INETI – Instituto Nacional de Engenharia, Tecnologia e Inovação, I.P.

EUROSUN 2008
1st International Conference on Solar Heating, Cooling and Buildings
7th to 10th October - Lisbon - Portugal

Towards a competitive use of solar driers: a case study for the lumber industry

Global Objective

Development of a low cost timber kiln, using solar energy as the heating source and controlled ventilation in order to optimize operational conditions and drying time, taking into account natural weather variations and allowing, at the same time, a very high drying quality. A monitoring and control system, based on a PC running dedicated software, with wireless comunications was developed and applied.

Figure 1 – Modelling study for the industrial prototype.

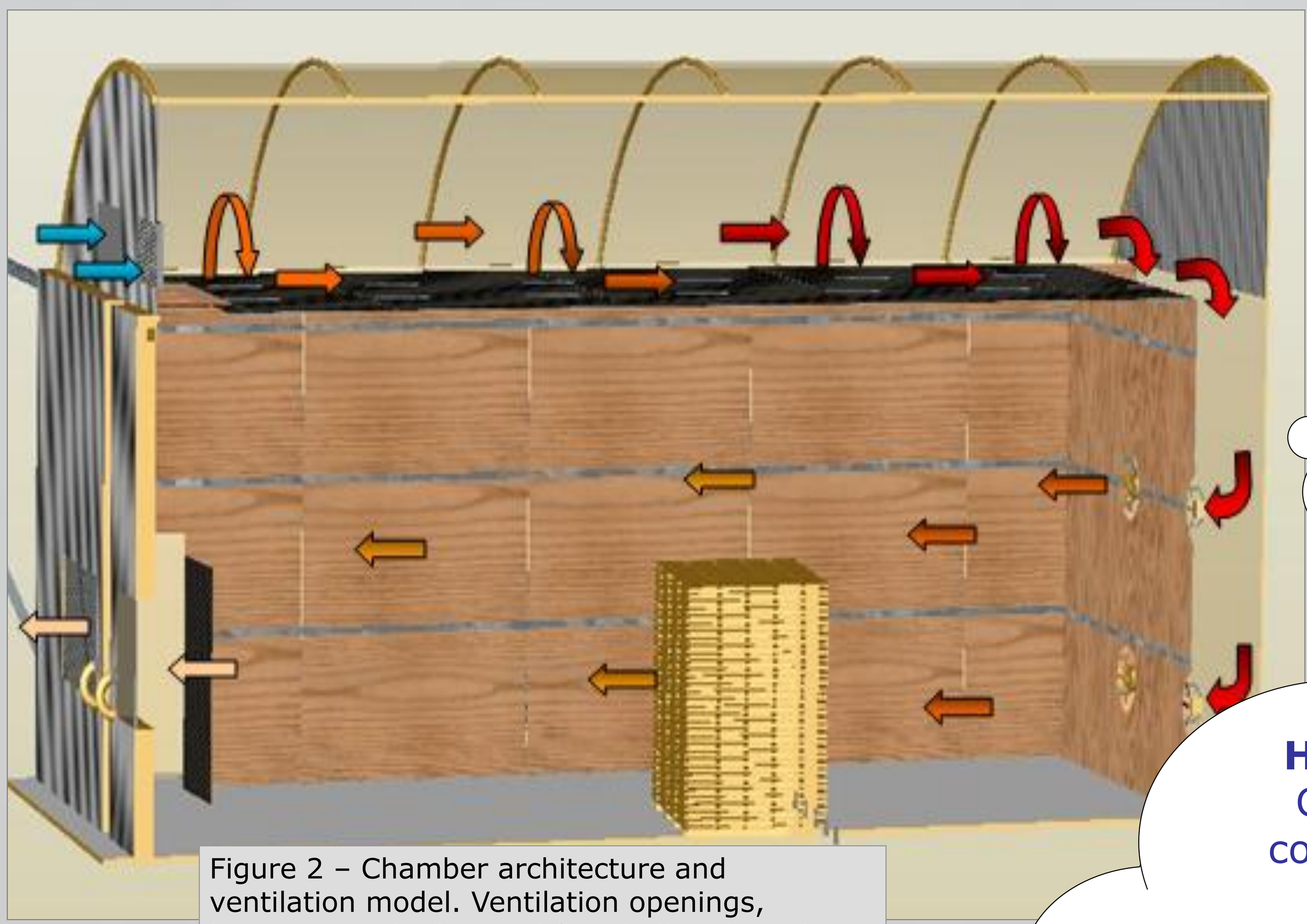

Figure 2 – Chamber architecture and ventilation model. Ventilation openings, heating panel, electrical fans hall and windows on the main door.

Heating and ventilation scheme

Colours indicate the psychometrics conditions of the air inside the dryer: **Blue** arrows indicate the arrival of outside air, which is heated by the solar collector at the wall and ceiling; **Red** arrows give an indication of the flow of hot dry air; **Brown** arrows indicate the direction of inside humid air. Moist air is expelled through vents by forced flow, while the fan is turned on (**pink** arrows).

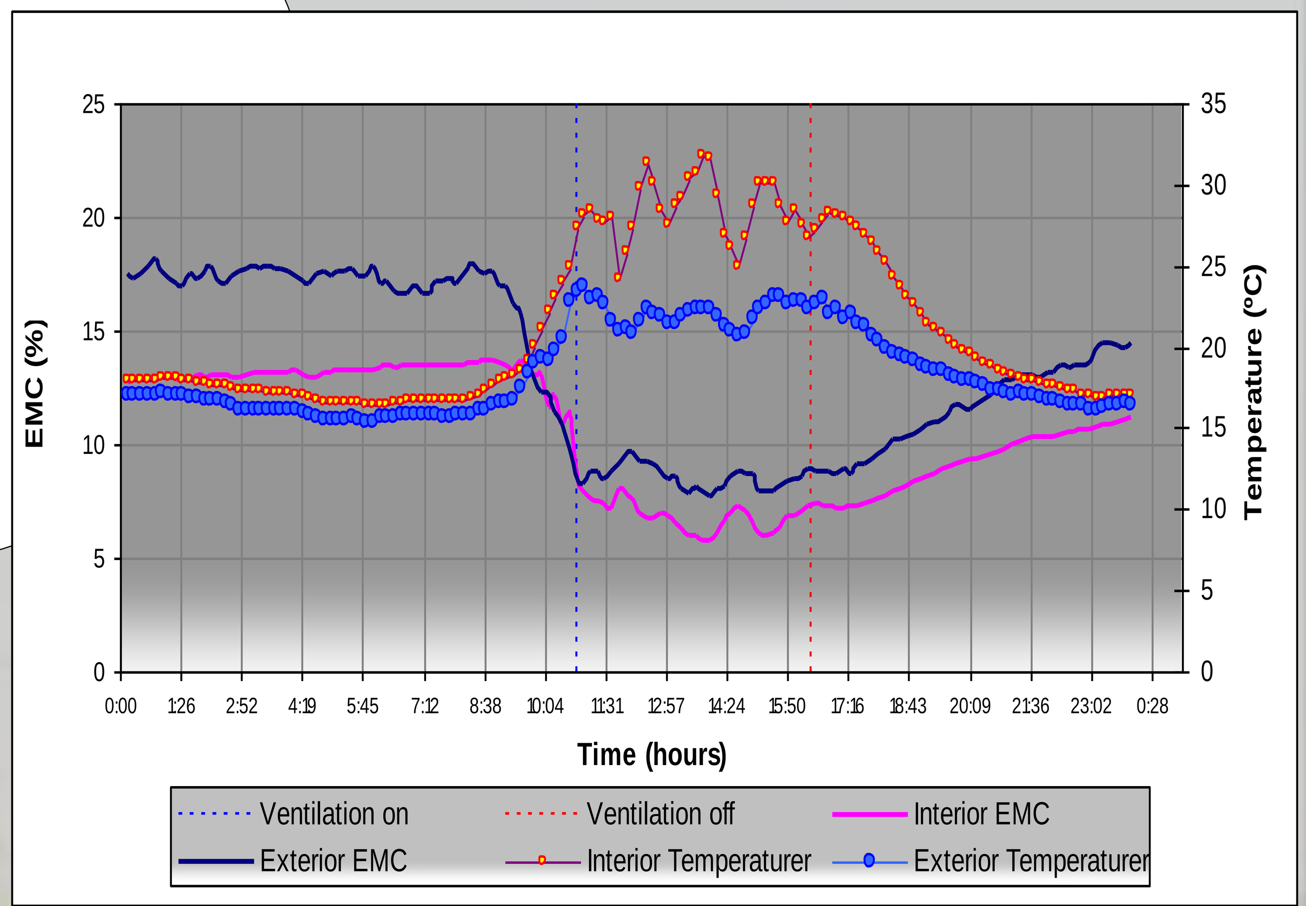

Figure 3 – Typical daily drying parameters in Autumn. Dry temperature inside de kiln, moisture equilibrium inside and outside the kiln.

Construction facilities

- Prefabricated galvanized steel tubes
- Plastic or acrylic glass transparent cover
- Interior halls in plywood
- Heat panel in black canvas or black painted metal sheets

Control strategy to optimize operational conditions and drying time

Flexible response to natural changes of external conditions

- **Fuzzy algorithm proved by simulation to give better results than traditional PI or PID solutions**
- **Wood moisture contents time rate evolution taken into account by the control algorithm, to prevent overtaking dynamic upper safety limit.**

Input variables:

- **Inside and outside temperature**
- **Inside and outside humidity**
- **Wood moisture content**

Controlled variable:

- **Ventilation (on / off)**
- **Open / close vents**

Figure 4 – External view of industrial prototype in Leiria.

Economical and technical advantages

Comparison costs between conventional kiln and solar kiln drying , taking into account investment costs and energy consumption.

- Lesser energy consumption compared with a conventional dryer.
- Much smaller initial capital investment (5 times less, although drying duration is 4 times more).

Drying kiln type	Energy costs	Amortization costs	Total costs (Euros)
Conventional	6,5 € / m³ (electricity) 2,5 € / m³ (heat)	6,0 € / m³	15,0 € / m³
Solar kiln	3,5 € / m³ (electricity) 0 € / m³ (heat)	4,8 € / m³	8,3 € / m³

Industrial Potential Dissemination

- Low cost of investment and maintenance
- good control versatility
- high quality of the dry wood,
- high potential of implementation in small companies.
- other potential end uses, such as: drying fruits, cones or seaweed, ceramics, etc.

Promotor / Industrial partners

INETI- Instituto Nacional de Engenharia Tecnologia e Inovação

DER – Renovable Energies Department

DMTP – Materials and Production Departament

DEL – Electronics Departament

Demonstration entreprises:

Bernardino Mendes Lda., (Leiria);

PREMAD S.A., (Alcácer do Sal)

prime – Programa de Incentivos à Modernização da Economia

Financing:

Total Project budget: 310.266,64€

Comparticipation – 75%

Financing program: PRIME, AdI

INETI's project team:

David Loureiro	david.loureiro@ineti.pt
Arnaldo Cruz Costa	cruz.costa@ineti.pt
José António Santos	jose.santos@ineti.pt
Maria João Martins	maria.martins@ineti.pt
António Nogueira	antonio.nogueira@ineti.pt
Luís Câmara Pestana	luis.pestana@ineti.pt
Edgar Ataíde	edgar.ataide@ineti.p