

Internship proposal (Engineering or Master degree)

« Solarized » craft activities: The solar bakery case

Mots-clefs : Solar energy, solar cooking, energy balance, business model, socio-economic impact, low-tech

Scientific background: This internship is part of **ARTBOUSOL** project funded by the *Fédération de Recherche “Energie et Environnement”* (FREE) of the *Université de Perpignan Via Domitia* (UPVD), which aims to develop research projects between the natural sciences and social sciences. **ARTBOUSOL** sets in energy and environmental context that is forcing our society to reinvent itself in order to reduce greenhouse gas emissions (GHG), energy consumption and fossil fuel dependence. In addition, energy cost has recently grown up due to the current geopolitical situation with war in Ukraine. As a result, many line of business are directly impacted, and therefore will inevitably have to evolve towards more sustainable technologies, based in particular on renewable energies. Many of craft activities use heat energy to accomplish their tasks. Heat production through solar energy conversion offers very wide power and temperature ranges (50°C to 3,000°C) to supply the needs of the craft industry. Moreover, solar resources are free, abundant and accessible to most of the world population (80% receives more than 2,000 hours of sunshine per year).

The use of solar heat in many craft activities, such as food drying [1], cooking [2], bakery [3], seed roasting [3], [4], [5], brewery, pottery/enamelling, metal casting and art glass, is still marginal in France. Craft activities and solar cooking are currently being promoted in developing countries by social companies. [6], [7] and by associations [8], [9], [10], [11]. The main goal is to replace the use of expensive and polluting fossil fuels and preserve wood, a natural resource with high environmental value. Behind these approaches we often find the values transmitted by the “low-tech” spirit, which aims to democratize techniques that are intended to be “Useful, Sustainable and Accessible” [13].

Work overview: Our study focuses on the use of solar energy in the bakery business line. Today, it accounts for approximately 35,000 facilities and employs over 200,000 people [14]. Our study is built on Fabien Forgues, a farmer/miller/baker currently based in Elne, a village in the south of Perpignan. He works in a cooperative spirit, sharing his bakery unit with two other bakers. He sells his entire production by direct selling, either directly from the bakery or from AB market gardeners offering vegetable baskets. Flour is produced on-site in a stone mill. Bread is kneaded by hand and baked at ~250°C in a rotating stone plate oven. It is a SEBASTIA continuous-heating oven. It is currently fuelled by wood pellets: around 65 kg are consumed each day, producing around 80 kg of bread. In order to “solarize” the bakery, several technical solutions (hybridization or 100% solar) have been identified and will have to be ranked according to several technical-environmental indicators. Based on these technical solutions, the socio-economic impacts for the artisan and consumers, mainly due to the solar resource intermittency, will be studied at the scale of the Pyrénées-Orientales (PO) and will lead to a new solution rank.

A group of students from Sup'EnR engineering school is currently working on a project with the following objectives: 1) study the state of the art in solar bakeries in France and worldwide, 2) draw up an energy balance for a batch of bread (preheating, baking and heat loss) and 3) propose several solutions for “solarizing” the bakery. The internship work will rely on this results.

Goals:

- Model the oven and simulate its static and dynamic operation. The model will be validated by observations of the real oven and feedback from the baker in Elne.
- Select two technical solutions for “solarizing” the oven, based on the work of the Sup'EnR group of students.
- Determine the required solar collector surface and hot source temperature to supply the needs of a batch (pre-heating and bread baking).
- Define and quantify the main energetic and environmental figures of merit (e.g. efficiency, energy return on investment, greenhouse gas emissions, ...).
- Study the business models for conventional and solar bakeries.
- Design a field survey to study the desirability to consumers of a solar bakery model that breaks with cultural habits and the current conventional model of bread consumption.

Supervision: The technical part will be supervised by Antoine Lemaire and Alain Ferrière from PROMES-CNRS laboratory, while the socio-economic part will be supervised by Marie Da Fonseca from MRM-UPVD laboratory.

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Candidate profile: Last year of Master or engineering school. The candidate should have a solid background in energy (thermodynamics and heat transfer). An interest in economic and social sciences is essential. Knowledge in solar energy conversion would be an advantage. Ability to work with the Python programming language. Excellent interpersonal skills and fluency in French language are required, as the candidate will be working directly with various people involved in the project.

Location: PROMES-CNRS laboratory – Rambla de la thermodynamique, 66100, Perpignan.

Duration: 6 months from 3rd February 2025, flexible according to availability.

Salary: 634 €/month (amount according to 2024’s regulation) based on 35 hours/week.

Application: A *cover letter*, a *Curriculum vitae* and a transcript of marks from the previous year must be sent to all supervisors before 13th December 2024.

References:

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