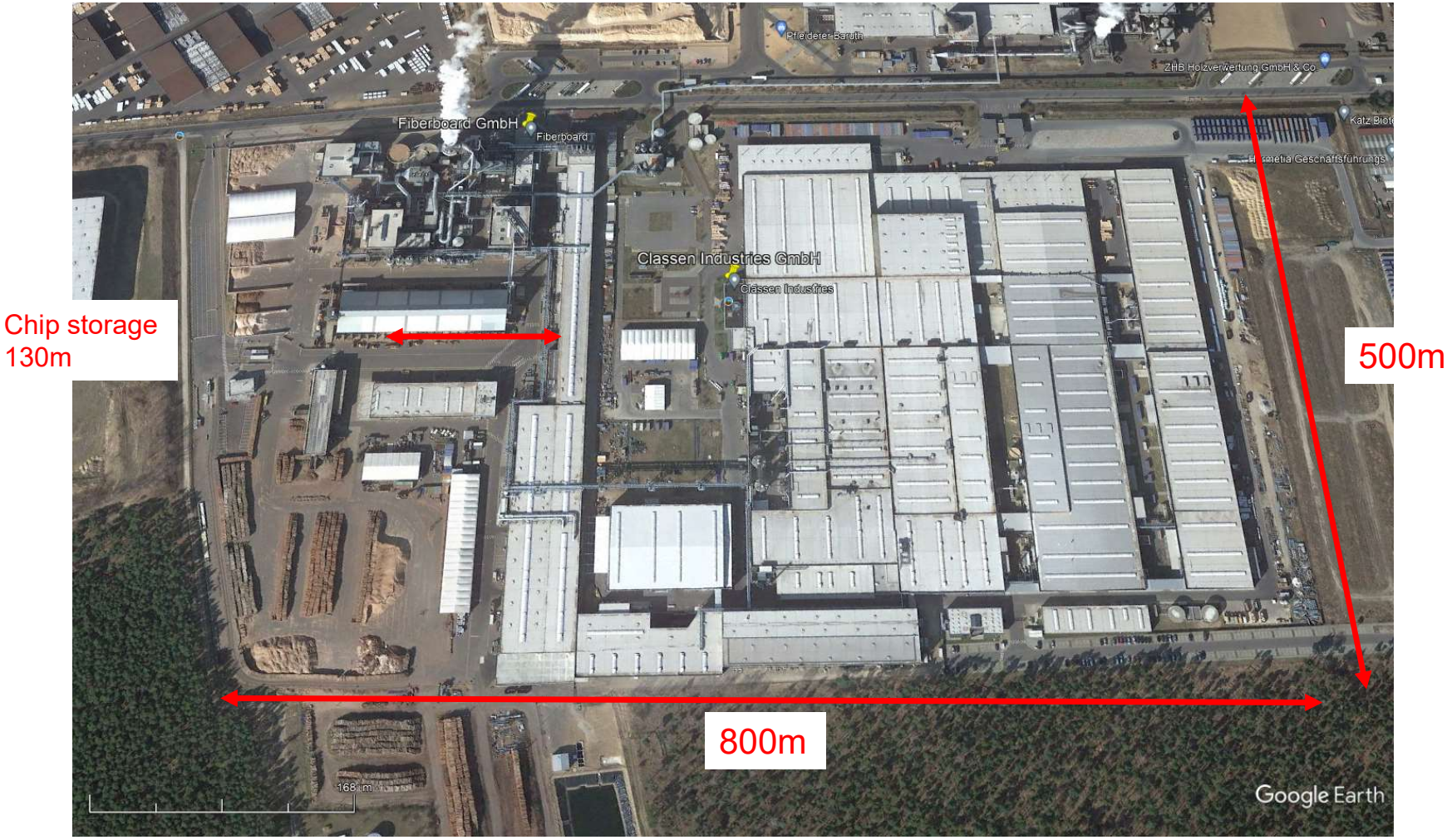
Turpentine from Medium Density Fibreboard: A new industrial Process, A new worldwide Source of Turpentine

PCA International Conference Dublin
September 19th, 2023

Prof. Dr.-Ing. Bernd Bungert, Kai Greten
Fiberboard GmbH, Classen Group
Baruth, Germany
Berlin University of Applied Science and Technology

Production site in Baruth, Germany:
Classen Group operates largest integrated MDF- and laminate-flooring site worldwide



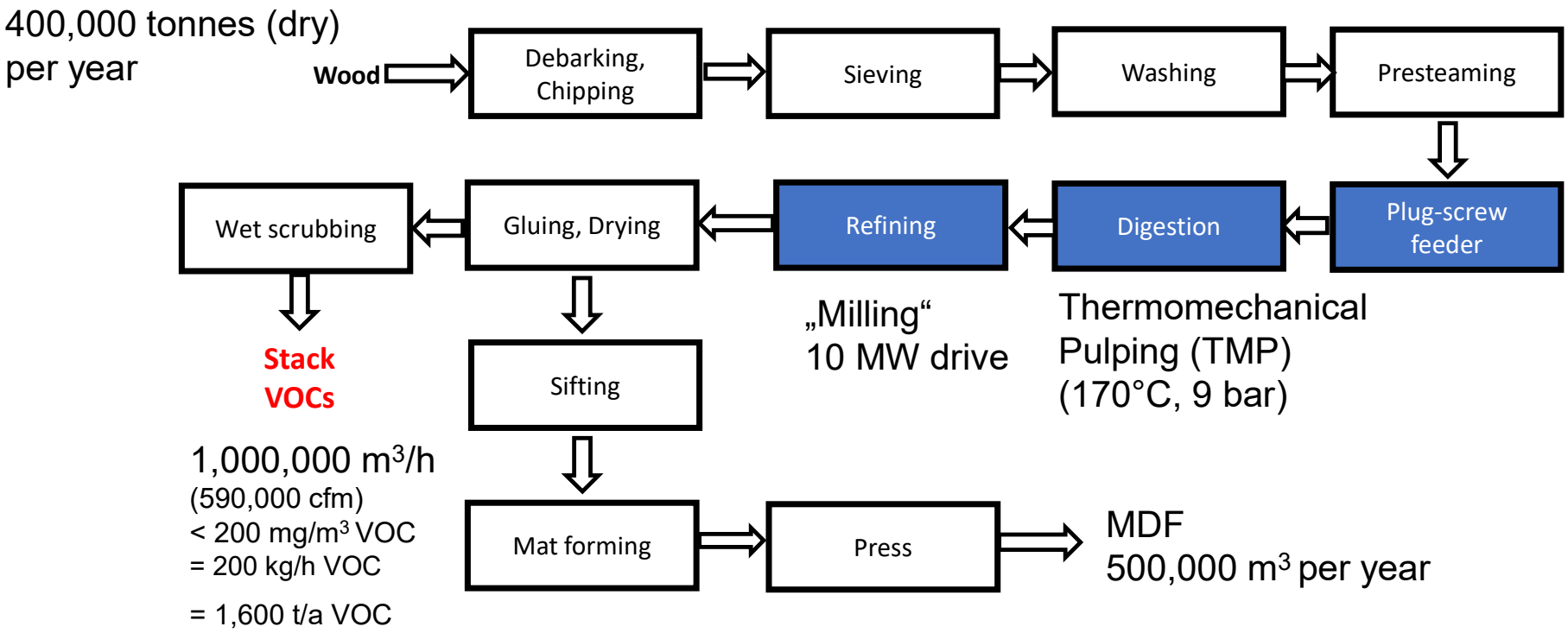
Fiberboard in Baruth/Mark

CLASSEN
Fiberboard GmbH is part of the CLASSEN Group

VOC: Volatile Organic Components

MDF Process

CLASSEN
Fiberboard GmbH is part of the CLASSEN Group



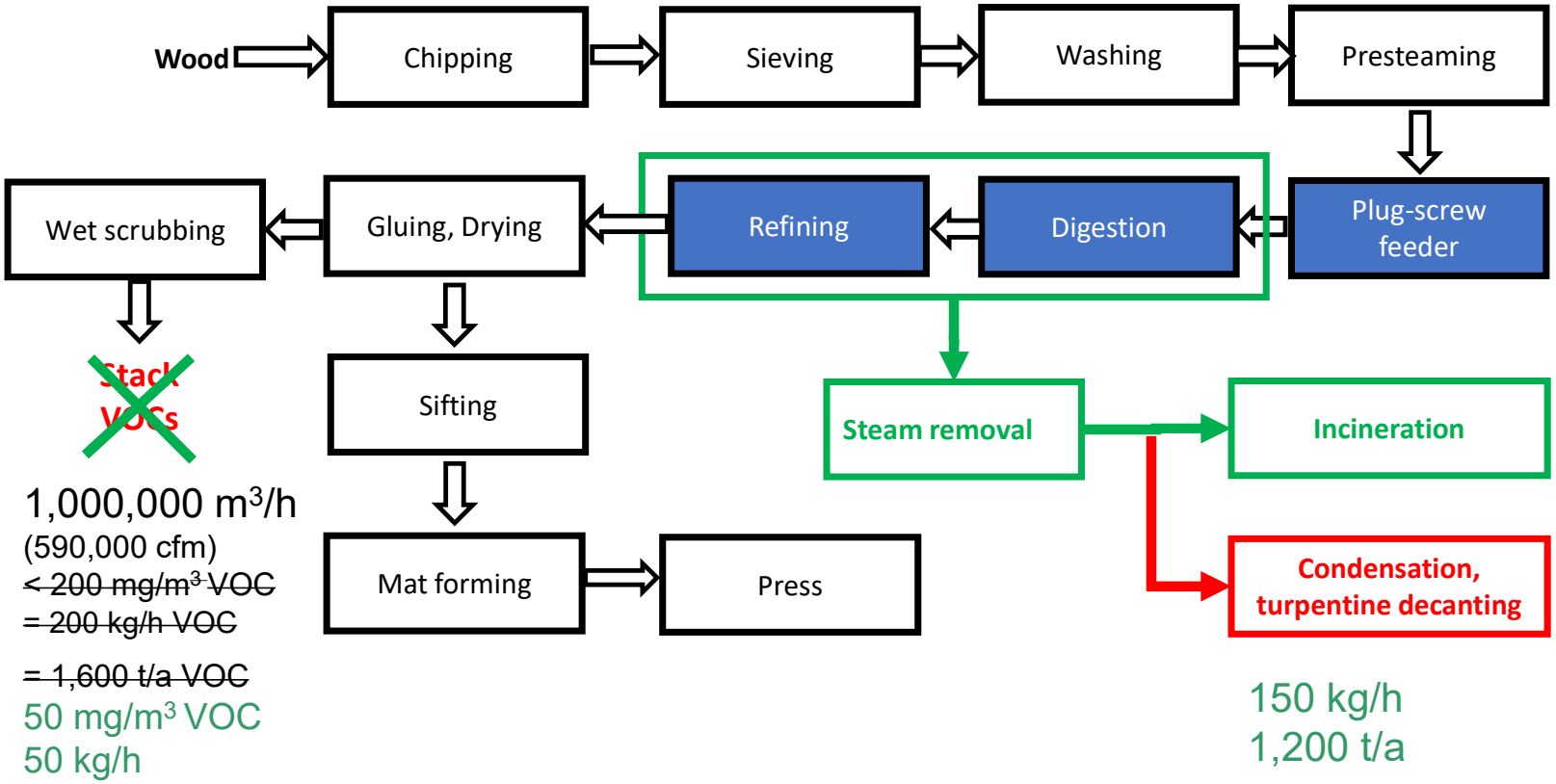
New route to turpentine

- Tree tapping	Gum Turpentine (GT)
- Extraction from pine stumps	Wood Turpentine
- Kraft process at pulp mills	Crude Sulfate Turpentine (CST)
- Medium Density Fiberboard production	MDF-Turpentine (MDF-T)

MDF-process

with VOC reduction
with turpentine production

CLASSEN
Fiberboard GmbH is part of the CLASSEN Group



System installation

CLASSEN
Fiberboard GmbH is part of the CLASSEN Group

Steam removal

Pipe to hot-gas generator

Combustion-chamber inlet

Turpentine plant: installation in 2 steps

CLASSEN®
Fiberboard GmbH is part of the CLASSEN Group

- Emission reduction
  - In industrial production
  - Incineration of steam in power plant
  - Low investment, Low operating costs
  - No authority approval

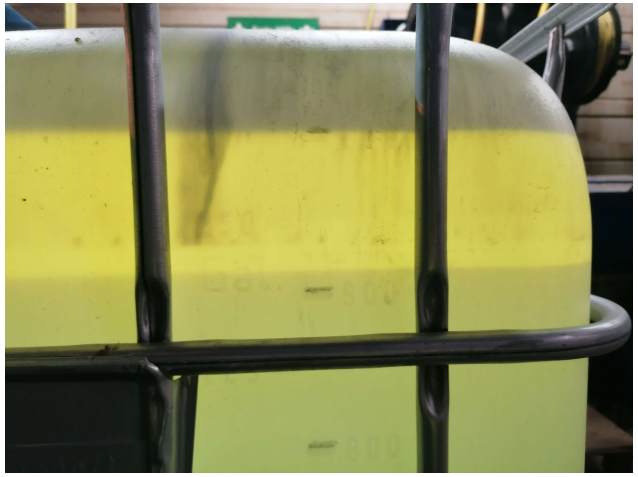
- Production of turpentine
  - Detailed engineering finished, procurement under way
  - Condensing of steam, separation of turpentine
  - Authority approval applied, REACH certification finished
  - Low operating costs due to heat recovery
  - Fast amortization

MDF Turpentine

Fiberboard GmbH is part of the CLASSEN Group

Typical Composition by GC MS for Baruth MDF-T

1. alpha-Pinen e	48,5
2. Camphen	1
3. beta-Pinene	3
4. beta-Myrcen	0,9
5. delta-3-Carene	35,2
6. alpha-Terpinene	0,4
7. p-Cymene	0,7
8. Limonene	3,8
9. Eucalyptol	0,1
10. Ocimene	0,1
11. gamma-Terpinene	0,5
12. Terpinolene	3,3
13. beta-Caryophyllene	0,1



Comparison to former East German Gum Turpentine

CLASSEN®
Fiberboard GmbH is part of the CLASSEN Group

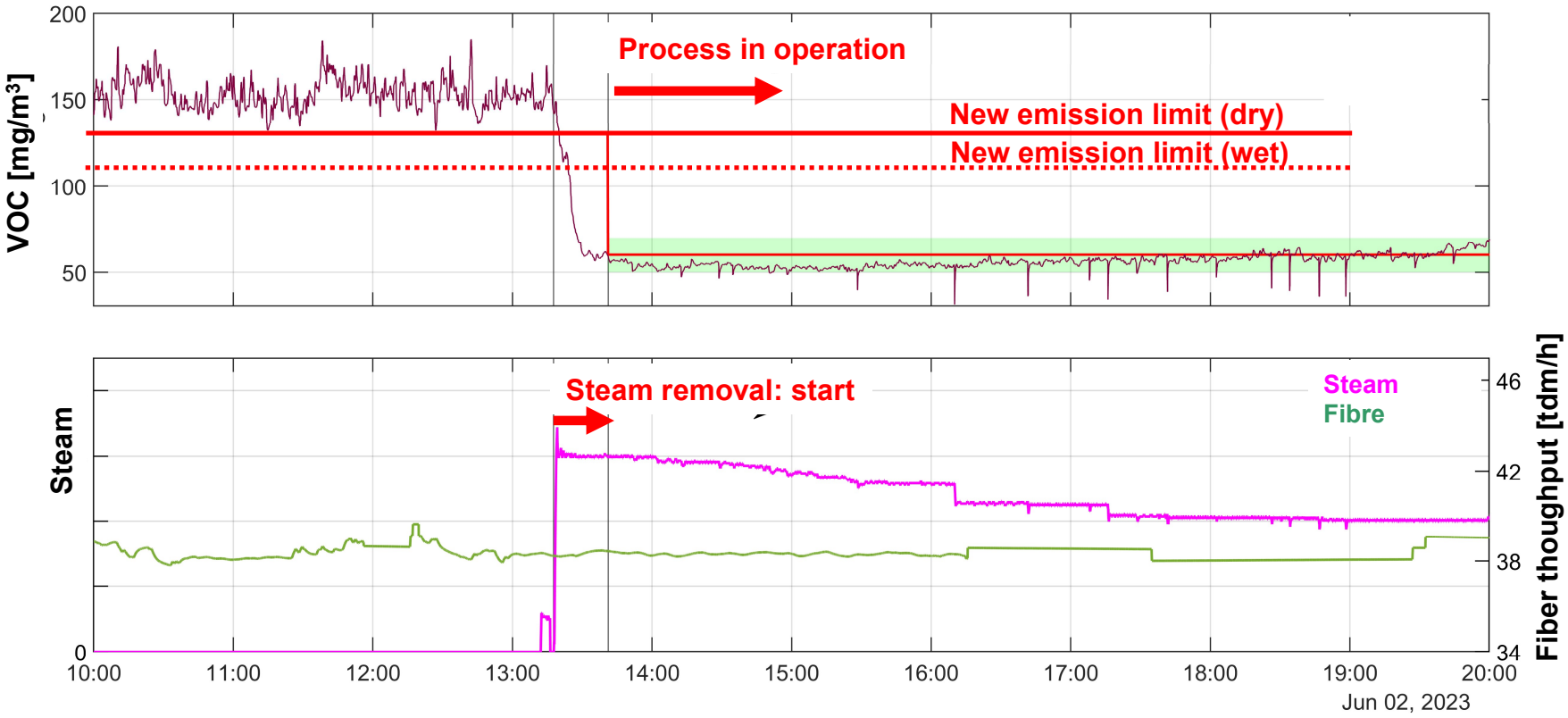
Tabelle 1: Die Zusammensetzung des Terpentinöls. VK = Variationskoeffizient.

Bestandteil	Variation (%)	Mittelwert (%)	VK (%)
α-Pinen	41,5-61,4	52,9	10,0
Camphen	1,2-2,2	1,6	18,8
β-Pinen	1,7-3,6	2,5	25,1
Δ_3-Caren	23,7-35,3	31,5	11,8
Dipenten	0,3-12,8	7,2	49,1
α-Phellandren	0,4-1,3	0,6	38,9
β-Phellandren	0-6,0	0,7	69,3
Terpinolen	0-0,5	0,1	121,9
Cymol	0-4,1	2,9	33,0

MDF turpentine process does not change composition!

Compliance with new emission values

CLASSEN
Fiberboard GmbH is part of the CLASSEN Group



- ✓ Reliable attainment of emission limits
- ✓ Proven in industrial operation

Benefits

CLASSEN®
Fiberboard GmbH is part of the CLASSEN Group

1) Compliance with environmental legislation
   - ✓ EU-BAT: 100 mg/m^3 (wet, old basis)
   - ✓ USA: PSD/ BACT

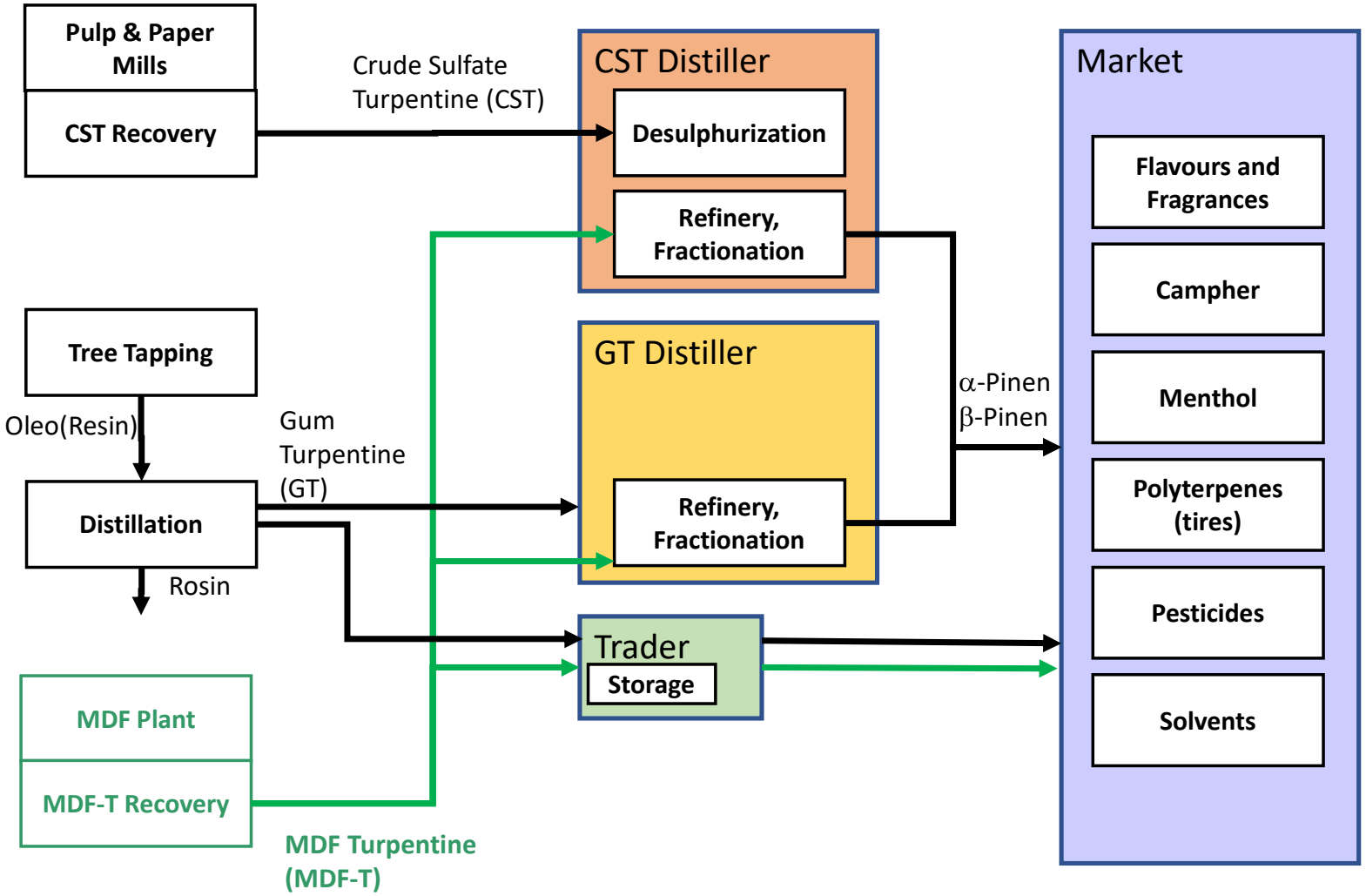
2) Reduction of operating costs
   - ✓ Alternative to Thermal Oxidization (RTO)

3) Revenue creation by turpentine production

4) No influence on product performance

5) Low investment costs, almost no operating costs

Production and Market route for CST, GT, MDF-T



CST, GT: market and amounts

- Crude Sulfate Turpentine (CST, 200 000 tpy)
  - Desulphurization necessary: oxidization of sulfides, costly fractionation
  - Production worldwide, based on pulp and paper industry

- Gum Turpentine (GT, 150 000 tpy)

• China	72 000 tpy
• Brasil	30 000 tpy
• Indonesia	18 000 tpy
• Spain, Portugal, France	9 000 tpy
• Mexico, Honduras	8 000 tpy
• India	3 000 tpy
• Vietnam	3 000 tpy

Comparison CST, GT, MDF-T

- **CST**	Continuous Production +	Sulphur components -	worldwide production O
- **GT**	Seasonal (price volatility) -	no sulphur components +	Dependency on regional suppliers -
- **MDF-T**	Continuous Production +	no sulphur components +	Diversification and local sourcing +

✓ MDF-T combines all the advantages of the available turpentine sources

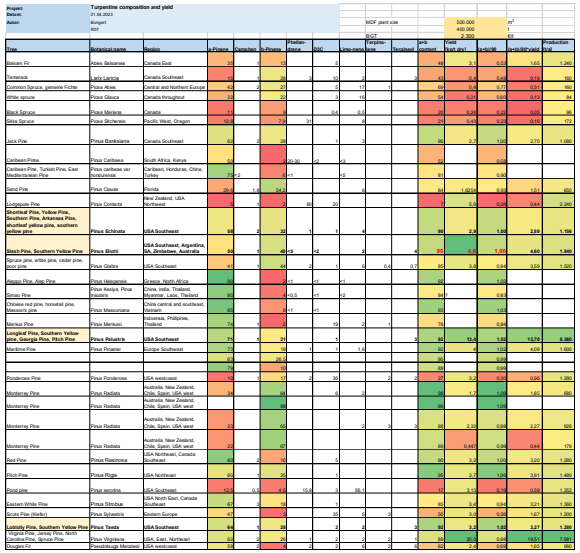
MDF market worldwide and possible theoretical yield *(assumption: 100% use of softwood/ pine)*

MDF market					
Country/ Region	**m3/a**	**t/a**	**Yield low (0,5kg/t) t/a**	**Yield medium (3kg/t) t/a**	**Yield high (6 kg/t) t/a**
Germany	4.100.000	3.280.000	1.640	9.840	19.680
Belarus	1.050.000	840.000	420	2.520	5.040
France	1.040.000	832.000	416	2.496	4.992
Italy	1.050.000	840.000	420	2.520	5.040
Poland	2.890.000	2.312.000	1.156	6.936	13.872
Russia	4.400.000	3.520.000	1.760	10.560	21.120
Spain	1.350.000	1.080.000	540	3.240	6.480
Portugal	625.000	500.000	250	1.500	3.000
Turkey	7.494.000	5.995.200	2.998	17.986	35.971
Europe	**23.999.000**	**19.199.200**	**9.600**	**57.598**	**115.195**
China*	65.000.000	52.000.000	26.000	156.000	312.000
Thailand	4.300.000	3.440.000	1.720	10.320	20.640
Iran	3.000.000	2.400.000	1.200	7.200	14.400
India	2.000.000	1.600.000	800	4.800	9.600
Korea	2.000.000	1.600.000	800	4.800	9.600
Vietnam	900.000	720.000	360	2.160	4.320
Others	5.500.000	4.400.000	2.200	13.200	26.400
Asia	**75.000.000**	**60.000.000**	**30.000**	**180.000**	**360.000**
Australia	530.000	424.000	212	1.272	2.544
New Zealand	810.000	648.000	324	1.944	3.888
Oceania	**1.340.000**	**1.072.000**	**536**	**3.216**	**6.432**
North Am.	**6.150.000**	**4.920.000**	**2.460**	**14.760**	**29.520**
South Am.	**8.800.000**	**7.040.000**	**3.520**	**21.120**	**42.240**
WORLD*	**115.289.000**	**92.231.200**	**46.116**	**276.694**	**553.387**
* Installed capacity, real production not known					

- Predominant material is softwood from pine or spruce
- Hardwood, eucalyptus, rubber tree, acacia are used in lesser amounts
- 150,000 tonnes per year is a realistic potential

Softwood: turpentine composition and yield

- Turpentine composition and yield are compiled from all over the world (ongoing)
- Additional data is generated by steam distillation and GC-MS in lab (ongoing)
- Evaluation of quality by
  - Yield [kg turpentine/ t dry wood]
  - α, β pinene content
  - Quality factor QF
    = (% α, β pinene)/
    (% α, β pinene Pinus eliotti, Brasil = 90%)



Project:	Turpentine composition and yield																	
Result:	27.06.2023																	
Autor:	Bungert								MDF plant size				500.000	m³				
	Alt2												400.000	t				
													2.000.000					
													GGT				EK	
Tree	Botanical name	Region	α-Pinene	Camphene	β-Pinene	Phellandrene	OAK		Longi-tudinal	Tangential	Terpinene	Tersilinene	Berb content	Yield [kg/t dry]	α+β/QM	α+β/EK/Yield	α+β/EK/Yield	Production [t/a]
Balsam Fir	Abies balsamea	Canada East	15		1	12		5					48	3,1	0,53	1,63		1.240
Tamarack	Larix laricina	Canada Southeast	18		2	20	1	10	2			2	43	0,4	0,49	0,19		384
Common Spruce, gemeine Fichte	Picea Abies	Central and Northern Europe	42	2	27			5	17	1			65	0,4	0,77	0,31		160
White spruce	Picea Glauca	Canada throughout	42		20			3	14				44	0,2	0,60	0,13		64
Black Spruce	Picea Mariana	Canada	12		12		0,4		0,5				45	0,35	0,22	0,14		56
Sitka Spruce	Picea Sitchensis	Pacific West, Oregon	10,9		7,9	31			6				47	0,45	0,23	0,10		172
Jack Pine	Pinus Banksiana	Canada Southeast	52	2	28		1		2				55	2,7	1,00	2,70		1.080
Caribean Pine	Pinus Caribaea	South Africa, Kenya	68			20-30	<1	<1					68		0,68			
Caribean Pine, Turkish Pine, East Mediterranean Pine	Pinus caribaea var hondurensis	Caribean, Honduras, China, Turkey	60-62		0-11			<5					51		0,90			
Sand Pine	Pinus Clausa	Florida	25,5	1,8	54,1				8				53	1,0-2,5	0,63	1,13		200
Lodgepole Pine	Pinus Contorta	New Zealand, USA Northwest	12		1	69	20						12	0,5	0,08	0,04		2.240
Shortleaf Pine, Yellow Pine, Southern Pine, Arkansas Pine, shortleaf yellow pine, southern yellow pine	**Pinus Echinata**	**USA Southeast**	**55**	**2**	**33**	**1**	**1**	**4**					**55**	**2,9**	**1,60**	**2,63**		**1.150**
Slash Pine, Southern Yellow Pine	**Pinus Elliotti**	**USA Southeast, Argentina, SA, Zimbabwe, Australia**	**60**	**1**	**40-45**	**<2**		**2**			**4**	**90**	**90**	**6,5**	**1,00**	**4,40**		**1.980**
Spruce pine, white pine, cedar pine, pitch pine	Pinus Glabra	USA Southeast	47	1	49	2	1	2	0,4	0,1			60	3,0	0,94	3,54		1.520
Aleppo Pine, Alep Pine	Pinus Halepensis	Greece, North Africa	58		1-2,1	<1	<1						58		1,50			
Gemeo Pine	Pinus Kesiya, Pinus merkuiis	China, India, Thailand, Myanmar, Laos, Thailand	60		1-2,5	<1	<2						54-7		0,93			
Chinese red pine, horsetail pine, Mexicans pine	Pinus Massoniana	China central and southeast, Vietnam	60		1-1,1	<1							55		1,03			
Merkus Pine	Pinus Merkusii	Indonesia, Philippines, Thailand	70	1	2		19	2	1				75		0,84			
Loblolly Pine, Southern Yellow pine, Georgia Pine, Pitch Pine	**Pinus Pelustris**	**USA Southeast**	**71**	**1**	**21**		**1**				**2**	**85**	**15,4**	**1,03**	**13,72**	**8.380**	
Maritime Pine	Pinus Pinaster	Europe Southwest	72		18		1	1,5				65		1,02	4,05	1.600	
			58		28,5							55		0,69			
			72		12							55		0,60			
Ponderosa Pine	Pinus Ponderosa	USA westcoast	52	1	27	2	36			2	2	57	3,2	0,33	0,95	1.280	
Monterey Pine	Pinus Radiata	Australia, New Zealand, Chile, Spain, USA west	52		40		8	2				58	1,7	1,09	1,91	680	
Monterey Pine	Pinus Radiata	Chile, Spain, USA west			40							58		1,09			
Monterey Pine	Pinus Radiata	Australia, New Zealand, Chile, Spain, USA west	53		60			2	2	2	2	58	2,32	0,88	2,27	920	
Monterey Pine	Pinus Radiata	Australia, New Zealand, Chile, Spain, USA west	51		47							58	0,447	0,99	0,44	175	
Red Pine	Pinus Resinosa	USA Northwest, Canada Southeast	50	2	13		2					58	3,2	1,03	3,30	1.280	
Rich Pine	Pinus Rigia	USA Northwest	50	1	30		1					58	3,1	1,08	3,61	1.480	
Pond pine	Pinus serotina	USA Southeast	11,7	0,7	4,1	15,8	3	55,1				17	3,1	0,19	0,59	1.230	
Eastern White Pine	Pinus Strobus	USA North East, Canada Southeast	47	1	19		1					45	3,4	0,94	3,21	1.560	
Scots Pine (Kiefer)	Pinus Sylvestris	Eastern Europe	47			35	6	2				58	3,0	0,56	1,67	1.200	
Loblolly Pine, Southern Yellow Pine	**Pinus Taeda**	**USA Southeast**	**54**	**1**	**28**	**2**	**2**			**3**	**58**	**3,3**	**1,03**	**3,27**	**1.280**	
Virginia Pine, Jersey Pine, North Carolina Pine, Spruce Pine	Pinus Virginiana	USA, East, Northeast	53	2	25	1	2	2	2	1	55	20,0	0,68	18,61	7.980	
Douglas Fir	Pseudotsuga Menziesii	USA westcoast	34	2	5	3	2	5	3	4	55	2,4	0,69	1,61	640	

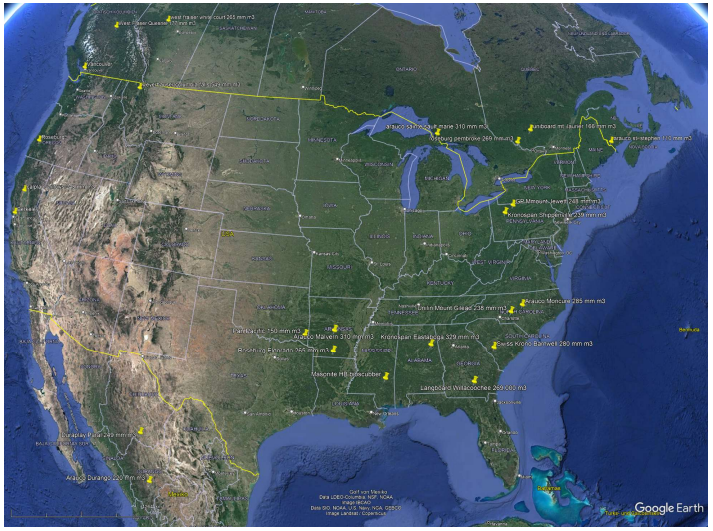
Business case examples: MDF Turpentine from 6 locations

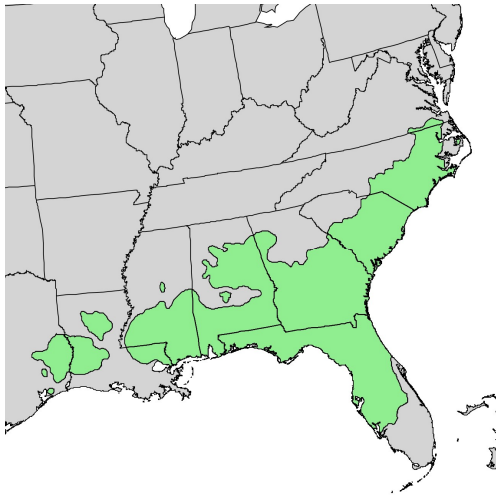
1) Baruth Germany (500,000 m^3/a; Pinus Sylvestris)
2) Brasil (600,000 m^3/a; Pinus Eliotti)
3) USA (300,000 m^3/a; Pinus Palustris)
4) Australia, New Zealand (300,000 m^3/a; Pinus Radiata)
5) Portugal, Spain (300,000 m^3/a; Pinus Pinaster)
6) Turkey (880,000 m^3/a; Pinus Sylvestris)

Business Case	Tree	Botanical name	Region	a-Pinene	b-Pinene	a+b content	QF = (a+b)/ (a+b) El.	Yield [kg/t dry]
	Common Spruce	Picea Abies	Central and Northern Europe	42	27	69	0,77	0,4
	Shortleaf Pine, Yellow Pine, Southern Pine, Arkansas Pine, shortleaf yellow pine, **southern yellow pine**	Pinus Echinata	USA Southeast	58	32	90	1,00	2,9
2) Brasil	Slash Pine, **Southern Yellow Pine**	**Pinus Eliotti**	**USA Southeast, Argentina, Brasil, SA, Zimbabwe, Australia**	**50**	**40**	**90**	**1,00**	**4,6**
3) USA	Longleaf Pine, **Southern Yellow pine**, Georgia Pine, Pitch Pine	Pinus Palustris	USA Southeast	71	21	92	1,02	13,4
5) P, E	Maritime Pine	Pinus Pinaster	Europe Southwest	73	19	92	1,02	4
				63	26,5	90	0,99	
				79	10	89	0,99	
4) AUS, NZ	Monterrey Pine	Pinus Radiata	Australia, New Zealand, Chile, Spain, USA west	34	64	98	1,09	1,7
	Monterrey Pine	Pinus Radiata	Australia, New Zealand, Chile, Spain, USA west	23	65	88	0,98	2,32
	Monterrey Pine	Pinus Radiata	Australia, New Zealand, Chile, Spain, USA west	22	67	89	0,99	0,45
1) D	Scots Pine (Kiefer)	Pinus Sylvestris	Eastern Europe	48	3	51	0,57	3,0
	Loblolly Pine, **Southern Yellow Pine**	Pinus Taeda	USA Southeast	64	28	92	1,02	3,2

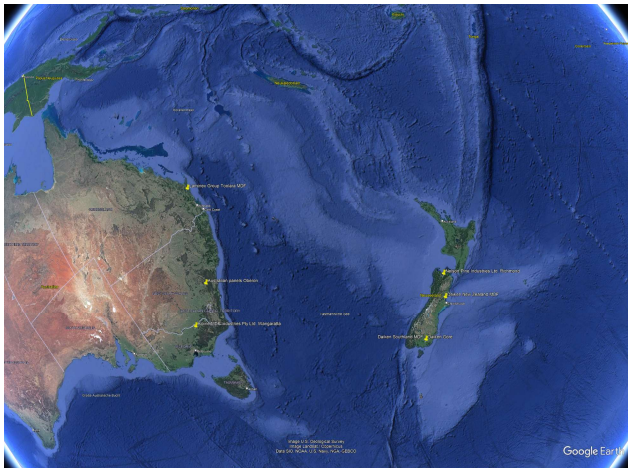
Brasil: Slash Pine, Southern Yellow Pine (Pinus Eliotti) 600,000 m^3/a

USA: Longleaf Pine, Southern Yellow pine, Georgia Pine, Pitch Pine (Pinus Palustris) 300,000 m^3/a

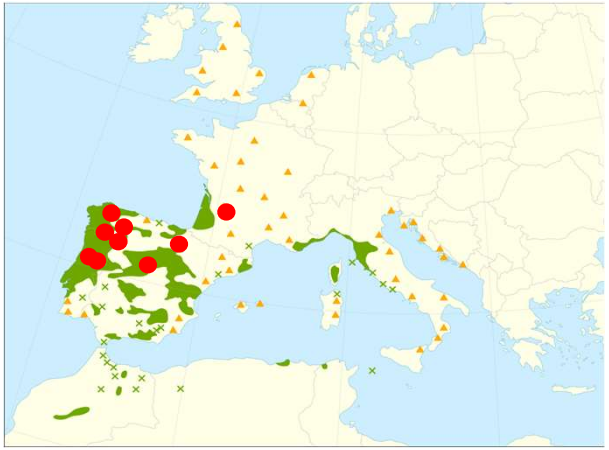




Australia, New Zealand: Monterey pine (pinus radiata) 300.000 m^3/a



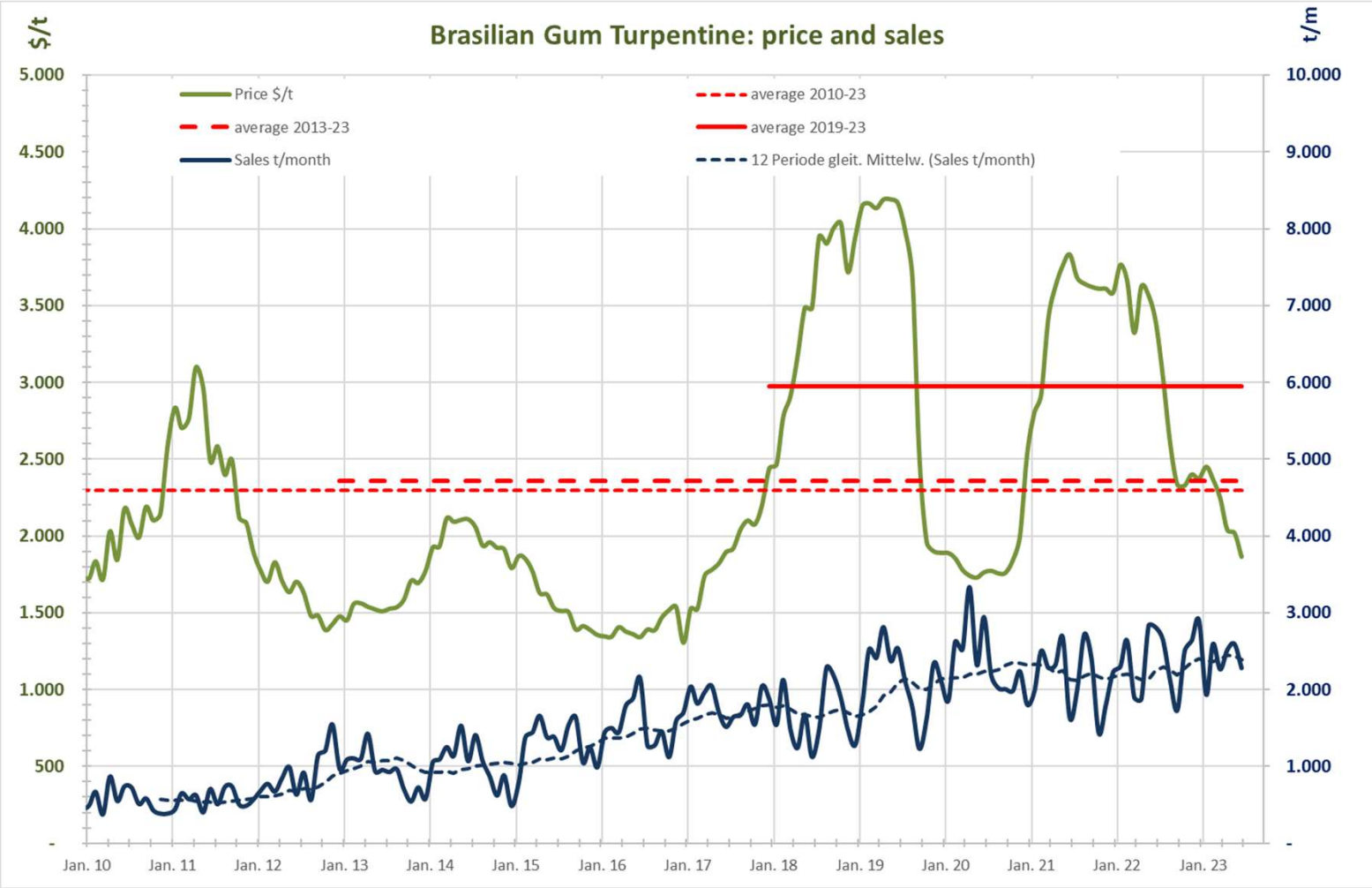
Portugal, Spain: Maritime pine (pinus pinaster) 300.000 m^3/a



● MDF sites

Source: wikipedia

Brasilian Gum Turpentine: monthly price and sales



Source: Comexstat, Brazilian foreign trade statistics

Comparison of 6 busines cases

- For purposes of illustration only
- An hypothetical price* was calculated from the (α+β) content based on
  - 14 year average price for Brasilian Gum Turpentine
  - BT = $ 2300/ ton (€ 2150/ton)
  - Price = QF * BT
- All cases are interesting for the MDF industry to start turpentine recovery

Nr.	Site	MDF m^3/a	Wood t/a	Turpentine kg/t	Turpentine t/a	(a+b)/ (a+b) e	Turpentine €/t *	Estimated* Revenue [€]	€/m^3 MDF
1	Baruth, Germany	500.000	400.000	3	1.200	0,55	1.183	1.419.000	2,8
2	Brasil	600.000	480.000	4,6	2.208	1,00	2.150	5.520.000	9,2
3	USA	300.000	240.000	13,4	3.216	1,02	2.193	8.200.800	27,3
4	Aus, NZ	300.000	240.000	1,7	408	1,09	2.344	1.111.800	3,7
5	Spain	300.000	240.000	4	960	1,02	2.193	2.448.000	8,2
6	Turkey	880.000	704.000	3,5	2.464	0,68	1.462	4.188.800	4,8

* No business information, only meant to assess an order of magnitude

Timeline for projects

✓ Emissions (MDF-VOC)

- Installation within less than ½ year possible
- In Europe: usually only notification of authorities necessary
- In US: application process with EPA and local authorities + continuous monitoring of VOC emission

✓ Turpentine Recovery (MDF-T)

- Installation within 1 year (delivery time of long-lead items like automization parts has to be checked)
- Technology transfer via Process Design Package (PDP) after commercial agreement
- Authority engineering: application process necessary
- System built modular (2 sizes, 3 options for heat recovery depending on site specific heat sinks)
- Engineering, procurement, construction (EPC)
  - Inhouse or
  - Preferred contractors experienced from turpentine recovery from pulp mills (CST) are available

Market & Project development

✓ Emissions (MDF-VOC)

- After Baruth, the first system of a licensee will be installed in Q4.2023
- Negotiations with other European and US producers in progress

✓ Turpentine Recovery (MDF-T)

- Negotiations have begun
- Most important market segments have been identified and are beeing adressed:
  - Over 320 MDF sites worldwide
  - Production rate, raw material (pinus xxx) are known
  - Marketing and Sales Process has started
- Possible licensing options:
  - Gobal MDF players (internationally operating companies)
  - Turpentine Distillers
    - Sales agreement, e.g. countrywise
    - Contracting/ Operating model
  - Turpentine Recovery Contractors

Conclusions

- New source of turpentine: MDF-Turpentine
- Process solves environmental problems and additionally creates revenue for MDF producers
- Worldwide potential > 100 000 tpy
- Yield and composition depends on raw material used („pinus xxx“)
- All of the ~ 320 worldwide sites and their turpentine potential are known
- Licensing options are still open
- A completely new business in pine chemicals industry has started

Contact persons

Prof.-Dr.-Ing. Bernd Bungert
Bungert@IB-Bungert.de
Bernd.Bungert@BHT-Berlin.de
+49 176 5532 6667

Kai Greten
Kai.Greten@Fiberboard.de

Fiberboard GmbH
An der Birkenpfuhlheide 4
15837 Baruth/Mark