

**PRODUCTION OF MISCANTHUS,
SORGHUM and CORN**

PRODUCTION OF PULP

PRODUCTION OF PAPER

MARKET ADVANTAGES



Why Miscanthus?

- Safety of supply
- Whole production of Miscanthus is completely mechanized and conventional agricultural machines can be used
- More than 25 years of exploiting period
- Low moisture, no need for drying
- Fields of Miscanthus have lower content of nitrate in subterranean waters
- Miscanthus stores CO₂ in the ground
- In the first year there is minimal feed and pesticides are not used

Description of Miscanthus

- Miscanthus x Giganteus is a C4 plant. C4 plants in comparison with C3 plants (grass, grain...) performs photosynthesis quicker, C4 plants have a possibility of using a low concentration of CO₂ for photosynthesis, that makes them durable and long lasting.
- Every year after the harvest, new plants are developed. Profitability will be longer than 30 years.
- Miscanthus has the largest potential of dry matter for production in all power plants. On good land, income can be 15-25 tons of dry matter, which is the same as 6.000 – 10.000 liters/Ha of fuel.

Rhizomes



General quality of our rhizomes are optimal climate and ground conditions. By using rhizomes 2-3 years old, we have a guarantee of fast development of supply and good contribution in second year !!

Hand made production of rhizomes



To ensure good quality, rhizomes are cut by hand into an appropriate dimension which results in more than 90% of fouling!

Planting



Planting is made mostly with simple machines.

For larger area, automatic machines can be used for planting rhizomes.

2 months after plantation



Development in first year



Supply in August



In August, the plant is in its full growth.

In optimal conditions, growth is possible over 4 m.

Miscanthus in Winter



Fall of the leaves



Leaves fall after the first frost. All nutrients are stored in Rhizomes.

Harvest



In the first year there is no harvest.

Conventional machine for picking corn and square bales can be easily used.

For regional use, harvest can be made with a machine for picking corn.

Harvest of the bales

In second year, by the middle of April, all the crops will be harvested below 15% of the moisture.

Conventional machines are used.

Optimal technique of harvest is cutting of the stem and pushing them in square bales.

It can be achieved $280 \text{ kg} / \text{m}^3$, that is around 1.250 kWh po m^3 . (sawdust $850 \text{ kWh} / \text{m}^3$). Harvest is made in the middle of April.



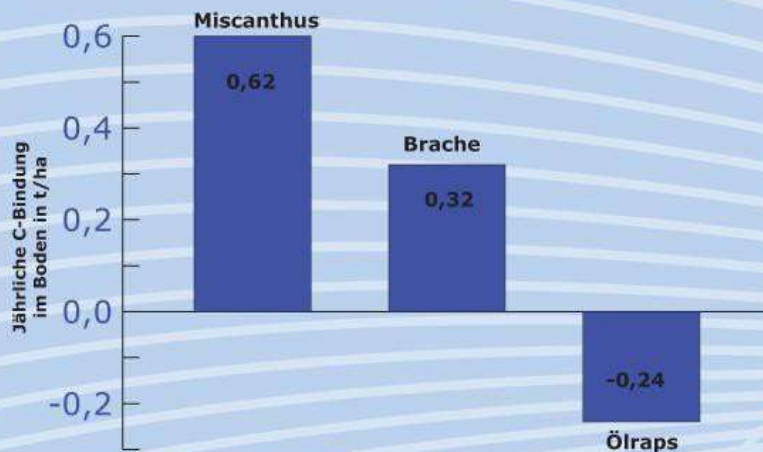
Estimation of life cyclus(Ökobilanz - LCA)

of CO₂

Miscanthus binds more CO₂ than it emits through production (harvest etc) and combustion.

Miscanthus has higher C-potential for storage than fallow area and therefore it contributes protection of climate

C-Bindung im Boden



Quelle: BRANDAO/MILA I CANALS/CLIFT: Soil organic carbon changes in the cultivation of energy crops: Implications for CHG balances and soil quality for use in LCA: Elsevier Science Ltd: 2010

CO₂-Einsparung Miscanthus



Quelle: eigene Berechnung

Compared with others, Miscanthus bonds more CO₂ in the ground and contributes high CO₂ savings for the whole lifecycle.

SORGHUM



What is sorghum?

- Sorghum is annual plant
- There are different types of plant regarding the purpose
- It is used as cereal, forage, in alcohol production and in beer production

Why Sorghum?

- Sorghum has low requirement regarding land
- High resistance to drough and high temperature
- High resistance to diseas and pests
- Wide palette od hybrids
- High cellulose pulp content

Sorghum benefits

- Sorghum yield is 100 t/ha
- Dry content for cellulose pulp production is 32 t/ha
- All over the world is planted more than 50 mil hectres of Sorghum
- For cellulose pulp production all types and hybrids are suitable

Planting and developement

- Sorghum is planted in May
- It is possible to achive density of 20 plants/m²
- Plant height 3.5-4.5 m



CORN



Why Corn

- Corn is annual plant that is spread across whole world
- It is industrial plant that has wide spectrum of application that is used in food industry, forage industry, for alcohol production and similar

- High prevalence of corn in Europe provides good possibility for cellulose plant mills in almost every agricultural area in Europe and makes logistics for plant work simpler
- Corn stem are biggest potential source for cellulose production raw material

- Ideal raw material for production based on our technology is dry stem that is residue after the harvest
- Yield per hectare is about 30 ton of dry content
- Usage of stem regarding dry content is 65%
- Cellulose produced from corn stem can have brightness higher than 91%, and mechanical properties meet highest standards
- This cellulose can be used for production of any type of graphic and packaging papers

New technology, patent number:
WO 2015/150841 A1
PCT/HR2016/000014

New technology of pulp production



New technology that has been patented, presents a revolutionary change in production of pulp.



Revolutionary, because nothing significant has happened in the last 60 years.



It is possible to produce pulp from Miscanthus with this technology, with characteristics shown in next chart:

As you can see from the chart we can produce pulp with better mechanical and optical properties then from the wood (birch, poplar, willow, beech etc.)

Sample	Parameter	Units	Measured value
PS-14-16-1 Milled,whitened	Grammage	g/m ²	96,11
	Breaking lenght	km	7,700
	Tear Index	kPam ² /g	3,50
	Opacity	%	83,40
	ISO brightness	%	97,66
	CMT ₀	N	180,3
	CMT ₃₀	N	145,9
	SCT	kN/m	1,8
PS-14-16-2 Without milling, whitened	Lignin content	%	4,8
	Grammage	g/m ²	100,92
	Breaking lenght	km	7,100
	Tear Index	kPam ² /g	3,25
	Opacity	%	85,13
	ISO brightness	%	97,94
	CMT ₀	N	188,8
	CMT ₃₀	N	150,2
SCT	kN/m	1,7	

Production Process

In the production process 72% of the plant is usable, and from the rest (sugar, starch) a quality raw material can be produced for production of connective tissue for coated papers.

With the utilization of processing residues Miscanthus goes up to 92% efficiency.



In the process of production, more than 2/3 of the processed water is recycled and 2/3 of the actively unused chemicals is recycled also.



The rest of the processed water with heavy metals is neutralised. Heavy metals are deposited and collected, and the processed water is used in the sequel of production process in the part of production of paper.



Complete procedure requires lower than 100 C°, that is the temperature that allows complete preservation of the quality of pulp fibers, respectively chemical structure of the pulp is not deformed.

Optical whiteness of the pulp is obtained with the procedure with default norms and it can achieve 98% of the whiteness, and that allows production of the most expensive papers in mass production.

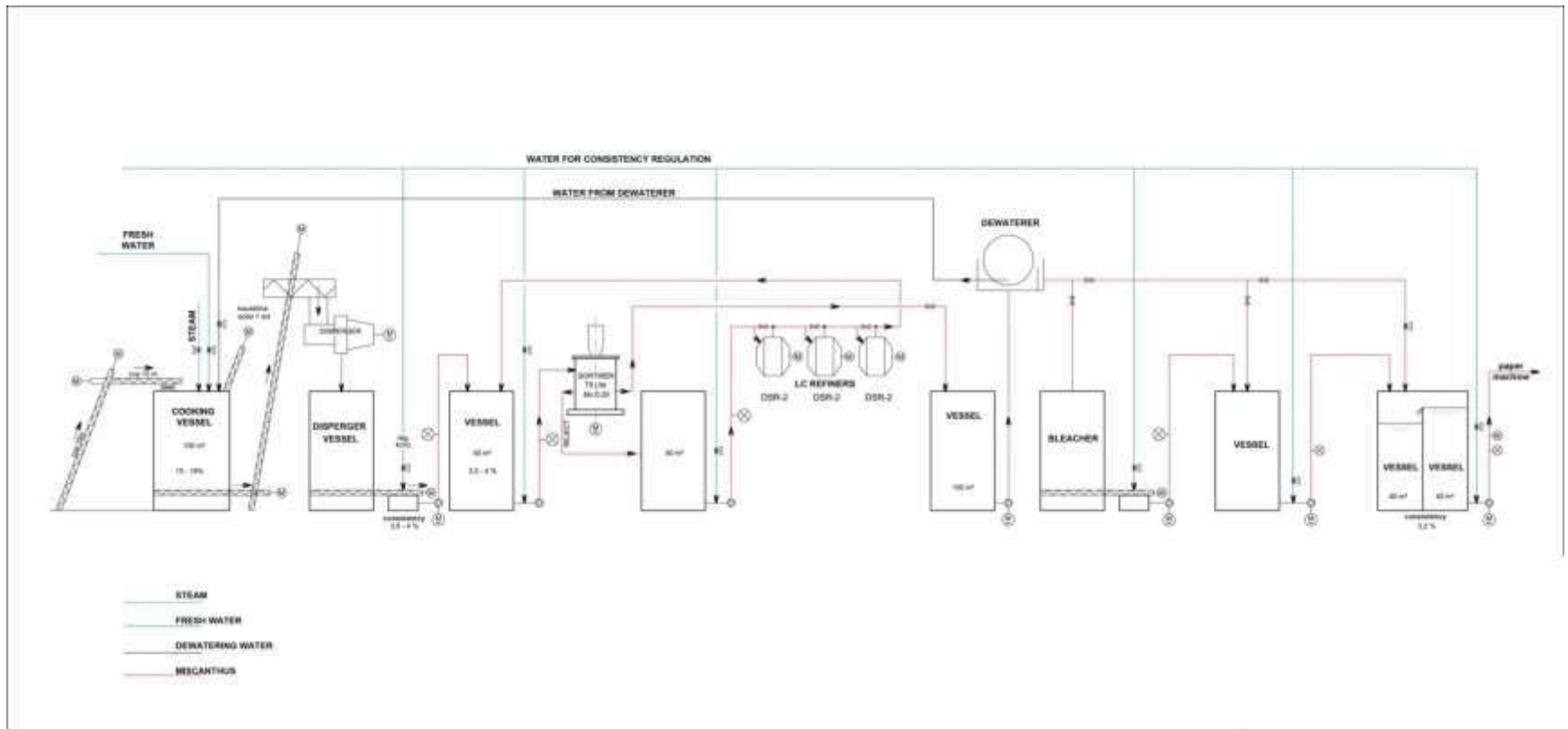
Produced pulp used in paper production generally does not require additional milling.

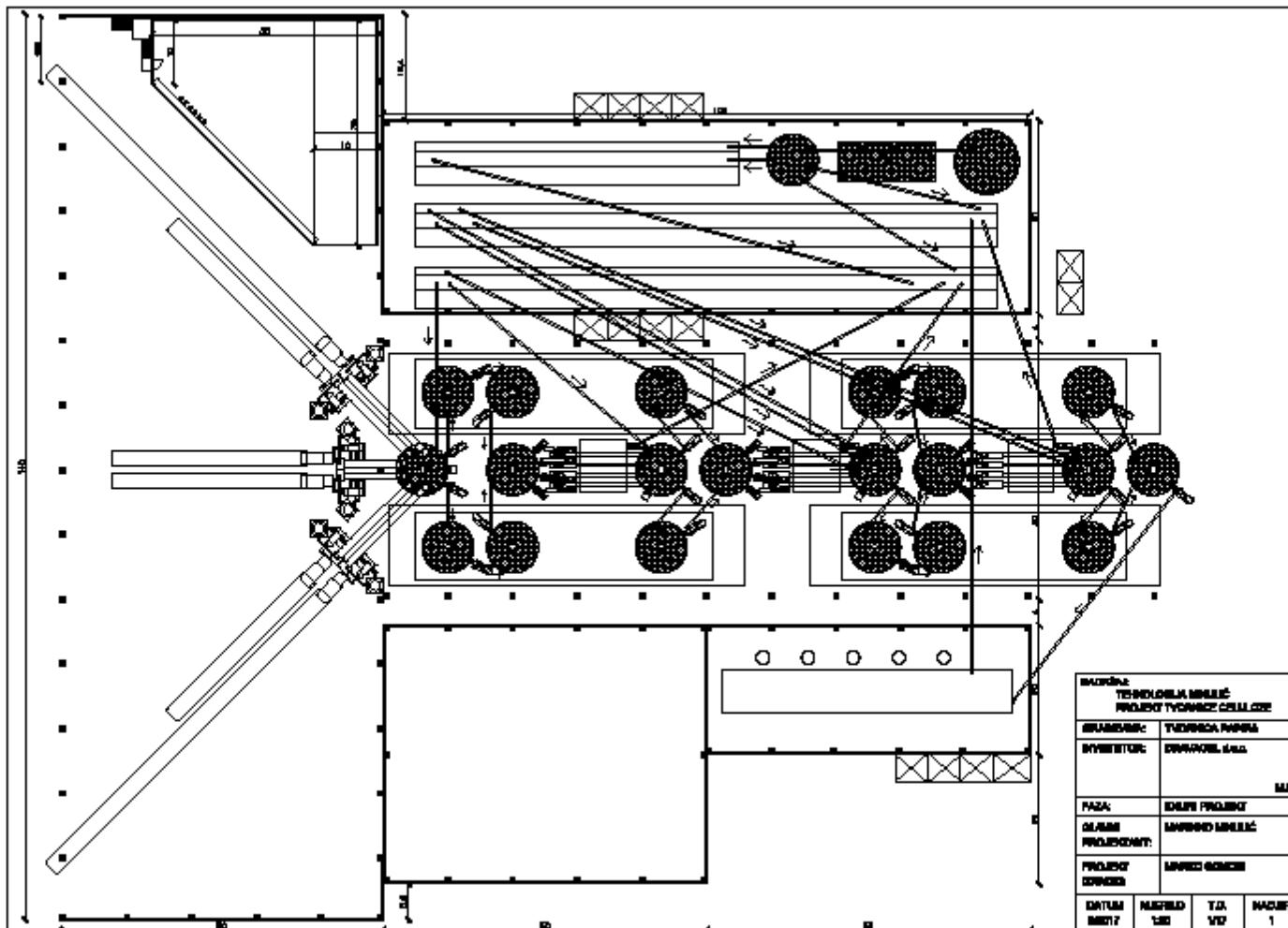
Freeness is about 50 °SR



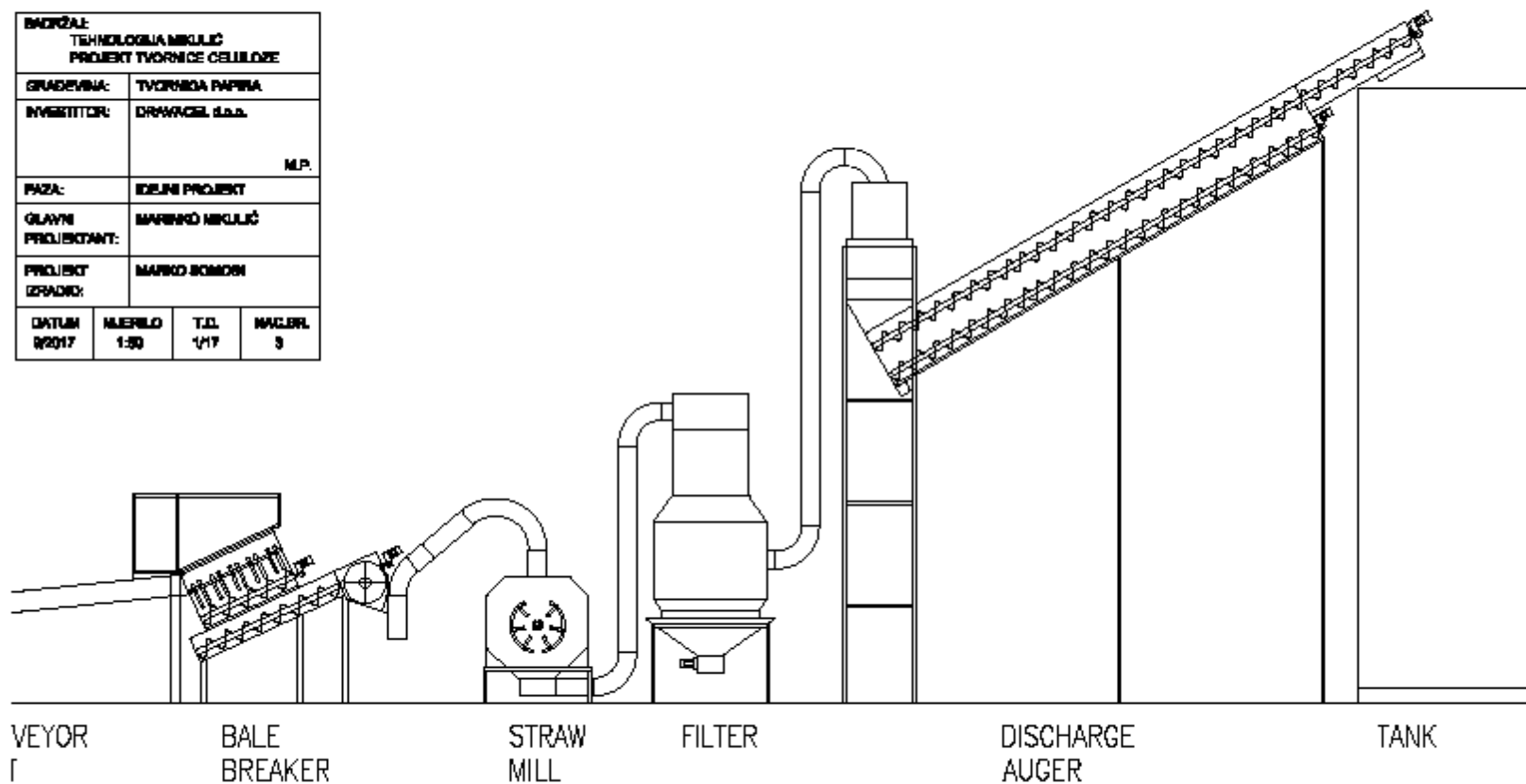


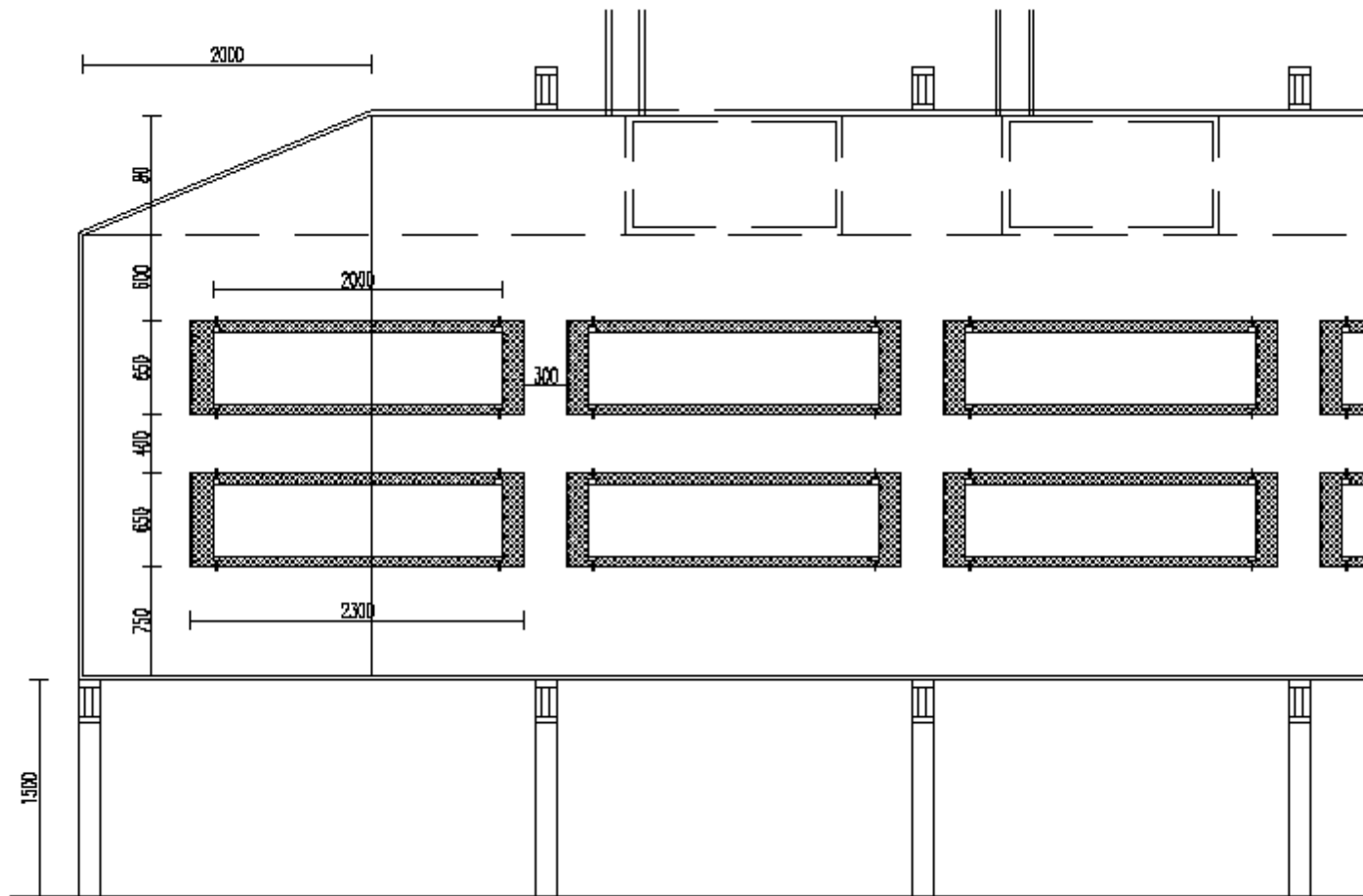
Sketch of Process





BADŹAL: TEHNOLOGIJA MEKLIČ PROJEKT TVORNIČE CELULOZE			
GRADIVINA:	TVORNIČA PAPIRA		
INVESTITOR:	DRVAČEL d.d.		
	M.P.		
FAZA:	IZJELNI PROJEKT		
GLAVNI PROJEKTANT:	MARKO MEKLIČ		
PROJEKT IZRAĐIO:	MARKO BOMBIH		
DATUM 2017	MSERLO 1:50	T.J.L. 1/17	NAČERL. 3





Equipment

All parts of the equipment that is necessary for production of pulp can be produced in larger European countries, with the highest standards.

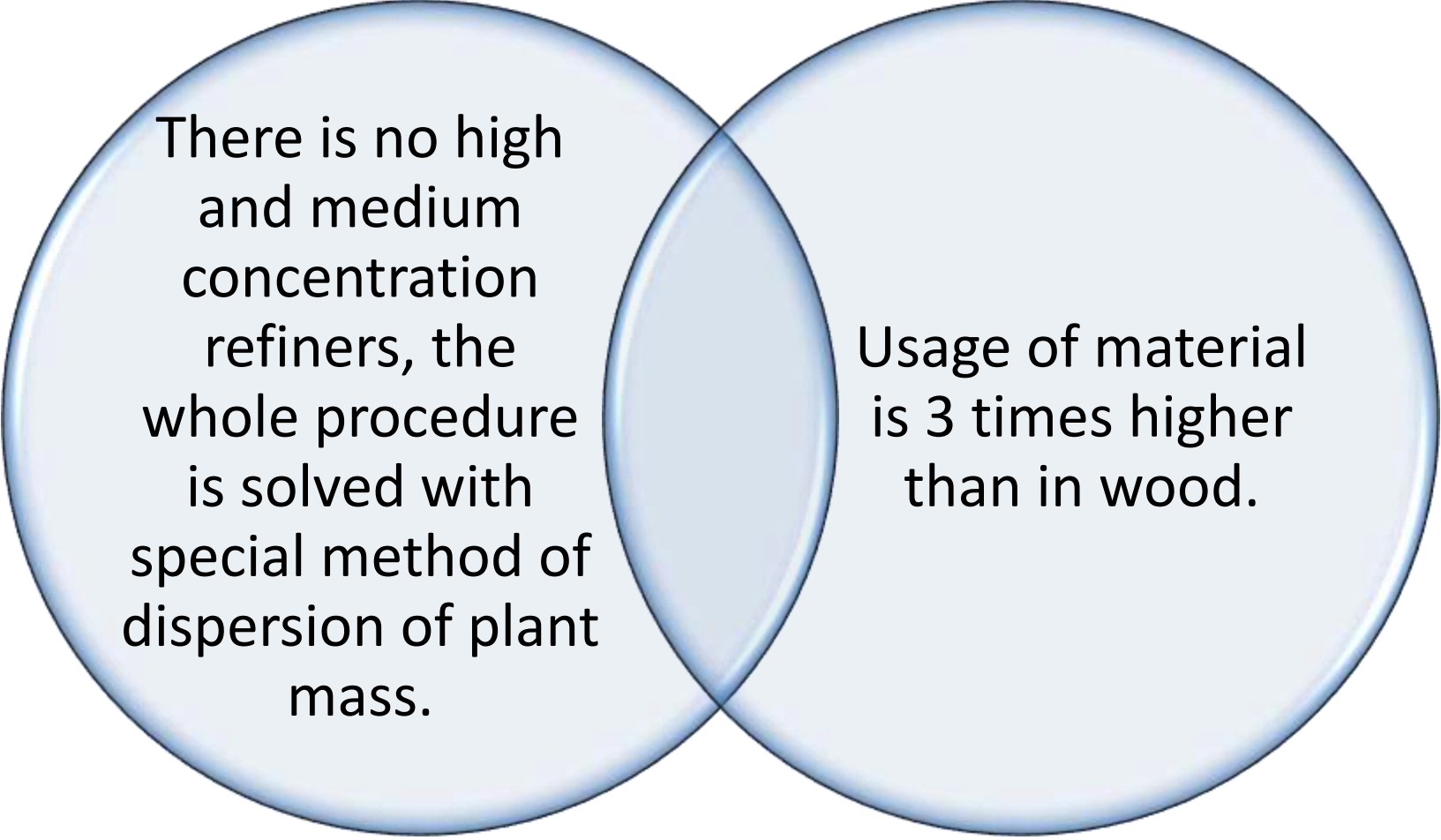
Special parts of the equipment and complete installation present our own know-how, and it also presents most closely guarded business secret.

Equipment

Warranty period for all equipment is 5 years.

During the period of patent protection only we are authorized for maintenance and spare parts replacement.

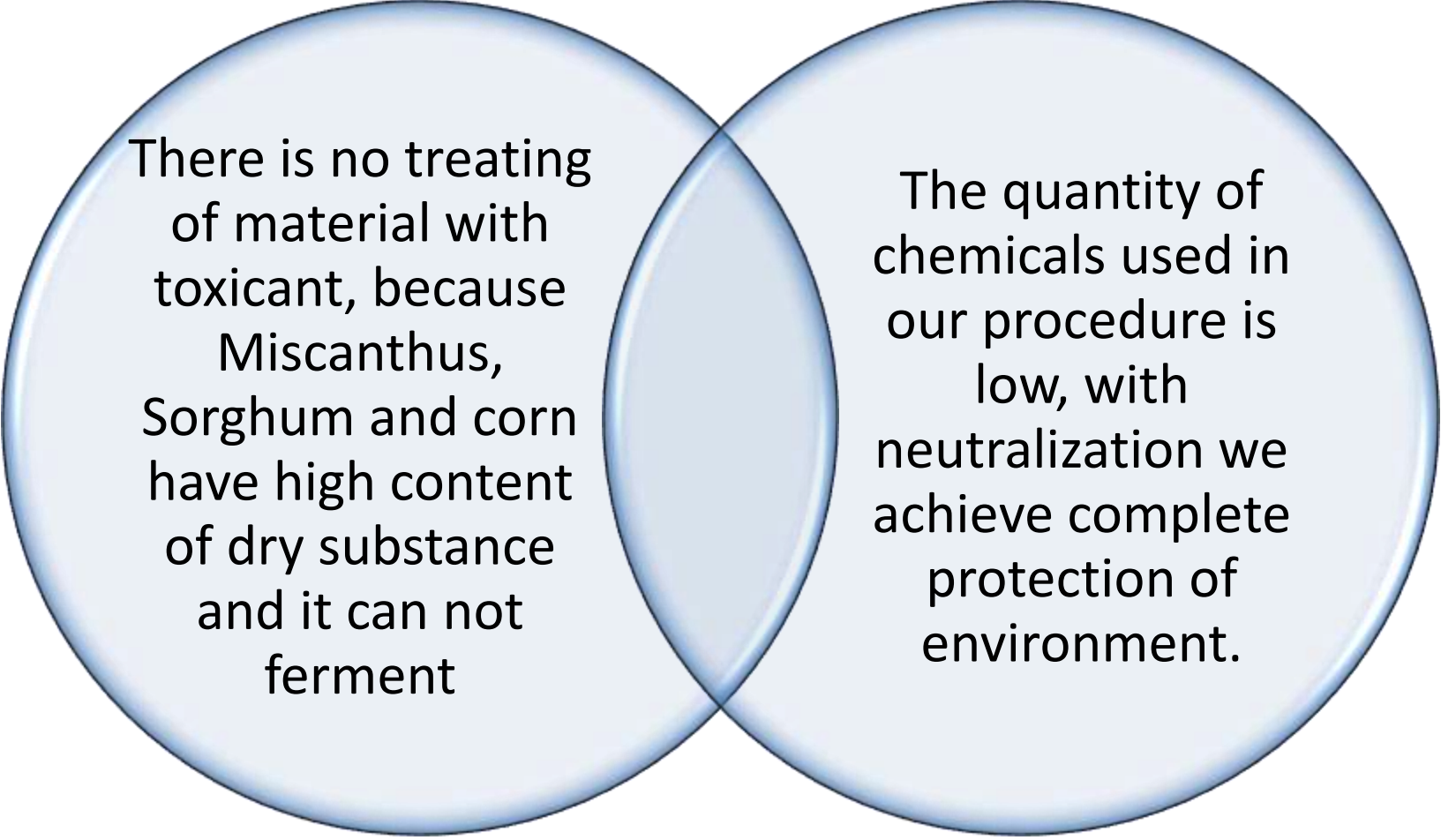
Reduced Energy Consumption



There is no high and medium concentration refiners, the whole procedure is solved with special method of dispersion of plant mass.

Usage of material is 3 times higher than in wood.

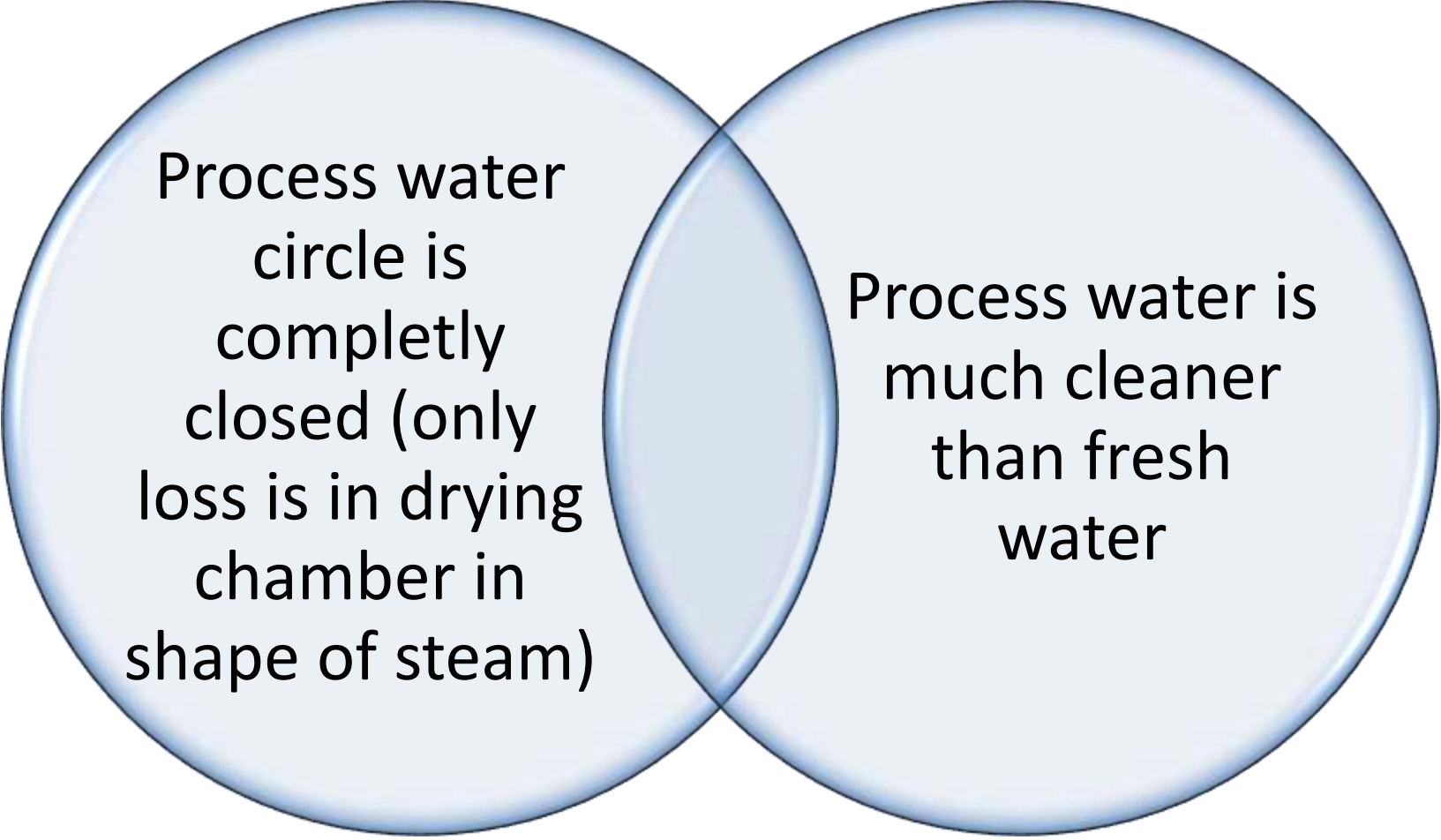
Reduced Chemical Consumption



There is no treating of material with toxicant, because Miscanthus, Sorghum and corn have high content of dry substance and it can not ferment

The quantity of chemicals used in our procedure is low, with neutralization we achieve complete protection of environment.

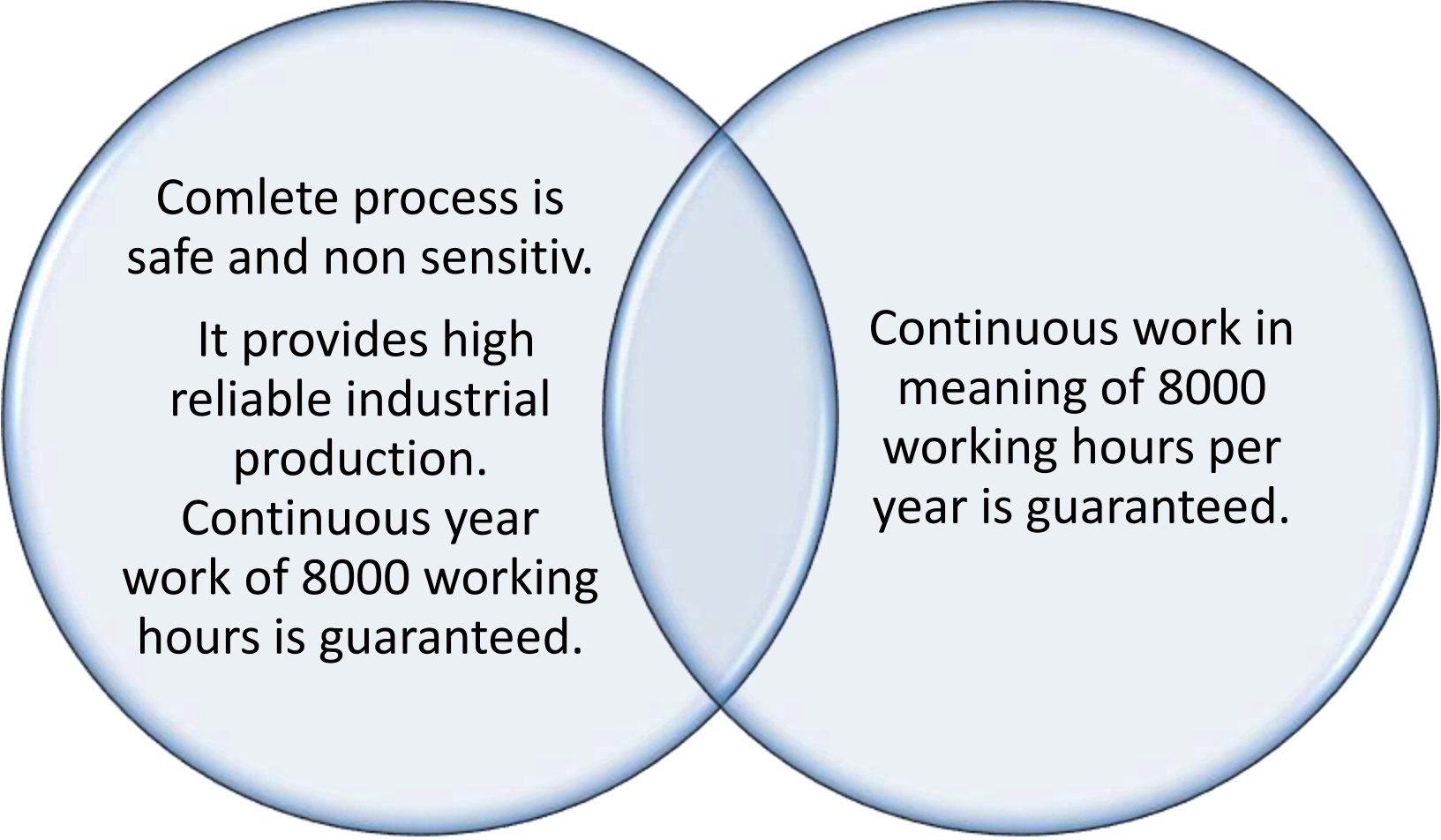
Reduced Chemical Consumption



Process water circle is completely closed (only loss is in drying chamber in shape of steam)

Process water is much cleaner than fresh water

Safe and efficient process



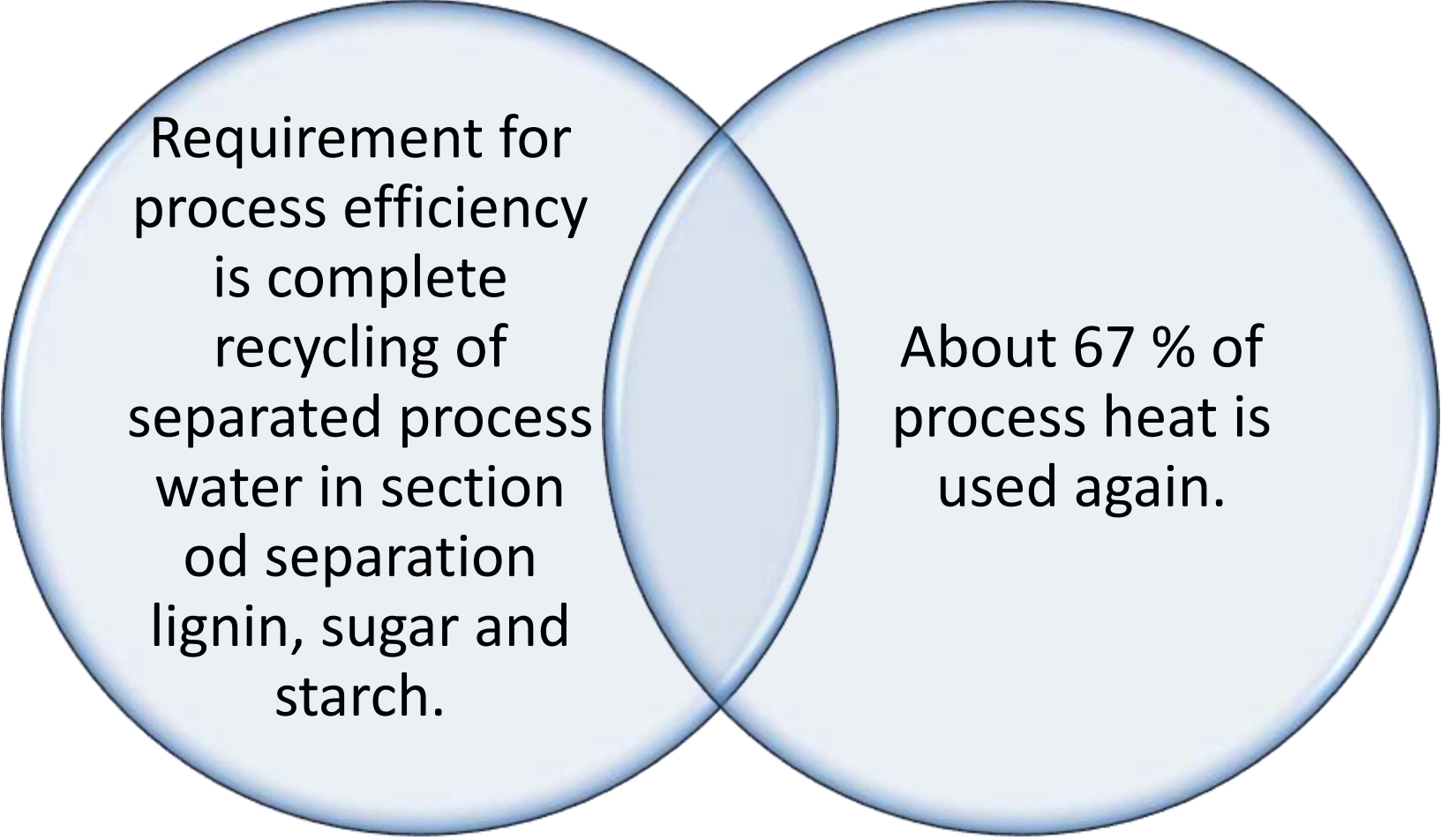
Complete process is safe and non sensitiv.

It provides high reliable industrial production.

Continuous year work of 8000 working hours is guaranteed.

Continuous work in meaning of 8000 working hours per year is guaranteed.

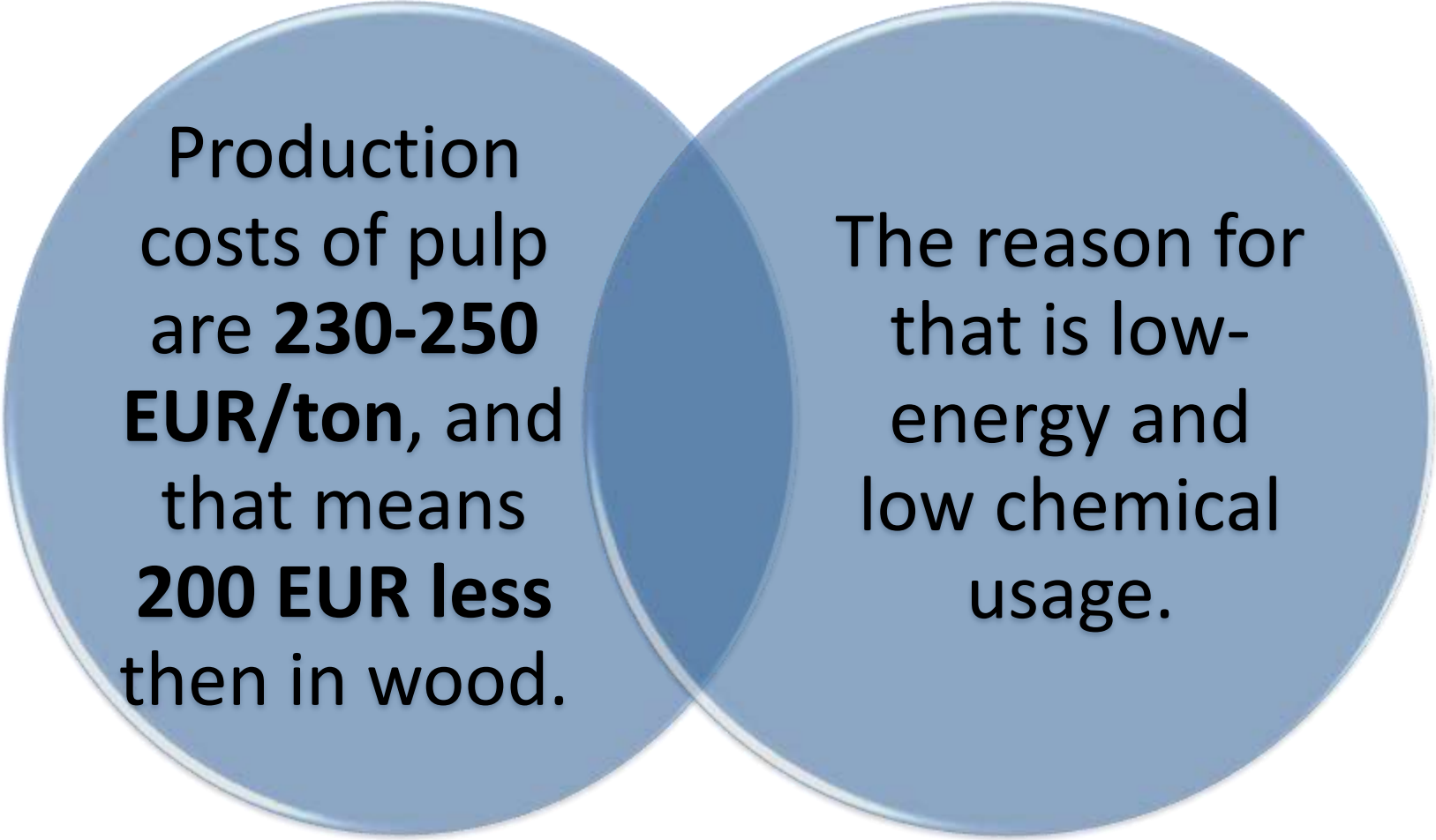
Process water and heat recycling



Requirement for process efficiency is complete recycling of separated process water in section of separation lignin, sugar and starch.

About 67 % of process heat is used again.

Production costs



Production costs of pulp are **230-250 EUR/ton**, and that means **200 EUR less** than in wood.

The reason for that is low-energy and low chemical usage.

Pulp Importers

Croatia and nearby countries do not have production of coated pulp papers.

All the countries around Croatia are large importers of pulp – Southeast Europe, Russia, Ukraine, Turkey.

Germany imports 3.000.000 t/year, and EU 8.000.000 t/year from transoceanic countries

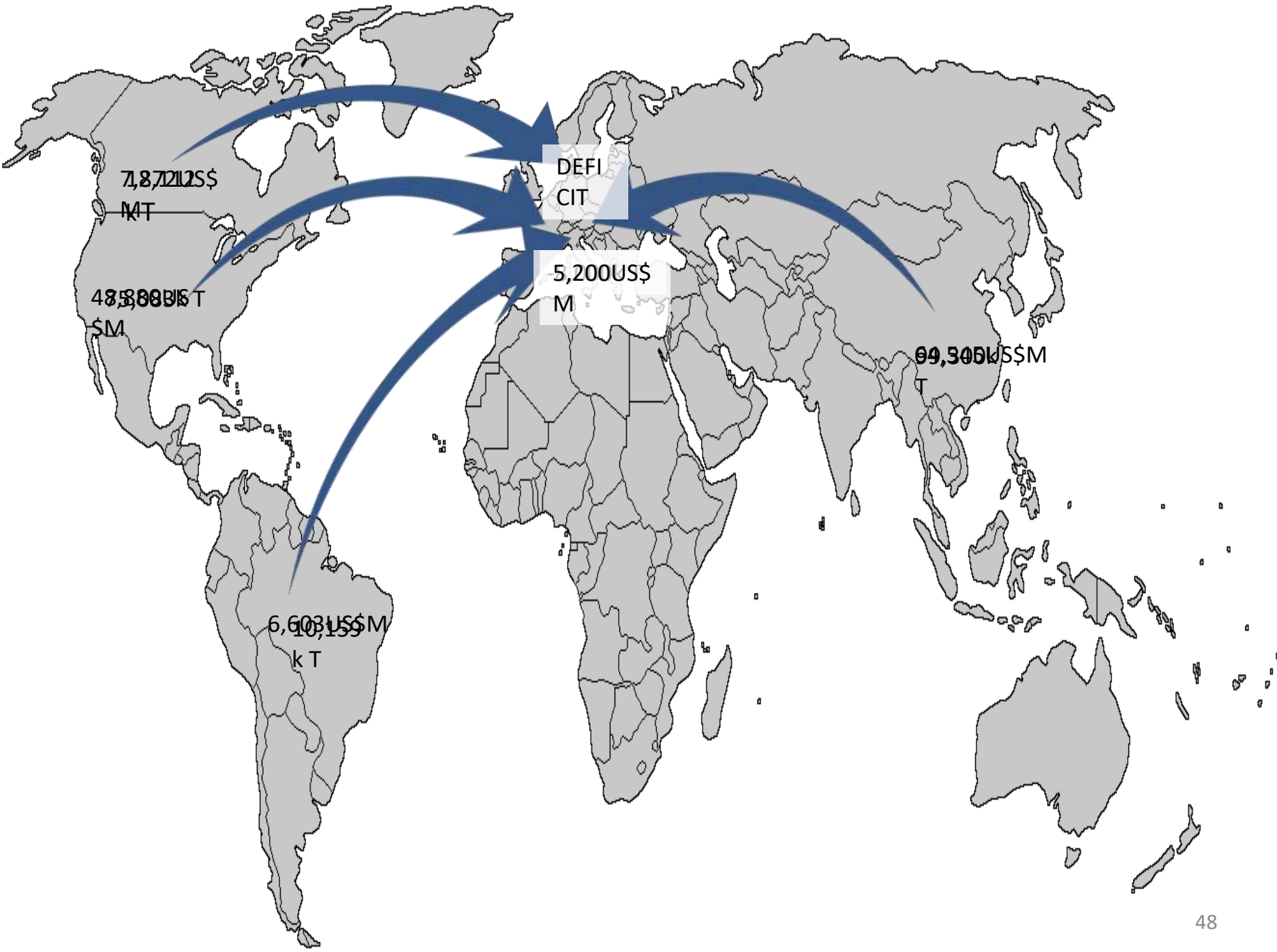
Large amounts of pulp are even imported from Brazil.

Coated pulp papers achieve highest prices on the market and present new possibility on the market.

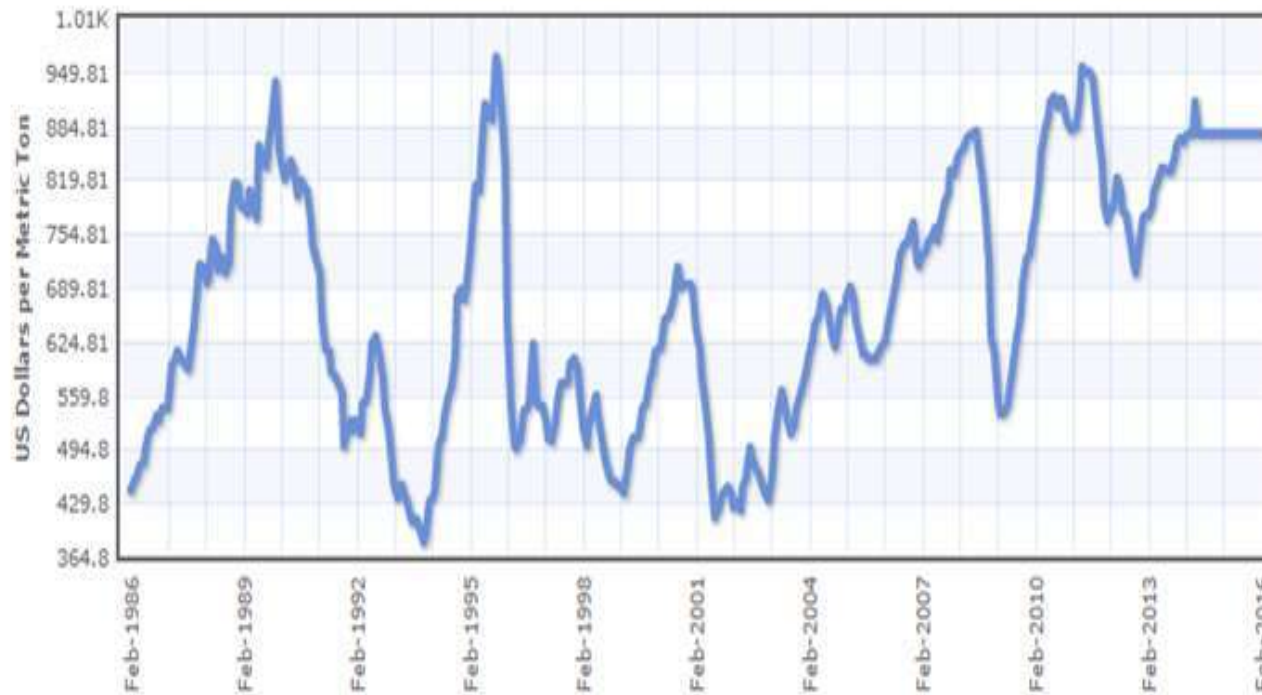
Competition is about 2000 km away, and it poses no threat to development of sales.

Development team

- Prof. dr. ing. Harald Grossmann – Technische Universität Dresden, Germany
- Prof. Lozo – Graphic Faculty of Zagreb, Croatia
- Mr. Marinko Mikulić (patent owner), Director of Dravacel
- Prof. Grizelj
- Prof. Nikolovski
- Mag. Mateja Mešl - Institut za celulozo in papir



Price overview in 30 years



6.2. Financial flow – DRAVACEL Ltd. in € (2017 – 2030)

FINANCIAL FLOW								
CASH FLOW		2017	2018	2019	2020	2021	2022	2023
	INCOME	120.000.000	0	84.360.000	94.350.000	95.460.000	97.680.000	98.790.000
I	Total income	0	0	84.360.000	94.350.000	95.460.000	97.680.000	98.790.000
II	Sources of funds	120.000.000	0	0	0	0	0	0
1	Own capital	0	0	0	0	0	0	0
2	Loan	120.000.000	0	0	0	0	0	0
III	Project –rest							
1	<i>FACILITIES</i>							
2	<i>EQUIPMENT</i>							
3	<i>INTANGIBLE ASSETS</i>							
	EXPENDITURES	120.000.000	16.807.667	58.414.637	66.599.860	67.404.507	69.052.188	69.647.701
I	Investments	120.000.000	1.106.400	4.320.000	7.380.000	7.380.000	8.328.000	8.328.000
1	<i>Investments in fixed assets</i>	120.000.000	116.640	2.280.000	5.400.000	5.400.000	6.240.000	6.240.000
2	<i>Investments in working capital</i>	0	988.800	1.968.000	1.968.000	1.968.000	1.968.000	1.968.000
II	Material costs	0	2.882.395	34.348.580	38.416.175	38.868.130	39.772.040	40.223.995
III	Personnel	0	474.835	698.782	781.533	790.727	809.116	818.311
IV	Other material costs	0	344.997	4.293.573	4.802.022	4.858.516	4.971.505	5.027.999
V	Obligations towards sources of	0	12.000.000	12.000.000	12.000.000	12.000.000	12.000.000	12.000.000
VI	Tax on profit	0	0	2.825.702	3.232.131	3.519.134	3.291.527	3.369.396
	NET-INCOME	0	-16.807.667	25.945.364	27.750.140	28.055.493	28.627.812	29.142.299
	CUMULATIVE OF NET-RECEIVABLES	0	-16.807.667	9.137.696	36.887.836	64.943.329	93.571.141	122.713.440

FINANCIAL FLOW

	CASH FLOW	2024	2025	2026	2027	2028	2029	2030
		99.900.000	99.900.000	99.900.000	99.900.000	99.900.000	99.900.000	99.900.000
I	Total income	99.900.000	99.900.000	99.900.000	99.900.000	99.900.000	99.900.000	99.900.000
II	Sources of funds	0	0	0	0	0	0	0
1	Own capital	0	0	0	0	0	0	0
2	Loan	0	0	0	0	0	0	0
III	Project –rest							
1	<i>FACILITIES</i>							
2	<i>EQUIPMENT</i>							
3	<i>INTANGIBLE ASSETS</i>							
	EXPENDITURES	69.647.701	69.647.701	69.647.701	69.647.701	69.647.701	69.647.701	69.647.701
I	Investments	8.328.000	8.328.000	8.328.000	8.328.000	8.328.000	8.328.000	8.328.000
1	<i>Investments in fixed assets</i>	6.240.000	6.240.000	6.240.000	6.240.000	6.240.000	6.240.000	6.240.000
2	<i>Investments in working capital</i>	1.968.000	1.968.000	1.968.000	1.968.000	1.968.000	1.968.000	1.968.000
II	Material costs	40.223.995	40.223.995	40.223.995	40.223.995	40.223.995	40.223.995	40.223.995
III	Personnel	818.311	818.311	818.311	818.311	818.311	818.311	818.311
IV	Other material costs	5.027.999	5.027.999	5.027.999	5.027.999	5.027.999	5.027.999	5.027.999
V	Obligations towards sources of	12.000.000	12.000.000	12.000.000	12.000.000	12.000.000	12.000.000	12.000.000
VI	Tax on profit	3.369.396	3.369.396	3.369.396	3.369.396	3.369.396	3.369.396	3.369.396
	NET-INCOME	29.142.299	29.142.299	29.142.299	29.142.299	29.142.299	29.142.299	29.142.299
	CUMULATIVE OF NET-	151.855.739	180.998.038	210.140.337	239.282.636	268.424.935	297.567.234	326.709.534

Thank you for attention !