Fostering diffusion of Heating & Cooling technologies using the seawater pump in the Adriatic-Ionian Region

Case study report – Albania

Elementary School "Gjergj Kastrioti"

Fostering diffusion of Heating & Cooling technologies using the seawater pump in the Adriatic-Ionian Region

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1 Contents

Purpose of this document

This document is a pre-feasibility study for Elementary School "Gjergj Kastrioti" and is one of altogether 6 pre-feasibility studies that will be done in the scope of the SEADRION project.

2 Introduction

The subject of this document is sea water heat pump utilization case study on an existing public building, i.e. the "Gjergj Kastrioti" High School, Durres.

The "Gjergj Kastrioti" High School building was built in 1970 and since then has been intensively used and maintained. Minor adaptations and changes have been made on the building since then. Today, the total available building area of about 3664 m^2 is used for the needs of the students.

3 Characterization of the site

3.1 Location

"Gjergj Kastrioti" Elementary School is the public education institution of the Republic of Albania. The high school is located in the ancient city of Durres. Its address is: Rruga "Bardhyl Shehu", Durres, Albania. It was inaugurated in 1970.

Figure 1 shows situtation of the building on on the satellite map. The building is about 120-150m away from the sea making the building ideal for the utilization of the seawater heat pump system.

Location (available from Google Map) with Latitude 41°18'43.1"N and Longitude 19°26'32.9"E.

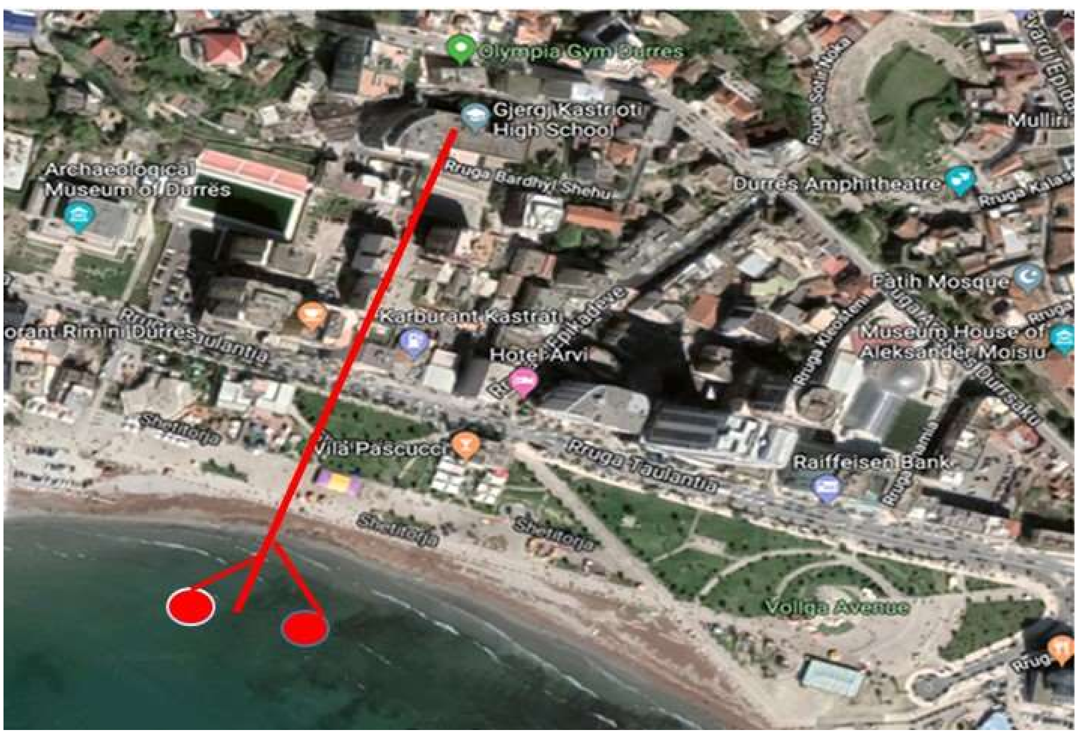


Figure 1 Situtation of the building on the satellite map

3.2 Building

3.2.1 The existing state of the building

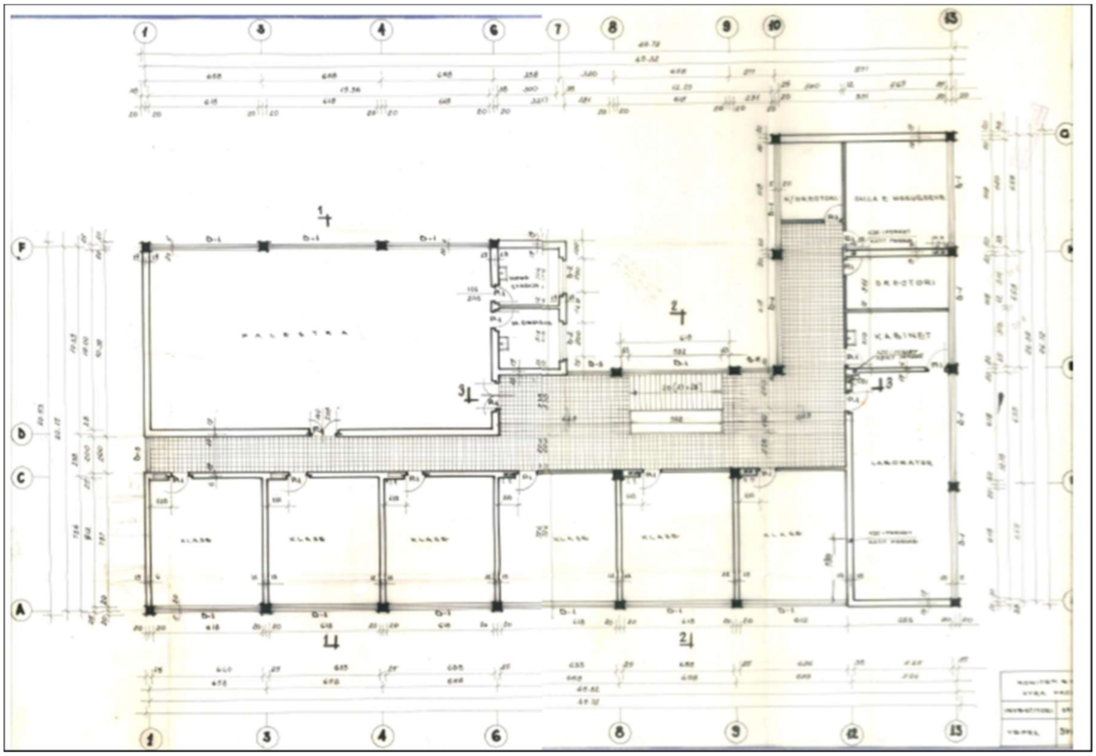
The subject of the case study is the application of the seawater heat pump in the "Gjergj Kastrioti" High School, Durres. The building was built in 1970 and is designed and constructed as a non-residential, free-standing building, 120-150 meters from the sea. Figure 2 shows facades, windows and the shape of the building.

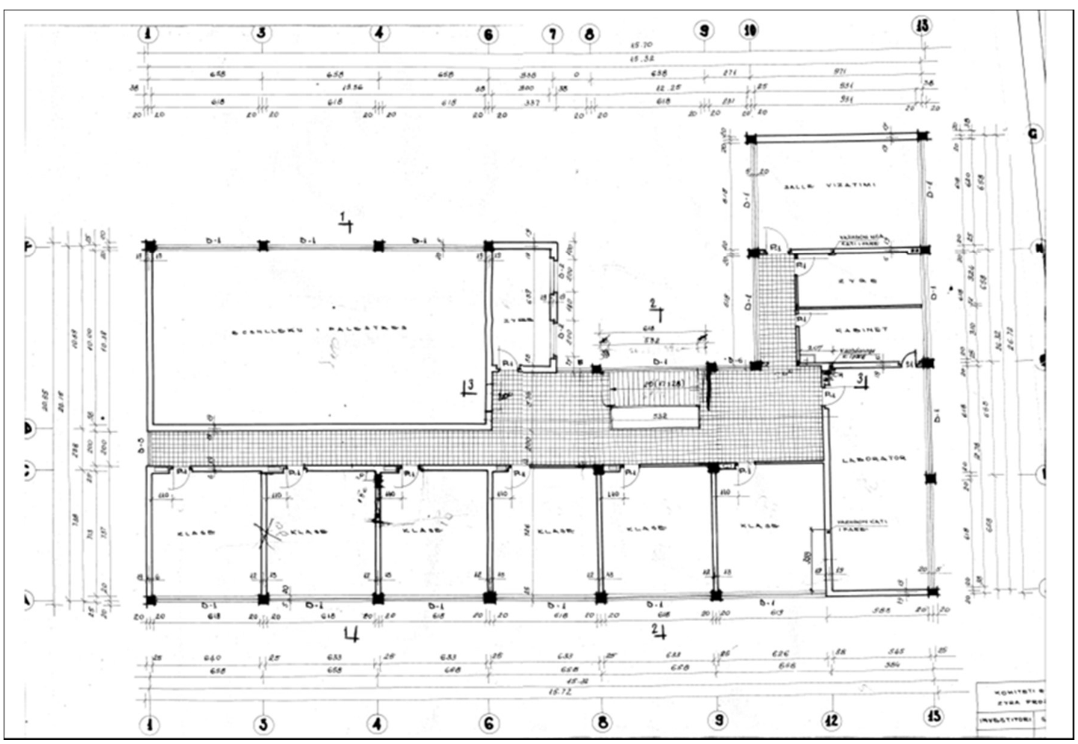
Figure 2 Existing state of the "Gjergj Kastrioti" High School building in Durres

This building has four floors: ground floor and 3 floors with reinforced-concrete external and internal walls as well as reinforced-concrete slabs. The building was built in 1970. It was partially reconstructed in 2004&2013 (new roof, new sinlge glass windows, new doors). This building has 4 floors, with 25cm solid red brick walls with 5cm plaster (outdoor&internal) and concrete foundations. Building has a flat roof, concrete slab. The windows are simple with duralumin frame, single glass. The thermal situation of this building is poor.

This building has a large surface of windows. It has about 593m^2 windows surface that are cover with curtains to protect the internal air from radiation of the sun.

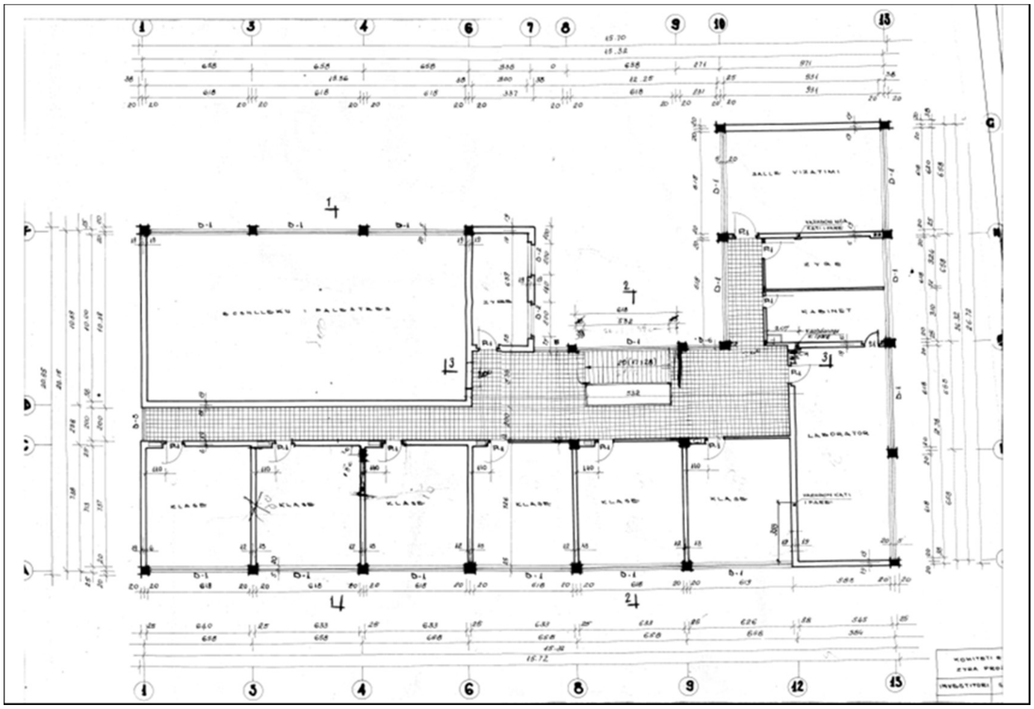
Plan of ground floor
Total net floor area= 916 m^2
Heated area= 536 m^2

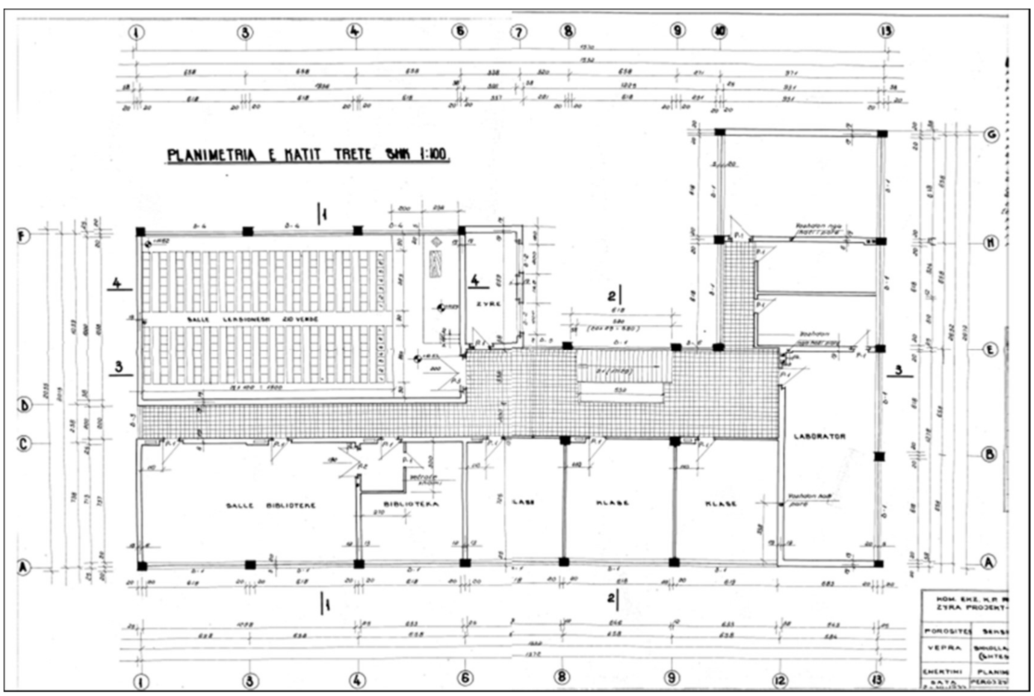




Plan of first floor
Total net floor area= 916 m^2
Heated area= 536 m^2

Plan of second floor
Total net floor area= 916 m^2
Heated area= 536 m^2





Plan of third floor
Total net floor area= 916 m^2
Heated area= 536 m^2

The number of the students in the building is 650. In the heated part of the building aren't all the rooms. Also the corridors aren't heating. Building height is 12.2m.

The values of the outer shell and floor parameters of the building are given in tables 1 and 2.

Table 1 Parameter values of the outer shell of the building

Parameter	Value
Area of the heated part of the building, A_h [m^2]	2145
Useful area of the building, A_u [m^2]	3664
Volume of the heated part of the building, V_h [m^3]	6435
Total area of the facade, A_t [m^2]	1848
Total window area, A_W [m^2]	593
Share of window area in the total area of the façade %	32

Table 2 Data on the heating floors of the High school building

Floor	Floor area, [m^2]	Floor height, [m]	Floor volume, [m^3]
0-GROUND FLOOR	536	3	1608
1-FIRST FLOOR	536	3	1608
2-SECOND FLOOR	536	3	1608
3-THIRD FLOOR	536	3	1608

3.2.2 Technical characteristics of the outer shell of the heated part of the building

Technical characteristics of the building parts and the external openings of the heated part of the building are given in tables 3 and 4:

Table 3 Technical characteristics of the building parts of the heated part of the building

Building part	A, [m²]	U, [W/(m²K)]
Walls, north (m²)	264	1.764
Walls, east (m²)	427	1.764
Walls, south (m²)	180	1.764
Walls, west (m²)	384	1.764
Roof (m²)	916	1.572
Floor (m²)	916	1.409

Table 4 Technical characteristics of the external openings of the heated part of the building

External opening	A_w, [m²]	U_w, [W/(m²K)]
Windows, doors etc., north (m²)	60	4.1
Windows, doors etc., east (m²)	173	4.1
Windows, doors etc., south (m²)	144	4.1
Windows, doors etc., west (m²)	216	4.1

3.3 The heating/ Cooling system

There is no central heating system in this school, so there is no fuel consumption used to heat the spaces. The Heat pump used only for Teacher and Directory rooms.

a) Heating/Cooling System

Elementary School "Gjergj Kastrioti" Building has not a central heating/cooling system. Previous measures were implemented for this building, such as installation of fan-coil split units. Installation of these unist is done partially (in some offices), so does not meet all energy requirements of the building. From inspections cocluded that the conditioner unit are not inverter technology, so we have haigher consumption by these equipment compared with inverter units. Due to the missing heating system staff of school are using electrical devices or small electric furnaces for heating. These heaters can be considered hazardous since they are note equipped with secure electrical plugs and are sources for frequent overload and short cuts. From the site visit was concluded that half of building use fan-coil split units and other part use electrical heaters.

Picture 21: Using of Fan-Coil units

The source of thermal energy for summer time is fan-coil split unit used partially in the building. Due to the lower energetic performance of these units, we have a higher consume of electricity during summer time. Also we have a kind of discrimination, bacuse some offices have cooling system for summer time and other offices didn have. So the using of this system is not the right solution for many reasons decribed above. We recommend installing a new heating/cooling system, which will be a system with high energetic performance according to contemporary technologies and will cover all permisses of the School “Gjergj Kastrioti” Building.

3.4 Domestic Hot Water system

b) Sanitary hot/cold water supply system

The sanitary water supply is done from public network and does not meet any design requirements or criteria. The network outside building is done through plastic pipe, is in very poor condition and without thermal insulation. The building has not sanitary water tank or any pump station and in toiltes they used plastic container for water if network water is missing. In general all water supply system is old and need to be renewed.

In this building is not installing any system for hot water production. According to Europian Norms and Standarts shuld have a quantity of hot water 10-200 liter for each person. The absence os sanitary hot water is an indicator that was not met the comfort condition for school Building.

2.5. Energy consumption

Estimating the energy demand for space heating for standard comfort level, the team calculated the thermal losses, the required heating components (boiler, burner, heating panel, etc.), the initial investments for the new space heating system, the energy costs and the other costs. The methodology for calculations include:

- Based on the existing general layout of the building, the thermal losses are calculated. The structures of the walls, ceilings, windows and doors are taken from the drawings of each floor. By using a method which calculates the thermal losses for each floor, it is calculated the overall coefficient of thermal volumetric losses (Gv), the energy needed in order to guarantee the space heating, and the annual thermal energy demand.
- Gv [W/m^3 °C] depends mainly on the numbers of floors, the volume of the building, the ratio of windows/walls area, the structural design of the building. This coefficient is based on the ratio of outside walls of the building/total building's volume as well as other secondary factors.
- **From the geometry and thermal characteristic of the building, the coefficient Gv for** the existing building is determined. Based on this coefficient and on the building volume the annual thermal energy demand is calculated.
- The Albanian Energy Building Code for Private and Public Buildings given the number of degree-days for the Durres, where 'school' is allocated. The calculation of the additional thermal losses depends on the space heating system function, the average heat transfer coefficient from the building, and the building orientation. From the studies carried out such additional thermal losses are determined for types and activities in a building. Coefficient *r* =1–0.6, represents the coefficient which takes into consideration the space heating interruptions during the day and/or the weekends (for schools, institutions and etc). Coefficient "*r*" has high value for hospitals and re-creative centers (such as school Durres) and low value for schools and administrative buildings.

Taking into consideration the difficult economic situation now and in the next years we assume a "poor thermal comfort" for the heating load before the investment for the purpose of this feasibility study[1], that the heated space will be only the absolutely necessary and will be heated with interruptions when needed. Based on the above the following assumptions have been used to calculate space heating energy demand:

- Heating Degree Days (base 17,5 ^{o}C taking into account internal thermal gains) : 1320
- Number of Heating Days: 99
- Volumetric Heat Losses Coefficient: 1.55 W/m3 0C
- Electricity is used for cooling
- Electricity used for heating
- Average yearly energy consumption: **176000** Kwh
- Average yearly energy costs: 5200 Euro (without VAT)

3.4.1 Thermal load of the Elementary School of Durres according to Albania Energy Code

Calculation of the thermal load of the city administration building of the School of Durres was conducted according to Albania Energy Code. Internal and external design temperature of the thermal load calculation for the location of Municipality of Durres are given in Table 7.

Table 5 Design temperatures for thermal load calculation

Description	Symbol	Value	Unit
External design temperature for Durres School	Tj	7	[°C]
Internal design temperature	Tb	22	[°C]

Table 8 shows the values of transmission, ventilation and total thermal losses of the school of Durres. The values are shown for each floor of the building, and are the largest for the basement of the building since the floor and wall of the cellar to the ground are not thermally insulated which is why the transmission heat losses are large. The total thermal load of the school building is $Htok = 73.40\ \ [\mathrm{kW}]$. This data will be used for selecting heat pumps in economic analysis.

Table 6 Thermal load calculation results

Floor	H_T, [W]	H_V, [W]	Hto, [W]	Htok, [kW]	Hsp, [W/m^2]
Ground floor	11257.12	7091.86	18348.99	18.35	8.55

[1] Note that the heating system has been dimensioned to cover the full load for heating and hot water

1st floor	11257.12	7091.86	18348.99	18.35	8.55
2nd floor	11257.12	7091.86	18348.99	18.35	8.55
3rd floor	11257.12	7091.86	18348.99	18.35	8.55
Total	45028.49	28367.45	73395.94	73.40	34.22

Figure 6 graphically illustrates the thermal losses of the School.

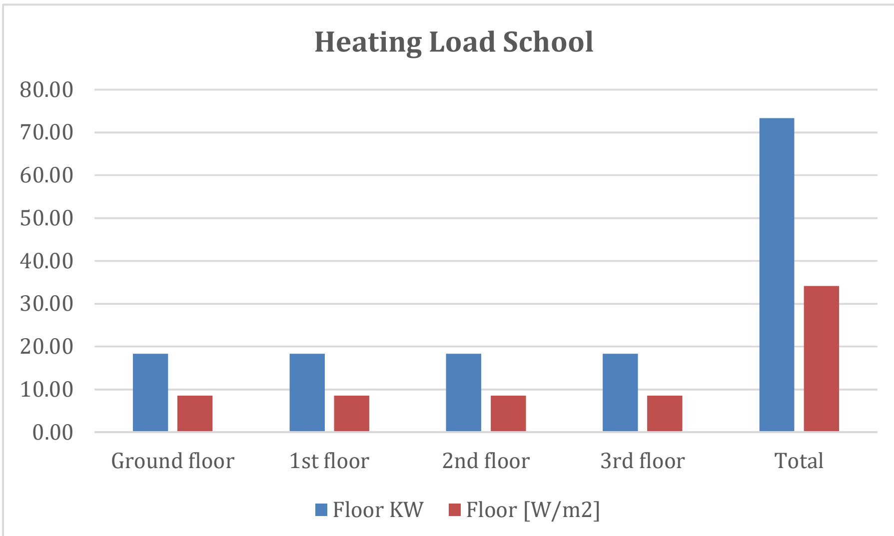


Figure 6 Graphical illustration of thermal loses in the Durres City

3.4.2 Cooling load of the School of Durres

Calculation of the cooling load of the Durres School is calculated based on Albania Energy Code. Internal and external design temperature of the cooling load calculation for the location of Durres are given in Table 9.

Table 7 Design temperatures for cooling load calculation

Description	Symbol	Value	Unit
External design temperature for Durres	Tj	34	[°C]
Internal design temperature	Tb	24	[°C]

Table 10 presents the values of the internal, external and total thermal gains of the Durres School. The values are shown for each floor of the building and are the largest for the basement of the building where the conference halls are located. It is assumed that the accumulation of the people on these premises is greatest so therefore the internal heat gains are high. Floors on which the offices are located also have high heat gains since on these floors the accumulation of people and appliances is large and there are a large number of transparent elements facing south. The total cooling load of the city administration building of the School is $Htokf = 126.12$ [kW]. This data will be used for selecting heat pumps in economic analysis.

Table 8 Cooling load calculation results

Floor	H_T,	H_V,	Hto,	Htok,	Hsp,
	[W]	[W]	[W]	[kW]	[W/m^2]
Ground floor	9745.10	21784.93	31530.03	31.53	14.70
1st floor	9745.10	21784.93	31530.03	31.53	14.70
2nd floor	9745.10	21784.93	31530.03	31.53	14.70
3rd floor	9745.10	21784.93	31530.03	31.53	14.70
Total	38980.39	87139.73	126120.12	126.12	58.80

Figure 7 graphically illustrates the thermal gains of the Durres School.

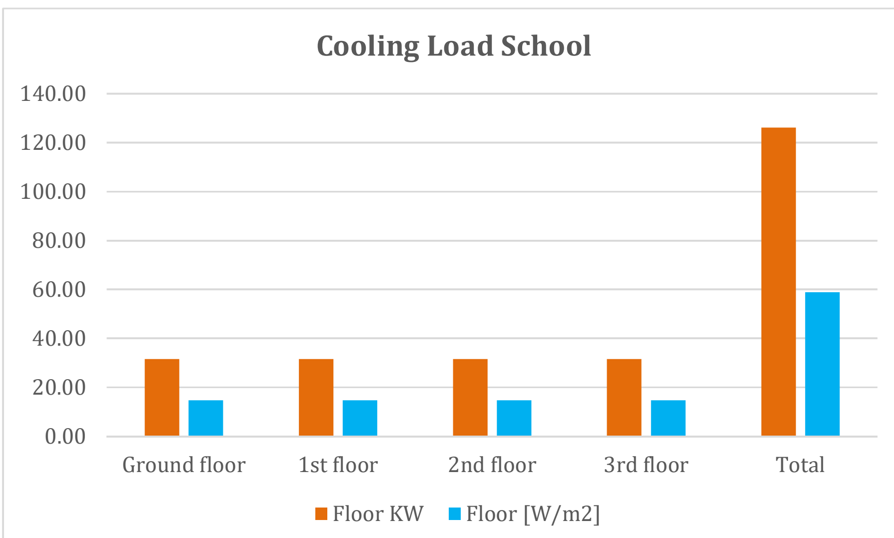


Figure 7 Graphical illustration of thermal loses in the Durres School

3.4.3 Calculation of the annual heat energy required for heating and cooling

The annual heat energy required for heating and cooling, $Htok$ and $Htokf$ is the calculated amount of heating/cooling energy that a heating/cooling system needs during a year to be brought into a building to maintain its internal design temperature during the building heating/cooling period and is calculated according to Albania Energy Code.

Input climatic and building calculation data are given in Table 11 and 12.

Table 9 Input building calculation data

Parameter	Value

Area of the heated part of the building, A_h [m²]	2145
Useful area of the building, A_u [m²]	3664
Volume of the heated part of the building, V_h [m³]	6435
Total area of the facade, A_t [m²]	1848
Total window area, A_w [m²]	593
Share of window area in the total area of the façade %	32
Roof area to the ground	916
Floor area to the ground	536

Table 10 Input climatic calculation data

Description	Symbol	Heating	Cooling	Unit
Average annual outdoor temperature	Tj	7	35	[°C]
Internal calculation temperature	Tb	23	24	[°C]

The results of the annual heat energy calculation required for heating and cooling are shown in Table 13. The total annual heat demand for the cooling period is $Hc = 42167.10[\mathrm{kWh/a}]$ and for the heating period $Hh = 72630.71[\mathrm{kWh/a}]$.

Table 11 Required annual heating/cooling energy in the elementary school "Gjergj Kastrioti"

Description	Symbol	Heating	Cooling	Unit
Annual heating/cooling demand	$Q_{H/C,nd}$	72630.71	42167.10	[kWh]
Annual heating/cooling demand	$Q_{H/C,nd}/A_k$	33.86	19.66	[kWh/m²]

Figure 10 shows the monthly distribution of the required heat energy for heating and cooling the Durres School. The greatest need for heat energy for heating is in January and February while the needs in October and April are almost negligible. On the other side, the greatest need for heat energy for cooling is in June, July and August.

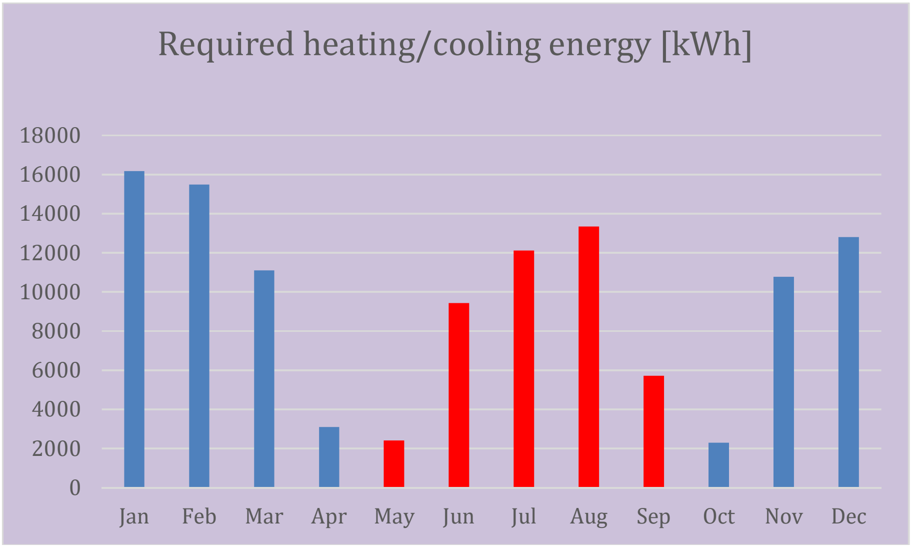


Figure 8 Monthly distribution of the required heat energy for heating and cooling Durres School

Calculated data will be used in the following section to carry out a techno-economic analysis.

4 Techno-economic analysis of sea water heat pump utilization for heating and cooling of the School "Gjergj Kastrioti" Durres

Economic feasibility analysis of different heating and cooling source implementation was carried out in the School of Durres. The School of Durres, with a building area of 2145 m^2, the thermal load of 73.40 [kW] and cooling load of 126.12 [kW], is located in Durres, a coastal part of Durres city of Albania . The specific annual heat energy required for heating divided to the useful surface of the building values 33.86 [kWh/m^2a)] while the total annual heat energy required for heating of the building values 72630.71 [kWh/a]. On the other hand, the annual cooling demand of the building values 42167.10 [kWh/a], while the amount of specific annual cooling energy divided to the useful surface area of the building values 19.66 [kWh/(m^2a)].

The reference scenario of the building consists of two systems: an oil boiler connected to the radiator distribution system as a heating system and a newly installed VRV cooling system. In this chapter, two scenarios will be analysed:

1. the seawater heat pump for the purpose of heating the School of Durres, $Ch = 65\ [\mathrm{kW}]$ and VRC system for cooling.
2. the seawater heat pump for the purpose of cooling the School of Durres, $Cc = 120\ [\mathrm{kW}]$ and iol boiler for heating.

3.1. Reference scenario - analysis of current consumption

Heating system

The heating system of the buillding consists of a SWHP with capacity 65 MW, and indoor units in the office spaces. There is no central regulation of the cooling system, but it is possible on every single indoor unit.

Annual heating demand of the city administration building values $Cc = 42167.10\ [\mathrm{kWh/a}]$. In conversation with building janitor, information was obtained that the heating season begins in October and lasts until April. The energy needed to operate the cooling system is electricity. In the economic analysis of the utilization of the two above-mentioned scenarios.

Cooling system

The cooling system of the School of Durres will have the power needs of 126 [kW]. Annual required cooling energy of the elementary school values $Ch = 72630.71\ [\mathrm{kWh/a}]$. The consumption was not modelled on the reference data since the aim of the calculation was not to determine the energy class of the building but to actual needs in order to gain the value to be used in the techno-economic analysis of seawater heat pump utilization. Actual total consumtion for heating and cooling is 138000 $[\mathrm{kWh/a}]$, and in the economic analysis of the utilization of the two above-mentioned scenarios, the amount of modelled annual heat energy consumption for heating at the input of the generation subsystem will be used $Ch = 72630.71\ [\mathrm{kWh}]$.

3.2. Seawater heat pump implementation

Once the total cooling load of the School of Durresi was calculated, a safety factor of 12% was applied, which was rounded off to 65 kw heating and 120 kw for cooling. All the components sized hereafter take into consideration this new load. A simple SWAC system, shown in Figure 9 as model, having a seawater pump, a heat exchanger, and a chilled water pump was selected for the school.

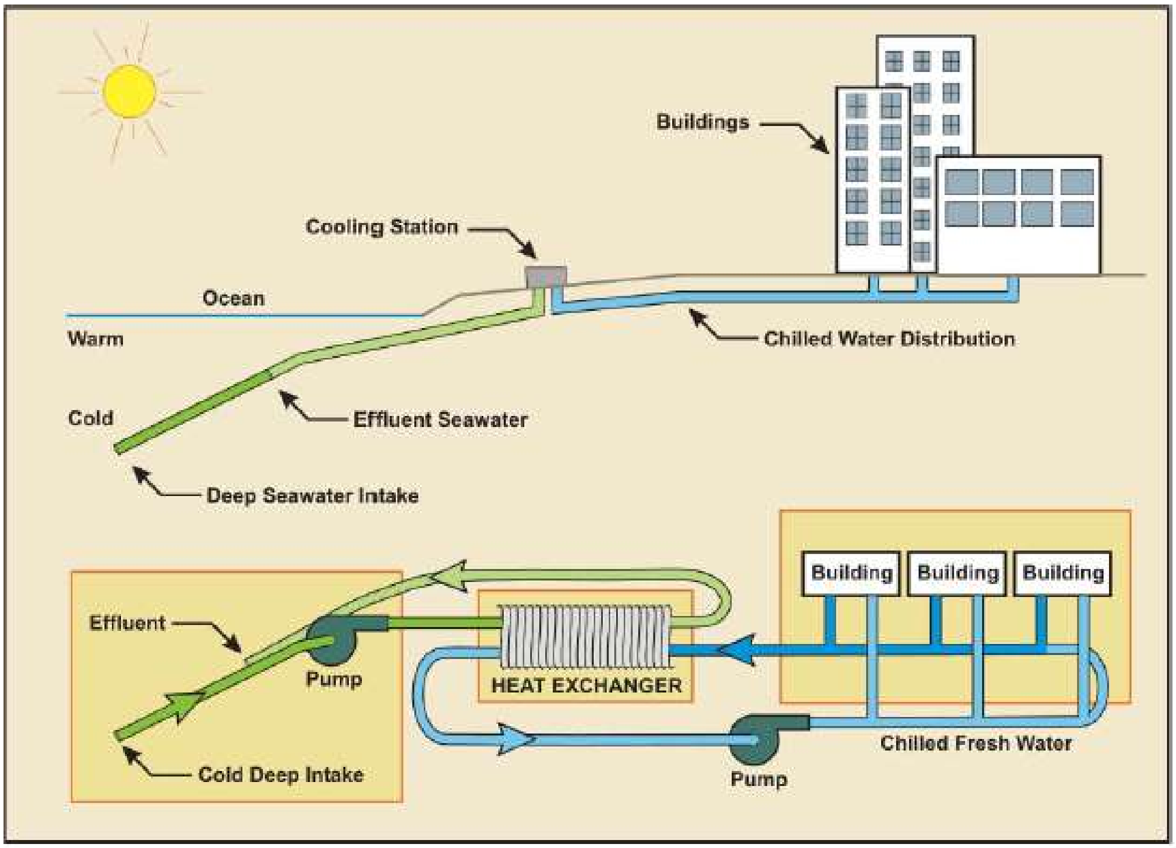


Figure 9: Layout of the recommended SWAC system (model)

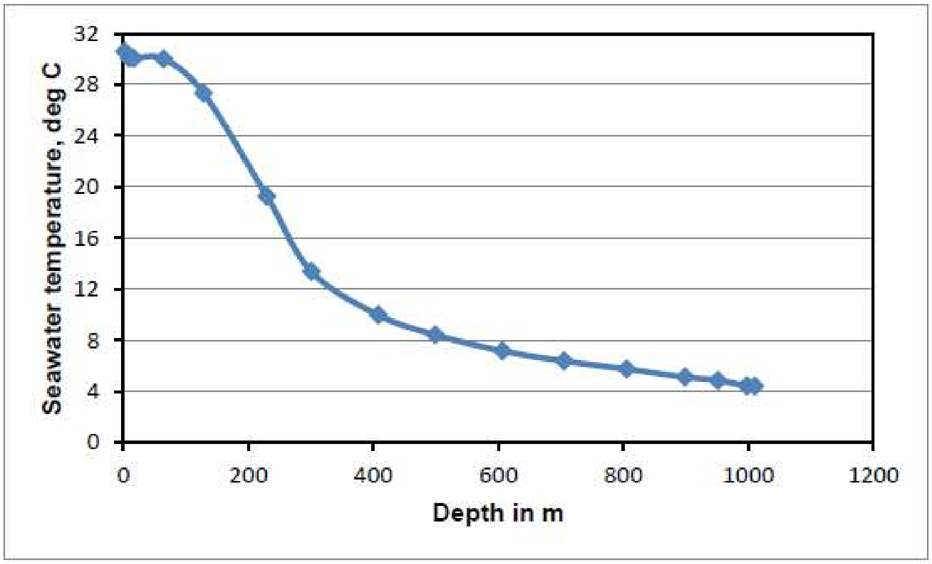


Figure 10: Temperature variation of seawater with depth in Durres**.**

Two boreholes with a depth of 35 m each and a diameter of 17’’ will be constructed with a 170 mm diameter pipe near the geothermal engine room located in a storage area adjacent to the boiler room of the school.

Figure:11 Model of intake of sea water

Due to the proximity of the drillings (<100 m) to the sea, special attention should be paid to the selection of equipment (submersible pump, piping, plate heat exchanger, etc.) to ensure their maximum strength to the corrosive brackish water. It is also emphasized that drilling depths will be at least 100 m (the exact depth will be determined by the first test drilling according to its results).

Upon completion of the pumping tests of the first drilling and provided that the quantity and quality of the pumped water is suitable, the final technical specifications of the equipment will be defined.

A titanium plate heat exchanger is selected to ensure its resistance to brackish water. The counterflow heat exchanger will be at an operating pressure of 10 bar (primary-secondary) at a maximum operating temperature of 100 °C. The pressure drop on the exchanger will be less than 50 kPa (0.5 bar). Thermometers will be placed on all the inlets / outlet. A manometer device will also be installed in order to control the clogging of the heat exchanger.

The Geothermal Heat Pump will be a water-to-water type with a R410A working medium, an internal reversible cooling-heating operation and an appropriate operating system to achieve the optimum efficiency depending on the fluctuations in the building's heat loads. It will have two SCROLL type compressors in a common refrigeration circuit.

3.3. Economic analyses

Prior to carrying out the economic analysis of the two scenarios mentioned in the introduction of this chapter, it is necessary to define the investment costs of the seawater heat pump implementation. The economic analysis of the investment and operating costs of heating and cooling systems of the city administration building is based on the following assumptions:

- Building a heating and cooling systems are independent of the source of the heating and cooling efficiency, ie. it is assumed that all devices shown in this analysis are able to deliver the heating or cooling medium in the required temperature regime.
- A seawater heat pump works in monovalent mode, ie. it can deliver the heat energy that covers the heating and cooling load of the building.

The above assumptions allow to easily determine the investment and operating costs of different thermotechnical systems and assume that there is no need to install additional auxiliary devices besides implemented thermal devices.

Investment costs for the implementation of the seawater heat pump system are:

- the costs of a seawater heat exchange system
- the cost of seawater heat pump unit
- the costs of heat energy distribution
- other costs (installation, maintenance)

The two scenarios listed at the beginning of the chapter will be analysed. The first scenario is a seawater heat pump for building heating for VRC for cooling. The heat pump system would be a new heating elements (radiators) with the change of the heating temperature regime from 90/70 [°C] to 55/45 [°C]. The power of installed radiators in the 55/45 [°C] temperature regime values 65 [kW] so there would be no need to install additional articles on the radiators as the thermal load of the building values $\Phi_{Gr} = 80\ [\text{kW}]$. In scenario 1, the implementation of a 65[kW] heat pump with all the accompanying equipment is planned which would be used for heating the school building.

The second scenario is the instalation a seawater heat pump with the cooling effect of 120 [kW] and oil boiler for heating. With the implementation of the heat pump, 90 new heating elements, fan coils, and all the accompanying equipment would be installed. Scenario 2 is much more demanding than scenario 1. Table 14 lists the prices of total investment cost for each scenario.

Table 12 The prices of total investment cost for each scenario

	Scenario 1	Scenario 2
Description	Seawater heat pump for building heating	Seawater heat pump for building heating and cooling
The wells + immersed pump	8,514.00 €	11,261.33 €
The pipeline to the heat exchanger	2,416.80 €	2,685.33 €
A plate titanium heat exchanger	1,378.80 €	1,532.00 €
A heat pump unit	10,987.87 €	16,259.38 €
A storage tank, 3000 l	3,649.20 €	4,054.67 €
An electric cabinet and the wiring	7,297.20 €	8,108.00 €
The fan coils	0.00 €	28,378.67 €
The pipelines and isolation	0.00 €	3,153.33 €
Installation works	8,108.40 €	20,270.67 €
Total	42,352.27 €	95,703.38 €

3.4. Cost analysis

Prior to carrying out an economic analysis, it is necessary to determine the cost of energy sources required for the operation of the system. The electricity price is determined according to the received electricity bills. The tariff model of the city administration building is HEP PRO and the electricity price values 0.9 [€/kWh]. For the price of extra light fuel oil 0.95 [€/kWh] is taken . The money needed to implement the heat pump system will be calculated, in both scenarios, by means of loans for entrepreneurs whose interest rate is 5%.

Tables 15 show the results of the economic feasibility analysis starting from the presentation of investment costs, through energy analysis to economic analysis at the end.

The table 15 above shows that with the payment term of 8 years for heating the annual cost of the implemented seawater heat pump system for heating the building is 42,352.27 euro and the total cost for cooling system is 95,703.37 euro.

Renewable energy system implementations are often financially supported by European projects or state subsidies. With a subsidy of 40 %, the investment cost of scenario 1 decreases to the return period of investment is reduced to 8 years which is 4 years less than the scenario without subsidies, so the possibility of subsidizing should certainly be taken into account.

The economic feasibility analysis of scenario 2 which from the obtained results shows that with the payment deadline of 29 years, the annual cost of the implemented seawater heat pump system is lower than the annual cost of the reference scenario which is completely unprofitable since the investment cost is far greater than the realized annual savings. If this is the case with a grant of 40 [%], the investment cost decreases to 40 % so the repayment period is reduced to 15 years which is certainly more acceptable.

Table 15 total investment cost for each scenario

	heating/ cooling	seawater heat pump for the purpose of heating, K=60 KW	seawater heat pump for the purpose of heating and cooling, K=120 KW
Total estimated investment		42,352.27 €	95,703.37 €
Annual cost of heating and cooling	5200 Euro	4800Euro	4200 Euro
Return period of investment		12 year	29 year
With 40% subsidies		8 year	15 year

3.5. Environmental impact

The return period of the investment has a significant impact on the decision to utilize seawater heat pumps, however, one of the most important factors is the environmental impact. By comparing the CO_2 emissions in each scenario, it is estimated that these emissions are 70% less in scenario 1 and 2 than in the reference scenario. This is a result of lower primary energy consumption in scenario 1 and 2 than in the reference scenario, which is used for generating the same amount of heating and cooling energy. Table 17 shows the values of primary energy consumption and CO_2 emissions for each scenario as well as its reductions.

Table 13 Primary energy consumption and CO_2 emissions for each scenario

	Reference scenario	**Scenario 1**	**Scenario 2**
Primary energy consumption, [kWh/a]	145670	72630.71	42167.10
Reduction of Primary energy consumption, [%]	0%	65%	68%
CO_2 emissions, [kg CO_2/a]	35965	10567	6135
Reduction of CO_2 emissions, [%]	0%	79%	81%

4. Conclusion

The school of Gjergj Kastrioti is located about 85 meters from the sea, whose winter temperature, at depths up to twenty meters does not fall below 13-15 [°C]. School Building has not a central heating/cooling system. Previous measures were implemented for this building, such as installation of fan-coil split units. Installation of these unist is done partially (in some offices), so does not meet all energy requirements of the building. From inspections cocluded that the conditioner unit are not inverter technology, so we have haigher consumption by these equipment compared with inverter units. Due to the missing heating system staff of school are using electrical devices or small electric furnaces for heating. These heaters can be considered hazardous since they are note equipped with secure electrical plugs and are sources for frequent overload and short cuts. From the site visit was concluded that half of building use fan-coil split units and other part use electrical heaters.

Due to the good energetic properties of the building, the thermal load of the building is considerably lower which allows the implementation of the seawater heat pump system on new radiators with a lower heating system temperature regime while the thermal load is still covered. The return period of such an investment would be 8 years as the investment cost is large, however, with financial subsidies, the system would be more cost-effective in the shorter period. The case of the heat pump implementation for building heating and cooling has also been considered, yet because of the necessary installation of a new heat energy distribution system, the investment cost is considerably higher than the previous case and the investment return period rises to 28 years, with a subsidy of 15 years.

Heat pump systems are systems with high investment costs and it is still easier and cheaper to implement conventional heating and cooling systems, however, attention should not be put on the cost and complexity of the system's performance. The ultimate goal in the current period of climate change and the struggle for fossil fuel reserves should be to reduce CO_2 emissions and increase the use of renewable energy sources, and in particular to achieve energy independence, as systems such as seawater heat pumps and heat pumps in general provide.

Table 18. Sumary of SWHP of Durresi Elementary school

Location	Elementary School of Durres
Building	1970
Last adaptations	2002
Situation	No thermal insulation
Flor area (m2)	2145
Sea distance (m)	120
Average yearly energy consumption kwh	176,000
Average yearly energy costs (euro)	15840
system heating and cooling	individual electric
SWHP	boreholes
Heat exchanger	boreholes

pipes length (m)	2332
Investment costs	
seawater heat pump for the purpose of heating, K=65 KW	42,352.27 €
Replacement of VRF system with seawater heat pump for the purpose of heating and cooling, K=120 KW	95,703.37 €
water flow (l/s)	8,5 l/s
payback period cooling (Year)	15
payback period heating (Year)	8
Heat needed for heating (MW)	65
Cooling energy needed for cooling (MW)	120
CO_2 [kg CO_2/a]	10567

5. References

1. Albania building Code 2003
2. Energy Balance of Albania, 2018
3. Energy data base University of Durres 2018
4. EU Directive for Energy Efficiency
5. Albania Machanical University Enerfy efficncy Manual 2014