Proceedings of the 13\textsuperscript{th} Task III Meeting

within IEA SolarPACES on

"Solar Technology and Applications"

Kibbutz Shefayim, Israel

August 1999

IEA-Solar Power and Chemical Energy Systems
Task III: Solar Technology and Applications
SolarPACES, Operating Agent TASK III
Deutsches Zentrum für Luft- und Raumfahrt e.V.
Solare Energietechnik (DLR, EN-SE)
D-51170 Köln
Telephone: (0)2203-601-2479
Telefax: (0)2203-66 900
E-mail: solare-energiotechnik@dlr.de
## Contents

Preface 3  
Minutes of the Meeting 7  
List of Action Items 13

### Annexes:

1. List of Participants 17  
2. Agenda 23  
3. Report of the Operating Agent 27  
4. Stand-Alone Heliostat 43  
   M. Romero, CIEMAT  
5. HELLAS Heliostat - Development Status Report 55  
   M. Romero, CIEMAT  
6. EUROTROUGH Project 73  
   P. Heller, DLR-PSA  
7. Parabolic Receiver Experiments (PAREX) 81  
   M. Romero, CIEMAT  
8. Parabolic Receiver Experiments (PAREX) 89  
   R. Pitz-Paal  
9. The PETAL Facility and Some Related Solar Research at Sede Boquer 93  
   D. Faiman, Ben Gurion Nat. Solar Energy Center  
10. The HYPHIRE Project 99  
    P. Heller, DLR-PSA  
11. REFOS / SOLASYS Project Status 111  
    M. Abele, DLR  
12. Preliminary Results on System Analysis Work on the REFOS System 127  
    R. Pitz-Paal  
13. A Multistage Solar Receiver: The Path to High Temperature 143  
    A. Kribus, WIS  
14. Solar Activities at the ANU 153  
    K. Lovegrove, ANU  
15. Solar Optical Concept of Compound Parabolic Concentrator for Coal Gasifier 161  
    O. Yokata, Tokyo Institute of Technology
First autonomous heliostat
(Project status)

Ginés García and Andrés Egea (CIEMAT-DER/PSA)
José Antonio Gázquez (UALM)
Stand-Alone Heliostat

THE NEW!

- PSA, with UALM collaboration, has designed a first Stand-Alone Heliostat
- Since April the stand-alone heliostat is continuously working at the PSA
- One 70m², “T” classical glass-metal heliostat has been adapted to include all the stand-alone concepts
- It’s working without wires&channels
- It can operate in cloudy days
- It knows the weather conditions for auto-protection

AUTHOR: Ginés García
File: StandAloneHeliostat.ppt
Sheet: 2

Solar Cluster
Jerusalem, July 1-3, 1999
Stand-Alone Heliostat

STAND-ALONE CONCEPTS
- To know real time and calendar
- Solar vector and axis position calculation
- Photovoltaic energy to work
- Radio communications
- It can decide security actions (autoprotection)
- Powerful diagnosis

- Photovoltaic panel located in the same facets plane
- Mirror maintenance permits optimal panel condition
- Energy productions in the same consumption time
- The heliostat solar tracking ↑ the energy produced
Stand-Alone Heliostat

- Classical “T” glass-metal heliostat of 70m²
- Located at 383m of the CESAl Tower

- Motors: 24Vdc, 10A, 3000rpm
- Geardrives ratio: 28000 / 1 azimuth&elevation
- Speed axis: High: 7.2°min & Low: 2° min
- Encoders: incremental type 3600x4 (14400bits)
- Angular resolution: 0.025° in each axe
- Photovoltaic panel: polySi, 24Vdc, 110Wp
- Battery: 2x12Vdc, 55AH
- Radiomodem: 400-470Mhz, messages encrypted 9600baud, a lot frequencies
- Wind sensor: special magnetic switch
- Additional sensors: anemometer, PT100, piranometer
- Solar vector calc.: PSA hybrid algorithm, error<0.5min
Stand-Alone Heliostat

NEW ELECTRONIC CARDS DEVELOPMENT

- Solar vector calculation using a hybrid PSA algorithm
- Microcontroller with real time clock and calendar
- Reading of two optical increm/abs encoders until 65536 bits
- Reading of eight analog. signal (wind, consumption, temp..)

- High efficiently & low noise control DC motor speed (>90%)
- DC Motors between 5 to 24Vdc, 0 to 15A
- Several adjustable speeds and right and left directions
- Overload and short-circuit protection

- An advanced radiomodem is controlled by microcontroller
- 400-470MHz band and 9600bauds
- Messages are identified and encrypted with time codes
- It can switch 255 radio channels on different frequencies

AUTHOR: Gines Garcia
File: StandAloneHeliostat.ppt
Sheet: 6

Jerusalem, July 1-3, 1999
Stand-Alone Heliostat

Stand-Alone Heliostats Field Advantages

• Very low Infrastructures costs (wires, channels, electrical distribution and protection elements, UPS,...)
• Immunity of lightning damages
• Each heliostat has an Uninterrupted Power Unit and it’ll not depend of conventional power supply
• These will use incremental encoders (cheaper) with the absolutes advantages (don’t loose references)
• The field will continue in operation when software o electric cracks situations happen
• The new heliostat ampliations are very easy

Autor: Ginés García
File: StandAloneHeliostat.ppt
Sheet: 7

SolarPACES
Jerusalem, July 1-3, 1999
Stand-Alone Heliostat

TEST CAMPAING
• We are going to check the preliminary photovoltaic & radiomodem designed
• We will get a data base from the electronic cards to evaluate its
• During August the heliostat will work without assistance.
• In September we will have enough data to adjust the designed. The results will be published in October

PRELIMINARY COSTS
• Photovoltaic: about 1 Wp / m² 5 $/m²
• Battery and loader: 2 $/m²
• Radiomodem and antenna: 350 $
• Wind switch: 10 $

Total for 70m² heliostat: 850 $

AUTOR: Ginés García
File: StandAloneHeliostat.ppt
Sheet: 8
Jerusalem, July 1-3, 1999
## Stand-Alone Heliostat

### Heliostat tests chronogram

<table>
<thead>
<tr>
<th>Id</th>
<th>Nombre de tarea</th>
<th>M</th>
<th>J</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PHASE I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Measurement procedure assess.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Tests A/D lab-scale</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Assembly hardware new chips</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Installing wind sensors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Routine software read A/D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Routine software data processing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Tests</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>PHASE II</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Functional tests</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Tests communications</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Routine operation (data acquisition)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Determination autonomy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Emergency situations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Cyclic autonomous operation (data acquisition)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Data analysis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Publication and dissemination</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>PHASE III</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Optimization hardware assess.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Cost analysis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Publication and dissemination</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

AUTOR: Ginés García

File: StandAloneHeliostat.ppt

Sheet: 9

Jerusalem, July 1-3, 1999