

# Application potential of solar process heat in the Spanish industry 2010 – 2020.

## Study carried out with EINSTEIN

Hans Schweiger, Claudia Vannoni

(energyXperts.NET)

# Preface

---

Typical use of EINSTEIN: case study in an individual company

**Here:** Parametric study for several industrial branches  
("representative" company for each branch")

EINSTEIN  
thermal energy  
industry audit

# Objective

---

Evaluate the application potential of solar process heat (and cooling):

- Breakdown by regions (52 “provincias” of Spain)
- Breakdown by industrial sectors (32 sectors selected + 1 sector “others”).
- Consideration of competitive and complementary technologies such as heat recovery, CHP, heat pumps and PV

EINSTEIN  
thermal energy  
industry audit

# Methodology

---

Base data and information:

- Energy consumption by fuels (breakdown by sector) from the national bureau for statistics (INE).
- Distribution of companies in each sector by geographic region
- Own study of the available surface and ground areas in each sector

EINSTEIN  
thermal energy  
industry audit

=> Representative company for each sector

# Methodology (2)

---

EINSTEIN design for each sector:

- Modeling of present state for a representative company in each sector
- Estimation of heat recovery potential (estimate mode)
- Design of appropriate solar thermal plants
- Consideration of non-homogeneity within the sectors

EINSTEIN  
thermal energy  
industry audit



# Modeling of solar thermal systems with EINSTEIN

# Solar systems in EINSTEIN

---

EINSTEIN disposes of a dynamic system simulation module that includes solar thermal systems:

- Direct modeling of solar collectors and solar buffer storage
- Simplified modeling of other system components by using an efficiency parameter  $\eta_{\text{sys}}$ .

EINSTEIN  
thermal energy  
industry audit

# Available solar collector types

---

- Stationary collectors (flat plate, evacuated tube, ...) with biaxial incidence angle modifier
- Parabolic trough collectors
- Fresnel collectors



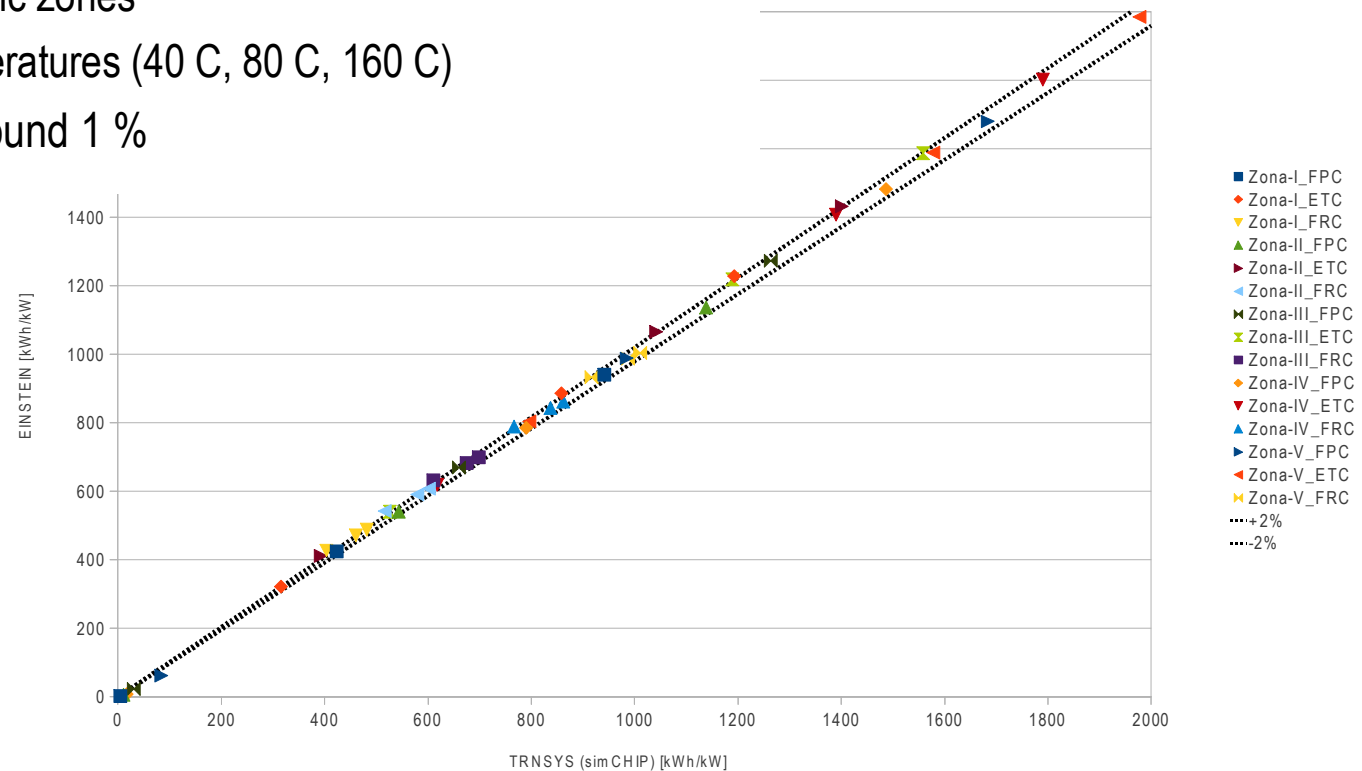
# Calibration of EINSTEIN with TRNSYS

## Calibration EINSTEIN vs. TRNSYS

- 3 collector types (Flat plate, evac. tube, Fresnel)
- 5 climatic zones
- 3 temperatures (40 C, 80 C, 160 C)

Typical error around 1 %

**EINSTEIN**  
thermal energy  
industry audit



# Solar potential

---

Calculations of EINSTEIN auto-design with different constraints:

- Unconstrained
- Constrained by available surface =  $N \times$  surface of reference company
- Minimum unit output (kWh/kW) as a function of collector type and economic scenario

1.440 EINSTEIN Simulations carried out as batch calculations:

32 sectors x 3 collector types x 5 climatic zones x 3 constraints

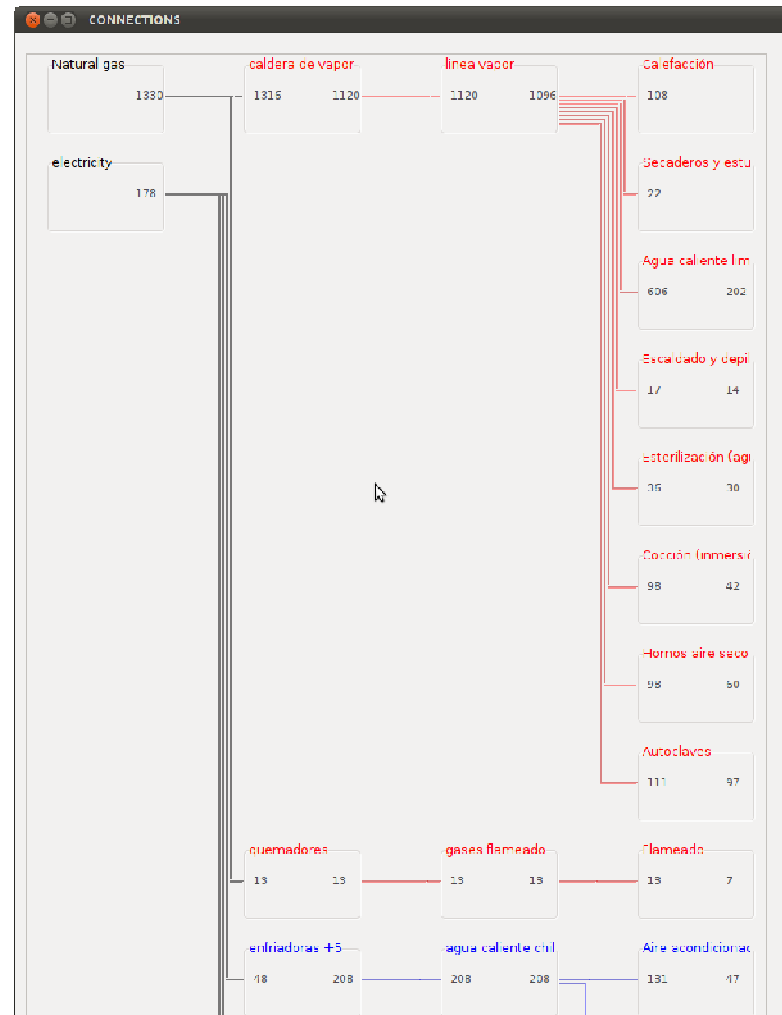
EINSTEIN  
thermal energy  
industry audit

Example of results:

NACE code 15.1: meat  
processing

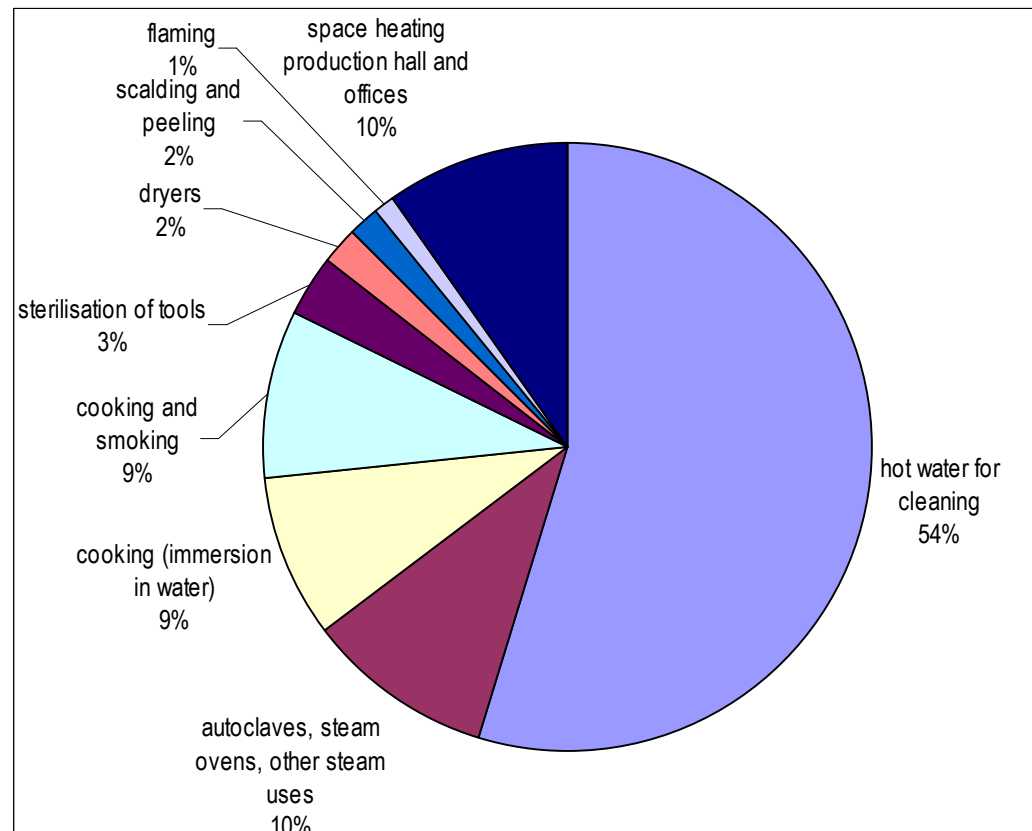
# EINSTEIN model: meat processing industry

**EINSTEIN**  
thermal energy  
industry audit

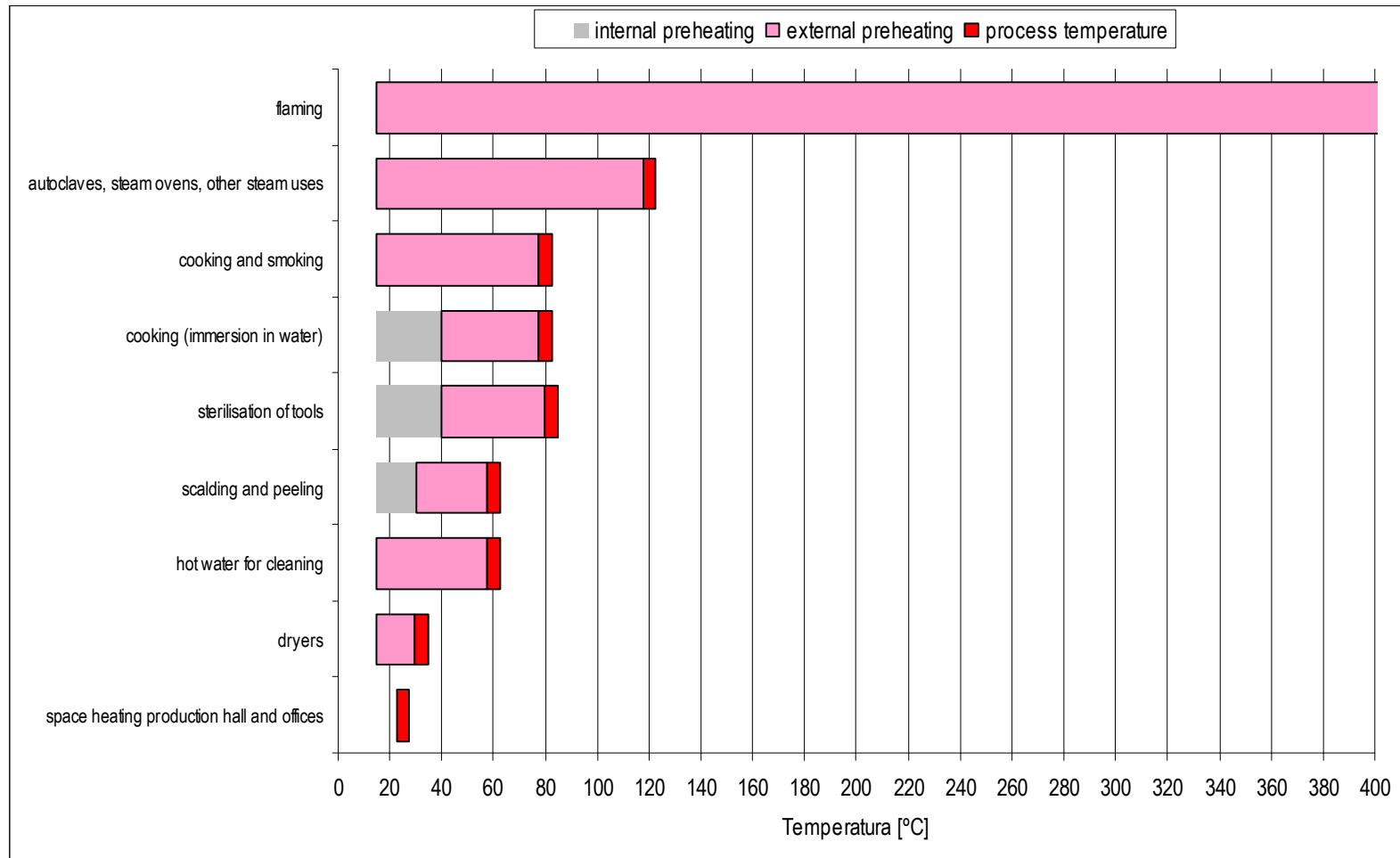


# Heat demand by processes

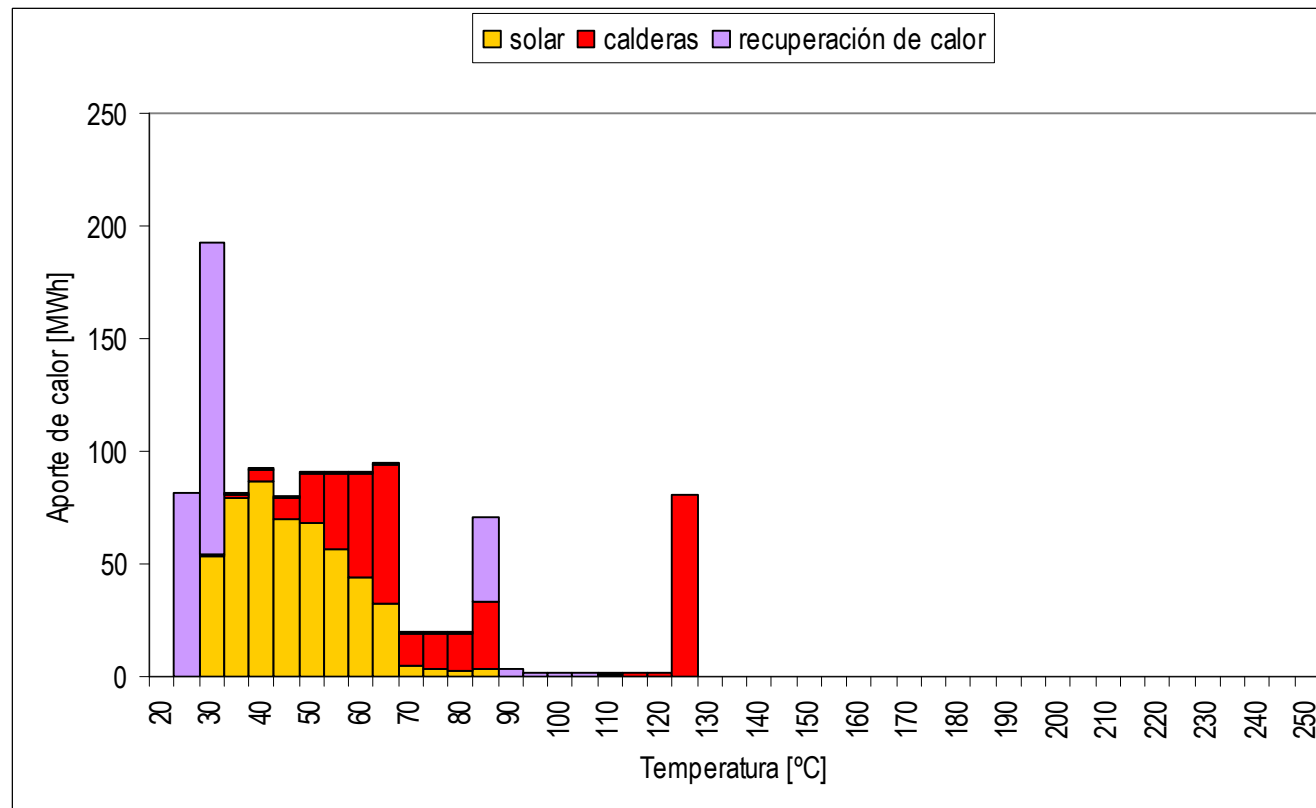
**EINSTEIN**  
thermal energy  
industry audit



# Temperature levels of heat demand



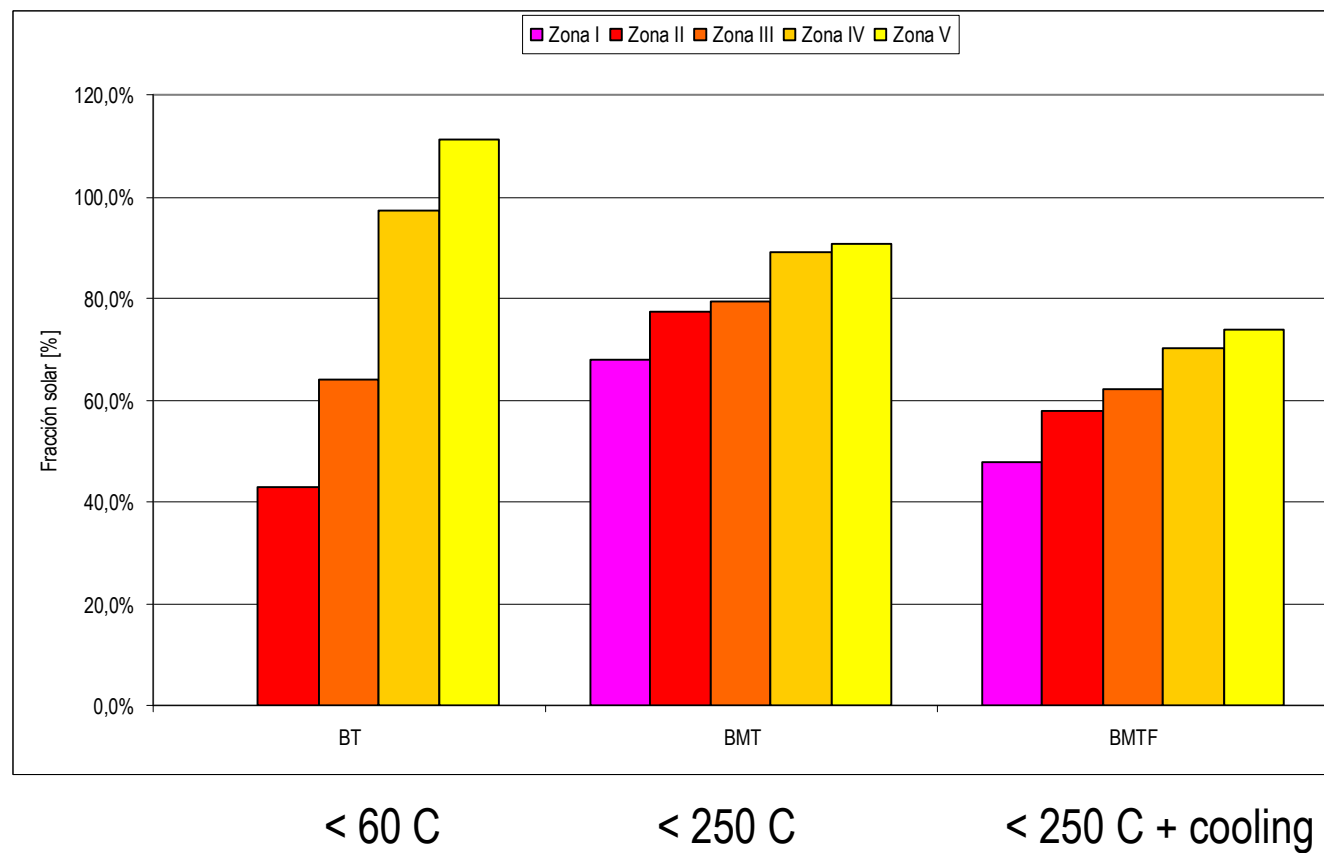
# Heat demand and solar potential



# Average solar fraction

By climatic zone (I to V).

**EINSTEIN**  
thermal energy  
industry audit

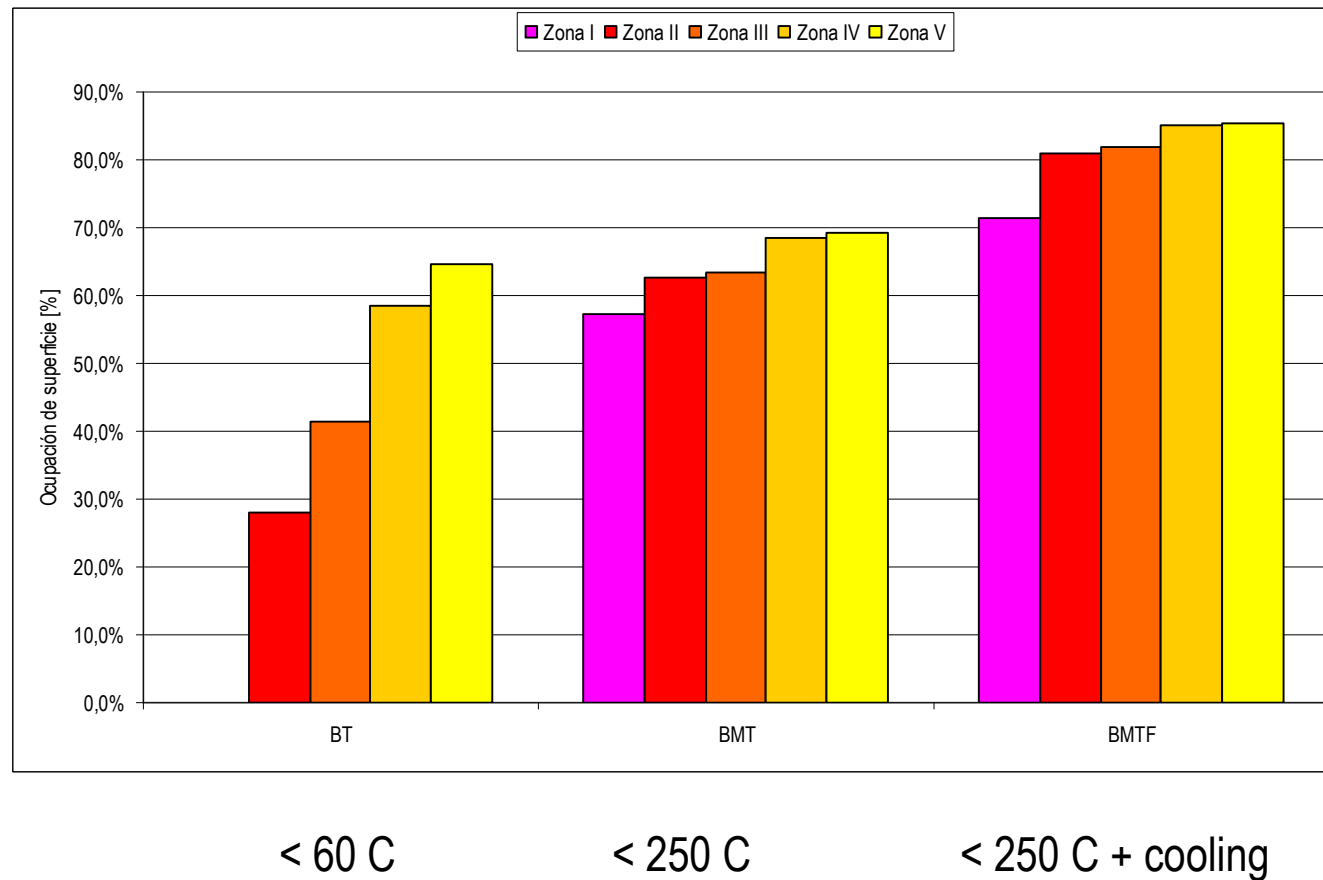




# Average roof occupation

By climatic zone (I to V).

**EINSTEIN**  
thermal energy  
industry audit



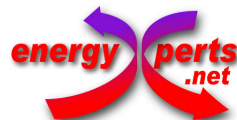
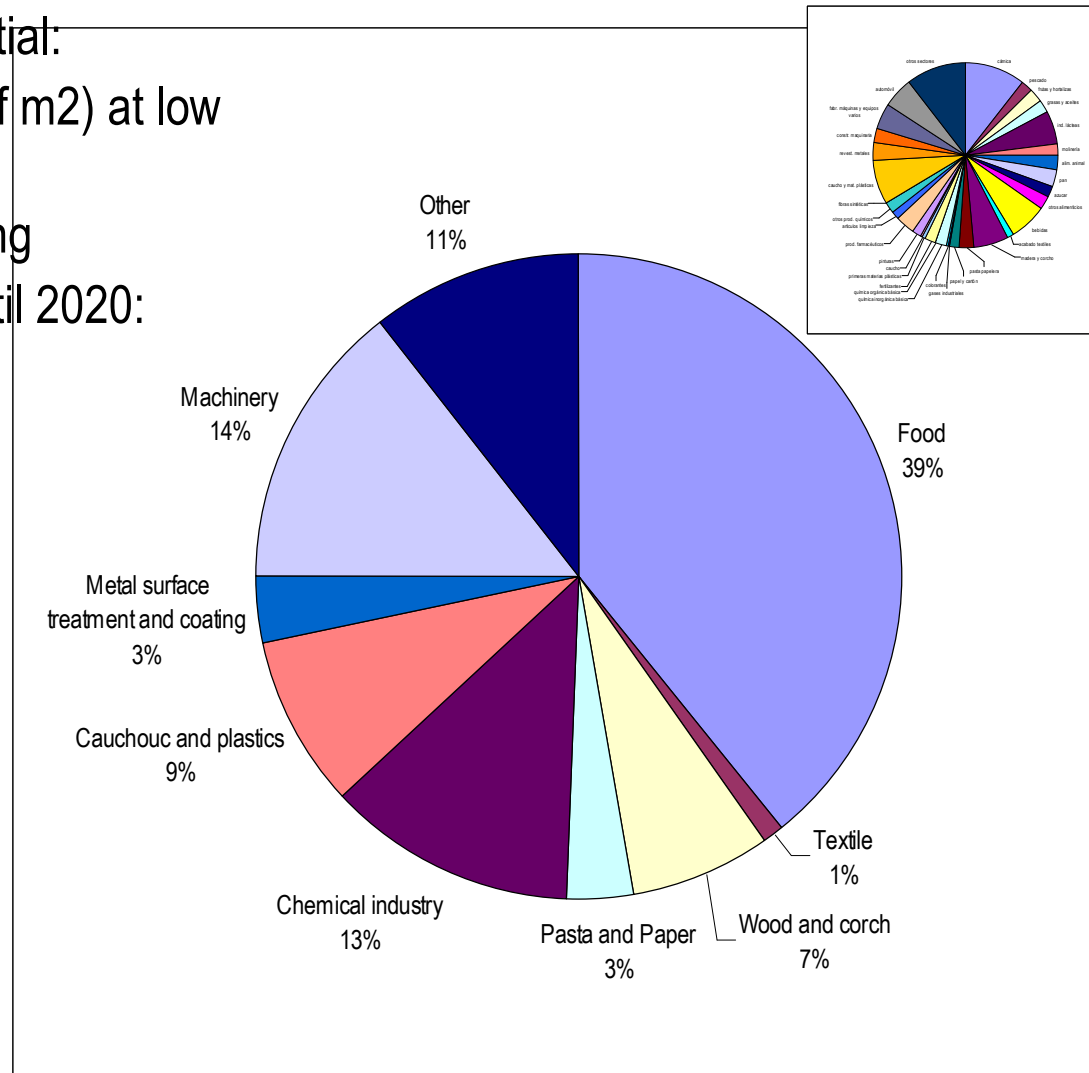


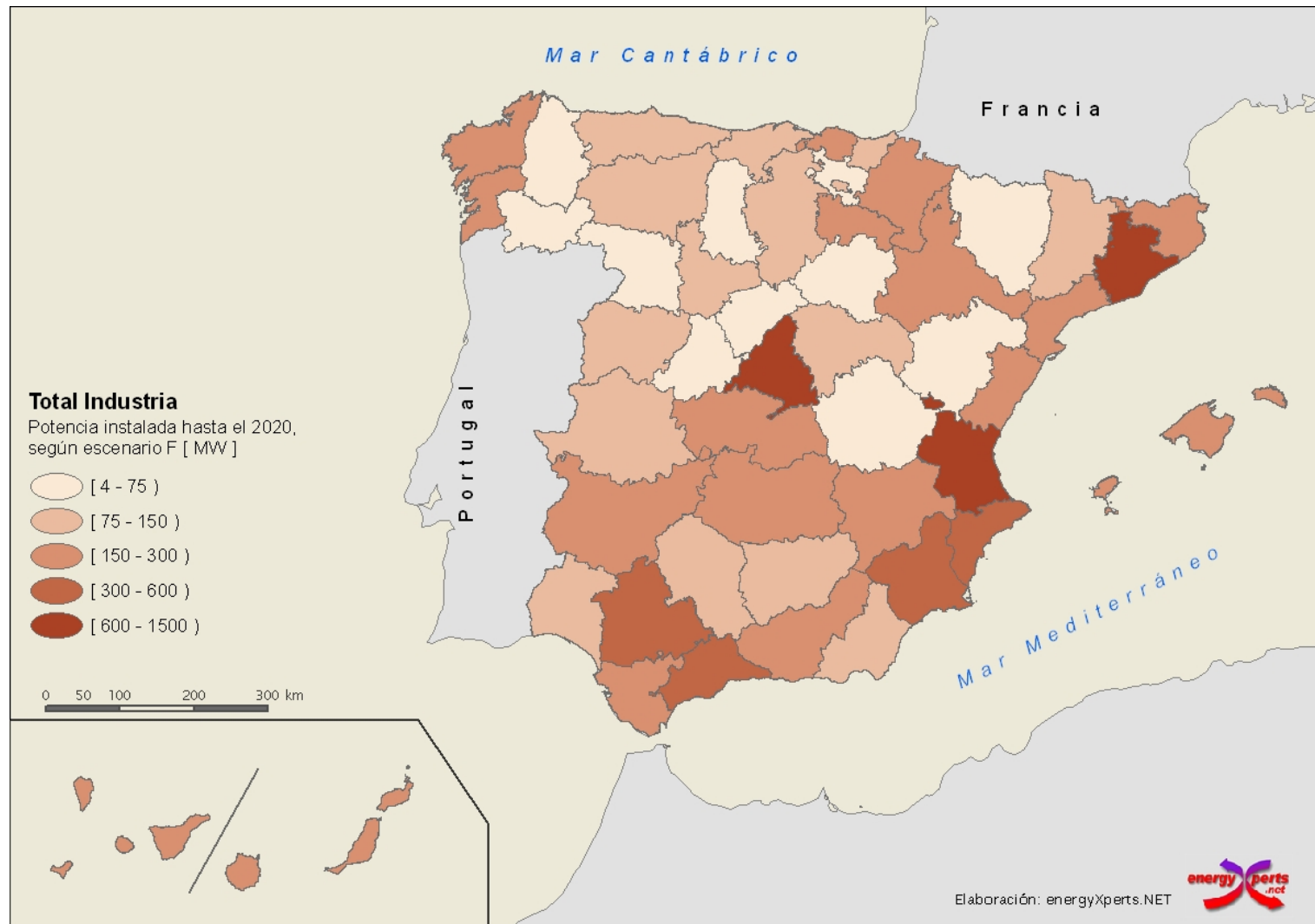
## Global results

# Solar process heat potential

- Global technical potential:
- 15 GW (> 20 millions of m<sup>2</sup>) at low temperature
- 68 GW total incl. cooling
- Economic potential until 2020:
- 10 GW

**EINSTEIN**  
thermal energy  
industry audit





# Conclusions

---

EINSTEIN  
thermal energy  
industry audit

EINSTEIN's auto-design options are a powerful tool for carrying out potential studies in branches, regions, ...

The EINSTEIN solar module has been calibrated with good accuracy against TRNSYS simulations

Results of 32+1 sector analysis form a database (reference industries, benchmarks) to be used also for

- other countries (structural differences usually low)
- other technologies (CHP, heat pumps, ...)