Energy efficiency in the agroindustrial branch

Support System for Collective Actions (Notification 01/SIAC/2011)

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Co-financed by:
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- Project substantiation
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1. Project substantiation (cont.)

- Increase of electric energy prices:

![Graph showing increase of electric energy prices]

Source: ERSE
1. Project substantiation (cont.)

- Failure in the compromise of GHG emissions (Kyoto Protocol):

![Graph showing CO₂ emissions to atmosphere in Portugal from 2008 to 2012. The limit is 76.39 million tonnes of CO₂ eq.](image-url)
1. Project substantiation (cont.)

- Potential of agro-industrial products in the future economy:
  - Concern about health
  - Quality of products
  - Diversity of products
  - Higher demand
1. Project substantiation (cont.)

- Agroindustrial branch → promotes regional and national economies:
1. Project substantiation (cont.)

- Lack of studies about the energy profile in agro-industrial branch.
- Presence of local R&D institutions → encourages practices about energy management.
- Problems detected when implementing energy efficiency measures:
  - lack of information;
  - heterogeneity of industrial processes involved.
1. Project substantiation (cont.)

- Industrial process → cold generation → higher energy consumptions:

- Relevant waste of energy in cold storage chambers → loss in competitive edge:

Electric energy (100 %) → Cold chamber → Wasted energy (20 %)
2. Project description

- Main goals:
  - characterization of industrial units which use cold generation in their processes;
  - development and disclosure of solutions in order to improve energy efficiency.
2. Project description (cont.)

- Rows of study:

  - Wine & vine
  - Fish
  - Fruits & vegetables
  - Milk & dairy
  - Meat
  - Distribution
2. Project description (cont.)

- Network of partners:

Region of Alentejo
3. Applied methodology

- Sequence of tasks (phase 1):
3. Applied methodology (cont.)

- Sequence of tasks (phase 2):

  - Start
  - Analysis of results (phase 1)
  - Building of decision's algorithm
  - Test & improvement of decision's algorithm
  - Disclosure of results
  - End
3. Applied methodology (cont.)

- Selection & characterization of companies by row:
  - choice of 252 agro-industrial companies scattered over the country;
  - 36 companies for each partner (distributed by the 6 rows).
3. Applied methodology (cont.)

Data collection:

- inquiry by questionnaire;
- variables of the questionnaire:

<table>
<thead>
<tr>
<th>Variables</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>General data about the company</td>
<td>Dimension, profits, R&amp;D investments</td>
</tr>
<tr>
<td>Energy</td>
<td>Tariff, energy sources, costs</td>
</tr>
<tr>
<td>Raw materials &amp; products</td>
<td>Types, quantities, industrial processes</td>
</tr>
<tr>
<td>Equipment for cold generation</td>
<td>Structure, temperatures, maximum capacities</td>
</tr>
</tbody>
</table>
3. Applied methodology (cont.)

- Data treatment:
  - data insertion in a common database (web platform);
  - determination of several energy efficiency indicators:
    - energy cost per kg of product;
    - electric energy cost per kW.h;
    - average deviation of temperatures from ideal values;
    - R&D investments;
    - ...

3. Applied methodology (cont.)

- Tools to decide which energy efficiency measures to apply:

  - Optimization of electric energy tariff
  - Optimization of cold storage consumptions
3. Applied methodology (cont.)

- Optimization of electric energy tariff:

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Data from electric energy bills

Electric energy prices

Simulation (Excel)

Ideal price?

N

Y

Tariff change is proposed
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3. Applied methodology (cont.)

- Optimization of cold storage consumptions:

![Diagram showing the methodology]

Initial parameters of cold storage → Simulation → Energy consumption → Ideal? → Definition of energy efficiency measures

If not ideal, change of parameters and repeat the process.
3. Applied methodology (cont.)

- Optimization of cold storage consumptions (cont.):
  - method: ASHRAE 2002;
  - thermal loads that influence energy consumption:

\[ \dot{Q} = c_p \dot{m} \Delta T \]

\[ \dot{Q} = U.A. \Delta T \]

\[ \dot{Q} = 221 \times A \times (h_i - h_r) \times \rho_r \times F_m \times \sqrt{g \times H \times (1 - \rho_i/\rho_r)} \]

Products

Across walls

Cold storage

People / electric equipment

Infiltration air
4. Achieved results

- Analysis of energy indicators:
4. Achieved results (cont.)

- Analysis of energy indicators (cont.):

![Energy cost per kg of product (meat row)](chart)
4. Achieved results (cont.)

- Analysis of energy indicators (cont.):

![Graph showing absolute average deviations of temperatures inside chambers compared to ideal values (dairy row)]
4. Achieved results (cont.)

- Analysis of energy indicators (cont.):

![Graph showing absolute average deviations of temperatures inside chambers compared to ideal values (meat row).]
4. Achieved results (cont.)

- Analysis of energy indicators (cont.):
4. Achieved results (cont.)

- Analysis of energy indicators (cont.):
4. Achieved results (cont.)

- Analysis of energy indicators (cont.):

![Diagram showing potential savings in the electric energy bill (tariff change)](image-url)

- Average: 25.96
5. Some final reflections

- Relevant disparities in several energy efficiency indicators.
- Revision of electric energy tariffs.
- Higher production → better efficiency.
- Approach cold chamber's temperature to the product's point of conservation.
- Other measures to observe:
  - installation of batteries of capacitors;
  - definition of a maintenance plan (substitution of rubber seals, defrost, condenser cleaning, ...);
  - heat recovery systems.
Thanks for the attention!