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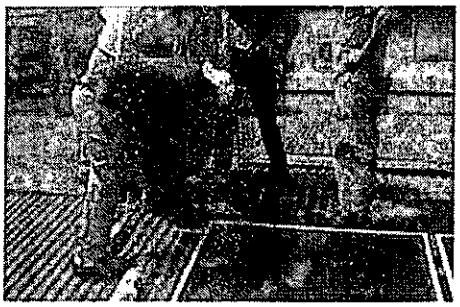
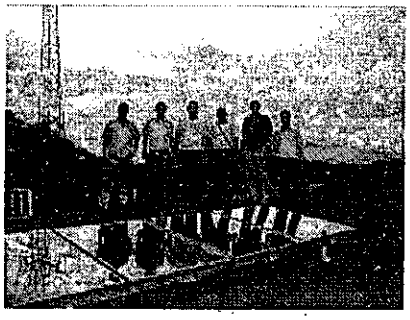
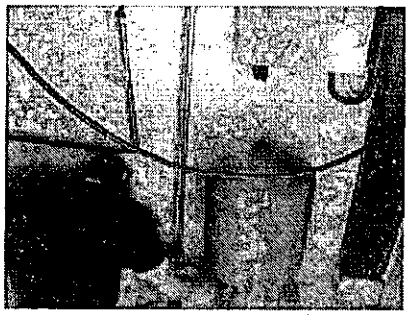
NICATECH

SUSTAINABLE INDUSTRIAL RESOURCE MANAGEMENT IN SELECTED NATIONAL PRIORITY SECTORS OF NICARAGUA







Jul - Dec 2007 Report

AEE INTEC

UNIDO

CPML
CENTRO DE PRODUCCIÓN MÁS LIMPIA

financiado por la
Cooperación Austríaca
para el Desarrollo

UE/NIC/06/001/11-51-2007

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SUSTAINABLE INDUSTRIAL RESOURCE MANAGEMENT IN SELECTED NATIONAL PRIORITY SECTORS OF NICARAGUA

UE/NIC/06/001/11-51-2007

Project Manager: Petra Schwäger-Quijano
United Nations Industrial Development Organization
Vienna

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I. Executive Summary

NicaTech projects aims to foster the sustainable industrial development by promoting the use of Environmental Sound Technology in service and production companies. The use of fossil fuels and its economical and environmental problems has been identified as one of the main constrains for SMSEs. Solar water heaters will be promoted as one Environmental Sound Technology to change the production pattern to a sustainable development approach.

The project will provide training and develop capabilities in the country to articulate the needed components for a solar water heater market in Nicaragua and Central America.

This report summarizes activities and results obtained from January to December 2007 of the project implementation. It has been identified a consultants group who has been continuously trained in designing and installing solar thermal water heaters for industrial and service application.

Results obtained from January to December 2007 are the following:

- Two awareness rising seminar have been carried out. Consultants, providers, private sector and government participated in the seminar
- 7 company assessments in metal mechanic workshops have been carried out. Five of them are participating in the project. They have shown interest in manufacturing components of the solar water heaters.
- Four training workshops were carried out. AEE is in charge of training national participants. A total of 27 persons are attending to the training workshops. 20 consultants, 7 from the metal mechanics and installing companies.
- 24 in plant assessments have been carried out. Assessments to identify the potential benefit, both economical and environmental have been done in 19 companies. After the feasibility studies were concluded, 11 out of the 19 companies have been selected including a subsidy from the project which varies from 50% to 75%.
- The installation of one demonstrative pilot Project in Hotel Mansión Teodolinda was done. 32 m^2 of solar collectors were installed. Economical benefits obtained during the four months of operation are estimated to be 9.7% of the electricity consumption in the company (**3,600 dollars)** equivalent to **1,440 kWh.**
- The installation of one demonstrative pilot Project in Hotel Estrella was done. 16 m^2 of solar collectors were installed. Economical benefits obtained during the four months of operation are estimated to be 18% LGP consumption in the company (**1,263 dollars)** equivalent to **2,157 l of LGP.**
- Designs carried out estimate annual economical benefits of 24,615.00 U$/year, this requires an investment of 222,125.00. The investment will be shared between the beneficiaries companies and the project, 82,937.50 is expected to be invested by the companies and 139,185.50 will be invested by NicatTech project. The environmental benefit will be 273,964 kWh/year and 100,999.62 kg of CO_2.

II. Introduction and background of the project

Since energy was available at low cost and without limitations for a long time, the industry did not care too much about energy efficiency and substitution of (fossil) fuels. On the other hand, it is obvious that fossil resources are finite and alternative sources have to be found for any application, including the use in industrial and commercial applications.

The G8 Renewable Energy Task Force Final Report noted that "Energy is the lifeblood of modern societies, and is a prerequisite for the welfare and well-being of all people. But, despite admirable accomplishments in providing energy for human purposes, it is increasingly clear that current energy systems are unable to provide needed energy to all people in a sustainable and affordable way. There is a growing realization that new patterns of energy supply and consumption are needed to move toward greater sustainability, and that renewable resources are a key element of that pathway. Use of renewable energy addresses all three of the pillars of sustainable development: economic progress, development and social improvement, and an improved environment."

The project reacts on these general conditions, as described above, and aims at enhancing the competitiveness and productivity of industry in Nicaragua, promoting sustained social advance in a way compatible with environmental protection. It will foster the development and diffusion of quality and productivity enhancing Environmentally Sound Technologies (ESTs), providing the national industries with the necessary tools, which will facilitate access to national and regional markets with environmentally sound products and improving the ability of national enterprises to successfully negotiate their position in the global markets.

The project is based on the experience that UNIDO and the National Cleaner Production Centre in Nicaragua have gained in the country during the past years of cooperation. It illustrates specific technical activities planned in the NCPC Nicaragua, which will focus on the implementation of the new strategy of the UNIDO Cleaner Production Programme, the SIRM (Sustainable Industrial Resource Management) approach.

The project has a strong sectoral approach, mainly focusing on the food and tourism sectors, in which the centre already gained significant experience through the implementation of CP and EST measures.

The activities of the project focus on capacity building in the EST development (especially on solar thermal systems) and promotions, policy advice and implementation of demonstration projects.

Duration of the project: June 2006 – August 2009

III.Previous Activities

From January 2006 to December 2006 the following main tasks were carried out under the supervision of the UNIDO project manager and in coordination between the NCPC Nicaragua and AEE – Intec

- 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.
- AEE experts visited Nicaragua for training 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
- Installation of two solar systems was carried out in August 2007 as planned. Achieving the installation and correct operation of these systems in two weeks.
- Four manuals were published to summarize the experiences of the installation of two demonstration projects donated by NicaTech: one installation procedure manual and one quality control manual for each project.
- Review and evaluation of 24 feasibility studies carried out by CPC-N in the year 2007.
- One presentation of the achievements of the project was done during the NCPC's directors meeting held in Austria in September 2007.
- Preparation of training material and the preparation of four training courses.
- Pre-selection of companies for case studies based on the company profiles provided by CPC-N.
- Conduction of an Information Dissemination workshop for reporting the results of the project to companies, consultants and government was done in July 2007.
- 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.
- 24 Feasibility studies were done to companies from the food and hotel sector.

- Detailed design of two demonstration projects installed in two hotels.
- Elaboration of five calls for tenders documents for the installation of three systems in hotels and two food processing companies.
- Follow – up technical advise by the CPC-N to Nicaraguan companies of the installation companies.
- Preparation of monthly performance reports for the four installed systems (two pilots: one at the university student residence and one at a Hospital, two systems in hotels in Managua).
- Two containers with all required materials were requested to be imported from Austria. One container was received in July. The second container has already been shipped from Austria and is expected to arrive the 25th of December.

IV. Activities 2007

4.1 Preparation of the fourth training course

4.1.1 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.

4.1.2 Simulation software for the fourth training course

The agreement with the German company Valentin Energy software GmbH, which provides the software T*Sol has been renewed, to use the simulation software for training purposes free of charge.

4.2 Fifth training course

The fifth training course "Installation of demonstration modules", was carried out from the ***3-11 of August of 2007***. The training aimed to build the capacity of the installing companies to develop practical capabilities to install systems in the Nicaraguan conditions. Specifically two

systems, one in Hotel Estrella and one in Hotel Mansión Teodolinda, were analyzed in detail: The first case study was Hotel Mansión Teodolinda which was designed with 32 m^2 of solar collectors and the second one in Hotel Estrella with 16 m^2 of solar collectors.

From 31st of July to 1st of August, a training course was carried out to explain the detailed design and calculation of these two solar systems. The tools, work plan, and procedure were explained in detail. T-SOL software was used to support these designs.

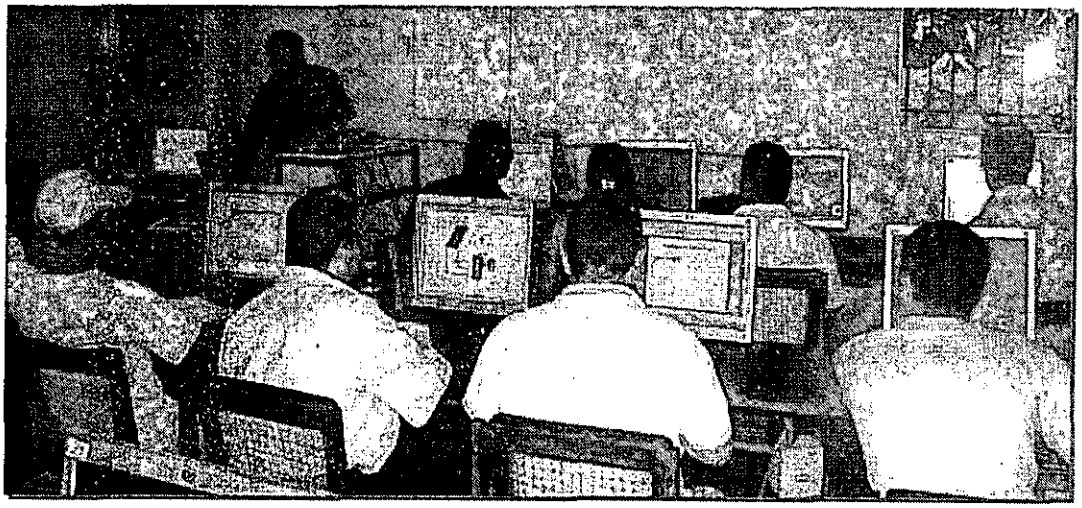


Figure 1 shows the training of using T-SOL software obtained by the Project NicaTech for the use of designers of solar systems.

Attendants to the training came from installing companies and personnel of the CPC-N.

The two systems were installed simultaneously by two installing companies: Tecnosol and ECAMI. This enabled the AEE INTEC to supervise the installation during the mission of August 2007.

V. INSTALLATION OF DEMONSTRATIVE PROJECTS

5.1 Thermal Solar System Installation in Hotel Mansión Teodolinda

5.2.1 Flat plate collectors

Collectors heat up the water up to 80 °C, They are connected in series with a weigh for 42 kg each collector in the roof of the hotel. 16 Collectors were installed, 8 in each one of the two buildings of the hotel.

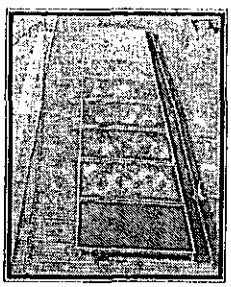


Figure 2. Flat plate collector.

5.2.2 Recirculation pump and accessories.

The pump was protected with a polyurethane box, connected to the systems with measurement devices to verify the operation of the system. A purge system was installed to protect against the increase of temperature. A pressure gauge was connected to a relief valve to protect the system against high pressure. It was set to open at 6 bars.

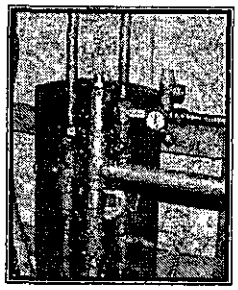


Figure 3. Pump and accesories

5.2.3 *Insulated Tank*

Storage tanks were installed with a capacity of 1000 l. Both tanks have heat exchangers two water loops are used, one for the solar system and the second for the hot water service. The back up system is electricity operated. Tanks are certified to be food grade, which is the Standard for hotels. Insulation of the tank allows keeping the temperature during night. Temperature in tank decreases from 2 to 3 degrees during night which is the standard for solar system installations.

Figure 4. Insulated Tanks

5.2.4 Expansion Vassel

Figure 5. Expansion *Vassel*

One expansion vassel of 50 l was connected to each system. The expansion vassels allow keeping the pressure in the system without loosing water in the solar collectors. Expansion vassels are membrane type and a chamber of nitrogen.

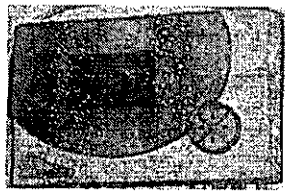


Figure 6. Control device

5.2.5 Electronic Control System

One electronic control was installed in each system. This device controls the operation of the system and switch on the pumping systems according to temperature signals from thermocouples in the collector and tanks. At the same time control storage specified parameters which are downloaded to computer for monthly reports. Heat production and consumption is recorded as well as meteorological conditions are stored to calculate the efficiency of the system. Annexes show the results of the operation of each system.

5.2 Installation of the Thermal Solar System in Hotel Estrella

5.2.1 Thermal Solar System Description

The solar system consists of eight solar flat plate collectors, an insulated tank of 1000 l with two heat interchangers, a pumping system, accessories and valves, expansion valve and an electronic control system.

5.2.2 Flat plate collectors

The flat plate collectors are the main part of the solar system. In the picture the final installation is shown.

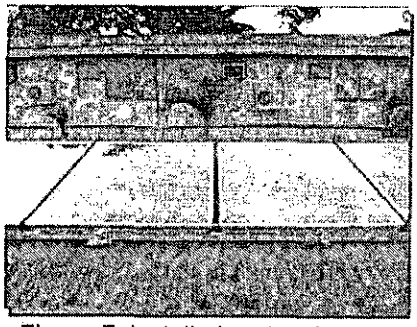


Figure 7. Installed system in Hotel Estrella.

Each collector is 2 m^2 of solar heat radiation. The main components of the system are listed bellow.

- A 80 W recirculation pump, 750 l/h
- Storage tank of 1000 l, set to 80 C.
- One Expansion Vassel of 50 l
- One Electronic Control system
- Accessories, pipes and valves.

Table 1: Time schedule of the AEE 4th mission to Nicaragua

Time	Monday 30th	Tuesday 31st	Wednesday 1st	Thursday 2	Friday 3	Saturday 4	Sunday 5
09:00 a.m.	Meeting at CPmL	Theoretical training (see detailed program)/Petra meetings with ministries	Theoretical training/visit to the installed system in León (Petra)	Installation Hotel Estrella/Feasibility Studies & Selection of 2 new demonstration plants 1			
10-11 am							
11-12 pm							
12-1:30 pm							
1:30-2:00 pm	Rudi Moschik– preparation of the materials, tools...meeting with the solar companies to discuss the installation of the two demonstration systems	Theoretical training (see detailed program)	Theoretical training/visita al Sistema instalado en Leon(Petra)	Installation Hotel Estrella/Feasibility Studies & Selection of 2 new demonstration plants 1			
2:30-3:30 pm		Demonstration plant preparation (Rudi Moschik)					
3:30-4:00 pm							
4:30-5:30 pm			Detailed design of demonstration plant 3 and 4 • This part is just for CPmL staff				
5:30-6:00 pm							
06:00 p.m.							
08:00 p.m.							

Time	Monday 30th	Tuesday 31st	Wednesday 1st	Thursday 2	Friday 3	Saturday 4	Sunday 5
8-9 am		Hotel Teodolinda		Final Session • Planning of the activities for the next 6 month • preparation of the installation of the next 2 demonstration plants. Summary and detailed planning of the next 6 months			
10-11 am							
11-12 pm							
12-1 pm							
1-2 pm							
02-03 pm							
3-4 pm							
4-5 pm							
5-6 pm							
6-7 pm							
7-8 pm							

5.3. Pilot Plants

5.3.1 Shipping of materials for pilot plants

On request of UNIDO, AEE INTEC prepared a tender document for the materials and components needed for the pilot plants installation. Furthermore AEE INTEC consulted UNIDO concerning technical questions, which were raised by the companies interested to submit a bid.

The materials and the components were shipped to Nicaragua by the Austrian company MIVA. The equipment arrived at CPmL in Managua on 15th of July 2007.

5.3.2 Preparation of first demonstration plants

Three of the companies for which case studies had already been carried signed a contract with the CPmL, for that the installation of the first demonstration plants. Installations were carried out during the 4th mission of AEE to Nicaragua in August 2007. During this 4th mission of AEE to Nicaragua, a second visit has been carried out to these three companies in order to revise the feasibility studies and to check details for the installations.

In order to train the staff of CPML Nicaragua on the detail design of the solar plants, on Friday 4th of May an intensive training session was carried out, revising some detail aspects of the plants to be installed. The detailed design of the three plants that will be the base of the tender for the installation of these systems will be carried out after the 4th mission in collaboration between CPML and AEE INTEC.

VI. Systems to be installed in January 2008

6.1. Hotel Villa Paraíso, Rivas Nicaragua

Hotel Villa Paraíso is located in Ometepe Island in the great lake of Nicaragua. It has 16 rooms: 7 doubles and 9 triple. Occupancy rate is 90% all through the year. The hotel does not provide hot water service. In order to prepare the hotel for the solar systems installation , the hotel has already installed the pipes for hot and cold water in the rooms.

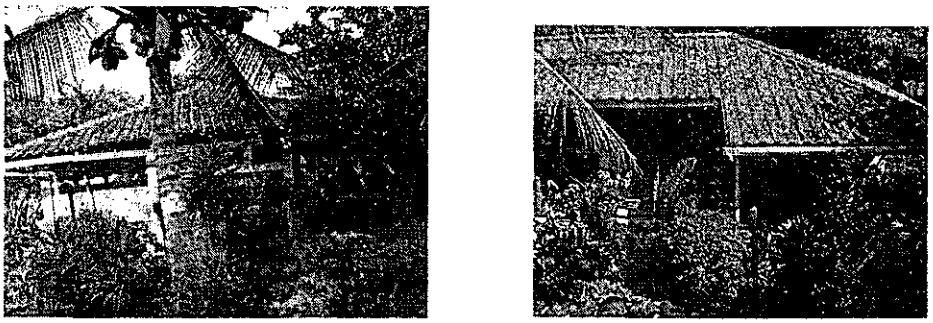


Figure 8. View of rooms in Hotel Villa Paraíso in Rivas Nicaragua

Demand of hot water system was calculated based in the following demand estimation:

- 13 rooms with an average of 2.56 beds
- Yearly occupancy rate of 90 %
- Average consumption rate per person: 50 l/day at 50 °C, intake temperature of cold water 26 °C
- System looses due to distribution: 25 %
- Kitchen consumption rate 400 liters / day.

Daily average consumption is 1850 l in the rooms and 400 in the kitchen. The system will be demand 2,250 l per day.

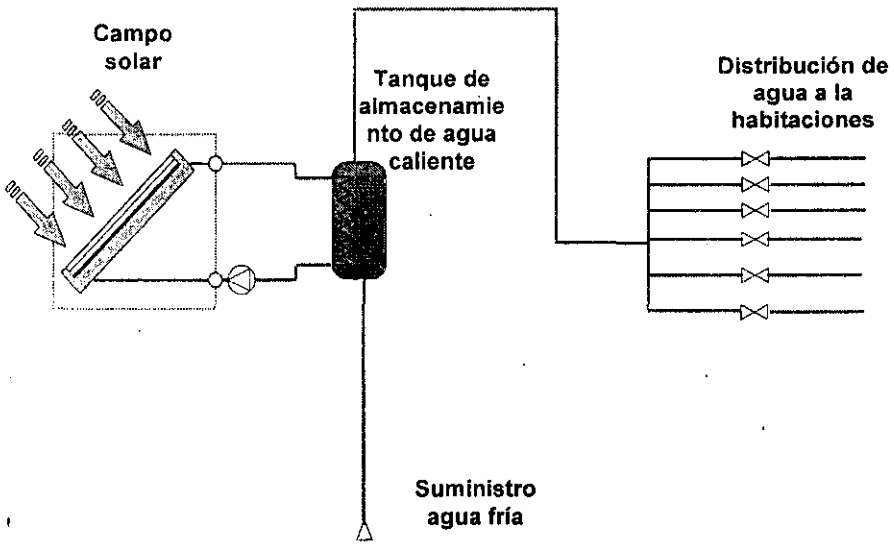


Figure 9: Scheme of the proposed solar thermal system.

6.2. Lácteos Santa Martha, Jinotega

The company "Lácteos Santa Martha" in Jinotega produces cheese and other milk products. The present turn-over is about C$ 1,400,000 (US-$ 80,000) per month.

An important objective of the company is to reduce production costs, and among those energy is the fourth most important cost factor representing 8.3 % of the total production cost.

Figure 10: Some of the products of Lácteos Santa Martha

The heat consuming processes in the company are:

- Hot water in the "hiladora" (75 °C)
- Pre heating in Pasteurization (72 °C)
- Thermo-packaging and other uses (up up to 95 °C)

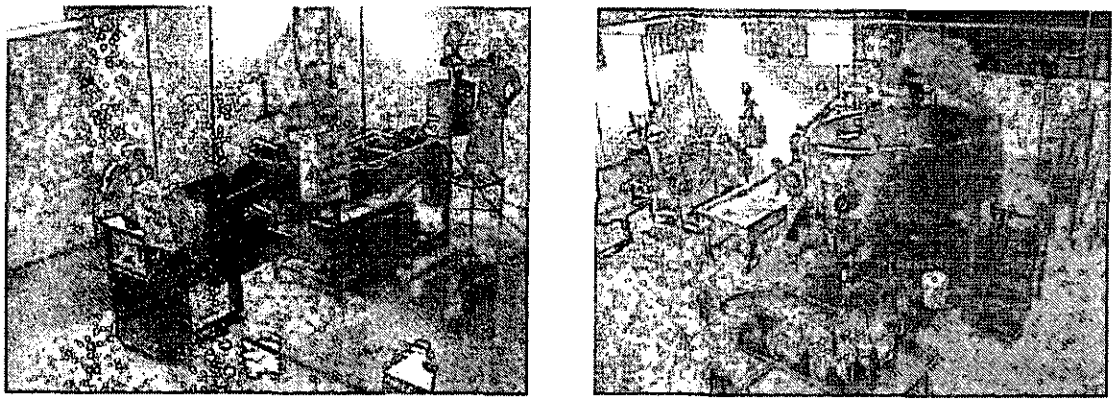


Figure 11: (a) "Hiladora" (b) Bath for scalding

A solar system with a capacity of 22.4 kW_{th} (32 m^2) for preheating of the water used in the processes and for heating of the scalding bath (37 – 40 °C) was proposed to the company, in

combination with a system for recovering heat from the waste water and condensates of the steam boiler.

The proposed system size is relatively small (approximately 22% savings) in order to obtain a good economic performance.

6.3. Industrias RODCEN

RODCEN is a food processing company in Managua. It produces Tomato, English and Chinese sauces; vinegar, cooking wine, vanilla and strawberry flavoring liquids.

The objective of the company is to reduce the production cost by the use of thermal solar systems. Currently, they use LGP to prepare hot water

Figure 12: Industrias RODCEN in Managua

In the production of Vanilla and strawberry liquid flavors; hot water at 85 °C is used. After 30 minutes of cooling, it is mixed with the formula to be bottled and sealed. The solar system will heat up water up to 80 °C, later the water will be warm up 5 °C more to achieve 85 °C required in the process

6.4. Feasibility studies

Several new feasibility studies have been carried out by CPmL in during the second semester 2007, Studies 3 listed in *Table 2*. These feasibility studies were reviewed as far as available by AEE INTEC prior to the 4th mission.

Table 2: Overview of the feasibility studies carried out within the NicaTech project.

Summary case studies NicaTec		1	2	3	4	5	6	7	8	9	10	11	12	
COMPANY NAME		La Matagalpa	Lácteos Santa Martha	Hotel Estrella	PROINCASA	Mansión Teodelinda	COPECEPRD	Lácteos La Completa	Cooperativa Masigüito R.L	Ríos de Leche	Hotel Suyapa Beach	Hotel Selva Negra	Hotel Caoba	TOTAL
Company														
Sector		food conserves	milk	hotel	meat	hotel	milk	milk	milk	milk	hotel	hotel	hotel	
Process		hot water	hot water; bath heating	hot water	hot water	hot water	pasteurisation			pasteurisation				
Location		Matagalpa	Jinotega	Managua	Managua	Managua	León			León				
State														
Feasibility study		X	X	X	X	X	X	in elaboration	in elaboration	in elaboration	in elaboration	in elaboration	in elaboration	
Company interested ?	kW	yes negotiation ongoing	Contract signed	Contract signed	yes negotiation ongoing	Contract signed	stand-by (restructuring of company)							0
Characteristic data of the proposed system														
Collector model (type)		SFPC	SFPC	SFPC	SFPC	SFPC	SFPC							
Installed thermal power	kW	10.5	35.0	10.5	14.0	21.0	35.0							
Collector area	m²	15	50	15	20	30	50							126
Volume of heat storage	m3	1.20	1.25	0.75	1.50	2.50	2.50							180
Working temperature (min. / max.)	°C	35	35	25	25	25	50							10
		80	75	56	80	53	85							
Additional notes		system including heat recovery	system including heat recovery											
Energy savings														
Solar production of useful heat	MWh	7.92	31.10	14.10	17.03	23.22	23.22							117
Useful heat per kW nominal power	kWh/kW	754	889	1 343	1 216	1 106	663							925
Heat recovery (useful heat)	MWh	3.50	12.00											16
Total savings (useful heat)	MWh	11.42	43.10	14.10	17.03	23.22	23.22							132
Total savings (fuel LCV)	MWh	15.23	57.47	17.63	20.04	27.32	27.32							165
Percentage of savings	%	25.1%	21.5%	42.7%	47.3%	77.4%	77.4%							
Economic parameters														
Installation cost	US-$	12 750,00	41 500,00	11 250,00	15 000,00	22 500,00	22 500,00							125 500,00
Nicatech funding	%	75%	65%	60%	50%	50%	50%							58%
	US-$	9 562,50	26 975,00	6 750,00	7 500,00	11 250,00	11 250,00							73 287,50
Company's contribution	US-$	3 187,50	14 525,00	4 500,00	7 500,00	11 250,00	11 250,00							52 212,50
Annual gross savings in energy cost	US-$	1 214,79	4 585,84	1 406,13	2 582,67	3 683,98	3 683,98							17 157
Maintenance contract	US-$	345,00	345,00	195,00	345,00	225,00	225,00							1 680
Annual net savings	US-$	869,79	4 240,84	1 211,13	2 237,67	3 458,98	3 458,98							15 477
Simple pay-back	a	3.7	3.4	3.7	3.4	3.3	3.3							3.4
Energy costs (without funcing, LCV)	US-$/MWh	111	82	78	98	95	95							90
Climatic data and system efficiency														
Yearly global radiation	kWh/m²	1 678	1 678	1 880	1 880	1 880	1 880							
Mean working temperature	°C	49	44	38	51	47	77							
Mean annual system efficiency	%	35%	37%	50%	45%	41%	25%							
Characteristics of load profile														
Continuous: C; 5 days: W; Seasonal: S; 5 days with weekend storage: W-L		W-L	C	C	C	C	C							

VII. Mission evaluation and follow-up activities next 4 months

On 7th June 2007, the evaluation of the activity and the planning of the follow-up activities were done for the next 4 months, as well as the preparation of the next mission was carried out.

The installation of the pilot plants and the training was considered a success, with minor points of critique being the pressure of time for the installations, and the suboptimal contribution of some of the installer companies.

The following main decisions were made:

- Follow up of the installed Pilot Projects.
- Preparation of the 5th, 6th and 7th Pilot Project

Table 3: The main activities and the corresponding due dates

Activity	Responsible	Deadline
Monitoring and supervision of pilot plants	CPML	Monthly,
Tender for demonstration plants + quality standards and maintenance contract	CPML, review by AEE INTEC	28/11/2007 1st draft
Feasibility studies finished	CPML under supervision of AEE INTEC	18/12/2007
Shipping of container with material for demonstration plants	AEE INTEC	Arrival of the material shall be assured for 5th mission (December 2007)

VIII. Regional Strategy

The project aims to integrate representatives of the Central American countries in the training workshops and preparation of feasibility studies in companies. Invitation to the CPCs in the region has been send to attend to trainings during AEE missions to Nicaragua.

The professional qualifications of the participants have been informed as well as the economical arrangement in which DSA for participants will be covered by the project and transportation cost will be covered by the participants. A commitment from the participants has been requested to participate in all training activities of the projects as well as the preparation of one feasibility study.

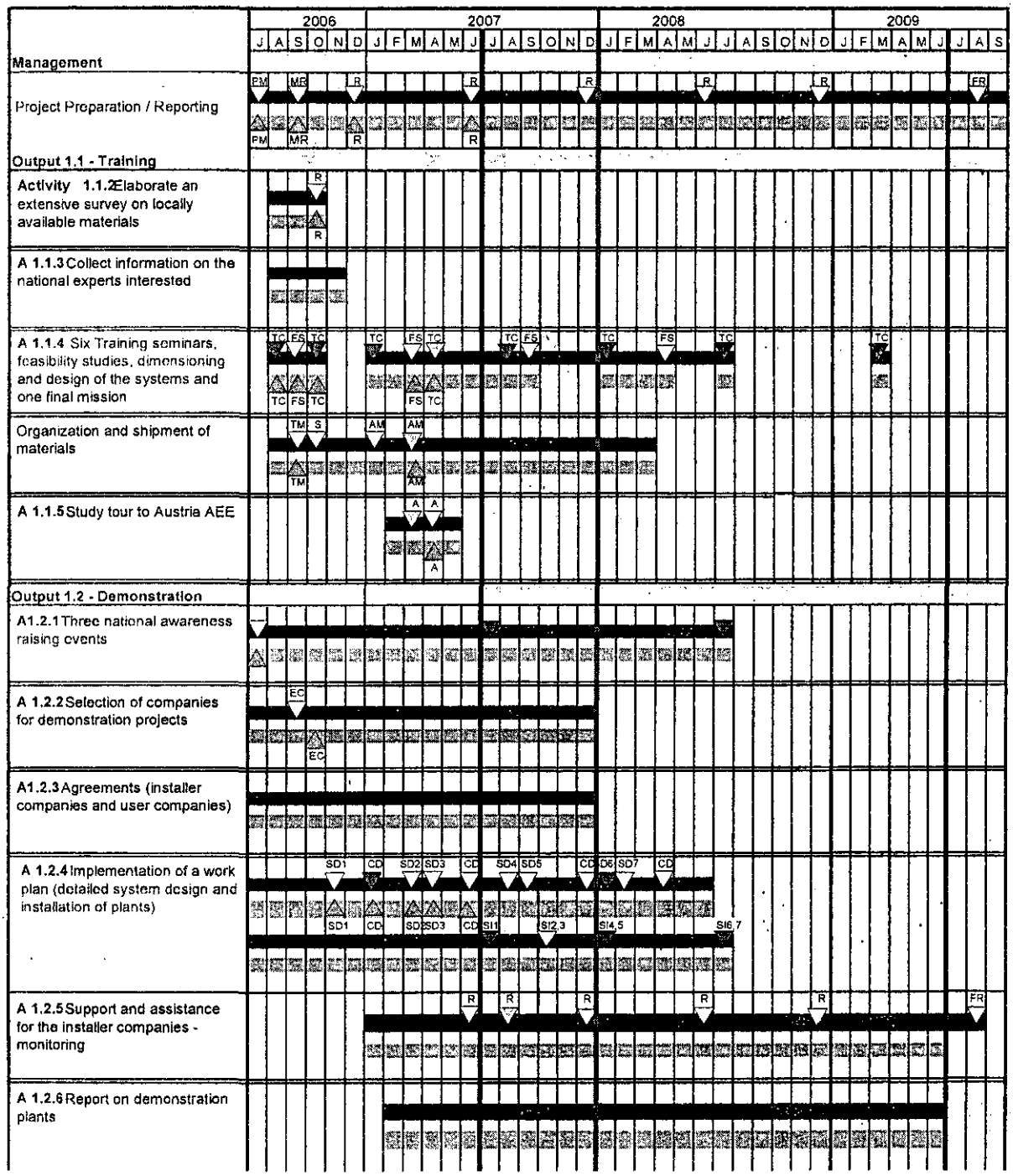
Up to now only one participant from Honduras has attended to the training activities. It is expected that participants from other countries will be attending to the training activities in January 2008.

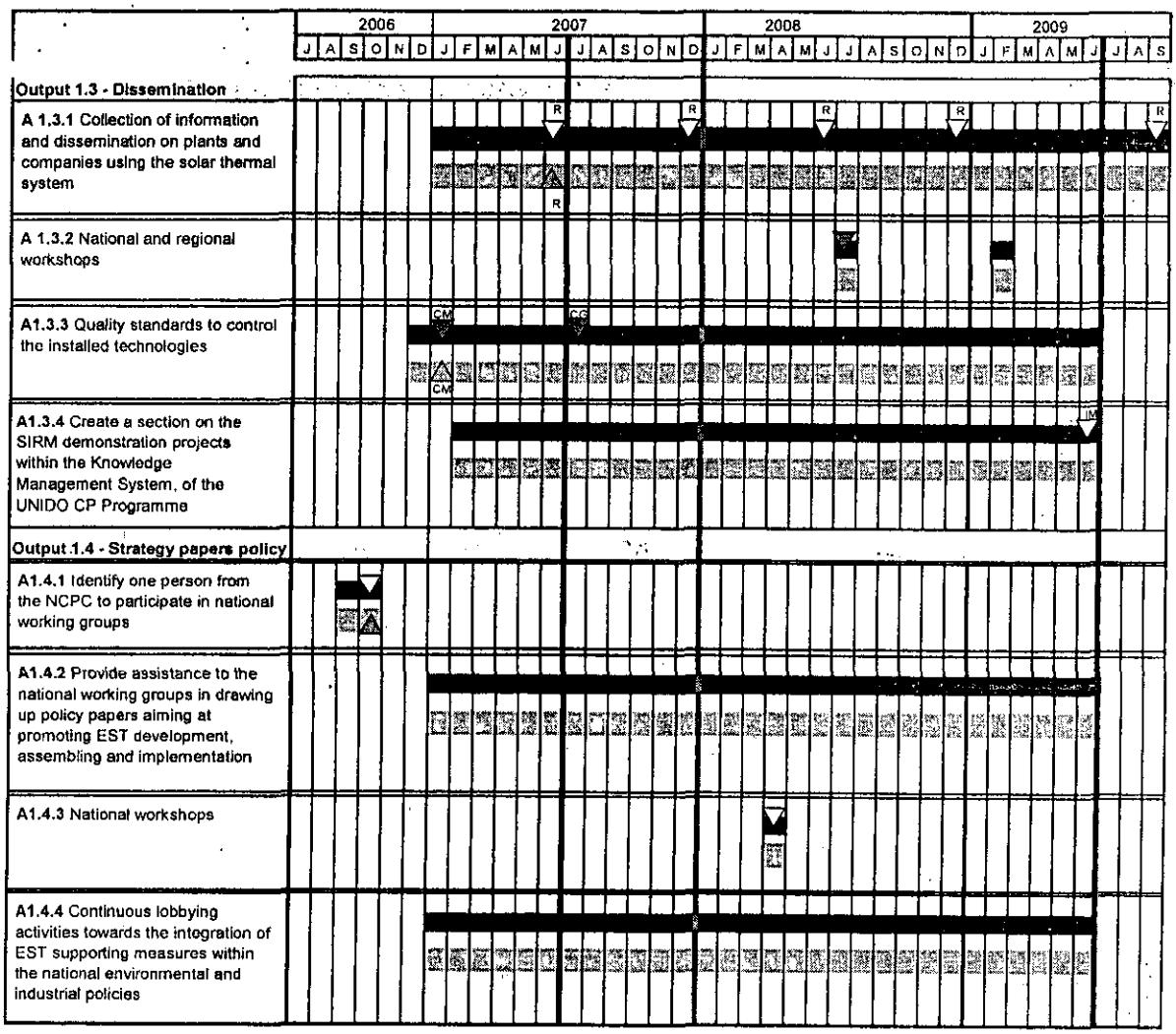
A strategy to include more participants form the Central American region has been agreed with the project manager. This strategy includes a crash training course to up date participants from the region it will be organized in January 2008. The CPCs from the region will be invited to attend to the updating training course. The professional requirements will remain the same, as well as the commitment to participate in all training activities. Cost will be shared by the CPCs and the NicaTech project. International travel will be pay by the CPCs and national accommodation and transportation will be supported by the NicaTech project.

The participants of the region will be requested to carry out assessment in their own country. The results of the solar water heater evaluation will be included in the case studies of the project. It is expected that suppliers will be interested in provide the systems to companies in Central American countries based in the prepared feasibility studies.

With the integration of participants from other countries of the Central American region, a better understanding of the sustainability of the project is expected since suppliers and installer companies from the region will be identified as well as the size of the market will be increased.

IX. Time table for the overall project





- Milestones scheduled
- Mission to Nicaragua
- Milestones postponed
- Milestones achived
- Milestones not achived

Abbreviation	Description of the Milestone or Deliverable
PM	Project preparation meeting in Vienna
MR (AEE INTEC)	Mission report
R (CMLP)	Semi annual report
FR	Final report
TC	Training Course
FS	Feasibility study report
TM	Tendering material for Nicaragua (container for the pilot systems and the first demonstration systems)
S	Shipment of the material from Austria to Nicaragua
AM	Arrival of the materials in Nicaragua
EC	Evaluation criteria finished
CM	Check list for commissioning and maintenance guidelines
CG	Operation control guidelines in conjunction with the monitoring of the systems
IM	CPML prepares information material for the UNIDO web page
SD1..	System design (detailed system design and call for tender) SD1 = design of system 1 completed
CD	Contract for a demonstration project
SI1...	System installation

X. ANNEXES

ANNEX 1 – Agenda of the 4th training course

SOLAR WATER HEATERS

Agenda - Training Seminar 4

(Theoretical part)

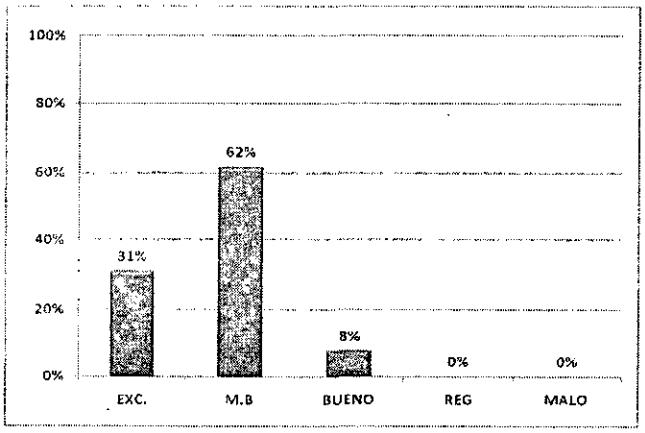
31 July and 1 August, 2007

CPML, Managua

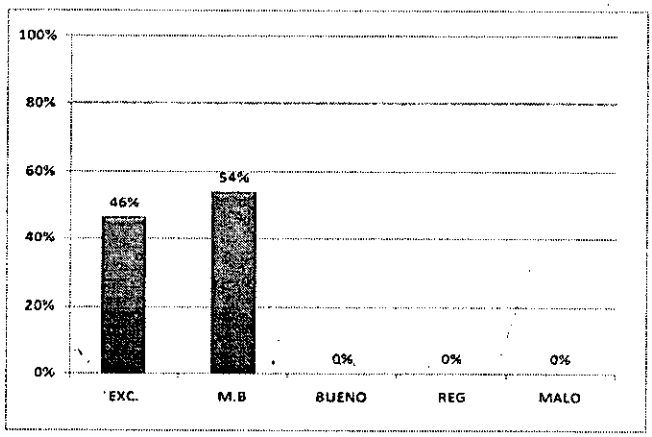
Tuesday, 31 July	
09:00 h	*Refresh of topics from training course 1 -3*: Demand calculations, system selection and solar system basic designs Werner Weiss, AEE INTEC
10:30 h	*Presentation of the pilot plants at UNI and HEODRA and* presentation of the plant operation experience. Analyses of the monitoring data.
11:00 h	Coffee break
11:30 h	Presentation System designs and data for a system calculation
12:00 h	Lunch
13:30 h	Work in groups: Calculation and lay out of a generic system Tutorial: Werner Weiss, AEE INTEC and Erick Lopez, CPML
15:0 0 h	**End of the first day of the training course**
15:30 – 17:30 h	**Demonstration plant preparation** This part is just for the companies, who will be involved in the installation of the two demonstration plants at Hotel Estrella and Hotel Mansión Teodolinda

Wednesday, 1 August	
09:00 h	**Presentation of a plant concept of an industrial application**
09:30 h	Werner Weiss, AEE INTEC
	Work in groups: System design, simulation with T-Sol, plant and collector hydraulics, dimensioning of components
10:30 h	Tutorial: Werner Weiss, Rudi Moschik, AEE INTEC and Erick Lopez, CPML
11:00 h	Coffee break
	Work in groups: System design, simulation with T-Sol, plant and collector hydraulics, dimensioning of components
12:00 h	Tutorial: Werner Weiss, Rudi Moschik, AEE INTEC and Erick Lopez, CPML
	Lunch
13:30 h	**Work in groups** continued
14:30 h	**Presentation and discussion of results** each working group is presenting the results
15:00 h	End
15:30 – 17:30 h	**Detailed design of demonstration plant 3 and 4**

ANNEX 2 – Training course: evaluation and list of participants

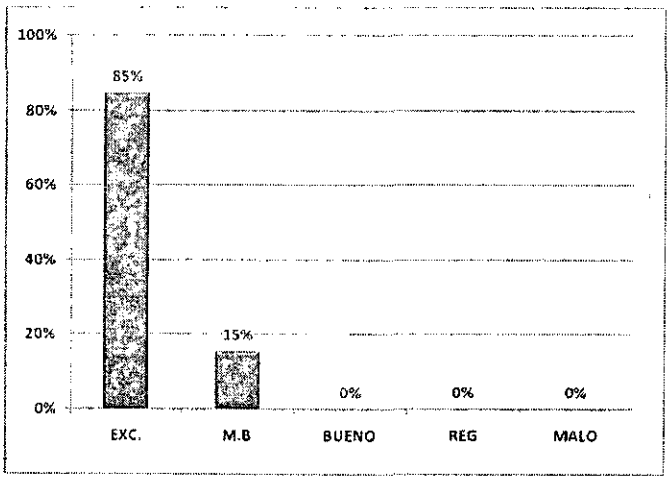


Evaluación General de la capacitación

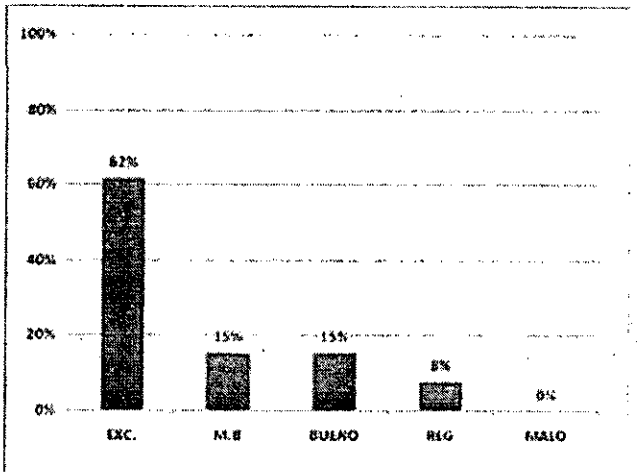


Contenido del Curso

At the same time, the participants evaluate the instructors' performance during the course. The score was **very good**.



Instructor General Evaluation



Ability to answer

ANNEX 3 – LIST OF PARTICIPANTS

No.	Nombres y Apellidos	Institución	Responsabilidad	Teléfono	E-mail
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12	Erick López Cuadra	CPmL-N	Consultor	278-3136	elopez@cpmlnic.org.ni
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ANNEX 4 – Case studies for demonstration plants