Solar cooling and heating systems Application in the *Cyprus University of Technology* mechanical engineering laboratories

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Archimedes Solar Energy Laboratory (ASEL)

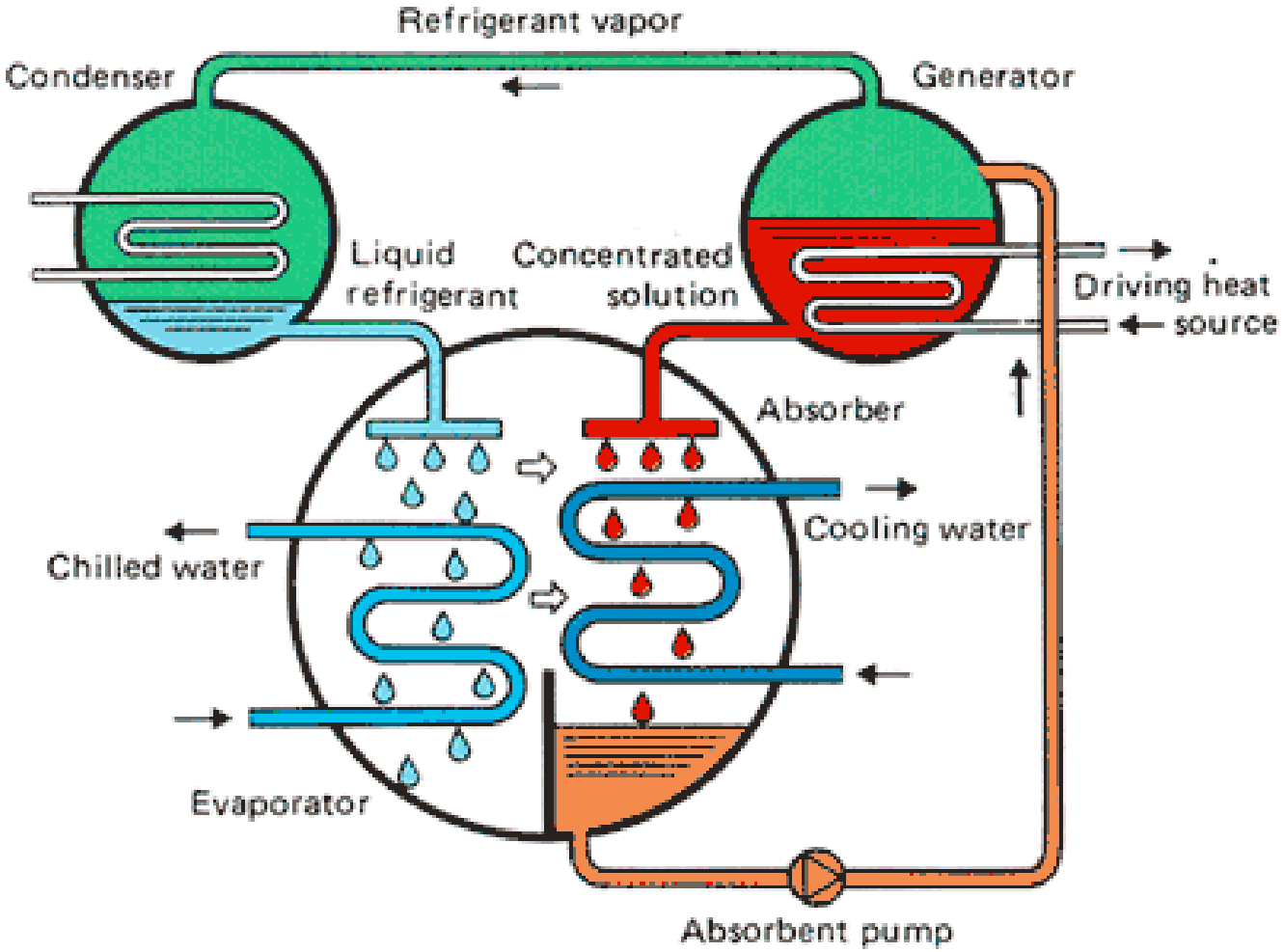
Introduction

Absorption machines are thermally activated and for this reason, high input (shaft) power is not required. In this way, where power is unavailable or expensive then gas, geothermal or solar heat can be used. Absorption machines provide reliable and quiet cooling

In absorption systems an absorbent, on the low-pressure side, absorbs an evaporating refrigerant. The most usual combinations of fluids include lithium bromide-water (LiBr-H2O) where water vapor is the refrigerant and ammonia-water (NH3-H2O) systems where ammonia is the refrigerant

Lithium bromide-water chillers are available in two types, the single and the double effect. The single effect absorption chiller is mainly used for building cooling loads, where chilled water is required at 6-7°C. Their coefficient of performance (COP) is about 0.7. They *operate with a hot water temperature ranging from about* 80°C to 120°C when water is pressurized, whereas for the double effect much higher temperatures are required.

Operation



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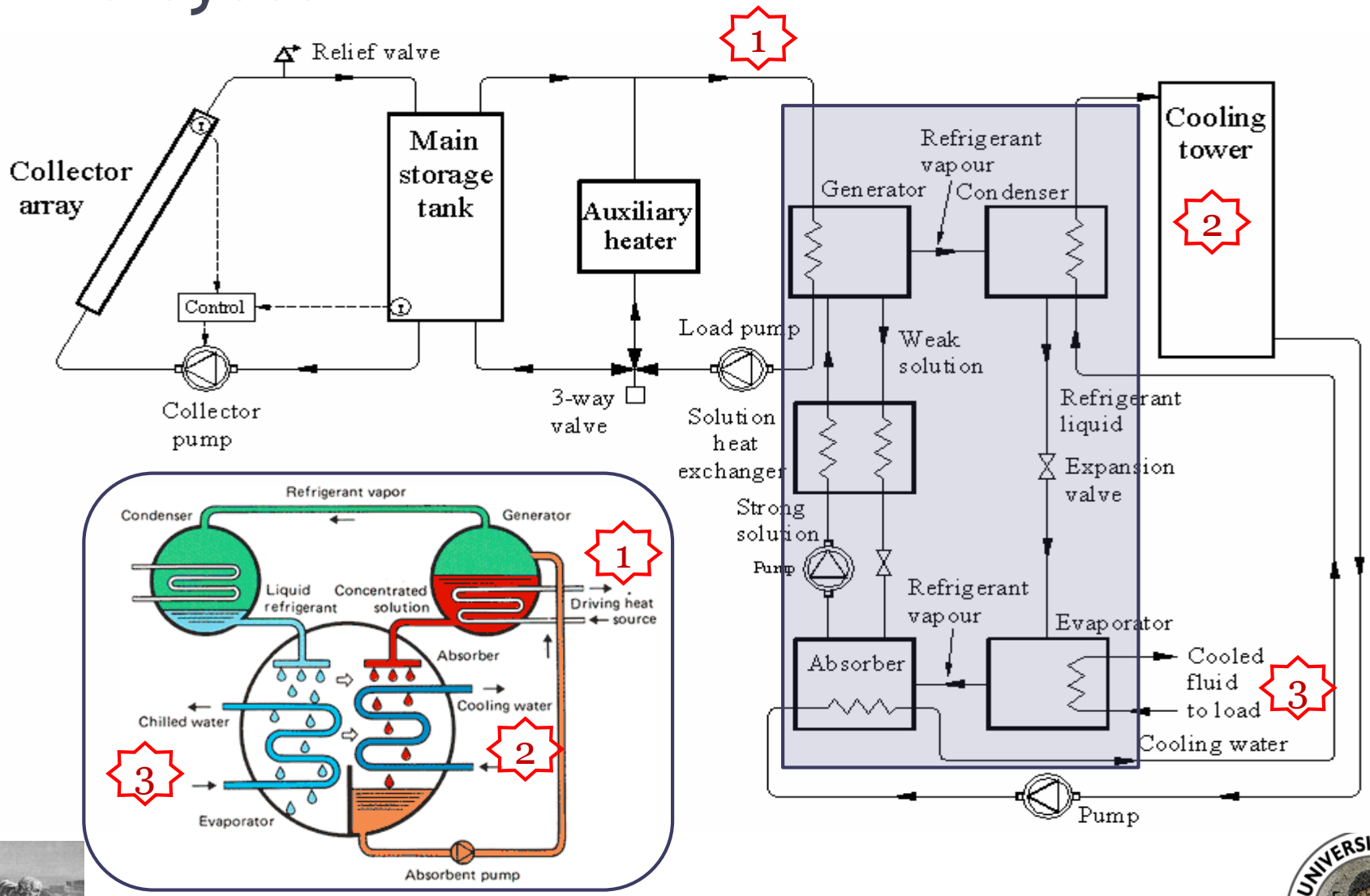
The system



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Building

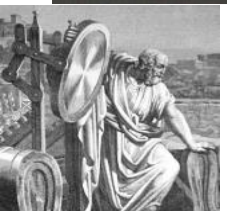
Old Building – constructed in 1950s.
Roof inclination 20°,
50 cm stone walls.
Total area is 1400 m²

Cooling load: 280 kW

System:
3 absorption units 95 kW each, 310 m² solar collectors,
4500 lt water storage

Solar collectors

LiBr Absorption cooler



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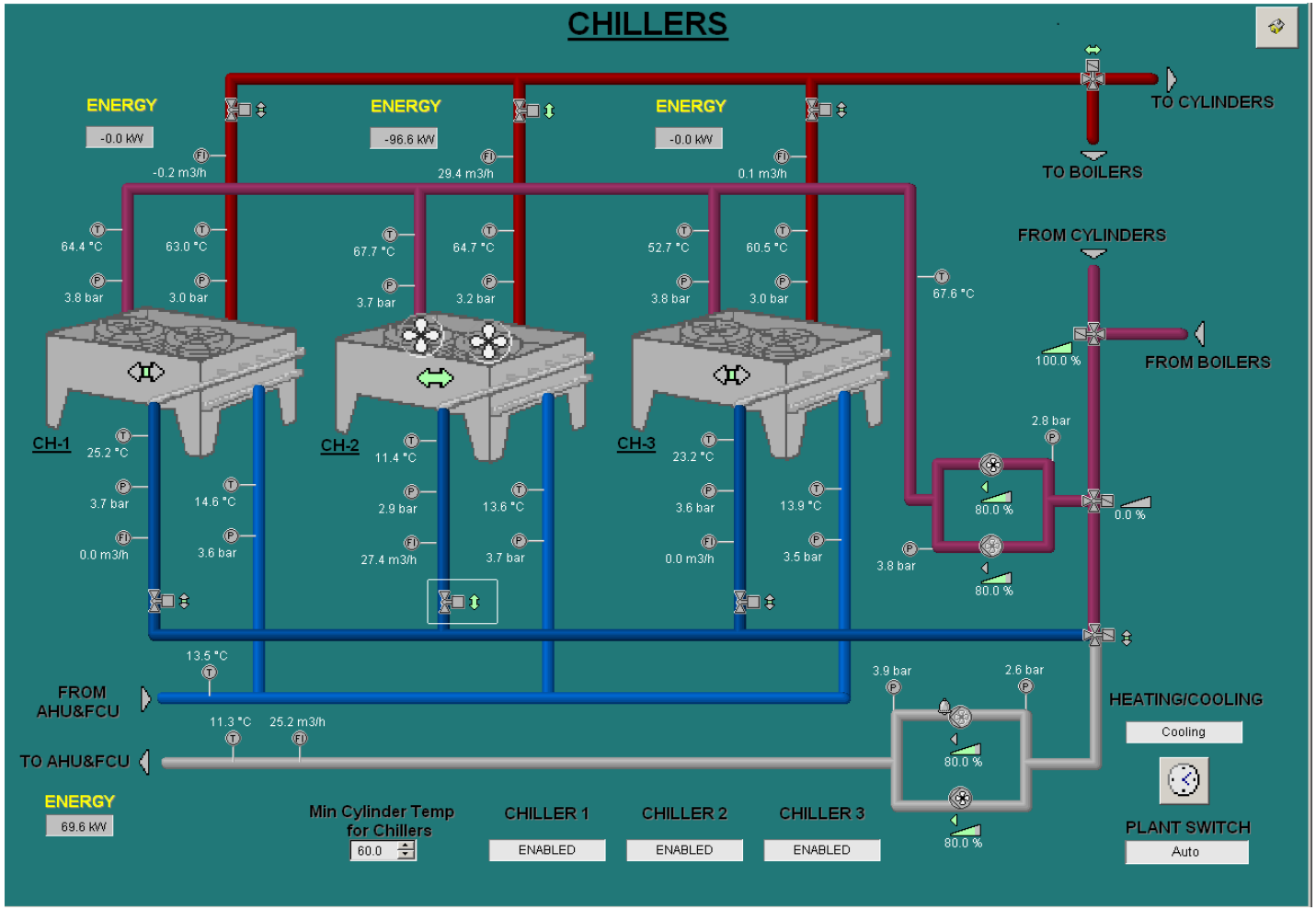
Auxiliary system

BMS showing the condition of the absorption chillers



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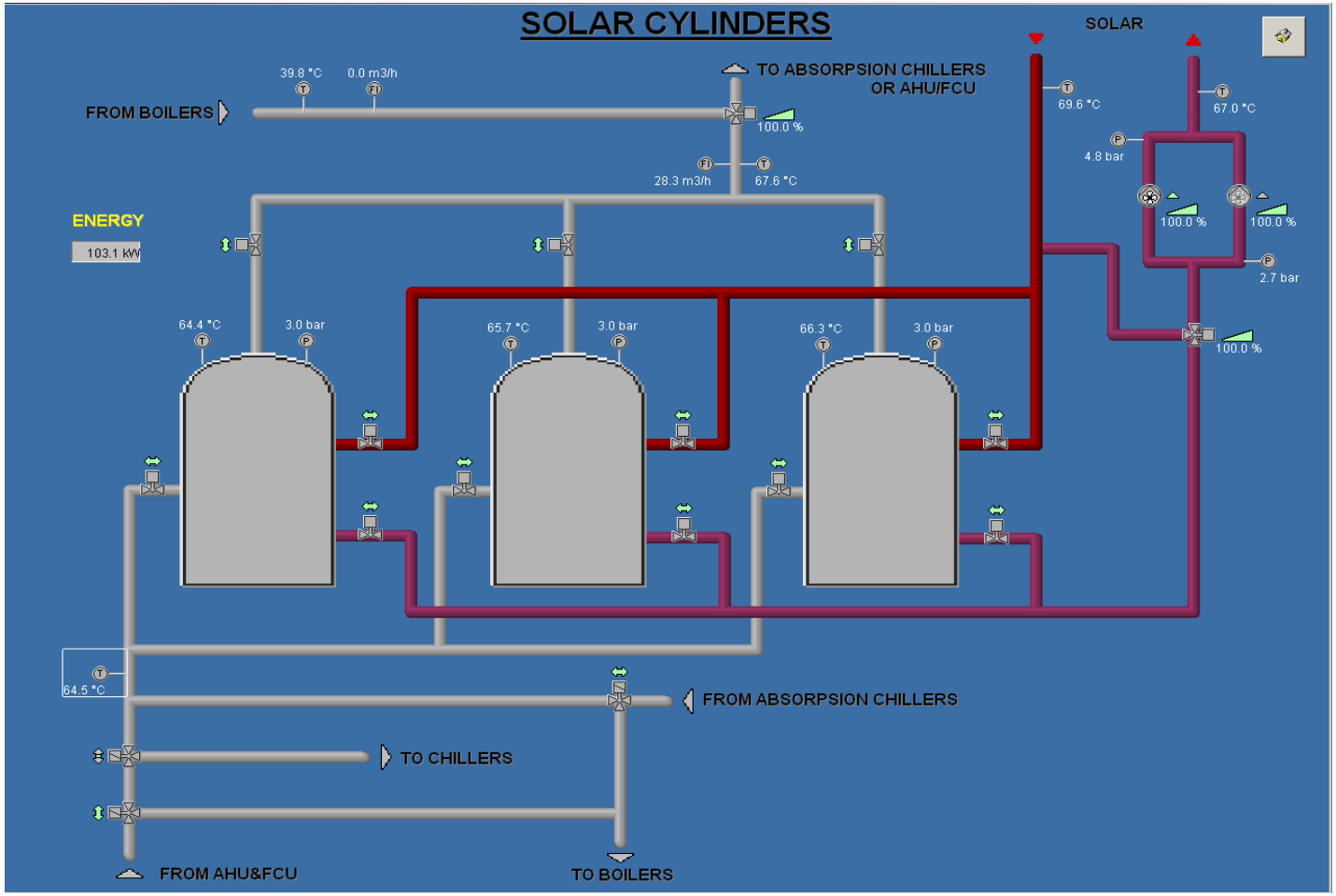
BMS showing the condition of the Solar cylinders



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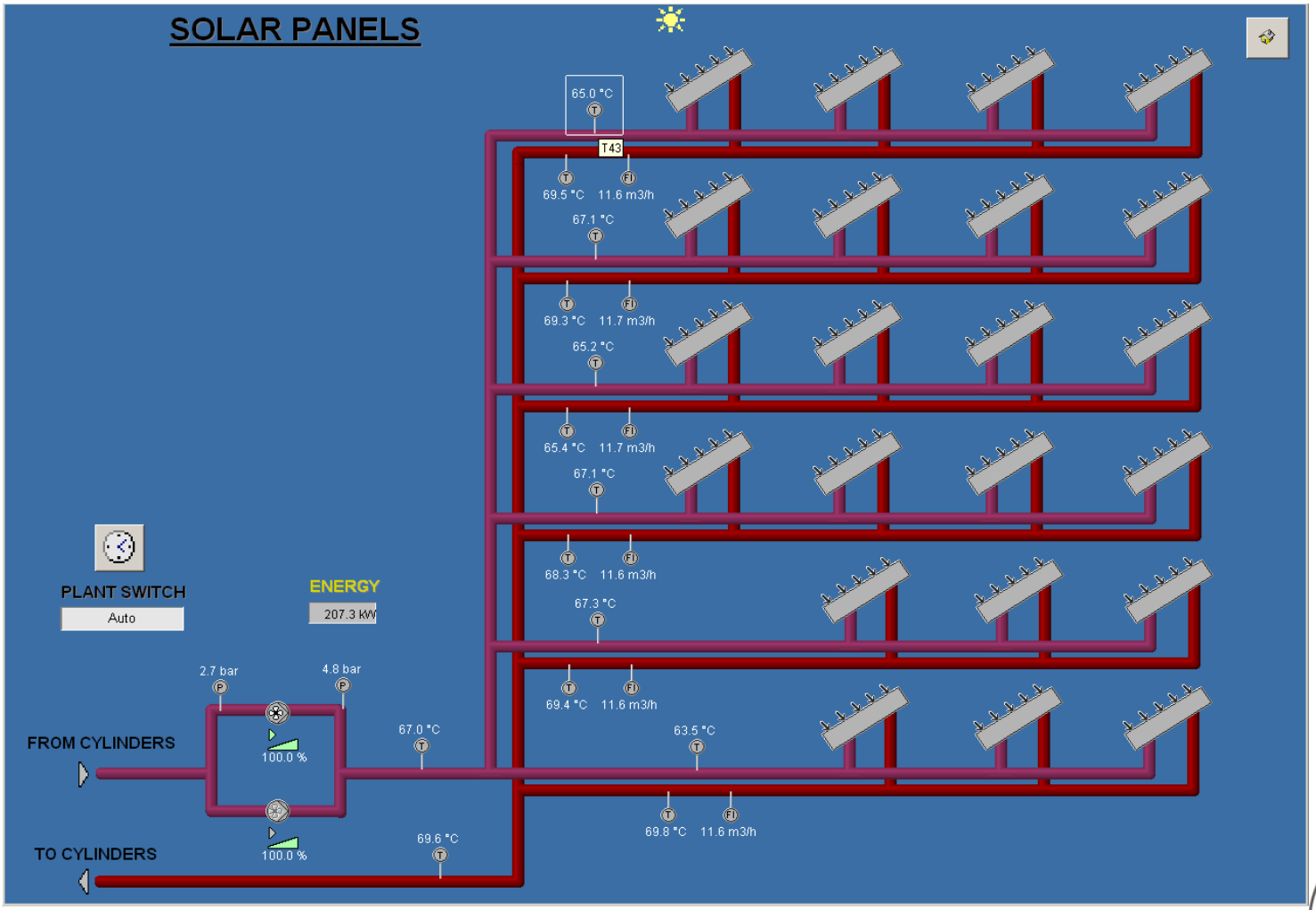
BMS showing the condition of the Solar panels



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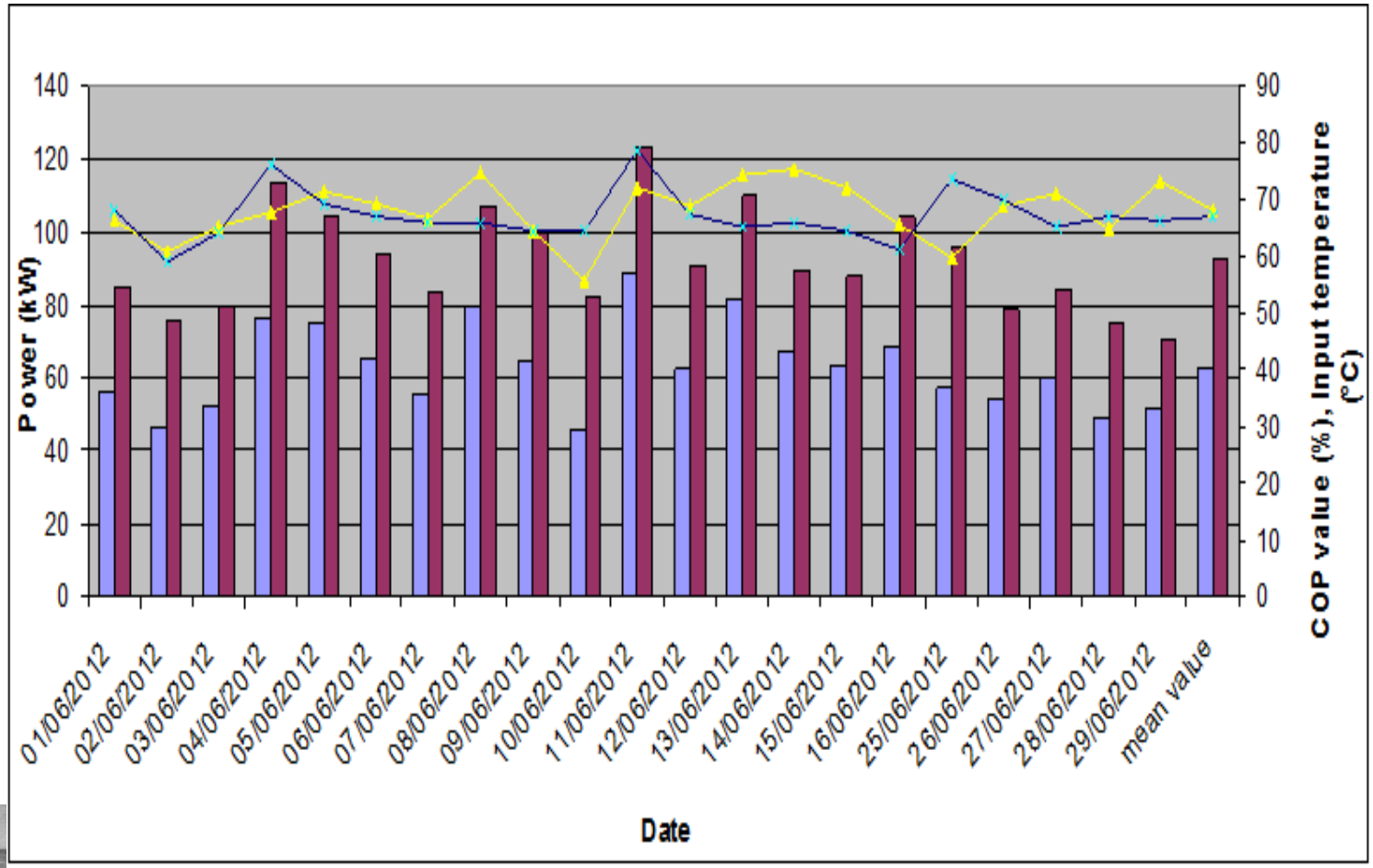
Graph showing the outgoing power from chillers (blue color), the incoming power to the chillers (red color), the incoming water temperature to the chillers (blue color line) and the coefficient of performance (yellow color line) for the period 01/06/12 – 29/06/12



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Inlet hot water temperature and performance of chillers in summer

Period	Chiller Performance (COP)	Inlet hot water temperature
May	0.69	71.7°C
June	0.68	67.1°C
July	0.68	67°C
August	0.68	67.1°C
September	0.69	67.3°C
October	0.66	66.3°C
Mean value	**0.68**	**67.8°C**

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Comparison of the building to a hotel

	Building	Hotel
Floor area (m)	45 x 35	45 x 35
Volume (m^3)	2 storey - 3200	Almost a 3 storey
walls	50 cm stone	Insulated
Roof	Inclined 20°	Flat
Roof cover	half	all
Cooling load:	280 kW	Not more than 280 kW
Total Cost (€)	500,000	500,000
Extra cost (€)	250,000	250,000
Pay back period of extra cost	5-8 years	3-7 years

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Conclusions

1. The energy consumed by the system was only electricity (no oil was used) and attention was given to reduce its consumption to the minimum.

2. A much lower water flow rate than the one used was required in the evacuated solar collector system in order to achieve higher water temperatures. The water flow should be adjusted to the minimum to avoid consumption of unnecessary electrical energy.

3. The differential temperature controller of the solar collector system should be set to $10^{o}C$ in order not to consume unnecessary power but on the other hand prevent the solar system to attain high temperatures.

Conclusions

5. The building in which the system was installed is not the best application for energy savings due to the nature of its operation (operating hours between 8:00 – 16:00). Also, during the months of July and August, where there is maximum solar input and thus better performance of the cooling system, the building is under-utilized or closed completely due to summer holidays.

4. The pay back period for a hotel would be shorter than the reference building due to the better utilisation of the roof area and the better insulation of its external surfaces. It is expected that a hotel will have a pay back period of 3-7 years.

Thank you

for your attention

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