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Use of Solar Energy for Hot Water Supply in Multi-Apartment Residential Buildings

(Bldg.1, IV Bl. Vazha-Pshavela Ave., 53/53a Saburtalo St.)

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(Bldg.1, IV Bl. Vazha-Pshavela Ave., 53/53a Saburtalo St.)

Prepared for: USAID/Caucasus

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1 Introduction

The goal of this report is to develop a design and related tender documentation for hot water supply systems based on the collective use of solar energy for two residential buildings: Building 1, IV Bl. Vazha-Pshavela Av. and 53/53a Saburtalo Str.

At the initial stage of the project the main technology principles and conceptual technical solutions pertaining to common solar water heater systems were developed. Namely:

1. The solar hot water system shall be of common (group) use. There will be one hot water riser pipe for every entrance. In Building 1, IV Bl. Vazha-Pshavela Ave. 21 families shall be connected to the hot water riser while on 53/53a Saburtalo St. 15 apartments will be getting their hot water supply through a single riser.
2. The type of solar water heaters was selected.
3. The locations for solar collector installation were defined.
4. The principle design of hot water supply piping from central reservoirs to individual apartments was developed, corresponding hydraulic calculations were made.

2 Selection of Solar Water Heater Type

The following requirements were taken into account while selecting the type of solar water heaters:

1. The solar water heater shall be a standard commercial solar water heater model in use for over 3 years.
2. Installation and especially the operation of the equipment shall be simple without the need of much maintenance orspare parts. The useful lifetime of the equipment shall be no less than 15 years.
3. The water heating system shall have the protection systems against water overheating, variation of cold water pressure and potential accidents caused by the disruption of the cold water supply.

Based on the above, evacuated tube collectors with a thermal rod of the type Sunpower SH5B-1.8-24 (or similar) andDixis Top (or similar), were selected for both buildings. For Building 1, IV Block, Vazha-Pshavela Ave. 54 collectors of these or similar models shall be installed, while 63 units will be needed for 53/53a Saburtalo St.

Fig.1 Conceptual design of the solar hot water system to be used in multi-apartment residential block buildings

The hot water supply system shall have an accumulating, interconnected reservoir systemwith heat exchangers. The total capacity of the tanks depends on the number of apartments to be fed. Based on the number of apartments and consumption incidence coefficients, for Building 1, IV Block, Vazha-Pshavela Ave. the needed volume is 9000 liters, the capacity of one tank shall be 500literswithan operating pressure of 10bar. The total number of tanks will be 18 (one tank per 4 apartments on average). The need for tank volume at 53/53a Saburtalo St. is 10000 liters, andthe capacity of one tank shall be 500literswith anoperating pressure of 10bar. The total number of accumulation tanks is 20 in this case (on average 1 tank for 3.6 apartments).

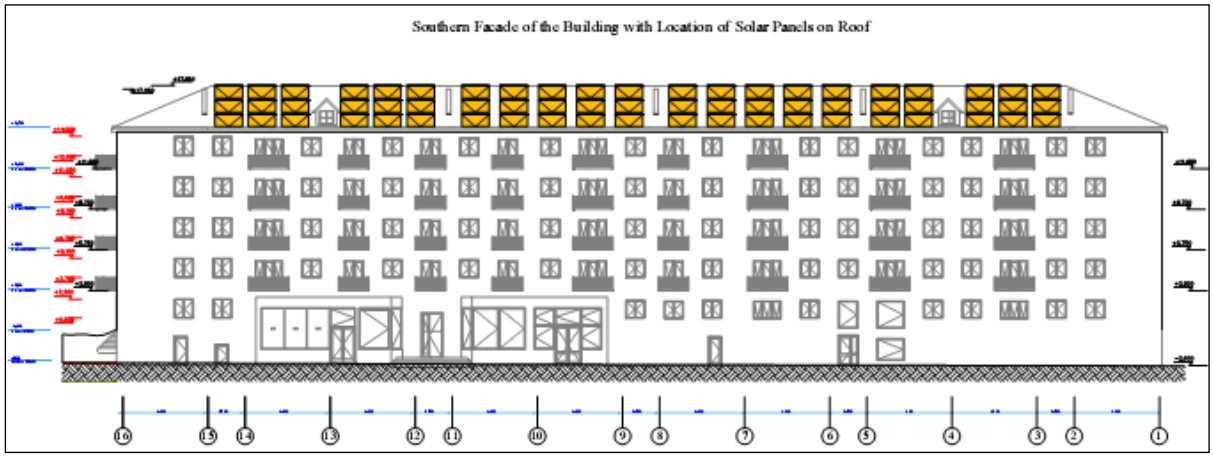

Fig.2 Scheme of installation of solar collectors on the roof of 53/53a SaburtaloSt. (front view)

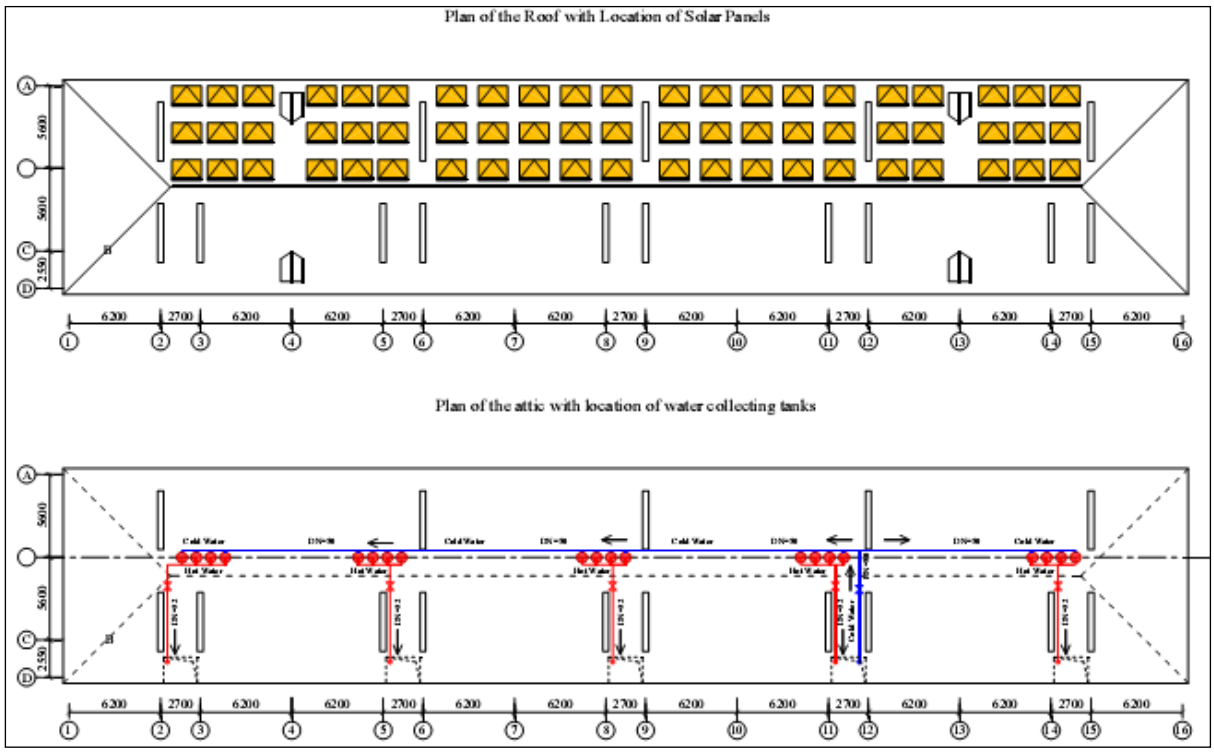

Fig.3 Scheme of installation of solar collectors on the roof of 53/53a SaburtaloSt. (top-down view) and location of accumulation/exchanger tanks.

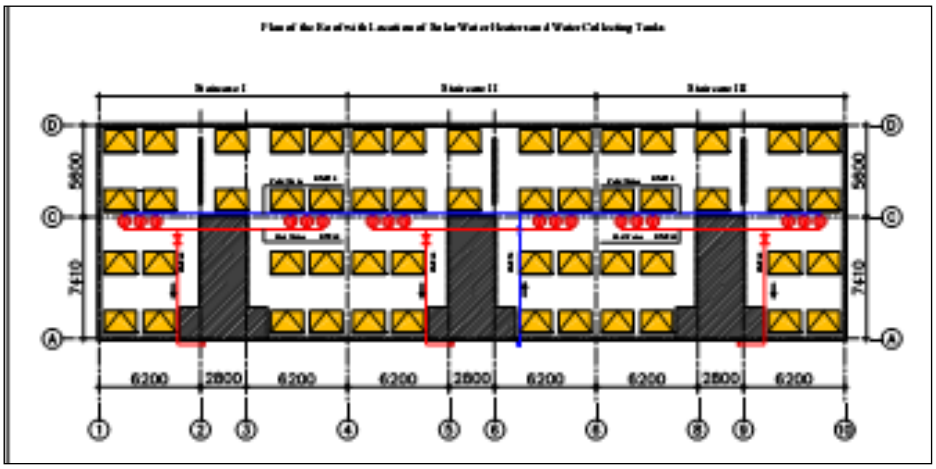

Fig.2 Scheme of installation of solar collectors on the roof of #1/IV VazhaPshavela Ave.

3 Special Technical Requirements for Installation of Solar Collectors.

The method of solar heater system installation shall provide for the safety and integrity of the roof structures as well as provide adequate access and the possibility to install equipment for roof repairs. The storage tanks shall be located only in the vicinity of the building's central axis, and the deviation from the axis shall be no more than 1 meter.

4 Cold and Hot Water Piping, Apartment Connections

Cold water shall be supplied to the solar collector system from the regular city network; the water pipe shall be tapped downstream from the meter installed by the water supply company for the buildings. Polipropilene pipes of various diameters (PP-R80 SDR7.4 or similar) shall be used for the cold water feed as well as for the hot water piping for the supply of apartments.

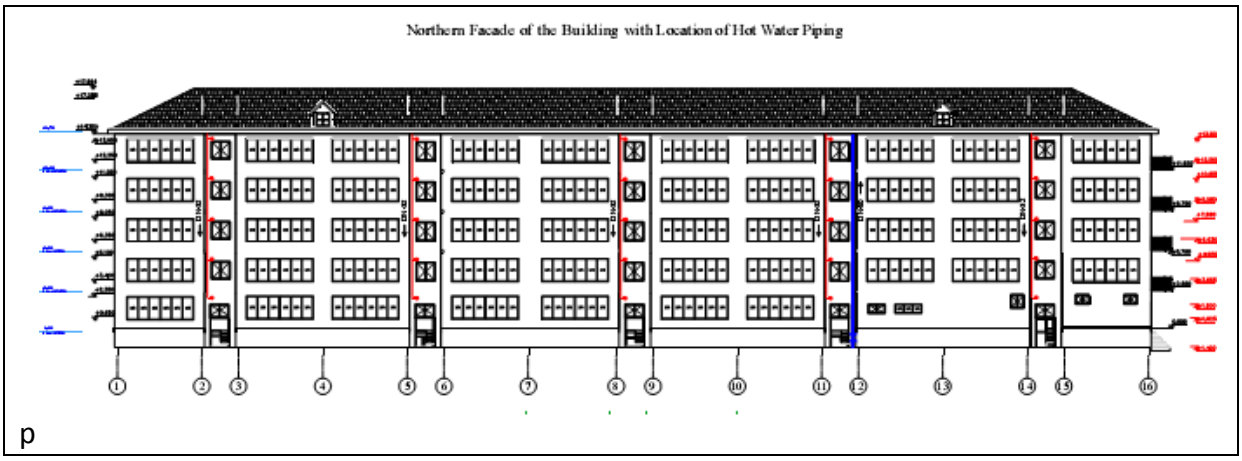

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Fig.3a External cold and hot water piping at 53/53a SaburtaloSt.

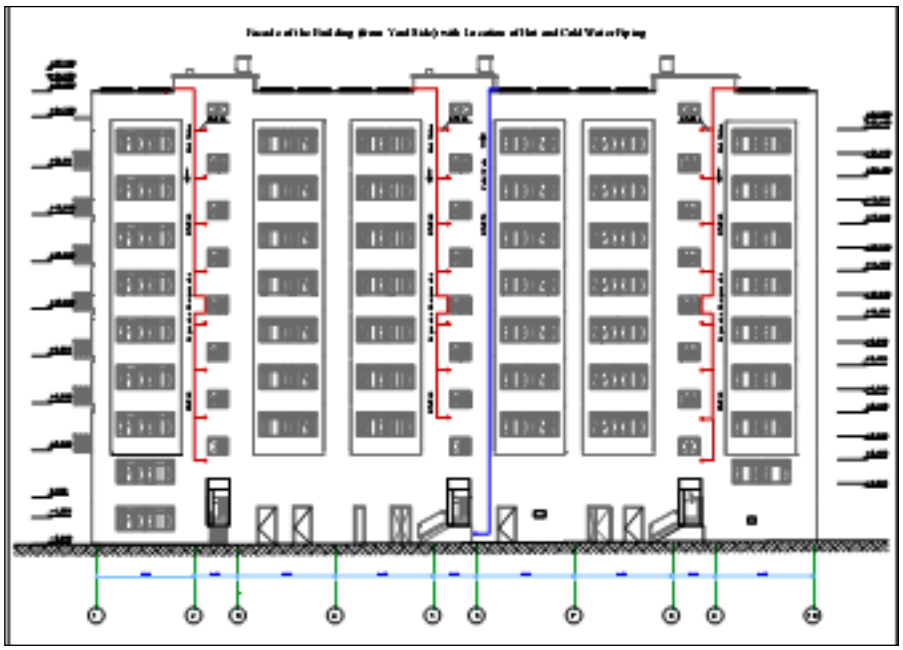

Fig. 3b Scheme of external cold and hot water pipilng #1/IV Vazha-Pshavela Ave.

The vertical part of the cold water feed pipe and hot water distribution pipes (risers) can be installed both on the building surface and inside the strairwells. These options can be considered by prospective bidders and the final decision shall be made in thetender stage.

In order to minimize thermal losses and supply the same temperature water to all residents, and to preventtemperature drop for furhter located consumers, it is necessary for all piping to have sufficient thermal insulation. Therefore it is necessary to wrap the polipropilene piping with 10mm porolone insulating sleeves and air tight foil that will also have the function of protecting the insulation and improving the external appearance of the building.

5 Metering of the Hot Water Supply

In order to measure the hot water consumption, to optimize its use and fairly reditstribute the capital and operational costs of hot water supply systems between the residents, it is necessary to arrange individual metering and assure disconnection capacity for each apartment.

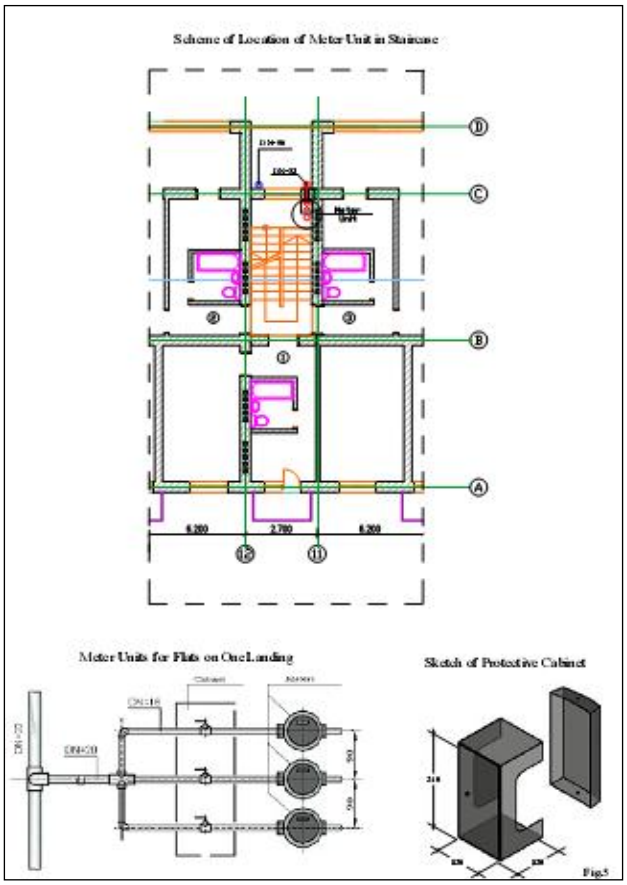

Fig. 4a Hot water supply to apartments 53/53a SaburtaloSt.

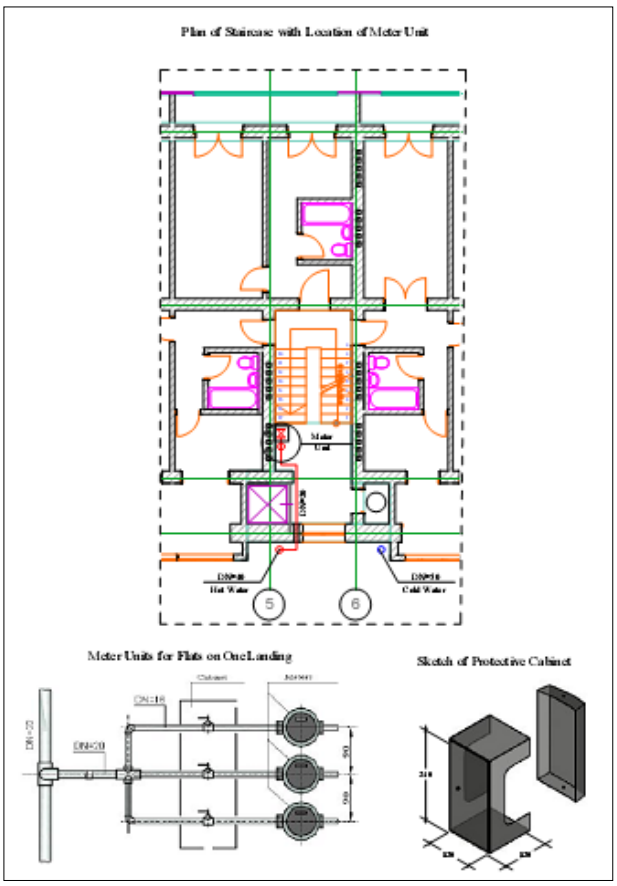

Fig. 4b Hot water supply to apartments #1/IV Vazha Pshavela Ave.

The meters can be of two types: one of them measures only the volume of the supplied hot water while the other can measure the total thermal energy supplied.The first type is relatively simple and cheap and its use is recommended if the temperature difference between the floors (or between close and remote consumers) is not significant. If the mentioned difference is considerable, it is necessary to install thermal energy meters.However, meters of this type are about 5 times more expensive. This is why it is necessaryto install the piping with adequate quality of thermal insulation. This will allow the use of simple flow meters.

Each metering point shall be equipped with shut-off valves to allow for the disconnection of the hot water supply to non-paying consumers who are not paying their share of capital and operational costs. In order to avoid meter tampering the meters shall be properly certified and sealed.

6 The Means of Monitoring

The suggested scheme of hot water supply with solar energy use in multi-apartment multi-storied buildings is the first pilot project of this kind in Georgia. Therefore it is likely that at the stage of operation design and installation errors as well as inaccuracies of the estimates

and organizational problems may show up. It is necessary to have a proper system and method for monitoring the performance of the installation, revealing and eliminating the problems (including technical and organizational). The program for the pilot project implementation and monitoring for the first year shall be prepared ahead of time.

The monitoring program has to be developed and the following main issues taken into account:

1. Monitoring the volumes and temperatures of hot water supply,
2. Control of thermal lossesand identifying the potential for their reduction,
3. Collection of reliable data on daily and seasonal consumption of hot water,
4. Monitoring of reliability and performance of the suggested system.

7 Tender Evaluation Criteria

The following criteria and weights are suggested for tender evaluation

	Criterion	weight
1	Bid price	60%
2	Adequacy of the proposal and technical solutions	20%
3	Warranty period on the system	10%
4	Impact on the living environment and exterior	10%

The final decision on exact criteria and weights shall be taken by the implementation agency at the time of actual tender announcement.

8 Tender Documentation

8.1 53/53a SaburtaloSt.

TASK DESCRIPTION

Works to be carried out consist of construction-installation works related to theinstallation of a solar water heating system (including its associated piping) on the roof of the five-story residential building 53/53a SaburtaloSt. in Tbilisi.

Tender participants should review the provided Scope of Work and conceptual drawings. This Scope of Work contains information about the quantities of materials and equipment needed for each type of work, but the construction sub-contractor shall check all these quantities on site himself. The construction sub-contractor shall provide all the necessarymaterials and equipment (fittings, fixing gear, etc.) that are needed for the full completion of works, even if they are not indicated in the given Scope of Work. The construction sub-contractor shall perform all works needed for the satisfactory completion of the contract and proper functioning of the completed installations even if they are not indicated in this description of work. All materials and equipment supplied by the construction sub-contractor should be accompanied by the manufacturer's certificate of quality and certificate of registration of goods in Georgia.

Tender participants should submit their bid proposals according to the attached form. Their bid proposal should be accompanied by a written description of the proposed method for carrying out the needed works and a tentative time-schedule.

All equipment and systems installed by the sub-contractor should be tested according to themanufacturers' recommendations prior to handing it over to the purchaser.

All construction-installation works carried out by the sub-contractor shall be performed according to the requirements of Georgian Construction Norms and Standards (SNIPs). All requirements of safety regulations shall be strictly observed during construction and installation works performed by the sub-contractor.

WORK DESCRIPTION and SCOPE OF WORK

Bid Proposal Form
(53/53[a]SaburtaloSt.)

Par tA Installation of the evacuated tube solar collector panels for water heating and water-collecting tanks.

##	Work Description and Scope	Cost (GEL)
1.	Installation of evacuated tube solar water hearing panels on the roof of the 5-story residential building	
1.1	Installation of Sunpower SH5B-1.8-24 type(or similar) evacuated tube solar water heater panels withDixis Top type(or similar) heat exchangerand connecting piping, 63 units.(total area of solar panel surface – 200 m^2)	
1.2	Installation of thermally insulated water collecting tanks (capacity 500l) designed for 10 bar pressure, and connecting piping, 20units. (total volume of tanks – 10.0 m^3)	
1.3	Installation of circulation units with expansion tanks and type SR868 (or similar) controllers and connecting piping, 5units.	
2.	Installation of power supply system for circulation units	
2.1	Installation of direct connection electric meter with nominal voltage 230V, 10A,should be fed from staircase lighting network, 3 units. - Single-pole automatic circuit breaker,230V, 5A- 3it. - Protective cabinet with connection bus – 3 it.	
2.2	Installation of cables 2X1.5 mm^2 (with copper cores and double insulation), L=100 m. - Corrugated flexible PVC pipes DN=16 mm, 100 m. - Terminal boxes (hermetic), 9 it.	
	Total cost for Part A	
3	Special Requirements	
3.1	Method of installation of solar panels and tanks on the roof of thebuilding should ensure that the existing roof cover will not be damaged	
3.2	Water collecting tanks should be installed strictly along axis B (with a permitted deviation 1 m).	

Part B Installation of the cold water supply and hot water distribution piping

##	Work Description and Scope	Cost (GEL)
1	Installation of the cold water supply piping and hot water distribution piping on the vertical sections of the façade walls of the building	

1.1	Installation of polypropylenepipes PP-R80 SDR7.4 DN=50 mmfor cold water supply piping from the building basement to the water collecting tanks (with installation of vertical sections of piping on the façade walls of the building), L=90.0 m. - ball valve D=50 mm, 1 it. - thermal insulation of pipes with poroloneinsulation sleeves (thickness 10mm) and airtight film, L=90.0 m.	
1.2	Installation of polypropylenepipes PP-R80 SDR7.4 DN=32 mm for hot water distribution piping from water collecting tanks to staircase landings (with installation of vertical sections of piping on the façade walls of the building), L=130.0 m. - ball valves D=32 mm, 5it. - thermal insulation of pipes with porolone insulation sleeves (thickness 10mm) and airtight film, L=130.0 m.	
1.3	Installation of polypropylenepipes PP-R80 SDR7.4 DN=20 mm for hot water piping on sections of entry into staircases, L=60.0m. - making of ∅40mm holes in brick walls (thickness 0.65m-0.4m), 25it. - installation of ∅32mm bush sleeves L=0.50-0.70m, 25 it. - thermal insulation of pipes with porolone insulation sleeves (thickness 10mm) and airtight film, L=60.0 m.	
1.4	Installation of polypropylenepipes PP-R80 SDR7.4 DN=16 mm in staircase landing for hot watermeter units, L=55.0m. - Ball valves D=16 mm, 75it. - Hot water meter D=16 mm, 75it. - Protective cabinets, 25it. thermal insulation of pipes with porolone insulation sleeves (thickness 10mm) and airtight film, L=55.0 m.	
	Total Cost of Part B	

Part C Connection of customers to hot water distribution piping

##	Work Description and Scope	Cost (GEL)
1	Installation of individual piping (per flat)	
1.1	Installation of polypropylenepipes PP-R80 SDR7.4 DN=16 mm from meter unit to hot water piping inside the flat, L=3.0 m. - Making of ∅40mm holes in brick walls (thicknessup to 0.4m), 1 it. - Installation of ∅25mm bush sleeves L=0.5m, 1 it. - Ball valve D=16 mm, 1 it. - Thermal insulation of pipes with porolone insulation sleeves (thickness 10mm) and airtight film, L=2.0 m.	
1.2	Installation of polypropylenepipes PP-R80 SDR7.4 DN=16 mm (per each additional 1 m. of pipe), 1 m.	

Name of Tender Participant Company:

8.2 Block 4, Bldg.1, Vazha Pshavela Avenue

TASK DESCRIPTION

Works to be carried out consist of construction-installation works related to the installation of a solar water heating system (including its associated piping) on the roof of the eight-story residential building at the following address: Tbilisi, VazhaPshavela Ave Block 4, Bldg.1.

Tender participants should review the provided Scope of Work and conceptual drawings. This Scope of Work contains information about the quantities of materials and equipment needed for each type of work, but the construction sub-contractor shall check all these quantities on site himself. The construction sub-contractor shall provide all the necessary materials and equipment (fittings, fixing gear, etc.) that are needed for the full completion of works, even if they are not indicated in the given Scope of Work. The construction sub-contractor shall perform all works needed for the satisfactory completion of the contract and the proper functioning of the completed installations even if they are not indicated in this description of work. All materials and equipment supplied by the construction sub-contractor should be accompanied by the manufacturer's certificate of quality and certificate of registration of goods in Georgia.

Tender participants should submit their bid proposals according to the attached form. Their bid proposal should be accompanied by a written description of the proposed method for carrying out the needed works and a tentative time-schedule.

All equipment and systems installed by the Sub-contractor should be tested according to the manufacturers recommendations prior to handing it over to the purchaser.

All construction-installation works carried out by the sub-contractor shall be performed according to the requirements of the Georgian Construction Norms and Standards (SNIPs). All requirements of safety regulations shall be strictly observed during construction and installation works performed by the sub-contractor.

WORK DESCRIPTION and SCOPE OF WORK

Bid Proposal Form
(VazhaPshavela Avenue Block 4, Bldg.1)

Part A Installation of the evacuated tube solar collector panels for water heating and water-collecting tanks.

##	Work Description and Scope	Cost (GEL)
1	Installation of the evacuated tube solar water heating panels on the roof of the 8-story residential building	
1.1	Installation of Sunpower SH5B-1.8-24 type (or similar) evacuated tube solar water heater panels with Dixis Top type(or similar) heat exchanger and connecting piping, 54 units. (total area of solar panel surface – 200 m^2)	
1.2	Installation of thermally insulated water collecting tanks (capacity 500l) designed for 10 bar pressure, and connecting piping, 18 units. (total volume of tanks – 9.0 m^3)	
1.3	Installation of circulation units with expansion tanks and type SR868 (or similar) controllers and connecting piping, 6 units.	
2	Installation of a power supply system for circulation units	
2.1	Installation of a direct connection electric meter with nominal voltage 230V, 10A thatshould be fed from staircase lighting network, 3 units. - Single-pole automatic circuit breaker 230V, 5A - 3 it. - Protective cabinet with connection bus – 3 it.	
2.2	Installation of cables 2X1.5 mm^2 (with copper cores and double insulation), L=100 m. - Corrugated flexible PVC pipes DN=16 mm, 100 m. - Terminal boxes (hermetic), 9 it.	
	Total cost for Part A	
3	Special Requirements	
3.1	Method of installation of solar panels and tanks on the roof of the building should ensure that the existing roof cover will not be damaged and should provide the possibility of easy dismantlingof equipment for repair of the roof cover.	
3.2	Water collecting tanks should be installed strictly along the axis C(with a permitted deviation 1 m).	

Part B Installation of cold water supply and hot water distribution piping

##	Work Description and Scope	Cost (GEL)
1	Installation of cold water supply piping and hot water distribution piping on vertical sections on façade walls of the building (Option I)	
1.1	Installation of polypropylene pipes PP-R80 SDR7.4 DN=50 mm for cold water supply piping from the building basement to water collecting tanks (with the installation of vertical sections of piping on façade walls of the building), L=90.0 m. - ball valve D=50 mm, 1 it. - thermal insulation of pipes with porolone insulation sleeves (thickness 10mm) and airtight film, L=90.0 m.	
1.2	Installation of polypropylene pipes PP-R80 SDR7.4 DN=40 mm for hot water distribution piping from water collecting tanks to staircase landings (with installation of vertical sections of piping on the façade walls of the building), L=130.0 m. - ball valves D=40 mm, 3 it. - thermal insulation of pipes with porolone insulation sleeves (thickness 10mm) and airtight film, L=130.0 m.	
1.3	Installation of polypropylene pipes PP-R80 SDR7.4 DN=20 mm for hot water piping on sections of entry into staircases, L=140.0 m. - making of ∅40mm holes in brick walls (thickness 0.65m-0.4m), 24 it. - installation of ∅32mm bush sleeves, L=0.50-0.70 m, 24 it. - thermal insulation of pipes with porolone insulation sleeves (thickness 10mm) and airtight film, L=140.0 m.	
1.4	Installation of polypropylene pipes PP-R80 SDR7.4 DN=16 mm in staircase landing for hot water meter units, L=45.0 m. - Ball valves D=16 mm, 64 it. - Hot water meter D=16 mm, 64 it. - Protective cabinets, 24 it. thermal insulation of pipes with porolone insulation sleeves (thickness 10mm) and airtight film, L=45.0 m.	
	Total Cost of Part B (Option I)	
2	Installation of cold water supply and hot water distribution piping in staircases (Option II)	
2.1	Installation of polypropylene pipes PP-R80 SDR7.4 DN=50 mm for cold water supply piping from building basement to water collecting tanks (with installation of vertical sections of piping in staircases), L=90.0 m. - Ball valve D=50 mm, 1 it. - Making of ∅70mm holes in reinforced concrete floor slabs (thickness 0.2 m), 10 it.	

	- Installation of ∅63mm bush sleeves L=0.3m, 10 it. - thermal insulation of pipes with porolone insulation sleeves (thickness 10mm) and airtight film, L=90.0 m.	
2.2	Installation of polypropylene pipes PP-R80 SDR7.4 DN=40 mm for hot water distribution piping from water collecting tanks on the roof to staircase landings (with installation of vertical sections of piping in staircases), L=130.0 m. - Ball valves D=40 mm, 3 it. - Making of ∅70mm holes in brick walls (thickness 0.4 m), 3 it. - Installation of ∅63mm bush sleeves L=0.5m, 3 it. - Making of ∅70mm holes in reinforced concrete floor slabs (thickness 0.2 m), 30 it. - Installation of ∅63mm bush sleeves L=0.3m, 30 it. - thermal insulation of pipes with porolone insulation sleeves (thickness 10mm) and airtight film, L=130.0 m.	
2.3	Installation of polypropylene pipes PP-R80 SDR7.4 DN=20 mm from vertical risers in staircases to meter units, L=60.0 m. - thermal insulation of pipes with porolone insulation sleeves (thickness 10mm) and airtight film, L=60.0 m.	
2.4	Installation of polypropylene pipes PP-R80 SDR7.4 DN=16 mm for meter units located on staircase landings, L=45.0 m. - Ball valve D=16 mm, 64 it. - Hot water meter D=16 mm, 64 it. - Protective cabinets, 24 it. thermal insulation of pipes with porolone insulation sleeve (thickness 10mm) and airtight film, L=45.0 m.	
	Total Cost of Part B (Option II)	

Part C Connection of Customers to Hot Water Distribution Piping

##	Work Description and Scope	Cost (GEL)
1	Installation of individual piping (per flat)	
1.1	Installation of polypropylene pipes PP-R80 SDR7.4 DN=16 mm from meter unit to hot water piping inside the flat, L=3.0 m. - Making of ∅40mm holes in brick walls (thickness up to 0.4m), 1 it. - Installation of ∅25mm bush sleeves L=0.5 m, 1 it. - Ball valve D=16 mm, 1 it. - Thermal insulation of pipes with porolone insulation sleeves (thickness 10mm) and airtight film, L=2.0 m.	
1.2	Installation of polypropylene pipes PP-R80 SDR7.4 DN=16 mm (per each additional 1 m. of pipe), 1 m.	

Name of Tender Participant Company: