Solar water heating systems -Guanajuato

Document prepared by Mercado Ambiental AP S.C.

Project Document Template (Version 1.0)	
Name of the project	Solar water heating systems - Guanajuato Solar water heating systems - Guanajuato
Project proponent	Mercado Ambiental AP S.C.
Project proponent's contact information	eduardop@mexico2.com.mx
Project holder	Ministry of Environment and Territorial Planning of the State of Guanajuato (SMAOT)
Project holder's contact information	drobledob@guanajuato.gob.mx
Project participants	Ministry of Social and Urban Development (SEDESHU) Beneficiary population Directorate General of Material Resources,General Services and Cadastre Transparency and Accountability Secretariat Mexico Renewables
Version	2.1

Project Document Template (Version 1.0)	
Date	01/12/2022
Project type	Energy - Solar thermal
Grouped project	Grouped project
Applied methodology	AMS-I.J.: Solar water heating systems (SWH) - Version 2.0
Project location (City, Country)	State of Guanajuato, Mexico
Starting date	01/01/2021
Quantification Period of GHG emissions reductions	01/01/2021 - 31/12/2030
Estimated total and average annual GHG emission reduction amount	Total: 56,248 tCO_2 Annual average: 5.62 $ktCO_2$ /year
Sustainable Development Goals	1. No Poverty 7. Affordable and clean energy 11. Sustainable cities and communities 13. Climate action

Project Document Template (Version 1.0)	
Special category, related to co-benefits	N/A

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1 Project eligibility

1.1 Scope

The project is eligible under the scope of the BioCarbon Registry (BCR) Standard by fulfilling one or more of the following conditions:

The scope of the BCR Standard is limited to:	
The following greenhouse gases, included in the Kyoto Protocol: Carbon Dioxide (CO_2), Methane (CH_4) and Nitrous Oxide (N_2O).	**X**
GHG projects using a methodology developed or approved by BioCarbon Registry, applicable to GHG removal activities and REDD+ activities (AFOLU Sector).	
Quantifiable GHG emission reductions and/or removals generated by the implementation of GHG removal activities and/or REDD+ activities (AFOLU Sector).	
GHG projects using a methodology developed or approved by BioCarbon Registry, applicable to activities in the energy, transport and waste sectors.	**X**
Quantifiable GHG emission reductions generated by the implementation of activities in the energy, transport and waste sectors.	**X**

The project will count devices installed from 2021 onwards, in accordance with the BCR Standard, which includes a start date within five (5) years prior to the start of validation. The project consists of the installation of residential solar water heating systemsfor the displacement of the use of fossil fuels such as LP gas by the use of boiler-type heaters or electric energy, determining the activity aseligible for the *AMS-I.J. Solar water heating systems* methodology, approved bythe BCR Standard.

1.2 Project type

Type of project under which the project activities are carried out:

Activities in the AFOLU sector, other than REDD+	
REDD+ activities	

Activities in the energy sector	**X**
Activities in the transport sector	
Activities related to waste management and disposal	

1.3 Project scale

Small scale

2 General description of the project

In order to promote the sustainable development of the state of Guanajuato, as well as to support the most vulnerable communities, the Government of the Stateof Guanajuato, through the Ministry of Environment and Territorial Planning (SMAOT) has implemented the State Solar Heaters Programme project. This project consists of the installation of Solar Water Heating Systems (SWH) in low-income households within the state.

Greenhouse gas (GHG) emissions generated by domestic water heating (showers, washing clothes, washing hands, etc.), come from the burning of fossilfuels such as liquefied petroleum gas (LP), natural gas or through the consumption of electricity (grills, heating elements or other electrical devices). SWH systems use solar radiation to heat water through heat exchange surfaces (tubes or plates) without any GHG emissions in their operation.

The implementation of the project aims to establish this technology to replace traditional systems in homes in Guanajuato in order to reduce emissions, increase its technology penetration in vulnerable communities, and reduce dependence on the consumption and burning of fossil fuels.

Mercado Ambiental serves as the coordinating organization for the project certification in conjunction with SMAOT. It should be noted that the implementation of the projectis not mandated by any kind of national, state, or local legislation.

Emission reductions from this project are estimated to amount to 56,248 kilo tonnes of carbon dioxide equivalent ($ktCO_2$ e) over a 10-year period from 2021 to 2030.

2.1 GHG Project name

Solar water heating systems - Guanajuato

Sistemas de Calentamiento Solar - Guanajuato

2.2 Objectives

Project objectives

- General objective

Promote the sustainable development of municipalities with greater vulnerability in the state of Guanajuato through the installation of SWH systems, in order to reduce GHG emissions from the use of fossil fuels and generate economic savings.

- Specific objectives

o Reduce GHG emissions through technology change from fossil fuel and/or electric power consuming devices to zero emission SWH systems.

o Contribute to the adaptation of the vulnerable population through the use of technologies that reduce dependence on fossil fuels and generate economic savings.

o Enhance the development of emission reduction projects in the state of Guanajuato to promote climate change mitigation actions and the development of national and local carbon markets.

2.3 Project activities

The project consists of the installation of SWH systems in homes in the municipalities of Guanajuato that present a degree of vulnerability, in accordance with the poverty index of the municipalities.

The SWH System includes a storage system and vacuum tubes heat exchangers. Heating occurs through a thermosyphon process, where water is brought into contact - through the surface of the heat exchanger - with solar radiation. As the water heats up, it begins to circulate to the top of the tank, while cold water will enter the collector tubes. This cycle is repeated until a uniform average temperature is reached throughout the system, as shown in Figure 1.

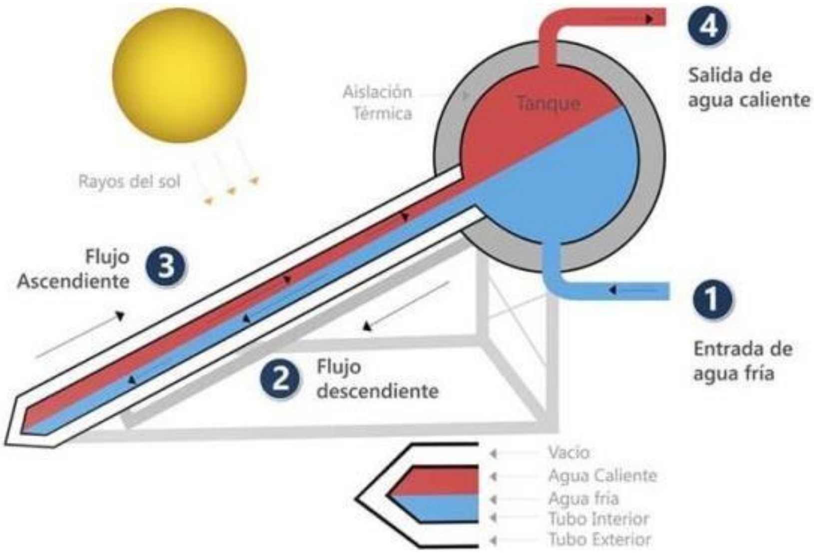

Figure 1. Solar thermosyphon water heating system

Source: Global Solare

The materials used by each installation were:

- o Renovables de México, S.A. de C.V. solar thermosiphon heater with a nominal capacity of 130 liters. Dimensions: 2.06 m long, 0.998 m wide and 1 m high. Maximum pressure allowed 0.5 kg/cm^2.
- o 10-12 3.3" borosilicate glass tubes with dimensions of 1.8 m length and 58 mm diameter.
- o Thermostatic tank made of stainless-steel inner layer 304-28 grade. Outer shell grade 201 BA. Stainless steel bolts grade 304 2B and minimum thickness of 2.5 mm.
- o 12m of ¾" pipe in tube-plus material
- o 10 ¾" 90° bend
- o 6 reinforced ¾" outer thread connectors
- o 6 ¾" internal thread connectors
- o ¾" copper bell connection
- o 2 x ¾" CPVC air jug tubes
- o 2 ¾" threaded ball valves
- o Weldable ¾" ball valve
- o Non-return valve ¾".
- o ¾" tee for connection of water connections
- o T of ¾" in case of side-mounted air jug made of galvanized steel
- o 20 cm magnesium bar

SWH Systems are installed at an average inclination of 20° with south orientation. In addition, the water heater must be placed below the base of the water tank to guarantee the water supply. It is recommended that the minimum distance between the top of the water heater and the base of the water tank is at least 30 cm, this ensures the thermosiphon effect and correct pressure at the outlet of the hot water.

2.4 Project location

The systems are located in residential houses distributed in different municipalities of the State of Guanajuato, Mexico. As shown in figure 2.

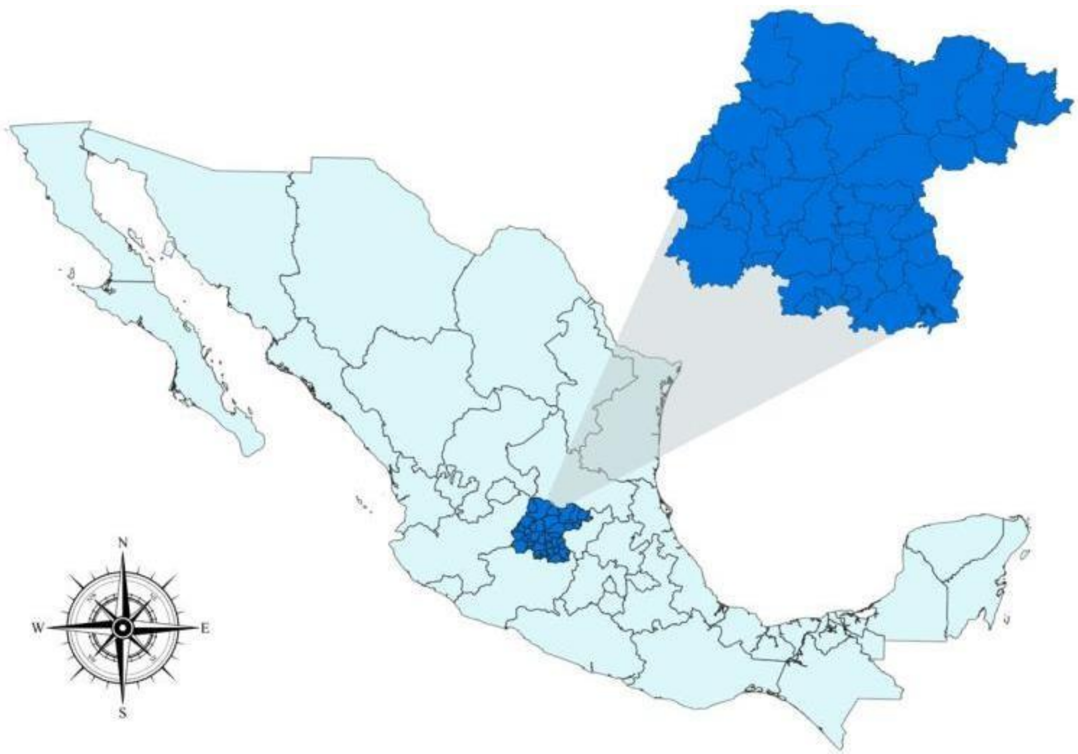

Figure 2. Geographical location of the project: Guanajuato, Mexico.

2.5 Additional information about the GHG Project

- Leakage management: Not applicable to the project
- Commercially Sensitive Information: No commercially sensitive information has been excluded from the public version in the project description.
- Budget allocation: The project was financed through the Performance Evaluation System (SED), through which SMAOT formulated the project and the Guanajuato Ministry of Finance, Investment and Administration responded to the allocation of resources for the approved project. In this case, as can be seen in the system, the amount allocated to the project corresponds to the state budget.

3 Quantification of GHG emissions reduction

3.1 Quantification methodology

Reference methodology Clean Development Mechanism (CDM): *AMS-I.J. Solar water heating systems.*
Small scale. Version 2.0. Valid from 31 August 2018 onwards.

3.1.1 Applicability conditions of the methodology

Table 1. Applicability of the project to the conditions set by the methodology

Concept of the methodology	Project concept
The installation of residential and commercial solar water heating systems for the production of hot water. For the purposes of this methodology, a residential SWH system includes: **(a) Heats water for domestic use only (personal hygiene, cooking, washing clothes, etc.).** **(b) Is installed to serve one or more residences** **(c) Has a maximum free-standing collector area of 100 m^2**	Installation of new residential solar water heating systems to retrofit homes that used fossil fuel or electricity for this purpose. The systems installed in dwellings use water for domestic purposes only and a collector area of 1.14m^2 each.
Displacement of electricity or fossil fuel that would otherwise have been used to produce hot water	Displacement of fossil fuels (LPG and natural gas) and electricity for hot water generation

For residential and commercial projects, the rate of hot water consumption and the temperature at which hot water is supplied to the load (e.g. 40 liters per day at 40 °C), which occur during the crediting period are used to determine the emission savings. **The consumption rate (andtemperature) is the rate of water actuallyused (e.g. for personal hygiene or an industrial process) and not the rate at which hot water is generated, which may be higher than the consumption rate (and temperature).**	Residential projects

3.2 Project boundaries

3.2.1 Project area

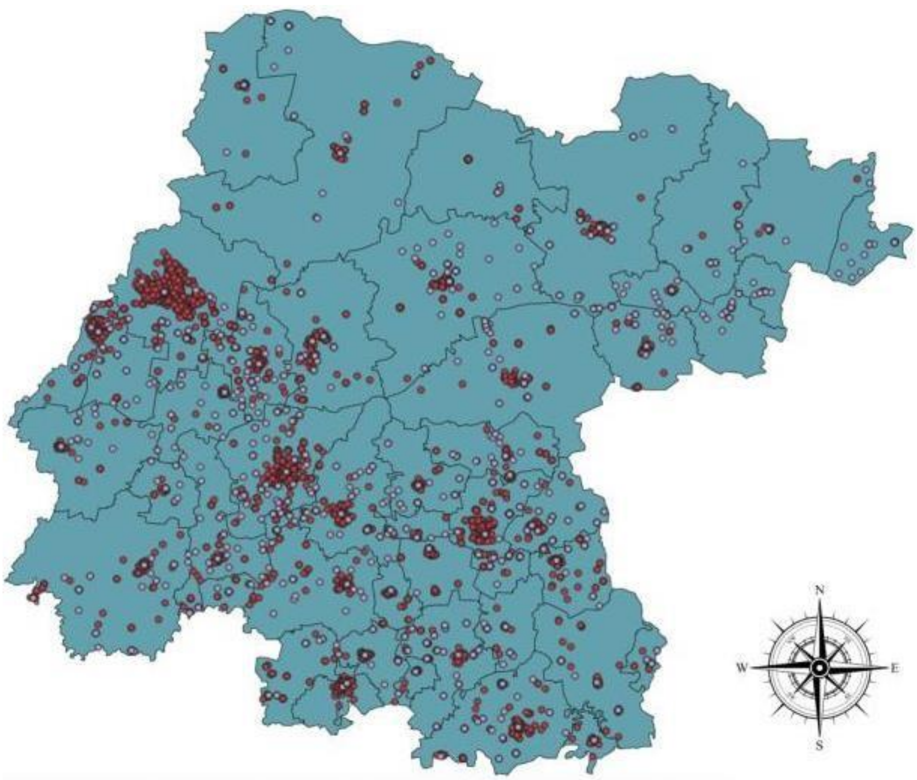

Figure 3. Geographical location of solar heaters

Figure 3 shows the geographical location of the SWH systems installed during 2021 and 2022.

3.2.2 Carbon reservoirs and GHG sources

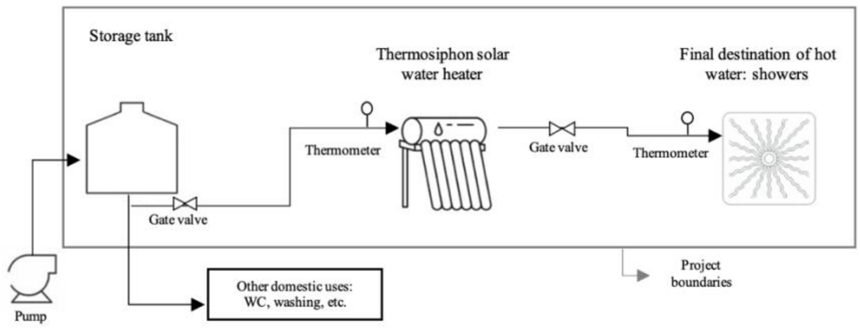

Figure 4. Project boundaries: Residential solar water heating system

Table 2. Emission sources and GHG sources covered by the project

Source		Gas	Inclusion	Justification
Baseline	Emissions from heat generation	CO_2	Yes	Direct emissions from the combustion of fuels: LP gas and natural gas Indirect emissions from the consumption of electricity generated on the national grid
		CH_4	No	Excluded for simplification
		NO_2	No	Excluded for simplification
Project	Emissions from electricity use	CO_2	Yes	Indirect emissions from the use of electricity by pumps or other devices for the system
		CH_4	No	Excluded for simplification
		NO_2	No	Excluded for simplification

3.2.3 Time limits and periods of analysis

Project start date

Project start date: 01-01-2021

In accordance with the Government Programme Update 2018-2024 of the State of Guanajuato, the start date is set as 2021. The first installations of SWH systems were carried out in March 2021, however, under consideration of the fiscal year and budget allocation, the project start date is set as 1 January 2021.

Quantification period of the GHG emissions reduction

01-01-2021 to 31-12-2030

Single 10-year accreditation period

In accordance with the provisions of the Government Programme Update 2018-2024 and the Guanajuato 2040 State Development Plan, one of the lines of action of Objective 5.3: Reduce the causes and effects of climate change in the state, is to harness the use of solar energy for domestic use. Also, taking into consideration a useful life of the devices of approximately 20 years, the accreditation period was defined as unique, ensuring the implementation of the project until 2030.

Monitoring periods

01-01-2021 to 31-12-2030

The checks will be conducted on a biennial basis for credit period years 3 (2023), 5 (2025), 7 (2027) and 9 (2030), as set out in the AMS-IJ methodology.

3.3 Identification and description of baseline scenario

According to a study conducted by the SMAOT, in which a sample of the project's target population was interviewed, it was determined that prior to the installation of the SWH systems, 63% of households used LP gas for water heating, 21% used electricity, 2% used natural gas and 14% used firewood.

Although not all beneficiaries of the programme were using fossil fuels or electricity for water heating before the project, the delivery of the devices was done considering the social impacts that this programme would have. For this reason, the emission reductions resulting from the installation in these households will not be counted for the purposes of the project. In this way, 86% of the installations carried out allowed a displacement of fossil fuel use through the change of technology to a SWH System.

According to the applied methodology, AMS - IJ, emission reductions are calculated as the product of energy savings resulting from project implementation and an emission factor of displaced electricity and/or fossil fuel.

In the first instance, the implementation of the project is considered to displace fossil fuel-based heat generation and therefore emission reduction estimates are provided for it based on the LPG savings reported by users, as shown in Equation 1:

$$RE_{estimación\ ex-ante} = Energía\ consumida_{gLP} * \ EF_{gLP}$$

Equation 1

3.4 Additionality

The project is proposed by Mercado Ambiental AP in conjunction with SMAOT. There is no national, state or local law making the installation and/or use of solar water heating systems mandatory.

According to the AMS-IJ methodology, it is possible to demonstrate additionality by CDM Tool 21 version 13.1: *Demonstration of additionality for small-scale projects*. It stipulates that:

Project participants should explain how the project activity would not have occurred due to one of the following barriers:

a) Investment barrier
b) Technological barrier
c) Barrier due to prevailing practices
d) Other barriers

Project participants may refer to the "Non-binding best practice examples to demonstrate additionality for small-scale project activities".

The document: Annex 34 Examples of non-binding best practice for demonstrating additionality for small-scale project activities indicates:

a) Investment barrier: A more financially viable alternative to project activity would have resulted in higher emissions.

Best practice examples include, among others, the application of an investment comparison analysis using a relevant financial indicator, the application of a benchmark analysis or a simple cost analysis (where the CDM is the only source of revenue, such as energy efficiency). It is recommended to use national or global accounting practices and standards for such an analysis.

From the investor's point of view, the present Solar Heater Programme does not have any economic return for the activity (only for the sale of carbon credits), so a simple cost analysis was carried out to determine the available options.

An evaluation of the initial investment, including the purchase of equipment and installation, was carried out for alternatives to reduce emissions from the use of fuels, most commonly LP gas. In this sense, Table 3 shows a comparison between solar heaters and their alternatives (LP gas boiler, electric boiler and electric shower).

The devices presented below were chosen based on the information available for sales sites or brands where a solar heater could potentially be compared to an alternative.

Table 3. Comparison of initial investment between solar water heating systems and alternatives

	Solar heater	LP gas boiler	Solar heater	Electric boiler	Electric shower	Solar heater
Brand	Master	AVERA	Heat Wave	Heat Wave	Bosch	Mexico Renewables

Sales site	Walmart	Walmart	Teknocontrol	Cimaco	Home Depot	Direct **wholesale** purchase
Capacity [L] (4 services)	120	4 services	120	120	Unlimited	120
Individual price (MXN)	10,999	9,349	8,726	6,699	3,229	7,021+VAT
Installation price (MXN)	1,800-3,500	300-1,000	1,800-3,500	2,640-3,080	2,500	1,800-3,500
Approximate average final cost per team	13,650	9,999	11,376	9,559	5,729	9,671
Approximate emission reductions per equipment (tCO_2e/year)**	0.4	Up to* 0.225	0.4	-0.2	-0.14	0.4

*According to product specifications, the gas savings can be up to 60% of the gas normally used.
** Obtained from the results of section 3.7 in the calculation of emission reductions per SWH system as well as from the data sheet of the devices considering their consumption.

As shown in Table 3, the comparison between solar heaters and their alternatives results in an approximate final investment cost of over MXN 11,000 for SWH systems in an individual quote, compared to investments below MXN 10,000 for electric or fossil fuel alternatives. On the other hand, it can be observed that for the wholesale quotation of SWH systems, the overall cost decreases, however, it is still higher compared to alternatives such as electric showers or the electric boiler.

In line with paragraph 10 of Tool 21, which alludes that the project may not have occurred in the scenario of some kind of barrier, such as the investment barrier, there are less costly alternatives to SWH systems. However, the emission reductions from such alternatives are lower compared to solar heaters, classifying SWH systems as additional by investment.

b) Technological barrier: Gas-based heaters began to be marketed with greater power in Mexico in the mid-20th century (Calorex, 2018), allowing the development over time of a technology that has become more consolidated and used by a large part of the country's population. In contrast, solar thermal energy began its commercial distribution in the first decade of the 2000s (CONUEE, 2014).

c) Barrier due to prevailing practices: According to the National Survey on Energy Consumption in Private Dwellings (INEGI, 2018). Only 43.5% of dwellings in Mexico used some type of water heater. Of the total 33.56 million dwellings in the country, only 5.9%, equivalent to 2 million devices, had a solar water heating system.

Of all the water heating systems in Mexico, the most predominant is the gas system (LP and natural), as can be seen in Figure 5

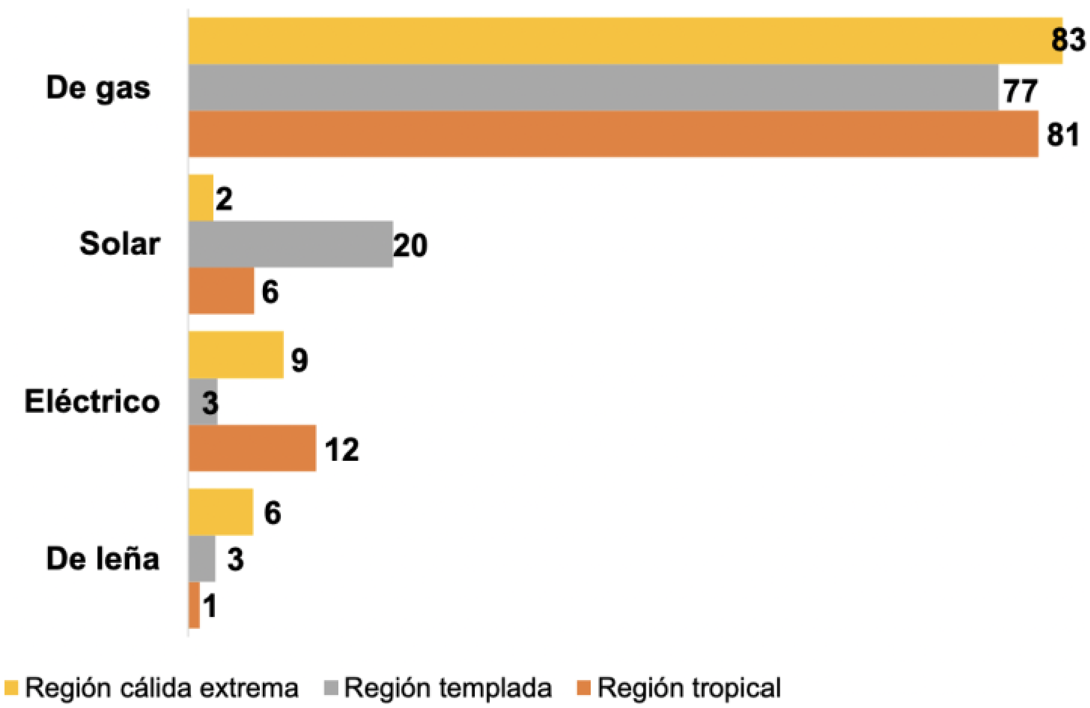

Figure 5. Percentage distribution of households using water heaters by climatic region according to type of water heater. Source: INEGI, 2018

d) Other barriers: Another of the main barriers to SWH systems is the lack of financing for their acquisition and installation (CONUEE, 2017). For this reason, the present project has a focus on supporting areas with a higher degree of poverty where this barrier is one of the main barriers for the population.

Additionally, CONUEE (2017) mentions that some of the barriers in the country for the establishment of a sustainable solar water heater market are:

1. Support for the legal and regulatory framework to allow for sustainable development of the SWH market.
2. Dissemination and awareness-raising on the use of solar water heaters.
3. Generation of financing schemes that encourage the growth of the market.
4. Quality assurance of the value chain.
5. Market monitoring, as well as exchange of lessons learned and information networking.

3.5 Uncertainty management

In keeping with the local context, the values of constants used for the calculation of emission reductions are national assumptions apart from the universal constants (density and specific heat of water).

Also, the baseline emission reduction estimate considers a percentage discount due to devices delivered to households where there was no change of fossil fuel or electricity. On the other hand, emission reductions for the entire current year were not considered, a discount was made as a result of temporary non-fixed installation for all devices.

Regarding the measurements made by the test method to determine the thermal efficiency of the installed solar heaters, this was 0.28 MJ.

3.6 Leakage and non-permanence

No leakage is considered for the project according to the methodology.

3.7 Mitigation results

3.7.1 Eligible areas in the GHG project boundary (if applicable)

Not applicable

3.7.2 Stratification (if applicable)

Not applicable

3.7.3 GHG emission reductions in the baseline scenario

Annex A shows the laboratory test study carried out on the model of the equipment delivered to the beneficiary population. According to the results of the thermal tests carried out for 2021, the useful heat of the system during the daytime period, in which hot water consumption is regularly generated, is 16.3 MJ/day considering an average warm temperature. In comparison, the tests carried out for the year 2022 indicate a useful heat of 14.9 MJ/day.

In relation to the above, through the RETScreen® Clean Energy Management Software, an estimation of the potential useful heat output of the systems was made through modelling, including the climatological data of the site as well as the system characteristics. The modelling information is shown below:

RETScreen - Ubicación | Suscriptor: Visualización

Condiciones de referencia del sitio

Ubicación de datos meteorológicos: México - Guanajuato | Ubicación de la instalación: Mexico - Guanajuato - Guanajuato

	Unidad	Ubicación de datos meteorológicos	Ubicación de la instalación	Fuente
Latitud		21.0	21.0	
Longitud		-101.3	-101.3	
Zona climática		38 - Templado - Seca		Suelo+NASA
Elevación	m	1999	1969	Suelo – Mapa
Temperatura de diseño de la calefacción	°C	7.3		Suelo
Temperatura de diseño del aire acondicionado	°C	30.2		Suelo
Amplitud de la temperatura del suelo	°C	17.6		NASA

Mes	Temperatura del aire	Humedad relativa	Precipitación	Radiación solar diaria - horizontal	Presión atmosférica	Velocidad del Viento	Temperatura del suelo	Grados-días de calefacción 18 °C	Grados-días de refrigeración 10 °C
	°C	%	mm	MJ/m²/d	kPa	m/s	°C	°C-d	°C-d
Enero	14.4	62.4%	12.71	16.81	79.3	0.8	12.0	112	136
Febrero	16.2	59.3%	11.76	20.30	79.3	1.0	14.2	50	174
Marzo	18.8	53.4%	4.65	23.90	79.2	1.1	17.1	0	273
Abril	20.9	51.7%	7.80	24.80	79.2	1.2	20.7	0	327
Mayo	21.9	54.8%	29.76	24.66	79.2	0.9	23.2	0	369
Junio	21.2	63.5%	103.50	22.90	79.2	1.2	21.9	0	336
Julio	19.7	69.7%	152.83	21.82	79.4	1.1	19.6	0	301
Agosto	19.7	72.5%	119.97	21.64	79.3	1.2	19.1	0	301
Setiembre	19.2	72.2%	103.80	19.51	79.3	1.0	18.2	0	276
Octubre	18.2	69.2%	35.96	19.12	79.3	0.9	16.6	0	254
Noviembre	16.1	66.1%	9.30	18.18	79.4	0.8	14.3	57	183
Diciembre	14.7	65.9%	6.51	16.45	79.3	0.5	12.3	102	146
Anual	**18.4**	**63.4%**	**598.55**	**20.84**	**79.3**	**1.0**	**17.4**	**321**	**3,075**
Fuente	Suelo	Suelo	NASA	NASA	NASA	Suelo	NASA	Suelo	Suelo
Medido a					m	10	0		

Figure 6. Modeling input information about the project location

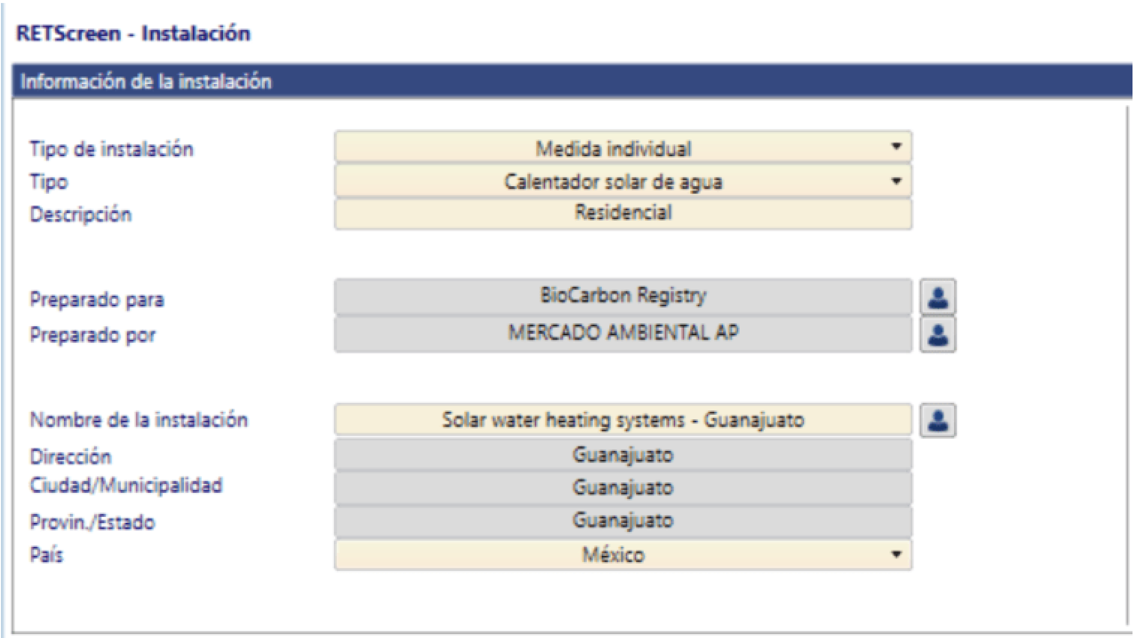

Figure 7. Modelling input information on the type of installation

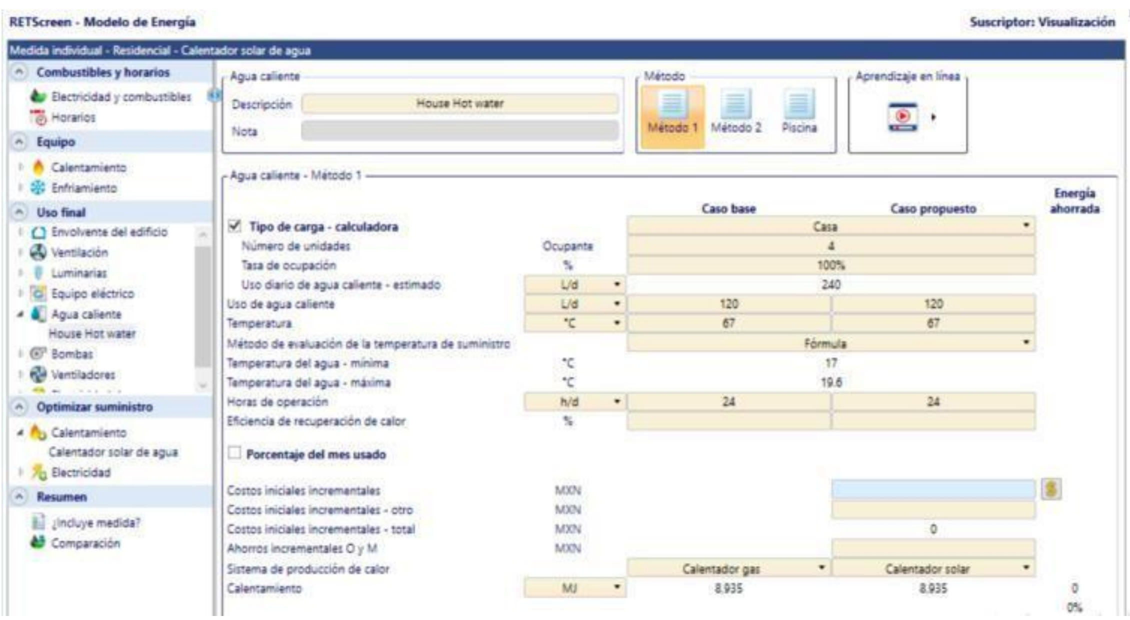

Figure 8. Modelling input information on the comparison between the baseline case and the project

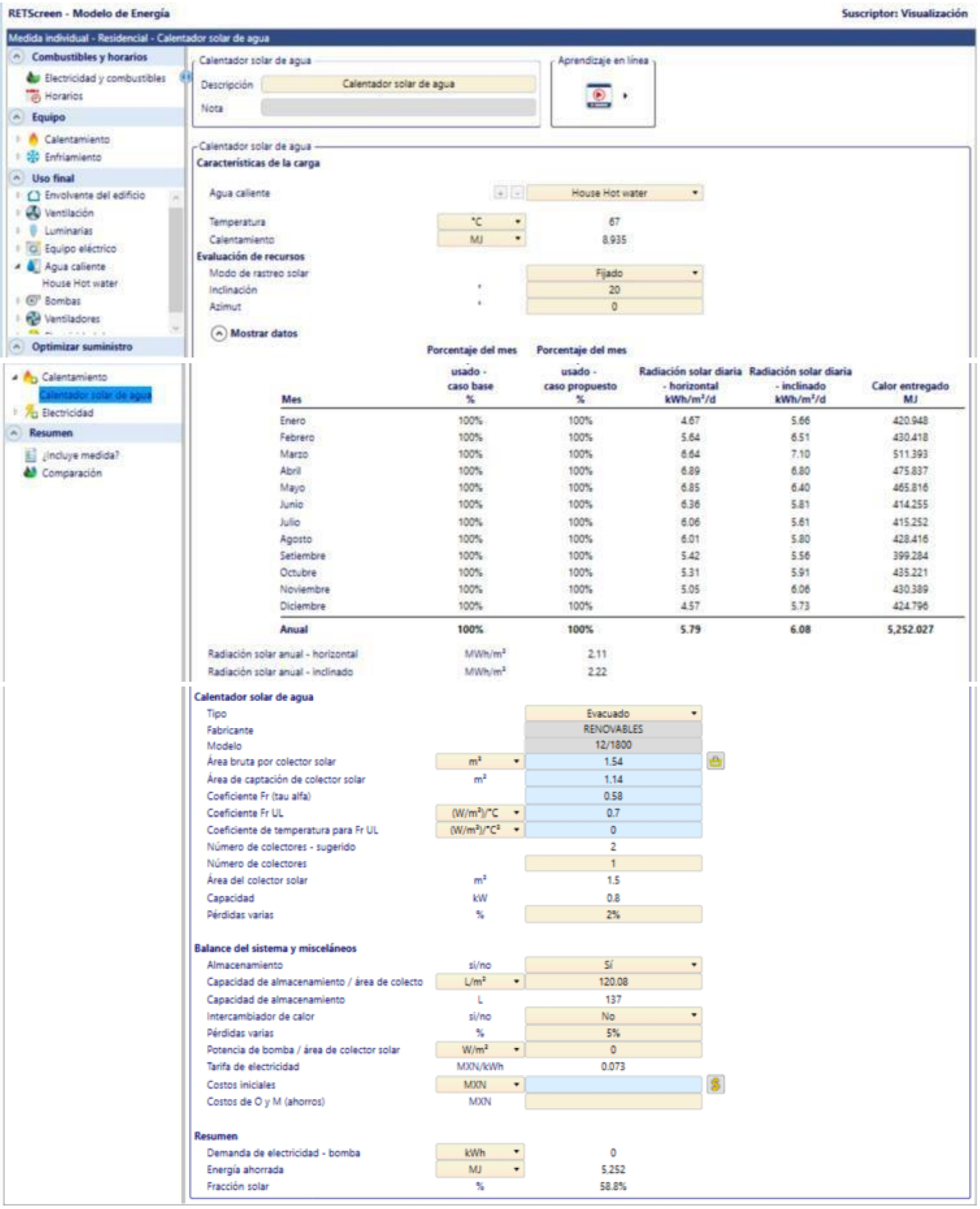

Figure 9. Modelling input information about the SWH system data

Taking this value into account, emissions were calculated for each type of fuel used in the baseline, as shown below:

$$Energy = Q_{ex} = 5{,}252.027\,\frac{MJ}{año}$$

$$RE = Q_{ex} * Emission\ factor$$

Ecuación 2

$$RE_{estimation\ ex-ante\ gLP} = 5{,}252.027\ MJ * \ 6.31\text{E}^{-05}\frac{tCO_2}{MJ} = 0.331\ tCO_2e$$

$$RE_{estimation\ ex-ante\ gn} = 5{,}252.027\ MJ * \ 5.61\text{E}^{-05}\frac{tCO_2}{MJ} = 0.294\ tCO_2$$

$$RE_{estimation\ ex-ante\ el} = 5{,}252.027\ MJ * \frac{1MWh}{3600MJ} * 0.423\,\frac{tCO_2e}{MWh} = 0.617\ tCO_2e$$

Table 4 shows the calculation of estimated total emission reductions (ER) by multiplying the individual reductions by the number of SHW systems corresponding to the displacement of the fuel or electricity set.

Table 4. Calculation of emission reductions from fossil fuel and electricity displacement

Year	Total number of SWH	Number of SWH systems by type of fuel displaced			RE LP gas	RE natural gas	RE electricity	ER total	Total adjusted ER*
		77.30%	4.10%	9.60%					
		LP Gas	Natural gas	Electricity	tCO_2	tCO_2	$tCOe_2$	$tCOe_2$	$tCOe_2$
2021	2262	1425.06	45.24	475.02	472.27	13.33	293.14	779	587
2022	6265	3946.95	125.3	1315.65	1308.03	36.92	834.94	2180	1122
2023	17265	10876.95	345.3	3625.65	3604.65	101.74	2300.91	6007	3615
2024	21265	13396.95	425.3	4465.65	4439.79	125.31	2833.99	7399	6529
2025	21265	13396.95	425.3	4465.65	4439.79	125.31	2833.99	7399	7399
2026	21265	13396.95	425.3	4465.65	4439.79	125.31	2833.99	7399	7399
2027	21265	13396.95	425.3	4465.65	4439.79	125.31	2833.99	7399	7399
2028	21265	13396.95	425.3	4465.65	4439.79	125.31	2833.99	7399	7399
2029	21265	13396.95	425.3	4465.65	4439.79	125.31	2833.99	7399	7399
2030	21265	13396.95	425.3	4465.65	4439.79	125.31	2833.99	7399	7399
Total								60760	**56248**

*Considering the whole year as operational, the total reductions amount to what is considered in total ER, however, an adjustment discount will be applied to the years 2021 and 2022 considering the timing of their installation in different months of the year. Likewise, for the years 2023 and 2024 an installation after May is projected. From 2025 onwards and for subsequent years, as there will be no increase in the number of devices, the estimate remains the same. For the calculation of the adjustment, see Annex B.

3.7.4 GHG emission reductions in the project- scenario

For the quantification of emission reductions, the Model-Based Approach, applicable to residential SWC system projects, will be considered. The method considerations are set out below:

a) Use an approved computer simulation model to determine the annual performance of baseline and project systems to calculate baseline and project energy use. Criteria for approval of computer simulation model programs include:

o The programme is not proprietary and is available at no or low cost.
o Simulation algorithms are available and documented.
o Reliable and documented programme-compatible real-time and historical meteorological data are available for the country where the projects are implemented.
o The programme has been tested and evaluated to demonstrate that it is reliable, and the results of such testing/benchmarking are in the public domain; and user support is available.

At the time of approval of this version of this methodology, the only pre- approved model simulation software is RET Screen.

b) The input parameters of the model will include:

o Baseline characteristics, including use of fossil fuels or electricity, heating system efficiency, storage tank size and insulation.
o The temperature of the water entering the water heating system, the average end-use hot water temperature and the consumption.
o Characteristics of the project system, including solar collector size, technical, thermal and orientation performance ratings.
o Solar radiation data, i.e. daily or monthly average daily solar insolation data and ambient temperature data - daily average daily or monthly average values.

c) The computer simulation model will be used to calculate the baseline and also the annual fossil fuel and/or electricity consumption of the project.

d) If more than one SWH system is installed as part of the project, it is possible to use water temperature entering the water heating systems, solar radiation data and ambient temperature data that are representative of the average data for all systems in the project. The model input parameters for the baseline and project systems should be based on the characteristics of each individual system.

Estimates and subsequent monitoring will be carried out through the use of the above mentioned software and all applicability conditions set out in this document.

Table 5. Estimated net emission reductions of the project

Year	GHG emission reductions inthe baseline scenario (tCO_2 e)	Project Emissions (tCO_2 e)	GHG emissions attributable to leakage (tCO_2 e)	Estimated net GHG reduction (tCO_2 e)
2021	587	0	0	**587**
2022	1122	0	0	**1122**
2023	3615	0	0	**3615**
2024	6529	0	0	**6529**
2025	7399	0	0	**7399**
2026	7399	0	0	**7399**
2027	7399	0	0	**7399**
2028	7399	0	0	**7399**
2029	7399	0	0	**7399**
2030	7399	0	0	**7399**
Total	**56248**	0	0	**56248**

4 Compliance with applicable legislation

There is currently no national legal obligation for the implementation of solar water heating systems.

In Mexico City, the Environmental Standard for the Distrito Federal NADF-008- AMBT-2017, establishes the Technical Specifications for the Use of Solar Energy for Water Heating in Buildings, Facilities and Establishments, is implemented, however, this legislation is not applicable to the State of Guanajuato.

On the other hand, the regulations applicable to solar water heaters in the country are aimed at quality assurance of the systems and their installations.

The quality assurance standards for equipment and installations are listed below:

- NMX-ES-001-NORMEX-2018 Thermal performance and functionality of solar water heating collectors - Test Methods and Labelling: Establishes the test methods to determine the thermal performance and functionality characteristics of solar collectors that use water as working fluid, marketedin the United Mexican States.
- NMX-ES-002-NORMEX-2007 Solar Energy - Definitions and terminology: Establishes the terms, symbology, and definition of the most commonly used concepts in the field of research and development of technology for the best use of solar radiation as an alternative energy source.
- NMX-ES-003-NORMEX-2021 Minimum requirements for the installation ofsolar thermal systems for water heating extends to all mechanical, hydraulic, electrical, electronic and other systems that are part of the installations of solar thermal systems of more than 500 liters, for systemssmaller than 500 liters, the provisions of the normative appendix I apply.
- NMX-ES-004-NORMEX-2010 Thermal evaluation of solar water heating systems - Test method (Test): This Mexican Standard establishes the test method (test) to evaluate and purchase the thermal performance of solar water heating systems, mainly for domestic use up to a maximum capacityof 500 liters and up to a maximum temperature of 90°C as a domain of hot water temperatures.
- Technical Standard of Labor Competence (NTCL) for "Installation of solarwater heating system" Certifies the labor competences of persons installing solar water heaters, which include interpreting diagrams and manuals, preparing the area, materials and tools, and installing and commissioning system components.
- NOM-027-ENER/SCFI-2018, Thermal performance, gas savings and safety requirements for solar water heaters and solar water heatersbacked up by a

water heater using L.P. gas or natural gas as fuel. Specifications, test methods and labelling.

- Technical opinion on solar thermal energy in housing
- EC-0325 Competence standard for the installation of thermosiphonic solar water heating system in sustainable housing
- EC-0473 Competence standard for installation of forced circulation solar water heating system with water heater

Information on the quality and performance tests carried out on the SWH systems is attached in Annex A.

5 Carbon ownership and rights

5.1 Project holder

The ownership of the project belongs to the SMAOT.

Table 6. Information on the project holder

Name of the organization	Guanajuato Ministry of Environment and Territorial Planning (SMAOT)
Contact person	David Robledo
Cargo	Director General for Climate Change and Energy Sustainability
Address	Aldana 12 esq. República Mexicana, Col. Pueblito de Rocha, C.P. 36040 Guanajuato, Guanajuato, Mexico
Telephone	4737352600 Ext 6205
E-mail	drobledob@guanajuato.gob.mx

5.2 Other project participants

Table 7. Project proponent information

Name of the organization	Environmental Market AP
Contact person	Eduardo Piquero
Cargo	Director
Address	Rio Tigris 129, int. 406, Col Cuauhtémoc, Del. Cuauhtémoc CP 06500, Mexico City
Telephone	(+52 1) 55 8530 1993
E-mail	eduardop@mexico2.com.mx

Table 8. Information on the company supplying the SWH systems

Name of the organization	Mexico Renewables
Contact person	Sandra Torres
Cargo	Supplier awarded in 2022
Telephone	472 7239102
E-mail	operacion@renovablesmx.com

Table 9. Information on other stakeholders

Name of the organization	Secretariat of Social and Human Development (SEDESHU)
Contact person	Abel Gallardo Morales

Cargo	Responsible for the integration of the register of applicants
Telephone	462 6074517
E-mail	agallardo@guanajuato.gob.mx
Name of the organization	**Director General for Material Resources, General Services and Cadastre**
Contact person	José Luis Cuellar Franco
Cargo	Responsible for the procurement of goods
Telephone	473 7353400
E-mail	jlcuellar@guanajuato.gob.mx

Name of the organization	**Transparency and Accountability Secretariat**
Contact person	María Melissa Palma Ortiz
Cargo	Responsible for programme evaluation through Contraloría Social
Telephone	473 7351300 Ext.8412
E-mail	mpalmao@guanajuato.gob.mx
Name of the organization	**Institute for the Women of Guanajuato**
Contact person	Rosa del Carmen Ramírez - Representative member
Name of the organization	**System for the Integral Development of the Family (Sistema para el Desarrollo Integral de la Familia)**
Contact person	Fabián Ronaldo García Márquez - Representative member

5.3 Agreements related to carbon rights

According to the Rules of Operation of the Solar Heater Programme, beneficiaries will only receive a SWH System as support together with training for its operation.

Annex C shows the format that potential beneficiaries of the programme must submit to the SMAOT to apply for support. In accordance with these Operating Rules, ownership of the emission reductions is not transferred to the beneficiary.

The purchase order for the devices, as well as the equipment for the installation by the Government of Guanajuato, is attached in Annex D. Through the Rules of Operation, the Government indicates that the operation of the programme is governed through the SMAOT. Therefore, the ownership of the reductions will be considered for the Government of Guanajuato by the SMAOT.

A letter between the proponent developer of the Environmental Marketplace PA project and the SMAOT specifying that the ownership of the carbon rights belongs to the Secretariat.

5.4 Land tenure (if applicable)

Not applicable to the project

6 Climate change adaptation

In its Article 27, Mexico's General Law on Climate Change (LGCC) establishes as one of the focal points the reduction of the vulnerability of society and ecosystems to the effects of climate change.

Among other objectives, this project aims to reduce the population's dependence on fossil fuels, avoiding a greater impact due to the variability of prices and availability of the resource as a result of climatic and civil phenomena. In the same way, the economic savings that it represents for the beneficiary population translates into additional income that can be used to improve the quality of life or to face any type of disaster derived from the effects of climate change.

7 Risk management

7.1 Reversal risk management

Table 10. Risks of reversal or impact on emission reduction activities

Factor	Risk	Management
Natural	• Device failures: Collapse or breakage of pipes due to factors such as storms, high wind speed, large hail, falling branches, etc.	During the training, the management plan for events and procedures to be followed for the replacement of broken pipes will be provided (handling of valves, handling of the pipe, handling of the waste, sites of availability of pipes, measures, among other recommendations).
Anthropogenic	• Breaking of tubes by objects such as rocks, balloons, etc.	
Financial	• Lack of resources for programme follow-up after change of • administration by the Ministry of Environment and Land Management	Considering that during 2024 there will be a change of administration due to a change of government in the State of Guanajuato, there is a risk that financial resources for monitoring, verifications and inspections will not be available. For this reason, it will be recommended to manage the resources collected from the sale of credits in order to continue with the programme.

The risks associated with community and stakeholder engagement are listed below.

Table 11. Risks and their management by the communities and beneficiary population

Temporariness	Risk	Management
Short term	• Low response or availability from the beneficiary population for the installation of the system and/or the instrumentation and control systems. • Low response or availability on the part of the beneficiary population for the collection of information for the construction of the baseline. • Presence of conditions unsuitable for system operability. Shadows, height of the water storage tank, i. e.	Through the Rules of Operation of the solar heaters programme in Guanajuato, the rights and obligations of the beneficiary user are established. By signing the application form (Annex C), the user accepts and commits to follow the mentioned specifications. Among the clauses of Article 37 are: Art. 37. The obligations of the beneficiaries: I. Provide in a timely, accurate and truthful manner all data, information and documentation required by the authorities or persons responsible for the programme. IV. Collaborate with the persons responsible for the

Medium and long term	• Low response from the beneficiary population to monitoring and inspection of the records and operation of the device • Theft of the device • Lack of maintenance by the beneficiary population • Disused due to a change of address • Lower efficiency due to modifications by the user	programme in the clarification of any fact concerning the programme. V. Actively participate in the operation of the programme VI. Inform the Climate Change Directorate of any act that would impede the correct operation of the programme. VII. Apply preventive maintenance to the heater in accordance with the equipment's use and operation manual. V.III Apply preventive maintenance to the tank, base and water lines. IX. Notifying a change of address of the beneficiary X. Use the heater for the purposes granted, refraining from renting, lending or disposing of it to third parties. XVI. Notify within ten days of installation in the event of malfunctioning XVII. Refrain from making any modifications to the installation carried out by the supplier. XVIII. Report immediately in case of theft of the heater and file the corresponding complaint with the Public Prosecutor's Office.

8 Environmental Aspects

According to Article 28 of Mexico's General Law on Ecological Balance and Environmental Protection (LGEEPA), the installation of solar water heating systems does not require an official environmental impact authorization.

As a simple environmental impact assessment, the overall environmental factors were identified and ranked from 0 to 10, where 0 is no negative impact and 10 is a strong negative impact, the impact of the project on each aspect. The biggest impact was identified in the end of life of the system due to the generation of materials such as exchange tubes, to avoid mismanagement, the programme will guide the users to make proper disposal.

Table 12. Simple environmental impact assessment matrix of the project

Environmental factor	Installation	Operation and maintenance	Closing
Soil	0	0	0
Water	0	1	0
Air	0	0	0
Noise	1	0	0
Waste	1	1	3
Plants	0	0	0
Animals	0	1	0
Land use	0	0	0

• Installation:

-Noise:Generated due to installation including modifications or adaptations to the structure for laying pipes, fittings and others.

-Waste: Derived from the packaging of the accessories and the device.

• Operation and maintenance:

-Water: In cases where there is a pipe break, the water contained in the heating device may fall out and be wasted.

-Waste: Tubes that may occasionally break and need to be replaced.

-Animals: Visual impact on birds due to the reflection of sunlight on the surface of the tubes.

• Shutdown: or end of life of device

-Waste: The disposal of heater materials including pipes and water container, as well as other accessories.

9 Socio-economic aspects

The project seeks to support the most vulnerable areas and populations. Through the installation of the devices, the aim is to reduce fuel or electricity consumption and, therefore, reduce expenditure by the population for the purchase of inputs. In this way, the risks of dependence on fossil fuels are reduced, as well as their variations for heating water for various domestic uses, generating benefits for the population.

10 Consultation with interested parties (stakeholders)

The SMAOT, together with the Secretariat for Transparency and Accountability, carried out a consultation with the beneficiaries of the project, and the results of the perception of a sample of 322 respondents were included in the report on Social Controllership in State Social Programmes. The evaluation considered the positive impacts and the search for irregularities in the delivery of the benefits, as well as the perception of the trainings carried out.

10.1 Summary of public comments received

The section will be completed once the public comment space is open.

10.2 Consideration of public comments received

The section will be completed once the public comment space is open.

11 Sustainable Development Objectives (SDG)

The project contributes to the fulfilment of several sustainable development objectives as listed below:

- SDG 1. No Poverty. Target 1.5: Build resilience of people in vulnerable situations and reduce their exposure to vulnerability: The project contributes to the reduction of fossil fuel dependency of the population invulnerable areas.
- SDG 7. Affordable and clean energy: Use of solar thermal energy.

- SDG 11. Sustainable cities and communities: The project contributes to the expansion of least-cost services while reducing negative environmental impacts.
- SDG 13. Climate action: The project favours the reduction of greenhouse gas emissions through the use of technology that displaces the burning of fossil fuels.

12 REDD+ Safeguards (if applicable)

Not applicable to the project

13 Special categories, related to co-benefits

Not applicable to the project

14 Grouped Project (if applicable)

The BCR Standard indicates that operators of GHG projects that include activities in the energy sector may develop bundled projects.

The activities to be covered by the validation of this project are those initiated in 2021 until December 2022. The clustered activities will be carried out through the installation of additional SWH systems during 2023 and 2024.

The following requirements must be met:

(a) identify, during the validation process, the geographical area(s) within which (initial and additional) instances of the project are to be developed and define the criteria for the addition of new instances.

The area where the clustered SWC systems will be installed during 2023 and 2024 will be within the municipalities of the State of Guanajuato, Mexico.

(b) Comply with the guidelines of the BCR Standard, in its most recent version.

(c) Comply with all the provisions of the applicable BIOCARBON REGISTRY methodological documents, in their most recent version.

A review of the versions of the BCR Standard will be carried out to includeany changes that have been established during 2023 and 2024, the yearsin which the systems bundled to the project will be installed.

(d) Include emission reductions only for validated project activities.

(e) Implement the GHG emission reduction activities described in the validated project document.

Emission reductions from new systems will operate under the provisions of this document as fuel displacement activities.

(f) Demonstrate that the new instances meet the applicability conditions described in the applied methodology.

(g) Demonstrate that geographic areas (to be included in the project boundaries) in which there are no initial instances are subject to the same baseline and additionality scenario conditions as areas in which initial instances are included.

Baseline, boundary and applicability conditions shall be recorded and documented as evidence to demonstrate compliance in accordance with the AMS-I.J. methodology.

(h) Provide evidence of the start date of activities in the new instances, demonstrating that this date is after the start date of GHG emission reduction activities in the instances included in the validation (initial instances).

(i) Determine the baseline scenario and demonstrate additionality based on the initial instances of the project.

(j) Demonstrate that each instance complies with all the provisions of the applied methodology, including the capacity limits set out in the methodologies applicable to the type of project.

The start date of the installations will be documented as well as the baseline, as required by the most recent version of the AMS-I.J. methodology. In addition, the additionality analysis shall be performed again for the determined dates.

15 Other GHG programs

The project is not under any other greenhouse gas or emissions trading programme.

16 Monitoring plan

16.1 Data and parameters for quantifying emission reductions

The following tables show the information regarding the quantification of emission reductions as well as monitoring.

Table 13. Information on the volume of hot water consumed

Parameter	V_{H_2O}
Unit	Litres/day
Description	Volume of hot water consumed
Source	National reference and/or on-site measurement data
Value applied	-
Measurement method and procedure (if applicable)	Use of measuring equipment in the connection pipe between the heater and the shower connection.
Frequency of measurement/recording	Measurement over 30 representative days
Monitoring equipment	N/A
Quality control procedures	Use of properly calibrated equipment
Purpose of the data	Calculation of the energy required to heat from T1 to T2 water
Calculation method	N/A
Comments	N/A

Table 14. Information concerning the outlet temperature of the SWH system

Parameter	T_2
Unit	°C
Description	SWH system outlet temperature at the final hot water destination
Source	National reference and/or on-site measurement data

Value applied	-

Measurement method and procedure (if applicable)	Use of measuring thermometer in the connection pipe between the heater and the shower connection.
Frequency of measurement/recording	Measurement over 30 representative days
Monitoring equipment	N/A
Quality control procedures	Use of properly calibrated equipment
Purpose of the data	Calculation of the energy required to heat from T1 to T2 water
Calculation method	N/A
Comments	N/A

Table 15. Information concerning the inlet temperature to the SWH system

Parameter	T_1
Unit	°C
Description	SWH system inlet temperature
Source	National reference and/or on-site measurement data
Value applied	-
Measurement method and procedure (if applicable)	Use of measuring thermometer in the connection pipe between storage tank and solar heater

Frequency of measurement/recording	Measurement over 30 representative days
Monitoring equipment	N/A
Quality control procedures	Use of properly calibrated equipment
Purpose of the data	Calculation of the energy required to heat from T1 to T2 water
Calculation method	N/A
Comments	N/A

Table 16. Information concerning the difference between the inlet and outlet water temperature of the SWH system

Parameter	ΔT
Unit	°C
Description	Difference between inlet water temperature and outlet water temperature
Source	Calculation from the above values
Value applied	-
Measurement method and procedure	N/A
Frequency of measurement/recording	Representative calculation
Monitoring equipment	N/A
Quality control procedures	Review of the system's databases

Purpose of the data	Calculation of the energy required to heat from T1 to T2 water
Method of calculation	Temperature difference realised from monthly averages of recorded temperatures.
Comments	N/A

16.2 Additional information to determine the baseline or reference scenario

Table 17. Information concerning the CO_2 emission factor for LP Gas

Parameter	EF_{gLP}
Unit	tCO_2 /MJ
Description	CO_2 emission factor of LPG per energy provided
Source	Official Journal of the Federation 03/09/2015. AGREEMENT that establishes the technical particularities and formulas for the application of methodologies for the calculation of emissions of greenhouse gases or compounds.
Value applied	6.31E-05
Justification of the choice	Values specified for Mexico
Purpose of the data	Estimating baseline emissions from fossil fuel use
Comments	N/A

Table 18. Information on CO_2 emission factor for natural gas

Parameter	EF_{gn}
Unit	tCO_2 /MJ

Description	CO_2 emission factor of natural gas per energy provided
Source	Official Journal of the Federation 03/09/2015. AGREEMENT that establishes the technical particularities and formulas for the application of methodologies for the calculation of emissions of greenhouse gases or compounds.
Value applied	5.61E-05
Justification of the choice	Values specified for Mexico
Purpose of the data	Estimating baseline emissions from fossil fuel use
Comments	N/A

Table 19. Information concerning the emission factor of the National Electricity System 2021

Parameter	EF_{NG2018}
Unit	tCO_2 e/MJ
Description	Emission factor of the National Electricity System - Mexico of 2021
Source	Energy Secretariat
Value applied	0.423
Justification of the choice	The factor selected was for the year 2021.
Purpose of the data	Estimating baseline emissions from electricity use
Comments	N/A

Table 20. Information on the emission factor of the National Electricity System 2022

Parameter	EF_{NG2018}
Unit	tCO_2 e/MJ
Description	Emission factor of the National Electricity System - Mexico of 2022
Source	Energy Secretariat
Value applied	0.435
Justification of the choice	The factor selected was that corresponding to the year 2021. According to the National Electricity System Development Programme 2022-2036, for the calculation of projected emission reductions until 2030, the same factor of 2022 is considered.
Purpose of the data	Estimating baseline emissions from electricity use
Comments	N/A

Table 21. Information on the specific heat of water

Parameter	c_{H_2O}
Unit	J/kg°C
Description	Specific heat of water at 17°C
Source	VAXA Software
Value applied	4184
Justification of the choice	Universal value, 17°C is considered as average ambient temperature at system inlet.

Purpose of the data	Calculation of the energy required to heat from T2 to T1 the water
Comments	N/A

Table 22. Information concerning the calorific value of LPG

Parameter	PC_{gLP}
Unit	MJ/L
Description	Calorific value of LPG
Source	National Commission for the Efficient Use of Energy
Value applied	26.12
Justification of the choice	Nationally approved factor
Purpose of the data	Estimate emission reductions per fuel displacement
Comments	N/A

Table 23. Information concerning the efficiency of the water heating equipment upstream of the SWH system

Parameter	s_{slb}
Unit	-
Description	Efficiency of water heating equipment upstream of the SWH system
Source	Clean Development Mechanism
Value applied	90%
Justification of the choice	It is considered for the unification of all previous equipment used
Purpose of the data	Calculation of net emission reductions

Comments	N/A

Table 24. Information on water density

Parameter	ρ_{H_2O}
Unit	kg/m^3
Description	Water density at 17°C
Source	VAXA Software
Value applied	998.86
Justification of the choice	Universal value, 17°C is considered as average system inlet temperature
Purpose of the data	Calculation of the energy required to heat from T2 to T1 the water
Comments	N/A

Table 25. Information concerning the density of LPG

Parameter	ρ_{gLP}
Unit	kg/L
Description	Density of LPG
Source	Energy Regulatory Commission
Value applied	0.54
Justification of the choice	National value
Purpose of the data	Calculation to estimate baseline emission reductions
Comments	N/A

Table 26. Information on fossil fuel consumption before the SWH system

Parameter	Q_{ex}
Unit	MJ/year
Description	Useful heat delivered by the system
Source	RETScreen ® Clean Energy Managment Software
Value applied	5252.027
Justification of the choice	Value determined by testing of project devices
Purpose of the data	Calculation for estimation of potential emission reductions of the project
Comments	N/A

16.3 Information related to environmental impact assessment of GHG project activities

Table 27. Monitoring of waste management in the system

Factor	Monitoring
Waste disposal during installation	It will be managed and monitored by the team in charge of the installation of the systems. One-off. The correct disposal of the materials shall be ensured, taking into account their potential for use.
Waste disposal in the operation	Surveys will be conducted during the inspection to monitor the disposal of waste such as broken pipes or fittings.

16.4 Procedures established for the management of GHG emission reductions or removals and related to quality control

Project monitoring will be carried out according to the approved AMS-IJmethodology listed below:

1. Within three months of installation, each SWH system shall be inspected and acceptance tested (commissioned) to verify that it is functioning properly according to the manufacturer's specifications.

   Acceptance tests shall be documented and confirm system performance, according to design specifications and changingoperating modes under a variety of typical operating conditions. The date of installation of each SWH system shall be recorded.

2. For residential SWH systems, in a given year, emission reductions canonly be issued for systems that are shown to be in operation and in compliance with the manufacturer's required maintenance procedureson an annual or biennial (every two years) basis during the crediting period.
   When biennial inspection is chosen, after inspection and acceptance testing during the installation year of the project, inspections can be carried out in years 3, 5, 7, 9 and the results of these inspections can be applied to credit years 3 and 4, 5 and 6, 7 and 8, etc. Compliance with this requirement shall be implemented by inspection of systems and review of maintenance records. A statistically valid sample of residences where systems are installed may be used to determine the percentage of systems operating and complying with the manufacturer's required maintenance procedures. Such sampling should take into account occupancy and demographic differences, as per the relevant requirement for sampling in the General Guidelines for Sampling and Surveys for Project Activities.

   In this case, the sample to determine the percentage of systems operating and complying with the procedures, was planned according to the CDM Guidelines as well as the BCR Standard Guidelines for Certification and Registration of Energy Sector Projects on confidence levels for small-scale projects, considering a confidence level of 90% and a precision of 10%.

When using the model-based method, the hot water load profile and consumption rates can be determined from at least 30 days of monitoring, taking into account seasonal variations in hot water use. This determination can be made once during the first year of project operation, e.g. using a temporary flow measurement device. If more than one SWH system is installed in the project, the average hot water load profile and consumption rate can be determined from a statistically valid sample of the residences where the SWH systems are installed. The sampling design should take into account occupancy and demographic differences, according to the relevant requirement for sampling in the General Guidelines for Sampling and Surveys for Small-Scale Project Activities. In lieu of such measurement, regional or national values per occupant or per residence from reliable sources, not exceeding a value of 40 liters per day of hot water consumption per full-time resident occupant, may be used.

Annex A. Quality and operational testing of SWH devices

IDEREE ENERGIA RENOVABLE Y EFICIENCIA ENERGÉTICA	Informe de Pruebas Pruebas particulares de calidad		
Código: **PLABSOL-13-F1.10, Rev. 03**	**No. de Informe:** **20-CSA-040.1**	**Fecha de Emisión:** **2020-12-08**	**Página:** 1 DE 20

Centro de Capacitación y Laboratorio de Pruebas IDEREE A.C.
Calle Fraternidad No. 102, Col. Jol Gua Ber, León, Guanajuato. México. CP 37353. Tel (477) 167 5270.

No. de informe:	20-CSA-040.1	**No. de dictamen:**	No Aplica
Empresa o Fabricante: *(Razón social)*	**Renovables de México SA de CV**		
Domicilio:	Circuito Logístico 150, Fracc. Bustamante, Silao, Gto, C.P. 36128		
Teléfonos:	(477) 122 1496		
Correo electrónico:	victor@e-renovables.com		
Descripción del Sistema:	Calentador de agua solar	**Marca:**	RENOVABLES
Tecnología del colector: *(Plano / No. de Tubos)*	12 tubos evacuados	**Modelo del sistema completo:**	12/1800
Tipo de circulación del agua:	Termosifónico	**Modelo del termotanque:**	12/1800
Año de producción:	2020	**Modelo de la estructura soporte:**	12/1800
Capacidad del termotanque: *(L)*	102.58	**Modelo del colector:**	12/1800
Presión hidráulica de operación: *(kg/cm^2)*	0.5	**No. de folio de las muestras:**	No Aplica
No. de muestras a analizar:	2	**No. de serie de las muestras:**	20ER041106, 20ER846
Fecha de ingreso de las muestras:	2020-10-07	**Fecha de finalización de pruebas:**	2020-11-11
Fecha de inicio de pruebas:	2020-10-07	**Fecha de emisión del informe de resultados:**	2020-12-08
Método de prueba utilizado:	Métodos de prueba con fundamento en las especificaciones técnicas requeridas en los términos de referencia de las bases de la licitación pública nacional mixta No.40051001-029-20 (CAGEG-029/2020) para adquisición de calentadores solares de agua de la Secretaría de Medio Ambiente y Ordenamiento Territorial del Gobierno del Estado de Guanajuato.		
Organismo certificador:	No aplica.		
Método de muestreo:	Ejecutado por la empresa o persona solicitante del servicio.		
Observaciones generales:	Se agregaron los resultados de la prueba de rendimiento térmico del Capítulo 7.0 de la Norma Mexicana NMX-ES-004-NORMEX-2010.		
Cumplimiento del sistema de calentamiento solar de agua con base en los métodos de prueba particulares utilizados.	X **Sí cumple**	☐ **No Cumple**	

Elaboró:	**Revisó:**
[signature]	[signature]

IDEREE ENERGIA RENOVABLE Y EFICIENCIA ENERGÉTICA	Informe de Pruebas Pruebas particulares de calidad		
Código: PLABSOL-13-F1.10, Rev. 03	**No. de Informe:** 20-CSA-040.1	**Fecha de Emisión:** 2020-12-08	**Página:** 2 DE 20

A. Características Generales de Componentes y Materiales del Sistema Evaluado.

Componentes y Materiales del Sistema	Especificaciones del Fabricante	Valores obtenidos en laboratorio
Clasificación por circulación del agua (Termosifónico / Forzada)	Termosifónico	Termosifónico
Clasificación por tecnología del colector (Plano / Autocontenido / Tubos evacuados con o sin tubos de calor o superficies reflejantes / Concentrado Parabólico)	Tubos Evacuados	Tubos Evacuados sin superficies reflejantes
Clasificación de presión hidrostática de operación (kg/cm²)	0.5	0.5
DIMENSIONES DEL CALENTADOR SOLAR DE AGUA		
Largo (m)	No indica	2.009
Ancho (m)	No indica	1.080
Altura (m)	No indica	1.000
TERMOTANQUE		
Tipo de material tanque externo (Nombre)	Acero Inoxidable Serie AISI 201	Acero Inoxidable Serie AISI 201
Espesor lamina tanque externo (mm)	0.31	0.328
Largo externo (mm)	N.A.	1080
Diámetro externo (mm)	N.A.	450
Circunferencia externa (mm)	N.A.	1445
Tipo de material aislante (Nombre)	Poliuretano	Poliuretano
Espesor material aislante (mm)	50	50.738
Tipo de material tanque interno (Nombre)	Acero Inoxidable Serie AISI 304-2B	Acero Inoxidable Serie AISI 304-2B
Espesor lamina tanque interno (mm)	0.50	0.523
Largo interno (mm)	N.A.	1023
Diámetro interno (mm)	N.A.	366
Temperatura de salida (°C)	N.A.	N.A.
ESTRUCTURA DE SOPORTE DEL SISTEMA		
Tipo de material (Nombre)	Acero Inoxidable Serie AISI 201	Acero Inoxidable Serie AISI 201
Espesor del material (mm)	1.7	1.718
TUBOS EVACUADOS / COLECTOR / ÁREA BRUTA *(Máxima área proyectada del colector solar completo, excluyendo todo elemento de soporte y conexión. NMX-ES-002-NORMEX-2007)*		
Área (m²)	N.A.	1.57
Inclinación sobre la horizontal (Grados)	21	21
Tipo de material de tubos (Nombre)	Vidrio de Borosilicato	Vidrio de Borosilicato
Número de tubos	12	12
Largo (mm)	N.A.	1665
Largo completo (mm)	N.A.	1800
Ancho (mm)	N.A.	940
Circunferencia (mm)	N.A.	183
Espesor del material de tubos capa externa (mm)	2.1	2.128
Espesor del material de tubos capa interna (mm)	1.6	1.621
TUBOS EVACUADOS / COLECTOR / ÁREA DE APERTURA *(Máxima área proyectada a través de la cual la radiación solar no concentrada entra al colector. NMX-ES-002-NORMEX-2007)*		
Área (m²)	N.A.	1.17
Largo (mm)	N.A.	1665
Diámetro (mm)	N.A.	58.39

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TUBOS EVACUADOS / COLECTOR / ÁREA DEL ABSORBEDOR *(Componente del colector solar destinado para absorber energía radiante y transferirla como energía calorífica a un flujo de trabajo. NMX-ES-002-NORMEX-2007)*		
Área (m^2)	**No Indica**	**0.94**
Diámetro del tubo (mm)	**N.A.**	**47.27**
Material del intercambiador de calor (Nombre)	**N.A.**	**N.A.**
Largo del intercambiador de calor (cm)	**N.A.**	**N.A.**
Diámetro del intercambiador de calor (cm)	**N.A.**	**N.A.**
Espesor del intercambiador de calor (mm)	**N.A.**	**N.A.**
Circunferencia del intercambiador de calor (mm)	**N.A.**	**N.A.**
Número de aletas	**N.A.**	**N.A.**
Tipo de unión de Tubo - Aleta	**N.A.**	**N.A.**
Tipo de material de aletas (Nombre)	**N.A.**	**N.A.**
Largo de aleta (cm)	**N.A.**	**N.A.**
Ancho de aleta (cm)	**N.A.**	**N.A.**
Espesor de aleta (mm)	**N.A.**	**N.A.**
Etiqueta		
Marca	**Renovables**	**Renovables**
Modelo	**12/1800**	**12/1800**

Fotografías del Sistema Completo

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B. Reporte de la secuencia de los métodos de prueba y resumen de resultados.

Método de prueba particular	Fecha Inicio	Fecha Final	Resultado
1. Verificación de acero inoxidable serie AISI 201 ó 304 a capa externa del termotanque.	2020-10-08	2020-10-08	Cumple
2. Verificación de acero inoxidable serie AISI 304 a capa interna del termotanque.	2020-10-08	2020-10-08	Cumple
3. Verificación de acero inoxidable serie AISI 201 a estructura soporte del sistema.	2020-10-08	2020-10-08	Cumple
4. Capacidad nominal del sistema. Método de prueba con referencia al DTESTV. *Capacidad de 130 a 150 Litros.*	2020-10-07	2020-10-07	Cumple
5. Medición del espesor de materiales del sistema. Capa externa de acero del termotanque. *Espesor mínimo de 0.31 mm.*	2020-10-08	2020-10-08	Cumple
6. Medición del espesor de materiales del sistema. Capa interna de acero del termotanque. *Espesor mínimo de 0.50 mm.*	2020-10-08	2020-10-08	Cumple
7. Medición del espesor de materiales del sistema. Aislante térmico del termotanque. *Espesor mínimo de 50 mm.*	2020-10-08	2020-10-08	Cumple
8. Medición del espesor de materiales del sistema. Estructura de soporte del sistema. *Espesor mínimo de 1.7 mm.*	2020-10-07	2020-10-07	Cumple
9. Medición del espesor de materiales del sistema. Capa externa del tubo evacuado. *Espesor mínimo de 2.1 mm.*	2020-10-07	2020-10-07	Cumple
10. Medición del espesor de materiales del sistema. Capa interna del tubo evacuado. *Espesor mínimo de 1.6 mm.*	2020-10-07	2020-10-07	Cumple
11. Prueba de rendimiento térmico Capítulo 7.0 NMX-ES-004-NORMEX-2010	2020-10-21	2020-11-11	No Aplica

Informe de Pruebas Pruebas particulares de calidad			
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C. MÉTODO DE PRUEBA DE VERIFICACIÓN DE ACERO INOXIDABLE.

Con referencia en la NORMA AISI/SAE (American Iron and Steel Institute / Society of Automotive Engineers) de clasificación internacional del acero inoxidable se utiliza el aparato electroquímico siguiendo una secuencia de pruebas y aplicando distintas soluciones electrolíticas con base en un criterio de descarte de resultados para comprobar la clasificación del acero inoxidable de la muestra.

1. **Preparación de la muestra.** Una vez seleccionada la superficie de la muestra del metal esta se prepara lijándola o esmerilándola para retirar cualquier rastro de recubrimiento o pintura.

2. **Prueba de control magnético para identificar el acero inoxidable de serie AISI 400 (martensíticos y ferríticos).** Una vez aplicada la solución de prueba se utiliza el imán del aparato electroquímico sobre la superficie de la muestra del acero inoxidable buscando que se produzca una atracción magnética para determinar la clasificación AISI del acero inoxidable.
    - **Con atracción magnética:** la muestra forma parte del acero inoxidable de la serie AISI 400.
    - **Sin atracción magnética:** no se concluye la clasificación AISI del acero inoxidable y se continúa con las pruebas complementarias.

3. **Prueba con reactivo de manganeso (Mn) para identificar el acero inoxidable de series AISI 200 y AISI 300.** Una vez realizada la prueba de control magnético y haber resultado negativa para la serie AISI 400 se sigue la secuencia siguiente:
    a. Colocar el papel secante sobre la misma superficie que dio negativo en la verificación de acero inoxidable de la serie AISI 400.
    b. Colocar la sonda retractable del aparato sobre el metal presionando al mismo tiempo la punta eléctrica sobre el papel secante para provocar una reacción electroquímica.
    c. Verificar la coloración final del papel secante para determinar la clasificación AISI del acero inoxidable.
        - **Rojo/morado:** de 5.5 a 10.5% de Mn para acero inoxidable de la serie AISI 200.
        - **Amarillo:** menor a 2% de Mn para acero inoxidable de la serie AISI 300.

4. **Prueba con reactivo de molibdeno (Mo) para identificar el acero inoxidable de series AISI 304 y AISI 316.** Una vez realizada la prueba con reactivo de manganeso y haber resultado positiva para la serie AISI 300 se sigue la secuencia siguiente:
    a. Colocar el papel secante sobre la misma superficie que dio positivo en la verificación de acero inoxidable de la serie AISI 300.
    b. Aplicar la solución electrolítica reactiva al Mo sobre la zona coloreada en amarillo del papel secante utilizado en la prueba con reactivo de manganeso.
    c. Verificar la coloración del papel secante después de comenzar la reacción química para determinar la clasificación del acero inoxidable de la serie AISI 300.
        - **Blanco:** ausencia de Mo para acero inoxidable de la serie AISI 304.
        - **Rosa:** de 2 a 3% de Mo para acero inoxidable de la serie AISI 316.

5. **Confirmación de verificación de clasificación del acero inoxidable.** Se repite por lo menos una vez más la secuencia completa de pruebas sobre una superficie distinta de la muestra del metal para verificar el resultado final obtenido. Si no existe un cambio en el resultado se considera definitiva la clasificación AISI obtenida del acero inoxidable.

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1. MÉTODO DE PRUEBA DE VERIFICACIÓN DE ACERO INOXIDABLE.

Descrito en el punto C de este informe de resultados de prueba o ensayo con referencia a la NORMA AISI/SAE de clasificación internacional del acero inoxidable.

1.1. CONDICIONES DE PRUEBA.

Características de la muestra: Capa externa del termotanque

Modelo de la muestra: 12/1800

Secuencia de pruebas	Valor de prueba 2020-10-08
Prueba de control magnético *Exposición a la atracción magnética*	Aplicada
Prueba con reactivo de manganeso (Mn) *Aplicación electroquímica*	Aplicada
Prueba con reactivo de molibdeno (Mo) *Aplicación de reactivo químico*	Aplicada

1.2. RESULTADOS DE LA PRUEBA.

CUMPLE: el acero inoxidable coincide con la clasificación de la NORMA AISI/SAE 201 ó 304.

Variables de medición o evaluación	Clasificación AISI del acero inoxidable	Valor de prueba	Composición Química
Prueba de control magnético	Serie 400	Negativo	No aplica
Prueba con reactivo de manganeso (Mn)	**Serie 201**	**Positivo**	**5.5 a 10.5% de Mn**
	Serie 300	Negativo	Menor a 2% de Mn
Prueba con reactivo de molibdeno (Mo)	Serie 304	Negativo	Ausencia de Mo
	Serie 316	Negativo	2 a 3% de Mo

1.3. FOTOGRAFÍAS DEL SISTEMA DURANTE LA PRUEBA. (12:20 h)

1.4. OBSERVACIONES.

Sin observaciones.

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2. MÉTODO DE PRUEBA DE VERIFICACIÓN DE ACERO INOXIDABLE.
Descrito en el punto C de este informe de resultados de prueba o ensayo con referencia a la NORMA AISI/SAE de clasificación internacional del acero inoxidable.

2.1. CONDICIONES DE PRUEBA.

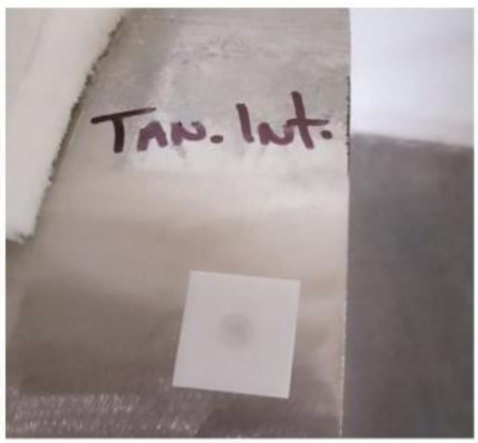
Características de la muestra: Capa interna del termotanque
Modelo de la muestra: 12/1800

Secuencia de pruebas	Valor de prueba 2020-10-08
Prueba de control magnético *Exposición a la atracción magnética*	Aplicada
Prueba con reactivo de manganeso (Mn) *Aplicación electroquímica*	Aplicada
Prueba con reactivo de molibdeno (Mo) *Aplicación de reactivo químico*	Aplicada

2.2. RESULTADOS DE LA PRUEBA.
CUMPLE: el acero inoxidable coincide con la clasificación de la NORMA AISI/SAE 304.

Variables de medición o evaluación	Clasificación AISI del acero inoxidable	Valor de prueba	Composición Química
Prueba de control magnético	Serie 400	Negativo	No aplica
Prueba con reactivo de manganeso (Mn)	Serie 201	Negativo	5.5 a 10.5% de Mn
	Serie 300	**Positivo**	**Menor a 2% de Mn**
Prueba con reactivo de molibdeno (Mo)	**Serie 304**	**Positivo**	**Ausencia de Mo**
	Serie 316	Negativo	2 a 3% de Mo

2.3. FOTOGRAFÍAS DEL SISTEMA DURANTE LA PRUEBA. (12:40 h)

2.4. OBSERVACIONES.
Sin observaciones.

IDEREE ENERGIA RENOVABLE Y EFICIENCIA ENERGÉTICA	Informe de Pruebas Pruebas particulares de calidad		
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3. MÉTODO DE PRUEBA DE VERIFICACIÓN DE ACERO INOXIDABLE.

Descrito en el punto C de este informe de resultados de prueba o ensayo con referencia a la NORMA AISI/SAE de clasificación internacional del acero inoxidable.

3.1. CONDICIONES DE PRUEBA.

Características de la muestra: Estructura de soporte del sistema

Modelo de la muestra: 12/1800

Secuencia de pruebas	Valor de prueba 2020-10-08
Prueba de control magnético *Exposición a la atracción magnética*	Aplicada
Prueba con reactivo de manganeso (Mn) *Aplicación electroquímica*	Aplicada
Prueba con reactivo de molibdeno (Mo) *Aplicación de reactivo químico*	Aplicada

3.2. RESULTADOS DE LA PRUEBA.

CUMPLE: el acero inoxidable coincide con la clasificación de la NORMA AISI/SAE 201.

Variables de medición o evaluación	Clasificación AISI del acero inoxidable	Valor de prueba	Composición Química
Prueba de control magnético	Serie 400	Negativo	No aplica
Prueba con reactivo de manganeso (Mn)	**Serie 201**	**Positivo**	**5.5 a 10.5% de Mn**
	Serie 300	Negativo	Menor a 2% de Mn
Prueba con reactivo de molibdeno (Mo)	Serie 304	Negativo	Ausencia de Mo
	Serie 316	Negativo	2 a 3% de Mo

3.3. FOTOGRAFÍAS DEL SISTEMA DURANTE LA PRUEBA. (13:05 h)


3.4. OBSERVACIONES.

Sin observaciones.

IDEREE ENERGIA RENOVABLE Y EFICIENCIA ENERGÉTICA	Informe de Pruebas Pruebas particulares de calidad		
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4. MÉTODO DE PRUEBA PARA DETERMINAR LA CAPACIDAD NOMINAL DEL SISTEMA.
Método de prueba particular con referencia a lo especificado en el inciso 8.13 Método de Prueba para Determinar la Capacidad del Termotanque del DTESTV.

4.1. CONDICIONES DE PRUEBA.

Variables de medición o evaluación	Valor de prueba 2020-10-07	
	Termotanque	Tubo evacuado
Peso con agua en kg (B)	115.8	5.30
Peso sin agua en kg (A)	13.4	2.40
Diferencia del peso en kg (B-A)	102.4	2.90

4.2. RESULTADOS DE LA PRUEBA.

CUMPLE: la capacidad nominal de 130 a 150 Litros.

Variables de medición o evaluación	Termotanque	Colector (12 Tubos)	Suma Total del Sistema
Capacidad Nominal del Sistema en Litros	**102.58**	**34.86**	**137.44**

Se utiliza agua a 20°C. La densidad del agua a esa temperatura a 1 atm es 998.29 kg/m^3.

4.3. FOTOGRAFÍAS DEL SISTEMA DURANTE LA PRUEBA. (16:20 h)

4.4. OBSERVACIONES.
Sin observaciones.

IDEREE ENERGIA RENOVABLE Y EFICIENCIA ENERGÉTICA	Informe de Pruebas Pruebas particulares de calidad		
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5. MÉTODO DE PRUEBA PARA LA MEDICION DEL ESPESOR DE MATERIALES DEL SISTEMA.
Método de medición particular para la toma de lectura del espesor de la lámina del termotanque seleccionando diferentes puntos de medición de forma aleatoria.

5.1. CONDICIONES DE PRUEBA.

Características de la muestra: Capa externa de acero del termotanque
Modelo de la muestra: 12/1800

Condiciones y secuencia de prueba	Valor de prueba 2020-10-08
Irradiación solar incidente sobre el material de prueba antes y durante la prueba	No
Corte transversal del termotanque en la mitad longitudinal dividiendo el cuerpo en dos partes iguales	Aplicada
Eliminación de residuos de la lámina de acero inoxidable generados por el corte transversal a la mitad longitudinal del termotanque	Aplicada
Toma de lectura aleatoria del espesor de la lámina de acero inoxidable en diferentes puntos de la circunferencia	Aplicada

5.2. RESULTADOS DE LA PRUEBA.

CUMPLE: el espesor del material es superior al espesor mínimo de 0.31 mm.

Medición No.	Valor de prueba (mm)	Medición No.	Valor de prueba (mm)	Promedio de Medición (mm)
1	0.32	**7**	0.32	0.328
2	0.32	**8**	0.34	
3	0.33	**9**	0.33	
4	0.34	**10**	0.33	
5	0.33	**11**	0.34	
6	0.32	**12**	0.32	

5.3. FOTOGRAFÍAS DEL SISTEMA DURANTE LA PRUEBA. (11:10 h)


5.4. OBSERVACIONES.
Sin observaciones.

IDEREE ENERGIA RENOVABLE Y EFICIENCIA ENERGÉTICA	**Informe de Pruebas** **Pruebas particulares de calidad**		
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6. MÉTODO DE PRUEBA PARA LA MEDICION DEL ESPESOR DE MATERIALES DEL SISTEMA.
Método de medición particular para la toma de lectura del espesor de la lámina de acero inoxidable del termotanque seleccionando diferentes puntos de medición de forma aleatoria.

6.1. CONDICIONES DE PRUEBA.

Características de la muestra: Capa interna de acero del termotanque
Modelo de la muestra: 12/1800

Condiciones y secuencia de prueba	Valor de prueba 2020-10-08
Irradiación solar incidente sobre el material de prueba antes y durante la prueba	No
Corte transversal del termotanque en la mitad longitudinal dividiendo el cuerpo en dos partes iguales	Aplicada
Eliminación de residuos de la lámina de acero inoxidable generados por el corte transversal a la mitad longitudinal del termotanque	Aplicada
Toma de lectura aleatoria del espesor de la lámina de acero inoxidable en diferentes puntos de la circunferencia	Aplicada

6.2. RESULTADOS DE LA PRUEBA.

CUMPLE: el espesor del material es superior al espesor mínimo de 0.50 mm.

Medición No.	Valor de prueba (mm)	Medición No.	Valor de prueba (mm)	Promedio de Medición (mm)
1	0.51	**7**	0.54	0.523
2	0.52	**8**	0.52	
3	0.54	**9**	0.52	
4	0.52	**10**	0.51	
5	0.52	**11**	0.54	
6	0.51	**12**	0.53	

6.3. FOTOGRAFÍAS DEL SISTEMA DURANTE LA PRUEBA. (11:30 h)

6.4. OBSERVACIONES.
Sin observaciones.

IDEREE ENERGIA RENOVABLE Y EFICIENCIA ENERGÉTICA	Informe de Pruebas Pruebas particulares de calidad		
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7. MÉTODO DE PRUEBA PARA LA MEDICION DEL CALIBRE DE MATERIALES DEL SISTEMA.
Método de medición particular para la toma de lectura del espesor del material aislante del termotanque seleccionando diferentes puntos de medición de forma aleatoria.

7.1. CONDICIONES DE PRUEBA.

Características de la muestra: Aislante del termotanque (Poliuretano)
Modelo de la muestra: 12/1800

Condiciones y secuencia de prueba	Valor de prueba 2020-10-08
Irradiación solar incidente sobre el material de prueba antes y durante la prueba	No
Corte transversal del termotanque en la mitad longitudinal dividiendo el cuerpo en dos partes iguales	Aplicada
Eliminación de residuos de la lámina de acero inoxidable generados por el corte transversal a la mitad longitudinal del termotanque	Aplicada
Toma de lectura aleatoria del espesor del material aislante en diferentes puntos de la circunferencia	Aplicada

7.2. RESULTADOS DE LA PRUEBA.

CUMPLE: el espesor del material es superior al espesor mínimo de 50 mm.

Medición No.	Valor de prueba (mm)	Medición No.	Valor de prueba (mm)	Promedio de Medición (mm)
1	51.96	7	51.28	50.738
2	49.76	8	50.08	
3	51.08	9	49.97	
4	51.16	10	50.98	
5	50.35	11	51.37	
6	50.72	12	50.15	

7.3. FOTOGRAFÍAS DEL SISTEMA DURANTE LA PRUEBA. (11:45 h)

7.4. OBSERVACIONES.
Sin observaciones.

IDEREE ENERGIA RENOVABLE Y EFICIENCIA ENERGÉTICA	Informe de Pruebas Pruebas particulares de calidad		
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8. MÉTODO DE PRUEBA PARA LA MEDICION DEL ESPESOR DE MATERIALES DEL SISTEMA.
Método de medición particular para la toma de lectura del espesor del material de la estructura soporte seleccionando diferentes puntos de medición de forma aleatoria.

8.1. CONDICIONES DE PRUEBA.

Características de la muestra: Estructura Soporte del Sistema
Modelo de la muestra: 12/1800

Condiciones y secuencia de prueba	Valor de prueba 2020-10-07
Irradiación solar incidente sobre el material de prueba antes y durante la prueba	No
Se realizan cortes transversales a una pieza de la estructura soporte dividiendo el cuerpo en tres partes iguales	Aplicada
Eliminación de residuos generados por el corte transversal de cada una de las tres partes iguales	Aplicada
Toma de lectura aleatoria del espesor del material de la estructura soporte en diferentes puntos de la pieza cortada	Aplicada

8.2. RESULTADOS DE LA PRUEBA.

CUMPLE: el espesor del material es superior al espesor mínimo de 1.7 mm.

Medición No.	Valor de prueba (mm)	Medición No.	Valor de prueba (mm)	Promedio de Medición (mm)
1	1.71	**7**	1.70	1.718
2	1.73	**8**	1.72	
3	1.70	**9**	1.73	
4	1.72	**10**	1.74	
5	1.72	**11**	1.72	
6	1.71	**12**	1.71	

8.3. FOTOGRAFÍAS DEL SISTEMA DURANTE LA PRUEBA. (16:45 h)

8.4. OBSERVACIONES.
Sin observaciones.

IDEREE ENERGIA RENOVABLE Y EFICIENCIA ENERGÉTICA	Informe de Pruebas Pruebas particulares de calidad		
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9. MÉTODO DE PRUEBA PARA LA MEDICION DEL ESPESOR DE MATERIALES DEL SISTEMA.
Método de medición particular para la toma de lectura del espesor del vidrio de la capa externa del colector solar seleccionando diferentes puntos de medición de forma aleatoria.

9.1. CONDICIONES DE PRUEBA.

Características de la muestra: Capa externa del tubo evacuado
Modelo de la muestra: 12/1800

Condiciones y secuencia de prueba	Valor de prueba 2020-10-07
Irradiación solar incidente sobre el material de prueba antes y durante la prueba	No
Se realizan cortes transversales a tres tubos evacuados dividiendo los cuerpos en dos partes iguales	Aplicada
Eliminación de residuos generados por el corte transversal de cada una de las tres partes iguales	Aplicada
Toma de lectura aleatoria del espesor del material de la capa externa del tubo evacuado en diferentes puntos de la pieza cortada	Aplicada

9.2. RESULTADOS DE LA PRUEBA.

CUMPLE: el espesor del material es superior al espesor mínimo de 2.1 mm.

Medición No.	Valor de prueba (mm)	Medición No.	Valor de prueba (mm)	Promedio de Medición (mm)
1	2.12	7	2.17	2.128
2	2.14	8	2.10	
3	2.10	9	2.11	
4	2.15	10	2.10	
5	2.16	11	2.14	
6	2.14	12	2.11	

9.3. FOTOGRAFÍAS DEL SISTEMA DURANTE LA PRUEBA. (17:20 h)

9.4. OBSERVACIONES.
Sin observaciones.

IDEREE ENERGIA RENOVABLE Y EFICIENCIA ENERGÉTICA	Informe de Pruebas Pruebas particulares de calidad		
Código: PLABSOL-13-F1.10, Rev. 03	**No. de Informe:** 20-CSA-040.1	**Fecha de Emisión:** 2020-12-08	**Página:** 15 DE 20

10. MÉTODO DE PRUEBA PARA LA MEDICION DEL ESPESOR DE MATERIALES DEL SISTEMA.
Método de medición particular para la toma de lectura del espesor del vidrio de la capa interna del colector solar seleccionando diferentes puntos de medición de forma aleatoria.

10.1. CONDICIONES DE PRUEBA.

Características de la muestra: Capa interna del tubo evacuado
Modelo de la muestra: 12/1800

Condiciones y secuencia de prueba	Valor de prueba 2020-10-07
Irradiación solar incidente sobre el material de prueba antes y durante la prueba	No
Se realizan cortes transversales a tres tubos evacuados dividiendo los cuerpos en dos partes iguales	Aplicada
Eliminación de residuos generados por el corte transversal de cada una de las tres partes iguales	Aplicada
Toma de lectura aleatoria del espesor del material de la capa interna del tubo evacuado en diferentes puntos de la pieza cortada	Aplicada

10.2. RESULTADOS DE LA PRUEBA.

CUMPLE: el espesor del material es superior al espesor mínimo de 1.6 mm.

Medición No.	Valor de prueba (mm)	Medición No.	Valor de prueba (mm)	Promedio de Medición (mm)
1	1.60	7	1.62	1.621
2	1.64	8	1.65	
3	1.61	9	1.60	
4	1.63	10	1.61	
5	1.62	11	1.62	
6	1.61	12	1.64	

10.3. FOTOGRAFÍAS DEL SISTEMA DURANTE LA PRUEBA. (17:35 h)

10.4. OBSERVACIONES.
Sin observaciones.

Informe de Pruebas Pruebas particulares de calidad			
Código: PLABSOL-13-F1.10, Rev. 03	No. de Informe: 20-CSA-040.1	Fecha de Emisión: 2020-12-08	Página: 16 DE 20

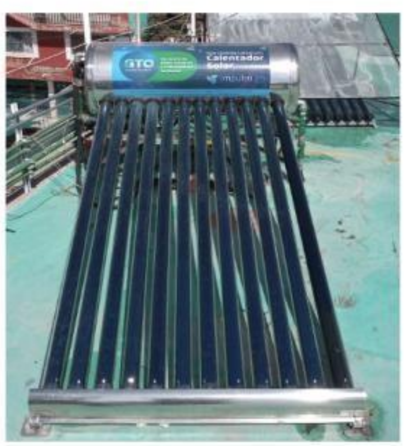
11. MÉTODO DE PRUEBA PARA DETERMINAR EL RENDIMIENTO TÉRMICO.
Método de prueba con acreditación No. MM-1066-169/18, de acuerdo a la NOM-027-ENER/SCFI-2018, inciso 8.1.1 que indica: "La prueba del rendimiento térmico al calentador de agua solar debe realizarse de acuerdo con lo especificado en el capítulo 7 de la norma mexicana NMX-ES-004-NORMEX-2010".

11.1. CONDICIONES DE PRUEBA.

Fecha		Temperatura Prom Diurna °C (≥ 15 °C)	Temperatura Prom Nocturna °C (≥ 5 °C)	Irradiancia H (H > 17 MJ/m^2)	Velocidad del Viento Prom Diurna (V ≤ 3 m/s)	Velocidad del Viento Prom Nocturna (V ≤ 3 m/s)
Día 1	2020-10-21	23.0	19.9	24.2	1.2	1.2
Día 2	2020-10-22	23.1	20.4	22.5	1.5	0.5
Día 3	2020-10-27	23.3	19.4	23.1	1.5	1.1
Día 4	2020-10-28	23.7	19.3	18.9	1.3	1.6
Día 5	2020-10-29	23.7	19.2	18.9	1.1	1.5
Día 6	2020-10-30	21.2	17.4	24.0	1.7	1.3
Día 7	2020-11-02	18.3	11.9	24.7	2.2	1.8
Día 8	2020-11-03	20.3	13.7	24.2	1.3	1.4
Día 9	2020-11-04	21.0	13.5	24.3	1.4	1.3
Día 10	2020-11-05	19.9	13.9	24.8	1.7	1.6
Día 11	2020-11-08	22.3	18.7	23.2	1.3	0.8
Día 12	2020-11-10	23.4	19.7	24.6	1.4	0.4

Incertidumbre de medición (±W/m^2)	1.2%

11.2. FOTOGRAFÍAS DEL SISTEMA DURANTE LA PRUEBA.



11.3. OBSERVACIONES.
Sin observaciones.

IDEREE ENERGIA RENOVABLE Y EFICIENCIA ENERGÉTICA	Informe de Pruebas Pruebas particulares de calidad		
Código: PLABSOL-13-F1.10, Rev. 03	No. de Informe: 20-CSA-040.1	Fecha de Emisión: 2020-12-08	Página: 17 DE 20

APENDICE NORMATIVO 3
Norma Mexicana NMX-ES-004-NORMEX-2010

Latitud Norte: 21° 07´ 22´´ **Medio día solar** 12:30 **(TSV):**
Latitud Oeste: 101° 41´ 00´´

A. Tabulación para la prueba diurna.

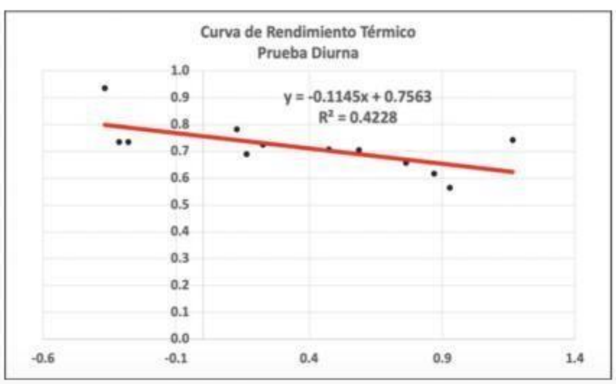
Fecha	No. Prueba	H (MJ/m²)	V (m/s)	T *amb, diurna* °C	T *ini, diurna* °C	T *fin, diurna* °C	X	Y	$Q_{U,diurno}$ MJ
2020-10-21	1	24.2	1.2	23.0	16.2	57.5	-0.3	0.7	17.7
2020-10-22	2	22.5	1.5	23.1	26.0	66.9	0.1	0.8	17.6
2020-10-27	3	23.1	1.5	23.3	36.9	74.7	0.6	0.7	16.25
2020-10-28	4	18.9	1.3	23.7	45.7	78.3	1.2	0.7	14.0
2020-10-29	5	18.9	1.1	23.7	16.7	57.9	-0.4	0.9	17.7
2020-10-30	6	24.0	1.7	21.2	26.7	67.1	0.2	0.7	17.4
2020-11-02	7	24.7	2.2	18.3	37.1	74.9	0.8	0.7	16.23
2020-11-03	8	24.2	1.3	20.3	41.4	76.0	0.9	0.6	14.9
2020-11-04	9	24.3	1.4	21.0	13.3	54.8	-0.3	0.7	17.8
2020-11-05	10	24.8	1.7	19.9	24.0	63.7	0.2	0.7	17.1
2020-11-08	11	23.2	1.3	22.3	33.2	71.3	0.5	0.7	16.36
2020-11-10	12	24.6	1.4	23.4	46.2	78.4	0.9	0.6	13.9

Dónde:

H: Radiación solar incidente sobre el plano de colector solar en unidades de irradiación y durante el periodo de prueba diurna.
V: Velocidad promedio del viento durante la prueba diurna.
$T_{amb,diurna}$: Temperatura promedio del medio ambiente durante la prueba diurna.
$T_{ini,diurna}$: Temperatura homogénea del agua al iniciar la prueba diurna.
$T_{fin,diurna}$: Temperatura homogénea del agua al final de la prueba diurna.
$Q_{U,diurno}$: Calor útil ganado por el sistema durante el periodo diurno, MJ.
X: Diferencia entre temperatura inicial de prueba y temperatura ambiente por MJ/m².
Y: Energía útil ganada después de 8 horas de exposición solar por MJ/m².
m_v: Masa de agua contenida en el equipo, kg.
C: Capacidad calorífica del agua líquida, 0.004186 MJ/(kg °C).

$$X = \frac{T_{ini} - T_{amb}}{H}$$

$$Y = \frac{m_v C (T_{fin} - T_{ini})}{H}$$



IDEREE ENERGIA RENOVABLE Y EFICIENCIA ENERGÉTICA	Informe de Pruebas Pruebas particulares de calidad		
Código: PLABSOL-13-F1.10, Rev. 03	No. de Informe: 20-CSA-040.1	Fecha de Emisión: 2020-12-08	Página: 18 DE 20

B. Tabulación para la prueba nocturna.

Fecha	No. Prueba	V (m/s)	$T_{amb,\ nocturna}$ °C	$T_{ini,\ nocturna}$ °C	$T_{fin,\ nocturna}$ °C	X	$Q_{U,nocturno}$ MJ
2020-10-21	1	1.2	19.9	57.5	49.2	37.6	3.5
2020-10-22	2	0.5	20.4	66.9	56.5	46.5	4.5
2020-10-27	3	1.1	19.4	74.7	61.2	55.3	5.79
2020-10-28	4	1.6	19.3	78.3	62.9	59.1	6.6
2020-10-29	5	1.5	19.2	57.9	49.7	38.7	3.5
2020-10-30	6	1.3	17.4	67.1	55.9	49.7	4.8
2020-11-02	7	1.8	11.9	74.9	60.4	62.9	6.21
2020-11-03	8	1.4	13.7	76.0	61.0	62.4	6.4
2020-11-04	9	1.3	13.5	54.8	45.9	41.3	3.8
2020-11-05	10	1.6	13.9	63.7	52.7	49.8	4.7
2020-11-08	11	0.8	18.7	71.3	57.3	52.6	6.02
2020-11-10	12	0.4	19.7	78.4	63.0	58.7	6.6

Dónde:

V: Velocidad promedio del viento durante la prueba nocturna.
$T_{amb,nocturna}$: Temperatura promedio del medio ambiente durante la prueba nocturna.
$T_{ini,nocturna}$: Temperatura homogénea del agua al inicio de la prueba nocturna.
$T_{fin,nocturna}$: Temperatura homogénea del agua al final de la prueba nocturna.
$Q_{U,nocturno}$: Calor útil perdido por el sistema durante el periodo nocturno, MJ.
X: Diferencia entre temperatura inicial de prueba y temperatura ambiente.
Y: Energía útil perdida después de 15 horas sin exposición solar.
m_v: Masa de agua contenida en el equipo, kg.
C: capacidad calorífica del agua líquida, 0.004186 MJ/(kg °C).

$$X = T_{ini} - T_{amb}$$

$$Y = m_v C\,(T_{ini} - T_{fin})$$

IDEREE ENERGIA RENOVABLE Y EFICIENCIA ENERGÉTICA	Informe de Pruebas Pruebas particulares de calidad		
Código: PLABSOL-13-F1.10, Rev. 03	**No. de Informe:** 20-CSA-040.1	**Fecha de Emisión:** 2020-12-08	**Página:** 19 DE 20

APENDICE NORMATIVO 5
Norma Mexicana NMX-ES-004-NORMEX-2010

Formato de Etiqueta

Información de salida de la prueba de Rendimiento Térmico para los datos que serán del conocimiento público del sistema y servirán como constancia de la certificación. Cifras obtenidas de los resultados de prueba en el Apéndice Normativo 3.

	Calor útil del sistema por día de 8 horas Mega Joules / día			Calor útil del sistema por día de 24 horas Mega Joules / día			Temperatura del agua a las 8 horas °C			Temperatura del agua a las 24 horas °C		
Semana No.	Frío	Templado	Cálido	Frío	Templado	Cálido	Frío	Templado	Cálido	Frío	Templado	Cálido
Promedio	17.3	16.3	14.2	12.7	10.3	7.7	65.9	73.6	77.6	55.0	59.6	62.3

IDEREE ENERGIA RENOVABLE Y EFICIENCIA ENERGÉTICA	Informe de Pruebas Pruebas particulares de calidad		
Código: PLABSOL-13-F1.10, Rev. 03	**No. de Informe:** 20-CSA-040.1	**Fecha de Emisión:** 2020-12-08	**Página:** 20 DE 20

APENDICE INFORMATIVO 1
Norma Mexicana NMX-ES-004-NORMEX-2010

Relación entre MJ y kg de gas LP

1.0 *kg de gas LP equivalente por día de 24 horas.*

El valor se calcula dividiendo la ganancia de calor del sistema por día entre el poder calorífico del gas LP y la eficiencia de conversión energética mínima.

$$m_{gas,\ LP} = \frac{m_V C\ (T_{fin,nocturno} - T_{ini,diurno})}{PC*EGC}$$

Dónde:

$m_{gas,LP}$: Masa del gas LP en kg.
m_v: Masa de agua contenida en el equipo, kg.
C: Capacidad calorífica del agua (0.004186 MJ/kgk).
$T_{fin,nocturno}$: Temperatura del agua al final de la prueba nocturna, ºC.
$T_{ini,diurno}$: Temperatura del agua al inicio de la prueba diurna, ºC.
PC: Poder calorífico del gas LP (46.057 MJ/kg).
EGC: Eficiencia de conversión energética (EGC)=0.74 Es la eficiencia mínima de 74% para calentadores de gas de acuerdo a la norma correspondiente.

2.0 *Funcionamiento característico del sistema solar evaluado.*

El funcionamiento está determinado por las condiciones climatológicas promedio en cada zona climática en los Estados Unidos Mexicanos.

	kg de Gas LP eqivalente en 24 horas			kg de Gas LP eqivalente en 30 días		
Semana No.	Frío	Templado	Cálido	Frío	Templado	Cálido
Promedio	0.4	0.3	0.2	11.1	9.0	6.8

Annex B. Determination of discount for adjustment of temporariness at installation

Table 28. Emission reductions from the SWH system for different fuel shifts per year and per month

	RE tCO_2 / device year	RE tCO_2 / device month
LP Gas	0.3314029037	0.02761690864
Natural gas	0.2946387147	0.02455322623
Electricity 2021	0.6171131725	0.05142609771
Electricity 2022	0.6346199292	0.0528849941

Table 29. 2021 emission reductions by month

2021		**LP Gas**	**Natural gas**	**Electricity**	**Total**
Month	**# SWH installed**	**tCO_2**	**tCO_2**	**tCO_2**	**tCO_2**
January	0	0	0	0	0
February	0	0	0	0	0
March	109	1.90	0.05	1.18	3.13
April	2240	38.97	1.10	24.19	64.26
May	2262	39.36	1.11	24.43	64.89
June	2262	39.36	1.11	24.43	64.89
July	2262	39.36	1.11	24.43	64.89
August	2262	39.36	1.11	24.43	64.89
September	2262	39.36	1.11	24.43	64.89
October	2262	39.36	1.11	24.43	64.89
November	2262	39.36	1.11	24.43	64.89
December	2262	39.36	1.11	24.43	64.89
Total					587

Table 30. 2022 emission reductions by month

2022		LP Gas	Natural gas	Electricity	Total
Month	**# SWH installed**	**tCO_2**	**tCO_2**	**tCO_2**	**tCO_2**
January	0	0	0	0	0
February	0	0	0	0	0
March	0	0	0	0	0
April	0	0	0	0	0
May	0	0	0	0	0
June	0	0	0	0	0
July	90	1.57	0.04	1.00	2.61
August	1063	18.49	0.52	11.81	30.82
September	1467	25.52	0.72	16.29	42.54
October	2387	41.53	1.17	26.51	69.21
November	2840	49.41	1.39	31.54	82.35
December	4003	69.65	1.97	44.46	116.07
Total					**344**

Table 31. Estimated emission reductions for 2023 by month

2023		LP Gas	Natural gas	Electricity	Total
Month	**# SWH installed**	**tCO_2**	**tCO_2**	**tCO_2**	**tCO_2**
January	0	0	0	0	0
February	0	0	0	0	0
March	0	0	0	0	0
April	0	0	0	0	0
May	1375	23.92	0.68	15.27	39.87
June	2750	47.85	1.35	30.54	79.74
July	4125	71.77	2.03	45.81	119.61
August	5500	95.69	2.70	61.08	159.48
September	6875	119.62	3.38	76.35	199.34
October	8250	143.54	4.05	91.62	239.21

November	9625	167.46	4.73	106.89	279.08
December	11000	191.39	5.40	122.16	318.95
Total					**1435**

Table 32. Estimated emission reductions for 2024 by month

2024		**LP Gas**	**Natural gas**	**Electricity**	**Total**
Month	**# SWH installed**	**tCO_2**	**tCO_2**	**tCO_2**	**tCO_2**
January	0	0	0	0	0
February	0	0	0	0	0
March	0	0	0	0	0
April	0	0	0	0	0
May	500	8.70	0.25	5.55	14.50
June	1000	17.40	0.49	11.11	29.00
July	1500	26.10	0.74	16.66	43.49
August	2000	34.80	0.98	22.21	57.99
September	2500	43.50	1.23	27.76	72.49
October	3000	52.20	1.47	33.32	86.99
November	3500	60.90	1.72	38.87	101.48
December	4000	69.59	1.96	44.42	115.98
Total					**522**

Annex C. Application for the installation of an SCA System

Programa de Calentadores Solares, Ejercicio fiscal 2021.

Anexo 2

Formato de Solicitud de Apoyo (FO-CSA-01)

Fecha de solicitud:

Datos generales de la persona solicitante (La identificación deberá coincidir con la CURP)		
Nombre completo (incluir correo electrónico en caso de tenerlo)	CURP	Teléfonos de contacto
Informantes adecuados (adjuntar identificación oficial de cada uno de los informantes adecuados declarados)		
Nombre completo	Parentesco	Teléfono de contacto
Nombre completo	Parentesco	Teléfono de contacto

Ubicación de la vivienda donde habita la persona solicitante (comprobante de domicilio deberá coincidir)			
Municipio		**Calle**	
Localidad		**Número**	
Colonia		**Entre calles**	
Código Postal		**Latitud**	
		Longitud	

Datos generales de la vivienda y sus ocupantes					
Tipo de hogar parental		**Cantidad de habitantes en vivienda**		**Ingreso mensual vivienda**	$
Monoparental liderado por mujer jefa de familia				Se obtiene al sumar los ingresos mensuales de cada uno de los habitantes que aportan ingresos.	
Monoparental liderado por hombre jefe de familia		Mujeres		**Promedio de ingreso por habitante**	$
Biparental		Hombres		Se obtiene al dividir el ingreso mensual de la vivienda entre el total de habitantes declarados.	

Combustible utilizado para calentar agua									
Gas LP		Gas natural		Electricidad		Leña/carbón		Otro	

Cantidad mensual		Unidad de medida		Monto mensual	

Declaraciones de la persona solicitante

1. Cuento con todas las adecuaciones mínimas requeridas, establecidas en la fracción VII del artículo 16.
2. Hago constar que la información es verídica y estoy consciente que si al momento de que me realicen una visita de verificación la información no concuerda, mi solicitud se dará por cancelada.
3. En caso que mi solicitud de apoyo sea aprobada conforme a lo establecido en las Reglas de Operación del Programa, autorizo la instalación del calentador solar en mi vivienda.
4. Manifiesto que no tuve que realizar ningún pago en especie o en económico para realizar mi solicitud de apoyo consistente en un calentador solar de agua a través del programa de Calentadores Solares, ejercicio fiscal 2021 operado por la Secretaría de Medio Ambiente y Ordenamiento Territorial así como las contrapartes con las cuales la SMAOT tiene suscrito un convenio de coordinación.
5. Confirmo estar enterada(o) que el apoyo solicitado está sujeto a la disponibilidad de equipos así como a la aprobación del Comité Técnico de Evaluación y Dictaminación del Programa en cuestión, por lo que entregar mi expediente completo y contar con todas las adecuaciones establecidas en la fracción VII del artículo 16 de las Reglas de Operación no da por aprobado el apoyo.
6. AVISO DE PRIVACIDAD: Se hace de mi conocimiento que los datos recabados en este formato están protegidos de acuerdo a lo que establece el Art. 5 y 7 de la Ley de Protección de Datos Personales en Posesión de Sujetos Obligados para el Estado de Guanajuato. Mis datos personales podrán ser transmitidos a otras autoridades siempre y cuando los datos se utilicen para el ejercicio de facultades propias de las mismas, además de otras transmisiones previstas en el artículo 97 de la Ley de Protección de Datos Personales en Posesión de Sujetos Obligados para el Estado de Guanajuato. Confirmo que el aviso de privacidad podrá ser consultado en la página institucional en Internet: http://smaot.guanajuato.gob.mx/sitio/

Atentamente

Nombre o firma de persona solicitante o informante adecuado

"Este programa es público, ajeno a cualquier partido político. Queda prohibido el uso para fines distintos a los establecidos en el programa."

Annex D. Carbon rights agreement between project owner and developer

RENOVABLES

Renovables de México, S. A. de C.V.

RENOVABLES DE MEXICO

RFC: RME0809017J6 Régimen: 601 - General de Ley Personas Morales
Circuito Logístico 150 A Col.Bustamante CP 36128
Silao, Silao de la Victoria, Guanajuato, México
facturacion@renovablesmx.com

Cliente: CL008 RFC: GEG850101FQ2
GOBIERNO DEL ESTADO DE GUANAJUATO
PASEO DE LA PRESA 103 Int.
CENTRO CP: 36000
GUANAJUATO, Guanajuato, México
Uso CFDI: G03-Gastos en general
Forma de pago: 99-Por definir
Método de Pago: PPD - Pago en parcialidades o diferido

FACTURA REN-1350

Fecha y Hora: 15/Ago/2022 10:46:56
Tipo de Comprobante: I - Ingreso
Lugar de expedición: 36128
Vencimiento: 15/Ago/2022
Moneda: MXN T.C.: 1.00000
Condición de pago:

No.	Código	Clave producto/servicio/descripción	Cantidad	Unidad	V. Unitario	Importe
1	NA007	POSICION ORIG. 1. CLAVE ART. 50403345. CALENTADOR SOLAR DE AGUA. CENTRO G. 3208 PARTIDA PRESUP. 4410 ELEMENTO PEP: Y22.GG.Q1417. DESCRIPCION TECNICA: CALENTADOR SOLAR DE AGUA. MARCA: RENOVABLES. MODELO: 12/1800. PEDIDO 9900009147. CONTRATO: 8900004084	340.00000	H87-Pieza	$7,021.55	$2,387,327.58
		Base: 2.38733e+006, Impuesto: 002, IVA,Tasa: 0.160000, Importe: 381972.41				

Total unidades: 340
Referencia:
Importe con letra: dos millones setecientos sesenta y nueve mil doscientos noventa y nueve Pesos 99/100 M.N.

Subtotal: $2,387,327.58
IVA: $381,972.41
Total: **$2,769,299.99**

Folio Fiscal: 8662807B-CB76-4C21-BA3C-E8B4BE4FBB12

Serie del Certificado del emisor: 00001000000505142236 No. de serie del Certificado del SAT: 00001000000505142236 Fecha y hora de certificación: 2022-08-15T10:47:08

Sello digital del CFDI

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Sello del SAT

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Cadena original del complemento del certificación digital del SAT

||1.1|8662807B-CB76-4C21-BA3C-E8B4BE4FBB12|2022-08-15T10:47:08|MAS0810247C0|IFCxsHLWvtb019g1Xt4m2z90yS9uCdw8x7tE6qyd3BAGvhdjyf
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J4MVvljrcVsAjQw0I/5CN/Zo1PWCssQt36svs7dA==|00001000000505142236||

Este documento es una representación impresa de un CFDI

Versión del comprobante: 3.3

CFDI Relacionado
Tipo relación: -