Adriacold

"Diffusion of Cooling and Refreshing Technologies using the Solar Energy Resource in the Adriatic Regions"

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SOLAR COOLING AT KINDERGARTEN MORNARČEK, PIRAN - FEASIBILITY STUDY SUMMARY

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1. **Energy audit, March 2013, GOLEA**
    a. Kindergarten Mornarček is a facility for providing preschool education. Located in Piran, it was built in 1973. The total heated area of the building amounts to 969,3 m^2. The conditioned space volume is 2.043,3 m^2. The building is in use throughout the year. The number of children only decreases in the second half of July and August. The kitchen is also in use throughout the year.
    b. Building construction:
        i. External loadbearing walls are made of concrete slabs, partially filled with brick inlays. The outer walls are 29 cm thick, finished in cement mortar. The walls lack thermal insulation. Thermal conductivity is U=3,04 W/m^2K.
        ii. The fixtures (windows) have been replaced in 2005. The installed windows feature PVC frames and double glazing with gas filling. Thermal conductivity is U=2,1 W/m^2K. South-facing windows are also equipped with external sun shades.
        iii. The building has two types of roofing. Referring to the project documentation data, both are equipped with 5 cm of heat insulating material. Thermal conductivity of the angled roof is U=0,54 W/m^2K. Thermal conductivity of the flat roof or ceiling towards the unheated loft is U=2,37 W/m^2K.
        iv. Thermal conductivity of the ground is U=0,35 W/m^2K.
    c. A boiler room has been built to provide heating and is equipped with an oil boiler (1994) with 349 kW nominal power. The pump automation controller is a product manufactured by Seltron. The heating temperature regime is 90/70°C. Space is heated using radiators (63 units), equipped with traditional valves without thermostats to regulate the temperature of the heated space.
    d. Playrooms are cooled using »split air-conditioners«. The average electrical power of this equipment is around 1,3 kW, the cooling power is around 3 kW. In total, 12 individual split air-conditioners are installed in the building. In 2012 a reversible heat pump with 12,5 kW nominal cooling capacity was installed for the needs of the kitchen. According to the data from the technical documentation, the necessary electrical power for that nominal cooling capacity is approx. 4 kW. The overall installed cooling capacity of the building is thus approx. 48,5 kW.
    e. The sanitary hot water is heated centrally. Throughout the year, it is provided entirely from the oil boiler. Due to sanitation regulatory requirements, the temperature of the water needs to be maintained at 60°C. There is a circulation system, powered by a circulation pump. The primary hot water consumer is the kitchen. According to available date, heating oil usage for hot sanitary water outside of the heating season is in the range 3.000 to 3.500 litres.
    f. The following table provides overall consumption along with energy and water costs for Kindergarten Mornarček.

	Oil		Electric Energy		Water		Total Costs
unit	kWh	€	kWh	€	m3	€	€
2009	141.634	9.277	31.995	6.137	1.027	2.579	17.993
2010	141.614	10.389	32.407	5.600	1.033	2.223	18.212
2011	132.250	11.870	32.726	5.431	1.003	2.113	19.414
Average	138.499	10.512	32.376	5.723	1.021	2.305	18.540

It follows from the data in the table, that the total costs of energy and water are increasing, which is primarily due to rising costs of the heating energy source (heating oil).
The energy performance, or the specific use of energy for heating, is on average142,9 kWh/m^2, the specific use of electric energy amounts to 33,4 kWh/m^2. The total energy performance index for the building is thus 176,3 kWh/m^2. We conclude, that this is classified as an energy

inefficient building. The average energy costs for heating in 2009-2011 was 75,9 €/MWh incl. VAT. In the same time period, the average costs of electric energy was 176,8 €/MWh incl. VAT.

g. Savings potential
    i. A comprehensive energy retrofit of the outer shell, including installation of modern fixtures (doors and windows), thermal insulation of the façade and additional insulation of the roof could achieve up to 70% savings in heating costs.
    ii. A sensible measure would be the installation of thermostatic valves on heaters and replacement of pumps with frequency converter circulation pumps. This would bring in between 5 and 15% savings in total energy used for heating.
    iii. At the moment, heating of sanitary water outside the heating season consumes 25% of the heating oil purchased during the year. The proposal is to install a solar thermal system to heat sanitary water.
    iv. A sensible measure would be to install an advanced cooking hood in the kitchen. Such a hood includes heat recovery with variable airflow to ensure suitable work conditions in the kitchen while enabling recuperation of heat from the exhaust. It is estimated that this measure could save up to 10% of the energy used for heating.

2. Potential for solar cooling, Feasibility Study, April 2013, GOLEA

a. As basis for a decision regarding the choice of suitable system for solar cooling, a comparison analysis was prepared in which the cost of cooling using the current system (split air-conditioning units) are compared with two evaluated systems:
    i. Absorption Chiller with Solar Thermal System
    ii. Adsorption Chiller with Solar Thermal System

In the table below, there is a cost comparison between the existing cooling system (operation and service costs), as well as the existing heating system with heating of sanitary water (operation and service costs). It is assumed that the current system needs no investment.

The investment estimate takes into account the costs of the entire system necessary for the functioning of solar cooling – thermal solar system, cooling unit, connection of unit ventilators in the classrooms, heating sanitary water, central control system for monitoring (CCS). Likewise, all the operation and service costs of the systems have been taken into account.

The costs of energy (electricity, heating oil and water) are taken from currently valid pricelists, which include all the necessary charges and taxes. Economic calculations do not take into account the discount rate, or expected price increases of energy sources or servicing costs. All the prices (including the investment cost estimate) are VAT excl.

		Current state	Absorption Chiller with Solar Thermal System	Adsorption Chiller with Solar Thermal System
Nominal cooling capacity [kW]			15	15
Investment	Boiler room (Chiller, Solar Thermal Collector, Heat storage, Electrical installations and all necessary mechanical installations) [€]		46.400	48.500
	Heating/cooling system (Plumbing through the building together with Unit Ventilators, Electrical installations and all necessary mechanical installations) [€]		18.450	18.450
	Control System [€]		4.500	4.500

		Investment total [€]		69.350	71.450
Costs/savings					
Electricity usage - cooling [kWh/a]			10.800	2.244	2.244
Energy consumption - heating [kWh/a]			105.999	105.999	105.999
Energy consumption - preparing hot water [kWh/a]			32.500	32.500	32.500
Water usage - cooling [m3/a]			0	23	23
No. of hours - cooling [h/a]			1.200	1.200	1.200
Electricity costs [€/kWh]	0,12				
Cost of heating oil [€/l]	1,002				
Cost of water [€/m3]	2,1				
Oil consumption for hot water – out of heating season [l/a]			3.250	0	0
Oil consumption for heating [l/a]			10.600	9.010	9.010
Electricity costs - cooling [€/a]			1.296	269	269
Water costs for cooling [€/a]			0	48	48
Hot water preparation costs - outside heating season [€/a]			3.257	0	0
Heating costs [€/a]			10.621	9.028	9.028
Maintenance (heating/cooling)[€/a]			360	1.248	1.286
Savings - cooling [kWh/a]				8.556	8.556
Savings - heating [kWh/a]				15.900	15.900
Savings - hot water preparation [kWh/a]				32.500	32.500
		Total costs [€/a]	15.534	10.593	10.631
		Savings [€/a]		4.940	4.902

b. Advantages and shortcomings of solar cooling systems

	Existing system	Absorption Chiller with Solar Thermal System	Adsorption Chiller with Solar Thermal System
Advantages	Low servicing costs, functioning in all circumstances, enables both heating and cooling.	Modern cooling system, very low electric energy consumption, no mechanical coolant evaporation, sanitary water heating and (supplemental) kindergarten heating, long operational life, possible reverse operation, very quiet, remote management and supervision.	Modern cooling system, very low electric energy consumption, no mechanical coolant evaporation, sanitary water heating and (supplemental) kindergarten heating, long operational life, possible reverse operation, very quiet, remote management and supervision.

Shortcomings	Higher energy consumption, higher operational costs, obsolete system, no remote management and operation	Higher investment costs (more demanding installation), higher maintenance costs, bigger installation footprint, less cooling when conditions unfavourable (low solar radiation).	Higher investment costs (more demanding installation), higher maintenance costs, bigger installation footprint, less cooling when conditions unfavourable (low solar radiation).

c. Investment co-financing – Adriacold

Co-financing has been secured for either of the proposed solutions within project IPA Adriatic to the amount of 85% of investment costs. The remaining funds (15%) have been secured from the national contribution, where the contribution amount is divided to 10% contribution from the Ministry of Economic Development and Technology and 5% contribution of Piran Municipality.

Source of investment financing	Contribution share [%]	Absorption Chiller with Solar Thermal System [€]	Adsorption Chiller with Solar Thermal System [€]
IPA Adriatic	85	58.948	60.733
Ministry of ED&T	10	6.935	7.145
Piran Municipality	5	3.468	3.573
Skupaj	100	69.350	71.450

3. Summary

Solar cooling systems are modern, innovative means of cooling buildings, which enable cutting operational costs of the building as well as helping lower emissions of greenhouse gasses into the environment.

Functionally, the system has been designed to allow simultaneous cooling of the building and preparation of hot sanitary water (toilets and kitchen). In transition between seasons, the system can act as a reversible chiller, having the capacity of (supplemental) heating of the building.

From the attached analysis of the solar cooling system, it follows that the annual costs of providing the kindergarten with the required energy for cooling, heating and preparation of hot water are cut by 68% in average for 4.920,00 €. Hence, the amount saved in the first year already exceeds the required financial contribution of Municipality Piran in the investment for the building of a solar cooling system.

It follows that the investment into a solar cooling system for the building of Kindergarten Mornarček in Piran is technically feasible and also economically justified. It is proposed that project partner Piran Municipality participates in project Adriacold and continues project activities with the drafting of the project documentation and tender documentation for a public call to tender for the implementation of a pilot example of absorption solar cooling for Kindergarten Mornarček. Key tenderer selection criteria, in addition to the actual cost of setting up the system of absorption solar cooling with the equipment as specified in the project documentation, should also be lower operational and maintenance costs, as well as savings in preparation of hot sanitary water and (supplemental) heating in transition periods outside of the heating season.