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CENTRAL AND EASTERN EUROPE
REGIONAL ENERGY EFFICIENCY PROJECT
EUR-0030-C-00-2053-00

Energy Pricing, Energy Efficiency, and
Energy Sector Restructuring Component

Romania
Equipment Procurement
Task Completion Memorandum

Prepared for:

U.S. Agency for International Development
Bureau for Europe and NIS
Office of Environment, Energy,
and Urban Development
Energy and Infrastructure Division

Prepared by:

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August 1996
CENTRAL AND EASTERN EUROPE
REGIONAL ENERGY EFFICIENCY PROJECT

Task Completion Memorandum

Romania - Equipment Procurement

Summary Task Description

This project builds upon the results of the 1993 Energy Efficiency and Market Reform Project in which energy market development programs were carried out with sixteen energy services companies (Certified Energy Managers) and eight industrial enterprises in Romania. In the 1993 project, the primary objective was to achieve training and capacity building among private energy service companies, and to assist these companies with developing their business through energy efficiency projects at eight industrial enterprises. Hagler Bailly had primary responsibility for organizing and managing the program. The Energy Efficiency Market Development (EEMD) project included concentrated attention to management and organizational issues, and primary responsibility for the field work was placed upon multiple Romanian private sector enterprises.

The Equipment Procurement (EP) Project is structured to expand the procurement of energy efficiency equipment, first for the existing participating plants, and second for additional plants if sufficient applications cannot be developed at the first plants. The expanded procurement will enable the installation of additional equipment, expand the technological base of the EEMD program, and assist the energy service companies in developing their experience with new energy efficient equipment and technologies.

The Romania Equipment Procurement Task is a follow on activity to the Energy Efficiency Market Development (EEMD) task which was initiated to serve as a catalyst to assist private Romanian firms to develop a market for energy efficiency services, and to develop their capability to serve this market. This effort is well underway and the Romanian firms are in the process of completing energy audit reports, specifying equipment, and preparing the participating plants for installation. Concurrently, Hagler Bailly is in the process of procuring the initial round of equipment and preparing for shipment to Romania.

Hagler Bailly Consulting

Task Completion Memorandum - 1
The major activities in the Romania EP task are:

1. To work with the participating Romanian Certified Energy Managers and plants to identify approximately $445,000 in energy efficiency equipment (including service contracts and shipping costs) for procurement by USAID.

2. To continue the process of technical and economic evaluation in the selection of this equipment.

3. Specify, procure, and ship the equipment to Romania.

4. Follow-up with technical assistance as required in start-up and commissioning.

5. Monitor the equipment performance and report annually on its use.

Specific Goals and Objectives

The general objective of the EP project will be to support the initial EEMD tasks for development of a market for an energy efficiency industry in Romania, and to assist firms in the private sector to develop their capability to serve this market.

The specific objectives of the EEMD project are:

1. Expand the capability of Romanian private firms to provide energy efficiency services, equipment, and financing to industrial clients;

2. Continue with improving energy efficiency in specific pilot sites (especially industrial enterprises), through provision of additional energy-saving equipment;

3. Expand Romanian-U.S. technical and commercial ties through linkages between energy efficiency associations, engineering and energy service companies, and equipment suppliers.

Expected Outputs

The expected outputs of the Equipment Procurement project are:

1. Equipment Specifications - Augment the planned energy audits and prepare, based on the Tasks of the workplan, specifications and justification for the purchase of energy efficiency equipment that will help improve the effectiveness, impact, and demonstration benefits of the Tasks.
2. **Procurement Management** - Manage the procurement of the equipment in accordance with USAID regulations. Proposed purchases and justifications indicating the cost/benefits (including environmental) of the introduction of the equipment will be submitted to the USAID project officer who will provide written recommendation to the USAID contracts officer who will authorize equipment procurement.

3. **Service Capability** - Agreement will be reached with the supplying company on servicing for the equipment installed in Central and Eastern Europe.

4. **Disposition Agreements** - Written agreements will be concluded with organizations receiving equipment that clearly specifies its use and responsibility for the equipment, and this documentation will be provided to USAID.

5. **Equipment Installation** - The equipment will be insured, shipped, and installed at its final destination exempt from customs duties and taxes. USAID will assist if needed with the host government if a USAID bilateral assistance agreement is not in place.

6. **Monitoring and Reporting** - Periodically monitor the use and condition of the equipment and prepare at least annually reports on functioning of the major installation and the estimated energy and environmental savings including the equipment in place under the emergency project

**Deliverables:**

Hagler Bailly provided short term consultants and technical assistance to aide the eight original Romanian enterprises with identifying, procuring, installing, and monitoring energy efficiency equipment. The seven plants who participated in the follow-on equipment program were:

- Stirom, glass products
- Matizol, insulation materials
- Terapia, pharmaceutical products
- Borsa, city hospital
- Muha, wood materials and construction
- Danubiana, tire plant
- VEGA, petroleum refinery

A walk-thru energy audit was completed by Hagler Bailly at each plant and a roster of potential energy efficiency measures developed and discussed with plant management. Based on the findings and plant needs, a number of measures and equipment were selected for implementation.
The following table denotes the energy efficiency measure and equipment that was implemented for each plant:

<table>
<thead>
<tr>
<th>Plant</th>
<th>Measure/Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stirom</td>
<td>Adjustable Speed Drive</td>
</tr>
<tr>
<td></td>
<td>Infrared Pyrometer/Flowmeters</td>
</tr>
<tr>
<td></td>
<td>Energy Management System</td>
</tr>
<tr>
<td></td>
<td>Data Acquisition System</td>
</tr>
<tr>
<td></td>
<td>Flue Gas Analyzer/Calibrator</td>
</tr>
<tr>
<td>Matizol</td>
<td>Gas Flowmeter/Controller/Burners</td>
</tr>
<tr>
<td></td>
<td>Dipping Probe System</td>
</tr>
<tr>
<td></td>
<td>Furnace Pressure Sensor/Damper Actuator</td>
</tr>
<tr>
<td></td>
<td>Energy Management System</td>
</tr>
<tr>
<td></td>
<td>TC Protection Tubes</td>
</tr>
<tr>
<td>Terapia</td>
<td>Flowmeters</td>
</tr>
<tr>
<td></td>
<td>Steam Traps</td>
</tr>
<tr>
<td></td>
<td>Portable Combustion Analyzer</td>
</tr>
<tr>
<td>Borsa</td>
<td>Heat Exchanger</td>
</tr>
<tr>
<td></td>
<td>Steam Meter</td>
</tr>
<tr>
<td></td>
<td>Electric/Hot Water Meters</td>
</tr>
<tr>
<td></td>
<td>Energy Management System</td>
</tr>
<tr>
<td></td>
<td>Data Acquisition System</td>
</tr>
<tr>
<td>Muha</td>
<td>Electric/Hot Water Meters</td>
</tr>
<tr>
<td></td>
<td>Controller/Temperature Probe/Damper Actuator</td>
</tr>
<tr>
<td></td>
<td>Energy Management System</td>
</tr>
<tr>
<td></td>
<td>Power Factor Correction</td>
</tr>
<tr>
<td>Danubiana</td>
<td>Flue Gas Analyzer</td>
</tr>
<tr>
<td></td>
<td>Steam Traps/Metering</td>
</tr>
<tr>
<td></td>
<td>Ultrasonic Probe</td>
</tr>
<tr>
<td>VEGA</td>
<td>Boiler Automation/Metering</td>
</tr>
<tr>
<td></td>
<td>Combustion Analyzer</td>
</tr>
</tbody>
</table>

All of this equipment was procured, delivered, installed, and commissioned during the life of the project.
Results and next Steps

The program has achieved positive results: both in terms of technical results (energy and cost savings) and the broader institutional issues of creating a market in Romania for energy services.

The final monitoring report for each plant is attached to this task completion memorandum. These reports summarize the results of the monitoring program and the equipment procurement and installation process.

As for next steps, the following recommendations are made:

- The monitoring program should be continued so that additional information can be gathered on the results of each energy efficiency measure.

- Each CEM and plant should use the results of the monitoring program to further implement energy efficiency measures at the respective plant, and for the CEM to develop further business prospects.

- The CEMs should pursue institutional reform (e.g. energy rate restructuring, import duty exemptions on energy efficiency equipment, etc.) with the appropriate government agencies and use the collective influence of the AEE chapter, and other Romanian associations, to promote energy efficiency market development policy.
### Romania - Summary of Energy and Cost Savings
USAID Energy Market Development Project
Industrial Energy Efficiency

<table>
<thead>
<tr>
<th>Plant/CEM</th>
<th>Energy Efficiency Measure</th>
<th>Energy Saved (m3-NG/yr)</th>
<th>Project Cost (USD $)</th>
<th>Cost Savings (USD $)</th>
<th>Payback (yr)</th>
<th>Notes:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stirom Glass Factory Bucharest Romania Mihail Zdravcu, CEM</td>
<td>Portable IR Pyrometer</td>
<td>137,500</td>
<td>10,250</td>
<td>15,000</td>
<td>0.68</td>
<td>Savings applied to multiple furnaces</td>
</tr>
<tr>
<td></td>
<td>Combustion Control</td>
<td>232,000</td>
<td>20,300</td>
<td>24,000</td>
<td>0.85</td>
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<tr>
<td></td>
<td>ASD, 22kw</td>
<td>45,000</td>
<td>19,000</td>
<td>8,730</td>
<td>4.24</td>
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<tr>
<td></td>
<td>ASD, 75 kw</td>
<td>144,000</td>
<td>39,000</td>
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<tr>
<td></td>
<td>Energy Monitoring System</td>
<td>2,000</td>
<td>103,000</td>
<td>100,000</td>
<td>1.03</td>
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<tr>
<td></td>
<td>Supercalibrator</td>
<td>55,000</td>
<td>2,600</td>
<td>6,150</td>
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<td></td>
<td>COG Belts</td>
<td>8,000</td>
<td>500</td>
<td>400</td>
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<tr>
<td></td>
<td>Fixed IR Pyrometer</td>
<td>25,000</td>
<td>4,200</td>
<td>3,750</td>
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<tr>
<td></td>
<td>Ultrasonic Leak Detector</td>
<td>525,000</td>
<td>4,200</td>
<td>29,250</td>
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<tr>
<td></td>
<td>Subtotal</td>
<td>449,500</td>
<td>203,050</td>
<td>190,480</td>
<td>1.07</td>
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<tr>
<td>Matizol materials Plant Ploiesti Romania Mihail Zdravcu, CEM</td>
<td>IR Pyrometer</td>
<td>40,000</td>
<td>9,250</td>
<td>10,250</td>
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<td></td>
<td>High Efficiency Burners</td>
<td>100,000</td>
<td>36,000</td>
<td>8,800</td>
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<td></td>
<td>Combustion Optimization</td>
<td>218,030</td>
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<td>20,850</td>
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<td>Ultrasonic Leak Detector</td>
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<tr>
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<td>COG Belts</td>
<td>12,705</td>
<td>1,100</td>
<td>635</td>
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<td></td>
<td>Glass Furnace Automation</td>
<td>125,000</td>
<td>37,160</td>
<td>63,750</td>
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<td></td>
<td>Subtotal</td>
<td>483,335</td>
<td>90,810</td>
<td>115,035</td>
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<tr>
<td>Borsa City Hospital Borsa Romania Georgeta Padureanu Vasile Grasin CEM</td>
<td>Steam Traps/Condensate Recovery</td>
<td>58,488</td>
<td>1,374</td>
<td>5,845</td>
<td>0.24</td>
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<tr>
<td></td>
<td>Boiler Combustion Efficiency</td>
<td>20,505</td>
<td>1,227</td>
<td>2,050</td>
<td>0.60</td>
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<tr>
<td></td>
<td>Boiler House Metering</td>
<td>57,934</td>
<td>6,079</td>
<td>5,793</td>
<td>1.20</td>
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<td></td>
<td>Water Heat Exchangers</td>
<td>127,881</td>
<td>27,016</td>
<td>15,425</td>
<td>1.70</td>
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<td>Energy Management System</td>
<td>43,518</td>
<td>24,339</td>
<td>18,829</td>
<td>1.29</td>
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<td></td>
<td>Subtotal</td>
<td>303,324</td>
<td>68,935</td>
<td>47,842</td>
<td>1.27</td>
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<tr>
<td>Terapia Pharmaceutical Cluj Romania Georgeta Padureanu Vasile Grasin CEM</td>
<td>Steam Traps - Phase I Boiler House</td>
<td>227,114</td>
<td>3,286</td>
<td>24,983</td>
<td>0.13</td>
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<td>Boiler Combustion Efficiency</td>
<td>262,304</td>
<td>4,976</td>
<td>28,890</td>
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<tr>
<td></td>
<td>Steam Traps - Phase II Boiler House</td>
<td>21,600</td>
<td>955</td>
<td>2,376</td>
<td>0.40</td>
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<td>Boiler Metering System</td>
<td>601,960</td>
<td>30,040</td>
<td>66,215</td>
<td>0.45</td>
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<td>Steam Traps - Factory</td>
<td>427,330</td>
<td>7,029</td>
<td>47,006</td>
<td>0.15</td>
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<td>Subtotal</td>
<td>1,540,368</td>
<td>46,286</td>
<td>169,440</td>
<td>0.27</td>
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</table>
### Industrial Energy Efficiency

<table>
<thead>
<tr>
<th>Plant/CEM</th>
<th>Energy Efficiency Measure</th>
<th>Energy Saved</th>
<th>Project Cost (USD $)</th>
<th>Cost Savings (USD $)</th>
<th>Payback (yr)</th>
<th>Notes:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VEGA Refinery</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ploiesti Romania</td>
<td>Combustion Optimization</td>
<td>970 t-FO/yr</td>
<td>53,210</td>
<td>93,702</td>
<td>0.57</td>
<td>Savings included in combustion/water optimization</td>
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<tr>
<td>Simona Parvu CEM</td>
<td>Reduction of Water Consumption</td>
<td>6,870 t-H2O/yr</td>
<td>2,460</td>
<td>3,420</td>
<td>0.72</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Metering</td>
<td>16,200</td>
<td>16,200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Subtotal</td>
<td>970 t-FO/yr</td>
<td>71,870</td>
<td>97,122</td>
<td>0.74</td>
<td></td>
</tr>
<tr>
<td><strong>MUHA Wood Manufacturing</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suceava Romania</td>
<td>Portable Humidity Meter</td>
<td>581</td>
<td>1,164</td>
<td>0.50</td>
<td>Savings result from product defect reduction</td>
<td></td>
</tr>
<tr>
<td>Haralambie Pavel CEM</td>
<td>Drying Automation</td>
<td>273 Gcal/yr</td>
<td>16,391</td>
<td>7,692</td>
<td>2.13</td>
<td>Savings include reductions in raw materials</td>
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<tr>
<td></td>
<td>Electric Metering</td>
<td>775</td>
<td>968</td>
<td>0.80</td>
<td>Savings result from applying time-of-use tariffs</td>
<td></td>
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<tr>
<td></td>
<td>Power Factor Control</td>
<td>9,617</td>
<td>5,640</td>
<td>1.74</td>
<td>Savings result from elimination of power factor penalty</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Subtotal</td>
<td>273 Gcal/yr</td>
<td>27,584</td>
<td>15,464</td>
<td>1.78</td>
<td></td>
</tr>
<tr>
<td><strong>Danubiana Tire Factory</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bucharest Romania</td>
<td>Heavy Fuel Oil Meter</td>
<td>13,174</td>
<td>Delivered, not installed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Florin Mihalcescu CEM</td>
<td>Natural Gas Flowmeter</td>
<td>4,291</td>
<td>Delivered, not installed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Steam Flowmeters</td>
<td>8,640</td>
<td>Delivered, not installed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ultrasonic Detector</td>
<td>3,718</td>
<td>Installed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Flue Gas Analyzer</td>
<td>10,640</td>
<td>Not Delivered</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hot Water Meter</td>
<td>4,550</td>
<td>Delivered, not installed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Steam Traps</td>
<td>19,506</td>
<td>Not Delivered</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Subtotal</td>
<td>2,400,000 m3-NG/yr</td>
<td>60 t-FO/yr</td>
<td>64,719</td>
<td>122,660</td>
<td>0.53</td>
</tr>
<tr>
<td><strong>Mobins Wood Manufacturing</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Bucharest Romania</td>
<td>Humidity Control</td>
<td>650 Gcal/yr</td>
<td>Delivered, not installed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Florin Mihalcescu</td>
<td></td>
<td>63 MWh/yr</td>
<td>(incl)</td>
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<tr>
<td></td>
<td>Subtotal</td>
<td>650 Gcal/yr</td>
<td>63 MWh/yr</td>
<td>6,217</td>
<td>11,418</td>
<td>0.54</td>
</tr>
</tbody>
</table>

**SUMMARY**

| | 4,872,987 m3-NG/yr | 3,354,588 KWh/yr | 304,344 t-FO/yr | 625 t-steam/yr | 923 Gcal/yr | |
| | $571,451 | $769,561 | 0.74 | |

**Legend:**

- **FO** - Fuel oil
- **Gcal** - Gigacalorie
- **GJ** - Gigajoules
- **H2O** - Water
- **KWh** - Kilowatt-hours
- **MWh** - Megawatt-hours
- **m3** - Cubic meters
- **NG** - Natural gas
- **t** - Tonne
- **yr** - Year

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Hagler Bailly Consulting
### Table: Energy and Cost Savings

<table>
<thead>
<tr>
<th>Plant/CEM</th>
<th>Energy Efficiency Measure</th>
<th>Energy Saved</th>
<th>Project Cost (USD $)</th>
<th>Cost Savings (USD $)</th>
<th>Payback (yr)</th>
<th>Notes:</th>
</tr>
</thead>
<tbody>
<tr>
<td>VEGA Refinery Ploiesti Romania Simona Parvu CEM</td>
<td>Combustion Optimization</td>
<td>970 t-FO/yr</td>
<td>53,210</td>
<td>93,702</td>
<td>0.57</td>
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<tr>
<td></td>
<td>Reduction of Water Consumption Metering</td>
<td>8,870 t-H2O/yr</td>
<td>2,460</td>
<td>3,420</td>
<td>0.72</td>
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<tr>
<td></td>
<td></td>
<td>16,200</td>
<td>16,200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Subtotal</td>
<td>970 t-FO/yr</td>
<td>71,870</td>
<td>97,122</td>
<td>0.74</td>
</tr>
<tr>
<td>MUHA Wood Manufacturing Suceava Romania Haralambie Pavel CEM</td>
<td>Portable Humidity Meter Drying Automation Electric Metering Power Factor Control</td>
<td>273 Gca/yr</td>
<td>581</td>
<td>1,164</td>
<td>0.50</td>
<td>Savings result from product defect reduction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16,391</td>
<td>7,692</td>
<td>2.13</td>
<td>Savings include reductions in raw materials</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>775</td>
<td>968</td>
<td>0.80</td>
<td>Savings result from applying time-of-use tariffs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>9,817</td>
<td>5,640</td>
<td>1.74</td>
<td>Savings result from elimination of power factor penalty</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Subtotal</td>
<td>273 Gca/yr</td>
<td>27,564</td>
<td>15,464</td>
<td>1.78</td>
</tr>
<tr>
<td>Danubiana Tire Factory Bucharest Romania Florin Mihalcescu CEM</td>
<td>Heavy Fuel Oil Meter Natural Gas Flowmeter Steam Flowmeters Ultrasonic Detector Flue Gas Analyzer Hot Water Meter Steam Traps</td>
<td>13,174</td>
<td>4,291</td>
<td>8,640</td>
<td>3,718</td>
<td>10,840</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Subtotal</td>
<td>2,400,000 m3-NG/yr 50 t-FO/yr</td>
<td>64,719</td>
<td>122,660</td>
<td>0.53</td>
</tr>
<tr>
<td>Mobins Wood Manufacturing Bucharest Romania Florin Mihalcescu</td>
<td>Humidity Control</td>
<td>650 Gca/yr 63 MWh/yr</td>
<td>6,217</td>
<td>8,250</td>
<td></td>
<td>Delivered, not installed</td>
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<tr>
<td></td>
<td></td>
<td>(incl)</td>
<td>3,168</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Subtotal</td>
<td>650 Gca/yr 63 MWh/yr</td>
<td>6,217</td>
<td>11,416</td>
<td>0.54</td>
<td></td>
</tr>
<tr>
<td>SUMMARY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>571,451</td>
<td>769,561</td>
<td>0.74</td>
<td></td>
</tr>
</tbody>
</table>

**Legend:**
- FO - Fuel oil
- Gca - Gigacalorie
- GJ - Gigajoules
- H2O - Water
- KWh - Kilowatt-hours
- MWh - Megawatt-hours
- NG - Natural gas
- t - Tonne
- yr - Year
MONITORING AND EVALUATION REPORT FOR THE EQUIPMENT INSTALLED AT STIROM GLASS FACTORY BUCHAREST, ROMANIA

PREPARED BY: MIHAIL ZDRAVCU, CEM

ROMANIA ENERGY EFFICIENCY MARKET DEVELOPMENT PROJECT
USAID - EAST EUROPE AND REGIONAL ENERGY EFFICIENCY PROJECT CONTRACT EUR-0300-C-00-2053-00
EXECUTIVE SUMMARY

1.0 Background
The USAID Industrial Energy Efficiency Project in Romania has assisted privat Certified Energy Managers (CEM’s) in developing an energy service company practice and this bring needed energy consulting services to Romanian industrial entreprises. The program consisted of four principal activities:

1. Training in energy efficiency for privat sector energy service to industry firms (ESCO’s) seeking to provide services to industry, which included: management, accounting, economics, finance, energy audit techniques, industrial management, maintenance, marketing and management for energy efficiency services companies. Included in training was the establishment of two Romanian Chapters of the US Association of Energy Engineers.

2. Energy management programs in 8 industrial entreprises. Each program included advice in energy management from Romanian and US experts, an energy audit report, and a package of US industrial energy efficiency equipment. Each industrial entreprise that agreed to participate in the program has paid a market oriented fee to the Romanian consultants for the services.

3. Conference and exhibition on industrial energy management in association with the US Association of Energy Engineers (US and Romanian Chapters). This tasks was concerned primarily with conducting a monitoring and evaluation program for STIROM which participated in the Energy Efficiency Program in Romania.

2.0 Plant description
STIROM Bucharest is a privatised Glass Factory, products being glass cups, bottles for wine, beer and vegetable oil, and PEPSI COLA, medicine ampuls, etc. Plant has 10 furnaces gas fired, a large air compressed station. All row materials are from local market, the energy required natural gas and electricity being ensurred from national grid.

Water is pumped from own wells and hot water 90°/70°C is fabricated by a Heat Recovery Station from flue gas flowing to the stacks, Hot Water has also a grid connection, Two thesdand and three hundred people work in yhis factory for 25 years-old. STIROM is the largest industrial user of natural gas from Bucharest. The factory is sharing about 40% from local market, the export being about 5-10% from the total production.

The major energy consumers are gas fired glass furnaces (10 furnaces), heat treatment kilns and electrical motors from Air Compressed Station (about 71% out of total electrical consumption) I.D.Fans for combustion air and I.S.Molding air cooling system (about 750Kwh/h) etc.

Baseline plant wide energy consumption and energy intensity (1994) with source of data, before the start of the USAID/CEM Program are shown as following (European energy cost)
3.0. Description of the project
During the course of the audit, the Romanian auditors and Hagler Bailly and ETSI's advisors identified several projects and agreed with STIROM to request USAID's support for funding. The project has two phases:

3.1. Phase I
Action 1. Control Signal Calibrator
Action 2. Infra-red Pyrometer and Infra-red Thermometer
Action 3. Ultrasonic Leak Detector

Action 1. Control Signal Calibrator

Existing conditions:
STIROM has 10 furnaces which already have classic automatic control of most parameters, including temperature, gas flow, air/fuel ratio, regenerator operation, etc. The audit team and the plant reached the conclusion that many of the controllers would need calibration to operate at the maximum efficiency level.

Recommended action:
Supply a portable calibrator, so that STIROM can calibrate all control loops and equipment on a regular basis. Equipment shall at the minimum provide source and measurement of mA, mV, Ohm... STIROM estimates that they have about 2,000 pieces of equipment that could be calibrated.

Cost of equipment: $2,300

Cost of installation:
$0 No installation
$300 Annual cost of in-house technician
Calculated benefits, energy savings (and economic savings - production increase)
Gas savings of 0.1% : $6,150 per year.
Energy saving are measured at main gas flowmeter.

The payback period:
Less than a year. (0.4 years)

**Action 2. Infra-Red Thermometer and Pyrometer**

Existing conditions:
1) Refractory bricks of furnaces deteriorate gradually and need to be monitored
2) Thermocouple temperature measurement in the furnaces should be verified with other measuring methods
3) Temperature of the glass gobs are not measured on exiting furnaces.

Recommended action:
Supply infra-red temperature measurement equipment covering the temperature range from ambient to 1,600°C to measure both installation, refractory and melted glass, so that STIROM can perform on-going refractory checks and upgrades, and better adjust temperature parameters in the furnaces:
- Infra-red pyrometer, with fast response time (approx. 400-1,600°C)
- Infra-red thermometer (approx. 0°C to 400°C)

Cost of equipment:
- Pyrometer: $2,500 (funded by USAID)
- Thermometer: $750 (funded by USAID)

Cost of installation:
- $0: Portable equipment
- $5,000: Initial implementation of measures (insulation)
- $2,000: Annual maintenance on measures

Calculated benefits, energy savings (and economic savings):
Gas savings of 0.25% : $15,000 per year. Measurements are on main gas flowmeter.

Payback period:
Less than a year. (0.4 years)
Action 3. Ultrasonic Leak Detector

Existing conditions:
The plant produces about 330,000,000 Nm³ of compressed air per year, with associated electricity usage of 35,000 MWh/year (72% of electricity consumption). Based on a comparison of compressed air production and estimated plant-wide compressed air balance, it is estimated that compressed air leaks represent more than 15% of the total.

Recommended action:
Supply a portable ultrasonic leak detector, so that STIROM can perform on-going detection and maintenance of compressed air leaks.

Cost of equipment:
$550 (funded by USAID)

Cost of installation:
$0 Portable equipment
$3,000 Initial implementation of measures
$500 Annual maintenance on measures

Calculated benefits, energy savings (and economic savings):
Compressed air savings of 1.5% (or 10% of estimated leaks)
525,000 Kwh/year : $26,250/year. Saving will be measured after completion of the Monitoring System.

Payback period:
Less than a year.

Action 4: COG Belts:
Audit team recommended changing of the existing belts with rybed belts (USA Daico type). The results were satisfactory, energy saving being 0.5% X 4motors X 50KWH/H X 8,000H/year = 8,000 Kwh, $400/year.

Cost of equipment:
$250 (funded by USAID)

Cost of installation:
$250
Payback period:
1.7 years.

3.2. Phase II

Action 1.: Fixed Flue Gas Analyser;
Action 2.: Fixed Infra-Red Pyrometer;
Action 3.: Compressed Air Monitoring System
Action 4.: Adjustable Speed Drive (ASD) on Combustion Air Fan
Action 5.: Adjustable Speed Drive (ASD) on cooling Fan of Glass Molding Machine

Action 1: Fixed flue gas analyser:

Existing conditions:
STIROM has 10 glass furnaces which do not have any fixed combustion analysers. During the audit, one measurement made on furnace C2 showed 7% excess oxygen, at 750°C stack temperature.

Recommended action:
Install one fixed combustion analyser, which the plant will integrate into a trim control loop. It is expected that natural gas savings of over 2% can be achieved.

Monitoring:
The plant already has basis flow metering instrumentation installed on the furnace (non-compensated orifice plate). The information provided by these meters will be used to the maximum extent possible to provide before and after measurements of the gas consumption of the furnace, and to get feedback on the effectiveness of the measures implemented on the furnace.

Cost of equipment:
$13,000 (funded by USAID)

Cost of installation:
$6,800

Initial implementation (O&M):
$500
Estimated benefits, energy savings (and economic savings):
Gas savings (@4%) : 232,000 SCM ; $24,000/year. After the measurements was established the Baseline for savings 1,450 SCMgas/H. Saving will be summarised in Energy Monitoring System.

Payback period:
0,5 year.

Action 2 : Fixed Infra-Red Pyrometer

Existing conditions:
Air temperature above the furnace melting bath is currently measured with thermocouples. Due to the high temperature, STIROM needs to frequently replace these thermocouples at an annual cost of over $1,000. Additionally, the poor reliability of the existing thermocouple system forces the plant to set target air/glass temperatures at higher levels than necessary with a safety margin, and contributes to the high rate of rejects. Rejects result in additional manufacturing costs due to re-melting (energy), re-handing (labor), and re-processing (capacity losses).

Recommended action:
Install one fixed infra-red pyrometer which the plant will eventually integrate into the control loops. Apart from the savings on thermocouple supplies, improved control of the melting bath temperature will improve energy efficiency. More accurate and reliable measurements will allow lower target temperatures and improve both product quality and consistency. The new system will also contribute to a reduction in the rate of rejects. Savings are conservatively estimated at 0,25% to take into account the lowering of temperature setpoints. Additional savings will results from improved quality and reduced rejects.

Monitoring:
Same as Action #1.

USAID Cost:
$ 3,000

Plant Cost:
$ 1,200

Calculated benefits, energy savings (and economic savings):
Baseline gas consumption for furnace : 10,000,000 SCM/year
Gas savings (@0,25%) : $ 2,750 per year. Gas savings are measured on main flowmeter and later on Energy Monitoring System.
Maintenance savings : $ 1,000 per year.
Estimated payback period:
1.1 years.

**Action 3: Compressed air monitoring system**

**Existing conditions:**
The plant produces about 330,000,000 Nm³ of compressed air per year, with associated electricity usage of 35,000 Mwh/year or $1,725,000 per year (72% of electricity consumption). Based on a comparison of compressed air production and estimated plant-wide compressed air balance, it is estimated that compressed air leaks represent more than 15% of the total. An ultrasonic leak detector was provided to STIROM under Phase I of this project, and STIROM has started a leak reduction program. However, STIROM cannot currently monitor compressed air consumption.

**Recommended action:**
Install compressed air flowmeters and electric meters on all air compressors (6 flowmeters and 7 electric meters), with a data logger, personal computer and printer. The system is programmed to monitor the overall compressed air consumption of the plant and to calculate the efficiency of each compressor.

**Monitoring:**
The flowmeters will provide feedback on the leak reduction program. Ratios of compressed air volume to electric consumption will also provide valuable information on individual compressor efficiencies and on the optimal mix of compressor loadings.

**USAID Cost:**
$63,000 (approximate breakdowns as follows: flowmeters: $43,000; data logger and computer system: $20,000). The data logging system was purchased from a local Romanian firm that can custom-design the software application and provide long-term support.

**Plant Cost:**
$35,000. Increase in annual O&M cost: $5,000

**Estimated benefits, energy savings (and economic savings):**
Baseline electric consumption for air compressor: 2,000,000 KWH/year
Electric savings (@ 5.70%): 2,000,000 Kwh/year - $100,000/year.
Demand savings are also likely but they have not been included in this cost/benefit analysis since it is difficult to predict their magnitude.
Estimated payback period:
1 year.
STIROM is measuring the electric consumption on main KWH-meter and now started on Energy Monitoring System.

Action 4: Adjustable Speed Drive on Combustion Air Fan

Existing conditions:
Combustion air on the glass furnaces is currently controlled through a damper. Furnaces generally operate with dampers 60 to 90% open. Power was measured at 15 KW on the 22 KW motor that is considered for the adjustable speed drive.

Recommended action:
Install one ASD on the combustion air fan of the furnace and integrate it in FUEL/AIR LOOP of the furnace Melting Bath. Modulate fan speed instead of using damper. Over the 60-90% range, it is expected that electrical savings will vary between 20% and 70%, averaging at least 35%. There may also be demand savings, but these are not included in the cost/benefit analysis, as they are difficult to predict. In addition, the ASD will allow for more precise control of the air/fuel ratio than the existing damper currently does and will therefore maximize the effects of the fixed flue gas analyser that we are also proposing to install.

Monitoring:
Since we started to discuss this proposed measure, the plant has installed a fixed electric meter on the motor. This meter is tied into the data logging system designed for compressed air monitoring (Action # 3). Additional natural gas savings, combined with the savings from Action # 1 and Action # 2, will be monitored through the plant’s basis flow metering instrumentation.

USAID Cost:
$ 16.000

Plant Cost:
$ 3.000 (including bypass system and electric meter)

Estimated benefits, energy savings (and economic savings):
Baseline electric consumption for fan: 127,500 Kwh/year
Baseline gas consumption for furnace: 10,000,000 Nm3/year
Electric savings (@ 35%): 45,000 Kwh/year, $ 2.230 per year
Gas savings (@ 0.5%): $ 5.500 per year

Estimated payback period:
2.4 years.
Action 5: Adjustable Speed Drive on Cooling Fan of Glass Molding Machine

Existing conditions:
Cooling air regulated with dampers, from 20-90% open, depending on the season. In the winter, when cooling volumes are lower, the air intake is partially blocked. On various occasions (cold weather), power was measured at 40 to 47 KW.

Recommended action:
Install one adjustable speed drive on the cooling fan of 75 KW. Install one static pressure sensor in the supply duct, and provide a static pressure controller with remote stepoint capabilities. Modulate fan speed instead of using the primary damper. It is expected that electrical savings will vary between 20% and 80%, providing an average of 35% savings. There may also be demand savings, but these are not included in the cost/benefit analysis, as there are difficult to predict.

Monitoring:
Since we started to discuss this proposed measure, the plant has installed a fixed electric meter on the motor. If possible, the output of this meter will be tied into the data logging system designed for compressed air monitoring (Action # 3).

USAID Cost:
$ 32,000

Plant Cost:
$ 7,800 (including bypass system and electric meter)

Estimated benefits, energy savings (and economic savings):
Baseline electric consumption for fan: 360,000 Kwh/year
Electric savings (@35%): 144,000 Kwh/year, $ 7,200 / year

Estimated payback period:
5,3 years.
SUMMARY
With a USAID grant of $132,850 in equipment for STIROM and with own cost of $63,300 plus $5,300 for O#M, the Plant can obtain $190,000 savings in energy, payback period being 1 year.

<table>
<thead>
<tr>
<th>PHASE I</th>
<th>USAID</th>
<th>STIROM</th>
<th>O#M</th>
<th>SAVINGS</th>
<th>PB</th>
</tr>
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<tbody>
<tr>
<td>Action #1</td>
<td>2.300</td>
<td>300</td>
<td>6.150</td>
<td></td>
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<tr>
<td>Action #2</td>
<td>3.000</td>
<td>7.000</td>
<td>15.000</td>
<td></td>
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</tr>
<tr>
<td>Action #3</td>
<td>550</td>
<td>3.500</td>
<td>26.250</td>
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<table>
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<th>USAID</th>
<th>STIROM</th>
<th>O#M</th>
<th>SAVINGS</th>
<th>PB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Action #1</td>
<td>13.000</td>
<td>6.800</td>
<td>24.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Action #2</td>
<td>3.000</td>
<td>1.200</td>
<td>3.750</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Action #3</td>
<td>63.000</td>
<td>35.000</td>
<td>5.000</td>
<td>100.000</td>
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</tr>
<tr>
<td>Action #4</td>
<td>16.000</td>
<td>3.000</td>
<td>7.730</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Action #5</td>
<td>32.000</td>
<td>6.800</td>
<td>7.200</td>
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</tr>
<tr>
<td>TOTAL PH I+PH II</td>
<td>132.850</td>
<td>63.300</td>
<td>15.300</td>
<td>190.080</td>
<td>1.06 years</td>
</tr>
</tbody>
</table>

5.0. Actions Taken by STIROM by Own Investment Funding

5.1. Provision of new high efficient burners on furnace C3.
5.2. Implementation of a SPM (puls vibration system) for all factory motor bearings and integration in Plants Energy Monitoring System (about 3,000 motors)
5.3. Automation of all 10 furnaces with digital controllers.
5.4. STIROM has overall changes in energy management practices do to monthly increase in energy price and do to market competition.
5.5. At the moment STIROM started another Integrated Energy Efficiency Program with Phare (EU)
5.6. After implementation of the USAID/CEM program the baseline plant wide energy consumption will be:

<table>
<thead>
<tr>
<th>S.N.</th>
<th>ENERGY</th>
<th>U/M</th>
<th>QUANTITY INITIAL</th>
<th>QUANTITY AFTER</th>
<th>% PLANT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Production (melted glass)</td>
<td>To</td>
<td>150.000</td>
<td>165.000</td>
<td>10 %</td>
</tr>
<tr>
<td>2.</td>
<td>Electricity</td>
<td>MWH</td>
<td>48.000</td>
<td>45.286</td>
<td>5.65 %</td>
</tr>
<tr>
<td>3.</td>
<td>Natural Gas</td>
<td>SCM</td>
<td>55.000.000</td>
<td>54.550.000</td>
<td>1 %</td>
</tr>
<tr>
<td>4.</td>
<td>Hot Water imported</td>
<td>GJ/H</td>
<td>1.5</td>
<td>0.75</td>
<td>50 %</td>
</tr>
</tbody>
</table>
6.0. Recommendations

6.1. Installation of a higher efficient heat exchanger on fuel gas heat recovery system and cancelation of the imported Hot Water.
6.2. Replacing of reciprocating Resita air compressors with dry compressors.
6.3. Provide ASD on all 75 KW motors and I.D.Fans after commissioning of the USAID ASD’s.
6.4. Modernise I.S. Molding Machines reducing as much possible air compressed usage, providing ASD’s etc.
6.5. Optimise combustion on all furnaces checking O₂ contents with fixed analysers on large furnaces (five) and with a portable analyser on small furnaces and kilns.
6.6. Installation of all sensors for measuring points on natural gas, compressed air, KWH and Completion of Energy Monitoring System.
6.7. Replacing Alcatel low efficient air compressors do to out of life cycle.
6.8. Redisign glass furnaces based on high energy efficiency and longer life cycle of the refractories.
6.9. Redisign engraving heat system with an UV System and elimination of the heat consumption.

7.0. Significance of the Project

This project was a pilot for Energy Efficiency for CEM, Plant and for glass factories in Romania. After the experience gained pilot measures can be generalised in STIROM and all another glass factories. The pilot job was a good practical training program for CEM.

In addition we have achieved following major tasks:
- Establishment in Romania of two Association of Energy Engineers - Chapter Bucharest and Chapter Cluj-Napoca. Members of AEE can develop there skil in Energy Efficiency as ESCO’s
- Receiving of a important Energy Efficiency Testing Equipment (by AEE Chapters) being capable with this to performe additional energy audits.

8.0. Appendixes
- Energy Audit Report: summary of the original audit report.
- Energy Efficiency Equipment Specifications including Monitoring Equipment.
- Baseline Energy Consumption Data.
- Monitoring Program Results
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   1.2 Recommendation with economics

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   2.3 Expectations

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   7.3 Converting ideas into recommendation actions
      A1. Put efficiency teams in action to reduce energy losses
      A1.1 Reduce energy losses by cogbelts (USAID)
      A2. Reduce compressed air losses
      A2.1 Reduce compressed air losses with ultracrobe tester, ultracrobe.com, air control system of Rand compressors and providing anubar flowmeters
A3. Reduce heat losses on gas fired furnaces and heat treatment ovens
A3.1 Reduce heat losses with I.R. non-contact thermometers -45 to 550°C and I.R. pyrometers 600-3000°C (USAID LIST1)
A3.2 Reduce heat losses by repairing refractory work by work by a suit for not work and by providing insulation blanket for crown of glass furnace
B1 Improve heating systems of the plant buildings
B2 Improve combustion efficiency at gas fired furnaces
B2.1 Improve combustion eff. at gas fired furnaces providing instruments calibration (USAID LIST 1)
B2.2 Improve combustion eff. at gas fired furnaces providing high eff burners, digital controllers with PC computer and variable FR. drive on furnace FD.Fane. (USAID-LIST2).

8.0 IMPLEMENTATION PLAN
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9.0 CLOSING MEETING WITH PLANT (Preliminary Results)
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  10.5 Ceramic fibre plates for blanketing of wells of furnaces C-1 and C-2, supplier PROCEA, Bucharest.
  10.6 Specification for redesigning glass melting furnace 6-1 at STIRCM Plant.
  10.7 LIST NO 1 of Equipment for STIRCM.
  10.8 LIST NO 2 of Equipment for STIRCM.
  10.9 LIST NO 3 Approved by STIRCM Management.
  10.10 Readings from electrical system.

BEST AVAILABLE COPY
Inventory for shipment  
19 December, 1994  
Consignee:  
STIROM S.A.  
Str. Theodor Pallady 45  
725291 Bucharest, sector 3  
Romania  
Attn.: Mr. Mihai Popescu  
Phone: 40-1-312-90-23

<table>
<thead>
<tr>
<th>Qty</th>
<th>Item</th>
<th>Description</th>
<th>Manufacturer</th>
<th>Part #</th>
<th>Unit Price</th>
<th>Total Price</th>
</tr>
</thead>
<tbody>
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<td>1</td>
<td>Infrared pyrometer</td>
<td>Mikron</td>
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On behalf of Stirom, I acknowledge receipt of the equipment listed in the above table.

**Signature:**

**Name:**

**Title:**

**Date:**
## ENTERPRISE ANUAL ENERGY PROFILE YEAR: 1994 FACILITY: STIROM

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<th>Fuel gas Quantity</th>
<th>Fuel gas GJ</th>
<th>Fuel gas USD</th>
<th>Total energy GJ</th>
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<td>199658</td>
<td>4759</td>
<td>169340</td>
<td>425016</td>
<td>183715</td>
<td>624674</td>
<td>12455</td>
<td>4.03</td>
</tr>
</tbody>
</table>

**Notes / conversion factors**

1 Mwh = 3.6 GJ USD/Mwh, 13.89 USD/GJ

Energy electricity

| Cost | 35.58 GJ/1000Nm³ - 70% imported
|      | 0.0893 USD/Nm³ - 76 USD/1000 Nm³ - 30% local
| 2,51 USD/GJ * 324 USD/To production

Natural Gas
Industrial Energy Efficiency Monitoring and Evaluation Program
for the Equipment Installed at STIROM in Framework
of the USAID Monitoring Program

Review of Project Information.
The consultant ARCON SRL has reviewed the informations to gain insight as to specific energy efficiency measures that were conducted at STIROM Bucharest, Romania. The conclusions are as following:
- original audit report prepared by consultant is valid
- the Baseline energy consumption, operating and maintenance cost, and general plant operating informations that was available before the energy efficiency measures were implemented were reviewed.
- consultant gathers the informations connected with specific energy efficiency equipment that was commissioned or will be.
- energy efficiency was recalculated taking in consideration:
  - offshore procurement cost
  - customs duties and taxes
  - installations cost
  - commissioning and training cost
  - ancilliary production cost
  - cost of new spare parts and materials
  - post installations data costs as energy, maintenance and operation, changes in production.

Development of the “Draft Monitoring Program”
The “Draft Monitoring Program” was elaborated with plants cooperations as following:
- Mr. Dumitrescu Mircea for electrical and compressed air installations
- Mr. Gerea Iulian for heat recovery heating and natural gas installations
- Mr. Stanga Gheorghe for instrumentation
The contents of the monitoring program:
The baseline for energy and production that were present before the beginning of USAID/CEM energy efficiency program are shown in “Appendix”

Phase I of USAID
STIROM had some energy efficiency efforts already in progress. The energy consumption and production records are kept in Energy Department.
Under USAID energy efficiency program an audit was performed and several opportunities were established which were splited in two phases:
Phase I for NO COST or extreme low cost action in general connected with general Energy Management and implementation of some testing equipment - See “Appendix”.
Phase II for short term, low cost energy efficiency and productivity improvement projects (payback of less than 3 years).
Expected results are in Energy Efficiency report at STIROM Bucharest Plant.
The Expected results without process changes are up to 20% - energy savings

1. Current status
1.1. Action 1. IR Pyrometer portable for 0-1,600°C and one IR Thermometer 0-550°C were provided.
The equipments are most valuable operation tool. Immediatelly it was commissioned and no more actions are needed to yield the full savings.
Plant is looking to generalyze IR Pyrometer Technique.

1.2. Action # 2. Supercalibration porable for instrumentation. Equipment was commissionned and is an valuable tool for operation. No mor actions are needed to yield the full savings.
1.3. Action # 3. COG Belts.
Belts are working in good conditions. Motor speed is low and there were not special problems to yield the potential saving.

1.4. Action # 4. IR Pyrometer fixed type.
Pyrometer was installed in worst operation position Melting Bath on C7 furnace. Pyrometer is giving full satisfaction to the operators and this technic will be generalised on all furnaces.

1.5. Action # 5. Combustion controll on C3 furnace with an oxygen analyser was installed and other few days was disconected.
The conclusion is that AMETEK equipment is necessary to be completed with gas calibration ballon, an UPS ( uninterruptted power source ) which are already oriented at Bucharest.

2. Planed dates for not installed and commissioned equipments
2.1. All equipment is in STIROM's hands, inspected and ready for installation. The difficulties are that Plant can’t be stopped immediately and to be ready for our job. The dates given below are realistic but not so sure.

2.2. Adjustable speed drives 22 KW and 75 KW. Equipment come in May, 1996 :
- installation up to 30.11.1996
- commissioning up to 30.11.1996

2.3. Installation of the flowmeters :
- gas flowmeter on C3 - installed
- compressed air flowmeters :
  - Resita compressors - up to 30.01.1997
  - Centac compressors - up to 30.01.1997
  - Alcatel compressors - up to 30.01.1997
2.4. Energy Monitoring System
- PC (Q-NET) in working position,
- DAQ - (Imperial) in working position
- electrical connections 6KV, kwh - meters are 90% installed completed (supply feeders are ready, compressor feeder are ready)
- training 75% ready
- O&M will connect oxygen analyser to PC by serial connection RS 485, available, up to 15.01.1997.
I was ensured by Mr. Dumitrescu Mircea that up to 30.02.1997 all equipment will be commissioned (There are production problems)

3. Planned methodology to evaluate the energy savings produced by measures
3.1. All savings due to new equipment installed at C3 furnace, will be measured on new gas flowmeters

3.2. IR Pyrometers
Savings will be by engineering calculation and measurements on main flowmeter.

3.3. COG Belts
Individual current measurements are performed on Motor with old belts and motor with COG Belts.

3.4. Compressed air
First of all a production balance of compressed air versus electrical energy consumption is performed. Specific energy consumption Kwh/1 SCM air will reported daily to the management and total electrical energy consumed for compressed air too.
Measures of savings actions will be issued weekly.
Data will be daily on each action.
The plants and USAID equipment will be used.
The responsible person for gathering and validation of data will above mentioned engineers including specific consumption department.
The methodology for evaluation of the results will be as per Hagler Bailly’s instructions already applied in our energy audits.
Industrial Energy Efficiency Monitoring and Evaluation Program
for the Equipment Installed at STIROM in Framework
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The methodology for evaluation of the results will be as per Hagler Bailly’s instructions already applied in our energy audits.
MONITORING & EVALUATION
REPORT
MATIZOL
MONITORING AND EVALUATION REPORT FOR THE EQUIPMENT INSTALLED AT MATIZOL MANUFACTURER OF INSULATION MATERIALS LOCATED IN PLOIESTI, ROMANIA

PREPARED BY: MIHAIL ZDRAVCU, CEM

ROMANIA ENERGY EFFICIENCY MARKET DEVELOPMENT PROJECT
USAID - EAST EUROPEAN REGIONAL ENERGY EFFICIENCY PROJECT CONTRACT EUR-0300-C-00-2053-00
EXECUTIVE SUMMARY

1.0 Background
The USAID Industrial Energy Efficiency Project in Romania has assisted privat Certified Energy Managers (CEM’s) in developing an energy service company practice and this bring needed energy consulting services to Romanian industrial entreprises. The program consisted of four principal activities:

1. Training in energy efficiency for privat sector energy service to industry firms (ESCO’s) seeking to provide services to industry, which included: management, accounting, economics, finance, energy audit techniques, industrial management, maintenance, marketing and management for energy efficiency services companies. Included in training was the establishment of two Romanian Chapters of the US Association of Energy Engineers.

2. Energy management programs in 8 industrial entreprises. Each program included advice in energy management from Romanian and US experts, an energy audit report, and a package of US industrial energy efficiency equipment. Each industrial entreprise that agreed to participate in the program has paid a market oriented fee to the Romanian consultants for the services.

3. Conference and exhibition on industrial energy management in association with the US Association of Energy Engineers (US and Romanian Chapters).
This tasks was concerned primarily with conducting a monitoring and evaluation program for MATIZOL which participated in the Energy Efficiency Program in Romania.

2.0 Plant description
Located in Ploiesti, MATIZOL manufactures insulation material. Two thousand employees work in this 50 years old facility. The main sections are: glass and mineral wool furnaces, fiber glass felt heat treatment, weaving, cardboard machines, bitumen preparation, etc. Steam is purchased from the neighbouring refinery. Natural gas is used in glass furnaces and heat treatment, etc.
Plant annual consumption (and 1994 European energy costs):
- Electricity: 21,000 MWH, $1,050,000 excluding demand ($50/MWH)
- Natural gas: 16,000 SCM, 575,000 GJ; $1,725,000 ($3/GJ)
- Purchased steam: 125,000 Tonnes, $1,250,000 ($10/To)

3.0 Description of the project
During the course at audit the Romanian auditors and Hagler Bailly and ETSI’s advisors identified several projects and agreed with MATIZOL to request USAID’s support for funding. The project has two phases:
3.1. Phase I

Action 1. Control ANALYSER
Action 2. Infra-red Pyrometer and Infra-red Thermometer
Action 3. Ultrasonic Leak Detector
Action 4. Demonstration COG Belts
Action 5. Demonstration Steam Traps

Action 1. Combustion Analyser

Existing conditions:
There are nine glass furnaces at MATIZOL (5 for mineral wool products, and 4 for fiberglass felt), plus seven furnaces for bitumen preparation. Air/fuel ratio is adjusted manually, based on flame color and Orsat tests. Testing conducted on 9 of these gas-fired furnaces showed that excess oxygen ranged from 5% to 11.5% and averaged 10.5%. Stack temperature was around 750°C for the mineral wool furnaces, 400°C for the glass stick furnaces, and 130°C for bitumen heating. If air/fuel ratio was properly adjusted to obtain 2% excess oxygen on all of these furnaces, efficiency gains would average 8-10% on the mineral wool furnaces, 4% on the glass stick furnaces, and 2% on the bitumen heating.

Recommended action:
Supply a portable combustion analyser so that MATIZOL can keep boiler combustion tuned optimally by performing regular combustion analyses.

Cost of equipment:
$5,000 (funded by USAID)

Cost of installation:
$0 Portable equipment
$500 for O&M

Benefits, energy savings (and economic savings):

<table>
<thead>
<tr>
<th>Furnace type</th>
<th>Achievable Improvement</th>
<th>Conservative Estimate</th>
<th>Baseline (GJ/year)</th>
<th>Savings (GJ/yr)</th>
<th>Savings ($/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mineral Wool</td>
<td>10%</td>
<td>2%</td>
<td>250,000</td>
<td>5,000</td>
<td>15,000</td>
</tr>
<tr>
<td>Glass Sticks</td>
<td>4%</td>
<td>1%</td>
<td>130,000</td>
<td>1,300</td>
<td>3,900</td>
</tr>
<tr>
<td>Bitumen</td>
<td>2%</td>
<td>0.5%</td>
<td>130,000</td>
<td>650</td>
<td>1,950</td>
</tr>
<tr>
<td>TOTAL</td>
<td>5.5%</td>
<td>1.4%</td>
<td>510,000</td>
<td>6,950</td>
<td>20,850</td>
</tr>
</tbody>
</table>

Savings are measured on main gas flowmeter, Baseline being 16,000,000 SCM.
The payback period:
Less than a year.

**Action 2. Infra-Red Thermometer and Pyrometer**

Existing conditions:
1) Many steam pipes are not insulated or have any deteriorated insulation;
2) Refractory bricks of furnaces deteriorate gradually and need to be monitored;
3) Thermocouple temperature measurement in the furnaces should be verified with other measuring methods.

Recommended action:
Supply infra-red temperature measurement equipment covering the temperature range from ambient to 1,600°C to measure both installation, refractory and melted glass, so that MATIZOL can perform on-going insulation maintenance and upgrades, and better adjust temperature parameters in the furnaces:
- Infra-red pyrometer (approx. 400-1,600°C);
- Infra-red thermometer (approx. 0°C to 400°C).

Cost of equipment:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Cost</th>
<th>Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pyrometer</td>
<td>$2,500</td>
<td>(funded by USAID)</td>
</tr>
<tr>
<td>Thermometer</td>
<td>$750</td>
<td>(funded by USAID)</td>
</tr>
</tbody>
</table>

Cost of installation:

<table>
<thead>
<tr>
<th>Cost</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
<td>Portable equipment</td>
</tr>
<tr>
<td>$5,000</td>
<td>Initial implementation of measures (insulation)</td>
</tr>
<tr>
<td>$1,000</td>
<td>Annual maintenance on measures</td>
</tr>
</tbody>
</table>

Benefits, energy savings (and economic savings):
- Steam savings of 0.5%: $6,250 per year  
  \[0.5\% \times 125,000 = 625 \text{ To}\]
- Gas savings of 0.25%: $4,250 per year  
  \[0.25\% \times 16,000,000 = 40,000 \text{ SCM}\]

Savings are measured at main gas flowmeter.

Payback period:
Less than a year.

**Action 3. Ultrasonic Leak Detector**

Existing conditions:
The plant produces about 50,000,000 Nm3 of compressed air per year, with associated electricity usage of 4,300 Mwh/year or $215,000 per year.

Based on a comparison of compressed air production and estimated plant-wide compressed air balance, it is estimated that compressed air leaks represent more than 40% of the total.
Recommended action:
Supply a portable ultrasonic leak detector, so that MATIZOL can perform on-going detection and maintenance of compressed air leaks. Although this equipment can also be used to detect steam leaks, the savings below are estimated based only on compressed air usage reduction.

Cost of equipment:
$600 (funded by USAID)

Cost of installation:
- $0 Portable equipment;
- $1,000 Initial implementation of measures;
- $200 Annual maintenance on measures.

Benefits, energy savings (and economic savings):
Compressed air savings of 5% (or 10% of estimated leaks);
215,000 Kwh/year: $10,750/year. Saving are measured at main gas flowmeter.

Payback period:
Less than a year (0.17 years)

Action 4: Demonstration COG Belts

Existing conditions:
The plant uses Romanian V-belts which are poor quality and have a short life. Based on the recommendation of the audit team, the plant expressed interest in trying COG V-belts, which provide both a longer belt life and better efficiency through reduced slippage. A V-belt audit of MATIZOL identified more than 1,200 installed belts, with installed electric power of 1,800 KW.

Recommended action:
Provide a set of COG V-belts to serve as demonstration for the technology. The following was selected:
(36) 1,500x13x8;
(44) 1,700x17x11.

Cost of equipment:
$400 (funded by USAID)

Cost of installation:
- $500 Replacement on normal schedule;
- $200 Annual price premium on replacement belts.
Benefits, energy savings (and economic savings):
12 sets (@ 3 belts/set) x 5.5 KW x 7 load factor x 8.000 h/yr x 1.5% eff. = 5,544 KWh
11 sets (@ 4 belts/set) x 7.5 KW x 7 load factor x 8.000 h/yr x 1.5% eff. = 7.161 KWh
Total 12,705 KWh/year - $635/year.
Savings are measured at main KWH meter.

Payback period:
1.7 years.

Action 5. Demonstration Steam Traps

Existing conditions:
The plant has 117 steam traps installed, out of which 50 are failed.

Recommended action:
Provide a set of steam traps to demonstrate the reliability and energy savings potential of high-quality US steam traps. The following was selected:
1 t/h nominal flow, 10 bar pressure differential, traps for cardboard machines.

Cost of equipment:
$1,500 (funded by USAID)

Cost of installation:
$3,500 Installation by MATIZOL;
$1,000 O&M.

Benefits, energy savings (and economic savings):
The steam loss is only 10% of the nominal flow:
3 traps x 1 t/h x 10% flow x 8,000 h/y x $10/to = $24,000 2,400 To/year
Savings are measured at main steam flow meter.

Payback period:
Less than three months. (0.2 years)

3.2. Phase II
Action 1: Automation of One Glass Furnace

Existing conditions:
Instrumentation of furnaces is poor, with manual control of the principal parameters (air, air/fuel, pressure, temperature, glass level...). Lack of appropiate furnace pressure control is the cause of hot air exhaust through the refractory. Inaccurate temperature and level controls contribute to a very high rate of rejects and remelting. (20%)
**Recommended action:**
Install furnace pressure controls, ceramic thermocouple protection tubes, glass level dipping probe, 6 digital controllers, and a computerized supervision system. It is expected that natural gas savings of over 12.5% can be achieved, per unit of useful output. The proposed computerized supervision system will also be used for a second furnace, when the plant replicates this efficiency measure to another glass furnace located nearby.

**Monitoring:**
Install one glass flowmeter on the individual furnace. In addition to allowing savings verification, a gas meter will allow improved energy management on the furnace.

**USAID Cost:**
$36,000

**Plant Cost:**
$10,000 Installation and local material cost.
$1,600 O&M

**Benefits, energy savings (and economic savings):**
Baseline gas consumption for furnace; 1,000,000 Nm3/yr
Gas savings (at 12.5%): 125,000 SCM; $13,750/year, per unit of useful output.
Saving by increasing production: 360 T0/year, $50,000. Energy saving will be measured at C3 furnace gas flowmeter connected to the Energy Monitoring System.
No savings are counted for the fact that the proposed system can be extended to a second furnace at reduced cost.

**Payback period:**
0.75 year.

**Action 2: High Efficiency Burners on One Glass Furnace**

**Existing conditions:**
Burners are old and do not permit correct adjustment of combustion parameters.

**Recommended action:**
Install new hot air burners. The new burners will allow a better adjustment of the flame to the specific operating conditions of the furnace. In particular, the flame length will be more adjustable to the furnace dimensions. The new burners will also provide more flexibility in adjusting to low firing rates, and, with high efficiency mixing nozzles, will allow lower air/fuel ratios than the existing burners. In addition to energy savings (evaluated at 8%), the new burners are expected to provide greater reliability, leading to improved furnace performance and fewer production interruptions.
Monitoring:
Use the gas flowmeter installed on the individual furnace as part of monitoring of the furnace automation measure.

USAID Cost:
$31,000

Plant Cost:
$5,000

Benefits, energy savings (and economic savings):
Baseline gas consumption for furnace: 1,000,000 Nm³/year
Gas savings (@8%): $8,800 per year.

Estimated payback period:
4.1 years.

4.0. Summary of the results for all energy efficiency measures
The USAID grant of $77,750 in equipment for MATIZOL and with own cost of $25,200 investment and $4,300 in O&M, savings of $139,285/year can be obtained, payback period being 0.76 years.

<table>
<thead>
<tr>
<th></th>
<th>USAID</th>
<th>MATIZOL</th>
<th>O#M</th>
<th>SAVINGS</th>
<th>ENERGY</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHASE I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Action # 1</td>
<td>5.000</td>
<td></td>
<td>500</td>
<td>20.850</td>
<td>200,000SCM</td>
</tr>
<tr>
<td>Action # 2</td>
<td>3.250</td>
<td>5.000</td>
<td>1.000</td>
<td>10.500</td>
<td>40,000SCM</td>
</tr>
<tr>
<td>Action # 3</td>
<td>600</td>
<td>1.000</td>
<td>200</td>
<td>10.750</td>
<td>715,000KWH</td>
</tr>
<tr>
<td>Action # 4</td>
<td>400</td>
<td>700</td>
<td></td>
<td>635</td>
<td>12.705KWH</td>
</tr>
<tr>
<td>Action # 5</td>
<td>1.500</td>
<td>3.500</td>
<td>1.000</td>
<td>24,000</td>
<td>2,400To-Steam</td>
</tr>
<tr>
<td>PHASE II</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Action # 1</td>
<td>36.000</td>
<td>10,000</td>
<td>1.600</td>
<td>63.750</td>
<td>125,000SCM</td>
</tr>
<tr>
<td>Action # 2</td>
<td>31.000</td>
<td>5,000</td>
<td></td>
<td>8.800</td>
<td>80,000SCM</td>
</tr>
<tr>
<td>TOTAL $ US</td>
<td>77,750</td>
<td>25,200</td>
<td>4,300</td>
<td>139,285</td>
<td></td>
</tr>
</tbody>
</table>

5.0. Actions Taken by MATIZOL by Own Investment Funding

5.1. Building and commissioning of a new production line for cardboard (new process)
5.2. Redesigning of feeders on two glass sticks furnaces
5.3. Reduction of leaks (steam and air) and repairing of all piping and valves thermal insulation
After implementation of the USAID/CEM program the Baseline plant wide energy consumption will be:

<table>
<thead>
<tr>
<th>S.N.</th>
<th>ENERGY</th>
<th>U/M</th>
<th>QUANTITY INITIAL</th>
<th>QUANTITY AFTER</th>
<th>% /PLANT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Electricity</td>
<td>MWH</td>
<td>21,000</td>
<td>20,772</td>
<td>1.08</td>
</tr>
<tr>
<td>2.</td>
<td>Natural gas</td>
<td>SCM</td>
<td>16,000,000</td>
<td>15,555,000</td>
<td>2.8</td>
</tr>
<tr>
<td>3.</td>
<td>Steam</td>
<td>TO</td>
<td>125,000</td>
<td>121,975</td>
<td>2.4</td>
</tr>
</tbody>
</table>

6.0. Recomendations
6.1. Improve of energy management and operation
6.2. Optimise combustion by operation procedures
6.3. Automise all furnaces with digital controllers and develop the existing Monitoring System.
6.4. Provide all new steam traps on steam lines
6.5. Replace Resita compressors
6.6. Provide all energy metering from grid connection to the consumers and connect them to Energy Monitoring System.
6.7. Redesign all furnaces on energy efficiency base.
6.8. Provide new efficient burners on liquid fuel.
6.9. Introduce I.R. Pyrometers in place of T.C.

7.0. Significance of the Project
This project was a pilot for Energy Efficiency for CEM, Plant and for insulation materials factories in Romania. After the experience gained pilot measures can be generalised in MATIZOL and all another insulation materials factories. The pilot job was a good practical training program for CEM.
In addition we have achieved following major tasks:
- Establishment in Romania of two Association of Energy Engineers - Romanian Chapter, in Bucharest and Chapter Cluj-Napoca. Members of AEE can develop there skill in Energy Efficiency as ESCO’s
- Receiving of a important Energy Efficiency Testing Equipment (by AEE Chapters) being capable with this to performe energy audits.

8.0. Appendixes
- Energy Audit Report : summary of the original audit report.
- Energy Efficiency Equipment Specifications including Monitoring Equipment.
- Baseline Energy Consumption Data.
- Monitoring Program Results ( later on )
CONTENT

EXECUTIVE SUMMARY

I. INTRODUCTION

II. ENERGY CONSUMPTION AND PRODUCTION ANALYSIS

III: RECOMMENDATIONS FOR ENERGY EFFICIENCY IMPROVEMENTS

A.1 - Put energy efficiency teams in action to reduce energy losses

A.2 - Reduce air compressed losses

A.3 - Reduce heat loss on gas fired furnaces

B.1 - Improve heating system of the Plant's Buildings

B.2 - Improve combustion efficiency at gas fired furnaces

B.3 - Improve combustion efficiency at 5 furnaces - Oxidation Plant

C.1 - Revamp Plant to improve design

APPENDICES

1. Plant Energy Consumption
2. Monthly Production 1993
3. Production vs. Energy Consumption 1993
4. Natural gas savings available by reducing oxygen to optimum
5. One line diagram of Energy System
6. Annual Energy Cost for steam leak
7. 30 Guidelines for designing and operating compressed air system
8. Steam System Audit
9. Steam Trap Losses
10. Efficiency of the CCG-Belts
11. Annual Energy Profile Year 1993
12. Annual Energy Profile Year 1992
13. LIST NO 1 OF equipment Approved by MATIZOL's Management
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Signature: [Signature]

Name: PETRI VEIGANG

Title: TECHNICAL MANAGER

Date: 04.04.95
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On behalf of Matulz I acknowledge receipt of the equipment listed in the above table.

Signature: 

PETRU VEIGANG

Name: TECHNICAL DIRECTOR

Title: 

Date: 23.07.1996

Hagler Bally Consulting, Inc
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Notes/Conversion factors:
- Electricity: 0,0036 Gj/kwh, 0,05 USD/KWH, 35,58 GJ/1000Nm³
- Natural gas: 2,513 USD/GJ, 89,426 USD/1000Nm³
- Steam: 0,653 Gcal/to, 3,97 USD/GJ, 2,7763 Gcal/to, 16,62 USD/Gcal
- Other steam: 4,186 GJ/Gcal, 10,94 USD/to
Industrial Energy Efficiency

Monitoring and evaluation program for the equipment installed at MATIZOL in framework of the USAID.

Review of Project Information.
The consultant Zdravcu Mihail, CEM has reviewed the informations to gain insight as to specific energy efficiency measures that were conducted at MATIZOL, Ploiesti, Romania. The conclusions are as following:
- original audit report prepared by consultant is valid
- the Baseline energy consumption, operating and maintenance cost, and general plant operating informations that was available before the energy efficiency measures were implemented were reviewed. See "Appendix"
- consultant gathers the informations connected with specific energy efficiency equipment that was commissioned or will be installed.
- energy efficiency was recalculated taking in consideration:
  - offshore procurement cost
  - customs duties and taxes
  - installations cost
  - commissioning and training cost
  - ancillary production cost
  - cost of new spare parts and materials
  - post installations data costs as energy, maintenance and operation, changes in production.

Development of the "Draft Monitoring Program"
The "Draft Monitoring Program" was elaborated with plants cooperations Mr. Zafiu, Energy Manager, and Mr. Veigang Petre, Technical Director.
The contents of the monitoring program:
1. The baseline for energy and production that were present before the beginning of USAID/CEM energy efficiency program are shown in "Appendix"

Phase I:
MATIZOL had some energy efficiency efforts already in progress. The energy consumption and production records are kept in Energy Department.
Under USAID energy efficiency program an audit was performed and several opportunities were established which were splited in two phases:
Phase I for NO COST or extreme low cost action in general connected with general Energy Management and implementation of some testing equipment - See "Appendix"
Phase II for short term, low cost energy efficiency and productivity improvement projects (payback of less than 3-4 years).
The results are in Energy Efficiency report at MATIZOL, Ploiesti, Insulation Materials. The expected results without process changes are up to 19% - energy savings.
1. Current status

1.1. Action 1. IR Pyrometer and IR Thermometer.
One portable digital infra-red pyrometer with standard accessories, including 220V, 50Hz battery charger/adapter with European plug MIKRON, type M 90H. The I.R. Pyrometer is most valuable operation tool. Immediately it was commissioned and is in use. Plant has 3 glass furnaces and 4 mineral wool furnaces, several gas heated ovens, steam insulated pipes, etc., substantial heat being radiated.
The full savings are already achieved and no more actions are needed to yield the full savings. Do to performance of the portable I.R.Pyrometer, the Plant is looking to implement the new technique providing fixed I.R.Pyrometers, especially on feeders temperature measurement. Non contact infra-red temperature indicator, I.R. 550 Dickson type, range 0-500°C. The action was implemented immediately and savings are already achieved and no more actions are needed to yield the full savings.
Non contact I.R. temperature indicator. Dickson 550, 0-500°C is a light portable equipment useful to all operators and maintenance, people.

1.2. Action #2.
Steam traps. Three steam traps 1 t/h were installed and are working successful important saving are already achieved and more actions are needed from the Plant to provide in all points new steam traps in order to yield the potential savings.

1.3. Action #3.
Combustion optimisation with a portable combustion analyser.
It was provided model Bacharach 300 combustion analyser with printer operated, 22V, 50Hz, charger 48.
Extended probe with type K high temperature thermocouple. Model 300 type “K” 10 hose. The combustion analyser has determined most valuable energy savings. A report is submitted to the Plant management with proposed actions for combustion optimisation. The important savings are already achieved but more actions are needed to yield the potential savings like automation of the furnaces.

1.4. Action #4.
Reduction of leaks with Ultrasonic leaks detector.
UE System type 4E-65 portable, was provided. The leak detector is very useful for detection of the compressed air leaks. Sometime in electrical installations contacts temperature were checked successfully hearing the sparks. The action is implemented and operators every day are discovering new fields of application. The savings are already achieved and no more actions are needed to yield the full savings.

1.5. Action #5. COG Belts.
There were 36 pieces, 59,3 x 1/2 x 11/32 and 44 pcs, 66,8 x 21/21 x 7/16, Dayco COG belt provided with good results.
2. Actual or Planned Dates for Glass Furnace. C3 Automation and Burners Installation.
   Furnace C3 is in production and Plants management do not agree to be shuted down for our job.
   The hard production season is up to december.
   2.1. The equipment is in Plant’s hands.
   2.2. Gas flowmeter was installed
   2.3. Controllers panel and control rooms boot will be installed up to 30.01.1997
   2.4. Commissioning on cold status of the PC, DAQ and Imperial Soft including operators training is ready installed
   2.5. Installation of the PC, DAQ and Monitoring System will be performed up to 30.01.1997
   2.6. Installation of the field equipment and pertaining network will be ready up to 30.03.1997
   2.7. Commissioning up to 30.03.1997.

3. Planned methodology to evaluate the energy savings produced by the measures
   3.1. Natural gas saving do to applying of I.R.Pyrometer and combustion gas analyser will be measured on Plants general flowmeter and on bills, compared with production. The measurement are daily.
   3.2. Savings on steam traps will be measured on general flowmeters of the Plant.
   3.3. Reduction of leaks (air and steam) will be calculated by operation
   3.4. Savings on C3 furnace (gas, electricity, compressed air) will be measured on flowmeters and KWh-Meter through Daq and PC. Actual consumption will be measured before commissioning of the USAID equipment.
   Frequency of the data will be daily/weekly.
   Instrumentation equipment for measurements will be Plants propriety and USAID.
   The responsability for gathering calculations the data will be Plants Consumption Division responsibility.
   Some data will be based on engineering calculations (production versus energy consumptions for one, two or three months).
MONITORING & EVALUATION REPORT
BORSA HOSPITAL
1.0 OBJECTIV DESCRIPTION

Borsa City Hospital is a 600 -bed hospital built 10 years ago, which serves a mountainous region to the North of the country. The Hospital purchases electricity from RENEL, the utility and uses light fuel oil to fire steam and hot water boilers. Steam is considered to be a technological utility and it is used for sterilization, in the laundry and in the kitchen. Hot water is used for space heating and domestic hot water preparation through water - water heat exchangers.

1.1 INITIAL CONDITIONS
Before the start of USAID / C.E.M. Energy Efficiency Project, based on Hospital's statistics and on the energy audits results, the baseline for 1993 physical energy consumption were (at 1994 European market prices, excluding taxes)
- electric energy: 934 MWH at US $ 46,700 price
- fuel oil: 719.578 tones (780.453 liters equivalent to 28.203.00 GJ/y) at US $ 71.958 price
which from 324.752 tones (352.225 liters equivalent to 12.730.50 GJ/y) at US $ 32.475 price were used for heat steam production and 394.826 tones (428.228 liters equivalent to 15.472.50 GJ/y) at US $ 39.483 price were used for hot water and domestic hot water production

OBS. The fuel oil usage it should have been huge that it was, due to budget and financial reasons, considering that the thermal energy production covered only just 20% the real space heating demand.

2.0 SUMMARY OF ACTIVITIES
2.1 The scope of contract between Borsa City Rehabilitation Hospital and ECO - ERG was to identify and to implement energy efficiency solutions in:
- thermal energy generation process
- thermal energy distribution
- thermal energy usage at end users
- electric energy usage

2.2 During USAID / C.E.M. Energy Efficiency Project, through HAGLER BAILLY CONS.,INC. assistance, at Borsa City Rehabilitation Hospital were recommended the following actions:
   a) In Boilers House
   a1) to meter the feed water
   a2) to adjust the boilers burning efficiency by using a portable gas combustion analyzer
   a3) to reduce the boilers fuel usage and the boilers maintenance costs by installing an economizer based on fuel aditivation and on catalytical fuel burning (using the ECOBIK system)
   a4) to preheat the fuel
   a5) to meter the fuel usage
   a6) to meter the steam and the steam heat production
   a7) to meter the hot water and the hot water heat generation
   a8) to monitor the fuel usage, the steam and steam heat content production and the hot water, including the hot water heat content
a9) to replace the steam traps and to recover the steam wastes by reinstalling the condensate recovering system
a10) to change the steam boilers burners with performant burners
a11) to change the domestic hot water generation system by using performant steam to water heat exchangers, instead of out of fashioned hot water to water heat exchangers in scope to maintain the hot water boiler for spaces heating and to domestic hot water generation with lowest fuel usage
a12) to analyze the dissolved solids in water and to improve the water feed system by using a portable dissolved solids meter and perhaps to change the actual water source with another one
b) regarding the thermal energy distribution
b1) to reduce the thermal energy wastes by changing the thermal distribution piping systems
c) regarding the thermal energy usage at the end users
c1) to reduce the thermal energy wastes through the hospitals building "envelope" by walls, doors and windows insulation
c2) to install on each radiator automatic thermostating valves
c3) to replace the steam traps
d) regarding the electric energy usage
d1) to replace the electric meter with a performant one with time switcher and to connect through a data logger at the monitoring system (the electric meter is located in the high voltage room)
d2) to meter the electric energy consumption on each building, by installing electric meters and to connect them to the monitoring system
d3) to replace the lighting incandescent and fluorescent fixtures with performant fixtures
d4) to replace the electric motors with performant ones

2.3 ECO-ERG auditor and HAGLER BAILLY CONSULTING, INC. advisor, with BORSA CITY REHABILITATION HOSPITAL agreed, implemented in Phase I of the project, through USAID Supports the following actions:
1. Steam traps replacement at the thermal energy end users
2. Boilers burning adjustments by a portable combustion gas analyzer
3. Metering the hot water and hot water heat generation and the fuel usage

In Phase II of the project were implemented the following actions:
4. Changing the domestic hot water generation system from hot water / water heat exchangers to steam/water heat exchangers tip Armstrong Flo Rite instantaneous heat exchangers
5. Energy management system including:
   Metering:
   - electric energy meter replacement in Hospitals high voltage room
   - the steam and steam heat production
   - the domestic hot water and domestic hot water heat production
   and monitoring through data acquisition system and a P.C. the followings:
   - electric energy consumption
   - fuel usage
   - steam and steam heat production
   - hot water and hot water heat production
   - domestic hot water and domestic hot water heat production

2.4 The Hospital has already implemented by their proper efforts the following actions:
- installs on one steam boiler an ECOBIK fuel economyzer
- installs on the feed water pipe line a water flow meter
- installs a new steam/water instantaneous heat exchanger for domestic hot water preparation
- reinstall the condensate recovery system
- replaced the whole windows at a floor (5th floor, pediatric section)
- insulated a few inside rooms walls
- bought heat pumps to create an alternative heat generation system
2.5 Major dates regarding the program implementation
- Audits 1993 - 1994
- Delivery of equipment Phase I 1995
- Phase II 1996
- Installation and commissioning 1995 - 1996
- Monitoring 1996

3.0 Energy Efficiency Implemented Measures with USAID supports

PHASE I

<table>
<thead>
<tr>
<th>Action</th>
<th>Annual savings</th>
<th>Costs</th>
<th>Pay-back</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fuel oil</td>
<td>Energy cost</td>
<td>USAID</td>
</tr>
<tr>
<td></td>
<td>($ 100 / metric</td>
<td>($</td>
<td>$</td>
</tr>
<tr>
<td></td>
<td>ton )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steam traps replacement at thermal energy</td>
<td>58.455</td>
<td>5.845</td>
<td>707</td>
</tr>
<tr>
<td>end users</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boilers burning adjustment by a portable</td>
<td>20.505</td>
<td>2.050</td>
<td>1,147</td>
</tr>
<tr>
<td>gas comb. Analyzer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metering the boilers fuel usage and the</td>
<td>57.934</td>
<td>5.793</td>
<td>6.179</td>
</tr>
<tr>
<td>hot water and hot water heat production</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL SAVINGS</td>
<td>136.894</td>
<td>13.688</td>
<td>8.033</td>
</tr>
<tr>
<td>Existing consumption</td>
<td>719.578</td>
<td>71.958</td>
<td></td>
</tr>
<tr>
<td>Percent savings</td>
<td>19</td>
<td>19</td>
<td></td>
</tr>
</tbody>
</table>

* REMARKS

DUE TO MALFUNCTION OF THE FUEL METERS FOR THE STEAM BOILERS (FOR ROMANIAN HEAVY FUEL OIL TIP) THE MEASUREMENTS FOR FUEL OIL SAVINGS AND MONEY SAVINGS WERE MADE BY DIRECT VOLUMETRIC MEASUREMENTS USING THE DAILY FUEL OIL TANK. THE FUEL AND MONEY SAVINGS FOR THE HOT WATER BOILER WERE MADE BY DISPLAY DATES READINGS FOR FUEL USAGE ON THE FUEL METER. THE HOT WATER AND HOT WATER HEAT PRODUCTION WERE MADE BY READING THE HEAT FLOW METER DISPLAYED DATES.
### PHASE II

<table>
<thead>
<tr>
<th>Action</th>
<th>Annual savings</th>
<th>Costs</th>
<th>Pay-back</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric Energy</td>
<td>Heavy Energy</td>
<td>Energy Savings</td>
<td>USAID costs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>[ $ 0.05 / KWh]</td>
</tr>
<tr>
<td>Installing new steam / water instantaneous heat exchangers</td>
<td>52,743</td>
<td>127,881</td>
<td>15,425</td>
</tr>
<tr>
<td>Energy management system</td>
<td>289,540</td>
<td>43,516</td>
<td>18,829</td>
</tr>
<tr>
<td>Total savings</td>
<td>342,283</td>
<td>171,397</td>
<td>34,254</td>
</tr>
<tr>
<td>Existing consumption</td>
<td>934,000</td>
<td>719,578</td>
<td>118,658</td>
</tr>
<tr>
<td>Percent savings</td>
<td>36.6</td>
<td>23.8</td>
<td>28.9</td>
</tr>
</tbody>
</table>

### PHASE I ADDED TO PHASE II (TOTAL IMPLEMENTED ACTIONS)

<table>
<thead>
<tr>
<th>TOTAL ACTIONS</th>
<th>Electric energy</th>
<th>Heavy fuel oil</th>
<th>Energy saving cost</th>
<th>USAID costs</th>
<th>Plant cost</th>
<th>Total costs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>[ $ 0.05 / KWh &amp; $ 100 / metric fuel ton]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>[KWh]</td>
<td>[ m. tons]</td>
<td>[ $ ]</td>
<td>[ $ ]</td>
</tr>
<tr>
<td>TOTAL PHASE I</td>
<td>136,894</td>
<td>13,688</td>
<td>8,033</td>
<td>1,550</td>
<td>9,583</td>
<td>0.70</td>
</tr>
<tr>
<td>TOTAL PHASE II</td>
<td>342,283</td>
<td>171,397</td>
<td>34,254</td>
<td>39,460</td>
<td>11,889</td>
<td>51,349</td>
</tr>
<tr>
<td>TOTAL SAVINGS</td>
<td>342,283</td>
<td>308,291</td>
<td>47,942</td>
<td>47,493</td>
<td>13,439</td>
<td>60,932</td>
</tr>
<tr>
<td>Existing consumption</td>
<td>934,000</td>
<td>719,578</td>
<td>118,658</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent saving</td>
<td>36.65</td>
<td>42.84</td>
<td>40.4</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
PHASE I

ACTION 1.
STEAM TRAPS REPLACEMENT AT THERMAL ENERGY END USERS

3.1.1 Initial Conditions
All the steam traps at the hospital’s end users such as laundry, sterilization and kitchen were found defective or by-passed.

3.1.2 Brief description

- Equipment specification
  Steam traps Armstrong Model No 800, Cast iron, inverted bucket steam traps (20 mm) BPST connection and 7/64 inch orifice

- Procurement costs
  Quantity: 12
  Unit price: $58.88
  Equipment price: $707

- Installation costs
  Hospital's costs: $670

- Process changes: steam boilers efficiency improvement

3.1.3 Summary of implementation

- Start-up: October 1995 and the implementation cost was financially supported by the Hospital

3.1.4 Monitoring Methodology and Procedure

The methodology used to evaluate the energy and money savings is based on “bucket meter” method, by measuring the condensate in situation “before” and “after” steam traps replacements. Using the following relations:

\[ \text{DGst} = q \% \times \text{Qst} \times C_f \times o \times 10 \quad \text{[tons / period]} \]

\[ q \% = \frac{\text{Qst}_b - \text{Qst}_a}{\text{Qst}_b} \times 100 \]

\[ \text{DCst} = \text{DGst} \times P_u \quad \text{[$/period]} \]

where:

- \( \text{DGst} \) [tons / period] is the total annual fuel savings
- \( q \% \) is the percentage of steam savings in the condition “before” & “after” steam traps installing
- \( \text{Qst} \) [GJ / period] is the total annual steam heat production
- \( C_f = 35.56 \text{ liter / GJ} \) is the specific fuel consumption for steam heat production as it was in base-line (initial conditions)
- \( o = 0.922 \text{ kg / liter} \) is the fuel density
- \( \text{Qst}_b \) & \( \text{Qst}_a \) [GJ / h] are the hourly steam heat consumption in the situation “before” & “after” in the kitchen steam heat end user
- \( P_u = $100 / \text{fuel metric ton} \) is the heavy fuel oil unit price [$ / metric ton]

\[ \text{DCst} \] [$ / period] is the total annual money savings

3.1.5 Results of measurement and monitoring

The measurements were made hourly and the results were extended for one year period of time.

\[ \text{Qst}_b = 0.806 \text{ GJ / h} \]
\[ \text{Qst}_a = 0.66 \text{ GJ / h} \]
\[ q \% = \frac{0.806 - 0.66}{0.806} \times 100 = 18 \% \]
\[ \text{DGst} = 0.18 \times 9,904.533 \times 35.56 \times 0.922 = 58.455 \text{ tons / year} \]
\[ \text{DCst} = 58.455 \text{ tons / year} \times \frac{100}{\text{tons}} = 5,845 \text{ $ / year} \]

3.1.6 Review of Economics of the Measures

- Energy savings: 58,455 metric tons / year
- Reducing the boilers feed water consumptions and maintenance activities
  * Savings cost: $5,845 / year
  * Implementation cost: $707 USAID costs
  $670 Hospitals costs

**TOTAL** $1,377 measure cost

- Start-up: October 1995
- Pay-back period: 0.24 years
- Estimated pay-back period: 0.73 years
ACTION 4
INSTALLING INSTANTANEOUS STEAM/WATER HEAT EXCHANGERS FOR DOMESTIC HOT WATER PREPARATION (FLO RITE SYSTEM)

3.4.1 Measure justification
The domestic hot water production through hot water/water heat exchangers is an expensive domestic hot water way to produce domestic hot water, with huge fuel usage. Due to these reasons and also for budgetarian reasons, the hospital supports the demand of domestic hot water production with huge financial efforts.

3.4.2 Brief description
* Equipment specification:
  - Two ARMSTRONG INT. instantaneous steam/water heat exchangers, tip FLO RITE model 535
* Procurement costs:
  - Quantity: 2
  - Unit price: $ 10,283
  - Equipment price: $ 20,566
* Installation cost: $ 6,450 (Hospital's financial effort)

3.4.3 Summary of implementation
* Start-up: June 1996. The implementation was made by "ECO-ERG" specialists

3.4.4 Monitoring Methodology and Procedure
The monitoring methodology used to evaluate the energy and money savings is based on the direct measuremets of water/water heat exchangers, which are still on postion, being a reserve system, and of steam/water heat exchangers, by comparing the total fuel and electric energy consumptions for steam boiler and for hot water boiler operating needs, at the similar operating conditions.

The results are calculate using the followings relations:

<table>
<thead>
<tr>
<th>Unit</th>
<th>water / water system</th>
<th>steam / water system</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ GJ / period ]</td>
<td>Q_{ew} = G_{dw} * (H^<em>_{dw} - H^</em>_{csw}) * Tf * 10^-5</td>
<td>Q_{sw} = G_{dw} * (H^<em>_{dw} - H^</em>_{csw}) * Tf * 10^-5</td>
</tr>
<tr>
<td>[ liters/period ]</td>
<td>G_{w} = G_{wh} * Tf</td>
<td>G_{w} = G_{wh} * Tf</td>
</tr>
<tr>
<td>[ GJ / period ]</td>
<td>Q_{w} = Q_{wh} * Tf</td>
<td>Q_{u} = Q_{wh} * Tf</td>
</tr>
<tr>
<td>[ Kwh / period ]</td>
<td>W_{ew} = W_{ewh} * Tf</td>
<td>W_{sw} = W_{swh} * Tf</td>
</tr>
</tbody>
</table>

\[ D_{gw} = (G_{w} - G_{st}) \cdot \rho \cdot 10^{-3} \text{ [t/period]} \]
\[ D_{g} = D_{gw} \cdot T_{f} \text{ (S / period)} \]
\[ D_{we} = W_{ew} - W_{sw} \text{ [kWh/period]} \]
\[ D_{C} = D_{we} \cdot P_{u} \text{ [$/period]} \]
\[ D_{Ct} = D_{C} + D_{Ce} \text{ [$/period]} \]

where

\[ Q_{ww}, Q_{sw} \text{ [GJ/period]} \] is total water quantity produced with the two systems for a year period
\[ G_{dw}, G_{dsw} \text{ [kg/h]} \] - the domestic hot water produced with the two systems, adjustment by mesurements with the ultrasonic portable flow meter
\[ H_{dw}, H_{dsw}, H_{csw}, H_{csw}\text{ [GJ/kg]} \] - the entalphy at water for the two systems, in function of the warm and cold water temperature
\[ G_{wh}, G_{wh}, G_{sh}, G_{st} \text{ [l/period]} \] - the hourly total fuel consumption for steam and hot water boilers, average hourly volumetric measurement for steam boiler
\[ Q_{wh}, Q_{sw}, Q_{u}, Q_{ui} \text{ [GJ/period]} \] - the hourly and total heat production measured for the heat water and for the steam boilers
\[ W_{ew}, W_{sw}, W_{ewh}, W_{sw} \text{ [kWh/period]} \] - the hourly and total electrical consumption for the hot water and steam boilers, measured with electric clamp-on meter
\[ T_{f} = 1,825 \text{ [l/h]} \] - the annual period for 5 hours/ day function of the systems
\[ \rho = 0.922 \text{ [kg/l]} \] - the fuel density
\[ P_{u} = 100 \text{ $/metric ton} \] unit price for fuel
\[ P_{e} = 0.05 \text{ $/kWh} \] - unit price for electricity
Geo Tech fuel flow meter for hot water boilers
Quantity: 2
Unit price: $602
Total price: $1,204

Mc Millan fuel flow meters for steam boilers
Quantity: 2
Unit price: $602
Total price: $1,204

TOTAL PROCUREMENT COST: $6,179

Installation costs: $800 (Hospital's cost)
Process changes: boilers efficiency improvement

3.3.3 Summary of implementation
Start-up of action implementation: July 1996
Implementation made by Hospital's financial efforts

3.3.4 Monitoring Methodology
The Monitoring Methodology used to evaluate energy and money savings are based on direct measurements of specific fuel consumption for hot water generation by the hot water boiler, after a good adjustment, and based on specific fuel consumption taken from the base-line annual statistics, based on the following relations:

\[ \Delta G_{ms} = (q_b - q_a) \times Q_{wt} \times o \times 10^{-3} \] [metric tons / period]

\[ D C_{ms} = D G_{ms} \times P_u \times $/period \]

where:
- \( q_b \) & \( q_a \) [liters / GJ] are the specific fuel consumption for heat production before & after measure (action) implementation
- \( Q_{wt} \) [GJ / period] is the annual heat production by the hot water boiler
- \( G_{bw} \) & \( Q_{bw} \) [liters / GJ] are the fuel usage for periodical heat generation & the periodical heat production as results from the base-line statistics
- \( G_{aw} \) & \( Q_{aw} \) [liters / GJ] are the average value for fuel usage & the heat production measured with the equipments

\[ o = 0.922 \text{ kg / liter} \] is the average heavy fuel oil density

\[ P_u = $100 / \text{metric ton} \] is the unit of fuel

3.3.5 Results of measurements and monitoring
\[ q_b = 428,228 / 10,632.4 = 40.27 \text{ liters / GJ} \]
\[ q_a = 354 / 10.3 = 34.36 \text{ liters / GJ} \]
\[ D G_{ms} = (40.27 - 34.36) \times 10,632.4 \times 0.922 \times 10^{-3} = 57.934 \text{ metric ton / year} \]
\[ D C_{ms} = 57,934 \text{ metric ton / y} \times 100 \times $/\text{metric ton} = 5.793 \times $/y \]

3.3.6 Review of Economics of the Measure
* Energy savings: 57.934 metric ton / year
* Improving maintenance operations
* Savings costs: $5,793 / y
* Implementation cost: $6,179 USAID costs
  $800 Hospital's costs

TOTAL $6,979 implementation cost

* Start-up: July 1996
* Pay-back period: 1.2 years
* Estimated pay-back period: 1.14 years and it was made for all boilers house metering system
The difference between the estimated and real pay-back period is due to the initial estimation which was made for all the boilers house metering
The difference between the estimation and the real pay-back is due to the fact that estimations were made for a higher steam traps unit price.

**ACTION 2**

**BOILERS BURNING ADJUSTMENTS WITH A PORTABLE COMBUSTION GAS ANALYZER**

3.2.1 Justification for measure
The boilers burning adjustments were made by "eye", based on operators experiences only by regarding at the flame and smoke colour.

3.2.2 Action description
* Equipment specification: Portable combustion gas analyzer tip Bacharach model Fyrite II T
* Procurement cost: $1,147 Plant cost: $80

3.2.3 Summary of implementation
The Hospital entered into the possession of the gas analyzer on August 1995, this date being considered the start-up date for action implementation.

3.2.4 Monitoring Methodology
The monitoring plan is based on direct measurements and adjustments of boilers burning efficiency and the value of savings is given by the following relation:

\[ DG_{ca} = Q_{sw} \times \left( \frac{E_{a} - E_{b}}{E_{a}} \right) \times o \times 10^{-3} \]  
\[ DC_{ca} = DG_{ca} \times Pu \]  
where
\[ DG_{ca} \] is the fuel saving by measure implementing [metric tons/year]
\[ Q_{sw} \] is the initial heavy fuel consumption for steam and hot water generation [liters/year]
\[ E_{b}, E_{a} \] are the burning efficiency "before" and "after" the adjustments [%]
\[ Pu \] is the unit price for heavy fuel oil [$/metric ton]
\[ o = 0.922 \text{ kg/liter} \] is the heavy fuel density
\[ DC_{ca} \] is the action money saving [$/period]

3.2.5 Results of measurements and monitoring
\[ DG_{ca} = 780,453 \text{ liter/year} \times 0.922 \text{ kg/liter} \times (0.91 - 0.884) / 0.91 \times 10^{-3} = 20.505 \text{ m. tons/year} \]
\[ DC_{ca} = 20.505 \text{ metric tons/year} \times 100 / \text{metric ton} = 2,050 \text{ $/year} \]

3.2.6 Review of Economics of the Measure
* Energy savings: 20.505 metric tons/year
* Money savings: 2,050 $/y
* Implementation costs: $1,147 USAID costs
* Plant costs: $80

**TOTAL** $1,227 implementation costs
* Start-up: August 1995
* Pay-back period: 0.6 years
* Estimated payback period: 0.65 years
* The difference is due to initial heavy fuel oil savings estimations at the Romanian gas price at the official exchange rate and by the other hand for the action cost estimation
* Other benefits: pollution reductions

**ACTION 3**

**METERING SYSTEM IN BOILERS HOUSE**

3.3.1 Measure justification
In the boilers house there was any performant metering system for boilers fuel usage and for space heating metering.

3.3.2 Action brief description
* Equipment specification:
  - Venturi Heat Flow Meter, including Mass flow computer, quantity: 1 piece
  - Geo Tech fuel flow meters for hot water boilers, quantity: 2 pieces
  - Mc Millan fuel flow meters for steam boilers, quantity: 2 pieces
* Procurement costs:
  - Venturi Heat Flow Meter, including Mass flow computer
    Quantity: 1
    Unit price: $3,771
    Total price: $3,771
### 3.4.5 Results of measurements and monitoring

**Water - water system**

\[ Q_{ww} = 15.200 \times (246.91 - 16.8) \times 1.825 \times 10^{-8} \times 6.383 \text{ GJ/y} \]

\[ (t_{w} = 59 \text{ °C}, t_{c} = 4 \text{ °C}) \]

\[ G_{ww} = 196 \times 1.825 \times 357.700 = 14.950 \times (251.09 - 16.8) \times 1.825 \times 10^{-8} \times 6.383 \text{ GJ} \]

\[ Q_{st} = 120 \times 1.825 = 219.000 \text{ GJ} \]

\[ W_{ew} = 36.7 \times 1.825 \times 10^{-8} \times 66.978 \text{ kWh/y} \]

\[ W_{es} = 7.8 \times 1.825 = 14.235 \text{ kWh/y} \]

\[ D_{Gw} = (357.700 - 219.000) \times 0.922 \times 10^{-3} = 127.881 \text{ t/y} \]

\[ D_{Cw} = 127.881 \times 100 = 12.788 \$ \text{ /y} \]

\[ D_{We} = 66.978 - 14.235 = 52.743 \text{ kWh/y} \]

\[ D_{Ce} = 52.743 \times 0.05 = 2.637 \$ \text{ /y} \]

**Steam - water system**

\[ Q_{sw} = 14.950 \times (251.09 - 16.8) \times 1.825 \times 10^{-8} \times 6.383 \text{ GJ} \]

\[ (t_{w} = 60 \text{ °C}, t_{c} = 4 \text{ °C}) \]

\[ G_{st} = 120 \times 1.825 = 219.000 \text{ GJ} \]

\[ Q_{st} = 3.9 \times 1.825 = 7.118 \text{ GJ} \]

\[ W_{ew} = 36.7 \times 1.825 \times 10^{-8} \times 66.978 \text{ kWh/y} \]

\[ W_{es} = 7.8 \times 1.825 = 14.235 \text{ kWh/y} \]

\[ D_{Gw} = (357.700 - 219.000) \times 0.922 \times 10^{-3} = 127.881 \text{ t/y} \]

\[ D_{Cw} = 127.881 \times 100 = 12.788 \$ \text{ /y} \]

\[ D_{We} = 66.978 - 14.235 = 52.743 \text{ kWh/y} \]

\[ D_{Ce} = 52.743 \times 0.05 = 2.637 \$ \text{ /y} \]

### 3.4.6 Revue of Economics of the Measure

* Electric energy savings: 52,743 kWh/y
* Fuel savings: 127,881 t/y
* Savings cost: $18,062/y
* Implementation costs: $20,566
* USAID costs: $6,450
* Hospital costs: $12,788

**TOTAL**  $27,016 measure cost

* Start-up: June 1996
* Pay-back period: 1.75 years
* Estimated pay-back period: 0.94 years

The difference between the real and estimated pay-back is due to the fact that the estimations were made for other prices, at romanian prices transalte at the official exchange rate at that time.

**ACTION 5**

**ENERGY MANAGEMENT (MONITORING) SYSTEM**

3.5.1 Justification of the measure: any performant system does not exist for monitoring and adjust the thermal and electrical consumptions in the boiler house to reduce the billing and the payments for fuel and electric consumptions. To reduce the billing and the payments it is necessary to know every day, every hour consumptions, to analyze the consumptions and by operating and organization way it will increase the boilers house efficiency.

3.5.2 Brief description

* Equipment specification and procurement costs
  - Data acquisition system (including data logger, monitoring host computer): $8,608
  - Data monitoring and recording system (including P.C., printer an M.O. for Windows '95): $3,279
  - Electric energy meter type ABB AIR 5A (4 tariff): $624
  - Steam energy meter (Kep Massstrol flow computer): $4,046.74
  - Hot domestic water flowmeter (Massstrol flow computer): $2,336.25
* Equipment costs: $18,894
* Installation cost: $5,439

3.5.3 Summary of implementation

* Start-up: November 1996
* Implementation made by "ECO - ERG" specialists and is not yet finished, only monitoring of electric energy being fully implemented.

3.5.4 Monitoring methodology and Procedure

Monitoring methodology used to evaluate energy and money savings is based on direct measurements.
of specific fuel usage for steam heat production average daily electric energy consumptions in the situation "before" and "after" measure implementation.

The situation "before" is calculated with extracted data from the hospital’s statistics from the base-line year.

* Thermal energy savings

\[ DG_s = q_s \times G_{sb} \times \rho \ [\text{ton/period}] \]

\[ q_s [\%] = \frac{(q_{sb} - q_{sa})}{q_{sb}} \times 100 \ [%] \]

\[ q_{sb} = G_{sb} / Q_{sb} [\text{liters/GJ}] \]

\[ q_{sa} = G_{sa} / Q_{sa} [\text{GJ/period}] \]

where

\[ DG_s \ [\text{ton/year}] \] is the total fuel savings for one year period

\[ G_{sb}, \ G_{sa} \ [\text{liters/period}] \] are the total fuel usages in the situation "before" and "after" implementation. For the "after" situation the savings are based on volumetric measurements.

\[ Q_{sb}, \ Q_{sa} \ [\text{GJ/period}] \] are the total heat steam production in the situation "before" and "after" implementation.

\[ q_s [\%] \] - percentage of savings

\[ q_{sb} [\text{liters/GJ}], \ q_{sa} [\text{liters/GJ}] \] are the specific fuel consumptions for steam heat production in the situations "before" and "after"

\[ \rho \ [\text{kg/liter}] \] is the fuel average density = 0.922 kg/l

* Electric energy savings

\[ Dw = q_w \times W_{by} \ [\text{Kwh/period}] \]

\[ q_w = \left( \frac{W_{hb} - W_{hh}}{W_{hb}} \right) \times 100 \ [%] \]

\[ W_{hb} = W_{by} / N \]

\[ W_{ha} = W_{aw} / n \]

where

\[ Dw \ [\text{Kwh/year}] \] is the total electric energy saving for one year period

\[ q_w [\%] \] percentage of electric energy savings

\[ W_{by}, \ W_{hb} \ [\text{Kwh/period}] \] - are the total annual and hourly energy savings in the "before" situation

\[ W_{aw}, W_{ha} \ [\text{Kwh/year}] \] - are the total annual and hourly energy savings in the "after" situation

\[ N, n \] - are the annual and weekly days

* Money Savings

\[ DCws = DGs \times Pu + DW \times Pe \ [\text{$/year}] \]

where

\[ DCws \ [$/year] \] is the total money saving for one year period

\[ DGs \ [\text{ton/year}] \], \ [\text{Kwh/year}] \] are the total fuel and electric energy savings

\[ Pu = 100 \ $ / \text{metric ton}, \ Pe = 0.05 \ $ / \text{Kwh} \] are the unit prices for heavy fuel oil and for electric energy

3.5.5 Results of measurement and monitoring

* Thermal energy savings:

\[ q_{sb} = 352.225 \text{ liters/y} : 9,904.533 \text{ GJ/y} = 35.56 \text{ liters/GJ} \]

\[ q_{sa} = 120 \text{ liters/h : 3.9 GJ/h} = 30.8 \text{ liters/GJ} \]

\[ q_s [\%] = \left( \frac{35.56 - 30.8}{35.56} \right) \times 100 = 13.4 \% \]

\[ DGs = 0.134 \times 352.225 \times 0.922 \times 10^{-3} = 43.516 \text{ tones/year} \]

* Electric energy annual savings

\[ W_{hb} = 934,000 \text{ kwh/y} : 365 = 2,559 \text{ kwh/day} \]

\[ W_{ha} = 12,362 : 7 = 1,766 \text{ kwh/day} \]

\[ q_w [\%] = \left( \frac{2,559 - 1,766}{2,559} \right) \times 100 = 31 \% \]

\[ DW = 0.31 \times 934,000 = 289,540 \text{ Kwh/year} \]

* Money savings:

\[ DCws = 43.516 \text{ tons/y} \times 100 \text{ $/ton} + 289,540 \text{ Kwh/y} \times 0.05 \text{ $/Kwh} = 18,829 \text{ $/y} \]
3.5.6 Review of Economics of the Measure

* Fuel energy savings: 43,516 metric tons / year
* Electric energy savings: 289,540 MWh / y
* Money savings: $ 18,829 / y
* Implementation cost: $ 18,894
  - USAID costs: $ 5,439
  - Hospital’s costs: $ 13,405

TOTAL $ 24,333 measures implementations costs

* Start-up: November 1996
* Pay-back period: 1.29 years
* Estimated pay-back period: 0.4 years

The difference is due to the fact that the action is not yet full implemented.

4.0 Plant-wide results

4.1 Interaction of measures

All the implemented actions are in a strongly interaction due to the fact that only the monitoring and metering system does not produce great economies without the implementation of all the recommended actions mentioned at point 2.

4.2 Summary of results for all the energy efficiency actions mentioned above

Regarding the summarized results for the implemented actions presented in page 3 and 4, we may say that the heavy fuel net reduction is: 308.291 metric tons / year, representing 42.84% fuel savings, which from in PHASE I the net reduction is: 136.894 metric tons / year and in PHASE II the net reduction is 171.397 metric tons / year.

The electric energy net reduction is obtained in PHASE I and is: 342.283 MWh / year, representing 36.65% electric energy net reduction.

The saved money in PHASE I are: $13,688 / y, in PHASE II are: $34,254 / y.

Total money savings in PHASE I and PHASE II are $47,942 / y, representing 40.4% money savings.

4.3 Other improvements at the Hospital’s

- The hospital bought a FLO RITE instantaneous steam/water heat exchanger to assure the demand domestic hot water in the Rehabilitation section. The implementation action value was $15,000.
- The hospital improved the one steam boiler’s thermal efficiency by installing, by their financial efforts, a fuel economizer tip ECOBIK. Implementation action cost: $1,100.
- The hospital’s bought heat pumps to create an alternative heat system production. Investment value $45,000. It is not full implemented.
- Installed a feed water meter. Investment value: $320.
- Reinstalling the condensate recovery system. Implementation action value: $2,800.
- The 5th floor windows replacement. Implementation action value: $42,500.
- The walls inside insulating for a few rooms (demonstrative project).
- The hospital create an energy department to monitor and to manage all the energy efficiency projects in the hospital. The hospital’s energy department is conducted by an A.E.E. member.
- The hospital’s begin to fight to obtain from RENEL 3 units MHC (micro-hidro power stations) in scope to satisfy, at a small price, the proper electric energy demand for the hospital and for the hotels belonging to the hospital.

5.0 Recommendations for maximize the benefits of the equipment

* To implement all the proposed measures mentioned at point 2.
* To improve the operators technical knowledges, regarding the work with the energy efficiency equipment, by organizing training courses with A.E.E. specialists.

6.0 Significance of the project for:

C.E.M. - work methodology improvement
- more about metering systems
- how to make money using the energy efficiency "market"
- how to develop in the future the work under performance contracts
- how to promote energy management concepts at the customers
- how to work in team
- to work for projects implementation as an general contractor
- net-working

11
HOSPITAL - increasing the work with private companies due to the trust in this companies
- has more clear planned activities for the next steps in energy efficiency improvement
- the own operators learned to work with modern and performant equipment and technologies
- encourage the investments in new equipments and technologies

ROMANIA - Promotion of joint ventures with US companies
- Training in project financing and energy audit technologies
- Establishment of an energy efficiency fund
- Expanded C.E.M. certification programs
- Joint Eastern European A.E.E. activities
- Training in demand-side-management
- Training in environmental impact of energy efficiency
- How to organize an energy service company
- Training and support for performance contracts

S.C. "ECO ERG" TEHNOLOGIE SERVICE S.R.L.

GEORGETA PADUREANU, C.E.M.

VASILE GRASIN, C.E.M.
MONITORING & EVALUATION
REPORT
TERAPIA
1.0 PLANT DESCRIPTION
Terapia, located in Cluj Napoca, is a pharmaceutical complex which employs 1,500 workers and produces both finished pills and ingredients for resale. The plant includes different production and conditioning sections, which vary in age from 20 to 80 years. Natural gas is used to generate steam for process applications and hot water for space heating. Small quantities of gas are used for warm air furnaces and laboratory burners.

Before the start of USAID/C.E.M. Energy Efficiency Projects, through Hagler Bailly Cons.Inc. assistance based on the plant statistics and the energy audits results, the baseline for 1993 energy consumptions, at 1994 European energy costs, was:
- electricity 11,338 MWH at US $ 566,900 (excluding taxes)
- natural gas 13,479,000 Ncm (equivalent to 482,508 GJ) at US $ 1,447,523 which from
  - 11,370,613 Ncm (equivalent to 407,033 GJ) at US $ 1,221,102 is used for steam production
  - 829,380 Ncm (equivalent to 29,689 GJ) at US $ 89,068 is used for warm water production and
  - 1,279,007 Ncm (equivalent to 45,785 GJ) at US $ 137,353 are used for other utilities outside of boilers house (the prices for natural gas excludes taxes)

2.0 SUMMARY OF ACTIVITIES
2.1 The scope of contract between TERAPIA and ECO - ERG was to identify and to implement energy efficiency solutions in:
- thermal energy production process in the boilers house
- thermal energy transportation and distribution from the boilers house to the plants, through the pipe distribution systems
- thermal energy utilization in technological processes in each plant
2.2 During USAID/C.E.M. Energy Efficiency Project, through HAGLER BAILY CONSULTING,INC. assistance, at TERAPIA were recommended the following actions:
  a) In Boilers House
     a1) steam traps replacement
     a2) combustion analyzer to improve burning efficiency
     a3) energy metering system
     a4) automated continuous blowdown system
     a5) to equip on steam boiler (tip CR 16/3) with a performant gas burner for low pressure
  b) On the pipe line distribution system
     b1) to replace the used installations on steam and hot water distribution pipe line system
     b2) to short pipe line distribution system, where it is possible
c) Improvements in thermal energy utilization at Calcium Panthotenat I and II plant,
Calcium Atonizer, Calcium Glue plant, Medium Synthesis I and II plants, Medium Synthesis
and opium plant, Glucose and Hormones plants.

1) Steam traps replacement
2) Energy metering system
3) To change the reactors used thermal insulation
4) To change the steam and condensate pipe lines used thermal insulation

2.3 ECO - ERG auditor and HAGLER BAILLY advisor, with TERAPIA agreed, implemented in
Phase I of the project, through USAID supports the following actions:

1. Steam traps replacement in the boilers house

In Phase II of the project were implemented the following actions:

2. Adjustments of boilers burning efficiency by using a portable combustion analyzer
3. Steam traps replacement in boilers house
4. Boilers house energy metering system including Panto II steam metering
5. Steam traps replacement for Calcium Panthotenat I and II plants

2.4 The plant has already implemented, by their proper efforts, the following actions:
- Eliminate 210 m pipe line to reduce the total length of distribution system
- Change the old atomizer, using the steam as primary energy agent for the steam to air heat
exchangers, with a performant atomizer using gas to air heat exchangers, offering a large range of
other technical facilities

2.5 Major dates regarding the program implementation
- Audits 1993-1994
- Delivery of equipment Phase I 1996
- Phase II 1996
- Installation and commissioning 1996
- Monitoring 1996

3.0 Energy efficiency implemented measures with USAID support

**PHASE I**

<table>
<thead>
<tr>
<th>Action</th>
<th>Annual Savings</th>
<th>Costs</th>
<th>Payback</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Natural Gas th. Ncm</td>
<td>Energy cost savings</td>
<td>USAID costs</td>
</tr>
<tr>
<td></td>
<td>$ ( $ 0.11 /Ncm )</td>
<td>$</td>
<td>$</td>
</tr>
<tr>
<td>Steam traps replacement in the boilers house</td>
<td>227.114</td>
<td>24.983</td>
<td>3.086</td>
</tr>
<tr>
<td>TOTAL SAVINGS</td>
<td>227.114</td>
<td>24.983</td>
<td>3.086</td>
</tr>
<tr>
<td>Existing consumptions</td>
<td>13,479,000</td>
<td>1,482,690</td>
<td></td>
</tr>
<tr>
<td>Percent savings</td>
<td>1.68</td>
<td>1.68</td>
<td></td>
</tr>
</tbody>
</table>

* REMARKS

Due to the fact that TERAPIA Factory entered into the possession of the donated
equipment by USAID in Phase I, only on February - March 1996, and the plant has
planned the annual revision period on August - September 1996. As usualy in each
year, the steam meter destined to be installed in CT 2 and which one was
SHIPPED IN PHASE I (USAID COST FOR IT BEING $ 6,540). IT IS NOT MENTIONED IN THE ABOVE PHASE I ACTIONS IMPLEMENTATIONS. THE STEAM METER FOR C'T 2 IMPLEMENTATION ACTION WILL ENTER IN THE PHASE II IMPLEMENTATION ACTIONS. BECAUSE IS STRONGLY RELATED TO THE WHOLE BOILERS HOUSE METERING SYSTEMS AND IT WAS INSTALLED WITH PHASE II SHIPPED EQUIPMENT.

PHASE II

<table>
<thead>
<tr>
<th>Action</th>
<th>Annual Savings</th>
<th>Costs</th>
<th>Payback</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Natural Gas</td>
<td>Energy cost</td>
<td>USAID</td>
</tr>
<tr>
<td></td>
<td>th . Ncm</td>
<td>($ .11 / Ncm)</td>
<td>costs</td>
</tr>
<tr>
<td>Boilers burning adjustment with a portable combustion gas analyzer</td>
<td>262.364</td>
<td>28.860</td>
<td>4.726</td>
</tr>
<tr>
<td>Steam traps replacement in boilers house</td>
<td>21.600</td>
<td>2.376</td>
<td>835</td>
</tr>
<tr>
<td>Installing the metering systems in the boilers house</td>
<td>601.960</td>
<td>66.215</td>
<td>28.240</td>
</tr>
<tr>
<td>Steam traps replacement in factory sections</td>
<td>427.330</td>
<td>47.006</td>
<td>6.129</td>
</tr>
<tr>
<td>TOTAL SAVINGS</td>
<td>1,313.254</td>
<td>144.457</td>
<td>39.930</td>
</tr>
</tbody>
</table>

Existing consumptions 13,479,000 1,447,523

Percent savings 9.74 9.98

PHASE I ADDED TO PHASE II (TOTAL IMPLEMENTED ACTIONS)

<table>
<thead>
<tr>
<th>Total actions</th>
<th>Annual savings</th>
<th>Costs</th>
<th>Payback</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Natural gas</td>
<td>Energy cost</td>
<td>USAID</td>
</tr>
<tr>
<td></td>
<td>th . Ncm</td>
<td>($ .11 / Ncm)</td>
<td>costs</td>
</tr>
<tr>
<td>TOTAL SAVINGS</td>
<td>1,540.368</td>
<td>169,440</td>
<td>43,016</td>
</tr>
</tbody>
</table>

Existing consumptions 13,479,000 1,447,523

Percent savings 11.43 11.7
PHASE I
ACTION 1.
STEAM TRAPS REPLACEMENT IN BOILERS HOUSE

3.1.1 Initial Conditions
In the boilers house all existing steam traps were found defective and by-passed

3.1.2 Brief description
* Equipment specification
  Steam traps Armstrong Model NO 816 .Cast iron ,inverted bucket steam traps ( 50 mm ) BPST connection
  and 5/8 inch orifice for feed water preheaters and blow-down & condensate expander
* Procurement costs
  Quantity : 5
  Unit price : $ 617.25
  Equipment price : $ 3.086
* Installation costs
  Plant costs : $ 200
* Process changes : steam boilers efficiency improvement

3.1.3 Summary of implementation
* Start -up : march 1996 and implementation was made by factory specialists own efforts
3.1.4 Monitoring Methodology and Procedure
The methodology used to evaluate the energy and money savings is based on "bucket meter " method .
by measuring the condensate in situation "before " and "after " steam traps replacements, using the
following relations :

\[
\begin{align*}
\text{Condensate ( GJ) } & \\
\text{"Before" } & Q_{cd\, b} = G_{cd\, b} \times H_{cd\, b} \times T_{fy} \\
\text{Steam ( GJ) } & \\
\text{"Before" } & Q_{st\, b} = G_{st\, b} \times H_{st\, b} \times T_{fy} \\
\text{"After" } & Q_{cd\, a} = G_{cd\, a} \times H_{cd\, a} \times T_{fy} \\
\text{"After" } & Q_{st\, a} = G_{st\, a} \times H_{st\, a} \times T_{fy}
\end{align*}
\]

Energy saving ( GJ / period )
\[
DQ = Q_{st\, a} - Q_{st\, b}
\]
Percent energy saving from periodical consumptions ( % )
\[
DQ(\%) = DQ / Q_{stt} \times 100
\]
Energy savings ( Ncm / period )
\[
DNG = DQ / c_{st} ( Ncm / period )
\]
Money savings ( $ / period )
\[
$DNG = DNG \times 0.11 \quad Ncm \times ( $ / period )
\]
where :
\[
\begin{align*}
Q_{cd\, b} & & G_{cd\, b} & G_{cd\, a} & H_{cd\, b} & H_{cd\, a} & T_{fy} & ( Gj = Gjsb ) \\
Q_{st\, b} & & G_{st\, b} & G_{st\, a} & H_{st\, b} & H_{st\, a} & T_{fy} & ( Gjsa = Gsa )
\end{align*}
\]

Energy saving ( GJ / period )
\[
DQ = Q_{st\, a} - Q_{st\, b}
\]
Percent energy saving from periodical consumptions ( % )
\[
DQ(\%) = DQ / Q_{stt} \times 100
\]
Energy savings ( Ncm / period )
\[
DNG = DQ / c_{st} ( Ncm / period )
\]
Money savings ( $ / period )
\[
$DNG = DNG \times 0.11 \quad Ncm \times ( $ / period )
\]
3.1.5 Results of measurement and monitoring
The measurements were made hourly and the results were extended for one year period of time.

Baseline $Q_{1y} = 35,347.496 \text{ GJ/}y$

<table>
<thead>
<tr>
<th></th>
<th>$Q_{cd}b = G_{cd}b \times H_{cd}b \times T_{fy}$</th>
<th>$Q_{st}b = G_{st}b \times H_{st}b \times T_{fy}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before</td>
<td>$2.039 \times 423.28 \times 4.767 = 4.414.225 \text{ GJ/}y$ \quad (G_{cd}b = G_{st}b)</td>
<td>$2.039 \times 3.089.6 \times 4.767 = 30.030.64 \text{ GJ/}y$</td>
</tr>
<tr>
<td>After</td>
<td>$1.487 \times 397.76 \times 4.767 = 2.819.570 \text{ GJ/}y$ \quad (G_{cd}a = G_{st}a)</td>
<td>$1.487 \times 3.089.6 \times 4.767 = 21.900.72 \text{ GJ/}y$</td>
</tr>
</tbody>
</table>

$DQ_{st} = Q_{stb} - Q_{sta} = 8.129.92 \text{ GJ/}y$

$DQ\% = \frac{DQ_{st}}{Q_{stt}} \times 100 = \frac{8.129.92}{35.347.496} \times 100 = 23\%$

$DNG = \frac{DQ_{st}}{c_{st}} = \frac{8.129.92}{0.035797} = 227.114 \text{ Ncm/}y$

$\$DNG = DNG \times 0.11 \$ / \text{Ncm} = 227.114 \times 0.11 \$ / \text{Ncm} = 24.983 \$ / \text{y}$

3.1.6 Review of Economics of the Measures
* Energy savings : 227.114 Ncm / y
* Reducing the boilers feed water consumptions and maintenance activities
* Savings cost : 24.983 $/y
* Implementation cost : $3.086 \text{ USAID costs}$
  
  $\$0.200 \text{ Plant costs}$

TOTAL $\$3.286 \text{ measure cost}$

* Start-up : march 1996
* Payback period : 0.13 years
* Estimated payback period : 0.15 years

The difference between the estimation and the real payback is due to the fact that the steam traps costs for the end of steam pipe line are not included in PHASE I

PHASE II

ACTION 2
Boilers burning adjustments with a portable combustion gas analyzer

3.2.1 Justification for measure
The existing old "ORSAT" gas analyzer is not a performant one and there for is not recommended to boilers burning adjustments

3.2.2 Action description
* Equipment specification: Portable combustion gas analyzer tip Bacharach model 300NXEB
* Procurement cost: $4.726 \text{ Plant cost:}$ $\$250$

3.2.3 Summary of implementation
The factory entered into the possession of the gas analyzer on September 1996. this date being considered the start-up date for action implementation.

3.2.4 Monitoring Methodology
The monitoring plan is based on direct measurements and adjustments of boilers burning efficiency and the value of savings is given by the following relation:

$DQ_{ca} = Q_{sw} \times [ (E_{a} - E_{b}) / E_{a}] \times Cu \quad (\$/\text{period})$

where

$DQ_{ca}$ is the action money saving $(\$/\text{period})$

$Q_{sw}$ is the natural gas consumption for steam and hot water generation (Ncm/period)

$E_{b}, E_{a}$ are the burning efficiency "before" and "after" the adjustments (%)

$Cu$ is the unit price for natural gas consumption $(\$0.11 / \text{Ncm})$
DGg = Qsw * ( Ea - Eb ) / Ea ( Ncm / period ) is the natural gas saving

3.2.5. Results of measurements and monitoring

DQ cn = 12,199.993 Ncm / y * ( 0.93 - 0.91 ) / 0.93 * 0.11 $ / Ncm = 28.860 $ / y

DG g = 12,199.993 Ncm / y * ( 0.93 - 0.91 ) / 0.93 = 262.364 Ncm / y

3.2.6 Review of Economics of the Measure

* Energy savings : 262.364 Ncm / y
* Money saving : 28.860 $ / y
* Implementation costs : $ 4,726 USAID costs
* Plant costs : $ 250

TOTAL $ 4,976 implementation costs

* Start-up: September 1996
* Payback period: 0.17 years
* Estimated payback period: 0.3 years
* The difference is due to initial natural gas savings estimations at the Romanian gas price at the official exchange rate
* Other benefits: pollution reductions

ACTION 3
STEAM TRAPS REPLACEMENT IN BOILERS HOUSE

3.3.1 Measure Justification
All the existing steam traps at the end steam pipe line were found defective

3.3.2 Action brief description

* Equipment specification:
Steam traps tip Armstrong model 813 for 8 & 4 bar header
* Procurement costs:
Quantity: 3
Unit price: $ 278.35
Total price: $ 835.05
* Installation costs: $ 120.00

3.3.3 Summary of implementation
Start-up of action implementation: September 1996
Implementation made by factory specialists own efforts

3.3.4 Monitoring Methodology
The Monitoring Methodology is based on "bucket meter" method and the saving calculations are based on the following relations:

Qhb = Ghb * Hhb * Tfh * N ( GJ / period )
Qha = Gha * Hha * Tfh * N

DQ h = Qhb - Qha ( GJ / period )
DNG h = DQ h / cst ( Ncm / period )
$DNG h = DNG h * $ 0.11 / Ncm ( $ / period )

where:
Qhb, Qha are the condensate heat content "before" and "after" ( GJ / period )
Ghb, Gha are the condensate quantity "before" and "after" ( Kg / h )
Hhb, Hha are the condensate enthalpy "before" and "after" ( KJ / Kg )
Tfh is the hours of function for steam headers ( h / period )
DQ h is the saved energy ( GJ / period )
DNG h is the natural gas savings ( Ncm / period )
$DNG h are the money savings ( $ / period )
N = 3 is the numbers of replaced steam traps

3.3.5 Results of measurements and monitoring

\[
\begin{align*}
Q_{hh} & = 1.191.35 \text{ GJ/y} \\
Q_{ha} & = 418.17 \text{ GJ/y} \\
DQ_h & = 773.20 \text{ GJ/y} \\
D_{NG} h & = 773.20 \text{ GJ/y} \times 0.035797 \text{ GJ/Ncm} = 21.600 \text{ Ncm/y} \\
\$ D_{NG} h & = 21.600 \text{ Ncm/y} \times 0.11 \$ / \text{ Ncm} = 2.376 \$/y
\end{align*}
\]

3.3.6 Revue of Economics of the Measure

* Energy savings: 21,600 Ncm/y
* Improving the internal steam heat consumptions and maintenance operations
* Savings costs: 21,600 Ncm/y
  \[ 2.376 \$/y \]
* Implementation cost: \$ 835  USAID costs
  \[ \$ 120 \text{ Plant costs} \]
  \[ \text{TOTAL} \ $ 955 \text{ implementation cost} \]
* Start-up: September 1996
* Pay-back period: 0.4 years
* Estimated pay-back period: 0.15 years
  The difference between the estimated and real pay-back period is due to the initial estimation which was made in Phase 1 for all the steam traps (see pg. 2)

ACTION 4
INSTALLING THE METERING SYSTEMS IN THE BOILERS HOUSE

3.4.1 Measure justification

There was any metering systems in the boilers house and the plant has not access to the gas meter used for billings and it is located in a separate room belonging to gas supplier (ROMGAZ)

3.4.2 Brief description

* Equipment specification:
  - two natural gas flow meters with KEP flow computer
  - one superheated steam meter for CT 2 with MASS flow computer
  - one superheated steam meter for CT 1 with KEP flow computer
  - one superheated steam meter for Pantho II with KEP flow computer
* Procurement costs:
  - two natural gas flow meters: \$ 11,180
  - Three superheated steam meters: \$ 17,060
* Installation cost: \$ 1,800

3.4.3 Summary of implementation

* Start-up: September 1996 and implementation was made by factory specialists efforts
* REMARKS the superheated steam meter for CT 2 is not set-up for steam. Therefore it is necessary to reset the hard of the steam meter (the meter is set-up for hot water metering)

3.4.4 Monitoring Methodology and Procedure

The monitoring methodology is based on the direct reading displayed on the gas and steam meters in CT 1 section of the boilers house.

The savings calculations are based on the specific gas consumptions (Ncm/GJ) realized by measuring the "before" and "after" boilers parameters adjustments in CT 1.

Saving calculation method is based on the following relation:

\[
\begin{align*}
D \text{ Gms} & = Q_{st} (C_{gb} - C_{ga}) \text{ (Ncm/period)} \\
\$ D \text{ Gms} & = D \text{ Gms} \times 0.11 \$ / \text{Ncm} \text{ ($/period)}
\end{align*}
\]
\[ C_{gb} = G_{stb} : Q_{stb} \quad (\text{Ncm} / \text{GJ}) \]
\[ C_{ga} = G_{sta} : Q_{sta} \quad (\text{Ncm} / \text{GJ}) \]

where

- \( D G_{ms} \) is the saved natural gas \((\text{Ncm} / \text{period})\)
- \( Q_{st} \) is the generated steam by the boilers house \((\text{GJ/period})\)
- \( C_{gb} \) is the "before" specific gas consumption \((\text{Ncm} / \text{GJ})\)
- \( C_{ga} \) is the "after" specific gas consumption \((\text{Ncm} / \text{GJ})\)
- \( G_{stb} \), \( Q_{stb} \) are the base line gas consumption for steam production and the steam production \((\text{Ncm/period} \& \text{GJ/period})\)
- \( G_{sta} \), \( Q_{sta} \) are the average gas consumption and heat production \("after") \(\) by direct reading the displayed dates on the flow computers \((\text{Ncm/period} \& \text{GJ/period})\)

\( \$D G_{ms} \) is the money saving \((\$ / \text{period})\)

### 3.4.5 Results of measurements and monitoring

- \( D G_{ms} = 376,224,914 \text{ GJ}/\text{y} \) \((30.22 \text{ Ncm/GJ} - 28.62 \text{ Ncm/GJ}) = 601,960 \text{ Ncm/y} \)

- \( C_{gb} = 11,370,613 \text{ Ncm/y} \) \( \div 376,224 \text{ GJ}/\text{y} = 30.22 \text{ Ncm/GJ} \)

- \( C_{ga} = 1417 \text{ Ncm/h} \) \( \div 49.5 \text{ GJ/h} = 28.62 \text{ Ncm/GJ} \)

\( \$D G_{ms} = 601,960 \text{ Ncm}/\text{y} \times 0.11 \$ / \text{Ncm} = 66.215 \$ / \text{y} \)

### 3.4.6 Revue of Economics of the Measure

- **Energy savings**: 601,960 \text{ Ncm/y}
- **Boilers house thermal efficiency increasing due to operation and maintenance based on parameters monitoring**
- **Savings cost**: 66,215 \$ / y
- **Implementation costs**: 28,240 \$ \text{UAID costs}
- **$1,800 plant costs**

**TOTAL**: 30,040 \$ measure cost

- **Start-up**: September 1996 (except the CT 2 steam meter)
- **Pay-back period**: 0.45 years
- **Estimated pay-back period**: 0.45 years

Even there is any difference between the real and estimated pay-back period we have to mention that Pantho II steam meter is useful to boilers house thermal efficiency improvement due to the fact that Pantho II is the hugger steam user of the factory and being strongly related to steam generation and steam users.

### ACTION 5

STEAM REPLACEMENT IN FACTORY SECTIONS (PLANTS)

#### 3.5.1

In all the factory sections the all steam traps were found defective and by-passed.

#### 3.5.2

- **Brief description**

<table>
<thead>
<tr>
<th>Plant</th>
<th>Model</th>
<th>Qty.</th>
<th>Unit price</th>
<th>total price</th>
<th>total price / plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pantho II</td>
<td>800</td>
<td>2</td>
<td>78.85</td>
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<td></td>
<td>811</td>
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<td>316.35</td>
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<td>812</td>
<td>6</td>
<td>180.50</td>
<td>1,083.00</td>
<td>1,976.95</td>
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<tr>
<td></td>
<td>814</td>
<td>1</td>
<td>419.90</td>
<td>419.90</td>
<td></td>
</tr>
<tr>
<td>Pantho I</td>
<td>811</td>
<td>1</td>
<td>105.45</td>
<td>105.45</td>
<td></td>
</tr>
<tr>
<td></td>
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<td>5</td>
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<td>902.50</td>
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<td>419.90</td>
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<tr>
<td>Gluconolactat</td>
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<td></td>
<td>814</td>
<td>1</td>
<td>419.90</td>
<td>419.90</td>
<td></td>
</tr>
</tbody>
</table>
TOTAL

Transportation

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
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<tr>
<td>Procurement cost</td>
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<tr>
<td>Equipment cost</td>
<td>5,378.90</td>
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<tr>
<td>Installation cost</td>
<td>900.00</td>
</tr>
<tr>
<td>Steam boilers thermal efficiency improvement</td>
<td></td>
</tr>
</tbody>
</table>

GRAND TOTAL

6,129.00

* Procurement cost: $5,378.90 + $750 = $6,129
* Equipment cost: $5,378.90
* Installation cost: $900.00
* Steam boilers thermal efficiency improvement and technological process improvements

3.5.3 Summary of implementation
* Start-up: September 1996
* Implementation made by factory specialists

3.5.4 Monitoring methodology and Procedure
Monitoring methodology is based on the "bucket meter" method and is the same as it was presented at ACTION 1 point 3.1.4

3.5.5 Results of measurement and monitoring
Base-line: Q t y = 69,532.35 GJ/y all the plants steam heat consumptions
DQ = 22.00 % savings average percentage. Calculation based on the above methodology applied to a few steam users which many operating hours
D Q st = 69,532.35 GJ/y * 0.22 = 15,297.12 GJ/y
D NG = 15,296.12 GJ/y : 0.03597 Ncm/GJ = 427,330 Ncm/y
$ D NG = 427,330 Ncm/y * 0.11 $ / Ncm = 47,006 $ / y

3.5.6 Review of Economics of the Measure
* Energy savings: 427,330 Ncm/y
* Savings cost: 47,006 $ / y
* Implementation cost: $6,129 USAID costs
* $900 Plants costs

TOTAL $7,029 measures implementation costs
* Start-up: September 1996
* Pay-back period: 0.15 years
* Estimated pay-back period: 0.3 years

The difference is due to the fact that the realized gas economies are greater than we have had estimated.

4.0 Plant-wide results
4.1 Interaction of measures
All the implemented actions from the boilers house to the plants end users are reflected in boilers house thermal efficiency improvement, by reducing the natural gas consumption for the same heat steam production. As a direct effect is the billing decrease for natural gas payments.

4.2 Summary of results for all the energy efficiency actions mentioned above
Regarding the summarized results for the implemented actions presented in page 3, we may say that the natural gas net reduction consumption is: 1,540,368 Ncm/y, meaning 11.43% gas savings from the initial consumption: 13,479,000 Ncm/y.
In money terms the savings are: 169,440 $ / y, meaning 11.7% from the initial natural gas consumption cost: 1,447,523 $ / y

4.3 Other improvements at the plant
- reducing the length of the steam heat distribution system by eliminating 210 ml, meaning 51,110 Ncm/y saving (5,622 $ / y)
- change in Calcium Glue Plant the old atomizer, having steam to air heat exchanger, with a performant one having gas to air heat exchanger, offering in the same time a lot of others technological facilities.

The factory investment cost was: 300,700 $, the estimated pay-back period being 3.8 years.
- developing of maintenance and operating practices
- developing of energy department
- as a result of auditors recommendations the next steps which will be made by the factory
in the very near future are:
- to improve the insulation on the thermal pipe line distribution system
- to monitor the energy consumption by using a data logger and an industrial monitoring system
- to meter the thermal energy consumption at the others factory sections
- to meter and to monitor the factory water consumption
- to replace the steam traps in the whole factory
- to install two temperature and pressure regulating valve on the desaerators

5.0 **Recommendations for maximize the benefits of the equipment**
* To satisfy the real heating demand with a corresponding heat generation it is necessary to install small capacities steam boilers (3 - 5 to / h). In this way the specific consumption will be in decreasing.

6.0 **Significance of the project for:**
C.E.M. - work methodology improvement
- more about metering systems
- how to make money using the energy efficiency "market"
- how to develop in the future the work under performance contracts
- how to promote energy management concepts at the customers

PLANT - increasing the work with private companies due to the trust in this companies
- has more clear planned activities for the next steps in energy efficiency improvement
- the own operators learned to work with modern and performent equipment and technologies
- encourage the investments in new equipments and technologies

ROMANIA - Promotion of joint ventures with US companies
- Training in project financing and energy audit technologies
- Establishment of an energy efficiency fund
- Expanded C.E.M. certification programs
- Joint Eastern European A.E.E. activities
- Training in demand -side-management
- Training in environmental impact of energy efficiency
- How to organize an energy service company
- Training and support for performance contracts

S.C. "ECO ERG " TEHNOLOGIE SERVICE S.R.L.

GEORGETA PADUREANU , C.E.M.

VASILE GRASIN , C.E.M.
ENERGY EFFICIENCY REPORT
30 T/H STEAM BOILER
VEGA REFINERY PLOIESTI

NOVEMBER 1996

PHASE: EVALUATION REPORT

PREPAIRED BY:
AUTOMATIZARI ORION SRL

eng. Simona PARVU, CEM
dr. eng. Andy DUMBRAVA
1. PLANT DESCRIPTION

The Energetic Section is an important sector of VEGA Refinery, because it is furnishing the medium and low pressure of technological steam for the units of this industrial platform. The thermal unit right functioning leads to a good functioning of the entire plant.

The boilers house has in composition 5 boilers, 3 of them, identical, being installed after 1978, while the other 2 being older.

One of the three identical boilers constituted the object of USAID and Hagler, Bailly Energy Efficiency Program.

The boilers which make our discussion object is named CR and its characteristics are:
- nominal capacity of produced steam: 30 tons/hour
- nominal temperature of produced steam: 250 °C
- nominal pressure of produced steam: 15 bars

CR is a steam boiler with natural circulation, watertube type, having 2 burners, running on heavy fuel oil. The boiler feeding is with make-up water, prepared in the own station for water treatment. Another source for feed the boiler is the recuperated condens from the refinery steam network.

As a fuel, the CR uses crude fuel oil, obtained from the Atmospheric Distillation Unit in VEGA.

Before the USAID action started, the situation of CR was as following:
- insufficient instrumental endowment of the CR
- reduced running cycles (40 - 45 days maximum)
- low steam efficiency (69 - 78%) related to the feeding water
- incomplete combustion of the fuel, presence of CO in the stack gas, with an excess air under optimal level
- stack gas temperature: 250 - 320 °C
- average energy efficiency calculation indicated values between 72% and 76%.

2. SUMMARY OF ACTIVITIES

As a result of the discussions made with the VEGA stuff, it came up the necessity to verify and improve of energetical point of view the boilers energetical performances with the functioning safety increase.

During the CEM/USAID Program, interviews have been held in the VEGA Refinery with Mechanical-Energy Manager, Chief of Energetic Section and the Plant Manager. The agreement concluded between AUTOMATIZARI ORION SRL and VEGA stipulated as major actions:

→ energy audit at CR1
→ CR1 energy efficiency improvements
→ measurement and control equipment procurement and installation
→ final evaluation of energy savings measures
Following the energy audit performed at this unit, AUTOMATIZARI ORION made the following recommendations regarding an energy management system implementation:

1. Combustion optimization
2. Fuel temperature control
3. A drum level control system
4. Water level recording
5. Flowrate measurement and counter implementation for fuel, water and steam
6. Temperature recording for superheated steam, preheated air and stack gas
7. Measurement and device implementation for purge automated control
8. Temperature measurement in the burning zone
9. Installation of an automated start-up for fuel spare pump
10. Replacement of the present fuel pumps
11. Revamping of the present fuel filtering system
12. System improvement for the fuel and water quality control
13. Improved methods for ash cleaning and removing during shut-downs of operation
14. Acquisition of a portable equipment for burning control and flowrate measurement

Related to these objectives, we can specify:
- 1, 3, 4, 5, 6, 11, 12, 13 measures have been already done;
- 7 and 14 measures are not realized because their too high cost; recommended for a long-term schedule;
- 3, 8, 9 measures are not considered urgent (fuel pumps were fixed and they are running normally and satisfactory);

The fuel oil filters have been relocated in the circuit, ensuring a continuous and safety operation. The fuel preheating temperature is continuously recorded and supervised.

The measures regarding blowdown counting and blowdown automatic loop control are not yet implemented. Still, it is considered to be next major improvements of the boiler efficiency. Therefore, these actions are kept as long-term actions.

The refinery stuff has permanently in view the promotion of other actions too regarding the overall plant, actions leading to energy conservation, such as:
- advanced condensate recovery
- sensible produced steam utilisation
- steam system audit
- computers technic implementation in plant energy management
- a better maintenance practice

**Major dates of program implementation:**

- Energy audit: November 1993
- Delivery of the Rosemount Analyzer: April 1995
- Installation of analyzer: end April 1995
- Start-up: November 1995
- Monitoring: January - April 1996
3. IMPLEMENTATION OF THE CEM/USAID PROJECT

The measures taken for energy efficiency improvement at CR boiler are grouped in following categories (see Monitoring Plan):

A. Combustion optimization
B. Reduction of water consumption
C. Boiler operating system improvement through flowrates and temperature measurements.

To describe and comment the obtained results for each measurement, we show the following tables:

1. Running (functionning) schedule (after the completion of the project)
3. Fuel consumption index (1993)
5. Material balance on CR
6. Fuel consumption index (January - April 1996)
7. List of Operation Data (January - April 1996)
8. Equipment and Project Implementation Costs

The following comments have to be made:
- In Table 1 is depicted the load capacity of CR for one year. It results operations days - 296, i.e. 82%.
- Prices are different in 1996 regarding 1993, when energy audit has been made:
  exchange rate: 1993 - 900 lei / 1 $  
  1995 - 2000 lei / 1 $  
  1996 - 3500 lei / 1 $
- According to Energy Audit Report, made in 1993, a summary of fuel consumption index is presented. Those data represent all five boilers from the boilers house.
- In order to exemplify the actual performances of the CR boiler, the period from Jan.24 to April.23 (see Table 1) was chosen for analysis and interpretation of data: fuel consumption
- Table 4, material balance on CR - Table 5, operation parameters - Table 7.
- According to the methodology applied in the Energy Audit Report, a fuel consumption index for above mentioned period is presented in Table 6.
- A summary of the equipment and implementation costs is presented in Table 8.

A. Combustion optimization

The energy audit performed in nov.1993 showed:
- low level of excess air, with CO in stack gas;
- big variations of O2 amount in stack gas (the Orsat analysis was performed once by shift).
For the combustion control, the study recommended an oxygen analyser installation. Endowed with an Intelligent Field Transmitter, which correlates O2 content in flue gas with the stack gas temperature, this equipment provides instantaneously the combustion efficiency level. The analyser was implemented in May 1995 by AUTOMATIZARI ORION SRL.

Starting from before combustion efficiency value (under 80%), recorded data (Table 7) shows an average value of 84%.

Savings due to this action are calculated as follows:

\[
\text{Savings, $} = \text{Fuel consumption} \times (\Delta \text{Eff}) / \text{New eff} \times (\text{new fuel consumption price} - 1996)
\]

\[
51.2 \text{ t/day} \times 82/100 \times 365 = 15,324 \text{ tons/year}
\]

\[
\text{(Table 4)} \times \text{load capacity} \times \text{days/year} = \text{tons/year}
\]

\[
\text{Old fuel consumption (1993): 16,294 tons/year}
\]

\[
\Rightarrow \text{Fuel saved: } 16,294 \times 5 / 84 = 970 \text{ tons/year}
\]

Savings: \[
16,294 \times 5 / 84 \times 96.6 = 93,702 \text{ $/year.}
\]

In order to evaluate energy savings, the following operation data are collected by the operators (at every 2 hours most of them):
- flue gas O2 content (performed by Orsat and Rosemount Analyzer)
- boiler efficiency (performed by Rosemount Analyzer)
- fuel flowrate
- fuel preheating temperature
- flue gas stack temperature
- air preheating temperature

Boiler efficiency can be computed on 4 ways:
1. input - output method
2. losses method
3. Rosemount Analyzer
4. specific graphs.

In Table 7 operation data for a run cycle (length: 90 days, i.e. Jan. 24 - Apr. 23) are presented.
For the same period were collected (table):
- water consumption
- superheated steam produced
- fuel consumption

These data were processed on a monthly basis. After that, an average value (day, hour) is obtained.
Considering a value of 82% for load capacity (running days / calendaristic days) average values were extended to a yearly basis.
Applying this action, efficiency raised from 79% to 84% (\(\Delta\) efficiency = 5%, which is a conservative value).

In fact, this gain of efficiency could be higher.
1993 data show that to produce 1 ton of steam in the boiler house (all 5 boilers being considered), 7.15 GJ are necessary (4.97 GJ coming from heavy fuel and 2.18 GJ/t from gas (Table 3).

1993 data show that, to produce 1 ton of steam in our CR boiler (after devices implementation), are needed only 4 GJ. That means that IPROM and SteinMuller boiler types are less attractive, for economical reasons (efficiency is under 70%).

Cost of the action is depicted in Table 8. The payback period is 0.74 years.

B. Reduction of water consumption

AUTOMATIZARI ORION SRL has installed a drum level automatic loop control. The application of this system showed:
- better water / steam ratio
- avoiding of inefficient blowdown
- safety running
- purge reduction

Overall material balance data for purge + losses shows:

- in 1993 - 32.5 % (Energy Audit)
- in 1996 (Jan.24 - Apr.23) - 28.3 % (Table 5)

Which means a 10% reduction of water consumption.

For the monitoring period, following data regarding drum level control (DLC) are available:

<table>
<thead>
<tr>
<th>ACTION</th>
<th>PRODUCED STEAM t</th>
<th>PURGE + LOSSES %</th>
<th>FEEDWATER t</th>
</tr>
</thead>
<tbody>
<tr>
<td>DLC</td>
<td>42297</td>
<td>28.3</td>
<td>58960</td>
</tr>
<tr>
<td>NO DLC</td>
<td>42297</td>
<td>31.1</td>
<td>61390</td>
</tr>
<tr>
<td>DIFFERENCE</td>
<td>0</td>
<td>2.8</td>
<td>2430</td>
</tr>
</tbody>
</table>

Savings, $ (yearly basis) (load capacity = 82%):

\[
2430 \times \frac{82}{100} \times 365 \text{ days/year} \times 0.386 \text{ $/t} = 3420 \text{ $/year.}
\]

Saved water is:

\[
2430 \times \frac{82}{100} \times 365 \text{ days/year} = 8870 \text{ t/y.}
\]

Equipment and project implementation cost are detailed in Table 8. The payback period is 0.72 year (Table 9).
C. Boiler operating System improvement byflows and temperatures measurement

Before starting the USAID Program in VEGA Refinery, all boilers had a poor instrumentation. At the time when the energy audit was conducted (1993), a material and energy balance was difficult (or even impossible) to perform.

The actual boiler endowment, with good and performant instrumentation, assures a proper characterization of operation and allows the attainment of optimal operation conditions quick and safely.

For overall boiler monitoring, as well as for highlighting of energy savings, the following measurement points are available now (after project implementation).

- Fuel flowrate
- Feeding water flowrate
- Produced steam flowrate
- Steam temperature (revamp)
- Steam pressure (revamp)

These data are collected regularly (every 2 hours) by the panel operator.

The equipments and implementation costs for this action are detailed in Table 8.

D. OTHER BENEFITS

The actions taken to raise the boiler efficiency had a sound effect in other areas, such as:

- increased running time in one cycle of operation (till 90 days) with good performances
- increased yearly running period (this boiler is used preferentially instead of the other boilers)
- reduced down-time (without CO in stack fluegas, the sour formed is minimal, which makes the cleaning easier)
- the pollution in refinery area is reduced due to smaller fuel consumption

In this next table, a comparison between original estimates and actual savings is presented:

<table>
<thead>
<tr>
<th>COMBUSTION IMPROVING</th>
<th>ESTIMATES</th>
<th>ACTUAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEI 81111</td>
<td>73000000</td>
<td>32790000</td>
</tr>
<tr>
<td></td>
<td>81111</td>
<td>93702</td>
</tr>
<tr>
<td>REDUCTION OF WATER CONS.</td>
<td>LEI 2222</td>
<td>11974500</td>
</tr>
<tr>
<td></td>
<td>2000000</td>
<td>3424</td>
</tr>
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</table>

Taking into consideration a slightly change in fuel and water prices, a very good match between estimated and actual costs is obtained.
4. PLANT - WIDE RESULTS

According to the results above mentioned, the stuff is convinced that the others boilers need to be revamped as well. The savings are enough impressive and can provide financial support for final actions to be taken.

For this boiler it is forecast a major improvement by installation of an automatic blowdown control. This action will bring major savings for the refinery.

Table 9 shows synthetically the efficiency improvement costs and payback period, that is 0.74 years.

The stuff is confident that next actions will include similar boilers (the other 2) aiming to get a greater energy efficiency increase for the whole unit.

Our long-term recomandations include:

- condensate recovery
- an efficient usage of the produced steam
- good control on steam - condensate system
- good equipments maintenance
- reduction of solid deposits on boiler internals
- software implementation for efficient energy management.

5. RECOMMENDATIONS MADE TO THE PLANT

During our meetings with the refinery stuff, we stressed on the following items regarding a better energy management of Energetic Section:

1. Additional equipment and instrumentation needs to be installed on the whole sector.
2. Major savings are expected from automatic blowdown system implementation.
3. Good control and maintenance of the actual equipment and instrumentation.
4. Maximization of the benefits through regularly boilers checking (including energy audits) for each boiler.
5. Revamp and better instrumentation for whole energy carriers (steam-condensate system, main consumers etc.).
6. Looking for energy opportunities related to electricity (pumps, fans, heating etc.).
Table 1  RUNNING PERIODS FOR CR BOILER

<table>
<thead>
<tr>
<th>NR.</th>
<th>STARTING</th>
<th>SHUT DOWN</th>
<th>Δ</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>09.09.1995</td>
<td>09.23.1995</td>
<td>14</td>
<td>DRUM PITTINGS</td>
</tr>
<tr>
<td>2.</td>
<td>09.25.1995</td>
<td>10.02.1995</td>
<td>8</td>
<td>ISCIR CHECK</td>
</tr>
<tr>
<td>3.</td>
<td>11.03.1995</td>
<td>01.21.1996</td>
<td>80</td>
<td>Shut down normal</td>
</tr>
<tr>
<td>4.</td>
<td>01.24.1996</td>
<td>04.23.1996</td>
<td>90</td>
<td>Idem</td>
</tr>
<tr>
<td>5.</td>
<td>04.30.1996</td>
<td>06.07.1996</td>
<td>39</td>
<td>Cleaning</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>360</td>
<td>296</td>
<td>82 % LOAD</td>
</tr>
</tbody>
</table>

Table 2  PRICES

<table>
<thead>
<tr>
<th></th>
<th>1993 (900 lei/$)</th>
<th>1996 (3500 lei/$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LEI</td>
<td>$</td>
</tr>
<tr>
<td>Fuel oil [lei/t]</td>
<td>76000</td>
<td>84.5</td>
</tr>
<tr>
<td>Treated water [lei/m3]</td>
<td>363</td>
<td>0.403</td>
</tr>
<tr>
<td>Superheated steam [lei/t]</td>
<td>2115</td>
<td>2.35</td>
</tr>
</tbody>
</table>
Table no. 3  
**FUEL CONSUMPTION INDEX 1993**

<table>
<thead>
<tr>
<th></th>
<th>GAS</th>
<th>REDUCED CRUDE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel consumption (th. Nm3/tccc)</td>
<td>19943</td>
<td>52377.5</td>
</tr>
<tr>
<td>Thermal consumption (GJ)</td>
<td>672079</td>
<td>1536230</td>
</tr>
<tr>
<td>Price lei/Nm3 ; lei/t</td>
<td>55</td>
<td>76000</td>
</tr>
<tr>
<td>Price USD/Nm3 ; USD/t</td>
<td>0.061</td>
<td>84.44</td>
</tr>
<tr>
<td>Total cost (th. lei)</td>
<td>1096865</td>
<td>2966662</td>
</tr>
<tr>
<td>Total cost (th. USD)</td>
<td>1218.7</td>
<td>3296.3</td>
</tr>
<tr>
<td>Produced steam (th. tons)</td>
<td>308775</td>
<td></td>
</tr>
<tr>
<td>Product index (GJ/t)</td>
<td>2.18</td>
<td>4.97</td>
</tr>
<tr>
<td>TOTAL (GJ/t)</td>
<td></td>
<td>7.15</td>
</tr>
</tbody>
</table>

Table no. 4  
**FUEL CONSUMPTION (1996)**

<table>
<thead>
<tr>
<th>MONTH</th>
<th>NO. DAYS</th>
<th>FUEL FLOW (t)</th>
<th>FUEL (kg)</th>
<th>PRODUCED STEAM (t/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>monthly</td>
<td>daily</td>
<td>hour</td>
</tr>
<tr>
<td>FEBRUARY</td>
<td>29</td>
<td>1650</td>
<td>56.9</td>
<td>2.371</td>
</tr>
<tr>
<td>MARCH</td>
<td>31</td>
<td>1350</td>
<td>43.5</td>
<td>1.815</td>
</tr>
<tr>
<td>APRIL</td>
<td>22</td>
<td>1200</td>
<td>54.5</td>
<td>2.273</td>
</tr>
<tr>
<td>Σ</td>
<td>82</td>
<td>4200</td>
<td>51.2</td>
<td>2.134</td>
</tr>
</tbody>
</table>

Table no. 5  
**MATERIAL BALANCE (82 days)**

<table>
<thead>
<tr>
<th></th>
<th>WATER CONSUMPTION M3</th>
<th>PRODUCED STEAM</th>
<th>PURGE + LOSS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>tons</td>
<td>%</td>
<td>tons</td>
</tr>
<tr>
<td>FEBRUARY 29</td>
<td>22800</td>
<td>64.9</td>
<td>16307</td>
</tr>
<tr>
<td>Flowrate / day</td>
<td>786.2</td>
<td>56.2</td>
<td>562.3</td>
</tr>
<tr>
<td>Flowrate / hour</td>
<td>32.8</td>
<td>23.4</td>
<td>23.4</td>
</tr>
<tr>
<td>MARCH 31</td>
<td>22120</td>
<td>51.3</td>
<td>15960</td>
</tr>
<tr>
<td>Flowrate / day</td>
<td>713.6</td>
<td>51.4</td>
<td>514.8</td>
</tr>
<tr>
<td>Flowrate / hour</td>
<td>29.7</td>
<td>21.5</td>
<td>21.5</td>
</tr>
<tr>
<td>APRIL (22)</td>
<td>14040</td>
<td>46.9</td>
<td>10030</td>
</tr>
<tr>
<td>Flowrate / day</td>
<td>638.2</td>
<td>51.4</td>
<td>515.8</td>
</tr>
<tr>
<td>Flowrate / hour</td>
<td>26.6</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>TOTAL (m3/t)</td>
<td>58950</td>
<td>51.8</td>
<td>42297</td>
</tr>
<tr>
<td>AVERAGE DAY (t)</td>
<td>719</td>
<td>515.8</td>
<td>515.8</td>
</tr>
<tr>
<td>YEAR (300 days)</td>
<td>213700</td>
<td>51745</td>
<td>515.8</td>
</tr>
</tbody>
</table>

Table no. 6  
**FUEL CONSUMPTION INDEX (1996)**

<table>
<thead>
<tr>
<th></th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel consumption (tons)</td>
<td>1650</td>
<td>1350</td>
<td>1200</td>
<td>4200</td>
</tr>
<tr>
<td>Thermal consumption (GJ)</td>
<td>66479</td>
<td>54392</td>
<td>48348</td>
<td>169219</td>
</tr>
<tr>
<td>Total cost (lei)</td>
<td>5.577 x 10^8</td>
<td>4.563 x 10^8</td>
<td>4.056 x 10^8</td>
<td>14.196 x 10^8</td>
</tr>
<tr>
<td>Total cost (USD)</td>
<td>159340</td>
<td>130370</td>
<td>115890</td>
<td>405600</td>
</tr>
<tr>
<td>Produced steam (tons)</td>
<td>15307</td>
<td>15960</td>
<td>10030</td>
<td>42297</td>
</tr>
<tr>
<td>Product index (GJ/t)</td>
<td>4.08</td>
<td>3.41</td>
<td>4.82</td>
<td>4</td>
</tr>
</tbody>
</table>
Table no. 7  LIST OF OPERATION DATA  ( 24.01.1996 - 23.04.1996 )

<table>
<thead>
<tr>
<th>DATE</th>
<th>01.27</th>
<th>01.29</th>
<th>02.05</th>
<th>02.06</th>
<th>02.22</th>
<th>02.26</th>
<th>02.27</th>
<th>02.28</th>
<th>03.06</th>
<th>03.10</th>
<th>03.17</th>
<th>03.23</th>
<th>03.31</th>
<th>04.07</th>
<th>04.08</th>
<th>04.14</th>
<th>04.22</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.of days from start</td>
<td>4</td>
<td>6</td>
<td>13</td>
<td>14</td>
<td>30</td>
<td>34</td>
<td>35</td>
<td>36</td>
<td>43</td>
<td>47</td>
<td>54</td>
<td>60</td>
<td>68</td>
<td>75</td>
<td>76</td>
<td>82</td>
<td>90</td>
</tr>
<tr>
<td>O2 content % vol</td>
<td>3</td>
<td>2.5</td>
<td>2.2</td>
<td>3</td>
<td>3.3</td>
<td>2.8</td>
<td>3</td>
<td>3.6</td>
<td>3.2</td>
<td>3.2</td>
<td>3.4</td>
<td>3.1</td>
<td>3.7</td>
<td>3.3</td>
<td>4.2</td>
<td>3.8</td>
<td></td>
</tr>
<tr>
<td>CO2 content % vol</td>
<td>13.4</td>
<td>13.9</td>
<td>14</td>
<td>13.8</td>
<td>13.6</td>
<td>14.2</td>
<td>14.1</td>
<td>13.4</td>
<td>13.8</td>
<td>14</td>
<td>13.5</td>
<td>14</td>
<td>13.2</td>
<td>13.8</td>
<td>14.1</td>
<td>13.8</td>
<td>13.6</td>
</tr>
<tr>
<td>CO content % vol</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>0</td>
<td>0</td>
<td>0</td>
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<td>0</td>
</tr>
<tr>
<td>Excess air</td>
<td>15.6</td>
<td>12.7</td>
<td>11</td>
<td>15.7</td>
<td>17.6</td>
<td>14.5</td>
<td>15.7</td>
<td>19.5</td>
<td>17</td>
<td>17</td>
<td>15.6</td>
<td>16.3</td>
<td>20.7</td>
<td>17.6</td>
<td>17.7</td>
<td>23.9</td>
<td>20.9</td>
</tr>
<tr>
<td>Fuel temp. °C</td>
<td>110</td>
<td>125</td>
<td>122</td>
<td>121</td>
<td>120</td>
<td>122</td>
<td>120</td>
<td>125</td>
<td>118</td>
<td>119</td>
<td>120</td>
<td>121</td>
<td>116</td>
<td>125</td>
<td>126</td>
<td>125</td>
<td>120</td>
</tr>
<tr>
<td>Fluegas temp. °C</td>
<td>225</td>
<td>260</td>
<td>280</td>
<td>280</td>
<td>260</td>
<td>190</td>
<td>200</td>
<td>205</td>
<td>200</td>
<td>210</td>
<td>190</td>
<td>205</td>
<td>182</td>
<td>220</td>
<td>205</td>
<td>170</td>
<td>190</td>
</tr>
<tr>
<td>Air preheat temp. °C</td>
<td>270</td>
<td>280</td>
<td>310</td>
<td>310</td>
<td>320</td>
<td>263</td>
<td>255</td>
<td>275</td>
<td>277</td>
<td>300</td>
<td>260</td>
<td>255</td>
<td>230</td>
<td>275</td>
<td>275</td>
<td>275</td>
<td>280</td>
</tr>
<tr>
<td>Steam temp. °C</td>
<td>250</td>
<td>240</td>
<td>250</td>
<td>250</td>
<td>240</td>
<td>241</td>
<td>240</td>
<td>238</td>
<td>235</td>
<td>242</td>
<td>240</td>
<td>235</td>
<td>235</td>
<td>225</td>
<td>228</td>
<td>230</td>
<td>220</td>
</tr>
<tr>
<td>Steam pressure atm</td>
<td>12</td>
<td>12.2</td>
<td>12.2</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>11.5</td>
<td>11.8</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>Water temp. °C</td>
<td>102</td>
<td>103</td>
<td>104</td>
<td>103</td>
<td>103</td>
<td>104</td>
<td>104</td>
<td>105</td>
<td>104</td>
<td>104</td>
<td>106</td>
<td>107</td>
<td>106</td>
<td>104</td>
<td>104</td>
<td>102</td>
<td>105</td>
</tr>
<tr>
<td>Combustion efficiency</td>
<td>83</td>
<td>84</td>
<td>83.5</td>
<td>83.3</td>
<td>83.6</td>
<td>86.4</td>
<td>85.2</td>
<td>85</td>
<td>85</td>
<td>85</td>
<td>86.2</td>
<td>85.1</td>
<td>86.5</td>
<td>84.9</td>
<td>85.2</td>
<td>86.9</td>
<td>86.2</td>
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</table>
Table 8  EQUIPMENT AND PROJECT IMPLEMENTATION COSTS

<table>
<thead>
<tr>
<th>NO.</th>
<th>ACTION</th>
<th>EQUIPMENT</th>
<th>EQUIPMENT COST [ $ ]</th>
<th>PROJECT IMPLEMENT COST [ $ ]</th>
<th>TOTAL PROJECT COST [ $ ]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Combustion optimization</td>
<td>Rosemount Analyzer + other</td>
<td>18600</td>
<td>34610</td>
<td>53210</td>
</tr>
<tr>
<td>2.</td>
<td>Drum level control</td>
<td>Level control system</td>
<td>1850</td>
<td>610</td>
<td>2460</td>
</tr>
<tr>
<td>3.</td>
<td>Metering</td>
<td>Feeding water flowmeters</td>
<td>10500</td>
<td>5700</td>
<td>16200</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Produced steam flowmeters</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fuel oil flowmeters</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Metering of feed.water, oil,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>steam, gas stack temperatures.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Registration apparatuses etc.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 9  ECONOMICAL ANALYSIS  ( FUEL REDUCTION )

<table>
<thead>
<tr>
<th>ACTION</th>
<th>DESCRIPTION</th>
<th>FUEL CONSUMPTION</th>
<th>FUEL NET REDUCTION</th>
<th>TOTAL FUEL COST</th>
<th>MONEY SAVING</th>
<th>ACTION COST</th>
<th>PAYBACK PERIOD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>T/Y</td>
<td>T/Y</td>
<td>$/Y</td>
<td>$/Y</td>
<td>$</td>
<td>YEAR</td>
</tr>
<tr>
<td>Initial conditions</td>
<td>16294</td>
<td>1574000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>Combustion optimization</td>
<td>15324</td>
<td>970</td>
<td>1480298</td>
<td>93702</td>
<td>53210</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Metering</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>16200</td>
<td></td>
</tr>
<tr>
<td>TOTAL (A+C)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>69410</td>
<td>0.74</td>
</tr>
</tbody>
</table>

### Table 10  ECONOMICAL ANALYSIS  ( WATER REDUCTION )

<table>
<thead>
<tr>
<th>ACTION</th>
<th>DESCRIPTION</th>
<th>WATER CONSUMPTION</th>
<th>WATER NET REDUCTION</th>
<th>TOTAL WATER COST</th>
<th>MONEY SAVING</th>
<th>ACTION COST</th>
<th>PAYBACK PERIOD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>T/Y</td>
<td>T/Y</td>
<td>$/Y</td>
<td>$/Y</td>
<td>$</td>
<td>YEAR</td>
</tr>
<tr>
<td>Initial conditions</td>
<td>224074</td>
<td>-</td>
<td>86490</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Drum level control</td>
<td>215204</td>
<td>8870</td>
<td>83070</td>
<td>3420</td>
<td>2460</td>
<td>0.72</td>
</tr>
</tbody>
</table>
MONITORING & EVALUATION
REPORT
MUHA
1. GENERALITIES.
The USAID programme of energetic efficiency improvement in Romania has been introduced at SC MUHA SRL SUCEAVA by the company of energetic consultancy SC INVEST PROIECT SRL SUCEAVA. All its activity has developed under the direction and with the technical assistance of Hagler Bailly Consulting Inc.

The aim of this programme was the ascertainment of the present energetic situation at MUHA Company, to indicate the points of energetic waste, measures of efficientization, necessary equipments, the costs of introducing of the proposed measures, benefits and economies achieved.

2. THE CUSTOMER
SC MUHA SRL SUCEAVA is a civil and industrial building company that has a production basis that produces timber, scaffoldings, furniture, metallic products, concrete prefabs, etc.

The production basis has ensured the following utilities:
- thermic energy is supplied by the own central of energy station as hot water at 95/75°C. from two "METALICA" Romanian boilers, that works with wood offals from the factory of timber and the factory of scaffolding and furniture in the same production basis;
- the electric energy is taken from the national energetic system;
- water for the technologic and domestic consumption is taken from the water network of the area where the production basis is placed;
- compressed air for the consumers in the factory of the production basis is taken from the own station of compressors;
- residual waters are drained in the sewerage network of the industrial platform;

The thermic station produces 0,8 Gcal/h.

The main consumers are:
- the timber drier;
- the timber steamer;
- the installations of technological and spatial heating in the factories of the production basis;
The main consumers of electric energy are:
- the saw-mill from the timber station;
- the station of compressors, that produces compressed air for all the consumers of the production basis;
- the installations of pneumatic transport of the factory of scaffolding-furniture;

Before the introduction of the USAID programme, from the energetic point of view, it was the following situation:
- the contorization was made by a Romanian, monotariff electromagnetic counter, AEM type. In order to draw the curve it was necessary that an operator survey the consumption from hour to hour;
- the monthly average power factor was of 0,454 because all the actings are with asynchronous engines and there is a large number of small-power engines (under 3 KW) that have a very weak natural factor;
- manual control of the timber drying leads to a waste of electric and termic energy and to a high level of drying faults in charges. Also, there is requested suplimentar operators;
- the impossibility of timber moisture determination at the place of unloading and before entering the processing flow chart leaded to suplimentar materials manipulation. After the result of the finite products. appeared faults of drying in materials.
- low yield, 0,55, at the boilers in the termic station, because of the feeding deficiency with wood wastes and because of the incomplete burning;
- high losses of termic energy in the external networks because of the incomplete insulation or unsuitable insulation;
- termic energy losses due to air non-recirculation in the equipments of pneumatic transport;
- electric energy losses due to working with no charge of the installations of pneumatic transport, when the technological equipment of wood processing (factory of scaffolding-furniture) doesn't work.
- losses of compressed air in the transport networks because of the non-tightness;
- losses of electric energy by working with no charge in the saw-mill in the facory of timber, because of the manual feeding with logs;

3. PROJECT DESCRIPTION

From the energetic study, it issues the following measures:
- The necessity of replacement the existing counter with a high performance one, that should allow the control of the energy consumption and of the power distribution at preset intervals.
- The compensation of the power factor with a specialized installation.
- The automatization of the timber drying process in the drier.
- The endowment with a portable device for the timber moisture determination.
- The improvement of the yield in the boilers from the termic station.
- The completion and the restoration of the layers of insulating materials at the external networks of termic energy.
- The execution of a filters station that will ensure the air recirculation in the installations of pneumatic transport.
- The design of a new technologic flow chart at the factory of scaffolding-furniture.
- The performing of capital reparations at the networks of compressed air transportation in order to tighten them.
- The mechanization of the saw-mill supply with logs in the factory of timber.

The conclusions and the explanatory calculations of the study were sent to the Hagler Bailly Company, that selected the necessary equipments requested by the project implementation.

4. PROJECT IMPLEMENTATION

Project implementation was performed in four stages:

4.1. First stage:

We have received from USAID a portable device for the timber moisture determination in the warehouse and at the introduction in the flow chart. This device was immediately given into utilization and consequently it was reduced the quantity of manipulated timber and dissappeared the drying faults in the finite products.

Device cost: 446,74$
Custom tax: 135,00$
Total costs: 581,74$
Pay-back (years): 0,5 years

4.2. The second stage:

In two portions came the parts of the equipment for the automat control of the timber drying in the drier.

From the parts of the equipment that was received and is working, there are:

- the installation of termic energy countering;
- the system of temperature and moisture control and determination inside the timber drier.

Presently, we are working in a semi-automat regime, with data supplied by the installed system.

We can't work in a completely automatized process-according to the supplied programme- because we didn't receive yet the psychometer.

Equipment cost: 11.527$
Cost of installation: 830$
Custom tax: 4.034$
Total costs: 16.391$
Savings: 7.685$
Pay-back (years): 2.1 years

4.3. The third stage:
In this stage it was bought, assembled and started working an electric counter, A1R10A type. Its economic efficiency is indirect and gives precisely data about the consumption curve and allow us to take the best decisions for their flattening and to obtain a minimum average price according to the tariff applied by the supplier.

Electric energy discount is made on the basis of this counter:

| Equipment cost: | 655$ |
| Cost of installation: | 120$ |
| Total costs: | 775$ |
| Savings: | 968$/year |
| Pay-back (years): | 0.8 years |

4.4. The fourth stage
The equipment for the automat compensation of the power factor, ACCUVAR Junior 105 Kvar, was installed according to the producer technical recommendations.

| Equipment cost: | 6217.4$ |
| Cost of installation: | 1.200$ |
| Custom tax: | 2.400$ |
| Total costs: | 9817.4$ |
| Savings: | 5.640$/year |
| Pay-back (years): | 1.74 years |

After the installation was assembled , the power factor increased to 0.95 and there were eliminated the penalties paid for the unachievement of the neutral factor.

SC MUHA SRL SUCEAVA has achieved, by itself, the following objectives:
- Filters station that represents the second stage of separation after cyclones of the solid suspensions in the installations of pneumatic transport and ensures the air recirculation.
- There were insulated the conducts.apparatuses and ventilis of the external networks of termic energy transportation and it was protected the insulation with zinc-coated sheets.
- There were performed works of reparation at the compressed air network and there were eliminated losses.
- Our experts from the production base thought and achieved an optimization plan of the flow chart at the factory of scaffolding-furniture, that ensures the proper working of all the equipments.
The monitoring of the energy, raw materials and scraps savings is done this way:

- At the timber drier, the operator keeps the evidence of termic energy consumption, raw material introduced and resulted from the charges and the percent of waste timber. Presently, especially at the resinous timber drying the percent of offals decreased almost totally, and the consumption of termic energy reported at the achieved production has also been dramatically reduced.

- In the energetic department of the production basis it is daily registered the energy consumption, the present counteroffering precise data for the consumption curve drawing. It allows to take several measures to flat it. We didn’t pay anything as penalties.

- At the factory of scaffolding-furniture, any raw materials brought from the own drier or from other producers, are tested from the point of view of the moisture. The efficiency of the portable device for moisture determination reflects in the quality of the products.

There were completely eliminated the faults of manufacturing, due to the moisture of the raw materials.

5. RECOMMENDATIONS

In order to continue the programme of energetic efficiency improvement, it were handled to SC MUHA SRL SUCEAVA the following recommendations:

- The mechanization of the flow chart of supply with loggs of the saw-mill in the factory of timber.

- The modification of the boilers in the termic station or their replacement with performant boilers and the mechanization of the supply with wood ofals in order to increase the yield.

- The extension of the counter AIR to A1RL in order to allow the data transfer at distance and to permit the straight visualization of the charge curve.

- The accomplishment of a preliminary energetic study for the extensions in order to balance the networks.

- The accomplishment of a global energetic balance in order to discover the high energy consumers and the ways of optimization.

6. PROJECT SIGNIFICATION FOR CEM

The accomplishment of the energetic study for the production basis of the Building Company MUHA and the introduction of the measures ascertained with the experts of USAID, was a good opportunity to improve the knowledge and to rise the professional level.

The fact that Mr. Laurent Pommier has worked with us in the production basis in two stages of 3 days each, made us think differently to the efficientization of the energy consumption. After the conference that took
Dear Mr. Michael,

I have received your fax dated December, 12 1996, about the Final Report of Assessment and Monitoring of SC MUHA SRL SUCEAVA. Here are some explanatory notes in completion at the fourth point in this report.

First step:

The portable device for moisture determinations contributes to the qualitative selection of the raw materials for furniture and scaffoldings by moisture measurements at the suppliers taking over, in the warehouse and in the moment of processing. Consequently, its efficiency reflects in products high quality and in the decreasing of the manufacturing faults.

Until we have received this device, we had to do rectifications estimated at about 97$/month (annual losses of 1164$) because furniture products and scaffoldings were manufactured from incomplete dried timber. These losses are eliminated now, because the moisture percent is strictly controlled in the raw materials that we use.

We may conclude that the manufacturing faults due to moisture have been reduced to zero.

Device cost = 446.74$
Customs tax = 135.00$
Total costs = 581.74$
Total savings = 1164$
Payback (years) = 0.5

The second step:

Until we have received the parts of the installation for automat control of the drying process, this operation was done manually. Manual operation of the timber drying process meant thermic energy extra-consumption, parts with drying faults and extra-working peoples.

Each month, the estimated losses are:
- thermic energy = 289$
- raw materials waste = 280$
- manpower = 128$
Total = 697$/month

Presently, SC MUHA SRL SUCEAVA didn't receive the psychometer yet because of customs misunderstandings and we are working in an semi-automat regime and we're using data from the installed system.
It is countered the thermic energy consumption, and the drying faults are decreased with 80%. At the timber drier, the operator monitors the consumption of thermic energy and it's obviously that there were eliminated the useless consumptions. There were also eliminated the expenditures for the manpower used for samples repeated handling and weighing for moisture determinations.

Hence, there are monthly achieved the following savings:

- thermic energy = 289$
- raw materials = 224$
- manpower = 128$
Total = 641$
Savings in a year = 7692$

Third step:

We buy electric energy from the national energetic system. Until A1R10A counter was mounted, the existing counter of the factory indicated the energy consumption and consequently, the discount is made on the basis of a simple monom tariff.

From the analysis of the payments made before, we can notice average monthly expenditures of 80,6$. After A1R10A electronic counter was mounted, the discount could be made on the basis of the binomial differentiated tariff. Also, it can be surveyed the consumption curve that enables us to take the best decisions for its flattening.

Hence, beside the advantage of small discounts, monitoring of the electric energy consumption has an indirect economic efficiency. Monitoring is made by an employee of the factory energetic department.

<table>
<thead>
<tr>
<th>Equipment cost</th>
<th>655$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of installation</td>
<td>120$</td>
</tr>
<tr>
<td>Total costs</td>
<td>775$</td>
</tr>
<tr>
<td>Total savings</td>
<td>968$</td>
</tr>
<tr>
<td>Payback (years)</td>
<td>0.8 years</td>
</tr>
</tbody>
</table>

Fourth step:

Until the assembly and working of the installation for automat control of the power factor type ACCUVAR, we had the following situation:

- all working equipments from the production basis are actuated by asynchronous engines and consequently, we had a natural power factor much under the accepted limit.
at a given moment there were working more small power engines and the natural power factor were between 0.45 and 0.65.

- the battery of condensers that worked manually doesn't ensure a proper correction of the power factor, that could hardly reach 0.7/

The penalties paid monthly because we were under the average power factor were of 470$/month and 5640$/year, respectively. After the introduction of the installation of power factor automat compensation, ACCUVAR type Junior 105KVAR, these penalties were completely eliminated.

This device is mounted and is working altogether with the old battery.

The new power factor got is 0.95.

Equipment cost = 6217.4$
Cost of installation= 800.0$
Design = 400.0$
Customs tax = 2400.0$
Total costs = 9817.4$
Total savings = 5640.0$
Payback (years) = 1.74 years

The same employee from the energetic department that controls the electric energy consumption also surveys the natural power factor to be in the limits of the neutral power factor.

For the next future, MUHA intends to enlarge the A1R counter to A1RL in order to permit remote data transportation and direct visualization of the charge curve.

After the USAID programme there are monitored:
- thermic energy consumption at the timber drier;
- electric energy consumption at the entire production basis;
- survey and control of the power factor;
- evidence of the timber waste issued after drying process;
- evidence of recovery at the furniture pieces and scaffoldings due to the drying faults.

SC MUHA SRL SUCEAVA also intends to monitorise:
- the electric energy consumption for each factory in the production basis
- thermic energy consumption at the furniture factory and at other consumers.

SC INVEST PROIECT sent to Hagler Bailly in original, the first audit accomplished at the production basis of SC MUHA SRL SUCEAVA.

Results got in the monitoring programme at the production basis of SC MUHA SRL SUCEAVA reflects in:
- decrease of the penalties to be paid to the electric energy supplier;
- thermic energy rationing at the timber drier;
- decrease of the waste at timber drier;
- substantial increase of production
  quality of scaffoldings and furniture by strictly controlling the raw materials
  moisture;
- electric energy rationing.

Haralambie Pavel CEM
THE PROJECT IN BRIEF

Danubiana-tyre company is one of the biggest energy consumer in Bucharest and for this reason the plant is very interested in the production process modernisation productivity growth, and in diminution of energy consumptions in the thermal unit, heat and hot water distribution, consumers of the production section.

Following the study of the energy consumers and also of the distribution and use of the electric energy for the force part on one side, a series of problems have been identified and the correcting solutions have been elaborated in the present study:

1. Improvement of the illuminating system

The replacement of the existing mercury vapour lamps having a nominal power of 400W with high pressure sodium lamps, which have a lower consumption, of only 250W. This realises a 93MWh annual saving, the yearly savings are 40,300US, and the simple payback is 0.2 year.

2. Energy consumption decrease for compressors, compressor section

We suggest reorganising the compressor section by installing measuring apparatus, controlling the energy consumption with a sensor for the upper limit and adjusting the air consumption to the needed level. Verifying the relation Pu/Pnom for the compressor’s motors, it became obvious that an optimal selection of these motors can lead to decrease in the energy consumption.

The continuous correlation between the functioning of the compressor and the other technological parameters is also suggested.

All these suggested procedures will lead to a decrease in energy consumption to 150MWh/year.

Yearly savings are $6,450 US and the payback period is 0.37 years.

3. Reduction of fuel consumption through automatically guided burning

The Danubiana thermal power station is currently equipped with three steam boilers CR12 type, 50 to/hr, 40 bar.

Currently the control of burning is carried out periodically through it’s testing with a
portable flue gas analyzer BACHARCH - 300 USA, purchased by the plant in 1995.

Important energy savings can be realized through the utilization of the automatically guided process of the boiler type BAILEY-ICSS.

The estimated savings of specific fuel average consumption are 3.5% and the equipment cost is $39,900 US. Yearly savings are 101,150 US and the payback period is 0.62 years.

4. Equipping the vulcanization presses with performant steam traps

An important measure for reduction of steam consumption is the equipping of the presses with the efficiently steam traps, ARMSTRONG USA that would reduce the leaks of the uncondensed steam to the equipment of condense recover. It is well known that the thermodynamic steam traps which equipped the presses even in the case the correct functioning can admit leaks of steam between 3-10%.

The energy savings are estimated to 10-15% given to actual consumption.

Yearly savings are $21,510 US and the total installation cost is $26,525 US.

The payback period is 1.4 years.

5. Recovering under pressure of warm drainage from the hot water for tire vulcanization

It is obvious that the losses reduction through recovering of the heat of these drainage conducts to reduction of consumptions of thermal energy at the CUT (utilities) that are necessary for preparation of vulcanization hot water.

Thus it is recommended the recuperation under pressure of the warm drainage proceeded from the presses at the end of the vulcanization.

The yearly savings are $150,000 US and the total installed cost is $387,000 US.

The payback period is 3.15 years.

6. Reduction of the steam consumption at the fuel oil reservoirs

Since there isn’t any automatic control of fuel oil deposit temperature, the steam consumption for fuel heating is higher than the strictly necessary one depending on the temperature of exterior.

Also the thermodynamic steam trap which is equipped the reservoir, has a defective functioning (steam evacuation).

It is suggested that reservoir to be supplied with:
-1 automatic valve for steam flow control
-1 corresponding steam trap

The yearly savings are $2,312 US and the total installation cost is $2,050 US.

The payback period is 0.97 years.

Danubiana also experiences some problems with its energy supply:
- low natural gas pressure in the winter
- decreased steam demand (internally and from outside customers) which results in lower electricity production on the back pressure turbo-generators, and proportionally higher electricity costs.
- varying composition of purchased fuel oil
- Danubiana is aware of the high energy consumption and is attempting to improve this situation.

The purchase of three new centrifugal compressors, to replace the three very old existing units, also the purchase of three new steam boilers, represented a major investment effort.

IMPLEMENTATION OF THE USAID PROJECT

Major dates of program implementation
Audit 1995
Delivery of equipment 1995-96
Installation and commissioning 1996
Monitoring 1996
BACKGROUND OF THE PROJECT

This energy audit made by CAMIGO Ltd BUCHAREST, represents the beginning of the implementation of fuel and energy saving measures, being a part of the U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT (USAID) technical assistance program entitled "ROMANIA ENERGY EFFICIENCY MARKET DEVELOPMENT " in. USAID gave support to that activity.

In May 1995 a US expert had helped Romanian expert from Camigo Ltd. in providing DANUBIANA-SA.BUCHAREST-tyre company with an energy audit.

In the course at this action the interviews had been held is the company with Technical Director, Chief Energy Engineer, Chief of Energy section and Danubiana’s energetic experts aiming at carrying out quick reviews on organizational, financing and tariff structures, the plant’s energy consumptions, operations and maintenance practice.

We inspected the boilers and turbo-generators, the hot water plant, the new compressed air plant and the production halls.

The specific energy consumptions at Danubiana is very high. The information provided by the plant translates into a global energy intensity of 80 GJ/to, which two-to three times as high as the intensity found in some developing countries.

This high energy intensity can be attributed to:
- low production, compared to capacity
- old facilities and equipment (boilers, compressors...)
- poor maintenance practice (insulation, bypassed traps, leaks...)
- no clear system of accountability and responsibility for energy consumption.

SUMMARY OF DELIVERY OF EQUIPMENT, INSTALLATION AND COMMISSIONING

<table>
<thead>
<tr>
<th>ITE</th>
<th>QTY</th>
<th>ITEM DESCRIPTION</th>
<th>PRICE $</th>
<th>SUPPLIER</th>
<th>OBSERVATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>Heavy fuel oil flowmeter</td>
<td>13174,2</td>
<td>Brooks Instrument</td>
<td>Delivered, but not yet installed</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>Natural gas flowmeter</td>
<td>4,291</td>
<td>Brooks Instrument</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>Superheated stem flowmeter</td>
<td>4,090</td>
<td></td>
<td>Partially delivered</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>Ultraprobe 2000 detector</td>
<td>3,718</td>
<td>UE System</td>
<td>Installed</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>Flue gases analysis system</td>
<td>7,860</td>
<td>Bailey Controls</td>
<td>Not delivered</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>Superheated steam flowmeter for CUT2</td>
<td>4,550</td>
<td>Brooks Instrument</td>
<td>Delivered, but not installed</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>Hot water energy meter for CUT 2</td>
<td>4,550</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>24</td>
<td>Steam traps</td>
<td>19,506</td>
<td>Armstrong</td>
<td>Not delivered</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>Refillable steel cylinder</td>
<td>2,980</td>
<td>Ametek</td>
<td>Not delivered</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TOTAL</td>
<td>45,213</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Action No.</td>
<td>Action Description</td>
<td>Thermal cons. Gcal/year</td>
<td>Fuel/To Nat. Gas/Nmc</td>
<td>Electric Energy Consumption MWh/year</td>
<td>Total Savings $/year</td>
</tr>
<tr>
<td>-----------</td>
<td>---------------------------------------------------------</td>
<td>------------------------</td>
<td>---------------------</td>
<td>-------------------------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>1</td>
<td>Improvement of the illuminating system</td>
<td></td>
<td></td>
<td>938</td>
<td>40,300</td>
</tr>
<tr>
<td>2</td>
<td>Energy consumption decrease for compressors</td>
<td></td>
<td></td>
<td>150</td>
<td>6,450</td>
</tr>
<tr>
<td>3</td>
<td>Reduction of fuel consumption through automatically guided burning</td>
<td>549/625</td>
<td></td>
<td>101,150</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Reduction of the steam consumption of the fuel oil reservoirs</td>
<td>112</td>
<td>15.9/-</td>
<td>2,312</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Equipping the vulcanisation presses with steam traps</td>
<td>1119</td>
<td>158/-</td>
<td>21,510</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Recovery under pressure of the warm drainage</td>
<td>8</td>
<td>1.09/-</td>
<td>7</td>
<td>150,000</td>
</tr>
<tr>
<td></td>
<td>TOTAL SAVINGS</td>
<td>1239</td>
<td>724/625</td>
<td>1095</td>
<td>321,722</td>
</tr>
</tbody>
</table>

**ULTRA PROBE 2000-ultrasonic detection system**

The condense recovery rate is less than 50% (probably between 30-50%). Annually steam production of 710,000 t/h with a 30% recovery rate, represents $320,000 per year in treated water costs.

An ULTRAPROBE 2000 type ultrasonic leak detector was delivered to the plant for the verification of the steam traps pipes heat exchangers and to be repaired or changed.

Danubiana purchase 24 steam traps ARMSTRONG which are installed on technology channel nr.3 in the vulcanisation section (There exist 14 technologic channels).

By the measurements made in June 1996 have been obtained reductions of the steam consume of about 3.2% respectively 20 steam to/month (fig 1).

Steam traps installation at all technological channel goes to energy savings estimated in the energy audit (10-15%) that confirms the opportunity of these energy efficiency action.
REDUCTION OF FUEL CONSUMPTION THROUGH AUTOMATICALLY GUIDED BURNING

We tested only one boiler (old type) with a portable combustion analyzer. If we assume that the boilers run at 125% excess air, 88% combustion efficiency and that for the average loading they can be brought down to, conservatively 20% excess air for gas and heavy oil, then the new combustion efficiency would be around 93-94%, or a 5-6% fuel reduction, which corresponds to about $275,000 US/year.

The installation of the Bailey automatically burning control system composed of a fixed flue gas analyser and control system for the functioning parameters of the boilers couldn’t be done because:
The action implementations required big installation costs and quite a large realisation time being necessary the design of the hole control system and purchasing of a performant burner from import, as the actual burners installed on the boilers are technically worn out and can't be integrated in the automatic system.

- The steam boiler required capital reparations to function at nominal parameters.
- Danubiana contracted later in 1996 with Cleaver Brooks the purchasing of three performant steam boilers of 30 to/hour to replace the old boilers by 50 tone/hour (CR 03).
- The installation of the Bailey control system can be realised thus on one of the newer boilers (CR 12) which can be adapted efficiently, following that in function of the economical obtained results to be extended at the other two boilers in the power station, too.

In these conditions we can partially anticipate the results of these action from the USAID project, by the presentation of the obtaining energy savings by the utilisation through gas portable analyser by which Danubiana works since 1995.

By the constant utilisation of this apparatus at Danubiana which realises the burning control by the chemical analyse of flue burning gas (O2, N, CO) and optimises the boiler efficiency obtained the following energy savings:

- The fuel savings are 1.5% which represent 56,000 cubic meter natural gas/month, at about $3,100 US/month
- By the evidence of the energetic consumers from Danubiana energetic department and by the measurements done in July and September in 1996 for the steam boilers have been identified the smallest specific consumers by the last 6 years, rapported to the tyre production (table 1):

<table>
<thead>
<tr>
<th>Specific Consumption</th>
<th>Sept 1995</th>
<th>Sept 1996</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mwh/to</td>
<td>100</td>
<td>98.4</td>
<td>-1.6</td>
</tr>
<tr>
<td>tcc/to</td>
<td>100</td>
<td>89.5</td>
<td>10.5</td>
</tr>
<tr>
<td>Tyre production</td>
<td>100</td>
<td>91.2</td>
<td>-8.8</td>
</tr>
</tbody>
</table>

- By the simple implementations of energy savings measures at Danubiana, the actual demand of the thermal energy is satisfied by the functioning only a two steam boilers facing the similar period from the last year when there where functioning three steam boilers obtaining thus important energy savings. These measures are:
  - The tuning of the burning installation of the boilers with flue gas analyser BACHARACH
  - The replacement of the steam traps only on one technologic channel
  - The replacement of some used technological steam transport pipes which have been located using ULTRAPROBE 2000
  - The converting of some steam consumers on warm water produced by the existing boilers

This action have been realised by Danubiana in this year and cost near $500,000 US in the modernisation and energetic consumers program promoted by the energetic department to the plant.

RECOMANDATIONS

The presented actions in this report doesn't represent but a part of the real energy savings possibilities which exists at Danubiana and which are under the attention of the Energetic Department and will be realised - we are sure -soon. We suggest a big attention to the next actions:

- Maximise benefits from the newly acquired BACHARACH for the boilers maintenance
• Install fixed flue gas analyser. Even if the portable combustion analyser is used regularly, the achievable savings will not be as big as the savings through fixed through gas analyser.
• Install the new three boilers in the power house.
• Repairing or replacing the dampers should be a high priority for the plant, as properly operating dampers could allow to achieve big fuel and gas savings (at least 3-5%) in combination with combustion analyser (the portable one plus any fixed one).
• Minimize the boiler’s fan powers by trying to use the most efficient combinations of dampers and rheostats.
• Re-evaluate the consumptions of all electric motors.
• Repairing steam and hot pipes insulation.
• Maximise benefits from ULTRAPROBE 2000 detection system for steam traps, pipes, bearing, etc.
• Implement a steam trap maintenance team so the operators can trust their traps.
• Check the current use of mixers during on-peak hours and during off-peak time.
• Evaluate the actual (not nominal) load of the mixers when in use.
EXECUTIVE SUMMARY

1.0. Plant description

Mobins SA Bucharest is a state owned wood furniture plant. The Mobins is approximately 43 years old and currently employs 785 full time employees. Wood waste is used as fuel for limited on site steam generation and the balance of steam is purchased from outside sources. Electricity is purchased from the utility. Energy consumption at Mobins is relatively small when compared to larger facilities but the opportunities for energy efficiency improvements is large. During the course of the audit, Camigo Ltd. Bucharest and Hagler Bailly advisor identified several projects and agreed with Mobins to request USAID's support improve energy efficiency through more efficient control of wood drying processes and steam improvement through better trapping.

Plant annual consumption (and 1994 European energy costs):

* Electricity: 3,304 Mwh, $165,200, excluding demand
* Purchased steam: 13,000 Gcal, $160,000

2.0 Summary of activities

2.1. The scope of contract between the Mobins and the C.E.M.:

* To evaluate energy consumption at the plant
* To identify the energy efficiency opportunities
* To identify low cost tuning, operational and maintenance recommendations
* To identify instrumentation and low cost equipment needed by the plant to implement the more attractive energy consumption actions

2.2. List of actions that were recommended to the plant:

- The modernisation of the drying department
- The monitoring of the thermal agent supply
- The redimensionalization of the ventilation and the heating systems
- The redimensionalization of the pneumatic transport system
- The substitution of the old illumination system
- The redimensionalization of the all electric engines
- The replacement of the compressed air system
- The modernisation of the thermal unit
- The implementation an efficiency condense recovery system
2.3. The implemented action

- Install fixed moisture meters and temperature/humidity controllers as a demonstration of optimising the drying process.

2.4. Major data of program implementation

<table>
<thead>
<tr>
<th>Audit</th>
<th>1994-1995</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delivery of equipment</td>
<td>1995</td>
</tr>
<tr>
<td>Installation and commisioning</td>
<td>1996</td>
</tr>
<tr>
<td>Monitoring</td>
<td>1996</td>
</tr>
</tbody>
</table>

3.0. Measure report

3.1. Justification for the measure

Existing conditions:

* The drying process management is carried out manually, with poor metering and monitoring of energy utilization

Recommended action:

* The recommended action focus for the immediate needs for energy efficiency improvement is the mounting of fixed moisture meters and temperature/humidity controllers for optimising the drying process.

3.2. Description and implementation

The fixed wood moisture content monitoring system type, DELMHORST SYSTEM RDM -25, $4,000, was implemented in July - August 1996 and start-up in September 1996. Mobins installed with their own forces the equipment for moisture control, installation cost is $1400 (design, installation, materials, probes).

3.3. Monitoring methodology and procedure.

* The functioning parameters measurement was made in the period 5-20 September for 1 drying cycle.
* The drying fans electric power consumption was measured with an ITT electronic meter.
* Because in the drying section it isn't installed one fixed steam flue meter, the steam consumption was evaluated in concordance with technological parameters of all steam consumers (presses, drying rooms).
The timber production (quality, final humidity, quantity of rejects, drying cycle time), was measured in the end of drying cycle and compared with technical dates existing in the evidence of the energetic department.

The technological parameters of drying process (humidity, temperature) was observed at 8 hours interval with Delmhorst System, when the operators change the steam and ventilation system.

### 3.4. Results of Measurements and Monitoring

<table>
<thead>
<tr>
<th>Baseline-existing conditions</th>
<th>Electricity</th>
<th>Thermal</th>
<th>Wood consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>492 Mwh/year</td>
<td>7936 Gcal/yr</td>
<td>4250 cub. met/yr</td>
</tr>
</tbody>
</table>

#### RESULTS

<table>
<thead>
<tr>
<th></th>
<th>Before installation (estimated)</th>
<th>After installation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Drying rejects reduction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>poplar</td>
<td>5-6%</td>
<td>7%;202 cub. met/yr</td>
</tr>
<tr>
<td>beech</td>
<td>10-12%</td>
<td>10%;42 cub met/yr</td>
</tr>
<tr>
<td>oak</td>
<td>12-14%</td>
<td>12%;112 cub met/yr</td>
</tr>
<tr>
<td>2. Electric energy</td>
<td>64 Mwh/year</td>
<td>63 Mwh/yr</td>
</tr>
<tr>
<td>3. Thermal energy</td>
<td>677Gcal/yr</td>
<td>650Gcal/yr</td>
</tr>
<tr>
<td>4. Reduction of the drying time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>oak</td>
<td>not estimated</td>
<td>9%</td>
</tr>
<tr>
<td>beech</td>
<td></td>
<td>7%</td>
</tr>
<tr>
<td>5. Growing of the loading degree:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Timber thickness (mm):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>not estimated</td>
<td>+6.2%</td>
</tr>
<tr>
<td>32</td>
<td></td>
<td>+3.5%</td>
</tr>
<tr>
<td>40</td>
<td></td>
<td>+3.8%</td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>+4.5%</td>
</tr>
<tr>
<td>6. Growing of the timber quality:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final humidity difference</td>
<td>2-3%</td>
<td>less1%</td>
</tr>
</tbody>
</table>
3.5. Review of Economics of the Measure

<table>
<thead>
<tr>
<th>ENERGY SAVINGS</th>
<th>Gcal/yr</th>
<th>Mwh/yr</th>
<th>cub. metre/yr</th>
<th>$US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal energy</td>
<td>650</td>
<td></td>
<td></td>
<td>8,250</td>
</tr>
<tr>
<td>Electric energy</td>
<td></td>
<td>63</td>
<td></td>
<td>3,168</td>
</tr>
<tr>
<td>Wood consump.</td>
<td></td>
<td></td>
<td>356</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>650</td>
<td>63</td>
<td>356</td>
<td>11,418</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>IMPLEMENTATION COST</th>
<th>Estimated</th>
<th>After implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td>2,000</td>
<td>-</td>
</tr>
<tr>
<td>USAID equipment</td>
<td>6,800</td>
<td>3,937</td>
</tr>
<tr>
<td>Supplementary equip.</td>
<td>8,650</td>
<td>250</td>
</tr>
<tr>
<td>Equipment installation</td>
<td>3,750</td>
<td>1,100</td>
</tr>
<tr>
<td>Equipment commisioning</td>
<td>5,625</td>
<td>150</td>
</tr>
<tr>
<td>Duties and taxes</td>
<td>1,300</td>
<td>780</td>
</tr>
<tr>
<td>Total implementation cost</td>
<td>28,125</td>
<td>6,217</td>
</tr>
<tr>
<td>Payback period</td>
<td>0.72 years</td>
<td>0.59 years</td>
</tr>
</tbody>
</table>

*The considered prices (European energy costs in 1994) are:

1 MWh = $ 50
1 Gcal = $ 12.69

*The difference between estimated costs in the energy audit and the real costs after the equipment implementation is made because Mobins has installed the equipment by own forces and renounced at the equipment delivery for phase II of the USAID program (steam traps, valves, fan actuators, etc.)

Recommendations:
*Maximize benefits from the newly aquired Delmhorst system by:

- Recommending and/or conducting some training for the operators
- Recommending a schedule for tests with the equipment
- Recommending a procedure for logging data, reviewing it, and setting performance goals.
MONITORING PLAN

MOBINS SA BUCHAREST-FURNITURE FACTORY

1. Current status
The DELMHORST SYSTEM-fixed moisture meters and temperature/humidity controllers for optimising the drying process is in function.

2. Actual dates
2.1. Equipment delivery to custom Mars 1995
2.2. Equipment delivery to plant June 1995
2.3. Installation Aug 1996
2.4. Start-up Sept 1996

3. Planned methodology to evaluate the energy savings produced by the measure

The data used to measure or evaluate system’s energy consumption is:

* The drying fan’s electric power consumptions
* The thermal energy consumptions
* The timber production evaluation (quality, final humidity, rejects, etc.)
* The humidity/temperature control.

The data was gathered for 1 drying cycle time (appr. 15 days) and the measurements had been done at 8 hours (for every shift).

The equipment used for the measurements is:

* ITT electronic meter for electrical consumers
* Delmhorst System for humidity and temperature control, supplied by USAID

3.1. The estimated energy savings "before" the equipment installation are:

a) Drying rejects reduction:
   poplar ........................................5.6%
   beech .......................................10-12%
   oak .........................................12-14%

b) Electric energy savings:
   37 MWh/year for 1 drying room
   64 MWh/year for 10 drying rooms

c) Thermal energy savings:
   210 Gcal/year for 1 drying room
   677 Gcal/year for 10 drying rooms.
3.2. The measured/estimated energy savings "after" the equipment start-up:

a) Drying rejects reduction:
   - poplar: 7%
   - beech: 10%
   - oak: 12%

b) Electric energy savings:
   - 34 MWh/year for 1 drying room (measured)
   - 65 MWh/year for 10 drying rooms (estimated)

* Mobins decided to mount the Delmhorst equipment only for 5 drying rooms because:
   - By the mounting in the drying room of more temperature/humidity control elements it is realised a better control for the technological parameters of the drying process.

c) Thermal energy savings:
   - 210 Gcal/year for 1 drying room (estimated)
   - 650 Gcal/year for 10 drying rooms (estimated)

d) Reduction of the drying time:
   - oak: 9% (measured)
   - beech: 7% (measured)

e) The drying timber quality is better than the old technological process, respectively the final humidity differences are less 1%, comparatively with 2-3% in the old process.

Eng. Florin Mihăilescu
CENTRAL AND EASTERN EUROPE
REGIONAL ENERGY EFFICIENCY PROJECT
EUR-0030-C-00-2053-00

Energy Pricing, Energy Efficiency, and
Energy Sector Restructuring Component

Macedonia
Industrial Energy Efficiency

Task Completion Memorandum

Prepared for:

U.S. Agency for International Development
Bureau for Europe and NIS
Office of Environment, Energy,
and Urban Development
Energy and Infrastructure Division

Prepared by:

Hagler Bailly Consulting, Inc.
1530 Wilson Boulevard, Suite 900
Arlington, VA 22209
(703) 351-0300

September 1996
CENTRAL AND EASTERN EUROPE
REGIONAL ENERGY EFFICIENCY PROJECT

Task Completion Memorandum

Macedonia - Industrial Energy Efficiency

Summary Task Description

In 1991 the USAID Emergency Energy Project carried out energy management programs in eight industrial enterprises in what was then Yugoslavia. The primary objective was to achieve short-term, low-cost energy savings, focusing on oil and gas. Energy audits were completed in these eight industries, but due to the breakup of the country and the outbreaks of violence, these audits were never followed up, nor was the equipment purchased. This purpose of this task is to complete the purchase of equipment for the plant in Macedonia which participated in the Emergency Energy Project. However, given changes in the economic situation of the country, and the more than two years that have passed since the original audit, an effort will be made to update the audit based on the plant's current operation.

This task involves the purchase and shipping of equipment up to $30,000 in value for a plant in Macedonia which had participated in the 1991 Emergency Energy Program for Yugoslavia. This will require updating of the energy audit performed under this program, and selection of equipment in conjunction with the plant management and technical personnel. The end result of this task will be the energy and cost savings resulting from the installation of energy efficient equipment in the plant. In addition, the plant will implement low-cost high payback measures for energy savings as identified in the audit report.

Specific Goals and Objectives

The general goal and objective of this task is to follow up on the energy audit performed at the Boris Kidric ceramics factory in Titov Veles, Macedonia, under the Emergency Energy Project for Eastern Europe in 1991.
The specific objectives of the task are:

1. Update the plant operation and energy use information originally included in the audit.

2. Reach agreement with the plant to provide energy saving equipment to be installed and used in the plant. This equipment is to be procured under the same conditions as for the Emergency Energy Project, i.e., up to a total value of US$30,000 as described to the plant management in 1991.

Expected Outputs

The project is expected to achieve the following outputs:

- installation of U.S. energy efficiency equipment in a plant in Macedonia
- energy and cost savings to the plant as a result of the installation of the energy efficiency equipment
- improved energy awareness on the part of the plant staff, including interest in implementing additional energy efficiency measures

Deliverables

- trip reports to AID
- monthly progress reports to AID
- energy efficiency equipment for the plant
- final report

Results and Next Steps

Project staff visited the plant three times between June 1993 and August 1994, and laid out a collaborative plan to update the technical data required to finalize the equipment specification and purchase. However, a number of problems, including changes in plant staff, technical requirements of the equipment, and finally, questions of the viability of the plant itself during the 1995-96 period of the trade embargo in Macedonia conspired to delay the equipment purchase. Changes in technology and new operating conditions ultimately increased the cost of the proposed equipment to the plant, and the equipment purchase was not finalized during the contract period. A brief chronology of project activities follows.
July 1993: Re-establishment of contact with plant, requesting updated information and a meeting on site.

August 1993: Meeting at plant facilities; plant operating 20-30% of former capacity, but claims to have same electrical demand as before, so are definitely interested in the equipment. Plant technical staff assigned to update load information.

January 1994: Meeting at plant. Plant operating at 40-50% of capacity. No progress on updated information from the plant. New head of Development Department promises to act, and a tentative project schedule is agreed upon.

June 1994: Meeting at plant. No new information available; plant staff assigned detailed technical tasks to define equipment operation.

August 1994: Meeting at plant. Still no detailed information available. Answered technical questions of plant staff; reviewed their progress in measurement. Energy consumption data obtained show plant operating at about 1/3 capacity, with demand about half the peak in 1990-91.

Jan-Jun 1995: Initial contacts with energy management equipment vendors. Technical information forwarded to plant for comment, but no response. Rumors plant is closed due to loss of market due to the embargo.

Sept. 1995: Plant staff send updated information on energy consumption and demand. Plant is apparently in the Macedonian government’s privatization process. No information on processes operating, nor individual equipment.

Oct 1995-Jan 1996: Repeated efforts to contact plant are in vain; likely closed for end of year holidays and low production.

Feb. 1996: Johnson Controls agrees to send staff at no cost to the project to meet with plant and prepare a proposal for the project. It takes several months to coordinate schedules and make the visit.

Sept. 1996: Proposal from Johnson Controls for required system improvements for $125,000. After discussion and evaluation of the most necessary equipment, cost is reduced to $75,000.

The plant is still interested in the equipment, but can not offer to cover any portion of this cost. Production is still low, and ownership aspects remain unclear. Recent energy data and detailed equipment operation are not available, so the basis to make a cost-benefit calculation for the purchase of the equipment does not exist. Given this lack of data, the difficulty of obtaining sole source approval to proceed with Johnson Controls, and the short time remaining on the project,

Hagler Bailly Consulting

Task Completion Memorandum
it was decided not to pursue the equipment procurement.

**Next steps:** As part of future USAID energy efficiency work in Macedonia, the status of the Porcelanka plant should be monitored. If the outlook for production has improved, and some commitment can be obtained from the plant, the installation of energy management equipment can offer an important reduction in operating costs at an attractive payback. The purchase of this equipment can provide USAID an industrial energy efficiency demonstration project and follow through on a commitment to the plant first made in 1991.
Memorandum

TO: Robert Archer, AID Bureau for Europe
FROM: Mark Oven
CC: David Keith
DATE: August 31, 1993
SUBJECT: Trip Report, Macedonia, August 23 (Boris Kidric)

I was in Macedonia on August 23 to visit the Boris Kidric porcelain and ceramic tile factory and discuss the finalization of the equipment specifications for the electric demand control system. I traveled by vehicle from Sofia, accompanied by Georgy Rampov, one of our consultant trainees in energy efficiency, who came along on his own initiative due to family ties in Macedonia.

At USAID I spoke to Leroy Jackson, who has taken over for Jim Grossman until the permanent representative arrives. I briefed him by telephone on the history and the current activities of the project. Due to both our time constraints, we could not arrange a meeting time in person.

At the plant I met with Mr. Andreja Stojanov, Director of Development, and two of his technical staff. The Deputy Director, Mr. Bogdan Daev, sent his regards, but could not participate due to a meeting he had in Skopje. We reviewed the proposed equipment in detail, as well as the conditions and responsibilities of Hagler, Bailly, USAID and the plant in its procurement and installation. Among the most important points made in the meeting are the following:

- Due to the transport and market problems caused by the war in the former Yugoslavia, the plant is operating at 20 to 30 percent of capacity. The floor tile line has recently been shut down, and only tableware production is continuing. The condition of the plant is tenuous, but they hope they can continue to operate at least these lines. The operation of the plant, therefore, has changed significantly since the audit was performed, and an update of that audit will be necessary.

- The plant staff were not ready to work on identifying the motor loads during my visit, but the plant electrical engineer, Mile, was assigned to present a study of the motors that should be connected to this system, updating the original audit information. (Demand costs remain an important part of their total electric bill; in fact, their contribution should increase due to the low overall load.) This study will be completed and communicated to us within approximately 2 months.

RCG/Hagler, Bailly, Inc.
Hagler, Bailly will remain in contact with the plant to share information and to support their efforts to identify the equipment needs.

Until the updated study is performed by the plant, and until a better idea is available of the overall viability of the plant, it will not be prudent to purchase any equipment. In fact, due to the changes in the operating parameters of the plant, other types of equipment may be more suitable than the electrical demand control equipment in question.

For the time being, we should await the plant's own work on this project. Eventually, we could support the plant by offering additional technical capability via our Bulgarian consultants (Georgy Rampov would be a good candidate, for example) to ensure proper specification of the equipment.
Memorandum

TO: Robert Archer, AID/ENI/EUR/DE/EI
FROM: Mark Oven
CC: David Keith
DATE: January 31, 1994
SUBJECT: Trip Report, Macedonia, January 23-24, 1994

I was in Macedonia on January 24 to visit the Boris Kidric ceramic tiles factory in Titov Veles.

At the plant I met with Trajce Trajkov, Director for New Investments and Andreja Stojanov, Head of the Development Department. The mood at the plant was more upbeat than on my previous visit; while the production is still lower than normal (about 40-50% of capacity), they are continuing to produce and find markets for the tiles.

We reviewed the technical situation at the plant with respect to the proposed purchase of a demand control system. We discussed the technical aspects of such a system, since Trajkov had not been present at the previous meeting last August. The large number of mixers and grinding machines are still required for the variety and quality of the product, and the electricity demand charges remain high. Trajkov produced the wiring diagrams and specific lists of motor loads we had requested in faxes over the last several months. He promised to fax the operating priorities of the motors within the next two weeks.

We agreed with the plant on a tentative schedule as follows:

- final information obtained from the plant: mid February
- preliminary specification prepared by Hagler Bailly: end February
- plant reviews and okays specification: early March
- evaluation of quotations and concurrence of plant: end March
- approvals and ordering of equipment: mid April
- delivery of equipment and shipping to plant: early July
- startup of equipment operation: mid August

I met with USAID Skopje Representative Linda Gregory after the plant visit, and briefed her on the results. She offered to help follow up with the plant, and described her visit to the director there last fall. I gave her a copy of Trajkov's card as the primary technical contact, and agreed to keep her posted on the progress.

RCG/Hagler Bailly
For your information, I am attaching a copy of a fax sent to Porcelanka in Titov Veles, summarizing our meeting on June 27.

Stojanka Ruzinova has been put in charge of the Development department at Porcelanka, and is now responsible for this project. I feel quite confident that she will be able to ensure a timely completion of the project. I gave her your name as a possible contact.

I'm sorry we weren't able to touch base on this trip, but I'll contact you when I'm back in early August.

Best regards.

[Signature]
It was a pleasure to meet with you last week and discuss the remaining details needed to finalize the energy efficiency project and equipment installation in your plant.

In the following points, I would like to summarize the agreements with your staff regarding the technical information required. We agreed that this information would be prepared in the course of the next four weeks, and be ready in early August. I hope to return for a meeting with you on August 8 or 9, when we can review this data and complete the technical specifications for the electronic control equipment.

Plant staff will undertake the following activities:

- Update the major motor list for the plant, including measurements of actual loads under typical conditions for all motors 5 kW or higher.

- Perform a continuous recording of total plant demand during a minimum of two 24-hour periods.

- Present a table of the plant-wide monthly electrical consumption data for the last three years (1991-1993) and the first six months of 1994. Add data on separate transformers when available.

- Identify the equipment required to obtain pulse signals from the two existing electricity meters installed in the plant. Prepare specifications and estimate approximate costs for this equipment.

I will provide technical data on various applicable systems when we meet next month.

I will look forward to meeting you and your technical staff in August. In the meantime, please do not hesitate to contact me if you have any questions.
Memorandum

TO: Robert Archer, AID/ENI/EEUD/EI
FROM: Mark Oven
CC: David Keith
DATE: August 18, 1994
SUBJECT: Trip Report, Macedonia, August 8-9 (Industrial Energy Efficiency)

I was in Macedonia on August 8 and 9, 1994 to follow up on the data promised by the plant during my previous meetings in June. I travelled by road from Sofia accompanied by Nick Zikatanov.

While the plant is operating at extremely low capacity this summer, most of the data promised by the plant was presented by them and the local consultant Hemija Komers. With this data, we can proceed to make contacts with potential equipment suppliers to specify the system and obtain quotations.

In the transition to a new manager of the development department, technical data on potential systems from Honeywell and Johnson Controls that I sent to Porcelanka over the past year has been lost. I promised to send a new package of updated technical materials.

With the technical staff of the plant, we identified two additional functions useful to the production process that the energy management system can perform: measuring and calculating energy consumed per motor or group of motors; and counting number of revolutions of the mills in order to optimize the mixing and grinding processes. Both of these can be included in the system to be purchased; we will check the additional costs of the equipment required to perform these functions.

The plant agreed to be responsible for customs clearance of the equipment, and we will plan to ship the equipment directly to the plant.

Given the overall economic situation in Macedonia, the short-term viability of the plant may become a question in the next few months. At this point however, we are still proceeding with the project. Before obtaining final approval for procuring the equipment, we will review this situation again.

Due to time constraints, it was not possible for us to return to Skopje to meet with the USAID representative. Attached is a copy of the fax sent to the representative regarding my trip.

RCG/Hagler Bailly
RCG/Hagler Bailly
1530 Wilson Boulevard, Suite 900
Arlington, VA 22209-2406 U.S.A.
Tel: (703) 351-0300; Fax: (703) 351-0360
Internet email: moven@habaco.com

To: Linda Gregory
From: Mark Oven
Sheraton Sofia, Room 158
Date: August 9, 1994

Fax No.: 389-91-118-105
Page 1 of 2

(1) I'm sorry I didn't contact you yesterday when Nick Zikatanov and I were at Porcelanka in Titov Veles. I had actually planned to come through Skopje on the way back, but we didn't finish discussions with the plant personnel until after 6 p.m. In any case, the following is just to bring you up to date on progress.

(2) The combination of a local consultant and the appointment of Stoyanka Ruzinova as the head of the development department appear to have gotten things moving at the plant, even in the middle of a hot summer. We now have detailed motor lists including electrical capacities and priority grouping of these motors. In addition, we have updated monthly energy demand, consumption and power factor figures for the plant during the last three years.

(3) Unfortunately, the new team does not have all the technical information we had provided to the previous team over the past year. I'll take care of that in the next two weeks. The new team does have a heads up electrical engineer who can be counted on for better information and who will be involved in the installation of the system.

(4) From the beginning, the idea has been to connect the 87 mills and mixers in 24 groups so that their operation may be controlled automatically in order to limit electrical demand during hours of peak demand on the electrical system. In addition to this energy and cost-saving control, yesterday we identified another potential function of the system: optimum run time of the mills and mixers to ensure optimum quality of the slip used for tiles and dinnerware while minimizing energy consumption. The microprocessor certainly has the capability for this additional function; it is a question of the costs of the sensors to determine the cumulative number of revolutions of the mills. I will look into the additional associated costs.
Plant energy consumption this year has been about two-thirds that of the peak year of 1991; this summer it has dropped to half. Actually, this summer it has dropped even lower. Current plans call for starting up additional production lines on September 15. Nevertheless, the overall financial state of the plant is likely not good; I don't know what that might bode for long-term operation. You probably have a better feel for such things in the context of the developing situation in the country. I'll be sure to contact you before submitting any request for approval of equipment purchase to Bob Archer; in any case this wouldn't happen before October. In the meantime, I'll keep you informed of any important developments in this work.

I don't foresee any need for a trip back here in the next several months; I will count on the contacts we have established in the last two trips.

Feel free to contact me with any questions or comments. I'll be back in the office on Monday, August 15.

[Signature]
CENTRAL AND EASTERN EUROPE
REGIONAL ENERGY EFFICIENCY PROJECT
EUR-0030-C-00-2053-00

Energy Pricing, Energy Efficiency, and
Energy Sector Restructuring Component

Macedonia
Independent Private Power Workshop

Task Completion Memorandum

Prepared for:
U.S. Agency for International Development
Bureau for Europe and NIS
Office of Environment, Energy,
and Urban Development
Energy and Infrastructure Division

Prepared by:
Hagler Bailly Consulting, Inc.
1530 Wilson Boulevard, Suite 900
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(703) 351-0300

December 1996
CENTRAL AND EASTERN EUROPE REGIONAL ENERGY EFFICIENCY PROJECT

Task Completion Memorandum

Macedonia - Independent Private Power Workshop

Summary Task Description

As with other countries of Eastern Europe, Macedonia has suffered from an economic crisis and a collapse in industrial output as the transition from central planning to the market economy has taken place. The power sector has been hard hit by a financial crisis resulting from mounting accounts receivables and a lack of investment in an aging and poorly maintained power system. In order to attract badly needed investment, the Macedonia Ministry of Economy expressed an interest in learning about the requirements for private power. For this reason, a seminar that summarizes the experience with private power in other countries and a summary of the requirements for attracting private capital into the power sector was arranged.

Specific Goals and Objectives

A seminar on private power was organized and implemented in Skopje for the Macedonian Ministry of Economy on privatization options for the power sector and ways to attract foreign investment. In preparation for this seminar, meetings were held with the Ministry of Economy and key Macedonian companies interested in power project development to discuss private power project development, including Skopje Steel Works and Makmetal. Specific projects were reviewed, including cogeneration and small scale hydro projects.

Final Delivered Outputs

A private power seminar agenda was defined, plans for seminar implementation were worked out with the co-sponsors, USAID and the Macedonia Ministry of Economy, and the seminar was implemented. Brief technical assistance was provided in the meetings with companies interested in private power projects in cogeneration and hydropower.
Deliverables

The final deliverables produced under this task were:

Private power seminar
seminar agenda and proceedings
technical assistance through meetings with companies

Results and Next Steps

The seminar was successfully competed and the requirements and experience with private power was communicated both through discussions and a proceedings that was distributed at the seminar. The AID program did not have plans or a budget for any follow-on actions in the area of private power. Therefore, no follow-on steps were prescribed or implemented.
MACEDONIA INDEPENDENT POWER SEMINAR

Sponsored by:

U.S. Agency for International Development
Macedonia Ministry of Economy

Skopje, Macedonia

June 22, 1994
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INDEPENDENT POWER: OBJECTIVES AND EXPERIENCE

by

Matthew Buresch

RCG/Hagler, Bailly, Inc.

at the

MACEDONIA INDEPENDENT POWER SEMINAR

Skopje, Macedonia

June 22, 1994
INDEPENDENT POWER: OBJECTIVES AND EXPERIENCE

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II THE OBJECTIVES AND ADVANTAGES OF INDEPENDENT POWER

III THE INTERNATIONAL EXPERIENCE WITH PRIVATELY DEVELOPED POWER PROJECTS

IV CONCLUSIONS: FUNDAMENTAL TRENDS IN THE IPP INDUSTRY
Independent power represents the financing, construction, and operation of a power generating facility by a company that is independent from the central power purchasing electric utility. The central utility can either be private or government owned, but in both cases is a regulated monopoly. The independent power generator is usually owned by a private company. It is typically an unregulated facility that enters into a clearly-defined power purchase agreement with the utility.
OBJECTIVES OF INDEPENDENT POWER

- **Access to Private Capital.** The attraction of both foreign and domestic private capital will increase investments in the country and reduce the debt burden of the utility. By integrating the power sector into the international capital markets, the ability of electric utilities to modernize and meet their expansion plans will be enhanced.

- **Transfer of Optimal Technologies.** With the infusion of foreign investment will come the application of state-of-the art technologies that will enable an electric company to improve the quality of service and operate in a more efficient and environmentally-sound manner. In addition, with private investments will come improved business management and accounting practices and expanded training and development of power sector workers.

- **Expanded use of Renewable Energy and Cogeneration.** An independent power policy framework will induce private companies and industry to cost-effectively expand indigenous renewable energy and cogeneration capacity in a way that could reduce a country's dependence on imported energy and hard currency requirements. These facilities could provide electricity at a price that is below an electric utility's avoided costs and would offer environmental benefits.

- **Competition Leading to Minimized Costs.** The competition fostered by independent power not only induces private developers to generate power at minimum prices but also provides important benchmarks for an electric utility in determining the actual costs of new generation.
THE INTERNATIONAL EXPERIENCE WITH INDEPENDENT POWER

- **The Demand for Power:** The demand for generation capacity outside of the United States between 1993 and 2000 is expected to be around 536 GW of new capacity by 405 utilities in 131 countries. This market represents about $1 trillion in generation, transmission, and distribution investments.

- **The Market for Independent Power:** The market for independent power investment currently under some stage of consideration/development outside the United States (both for privatization as well as construction of new capacity) is around 410 GW.

- **Restructuring of the Power Sector:** The restructuring and privatization is proceeding rapidly in most countries of the world:
  - More transparent power sector regulatory frameworks are being established
  - Power monopolies are being dissolved and markets are becoming more competitive
  - Independent generators are supplying a growing share of electric power
  - Existing utilities are being restructured and privatized

- **The Demand for Private Capital:** With over 350 GW of capacity investments required by the year 2000 by 90 different countries, the requirement for private investment will be on the order of $300 - $350 billion. The availability of private capital for the private sector, however is constrained due to extensive competition for investments.
CONCLUSIONS: FUNDAMENTAL TRENDS IN THE IPP INDUSTRY

- **Project versus Policy Development:** Individual independent power projects are proceeding on a contractual basis without all the necessary policy, regulatory, and institutional conditions.

- **Competition for Capital:** The demand for power investment has exceeded the supply of capital in many countries creating a very competitive financial market, particularly for debt financing.

- **Credit Enhancement Needs:** The high levels of country risk in many emerging markets will require credit enhancement from multilateral (e.g. World Bank, IFC, EBRD) and bilateral (e.g. EX-IM, ECGD, OPIC, etc.) institutions.

- **Project Development TimeFrame:** The time required to develop projects from negotiations, financing, to construction are taking longer than expected due to the complexity of emerging markets and limited recourse financing.

- **Environmental and Bidding Requirements:** The introduction of more strict environmental, permitting, least cost expansion planning, and competitive bidding requirements in some countries is adding new but generally necessary layers of complexity.
The Independent Power Market Abroad
-- A Market at Various Stages --

Operating 26,290 MW

Under Development 99,475 MW

Early Planning 69,955 MW

Responding to Bids 16,800 MW

Under Bid Consideration 160,130 MW

Planned for Privatization 37,795 MW

Source: RCG/Hagler, Bailly, Inc., September 1993
International Independent Power Data Base
Participation and Equity Controlled by Different Competitors

No. of Companies

TOTAL = 120 Companies

Source: RCG/Hagler Bailly, November 1993
International Independent Power Capacity Announced

Source: RCG/Hagler, Bailly. Inc., September 1993
The Independent Power Market Abroad

177 Initiatives
23 Countries
52,978 MW

188 Initiatives
22 Countries
70,137 MW

464 Initiatives
16 Countries
272,290 MW

862 Projects
74 Countries
410,445 MW

> 20,000 MW  5,000-20,000 MW
China  Argentina  Colombia
India  Hong Kong  Italy
Pakistan  Hungary  Portugal
Indonesia  Thailand  Turkey
Malaysia  Turkey  U.K.
Mexico  Philippines  Venezuela

Current Distribution of Announced International Independent Power Projects Worldwide by Energy Source

- Number of Projects: Total 706
- Capacity (MW): Total 375,210

Source: RCG/Hagler, Bailly, Inc., September 1993
Projected Generation Capacity Additions Overseas
1993 - 2000

Total: 536 GW

Europe: 125 GW
Middle East/Africa: 78 GW
Asia/Pacific: 277 GW
Central/Latin America: 56 GW

Source: RCG/Hagler, Bailly, Inc., September 1993
POLICY AND INSTITUTIONAL FRAMEWORK FOR PRIVATE POWER

by

Peter Lalor

Commonwealth Power, Inc.

at the

MACEDONIA INDEPENDENT POWER SEMINAR

Skopje, Macedonia

June 22, 1994
POLICY AND INSTITUTIONAL FRAMEWORK FOR
PRIVATE POWER

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I INTRODUCTION

II POLICY AND LAWS

III ENERGY REGULATIONS AND INSTITUTIONS

IV POLICY GOALS AND EARLY PROJECT DEVELOPMENT
- "fresh start" for revenues and cost recovery
  - streamline operations
  - induce private capital for expansion/
    modernization

- destructuring/ privatization option and implementation problems
  - theory vs. practice
  - competitive systems must be sufficiently large
  - competitive systems must have generating diversity
  - competitive systems must have effective markets

INTRODUCING COMPETITION INTO THE GENERATION SECTOR

- maintain monopoly in generation and transmission

- complete vs. partial opening of the generation market

- forms of solicitation
POLICY AND INSTITUTIONAL FRAMEWORK FOR PRIVATE POWER

I. INTRODUCTION

CONVENTIONAL MODELS FOR ELECTRIC UTILITIES WORLDWIDE

- state ownership
- regulated private ownership
- semi-regulated subsectors
- "unregulated," competitive subsector markets

RELEVANCE OF CONVENTIONAL MODELS TO EASTERN EUROPE AND MACEDONIA

- goals of policy/structural reform
economic efficiency

- electric transmission
- electric distribution
- electric generation (until recently)

- the state grants the monopoly an exclusive franchise
- the monopoly accepts its obligation to serve the public and accepts limits on profits
- the state reviews major actions by the monopoly company
  - raising money
  - siting and building new facilities
  - establishing tariffs and rates
- the extent and timing of review varies by jurisdiction

Scope of Monopoly Regulation

- the state reviews policy-level matters the utility freedom implements the policy
- competitive negotiation
- competitive bid
- self-scoring bid

ROLE OF REGULATION IN NEWLY COMPETITIVE MARKETS

RELEVANCE OF MARKET/REGULATORY MODELS TO MACEDONIA

- "destructured" model
- U.S. model

II. POLICY AND LAWS

DESCRIPTION OF TYPICAL STATE REGULATION IN U.S.

- natural monopolies which provide a public service are tolerated on grounds of
OTHER KEY LAWS

- environmental law
- commercial code
- foreign investment law

III. ENERGY REGULATIONS AND INSTITUTIONS

EVOLUTION OF MONOPOLY REGULATION

- recognition that generation is no longer a natural monopoly; perverse incentives associated with traditional ratemaking
- greater efficiency attained through market discipline than regulation by the state, preference for reduced government involvement where market conditions exist
- U.S. experiment has been with gradual and partial introduction of market mechanisms
states increasingly involved with management decisionmaking

- If the state is unhappy with the implementation of its policies, it reduces the profits of the monopoly company
- operational efficiency, reliability goals
- "incentive ratemaking"

ESSENTIAL ELEMENTS OF MACEDONIA ENERGY LEGISLATION

- right of IPPs to sell to grid
- right of grid to buy from IPPs

DESIRABLE ELEMENTS OF MACEDONIA ENERGY LEGISLATION

- independent regulatory agency
- right of agency to establish regulations governing solicitation and purchase of independent power
- authorize foreign dispute resolution
US INDEPENDENT POWER POLICY/INSTITUTIONAL FRAMEWORK DEVELOPMENT TIMELINE

PURPA PASSES
REGULATORY DISPUTES
U.S. NUG MARKET HITS 6,000 MW
U.S. COMPETITIVE BIDDING STARTS
1ST INDEPENDENT POWER PROJECT
ANNUAL NUG CAPACITY EXCEEDS UTILITY
INTERNATIONAL NUG MARKETS TAKE OFF. NUG MARKET IN U.S. HITS 43 GW
PUHCA REFORM?


OTHER IMPORTANT TRENDS
ENVIRONMENTAL AWARENESS
INTEGRATED RESOURCE PLANNING AND DSM

NUG - NON UTILITY GENERATOR
important change over the past ten years in the processes for purchasing independent power as the "experiments" have evolved

- the experience is not uniform, with over 50 jurisdictions and experiences
- the mistakes are at least as instructive as the successes
- need to be selective in applying specific experiences to the Macedonian context
- U.S. federal/state complexities not relevant

significant regulatory involvement is still necessary to supervise "market," to assure fair process and price

key regulatory mechanism is the "IRP"

- IRP vs. LCP
- the IRP as a regulatory tool
- the IRP as the basis for IPP involvement
- timing of need
- value of incremental power to system
- cost of incremental power to system
- compare IPP with other IPP options
- compare IPP with self-build option
- "wild-card" vs. "bid-in" self-build options
IV. POLICY GOALS AND EARLY PROJECT DEVELOPMENT

All elements of the policy and institutional framework described above will be necessary to encourage an active, long-term independent power market in Macedonia.

It is not necessary to have a complete institutional structure in place to bring the first projects to completion:

- early projects can substitute contract provisions for regulation
- early projects can help to identify gaps and deficiencies in the institutional structure

Although none of the above institutional goals is an absolute requirement in order to pursue independent power, if a well-trained review and negotiation team is not put in place it is unlikely that any IPP contracting efforts will be successful.
INSTITUTIONAL REQUIREMENTS FOR PURCHASING GOVERNMENT/UTILITY

To implement the policy framework established by the energy and foreign investment legislation, consider taking the following steps to strengthen the institutional framework for independent power in Macedonia:

- establish an independent regulatory institution to ensure fair process, staffed with qualified technical staff
- draft detailed regulations based on, and implementing the goals established by, the energy law
- establish a central information clearinghouse for prospective project developers, including IRP data, protocols, models and results
- establish consistent policies on incentives and guarantees available to IPPs
- establish the procedure for soliciting independent power
- establish and train a multi-disciplinary review and negotiation team
- prepare standard offer contracts for renewable energy and cogeneration projects
- provide standard non-price terms for large projects
FINANCING INTERNATIONAL INDEPENDENT POWER PROJECTS

by

Matthew Buresch

RCG/Hagler, Bailly, Inc.

at the

MACEDONIA INDEPENDENT POWER SEMINAR

Skopje, Macedonia

June 22, 1994
FINANCING INTERNATIONAL INDEPENDENT POWER PROJECTS

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I  THE LINK BETWEEN RISK AND REWARD

II  ISSUES AND STRATEGIES IN REDUCING PROJECT RISK

III  MECHANISMS AND SOURCES FOR PROJECT FINANCING

IV  INDEPENDENT POWER PROJECT FINANCING CASE STUDY

V  RECOMMENDATIONS
THE LINK BETWEEN POLITICAL AND ECONOMIC RISK AND THE REQUIRED RETURN ON INVESTMENT

The level of political and economic risk determines the return on investment that investors will require for project financing. Countries with very high levels of political and economic risk (e.g. Lebanon or Iraq) would require such high returns that only equipment sales for cash would normally be feasibly, while countries with very low levels of risk (e.g. United States, Germany, and Japan) present attractive opportunities for long term investment. Risk is typically broken down into country and project risk. Country risk is composed of two interrelated components:

**Political Risk:** Political conditions that lead to (1) political violence, (2) expropriation of assets, (3) inconvertibility of local currency, and (4) legal unpredictability have a major impact on the investment climate for both domestic and foreign businesses.

**Economic Risk:** The credit risk of a country is measured by such economic indicators as (1) GDP/capita, (2) GDP growth, (3) country debt, (4) trade balance, (5) months of imports coverage, (6) international reserves, (7) current account balance, and (8) government budget balance.

Country risk ranking services such as Euromoney and Institutional Investor grade most of the countries worldwide according to a range of economic and financial indicators. For instance, Euromoney uses 9 criteria that include economic data, political risk indicators, debt indicators, access to bank finance, access to short term finance, access to international bond and syndicated loan markets, access to and discount on forfaiting, credit ratings, and debt in default. Macedonia had a listing of 142 out of 167 countries in the March 1994 edition of Euromoney. This rating means that most commercial banks would regard Macedonia as having an unacceptable level of country risk at this time.
REQUIRED RATES OF RETURN ON EQUITY FOR INTERNATIONAL POWER PROJECT INVESTMENTS

Country

Project Risk Premium
- Pre-project closing risk
- Construction risk
- Operation risk

Country Risk Premium
- Sovereign risk
- Currency risk

Corporate Cost of Capital

Source: RCG/Hagler Bailly, Inc. 1993
THE RISK THAT THE PROJECT'S ACTUAL CASH FLOWS DO NOT MEET EXPECTATIONS PRESENTS A MAJOR CONCERN FOR INVESTORS

The expected cash flow of a project must cover the debt service payments, the fuel and operating expenses, taxes, and the net income (after taxes) required to satisfy the equity investors. Typically, debt is serviced over about a 10 year period. There are various project risk factors that could effect project cash flow:

**Development Risk:** Problems and delays in citing the project, obtaining the necessary permits and licenses, negotiating the power purchase agreement, obtaining the required fuel and other security agreements, and securing the financing affect the capital cost and thus the debt service required for the project.

**Construction Risk:** Problems and delays with managing the construction, management/labor disputes, construction financing, cost increases, performance failures or discrepancies, and force majeure may result in major cost overruns.

**Operation Risk:** Problems with performance shortfalls, operating cost overruns, fuel price volatility, electricity payment delays, exchange rate volatility, legal changes, new environmental standards, force majeure catastrophes all influence the fuel and operating expenses and thus the level of net income earned.

Failure to generate the expected cash flows could prevent the project owners from delivering an adequate return to the equity investors, paying taxes, meeting operating expenses, or servicing the debt.
PRIVATE POWER PROJECT CASH FLOW

* assumes 10 year tax holiday
A PRIVATE POWER DEVELOPER FACES A MORE RISKY PROCESS WHEN DEVELOPING POWER PROJECTS

The impetus for developing country government-owned utilities to consider private power and privatization is largely due to two factors: (1) a shortage of public sector capital for electric power capacity expansion, (2) inadequate performance of power plants leading to reliability, efficiency, and financial indicators below what can be achieved in the private sector. While private developers can often build and operate power plants more efficiently, reliably, economically, they generally face a higher cost of capital and a more complex and risky process for project development. In the project development phase, there are a larger number of important hurdles that a private developer faces:

- **Pre-Feasibility Assessment** (preliminary internal analysis)
- **Initial Equity Commitment** (to finance initial development work)
- **Letter of Intent** (optional) (between government and developer)
- **Power Purchase Agreement** (locking in buy back rate and term)
- **Permits and Licenses** (for construction, environment, resource rights, etc.)
- **Full Feasibility Study** (complete technical and financial analysis)
- **Security Package** (for power purchase, construction, operation, insurance, fuel, etc.)
- **Financing Arrangement** (covering both equity and debt)

The process of satisfactorily completing these development stages is both time-consuming and costly. The greater number of hurdles, the higher the probability that the project will fail at some point and the investors/developers will lose all their investments up until that point. A greater number of hurdles also increases the chances for delays that will drive up project costs.
As a government utility power project evolves through the development process, there are various key events that serve to reduce the risk of project failure but also increase the level of time and money that has been invested in the project. When the project is no more than a concept in the mind of planners, the risks that the project will never generate power are high, but the costs invested are minimal. As a successful project development proceeds, the following major events occur:

**Development Phase:** A favorable energy resource assessment and feasibility study and a successful bond issue or loan agreement are the key risk reducing milestones in the development phase.

**Construction Phase:** Construction completion on schedule and on budget followed by a successful start-up with on-specification performance are critical.

**Operation Phase:** Successful plant operation on budget and without unaccounted for fuel or operating cost increases and disasters over 20 to 30 years is essential.

Given that the government owns most if not all of the relevant institutions and resources needed for power generation (e.g. electric utility, grid, primary energy resources, central bank, environmental and other regulatory bodies, etc.), the process of project development is relatively simple compared to what private developers face. In addition, the cost of capital for the government is the lowest in the national economy, thus putting the developer at a financial disadvantage.
THE FORMATION OF A PROJECT COMPANY AND THE NEGOTIATION OF SECURITY AGREEMENTS IS THE WAY THE DEVELOPER REDUCES RISK

In order to reduce the risks involved in large private power project development, the private developer establishes a project company that is based on limited-recourse project financing, and enters into a range of security agreements:

**Project Financing:** With project financing, a separate project company is formed which relies entirely on the revenues of the power plant to earn its return; the debt and equity holders have little or no recourse to the financial assets of the parent company. For this reason, project financing is often considered as "off balance sheet" financing.

**Security Package:** An interlocking web of security agreements are negotiated to minimize the risk to the project's investors and to allocate parts of the project's risk to those parties that are best able to manage it. These agreements cover the purchase of power, supply of fuel, construction and operation, insurance, investors, etc.

Only through the security agreement process is the developer able to convince the equity and debt holders to invest while simultaneously limiting its own exposure.
SECURITY PACKAGE FOR A PRIVATE POWER PROJECT

- Shareholders
- Host Government
- Electric Utility
- Lenders
- Implement Agreement
- Power Sales Agreement
- Term Loan Agreements
- Equity Subscription Agreement
- Operating Agreement
- Plant Supply Contracts
- Project Company
- Plant Operator
- Insurers
- Fuel Suppliers
- Fuel Purchase Agreements
- Insurance Policies

Source: RCG/Hagler Bailly, Inc. 1993
The successful implementation of a private power project is ultimately dependent upon raising sufficient quantities of debt capital. Private power financing in emerging economies typically requires about 20% to 40% equity and 60% to 80% debt. In developed countries, projects typically only require about 10% to 20% equity. Since the lenders provide the bulk of the capital, they represent the critical party whose interests must be satisfied.

**Equity capital:** The investors in common stock equity are the project owners and take the greatest risk because they are last to have any claim on the project's assets should it fail; in contrast they have the highest potential for reward should the project succeed. Preferred stock holders typically have no voting rights and earn a fixed dividend but are the first to earn dividends and have a higher claim on assets in the event of default.

**Debt capital:** The lenders or debt investors (particularly holders of senior debt) take less risk because they have first access to the assets or collateral of the project should it go bankrupt. As a result, they accept a lower rate of return typically in the form of a fixed interest charge.

**Insurance and Guarantees:** To reduce the risks of investing in a foreign developing country, developed country governments and multi-lateral banks provide insurance and guarantees for both debt and equity primarily against political risk.

The project lenders will scrutinize the company's performance, project financial projections, and country credit risk and will insist the project owners put equity into the project as a sign of confidence.
Private Power Project Financing
For a 20 year Build, Operate and Transfer (BOT) Power Project

- Loan Guarantees & Risk Insurance
- Senior Debt
- Subordinated Debt
- Equity
- National Government
- National Bank
- Fuel Supplier
- Fuel Supply Agreement
- Implementation Agreement
- Currency Exchange
- Developer Has Title to Equipment Yrs. 0 - 20
- Payments for Power Yrs. 0 - 20
- Power Purchase Agreement
- Utility Has Title After Yr. 20

Project Company

Owner/Operator

RCG/Hagler Bailly, 1994
**Build, Lease, Operate (BLO):** The project developer finances and builds the power plant and then leases it to the utility in exchange for an agreed upon rent or lease payment. Leasing is particularly favored in those countries where the government or utility will not allow private and/or foreign entities to operate a major power plant. Leasing simply is a financing mechanism to employ private capital for a publicly operated power plant.

**Debt/Equity Swap (DES):** In a debt/equity swap, a sovereign debtor's foreign currency obligation to a commercial bank is exchanged at a discount for equity claims by an investor in the private sector. Debt/equity conversions have been endorsed by commercial banks as one means of reducing debt servicing burdens of highly indebted countries and increasing investments in the private sector.

These varied project financing mechanisms ensure that the equity and debt holders in the project earn their required return during the first 10 to 20 years of the project while meeting the utility's power and operational needs. Debt/equity swaps convert the excess debt that is unlikely to be repaid into productive equity investments.
THERE ARE DIFFERENT OPTIONS FOR STRUCTURING A PRIVATE POWER PROJECT

Various ownership and financing mechanisms have been employed with private electric power projects. These different financial designs serve the different requirements of electric utilities and developers in terms of project ownership and operation.

Build, Own, Operate (BOO): The private power developer finances, builds, owns, and operates the power plant and sells power to the electric utility under a power purchase agreement. The developer retains title and ownership to the power plant during its entire life.

Build, Own, Operate, Transfer (BOOT): The project developer finances, builds, owns and operates the project and sells power to the electric utility for an agreed upon term. After a specific period of typically 20 years, the developer transfers ownership and operation of the power plant to the electric utility.
PRIVATE POWER PROJECT SCALE AND CONFIGURATION
DICTATE FINANCING STRUCTURE

The size of the project and the degree to which it is centralized or decentralized plays a key role in defining the type of financing mechanism that will be used:

<table>
<thead>
<tr>
<th>Scale of Project</th>
<th>Off-Balance Sheet Financing</th>
<th>Balance Sheet Financing</th>
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<tbody>
<tr>
<td>MEDIUM TO LARGE SCALE PROJECTS (&gt; 5 MW)</td>
<td>Build, Own, Operate (BOO)</td>
<td>Corporate Balance Sheet (BS)</td>
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<tr>
<td></td>
<td>Build, Own, Operate, Transfer (BOOT)</td>
<td>Equipment Lease (EL)</td>
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<td>Build, Lease, Operate (BLO)</td>
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<td>Debt Equity Swaps (DES)</td>
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The larger the project, the greater the tendency for project developers to pursue the formation of a project company and the use of limited recourse or off-balance sheet financing. The developer's and lender's transaction and due diligence costs are roughly the same regardless of the project's size. The larger projects therefore are more attractive to lenders, since their processing costs are spread across higher potential revenues.
### Private Power Project

#### Scale and Configuration

**Power Plant Configuration**

<table>
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<th>Centralized</th>
<th>Decentralized</th>
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**Power Plant Scale (MW)**

- **> 50 MW**
  - Power Plant Direct Sale To Utility; High Voltage Substation (BOO, BOOT, BLO, DES)

- **5 - 50 MW**
  - Power Plant Direct Sale To Utility; Lower Voltage Feeder (BOO, BOOT, BLO, DES) Industrial Cogeneration: Utility-Interactive (BOO, BOOT, BLO, DES, BS)

- **1 - 5 MW**
  - Captive Power Cogeneration: Captive Power (BS, EL) Industrial Cogeneration: Captive Power Plant: Captive Power (BS, EL)

**Financing Options**

- -- Build, Own & Operate (BOO)
- -- Build, Own, Operate & Transfer (BOOT)
- -- Build, Lease, Operate (BLO)
- -- Debt/Equity Swap (DES)
- -- Equipment Lease (EL)
- -- Corporate Balance Sheet (BS)
IMPORTANT INTERNATIONAL SOURCES OF CAPITAL AND FINANCIAL SERVICES

The major international sources of capital and financial services are found in three distinct arenas:

- **Private Sector Investors** provide both debt and equity and involve commercial banks, institutional investors (e.g. pension funds), venture capitalists, individual investors, and equipment suppliers.

- **Multi-lateral Development Banks** mainly provide loans to developing country governments, but increasingly have developed institutions such as the International Finance Corporation (IFC) and the European Bank for Reconstruction and Development (EBRD) which take both equity and debt positions in private sector projects. The World Bank (IBRD) can also provide financing for private sector projects by onlending through a government institutions.

- **Government Export Trade and Investment Programs** such as those provided by the U.S. government provide funds for feasibility studies (e.g. US Trade and Development Agency (TDA)), equity and debt investments, and political risk insurance and loan guarantees (e.g. US Export Import Bank (EX-IM) and US Overseas Private Investment Corporation (OPIC)). These programs help US companies selling equipment or making investments overcome some of the critical risk and financial hurdles to doing international business.

By working together with these multiple sources of capital and financial assistance, private developers can assemble a financing package when the project and investment climate in Macedonia are attractive.
# U.S. Government Trade Assistance Programs

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<td>U.S. Overseas Private Investment Corporation</td>
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<td>U.S. Agency for International Development</td>
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<td>U.S. Trade and Development</td>
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PRIVATE SECTOR INVESTORS

- COMMERCIAL BANKS
- INSTITUTIONAL INVESTORS
- VENTURE CAPITALISTS
- INDIVIDUAL INVESTORS
- EQUIPMENT SUPPLIERS

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<th>EQUITY INVESTMENT</th>
<th>DEBT INVESTMENT</th>
<th>DEBT/EQUITY SWAPS</th>
<th>PROJECT CO-FINANCING</th>
<th>EQUIPMENT FINANCING</th>
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<td>VENTURE CAPITALISTS</td>
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<td>INDIVIDUAL INVESTORS</td>
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<td>EQUIPMENT SUPPLIERS</td>
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### Multi-Lateral Development Banks

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<th>Equity Investment</th>
<th>Debt Investment</th>
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<th>Loan Guarantees</th>
<th>Lease Guarantees</th>
<th>Political Risk Insurance</th>
<th>Technical and Training Assistance</th>
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<td><strong>International Finance Corporation (IFC)</strong></td>
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<td><strong>European Bank for Reconstruction and Development (EBRD)</strong></td>
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- Black dots indicate areas of activity or cooperation.
Pagbilao Independent Power Project, Philippines

Guarantors
- JEXIM
- IFC

Lenders
Export Credit
- USEXIM 25.0%
- JEXIM 52.5%
- IFC
"A" Loan 8.5%
"B" Loan 3.3%
CDC 5.0%
ADB 5.7%
Total Debt US$ 698 million

Shareholders
HEIL 87.22%
IFC 4.26%
CDC 4.26%
ADB 4.26%
Total Equity US$ 235 million

Insurers
- Johnson & Higgins

Project Company
Hopewell Power (Phils.) Corp.

Government of the Philippines
Fuel Supplier
National Power Corp.

Power Plant 700 MW Coal-Fired
HPPC Has Title
Yrs 0 - 25
Payments for Power
Yrs. 0 - 25
NPC Has Title After Yr. 25

Electric Utility
National Power Corp.

Construction Consortium
- Mitsubishi
- Slipform Engineering

Operations & Maintenance
Hopewell Tileman Ltd.

Implementation Agreement
Fuel Supply Agreement
O&M Agreement
Energy Conversion Agreement
Shareholder Agreements
Construction Agreement
Loan & Common Agreements
# PAGBILAO INDEPENDENT POWER RISK MATRIX

## Project Risk

### Risk Categories
- **Pre-Construction**
  - Government consents
  - Permitting
  - Financial closure
- **Construction**
  - Cost overruns
  - Completion delays
  - Performance
  - Force majeure
- **Operation**
  - O&M cost overruns
  - Technology performance
  - Fuel supply
  - Force majeure

### Risk Tiers
- Takes on little or no risk
- Takes on particular or partial risk
- Takes on major risk

### Contributors
- Developing Country Government
- Project Sponsor
- Commercial Lenders
- Development Bank Lender
- Ex-Im Bank Lender
- Suppliers
- Contractor
- Utility
- MDB/Sponsor Government Insurer
- Commercial Insurer

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RCG/Hagler Bailly, Inc., 1994

DRAFT 1/26/94
# PAGBILAO INDEPENDENT POWER RISK MATRIX

## Country Risk

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<thead>
<tr>
<th>Risk</th>
<th>Developing Country Government</th>
<th>Commercial Lenders</th>
<th>Development Bank Lender</th>
<th>Ex-Im Bank Lender</th>
<th>Suppliers</th>
<th>Contractor</th>
<th>Utility</th>
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- Takes on little or no risk
- Takes on particular or partial risk
- Takes on major risk
MAJOR RECOMMENDATIONS FOR ATTRACTING FOREIGN INVESTORS INTO THE POWER SECTOR

In order for Macedonia to increase the level of both domestic and foreign private investment in the private sector, there are various measures that can be implemented:

- **Understand the needs of the private sector** so that the Macedonian government can obtaining the best electricity price, while simultaneously satisfying the valid needs and concerns of the investor and lender.

- **Establish a legal framework** that responds to private sector concerns, is stable, and is relatively clear to understand and apply.

- **Streamline the negotiation process** between the government and private developers by reducing where possible the complexity involved in finalizing key agreements and contracts and obtaining the necessary permits and licenses. Train a project negotiations team.

- **Provide incentives** such as tax holidays and import tariff reductions that will reduce the project's costs in the critical early years. The first private power project may need extra incentives because it is the most risky and will set the stage for more to follow.

The goal is to create a policy and business climate that is a win-win situation for both the country and the individual companies and investors engaged in the private power projects. In the early stages, most if not all debt financing and some equity will come from multilateral institutions such as the EBRD, IBRD, and IFC.
THE DEVELOPMENT PROCESS FOR A HYDRO PROJECT: A CASE STUDY

by

Peter Lalor

Commonwealth Power, Inc.

at the

MACEDONIA INDEPENDENT POWER SEMINAR

Skopje, Macedonia

June 22, 1994
THE DEVELOPMENT PROCESS FOR A HYDRO PROJECT: A CASE STUDY

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I INTRODUCTION

II REQUIREMENTS OF THE PURCHASER

III REQUIREMENTS OF THE IPP DEVELOPER

IV CONCLUSIONS: KEY SUCCESS FACTORS
THE DEVELOPMENT PROCESS FOR A HYDRO PROJECT

I. INTRODUCTION

- public resource

- high risk
  - hydrology
  - geology
  - environmental impact
  - expensive studies
  - long lead time

- high reward
  - clean
  - reliable
  - inexpensive
  - very long term
III. REQUIREMENTS OF THE IPP DEVELOPER

WHAT DOES A PROJECT DEVELOPER DO?

A developer will typically perform the following tasks in developing a project:

- **Project Identification**
  - preliminary resource evaluation and reconnaissance
  - perform prefeasibility studies
    - hydrology
    - geology
    - environment and community impact assessment
  - apply for necessary concessions and permits

- **Project Negotiation**
  - identify utility needs
    - simulations
    - system impact analyses
  - optimize size
    - firm energy
    - nonfirm energy
    - current and projected system needs and value of firm/nonfirm energy by season/time of day
  - letter of intent with utility stipulating price and major non-price terms
II. REQUIREMENTS OF THE PURCHASER

The purchaser must have the capability to:

- identify need for and value of additional capacity and energy, and project required in-service dates, through an IRP or LCP process
- identify transmission constraints, existing regional imbalances and other relevant factors
- determine the form of solicitation and the procedure for evaluation
  - transient stability
  - short-circuit
  - load flow
- prepare the solicitation, including a draft contract which contains all material non-price terms
- if the purchaser does not have established credit in the international market, identify a source of credit support (central bank, or government ministry)
- once the purchaser has announced a solicitation program, IPP developers will present proposals to the purchaser in accordance with the solicitation requirements
solicit bids and/or negotiate with institutions with continuing interest after understanding project risks

execute commitment letters with those providing the lowest-cost capital

- negotiate and sign turnkey contracts with guarantees
- financial closing
- notice to proceed to contractor
- construction
- startup
- operation
- detailed feasibility study; prepare performance and quality general specifications
- obtain permits
- execute power sales agreement
- obtain preliminary commitments from financing institutions, conduct "due diligence"

components:

prepare "Financing Memorandum" containing descriptive information concerning the project, the legal and institutional circumstances affecting the project and its viability (government agencies and the extent of their jurisdiction, etc.)

estimates of project costs and revenues, including uncertainties affecting the proposed investment

identify institutions currently active in the project finance market (this varies from month to month)

send the FM to active institutions, and make presentations to those expressing serious interest
IV. FINANCING AND SECURITY PACKAGE ISSUES -- HYDRO PROJECTS

FINANCING

- Financing a hydroelectric project has some unusual aspects due to the nature of the technology.
- Hydrologic risk and its impact on project revenues must be clearly defined
  - if energy is sold "when delivered" at a fixed price per kWh, regardless of time of day, season or system cost
  - if energy is sold "when delivered" at a time-dependent price per kw
  - If energy is sold "firm"
- Geologic risk can play an important part in the evaluation if the dam or conveyance structures are a significant element of the design
- Hydro projects have significantly less risks than thermal plants in some aspects; costs are predominantly capital costs, which are determined at the time of financial closing, so there is no fuel price risk, etc.
WHAT DOES A DEVELOPER NEED FROM A PURCHASING UTILITY?

- the timing of need for new capacity
- the characteristics of the existing utility system
- the impact and cost of the developer's plant on the existing system
- a letter of intent
- an enforceable contract
V. CONCLUSIONS: KEY SUCCESS FACTORS

- FAIR PROCESS
- FAIR PRICE
- FAIR TERMS
- CREDITWORTHY BUYER OR CREDIT SUPPORT
SECURITY PACKAGE

- There are several issues specific to hydro projects which are not common to other types of project financings:
  - confirmation by environmental agency that minimum flow studies are complete and satisfactory
  - evidence of noncancellable right to nonconsumptive use of water (based on statute or confirmation from jurisdictional agency)
  - confirmation by jurisdictional agency that flow regulation will respect project water rights
INDEPENDENT POWER OPTIONS AND
RECOMMENDATIONS FOR MACEDONIA

presented

at the

MACEDONIA INDEPENDENT POWER SEMINAR

Skopje, Macedonia

June 22, 1994
PROJECT OPTIONS FOR INDEPENDENT POWER PROJECT DEVELOPMENT

The various options for independent power project development are as varied as the power system itself:

- **Hydro Power:** Private development of one or more of the hydro sites;
- **Industrial Cogeneration:** Private investment for rehabilitating one or more major industrial cogeneration projects;
- **District Heating Cogeneration:** Private investment for rehabilitating one or more of the major district heating plants;
- **Coal-Fired Power Plants:** Private investment for rehabilitating one or more of the existing coal-fired power plants;
- **New Generation:** Private investment for the construction of a new combined cycle gas or coal-fired power plant.

Attracting investments to these projects will depend on the overall country risk as well as the financial merits of each individual project.
INDEPENDENT POWER OPTIONS AND RECOMMENDATIONS FOR MACEDONIA

I PROJECT OPTIONS FOR INDEPENDENT POWER PROJECT DEVELOPMENT

II LONG TERM INDEPENDENT POWER PROJECT DEVELOPMENT POLICY/INSTITUTIONAL FRAMEWORK REQUIREMENTS

III NEAR TERM POLICY POLICY/INSTITUTIONAL FRAMEWORK NEEDED FOR INITIAL PROJECT DEVELOPMENT
Define Government Guarantees and Incentives Offered: Establish consistent policy regarding government incentives and guarantees covering utility performance, fuel supply, etc.;

Define Solicitation Process: Establish the procedure for soliciting independent power;

Train Negotiations Team: Establish and train a multi-disciplinary review and negotiation team;

Prepare Standard Small Power Contracts: Provide standard offer contracts for small renewable and cogeneration projects;

Prepare Terms for Large Power Contracts: Provide standard non-price terms for large projects.

While all elements of the policy and institutional framework described above are necessary in order to enable an active long term independent power market, not all components are essential to develop the initial projects. Independent power projects can potentially move forward in an incomplete policy and institutional framework. In fact, experience in other countries has shown that promoting specific projects early on can in fact help refine the policy development process.
NEAR-TERM POLICY/INSTITUTIONAL FRAMEWORK NEEDED FOR INITIAL PROJECT DEVELOPMENT

In order to implement a parallel policy and project development strategy, certain priority elements of the policy and institutional framework need to be developed early on, which includes:

- **Policy & Incentives Framework:** establish a consistent policy regarding government guarantees and incentives;

- **Negotiations Team:** establish and train a multi-disciplinary review and negotiation team within the electric utility;

- **Small Power Contracts:** prepare standard offer contracts for small renewable and cogeneration projects;

- **Large Power Contracts:** provide standard non-price terms for large, central, hydro, or cogeneration projects.

With these basic elements in place, it should be possible to attract independent power investments.