



EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR ENERGY
SAVE II Programme



Energy Savings by CHCP plants in the Hotel Sector

Energy Audits - Italy

May 2001

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1. Selection of hotels in Italy

An important part of the project was to conduct energy audits on a typical sample of hotels which cover the minimum criteria of CHCP installations in Italy. Initially 21 hotels have been considered, out of which 10 hotels have been chosen for a detailed energy audit to characterise the energy profile demand for electricity, heating and cooling.

Table 1.1 Climate characteristics

Hotels situated in the case studies	Latitude	Longitude	Degree days	Climatic zone	External reference temp
Rome	N 41°53'	E 12° 28'	1415	D	0° C
Neaples	N 40°51'	E 14° 15'	1034	C	2° C
Agrigento	N 37°18'	E 13°35'	729	B	2° C
Florence	N 43°41'	E 11°15'	1821	D	0° C
Bologna	N 44°29'	E 11°20'	2259	E	0° C
Milan	N 45°23'	E 9°11'	2404	E	0° C
Bergamo	N 45°41'	E 9°40'	2533	E	0° C
Genoa	N 44°25'	E 8°53'	1435	D	0° C
Turin	N 47°07'	E 7°43'	2617	E	0° C
Trieste	N 45°39'	E 13°47'	1929	D	0° C
Venice	N 45°26'	E 12°20'	2345	E	0° C

Table 1.2 Original selected hotels in Italy. Hotels with a * were selected for detailed energy audits.

Case	Location	Type Category	Rooms (beds)	Activities	Other, total area m ²
Hotel 1 *	Rome	Business/leisure 4*	646 (1174)	3 restaurants (public), Bars Swimming pool, Parking indoors Conference rooms, Laundry	63 000
Hotel 2 *	Rome (city centre)	Business /leisure 4*	162 (300)	2 restaurants (public), Bars Conference rooms Laundry	7 700
Hotel 3	Rome (city centre)	Business /leisure 4*	268 (492)	Restaurant (public) Conference rooms	n.a.
Hotel 4	Neaples	Business /leisure 4*	168 (350)	2 restaurants (public), Bars Conference rooms Roof garden, garage, fitness	n.a.
Hotel 5 *	Agrigento	Business/leisure 4*	146 (240)	Restaurant (public), Bars Conference rooms Swimming pool, Laundry	7 364
Hotel 6 *	Florence (industrial zone)	Business/leisure 4*	127 (220)	Restaurant (public), Bars Conference rooms Laundry	4 800
Hotel 7 *	Florence (city centre)	Business/leisure 4*	119 (218)	Restaurant (public), Bars Conference rooms Laundry	6 608
Hotel 8	Florence	Business/leisure 4*	49 (60)	Bar Swimming pool Laundry	790
Hotel 9	Florence	Business/leisure 4*	80	Restaurant (public)	n.a.

Case	Location	Type Category	Rooms (beds)	Activities	Other, total area m ²
	(near airport)	leisure 4*		Conference rooms	
Hotel 10	Bologna (city centre)	Business/ leisure 4*	184 (358)	Restaurants (public) Conference rooms	n.a.
Hotel 11 *	Milan	Business/ leisure 4*	140 (250)	Restaurant (public) Conference rooms Laundry	6 250
Hotel 12	Milan (city centre)	Business/ leisure 4*	152 (232)	Restaurant (public) Conference rooms	n.a.
Hotel 13 *	Milan (city centre)	Business/ leisure 4*	176 (302)	Restaurant (public) Conference rooms Laundry	7 627
Hotel 14	Milan (city centre)	Business/ leisure 4*	195	Restaurant (public) Conference rooms	n.a.
Hotel 15 *	Milan (city centre)	Business/ Leisure 4*	107 (131)	Restaurant (public) Conference rooms Laundry	3 800
Hotel 16 *	Milan	Business/ Leisure 4*	248 (470)	Restaurant (public) Conference rooms Laundry	9 460
Hotel 17	Bergamo	Business/ Leisure 4*	90 (164)	Restaurant (public) Conference rooms Swimming pool	n.a.
Hotel 18	Genoa	Business/ Leisure 4*	193	Restaurant (public) Conference rooms	n.a.
Hotel 19	Turin	Business/ Leisure 4*	162	Restaurant Conference rooms	n.a.
Hotel 20	Trieste	Business/ Leisure 4*	155	Restaurant Conference rooms	n.a.
Hotel 21 *	Venice (city centre)	Business/ Leisure 4*	168 (318)	Restaurant, Bar Laundry	9 710

2. Energy usage in hotels

Of the original 21 hotels, ten (marked with a * in the above table) were selected for the detailed energy audits. In the rest of this report, only the ten selected hotels are presented.

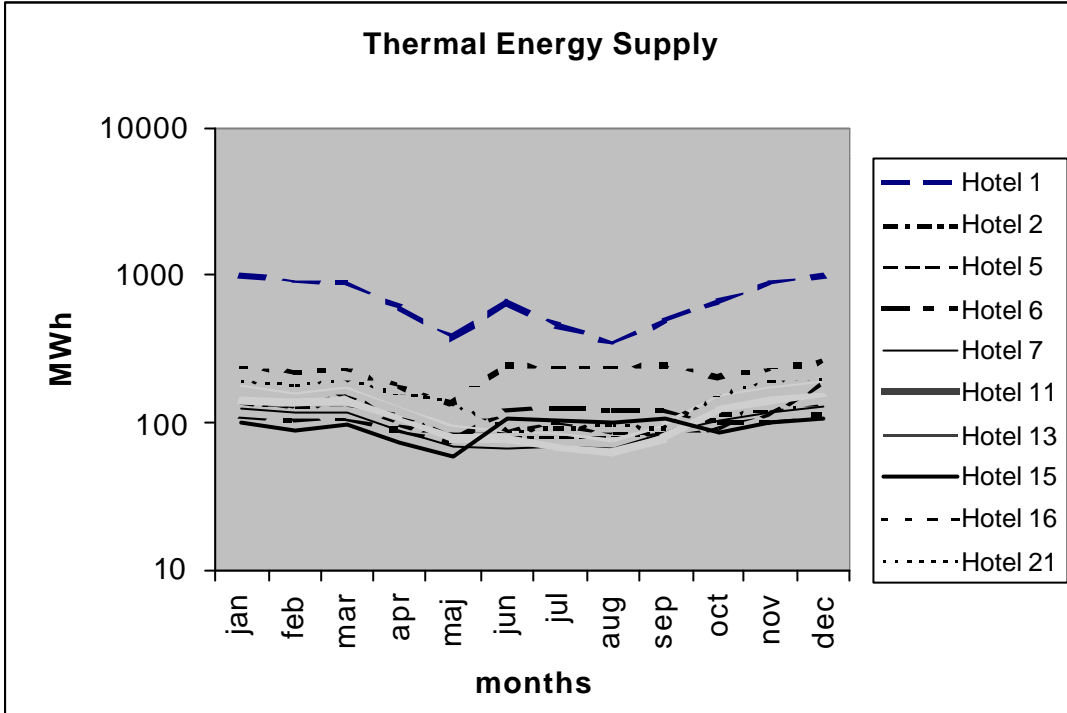


Figure: 2.1 Thermal demand profile

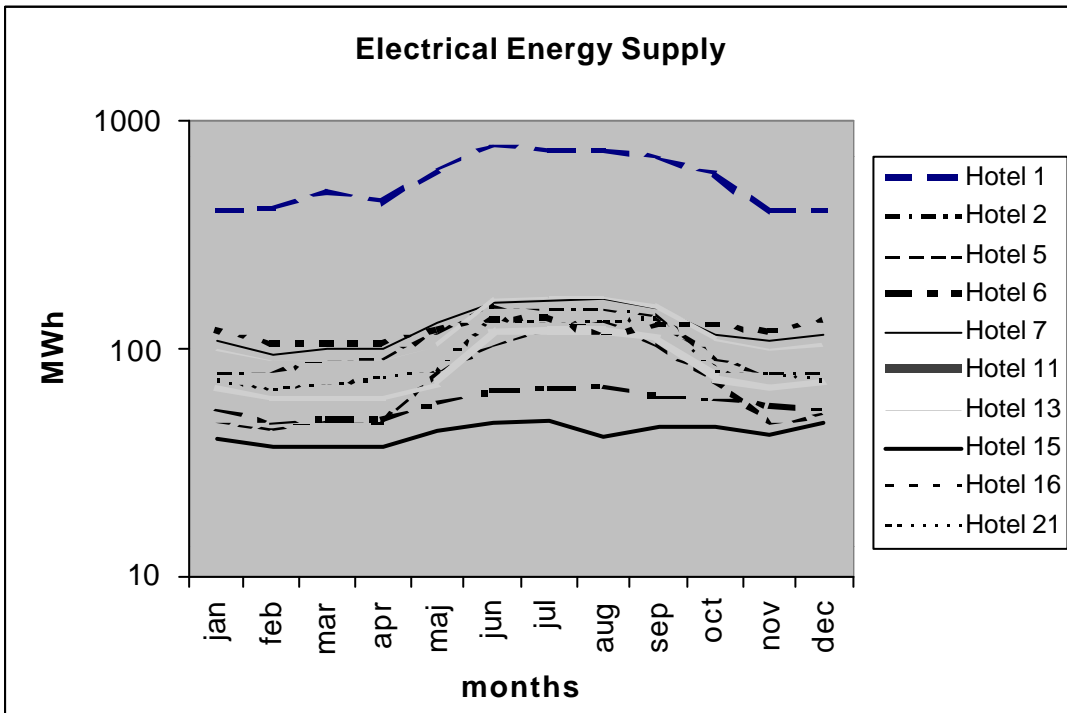


Figure: 2.2 Electrical energy supply

Table 2.3 Source and use of energy (MWh per year)

HOTELS	Electricity	Natural gas	Gasoil
Hotel 1	6714		8292 63000
Hotel 2	1297	1295	7700
Hotel 5	899	1328	7364
Hotel 6	683		1274 4800
Hotel 7	1495	1145	6608
Hotel 11	1006	1331	6250
Hotel 13	1439	1611	7627
Hotel 15	513	1124	3800
Hotel 16	1457	2665	9460
Hotel 21	1137	1789	9710

Table 2.4 Specific use (kWh/m² and year)

HOTELS	Electricity consumption (kWh/m²)		Fuel consumption (kWh/ m²)				
	Lighting and Other	Air conditioning	Space heating	Domestic hot water	Laundry	Cooling	Other
Hotel 1	88	19	62	37	12	22	9
Hotel 2	136	32	55	80	-	34	-
Hotel 5	88	34	58	91	3	32	5
Hotel 6	142	-	112	114	-	40	-
Hotel 7	196	31	63	78	7	25	-
Hotel 11	136	25	82	99	13	18	-
Hotel 13	163	25	82	100	11	17	-
Hotel 15	135	-	149	123	-	23	-
Hotel 16	155	-	144	115	-	22	-
Hotel 21	99	18	84	79	9	13	-

Case studies – Systems installed and End use of energy

Case Study – 1

Location and character

Rome – Italy

Latitude: N 41° 53'

Longitude: E 12° 28'

Height above sea level 20 m

Degree-days: 1415

Climatic zone: D

Heating season 166 days

External reference temperature: 0 °C

Case 1 is located in Rome, between downtown and Fiumicino Airport.

It is a four star hotel, with full range of business and leisure services, operating the whole year around. The activities are conference and hotel business.

The hotel has 6 floors and the total area is 63000 m².

The main part of the room is double rooms. The hotel consists on 646 rooms for 1174 guests. The baths are 621.

The average room size is 25 m².

Common areas and bars: 1500 m².

Service areas: 1750 m².

Conference rooms: 2400 m².

Restaurants: 850 m².

The three restaurants, for 210 seats, are public and not only for hotel and conference guests.

The hotel has one swimming pool, 27 m. max diameter open June to September.

Inside the hotel has parking for the hotel guests.

Energy systems installed

Air conditioning, heating and air handling systems

The air-conditioned area is 43000 m².

The rooms and the common areas are fully air-conditioned (heating/cooling). The rooms have their own individual fan coil units, which are thermostatically controlled. They contain a heating coil, cooling coil, fan and filter.

The common areas are served through a number of multi-zone units consisting of a cooling coil and a re-heat or heating coil. A series of outlets are provided from both the hot deck and the cold deck. Dampers modulate and mix the air to attain the proper temperature. The dampers are controlled from a remote zone or area. These units are capable of heating one zone while at same time, cooling another. In the winter steam is used to humidify the hot air.

The air conditioning plant produce cold air for 150 days per year and for 24 hours per day in the summer; and hot air for 166 days per year and 24 hours per day in winter. In the intermediate seasons operates 10-17 hours per day.

Fans-blowers

Exhaust electrical fans are used in bathrooms and to exhaust the heat of the kitchen area, also, units are used to supply fresh (not conditioned) air to the kitchen and laundry area.

The following systems are installed:

Thermal plant

Tree oil fired steam boilers, for a total of 8200 kW installed, and tree heat exchangers produce steam for laundries, dishwashers and cooking and hot water for space heating and domestic purposes. The plant is 19 years old.

Chillers for a total of 800 kW and 2,15 nominal COP produce cold water for air conditioning purposes. The plant is 19 years old.

Electric transformers room

The electric transformers room has n° 3 step-down transformers 20000/380 V of 1250 kW each and 2 step-down transformers 20000/380 V of 650 kW each.

Energy input

The Energy input used is oil and electricity. In the following table and diagrams the energy used for the year 1999 is presented, In the table also the use of water is added presented as a primary source.

Energy input	Consumption	% of total	Consumption/room	Consumption/m ²
Oil (MWh)	8291,9	55	12,8	0.130
Electricity (MWh)	6713,8	45	10,4	0.105
Total	15005,7		23,2	0.235
Water (m ³)	164730,0		255	2.61

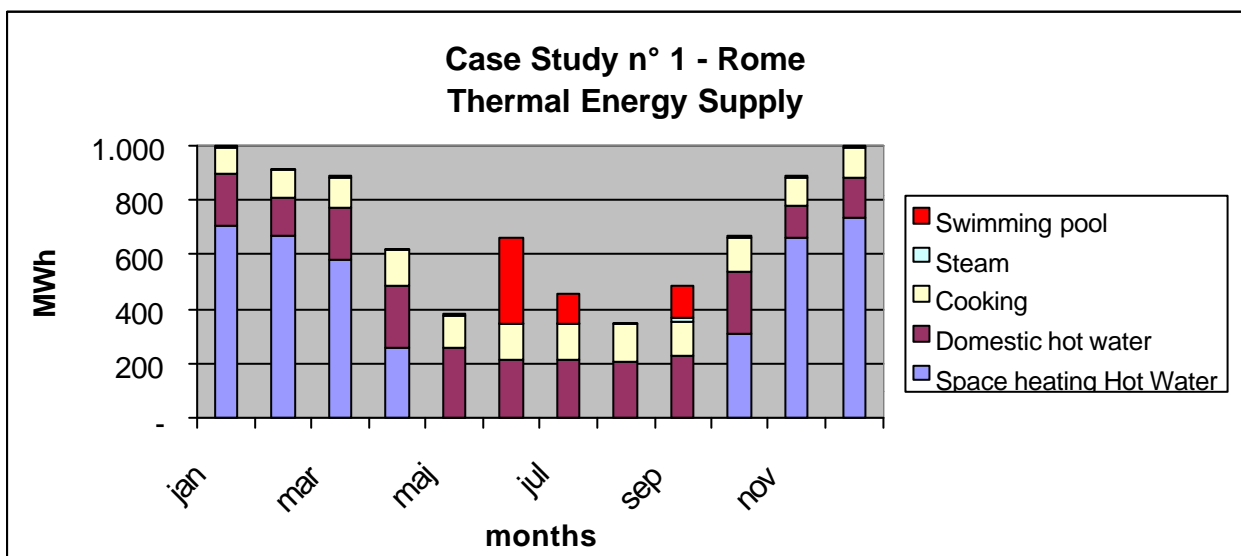


Figure 1 - Thermal energy supply

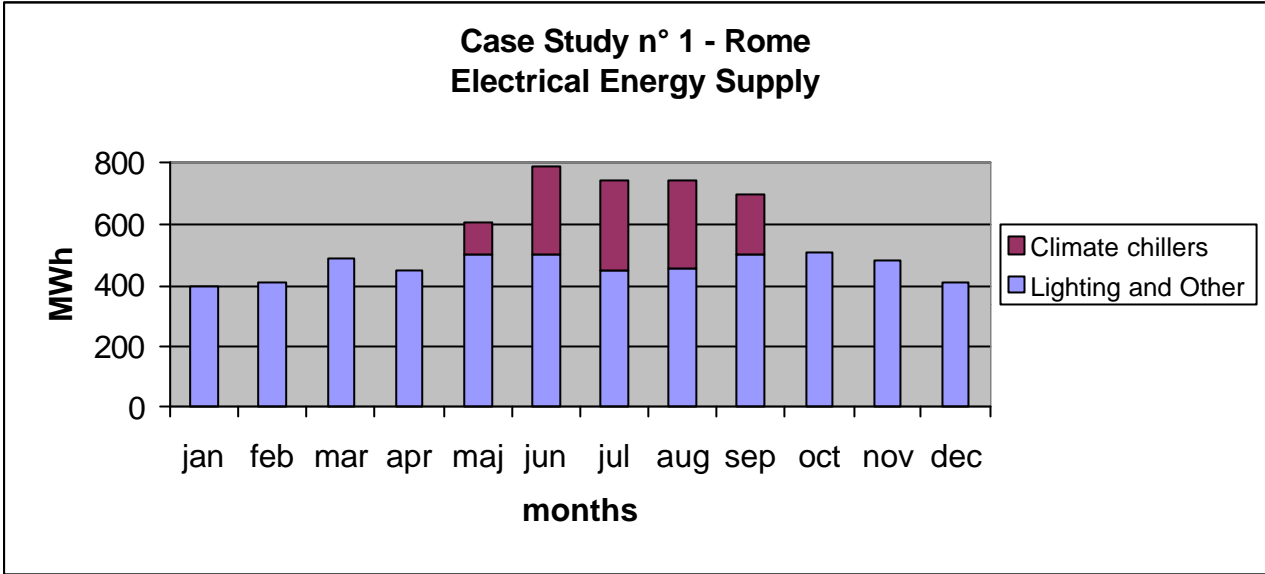


Figure 2 - Electric energy supply

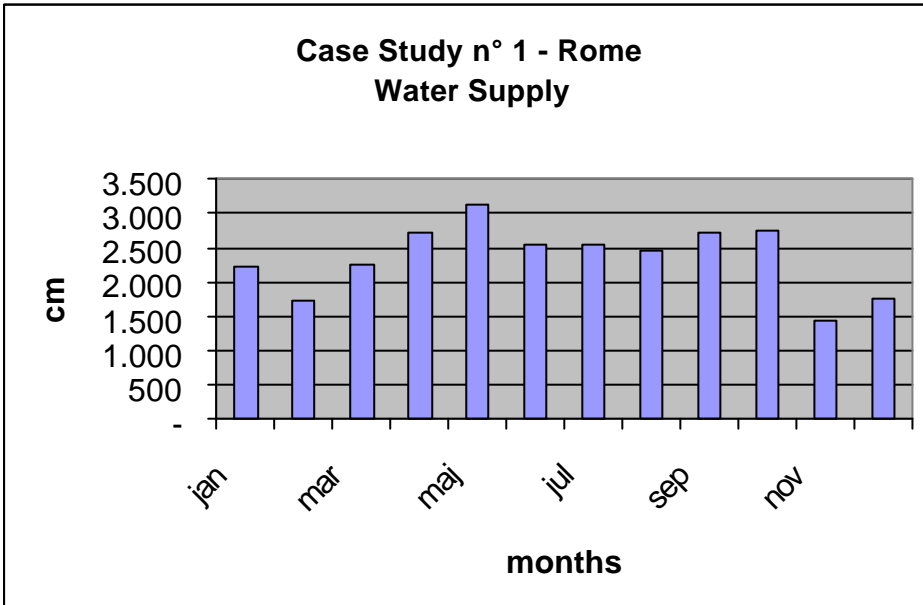


Figure 3. Water supply

The estimate end use of the primary fuel supplied is the following:

Energy input	End use	Temperature level	kW	MWh	Divided into CHCP production
Oil	Space heating hot water	85°C	8720	3919	Heat
	Domestic hot water	60°C		2348	Heat
	Steam	115°C		77	Heat
	Cooking			1410	
	swimming pool			539	Heat
Electricity	Lighting		485	5544	Electricity
	Catering		340		Electricity
	Refrigerator chillers	-2°C	25		Electricity
	Climate chillers	5°C	800		1169

Case Study – 2

Location and character

Rome – Italy

Latitude: N 41° 53'

Longitude: E 12° 28'

Height above sea level 20 m

Degree-days: 1415

Climatic zone: D

Heating season 166 days

External reference temperature: 0 °C

The hotel is located downtown.

It is a four star hotel, with full range of business and leisure services, operating the whole year around.

The activities are conference and hotel business.

The hotel is 7 floors and the total area is 7700 m².

The main part of the rooms is double room. The hotel consists on 162 rooms for 300 guests. The baths are 158.

The average room size is 21 m².

Common areas and bars: 260 m².

Service areas: 700 m².

Conference rooms: 420 m².

Conference rooms are available for 150 seated guests.

Restaurants: 320 m².

Restaurant and self-service, for 80 and 50 seats, are public and not only for hotel and conference guests.

Energy systems installed

Air conditioning, heating and air handling systems

The air-conditioned area is 7000 m².

The rooms and the common areas are fully air-conditioned (heating/cooling). The rooms have their own individual fan coil units, which are thermostatically controlled. They contain a heating coil, cooling coil, fan and filter.

The common areas are served through a number of multi-zone units consisting of a cooling coil and a re-heat or heating coil. A series of outlets are provided from both the hot deck and the cold deck. Dampers modulate and mix the air to attain the proper temperature. The dampers are controlled from a remote zone or area. These units are capable of heating one zone while at same time, cooling another. In the winter steam, electrically produced, is used to humidify the hot air.

The air conditioning plant produce cold air for 150 days per year and for 24 hours per day in the summer; and hot air for 166 days per year and 24 hours per day in winter. In the intermediate seasons operates 10-17 hours per day.

Fans-blowers

Exhaust electrical fans are used in bathrooms and to exhaust the heat of the kitchen area, also, units are used to supply fresh (not conditioned) air to the kitchen and laundry area.

Thermal plant

Two natural gas hot water boilers, for a total of 1400 kW installed produce hot water for space heating and domestic purposes

Chillers for a total of 191 kWe and 2,2 nominal COP produce cold water for air conditioning purposes.

Electric transformers room

The electric transformers room has one step-down transformers 20000/380 V of 630 kW.

Energy input

The Energy input used is natural gas and electricity. In the following table and diagrams the energy used for the year 1999 is presented, In the table also the use of water is added presented as a primary source.

Energy input	Consumption	% of total	Consumption/room	Consumption/m ²
Natural gas (MWh)	1295,35	49	8	0.211
Electricity (MWh)	1297,25	51	8,1	0.2105
Total	2602,60		16.1	0.411
Water (m ³)	28251		174	4.60

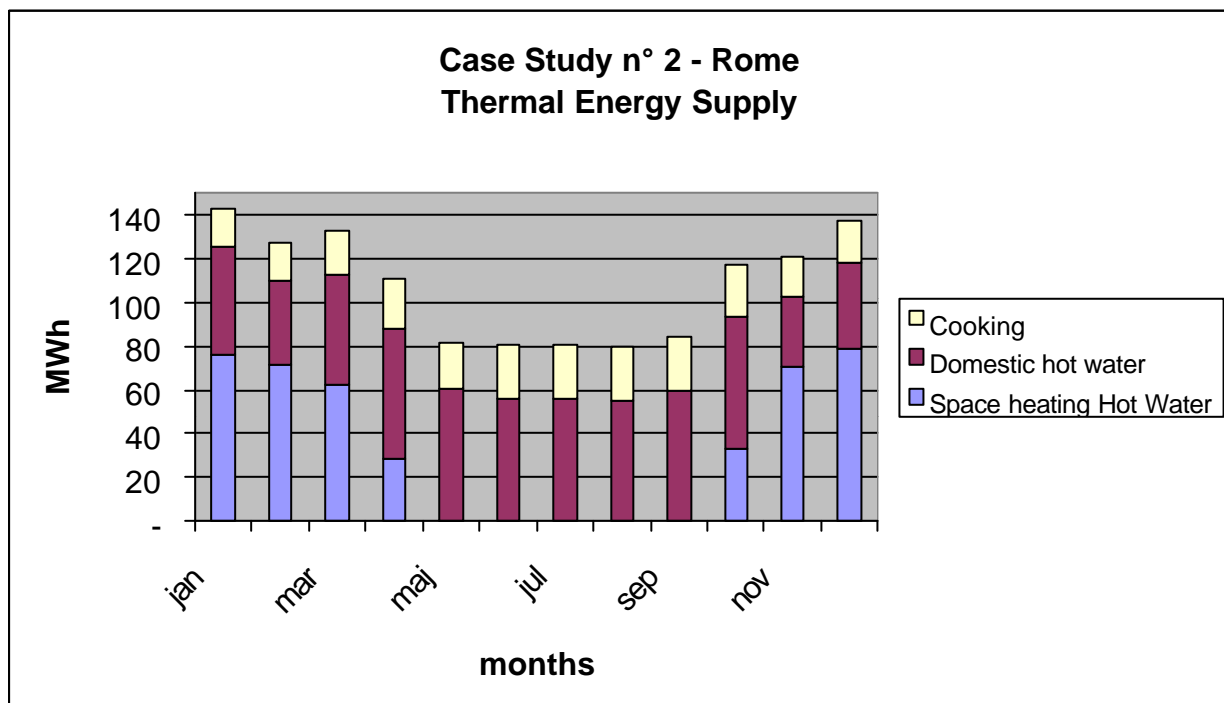


Figure 1 - Thermal energy supply

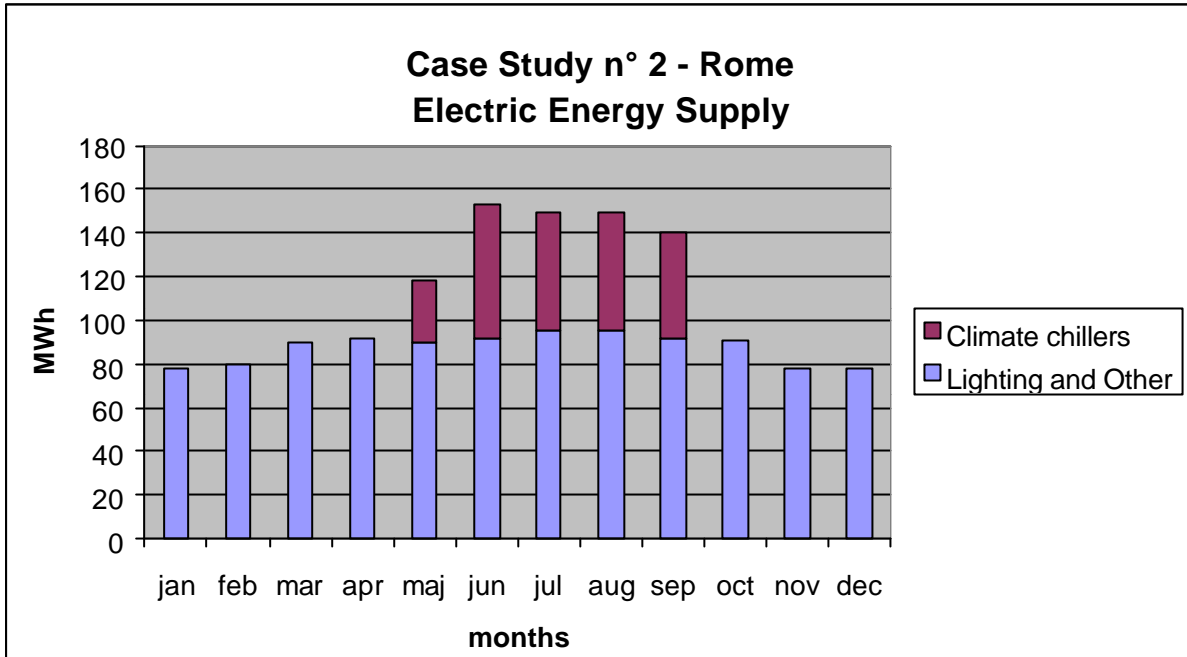


Figure 2. Electric energy supply

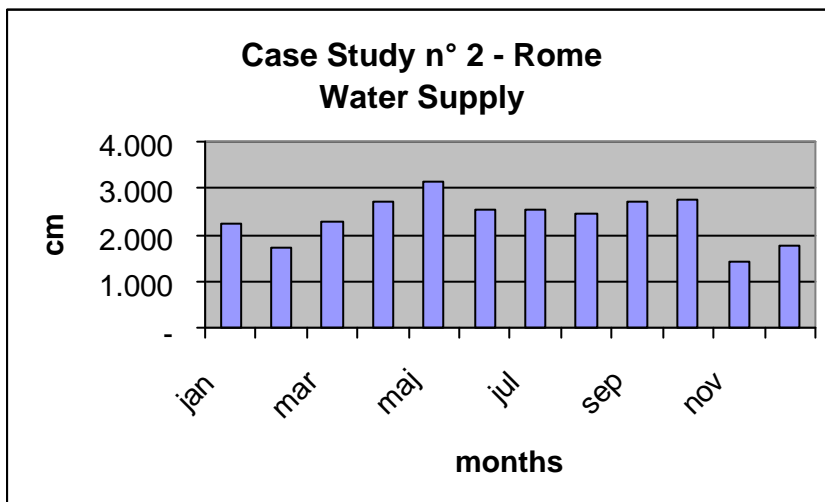


Figure 3 - Water supply

The estimate end use of the primary fuel supplied is the following:

Energy input	End use	Temperature level	KW	MWh	Divided into CHCP production
Natural Gas	Space heating hot water	85°C	1400	422	Heat
	Domestic Hot water	60°C		615	Heat
	Cooking		40	258	
Electricity	Lighting		180	1048	Electrical
	Catering		160		Electrical
	Refrigerator chillers	-5°C	125		Electrical
	Climate chillers	5°C	191	247	Cooling

Case Study – 5

Location and character

Agrigento – Italy

Latitude: N 37° 18'

Longitude: E 13° 35'

Height above sea level 230 m

Degree-days: 729

Climatic zone: B

Heating season 121 days

External reference temperature: 3 °C

The hotel is located in the centre of a large park, near the archaeological valley.

It is a four star hotel, with full range of business and leisure services, operating the whole year around.

The activities are conference and hotel business.

The hotel is 5 floors and 23400 m³, The total area is 7364 m².

The main part of the rooms is double rooms. The hotel consists on 146 rooms for 240 guests. The bats are 146.

The average room size is 20 m².

Common areas and bars: 5400 m².

The hotel has 8 meeting rooms from 30 up to 500 people, for a total of 600 seats.

The restaurant for 120 seats, is public and not only for hotel and conference guests.

The hotel has one swimming pool, open June to August.

Outside the hotel has parking for the hotel guests.

Energy systems installed

Air conditioning, heating and air handling systems

The air-conditioned area is 5400 m².

The rooms and the common areas are fully air-conditioned (heating/cooling). The rooms have their own individual fan coil units, which are thermostatically controlled. They contain a heating coil, cooling coil, fan and filter.

The common areas are served through a number of handling units consisting of a cooling coil and a re-heat or heating coil. A series of outlets are provided from both the hot deck and the cold deck. Dampers modulate and mix the air to attain the proper temperature. The dampers are controlled from a remote zone or area. In the winter steam is used to humidify the hot air.

The air conditioning plant produce cold air for 150 days per year and for 24 hours per day in the summer; and hot air for 121 days per year and 24 hours per day in winter. In the intermediate seasons the air conditioning system operates 10-17 hours per day.

Fans-blowers

Exhaust electrical fans are used in bathrooms and to exhaust the heat of the kitchen area, also, units are used to supply fresh (not conditioned) air to the kitchen and laundry area.

Thermal plant

One gas fired steam boiler, of 793 kW installed, produces two bar superheated steam for laundries and dishwashers and to supplies four heat exchangers for space heating and domestic purposes.

Chillers for a total of 66 kWe and 2,5 nominal COP produce cold water for air conditioning purposes.

Electric transformers room

The electric transformer room has n° 1 step-down transformer 20000/380 V of 400 kW.

Energy input

The Energy input used is natural gas and electricity. In the following table and diagrams the energy used for the year 1999 is presented, In the table also the use of water is added presented as a primary source.

Energy input	Consumption	% of total	Consumption/room	Consumption/m ²
Natural gas (MWh)	1327,8	60	9,1	0,181
Electricity (MWh)	898,4	40	6,1	0,122
Total	2225,2		15,2	0,303
Water (m ³)	21851,1		150	2,97

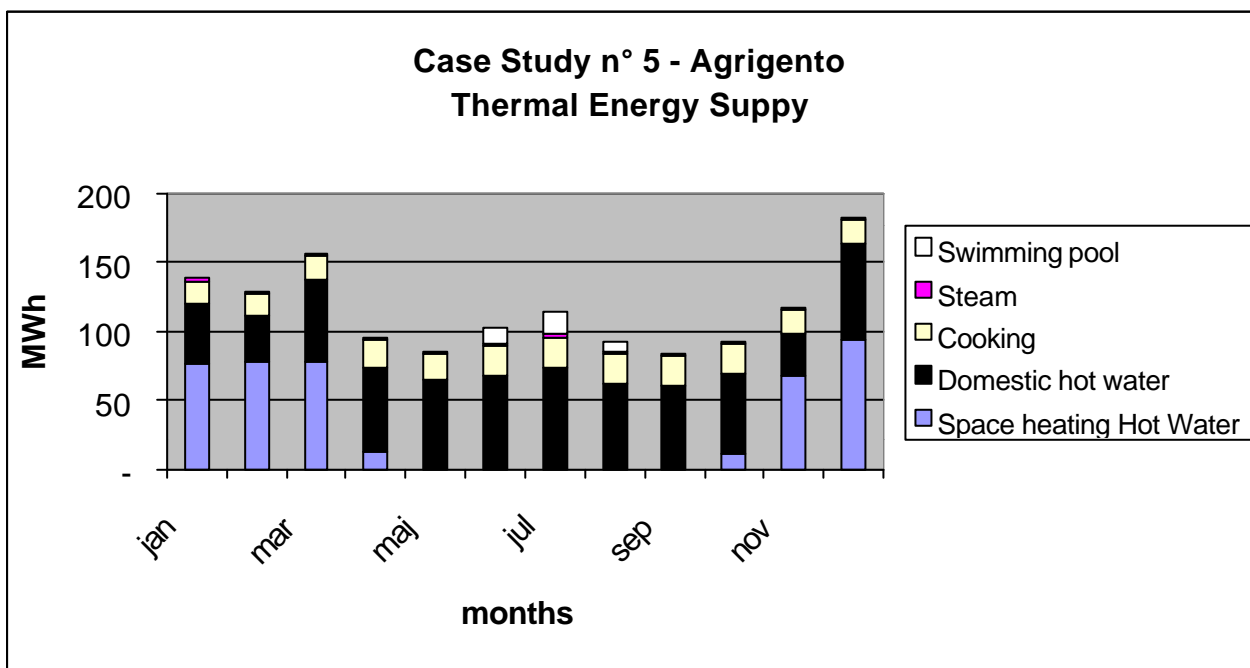


Figure 1 - Thermal energy supply

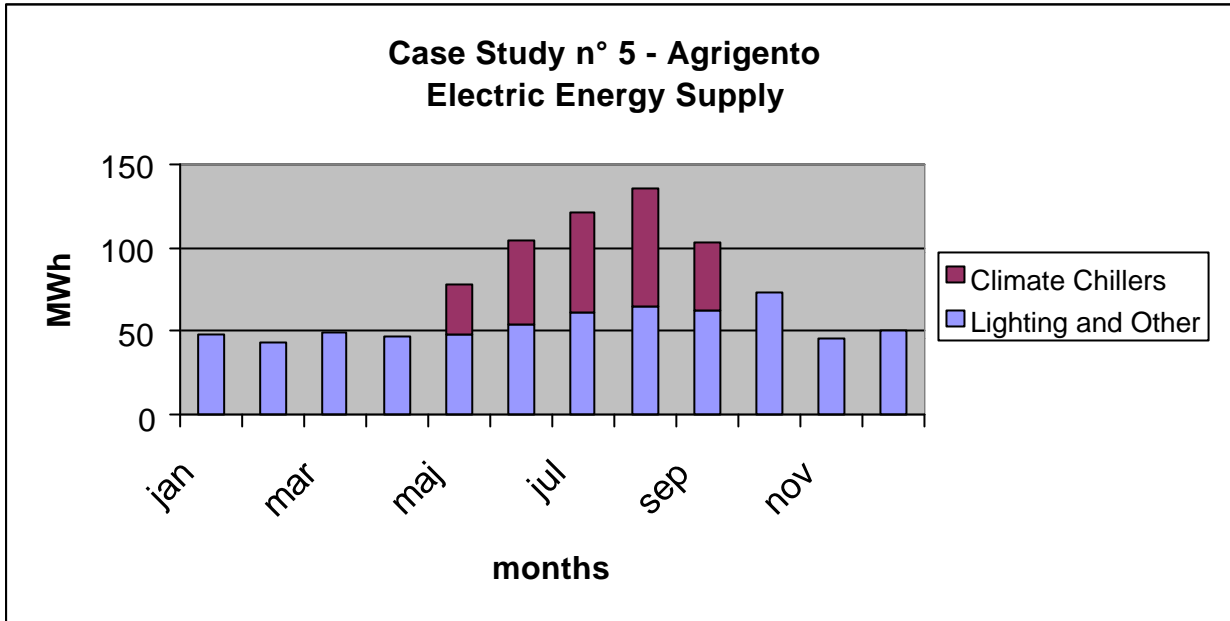


Figure 2 Electric energy supply

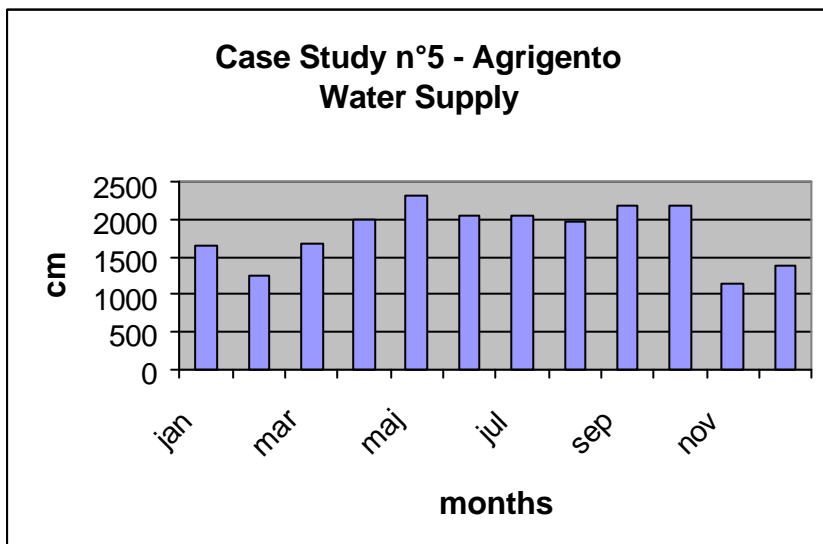


Figure 3-Water supply

The estimate end use of the primary fuel supplied is the following:

Energy input	End use	Temperature level	kW	MWh	Divided into CHCP production
Natural Gas	Space heating hot water	50°C	523	427	Heat
	Domestic hot water	50°C	93	671	Heat
	Steam	140°C	9	23.3	Heat
	Cooking		40	232.7	
	Swimming pool			33.5	Heat
Electricity	Lighting		485	649	Electrical
	Catering		340		Electrical
	Refrigerator chillers	-8°C	25		Electrical
	Climate chillers	5°C	66		250

Case Study – 6

Location and character

Florence – Italy

Latitude: N 43° 41'

Longitude: E 11° 15'

Height above sea level 50 m

Degree-days: 1821

Climatic zone: D

Heating season 166 days

External reference temperature: 0 °C

Case 6 is located in Florence, in the modern industrial zone.

It is a four star hotel, with full range of business and leisure services, operating the whole year around.

The activities are conference and hotel business.

The hotel is 11 floors and the total area is 4800 m².

The main part of the rooms is double rooms. The hotel consists on 127 rooms for 220 guests. The baths are 127 .

The average room size is 20 m².

Common areas and bars: 250 m².

Service areas: 400 m².

Conference rooms: 150 m².

The hotel has 2 meeting rooms from 15 up to 65 people.

Restaurants: 400 m².

The restaurant, for 150 seats, is public and not only for hotel and conference guests.

Outside the hotel has parking for the hotel guests.

Energy systems installed

Air conditioning, heating and air handling systems

The air-conditioned area is 4400 m². The rooms and the common areas are fully air-conditioned (heating/cooling). The rooms have their own individual fan coil units, which are thermostatically controlled. They contain a heating coil, cooling coil, fan and filter. The common areas are served through a number of handling units. The air conditioning plant produce cold air for 150 days per year and for 24 hours per day in the summer and hot air for 166 days per year and 24 hours per day in winter. In the intermediate seasons the air conditioning system operates 10-17 hours per day.

Fans-blowers

Exhaust electrical fans are used in bathrooms and to exhaust the heat of the kitchen area, also, units are used to supply fresh (not conditioned) air to the kitchen and laundry area.

Thermal plant

One oil-fired boiler, of 700 kW installed, produces hot water for domestic purposes.

One oil fired absorption chiller of 190 kWt produces cold water and hot water for air conditioning purposes

Electric transformers room

The electric transformer room has n° 1 step-down transformer 20000/380 V of 260 kW.

Energy input

The Energy input used is natural gas and electricity. In the following table and diagrams the energy used for the year 1999 is presented, In the table also the use of water is added presented as a primary source.

Energy input	Consumption	% of total	Consumption/room	Consumption/m ²
Oil (MWh)	1274,4	65%	10	0,265
Electricity (MWh)	683,7	35%	5,4	0,142
Total	1958,1		15,4	0,407
Water (m ³)	27885		219,3	5,81

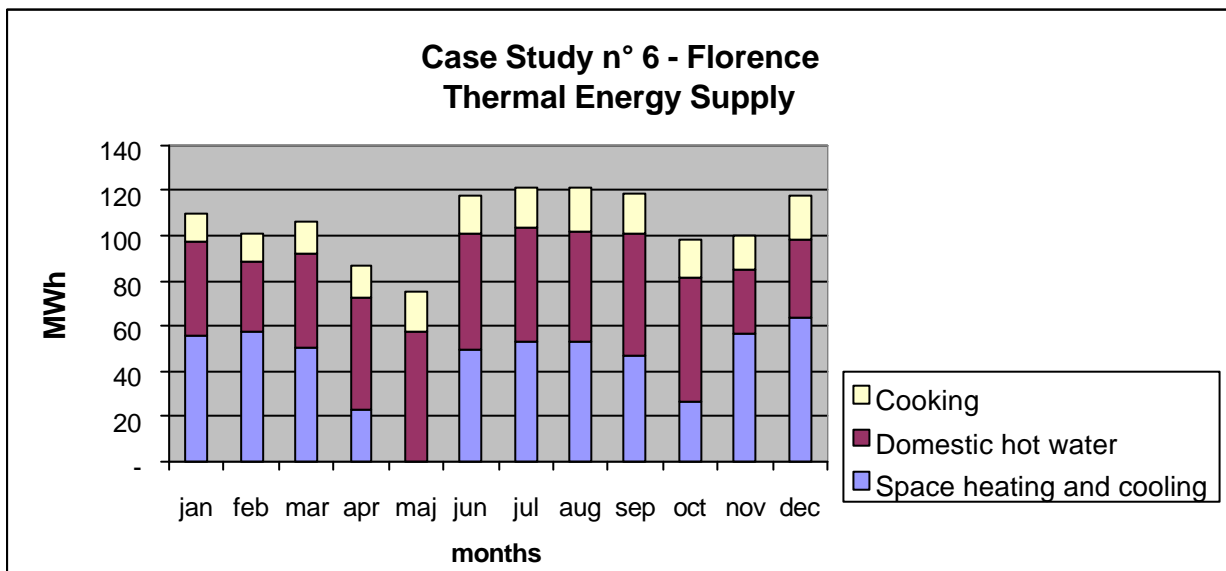


Figure 1. Thermal energy supply

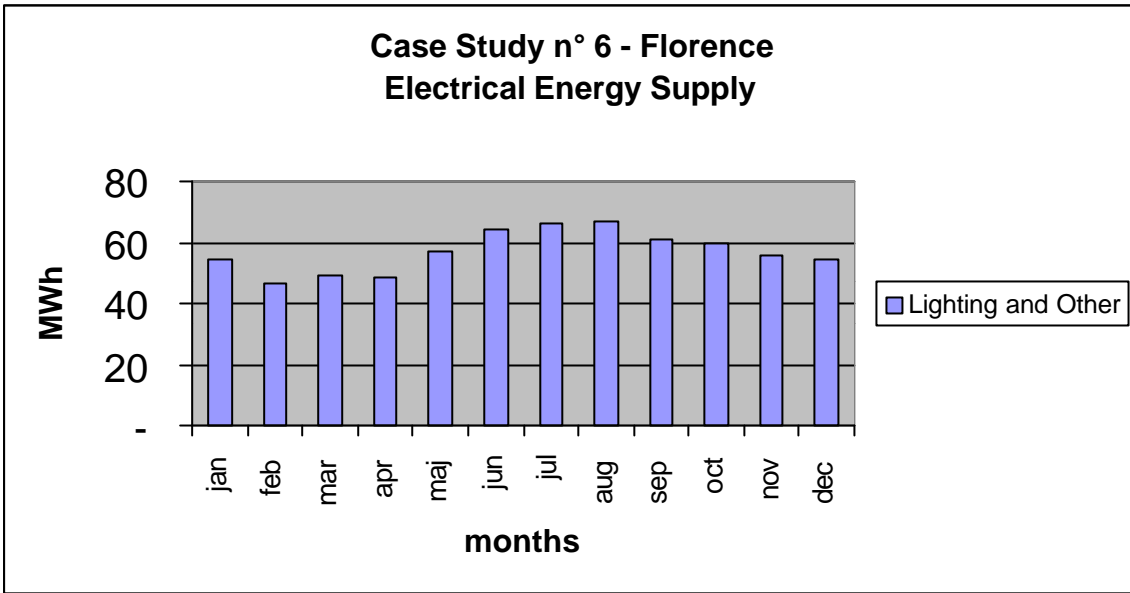


Figure 2 Electric Energy Supply

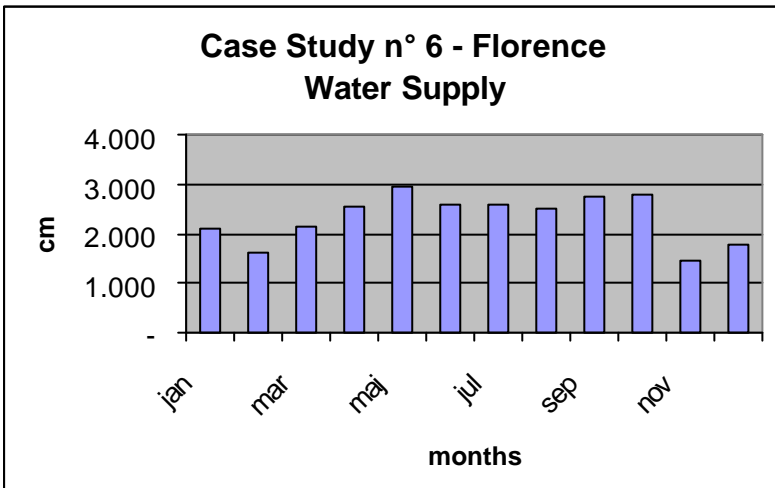


Figure 3. Water Supply

The estimate end use of the primary fuel supplied is the following:

Energy input	End use	Temperature level	kW	MWh	Divided into CHCP production
Natural Gas	Space heating and cooling	Gas fired Summer 5°C Winter 85°C	360	536	Heat
	Domestic hot water	60°C	700	545	Heat
	Cooking		30	193	
Electricity	Lighting		260	683,7	Electrical
	Catering				Electrical
	Refrigerator chillers	-2°C			Electrical

Case Study – 7

Location and character

Latitude: N 43° 41'

Longitude: E 11° 15'

Height above sea level 50 m

Degree-days: 1821

Climatic zone: D

Heating season 166 days

External reference temperature: 0 °C

Case 7 is located in the centre of Florence.

It is a four star hotel, with full range of business and leisure services, operating the whole year around.

The activities are conference and hotel business.

The hotel has 6 floors and the total area is 6608 m².

The main part of the rooms is double rooms. The hotel consists on 119 rooms for 218 guests. The baths are 119

The average room size is 17 m².

Common areas and bars: 684 m².

Service areas: 1344 m².

Conference rooms: 784 m².

Restaurants: 660 m².

The restaurant, for 220 seats, is public and not only for hotel and conference guests.

The hotel has 6 conference rooms from 20 to 250 people, for a total of 595 seats.

Inside the hotel has parking for the hotel guests.

Energy systems installed

Air conditioning, heating and air handling systems

The air-conditioned area is 5264 m².

The rooms and the common areas are fully air-conditioned (heating/cooling). The rooms have their own individual fan coil units, which are thermostatically controlled. They contain a heating coil, cooling coil, fan and filter.

The common areas are served through a number of handling units consisting of a cooling coil and a re-heat or heating coil. A series of outlets are provided from both the hot deck and the cold deck. Dampers modulate and mix the air to attain the proper temperature. The dampers are controlled from a remote zone or area. These units are capable of heating one zone while at same time, cooling another. In the winter steam is used to humidify the hot air.

The air conditioning plant produce cold air for 150 days per year and for 24 hours per day in the summer; and hot air for 166 days per year and 24 hours per day in winter. In the intermediate seasons the air conditioning system operates 10-17 hours per day.

Fans-blowers

Exhaust electrical fans are used in bathrooms and to exhaust the heat of the kitchen area, also, units are used to supply fresh (not conditioned) air to the kitchen and laundry area.

Thermal plant

One natural gas fired steam boiler, of 1400 kW is installed and produces two bar superheated steam for laundries and dishwashers. It also supplies heat exchangers for space heating and domestic purposes.

Chillers for a total of 170 kW_e and 2,2 nominal COP produce cold water for air conditioning purposes.

Electric transformers room

The electric transformer room has n° 1 step-down transformer 20000/380 V of 630 kW.

Energy input

The Energy input used is natural gas and electricity. In the following table and diagrams the energy used for the year 1999 is presented in the table below. Added to the table is the use of water, presented as a primary source.

Energy input	Consumption	% of total	Consumption/room	Consumption/m ²
Natural gas (MWh)	1144,3	43.3	9,6	0,173
Electricity (MWh)	1495,3	56.7	12,6	0,226
Total	2639,6		22,2	0,399
Water (m ³)	12566		105	1,90

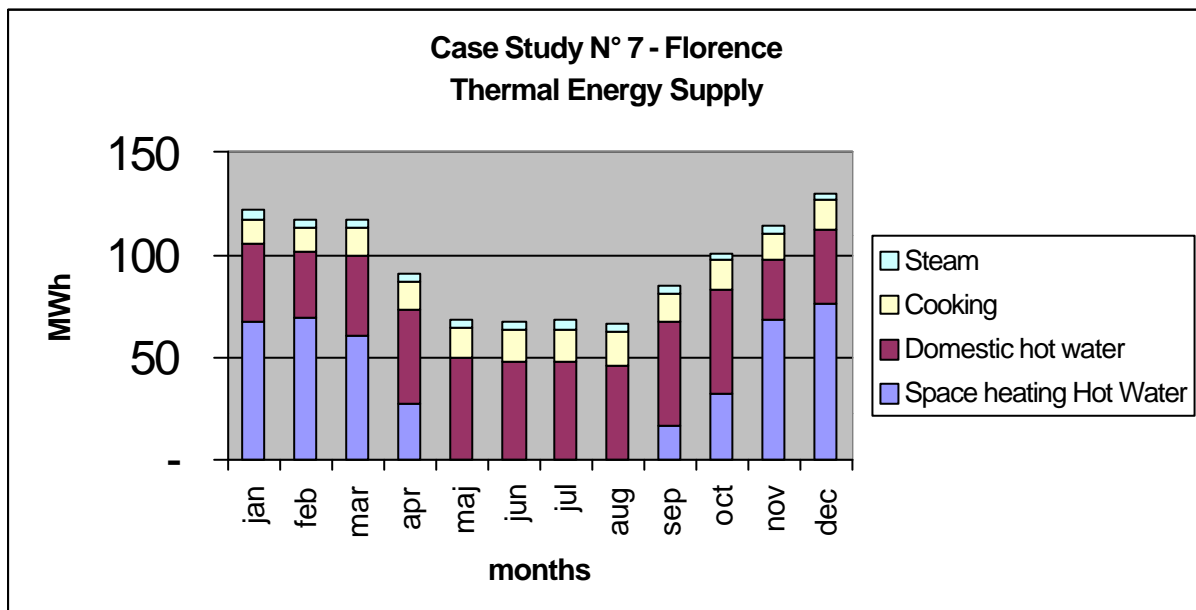


Figure 1. Thermal energy supply

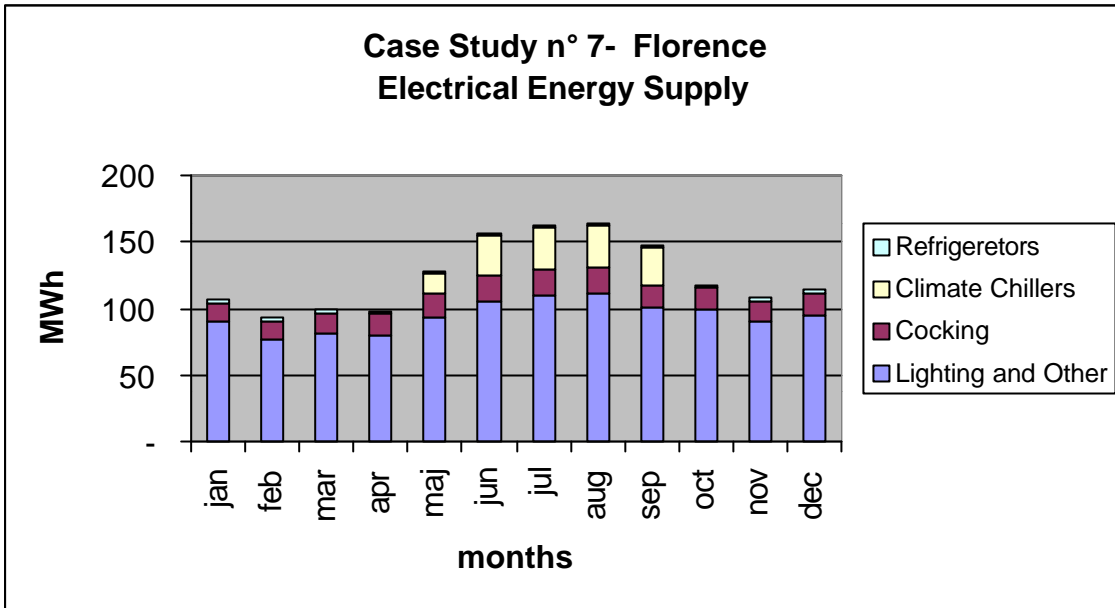


Figure2 Electric energy supply

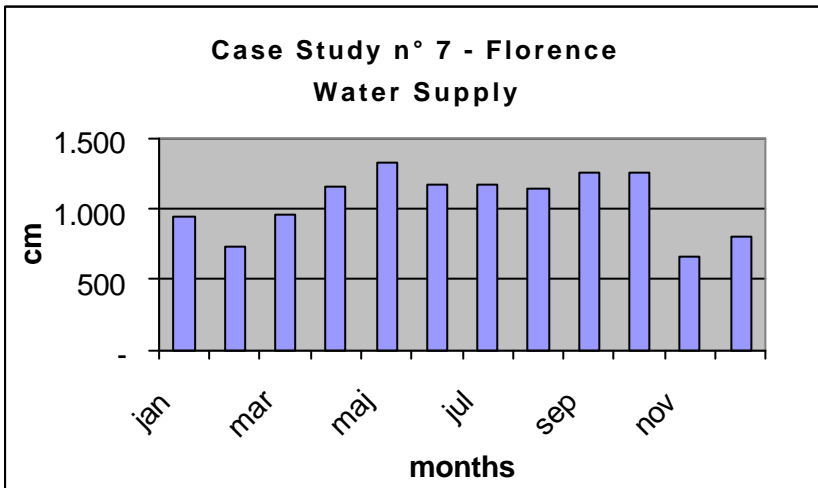


Figure 3 Water supply

The estimate end use of the primary fuel supplied is the following:

Energy input	End use	Temperature level	KW	MWh	Divided into CHCP production
Natural Gas	Space heating hot water	85°C	1400	415	Heat
	Domestic Hot water	60°C		517	Heat
	Steam			48	
	Cooking		20	165	Heat
Electricity	Lighting		460	1270	Electrical
	Cooking				Electrical
	Catering				Electrical
	Refrigerator chillers	-8°C		24	Electrical
	Climate chillers	5°C	170	204	Cooling

Case Study – 11

Location and character

Milan – Italy

Latitude: N 45° 23'

Longitude: E 9° 11'

Height above sea level 122 m

Degree-days: 2404

Climatic zone: E

Heating season 183 days

External reference temperature: 0 °C

Case 11 is located in the business area to north east of Milan.

It is a four star hotel, with full range of business and leisure services, operating the whole year around.

The activities are conference and hotel business.

The hotel is 5 floors and the total area is 6250 m².

The main part of the rooms is double room. The hotel consists on 140 rooms for 250 guests. The baths are 140.

The average room size is 21 m².

Common areas and bars: 425 m².

Service areas: 875 m².

Conference rooms: 1000 m².

Restaurants: 450 m².

The restaurant for 145 seats, is public and not only for hotel and conference guests.

The hotel has 7 conference rooms from 32 to 170 people, for a total of 454 seats.

Inside the hotel has parking for the hotel guests.

Energy systems installed

Air conditioning, heating and air handling systems

The air-conditioned area is 5375 m².

The rooms and the common areas are fully air-conditioned (heating/cooling). The rooms have their own individual fan coil units, which are thermostatically controlled. They contain a heating coil, cooling coil, fan and filter.

The common areas are served through a number of multi-zone units consisting of a cooling coil and a re-heat or heating coil. A series of outlets are provided from both the hot deck and the cold deck. Dampers modulate and mix the air to attain the proper temperature. The dampers are controlled from a remote zone or area. In the winter steam, electrically produced, is used to humidify the hot air.

The air conditioning plant produce cold air for 120 days per year and for 24 hours per day in the summer; and hot air for 183 days per year and 24 hours per day in winter. In the intermediate seasons operates 10-17 hours per day.

Fans-blowers

Exhaust electrical fans are used in bathrooms and to exhaust the heat of the kitchen area, also, units are used to supply fresh (not conditioned) air to the kitchen and laundry area.

Thermal plant

Two natural gas hot water boilers, for a total of 1400 kW installed produce hot water for space heating and domestic purposes.

Chillers for a total of 170 kWe and 2,15 nominal COP produce cold water for air conditioning purposes.

Electric transformers room

The electric transformers room has one step-down transformers 20000/380 V of 400 kW.

Energy input

The Energy input used is natural gas and electricity. In the following table and diagrams the energy used for the year 1999 is presented, In the table also the use of water is added presented as a primary source.

Energy input	Consumption	% of total	Consumption/room	Consumption/m ²
Natural gas (MWh)	1331,4	57	9,5	0,213
Electricity (MWh)	1005,8	43	7,2	0,161
Total	2337,2		16,7	0,374
Water (m ³)	15074		107,7	2,41

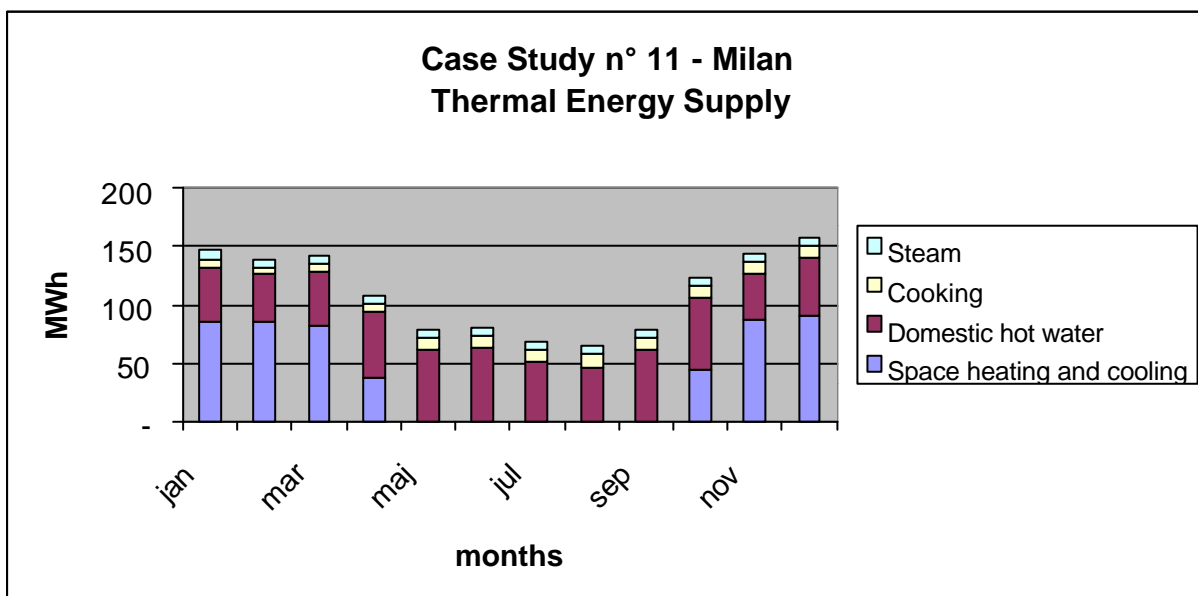


Figure 1 - Thermal energy supply

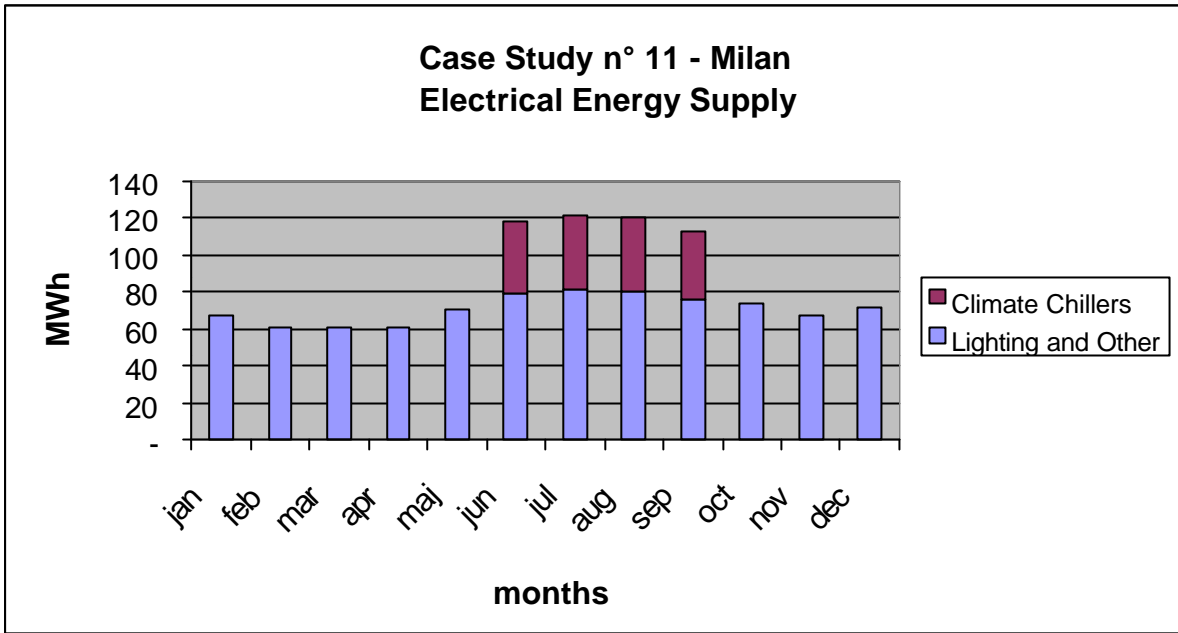


Figure 2. Electrical energy supply

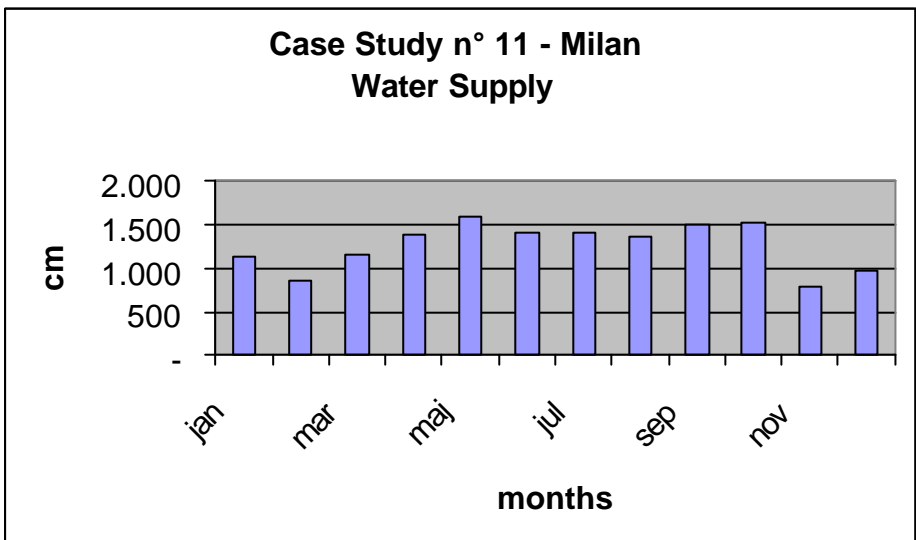


Figure 3 - Water supply

The estimate end use of the primary fuel supplied is the following:

Energy input	End use	Temperature level	KW	MWh	Divided Into CHCP Production
Natural Gas	Space heating hot water	85°C	1400	513	Heat
	Domestic Hot water	60°C		621	Heat
	Cooking		20	197	Heat/steam
Electricity	Lighting		230	849	Electrical
	Catering				Electrical
	Refrigerator chillers	-8°C			Electrical
	Climate chillers	5°C	170	157	Cooling

Case Study – 13

Location and character

Latitude: N 45° 23'

Longitude: E 9° 11'

Height above sea level 122 m

Degree-days: 2404

Climatic zone: E

Heating season 183 days

External reference temperature: 0 °C

Case 13 is located in the historical centre of Milan.

It is a four star hotel, with full range of business and leisure services, operating the whole year around.

The activities are conference and hotel business.

The hotel has 4 floors and the total area is 7627 m².

The main part of the rooms is double room. The hotel consists on 176 rooms for 302 guests. The baths are 52 and the showers are 129.

The average room size is 22 m².

Common areas and bars: 465 m².

Service areas: 1525 m².

Conference rooms: 550 m².

The Hotel has 5 conference rooms from 15 to 130 people, for a total of 275 seats.

Restaurants: 510 m².

The restaurant, for 170 seats, is public and not only for hotel and conference guests.

Energy systems installed

Air conditioning, heating and air handling systems

The air-conditioned area is 6101 m².

The rooms and the common areas are fully air-conditioned (heating/cooling). The rooms have their own individual fan coil units, which are thermostatically controlled. They contain a heating coil, cooling coil, fan and filter.

The common areas are served through a number of multi-zone units consisting of a cooling coil and a re-heat or heating coil. A series of outlets are provided from both the hot deck and the cold deck. Dampers modulate and mix the air to attain the proper temperature. The dampers are controlled from a remote zone or area. These units are capable of heating one zone while at same time, cooling another. In the winter steam, electrically produced, is used to humidify the hot air.

The air conditioning plant produce cold air for 120 days per year and for 24 hours per day in the summer; and hot air for 183 days per year and 24 hours per day in winter. In the intermediate seasons operates 10-17 hours per day.

Fans-blowers

Exhaust electrical fans are used in bathrooms and to exhaust the heat of the kitchen area, also, units are used to supply fresh (not conditioned) air to the kitchen and laundry area.

Thermal plant

Two natural gas steam boilers, for a total of 1600 kW installed and tree heat exchangers produce steam for laundries, dishwashers and cooking and hot water for space heating and domestic purposes

Chillers for a total of 170 kWe and 2,15 nominal COP produce cold water for air conditioning purposes.

Electric transformers room

The electric transformers room has two step-down transformers 20000/380 V of 400 kW.

Energy input

The Energy input used is natural gas and electricity. In the following table and diagrams the energy used for the year 1999 is presented, In the table also the use of water is added presented as a primary source.

Energy input	Consumption	% of total	Consumption/room	Consumption/m ²
Natural Gas (MWh)	1611,6	53	9,2	0,211
Electricity (MWh)	1438,8	47	8,2	0,188
Total	3050,4		17,4	0,399
Water (m ³)	24905		137,6	3,27

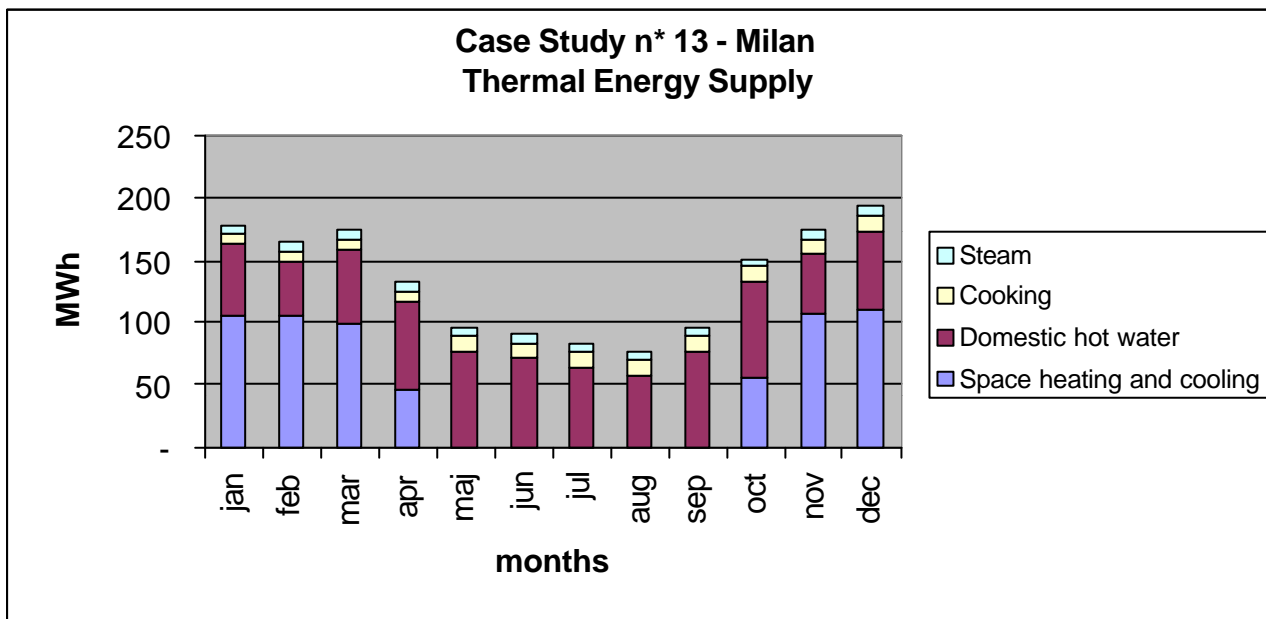


Figure 1. Thermal energy supply

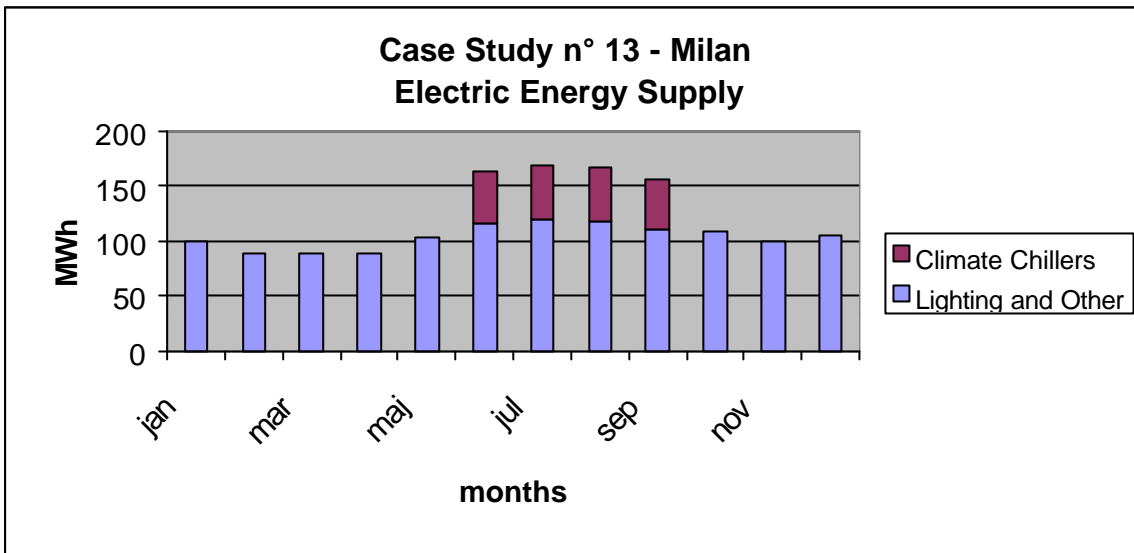


Figure 2. Electric energy supply

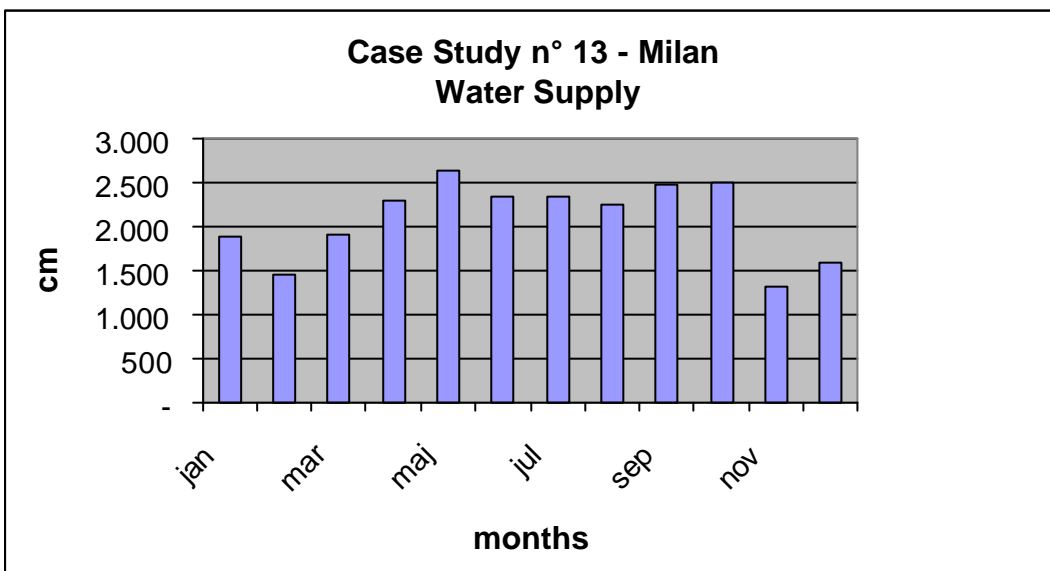


Figure 3.- Water supply

The estimate end use of the primary fuel supplied is the following:

Energy input	End use	Temperature level	kW	MWh	Divided into CHCP production
Natural Gas	Space heating hot water	85°C	1600	626	Heat
	Domestic Hot water	60°C		768	Heat
	Steam			84	Heat
	Cooking		20	133	
Electricity	Lighting		630	1247	Electrical
	Catering				Electrical
	Refrigerator chillers	-8°C			Electrical
	Climate chillers	5°C	170	191	Cooling

Case Study – 15

Location and character

Milan – Italy

Latitude: N 45° 23'

Longitude: E 9° 11'

Height above sea level 122 m

Degree-days: 2404

Climatic zone: E

Heating season 183 days

External reference temperature: 0 °C

Case 15 is located near the Central Railway Station of Milan.

It is a four star hotel, with full range of business and leisure services, operating the whole year around.

The activities are conference and hotel business.

The hotel has 9 floors and the total area is 3800 m².

The main part of the rooms is single room. The hotel consists on 107 rooms for 131 guests. The baths are 107.

The average room size is 18 m².

Common areas and bars: 200 m².

Service areas: 380 m².

Conference rooms: 180 m².

Restaurants: 380 m².

The restaurant, for 110 seats, is public and not only for hotel and conference guests.

The hotel has 3 conference rooms from 25 up to 60 people.

Inside the hotel has parking for the hotel guests.

Energy systems installed

Air conditioning, heating and air handling systems

The air-conditioned area is 3420 m².

The rooms and the common areas are fully air-conditioned (heating/cooling). The rooms have their own individual fan coil units, which are thermostatically controlled. They contain a heating coil, cooling coil, fan and filter.

The common areas are served through a number of multi-zone units consisting of a cooling coil and a re-heat or heating coil. A series of outlets are provided from both the hot deck and the cold deck. Dampers modulate and mix the air to attain the proper temperature. The dampers are controlled from a remote zone or area. These units are capable of heating one zone while at same time, cooling another. In the winter steam, electrically produced, is used to humidify the hot air.

The air conditioning plant produce cold air for 120 days per year and for 24 hours per day in the summer; and hot air for 183 days per year and 24 hours per day in winter. In the intermediate seasons operates 10-17 hours per day.

Fans-blowers

Exhaust electrical fans are used in bathrooms and to exhaust the heat of the kitchen area, also, units are used to supply fresh (not conditioned) air to the kitchen and laundry area.

Thermal plant

One gas oil fired boiler of 420 kW installed produces hot water for domestic purposes

One gas oil fired absorption chiller of 320 kWt produces cold and hot water for air conditioning purposes.

Electric transformers room

The electric transformers room has one step-down transformer 20000/380 V of 260 kW.

Energy input

The Energy input used is gas oil and electricity. In the following table and diagrams the energy used for the year 1999 is presented, In the table also the use of water is added presented as a primary source.

Energy input	Consumption	% of total	Consumption/room	Consumption/m ²
Oil (MWh)	1123,7	68,6	10,5	0,296
Electricity (MWh)	513,3	31,4	4,8	0,135
Total	1637,0		15,3	0,431
Water (m ³)	20006		187	2,61

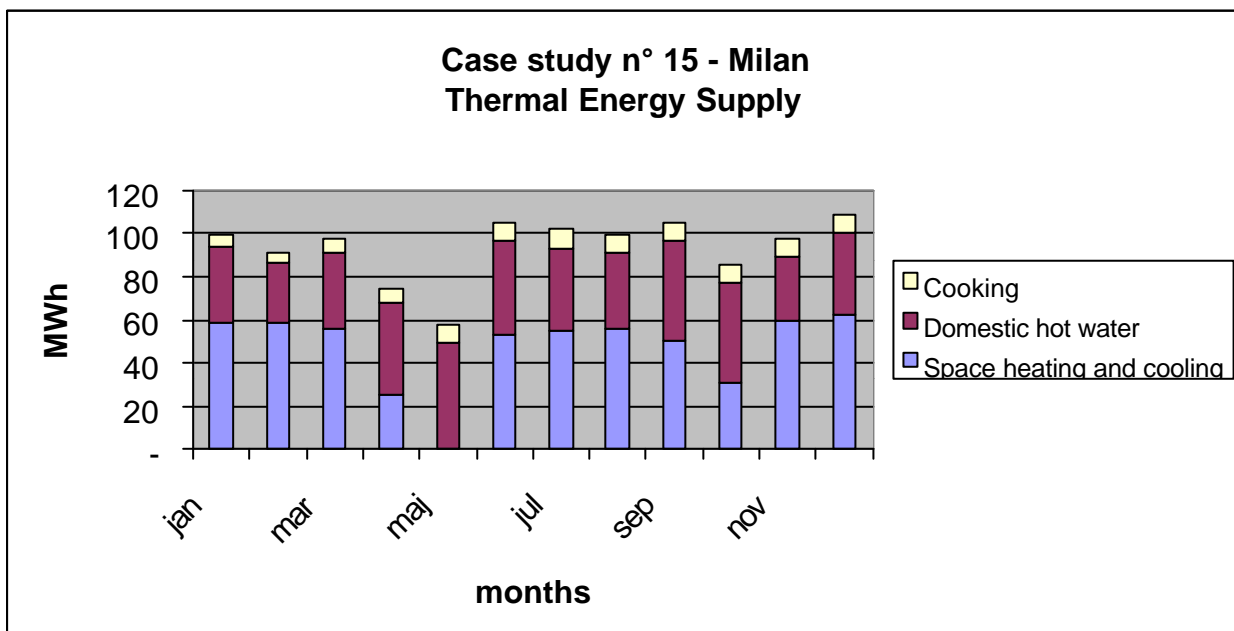


Figure 1. Thermal energy supply

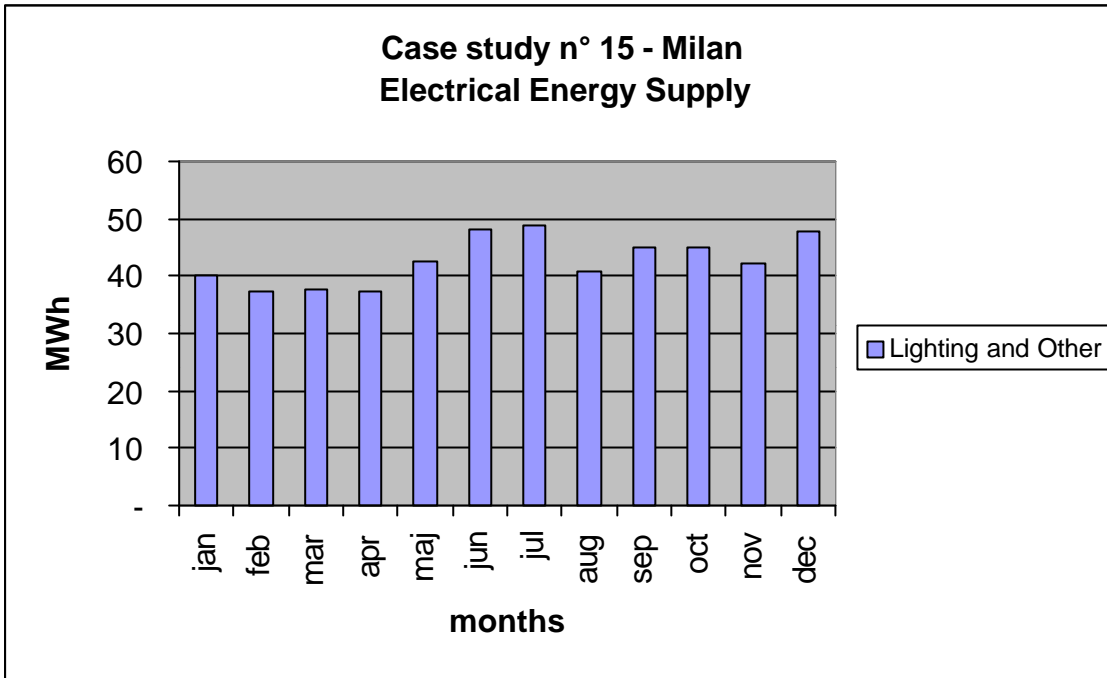


Figure 2. Electrical energy supply

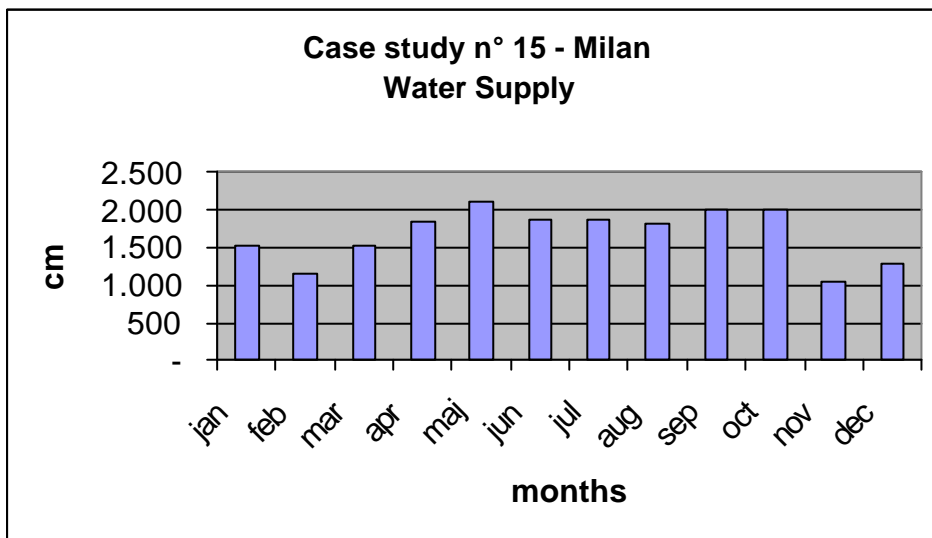


Figure 3. Water supply

The estimate end use of the primary fuel supplied is the following:

Energy input	End use	Temperature level	kW	MWh	Divided into CHCP production
Natural Gas	Space heating and cooling	Gas fired Summer 5°C Winter 85°C	320	566	Heat
Natural Gas	Domestic hot water	60°C	420	469	Heat
Natural Gas	Cooking		10	89	
Electricity	Lighting		260	513,6	Electrical
	Catering				Electrical
	Refrigerator chillers	-5°C			Electrical

Case Study – 16

Location and character

Milan – Italy

Latitude: N 45° 23'

Longitude: E 9° 11'

Height above sea level 122 m

Degree-days: 2404

Climatic zone: E

Heating season 183 days

External reference temperature: 0 °C

Case 16 is located in the business area of east Milan, near the Linate airport.

It is a four star hotel, with full range of business and leisure services, operating the whole year around.

The activities are conference and hotel business.

The hotel has 3 floors and the total area is 9460 m².

The main part of the rooms is double room. The hotel consists on 248 rooms for 470 guests. The beds are 248.

The average room size is 20 m².

Common areas and bars: 500 m².

Service areas: 1200 m².

Conference rooms: 920 m².

The hotel has 9 conference rooms from 20 up to 270 people, for total 680 seats.

Restaurants: 840 m². The restaurant for 280 seats, is public and not only for hotel and conference guests.

Inside the hotel has parking for the hotel guests.

Energy systems installed

Air conditioning, heating and air handling systems

The air-conditioned area is 8260 m². The rooms and the common areas are fully air-conditioned (heating/cooling). The rooms have their own individual fan coil units, which are thermostatically controlled. They contain a heating coil, cooling coil, fan and filter. The common areas are served through a number of handling units.

The air conditioning plant produce cold air for 150 days per year and for 24 hours per day in the summer; and hot air for 183 days per year and 24 hours per day in winter. In the intermediate seasons the air conditioning system operates 10-17 hours per day.

Fans-blowers

Exhaust electrical fans are used in bathrooms and to exhaust the heat of the kitchen area, also, units are used to supply fresh (not conditioned) air to the kitchen and laundry area.

Thermal plant

Two natural gas boilers, of 1400 kW installed, produce hot water for domestic purposes.

One natural gas fired absorption chiller of 840 kWt produces cold water and hot water for air conditioning purposes

Electric transformers room

The electric transformer room has n° 1 step-down transformer 20000/380 V of 630 kW.

Energy input

The Energy input used is natural gas and electricity. In the following table and diagrams the energy used for the year 1999 is presented. In the table also the use of water is added, presented as a primary source.

Energy input	Consumption	% of total	Consumption/room	Consumption/m ²
Natural Gas (MWh)	2667,6	65	10,7	0,28
Electricity (MWh)	1457,2	35	5,8	0,15
Total	4113,8		16,5	0,43
Water (m ³)	23196		93	2,45

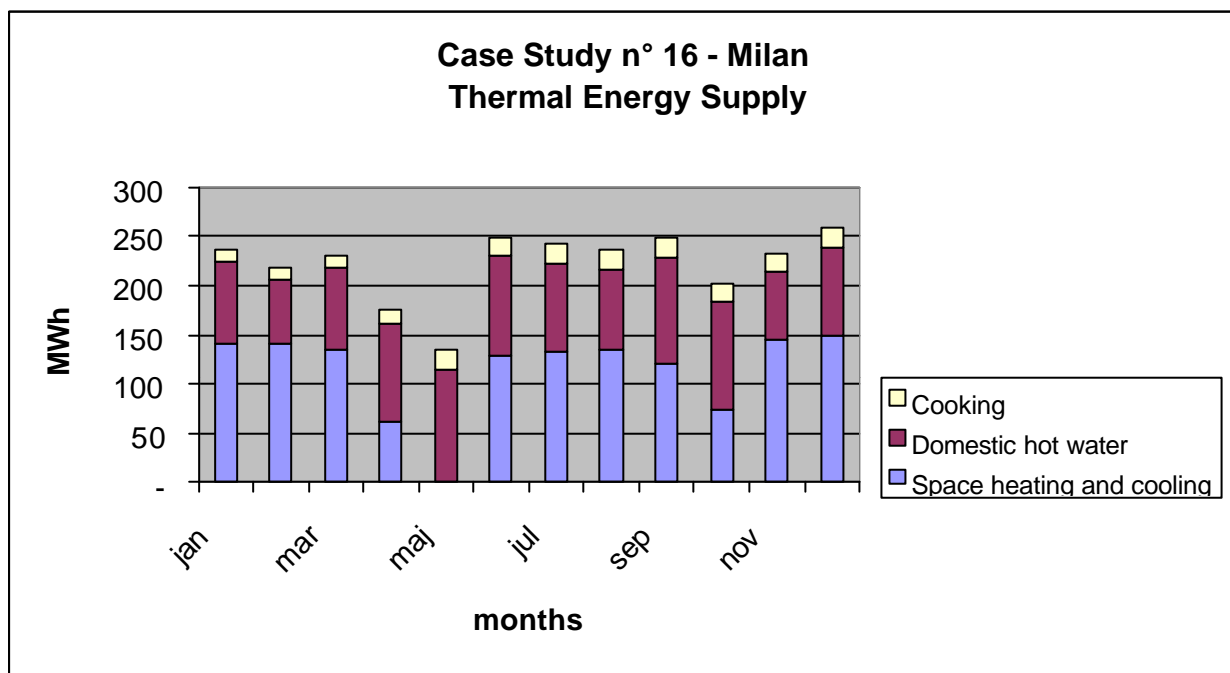


Figure 1. Thermal energy supply

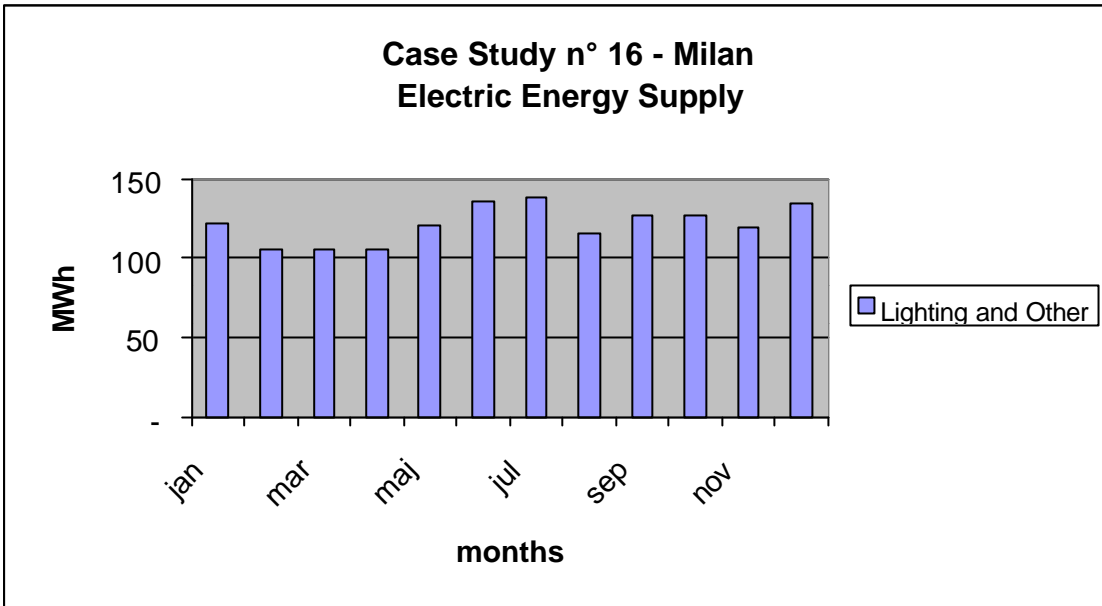


Figure 2 Electric Energy Supply

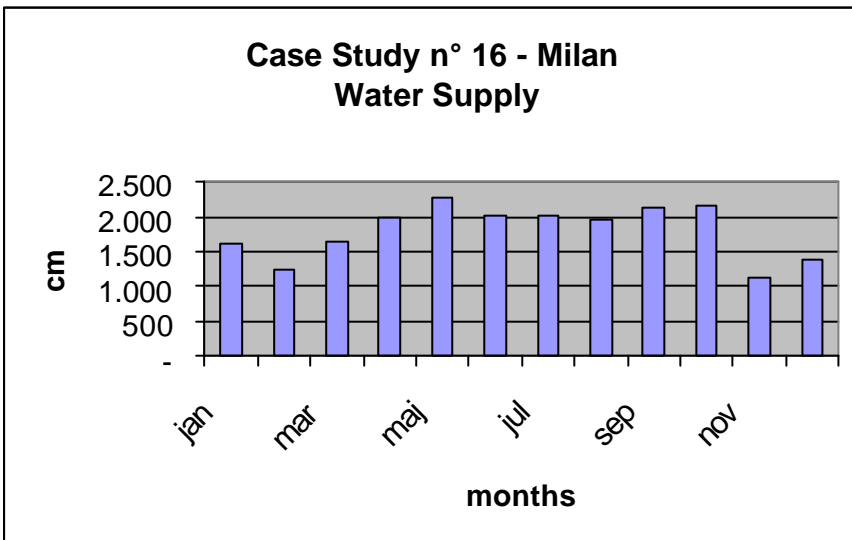


Figure 3. Water Supply

The estimate end use of the primary fuel supplied is the following:

Energy input	End use	Temperature level	kW	MWh	Divided into CHCP production
Natural Gas	Space heating and cooling	Gas fired Summer 5°C Winter 85°C	840	1366	Heat
Natural Gas	Domestic hot water	60°C	1400	1088	Heat
Natural Gas	Cooking		40	211	
Electricity	Lighting		630	1446	Electrical
	Catering				Electrical
	Refrigerator chillers	-5°C			Electrical

Case Study – 21

Location and character

Venice – Italy

Latitude: N 45° 26'

Longitude: E 12° 20'

Height above sea level 1 m

Degree-days: 2345

Climatic zone: E

Heating season 183 days

External reference temperature: 0 °C

Case 21 is located in Venice, very close San Marco's Square.

It is a four star hotel, with full range of business and leisure services, operating the whole year around.

The activities are hotel business.

The hotel is 6 floors and the total area is 9710 m².

The main part of the rooms is double rooms. The hotel consists on 168 rooms for 318 guests. The baths are 168 .

The average room size is 22 m².

Common areas and bars: 860 m².

Service areas: 1340 m².

Restaurants: 480 m².

The restaurant, for 160 seats, is public and not only for hotel and conference guests.

Energy systems installed

Air conditioning, heating and air handling systems

The air-conditioned area is 8040 m². The rooms and the common areas are fully air-conditioned (heating/cooling). The rooms have their own individual fan coil units, which are thermostatically controlled. They contain a heating coil, cooling coil, fan and filter. The common areas are served through a number of multi-zone units consisting of a cooling coil and a re-heat or heating coil. A series of outlets are provided from both the hot deck and the cold deck. Dampers modulate and mix the air to attain the proper temperature. The dampers are controlled from a remote zone or area. These units are capable of heating one zone while at same time, cooling another. In the winter steam, electrically produced, is used to humidify the hot air. The air conditioning plant produce cold air for 120 days per year and for 24 hours per day in the summer; and hot air for 183 days per year and 24 hours per day in winter. In the intermediate seasons operates 10-17 hours per day.

Fans-blowers

Exhaust electrical fans are used in bathrooms and to exhaust the heat of the kitchen area, also, units are used to supply fresh (not conditioned) air to the kitchen and laundry area.

Thermal plant

Two natural gas steam boilers, for a total of 1700 kW installed and tree heat exchangers produce steam for laundries, dishwashers and cooking and hot water for space heating and domestic purposes. Chillers for a total of 150 kWe and 2,15 nominal COP produce cold water for air conditioning purposes.

Electric transformers room

The electric transformers room has two step-down transformers 20000/380 V of 400 kW.

Energy input

The Energy input used is natural gas and electricity. In the following table and diagrams the energy used for the year 1999 is presented, In the table also the use of water is added presented as a primary source.

Energy input	Consumption	% of total	Consumption/room	Consumption/m ²
Natural gas (MWh)	1789,2	61	10,6	0,184
Electricity (MWh)	1136,8	39	6,8	0,117
Total	2926,0		17,4	0,301
Water (m ³)	37046		220,5	3,82

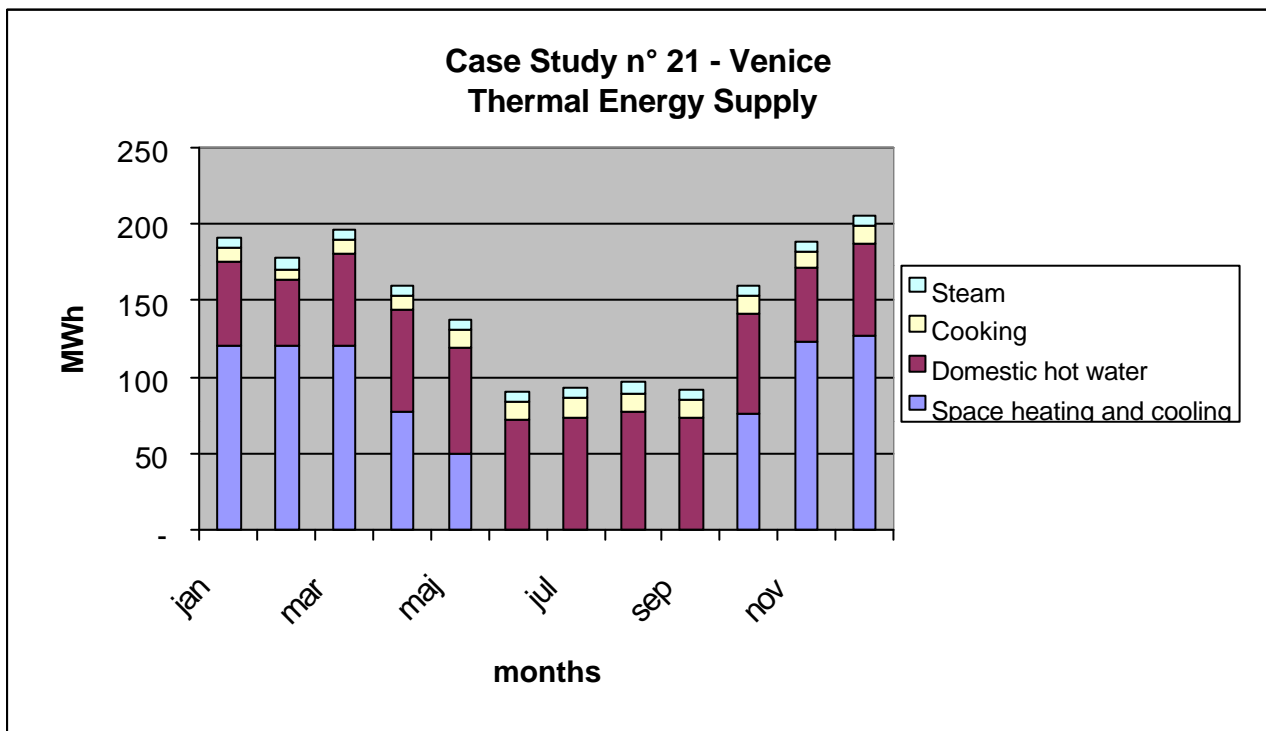


Figure 1 - Thermal energy supply

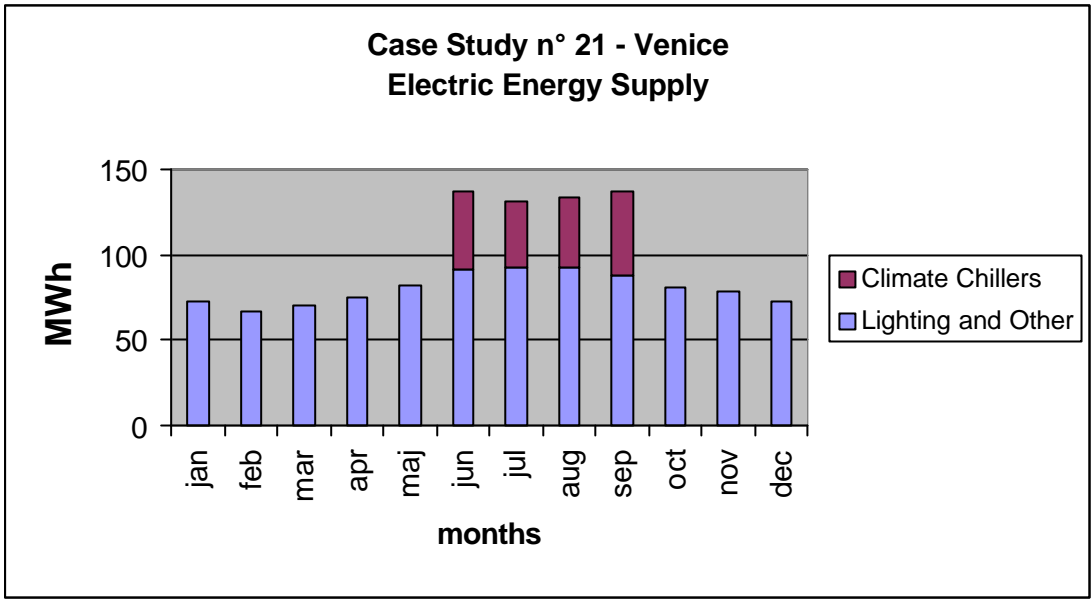


Figure 2 - Electric energy supply

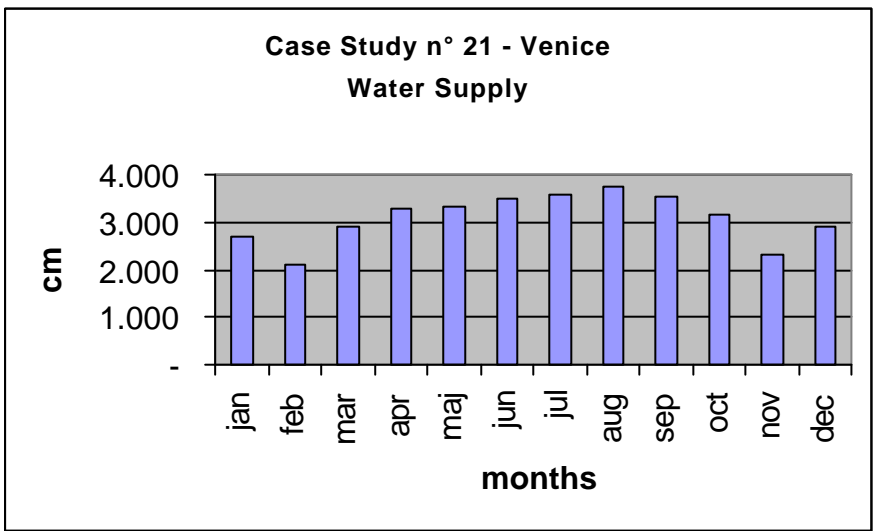


Figure 3 - Water supply

The estimate end use of the primary fuel supplied is the following:

Energy input	End use	Temperature level	kW	MWh	Divided into CHCP production
Natural Gas	Space heating hot water	80°C	1700	814	Heat
	Domestic hot water	60°C		763,7	Heat
	Steam	105°C		84	Heat
	Cooking		40	127	
Electricity	Lighting		650	961,3	Electricity
	Catering				Electricity
	Refrigerator chillers	-5°C			Electricity
	Climate chillers	5°C			150