OPTIMIZATION BIOBASED PRODUCTS

Carme Murcia

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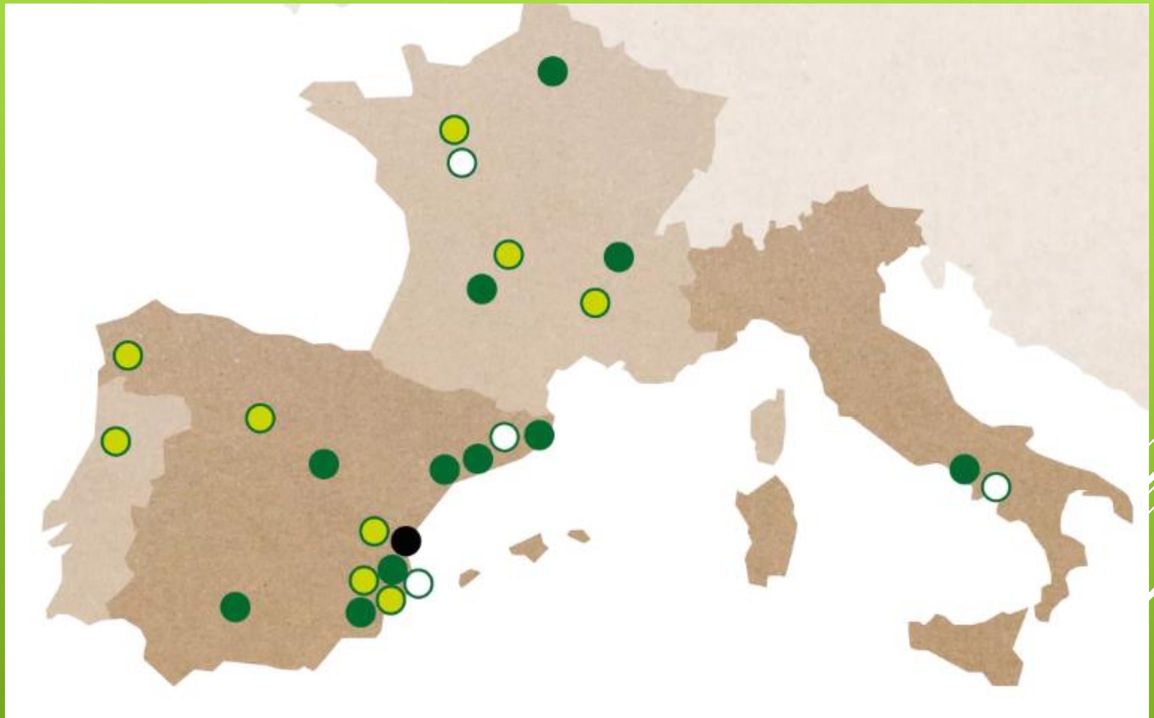
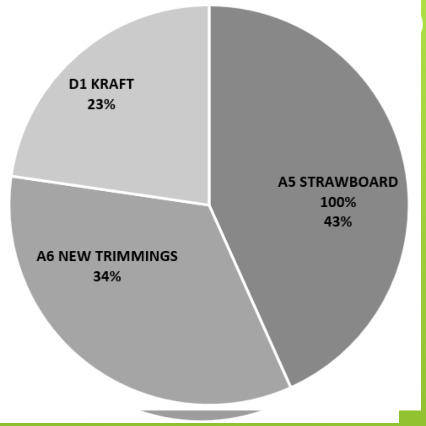
Responsible teacher: Julien Bras

HINOJOSA

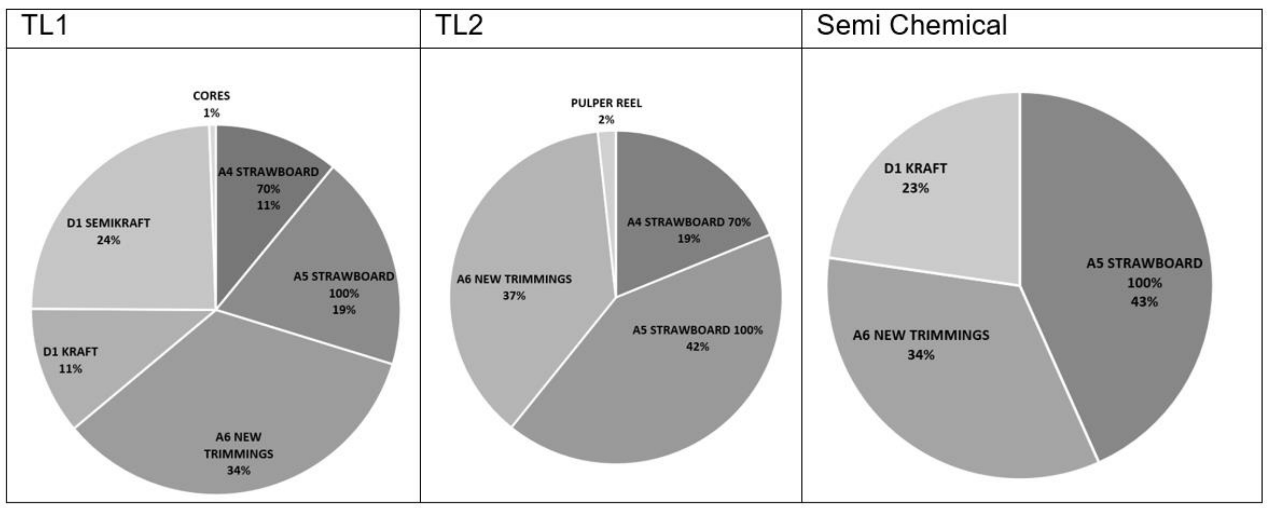
SARRIÀ HINOJOSA PAPER

- Packaging group:
  - 14 packaging plants
  - 4 paper mills
- Sarrià since 2016.
  - Paper mil installed around 1950.
  - Sold on 2008 and bought byHinojosa in 2016
- TL1 TL2 SEMIQ.





ROPERTIES



TEST	ACCORDING TO	UNIT	GRAMMAGE					
Nominal basis weight	PA-IT02.13 PS-IT02.13	g/m^2	**165**	± 4%	**170**	± 4%	**195**	± 4%
Nominal moisture content	PA-IT02.29 PS-IT02.107	%	9	± 1	9	± 1	9	± 1
SCT, DT	PA-IT02.15 PS-IT02.77	KN/m	3.15		3.24		3.72	
		KN.m/kg	19.1		19.1		19.1	
Burst strenght	PA-IT02.19 PS-IT02.78	Kpa	421		433.2		490	
		Kpa.m^2/g	2.5		2.5		2.5	
Maximum Cobb 60	PA-IT02.12 PS-IT02.12	g/m^2	20-50		20-50		20-50	

Guaranteed characteristics TL1

TEST	ACCORDING TO	UD	GRAMMAGE									
Nominal basis weight	PA-IT02.13 PS-IT02.13	g/m^2	**120**	± 4%	**140**	± 4%	**150**	± 4%	**160**	± 4%	**170**	± 4%
Nominal moisture content	PA-IT02.29 PS-IT02.107	%	9	± 1	9	± 1	9	± 1	9	± 1	9	± 1
SCT, DT	PA-IT02.15 PS-IT02.77	KN/m	1.96		2.26		2.45		2.59		2.75	
		KN.m/kg	16		16		16		16		16	
Burst strenght	PA-IT02.19 PS-IT02.78	Kpa	235.2		274.4		294		313.6		333.2	
		Kpa.m^2/g	1.96		1.96		1.96		1.96		1.96	
Maximum Cobb 60	PA-IT02.12 PS-IT02.12	g/m^2	20-50		20-50		20-50		20-50		20-50	

Guaranteed characteristics TL2

	ACCORDING TO	UD	GRAMMAGE											
Nominal basis weight	PA-IT02.13 PS-IT02.13	g/m^2	**120**	± 4%	**140**	± 4%	**145**	± 4%	**150**	± 4%	**160**	± 4%	**170**	± 4%
Nominal moisture content	PA-IT02.29 PS-IT02.107	%	9	± 1	9	± 1	9	± 1	9	± 1	9	± 1	9	± 1
SCT, DT	PA-IT02.15 PS-IT02.77	KN/m	2.35		2.74		2.84		2.94		3.14		3.33	
		KN.m/kg	19.60		19.60		19.60		19.60		19.60		19.60	
CMT, DM	PA-IT02.18 PS-IT02.76	N	216		294		313		317		336		359	
		N.m2/g	1.8		2.1		2.1		2.1		2.1		2.1	

Guaranteed characteristics SEMI-CHEMICAL

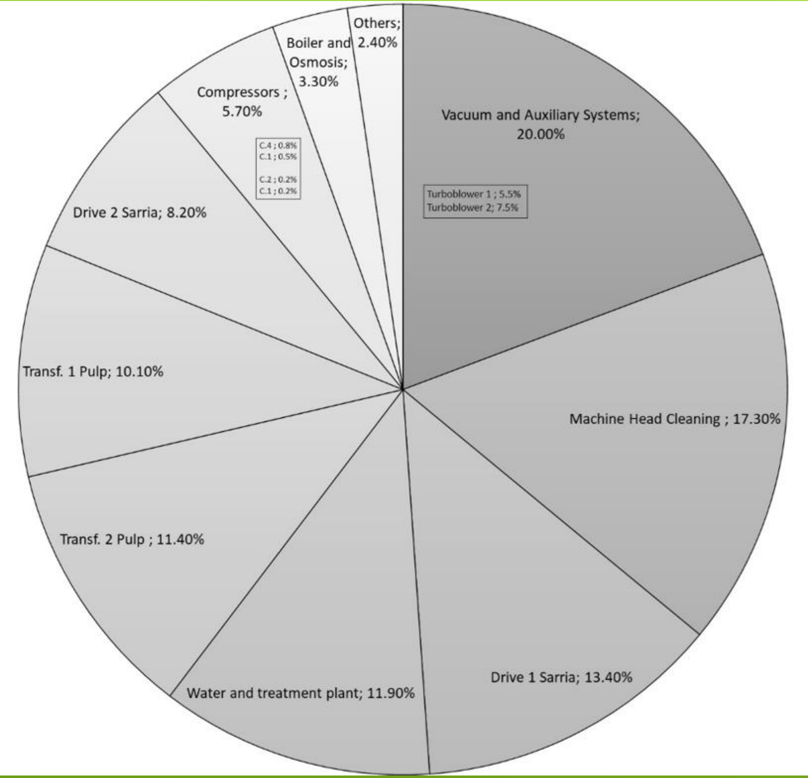
SCT – SHORT-SPAN COMPRESSION TEST

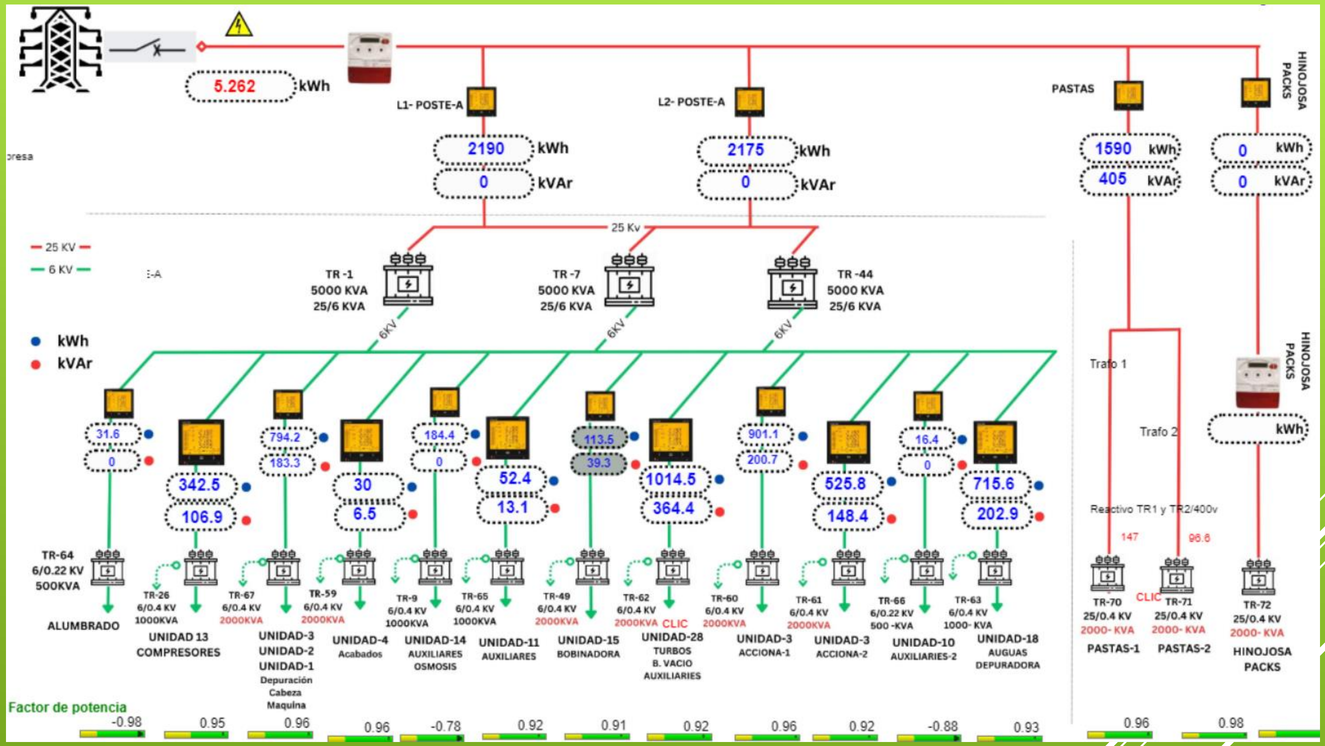
RAW MATERIALS

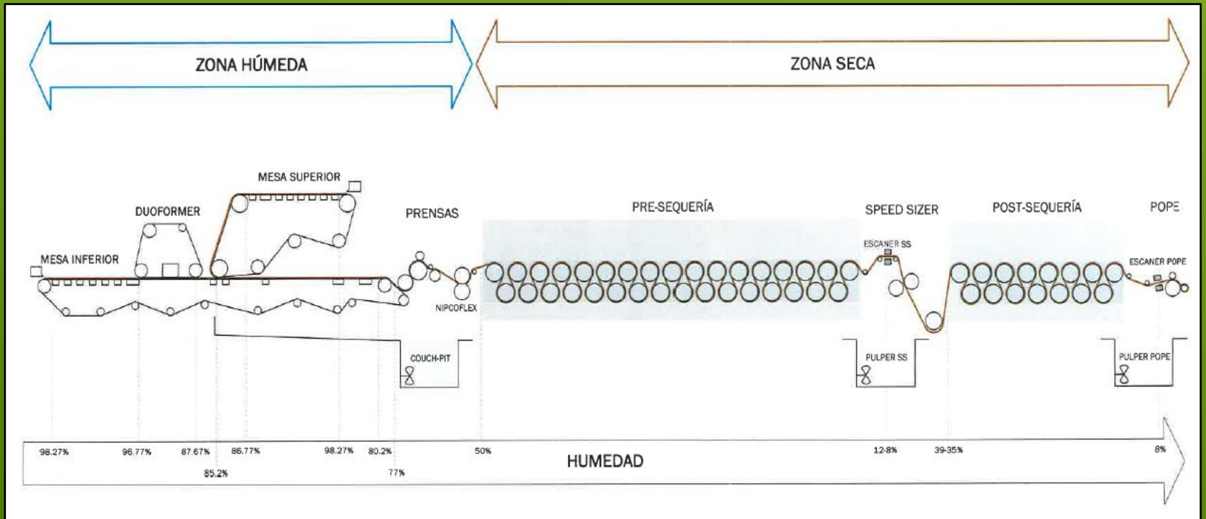
Name	Type	Label
A4 STRAWBOARD 70		
A5 STRAWBOARD 100		
A6 STRAWBOARD		

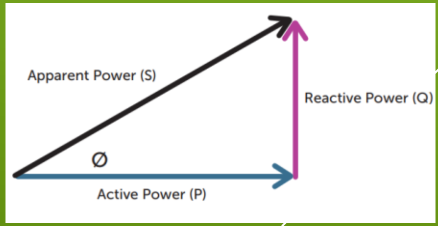
Name	Type	Label
D1 SEMIKRAFT		
KRAFT		

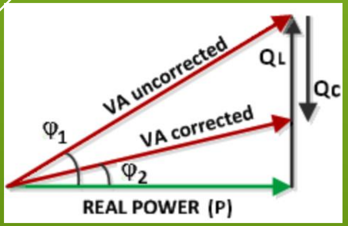
ELECTRIC CONSUMPTION

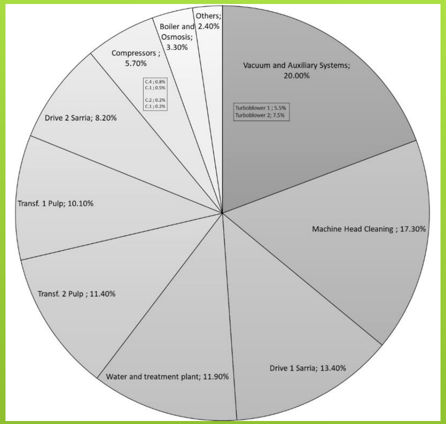


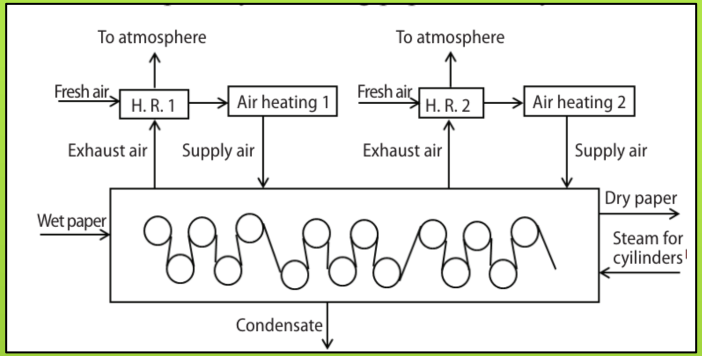


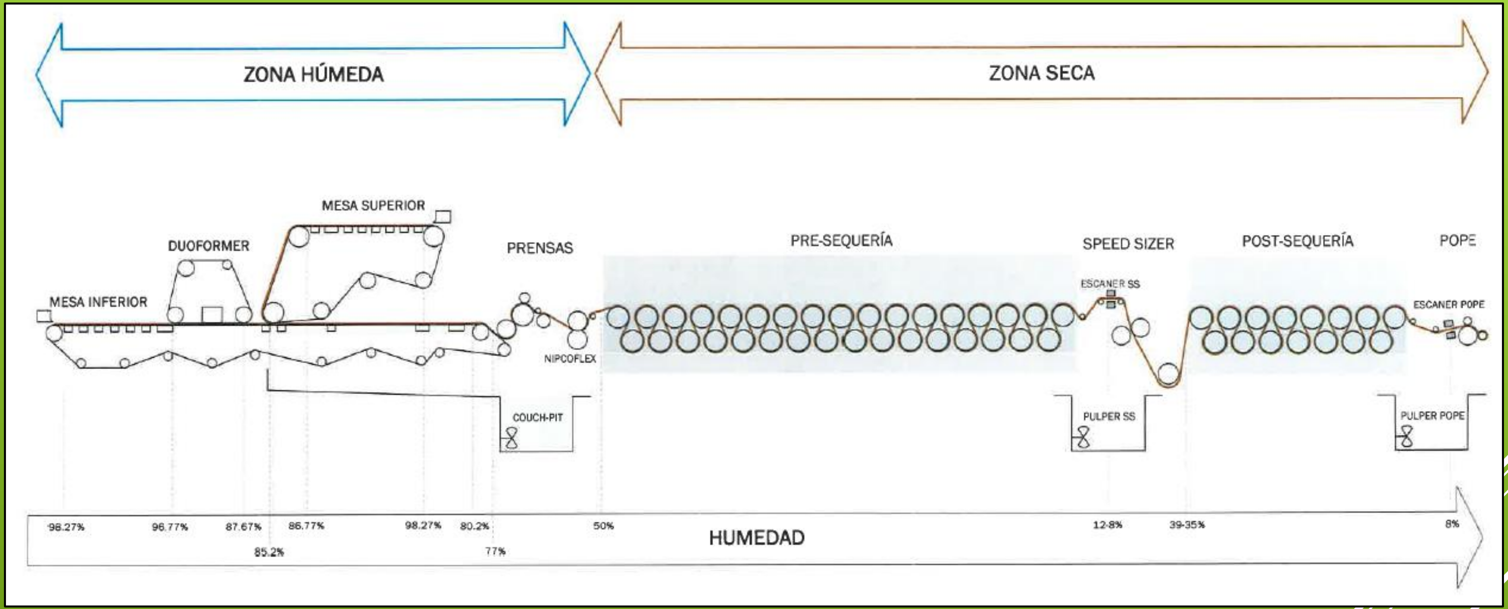












Pulp building

90% of water is recirculated

DAF

Brown water

steam

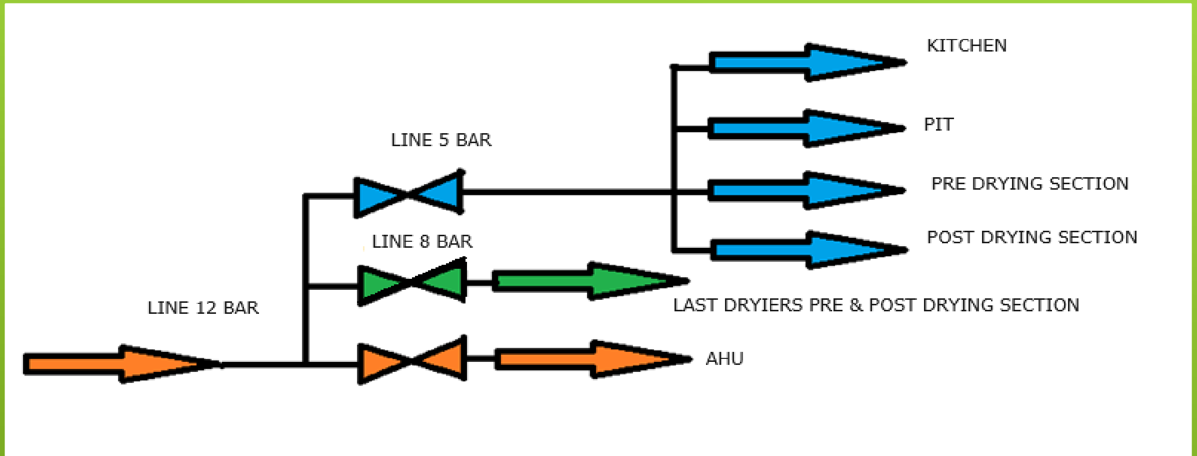
3 Boilers

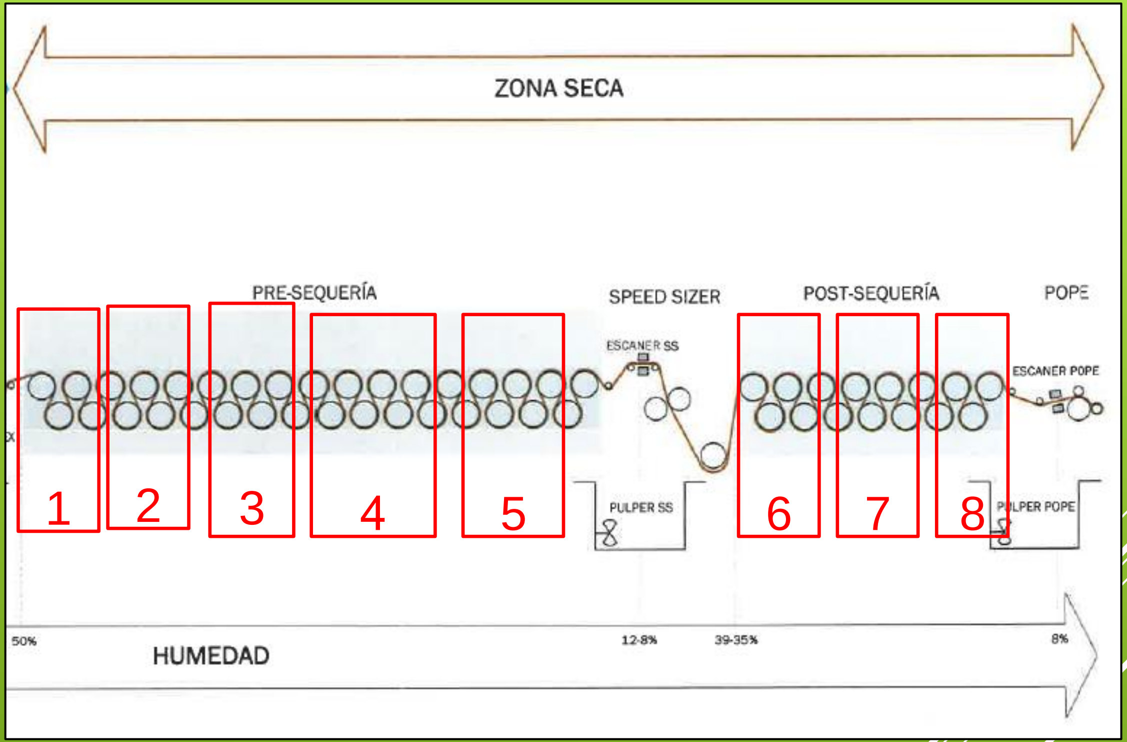
WWTP

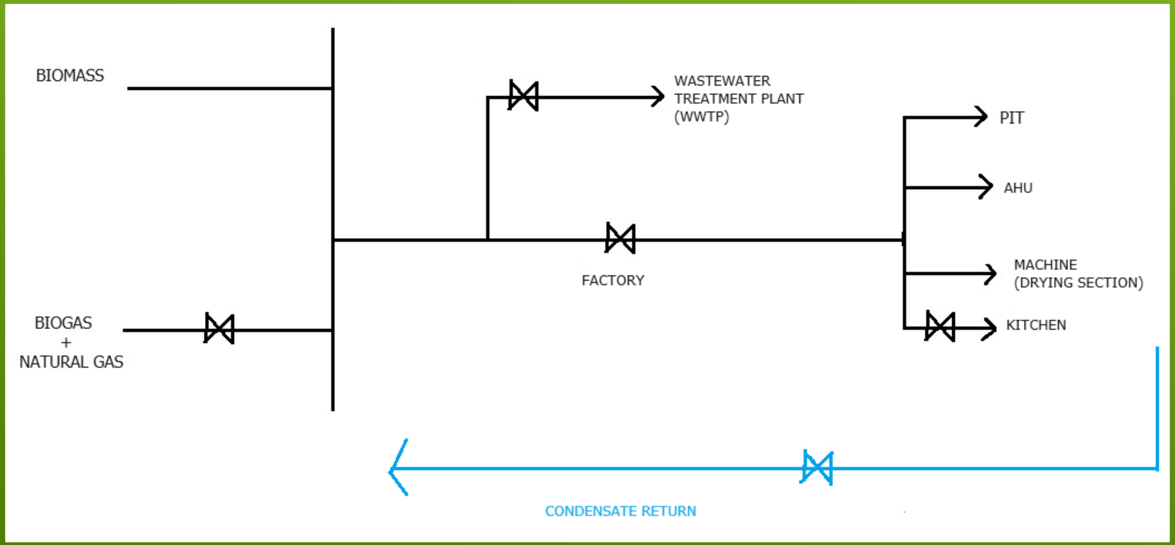
Clean water

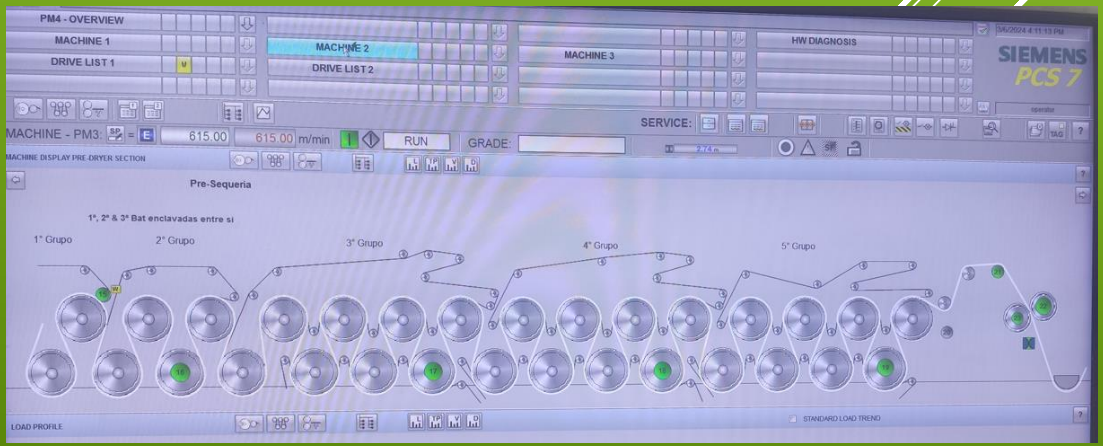
Super clean water

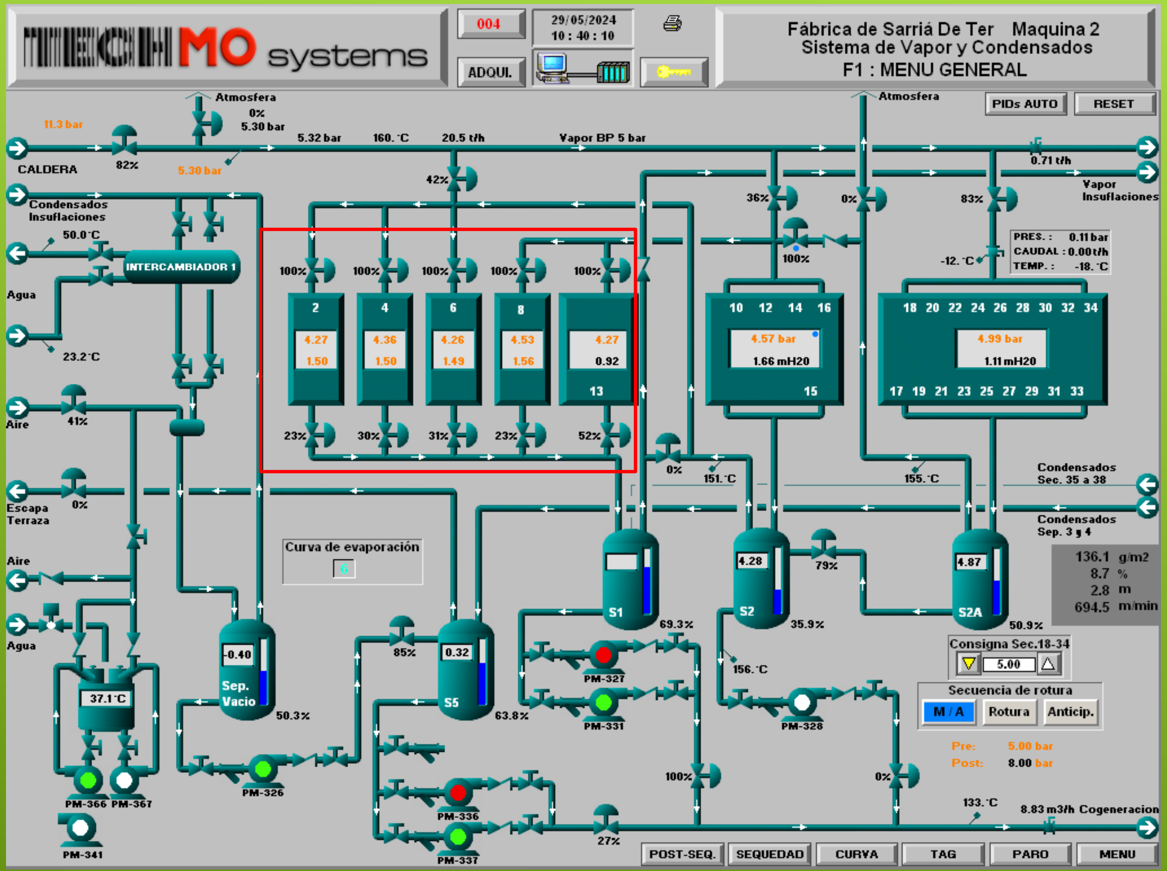
STEAM CONSUMPTION

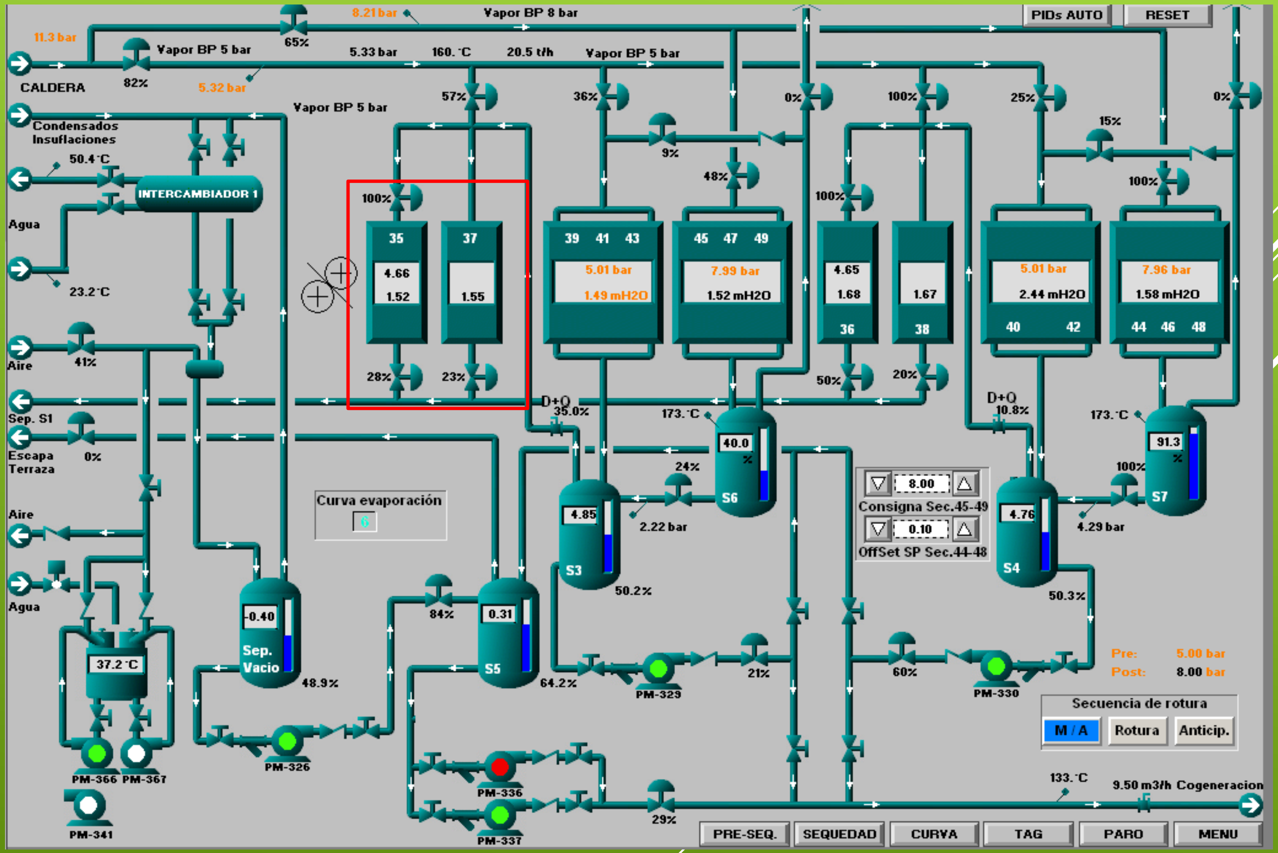









TECHMO systems
004
29/05/2024
10 : 40 : 10
ADQUI.
Fábrica de Sarriá De Ter Maquina 2
Sistema de Vapor y Condensados
F1 : MENU GENERAL
Atmosfera
PIDs AUTO
RESET
CALDERA
Vapor BP 5 bar
Vapor Insuflaciones
Condensados Insuflaciones
INTERCAMBIADOR 1
Agua
Aire
Escapa Terraza
Condensados Sec. 35 a 38
Condensados Sep. 3 y 4
Curva de evaporación
Sep. Vacio
Consigna Sec.18-34
Secuencia de rotura
M / A
Rotura
Anticip.
Pre: 5.00 bar
Post: 8.00 bar
8.83 m3/h Cogeneracion
POST-SEQ.
SEQUEDAD
CURVA
TAG
PARO
MENU


PIDs AUTO
RESET
Vapor BP 8 bar
Vapor BP 5 bar
CALDERA
Condensados Insuflaciones
INTERCAMBIADOR 1
Agua
Aire
Sep. S1
Escapa Terraza
Curva evaporación
Sep. Vacio
Consigna Sec.45-49
OffSet SP Sec.44-48
Secuencia de rotura
M / A
Rotura
Anticip.
Pre: 5.00 bar
Post: 8.00 bar
9.50 m3/h Cogeneracion
PRE-SEQ.
SEQUEDAD
CURVA
TAG
PARO
MENU

ENERGY BALANCE

- **Adiabatic equation**

$$q_1 h_1 + \cancel{P_2}\left(-\frac{\cancel{dV_c}}{\cancel{dt}}\right) + P_{shaft} + Q = q_2 h_2 + \frac{dU}{dt}$$

V_c (m^3) = valve inner volume accessible to fluid = constant.

P_{shaft} (kW) = refers to loss of energy on the wall heat flux, is negligible compared to the heat that goes through to the valve.

Q (kW) = 0 at it is an adiabatic valve.

U (kJ) = rate of variation internal energy, it is also considered negligible compared to the heat that goes through the valve.

As q_1=q_2 ; $h_1 = h_2$

flow exchange in valves from 12 bar to 8 and 5 bar

Non-adiabatic equation:

In non-adaibatic case, equation (1) would go as:

$$q_1 h_1 + \cancel{P_2}\left(-\frac{\cancel{dV_c}}{\cancel{dt}}\right) + P_{shaft} + Q = q_2 h_2 + \frac{\cancel{dU}}{\cancel{dt}} \qquad (5)$$

Signs of P_{shaft} and Q :

- Positive sign: some energy is gained by the fluid when its passes through the valve.
- Negative sign: some energy is lost by the fluid when it passes through the valve.

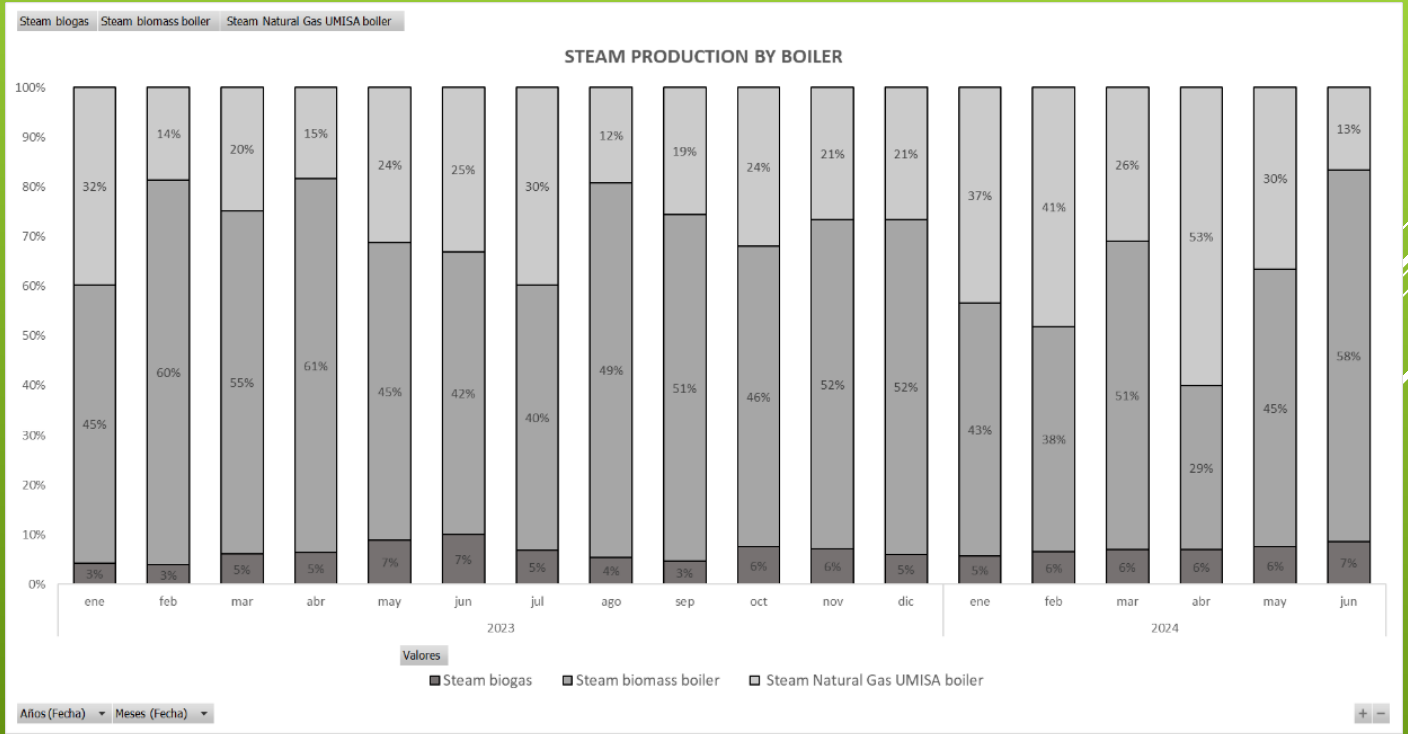
The normal case for a real valve (non-adiabatic) is that some energy is lost by the fluid when it passes through; then a lower T is observed after the valve.

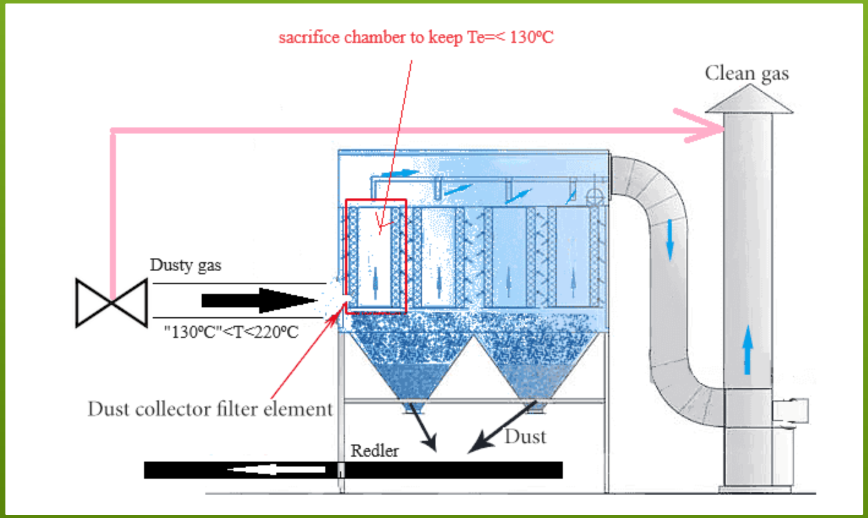
- The Temperature can be read with a laser tool and with XSTEAM tool the new h_2, s_2 and x_{v2} can be calculated

STEAM MIX

Fuel	Annual percentage (%)
Biomass boiler	70,1%
Biogas boiler	6,4%
Natural gas UMISA boiler	23,5%

- Natural Gas (UMISA)
- Biogas (September 2021) (Veolia)
- Biomass (January 2022) (Neoelectra)





BIOMASS BOILER

- The biomass boiler is fueled by wood chips sourced from silvicultural operations.

- For the bag filters to operate effectively, the gases need to enter at temperatures between 130 and 220 degrees Celsius. There's a safety valve in place to prevent the bag filters from burning.
  - Entry conditions: 130ºC < T <220ºC
  - If T<130ºC→ the filter becomes wet, causing steam to condense, crystallize and damage the filters, resulting in reduced filtration efficiency.
  - If Ti > 220ºC → there is fire hazard → After firefighting, the filters end up with holes and they won't work properly anymore.
- There are 4 compartments in the bag filters arranged in series, with the first compartment sacrificially designed to prevent temperatures from dropping below 130°C at the inlet, requiring regular replacement.

METHODS: LIST OF MOTORS

- With the aim of better understanding the factory and its processes, only those connected to the highest consumption analyzers were compiled (Depuration and Machine Head, Water and Treatment, Vacuum and Auxiliaries, Drive 1, and Drive 2)

   a. Starting from incomplete Excel lists of motors from 2016 and 2022, the following steps were taken:

   b. Categorize the motors according to electrical lines (analyzers, transformers).

   c. Physical Listing: Simultaneously, a physical listing of each motor in the factory was conducted.

   d. Verify the physical list with electrical list and then with DCS to check if the motor are still working

   e. Final verification by confirming data with the electrical team and maintenance supervisor.

DAILY ENERGETIC ANALYSIS

- Daily reports generated and shared via email with all the factory management team:
- Compare total consumption (kWh) with days with similar data on:
  - Production ± 5000 kg from the previous day.
  - Basis weight ± 5 g/m².
    - affects speed and drivers energy consumption.
  - Average paper width ± 200 mm.
    - It is influenced by customer demand, it is highly related to the production
  - Downtime (min)

Three days with similar characteristics are compared:

	Gross Production (kg)	Average width (mm)	Average basis weight (gr/m2)	Downtime (min)	Rate (m/min)	Actual total consumption (kwh)	Electrical ratio (kwh/kg)
12/06/2024	**389126**	**2992**	**140.0**	**40**	**622.0**	**154.945**	**0.398**
03/04/2024	391420	3017	142.9	98	676.8	153631	0.392
26/05/2024	387290	3067	141.0	0	651.4	152082	0.393
20/04/2024	389240	2921	142.5	130	684.1	159139	0.409

	Turboblower-1 (kwh)	WWTP Sarria (kwh)	Transf-1 Pastas (kwh)
12/06/2024	9710	18947	17393
03/04/2024	7429	19105	15698
26/05/2024	8582	17003	15389
20/04/2024	10254	16242	15421

	Turboblower-1 (kwh)	WWTP Sarria (kwh)	Transf-1 Pastas (kwh)
reference day consumption (kwh)	**9710**	**18947**	**17393**
average compared days (kwh)	8755	17450	15503
overconsumption average (%)	10.91%	8.58%	12.19%
difference in consumption (kwh)	955	1497	1890

sum (kwh)	4343
real consumption - overconsumption (kwh)	150602
new electrical ratio	0.387

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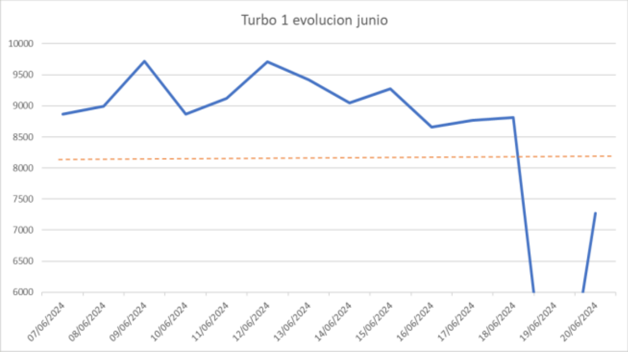
DÍA:		12
MES:		6

Producción bruta	Kg	389,126
Gramaje	Gr/m2	140
Tiempo muerto	min	40
ancho	mm	2,992

		Objetivo	Real	Obj. Acum. Mes	Acum. Mes	Desviación
Consumo eléctrico	kWh	151,759	154,945	1,635,727	1,636,407	-680
Ratio eléctrico	KWh/Kg	0.390	0.398	0.390	0.390	-
Coste	€	30,237 €	30,871 €	325,905 €	326,040 €	-136 €
Consumo Vapor Total	Tn	700	700	7,550	8,099	-549
Ratio Vapor Total	Tn/Tn	1.80	1.80	1.80	1.93	-
Consumo Gas	Nm3	15,805	8,677	170,348	88,993	81,355
Ratio gas	Nm3/Kg	0.041	0.022	0.041	0.021	-
Coste	€	10,591 €	5,814 €	114,150 €	59,634 €	54,516 €
Consumo Agua fresca	m3	3,444	2,573	37,118	29,563	7,555
Ratio agua	m3/Tn	8.85	6.61	8.85	7.05	-
Coste	€	0 €	0 €	0 €	0 €	0 €

Mix vapor		Real
Biomasa	%	73%
Biogas	%	8%
Gas Natural	%	19%

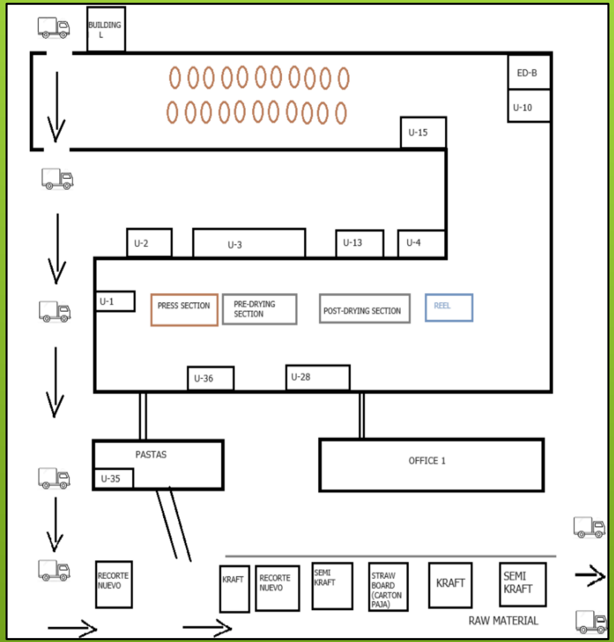
Autoconsumo eléctrico		Real
Generación FV	Kwh	2,387
% Autoconsumo	%	1.54%

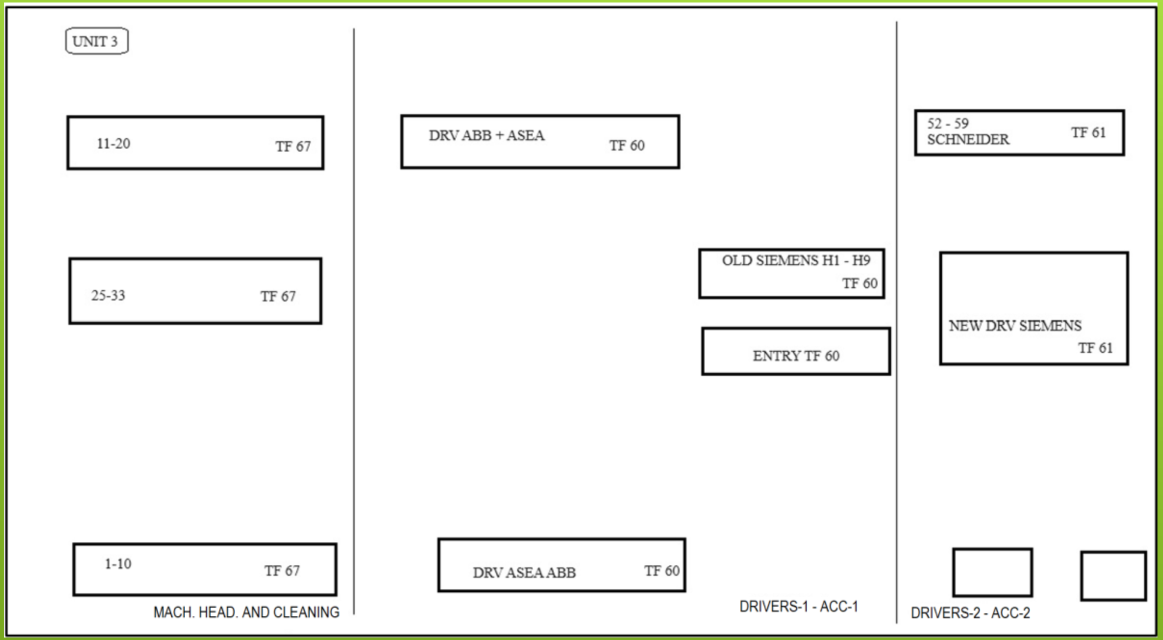


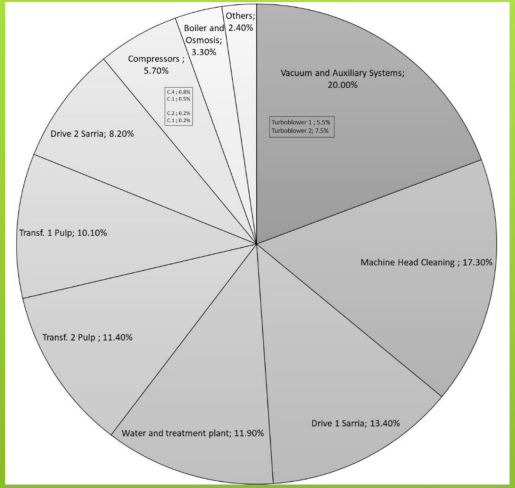
+ Team work: Collaboration and communication

RESULTS AND DISCUSSION.

- List of motors







ANALIZADOR	num	CODI	KW
D.C.M.	U-1	PM111	132

De la unitat 2:

ANALIZADOR	num	CODI	armario	KW	DESCRIPCIO
D.C.M.		PM-242	11	200.00	BOMBA FAN PUMP SUPERIOR
D.C.M.	U-2	PM-241	2	75	BOMBA PASTA ESPESA SUPERIOR
D.C.M.	U-2	PM-243	2	75.00	BOMBA DESCARGA TORRE DE ROTOS
D.C.M.	U-2	PM-217B	4	55.00	BOMBA 2 REGADERAS FILTRO DE DISCOS
D.C.M.	U-2	PM-244	3	55	BOMBA AIGUA PREPARACIÓ DE PASTES
D.C.M.	U-2	DM-206	5	55.00	SCREEN 1ª ETAPA SUPERIOR
D.C.M.	U-2	QM-203	9	55.00	ROTOR PULPER 5
D.C.M.	U-2	PM-245	4	37	BOMBA FILTRO DE DISCOS
D.C.M.	U-2	DM-207	6	30.00	SCREEN 2ª ETAPA SUPERIOR
D.C.M.	U-2	PM-210	9	30.00	BOMBA EXTRACCIÓ PULPER 5

I de la unitat 3 els primers 20 armaris:

D.C.M.	U-3	QM-304	14	160	ROTOR PULPER Nº 4
D.C.M.	U-3	PM-307	16	110	BOMBA 2 (AUXILIAR) FOSO TELA
D.C.M.	U-3	PM-357	14	90	BBA. EXTRACCIO PULPER Nº 4
D.C.M.	U-3	PM-302	13	45	BOMBA Nº2 30 BARS NETEJA BAIETES

ISO 50001.

Objective 1: Increase monitored consumption by 20% through the installation of analyzers below the single-line diagram, focusing on significant general analyzers.

62	VAC Y AUX	U-28	PM-2801	250	BBA. NASH BUIT 1ª i 2ª BAIETES
62	VAC Y AUX	U-28	QM-2801	250	ROTOR PULPER 8 SOTA SPEED-SIZER
62	VAC Y AUX	U-28	PM-2802	200	BBA. SAFEM BUIT PICK-UP I PREMSA ASPIRANT
62	VAC Y AUX	U-28	PM-2803	132	BBA. SAFEM BUIT 3ª BAIETA S01532 M1264
62	VAC Y AUX	U-28	PM-2806	132	6TV00 BOMBA DE BUIT TELA SUPERIOR
62	VAC Y AUX	U-28	DM-2801	110	SCREEN 1A ETAPA MESA INFERIOR
62	VAC Y AUX	U-28	PM-2804	75	BBA. SAFEM BUIT CAIXES ASPIRANTS
62	VAC Y AUX	U-28	PM-2811	75	BBA. EXTRACCIO PULPER 8 SOTA SPEED-SIZER
62	VAC Y AUX	U-28	PM-2815	75	BBA. BUIT TRIVAC TAULA
62	VAC Y AUX	U-28	PM-2830	75	BBA. DILUCIO CAIXA ENTRADA
62	VAC Y AUX	U-28	PM-2812	55	BBA. ENVIO A DEPURADOR SECUNDARI M4267
62	VAC Y AUX	U-28	PM-2805	37	BBA. SAFEM BUIT PICK-UP I PREMSA ASPIRANT
62	VAC Y AUX	U-28	PM-2835	30	BOMBA Nº3 RED AGUA FRESCA 4 BARS
62	VAC Y AUX	U-28	DM-2802	22	DEPURADOR SECUNDARI

DAILY ANALYSIS EXAMPLE

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DÍA:		10
MES:		5

Producción bruta	Kg	368,900
Gramaje	Gr/m2	145
Tiempo muerto	min	85
ancho	mm	2,968

		Objetivo	Real	Obj. Acum. Mes	Acum. Mes	Desviación
Consumo eléctrico	kWh	143,871	144,531	1,650,609	1,616,471	34,138
Ratio eléctrico	KWh/Kg	0.390	0.392	0.390	0.382	-
Coste	€	25,262 €	25,378 €	289,828 €	283,834 €	5,994 €
Consumo Vapor Total	Tn	664	697	7,618	8,181	-563
Ratio Vapor Total	Tn/Tn	1.80	1.89	1.80	1.93	-
Consumo Gas	Nm3	14,983	39,737	171,898	259,832	-87,934
Ratio gas	Nm3/Kg	0.041	0.108	0.041	0.061	-
Coste	€	15,054 €	39,925 €	172,712 €	261,063 €	-88,351 €
Consumo Agua fresca	m3	3,265	3,157	37,456	30,305	7,151
Ratio agua	m3/Tn	8.85	8.56	8.85	7.16	-
Coste	€	0 €	0 €	0 €	0 €	0 €

Mix vapor		Real
Biomasa	%	7%
Biogas	%	6%
Gas Natural	%	85%

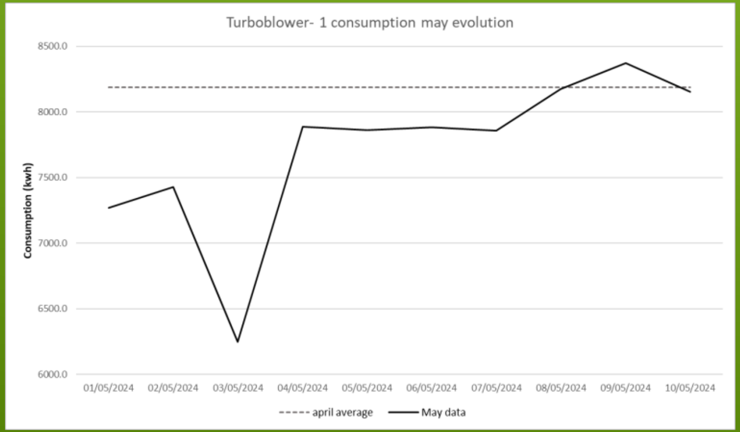
Autoconsumo eléctrico		Real
Generación FV	Kwh	11,503
% Autoconsumo	%	7.96%

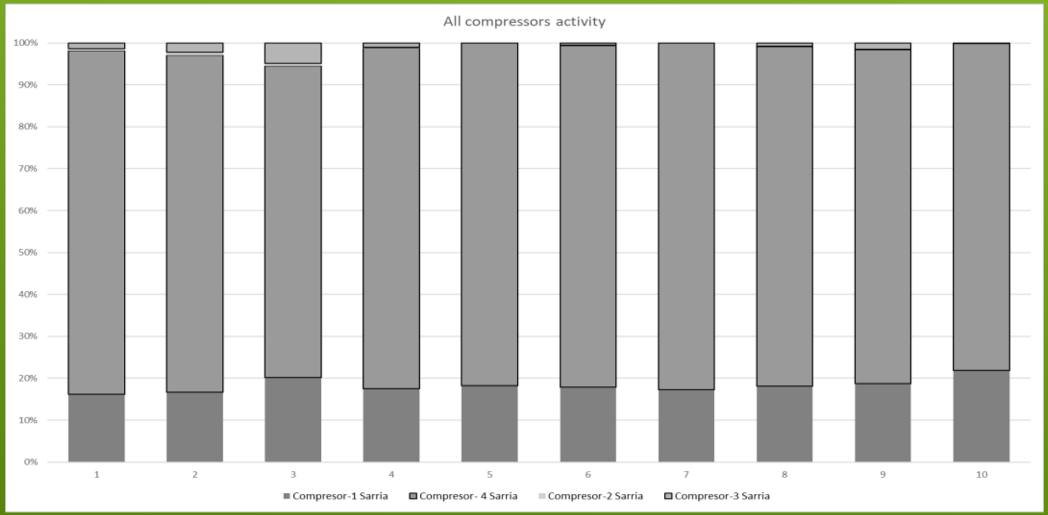
	Gross Production (kg)	Average width (mm)	Average basis weight (gr/m2)	Downtime (min)	Actual total consumption (kwh)	Electrical ratio (kwh/kg)
10/05/2024	368900	2968	145.0	85	144531	0.392
10/04/2024	368680	2748	145.0	110	142405	0.386
23/11/2023	363320	2794	145.0	45	142875	0.393
16/09/2023	369141	2763	145.0	0	147005	0.398

	Turboblower-1 (kwh)	Compressors (kwh)
10/05/2024	8153	8209
10/04/2024	7399	7553
23/11/2023	7421	7281
16/09/2023	10401	7327

	Turboblower-1 (kwh)	Compressors (kwh)
reference day consumption (kwh)	**8153**	**8209**
average compared days (kwh)	7410	7387
overconsumption average (%)	10.03%	11.13%
difference in consumption (kwh)	743	822

sum (kwh)	2151
real consumption - overconsumption (kwh)	141574
new electrical ratio	0.384



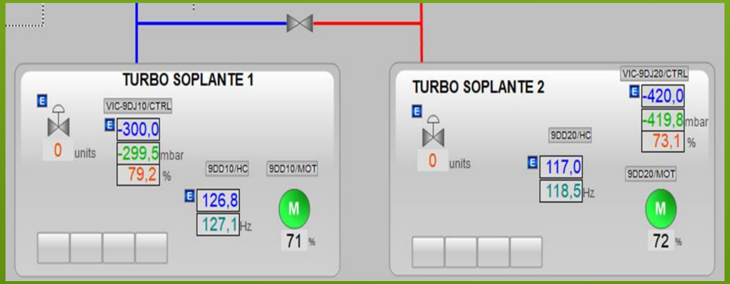


	Compressor 1	Compressor 2	Compressor 3	Compressor 4
Manufacturer	Atlas Copco			
Model	GA90-VSD-FF	GA90-FF	GA90-FF	GA160-VSD
Power (kW)	90	90	90	160
Type of regulation	Variable	Continuo	Continuo	Variable

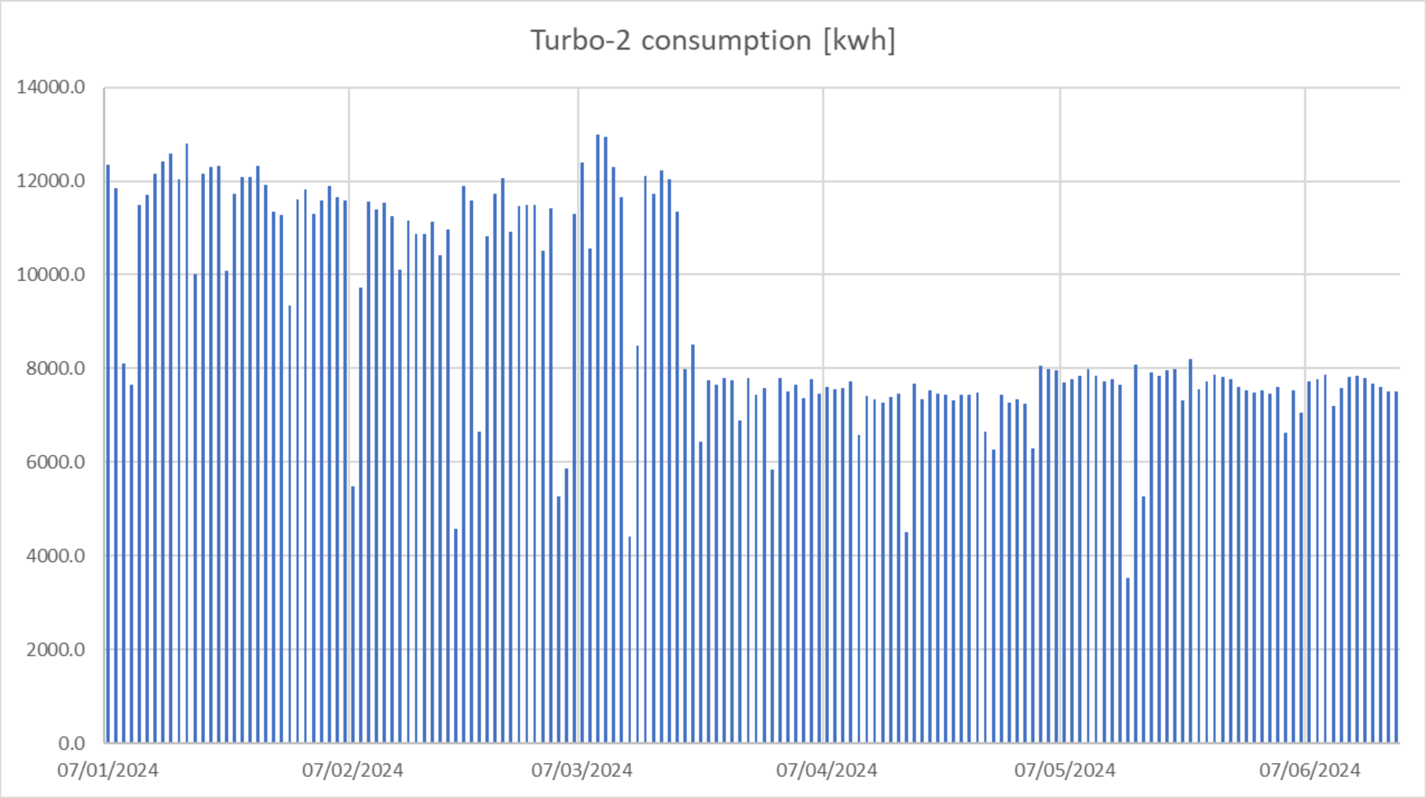
TURBOBLOWER 2 REDUCTION

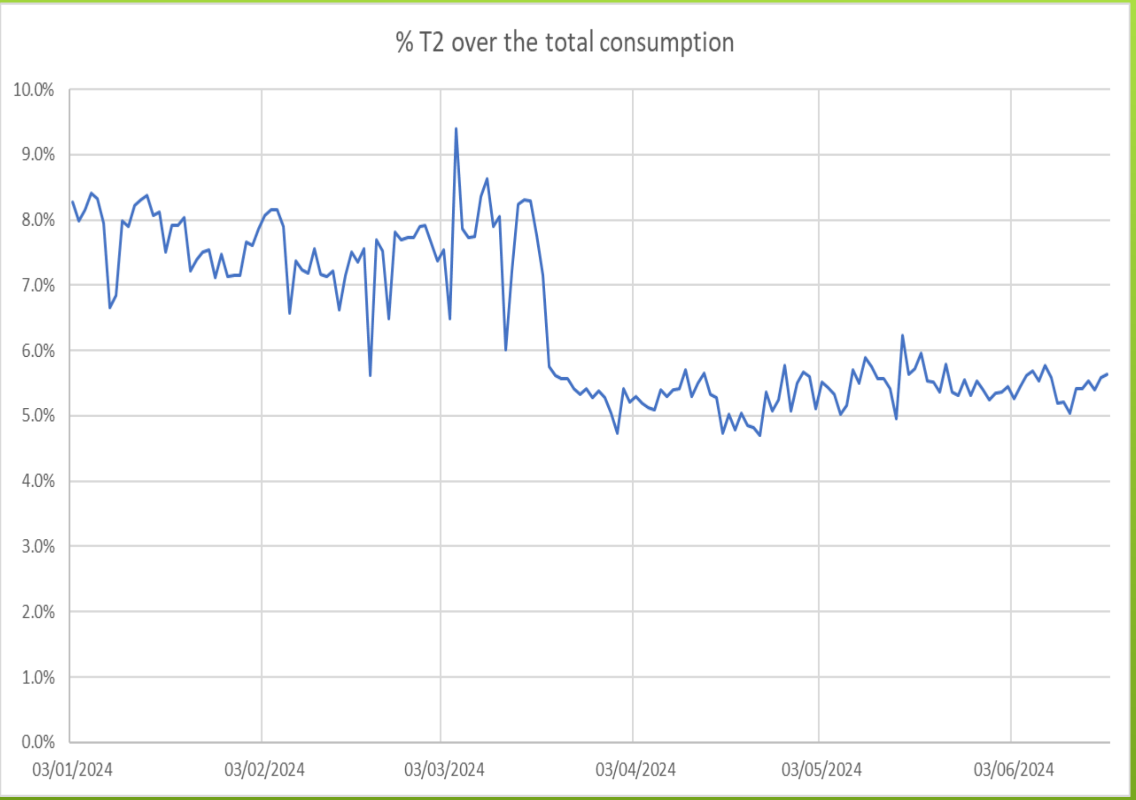
- In the daily reports from March 16, 17, and 28, an overconsumption of Turbo Blowers 1 and 2 was observed

Average consumption Jan-Feb kwh/day			
	2023	2024	% difference
Turboblower-1	8508	7770	-8,67%
Turboblower-2	7135	11116	55,80%
Total	15643	18886	20,73%



Date	Set Point
12/3/24	510 mbar
21/3/24	420 mbar





	Average consumption (kwh)		
	Total Factory	Turbo 2	% T2 over total factory
Before Set-point change	148350	11462	7.73%
After Set-point change	140465	7579	5.40%

Fixed price= 0.056 €/

economic savings:
Before SP change, turboblower cost an average of:

$$11462 * 0{,}056 = 642\ €/day$$

After SP change, the daily cost of turboblower 2 was:

$$7579 * 0{,}056 = 424\ €/day$$

$$642 - 424 = 218\ €\ saved\ each\ day$$

$$218 * 7 = 1526\ €\ saved\ each\ week$$

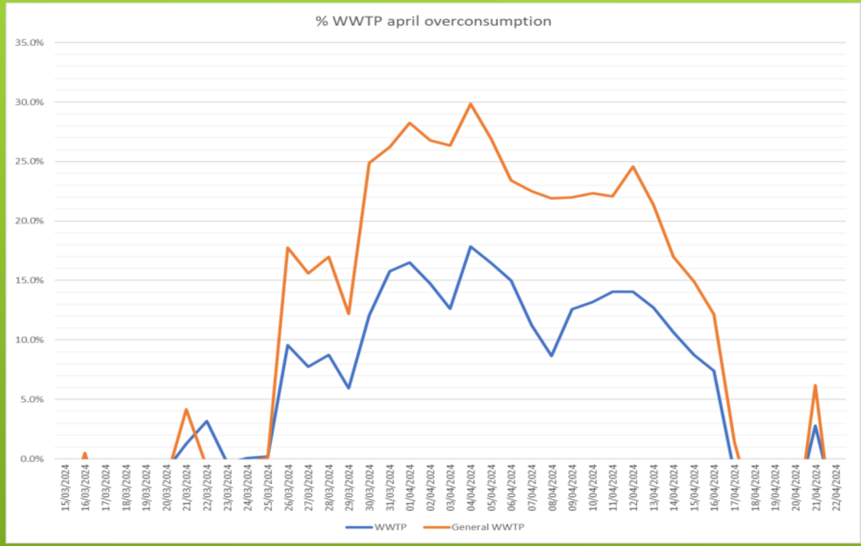
$$1526 * 4 = 6104\ €\ saved\ each\ month$$

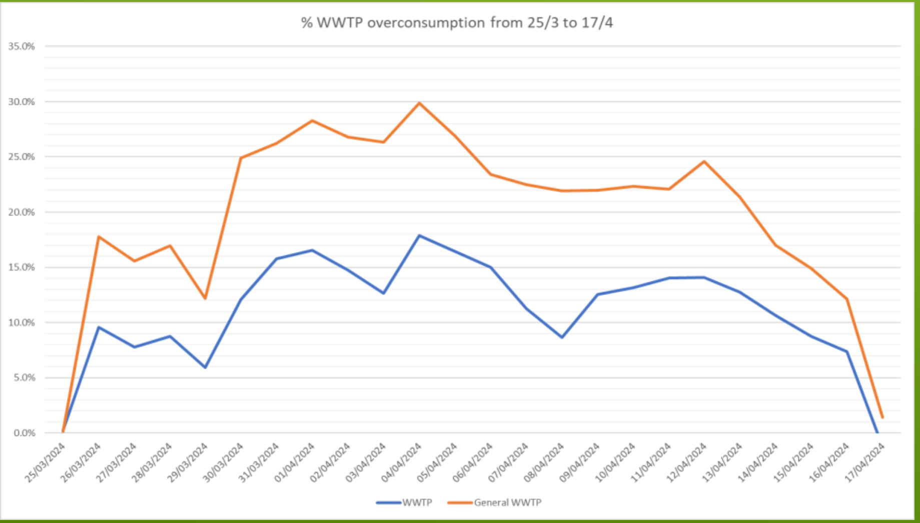
From April until July it would be:

$$6104 * 4 = \ 24416\ €\ saved\ during\ the\ project$$

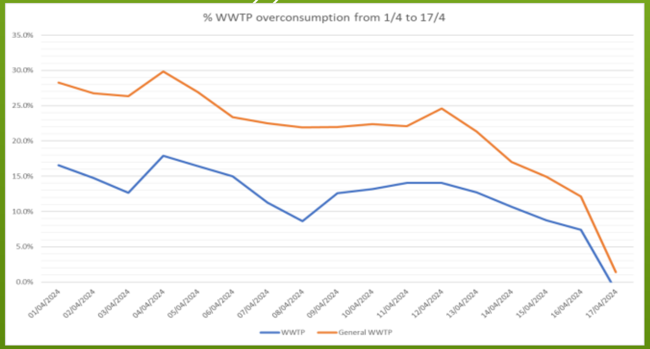
WASTEWATERTREATMENT PLANT

Date report	WWTP behavior
3/4/24	Overconsumption detected
4/4/24	Overconsumption increased
10/4/24	Factory stop sending solids to WWTP
14/4/24	Overconsumption by Accumulative solids
18/4/24	Stop Overconsumption



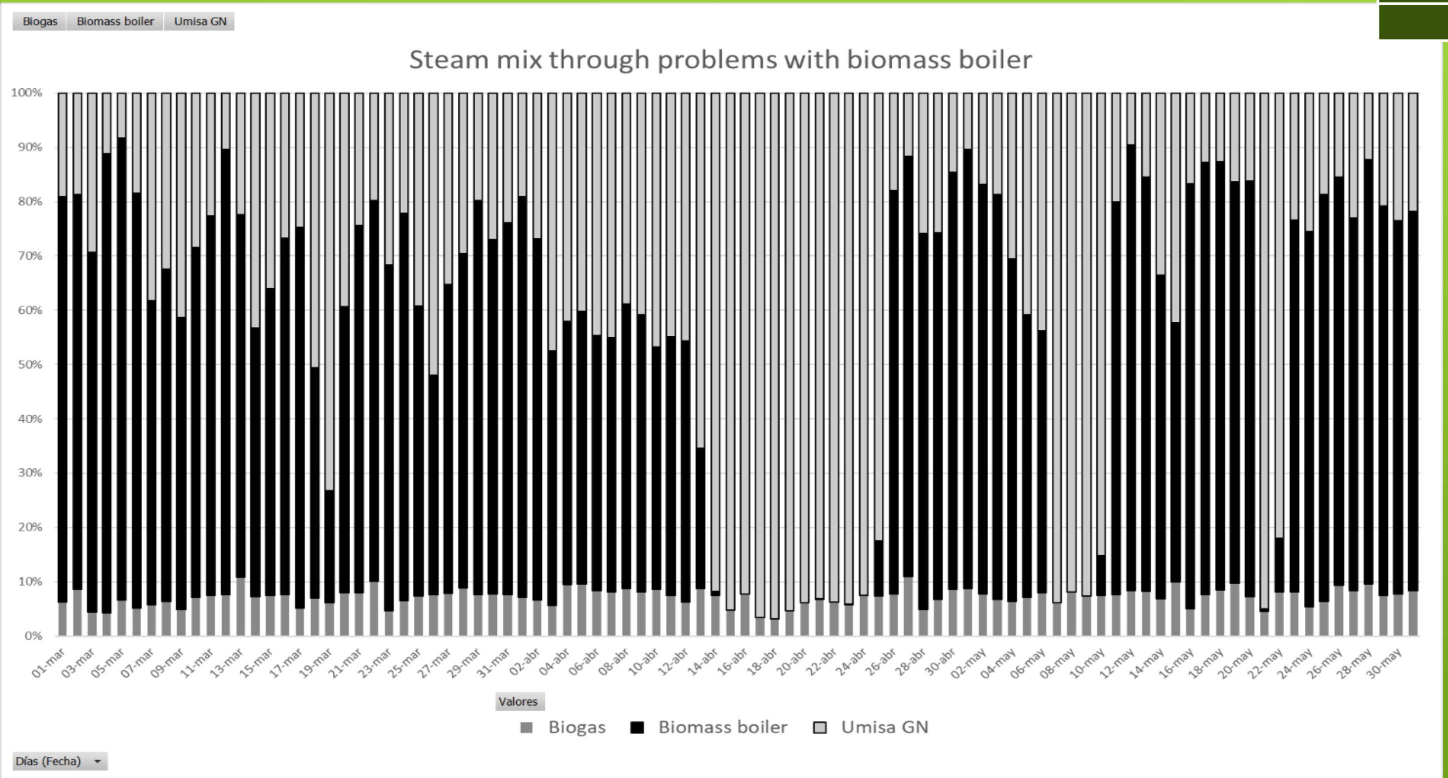


- **Issue Overview:**
- **Problem:** Massive influx of solids to the WWTP.
- **Cause:** Failures in the DAF and pulp plants.
- **Impact:**
  - Reduced methane generation.
  - pH imbalance (6.0 instead of 6.9-7.0).
  - Increased turbine speed (from 30 Hz to 43 Hz), leading to higher energy consumption.
- **Actions Taken:**
- **Improved DAF System Operation:**
  - Goal: Stop solids from reaching the treatment plant.
  - Success: Achieved around April 13th-14th.
- **Ongoing Overconsumption:**
  - Accumulated solids continued to impact turbine performance.

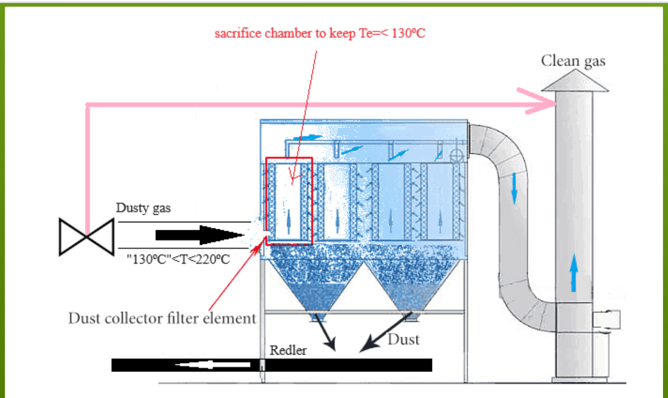


BIOMASS BOILER CHANGE OF FILTERS

Date report	Biomass boiler behavior
28/3/24	Bag filter problems
26/3/24	Official slow down for bag filter problems
15/4/24	Stopped for changing bag filters
26/4/24	Working well
3/5/24	Feeding problems
6/5/24	Inspection of the filters



- **Boiler Operation:**
- **Setup:**
  - Four chambers of bag filters: Two operational, one for temperature control, one backup.
- **Planned Maintenance:**
  - Scheduled to replace all filters during the next shutdown.
- **Problem Emergence:**
- **Blocked Backup Filter:**
  - Filters began breaking down, causing debris to fall into the redle valve, leading to operational issues.
- **Mitigation:**
  - Boiler operated at minimum load to reduce air pressure until filters could be replaced.
- **Escalation:**
- **Community Complaint:**
  - Smoke containing ash reached nearby town, prompting complaints.
- **Response:**
  - Filter replacement advanced by 15 days, resulting in shutdown from April 13 to April 26.
- **Additional Shutdown:**
- **Installation Issues:**
  - Some filters came loose due to rushed installation.
  - Boiler required a second shutdown from May 7 to May 10 for thorough inspection and proper installation.



BIOMASS BOILER CHANGE OF FILTERS

Item	Unit Cost (€)	Quantity	Total Cost (€)
Bag Filters	80	576	46,080
Labor Costs and Crane Rental	-	-	10,000
Total Investment	-	-	**56,080**

	Natural Gas Consumption (Nm3)			
	Target	Real	Diference (Target-Real)	Different %
Poor month (april)	440459	825724	-385265	-47%
Good month (june)	397145	238916	158229	66%
	Cost (€)			
	Target Cost	Real Cost	Diference (Target-Real)	Different %
Poor month (april)	501502	940161	-438659	-47%
Good month (june)	266127	160098	106029	66%

- **Investment & Savings:**
- **Bag Filter Cost:** 56,080 euros.
- **Planned Natural Gas Cost for June:** 266,127 euros.
- **Actual Cost Due to Increased Biomass Use:** 160,098 euros.
- **Savings:** 106,029 euros.
- **Economic Viability:**
- **Break-Even:** Filters must last at least 5 months with performance similar to June to justify the investment.

$$(target\ € - real\ €) * good\ months - (target\ € - real\ €) * bad\ month - bag\ filter\ investment > 0$$

$$(266127 - 160098) * x + (501502 - 940161) * 1 - 56080 > 0$$

$$(106029) * x - 438659 - 56080 = 0$$

$$(106029) * x = 494739$$

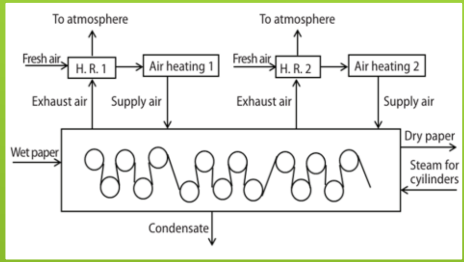
$$x = 4{,}67$$

STEAM AUDIT ACTUATIONS

Valmet

INFORME DE AUDITORÍA	12/39
AUDITORÍA DEL SISTEMA AEROTÉRMICO	Final
HNOJOSA SARRIÁ MP4	JS
R-23-014 (B-2013)	05/2023

• Suciedad en la entrada al cambiador vahos-aire, que provoca una disminución del caudal. Es necesario proceder a su limpieza.	 
• Fuelle de impulsión del ventilador SM-320 roto, provocando fugas de aire. Es necesaria su sustitución.	



PROJECT CO.230085.240 CUSTOMER: HINOJOSA PAPER
VISIT DATE: 15 January- 18 January 2024

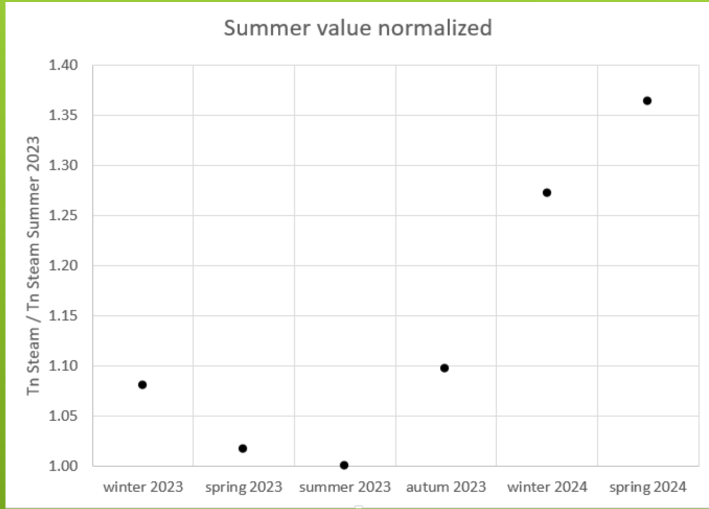
KADANT

Description	Priority	Benefit
Clean the air inlet of the heat recovery system upstream the fans SM-319, SM-320 and 6PD14 	High	Energy saving, Drying capacity

Since January 2023	After May 30, 2024
	
	

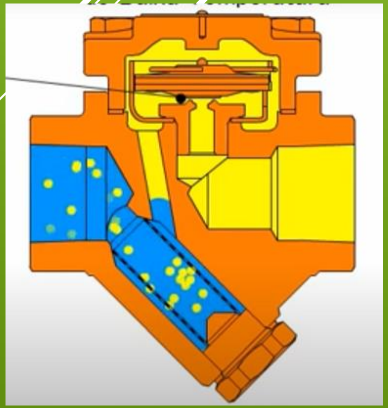
Basis weight (gr/m2)		Average Gross Production (kg)	Steam total consumption (Tn/day)	Ratio Steam/ production (Kg/Tn)	Average T Girona (ºC)
140	before	394691	645	1.64	18.0
140	after	397538	716	1.80	18.6
145	before	325867	621	1.90	21.5
145	after	325404	671	2.06	22.9
145	before	365554	698	1.91	12.4
145	after	366728	671	1.83	22.3
165	before	354774	688	1.94	12.6
165	after	355270	643	1.81	22.9
165	before	315161	645	2.05	11.9
165	after	321240	641	2.00	21.9
195	before	368691	683	1.85	14.2
195	after	360779	690	1.91	21.7

		Gross Production (kg)	Average steam machine consumption (Tn/day)	Average Ratio (Tn prod/Tn steam)	Difference % versus summer ratio	Difference % average consumption VS summer	Summer value normalized
winter 2023	1/1 a 21/3	294805	516	1,832	20,4%	7,9%	1,08
spring 2023	22/3 a 21/6	306272	486	1,721	13,1%	1,7%	1,02
summer 2023	**22/6 a 21/9**	**311622**	**478**	**1,521**	**0,0%**	**0,0%**	1
autum 2023	22/9 a 21/12	294304	524	1,921	26,3%	9,6%	1,10
winter 2024	22/12 a 21/3	318297	608	2,262	48,7%	27,2%	1,27
spring 2024	22/3 a 6/5	354521	652	1,879	23,5%	36,4%	1,36



Month	Average Gross Production (Tn)	Std. Dev. Gross Production (Tn)	Relative difference production (%)
ene	330	71	-1.33%
feb	326	87	-0.14%
mar	334	84	-2.51%
abr	361	58	-9.88%
may	346	82	-5.77%
jun	326	80	0.00%

- **Production Variance (June):**
- ⬇️ Low production → Change in production manager, reduced machine speed
- **Steam Consumption Issues:**
- ⬇️ Unplanned downtimes → Excess steam released to prevent condensation
- **Proposed Solutions:**
- 💡 Steam traps → Conserve steam during downtimes
- 💡 Flow meters installation on October 4th → Improved monitoring
- **Challenges in Analysis:**
- ❓ Low production + Lack of comparable data → Difficult to conclude savings
- **Cost-Effective Cleaning:**
- ✅ Cleaning performed by factory workers → No cost incurred



CONCLUSIONS

Project Success & Energy Savings

- ✅ **Structured Approach:**
  - Daily energy monitoring → Early detection of overconsumption → Prompt corrective actions.
  - Savings of minimum €24,000 → Covers 6 months of a trainee's salary in Spain.

Electricity Conclusions

- **Energy Consumption Analysis:**
  - **Efficient:** >385,000 kg production → ~1,450,000 kWh.
  - **Overconsumption:** >149,000 kWh (target to stay below).
- 🔧 **Recommendations:**
  - Maintain the lower setpoints for Turbo Blowers 1 & 2
  - **Additional Analyzers:** Needed in U1, U2, and blower and centrifugues in WWTP
  - **DAF Solids Management:** Reduce solids in water before treatment to lower oxygen demand.

Steam Conclusions

- 💡 **Flow Meters Installation:**
  - Install in pre-drying, post-drying, and Umisa boiler → Identify and prevent steam losses.
- 📋 **ISO 50001 Compliance:**
  - Recommendations align with standards → Supports EU subsidy requirements.

REFERENCES

1. Gosh, A. K. (2011). Fundamentals of paper drying-theory and application from industrial perspective. In *Evaporation, Condensation and Heat Transfer*.
2. Jacobs, I.P.S.T. (2006) Report for Pulp and Paper Industry Energy Bandwidth Study. *American Institute of Chemical Engineers: New York, NY, USA*.
3. Chen, X., Li, J., Liu, H., Yin, Y., Hong, M., & Zeng, Z. (2016). Energy system diagnosis of paper-drying process, Part 1: Energy performance assessment. *Drying Technology, 34(8)*, 930–943. https://doi.org/10.1080/07373937.2015.1087022
4. Chen, X., Li, J., Liu, H., Yin, Y., & Zhang, Y. (2016). Energy system diagnosis of paper-drying process, Part 2: A model-based estimation of energy-saving potentials. *Drying Technology*, 34(10), 1219–1230. https://doi.org/10.1080/07373937.2015.1095206
5. Chen, X., Zheng, Q., & Dong, Y. (2021). Theoretical Estimation of Evaporation Heat in Paper Drying Process Based on Drying Curve. Processes, 9(7), 1117. https://doi.org/10.3390/pr9071117
6. Bhutani, N., Lindberg, C.-F., Starr, K., & Horton, R. (2012). Energy assessment of paper machines. Energy Procedia, 14, 955–963. https://doi.org/10.1016/j.egypro.2011.12.887
7. Ghodbanan, S., Alizadeh, R., & Shafiei, S. (2017). Optimization for Energy Consumption in Drying Section of Fluting Paper Machine. Original scientific paper. Chemical Engineering Faculty, Sahand University of Technology, Tabriz, Iran. Recuperado de https://doi.org/10.2298/TSCI150503141G
8. Videau, J. L., Lemaitre, A., & Foulard, C. (1980). Dynamic Modelling and Simulation of Paper Machine Multicylinder Drying Section. Laboratoire d'Automatique de Grenoble, B.P. 46, 38042 St Martin-d'Heres. Centre Technique du Papier, B.P. 7110, 38020 Grenoble Cedex. https://doi.org/10.1016/S1474-6670(17)64428-8
9. Hedlund, A., Björkqvist, O., Nilsson, A., & Engstrand, P. (2022). Energy optimization in a paper mill enabled by a three-site energy cooperation. *Energies*, 15(8), 2715. https://doi.org/10.3390/en15082715
10. Ji, X., Lundgren, J., Wang, C., Dahl, J., & Grip, C.-E. (2012). Simulation and energy optimization of a pulp and paper mill – Evaporation plant and digester. Applied Energy, 97, 30-37. https://doi.org/10.1016/j.apenergy.2012.01.040
11. Ajit K Ghosh (2011). Fundamentals of Paper Drying – Theory and Application from Industrial Perspective, Evaporation, Condensation and Heat transfer, Dr. Amimul Ahsan (Ed.), ISBN: 978-953-307-583-9, InTech, Available from: http://www.intechopen.com/books/evaporation-condensation-and-heat-transfer/fundamentalsof-paper-drying-theory-and-application-from-industrial-perspective
12. Chaudhari, M., Bhatt, J. G., & Shah, P. (2024). *Reactive Power Compensation mechanism for three phase AC induction motor*. In *Proceedings of the International Conference on Power Quality*, 123-130.
13. Rodrigues, M. A. L. B. (2022). *Reactive Power Management considering Transmission System Operator and Distribution System Operator Coordination* (Master's thesis, Universidad Técnica de Lisboa).
14. Sáez, J. (2023). Auditoría del sistema aerotérmico: Informe de auditoría R-23-014 (B-2013). Report prepared for Mr. Juan José Calvo.
15. GCT PLUS. (2020). Auditoría Energética de Sarrià Hinojosa Paper y Dei B Braun Rubí.
16. Alarcon, C. (2024). Survey Report: PM4 Hinojosa Paper, Sarrià de Ter, Spain. Project CO.230085.240, Revision 0.0. Kadant Johnson Systems International.