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Final Report:

Solindustrias

Solar Process Heat in Cuenca

Author(s):
Andreas Häberle, Eastern Switzerland University of Applied Science (OST)
Andrés Montero Izquierdo, Universidad de Cuenca

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Prepared by:
Eastern Switzerland University of Applied Science (OST),
Oberseestr. 10, CH-8640 Rapperswil
+41 58 257 48 21, andreas.haeberle@ost.ch, www.ost.ch

Universidad de Cuenca,
Av. 12 de abril y Av. Loja, Cuenca, Ecuador
(593-7) 4134520, andres.montero@ucuenca.edu.ec, www.ucuenca.edu.ec

With the Support of:
REPIC Platform
c/o NET Nowak Energy & Technology Ltd.
Waldweg 8, CH-1717 St. Ursen
Tel: +41(0)26 494 00 30, Fax: +41(0)26 494 00 34, info@repic.ch / www.repic.ch

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Contents

1. Summary

Solindustrias arose from the need to promote the decarbonization of industrial processes based on the use of fossil fuels in the city of Cuenca.

In 2020, the project "Energy City Cuenca: a participatory municipal planning tool to promote energy transition in Ecuador," funded by the Swiss government through the REPIC (Renewable Energy, Energy and Resource Efficiency Promotion in Developing and Transition Countries) platform and with the participation of the University of Cuenca, proposed a series of projects related to energy use for the city of Cuenca. One of the proposed ideas was to use solar thermal energy in industrial processes.

The Solindustrias project aimed to prepare the technical and economic basis for the successful deployment of solar heat for industrial processes (SHIP) projects in Cuenca by transferring knowledge, piloting and demonstrating SHIP examples, and promoting these technologies to other industrial end users and to local and national governments.

Solindustrias is the first project that has harnessed solar thermal energy to supply heat to industrial processes in Ecuador. The main benefits of the project have been the reduction of emissions in Cuenca's industrial sector, as well as the transfer of technology and knowledge on solar thermal energy through seminars and training to different target groups such as engineering students, installers, and technicians.

The project has been carried out by the Eastern Switzerland University of Applied Sciences (OST) / SPF Institute for Solar Technology, as project manager, the University of Cuenca, as the local coordinator, the company Lácteos San Antonio (Nutri) as the private partner for the installation site, the Environmental Management Commission (CGA, in Spanish) as the public partner for dissemination, communication, and social acceptance, the Municipal Public Company for Economic Development (EDEC EP) as a collaborator in the training and promotion of entrepreneurship phase, and SOLTEC as the company in charge of the installation of the SHIP system.

2. Resumen

Solindustrias surgió de la necesidad de promover la descarbonización de los procesos industriales basados en el uso de combustibles fósiles en la ciudad de Cuenca.

En 2020, el proyecto «Ciudad Energética Cuenca: una herramienta de planificación municipal participativa para promover la transición energética en Ecuador», financiado por el Gobierno suizo a través de la plataforma REPIC (Promoción de las Energías Renovables, la Eficiencia Energética y la Eficiencia de los Recursos en los Países en Desarrollo y en Transición) y con la participación de la Universidad de Cuenca, propuso una serie de proyectos relacionados con el uso de la energía para la ciudad de Cuenca. Una de las ideas propuestas fue utilizar la energía solar térmica en los procesos industriales.

El proyecto Solindustrias tenía como objetivo preparar la base técnica y económica para el despliegue exitoso de proyectos de energía solar térmica para procesos industriales (SHIP) en Cuenca mediante la transferencia de conocimientos, la puesta en marcha y demostración de ejemplos de SHIP, y la promoción de estas tecnologías entre otros usuarios finales industriales y los gobiernos locales y nacionales.

Solindustrias es el primer proyecto que ha aprovechado la energía solar térmica para suministrar calor a procesos industriales en Ecuador. Los principales beneficios del proyecto han sido la reducción de las emisiones en el sector industrial de Cuenca, así como la transferencia de tecnología y conocimientos sobre energía solar térmica a través de seminarios y formación a diferentes grupos destinatarios, como estudiantes de ingeniería, instaladores y técnicos.

El proyecto ha sido llevado a cabo por la Universidad de Ciencias Aplicadas de Suiza Oriental (OST) / Instituto SPF de Tecnología Solar, como gestor del proyecto, la Universidad de Cuenca, como coordinador local, la empresa Lácteos San Antonio (Nutri) como socio privado para el lugar de instalación, la Comisión de Gestión Ambiental (CGA) como socio público para la difusión, la comunicación y la aceptación social, la Empresa Pública Municipal de Desarrollo Económico (EDEC EP) como colaboradora en la fase de formación y promoción del espíritu empresarial, y SOLTEC como empresa encargada de la instalación del sistema SHIP.

3. Starting Point

The city of Cuenca in Ecuador is committed to its sustainable development and decarbonization, aiming to become an Energy City (based on the Swiss Energiestadt). In order to fulfill this ambitious goal, an Energy Plan for Cuenca was developed by the Municipal government and the energy transition is pushed forward by implementing energy efficiency measures and renewable energy technologies, involving all large energy consumers, especially in the industrial sector.

In 2019, the industrial sector in the city consumed 2445 kBOE (approx. 4 TWh), mainly provided by fossil fuels, thus releasing a large amount of greenhouse and pollutant gases. Industrial companies are constantly exploring alternative, low carbon energy sources to produce heat for their processes.

4. Objectives

General objective of the project

- Install a SHIP pilot system to produce hot water at the Lácteos San Antonio company, located in the Cuenca industrial park, in order to partially substitute fossil fuels and demonstrate the benefits and potential of adopting this type of energy in the Ecuadorian industrial sector.

Specific objectives of the project

- Demonstrate the great potential of carbon-neutral SHIP by conducting technical, economic and environmental analyses on the benefits of adopting SHIP systems by showcasing on demo-site.
- Capacity-building and knowledge-transfer by training courses on the design, assembly, and maintenance of solar thermal energy systems thereby encouraging local entrepreneurship.
- Promote new installations using a strategy plan for market introduction and recommendations on energy policies and legal framework to promote the use of solar thermal energy in Ecuador.

5. Project Review

5.1 Project Implementation

This report presents a description of the deliverables produced to fulfill the objectives of
WP1 Implementation and demonstration of SHIP,
WP2 Capacity building and education,
WP3 Socio-economic and environmental evaluation, and
WP4 Potential SHIP in Cuenca and Ecuador.

For more detailed information regarding each deliverable, please refer to the specific reports in the Annex.

WP1 Implementation and demonstration of SHIP
MS1 Installed and running SHIP plant
D1.1 Evaluation of SHIP performance

A preliminary technical, economic, and environmental evaluation of the solar thermal system installed at Lácteos San Antonio was conducted by analyzing the output parameters recorded by the monitoring equipment on December 9, 10, and 11, 2024.

This analysis revealed that the SST installed at Lácteos San Antonio achieves a performance of over 50%. Additionally, the system is estimated to reach an annual solar fraction of 2,5%. These results confirm that the system is meeting technical expectations, as its performance aligns with the standard efficiency levels expected for this type of technology in industrial applications.

On the other hand, the company can achieve fuel savings of approximately 4.800 USD per year with the installation of the solar thermal system, which would allow for the recovery of the capital investment within the system's useful life. However, to maximize system performance and associated economic benefits, it is essential for Lácteos San Antonio to manage the use of the hot water generated, ensuring that the company fully utilizes the total energy the system is capable of supplying on a daily basis. In terms of environmental benefits, it has been estimated that Lácteos San Antonio would displace approximately 6.000 kg of LPG per year, avoiding the emission of 18 tCO2 annually. Nonetheless, for a more objective technical, economic, and environmental analysis, data over at least one year should be reviewed, as the energy provided by the solar thermal system fluctuates daily based on the availability of solar radiation on the collector surface.

**For more details on this deliverable, please review the technical report "Evaluación del rendimiento del sistema solar térmico instalado en Lácteos San Antonio (Nutri)" (Solindustrias_D1.1_Evaluation of SHIP performance) in the Annex.*

D1.2 Road-map for Nutri decarbonization

The urgency of implementing sustainable practices across the value chain in the food industry is clear and critical to mitigating climate change. This report presents alternatives for Lácteos San Antonio to reduce CO_2 emissions throughout its value chain, aiming to incorporate sustainable solutions as part of a comprehensive roadmap toward the company's future decarbonization. To identify these alternatives, a review of the key stages in the dairy industry's value chain was carried out to pinpoint areas where the integration of sustainable projects would yield the greatest benefits.

In this context, while Lácteos San Antonio has already implemented a photovoltaic plant, a solar thermal system, and replaced diesel with LPG as boiler fuel, there are additional measures the company could adopt in the future to further reduce its carbon footprint. At the milk production stage, one proposed solution to lower emissions from livestock manure is for Lácteos San Antonio to provide technical assistance and equipment to help dairy producers integrate biodigesters on their farms. For the collection, storage, and transportation of milk, the installation of solar thermal collectors for heating

and cleaning water at collection centers could be evaluated as a sustainable alternative to reduce fossil fuel consumption in this process. Lastly, at the milk processing stage, conducting an energy audit has been identified as a crucial step to explore opportunities for energy savings in the industry.

**For more details on this deliverable, please review the technical report "Alternativas sostenibles para la descarbonización de Lácteos San Antonio (Nutri)" (Solindustrias_D1.2_Road-map for Nutri decarbonization).*

WP2 Capacity building and education
MS2 Development of educational material
D2.1 Educational material

To develop the educational materials for the solar thermal energy courses, we used the bibliographic resources provided by SPF. The courses were tailored for different audiences: the general public (basic level), microenterprise personnel, university students, and technical college students (intermediate level). These were delivered via the EDEC Moodle platform (https://capacitacion.edec.gob.ec:1234/). Meanwhile, the course designed for engineers and technicians in Cuenca's industrial sector (advanced level) was conducted through the eVirtual platform of the Continuing Education Department at the University of Cuenca.

The basic and intermediate courses were structured so that, for each chapter, students could access an introductory video, a PowerPoint presentation, and additional educational resources such as videos, podcasts, books, and relevant web pages. For the advanced-level course aimed at industrial technicians, virtual classes for each chapter were conducted live via the Zoom platform. As with the other courses, students had access to supplementary learning materials on the platform.

To successfully complete the course, students at all levels were required to complete a questionnaire on the platform. The specific characteristics of each solar thermal energy course offered are summarized in Table 1.

Table 1: Characteristics of solar thermal energy courses

Curso	**Solar thermal energy - Basic level**	**Solar thermal energy - Intermediate level**	**Application of solar thermal energy to low temperature industrial processes - Advanced Level**
General objective	To make available to the general public essential information on solar thermal energy and its main applications in the residential, commercial and industrial sectors.	To provide microenterprise personnel, university and technical college students with essential information on solar thermal energy and its main applications in the residential, commercial and industrial sectors.	To provide participants with the skills and knowledge necessary to harness solar thermal energy as a renewable energy source in industry, which can contribute to energy efficiency and carbon emission reductions.
Target group	General public	Personnel of micro-enterprises, university and technical college students	Technical personnel of the food and beverage industries of the city of Cuenca
Duration	10 hours of asynchronous activities on the platform	10 hours of asynchronous activities on the platform	20 hours (10 synchronous hours and 10 asynchronous hours)
Topics	1. Energy situation 2. Solar energy 3. Solar thermal technologies 4. Solar thermal system 5. Applications of solar thermal energy 6. Benefits and limitations of solar thermal energy	1. Energy situation 2. Solar radiation potential 3. Introduction to solar thermal energy 4. Solar thermal collectors 5. Solar thermal system 6. Software for simulation of solar thermal systems. 7. Applications of solar thermal energy 8. Sizing of a solar thermal system 9. Benefits and limitations of solar thermal energy	1. Global and national energy situation 2. Fundamentals of solar energy 3. Solar thermal technologies applied to industry 4. Solar thermal energy in industry 5. Solar thermal system for water heating 6. Basic design criteria of a solar thermal system. 7. Basic criteria for the installation, operation and maintenance of a solar thermal system. 8. Economic and environmental evaluation of the installation of solar thermal systems. 9. Pre-design of a solar thermal system. 10. Benefits and limitations of solar thermal energy

The basic and intermediate level courses were promoted on November 17, 2023, through the social media channels of Lácteos San Antonio (Nutri), CGA, EDEC, and the University of Cuenca. The courses officially began on November 27, 2023 (see Figure 1). A total of 67 participants enrolled in the basic-level course, while 78 participants registered for the intermediate-level course.

Figure 1: Invitations for solar thermal energy courses: basic level (left) and intermediate level (right)

For the advanced-level course aimed at technicians in the industrial sector, invitations were sent to companies within Cuenca's food and beverage industry. Additionally, undergraduate students, technicians from companies specializing in solar technologies, and individuals interested in solar thermal energy also participated. The course ran from November 22 to December 5, 2023, with a total enrollment of 22 participants. Figure 2 provides a photograph documenting one of the sessions of the advanced-level course.

Figure 2: Participants of the course on the application of solar thermal energy to low temperature industrial processes - advanced level

**For more details on this deliverable, please review the technical report "Cursos impartidos para contribuir en el proceso de transferencia de conocimientos en energía solar térmica" (Solindustrias_D2.1_Educational material) in the Annex.*

D2.2 Program for excursion to pilot site

Recognizing that knowledge transfer is essential to promoting the adoption of solar thermal energy in the industrial sector, one of the project's objectives was to educate representatives from other industries, university students, and technicians about the installation, operation, benefits, and limitations of the solar thermal plant at Lácteos San Antonio. To fulfill this objective, a guide was developed to facilitate the planning of technical visits to the dairy company's facilities. The excursion

program to the pilot site includes a detailed schedule of activities, as well as the requirements and responsibilities that visitors must consider during their time at Nutri's facilities.

Visits to the solar thermal system at Lácteos San Antonio commenced on November 20, 2024, as part of the plant's inauguration program. The event was attended by approximately 60 participants, including city officials, representatives from the Swiss Embassy in Ecuador, researchers, faculty members, university students, company managers, technicians, and other professionals. Figure 3 highlights the attendees of the inauguration program and the key stakeholders involved in the project's execution.

Figure 3: Inauguration program of the solar thermal plant at Lácteos San Antonio: a) attendees and b) main actors involved in the development of the Solindustrias: Solar Process Heat in Cuenca project.

For logistical reasons, it was agreed with Lácteos San Antonio's technicians that the technical visits to the solar thermal plant will resume between February and March 2025.

**For more details on this deliverable, please review the technical report "Plan de visitas técnicas a la instalación solar térmica de la Industria Lácteos San Antonio (Nutri)" (Solindustrias_D2.2_Program for excursion to pilot site).*

WP3 Socio-economical and environmental evaluation
D3.1 Report on social acceptance (barriers and benefits)

Evaluating the acceptance of integrating solar thermal energy projects is essential, as it will help identify the barriers and needs that hinder the advancement of this type of sustainable energy installation in the industrial sector of Cuenca and the country. To assess the acceptance of solar thermal energy in the industrial sector of Cuenca, surveys were developed targeting the industry (30 survey invitations sent), Municipal Decentralized Autonomous Governments (12 survey invitations sent), Higher Education Institutions (22 survey invitations sent), and companies supplying solar thermal systems (29 survey invitations sent). The surveys were sent to the representatives of all the aforementioned stakeholders via email for online completion. Based on the responses provided by the surveyed stakeholders and following the statistical evaluation conducted, the main conclusion drawn from the acceptance analysis is outlined below.

By integrating the perspectives of all the surveyed stakeholders (8 representatives from industries, 6 from Municipal Decentralized Autonomous Governments, 14 from higher education institutions, and 6 representatives from companies supplying solar thermal equipment), it is evident that in Cuenca and throughout the country, solar thermal energy for industrial processes does not have a developing market, as is the case for solar thermal energy used in residential and service sector applications. Furthermore, these stakeholders agree that solar thermal energy should be expanded in the country as an alternative to reduce CO2 emissions, generate economic savings through the reduced use of fuel in conventional systems, and as a strategy to decrease energy dependence. However, they consider that to expand the solar thermal energy market, it is necessary to eliminate fossil fuel

subsidies, disseminate information about the benefits of solar thermal energy, seek funding for research projects (involving academia, private companies, industry, and Municipal Decentralized Autonomous Governments), and work on enacting fiscal and economic incentives to facilitate initial investment and mitigate financial barriers.

**For more details on this deliverable, please review the technical report "Análisis de aceptación social y ambiental sobre la integración de sistemas solares térmicos en el sector industrial en Ecuador" (Solindustrias_D3.1_Report on social acceptance) in the Annex.*

D3.2 Economical analysis

Considering the global deployment of this type of technology in the industrial sector, it is crucial to analyze the current situation of the solar thermal market in Ecuador to encourage the integration of renewable heat projects into the Ecuadorian industry. As part of the tasks of this project, a situational and economic analysis of the solar thermal energy market in Ecuador was conducted, which included identifying the companies that market solar thermal technologies and components, as well as evaluating the prices of these technologies.

To conduct the analysis of the current state of the solar thermal energy market in Ecuador, an online search was carried out to identify companies that market and install solar thermal technologies, as well as companies that specialize in the sale of other components such as recirculation pumps and pipes (made of steel or copper). Additionally, a record was created of the costs of the different types of solar thermal systems available in Ecuador

Based on the conducted search, 30 companies were identified that market solar thermal technologies, with flat plate collectors, unglazed collectors, and evacuated tube collectors being the most commonly offered technologies for sale. Regarding the commercialization of recirculation pumps and pipes, 6 and 13 companies were recorded, respectively. In this case, one possible reason for the relatively small number of companies selling recirculation pumps could be related to the fact that a large portion of solar thermal systems are installed in the residential sector and are of the thermosiphon type.

In addition, it was found that the average cost of thermosiphon systems for domestic hot water heating with flat plate collectors ranges from 1.577 USD (200 liters) to 2.182 USD (300 liters); while the average cost of the same type of system with evacuated tube collectors ranges from 1.150 USD (200 liters) to 1.409 USD (300 liters). In the case of forced circulation solar thermal systems with flat plate collectors for the same application, the price is 4.597 USD or 916 USD/m². Finally, in the industrial sector, the average cost per installed square meter of a forced circulation system with flat plate collectors for process water heating is 528 USD (data derived from the solar thermal system installed at Lácteos San Antonio under the Solindustrias: Solar Process Heat in Cuenca project).

**For more details on this deliverable, please review the technical report "Informe técnico económico sobre el uso de sistemas solares térmicos en la industria de bebidas y alimentos de Cuenca" (Solindustrias_D3.2_Economical analysis) in the Annex.*

WP4 Potential SHIP in Cuenca and Ecuador
MS3 Replication Strategy for SHIP
D4.1 Potential study for SHIP in Cuenca

Investigating the potential for renewable solar heat generation in the industrial sector presents an opportunity to contribute to achieving a more sustainable environment. In order to expand the study of SHIP (Solar Heat for Industrial Processes) plant implementation, this report presents and analyzes the design of solar heat generation systems to evaluate the technical, economic, and environmental prefeasibility of implementing solar thermal technologies for process water heating in the food and beverage industrial sector in the city of Cuenca.

The methodology employed to analyze the potential for the installation of solar thermal energy in the food and beverage industry in the city of Cuenca was as follows: determine the industries interested in solar thermal energy projects, identify the study area, collect technical information on the production processes of the industries, assess the available roof space for the installation of solar collectors, select the type and model of technology to be used (the study was conducted with flat plate collectors and evacuated tubes), estimate the amount of energy that can be supplied using solar thermal energy, and determine the economic-environmental benefits that can be obtained from this renewable energy source.

The industries interested in exploring the potential of solar thermal energy were the food industry La Europea, the company Pastificio Tomebamba, and Corporación Azende. However, Corporación Azende, a company dedicated to the production and commercialization of beverages and liquors, with its production plant located in the Paute canton (Azuay province), did not provide the necessary technical information for the pre-dimensioning of the solar thermal system, and therefore, was excluded from this analysis.

In the La Europea food industry, the integration of a PR-F collector system with a gross area of 1.064 m² could supply 34,22 % of the total energy demand for heating water to 60 °C in the cleaning process. On the other hand, the simulation results demonstrated that with the ETC-20 collector system, with a gross area of 1.044 m², it is possible to replace 30,53 % of the energy required for the same process. In the case of the company Pastificio Tomebamba, in the dough mixing process, installing a PR-F collector system with approximately 100 m² of gross area would allow the replacement of 49,64 % of the total energy required to heat 5,5 m³ of water to 60°C. Furthermore, the installation of an ETC-20 collector system with 102 m² of gross area would be able to supply 45,72 % of the total energy required in the same process.

By performing an analysis of indicators such as Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period (PP), it was found that neither the La Europea Food Industry nor the Pastificio Tomebamba company would find it feasible to make an investment with either of the two technologies. However, through a sensitivity analysis, it was found that increasing the price of industrial premium diesel, reducing the discount rate, or obtaining subsidies are alternatives that could improve the profitability of installing PR-F and ETC-20 systems for water heating in these industries.

In environmental terms, the average CO2 emissions savings that can be achieved with both technologies (PR-F and ETC-20) in the La Europea Food Industry and the Pastificio Tomebamba company are 147 tCO2/year and 14 tCO2/year, respectively.

**For more details on this deliverable, please review the technical report "Potencial de la energía solar térmica en la industria de alimentos y bebidas de Cuenca" (Solindustrias_D4.1_Potential study for SHIP in Cuenca).*

D4.2 Report on appropriate business models

To promote the deployment of solar thermal energy in the industrial sector, the development of business models is essential, as they allow for the management of perceived risks associated with this type of energy and help reduce investment costs. Therefore, in this report, a solar thermal energy business model has been proposed based on the needs of the industrial sector in Cuenca through the analysis of the Ecuadorian context, with the aim of providing tools to encourage the installation of solar thermal systems in the industry of this city.

Based on the context analysis of Ecuador and after reviewing the different business models applied in the solar thermal energy market, it was determined that to begin the expansion of solar thermal energy in the industrial sector of the Cuenca Canton and Ecuador, the "turnkey" business model should be promoted with active collaboration from both internal and external stakeholders. This "turnkey" business model includes internal stakeholders (authorities and financial institutions) and external stakeholders (technology providers and international cooperation organizations), in addition to those of

the standard "turnkey" business model. Figure 4 shows a diagram of the proposed "turnkey" business model according to the needs of the solar thermal market in Ecuador.

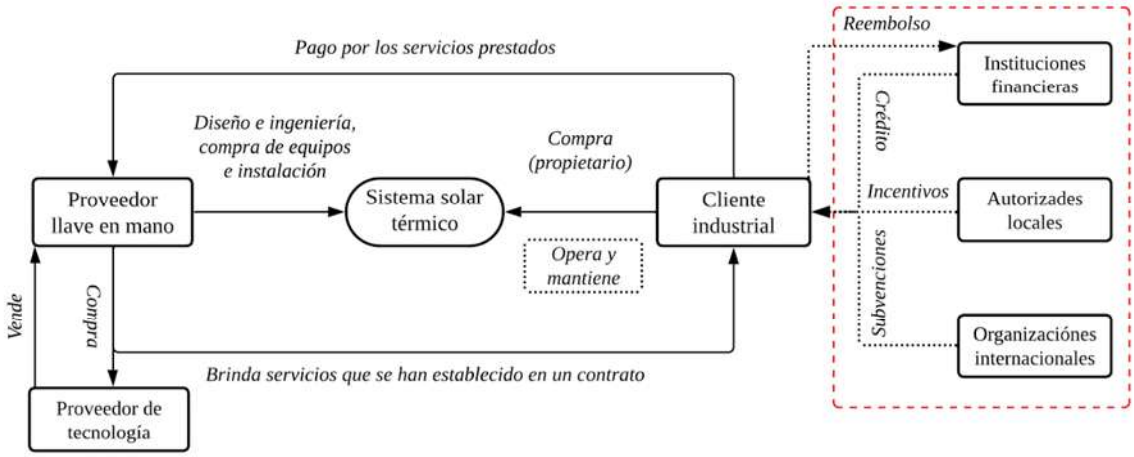

Figure 4: Diagram of the turnkey business model with active collaboration of internal and external stakeholders for solar thermal energy in the industrial sector in Cuenca.

On the other hand, the creation of Energy Service Companies (ESCOs) that incorporate solar thermal energy business models as part of their services is an option that could contribute to the future expansion of the solar thermal market in Ecuador. However, the establishment of these companies requires the support of industry, government, and academia to overcome the existing regulatory, technical, social, and economic barriers.

**For more details on this deliverable, please review the technical report "Análisis de modelos de negocio para la implementación de energía solar térmica en el sector industrial en Cuenca" (Solindustrias_D4.2_Business Models) in the Annex.*

D4.3. Report on recommendation policies

To foster the implementation of SHIP plants in Cuenca's industrial sector, it is crucial for the Municipality of Cuenca to enact policies that promote the adoption of this renewable energy source. In support of this initiative, the University of Cuenca, in collaboration with the Environmental Management Commission (CGA), has conducted a comprehensive review of solar thermal energy policies implemented across various Latin American countries. The review revealed that, within Latin America, the only countries that have implemented policies aimed at promoting the installation of solar thermal systems are Brazil, Argentina, Uruguay, Panama, Chile, Mexico, Dominican Republic, Guatemala, and Honduras. However, the regulatory frameworks in these countries do not stipulate the application of financial incentives; rather, they have primarily focused on the regulation of tax incentives. Overall, the tax incentives implemented in these countries are associated with complete or partial VAT exemption, income tax exemption, local tax exemption, import tax benefits, and accelerated depreciation of solar thermal equipment.

Upon project completion, the identified regulatory framework will be reviewed in collaboration with the CGA to validate recommendations that the Municipality of Cuenca may consider for promoting the installation of SHIPs in the industrial sector. As these recommendations are intended to support policy development, their implementation at the local level falls beyond the project's scope.

**For more details on this deliverable, please review the technical report "Informe sobre políticas para uso de energía solar térmica en la industria en Cuenca" (Solindustrias_D4.3._Report on recommendation policies) in the Annex.*

5.2 Achievements of Objectives and Results

All tasks of the project were completed, and all objectives were achieved.

5.3 Multiplication / Replication Preparation

WP4 “Potential of SHIP in Cuenca and Ecuador” includes a replication strategy.

5.4 Impact / Sustainability

The project is the very first solar thermal installation for industrial processes in Ecuador.

The installed renewable energy capacity is small compared to the total heat demand of the company (the solar share is approx. 2.5%), but it is the biggest installation in Ecuador and the investment should pay back within its lifetime by the fuel savings it allows for.

The professional trainings that were developed within the project and were executed by Uni Cuenca are of high quality and the interest in both the installation and the training courses was high.

Ecological	**Unit**	**At the REPIC Project’s Completion**
Installed renewable energy capacity	[kW]	105
Renewable energy produced	[kWh]/year	71'779
Amount of fossil fuel energy saved	[kWh]/year	71'779
Greenhouse gas reduction	[t CO_2-eq]/year	18
Economic		
Total investment	[USD]	88’760
Estimated fuel savings	[USD]/year	4’800
Social		
Number of trained personnel	[Number]	167

6. Outlook / Further Actions

6.1 Multiplication / Replication

The technical monitoring of the solar thermal plant at Nutri was pursued by the Universidad de Cuenca and will also be continued after the formal end of this project. This monitoring is of high importance because there is the danger of not noticing potential malfunctions: the heating contribution of the solar plant would be compensated by the conventional heating system and because the solar share is small it could be that nobody noticed the missing solar heat.

The Solindustrias project partners in Ecuador use the project to actively promote SHIP with companies who might be interested to invest in renewables in order to reduce their fossil fuel consumption.

As a side effect: a spare collector of the project is being installed in a small water heating cycle at the Campus of the Universidad de Cuenca at a very visible position to be used for training courses and in order to raise attention among students about the technology.

6.2 Impact / Sustainability

The main arguments for Solar Heat in Industrial Projects (SHIP) in Ecuador are:

1. Industrial Decarbonization & Wide Applicability

SHIP is a ready-made solution to support industrial decarbonization efforts that especially suits industrial sectors heavily using low to medium-temperature heat such as food & beverage, textiles, mining, dairy, pulp & paper.

2. Economic Competitiveness & Long-Term Price Stability

Despite higher upfront costs, SHIP provides favourable economic returns over its lifetime. Solar heat also locks in stable pricing for at least 20 years, buffering against volatile fuel prices.

3. Energy Security, Local Economic Benefits, and Job Creation

Deploying SHIP systems reduces dependence on imported energy, thereby enhancing local energy security. Moreover, the solar thermal industry spurs local manufacturing, installation, and maintenance jobs.

These arguments together with the positive example of the Solindustrias demonstration project are expected to convince investors to realize more projects in Ecuador in the medium term.

7. Lessons Learned / Conclusions

- Proven and Mature Technology

Solar thermal energy is a well-established and reliable technology. Still it is important to demonstrate the technology in industrial applications.

- Need for Training and Knowledge Transfer

Capacity building remains a key success factor. Currently, knowledge and practical experience with solar thermal technologies are still limited in many regions. Structured training and systematic knowledge transfer are therefore essential for wider adoption.

- Value of Simplicity

Simple, robust system designs often prove to be the most effective. Reducing complexity increases reliability and facilitates operation and maintenance.

- Impact at Lower Temperature Levels

Many industrial processes require heat at relatively low temperatures. Systems designed for these operating ranges are technically simpler and can already deliver substantial energy and emissions savings.

- Realistic Time Planning

Implementation processes frequently take longer than originally anticipated. This should be taken into account in project planning and scheduling.

- Importance of technical monitoring

Continuous monitoring is often perceived as time-consuming and costly, and is therefore sometimes neglected. However, it is critical for quality assurance, performance evaluation, and generating valuable learning effects for future projects.

8. References

Andres Montero et.al., SOLAR THERMAL ENERGY FOR INDUSTRIAL PROCESSES: INSIGHTS FROM CUENCA, ECUADOR, ISES Solar World Congress 2025, November 4-7 2025, Fortaleza, Brazil.

Paper accepted for oral presentation.

9. Annex

The Annex contains more detailed reports on each deliverable in Spanish language:

- D1.1_Evaluation of SHIP performance
  "Evaluación del rendimiento del sistema solar térmico instalado en Lácteos San Antonio (Nutri)"
- D1.2_Road-map for Nutri decarbonization)
  "Alternativas sostenibles para la descarbonización de Lácteos San Antonio (Nutri)"
- D2.1_Educational material
  "Cursos impartidos para contribuir en el proceso de transferencia de conocimientos en energía solar térmica"
- D2.2_Program for excursion to pilot site
  "Plan de visitas técnicas a la instalación solar térmica de la Industria Lácteos San Antonio (Nutri)"
- D3.1_Report on social acceptance
  "Análisis de aceptación social y ambiental sobre la integración de sistemas solares térmicos en el sector industrial en Ecuador"
- D3.2_Economical analysis
  "Informe técnico económico sobre el uso de sistemas solares térmicos en la industria de bebidas y alimentos de Cuenca"
- D4.1_Potential study for SHIP in Cuenca
  "Potencial de la energía solar térmica en la industria de alimentos y bebidas de Cuenca"
- D4.2_Business Models
  "Análisis de modelos de negocio para la implementación de energía solar térmica en el sector industrial en Cuenca"
- D4.3._Report on recommendation policies
  "Informe sobre políticas para uso de energía solar térmica en la industria en Cuenca"