

Prediction of Paper for Recycling quality on a regional level by using fibre flow models

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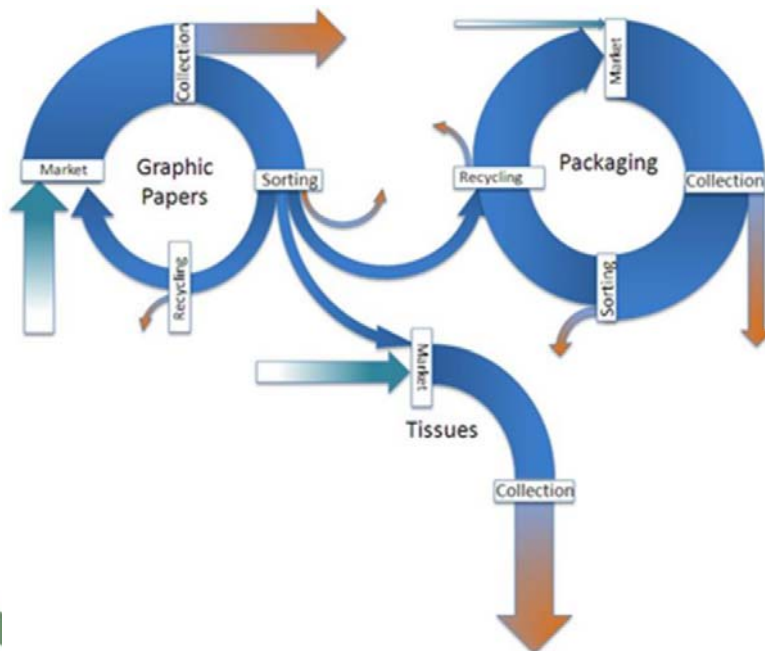
Workshop on 3rd of November
2015, Munich, Germany

Outline

1. Why dealing with fibre flows? What is your benefit?
2. Specialities of European regions
3. How a (regional) fibre flow looks like?
4. Current situation in the Central European region
5. Future development of fibre flow
6. Summary

1. Why dealing with fibre flows? What is your benefit?

Fibre Flow Model



- A mass balance of all paper product, paper for recycling and virgin pulp mass flows
- Can be established over various time and areal scales (from mill scale up to global scale)
- Major challenge for building up a fibre flow: to take recycling loops into account

Source: Robert J-F. "French graphic paper EPR: an incentive to eco-design"

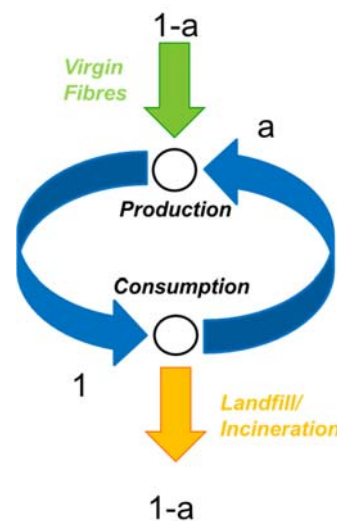
Why dealing with fibre flows?

- To understand the interactions between the various paper / paper for recycling flows within a region and their influence on quality of paper for recycling within a certain region
- To quantify the quality of paper for recycling (PfR) in terms of
 - Composition of (used) paper products
 - Amount of ash
 - Mean fibre age
- To predict the effect of future changes (global/local) in paper production and consumption on
 - changes in (global/local) fibre flows
 - changes in quality of PfR

Fibre age

- The number of recycling loops a fibre is used; counting starts with one
- Influence on paper properties was examined in various experiments with remarkable results
- In a One-Input/One-Output recycling system with PfR utilization rate a yields

$$\text{Mean Fibre Age} = \frac{1}{1 - a}$$
- In more complex systems calculation can be very expensive



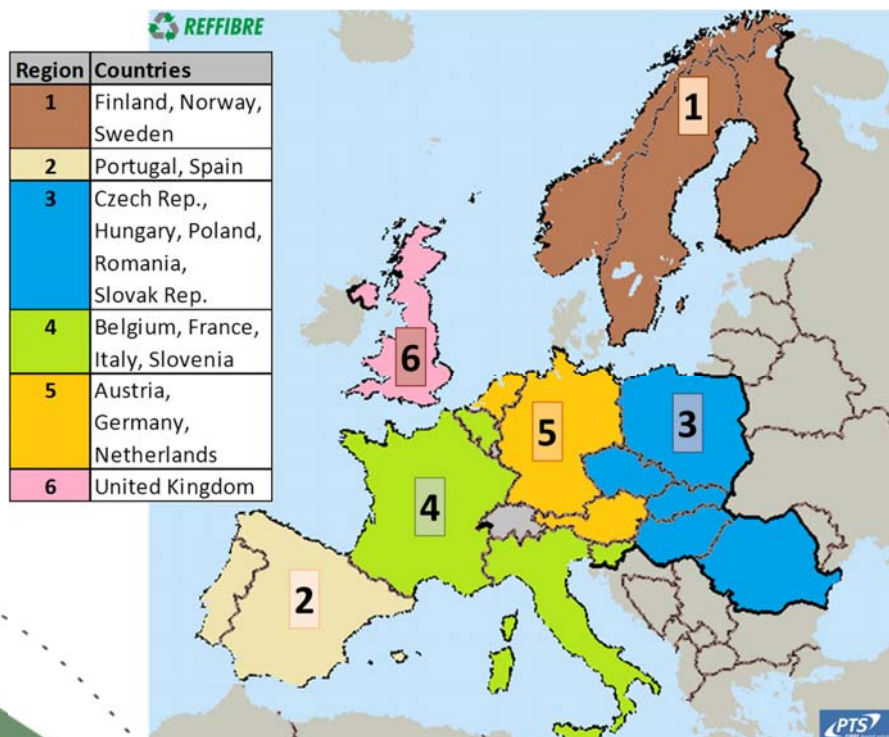
What is your benefit?

- From a paper mill or sorting plant point of view:
 - Preparation of strategic decision making
 - Investments in new raw materials vs. investments in new technologies
 - Partnerships
- From a society point of view
 - Preparation of legislative actions concerning
 - Waste paper collection
 - Paper sorting

→ Improvement of resource efficiency

2. Specialities of European regions

Geographical regions (1)



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Geographical regions (2)

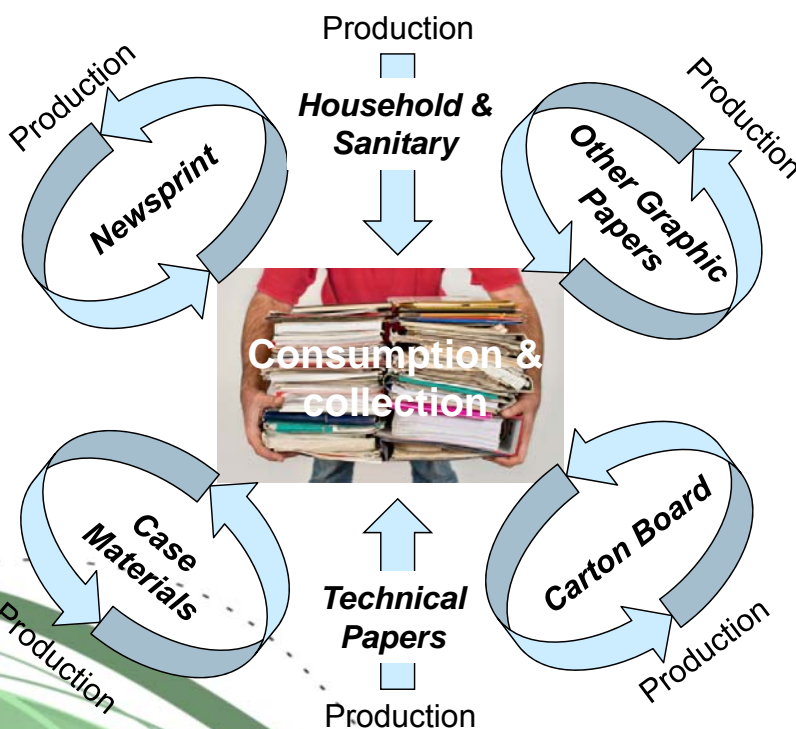
Region	Countries	Characteristics
1	Finland, Sweden, Norway	High PfR collection rate > 70%; low PfR utilization rate; low population density
2	Spain, Portugal	Separate household collection is widespread, high PfR collection rate
3	Czech Rep., Slovak Rep., Poland, Hungary, Romania	Developing waste collection systems; low PfR collection rate
4	Italy, France, Belgium, Slovenia	Co-mingled household collection is widespread, PfR net export
5	The Netherlands, Germany, Austria	Dominating separated household collection; high PfR utilization and collection rates
6	UK	Dominating co-mingled household collection; high PfR net export

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3. How a (regional) fibre flow looks like?

Outline of a 4-Loop Fibre Flow Scheme



- 6 paper sectors*
 - Newsprint (NP)
 - Other Graphic Papers (OGP)
 - Case Materials (CM)
 - Carton Board CB)
 - Household & Sanitary
 - Technical Papers
- Only 4 of them have an Recycling Loop (nearly all of H&S and Technical Papers go to waste)
- Due to consumption & collection fibres migrate from one to another loop

*) The paper sectors were selected according to the needs of the REFFIBRE project. If necessary more or less paper sectors can be introduced.

What is in our paper for recycling?

- To quantify migration of fibres between the loops we need information of the PfR composition per region

PfR Grade	EN 643	Newsprint	Other Graphic Papers	Case Materials	Carton Board
Mixed grades	1.01,1.02				
OCC + Kraft	1.04/4.x		?		
ONP + OMG	1.11				
High Grades	2.x/3.x				

- Composition of selected PfR grades in Germany (2010)

PfR Grade	Newsprint	Other Graphic Papers	Case Materials	Carton Board
1.02	12%	46%	28%	14%
1.04	3%	16%	59%	22%
1.11	35%	61%	1%	3%

Source: TU Darmstadt (PMV),2010

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4. Current situation in the Central European region (Region 5: Germany, The Netherlands, Austria)

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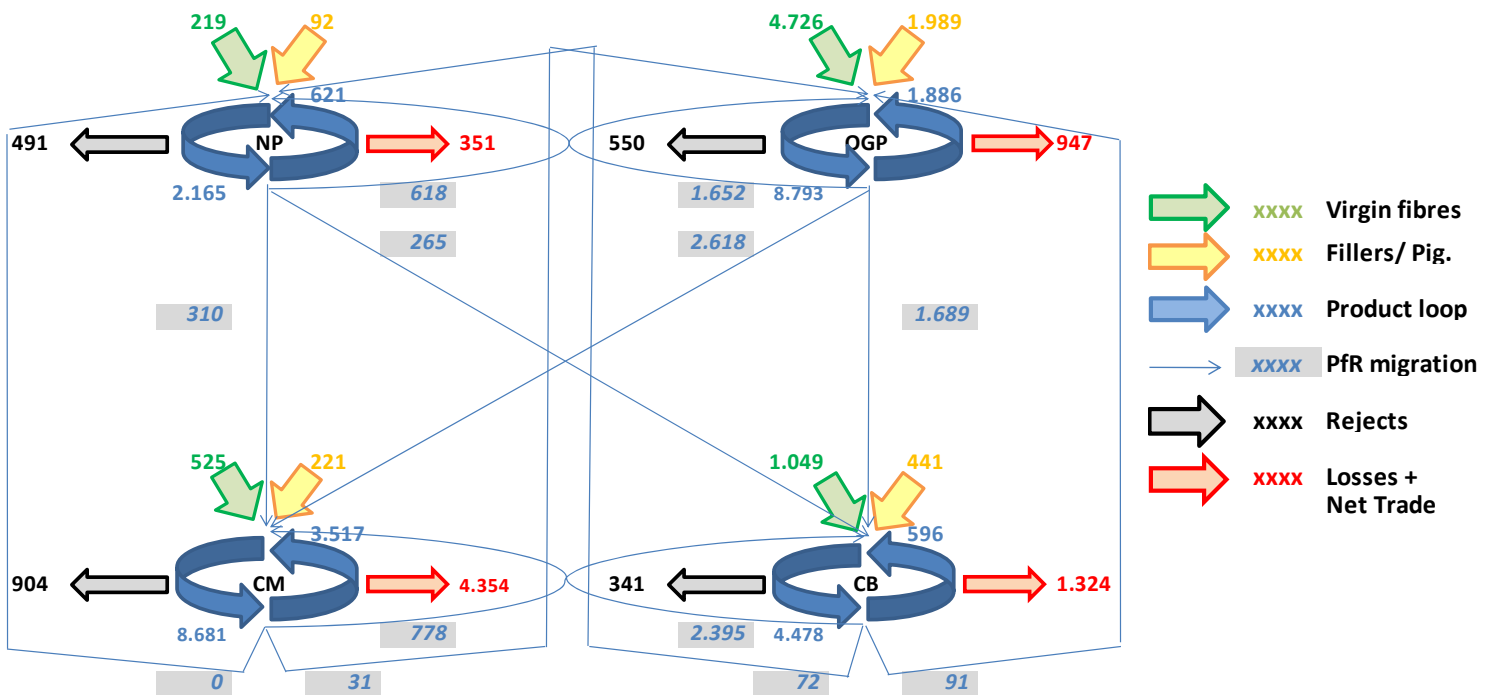
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Data set for region 5

Paper Sector	Sub group	Used Grades of Paper for Recycling				Total	Virgin Fibres	Non-Fibrous Materials	Total Production	Total Consumption
		Mixed Grades	Corrugated & Kraft	Newspapers & Magazines	High Grades					
		1.01/1.02	1.04/4.x	1.11	2.x/3.x					
		kt	kt	kt	kt	kt	kt	Mio. t	Mio. t	
Graphic Papers	Newsprint	1	0	2.445	11	2.457	n.a.	n.a.	2.188	2.482
	Other Graph	97	15	2.352	287	2.752			9.290	7.039
Packaging Papers	Case Mater	2.182	6.375	185	303	9.044			8.736	7.116
	Carton Boar	2.144	537	26	698	3.406			4.589	3.780
Houshold & Sanitary		188	0	57	728	973			1.556	1.596
Other papers		56	477	15	80	629			1.400	1.224
Total		4.669	7.405	5.080	2.107	19.260	7.820	4.114	27.758	23.236

Source: CEPI (converted to oven dry material)

Mass balance for region 5

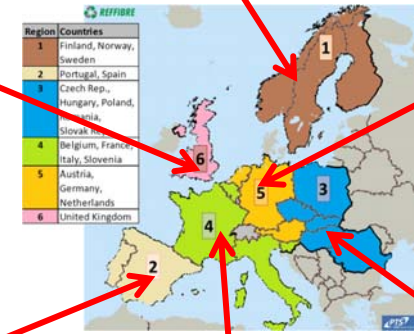


A European map of Paper and Pfr quality (based on regional mass balance calculations)

6		Ash	Fibre Age
Paper products	NP	2%	2,85
	OGP	11%	1,00
	CM	1%	4,81
	OP	7%	2,62
Pfr grades	Mixed	4%	2,90
	OCC	1%	4,73
	ONM	6%	2,14

2		Ash	Fibre Age
Paper products	NP	17%	1,65
	OGP	27%	1,01
	CM	19%	2,55
	OP	21%	2,11
Pfr grades	Mixed	22%	1,91
	OCC	21%	2,19
	ONM	24%	1,21

1		Ash	Fibre Age
Paper products	NP	12%	1,26
	OGP	16%	1,00
	CM	14%	1,20
	OP	15%	1,06
Pfr grades	Mixed	15%	1,10
	OCC	15%	1,09
	ONM	14%	1,12



5		Ash	Fibre Age
Paper products	NP	16%	2,65
	OGP	26%	1,51
	CM	18%	3,41
	OP	22%	2,58
Pfr grades	Mixed	22%	2,32
	OCC	21%	2,74
	ONM	23%	1,84

3		Ash	Fibre Age
Paper products	NP	2%	2,47
	OGP	12%	1,09
	CM	4%	2,57
	OP	12%	1,11
Pfr grades	Mixed	9%	1,68
	OCC	8%	1,87
	ONM	10%	1,35

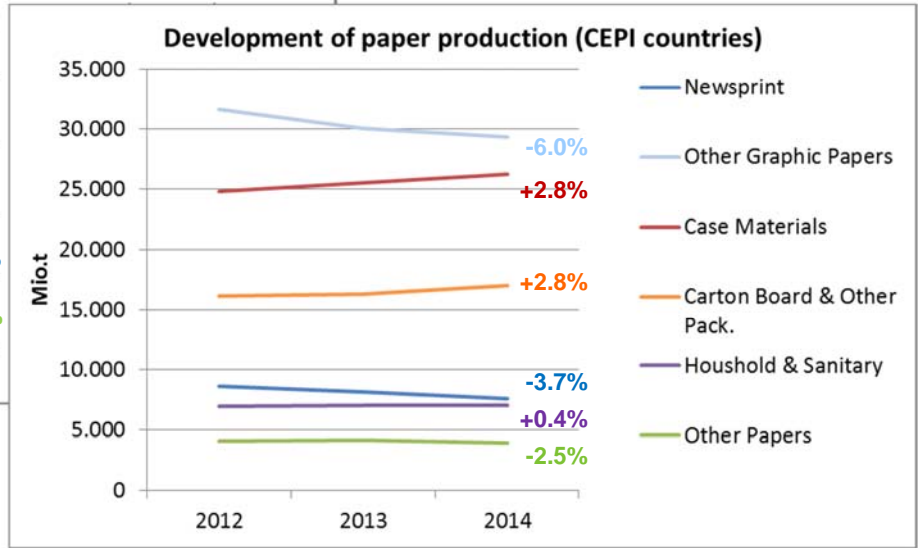
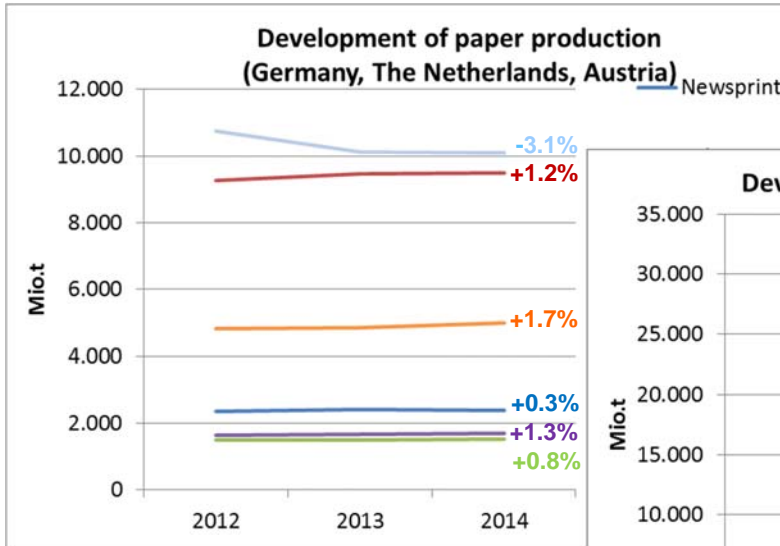
4		Ash	Fibre Age
Paper products	NP	12%	2,04
	OGP	22%	1,09
	CM	12%	3,16
	OP	16%	2,53
Pfr grades	Mixed	17%	2,00
	OCC	15%	2,55
	ONM	20%	1,29

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5. Future development of fibre flow

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Regional vs. European paper production development 2012-2014



Source: CEPI

Scenario "REG"

Scenario "EU"

Source: CEPI

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Ash and Mean Fibre Age Germany, The Netherlands and Austria; 2020 (Prediction) Scenario "REG"

		2014	
		Ash	Fibre Age
Paper products	NP	16%	2,65
	OGP	26%	1,51
	CM	18%	3,41
	OP	22%	2,58
PFR grades	Mixed	22%	2,32
	OCC	21%	2,74
	ONM	23%	1,84

PfR utilization rate of OGP production in 2020 remains constant (~30%)

PfR utilization rate of OGP production in 2020 increases (~40%)

		2020	
		Ash	Fibre Age
Paper products	NP	15%	2,74
	OGP	26%	1,55
	CM	17%	3,53
	CB	22%	2,67
PFR grades	Mixed	21%	2,45
	OCC	20%	2,86
	ONM	23%	1,83

		2020	
		Ash	Fibre Age
Paper products	NP	19%	2,95
	OGP	29%	1,84
	CM	21%	3,67
	CB	24%	2,79
PFR grades	Mixed	25%	2,66
	OCC	24%	3,02
	ONM	27%	2,10

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Ash and Mean Fibre Age Germany, The Netherlands and Austria; 2020 (Prediction) Scenario “EU”

2014

		Ash	Fibre Age
Paper products	NP	16%	2,65
	OGP	26%	1,51
	CM	18%	3,41
	OP	22%	2,58
PFR grades	Mixed	22%	2,32
	OCC	21%	2,74
	ONM	23%	1,84

PfR utilization rate of OGP production in 2020 remains constant (~30%)

PfR utilization rate of OGP production in 2020 increases (~40%)

2020

		Ash	Fibre Age
Paper products	NP	17%	2,55
	OGP	26%	1,48
	CM	18%	3,44
	CB	22%	2,60
PFR grades	Mixed	22%	2,31
	OCC	21%	2,75
	ONM	23%	1,79

2020

		Ash	Fibre Age
Paper products	NP	21%	2,76
	OGP	30%	1,76
	CM	22%	3,58
	CB	25%	2,71
PFR grades	Mixed	26%	2,51
	OCC	25%	2,91
	ONM	27%	2,05

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Consequences for quality development of paper for recycling in Germany, The Netherlands and Austria until 2020 based on calculations

Results:

Influence of Scenario:

- REG scenario (vs. EU scenario): lower ash content but higher fibre age
- EU scenario (vs. REG scenario): higher ash content but lower fibre age

Influence of PfR utilisation rate (OGP production):

- Constant rate: only moderate change of ash content and fibre age
- Increasing rate: remarkable increase of ash content and fibre age

Remarks:

- The calculated cases ignore effects of foreign trade of paper and PfR from other CEPI regions or from outside Europe

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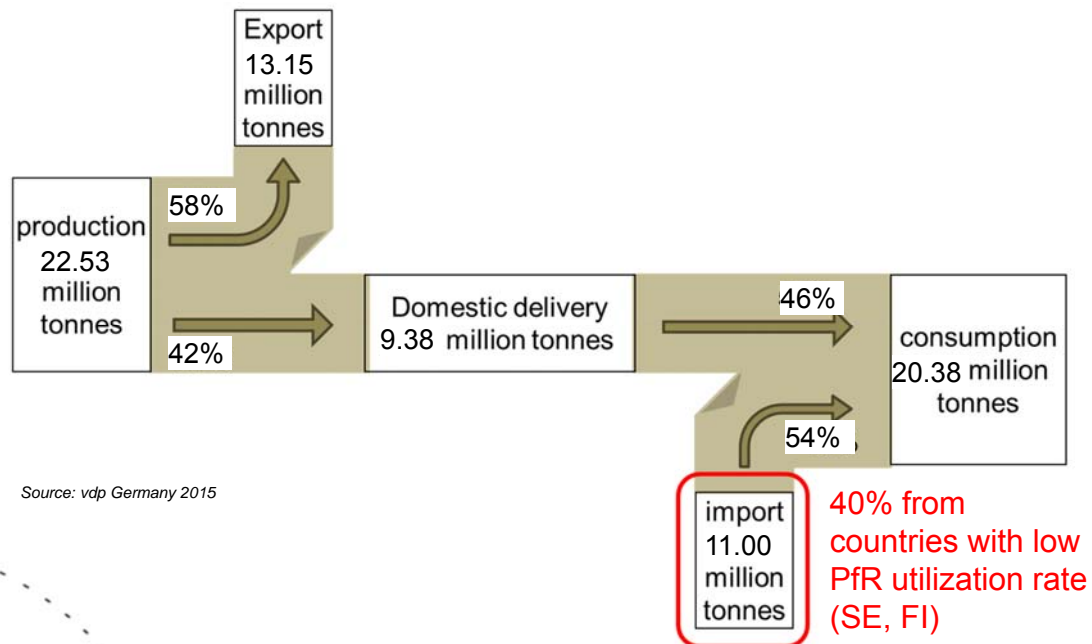
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6. Summary

Summary – PfR quality

- A tool is available to quantify fibre flows and to derive forecasts for future PfR quality in predefined European regions.
- Ash content and fibre age will increase until 2020 in ranges of 0-4% for ash content and 0.1-0.3 for fibre age depending on the scenario (to be assumed for the Central European region) and the PfR grade.
- Remarkable differences in PfR quality can be observed for different European regions (due to different raw material use and paper collection systems).
- Trade relations between the European do also influence PfR quality.

Foreign trade of paper (Germany 2014)



Summary - Fibre Flow modelling

- Available Fibre Flow models allow calculation of various PfR characteristics (ash content, fibre age) on regional or global level. Also numbers to characterize resource efficiency, e.g. material uses number, can be derived.

		Material Uses
Paper products	NP	3,61
	OGP	3,51
	CM	2,07
	CB	2,57

Material uses numbers (number of repeated uses of paper product material) for region 5

- To be done next:
 - Modelling the interaction (import/export) of fibre flows between different regions
 - Connecting the fibre flow models with
 - LCA tools
 - Process simulation tools for individual paper mill or sorting plant

Many thanks for your attention!

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