OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

23716

CPML
CENTRO DE PRODUCCIÓN MÁS LIMPIA

UNI

AEE INTEC

UNIDO

NICATEC

Sustainable Industrial Resource Management in selected national priority sectors of Nicaragua

PROYECTO NICATEC

FINAL PROYECT REPORT

UE/NIC/06/001 - Contract no. 16001409ML/CZ
UNIDO Project Number: UE/NIC/06/001

October 30th, 2009

Cooperación Austríaca para el Desarrollo

Summary

- Preparation and accomplishment of the VII module of the course "Solar Thermal Systems monitoring and follow up", carried out at the Universidad National de Ingeniería in Managua from 23 – 25 March.
- Analysis of 35 feasibility studies carried out
- Detailed design, layout and calculation of the material demand for nineteen (19) solar thermal systems for Hotel Mansión Teodolinda (2 plants), Hotel Estrella, Hotel Villa Paraíso (2 plants), Lácteos Santa Martha, Industria Alimenticia RODCEN, Finca Santa Clara, Hotel Los Altos, Hotel Posada Don Pantaleón, Hogar de Protección Pajarito Azul, HEODRA, Hotel Brandt's, Hotel Vistamar, Hotel Villa Aller, La Matagalpa, Lácteos Nicarao and Fábrica POCHI.
- From the beginning of the project and based on the feasibility studies, the following 9 Hotels and 8 companies were selected for the installation of demonstration plants:
    - ✓ Hotel Mansión Teodolinda, Managua
    - ✓ Hotel Estrella, Managua
    - ✓ Hotel Villa Paraiso, Ometepe Island
    - ✓ Hotel Villa Aller, Ometepe Island
    - ✓ Hotel Los Altos, Managua
    - ✓ Hotel Posada Don Pantaleón
    - ✓ Hotel Vista Mar, Managua
    - ✓ Hotel Brandt´s, Managua
    - ✓ Hotel Sueño de Meme, León
    - ✓ Lácteos Santa Martha, Jinotega
    - ✓ Lácteos Nicarao, Rivas
    - ✓ Industria Alimenticia RODCEN, Managua
    - ✓ Finca Santa Clara, Carazo
    - ✓ Fábrica de Alimentos La Matagalpa, Matagalpa
    - ✓ Hogar de Protección Pajarito Azul, Managua
    - ✓ Fábrica POCHI, Managua
    - ✓ Hospital Escuela Oscar Danilo Rosales Aguilar HEODRA, León.

  It has to be mentioned that instead of 5 solar thermal demonstration plants – which were foreseen in the contract - now in total 19 solar thermal plants at 17 sites were installed in the tourism and industry sector of Nicaragua.
- The commissioning of the 19 solar thermal plants has been done.
- Preparation and accomplishment of three more awareness raising events. The Regional Workshop on Thermal Solar Energy (INCAE, March), National Solar Energy Forum (León, July) and the Regional Workshop 2009 "Business Opportunities for Solar Energy in Central America" (Barceló Managua, October).

- The maintenance guidelines for solar thermal systems has been updated and selected companies have been trained to perform it according to the required standard.
- Participation in the fair of renewable energy in the National University of engineering

I. Previous Activities

Activities 2006

- Preparatory meeting in Vienna (11 – 13 July 2006) in order to schedule the work programme in detail and to describe the activities for the whole duration of the project (3 years) and especially for the first 12 months of the project.
- Preparation of training material and the preparation of the first and second training course
- Pre-selection of companies for case studies based on the company profiles provided by CPmL.
- Conduction of a kick-off meeting for CPmL staff to introduce the project and the work programme (Managua: 24 July 2006).
- Company visits from the metal-mechanic sector to collect information on their previous experience with solar thermal systems and the capability of these Nicaraguan companies to manufacture, assemble and install solar thermal systems.
- Company visits (food and tourism sector) to discuss their interest in the installation of a solar thermal system and to collect data and information to be able to carry out feasibility studies.
- Feasibility studies for four companies from the food sector (1 canning factory, 2 dairies, 1 slaughterhouse) and for two Hotels.
- Design of two pilot plants to be installed during the 3rd mission. Elaboration of a tender document for the pilot plants.
- Conduction of two training courses in Managua for CPmL staff and other national experts from 31 July – 3 August 2006 (1st training course) and from 25th to 27th of October 2006 (2nd training course).
- Final meetings with CPmL staff to discuss and prepare the follow-up activities for the following missions.
- Follow –up technical advise for CPmL and Nicaraguan companies.
- Preparation of mission reports and the final reports for phase I and phase II.

Activities 2007

- Activities of the project included the preparation of feasibility studies which was carried out by the trained personnel of the CPC-N, and preparation of the sites for installation of the third mission of AEE to Nicaragua which was carried out by Mr. Werner Weiss and Dr. Hans Schweiger, international experts on energy efficiency and renewable energy from AEE - Institute for Sustainable Technologies (AEE INTEC), located in Gleisdorf, Austria.
- In March 2007 a study tour for a Nicaraguan delegation to Austria was organised. Four project participants were invited to the study tour. One week attending to manufacturers installers and installed systems all over Austria was accomplished.
- A call for tenders was organized in to purchase and delivery the materials and components for installing the solar thermal systems in Nicaragua. All required materials were purchased and delivered to Nicaragua.
- AEE experts visited Nicaragua for the 3rd training course and system installation from 24th of April to 4th of May 2007.
- Installation of two pilot plants and training of solar companies in the installation of solar thermal systems.
- Detailed planning, design and cost calculation of the first demonstration plants, which will be installed at Nicaraguan hotels in August 2007
- Review and evaluation of new feasibility studies carried out by CPmL since October 2006
- Meeting with NCPC staff and AEE INTEC staff to discuss the follow-up activities for the next 6 months.
- Preparation of a mission report and a progress report for phase III
- Preparation of the fourth training course; Preparation of a training manual and documentation The agenda for the 4th training course was prepared by AEE INTEC in July a sent to CPmL. CPmL made all organizational arrangements in Nicaragua (invitation of the participants, reservation of rooms, computers and other training facilities). Power point slides and additional material (EXCEL calculation tools and exercises for students) were sent to CPmL prior to the training course and have been translated and delivered to the students in printed and electronic format. In total 11 copies of the training manual were printed by CPmL and distributed to the participants of the fourth training course.
- Simulation software for the fourth training course: The agreement with the German company Valentin Energiesoftware GmbH., which provides the software T*Sol has been renewed, to use the simulation software for training purposes free of charge.

Activities 2008

- Preparation and accomplishment of two training workshops. The 5th training workshop was carried out on 17 and 18 January 2008 and the 6th training workshop was carried out on 4th, 7th and 8th July 2008. All training courses took place at the National University Engineering in Managua.
- Analysis of 23 feasibility studies carried out.
- Detailed design, layout and calculation of the material demand for fiveteen (15) solar thermal systems for Hotel Mansión Teodolinda (2 plants), Hotel Estrella, Hotel Villa Paraíso (2 plants), Lácteos Santa Martha, Industria Alimenticia RODCEN, Finca Santa Clara, Hotel Los Altos, Hotel Posada Don Pantaleón Hotel Brandt's, Hotel Vistamar, Hotel Villa Aller, La Matagalpa, Lácteos Nicarao and Empresa Productora de agua POCHI.
- From the beginning of the project and based on the feasibility studies, the following 5 Hotels and 3 companies were selected for the installation of demonstration plants:
  - ✓ Hotel Mansión Teodolinda, Managua
  - ✓ Hotel Estrella, Managua
  - ✓ Hotel Villa Paraiso, Ometepe Island
  - ✓ Hotel Los Altos, Managua
  - ✓ Hotel Posada Don Pantaleón
  - ✓ Lácteos Santa Martha, Jinotega
  - ✓ Industria Alimenticia RODCEN, Managua
  - ✓ Finca Santa Clara, Carazo

  It has to be mentioned that instead of 5 solar thermal demonstration plants – which were foreseen in the contract - now in total 10 solar thermal plants at 8 sites were installed in the tourism and industry sector of Nicaragua.
- The commissioning of the 10 solar thermal plants has been done.
- Preparation and accomplishment of the one more awareness raising event. The "Foro de Energía Solar 2008" took place in Managua at the Centro de Capacitación PAEBANIC in Managua on 3 July 2008. Besides the vice-minister Lorena Lanza of Energy, representatives from the Austrian Development Agency and 67 participants from national congress, government administration, the university, companies and the media attended this event.
- Preparation of maintenance guidelines for solar thermal systems has been prepared and selected companies have been trained to perform it according to the required standard.
- Three companies have been trained and have installed the solar systems in Nicaragua.
- Relocation of the solar system pilot in Home of children Pajarito AZUL, Managua.
- Participation in the fair of renewable energy in the National University of engineering

II. Outputs

1.1. The staff of the Centre and a number of selected national consultants trained on UNIDO's SIRM concept, with emphasis on the development, application and transfer of ESTs.

1.1.1. Appoint the international experts for delivering training on the UNIDO's SIRM concept, with emphasis on the development, construction, assembling, application and transfer of ESTs.

In July 2006 AEE INTEC (Austrian research institute) was selected to be the international expert organization to support the Cleaner Production Center of Nicaragua to carry out all training activities. All scheduled training workshop have been successfully carried out.

1.1.2. Elaborate an extensive survey on locally available materials and develop a modular plant concept to respond to the needs of the potential clients. Based on the results of an economic analysis of the locally available materials and their potential to be used in the development of the ESTs, identify which components can be produced in Nicaragua or if an assembling system should be introduced.

An extensive survey was carried out to identify the main stakeholders. Four companies to be trained in installation of EST were identified. Those companies had experience in working with environmental and Renewable technology. The training was to upgrade the skills of their technicians to cope with the international requirements of the new identified EST.

The survey identified Thermal Solar Systems to be the more relevant technology to be transferred. Design and installation of Thermal Solar Systems was identified to be the activity with higher added value. Therefore, it was agreed to focus the training in this two activities.

Metal mechanic workshops were visited to assess the capability to assemble the components of the solar system. Main barrier was identified to be the lack of availability of materials to build nationally the components. As a result, importing the components from already certified companies was agreed, in order to assure the success installations. The survey was attached to the assessment report of 2007. There are not experienced suppliers of thermal solar systems components in the national market.

Clients with demand of hot water between 60°C to 85°C were identified to be **agro food industry** and **Hotels**. Agro food industry uses warm water for production processes and cleaning. Hotels use warm water for showers, cooking and the laundry.

1.1.3. Collect information on the national experts interested in participating in the training course and proceed to the selection of a minimum of 20 participants.

The selection criteria for participating in the training course were established to be: Sound experience in working with industry, preferable in the selected sectors (food, tourism and metal mechanic); academic background in science or equal practical work experience; experience in CP related areas is an asset.

Attendants from installing companies, consultants, government representatives and academia were identified. Special invitation was send to invite participants from other countries of the Central American Region. *List of participants to the VII workshops can be found in annex 1.*

1.1.4. Organize and carry out national and regional workshops to disseminate the results of the EST demonstration projects. Evaluate the possibility to extend the same approach to companies of other companies and sectors

The VII module of the course "Solar Thermal Systems monitoring and follow up" was carried out at the Universidad National de Ingeniería in Managua from 23 – 25 March. 25 participants attended the training course, organized by AEE INTEC and Cleaner Production Center, with a total length of 18 hours of classroom session, also accompanied with a field visits to companies where were installed solar thermal systems.

Figure 1. Course Solar Thermal Systems. Module VI. " Solar Thermal Systems monitoring and follow up"

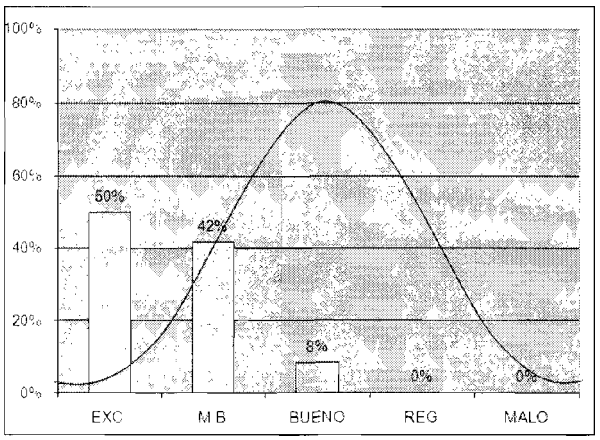
During the training attended staff of the companies installing, students in recent years of the careers of Industrial Engineer and mechanics of the National Engineering University, teachers at the university, staff of companies interested in the installation of solar thermal systems and technical staff of CPmL, adding a total of 25 people.

The module VI of the course " Solar Thermal Systems monitoring and follow up " of the draft NICATEC, to resulted in the creation of practical skills in the information analysis of the Monitoring and Follow

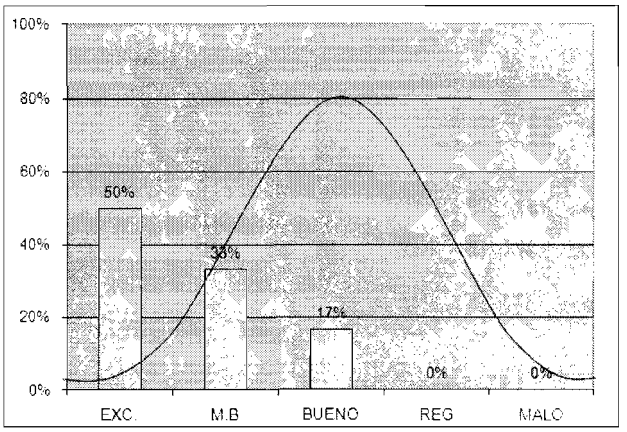
up of Solar Thermal Systems, mainly the automatic controls and download information of their software.

1.1.5. Carry out a final evaluation test upon completion of the training course.

An extensive evaluation of the training course was also carried out by CPmL. The participants evaluated the organization, the content of the course as well as the presenters by more than 85% as either "excellent" or "very good". The detailed results are presented in the following graphs.

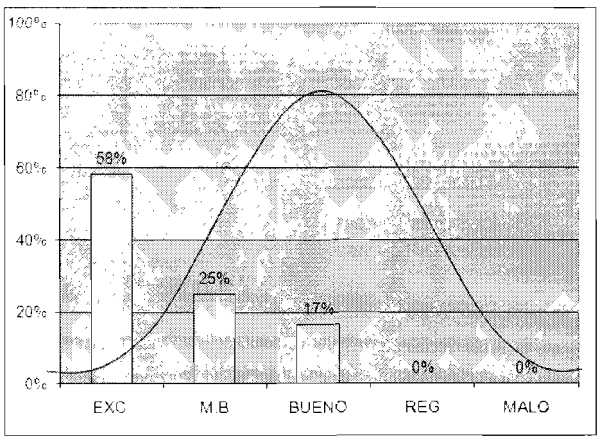


Balance Theoretical and practical

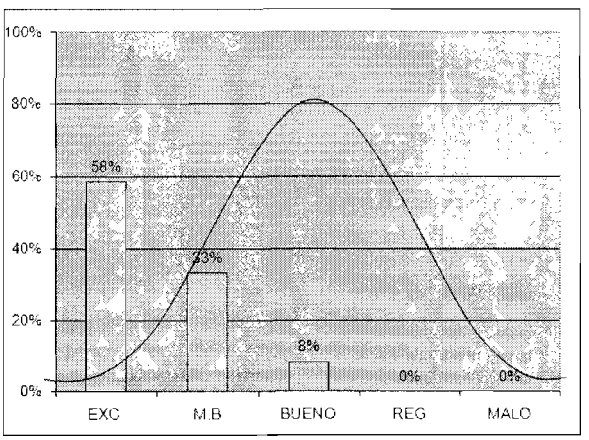


Content of the Course

Similarly participants evaluated the performance of the trainers during the development of the course. That was described as very good



General Assessment of the Trainers



Capacity to respond to questions submitted

1.2. SIRM demonstration projects have been implemented, at least a minimum of three involving one company per participating sector (food, tourism and metal mechanic sector).

1.2.1. Establish evaluation criteria for the selection of companies that are interested in the implementation of the SIRM demonstration projects and carry out the final selection of the companies and national experts.

The evaluation criteria for implementing installation of thermal solar systems in companies are described in the following table:

Table 1. Evaluation Criteria

Concept	Criteria	Comment
Companies from the agro food or Hotel industry	Small or Medium Size company	Willing to adapt their procedure to the use of solar system and contributing economically to the installation
Use of warm water	From 60°C to 85°C	Water storage tanks from 300 l to 2000 l
Contribution of the project	Up to the needed contribution so that the pay back time is reduced to four years	The rest of the investment has to be provided by the receiving company
Dissemination proposes	The company will sign an commitment to be used as dissemination installation	Time and conditions for interested visitors have to be prepared

1.2.2. Establish individual agreements with the participating companies and carry out initial meetings at plant level to discuss the individual needs, benefits and timeframe for the implementation of the SIRM demonstration projects.

Fifty seven companies have signed an agreement to be visited to assess the installation of thermal solar systems. The list of companies is show in table 2 and 3. In all companies, a feasibility study was carried out and an investment proposal was submitted.

Table 2. Companies visited to implement thermal solar systems.

No.	Company for which a feasibility study was carried out	Comment
1	Matadero PROINCASA	Not signed, the company had interest in pollution prevention

No.	Company for which a feasibility study was carried out	Comment
2	Matadero Nuevo Carnic	Feasibility study carried out in November 2006
3	Hotel CAOBA-1	Hotel closed : no more activity
4	Hotel Backpacker´s Inn	Feasibility study carried out in February 2009
5	UNI	Feasibility study carried out in October 2006
6	Hotel Selva Negra	Small demand of hot water
7	Lácteos la completa	Not signed, they had other activities (re-opening)
8	Ríos de Leche, Santo Tomás	The company wasn't willing to contribute with their share of the investment due to its economical situation
9	Lácteos Masiguito	The company wasn't willing to contribute with their share of the investment due to its economical situation
10	Hotel SUYAPA BEACH	The company wasn't willing to contribute with their share of the investment due to its economical situation
11	Taller de Rectificación el Triunfo	The company wasn't willing to contribute with their share of the investment due to its economical situation
12	Hospital Alemán Nicaragüense	It is a governmental hospital and couldn't obtain authorization for the use of funds
13	Los pipitos, Managua	Lack of funds for their share of investment
14	TIP TOP industrial - Ticuantepe	More detailed study needed the system was too big for this project
15	MACESA	Feasibility study carried out in December 2006
16	Tenería Batan	Feasibility study carried out in November 2006
17	Panadería El León Dorado	Feasibility study carried out in November 2006
18	NicaraoCoop	More detailed study needed the system was too big for this project
19	Ministerio de Transporte	Feasibility study carried out in February 2009
20	Hotel El Convento	Quick Scan carried out in May 2008
21	Clínica Hospital San José	Feasibility study carried out in June 2009
22	NAISA	Feasibility study carried out in May 2008
23	Matadero PROCERSA	Feasibility study carried out in May 2007
24	Hotel Casa Naranja	Feasibility study carried out in June 2008
25	Hotel Boutique	Feasibility study carried out in June 2008
26	INGEMANN Nic	Feasibility study carried out in July 2008
27	Rastro Municipal Masaya	Feasibility study carried out in April 2009
28	Hotel Guayacan	Feasibility study carried out in July 2008

No.	Company for which a feasibility study was carried out	Comment
29	Hotel Europa	Feasibility study carried out in July 2008
30	Turicentro Estelimar	Feasibility study carried out in August 2008
31	Hostal La Comarca	Feasibility study carried out in July 2008
32	Restaurante Ola Verde	Feasibility study carried out in July 2008
33	Hostal La Granja	Feasibility study carried out in August 2008
34	Hostal Tomabu	Feasibility study carried out in August 2008
35	Chocolate Momotombo	Feasibility study carried out in July 2008
36	Matadero Chontales	Feasibility study carried out in August 2008
37	Hotel Los Portales	Feasibility study carried out in August 2008
38	Hotel CAOBA – 2	Hotel closed: no more activity
39	Industrial de Carnes	The company wasn't willing to contribute with their share of the investment due to its economical situation
40	Hotel Charco Verde	Feasibility study carried out in June 2009
41	Lácteos Masiguito – 2	Feasibility study carried out in October 2009
42	CANTERA	Feasibility study carried out in October 2009

Of all these companies, nineteen demonstration plants have been installed in seventeen companies during the project.

Table 3: Companies with thermal solar systems installed.

No.	Company for which a thermal solar system was installed	Comment
1	Hospital Escuela Oscar Danilo Rosales Aguilar - HEODRA	contract signed, installed in April 2007
2	Hotel Estrella	contract signed, installed in August 2007
3	Hotel Mansión Teodolinda	contract signed, installed in August 2007
4	Hotel Villa Paraíso. Isla de Ometepe, Rivas	Contract signed, installed in January 2008
5	Industrias RODCEN	contract signed, installed in January 2008
6	Lácteos Santa Martha	contract signed, installed in January 2008
7	Finca Santa Clara	contract signed, installed in June 2008
8	Hotel Las Altos	contract signed, installed in June 2008
9	Hotel Posada Don Pantaleón	contract signed, installed in July 2008
10	Hogar de protección "Pajarito Azul"	contract signed, installed in October 2008
11	Hotel Brandt´s	contract signed, installed in February 2009

No.	Company for which a thermal solar system was installed	Comment
12	Lácteos Nicarao	contract signed, installed in March 2009
13	Fábrica POCHI	contract signed, installed in June 2009
14	Hotel Villa Aller	contract signed, installed in June 2009
15	Fábrica de Alimentos La Matagalpa	contract signed, installed in July 2009
16	Hotel Vista Mar	contract signed, two thermal solar systems installed in June – July 2009
17	Hotel Meme	contract signed, installed in November 2009

1.2.3. Develop and implement the work plan for the SIRM demonstration projects in the selected companies.

The following table shows the companies where solar systems have been installed with the specified collector´s area. The project installed a total of **307 m^2** in the **17 companies**.

Table 4. List of Companies with thermal solar systems installed.

No.	Company for which a thermal solar system was installed	Location	Area (m^2)
1	Hospital Escuela Oscar Danilo Rosales Aguilar - HEODRA	León	12 m^2
2	Hotel Sueño de Meme		16 m^2
3	Hotel Villa Paraíso	Isla de Ometepe, Rivas	32 m^2
4	Hotel Villa Aller		6 m^2
5	Lácteos Nicarao	Rivas	19 m^2
6	Fabrica de Alimentos La Matagalpa	Matagalpa	16 m^2
7	Finca Santa Clara	Carazo	6 m^2
8	Lácteos Santa Martha	Jinotega	16 m^2
9	Hotel Posada Don Pantaleón	Managua	16 m^2
10	Hotel Estrella		16 m^2
11	Hotel Las Altos		14 m^2
12	Hotel Brandt´s		32 m^2
13	Hotel Mansión Teodolinda		32 m^2
14	Industrias RODCEN		32 m^2
15	Hotel Vista Mar		20 m^2
16	Hogar de protección "Pajarito Azul"		6 m^2
17	Fábrica POCHI		16 m^2

1.2.4. Provide – on a continuous basis – support and assistance to the companies participating in the projects. Assistance will be provided by the national experts and the staff of the Centre, under the guidance of the international experts

A follow up scheme of six months after the installation has been carried out in each one of the companies. All systems are working without any problems. Examples of designs, layouts and operation values are shown:

i) Demonstration Plant 1 and 2: Hotel Mansión Teodolinda

Hotel "Mansión Teodolinda" in Managua is a Hotel with 41 rooms of 1 and 2 beds respectively. The occupation rate is estimated to be about 70%. The rooms dispose of hot water and air conditioning.

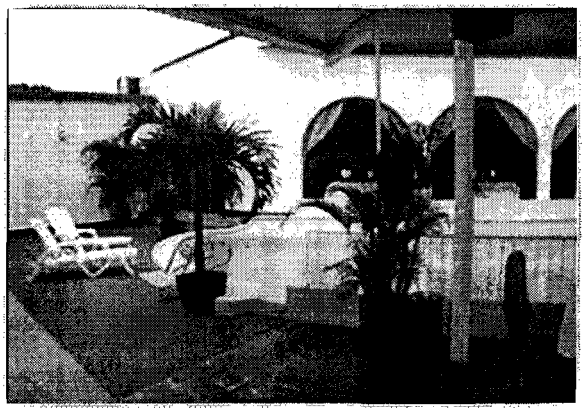


Figure 1: Hotel Mansión Teodolinda in Managua

The hot water demand of this Hotel is about **2,500 litre per day**, corresponding to a heat consumption of about **30 MWh/year**. Based on the feasibility study, a solar thermal system was proposed with a total capacity of **22.4 kW_{th}** (32 m^2 collector area) for hot water preparation, composed of two **sub-systems** (16 m^2 collector area / 11.2 kW_{th} each) for the two main buildings of the Hotel. The proposed system size was designed to cover 77% of the hot water demand.

Design

Based on the feasibility study for Hotel Mansión Teodolinda a detailed design, layout and calculation of the material demand was carried out. An overview of the design results and the key data of the plant are shown in the following figure.

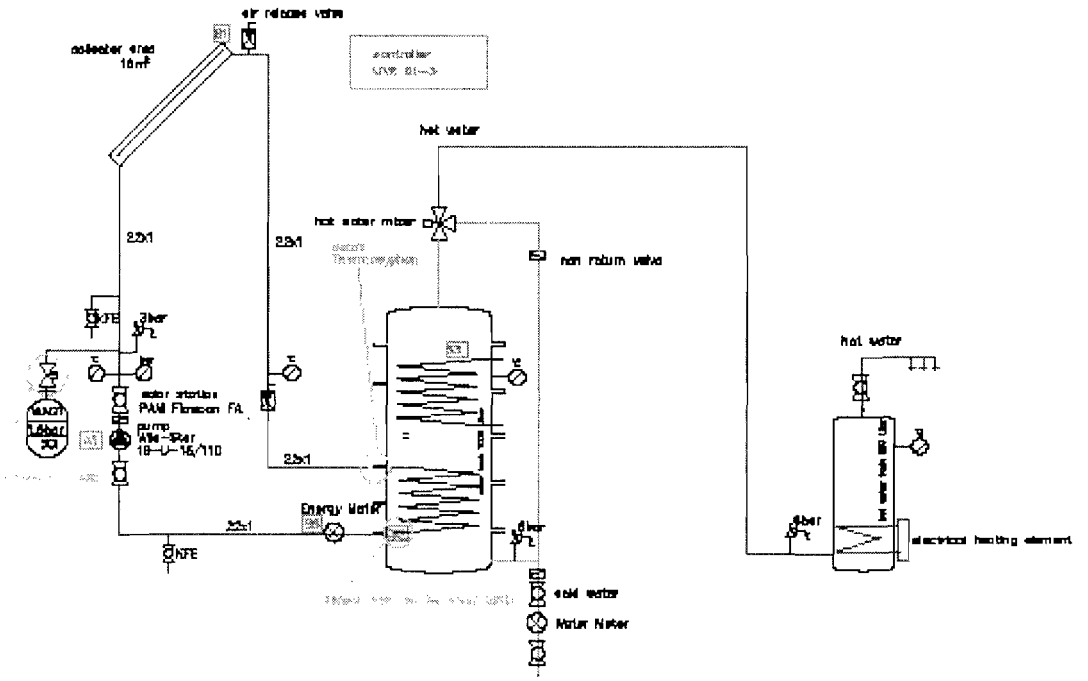


Figure 2: Hydraulic scheme of the solar thermal plants 1 & 2 at Hotel Mansión Teodolinda

Some key data (collector area and inclination, installed capacity, storage capacity) of the two subsystems is shown in tables 5 and 6.

Table 5: Key data of the solar thermal plant at Hotel Mansión Teodolinda 1

Main component of the solar plant	Unit		Remark
Collector area	[m^2]	16	Selective coated absorber
Installed capacity	[kW_{th}]	11.2	
Inclination of the collector	[°]	20	
Hot water storage capacity	[ltr.]	1000	Enamelled steel tank

Table 6: Key data of the solar thermal plant at Hotel Mansión Teodolinda 2

Main component of the solar plant	Unit		Remark
Collector area	[m^2]	16	Selective coated absorber
Installed capacity	[kW_{th}]	11.2	
Inclination of the collector	[°]	20	
Hot water storage capacity	[ltr.]	1000	Enamelled steel tank

Installation

The installation of the these demonstration plants took place in August 2007 by the Nicaraguan company TECNOSOL S.A. with assistance of Rudolf Moschik of AEE INTEC and CPmL staff. The following pictures show the installation of the plants.

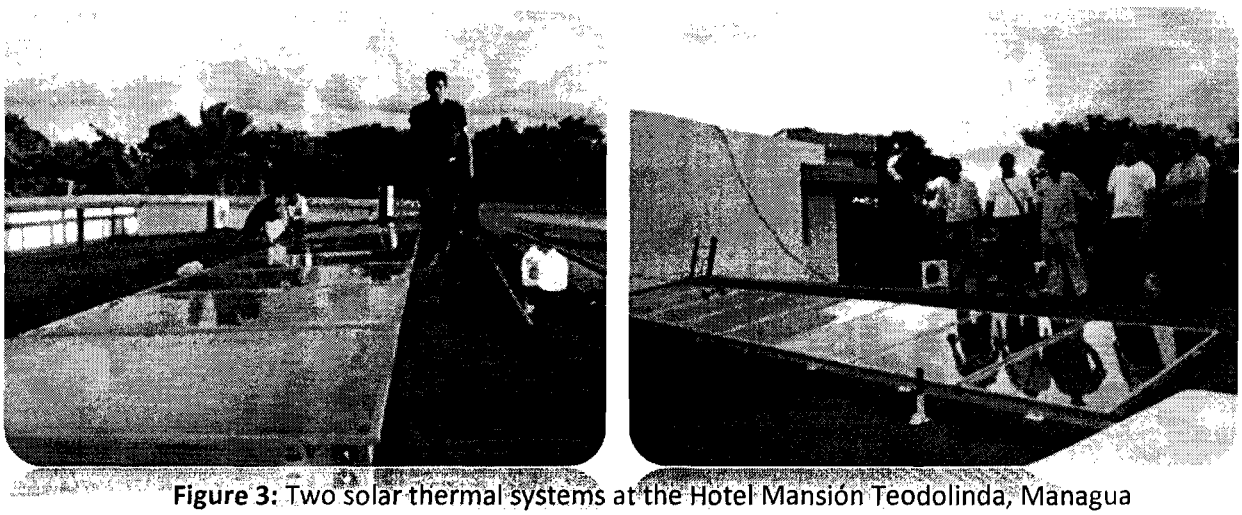


Figure 3: Two solar thermal systems at the Hotel Mansión Teodolinda, Managua

Hotel Mansión Teodolinda is promoting the solar thermal systems also on the front page of the Hotel website. See http://www.teodolinda.com.ni/

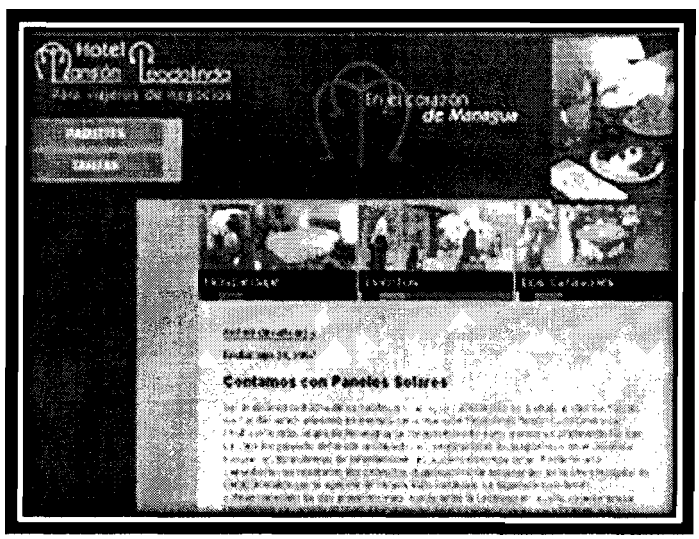


Figure 4: Screen shot of the Hotel website

ii) Demonstration Plant 3: Hotel Estrella

Hotel Estrella in Managua is a Hotel with 40 rooms of 2 and 3 beds respectively. The occupation rate is about 50 %. The rooms dispose of hot water and air conditioning.

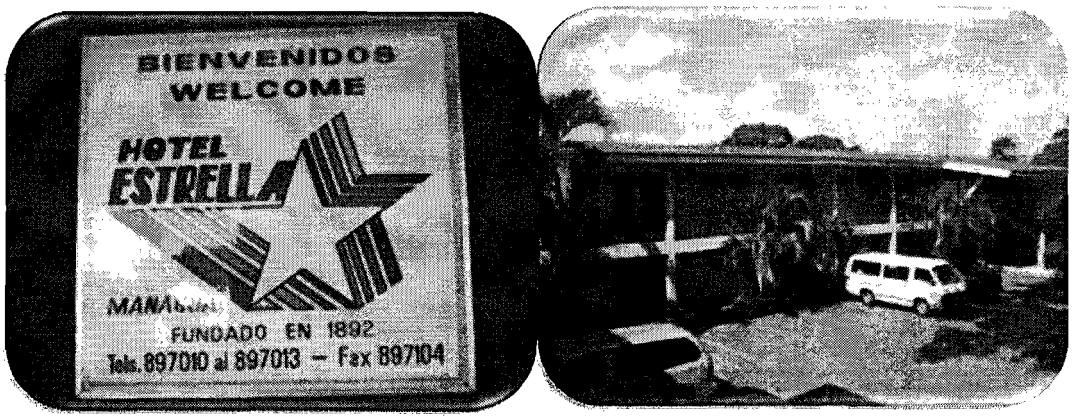


Figure 5: Hotel Estrella in Managua

The hot water demand of the Hotel is about **2,500 litre per day**. As a first step a solar thermal system with a capacity of **11.2 kW_{th}** (16 m^2 collector area) for hot water preheating was proposed to the Hotel owner. The proposed system size is designed to cover 43% of the hot water demand, in order to obtain a good economic performance.

Design

Based on the feasibility study for Hotel Estrella a detailed design, layout and calculation of the material demand were carried out. An overview of the design results and the key data of the plant are shown in the following.

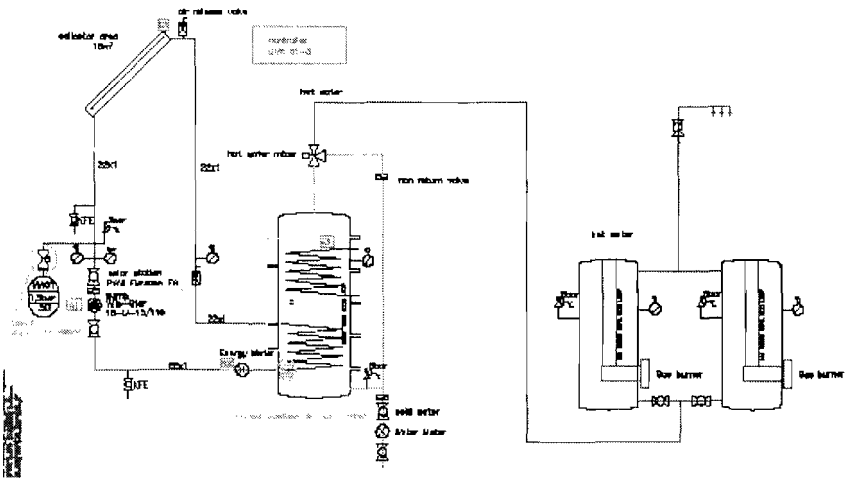


Figure 6: Hydraulic scheme of the solar thermal plant at Hotel Estrella

Some key data (collector area and inclination, installed capacity, storage capacity) of the system is shown in table 7.

Table 7: Key data of the solar thermal plant at Hotel Estrella

Main component of the solar plant	Unit		Remark
Collector area	[m^2]	16	Selective coated absorber
Installed capacity	[kW_{th}]	11.2	
Inclination of the collector	[°]	20	
Hot water storage capacity	[ltr.]	1000	Enamelled steel tank

Installation

The installation of this demonstration plant took place in August 2007 by the Nicaraguan company ECAMI S.A. with assistance of Rudolf Moschik (AEE INTEC) and CPmL staff. The following picture show the installation of the plant.

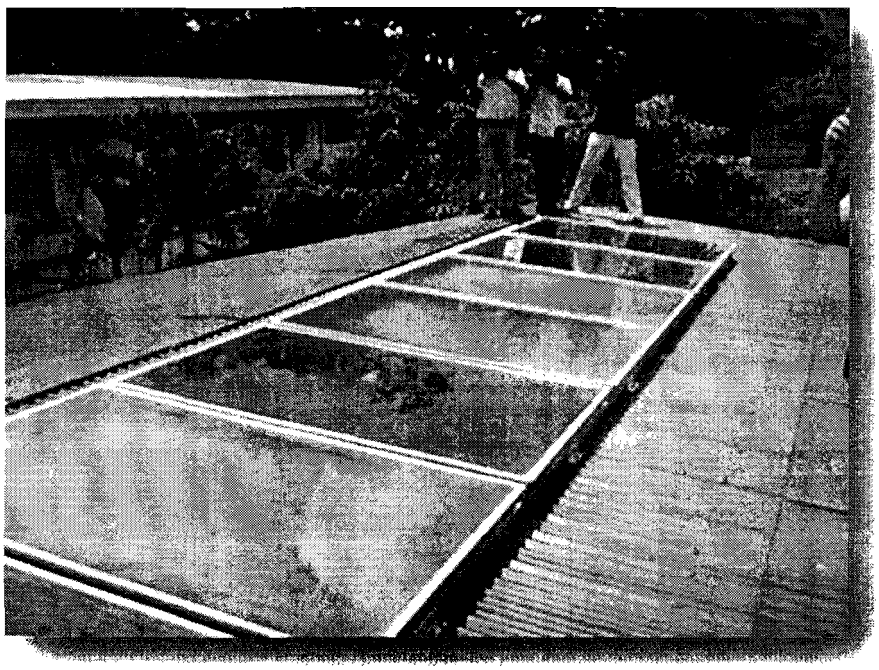


Figure 7: Solar thermal system at the Hotel Estrella in Managua during the presentation to national television press in July 2008

iii) Demonstration Plant 4 and 5: Hotel Villa Paraiso

Hotel Villa Paraiso is located on Ometepe Island in the Lake Nicaragua. The Hotel offers 16 rooms, of which 7 are double rooms and 9 rooms are equipped with 3 beds. The occupation of the Hotel is with 90% quite high all over the year. Before the installation of the solar thermal systems, besides of two rooms, no hot water preparation plant was installed. Therefore it was the intention of the owner of the Hotel to increase the level of comfort by installing solar hot water systems. In addition to the connection of the showers of the 16 rooms to the solar hot water system, also the kitchen of the restaurant was connected to the solar hot water supply.

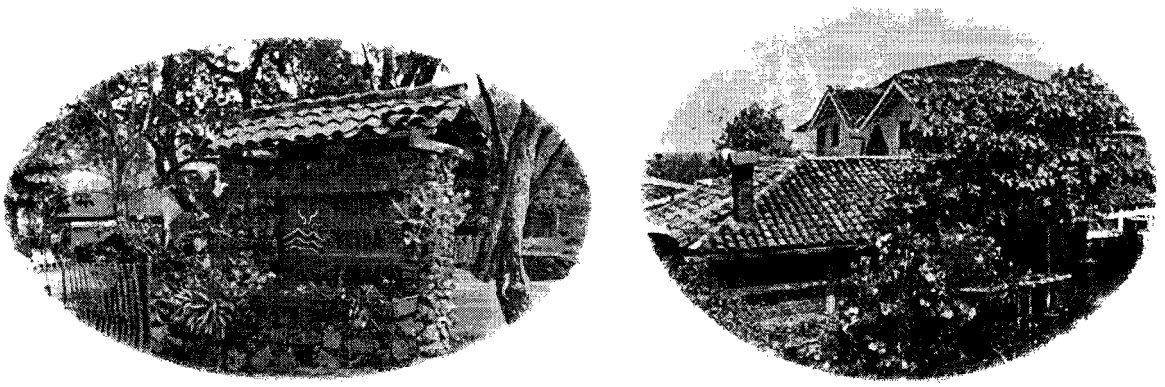


Figure 8: Hotel Villa Paraíso

Since the Hotel consist of several buildings, it was decided to install two independent systems in order to keep the pipe distances short from the collector to the hot water storage tank and to the consumers as short as possible. A further challenge was the fact that no electricity supply from a public gird is available at the location. Due to this reason the pumps of the two installed solar thermal plants are powered also by solar energy via a Photovoltaic panel.

Design

Based on the feasibility study for Hotel Villa Paraíso a detailed design, layout and calculation of the material demand was carried out. An overview of the design results and the key data of the plant are shown in the following.

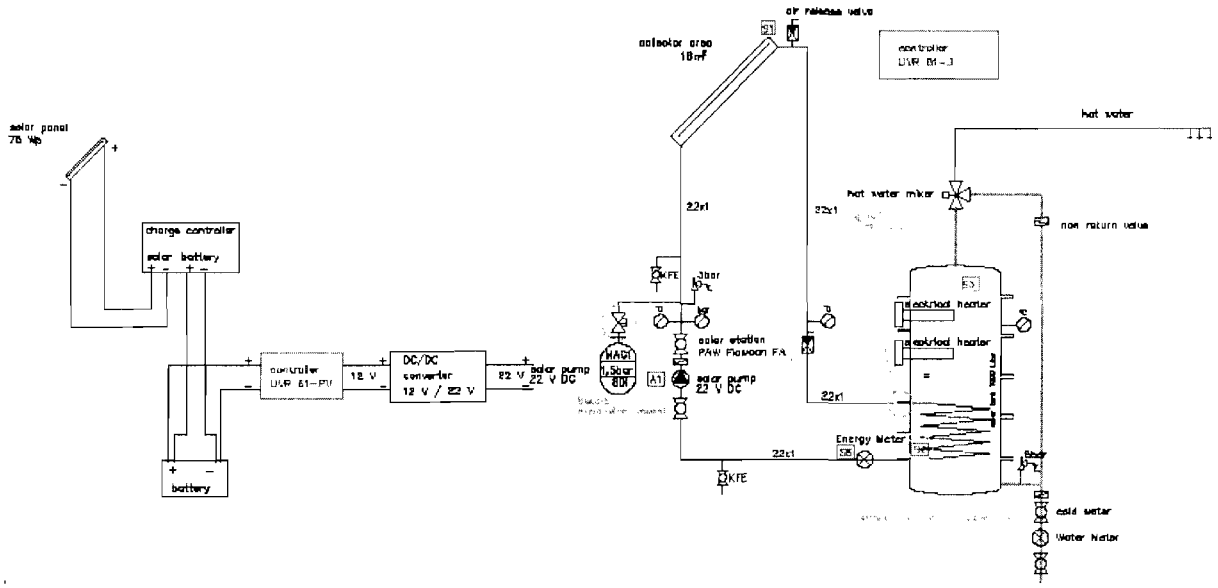


Figure 10: Hydraulic scheme of the solar thermal plant 1 at Hotel Villa Paraiso

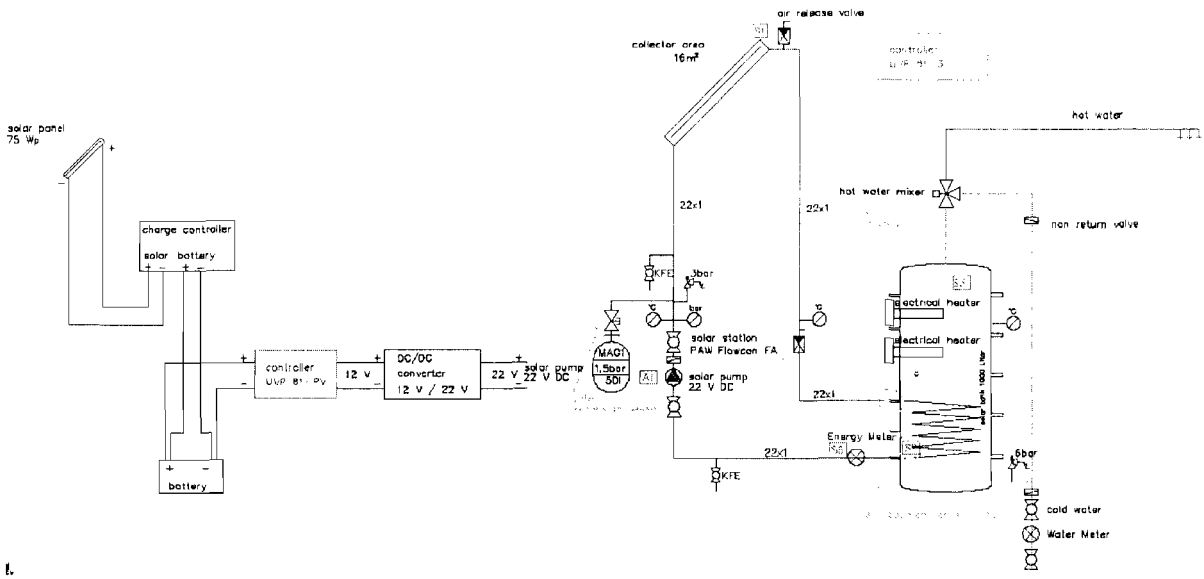


Figure 11: Hydraulic scheme of the solar thermal plant 2 at Hotel Villa Paraiso

Some key data (collector area and inclination, installed capacity, storage capacity) of the two subsystems is shown in tables 8 and 9.

Table 8: Key data of the solar thermal plant at Hotel Villa Paraiso 1

Main component of the solar plant	Unit		Remark
Collector area	[m^2]	15	Selective coated absorber
Installed capacity	[kW_{th}]	10.5	
Inclination of the collector	[°]	25	
Hot water storage capacity	[ltr.]	1000	Enamelled steel tank

Table 9: Key data of the solar thermal plant at Hotel Villa Paraiso 2

Main component of the solar plant	Unit		Remark
Collector area	[m^2]	17.5	Selective coated absorber
Installed capacity	[kW_{th}]	12.25	
Inclination of the collector	[°]	17	
Hot water storage capacity	[ltr.]	1000	Enamelled steel tank

Installation

The installation of these demonstration plants took place in February 2008 by the Nicaraguan company SOLTECH with assistance of Rudolf Moschik of AEE INTEC and CPmL staff.
The following pictures show the installed plants.

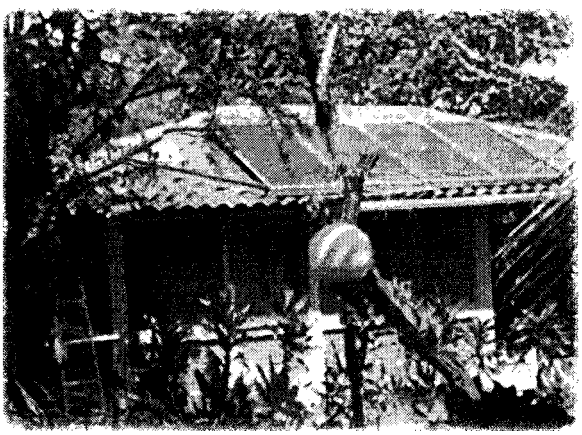


Figure 12: Solar plant 1 at Hotel Villa Pariso. The pump is powered by a PV module

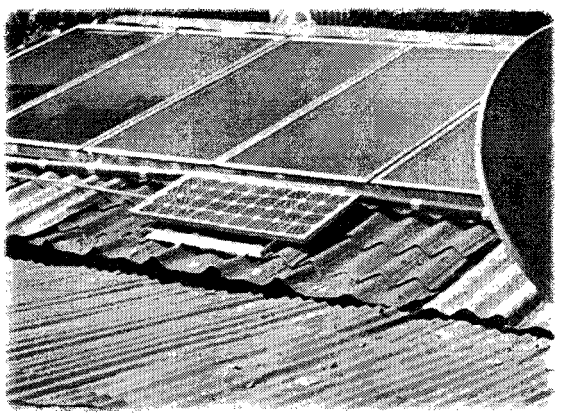


Figure 13: Solar plant 2 at Hotel Villa Pariso. The pump is powered by a PV module

iv) Demonstration Plant 6: Lácteos Santa Martha

Fábrica de Lácteos Santa Martha is located in the city of Jinotega and is producing cheese and other milk products. The company was interested in the installation of a solar thermal system since they wanted to reduce the energy cost for the production.

Figure 14: Lácteos Santa Martha

The company is in operation 10 hours a day and 7 days a week. There are several processes that have a need of hot water in the temperature range between 23 and 95°C. These processes are described in detail in the case study, which was carried out for the company. This case study was submitted to UNIDO in the 3rd progress report of the previous phase of the project.

After discussions with the owner of the company it was decided to install as a first step a solar thermal system, which can provide hot water for the cheese production as well as for cleaning purposes.

Design

Based on the feasibility study for the company Lácteos Santa Martha a detailed design, layout and calculation of the material demand was carried out. An overview of the design results and the key data of the plant are shown in the following.

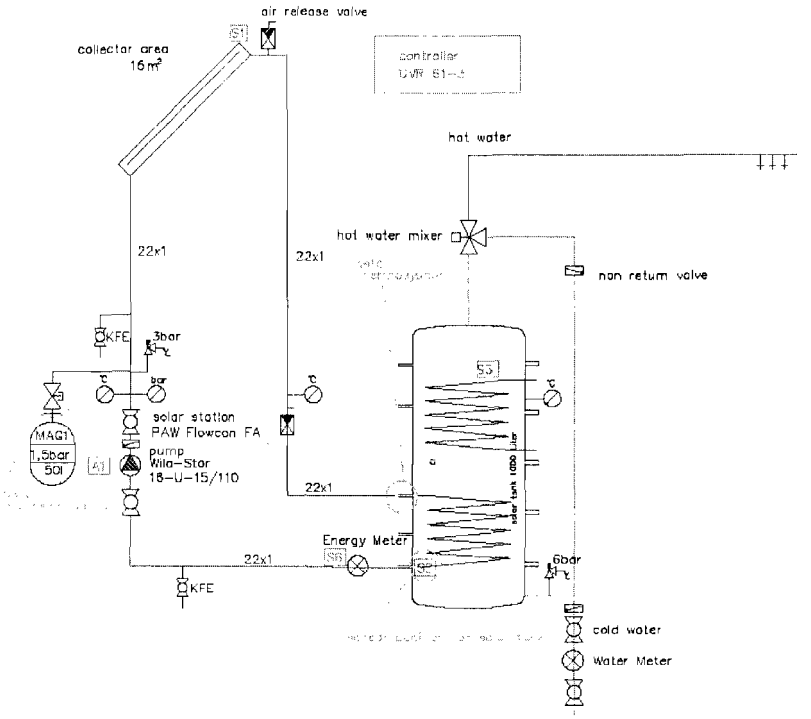


Figure 15: Hydraulic scheme of the solar thermal plant at Lácteos Santa Martha

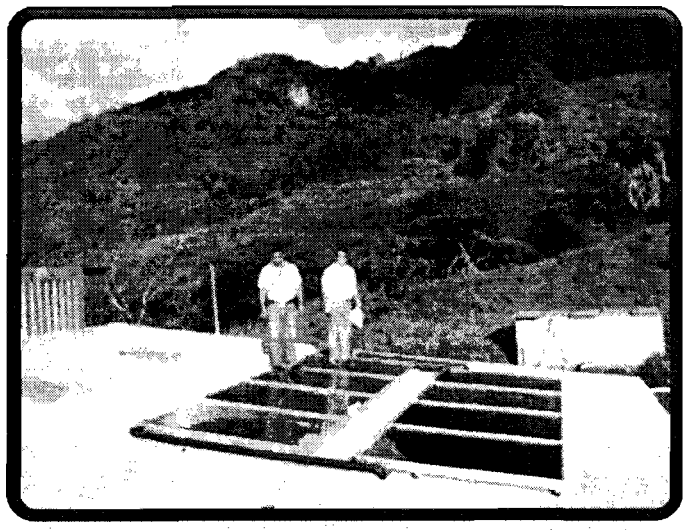
Some key data (collector area and inclination, installed capacity, storage capacity) of the system is shown in table 10.

Table 10: Key data of the solar thermal plant at Lácteos Santa Martha

Main component of the solar plant	Unit		Remark
Collector area	[m^2]	16	Selective coated absorber
Installed capacity	[kW_{th}]	11.2	
Inclination of the collector	[°]	12	
Hot water storage capacity	[ltr.]	1000	Enamelled steel tank

Installation

The installation of the this demonstration plant took place in February 2008 by the Nicaraguan company TECNOSOL S.A. with assistance of Rudolf Moschik (AEE INTEC) and CPmL staff. The following pictures show the installed plant.



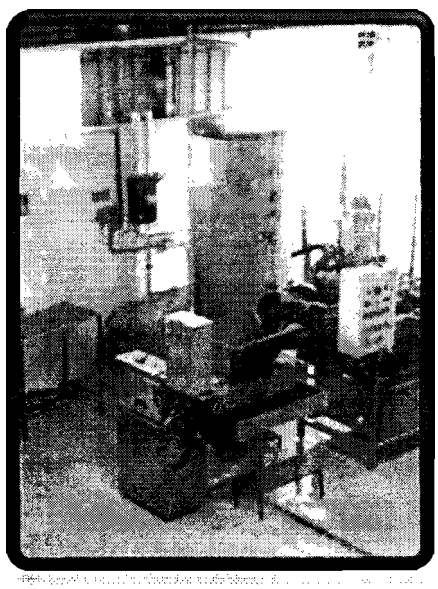


Figure 16: Installed solar thermal system at Lácteos Santa Martha

v) Demonstration Plant 7: Industria Alimenticia RODCEN

The company RODCEN is a small company located in the city of Managua. It employs 12 persons and it is producing tomato sauces and dressings, vinegar, vanilla and mustard for the national Nicaraguan market. Hot water is needed in this company for heating up the different products. The maximum temperature level needed is 80°C.

Figure 17: Products of RODCEN

Design

Based on the case study for the company Industria Alimenticia RODCEN a detailed design, layout and calculation of the material demand was carried out. An overview of the design results and the key data of the plant are shown in the following. A more detailed design plan and the list of materials and components needed were documented in Annex 9 of the 2007 assessment report.

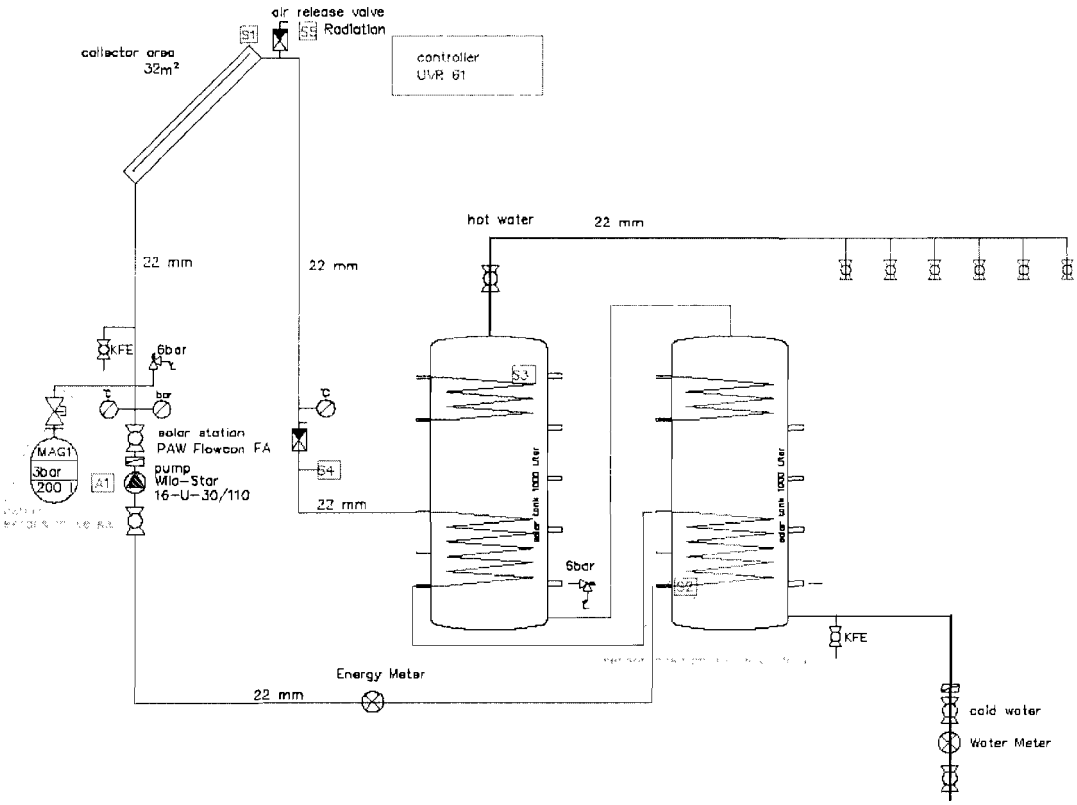


Figure 18: Hydraulic scheme of the solar thermal plant at the company Industria Alimenticia RODCEN

Some key data (collector area and inclination, installed capacity, storage capacity) of the system is shown in table 11.

Table 11: Key data of the solar thermal plant at Industria Alimenticia RODCEN

Main component of the solar plant	Unit		Remark
Collector area	[m^2]	32	Selective coated absorber
Installed capacity	[kW_{th}]	22.4	
Inclination of the collector	[°]	12	
Hot water storage capacity	[ltr.]	2000	Enamelled steel tank

Installation

The installation of this demonstration plant took place in February 2008 by the Nicaraguan company SOLTECH with assistance of Rudolf Moschik (AEE INTEC) and CPmL staff. The following pictures show the installed plant.

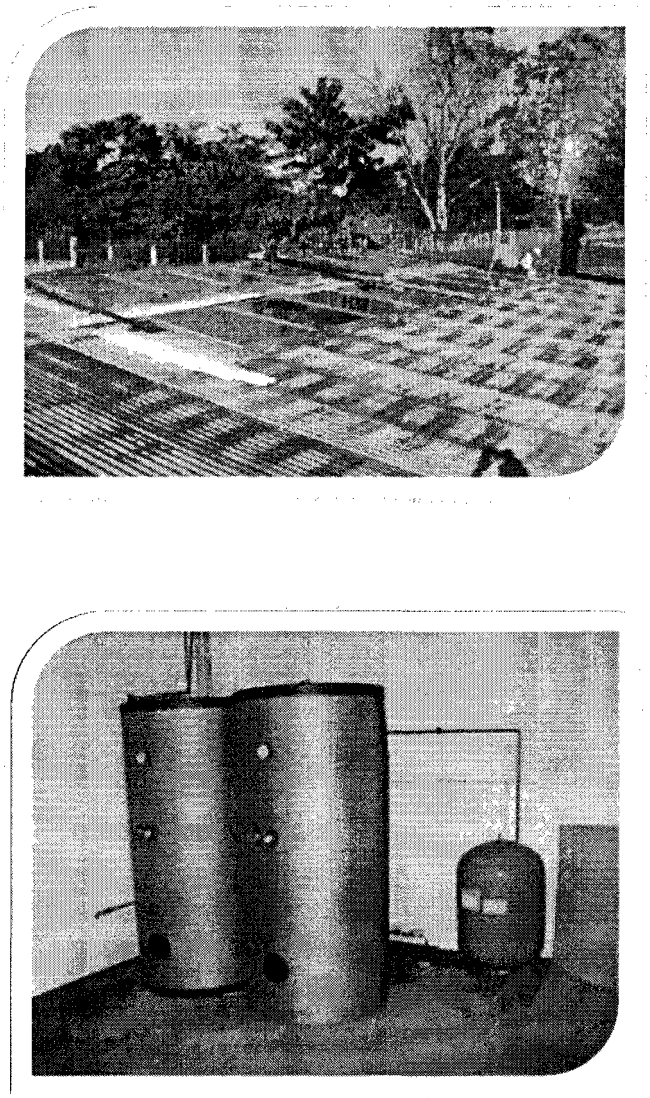


Figure 19: Collector area (up) and hot water storage tanks - 2 x 1000 litre (down).

vi) Demonstration Plant 8: Hotel Las Altos

Hotel "Los Altos" in Managua is a Hotel with 7 suites and 8 apartments, which are equipped with a kitchen and two room units with complete laundry facilities. The hot water demand for the apartments and suites as well as for the laundry (hot water connection to the washing machines) is about 900 litre per day, corresponding to a heat consumption of about 17 MWh/year. Based on the feasibility study a solar thermal system was installed with a total capacity of 9.8 kWth (14 m2 collector area).

Figure 20: Hotel Los Altos in Managua

Design

Based on the case study for Hotel Los Altos a detailed design, layout and calculation of the material demand was carried out. An overview of the design results and the key data of the plant are shown in the following.

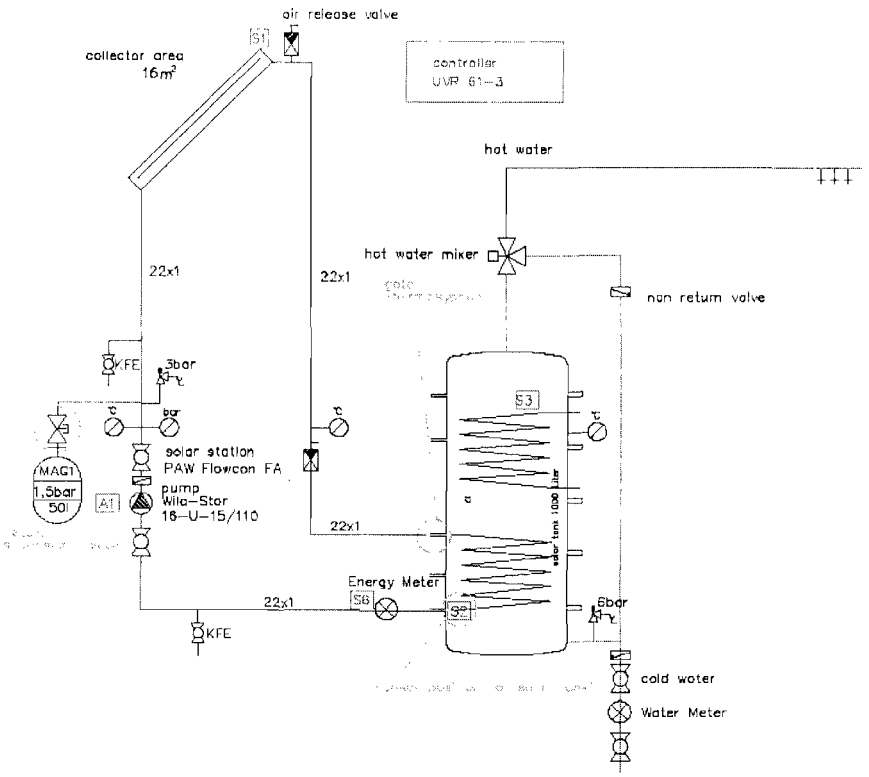


Figure 21: Hydraulic scheme of the solar thermal plant at the Hotel Los Altos

Some key data (collector area and inclination, installed capacity, storage capacity) of the system is shown in table 12.

Table 1: Key data of the solar thermal plant at the Hotel Los Altos

Main component of the solar plant	Unit		Remark
Collector area	[m^2]	14	Selective coated absorber
Installed capacity	[kW_{th}]	9.8	
Inclination of the collector	[°]	32	
Hot water storage capacity	[ltr.]	1000	Enamelled steel tank

Installation

The installation of this demonstration plant took place in June 2008 by the Nicaraguan company SOLTECH and CPmL staff. The following pictures show the installed plant.

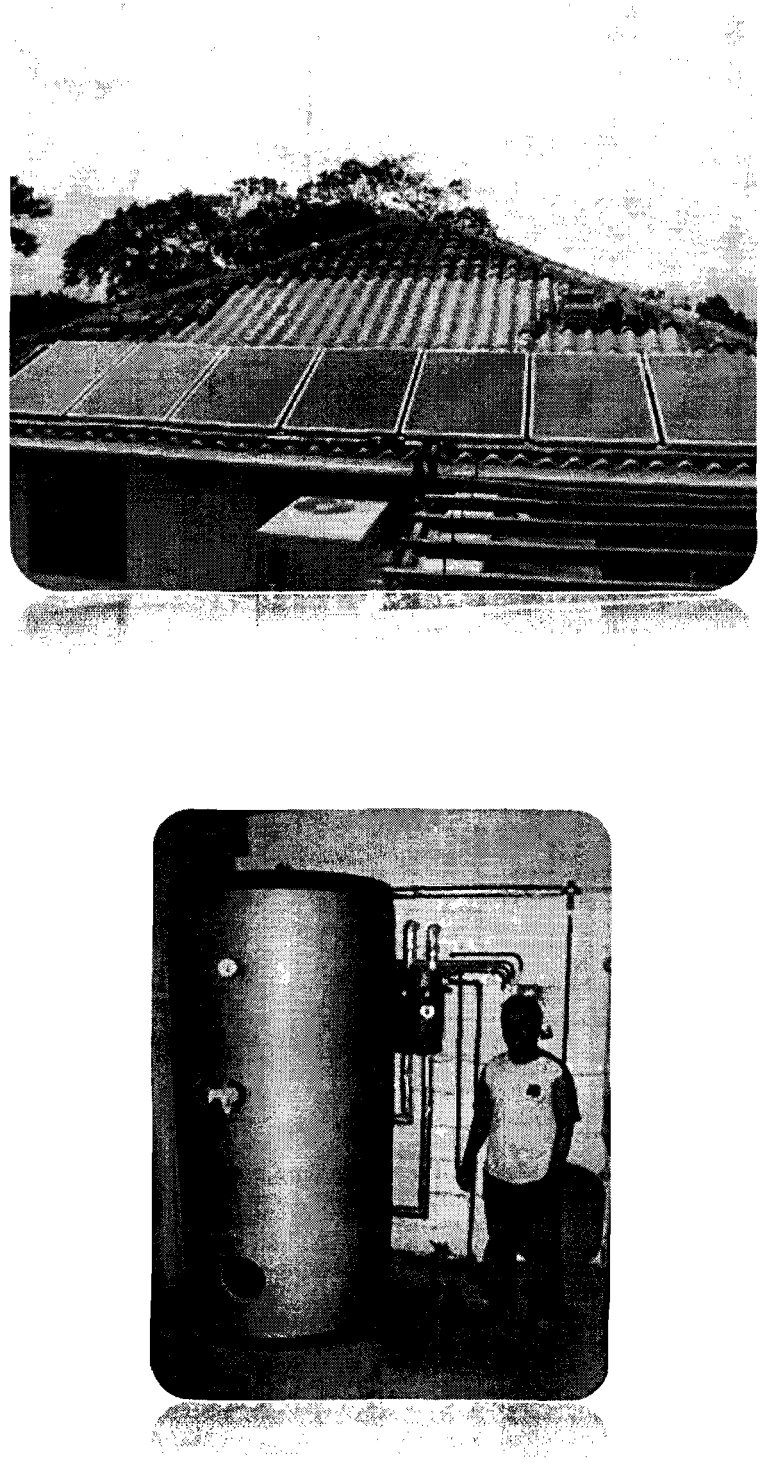


Figure 22: Collector area (up) and hot water storage tank 1,000 litre (down)

vii) Demonstration Plant 9: Finca Santa Clara

Finca Santa Clara is a small company located in Jinotepe. It employs 4 persons and it is producing jam and canned vegetables for the national Nicaraguan market. Hot water is needed in this company for sterilizing the canned products. The maximum temperature level needed is 80°C. For the sterilization process 300 litre of hot water are needed per day. The company operates the sterilization plant 6 days a week.

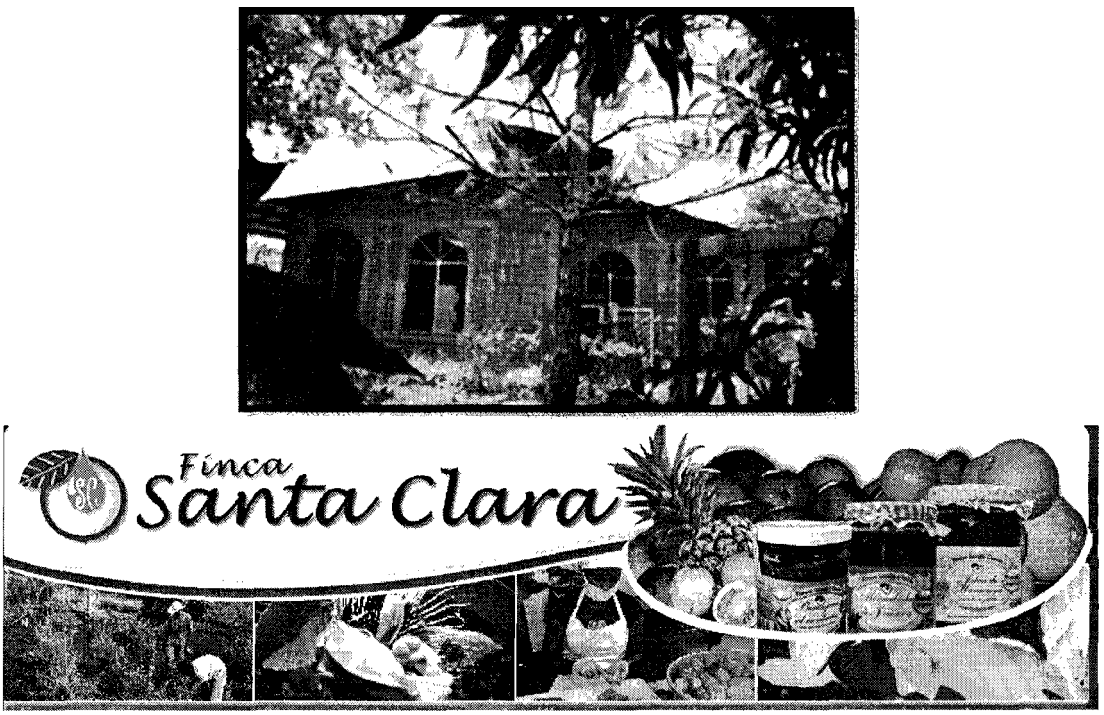


Figure 23: *Finca Santa Clara*

Design

Based on the case study for Finca Santa Clara a detailed design, layout and calculation of the material demand was carried out. An overview of the design results and the key data of the plant are shown in the following.

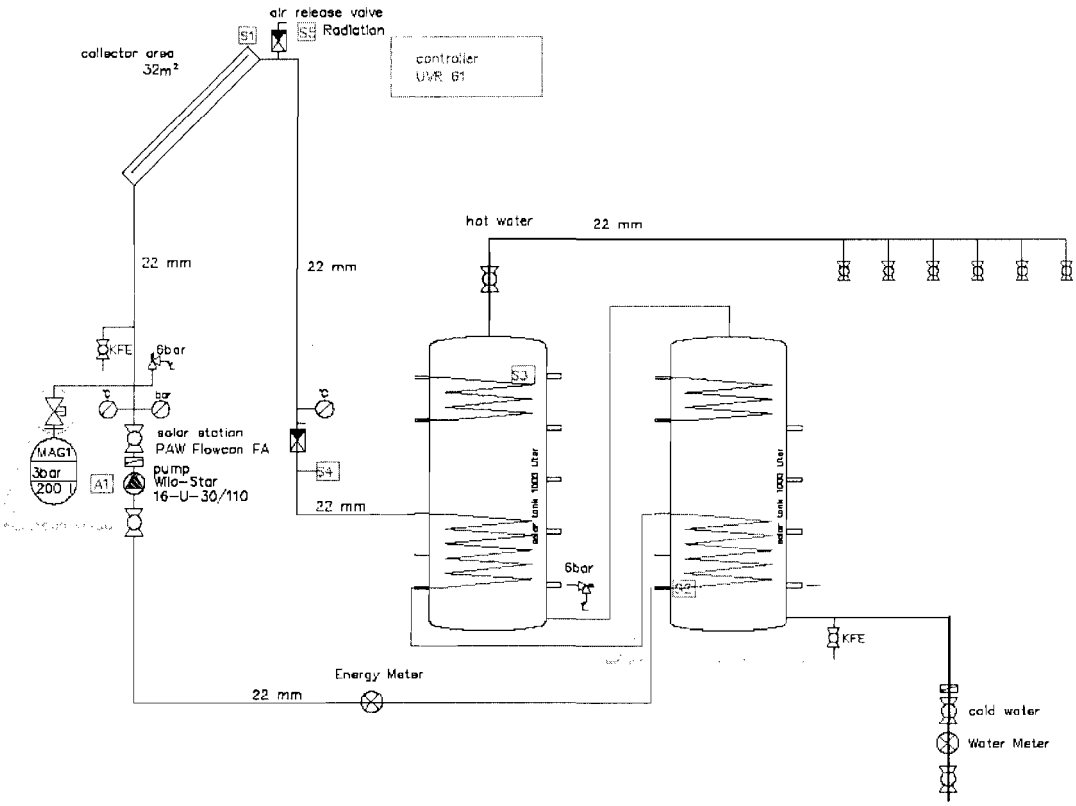


Figure 24: Hydraulic scheme of the solar thermal plant at Finca Santa Clara

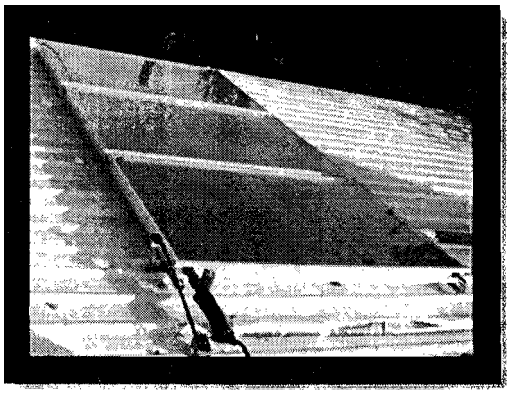
Some key data (collector area and inclination, installed capacity, storage capacity) of the system is shown in table 13.

Table 13: Key data of the solar thermal plant at Finca Santa Clara

Main component of the solar plant	Unit		Remark
Collector area	[m^2]	6	Selective coated absorber
Installed capacity	[kW_{th}]	4.2	
Inclination of the collector	[°]	20	
Hot water storage capacity	[ltr.]	300	Enamelled steel tank

Installation

The installation of this demonstration plant took place in June 2008 by the Nicaraguan company SOLTECH with assistance of CPmL staff. The following pictures show the installed plant.



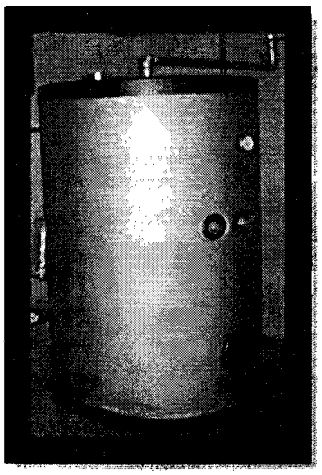


Figure 25: Collector area (up) and hot water storage tank 300 litre (down)

viii) Demonstration Plant 10: Hotel Posada Don Pantaleon

The hotel has a total of 16 double rooms. The aim is to install a solar heat to provide hot water in the 16 hotel rooms. The contribution of the solar system heat is estimated at 80 % of total demand of heat, whereas they need heat **600 liters** of water per day to 70ºC, corresponding to a heat consumption of **11.27 MWh/year**. Based on the feasibility study a solar thermal system was installed with a total capacity of **9.8 KWt** (14 m^2 collector area).

Figure 26: Hotel Posada Don Pantalen

Based on the case study for Hotel Los Altos a detailed design, layout and calculation of the material demand was carried out. An overview of the design results and the key data of the plant are shown in the following.

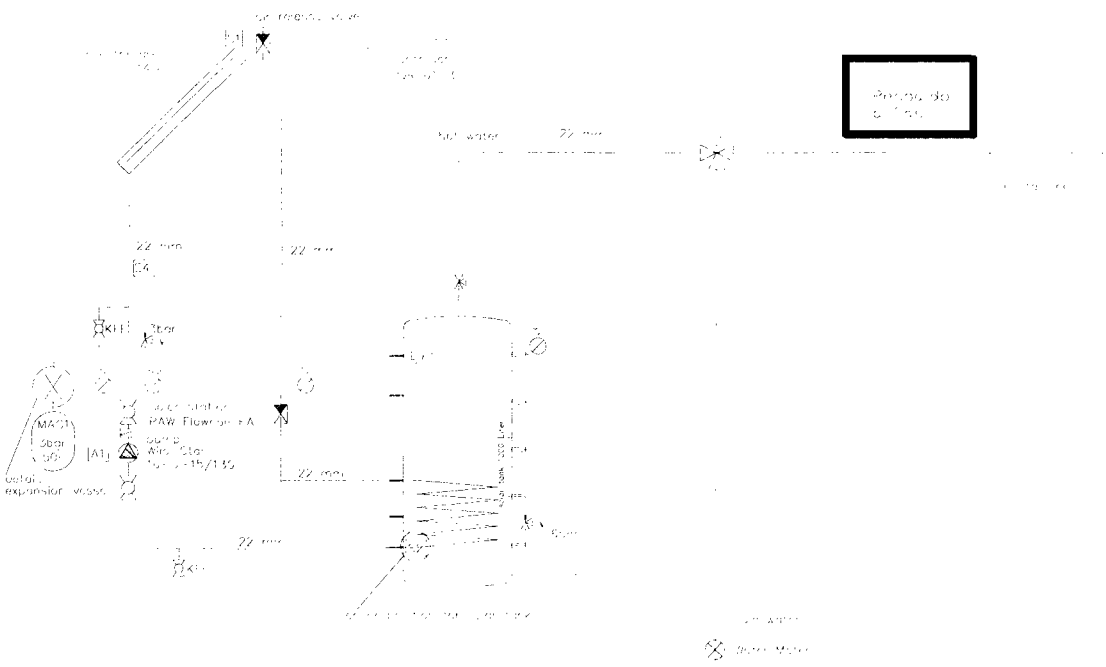


Figure 27: Hydraulic scheme of the solar thermal plant at the Hotel Posada Don Pantaleón.

Some key data (collector area and inclination, installed capacity, storage capacity) of the system is shown in table 14.

Table 14: Key data of the solar thermal plant at the Hotel Posada Don Pantaleon

Main component of the solar plant	Unit		Remark
Collector area	[m^2]	14	Selective coated absorber
Installed capacity	[kW_{th}]	9.8	
Inclination of the collector	[°]	32	
Hot water storage capacity	[ltr.]	1000	Enamelled steel tank

Installation

The installation of this demonstration plant took place in July 2008 by the Nicaraguan company SOLTECH and CPmL staff. The following pictures show the installed plant:

Figure 28: *Collector area (left) and hot water storage tank 1,000 litre (right)*

ix) ***Demonstration Plant 11: Hogar de protección Pajarito Azul.***

Pajarito azul is a place to protect children with a capacity for 104 persons. Also it has a bakery plant. The contribution of the solar system heat is estimated at 50 % of total demand of heat, whereas they need heat **300 liters** of water per day to 70ºC. Based on the feasibility study a solar thermal system was installed with **6 m^2** collector area.

Figure 29: Hogar de Protección Pajarito Azul.

Based on the case study for Hogar de Protección Pajarito Azul a detailed design, layout and calculation of the material demand was carried out. An overview of the design results and the key data of the plant are shown in the following.

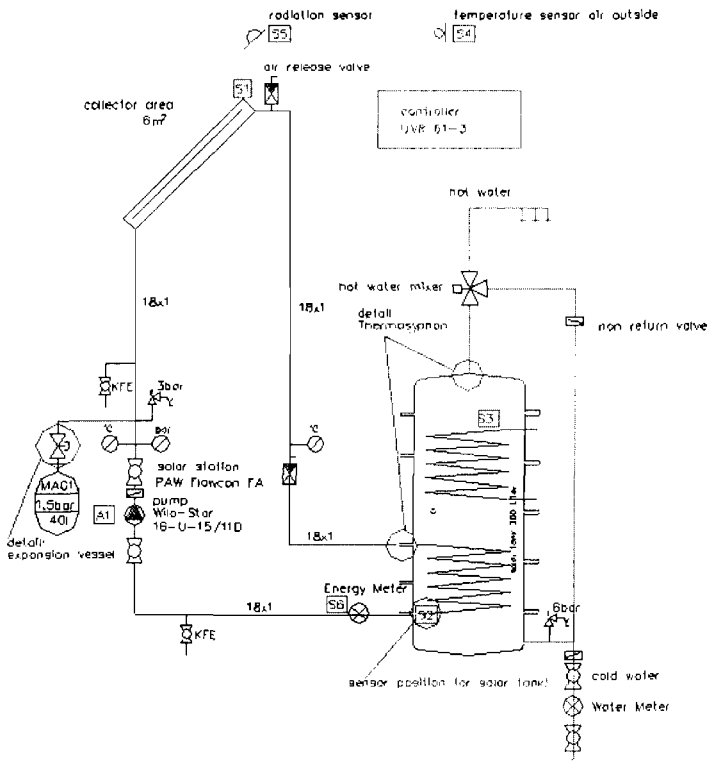


Figure 30: Hydraulic scheme of the solar thermal plant at the Hogar de Protección Pajarito Azul.

Some key data (collector area and inclination, installed capacity, storage capacity) of the system is shown in table 15.

Table 15: Key data of the solar thermal plant at the Hogar de protección Pajarito Azul

Main component of the solar plant	Unit		Remark
Collector area	[m^2]	6	Selective coated absorber
Installed capacity	[kW_{th}]	4	
Inclination of the collector	[°]	12	
Hot water storage capacity	[ltr.]	300	Enamelled steel tank

Installation

The installation of this demonstration plant took place in October 2008 by CPmL staff. The following pictures show the installed plant:

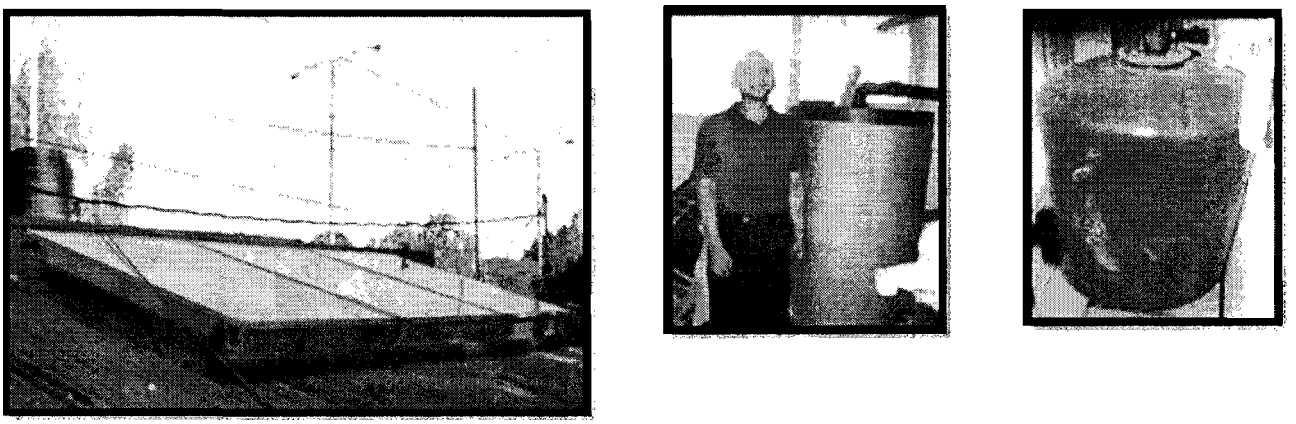


Figure 31: Collector area (left) and hot water storage tank 300 litre and accessories (right)

x) ***Demonstration Plant 12: Fábrica POCHI.***

Fábrica POCHI is located in Managua and it is processing jelly and purified water in two presentations (bottles and bags). The contribution of the solar system heat is estimated at 70 % of total demand of heat, whereas they need heat **1,000 liters** of water per day to 70ºC. Based on the feasibility study a solar thermal system was installed with **16 m^2** collector area.

Figure 32: Fábrica POCHI

Based on the case study for Fábrica POCHI a detailed design, layout and calculation of the material demand was carried out. An overview of the design results and the key data of the plant are shown in the following.

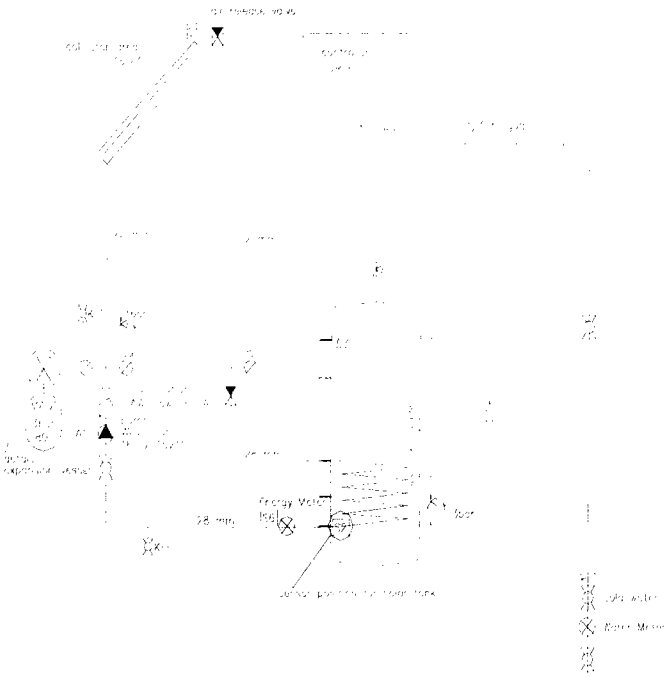


Figure 33: Hydraulic scheme of the solar thermal plant at the Fábrica POCHI

Some key data (collector area and inclination, installed capacity, storage capacity) of the system is shown in table 16.

Table 16: Key data of the solar thermal plant at the Fábrica POCHI

Main component of the solar plant	Unit		Remark
Collector area	[m^2]	16	Selective coated absorber
Installed capacity	[kW_{th}]	11	
Inclination of the collector	[°]	12	
Hot water storage capacity	[ltr.]	1,000	Enamelled steel tank

Installation

The installation of this demonstration plant took place in June 2009 by the Nicaraguan company TECNOSOL and CPmL staff. The following pictures show the installed plant:

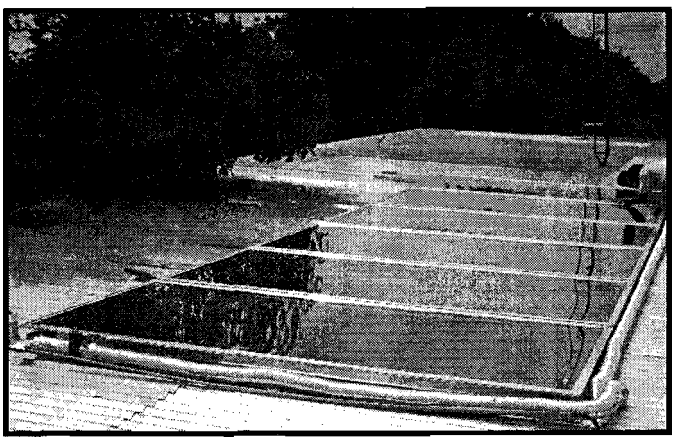


Figure 34: *Collector area*

xi) ***Demonstration Plant 13: Hospital HEODRA .***

HEODRA is a public hospital located in León. It is recognized for being the formation place of doctors with high quality standards. The thermal solar system was installed to bring warm water to the laundry. The contribution of the solar system heat is estimated at 10 % of total demand of heat, whereas they need heat **1,000 liters** of water per day to 70ºC. Based on the feasibility study a solar thermal system was installed with **12 m^2** collector area.

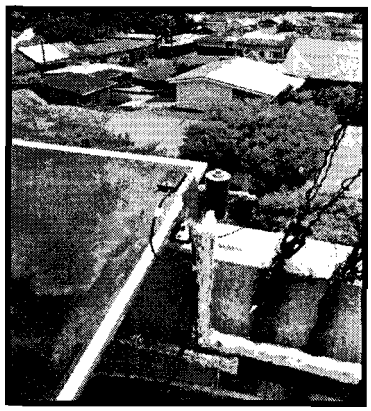


Figure 35: *Hospital HEODRA*

Based on the case study for Hospital HEODRA a detailed design, layout and calculation of the material demand was carried out. An overview of the design results and the key data of the plant are shown in the following.

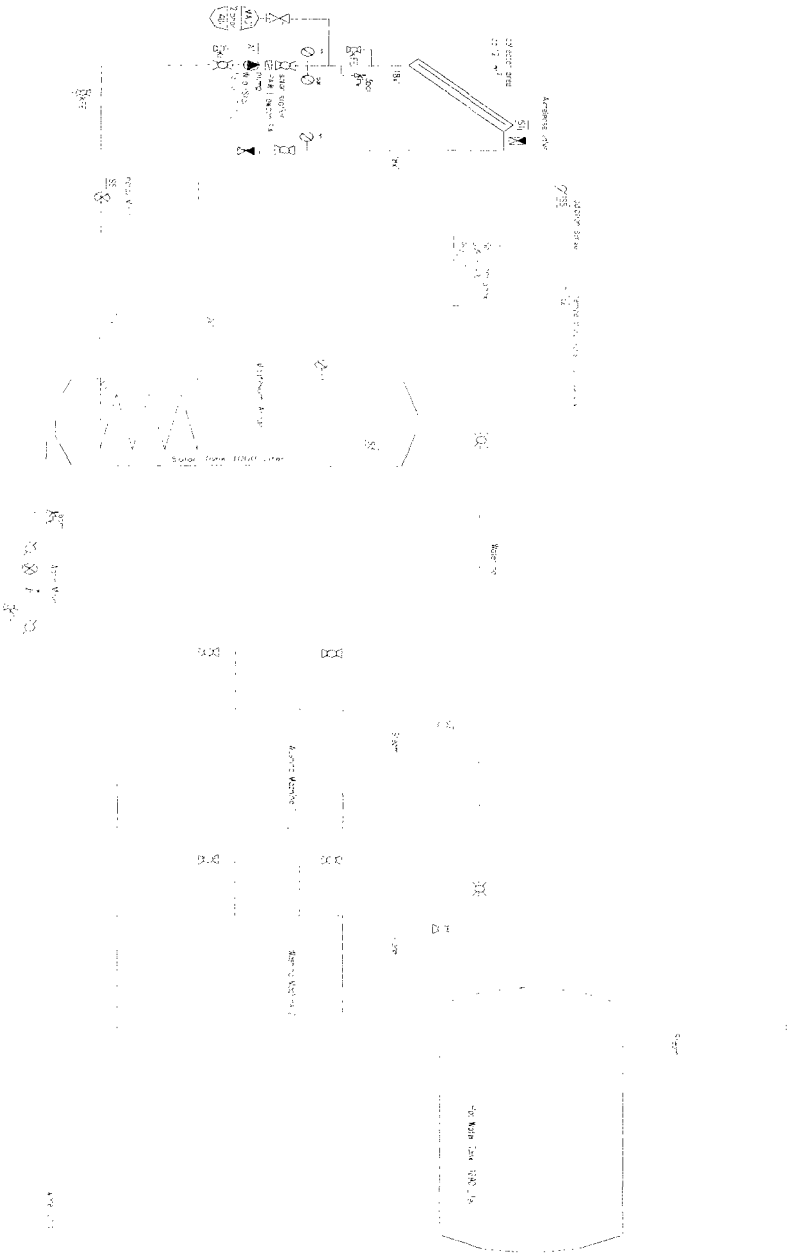


Figure 36: *Hydraulic scheme of the solar thermal plant at the Hospital HEODRA*

Some key data (collector area and inclination, installed capacity, storage capacity) of the system is shown in table 17.

Table 17: Key data of the solar thermal plant at the Hospital HEODRA

Main component of the solar plant	Unit		Remark
Collector area	[m^2]	12	Selective coated absorber
Installed capacity	[kW_{th}]	8	
Inclination of the collector	[°]	12	
Hot water storage capacity	[ltr.]	1,000	Enamelled steel tank

Installation

The installation of this demonstration plant took place in May 2007 by CPmL staff. The following pictures show the installed plant:

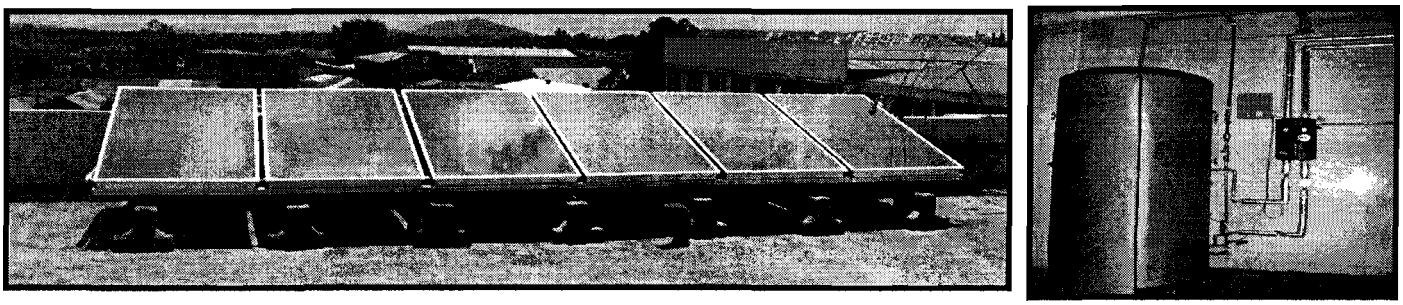


Figure 37: Collector area (left) and hot water storage tank 1,000 litre (right)

xii) *Demonstration Plant 14: Hotel Vistamar*

Hotel Vistamar is located in San Rafael del Sur, on Pochomil beach. It has 23 bungalows, with a occupation rate of 50 %.The contribution of the solar system heat is estimated at 90 % of total demand of heat, whereas they need heat **2,600 liters** of water per day to 60ºC, corresponding to a heat consumption of **27.87 MWh/year**. Based on the feasibility study a solar thermal system was installed with a total capacity of **30 KWt** (44 m^2 collector area).

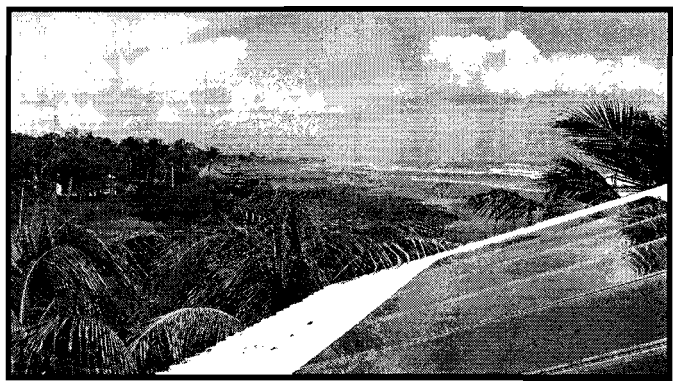


Figure 38: Hotel Vistamar

Based on the case study for Hotel Vistamar a detailed design, layout and calculation of the material demand was carried out. An overview of the design results and the key data of the plant are shown in the following.

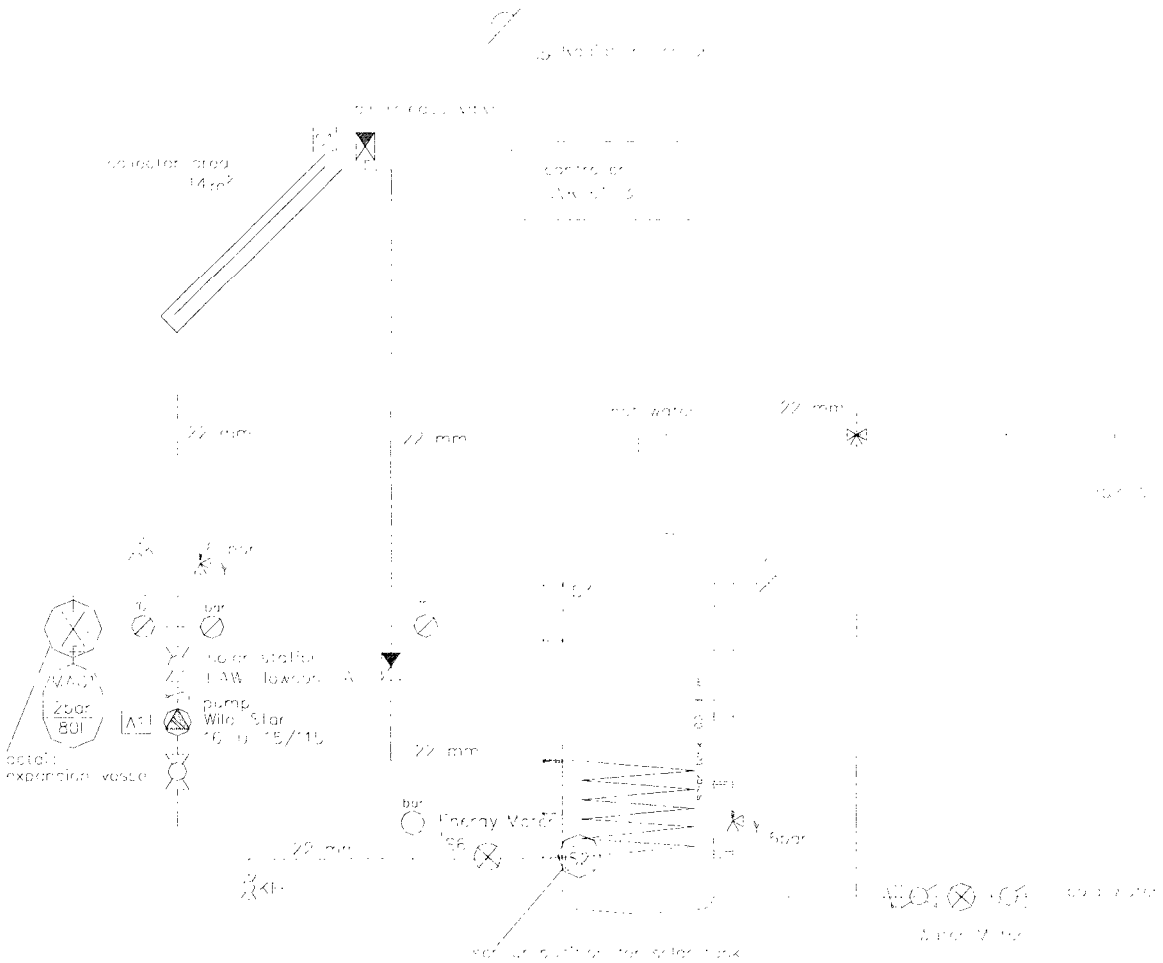


Figure 39: Hydraulic scheme of the solar thermal plant at the Hotel Vistamar.

Some key data (collector area and inclination, installed capacity, storage capacity) of the system is shown in table 18.

Table 18: Key data of the solar thermal plant at the Hotel Vistamar

Main component of the solar plant	Unit		Remark
Collector area	[m^2]	44	Selective coated absorber
Installed capacity	[kW_{th}]	30	
Inclination of the collector	[°]	15	
Hot water storage capacity	[ltr.]	2,600	Enamelled steel tank

Installation

The installation of this demonstration plant took place installed in June – July 2009 by the Nicaraguan company TECNOSOL and CPmL staff. The following pictures show the installed plant:

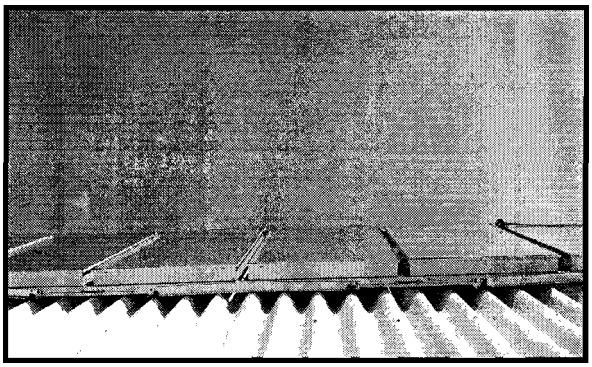


Figure 40: Collector area.

xiii) *Demonstration Plant 15: Hotel Brandt´s.*

Hotel Brandt`s is located in Managua and it has 13 rooms (doubles). It occupation rate is 50 %. The contribution of the solar system heat is estimated at 42 % of total demand of heat, whereas they need heat **2,000 liters** of water per day to 60ºC, corresponding to a heat consumption of **25.49 MWh/year**. Based on the feasibility study a solar thermal system was installed with a total capacity of **18.73 KWt** (28 m^2 collector area).

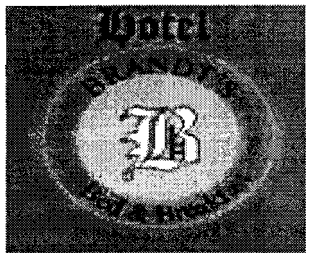


Figure 41: Hotel Brandt´s.

Based on the case study for Hotel Brandt´s a detailed design, layout and calculation of the material demand was carried out. An overview of the design results and the key data of the plant are shown in the following.

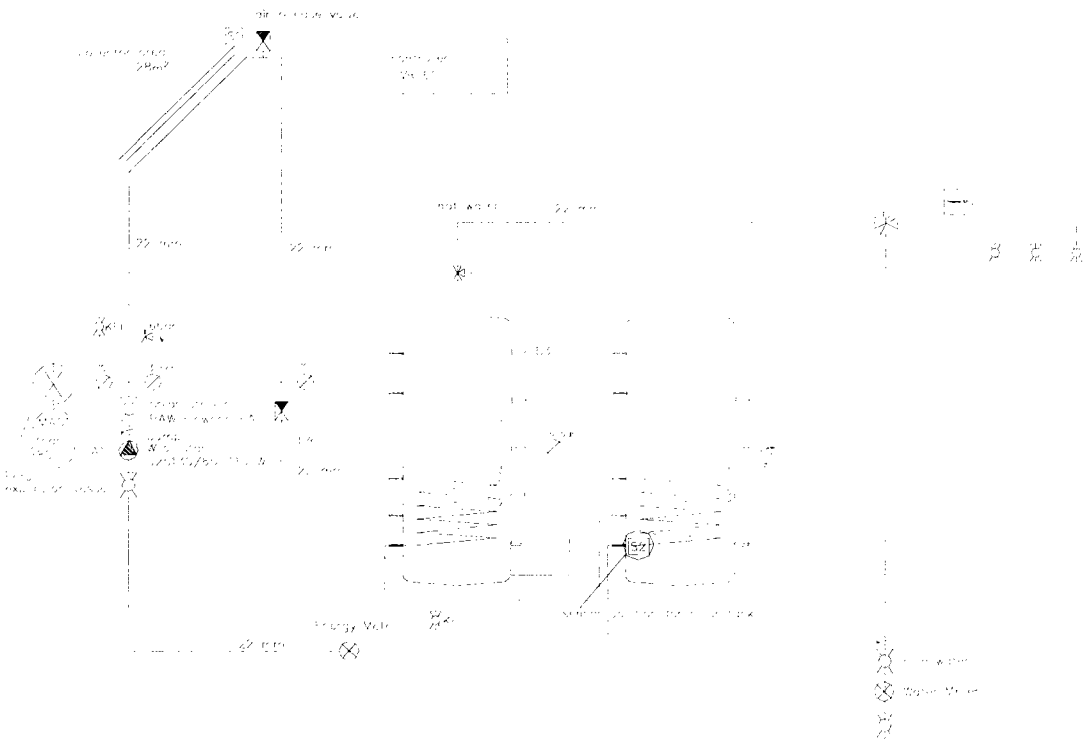


Figure 42: Hydraulic scheme of the solar thermal plant at the Hotel Brandt´s.

Some key data (collector area and inclination, installed capacity, storage capacity) of the system is shown in table 19.

Table 19: Key data of the solar thermal plant at the Hotel Vistamar

Main component of the solar plant	Unit		Remark
Collector area	[m^2]	28	Selective coated absorber
Installed capacity	[kW_{th}]	18.73	
Inclination of the collector	[°]	15	
Hot water storage capacity	[ltr.]	2,000	Enamelled steel tank

Installation

The installation of this demonstration plant took place installed in February 2009 by the Nicaraguan company SOLTECH and CPmL staff. The following pictures show the installed plant:

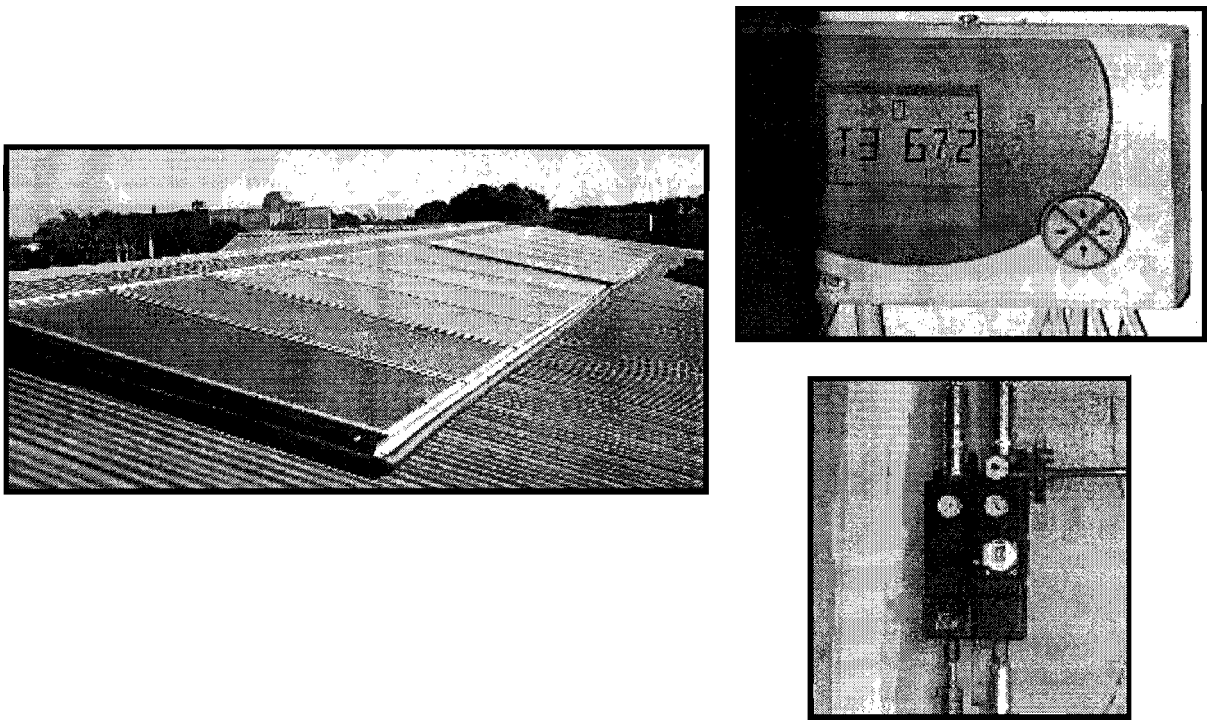


Figure 43: Collector area (left) and accessories (right)

xiv) *Demonstration Plant 16: Lácteos Nicarao.*

Lácteos Nicarao is located in Rivas. The contribution of the solar system heat is estimated at 46 % of total demand of heat, whereas they need heat **1,000 liters** of water per day to 72ºC, corresponding to a heat consumption of **13.44 MWh/year**.. Based on the feasibility study a solar thermal system was installed with a total capacity of **12.6 KWt** (18 m^2 collector area).

Figure 44: Lácteos Nicarao.

Based on the case study for Lácteos Nicarao a detailed design, layout and calculation of the material demand was carried out. An overview of the design results and the key data of the plant are shown in the following.

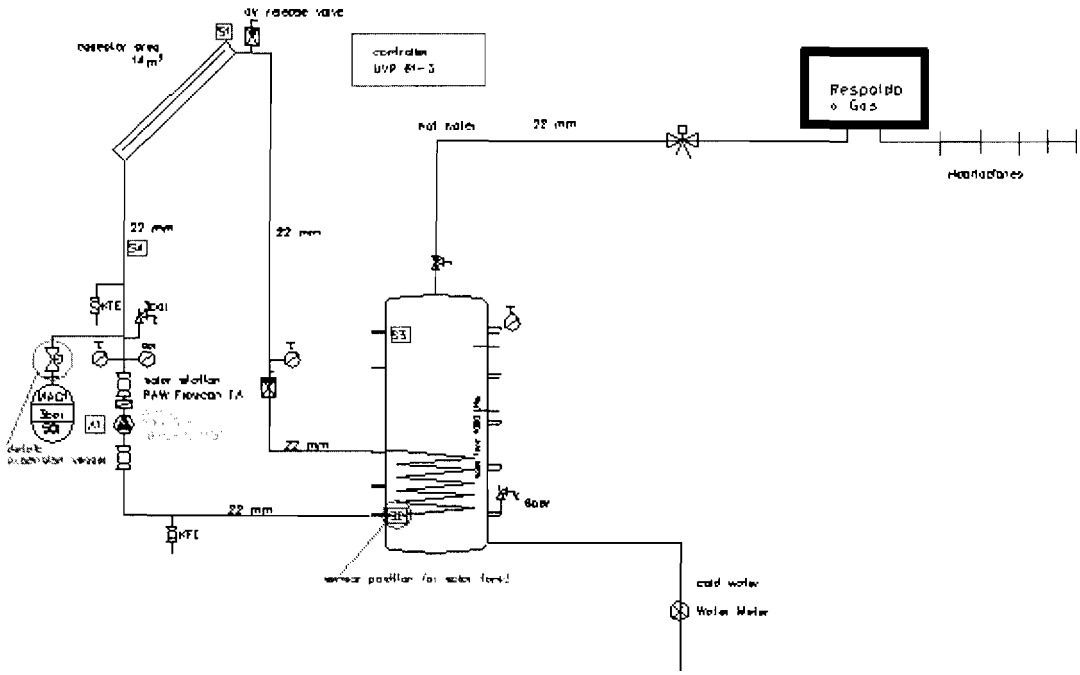


Figure 45: Hydraulic scheme of the solar thermal plant at the Lácteos Nicarao.

Some key data (collector area and inclination, installed capacity, storage capacity) of the system is shown in table 20.

Table 20: Key data of the solar thermal plant at the Lácteos Nicarao

Main component of the solar plant	Unit		Remark
Collector area	[m^2]	18	Selective coated absorber
Installed capacity	[kW_{th}]	12.95	
Inclination of the collector	[°]	12	
Hot water storage capacity	[ltr.]	1,000	Enamelled steel tank

Installation

The installation of this demonstration plant took place installed in March 2009 by the Nicaraguan company SOLTECH and CPmL staff. The following pictures show the installed plant:

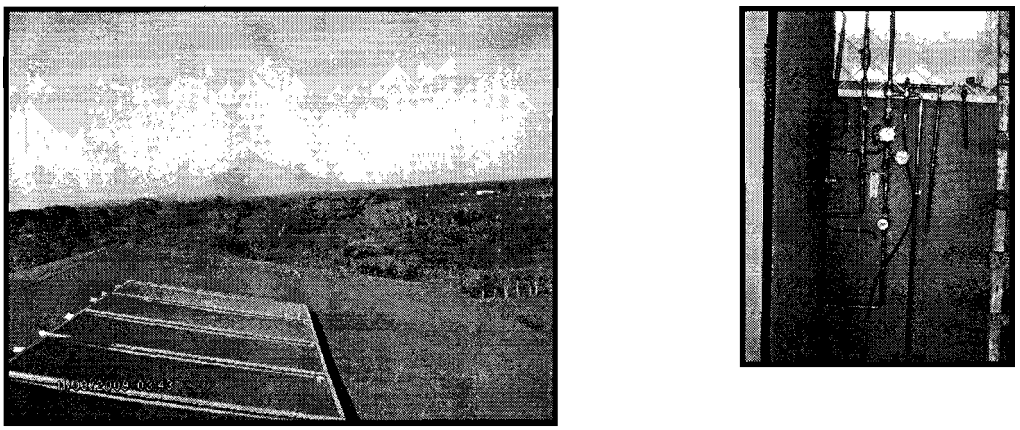


Figure 46: Collector area (left) and accessories (right)

xv) ***Demonstration Plant 17: Hotel Villaller.***

Villa Aller is located in Ometepe Island, Rivas. It has an accomodation capacity to 11 persons. The contribution of the solar system heat is estimated at 90 % of total demand of heat, whereas they need heat **500 liters** of water per day to 60ºC, corresponding to a heat consumption of **4.8 MWh/year**. Based on the feasibility study a solar thermal system was installed with a total capacity of **2.5 KWt** (6 m^2 collector area).

Figure 47: Hotel Villa Aller

Based on the case study for Hotel Villa Aller a detailed design, layout and calculation of the material demand was carried out. An overview of the design results and the key data of the plant are shown in the following.

Figure 48: Hydraulic scheme of the solar thermal plant at the Villa Aller.

Some key data (collector area and inclination, installed capacity, storage capacity) of the system is shown in table 21

Table 21: Key data of the solar thermal plant at the Villa Aller

Main component of the solar plant	Unit		Remark
Collector area	[m^2]	6	Selective coated absorber
Installed capacity	[kW_{th}]	2.5	
Inclination of the collector	[°]	15	
Hot water storage capacity	[ltr.]	500	Enamelled steel tank

Installation

The installation of this demonstration plant took place installed in June 2009 by the Nicaraguan company SOLTECH and CPmL staff. The following pictures show the installed plant:

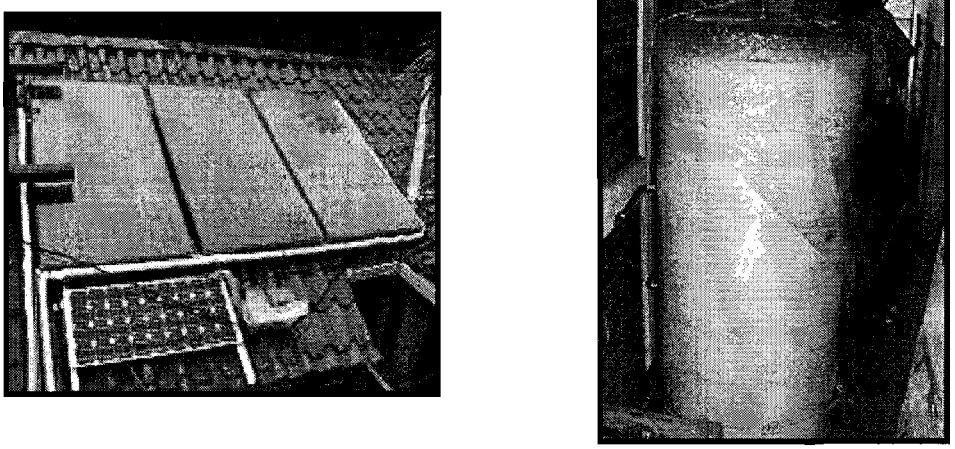


Figure 49: Collector area (left) and hot water storage tank 500 litre (right)

xvi) ***Demonstration Plant 18: Fábrica de Alimentos La Matagalpa.***

Fábrica de Alimentos La Matagalpa produces pickles of vegetables, sauces and pasta. The contribution of the solar system heat is estimated at 29.7% of total demand of heat, whereas they need heat **1,000 liters** of water per day to at least 60ºC, corresponding to a heat consumption of **11.42 MWh/year**. Based on the feasibility study a solar thermal system was installed with a total capacity of **11 KWt** (16 m^2 collector area).

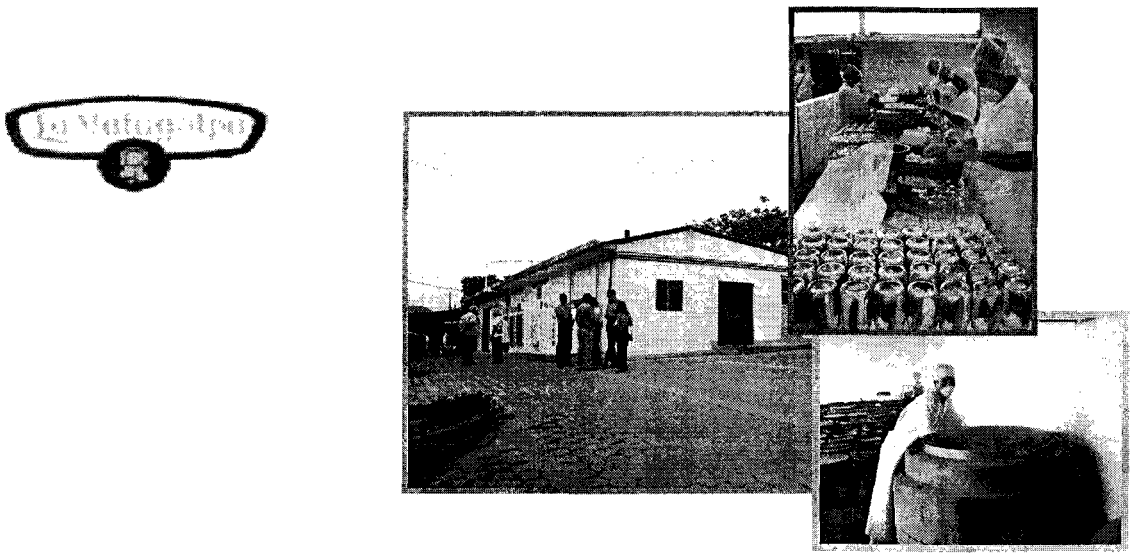


Figure 50: Fábrica de Alimentos La Matagalpa

Based on the case study for La Matagalpa a detailed design, layout and calculation of the material demand was carried out. An overview of the design results and the key data of the plant are shown in the following.

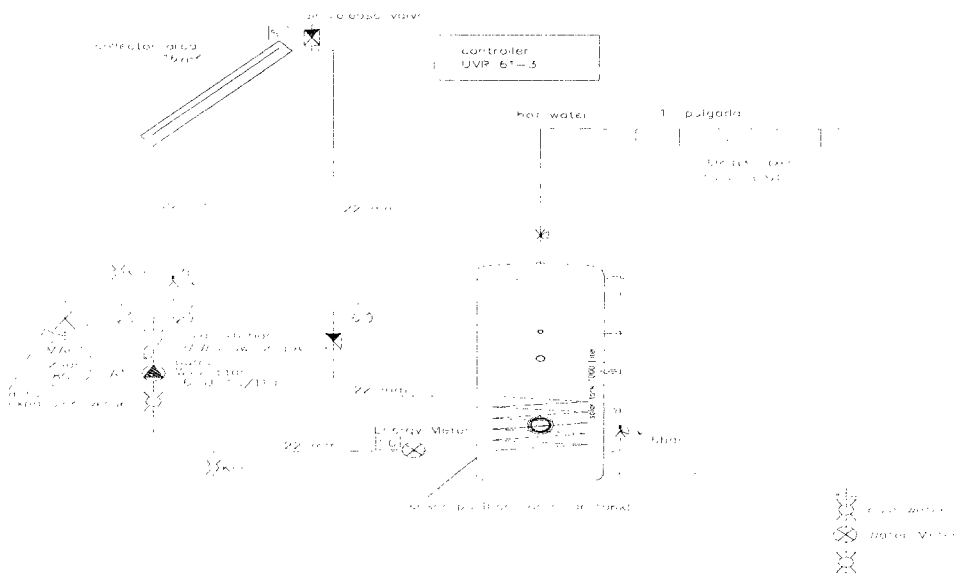


Figure 51: Hydraulic scheme of the solar thermal plant at the La Matagalpa.

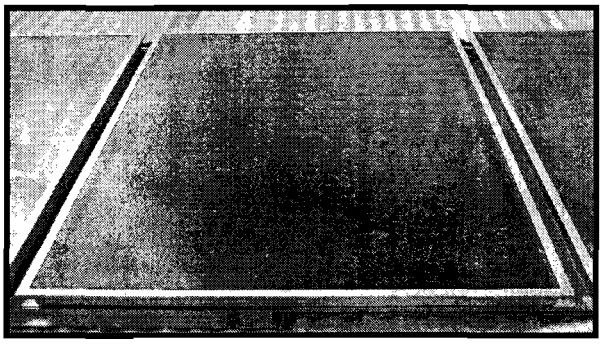
Some key data (collector area and inclination, installed capacity, storage capacity) of the system is shown in table 22.

Table 22: Key data of the solar thermal plant at the La Matagalpa

Main component of the solar plant	Unit		Remark
Collector area	[m^2]	8	Selective coated absorber
Installed capacity	[kW_{th}]	11	
Inclination of the collector	[°]	12	
Hot water storage capacity	[ltr.]	1,000	Enamelled steel tank

Installation

The installation of this demonstration plant took place installed in July 2009 by the Nicaraguan company ECAMI and CPmL staff. The following pictures show the installed plant:



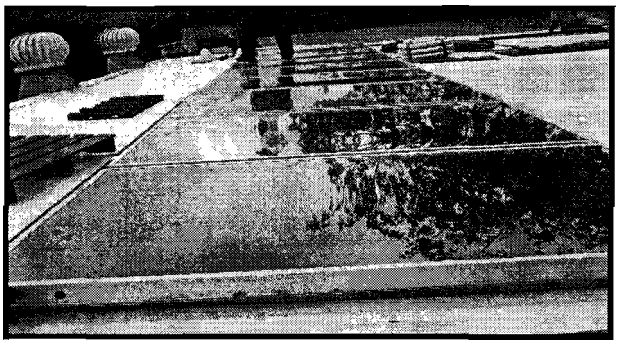


Figure 52: Collector area.

xvii) *Demonstration Plant 19: Hotel Sueño de Meme.*

Hotel El Sueño de Meme is located in León. It has 15 rooms (doubles) and an occupation rate of 70%. The contribution of the solar system heat is estimated at 62% of total demand of heat, whereas they need heat **1,000 liters** of water per day to 60ºC, corresponding to a heat consumption of **9.18 MWh/year**. Based on the feasibility study a solar thermal system was installed with a total capacity of **11 KWt** (16 m^2 collector area).

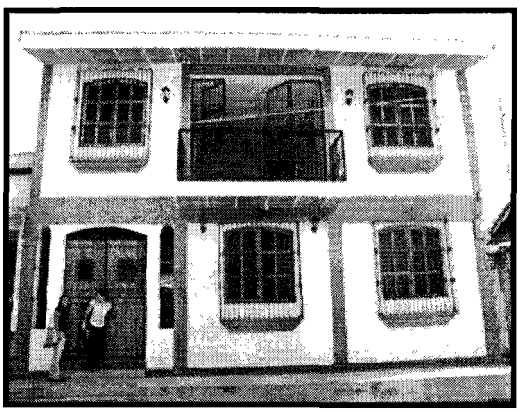


Figure 53: Hotel Sueño de Meme.

Based on the case study for Hotel Meme a detailed design, layout and calculation of the material demand was carried out. An overview of the design results and the key data of the plant are shown in the following.

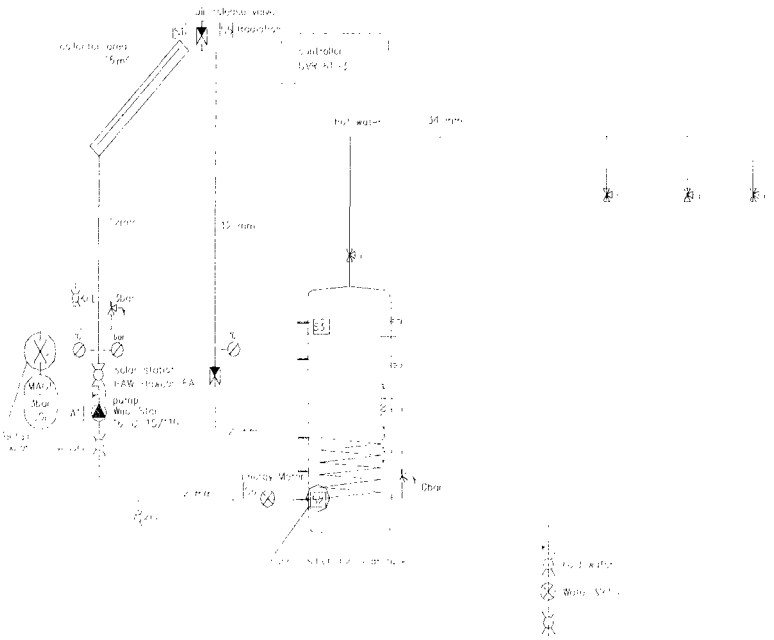


Figure 54: Hydraulic scheme of the solar thermal plant at the Hotel Sueño de Meme.

Some key data (collector area and inclination, installed capacity, storage capacity) of the system is shown in table 23.

Table 23: Key data of the solar thermal plant at the La Matagalpa

Main component of the solar plant	Unit		Remark
Collector area	[m^2]	16	Selective coated absorber
Installed capacity	[kW_{th}]	11	
Inclination of the collector	[°]	12	
Hot water storage capacity	[ltr.]	1,000	Enamelled steel tank

Installation

The installation of this demonstration plant took place installed in November 2009 by the Nicaraguan company SOLTECH and CPmL staff. The following pictures show the installed plant:

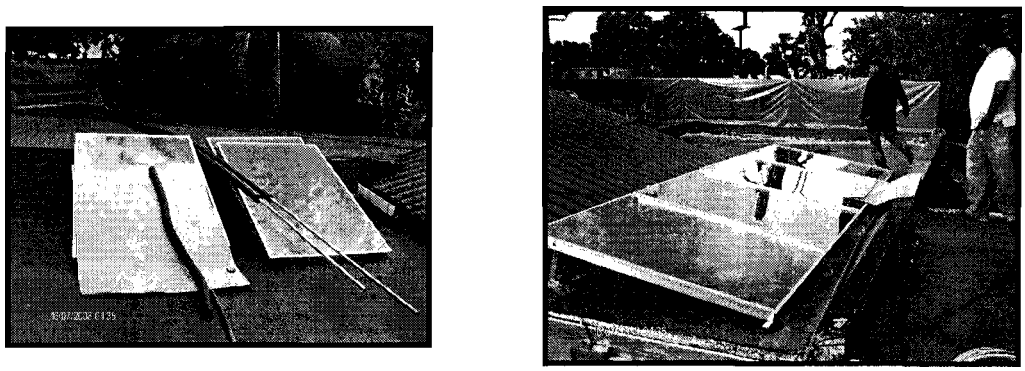


Figure 55: Collector area (left) and hot water storage tank 1,000 litre (right)

1.2.5. Follow –up technical advice for CPmL and Nicaraguan companies.

In these technical advices for the follow-up, CPmL and Nicaragua companies analyze system operation parameters of the solar thermal systems and calculate the system efficiency. Experts from CPmL visit the companies monthly to the physical inspection and to collect the information of the system. With this information is possible to follow up the efficiency of the collectors and the whole system. Also reports the environmental benefits. The following table explains it.

Table 24: Parameter calculated in the 6 months follow up.

Nº	Company	Collectors area (m^2)	Water consumption (m^3)	Energy Savings (kWh/year)	CO_2 reduction (Kg/year)
1	Fábrica POCHI	16.00	1.00	12,528.00	2,505.60
2	Finca Santa Clara	6.00	0.3	4,124.00	824.80
3	Fábrica de Alimento La Matagalpa	16.00	1.00	11,420.00	2,284.00
4	Hotel Mansión Teodolinda	32.00	2.00	18,127.00	16,314.30
5	Hotel Estrella	16.00	1.00	8,720.00	1,744.00
6	Hotel Villa Paraíso	32.00	2.00	16,360.00	14,724.00
7	Hotel Brandt´s	32.00	2.00	16,950.00	3,390.00
8	Hotel Los Altos	14.00	1.00	8,728.00	1,745.60
9	Hotel Posada Don Pantaleón	16.00	1.00	9,360.00	1,872.00
10	Hotel Villa Aller	6.00	0.5	4,886.00	4,397.40
11	Hotel Vistamar	20.00	1.5	12,668.00	2,533.60
12	Hotel Sueño de Meme	16.00	1.00	8,180.00	7,362.00
13	Hospital HEODRA	12.00	1.00	14,180.00	3,686.80
14	Hogar De Protección Pajarito Azul	6.00	0.3	6,424.00	5,781.60
15	Industrias RODCEN S.A.	32.00	2.00	16,126.00	3,225.20
16	Lácteos Nicarao	19.00	1.00	13,440.00	8,601.60
17	Lácteos Santa Marta	16.00	1.00	13,750.00	8,800.00
Total		**307.00**	**20.00**	**195,971.00**	**89,792.50**

The estimated savings calculated with this 6 months follow up is approximately **US$ 25,808.13 per year.** The Project achieved the reduction of the Recovery Investment Period of companies from 8 to 4 years.

Table 25: Economical Analysis of Systems in the 6 months follow up.

Nº	Company	Total Cost (US)	% NICATEC	Estimated savings (US/year)	Recovery Period Years
1	Fábrica POCHI	12,400	58%	1,540.94	3.37
2	Finca Santa Clara	6,753.4	70%	507.25	3.99
3	Fábrica de Alimento La Matagalpa	17,080	65%	1,404.66	4.27
4	Hotel Mansión Teodolinda	25,300	52%	3,625.40	3.38
5	Hotel Estrella	13,600	74%	1,072.56	3.28
6	Hotel Villa Paraíso	21,427.5	70%	3,272.00	1.97
7	Hotel Brandt´S	22,000	50%	2,084.85	5.28
8	Hotel Los Altos	14,000	61%	1,073.54	5.12
9	Hotel Posada Don Pantaleón	14,500	50%	1,151.28	6.30
10	Hotel Villa Aller	9,000	44%	977.20	5.12
11	Hotel Vistamar	20,540	62%	1,558.16	5.03
12	Hotel Sueño de Meme	15,500	55%	1,636.00	4.28
13	Hospital HEODRA	9,516	100%	623.92	-
14	Hogar De Protección Pajarito Azul	4,500	100%	1,284.80	-
15	Industrias RODCEN S.A.	34,090	70%	1,983.50	5.16
16	Lácteos Nicarao	16,000	66%	994.56	5.48
17	Lácteos Santa Marta	15,982	63%	1,017.50	5.79
Total		**272,189**	**65%**	**25,808.13**	**3.99**

1.2.6. Commissioning

Right after the installation of the plants nb. 1 – 3 in August 2007 also the commissioning was carried out. The commissioning of the plants number 4 – 7 was carried out in February 2008 and the commissioning of the plants number 8 – 10 was carried out in July and August 2008. The commissioning of plants 11 – 19 was carried out in March and November 2009.

The "Commissioning Reports" for all demonstration plants signed by (CPmL), the Hotel or company owners (end users) as well as by an AEE INTEC expert. The commissioning reports also show the date of installation, the date of commissioning and the date of full operation of the solar thermal plant.

1.2.7. Elaborate the final reports on the results of the implementation of the SIRM demonstration projects, including achievements and lessons learned, as basis for the EST dissemination at large scale to enhance productivity and efficiency of national industry, according to the UNIDO format and submit to UNIDO in a timely fashion.

The Final Report of the results of the project was carried out by in June 2009. See annex 2.

Figure 56: Cover page of the final report on the results of the implementation of the SIRM demonstration projects

1.3. Information on the results of implementation disseminated among industry and governmental institutions.

1.3.1. Collect information from the companies, which have implemented the SIRM demonstration projects, and disseminate the results at national, regional and international level. The information should be presented both to industrial associations and companies and to governmental institutions.

For each demonstration plant, the information has been collected and summarizes in fact sheets. Some fact sheets are in annex 3.

Figure 57: Cover pages of some fact sheets.

Press conference at the Hotel Estrella

In order to raise the public awareness concerning solar thermal systems in Nicaragua, CPmL organized on 4 July 2008 a press conference at Hotel Estella in Managua. Five national TV stations three representatives from the press were present. The TV stations broadcasted the news already on 4th July 2008.

Besides the director of the CPmL, Cesar Barahona also the representative of the Austrian Development Agency, Yader Baldizón as well as two representatives from the Hotel sector (Hotel Estrella and Hotel Mansión Teodolinda) were interviewed.

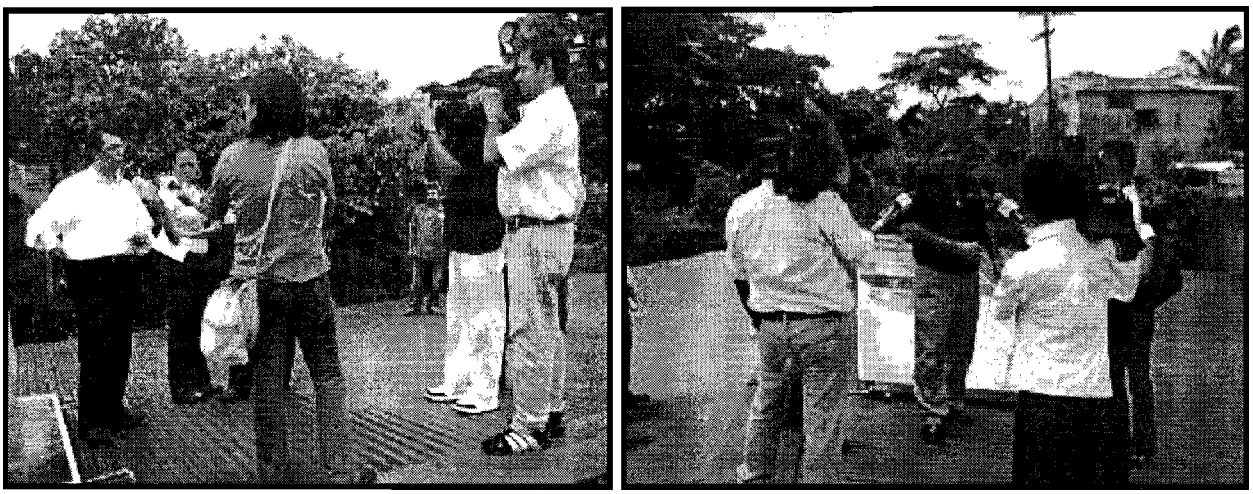


Figure 58: Press conference at Hotel Estella in Managua on 4th July 2008

1.3.2. Organize and carry out national and regional workshops to disseminate the results of the EST demonstration projects. Evaluate the possibility to extend the same approach to companies of other companies and sectors.

2 national forums and 2 regional forums are carried out. To see all the final reports, go to annex 4.

Foro de Energía Solar 2008 / Solar Energy Forum 2008

The second awareness raising event, called "Foro de Energía Solar 2008" took place in Managua at the Centro de Capacitación PAEBANIC in Managua on 3 July 2008. Besides the vice-minister of Energy Lorena Lanza, representatives from the Austrian Development Agency and 67 participants from policy, administration, the university, companies and the media attended this event.

The detailed agenda of the Solar Energy Forum 2008 can be found next:

El Ministerio de Energía y Minas (MEM), El Centro de Producción más Limpia de Nicaragua de la Universidad Nacional de Ingeniería (CPmL-N/UNI) y La Organización de Las Naciones Unidas para el Desarrollo Industrial (ONUDI).

"FORO ENERGIA RENOVABLES 2008".
AGENDA
JUEVES 3 DE JULIO DEL 2008

08:30 – 09:00	Llegada e Inscripción de los participantes.
09:00 – 09:10	Palabras de apertura del Ministerio de Energía y Minas.
09:10 – 09:20	Palabras de representante Agencia Austriaca para el Desarrollo.
09:20 – 09:35	Avances de la energía renovable en Europa; Especialista en *Energías* Renovables de la ONUDI, director general de AEE INTEC. Austria (Werner Weiss).
09:35 – 09:50	Presentación del Ministerio de Energía y Minas (Vice Ministra Lorena Lanza).
9:50 – 10:05	Energía solar en Nicaragua, Presente y futuro de la Energía Solar. Presentación del Sector Privado, (Tecnosol, Vladimir Delagneau)
10:05 - 10:30	**REFRIGERIO**
10:30 – 10:50	Presentación de estudio de políticas de Energía Renovables Especialistas de Energía Solar CPmL-N.
10:50 – 11:10	Resultados de la mesa solar del primer foro de Energía "Fortaleciendo el sector Energético en Nicaragua UNI". (Jerónimo Zeas)
11:10 – 11:30	Presentación situación de la Energía Renovable en Nicaragua Diputado Agustín Jarquín Anaya.
11:30 – 11:45	Presentación: Caso de instalación de Sistemas Solares Termicos en un hotel. Hotel Mansión Teodolinda.
11:45 – 12:00	PREGUNTAS Y RESPUESTAS
12:00 – 01:00	ALMUERZO
01:00 – 02:30	MESAS DE DISCUSIONES: Mesa 1: Lic. Arturo Solórzano. "Incentivos y desincentivos para la energía renovable" Mesa 2: Jerónimo Zeas. "Políticas y legislaciones: los aciertos y cambios necesarios" Mesa 3: Fernando Sánchez. "Rol de los involucrados para la implementación de Energía Renovable"

Centro de Producción Más Limpia de Nicaragua

02:30 – 03:00	**REFRIGERIO**
03:00 - 03:45	PRESENTACIÓN DE RESULTADOS
03:45 – 04:00	**PALABRAS DE CLAUSURA UNI. Rector Aldo Urbina.**

Lugar del Foro de Energía Renovables: Centro de Capacitación **PAEBANIC** REPTO Montserrat Ira entrada 200m AL Norte. Managua.

Figure 59: Agenda - Foro de Energia Solar 2008.

The following pictures give some impression of the event.

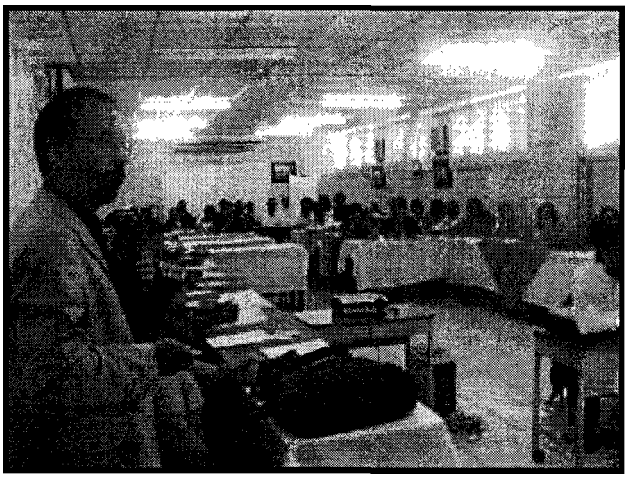


Figure 60: Solar Energy Forum 2008. From left to the right: Cesar Barahona (CPmL), Diego Muñoz General (Secretary, UNI), Vice Minister Lorena Lanza (Energy), Jader Baldizón (ADA) and Juan Fernando Ramirez (UNIDO representative)

Taller Regional de Energía Solar Térmica / Regional Workshop on Thermal Solar Energy

The third awareness raising event, called "Taller Regional de Energía Solar Térmica" took place in Managua at the INCAE on 16 – 17 March 2009. The objective was to explore the possibilities of technology transfer for the thermal solar systems and contribute to harmonize activities within the region. Representatives of the Ministers of Energy and Environment of Central America, international organizations, NGO´s, the university, privates companies of the region and the media attended this event. A total of 27 participants.

The detailed agenda of the *Regional Workshop on Thermal Solar Energy* can be found next:

AEA Alianza en Energía y Ambiente con Centroamérica

Global Forum on Sustainable Energy
GFSE - www.gfse.at

apoyado por la
Cooperación Austríaca para el Desarrollo

TALLER DE APLICACIONES SOLARES TÉRMICAS EN CENTROAMÉRICA

Campus INCAE, Managua, Nicaragua, 16 al 17 de marzo de 2009

Agenda

Lunes 16 marzo	
09:00 h	Inscripción de Participantes
09:30 h	**Inauguración y Palabras de Bienvenida** **Mag. Wendy Rodríguez,** Directora de Desarrollo, INCAE **Dr. Hubert Neuwirth**, Jefe Oficina de Coordinación en Managua, Cooperación Austríaca para el Desarrollo **Dr. Markku Nurmi**, Director General, Ministerio de Ambiente de Finlandia y Presidente del Comité Técnico AEA **Dr. Petra Schwager**, ONUDI **MsC Sergio Martinez**, Vice- Rector Acadêmico UNI **Emb. Eija Rotinen**, Embajada de Finlandia para Centroamérica **Ing. Emilio Rappaccioli**, Ministro, Ministerio de Energía y Minas de Nicaragua **Ing.**, Roberto Araquistain Ministra, Ministerio de Ambiente y los Recursos Naturales de Nicaragua y Presidenta Protempore de CCAD
	Sesión I – Oferta Energética en Centroamérica Moderadora: **Lorena Lanza Espinoza**
10:00 h	Oferta Energética y la Dependencia Energética de Centroamérica **Lic. Carlos Roberto Pérez,** Director de Asuntos Económicos de SG-SICA
10:30 h	Energía Renovable en Nicaragua **Ing. Aracely Hernández Responsable del Departamento Biomasa Eólico y Solar del MEM.**
11:00 h	**Refrigerio**
	Sesión II – Energía Solar Térmica: Mercados y Aplicaciones Moderador: **Sr. Julio Cesar Pérez Aguilar**

11:30 h	Calentamiento con Energía Solar en el Mundo – un vistazo a los desarrollos globales **Werner Weiss,** AEE INTEC
12:00 h	Aplicaciones para Sustemas de Energía Solar Térmica **Werner Weiss,** AEE INTEC
12:30 h	**Almuerzo**

	Sesión III – Aplicaciones Solare Térmicas en Centroamérica Moderador: **Ing. Eddy Blandon**
14:00 h	Sistemas de Energía Solar Térmica en el Sector Hotelero e Industrial de Nicaragua Experiencias de los Usuarios Industria Hotelera La Posada don Pantaleón, Hotel Mansión Teodolinda
14:20 h	Tecnología Solar de Aire y Plantas de Secado Solar **Dr. Georg Hubmer**, CONA
14:40 h	Energía Solar para Aire Acondicionado y Enfriamiento **Dr. Christian Holter**, SOLID
15:20 h	Calentamiento Solar para una Compañía de Alimento para Animales en Jamaica **Maikel Oerbekke or Jorge Bekris,** ECO-TEC
16:00 – 17:00 h	Discusión de las presentaciones del primer día

Martes **17 de marzo**	
09:00 h	**Sesión IV – Obstáculos y Desarrollo de Mecanismos para Energía Solar Térmica** Moderadora: **Ana María Majano**
09:00 h	*Regulaciones de Mejores Prácticas y Medidas de Apoyo Político para Energía Solar* Térmica **Werner Weiss,** AEE INTEC
09:45 h	Disponibilidad de los Componentes y Sistemas Solares Térmicos en Centroamérica **Cesar Barahona,** CPmL
10:05 h	Temas Regulatorios, Obstáculos y Condiciones Marco en Centroamérica **José Maria Blanco,** BUN-CA
10:30 h	Refrigerio
11:00 h	Discusión sobre la Utilización de una Estrategia de Energía Solar Térmica para Centroamérica

12:00 h	**Almuerzo**
	Visita de Campo a Proyectos con Sistemas Solares Térmicos en Managua **Rudi Moshik**
Tarde 14:00 - 17:00 h	Guías del Tour: Rudi Moschik y Robelt Romero • Hotel Estrella • Hotel Mansión Teolinda - RODCEN
18:00 - 20:30 h	**Cóctel en el Campus INCAE** Nota: Conjuntamente con los miembros del Comité Técnico de la AEA

Figure 61: Agenda "Regional Workshop on Thermal Solar Energy"

The following pictures give some impression of the event.



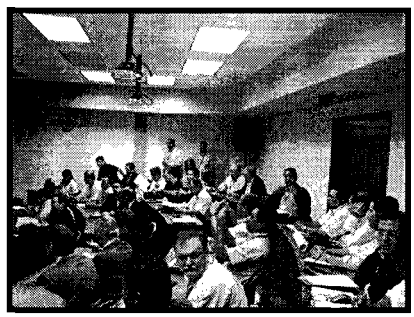


Figure 62: Participants "Regional Workshop on Thermal Solar Energy"

Foro de Energía Solar 2009 / Solar Energy Forum 2009

The fourth awareness raising event, called "Foro de Energía Solar 2009" took place in León at the Hotel El Convento in Managua on 28th July, 2009. Besides the Mayor of León Manuel Morales, representatives from the Minister of Energy, Economics and Environment and from policy administration, the university, companies and the media attended this event, for a total of 69 participants. Ing. Heinz Leuenberger (Director of Cleaner Production and Renewable Energy of UNIDO) and Petra Schwager (UNIDO CP Coordinator for Latin America) attended this event.

The detailed agenda of the Solar Energy Forum 2009 can be found next:

09:00 – 09:15 a.m.	Palabras de Apertura a cargo del Sr. Manuel Calderón, Alcalde de la ciudad de León
09:15 – 09:30 a.m.	Palabras del Ing. Donald Espinoza, Secretario General del Ministerio de Energía y Minas (MEM)
09:30 – 09:45 a.m.	Palabras del Sr. Heinz Leuenberger, Director de la División de Producción más Limpia y Energía Renovable con sede en Viena, Austria.
09:45 – 10:00 a.m.	Presentación de "Resultados y avances del I Foro Energía Solar 2008" por Adiack Chevez, funcionario del MITRAB.
10:00 – 10:30 a.m.	Presentación "Resultados en la promoción de Energía Renovables". Por el Ing. Donald Espinoza Secretario del MEM.
10:30 – 11:00 a.m.	Presentación sobre el Mercado Mundial de Sistemas Solares; a cargo del Sr. Werner Weiss, Director General de AEE INTEC con sede en Austria
11:00 – 11:15 a.m.	Presentación de normativas de Eficiencia Energética. Ing. Oscar López, Responsable de la Unidad de Normalización del MIFIC.
11:15 – 11:30 a.m.	Presentación "Estrategia nacional para cambio climático por el Ing. Manuel Madriz, Coordinador ONDL- MARENA
11:30 – 12:00 a.m.	Presentación "Resultados del Proyecto NICATEC por el Ing. César Barahona Director del CPmL-N
12:00 – 12:15 a.m.	Presentación de un caso de instalación de un sistema solar térmico a cargo del Ing. Sergio Rodríguez, Gerente General de Industrias Alimenticias RODCEN.
01:30 - 04:00 p.m.	**MESAS DE DISCUSIÓN Y PRESENTACIÓN DE RESULTADOS**
04:00 – 04:30 p.m	Palabras de Clausura del II Foro de Energía 2009 a cargo del Ing. Luis Molina Coordinador de la Unidad de Gestión Ambiental -MEM

Figure 63: Agenda "Solar Energy Forum 2009"

The following pictures give some impression of the event.

Figure 64: (Left) Presidium "Solar Energy Forum 2009": Ing. Donald Espinoza, General secretay MEM; Ing. Heinz Leuenberger, Director of UNIDO Renewable Energy Division; Ing. Petra Schwager, CP Coordinator for Latinamerica; Mr. Manuel Calderón, León Mayor; Ing. César Barahona, Dir. CPC-N. (Right) Ing. Sergio Rodríguez, General Manager Industrias Alimenticias RODCEN.

Taller Regional 2009 "Oportunidades de negocios para la Energía Solar en Centroamérica / Regional Workshop 2009 "Business Opportunities for Solar Energy in Central America".

The last awareness raising event, called "Business Opportunities for Solar Energy in Central America" took place in Managua at the Hotel Barceló Managua on 6 - 8 October, 2009. Besides the vice-minister of Energy Lorena Lanza, representatives from the Minister of Energy , Congress and Cleaner Production Centers of the region, and from policy administration, the university, companies and the media attended this event, for a total of 80 participants.

The detailed agenda of the Regional Workshop 2009 can be found next:

	06 DE OCTUBRE DE 2009
08:00 a.m.	Inscripción de participantes.
08:30 a.m.	Palabras de apertura:
	• Lorena Lanza, Vice-Ministra de Energía y Minas de Nicaragua. • Hubert Neuwirth, Director de la Agencia de Cooperación Austriaca para el Desarrollo.
	• Petra Schwager, Directora del Programa de Producción más Limpia para América Latina de la ONUDI.
09:00 a.m.	Situación de la Energía Solar en Centroamérica y su relación con la pobreza y el desarrollo. Ana María Majano, Consultora INCAE.

SESIÓN I.	***Consideraciones sobre la situación de la Energía Solar en los países de Centroamérica.***
	Moderador: Ana María Majano, Consultora INCAE.
09:30 a.m.	El Salvador. Carlos Nájera, Encargado del Programa de Eficiencia Energética del Consejo Nacional de Energía de El Salvador.
09:50 a.m.	Honduras. Allan Lobo, Coordinador de Área Técnica del Consejo Hondureño de Ciencia, Tecnología e Innovación.
10:10 p.m.	Costa Rica. Fernando Lizana, Coordinador Área de Energías Alternativas del Instituto Costarricense de Electricidad.
10:30 a.m.	Refrigerio
10:50 m.	Nicaragua. Aracely Hernández, Responsable Departamento Eólico - EUROSOLAR del Ministerio de Energía y Minas de Nicaragua.
11:10 a.m.	Guatemala. Carlos Echeverría, Asesor del Vicedespacho del Ministerio de Energía de Guatemala.
11:30 p.m.	Preguntas y respuestas
12:00 m.	ALMUERZO, brindado por el Proyecto ARECA.
1: 30 P.M	***Lectura de la declaratoria de representantes de la Comisión Interparlamentaria Centroamericana y de la Cuenca del Caribe de Servicios Públicos (CICASEP)***
SESIÓN II.	***Experiencias exitosas en la implementación de Energía Solar.***
	Moderador: José María Blanco, Director de BUNCA
02:00 p.m.	Proyecto NICATEC. César Barahona, Director del CPmL-N.
02:25 p.m.	Casos exitosos del financiamiento MEZZANINE. Walter Vargas, Ejecutivo EandCo.
02:45 p.m.	Desarrollo del Mercado Solar – Microcrédito. Elieneth Lara, Ingeniera de Proyecto, MEM Nicaragua.
03:05 p.m.	Electrificación Rural con proyectos de Energía Solar TECNOSOL / BID. Vladimir Delagneau, Gerente de TECNOSOL.
03:25 p.m.	Refrigerio
03:45 p.m.	Energía Renovable Limpia por naturaleza. Fundación Solar. Edward Morales, Gerente General.
04:05 p.m.	Enfriamiento Solar. SOLID. Christian Holter, Director SOLID.
04:25 p.m.	Programa Euro-Solar desde la perspectiva de género y pueblos indígenas. Carmen Magzul, JATI.
04:45 p.m.	Preguntas y respuestas de las exposiciones
05:15 p.m.	Estrategia de ONUDI para el desarrollo de Industrias Verdes. Petra Schwager, Directora del Programa de Producción más Limpia para América Latina de la ONUDI.
	07 DE OCTUBRE DE 2009
08:00 a.m.	Inscripción de participantes.
08:30 a.m.	Barreras a la implementación de la Energía Solar en Centroamérica. José María Blanco, director de BUNCA.
08:50 p.m.	Barreras para la implementación de proyectos de Energía Solar. Deborah Ley, Consultora del Banco Mundial.

SESIÓN III.	***Demanda y oferta de sistemas solares en los países de Centroamérica***
	Moderador: Petra Schwager, Directora del Programa de Producción más Limpia para América Latina de la ONUDI.
09:10 a.m.	Guatemala. Luis Muñoz, Director del Centro Guatemalteco de Producción más Limpia.
09:30 a.m.	El Salvador. Isabel Marroquin, Técnico del Centro Nacional de Producción más Limpia de El Salvador.
09:50 a.m.	Honduras. Claudia Díaz, Sub Director del Centro Nacional de Producción más Limpia de Honduras.
10:10 a.m.	Costa Rica. Carlos Perera, Director del Centro de Producción más Limpia de Costa Rica.
10:30 a.m.	Refrigerio
10:50 a.m.	Nicaragua. Eddy Blandón, Centro de Producción más Limpia de Nicaragua.
11:10 a.m.	Preguntas y respuestas
SESIÓN IV.	***Financiamiento de proyectos para energía solar.***
	Moderador: Salvador Tapia, Asesor Desarrollo Rural, Embajada de la República de Finlandia.
11:30 a.m.	HIVOS. Daniel Debeer, Consultor Técnico.
11:50 a.m.	Alianza Energía y Ambiente con Centroamérica. Ismael Sánchez, Consultor Técnico.
12:30 p.m.	ALMUERZO, brindado por el Proyecto ARECA.
02:00 p.m.	Proyecto ARECA, Programa de Garantías Parciales de Crédito. Geilyn Aguilar, representante.
02:20 p.m.	ECOS. Antonio Arauz, Analista de Inversiones.
03:40 p.m.	Preguntas y respuestas
03:00 p.m.	Refrigerio
SESIÓN V.	***Mesas de discusión.***
03:20 p.m.	Mesa 1. Barreras Socio-Económicas y Culturales. Moderador: Rolando Lugo, Ministerio de Energía y Minas, Nicaragua
	Mesa 2. Barreras Técnicas. Moderadora: Herminia Martínez, Programa EUROSOLAR Nicaragua
	Mesa 3. Barreras Institucionales y Legales. Moderadora: Cecilia Mendoza, Ministerio de Energía y Minas, Nicaragua
05:00 p.m.	Presentación de conclusiones de cada una de las mesas.
05:30 p.m.	Palabras de Clausura. Aldo Urbina, rector de la Universidad Nacional de Ingeniería - UNI.
06:00 p.m.	Cóctel de despedida por cortesía de la empresa nicaragüense TECNOSOL.
	<u>08 DE OCTUBRE DE 2009.</u>
08:30 a.m.	Inscripción de participantes a visita. Guías: Robelt Romero y Luis Fuentes.
09:00 a.m.	Transporte hacia "Hogar de Protección Pajarito Azul".
	Institución sin fines de lucro que atiende a 104 personas menores de edad en situación de abandono y maltrato.
09:30 a.m.	Recorrido por las instalaciones.

	• El Sistema Solar Térmico fue financiado 100% por el proyecto NICATEC como caso demostrativo, usado en el área de panadería y ducha para las habitaciones.
10:45 a.m.	Visita y Recorrido Hotel Mansión Teodolinda Recorrido por las instalaciones
	• A través del Proyecto NICATEC, se instaló un Sistema Solar Térmico, para utilizar agua caliente en las duchas y lavamanos de las habitaciones del hotel.
11:45 a.m.	Regreso al Hotel Barceló Managua.
12:00 m.	ALMUERZO, *brindado por el Proyecto ARECA.*
01:30 p.m.	Fin del Taller Regional.

Figure 65: Agenda Regional Workshop 2009 "Business Opportunities for Solar Energy in Central America".

The following pictures give some impression of the event.

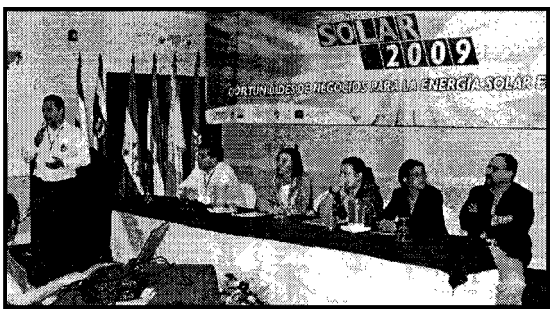


Figure 66: Participants Regional Workshop 2009 "Business Opportunities for Solar Energy in Central America".

1.3.3. Create a section on the SIRM demonstration projects within the Knowledge Management System, which form part of the UNIDO CP Programme for Latin America and the Caribbean, and update the information, illustrating the procedures followed during the project implementation and the measured impact on quality, environment and economy.

All the documents are published in the Nicaragua Cleaner Production Center website and the ONUDI Cleaner Production Latinweb.

1.3.4. Jointly with the companies involved in the SIRM demonstration project implementation, elaborate quality standards to control the installed technologies. Verify the draft version of the procedures.

A comprehensive manual on quality standards and inspection guidelines for solar thermal systems was prepared by AEE INTEC jointly with the companies involved in the project and handed over to CPmL in August 2007. This manual should help to check the quality of the installed systems according to European standards. Also a comprehensive manual on maintenance for solar thermal systems was prepared and translated into Spanish language. Both reports were updated in 2009. See annex 5.

Figure 67: Cover pages of the quality standards and inspection guidelines manuals

1.4. Staff of the Centre participating in the preparation of strategy papers aiming at the introduction of measures and incentives into the national environmental and industrial policies to promote EST development, assembling and implementation, within the SIRM approach.

1.4.1. Identify one person from the NCPC to participate in national working groups on environmental and industrial policies and provide inputs on incentives and policy instruments to promote the development and implementation of ESTs.

The project director has identified one consultant to take part in the national working groups related to renewable energy. As a result of this involvement, 2 national forums on Solar Energy have been agreed upon (carried out in July 2008 and in July 2009) and 2 regional forums (March 2009 and October 2009).

1.4.2. Through the contribution of the NCPC staff, provide assistance to the working groups in drawing up policy papers aiming at promoting EST development, assembling and implementation.

Under this context, a proposal to modify Law 532: Electricity generation via Renewable Energy, was submitted to the Minister of Energy. The response of the Minister was that Nicaragua needs a new Law on Energy Efficiency.

1.4.3. Organize national workshops to present the policy proposals to the national authorities and other relevant stakeholders involved in EST development, assembling and implementation.

The project organized the forums described in 1.3.2. At national, to present policy proposals to national authorities and other relevant stakeholders involved in Thermal Solar Systems. At regional level, to homologate laws and incentives oriented to promote the implementation of ESTs.

1.4.4. Maintain continuous lobbying activities towards the integration of EST supporting measures within the national environmental and industrial policies.

Participation in Fair of Renewable Energy

In 2008 and 2009, NICATEC participated in the Annual Fair of Renewable Energy at National Engineering University with the fact sheets of the demonstrative plants and explaining the basic operation and maintenance of the Thermal Solar Systems.


Figure 68: NICATEC participation in National Fairs.

In the participation of this fair is explained the methodology of cleaner production and the major benefits in the production processes and the environment. The duration of this fair realized as 9 a.m. until 4 PM, recorded a total of 25 people who sought information on the methodology of cleaner production and use of the thermal panels.

The interest on the part of the students was clear, making many questions about working conditions and the results that might, under the criteria of use, among the questions most frequently are: the internal structure of the collectors, as was transferred the accumulated energy toward the tank and the physical principle of stratification of water in the accumulation tank.