varies between species

Log volume measurement Bark volume

Log volume can be measured over or under bark.

A bark factor must be applied on log volume over bark.

Bark factor depends mainly on :

- species
- log size

	DBH Diameter		
	Ø ≤ 20 cm	Ø 25-35 cm	Ø > 40 cm
Oak	19 %	14,5 %	13 %
Beech	10 %	6 %	5,5 %
Norway spruce	15 %	12 %	9 %
Douglas fir	16 %	14 %	13 %
Maritime pine	27 %	23 %	23 %



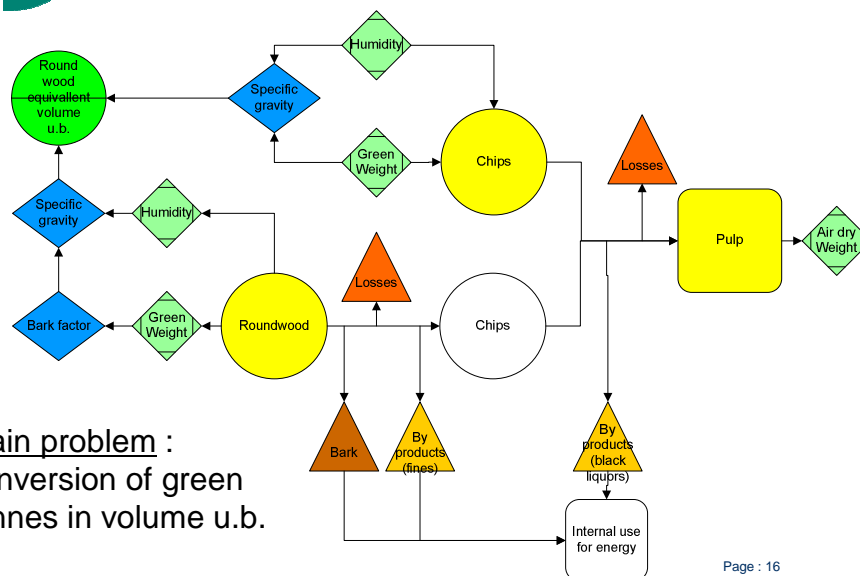
Volume measurement of sawn timber

- Rough sawn timber
- Dried sawn timber : shrinkage can induce 15 to 25 % of volume reduction
- Planning and surfacing : can induce 5 to 10 % of volume reduction

Page : 15



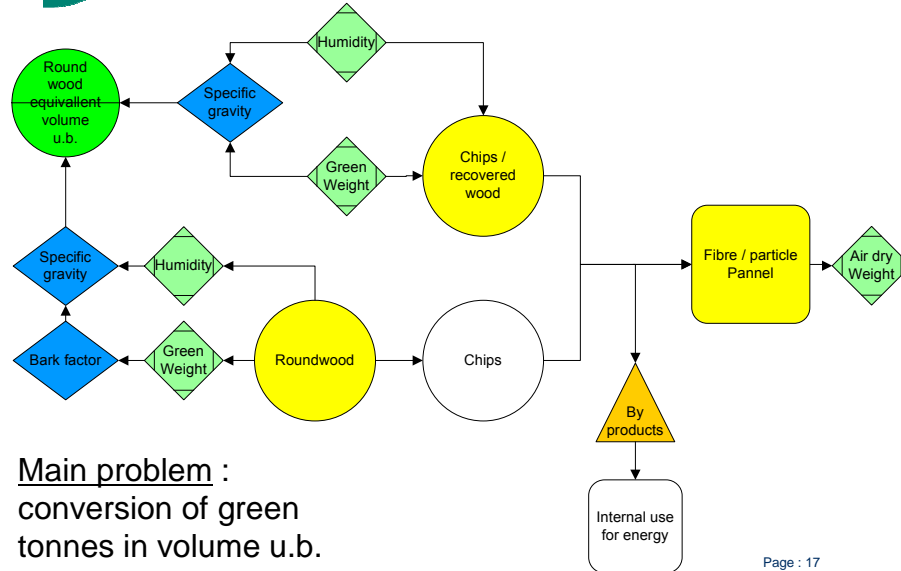
Pulp industry



Main problem :
conversion of green
tonnes in volume u.b.

Page : 16

Fibre/Particle Panel industry



Pulp wood measurement

Measurement realised

- fresh weight of round wood over bark
- fresh weight of chips
- air dry weight of pulp

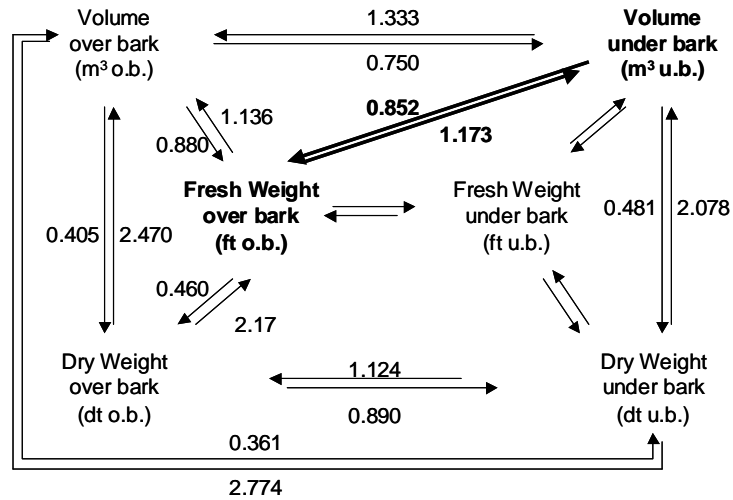
Needed values of inputted wood

- Volume under bark

Necessity of conversion factors for conversion of fresh weight measurement in volume u.b. ⇒

$$\frac{\text{fresh weight} \times \text{dryness} \times \text{bark factor}}{\text{wood density}}$$

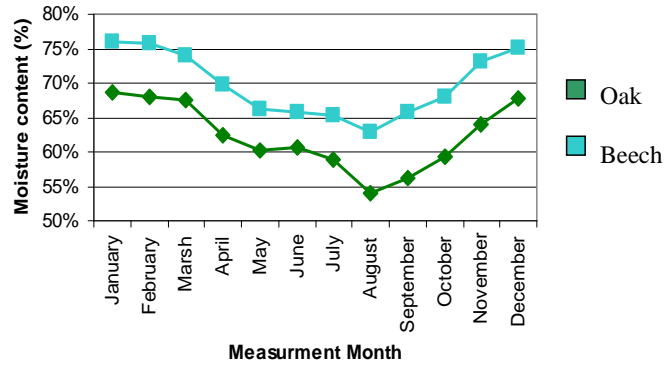
Matrix conversion factor Maritime pine example



Pulp wood measurement

- Dryness = $\frac{\text{Dry weight}}{\text{Green weight}}$
- Humidity = $\frac{\text{Water content}}{\text{Dry weight}}$
- Bark factor = $\frac{\text{Volume o.b.} - \text{Volume u.b.}}{\text{Volume o.b.}}$
- Seasonal variations
- Great variability inside a short log
- Species variations

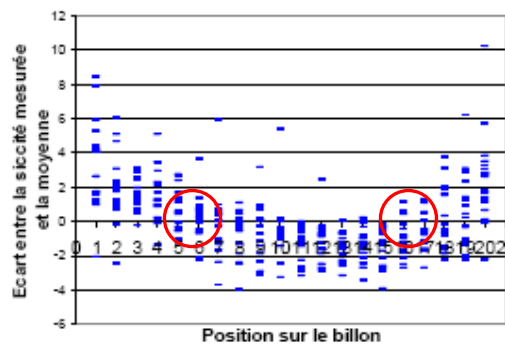
Pulp wood measurement Humidity variation



Seasonal variations of green tonne \Rightarrow necessity of association of humidity measure to weight measure

Pulp wood measurement

Difference of dryness between the point of sampling and the mean dryness of the short log.



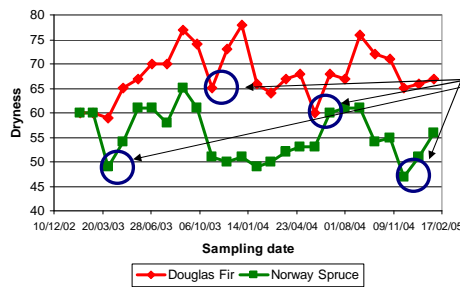
Mean dryness is best estimated when sampling is made at about 50cm from the end of the log.



Pulp wood measurement

Number of samples by truck load for a given precision rate

Log length	1 %	2 %	3 %	5 %	10 %	15 %
2 m	128	32	14	5	2	1
4 m	189	48	21	8	2	1



Page : 23



Proposition for conversion factor improvement

Accurate conversion factors must be calculated with accurate data :

We need :

- Data knowledge / Process knowledge
- Accurate volume measurement and conversion in volume u.b.
- Weight measure and accurate conversion in volume u.b.
- Work level : country and process

Page : 24



Data knowledge

- Inputted wood volume
 - Measurement procedure
 - Unit
 - Object
 - Procedure of calculation of equivalent round wood under bark (measures used, bark factor, volume calculation formula)
- Output quantities of final product
 - Object
 - Characteristics
 - Unit

Page : 25



Volume measurement Sawing / veneer industry

- Quantify the difference between volume measured u.b. and real volume u.b.
- Real bark factor at mill yard
- Verify that final product measurement is raw sawn timber

Page : 26



Weight measurement Pulp / fibre and particle panel industry

- Matrix of conversion between green/rough tonne to round wood equivalent volume u.b. by species, country and type of wood
- Real bark factor at mill yard
- Specific gravity
- Mean annual humidity or monthly mean humidity

Page : 27



All industries

- Loss analysis and estimation
- By products generation
- By products utilisation (energy, pulp and panel industry)

Panel industry (and processed wood fuel)

- Bark content in final products

Page : 28