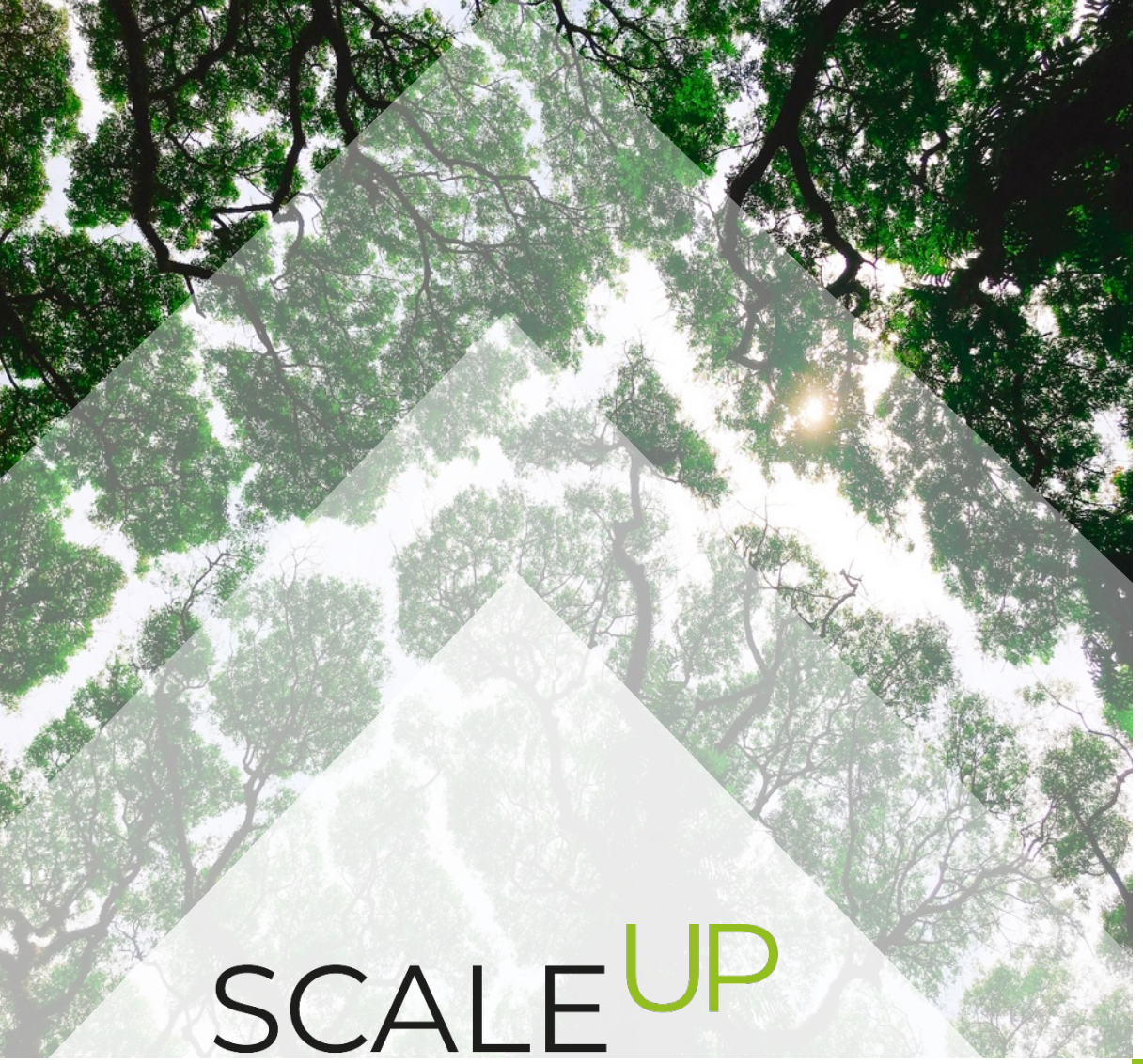

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EFFICIENT BIOMASS LOGISTICS AND INFRASTRUCTURE

CHALLENGES AND BEST PRACTISES

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BioFuel Region

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BioFuel Region™

– fuelling the bioeconomy and sustainable transports

BioFuel Region is a member owned non-profit organization working for a well-developed bioeconomy and a low carbon vehicle fleet by initiating, coordinating, and collaborating on project.

Area: 7*Belgium (221 800 km^2) 70 % Forest land

The aim is to further develop the region!

ACTIONS LEADING THE WAY TOWARDS A SUSTAINABLE, CIRCULAR BIOECONOMY

EU BIOECONOMY STRATEGY

1. strengthen and scale-up the bio-based sectors, unlock investments and markets
2. deploy local bioeconomies rapidly across Europe;
3. understand the ecological boundaries of the bioeconomy.

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DIFFERENT BIOMASS CHALLENGES

- Dedicated bio crops

Optimized logistics not considering main product

- Forestry or agricultural by products

Low biomass density over large geographical areas, Seasonality

- Bioindustries by products

Dependency on main products

Byproduct logistics is secondary to main product

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COMMON CHALLENGES

The costs of harvesting, transporting, storing and handling biomass are prime determinants of overall biorefining costs.

Thus, it is vitally important to develop local biomass supply systems that for long time can efficiently supply end-users with sufficient raw material that meets their specific quality and seasonal demands.

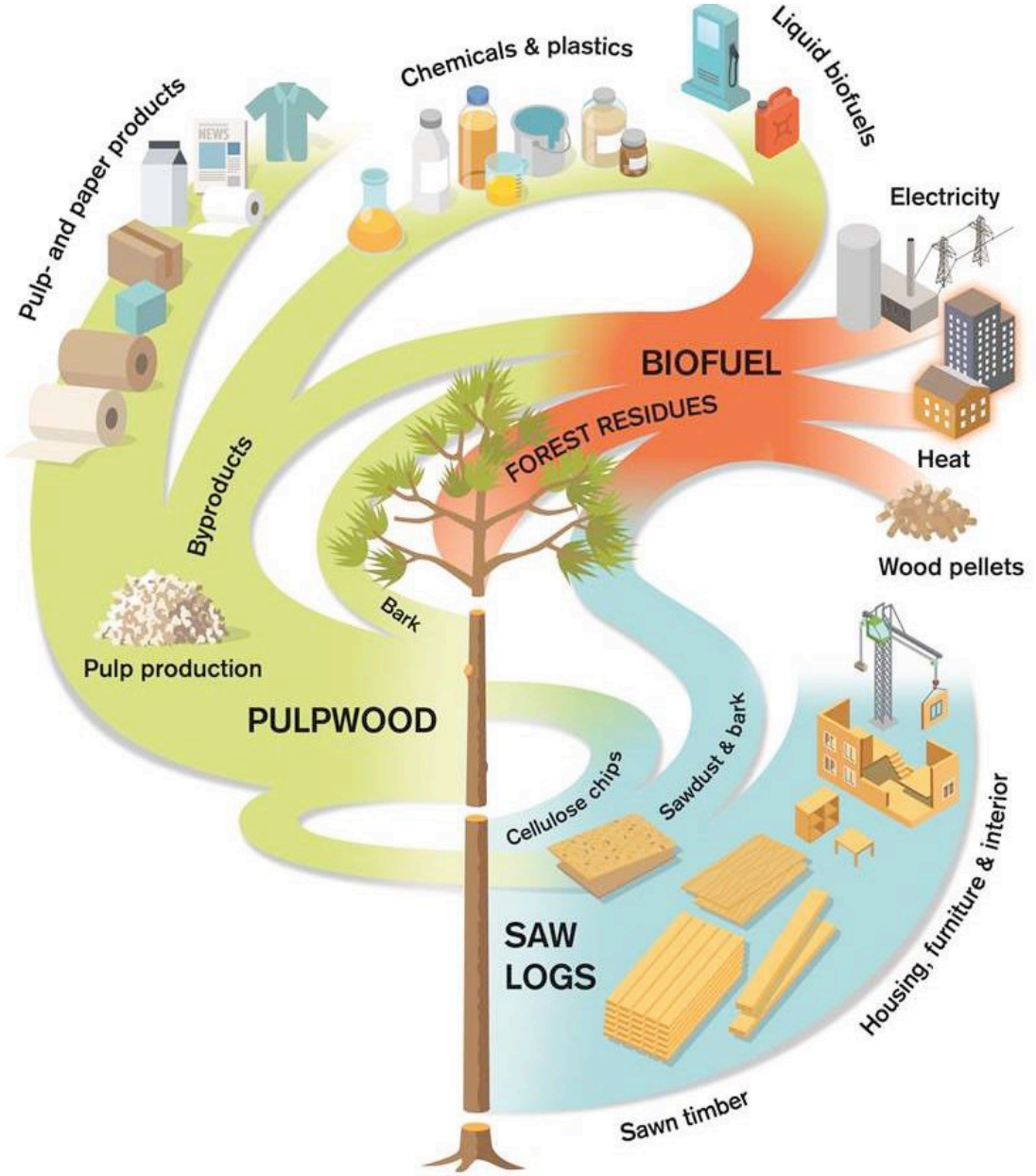
20 YEARS HISTORY OF CROSS BORDER COOPERATION

HIGHLY APPLIED RESEARCH ON BIOMASS LOGISTICS

- 2003 - 2004 Bioenergy from Forest
- 2005 - 2007 Bioenergy from Forest 2
- 2009 - 2012 Forest Power
- 2012 - 2014 Forest Refine 2.5 M €
- 2016 – 2019- Bio Hub 2.3 M €
- 2021 – 2022 Added Value 0.6 M €

FEEDSTOCK COSTS IS OFTEN NEGLECTED

- People often make unrealistic optimistic assumptions about things like feedstock costs
- Raw material supply cost often represents >50% of the overall cost for refining
- To be competitive - more focus should be put on the feedstock instead of on the technology to process it



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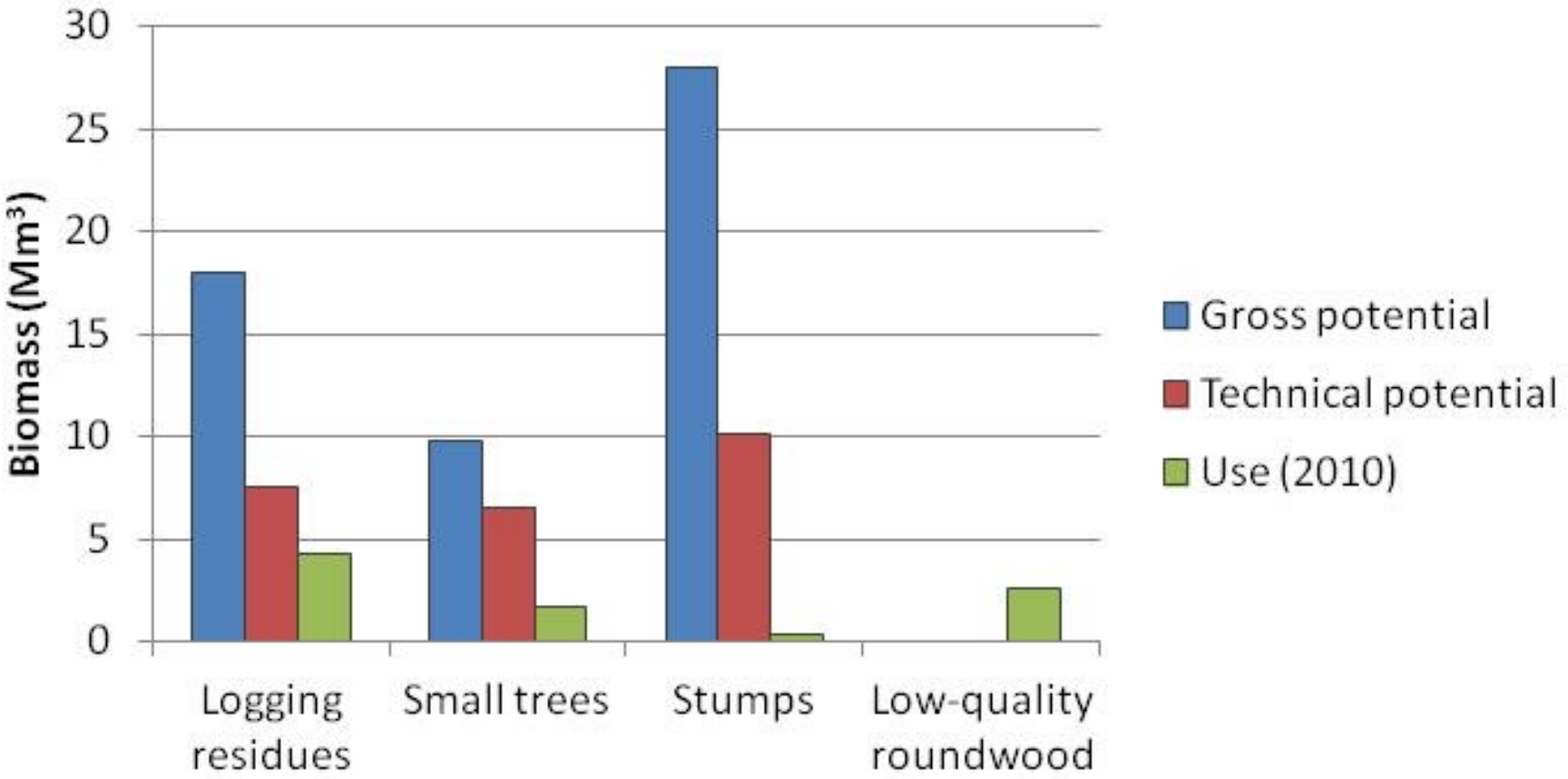
DIFFERNT MATURITY OF THE VALUE CHAINS

In Sweden forest biomass has providied the basis for significant industrial activitiy for more than 150 years

- Forest biomass value chain very well developed
- All infrastructure available (roads, machinery, know how)
- Add value in an existing value chain

Annual Forest Biomass potential in Sweden

Actual use is often much smaller than gross potential



SAWMILL BY PRODUCTS ARE PRODUCED AS A RESULT OF SAWMILL OPERATION **ALL THE YEAR AROUND**

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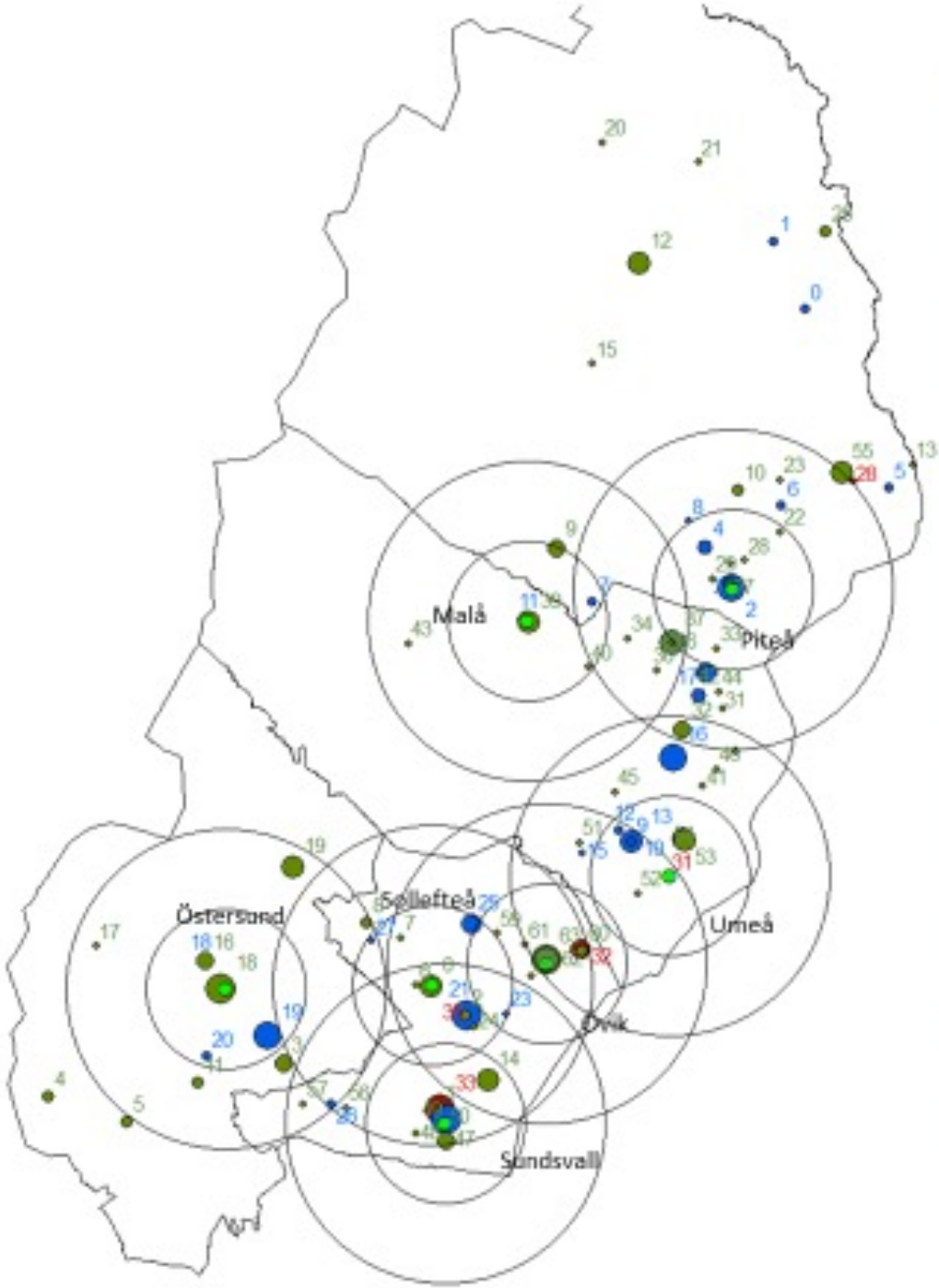
Biomass availability is not seasonality,
but demand is

Sawdust - 15% of the wood
Today used for pellet production and combustion
Woodchips – 25 % of the wood –
Today used by the pulp and paper industry
Bark – 10% of the wood – Today used for combustion

28 SAWMIILS IN NORTHEN SWEDEN
Location, owner, county, and production of sawn wood for the year 2019

2021- Large increase in price for sawn goods – increased output

Location	Owner	County	Production (m³ sawn wood/ year)
Korpilombolo	Jutos Timber	Norrbotten	60 000
Tärendö	Krekula & Lauri	Norrbotten	52 000
Piteå, Munksund	SCA Wood	Norrbotten	420 000
Piteå, Lövholmen	Stenvalls trä	Norrbotten	140 000
Sikfors	Stenvalls trä	Norrbotten	140 000
Seskarö	Stenvalls trä	Norrbotten	0
Luleå, Örarna	Stenvalls trä	Norrbotten	65 000
Glommersträsk	Glommers Timber	Norrbotten	50 000
Älvsbyn	Älvsbyhus	Norrbotten	40 000
Brattby	Brattbysågverk	Västerbotten	50 000
Rundvik	SCA Wood	Västerbotten	315 000
Malå	Setra Trävaror AB	Västerbotten	210 000
Vännäs	NK Lundströms	Västerbotten	65 000
Sävar	Norra Skog	Västerbotten	256 000
Kåge	Norra Skog	Västerbotten	263 000
Agnäs	Norra Skog	Västerbotten	18 000
Bygdsiljum	Martinsson/Holmen	Västerbotten	430 000
Kroksjön, Skellefteå	Martinsson/Holmen	Västerbotten	117 000
Hissmofors	Norra Skog	Jämtland	120 000
Gällö	SCA Wood/Persson Invest	Jämtland	360 000
Svenstavik	Rödins Trä AB	Jämtland	78 000
Bollsta	SCA Wood	Västernorrland	550 000
Tunadal	SCA Wood	Västernorrland	550 000
Ullånger	MST Sågverk Ullånger AB	Västernorrland	35 000
Örnsköldsvik	Högland	Västernorrland	50 000
Anudsjö, Bredbyn	Högland	Västernorrland	190 000
Fränsta	Callans Trä AB	Västernorrland	85 000
Edsele	Edsele Såg AB	Västernorrland	28 000



Heating plants

0	Adven energilösningar ab	solefteå
1	Adven energilösningar ab	Timrå
2	Adven Värme AB.	Bollstabruk
3	Adven Värme AB.	Bräcke, Ersyon
4	Adven Värme AB.	Funäsdalen
5	Adven Värme ab.	Hede
6	Adven Värme ab.	Långsele
7	Adven Värme AB.	Näsåker
8	Adven Värme AB.	Ramsele
9	Arvidsjaurs energi ab	Arvidsjaur
10	Bodens energi AB	Boden
11	BTEA Energi AB	Berg
12	Gällivare Energi AB	Gällivare-Malmberget
13	Haparanda Värmeverk AB	Haparanda Residual
14	Härnösand energi & miljö ab	Härnösand
15	Jokkmokks värmeverk AB	Jokkmokk
16	Jämtkraft AB	Krokom
17	Jämtkraft AB	Åre
18	Jämtkraft ab	Åsterund
19	Jämtkraft värme AB	strömsund
20	Kiruna kraft AB	Kiruna C
21	Kiruna kraft AB	Vittangi
22	Luleå Energi AB	Luleå
23	Luleå energi ab	nåsed
24	Nevel AB	kiruna
25	Pajala Värmeverk AB	Pajala
26	PiteEnergi AB	Norrfjärden
27	Piteenergi AB	Piteå
28	Piteenergi AB	Rosvik
29	PiteEnergi AB	Sjulnäs
30	Skellefteå Kraft AB	Boliden
31	Skellefteå Kraft AB	Bureå
32	skellefteå kraft ab	Burträsk
33	skellefteå kraft ab	Ryrkie
34	Skellefteå Kraft AB	Jörn
35	Skellefteå Kraft AB	Kåge
36	skellefteå kraft ab	Lidbacken
37	skellefteå kraft ab	Lycksele
38	Skellefteå Kraft AB	Lövånger
39	Skellefteå Kraft AB	Malå
40	Skellefteå Kraft AB	Norsjö
41	skellefteå kraft ab	robertsfors
42	skellefteå kraft ab	skellefteå
43	Skellefteå Kraft AB	Storuman
44	Skellefteå Kraft AB	Urzviken-Skellefteharnn
45	skellefteå kraft ab	Vindeln
46	skellefteå kraft ab	Åmåsel
47	Sundsvall Energi AB	Kvicksleby
48	Sundsvall Energi AB	Matfors
49	Sundsvall Energi AB	Sundsvall
50	sundsvall energi ab	Tunadal
51	Umeå energi ab	Bjurholm
52	Umeå Energi AB	Hörnefors
53	Umeå Energi AB	Sävar
54	umeå energi ab	Umeå
55	Vasa Värme Holding ab	kalix
56	Ånge Energi AB	Fränota
57	Ånge Energi AB	Ånge
58	Övik Energi AB	Björka
59	Övik energi ab	enedbyn
60	Övik energi ab	Husum
61	Övik Energi AB	Molliden
62	Övik Energi AB	Processänga
63	Övik energi ab	Örnsköldsvik

Sawmills

0	Arbo Timber	korpilombolo
1	Krekula & Lauri	Tärendö
2	sca Wood	Piteå, Munksund
3	Stenvalls trä	Piteå, Lövholmen
4	Stenvalls trä	sikfors
5	Stenvalls trä	Sorkerö
6	stenvalls trä	Luleå, Gamla
7	Glommers Timber	Glommerstrask
8	Älvsbyhus	Älvsbyn
9	Bratbysågverk	Bratby
10	sca Wood	Kundvik
11	Setra Trävaror AB	Malå
12	NK Lundströms	Vännäs
13	Norra Skog	Sävar
14	Norra Skog	Kåge
15	Norra skog	Agnäs
16	Martinsson/Holmen	Bygdsiljum
17	Martinsson/Holmen	Kroksjön, skellefteå
18	Norra Skog	Hörnefors
19	sca Wood/Persson Invest	Bålå
20	Rödins Trä AB	Svenstavik
21	sca Wood	Bollsta
22	SCA Wood	Tunadal
23	Mtr sågverk ulånger ab	Ulånger
24	Högland	Örnsköldsvik
25	Högland	Anundsjö, enedbyn
26	Dellers Trä AB	Fränota
27	sdsele såg ab	sdsele

Pulp and paper industries

28	Billerud Korsnäs	Karlsborg
29	smurfit kappa	
30	SCA Munksund	
31	sca obbola	
32	Metsä Board	
33	sca Östrand	
34	SCA Ortviken	
35	Mondi Dynäs	
36	Aditya Birla	

Production raw tonnes

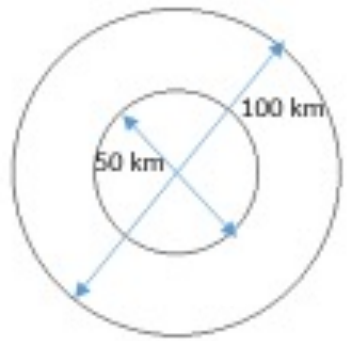
- 0 - 10000
- 10000 - 20000
- 20000 - 40000
- 40000 - 60000
- 60000 - 80000
- 80000 - 100000
- 100000 - 130000

Production raw tonnes

- 0 - 20000
- 20000 - 30000
- 30000 - 40000

Consumption raw tonnes

- 0 - 1000
- 1000 - 6000
- 6000 - 15000
- 15000 - 50000
- 50000 - 100000
- 100000 - 150000



RAW MATERIAL SUPPLY TO BIOREFINERIES

- **Coastal** - Synergies and competition with existing biomass users. Proximity to harbour Import /Export

- **Inland** - Close to raw material - Raw material supply area full circle

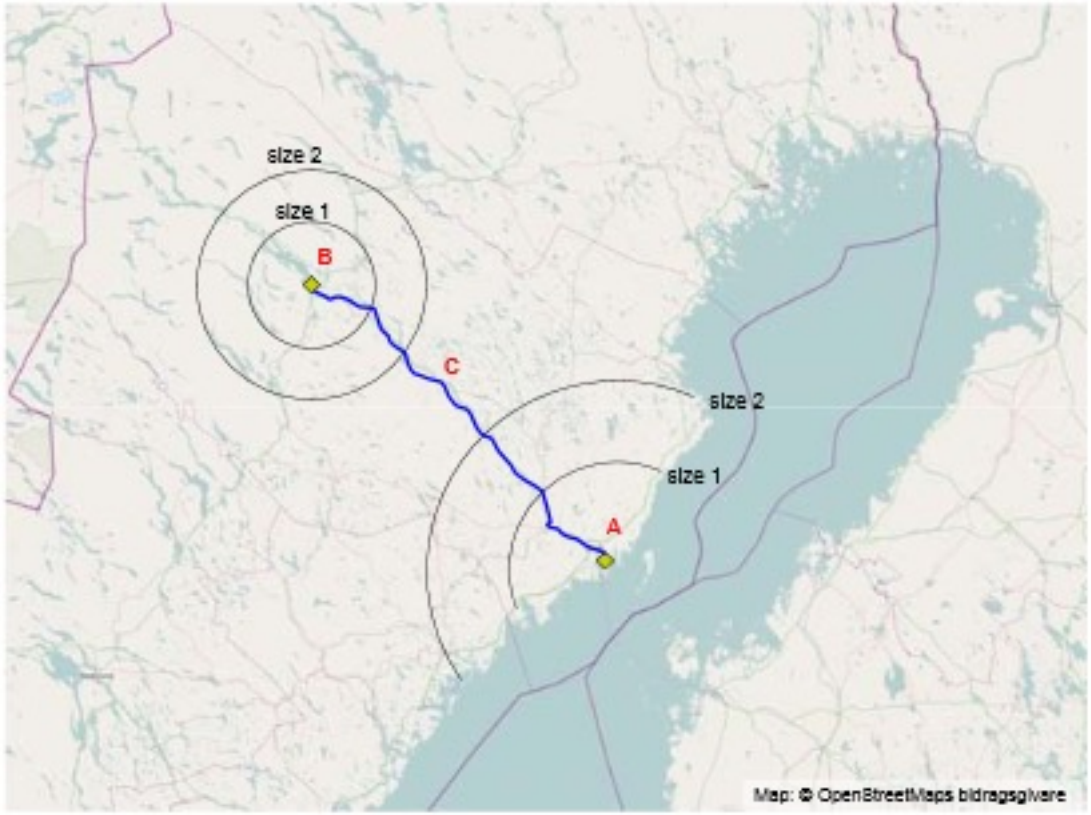
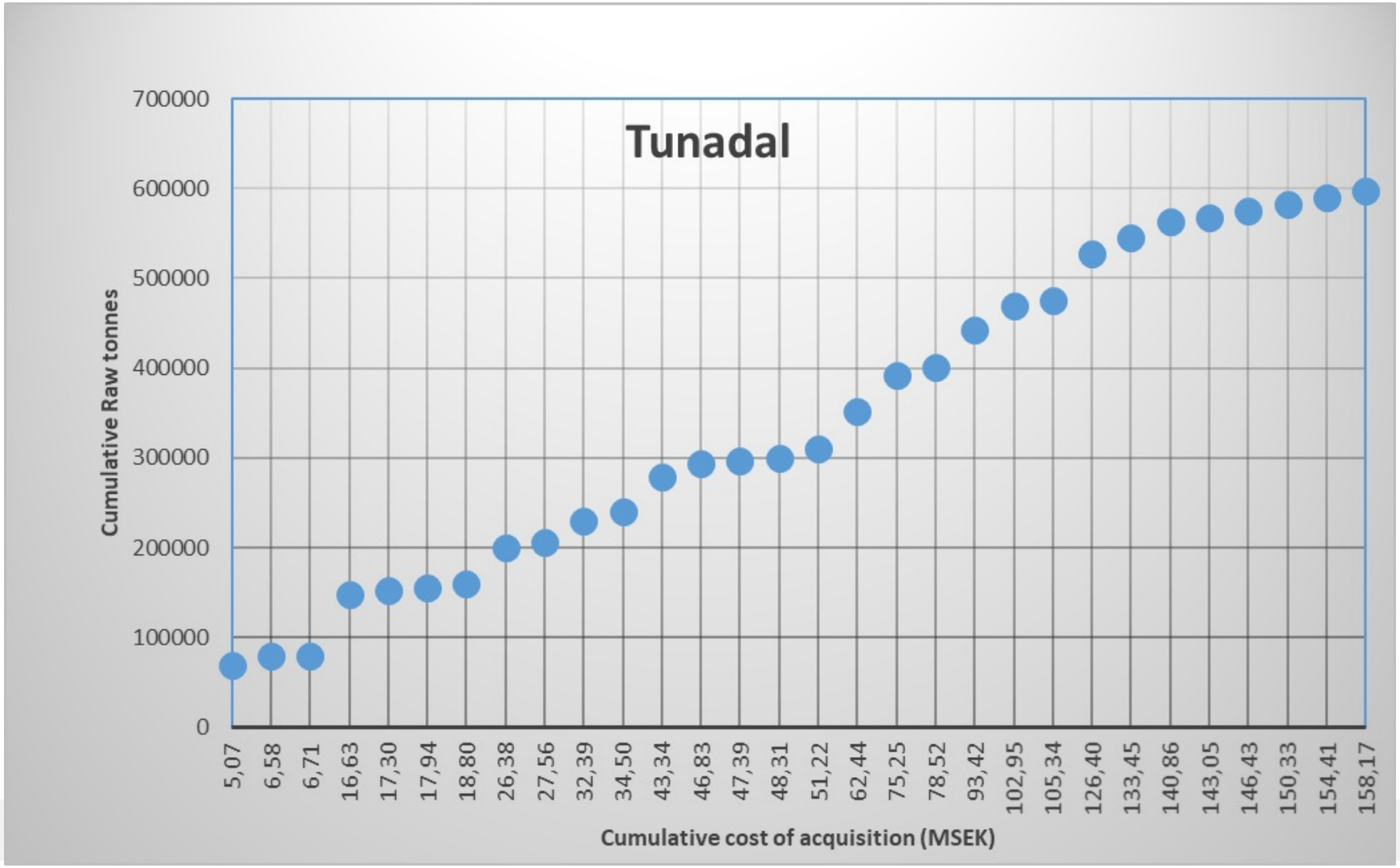


Figure 1. Example of biorefinery locations and supply areas. A: Biorefiney on the coast with local supply, B: Inland biorefinery with local supply, C: Biorefinery on the coast with supply from an inland terminal. Supply area sizes are indicated for two different levels of feedstock requirements.

Marginal cost curves – Important tool for design of biorefinery

Biorefinery investments are often characterized by economics of scale

Raw material supply cost have negative economies of scale



BIOMASS POTENTIAL IS OFTEN DYNAMIC

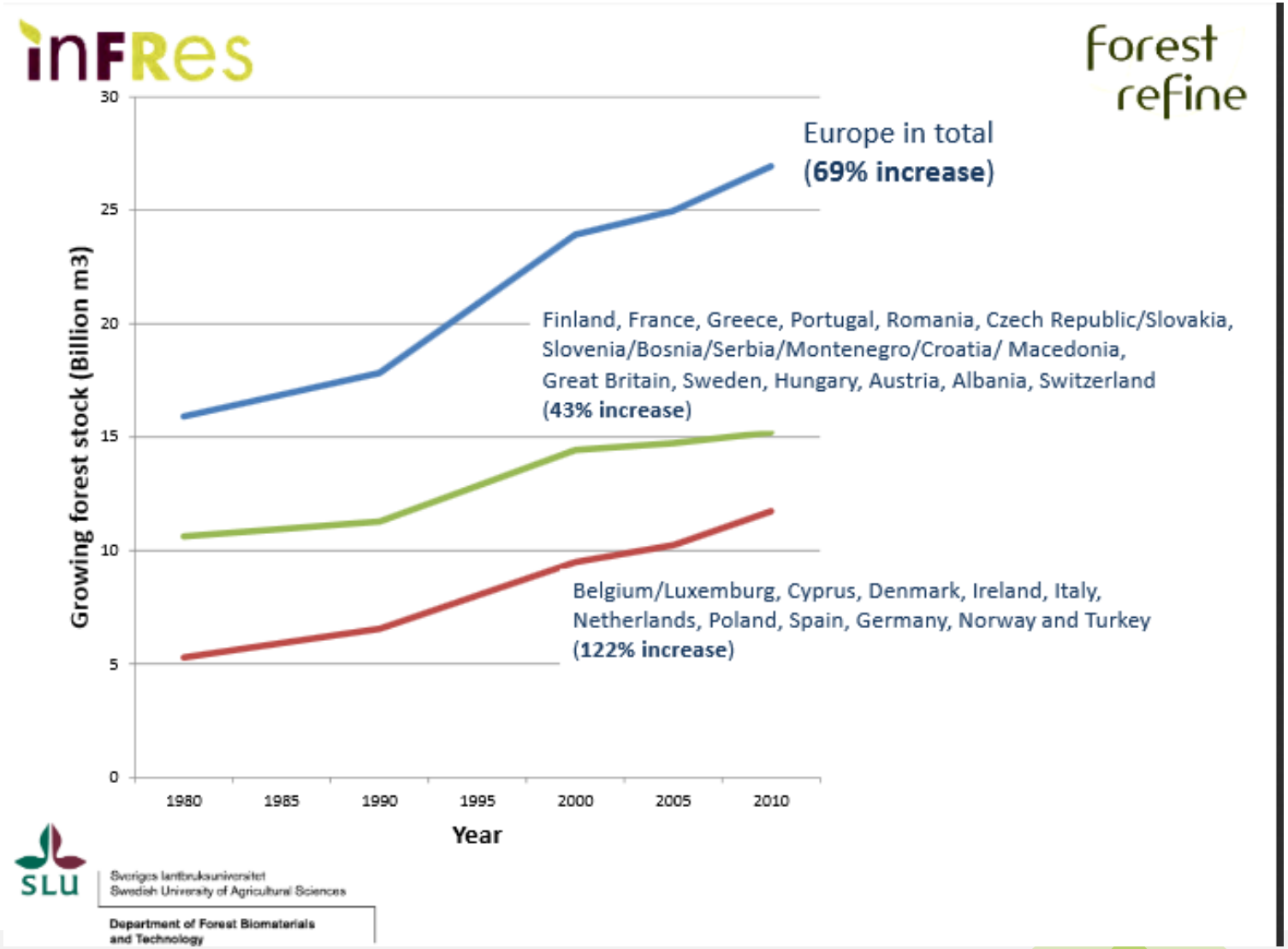
- Innovations can be a driver for new products with higher value
- More effective and profitable biomass processing

– End user can pay more

- Higer price gives incentives for primary producers to produce and sell more
- Improved biomass logistics can make more biomass economical available
- Dependency on business for main product - Risk/profit sharing

The growing forest stock in EU is increasing

- Incresed demand for biomass results in more biomass – not less
- It gives primary producers incentives to improve forest management to produce more



THE COST FOR HARVEST, TRANSPORT, STORING AND HANDLING OF THE BIOMASS IS OF PRIME IMPORTANCE WHEN CALCULATING THE OVERALL COST FOR BIOREFINING

Solid volume content			
15-20 %	35-40 %	40 %	60-70%
50 km	100 km	120 km	200 km

Bulk density of biomass is a major factor in determining the cost and logistics requirements of handling and moving biomass from farm to biorefinery.

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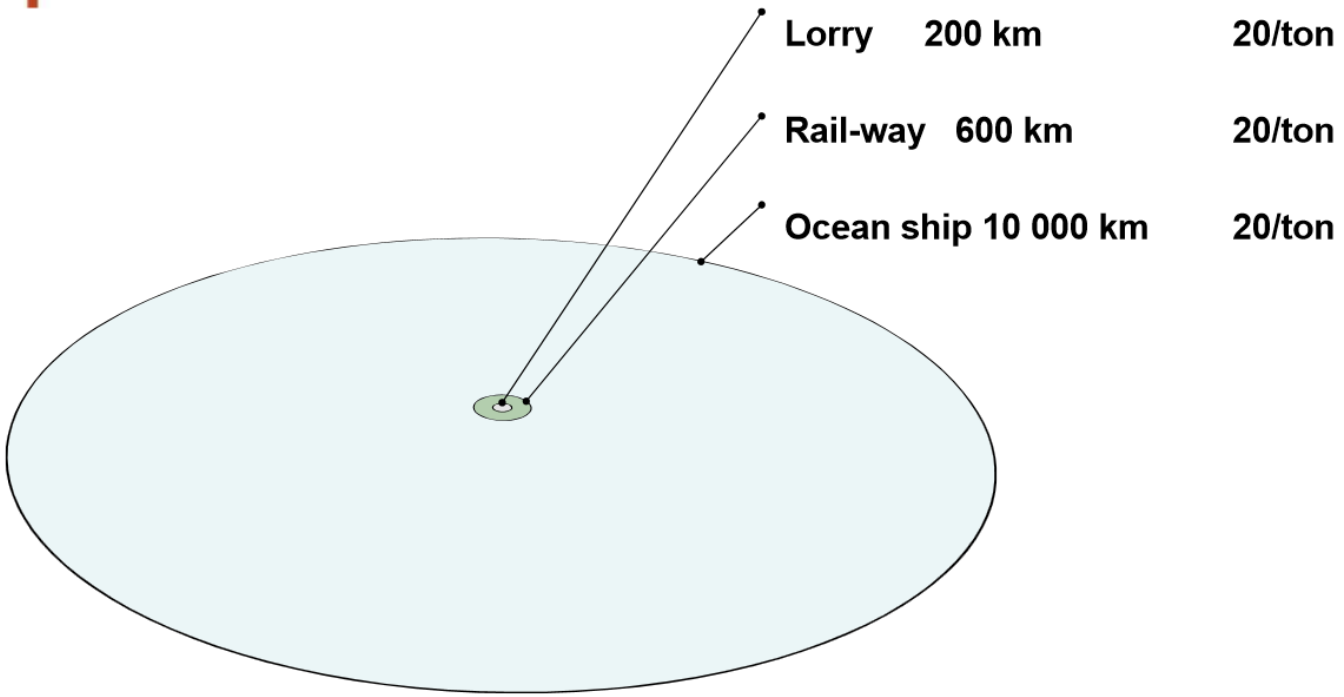
TallOil

Transport Costs

(general example)



A specially designed rail solution with 26 cars with 3x60 m3 containers providing 4700 m3 loose per train set.

LOADING/UNLOADING IS OFTEN COSTLY

Dependency between different machinery often causes waiting time

– Logistical hot systems are difficult to plan

POSSIBLE SOLUTIONS SELF LOADING/ UNLOADING

INFORMATION FLOW BETWEEN DIFFERENT ACTORS

- Biomass logistics is often understood as a flow of biomass from the field to the end users
- Logistics is also a flow of information between different actors in the value chain
- Poor information flow can have a negative impact on feed stock cost and biomass quality
- Multi actor partnership

Different actors are doing different things during different time of the year

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YES/NO

NO

NO

POOR ATTITUDE – POOR LOGISTICS

Don’t use the word waste!

- It has a negative impact on the work actors involved in the value chain are doing
- It suggests that the biomass resource is for free

To be fully involved - Primary producers also wants some income

- If you introduce a price – you can set quality requirements of the biomass resource

QUALITY CONTROL OF BIOMASS IS DETERMINED BY END USERS DEMANDS

- Moisture content – Effects transport cost and storability
- Calorific value – If used as a fuel
- Contaminations –Content of specific compounds (eg sulphur alakali)
- Ash content - Process disturbing
- Particle size distribution – Feeding of the biomass and processing
- Freshness – Some chemicals are volatile and can be lost during handling and storage. Chipping/Crushing accelerates volatility

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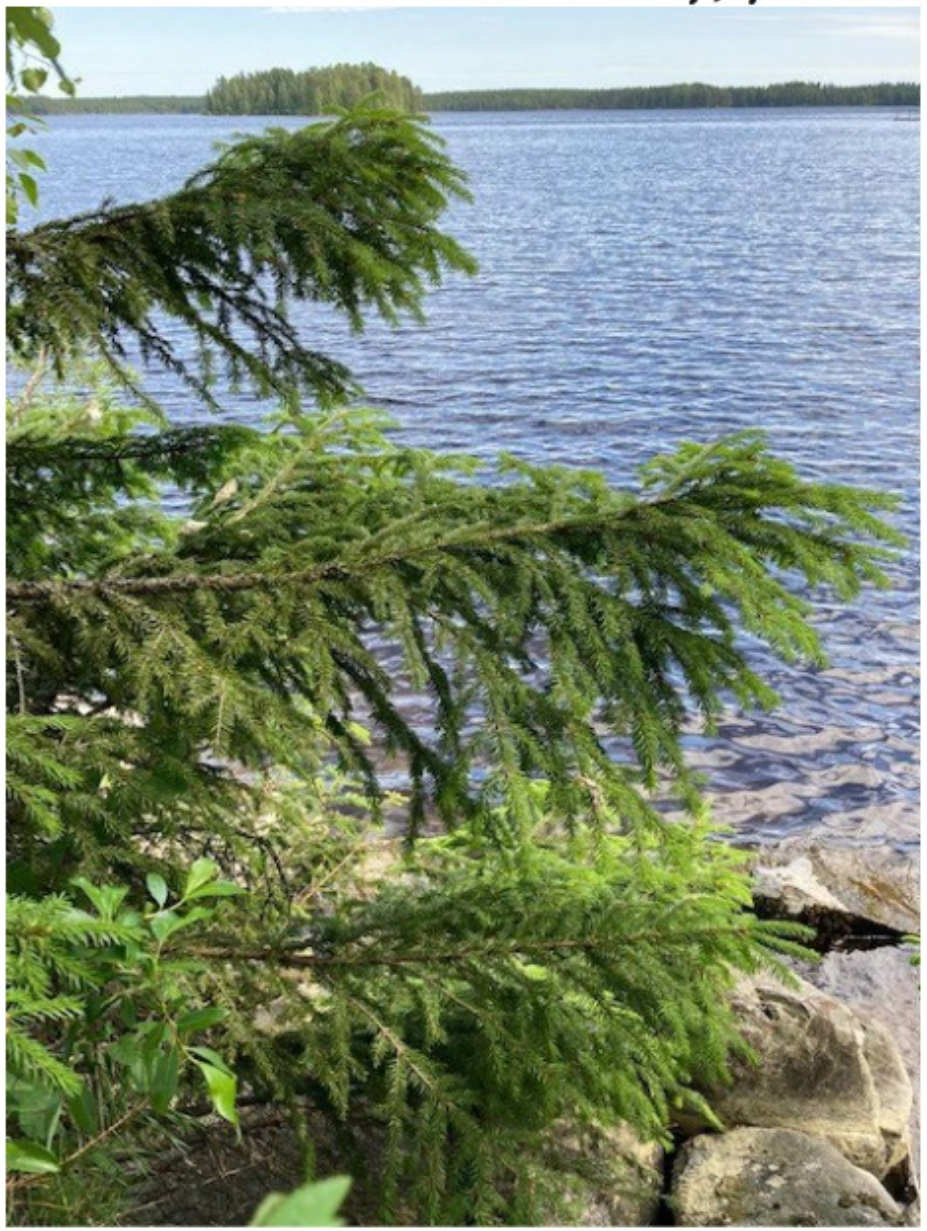
PRODUCING MULTIPLE PRODUCTS

- By producing multiple products, a biorefinery can take advantage of the differences in the biomass feed stocks and maximize the value from the biomass feed stocks
- Big incomes can come from small volumes of high value chemicals
- What can you extract from your feedstock ?

Best sources of total polyphenolic concentrations in a spruce tree
A case study; potential quantities of polyphenolics

added value



Needles, total phenolics 58 mg GAE/g (average 3 batches)

37 kg in a tree

Total phenolics in needles: **2 kg** (based on mg GAE/g)

Bark, total phenolics 35 mg GAE/g (average 3 batches)

29 kg in a tree

Total phenolics in bark: **1 kg** (based on mg GAE/g)

Branches, total phenolics 7,5 mg GAE/g (average 3)

69 kg in a tree

Total phenolics in branches: 0,5 kg (based mg GAE/g)

EXTRACTIVES ARE QUICKLY LOST DURING STORAGE

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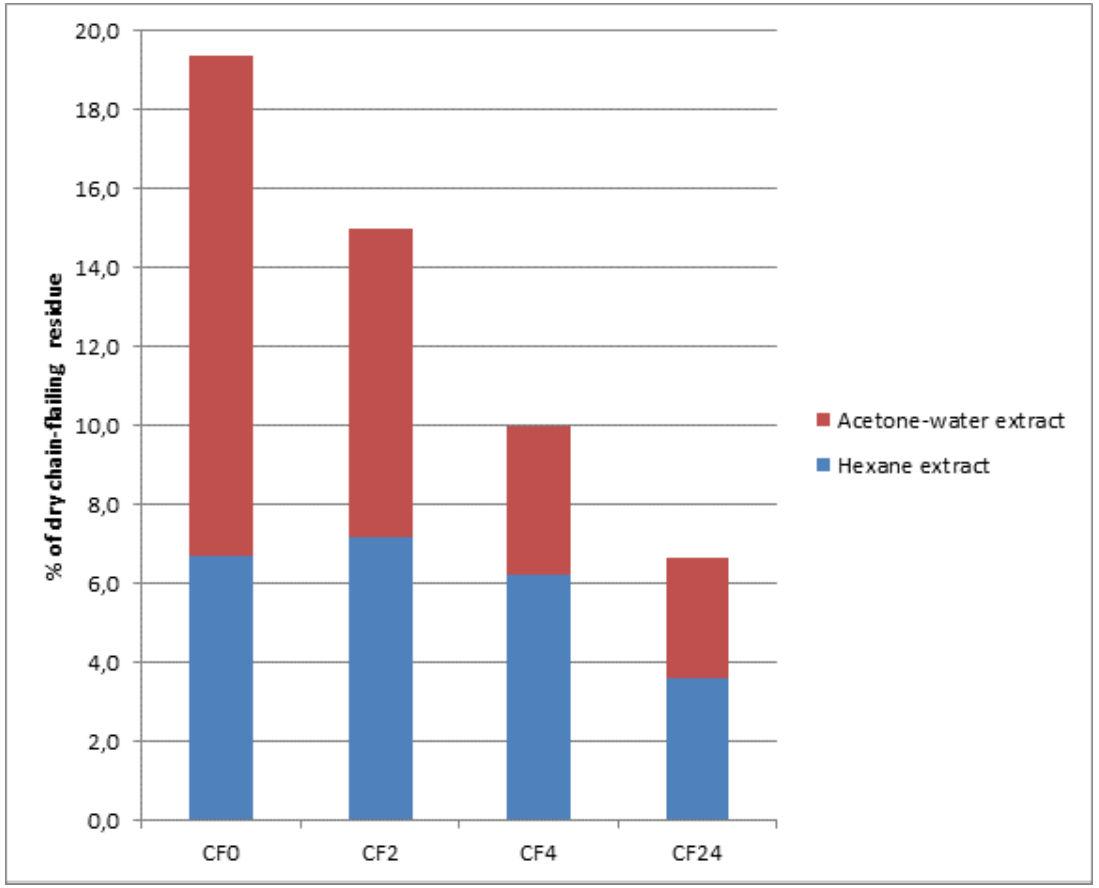

Extractive content analyzed after 0,2,4 and 24 weeks of storage

High temperatures, sunlight and chipping/crushing will increase losses

Conclusion – Biomass must be delivered quickly to industry for refining

KNOWLEDGE GAP - MISMATCH BETWEEN END USERS QUALITY DEMAND AND WHAT IS AVAILABLE

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Biomass properties

- Outspread (expensive to harvest and transport) – seasonality
- Wet and bulky
- Complex and varied quality

- High ash and alkali

- Varied particle size distribution

End users' quality demand

- Cheap and a warehous

- Dry and densified

- Well defined quality

- Low ash and alkali

- Even particle size (sawdust)

SOLUTION BIOHUB

- A business centre, BioHub, which delivers
  the right assortment
  to the right place
  at the right price