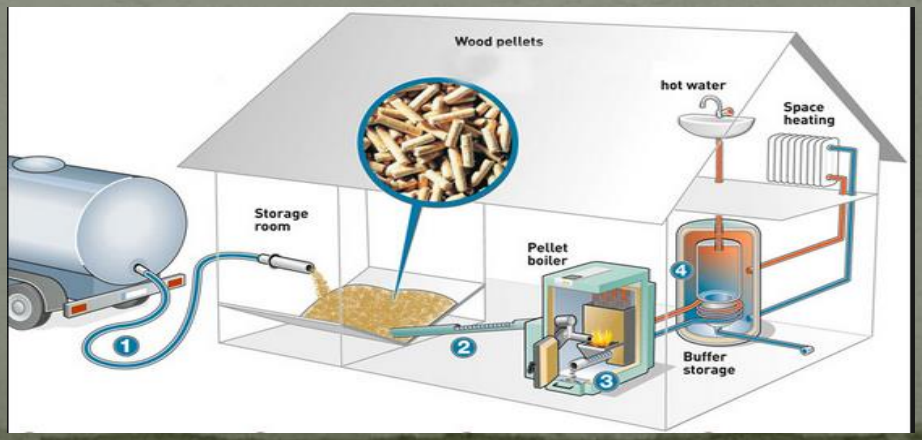
Biomass for Sustainable Rural Development

Replacing diesel with biomass in local schools

VICENT ESCRIG ROVIRA XAVIER CELADES APARICI

- Increasing awareness in society about the need to decrease the use of fossil fuels .
- Increasing competitiveness of biomass technology
- Biomass is an option more and more demanded in heating sector, especially in rural areas.

- Biomass boilers
  - have reached levels of efficiency and comfort in the use which are similar to oil or gas boilers
  - handicap is the bigger storage space for solid biomass, which far exceeds the space needed to store diesel.
  - In the case of natural gas, it is where competitiveness of biomass is compromised.
    - lower energy price compared to diesel
    - higher comfort due to the fact that storage is not needed.



- Energy dependence of countries that have not oil in the subsoil is a great disadvantage on their economy.
- Oil is necessary for the composition of materials very common in our daily lives and a source of energy that, in many applications, a competitive replacement has not been found.

- The globalization of the economy threatens the balance of the local economy in many towns in rural areas.
- Heating sector opens an opportunity for the rural economy which needs to reinvent itself.
- Biomass is a local product that earns competitiveness when the transport get smaller.
- Biomass in many cases is the by-product of an activity that takes place in the same area and it is given a value. The energy of this biomass, in addition to heat, will have generated jobs and economic activity in the area.

- Project: Analysis of the heating system in the school of Atzeneta and reducing its cost with biomass.

- Objective: The council of Atzeneta wants to reduce the energy bill in the school. Two parts:

  - Reducing the fuel cost (heating oil)
  - Obtaining biomass in the local olive mill

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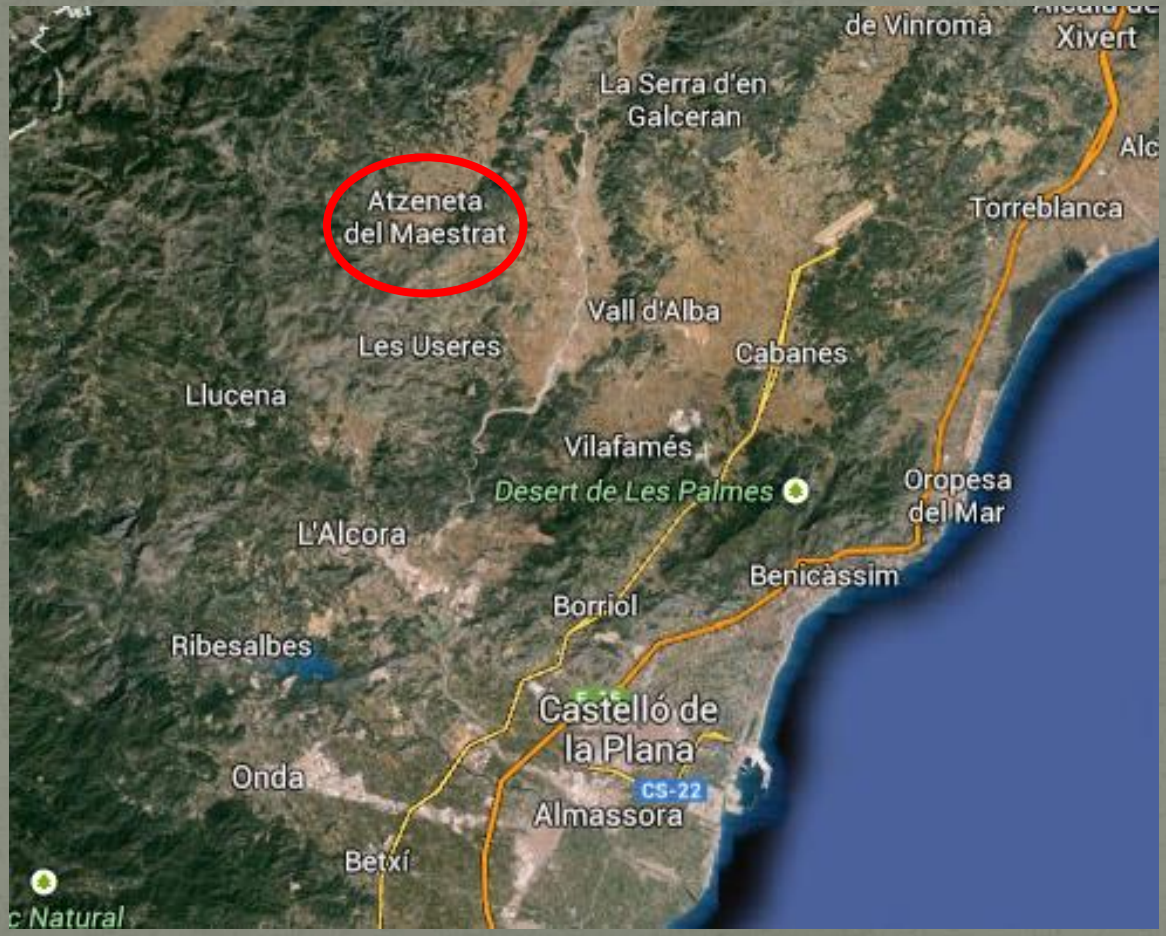
ATZENETA DEL MAESTRAT



- 45 km from Castelló de la Plana

ATZENETA DEL MAESTRAT

- Province of Castelló
- Region: Alt Maestrat
- Population: 1409
- Municipal area: 72,5 sq km
- Altitude: 405 meters

Climate

- Heat in summer . Maximum temperatures exceed 34 ºC
- Cold in winter. Minimum temperatures lower than -6ºC
- Annual precipitation average is 720 mm

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Des
AVERAGE T ºC	7,66	8,71	10,97	13,06	16,52	20,50	23,58	23,59	20,48	16,06	11,26	8,43
AVERAGE MÍNIMUM T ºC	1,18	1,67	3,70	5,95	9,21	12,94	15,61	16,03	13,30	9,29	4,73	2,12

ECONOMY

- Agriculture

Almond trees

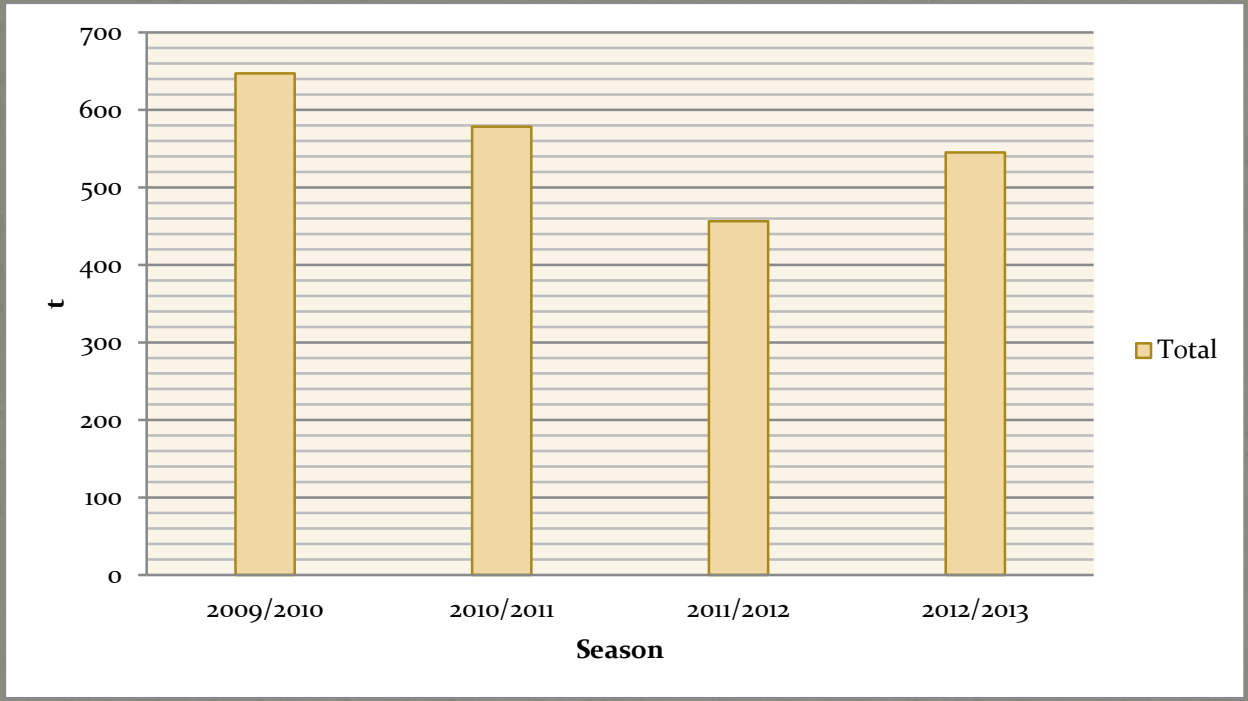
Olive trees

- Almonds

Almond shells

Biomass ready to be used

- Almond production in Atzeneta



- Average
  - 585 t of almonds per season
  - 70% shell
  - 409,5 tonnes of shell per season

- Almond shell

Properties and composition	
Humidity(%)	15.02
Ashes (%)	1.04
Density (kg/m^3)	345
C (%)	42.92
H(%)	6.61
N (%)	0.18
S(%)	0.02
Cl (%)	0.02
O (%)	49.21
Calorific value (kWh/kg)	4,56

Average energy price	
Almond shell	0,022 €/kWh
Heating oil	0,093 €/kWh

We need 2,3 kg of almond shells to substitute a liter of heating oil

Heating oil: 10,4 kWh/l

- Olive oil

Biomass ready to be used

Crushed olive pit

- Olive pit

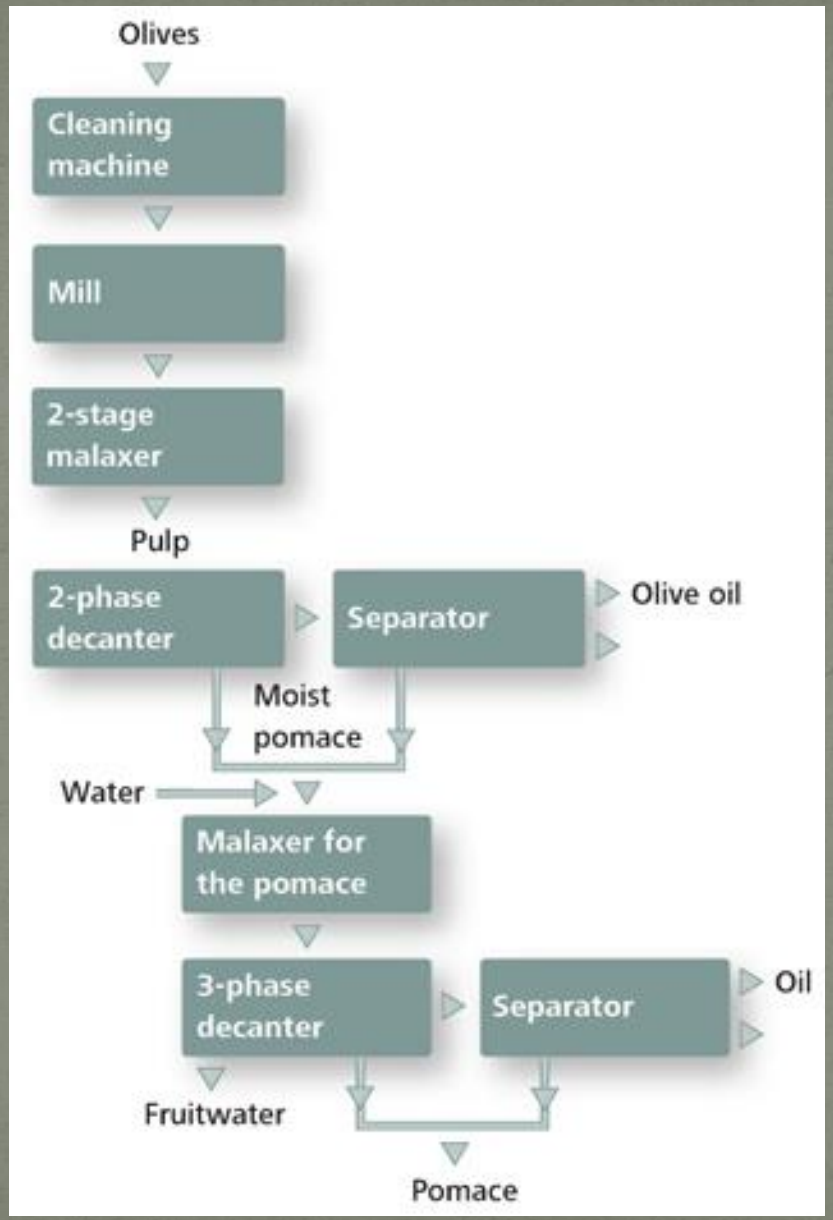
Properties and composition	
Humidity (%)	14.02
Ashes (%)	1.62
Density(kg/m^3)	660
C (%)	50.79
H (%)	5.95
N (%)	0.48
S (%)	0.04
Cl (%)	0.02
O (%)	42.74
Calorific value(kWh/kg)	5.23

Average energy price	
Olive pit	0,027 €/kWh
Heating oil	0,093 €/kWh

We need 2 kg of olive pit to substitute a liter of heating oil

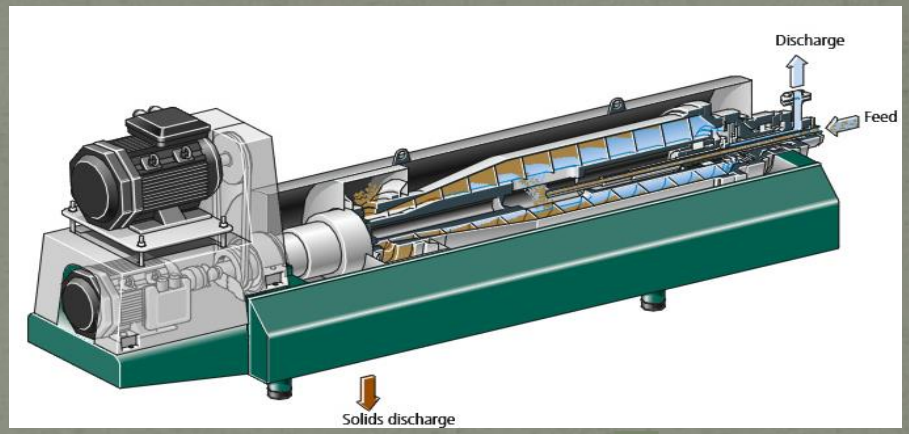
Heating oil: 10,4 kWh/l

- Olive oil process



- Project for obtaining olive pit in Atzeneta

Pomace

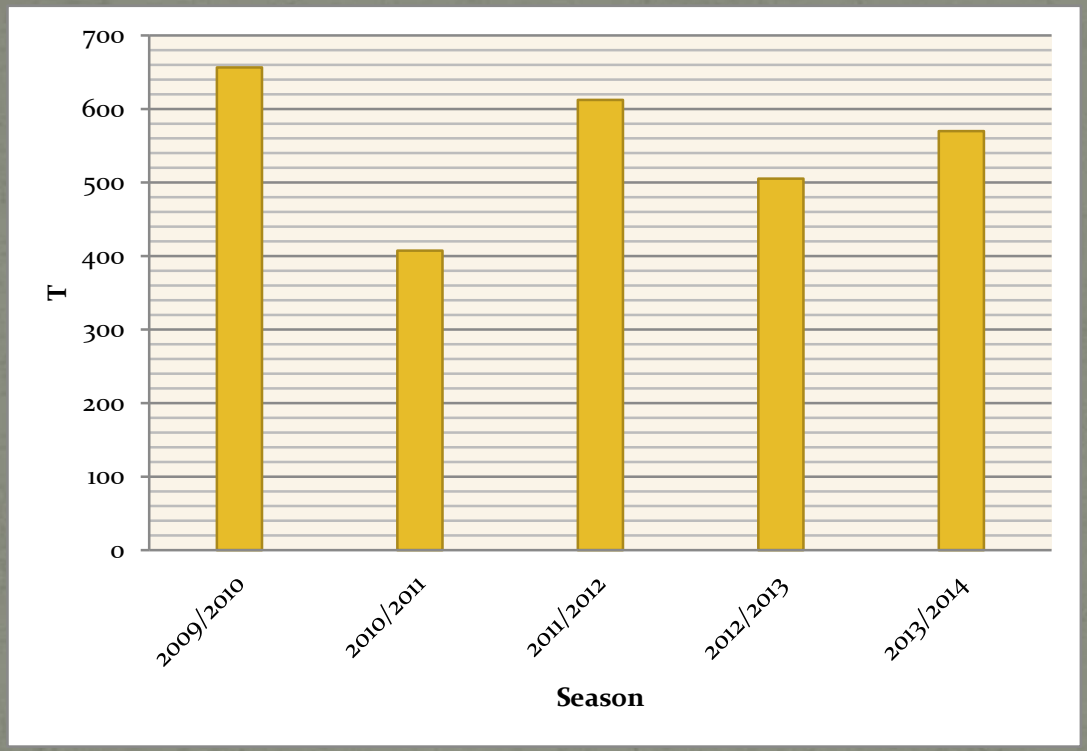


Pit-pulp separator

- Fruitwater is used for fertilizing olive trees

Crushed olive pit

- Olive production in Atzeneta



- 550 t of olives per season
- 80,35% pomace
- 66 t of pit per season
- 441,9 t of fruitwater per season

- Investment 21.641,27 €

- Pit-pulp separator
- Piston pump
- Electrical installation

- Expenses
  - Energy use
  - Worker salary
  - Pit transport
  - Pit storage
- Earnings
  - Olive pits sale
  - Saving in pomace rate

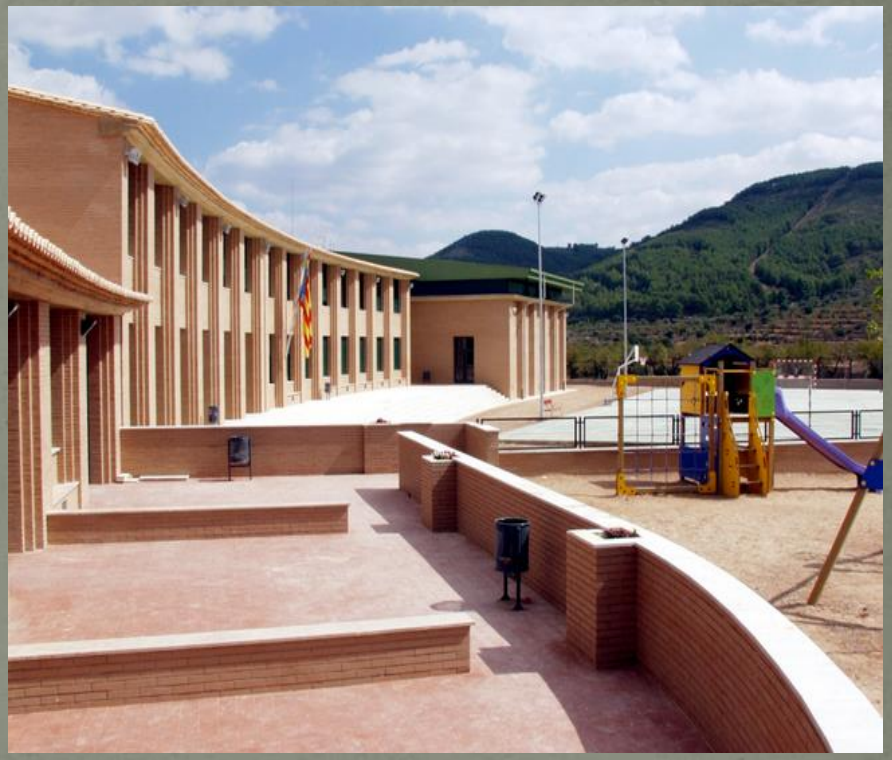
- Feasibility

Year	Energy use	Worker	Rate saving	Pit sale	Total expenses	Total earnings	Benefit	Cash-flow aggregate	Payback
0					26.641	0	-26.641	0	
1	453	6.240	1.644	13.860	6.693	15.504	8.811	8.811	-17.830
2	462	6.365	1.660	13.929	6.827	15.590	8.763	17.574	-9.067
3	471	6.492	1.677	13.999	6.963	15.676	8.713	26.287	-354
4	480	6.622	1.694	14.069	7.102	15.763	8.660	34.948	8.306
5	490	6.754	1.711	14.139	7.244	15.850	8.606	43.553	16.912
6	500	6.889	1.728	14.210	7.389	15.938	8.549	52.102	25.460
7	510	7.027	1.745	14.281	7.537	16.026	8.489	60.591	33.949
8	520	7.168	1.763	14.352	7.688	16.115	8.427	69.018	42.377
9	530	7.311	1.780	14.424	7.842	16.204	8.363	77.381	50.739
10	541	7.457	1.798	14.496	7.998	16.294	8.296	85.677	59.035

- Payback: three years
- Benefit: 85.677 € in ten years

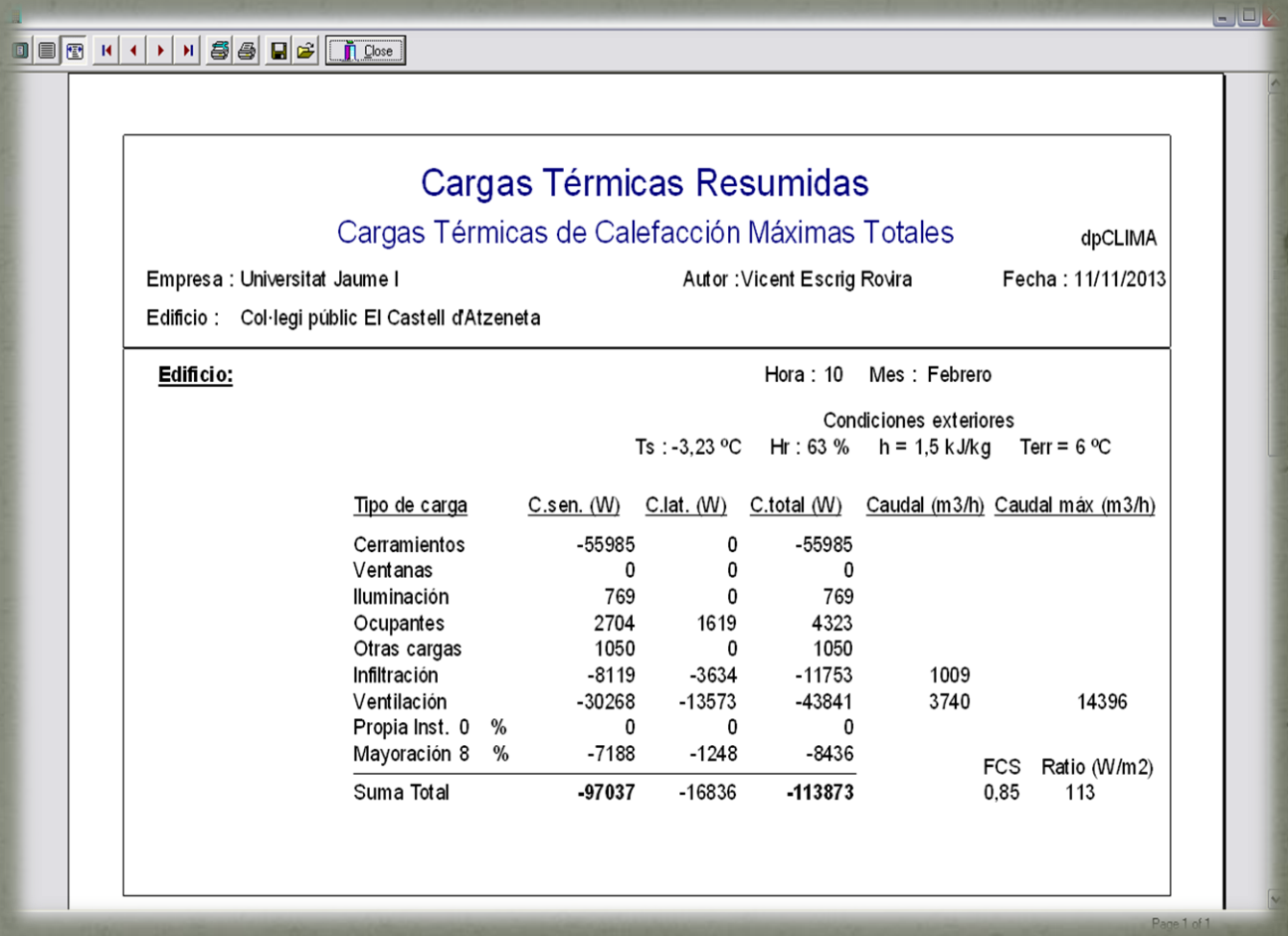
- Atzeneta local school

  - Built in 2002
  - 110 pupils
  - Heated zone 1.300 sq m
  - Oil boiler
    YGNIS PY-195 kW
  - Oil burner
    Max Weishaupt X-R3



Heating loads summary in the school

- Walls
- Ventilation
- Infiltration
- Lights
- Occupancy
- Other loads



Cargas Térmicas Resumidas

Cargas Térmicas de Calefacción Máximas Totales

dpCLIMA

Empresa : Universitat Jaume I — Autor :Vicent Escrig Rovira — Fecha : 11/11/2013

Edificio : Col·legi públic El Castell d'Atzeneta

Edificio: Hora : 10 Mes : Febrero

Condiciones exteriores

Ts : -3,23 ºC Hr : 63 % h = 1,5 kJ/kg Terr = 6 ºC

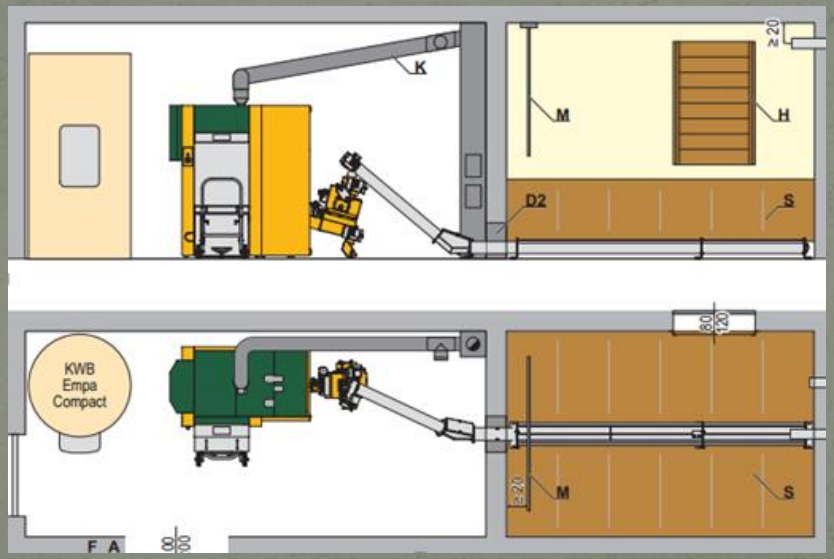
Tipo de carga	C.sen. (W)	C.lat. (W)	C.total (W)	Caudal (m3/h)	Caudal máx (m3/h)
Cerramientos	-55985	0	-55985		
Ventanas	0	0	0		
Iluminación	769	0	769		
Ocupantes	2704	1619	4323		
Otras cargas	1050	0	1050		
Infiltración	-8119	-3634	-11753	1009	
Ventilación	-30268	-13573	-43841	3740	14396
Propia Inst. 0 %	0	0	0		
Mayoración 8 %	-7188	-1248	-8436		
				FCS	Ratio (W/m2)
Suma Total	**-97037**	-16836	**-113873**	0,85	113

- Atzeneta local school

  - Heating energy needed: 78.264 kWh per year
  - Fuel amount needed per year:

Fuel	Calorific value	Amount
Heating oil	10,4 kWh/l	9.407 l
Almond shell	4,6 kWh/kg	21.267 kg
Olive pit	5,2 kWh/kg	18.814 kg

- Fuel storage
  - In the coldest month 18.305 kWh are needed
  - For having biofuel stored for that month, a new building of 5,77 cubic meters is needed



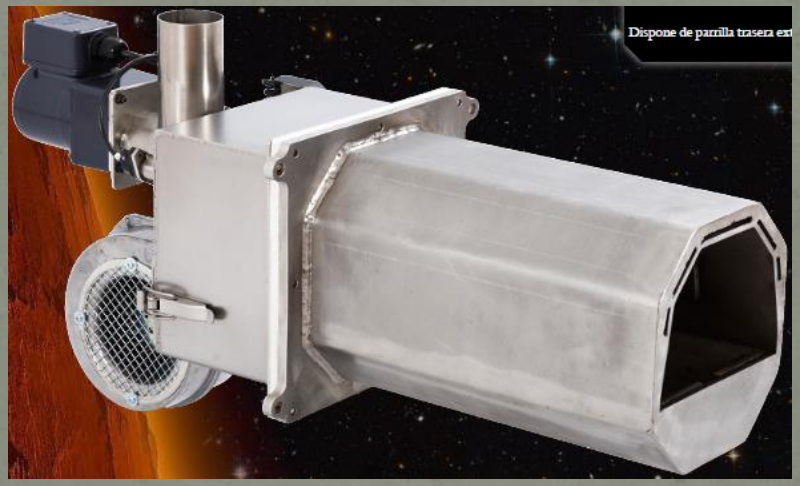
- Total price building: 2.668,28 €
- Biomass is conveyed via the worm screw to the boiler.

- Three options to adapt the heating installation to biomass:

  - Changing the current boiler burner for a biomass one
  - Changing the current boiler to a new biomass boiler
  - Changing the current boiler to a new biomass boiler with a buffer tank to lower the power required

- 1. Changing the burner

Burner	Manufacturer	Rated power	Power range	Efficiency	Consumption
ECO-150	Ecobiotérmica	150 kW	40 – 150 kW	96%	9 – 30 kg/h

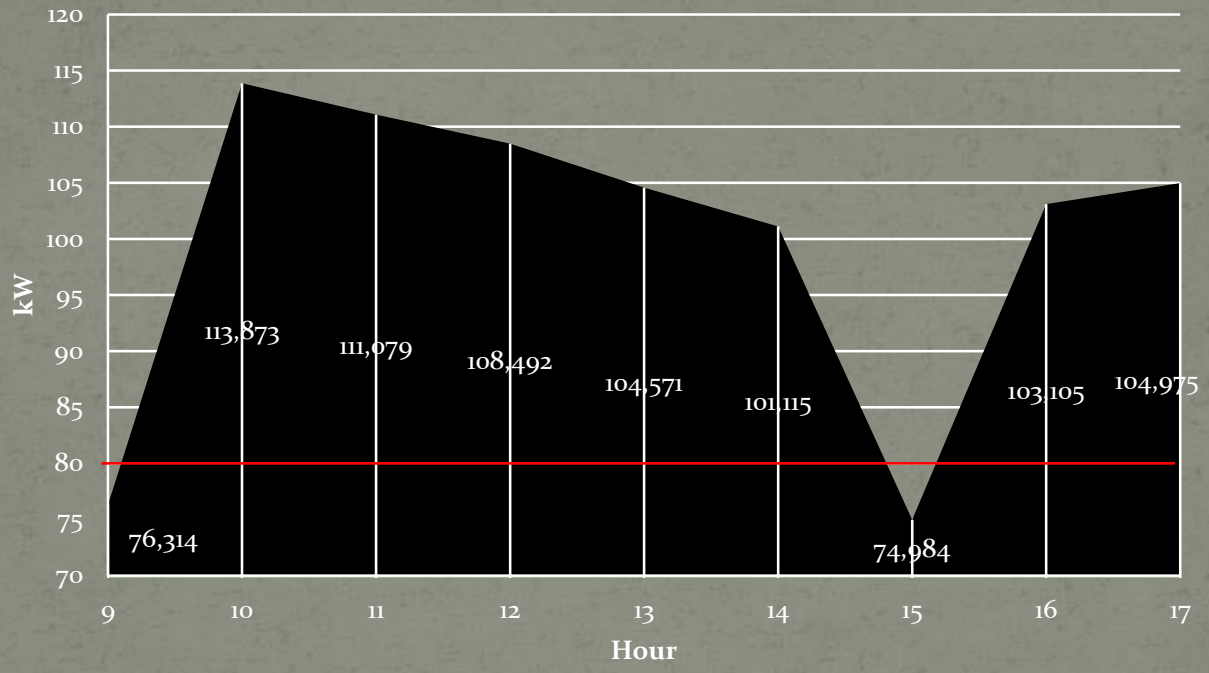


- Boiler useful life: 10 years
- Total price: **6.467 €**

- 2. New biomass boiler

  - Rated power 115 kW
  - Efficiency 93%
  - Power range: 30-115 kW
  - Automatic ignition
  - Automatic cleaning
  - Total price **27.337,53 €**

- 3. New biomass boiler + buffer tank



Boiler power (kW)	Energy (kWh)	Volume needed(l)	Time needed(min)
60	327,86	7430,81	327,86
80	167,86	3804,51	125,90
90	87,86	1991,37	58,58
100	7,86	178,22	4,72

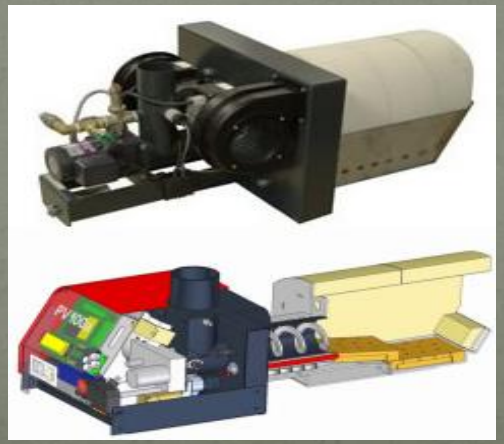
- Rated power 80 kW
- Efficiency 93%
- Power range: 25-80 kW
- Automatic ignition
- Automatic cleaning

- Capacity 4.000 liters
- Thermal loss lower than 4%

- Total price: **27.597,5 €.**

- Option chosen

  - Changing the current burner is the option chosen by the council of Atzeneta because its lower price.
  - The boiler will be changed by a new biomass one in ten years when it's considered that ends its useful life.
  - The total cost is 9.135,28 €, which includes the biomass tank and the burner change



- Feasibility

Year	Growth electricity consumption	Growth maintenance	Biomass	Total expenses	Oil cost savings	Total savings	Cash-flow aggregate	Payback
0				9.135		-9.135		
1	75	380	2637	3.092	8.937	5.845	5.845	-3.291
2	77	391	2650	3.118	9.205	6.087	11.931	2.796
3	78	403	2664	3.145	9.481	6.336	18.267	9.132
4	80	415	2677	3.172	9.765	6.594	24.861	15.726
5	81	428	2690	3.199	10.058	6.859	31.720	22.585
6	83	441	2704	3.227	10.360	7.133	38.853	29.718
7	84	454	2717	3.255	10.671	7.415	46.268	37.133
8	86	467	2731	3.284	10.991	7.707	53.975	44.840
9	88	481	2744	3.314	11.321	8.007	61.982	52.847
10	90	496	2758	3.344	11.660	8.317	70.299	61.163

- Payback: two years
- Benefit: 70.299 € in ten years

CONTENTS

- Vistabella del Maestrat
- Biomass resources
- Forest Clearing
- School
- Heating Installation
- Fuel Storage
- Chimney
- Feasability Study

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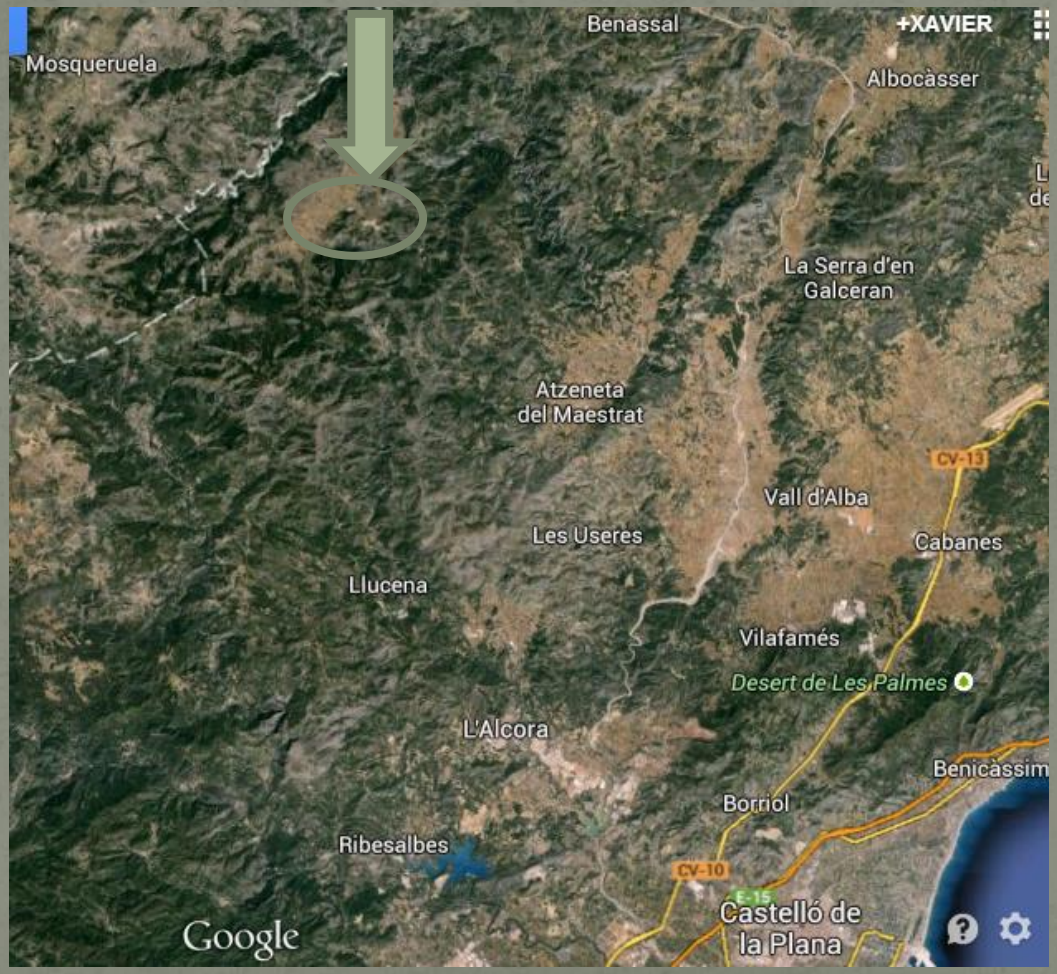
Vistabella del Maestrat



Vistabella del Maestrat

- The population is 420 people.
- Altitude: 1250 m.
- Temperatures :

	Minimum Average	Average
January	-3,6	6,2
February	-5,9	3,7
March	-1,9	7,4
April	-0,7	9
May	6,1	10,3
June	8,8	15,5
July	11,5	20,1
August	11,4	19,5
September	8,6	16,8
October	4,1	14,7
November	-1	7
December	-1,7	4,9

BIOMASS RESOURCES

- The main biomass resources in Vistabella come from the **Forest Biomass**.
- High Mountain zone.
- High Density
- Dry biomass in the soil
- Biomass (oaks and pine trees):
  - Branches,
  - wood trunks,
  - bushes and shrubberies

PROBLEMS ??

FOREST FIRES

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BIOMASS RESOURCES

- FOREST FIRES IN SPAIN IN 2013:

REGION	FIRES	INTERVENTION	FLOWN HOURS	WATER UNLOADS
ANDALUCIA	54	88	0180:36	883
ARAGÓN	10	21	0044:60	168
ASTURIAS	65	105	0249:23	1.497
C. VALENCIANA	12	39	0155:33	473
CANARIAS	8	13	0024:59	92
CANTABRIA	18	19	0043:06	241
CASTILLA LEÓN	111	368	0812:45	4.056
CASTILLA-LA MANCHA	27	118	0376:53	1.734
CATALUÑA	15	36	0067:54	172
EUSKADI	Sin actuación			
EXTREMADURA	49	140	0345:30	2.232
GALICIA	326	1.081	1945:42	10.441
ISLAS BALEARES	11	74	0351:33	1.581
LA RIOJA	3	4	0002:27	6
MADRID	9	35	0070:20	364
MURCIA	6	8	0015:36	76
NAVARRA	13	15	0014:45	28
MELILLA	Sin actuación			
CEUTA	Sin actuación			
TOTAL NACIONAL	**737**	**2.164**	**4701:42**	**24.044**

BIOMASS RESOURCES

- MONEY INVESTED:

	€
Prevention	12.740.792
Extinction:	
Human resources	14.465.219
Flight resources	51.444.675
TOTAL	**78.650.868**

www.magrama.gov.es
Ministerio de agricultura, alimentación y medio ambiente.

- Energy generated: 5.141.873.446,14 kWh (IDAE. Estudio técnico PER 2010-2020)

0,5% Gross Energy consumed in the Country

SOLUTION ??

FOREST CLEARING

FOREST CLEARING

- PROCEDURES:

Collect

- Processor

Reduce

- Wood Schredder

Transport

- Truck

FOREST CLEARING

- Production cost:
  - Collecting and Reducing: 69,06 €/t (IDAE)
  - Transport (max. 40 km around): 11,90 €/t (IDAE)

TOTAL: 80,96 €/t

How many tons of forest biomass could have been collected with the money wasted to put the fires out?

814.104 tons of forest biomass.

Average of 3kWh/kg

2,442,313,266 kWh

47,49% of the energy produced by the fires In 2013

School

- The school was built in 1970.
- Total Area: 485m²
- School Area: 340m²
- The building is share with the Drugstore and the Cultural Hall.
  - Chemist's area: 70m²
  - Cultural Hall: 75m²

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SCHOOL

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- HEATING SYSTEM

ROCA NGO 45

- 45 kW Diesel Boiler

DIESEL TANK

- Number: 2 Diesel tank
- Capacity: 1500 liters each

SCHOOL

- INSTALLATION MANAGEMENT

-The maintenance staff of the city hall is in charge of turning on and off the boiler whenever is required.

-The heat exchanger is cleaned up once a month.

- COST

-In 2013 there were 2 refills of 2.100€ each. (0,96 €/l)

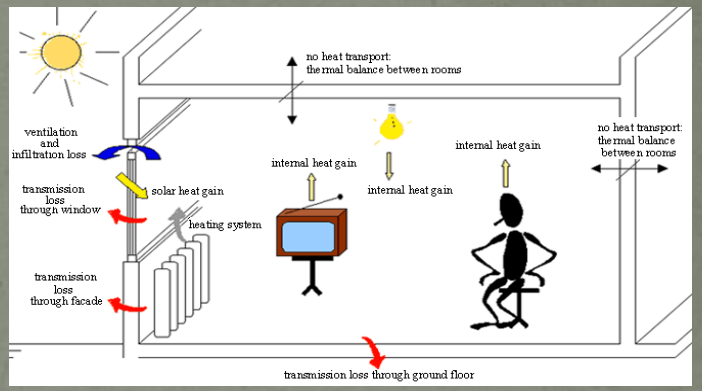
-Aproximately 4.500 Gasoil-C liters per year.

4.200 €/year

HEATING INSTALLATION

1. SCHOOL ANALYSIS

- THERMAL LOAD CALCULATION
- ENERGY DEMAND
- CONSUMPTION



2. TECHNICAL ALTERNTIVES

- MODULATING BIOMASS BOILER
- BIOMASS BOILER + BUFFER TANK
- DIESEL BOILER+BIOMASS BOILER WORKING CONCURRENTY
- CHANGE THE BURNER

HEATING INSTALLATION

1. **SCHOOL ANALYSIS**

- Thermal Load Calculation

Required Temperature inside the buidling: 21ºC

Outside Temperature: -6ºC

-Losses due to the walls

$$Q\ [W] = U\ [W/m^2\ C] \times A\ [m^2] \times \Delta T\ [C]$$

-Losees due to the windows

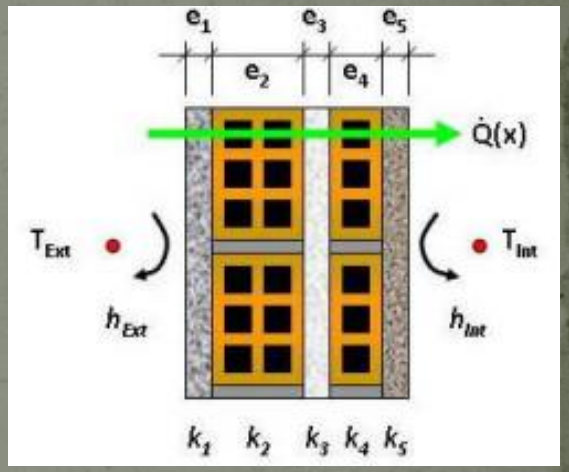
-Losses due to the ventilation

$$Q\ [W] = m\ [kg/s] \times Cp\ [kJ/kgC] \times \Delta T\ [C]$$

HEATING INSTALLATION

1. SCHOOL ANALYSIS

-Losses due to the walls: $Q\,[W] = U \times A \times \Delta T$



- U: Global Heat Transfer [W/m2C]

U=1/R R (k, thickness, h): Thermal resistance

- A: Area of the wall [m2]
- ΔT: Tint-Text=(21-(-6))=27

HEATING INSTALLATION

1. SCHOOL ANALYSIS

WALL	MATERIAL	THICKNESS (mm)	TRANSMITANCE λ (W/mK)	THERMAL RESISTANCE R(m2K/W)	U (W/m2K)
Muro exterior Norte, Este y Oeste	Mortero de cemento para albañilería	50	1,8	0,028	1,22
	Tabicón de LH doble [60mm<E<90mm]	240	0,432	0,556	
	Enclucido de Yeso aislante	20	0,3	0,067	
Muro exterior Sur	Mortero de cemento para albañilería	70	1,8	0,039	0,98
	Tabicón de LH doble [60mm<E<90mm]	320	0,432	0,741	
	Enclucido de Yeso aislante	20	0,3	0,067	
Suelo contra terreno	Pavimento genérico + mortero	50	1,8	0,028	2,06
	Losa de Hormigón armado	150	2,5	0,060	
	Bolos de piedra	150	2,3	0,065	
Suelo a local no acondicionado	Pavimento genérico + mortero	50	1,8	0,028	1,44
	Bovedilla cerámica 20 c.c. arm. Norm	230	0,67	0,343	
	Cámara de aire	30		0,160	
	Placa de Yeso	20	0,25	0,080	
Tejado	Teja de arcilla cocida	10	1	0,010	1,61
	Pavimento genérico + mortero	50	1,8	0,028	
	Bovedilla cerámica 20 c.c. arm. Norm	230	0,67	0,343	
	Cámara de aire	30		0,160	
	Placa de Yeso	20	0,25	0,080	
Medianera	Enlucido de Yeso	15	0,3	0,050	2,21
	Ladrillo Hueco	65	0,445	0,146	
	Bolos de piedra	15	0,3	0,050	

HEATING INSTALLATION

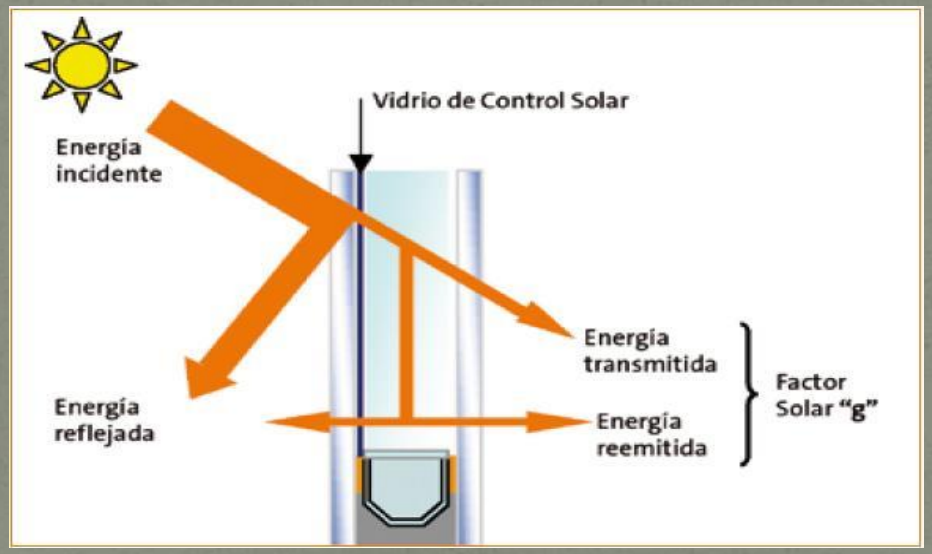
1. SCHOOL ANALYSIS

WALL	U (W/m2K)	ΔT (K)	Area (m2)	Heat Flow (W)
Muro exterior Sur	0,98	27,00	147,51	3.787,47
Muro exterior Norte	1,22	27,00	151,38	4.838,71
Muro exterior Este	1,22	27,00	70,00	2.237,48
Muro exterior Oeste	1,22	27,00	48,00	1.534,27
Suelo contra terreno	2,06	14,00	113,48	3.272,76
Suelo a local N.A.	1,44	18,00	140,21	3.634,24
Tejado	1,61	27,00	269,61	11.372,69
Medianera	2,21	18,00	25,26	1.004,84
				31.682,47

HEATING INSTALLATION

1. SCHOOL ANALYSIS

-Losses due to the Windows: $Q\ [W] = U \times A \times \Delta T$



HEATING INSTALLATION

1. SCHOOL ANALYSIS

WINDOWS AND DOORS	MATERIAL	THICKNESS (mm)	FS	U (W/m2K)
Ventana 100	Cristal Doble tipo Climalit	4-6-4	0,76	3,3
	Carpinteria Metálica sin RPT			
Ventana 120	Cristal Doble tipo Climalit	4-6-4	0,76	33
	Carpinteria Metálica sin RPT			
Ventana 150	Cristal Doble tipo Climalit	4-6-4	0,76	3,3
	Carpinteria Metálica sin RPT			
Ventana 180	Cristal Doble tipo Climalit	4-6-4	0,76	3,3
	Carpinteria Metálica sin RPT			
Puerta	Cristal Doble tipo Climalit	4-6-4	0,76	3,3
	Carpinteria Metálica sin RPT			

HEATING INSTALLATION

1. SCHOOL ANALYSIS

Windows and doors	U (W/m2K)	ΔT (K)	Area (m2)	Number	Heat Flow (w)
Ventana 100	3,30	27,00	1,00	1,00	89,10
Ventana 120	3,30	27,00	2,16	10,00	1.924,56
Ventana 150	3,30	27,00	2,70	20,00	4.811,40
Ventana 180	3,30	27,00	3,24	2,00	577,37
Puerta	3,30	27,00	5,00	2,00	891,00
				Total:	**8.293,43**

HEATING INSTALLATION

1. SCHOOL ANALYSIS

-Losses due to the ventilation: $Q[W] = m \times Cp \times \Delta T$

- m: Flow [kg/s]
- Cp: Specific Heat Capacity [J/kg C] $Cp_{air} = 1.000 J/kgC$
- ΔT: Temperature difference [C]

HEATING INSTALLATION

Zone	Flow (l/s person)	People	Outside Air Flow(l/s)
AULA INFANTIL	12,50	15,00	187,50
AULA PRIMARIA	12,50	15,00	187,50
SALA ORDENADORES	8,00	10,00	80,00
COCINA	2 (por m2)		30,00
BAÑOS			15 (por local)
COMEDOR	12,50	22,00	275,00
FARMACIA	12,50	2,00	25,00
SALA DE MÚSICA	12,50	12,00	150,00
DESPACHO	12,50	1,00	12,50
	Caudal Ventilación Total		**962,50**

HEATING INSTALLATION

The volume of air from the classroom that flows to the exterior is less than the air flowing in to create higher pressure inside.

Higher pressure inside let us to controll the air infiltrations.

Air going in: 962,5 l/s
Air going out: 739,9 l/s

Minimum Extraction Air Flow. RITE		
2 l/s por m2		
ZONE	AREA m2	FLOW l/s
COCINA	15	30
BAÑO	17	34
AULA INFANTIL	49	98
AULA PRIMARIA	49	98
SALA ORDENADORES	49	98
COMEDOR	60	120
FARMACIA	24,5	49
COMEDOR	56,45	112,9
SALA DE MUSICA	50	100
	TOTAL	739,9

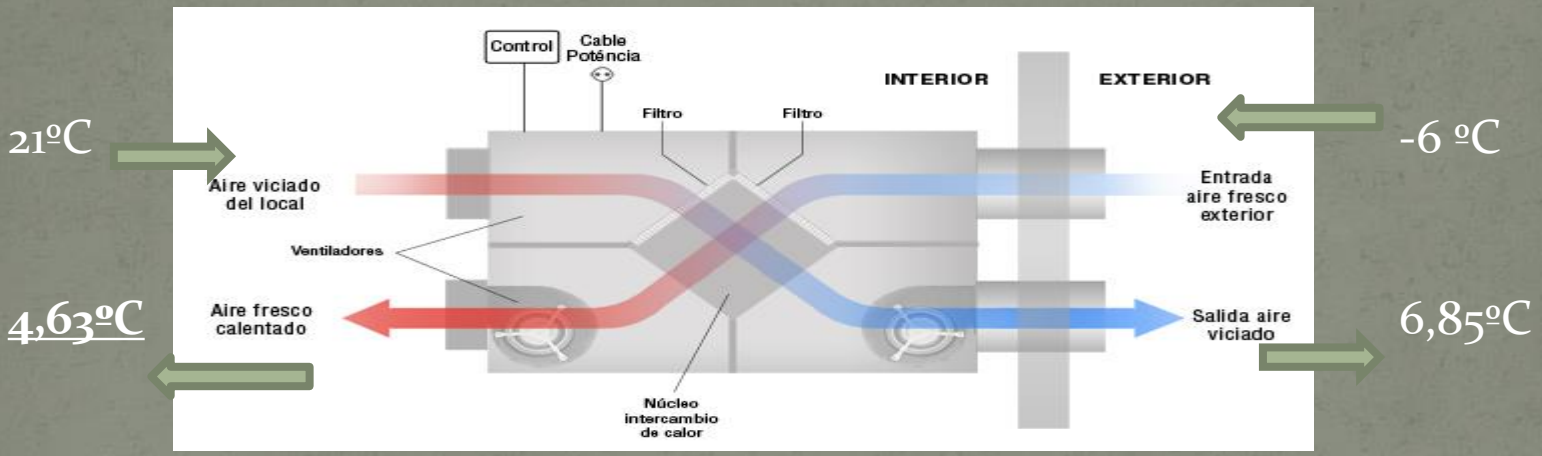
HEATING INSTALLATION

Zone	Flow (l/s)	Density (kg/m³)	ΔT (K)	Cp (J/kgK)	Power (W)
Cocina	30,00	1,20	27,20	.1000,00	943,20
Baños	15,00	1,20	27,20	1.000,00	471,60
Comedor	275,00	1,20	27,20	1.000,00	8.646,00
Aula infantil	187,50	1,20	27,20	1.000,00	5.895,00
Aula primaria	187,50	1,20	27,20	1.000,00	5.895,00
Sala ordenadores	80,00	1,20	27,20	1.000,00	2.515,20
Despacho	12,50	1,20	27,20	1.000,00	393,00
Sala de música	150,00	1,20	27,20	1.000,00	4.716,00
Farmacia	25,00	1,20	27,20	1.000,00	786,00
			Total (W):		**30.261,00**

HEATING INSTALLATION

- Heat Recovery System:

$\Delta T = 21\text{-}4{,}63 = 16{,}37\ ^{o}C$



Q=18.907,35 W

HEATING INSTALLATION

1. SCHOOL ANALYSIS

-Thermal Losses:

		THERMAL LOAD [W]
WALLS		31.682,47
WINDOWS		8.293,43
VENTILLATION		18.097,35
TOTAL:		**58.073,25**

HEATING INSTALLATION

1. SCHOOL ANALYSIS

-Energy Demand:

45.321,54 kWh / 0,90 efficiency = **50.357,26 kWh/year**

-Consumption

FUEL	ENERGY kWh	Calorific value	Amount	Estimated price €
BIOMASS (PELLET)	50.357,56	4,9 kWh/kg	10227,05 kg	2.556,76 €
GASOIL-C	50.357,56	10,45 kWh/liter	4.818,90 liters	4.674,33

HEATING INSTALLATION

2. TECHNICAL ALTERNATIVES

- DIESEL BOILER+BIOMASS BOILER WORKING CONCURRENTY
- CHANGE THE BURNER
- MODULATING BIOMASS BOILER
- BIOMASS BOILER + BUFFER TANK

HEATING INSTALLATION

2. TECHNICAL ALTERNATIVES

- DIESEL BOILER+BIOMASS BOILER WORKING CONCURRENTY

HEATING INSTALLATION

2. TECHNICAL ALTERNATIVES

- CHANGE THE BURNER

  - Biomass burners are bigger than Diesel ones for the same power.
  - The boiler should be in good conditions.
  - The heat exchanger needs to be setted in an easy access place which allows us to clean it up.
  - Biomass produces post-combustion ashes that must be taken out by hand with that burners.

HEATING INSTALLATION

2. TECHNICAL ALTERNATIVES

- MODULATING BIOMASS BOILER

For this option is required a boiler able to give the maximum power calculated before(60 kW).

It does not need any Buffer Tank.

The modulation allows the boiler to work at the rate required at any moment.

Two biomass boilers are going to be compared.

HEATING INSTALLATION

2. TECHNICAL ALTERNATIVES

- MODULATING BIOMASS BOILER

	Hargassner Classic Lamba 60	Biocalora KP62S
Automatic Cleaning for Heat exchanger	yes	yes
Automatic Clearning for ashes	yes	yes
Higher modulation	yes	no
Forced Draft fan	yes	yes
Controller	yes	yes
Biomass Tank Controller	yes	no
Higher efficiency	yes	no
Price	12.785,00 €	11.284,00 €

Spanish Company → Lowest thecnical service prices

HEATING INSTALLATION

2. TECHNICAL ALTERNATIVES

Biocalora KP Serie 3, SP62S

Descripción		Precio	D
KP62S Caldera policombustible, automática, compacta, bajas emisiones y alta eficiencia energética, con sistema automático de limpieza incorporado		11.284 €	D
Potencia	62 kW		
Modulación	18,6-62 kW		
Eficiencia	90,6%		
Peso	590 kg		
Dimensiones (ancho, largo, alto)	1123x760x1744 mm		
Consumo eléctrico	340 W		
Voltaje	230 VAC ± 10% / 50 Hz ±		

Additional costs:

- Transport: 400€
- Start up: 250€
- Other: 200€

TOTAL: 14.682,14 € (taxes included)

HEATING INSTALLATION

2. TECHNICAL ALTERNATIVES

- BIOMASS BOILER + BUFFER TANK

Reduce the power of the biomass boiler (cheaper boilers)

The boiler works at its rated power having the maximum efficience.

No need to have a modulation biomass boiler (cheaper boilers)

HEATING INSTALLATION

2. TECHNICAL ALTERNATIVES

- Biomass boiler (50kW) + Buffer Tank: OPTION 1

Working hours:

POWER REQUIRED

-School: 10 am to 5 pm → 43.719 W

-Chemist's: 10 am to 1pm / 5pm to 7 pm → 4.405W

-Cultural Hall: 5 pm to 8 pm → 9.949 W

Power Required between 10 am to 5 pm: School + Chemist's (10 am to 1 pm)=48.124W

- 50 kW Biomass boiler

Power Required between 5 am to 8 pm: Cultural Hall + Chemist's (5 am to 7 pm)=14.354W

Energy required (after 5 pm) : 9.949 x 3hours + 4.405 x 2 hours = 38.657 Wh

(38.657 x 3600)J=(M)Kg x (4180) J/KgC x (40) C → 831 liters BUFFER TANK

HEATING INSTALLATION

2. TECHNICAL ALTERNATIVES

- 50 kW Biomass boiler +1000 l Inertial Tank: OPTION2

LASIAN BIOSELECT PLUS 50
-50 kW rated power
-Efficiency : 92%
-Automatic
-8.342,58€

TOTAL: 9.627,85€

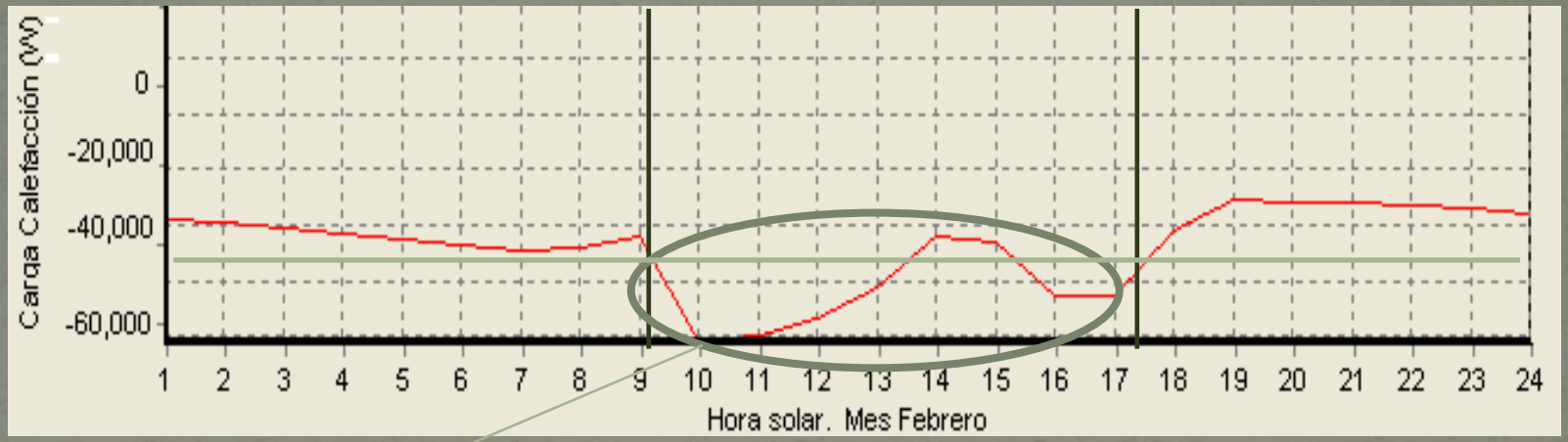
SERIE PF1000
-Volume: 1000 liters
-Thermal losees <5%
-1.285€

HEATING INSTALLATION

2. TECHNICAL ALTERNATIVES

- Biomass boiler + Inertial Tank: OPTION 2

45 kW Biomass boiler + Buffer Tank



20,78 kWh

619,82 liters + Volume for Chemist's and Cultural Hall (831 liters)

1451 liters

HEATING INSTALLATION

2. TECHNICAL ALTERNATIVES

- 45 kW Biomass boiler +1500 l Inertial Tank: OPTION2

HERZ PELLETSTAR 45
-45 kw rated power
-90 % efficiency at the rated power
-automatic
-7.868,85€

TOTAL: 9.227,85€

SERIE PF1500
1500 liters Buffer Tank
Thermal losses <5%
1,359 €

HEATING INSTALLATION

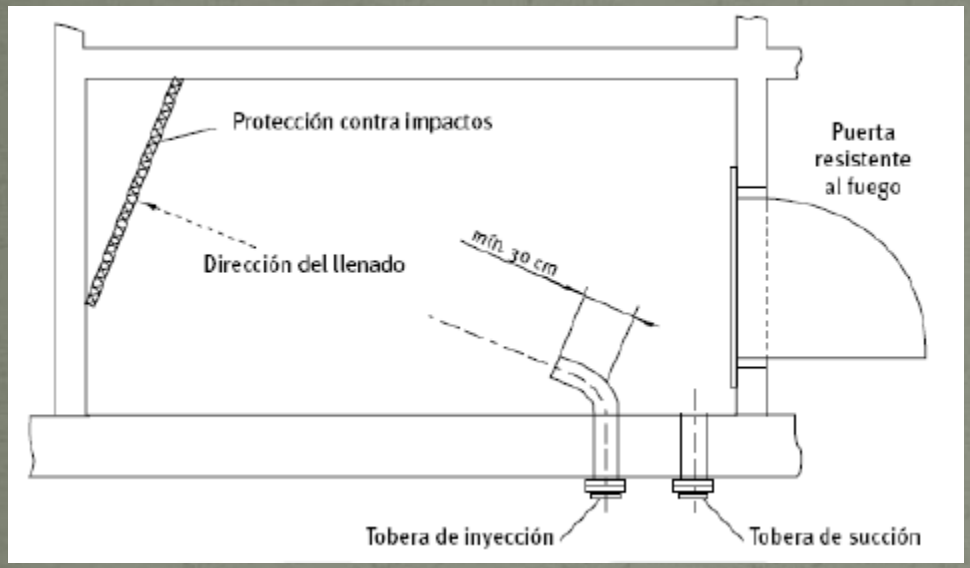
2. TECHNICAL ALTERNATIVES

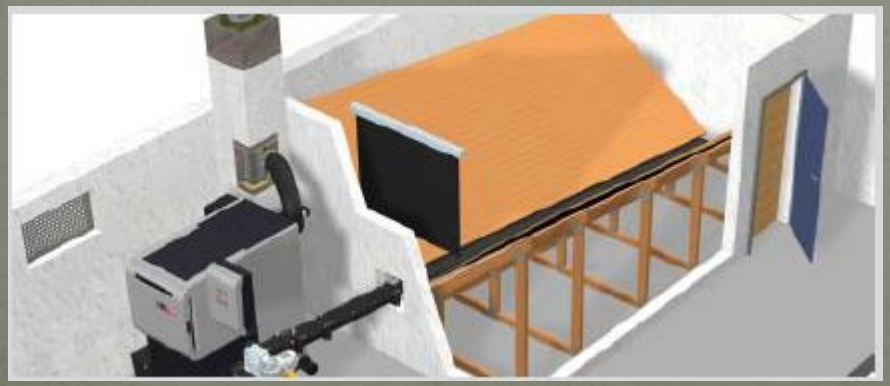
ALTERNATIVES		PRICE
HARGASNER CLASSIC LAMBDA 60		12.785
BIOCALORA KP62S		11.284
LASIAN BIOSELECT PLUS 50 + PF1000		9.627,85
HERZ PELLETSTAR 45 +PF1500		9.227,85

Programa de Aprendizaje Permanente

UNIVERSITAT JAUME·I

FUEL STORAGE





Volume: 5 cubic meters
3 fillings in a year
Stored Energy: 17.000 kWh

2.500€

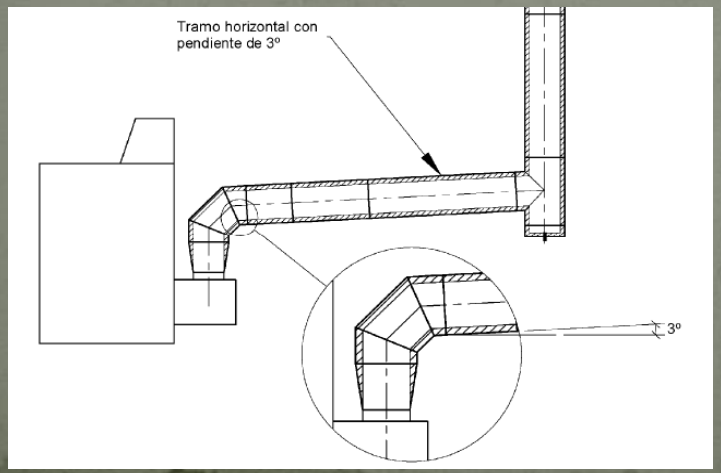
Programa de Aprendizaje Permanente

CHIMNEY

UNIVERSITAT JAUME·I

Biomass has much humidity than other fuels and that produce more steam and the volume of the post-combustion gases are higher.
For the same power the biomass boilers requiere a bigger chimney diameter.

Codes:
UNE 123001
UNE-EN-13384-1
UNE-EN 1856-1



FEASABILITY

Year	Biomass	Maintenance	Expenses	Gasoil savings	Total Savings	Cash Flow	Pay Back
0			11727,85	0	-11727,85		
1	2569,25	200,00	2769,25	4834,30	2065,05	2065,05	-9662,80
2	2582,09	206,00	2788,09	5027,67	2239,57	4304,62	-7423,23
3	2595,00	212,18	2807,18	5228,78	2421,59	6726,21	-5001,64
4	2607,98	218,55	2826,53	5437,93	2611,40	9337,62	-2390,23
5	2621,02	225,10	2846,12	5655,44	2809,32	12146,94	419,09
6	2634,12	231,85	2865,98	5881,66	3015,68	15162,62	3434,77
7	2647,30	238,81	2886,11	6116,93	3230,82	18393,44	6665,59
8	2660,53	245,97	2906,51	6361,60	3455,10	21848,54	10120,69
9	2673,83	253,35	2927,19	6616,07	3688,88	25537,42	13809,57
10	2687,20	260,95	2948,16	6880,71	3932,55	29469,98	17742,13

Pay back: 5 years

Savings in 10 years: 17.742,13 €