Reducing California PV Balance of System Costs by Automating Array Design, Engineering, and Component Delivery

SUNLINK

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CSI RD&D
Program Manager

Outline

SunLink Overview

Grant Scope Overview

- Automation of Array Structural Analysis
- Seismic and Wind Array Research
- Wiring Layout Automation And Fabrication
- Construction & Permit Documentation

Deliverables and California Benefits

Summary

SunLink Corporation Background

- Founded 2004; 60 employees; privately held
- Offices in San Rafael, CA & Toronto, Canada
- Roof mount, ground mount and balance of system solutions for commercial and utility-scale PV
- 200 MW /1,000 projects across North America
- Systems designed to accommodate most crystalline and thin-film modules currently available.

RMS Details

Low Total Installed Cost

- Prepanelization service reduces labor time
- New Fast Attach Wind Deflectors
- Simplified wiring process

Roof Friendly

- Zero Penetrations
- Tilt Access™ for easy roof maintenance
- Unimpeded Drainage

Permitting Support

- Rigorously wind tunnel tested
- Full engineering support ensures code compliance

SunLink Ground Mount System (GMS)

- Ballasted & Post Mount
- Simple and fast installation
- Portable (ballasted)

Thin-film Mounting Systems

- Roof or ground mount options
- Lightweight, ballasted system
- Simple 3-step install process

SunLink Homerun Combiner Boxes

- Disconnect at the source
- Vertical & horizontal mounting
- Roomy design for easy wiring

Integrated Wire Management

- Fully integrated wire trays
- Faster and simpler wiring process
- New string layout software
  (coming soon!)

SunLink Sales Process

QUOTE - Customers fill out the *Request a Quote* form on www.sunlink.com

LAYOUT - SunLink provides a free layout and preliminary budget within 48 hours

ENGINEERING - Wind load analysis, ballast pan or connector placement, roof loading, etc.

CONTRACT - Customer sends signed sales contract and deposit

DELIVERY – Normally, 4-5 weeks for standard roof mount, 8-9 weeks for ground mount

January 2010 Challenges

Areas for Efficiency Gain

- Structural analysis of unique projects
- Wiring time on roof
- Iteration time with permitting agencies
- Use of validated seismic and wind load response data

Areas to Enable Market Expansion

- Minimization of roof penetrations and loads
- Full engineering on smaller projects
- Removal of barriers for lower-cost contractors

Grant Motivation

Decrease BOS and System Cost

- Unique layouts of rooftop installations require costly custom engineering.
- On-roof wiring is time-consuming and costly.
- Unless wind and seismic loading are fully addressed with test and analysis, system costs are higher than necessary.
- Permitting can require a lengthy and iterative process.
- Facilitate ability of lower-cost contractors to develop projects.

Increase Market

- Customers prefer to minimize roof penetrations and loads.
- More small-systems will be ordered when full system engineering becomes cost effective through automation

Grant Concept

Automate Where Possible

- Increase automation of structural engineering
- Create specs for factory-made wiring harnesses
- Automate and standardize permit document package
- Create database of local code requirements
- Work with California State committees to implement solar-specific codes

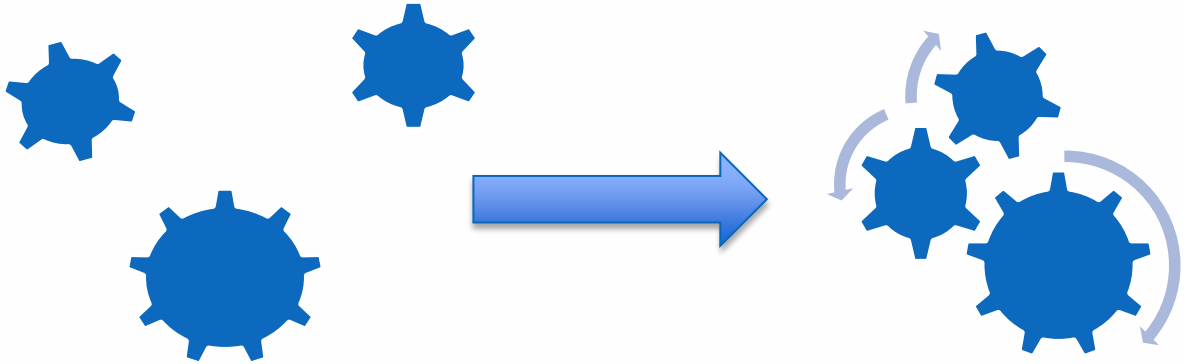
Improve Load Inputs

- Perform seismic testing at PEER
- Analyze wind tunnel data

Scope:
Automation of Array Structural Analysis

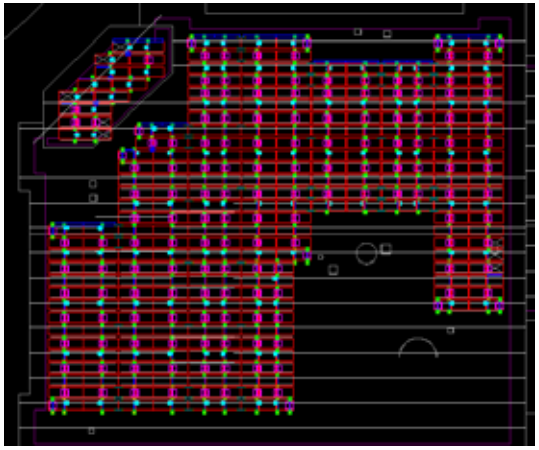
Custom Software Components Cut Engineering Time by Half

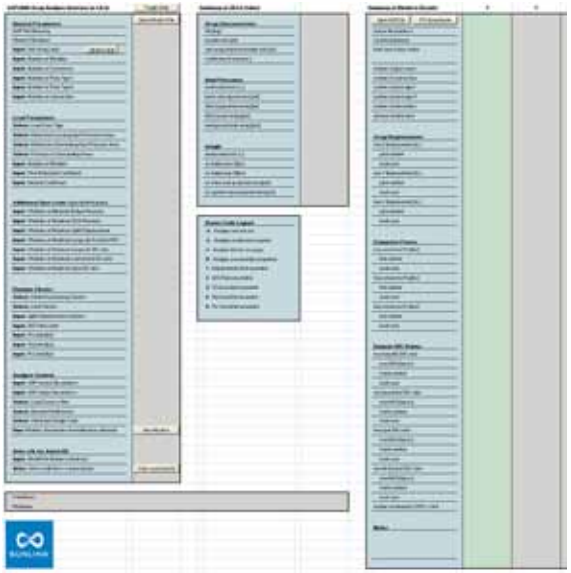
- AutoCAD layout components simultaneously build layout drawings and structural analysis models
- Excel interfaces support structural modeling and reporting functions
- MATLAB scripts automate loading patterns and control analysis process
- AutoCAD components update layout drawings from structural analysis results

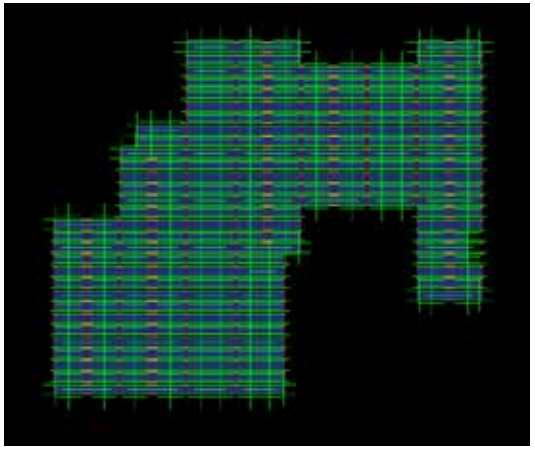


Deliverables: Structural Automation

- Reports on the layout, interface and analysis control components
- Software programs and components, integrated with representative wind tunnel and shake table data, installed on a PC for demonstration and use.

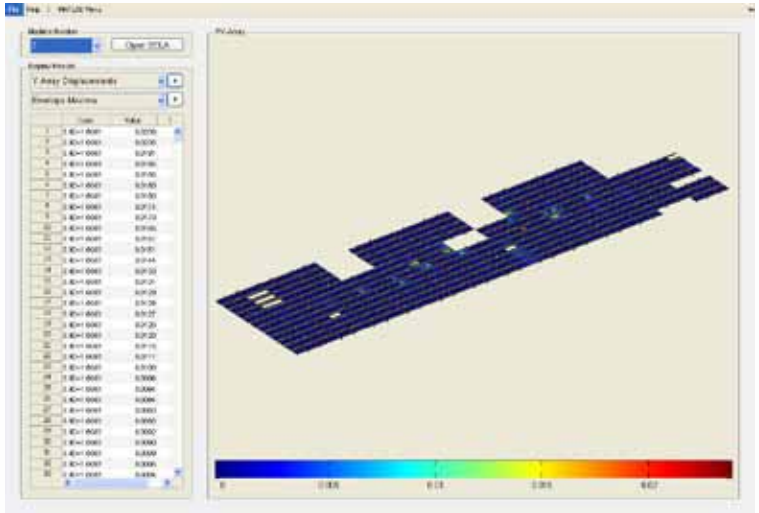






AutoCAD Layout è Excel / MATLAB Interface è SAP Analytical Model

California Benefits: Structural Automation



MATLAB visualization tool that aggregates and displays analysis results from multiple, separate wind load pattern cases. 100 kW array shown.

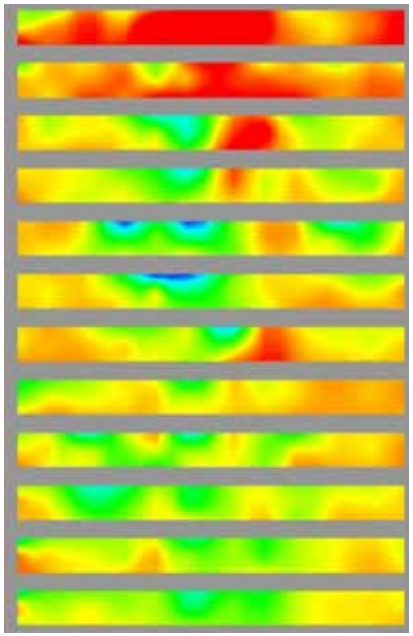
- Demonstration of a versatile roof mount PV array structural design method based on array structural properties and wind tunnel generated pressure patterns
- Increased adoption of PV on roofs facilitated by design method
- Demonstration of automated structural analysis methods
- 50% reduction in engineering design time from automation
- 50% reduction in engineering cost for arrays <100kW

Scope:
Seismic and Wind Array Research

Tests and Analysis of Array Inertial Effects for Better Designs and Lower Cost

- Shake table tests of unanchored arrays validate and calibrate analytical models used for design
- Non-linear dynamic analysis of arrays, using time history loading developed from extensive wind tunnel testing, improves understanding of array behavior under extreme events and may provide a basis for array design optimization.

Deliverables: Seismic and Wind Research



- Seismic Test Plans
- Invited Demonstration of Seismic Performance at PEER Shake Table
- Report on Seismic Test and Analysis Results
- Report on Dynamic Wind Analysis Results
- Incorporation of Research Results into Design Process

Visualization of array pressures from wind tunnel tests (3 sec.)
Red: downward pressure
Blue: upward suction
Gray: space between module rows

California Benefits:
Shake Table Test and Wind Data Analysis

PEER Earthquake Shaking Table – UC Berkeley
(bridge test shown)

- Pioneering shake table tests on roof-mounted unanchored PV arrays
- Pioneering wind analysis methods applied to on-roof PV arrays
- Reduced costs from new design methods
- Data to support more PV design options in building codes
- Increased adoption of PV on roofs due to expanded design options

Scope:
Wiring Layout Automation And Fabrication

Cut Wiring Cost and Improve Reliability

- Streamline string and wiring layouts with new SunLink String Layout Tool
- Generate project-specific wiring harness specifications
- Implement off-site fabrication of wiring harnesses designed for each job
- Quantify time savings in comparison to craft wiring on roof.

Deliverables : String Layout Tool and Wire Harness Development

SLT Development

- Proof of concept
- Prototyping
- Agile Development
- Pilot
- Release

Wire Harness Development

- Assessment of current construction needs
- Design, analysis, prototyping
- Pilot trials with targeted customers
- Design for high volume manufacturing

California Benefits:
Wiring Layout Automation and Fabrication

- Reduce on-roof installation time 30-40%
- Reduce total installation cost
- Enhanced reliability of connector installation, improving system safety

Scope:
Construction & Permit Documentation

California PV Permitting Requirements Database

- Develop database of CA permitting requirements by jurisdiction, including requirements for snow and wind load, PV array permitting procedures, etc.

Project Document Management System

- Develop or implement project document management system to reduce project engineering time and cost.
- Develop means to automatically enter data originating from different software tools.
- Create process guide for documentation generation process.
- Identify in software and new procedures any issues for further development.

Deliverables:
Construction & Permit Documentation

California PV Permitting Requirements Database

- Report on permit document requirements and delivery in SunLink project locales
- Database with a minimum of 10 records at the end of 2011
- Updates through 12/2012

Example Contents

- Required structural environmental loads and prescriptive structural requirements
- Agency acceptance of alternative design methods, such as ballasted systems and wind tunnel testing
- Project documentation requirements
- Key agency contacts

Project Document Management System

- Reports on implementation of a comprehensive project documentation management and tracking system, and its efficacy in cutting project delivery and installation time.

California Benefits: Construction & Permit Documentation

California PV permitting requirements database

- Better overview of permitting procedures throughout the state will allow for the development of more consistency.
- California PV system designers gain a useful resource

Project document management system

- Demonstration and documentation of SunLink's approach will provide useful insights on the development of similar systems for other customizable, rapidly configurable PV array products.
- The ability to rapidly design and document customized systems, while minimizing construction issues, is key to increasing the penetration of low-slope roof-mounted systems in California.

Summary

The outcomes of this CSI project will reduce component and installation costs, improve system safety, and open significant additional markets for commercial rooftop systems in California.

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