



غرفة تجارة الأردن
Jordan Chamber of Commerce



International tender

Bidding purchase documents

**Project Titled: Supplying, installing operating and
commissioning of the solar energy cooling system for
Aqaba Chamber of Commerce**

Aqaba - Jordan

“MAIA-TAQA Solar Thermal Cooling System pilot project in Aqaba”



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General and specific terms of reference and technical specifications

Tender No. (01/2021 / Works 12/2020)

Project: **“Supplying, installing, operating and commissioning of a solar thermal energy cooling system for the Aqaba Chamber of Commerce”**

Introduction:

The project aims at demonstrating the capability of solar thermal systems in reducing consumption of energy used for cooling in office buildings in the Mediterranean area through the implementation of a solar thermal cooling system in Aqaba.

This project is implemented in the framework of the European project: *Mobilizing new Areas of Investments And Together Aiming to increase Quality of life for All - MAIA-TAQA*, which is funded by the EU under the ENI CBC Med Programme.

The 2014 2020 ENI CBC Mediterranean Sea Basin Programme is a multilateral Cross Border Cooperation (initiative funded by the European Neighbourhood Instrument (ENI)). The Programme objective is to foster fair, equitable and sustainable economic, social and territorial development, which may advance cross border integration and valorize participating countries' territories and values. The following 13 countries participate in the Programme: Cyprus, Egypt, France, Greece, Israel, Italy, Jordan, Lebanon, Malta, Palestine, Portugal, Spain, Tunisia. The Managing Authority (JMA) is the Autonomous Region of Sardinia (Italy). Official Programme languages are Arabic, English and French. For more information, please visit: www.enicbcmed.eu

The European Union is made up of 28 Member States who have decided to gradually link together their know how, resources and destinies. Together, during a period of enlargement of 50 years, they have built a zone of stability, democracy and sustainable development whilst maintaining cultural diversity, tolerance and individual freedoms. The European Union is committed to sharing its achievements and its values with countries and peoples beyond its borders



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The project consists of two parts:

Part I: Solar energy cooling system: the total budget for this part is € 120,000 (one hundred and twenty thousand Euros).

Part II: Monitoring System : the total budget for this part is € 12,000 (twelve thousand Euros).

First: Definitions:

Project Fund: European support within the European project: MAIA-TAQA - Mobilizing new Areas of Investments And Together Aiming to increase Quality of life for All

Beneficiary: Jordan Chamber of Commerce, Aqaba – Jordan

Government: Jordanian Government

Second: Description of the project:

The work includes the implementation of the project works for the supply, installation, operation and commissioning of a solar thermal cooling system, which includes the supply and installation of solar collectors and a cooling system. The solar cooling system works on the principle of absorption or adsorption and is to be installed on the roof of the Aqaba Chamber of Commerce building in Aqaba. It includes all necessary devices and equipment, including solar thermal collectors, hot water tanks, cold water tank, pumps, control system, cooling tower, connections, pipes, valves, expansion tanks, and others. This shall include the installation and all electromechanical and construction works related to the project, commissioning, training on operation and maintenance for the whole system components and according to technical specifications, attached design schematic diagrams and site requirements.

Third: General Conditions:

1. Government Procurement System No. (28) of 2019 and the instructions issued pursuant to it.

2. The general conditions mentioned in the unified contracting contract book for construction projects 2010 / MPWH / Government Tenders Department / amended 2013 edition.
3. Technical specifications for electrical, mechanical, architectural and civil works issued by the MPWH.
4. National codes for public safety systems.
5. All national building codes, including the following Jordan National Codes:
 - a) Electrical installation
 - b) Central heating
 - c) Gas installations in buildings
 - d) Solar energy
 - e) Energy-saving buildings
 - f) Building waterproofing and moisture
 - g) Structures resistance to earthquakes
 - h) Design and implementation of metal structures
6. General and special conditions for tender documents.
7. Bills of quantities and any annexes issued by the tender documents.
8. Tender documents with re-packing system and final accounting for the actually executed quantities.

These provisions and instructions shall be binding on the bidders, and the Special Purchase Committee has the right to exclude any offer that is not committed to all, some or one of these conditions, and submitting the bid by the tenderer is considered a commitment from him that he agrees with all the general and specific terms of reference. In the event that the specific terms of reference conflict with the provisions of the government procurement system, the provisions of the government procurement system shall be complied with.

Fourth: specific Terms of Reference:

1. The specific terms of reference are considered complementary to the provisions and instructions mentioned in the general conditions.
2. The tenderer must attach to his submitted bid what proves his technical and financial ability to implement the requirements of the procurement documents, by attaching documents proving the following:



- a) Attaching the commercial register and valid professions license of the contractor and the name of the main partner or partners of the contractor with specifying the region, zip code, e-mail and any other information about the identity of the bidder.
 - b) That the tenderer has the technical staff qualified to implement the project professionally, with a minimum of a project manager with at least 3 years of experience (electrical or mechanical engineer) and site engineers, with a minimum: (1) mechanical engineer, (1) electrical engineer and (1) technician Mechanics and (1) electrical technician.
 - c) Designating a manager for the implementation of the project (electrical or mechanical engineer), who has experience in the field of implementing project works of designing, supplying, installing and operating large scale solar systems for a period of not less than three years.
 - d) Designating a general construction supervisor engineer for the project with at least 8 years of experience.
 - e) Attach the academic certificates and the curriculum vitae of each person working within the tenderer staff concerned with the implementation of the project.
 - f) The tax number must be mentioned (in case it is subject to the general sales tax), and a valid income tax clearance must be attached and a clearance proving payment of taxes and social security dues.
3. The tenderer must prove experience in solar cooling and solar thermal installations. The tenderer in order to be eligible has to provide Annex 4 completed separately for at least one (1) solar cooling system of minimum chiller cooling capacity 30 kW and five (5) pumped solar thermal projects of minimum collecting area (gross) 50m² each.
 4. The bidder must approve the purchase invitation and documents and their attachments in preparing his bid, so that the tenderer signs and puts a seal on every page of the purchase documents and submits it with his bid, and no offer otherwise will be accepted. The presentation of the bid by the bidder is also considered as a confirmation of him that he has read the tender documents and that he has complied with what is stated in them and within the specifications and conditions contained therein.
 5. The tenderer submits his offer in two separate envelopes, one of which contains (the technical offer) and the other contains (the financial offer), and a separate third envelope to guarantee the entry

of the bid. Provided that the name of the bidder, the bid number and the type of offer are written on each envelope, and the financial offer envelope, the technical offer envelope and the bid bond envelope shall be placed in one sealed envelope with the name of the bid, its number and the name of the bidder written on it. It is presented in tight and sealed envelopes with the tenderer's seal, with an emphasis on not indicating the financial offer in the technical offer in any form, including the CD of the technical offer.

6. The technical offer shall have two separate sections, one for each Part of the project (Part I and Part II). Similarly, the financial offer shall include two distinct parts, one for each part of the project.
7. The offer shall be submitted
8. Each bid shall be submitted one original copy, two photocopies, and one electronic copy (copied on a CD) of each offer in two separate envelopes, one of which contains (the technical offer) and the other contains (the financial proposal) to be presented in sealed envelopes and sealed with the seal of the bidder. That the original copy be among them, and if there is any inconsistency in the information between the submitted copies, the original copy shall be approved.
9. The tenderer is obliged to visit the site to be installed in according to the date specified in the purchase documents, to determine the appropriate places for the installation of the required units and equipment, and to make the appropriate designs accordingly, and the price provided includes any work required to prepare the place and is within the responsibility of the bidder.
10. The contractor assigned the bid shall visit the site to be installed in to confirm the appropriate places for the installation of the required units and equipment, and to confirm the appropriate designs accordingly, duly approved.
11. The contractor is obligated to provide all design plans and calculations for the project sites with the necessary approvals from the relevant authorities, while providing full specifications for all the equipment to be installed.
12. The specifications contained in the tenderer proposal must be clear and well categorized and filled in the attached forms (compliance sheets) in Clause Seven below, which includes the technical



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specifications and supported by technical catalogs (Data Sheets) for each part of the system. So that the technical offer includes all general and special reference conditions, specifications and special technical requirements according to the reference conditions in addition to matching those specifications to the illustrations and operational plans, and the technical offer shall be in a separate, sealed envelope with the words: Technical proposal, bid number and name of the tenderer; As for the financial offer, it must include the unit, the quantity, the individual and total price of all components of the system according to the tables of quantities in item VIII below, and the tenderer must submit the prices in Euro, including design, supply, installation, operation, maintenance and inspection, including all the works executed, and maintenance for a period of five calendar years from the date Commercial operation, including any fees and taxes required on the components of the system, if any, for any party, and the financial offer shall be in a separate sealed envelope with the words: the financial offer, the bid number and the name of the tenderer.

13. The tenderer must set a time plan for the implementation of the project phases within the period specified in the tender documents, which is (120) calendar days.
14. The tenderer must submit a training plan that includes the items mentioned in the special conditions within the submitted offer, and in the event that the tenderer is referred, he must submit a report approved by the beneficiaries stating that he has fully implemented the terms of this plan and before the final receipt of the project.
15. The tenderer must set a plan for the preventive maintenance work that the tenderer will adhere to during the maintenance and operation guarantee period, including all the preventive maintenance works included in the plan, to be executed for a period of five years from the date of commercial operation and submit it to the beneficiary before the final receipt of the project.
16. The bid must meet all specifications and conditions stated in the procurement documents, and a statement of the technical violations with an explanation of their causes with the bidder, if any.



17. The tenderer must, upon commencing the design work, verify the electrical loads of the circuit breakers in the sub and main panels and ensure their compatibility with the new loads for all the proposed systems in the design and submit a technical report on that and before starting the work, and the presented price shall include any changes required for that.
18. The bidder against whom the bid is referred is obligated to submit weekly periodic reports showing the progress of implementing the project works to the Supervisory Committee.
19. Tenders are obligated to submit the following guarantees (and according to the approved forms for that):
 - a. Bid bond entry / bank guarantee or certified bank check with a value of (3000) Euro and in words, three thousand Euro only. The guarantee is presented in a separate and duly sealed envelope, valid for at least (90) days.
 - b. A well-executed guarantee or a certified bank check of 10% of the assignment value.
 - c. A five-year maintenance guarantee of (5%) of the value of the assignment from the date of commercial operation, after the completion of the installation of all required systems and the initial receipt report.
20. The tenderer is obligated to arrange the sites, remove the waste, and hand over the site according to its original condition.
21. The tenderer is required to submit a load study for the building approved by the Engineers Association before implementation or to propose an equivalent alternative that should be approved by the buyer.
22. The tenderer or tenderer against whom the bid is referred is obliged to pay the fees of the import stamps on the bid execution contract if he was referred to it within ten days and any other fees incurred by him, and he must submit a good execution guarantee within two weeks from the date of his notification in preparation for signing the contract, and if he does not attend during that period, he shall be considered an objector and taken against him. The legal procedures stipulated in the procurement documents, including confiscation of the bid bond.
23. The submitted bid shall be effective and may not be revoked for a period of no less than (90) ninety days from the date of submitting

the offers. The tenderer must inform the president of the Jordan Chamber of Commerce in writing of his unwillingness to extend his bid and at least ten days before the expiry of the period specified above. Certification of the referral decision from the competent authority.

24. The period of validity of the bid bond must be sufficient to cover the period of validity of the offer and according to the period required in the purchase documents as a minimum, otherwise the competent committee has the right to exclude the submitted offer and no conditional guarantee will be accepted and any offer that violates the attached bid bond will not be accepted.
25. The buyer has the right to divide the bid on more than one contractor, provided that each of them fulfills all the necessary conditions for the part related to it and according to the interest of the work.
26. The tenderer shall submit a written declaration stating that he is not colluding with the tenderers or practicing or acting fraudulently or / and with corruption or / and coercion.
27. The bidders referred to the bid are obligated to sign agreements with the buyer represented by the president of the Jordan Chamber of Commerce or his representative, and with all the beneficiaries.
28. The time period for implementing project works is (120) calendar days.
29. The time period is calculated after issuing an order to start work.
30. The contractor is obligated to deliver the required works with the purchase documents within a period not exceeding the specified time period for the implementation of the project, so that a fine of (150) Euro in writing is one hundred and fifty Euro for each day of delay, provided that the total of fines does not exceed 15% of the value of the referral.
31. The tenderer is obligated to submit bids in English.
32. Contractors are obligated to supply and install warning panels in locations that require this during the project implementation phases and after operation and to take all measures related to public safety matters, according to the legislation in force.

33. The tenderer must present in the submitted proposal his plan regarding the safety and public safety requirements of the systems to be studied in accordance with the legislation in force.
34. The contractor must provide practical and theoretical training during operation to the beneficiaries and users of the systems and before signing the initial delivery report to the site, the training includes the following:
- Basic introduction to installed solar thermal system.
 - Detailed explanation of the components of the system that have been installed
 - Detailed explanation of the system operation and control.
 - Detailed explanation of the expected problems, possible solutions and maintenance schedule.
35. Detailed explanation of monitoring system. The contractor prepares implementation plans for the system, including designs, accounts, approvals, bills of quantities, and details of the materials that have been installed according to reality, and provides an electronic copy and a hard copy to the beneficiaries.
36. Rules of nationality and origin set forth in Articles 8 and 9 of Regulation (EU) No 236/2014 shall apply to this tender. The tenderer/bidder should provide official documents supporting the stated origin for all the equipment that will be supplied in her/his offer. It could be Certificate of Origin. Alternatively, the tenderer/bidder must provide a declaration of origin or additional information considering that the issuing authority may refuse to deliver a certificate of origin at the tendering stage without presentation of commercial invoices. In any case, the declaration of origin must be submitted at the latest before final acceptance of the project by the contracting authority.
37. Joint venture or consortium:
- If a tenderer is a joint venture or consortium of two or more persons, the tender must be single with the object of securing a single contract, each person must sign the tender and will be jointly and severally liable for the tender and any contract. Those persons must designate one of their members to act as leader with authority to bind the joint venture or consortium.



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The composition of the joint venture or consortium must not be altered without the prior consent in writing of the Contracting Authority.

- b. The tender may be signed by the representative of the joint venture or consortium only if it has been expressly so authorized in writing by the members of the joint venture or consortium, and the authorizing contract, notarial act or deed must be submitted to the Contracting Authority. All signatures to the authorizing instrument must be certified in accordance with the national laws and regulations of each party comprising the joint venture or consortium together with the powers of attorney establishing, in writing, that the signatories to the tender are empowered to enter into commitments on behalf of the members of the joint venture or consortium.
- c. A short company profile should be provided from the companies that form the consortium.

38. The Programme visibility/publicity rules should be respected, see annex 5 “COMMUNICATION AND VISIBILITY” item 10.10.

39. Taxes and other charges: The European Commission and The Hashemite Kingdom of Jordan have agreed in Framework Agreement signed on 12/9/1997 fully exonerate all Taxes, Customs dues and any other charges payable in Jordan. **The focal point for all tax exemptions activities is the Ministry of Planning and International Cooperation. Beneficiaries should request exemptions beforehand from the Ministry through the EU Delegation. Requests should be detailed (procurements, envisaged costs and suppliers).**

40. PAYMENTS:

- a. Payments shall be made in euro.
- b. Payments shall be made to the bank account. The Contracting Authority shall pay the Contractor sums due within 45 days of the date on which an admissible payment request is registered,
- c. The payments shall be made as follows:
 - i. 20% of the contract price after the signing of the contract, against provision of the performance guarantee.

- ii. 40% after supplying the solar thermal system, the chiller system, cooling tower and monitoring system.
- iii. 40% of the contract price, as payment of the balance outstanding, following final commissioning.

41. The maximum available budget for PART I is 120.000 euros for the solar cooling system and for and PART II is 12.000 euros for the monitoring system.

Fifth: the time frame:

The date of announcing the launch of the purchase documents	Monday.4/01/2021
Period of purchase of copies of purchase documents	Starting from the date of announcing the launch of the procurement documents on Monday4/01/2021, and the last date for purchasing a copy of the procurement documents is the second hour of the working day of Wednesday 24/02/2021
Date of visit to work sites	From 26/01/2021 to 27/01/2021
Deadline for accepting inquiries	Inquiries on Wednesday10/02/2021 and any inquiries that arrive after this date will not be accepted. For more information, please refer to the Jordan Chamber of Commerce: E-mail: info@jocc.org.jo, http:www.jocc.org.jo With the bid number placed in the subject field.
Deadline for submission of bids	Wednesday 24/02/2021 at 2 pm, offers are deposited in the Jordan Chamber of Commerce / (Taking into consideration the minimum period for submitting offers is 45 days).
The time period for implementing project work	A period not exceeding (120) calendar days from the date of the commencement order, so that a fine of 150 Euro is one hundred and fifty Euro



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	for each day of delay, provided that the total of the fines does not exceed 15% of the assignment value.
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42. Submission of Tenders

Tenders must be received before the deadline specified in the above time frame table. They must include all the documents specified in point 5 of the Fourth item and be sent to the following address:

Ms. Hala Khasawneh (Project contact person)

Jordan Chamber of Commerce

P.O. Box: 7029 Amman 11118 Jordan

Tel: +962 6 5902040

Fax: +962 6 5902051

E-mail: info@jocc.org.jo

http:www.jocc.org.jo

If the tenders are hand delivered they should be delivered to the following address:

Ms. Hala Khasawneh (Project contact person)

Jordan Chamber of Commerce

Abdoun Area- Princess Basma Street, building #218

Amman-Jordan

Sixth: Bid Evaluation Mechanism:

1. Technical offers for bidders are opened first by the competent committee in the presence of representatives of the companies and on the date specified in the procurement documents, or by sending an invitation to all bidders on the specified date.
2. The offers are referred to a specialized technical committee to study and evaluate them, select the proposals that meet the requirements of the



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- purchase documents, and ensure that the technical offer is met with all technical requirements and specifications, and on a successful or failed mechanism (Pass or Fail).
3. Only if the technical offer is successful and the tenderer is technically qualified, then his financial offer will be opened in an open session to which representatives of technically qualified companies are invited, the date of which is set later.
 4. In the event that the technical tenderer's offer does not fulfill any of the specifications and technical requirements, his financial offer shall be kept closed and it shall be returned to him after the bid is referred.
 5. Referral shall be made to the lowest price offer that is technically identical or in the interest of the buyer, in case the Jordan Chamber of Commerce wishes to split the bid.

Seventh :Technical specific conditions:

Part I: solar energy cooling system

The name of bidder:

a) Solar thermal loop

Solar system description: The solar collectors will be installed at the roof of the building in two separate collector fields. An indicative layout of the two solar collector fields for a solar collector is shown in annex (1). The arrays in each solar collector filed should be connected among them according to the “Tichelmann configuration” (or reverse return) in order to provide balanced flow rate to the solar collectors and also balancing valves.

Solar array specifications

Component	Required specifications	QTY	Offer
Collectors		≥150 m ² aperture area	
type	Glazed flat plate solar thermal collector		
absorber surface	Selective coating		
cover material	Low secured iron tempered glass		

Component	Required specifications	QTY	Offer
efficiency	$\eta_0, b \geq 0.75$ and $a_1 \leq 3.6W/(m^2K)$, $a_2 \leq 0.03W/(m^2K)$, (Gross reference area, quasi dynamic method)		
insulation	Back 40 mm, sides 20 mm		
operating temperature	$\leq 200^\circ C$		
operating pressure	10 bar		
heat transfer medium	Aqueous solution of glycol		
certificates	Valid Solar Keymark license number or valid Test Report from an accredited laboratory according to latest valid version of EN 12975-1 and EN ISO 9806		
Collector field			
orientation and inclination	The collectors' orientation and inclination should be selected to avoid shading, according to Jordanian solar code (2012).		
connection	Due to space limitations, the collectors will be installed in two separate fields (Annex 1). Each field will have a specific number of arrays. One array should consist of up to 6 collectors. All arrays of the field should have the same number of collectors. The arrays of each field should be connected among them according to the Tichelmann configuration. The collectors in each array should be connected in series.		
Control system		1	
type	Programmable Logic Controller PLC. The controller shall receive all input signals from the sensors (solar collectors, HX, Solar circuit, upper and lower parts of tank, flowrate, fluid		

Component	Required specifications	QTY	Offer
	pressure, pumps on/off signal and to be show on central screen). Alarms for the following conditions should be showed: 1. Low Operation Pressure 2. Any pump trips. 3. High collector temperature.		
Inputs/Outputs	Suitable sensors, electronic and hydraulic equipment should be installed for the efficient operation of the control system.		
data communication	The controller should be equipped with an S-bus for data transfer		
documentation	Operation and installation manuals.		
Hot water storage tanks		2*1500 lt	
Description	Two hot water storage tanks, 1500 litres each. Stands made of galvanized steel should be used.		
Connection and control	The hydraulic and control connection of the two storage tanks will ensure sufficient temperature stratification. The water flow direction to each storage tank will be defined by proper control of two 3-way valves, "on-off" type. The first storage tank will store water at lower temperatures and the second storage tank will store water at higher temperatures and it will be connected with the hot water inlet of the solar chiller. The tanks should be fitted with suitable holes at the top, middle and bottom of the tanks to install the necessary sensors.		
material	carbon steel		
insulation	Polyurethane, minimum thickness 100 mm		
operating	120°C		

Component	Required specifications	QTY	Offer
temperature			
operating pressure	6 bar (tests certification should be made in commissioning stage))		
corrosion prevention	Magnesium anode		
further specifications	The storage tanks should have such external dimensions, so that it can fit a door opening with width 1.46 m and height 2.10m. Also, it should be taken account that it will be installed in a room with height 3.21m.		
Hydraulic system			
Description	Only copper pipes are accepted for the water network between solar collectors and storages. All hot water tubes should be insulated with thickness of at least 30 mm and the insulation should be covered with suitable metal cladding to withstand the outdoor weather conditions. Check valves, safety valves, automatic air vents and all other needed fittings should be installed and should be made of copper. All temperature sensors should be installed in solar components. All copper pipes should be fixed on metal bases such that all pipe networks should be at least 150 mm above the surface.		
pumps	All pumps shall have a built-in VFD w/suitable feedback sensor.		
Other components			
Expansion vessels	Suitable expansion vessels should be used. Stands made of galvanized steel should be used.	1	
External heat exchanger	Plate heat exchanger with minimum heat transfer 17,000 W/K	1	

Component	Required specifications	QTY	Offer
Solar pump	Suitable circulating pump between solar collector array and HX should be selected.	1	
Electrical components	Electrical board, circuit breaker, wiring, etc. should be installed. All outdoor cables and wires (data and electrical cables) should be protected from weather circumstances using suitable conduits. Panel distributing power to all system components shall be located at mechanical room on the roof.		
<ol style="list-style-type: none"> 1. The solar system components should be installed according to the design layout. 2. All fittings, thermal couples, wiring and network that are mentioned in the design layout should be considered. 3. The field visit will be arranged for all bidders after 7 days from the tender announcement. 4. The solar collectors should be installed on suitable steel structure and above the roof surface by minimum 50 mm. 			

b) Solar Thermal Chiller

For Aqaba chamber of commerce in the city of Aqaba, the existing chiller system is covering the cooling needs of the building through a central cooled water system. There are two air cooled water chillers with reciprocating compressors, installed at the roof of the building. The cooling capacity of each chiller is 49 RT and the total cooling capacity of both chillers is 98 RT. The chillers are connected with a central piping network system (with estimated flow rate 5.5 m³ /hr) distributing cooled water to the floors. The terminal units of the network system are 46 fan coil units (RAC system), installed in the ceiling of the floors. There is also one Air Handling Unit (AHU) in the building, used for providing fresh air in the auditorium. The ST cooling system will be coupled to the existing cooling system at return chilled water pipe, and it will contribute to cover part of the cooling loads of the building. Annex 2 shows an indicative solar-cooling layout design for the whole solar-cooling system. Annex 3 shows suggested connection

of chilled water storage within the loop and the connections between the solar chiller and the existing chiller.

Solar chiller technical specifications:

Item	Required specifications	QTY	Offer
Technology Type	Closed loop thermal sorption chiller (absorption or adsorption)	1	
Capacity	≥ 30 kW		
COP thermal	≥ 0.6		
Hot water inlet temperature	$\leq 92^{\circ}\text{C}$ (the hot water temperature depends on chiller manufacturer requirements and according to solar thermal output temperature)		
Chilled water outlet temperature	$\leq 10^{\circ}\text{C}$		
Chilled water tank	Chilled water tank (capacity of tank shall be defined by the contractor). Stands made of galvanized steel should be used.	1	
Documentation	Operation and installation manuals		

c) Cooling tower

The Cooling tower will be connected to the solar chiller in order to reject the waste heat during the cooling process. The selection of a cooling tower should be made in order to reject the heat from the chiller at the local Wet Bulb summer design temperature. The risk of Legionella should be evaluated in the cooling tower and proper actions should be taken if needed. The cooling tower shall stand on a galvanized steel. Cooling tower specifications should be defined by the contractor.

Eighth: bill of quantities

A) Solar thermal system

The name of bidder:

#	statement	size	Number	Price/unit (€)	Gross price (€)

1	Collectors m ²			
2	Control system PLC	-			
3	Hot water tanksm ³			
4	Expansion vessels L			
5	External heat exchanger				
6	Solar circulating pump	Q= l/s H = m			
7	HX-storage Pump	Q= l/s H = m			
8	Electrical components				

B) System loop fittings:

The name of bidder:

#	statement	size	Number	Price/unit (€)	Gross price (€)
1	Isolating Valves				
2	Check valves				
3	Balancing valve				
4	Safety valves				
5	Automatic air vent				
6	3Way valves				
7	Thermocouples PT 1000 (plus 8 pieces spare parts)				
8	Protection pockets made of brass.				

9	Digital temperature gauges				
10	Digital Pressure gauges				
11	Copper pipes w/insulation				
12	Solar loop electromagnetic flowmeter (0.03...12 m/s)				
13	chilled water loop Electromagnetic flowmeter (0.03...12 m/s)				

Note: temperature gauges, pressure gauges and flowmeters should be recently calibrated according to international standards (certificates should be attached)

C) Solar Thermal Chiller

The name of bidder:

#	statement	size	Number	Price/unit (€)	Gross price (€)
1	Solar chiller kW			
2	Cold water tankm ³			
3	Chilled water pump	Q= l/s H = m			

D) Cooling tower

The name of bidder:

#	statement	size	Number	Price/unit (€)	Gross price (€)
1	Cooling tower kW			
2	Circulating pumps	Q= l/s H = m			
3	Valves				



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MCC panel: distributing power to all system components. (located at boiler room).

Ninth : Training of staff

Training in Solar thermal and cooling system for technical Aqaba Chamber of Commerce staff shall be conducted. It shall include, two days of training to cover topics about principles, operation and maintenance of the system in Aqaba Chamber of Commerce through lectures and field work practices. 5 full colored hard copies materials should prepared for the staff.

Tenth: Testing and Commissioning plan:

1. All commissioning procedures will be carried out according to the standard protocol.
2. The contractor shall clean up the project site and remove any temporary structures, equipment or dirt and construction debris before the final acceptance.
3. The contractor shall submit three original hard copies and two soft copies of:
 - a. As built drawings
 - b. Instruction manual
 - c. Installation, operation and maintenance manuals
 - d. Checklists and troubleshooting & corrective actions
 - e. Safety plan and monitoring
 - f. Software system.
 - g. List of spare parts and its cost.
 - h. Calibration certificates (temperature, pressure, and flowmeter equipment)
 - i. Warranty certificate. At least 2 years to ensure the quality of all supplies against workmanship defects. At least 5 years for the solar collectors.
 - j. Test reports for solar collectors, storage tank and solar chiller according to international standards.
4. The contractor shall prepare the commissioning and testing plan including all equipment and instruments that will be used in the commissioning and provide it to the Aqaba Commerce Chamber prior to the final commissioning.

5. The final commissioning will be performed after the following:
 - a. Completion of all above mentioned work.
 - b. Completion of all project documentation.
 - c. Approval of the commissioning and testing plan report by Aqaba Commerce Chamber and its third party consultant.
 - d. Approval of the proposed testing equipment and instruments by Aqaba Commerce Chamber and its third party consultant.
6. If there is a need of any additional tests or testing equipment asked by Aqaba commerce chamber and its third part consultant, the contractor must accept and provide the inquiries on his own expense.

Eleventh: Final acceptance

1. Final acceptance will be issued once all of the above works and required items has been completed.
2. Final acceptance will be issued to the contractor by the Aqaba commerce chamber at that time in accordance with the contractor.

Part II: Monitoring System

1. GENERAL DESCRIPTION

Monitoring of solar cooling systems is a fundamental tool to optimize the system operation and to enable the maximum energy yield with the minimum operational cost. The list of monitoring equipment that will be installed are shown in the Table 1.

Quantity	Name and short description
1	Pyranometer
3	Heat flow rate sensors
1	Electricity meter for the whole system
1	Temperature sensor PT100 with shield
7	Temperature sensor PT100 (optional)
1	Desktop PC for supporting the operation of the monitoring system
1	Monitoring software and set up
1	Equipment and services for data storage and communication
Other equipment and services for the operation of the monitoring system (electrical board, relays, cables, database, installation, etc)	

Table 1: List of needed equipment

All sensors should have calibration certificates, issued from international accredited labs.



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1.1. POSITIONING OF SENSORS

The pyranometer “ I_{amb} ” will be positioned on top of one collector that it is not shaded at all. Its surface shall be parallel to the collector’s surface, (the tilted angles with respect to the roof surface for the collector and for the pyranometer should be the same). The electricity meter “ E ” will be positioned inside the main electrical board of power supply and distribution. Its role is to measure the electricity consumption of all the pumps, the chiller, the cooling tower and the motorized valves. The positioning of all sensors are shown in the figure below.



1.2. DATA LOGGING AND COMMUNICATION

The measured values will be recorded in five minutes intervals via M-Bus and stored in a database. This measured data will be daily called from the database, evaluated and analyzed with the visualization and analysis tool. Additionally, an online visualization and analysis tool with restricted access is available for supervising the plant operation in real time. This tool will provide the following services:

- Visualization in a mimic diagram of the states of actuators and instant values in real time (plain values),
- Plots of selected values over a selected time frame (i.e. temperatures, volume flows and energy consumption versus time),
- Data logging with mean values of five minutes timestep. Filetype: csv or txt. Data saved in one file per day (example file name: yearmonthday.csv),
- Connection: through browser for visualization and data download.

2. ANALYTICAL DESCRIPTION

The installed monitoring system will be independent from the control system. Monitoring of solar cooling systems is a fundamental tool to optimize the system operation and to enable the maximum energy yield with the minimum operational cost.

The system monitors the heat and electricity flow according to the IEA Task 38 1st level monitoring procedure. This procedure is performed by measurements of the temperature of the water in various points, the water flow, the irradiation incident to the collector field and the electricity consumption of the entire solar cooling system.

The aim of the monitoring process is to calculate the Key Performance Indicators (KPI) as defined in IEA Task 38, common for all solar heating and cooling plants. These KPIs are shown in Table 2.

Table 2: KPIs, definition and necessary instruments.

KPI	Description	Equation used	Definition	Instrument name
1	Efficiency of solar system	$n_{solar} = \frac{Q_{solar}}{Q_{irr}}$	Q_{solar} Solar outlet, kWh Q_{irr} Solar Irradiation, kWh	T_{chill_in} , T_{chill_out} , F_{chill} I_{amb}
2	Coefficient of Performance – Thermal energy	$COP_{th} = \frac{Q_{cool}}{Q_{coll}}$	Q_{cool} Chiller outlet, kWh Q_{coll} Collectors' outlet, kWh	T_{cwt_in} , T_{cwt_out} , F_{cwt} T_{coll_in} , T_{coll_out} , F_{coll}
3	Coefficient of Performance – Electricity	$COP_{el} = \frac{Q_{cool}}{E}$	Q_{cool} Chiller outlet, kWh E Electricity consumption of the solar thermal system, kWh	T_{cwt_in} , T_{cwt_out} , F_{cwt} E

Apart from the KPIs calculation, additional monitoring sensors will be installed for the sufficient supervision of the system operation. The analytical descriptions of the monitoring sensors that will be installed are shown in Table 3.

Table 3: List of all sensors that will be installed for the monitoring system.

#	Name	Description	Unit	type	operation range	distance from PLC	Indicative copper pipe int diameter
Irradiation meter							
1	I_{amb}	Total irradiation on tilted surface	W/m ²	silicon SRC	0-2000 W/m ²	20m	n/a
Heat flow sensors							
2	Q_{coll} Collectors' outlet, kWh	F_{coll} : Glycol volumetric flow from heat exchanger to collectors	m ³ /hr		8500 lt/hr	20m	43.1mm
		T_{coll_in} : Solar field inlet temperature (Glycol)	°C	PT100	5...200 °C, 4bar		39mm
		T_{coll_out} : Solar field outlet temperature (Glycol)	°C	PT100	5...200 °C, 4bar		39mm
3	Q_{solar} Solar outlet, kWh	F_{chill} : Water volumetric flow from chiller to tank	m ³ /hr		8500 lt/hr	20m	51mm
		T_{chill_in} : Chiller inlet temperature from hot tanks (Water)	°C	PT100	5...200 °C, 4bar		51mm
		T_{chill_out} : Chiller outlet temperature to hot tanks (Water)	°C	PT100	5...200 °C, 4bar		51mm
4	Q_{cool} Chiller outlet, kWh	F_{cwt} : Water volumetric flow from chiller to cold water tank	m ³ /hr		8500 lt/hr	10m	43.1mm

		Tcwt_in: Cold tank inlet temperature from chiller (water)	°C	PT100	5...200 °C, 4bar		43.1mm
		Tcwt_out: Cold tank outlet temperature to chiller (water)	°C	PT100	5...200 °C, 4bar		43.1mm
Electricity meter							
5	E	Electricity meter of the whole system	kWh	current meter, class 1, 100 impulses/kWh, 3ph 80A		5m	n/a
Temperature sensors							
6	Tamb	Ambient air temperature	°C	PT100, with shield	-15...50 °C, 4bar	20m	-
7	T1_top	Water temperature in tank 1, top	°C	PT100	5...200 °C, 4bar	5m	immersion
8	T1_bottom	Water temperature in tank 1, bottom	°C	PT100	5...200 °C, 4bar	5m	immersion
9	T2_top	Water temperature in tank 2, top	°C	PT100	5...200 °C, 4bar	5m	immersion
10	T2_bottom	Water temperature in tank 2, bottom	°C	PT100	5...200 °C, 4bar	5m	immersion
11	Tcwt_top	Water temperature in cold tank, top	°C	PT100	5...200 °C, 4bar	5m	immersion
12	Tcwt_bottom	Water temperature in cold tank, bottom	°C	PT100	5...200 °C, 4bar	5m	immersion
13	Tct_out	Water temperature cooling tower outlet	°C	PT100	5...200 °C, 4bar	5m	79mm


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