Integrating Parabolic Trough Solar Fields into Computerized Maintenance Management Systems (CMMS)

SolarPACES 2022: Sept. 27-30, Albuquerque, New Mexico
• U.S. DOE Solar Energy Technology Office funded project
  ▪ SETO 2020 Small Innovative Projects in Solar FOA
  ▪ Schedule: 18-months
  ▪ Collaboration with Atlantica Solana O&M team

• OPTOM Key Elements
  ▪ Integrated data storage & software platform
  ▪ Solar field CMMS
  ▪ Enhanced data analytics
  ▪ Mirror cleaning / reflectivity monitoring
  ▪ Effective reporting
  ▪ Specialized tools for O&M - Drones
  ▪ Plant DCS data and CMMS interface
  ▪ Enhanced performance model
  ▪ Improved automation and control
Concentrating on a new energy future

Conventional Computerized Maintenance Management Systems (CMMS) work well for a power plant where you have 3 feedwater pumps to maintain.

But CMMS do not work as well for solar fields where you have 3200 SCAs; 100,000 HCEs; or 900,000 mirrors to track.
  - Not good at tracking large number of similar components spread geographically over a large area.
  - A burden to set up and bogs system down.

Solar Field CMMS = Conventional CMMS + Field Status Program

The Field Status Program (FSP):
  - Designed to complement the convention CMMS, not replace it.
  - Fill in gaps from Conventional CMMS – track SF components.
  - Eliminate paper lists, data entry, and spreadsheets.

Patterned after system developed by KJC Operation Company
Field Status Program (FSP)

- Developed by KJC Operating Company (SEGS III – VII)
  - Equipment Hierarchy
  - FRACAS Coding
    - FRACAS - failure reporting, analysis, and corrective action system
    - Failures and Causes
    - Linkages of Failures and Cause to Equipment
  - FSP Database
  - FSP Graphical User Interface

- NextEra took over system when they acquired SEGS III-VII
  - Used at all NextEra parabolic trough plants

- The system was not developed further

- Led to improved receiver designs by Solel & Schott

NREL Analysis of Hot Receivers (2006)

- Led to identification of hydrogen build up
- Led to improved hydrogen features in receivers
- Resulted in $100M receiver retrofit of SEGS by NextEra
Objectives of Field Status Program

- Digitize solar field equipment status to support improved O&M through improved data.
  - Field tablet application enables rapid identification of new problems
  - Improves accuracy of data through GUI real time view of data
  - Eliminates paper reports, separate data entry, and data delays
  - Provides access to data that currently only exists on paper.
  - Allows preventative maintenance tasks (PMs) to be tracked
  - Improved communication between departments (CR operations, SF operations, SF maintenance, warehouse, management)
  - Timely reporting – anyone with access can generate reports
  - Improve maintenance labor efficiency, solar field availability & performance
  - Provide data for Reliability/Availability/Maintainability analysis of SF.

- Complement existing CMMS
  - Data can be transferred electronically to CMMS
  - Provides enhanced timely data in CMMS with reduced manual data entry
Field Status Program (FieldStatus)

- **OPTOM System Architecture**
  - Centralized primary database on plant network
  - Local database on field tablets

- **Field Status Program Elements**
  - Solar field equipment hierarchy for Solana parabolic trough technology
  - Standard failure, cause, and repair codes (FRACAS)
  - OPTOM relational database (current status and component history)
  - Field tablet application
  - Reporting & management application

### Equipment Hierarchy

<table>
<thead>
<tr>
<th>Family</th>
<th>Major</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00</td>
<td>Fluid</td>
<td></td>
</tr>
<tr>
<td>2.00</td>
<td>Electrical</td>
<td></td>
</tr>
<tr>
<td>3.00</td>
<td>Mechanical</td>
<td></td>
</tr>
<tr>
<td>4.00</td>
<td>Grounds</td>
<td></td>
</tr>
</tbody>
</table>

### FRACAS Coding

<table>
<thead>
<tr>
<th>Priority</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>101</td>
<td>Loss of Vacuum</td>
</tr>
<tr>
<td>102</td>
<td>Weld Leak</td>
</tr>
<tr>
<td>103</td>
<td>Glass/Metal Seal Problem</td>
</tr>
<tr>
<td>104</td>
<td>Oil in Glass</td>
</tr>
<tr>
<td>106</td>
<td>Bowing</td>
</tr>
<tr>
<td>108</td>
<td>HR Related Problem</td>
</tr>
<tr>
<td>109</td>
<td>Fluorescent - Major</td>
</tr>
<tr>
<td>110</td>
<td>Slacks in Flex Hose</td>
</tr>
<tr>
<td>111</td>
<td>Breakage</td>
</tr>
<tr>
<td>112</td>
<td>Outer Skin Damage</td>
</tr>
<tr>
<td>113</td>
<td>S-Curve</td>
</tr>
<tr>
<td>116</td>
<td>Fluorescent - Minor</td>
</tr>
<tr>
<td>201</td>
<td>Short Circuit</td>
</tr>
<tr>
<td>202</td>
<td>Open Circuit</td>
</tr>
<tr>
<td>203</td>
<td>Torn/Severed Cable</td>
</tr>
<tr>
<td>204</td>
<td>Bad Connector</td>
</tr>
<tr>
<td>205</td>
<td>Power Outage</td>
</tr>
<tr>
<td>206</td>
<td>Burnt Fuse</td>
</tr>
<tr>
<td>207</td>
<td>Cable Insulation Damage</td>
</tr>
<tr>
<td>208</td>
<td>Arcing</td>
</tr>
</tbody>
</table>

### Database

- [Database Diagram]

### Field Tablet Application

- [Field Tablet Application Diagram]

### Reporting & Management Interface

- [Reporting & Management Interface Diagram]
Field View Filtered for SCAs With Broken Mirrors
Wash View with Sample Data

Deluge Wash Status

Days since wash:
- 1-2
- 3-4
- 5-7
- Over 7
Field Status Development Summary

- **New FieldStatus Program**
  - New tablet & desktop FSP applications
  - GIS solar field data mapping
  - Integrated GPS tracking
  - Monitoring of mirror cleaning
  - KPI and other reports

- **Future FSP Development**
  - PM tracking & field inspections
  - Integrate data from aerial drone inspections
  - Interface with existing CMMS
  - Reliability data analysis
  - Expand to monitoring solar field construction
  - Implementation for heliostats at tower plants
Thank you for your Attention!

Hank Price  
Hank.Price@solardynllc.com  
+1 (720) 955-6404

Solar Dynamics OPTOM & ASTRO Team
- Rick Sommers, Keith Boyle, Tim Wendelin, Luca Imponenti, Ryan Shininger

Atlantica OPTOM Team
- Manuel Diaz, Sara Trujillo, Zachary Sleppy
- Scott Nolan, James Dean, Andrew Fifer
- Wesley Readinger, Christian Straube

This material is based upon work supported by the U.S. Department of Energy’s Office of Energy Efficiency and Renewable Energy (EERE) under the Solar Energy Technology Office (SETO) Award Number DE-EE0009379.

Legal Disclaimer
This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.