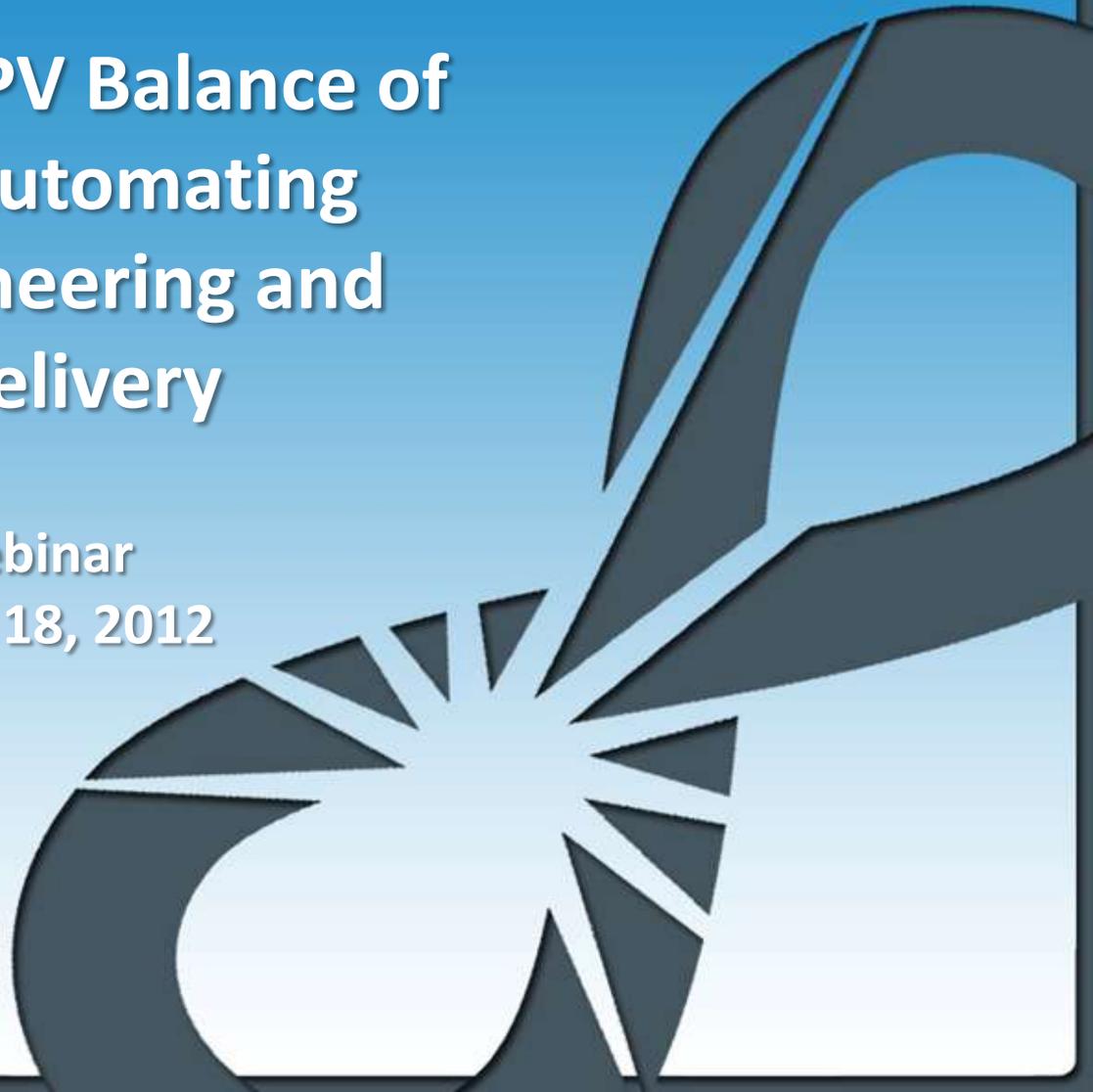




Reducing California PV Balance of System Costs by Automating Array Design, Engineering and Component Delivery

Final Project Webinar
Tuesday December 18, 2012



Agenda

- **Introductions**
- **Project Scope and Vision**
- **Automated Layout and Design Tools**
- **Document Management**
- **California Permitting Agency Database**
- **Shaking Table Experiments**
- **SunLink Publications**
- **Building Code Developments**
- **Wrap Up**
- **Questions and Answers**



Introductions

SunLink

Mike Williams

SVP Engineering and PI

Rob Ward

Chief Structural Engineer

Kate Miller

P.E.

Chris Harbich

Project Engineer

Eric Franzen

Director, Operations & IT

Rutherford and Chekene

Andreas Schellenberg

Ph.D., P.E.





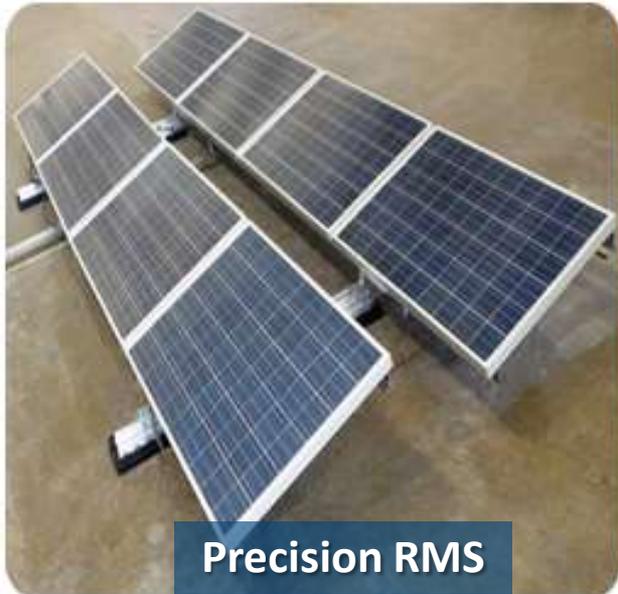
Large-Scale GMS



Combiner Boxes



Core RMS



Precision RMS



Ballasted GMS



SunLink Overview

SunLink's Project Partners



PEER

PACIFIC EARTHQUAKE ENGINEERING RESEARCH CENTER



RUTHERFORD + CHEKENE

Autodesk



COMPUTERS & STRUCTURES, INC.

STRUCTURAL AND EARTHQUAKE ENGINEERING SOFTWARE

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Welcome

The CalSolarResearch website provides information about the California Solar Initiative (CSI) Research, Development, Demonstration, and Deployment (RD&D) Program activities, including the program's history and current CSI RD&D solicitations. Please check back regularly for updates!

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Dec 6, 2012

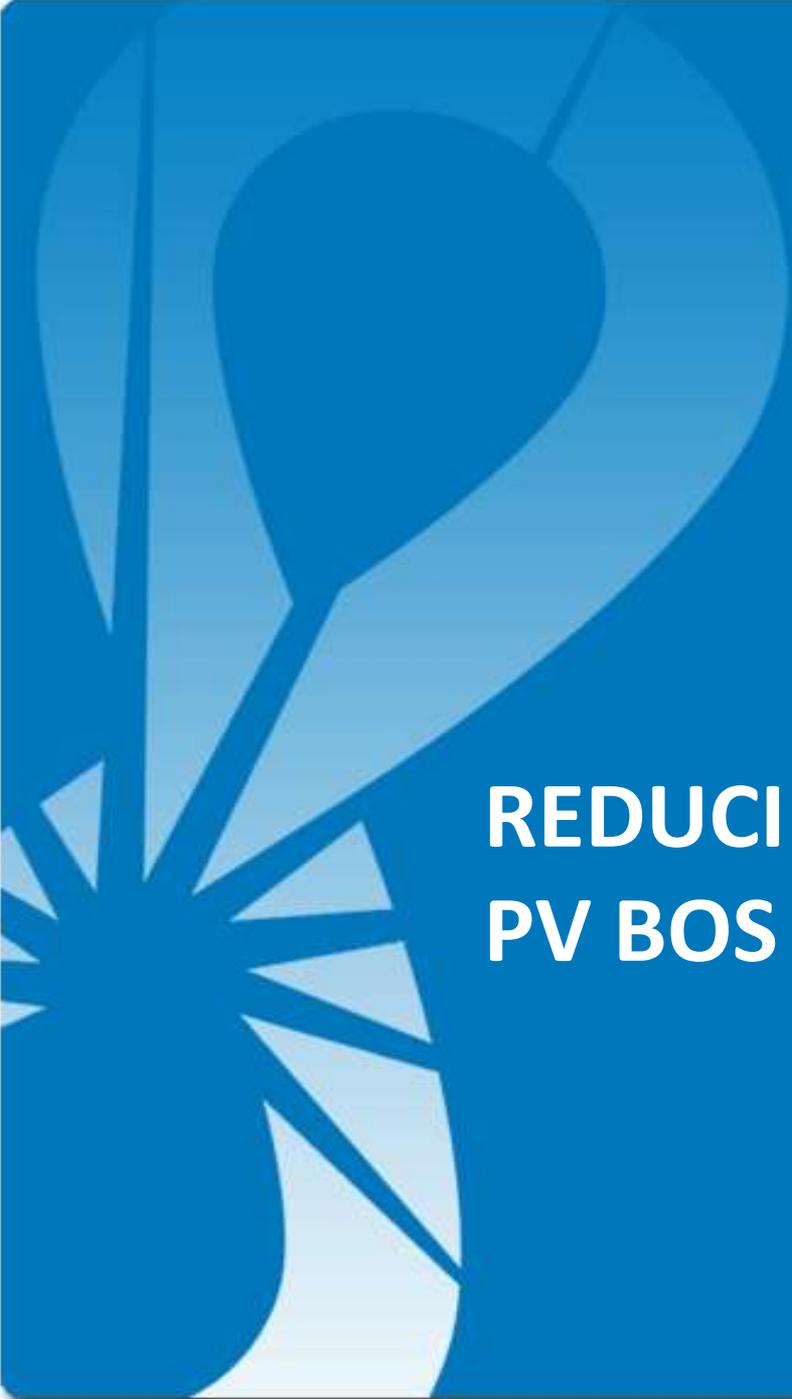
SUNLINK WEBINAR

Date: Tuesday, December 18, 2012

Time: 10:00 AM - 12:00 PM PST

REDUCING CALIFORNIA PV BALANCE OF SYSTEM COSTS BY AUTOMATING ARRAY DESIGN, ENGINEERING, AND COMPONENT DELIVERY



A large, stylized graphic of a leaf or plant branch in various shades of blue, positioned on the left side of the slide.

REDUCING CALIFORNIA PV BOS COSTS

BoS Definition

Balance of System = (Installed Cost of PV Array) – (Cost of Modules):

- Mounting System
- Inverters (typically)
- Wiring and wiring management components
- Combiner Boxes
- Monitoring
- Installation labor
- Engineering and permitting fees
- Interconnection fees
- Financing costs

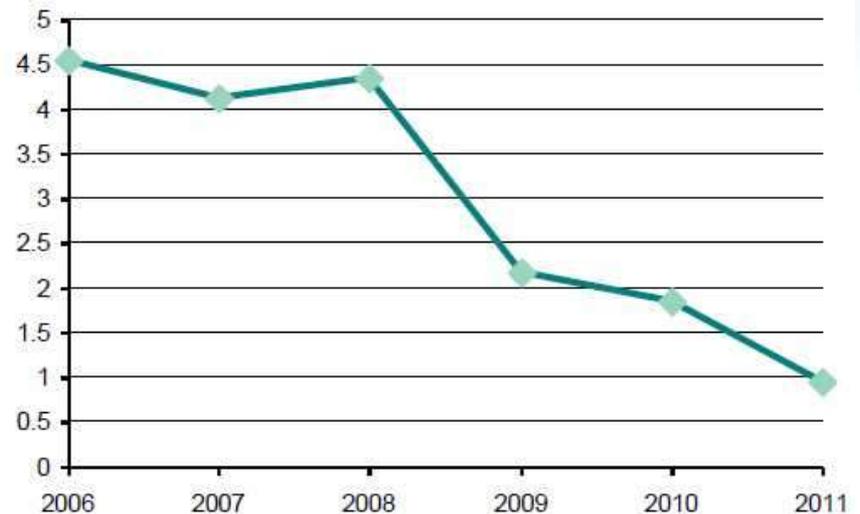
Solar PV BoS Costs

Grid Parity for Solar PV with Balance of System Cost Reductions

By John Farrell | April 29, 2011



*“ Half of the installed cost of a solar PV array is the solar module, but the other half (the “balance of system”) involves labor, assembly, and other components. With module prices continually falling, **significant decreases in total installed cost depend on reducing balance of system costs.** ”*



Chinese c-Si PV module prices (\$/W) ⁽¹⁾



As reported in Solar Novus Today - www.solarnovus.com

Solar PV BOS Costs to Surpass PV Module Costs by 2012

30 June 2011



Reducing PV BoS Costs in California

What's Needed:

- **Design optimization tools**
 - Lower design time and costs
 - All project sizes
- **Documentation tools**
 - Done faster
 - Less opportunity for error
- **Consistent state-wide acceptance criteria**
 - Understood by plan reviewers
 - Accepted by the engineering community
 - Allows for optimal designs
 - Demonstrated code-level performance

Project Tasks:

- Structural Design Automation
- Documentation Automation
- Wiring Software and Components
- Document Management
- Permitting Database
- Seismic and Wind Research
- Industry Publications

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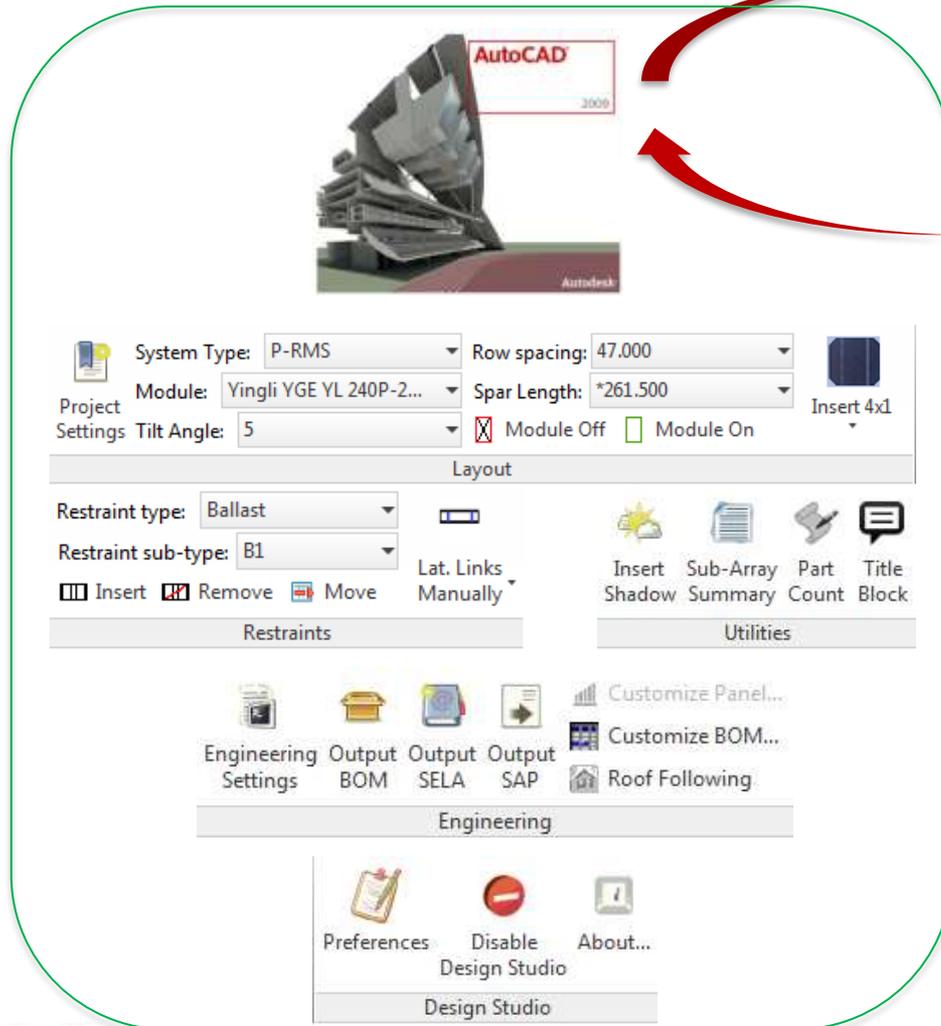
AUTOMATED LAYOUT AND DESIGN TOOLS



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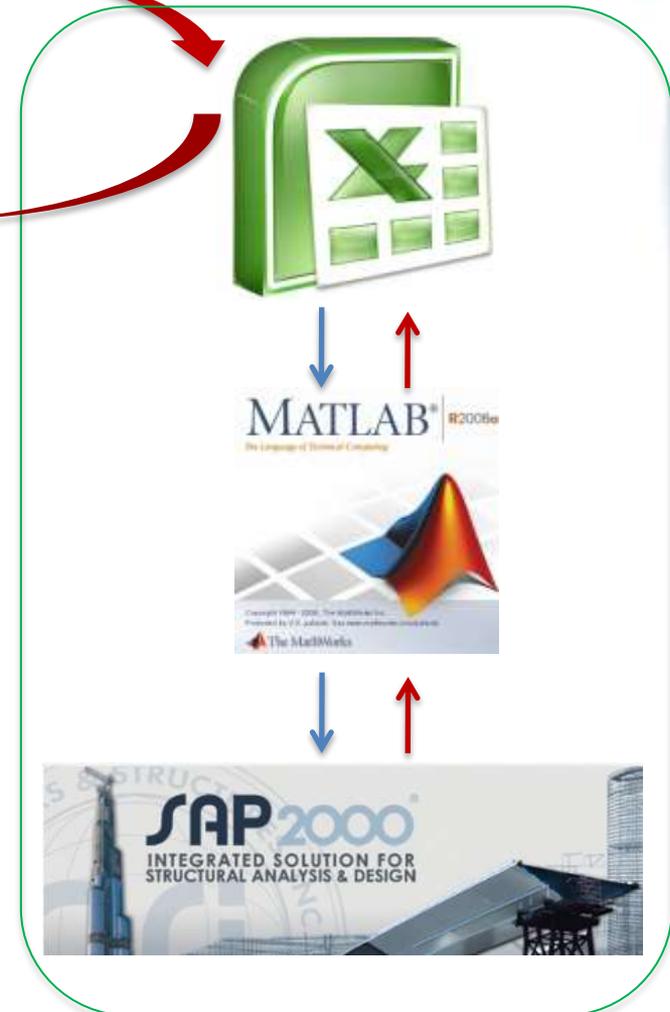
Layout and Engineering Tools

SunLink Design Studio



The screenshot displays the SunLink Design Studio interface. At the top, there is a 3D rendering of a solar panel array with a label 'AutoCAD 2009' and 'Autodesk'. Below this, the 'Project Settings' section includes: System Type: P-RMS, Row spacing: 47.000, Module: Yingli YGE YL 240P-2..., Spar Length: *261.500, Tilt Angle: 5, and checkboxes for Module Off (checked) and Module On. The 'Layout' section features Restraint type: Ballast, Restraint sub-type: B1, and buttons for Insert, Remove, and Move. The 'Utilities' section includes buttons for Insert Shadow, Sub-Array Summary, Part Count, and Title Block. The 'Engineering' section has buttons for Engineering Settings, Output BOM, Output SELA, Output SAP, Customize Panel..., Customize BOM..., and Roof Following. The 'Design Studio' section at the bottom includes Preferences, Disable Design Studio, and About... buttons.

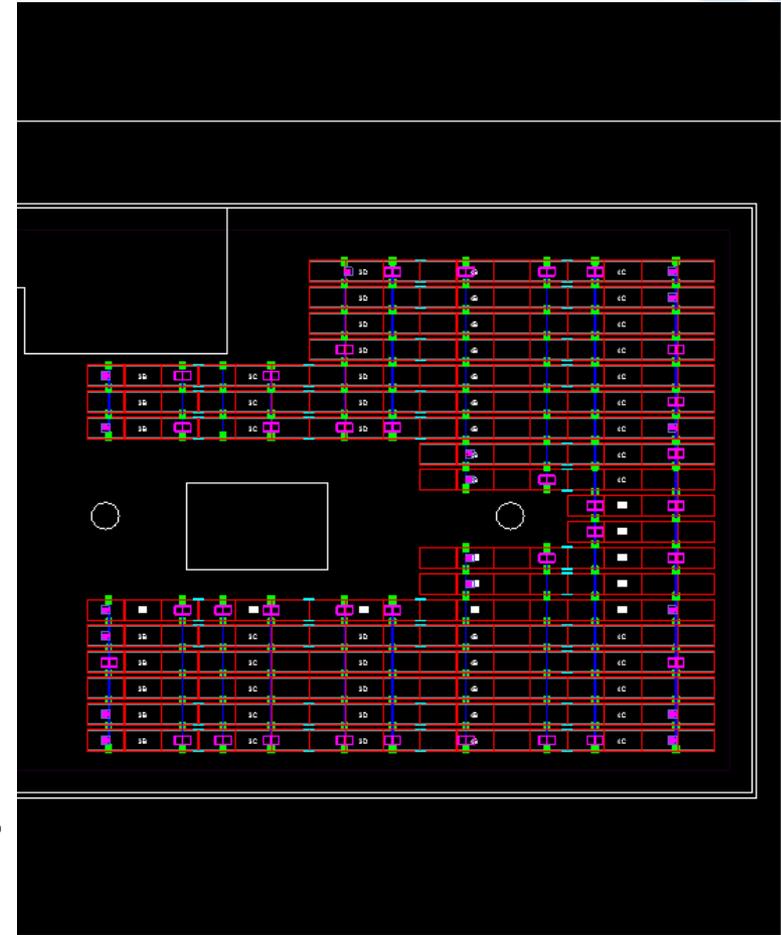
PV-SAP



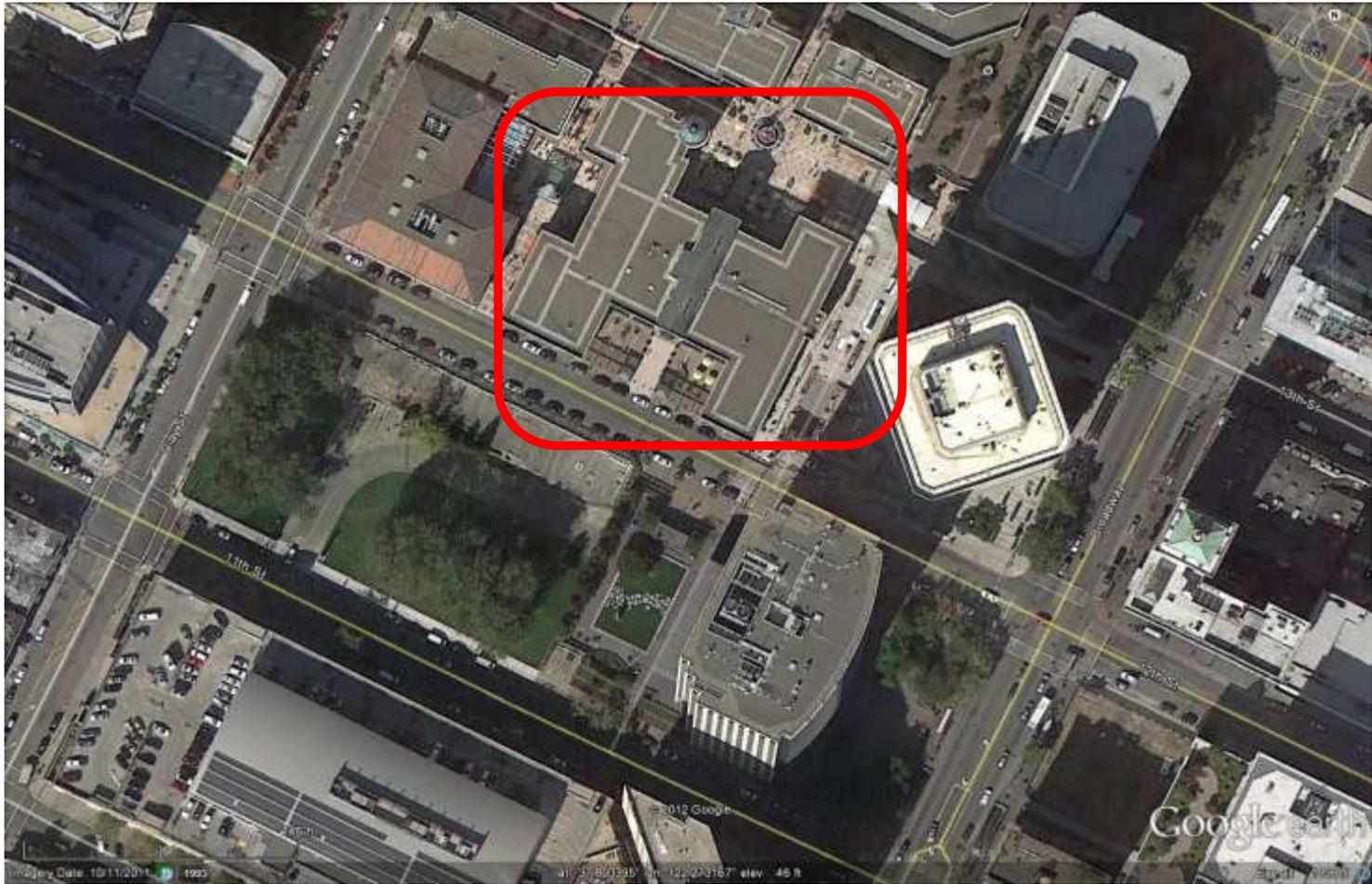
The diagram illustrates the data flow between SunLink Design Studio and PV-SAP. A red arrow points from SunLink Design Studio to PV-SAP. Below PV-SAP, a blue arrow points down to the MATLAB R2008a logo, and a red arrow points up from MATLAB to PV-SAP. Another blue arrow points down from PV-SAP to the SAP 2000 logo, and a red arrow points up from SAP 2000 to PV-SAP. The SAP 2000 logo is labeled 'INTEGRATED SOLUTION FOR STRUCTURAL ANALYSIS & DESIGN'.

SunLink Design Studio

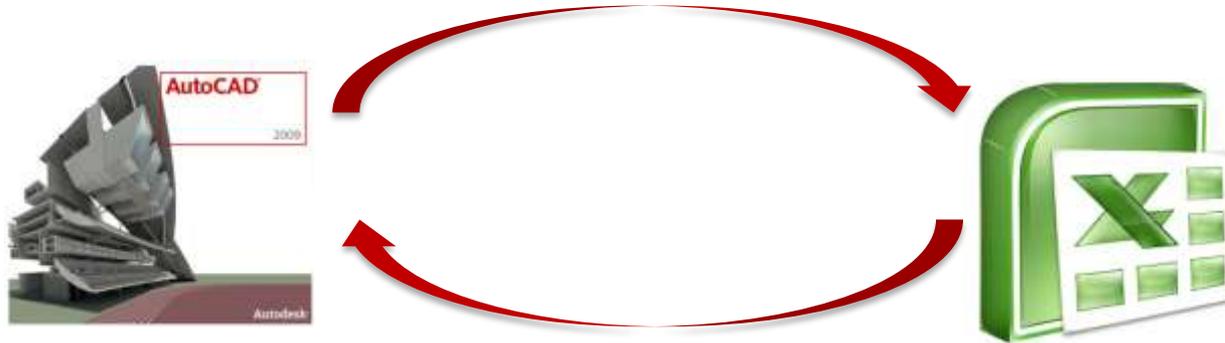
- Driven by a database that contains the specifications and constraints of each product
- Supports the creation of any size projects through layout automation
- Easily supports the placement of engineering components into the drawing for analysis
- Integrated with Microsoft Excel & SAP2000 to create analytical models for wind & seismic analysis
- Provides tools to create and setup drawing sets for permitting and installations



SunLink Design Studio Demonstration



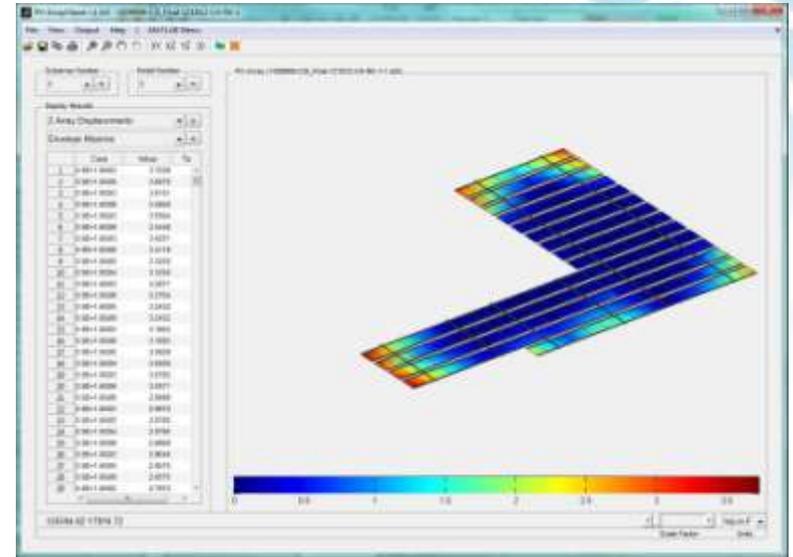
PV-SAP Automation



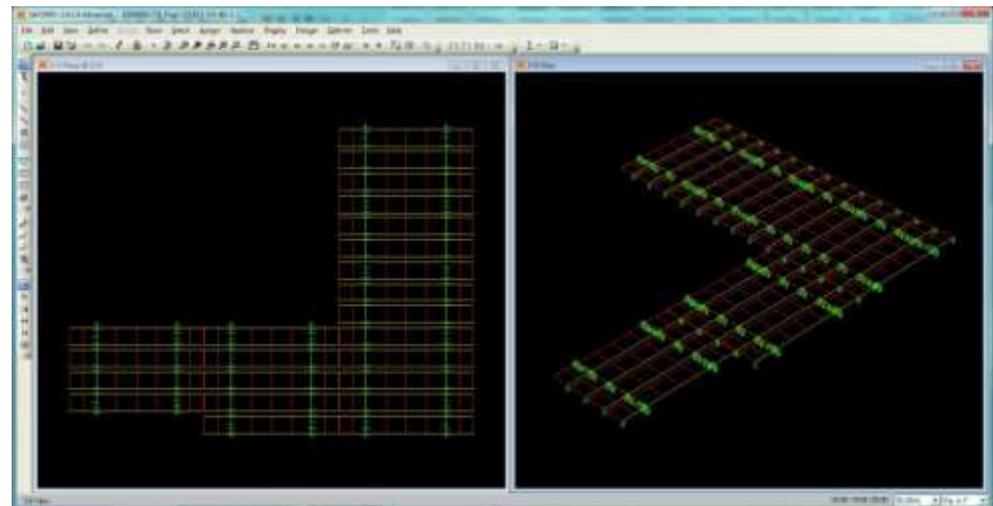
- SunLink's Structural Engineering Load Advisory (SELA) generated from Design Studio
- Uploads all project specific inputs to calculate Wind, Seismic, and Snow loads
- Automatically formatted to provide as customer deliverable

Item	Status	Description	Value	Units	Notes
1.1.1.1	OK	Dead Load	100	lb/ft ²	
1.1.1.2	OK	Live Load	50	lb/ft ²	
1.1.1.3	OK	Roof Live Load	20	lb/ft ²	
1.1.1.4	OK	Wind Load	15	psf	
1.1.1.5	OK	Seismic Load	0.1	g	
1.1.1.6	OK	Snow Load	0	lb/ft ²	
1.1.1.7	OK	Temperature Load	0	lb/ft ²	
1.1.1.8	OK	Shrinkage and Creep Load	0	lb/ft ²	
1.1.1.9	OK	Impact Load	0	lb/ft ²	
1.1.1.10	OK	Other Load	0	lb/ft ²	

PV-SAP Automation Cont.

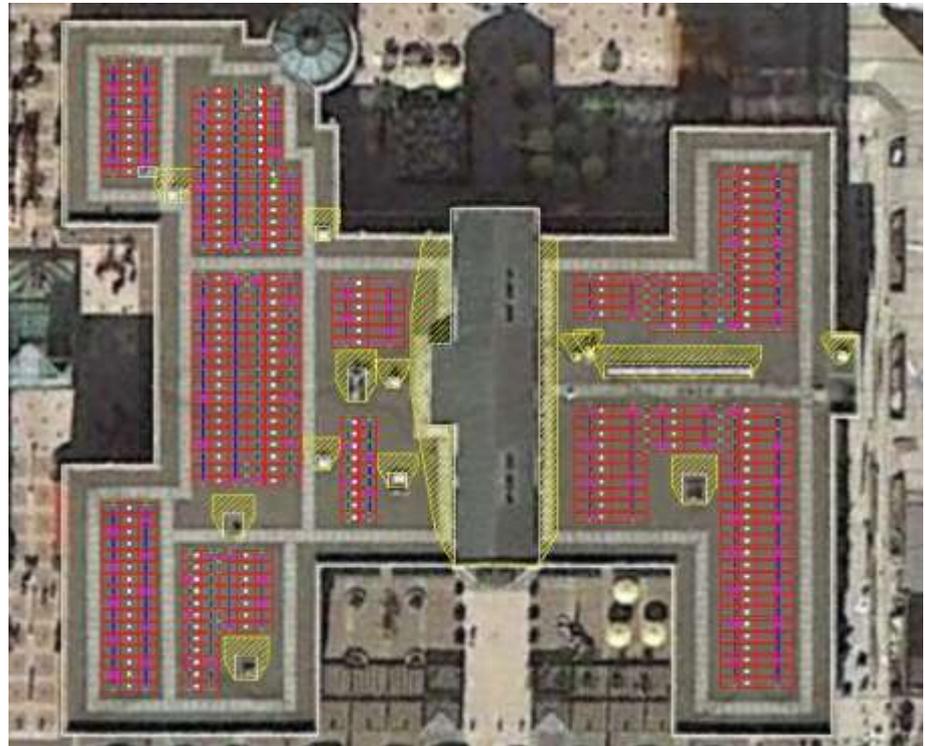
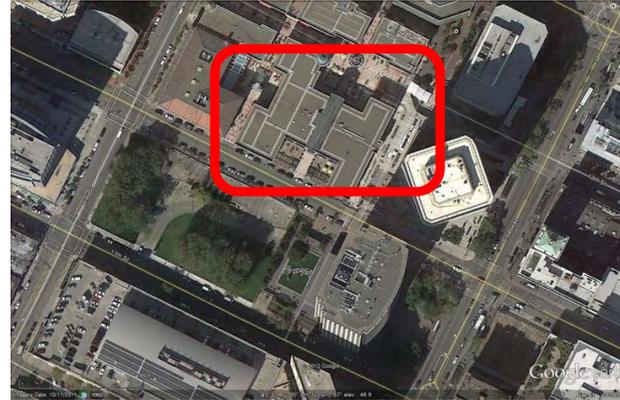


- Analyzes structural model generated from Design Studio
- Writes and reports all results to the SELA excel document
- Graphical user interface (GUI) allows ease of interpreting results



Benefits to California

- Better customer communication
- Lower cost of PV systems by quickly automating multiple layouts
- Reduce design time for both SunLink and its customers
- Deliver projects with less opportunity for error



DOCUMENT MANAGEMENT



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Why Investigate DMS?

- Solar projects involve a number of documents including drawings, contracts, engineering reports, permitting documents, etc.
- Challenges:
 - Locating files on a file share
 - Version Control
 - Security
 - Document Processes
 - Collaboration
 - Sharing documents with external partners
- Seek more efficient means of working with documents



Process

- Gathered high level requirements
- Held interdepartmental workshops to establish process steps, activities, and associated documents and data
 - Workflow Drawing & Excel Workbook
- Researched document management system capabilities and offerings
- Established scope for evaluating DMS
 - Roof mount products
 - Quote Request -> Customer Contract
- Selected DMS for pilot
- DMS configuration
- DMS pilot



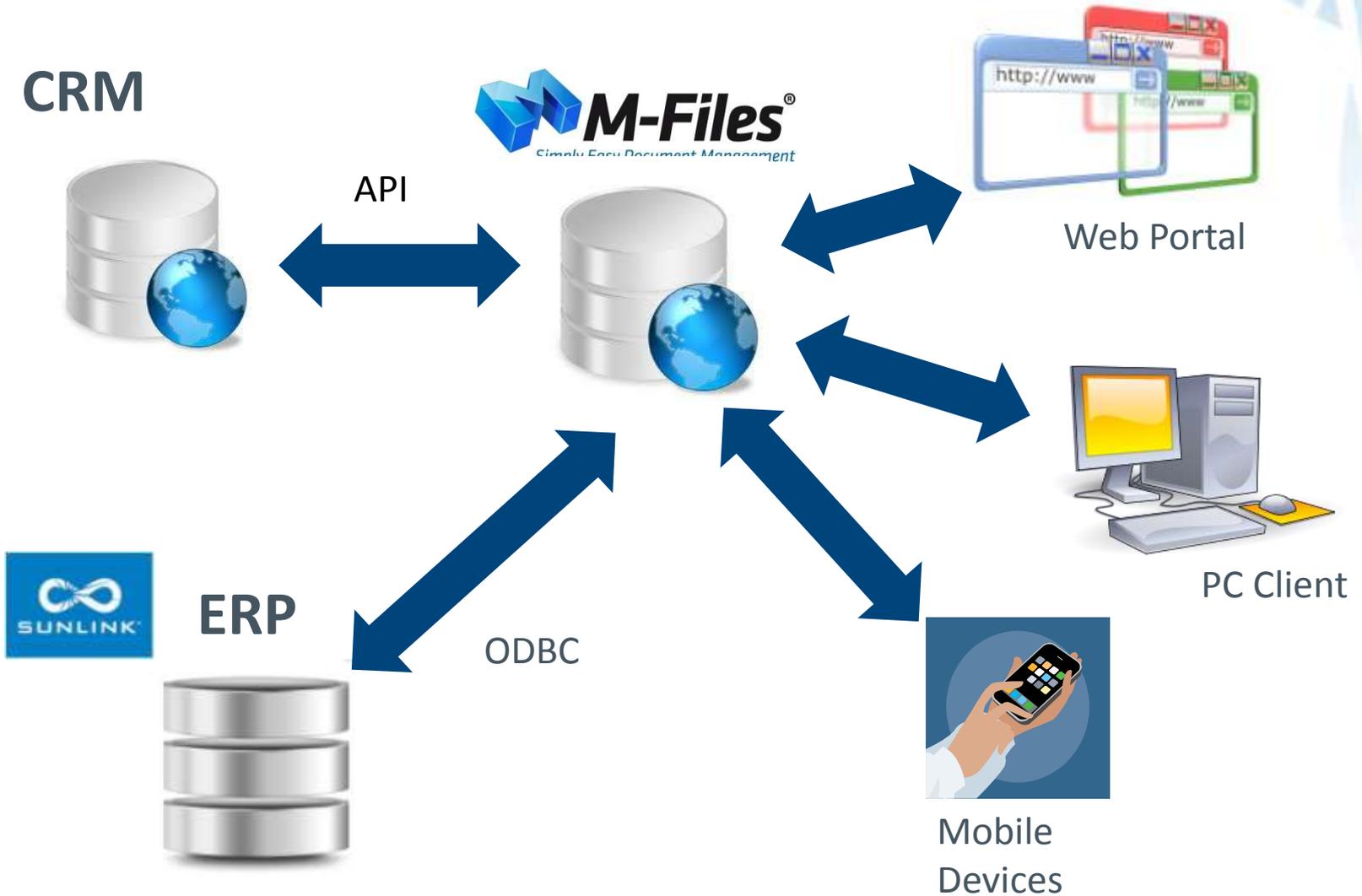
DMS Selection



DMS Features :

- Document Versioning / Tracking
- Integrated MS Windows Explorer Client
- Web Client / Portal
- Work Flow / BPM & Project Tracking
- Microsoft Office, Outlook & AutoCAD integration
- Reporting
- Mobile Device Browser
- Digital Signing / Certificate Module
- Document Security
- OCR – Optical Character Recognition
- CRM Integration

DMS Pilot Architecture



DMS Screen Shots

Search all objects Search within this folder

Type search words

Name	State	Project Size (kW)	Project Engi...	Project Ma...	Deadline	State/province	Product type	Tilt Angle	Roof Height (ft)
> 1004637	11. Structural Eng Review	1487	Chris Harbich	Casey Purcell	-	CA	CoreRMS	10 Degree	37.5
> 1004969	11. Structural Eng Review	441	Chris Harbich	Casey Purcell	-		PrecisionRMS	5 Degree	50.0
> 9005001	9. Engineering Request	1200		Nick Troia	8/24/2012		Flat Roof Mount	10 Degree	30

Computer > M-Files (M) > SunLink Pilot

File Edit View Tools New Operations Settings Help

Organize View New Operations Settings

MSOCache
PerfLogs
Program Files
Program Files (x86)
ProgramData
sensenat
swshare
SWTOOLS
System Volume Inf.
TEMP
Users
VSPATH
wamp
Windows
Gower_dtdbrowse
MFApi_8_0_2910_32
DVD RW Drive (E:)
M-Files (M)
Lerevo_Recovery (Q)
Network
Control Panel
Recycle Bin
Desktop
EF
MFiles

Search all objects Search within this folder

Type search words

Name Type

- Common Views
- Assignments View
- Customers (Epicor)
- Documents
- Layout Queue
- Project Engineering Queue
- Project Engineering Schedule
- Projects
- Projects - Classic SunLink Folder View
- PV Modules
- Templates
- Other Views
- Assigned to Me
- Checked Out to Me
- Favorites
- Recently Accessed by Me
- Recently Modified by Me
- Offline

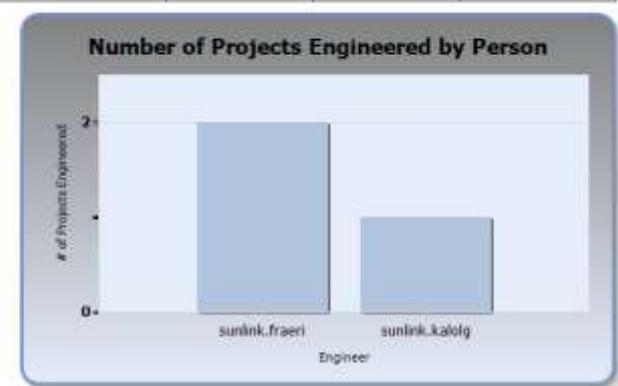
Start Date: 1/31/2001 End Date: 1/31/2014

SUNLINK Engineering Process Report

Engineer	Project	Requested Date	Complete Date	Estimated Hours
sunlink.fraeri		6/19/2012	6/19/2012	
sunlink.kalolg	tarity	6/25/2012	6/25/2012	
sunlink.fraeri		6/28/2012	6/28/2012	

Layout Person Count

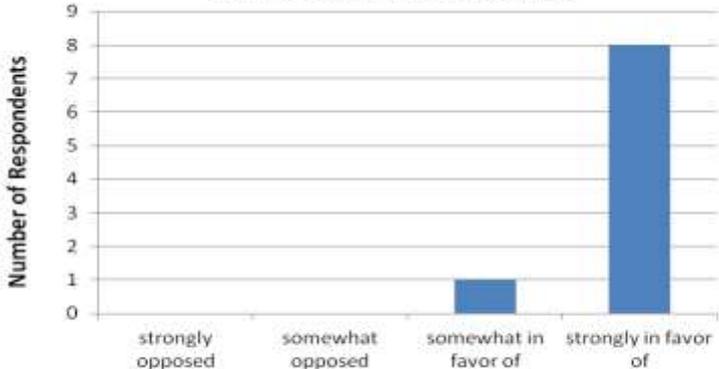
sunlink.fraeri	2
sunlink.kalolg	1
Total	3



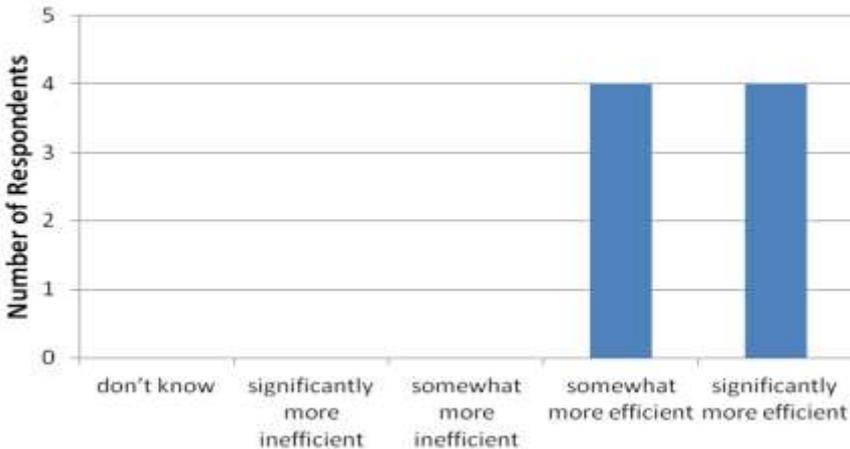
9/27/2012 5:40:08 PM

DMS Pilot Feedback

Based on the pilot, what is your position on moving ahead with M-Files DMS for production use?



Based on the pilot, how do you think the M-Files DMS will impact your job in terms of efficiency?



Benefits to California

- Established Document Management systems can play a vital role in creating organizational efficiencies and reducing errors
- Our work serves as a starting point for solar organizations to pursue document management
- Identified and reviewed DMS products
- Identified key functionality and features worthy of consideration as DMS selection criteria





CALIFORNIA PERMITTING AGENCY DATABASE

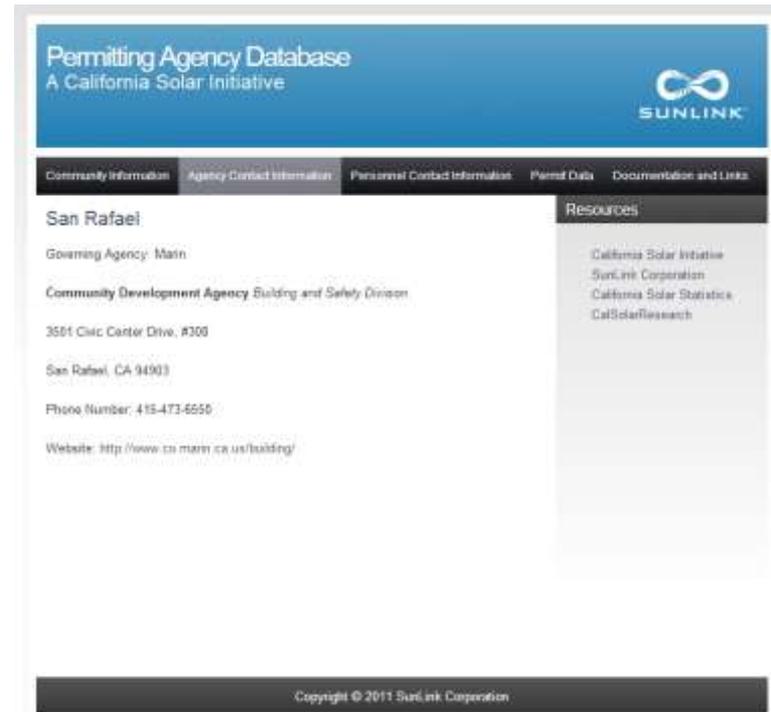
Benefits of the Database Application

- Improve visibility and efficiency of permitting process in California
- Improve communication between building owners, solar installers, engineers, and permitting departments
- Reduce the time and effort required in gathering engineering requirements
- Encourage future universal code requirements for solar installations



What it Does

- Web-accessible database application
 - Engineering parameters for solar projects
 - Building official contact information
 - Links to adopted building codes
 - 1,527 California cities and towns already added



<http://ec2-54-245-104-33.us-west-2.compute.amazonaws.com/>

The Future of the Database

- SunLink-hosted for one year
- Administrator privileges to be determined
 - Potential to transition to a public wiki
- Future database management

SunLink Permit DB administration

Home > ADapp > Agency names > Marin

Change agency name

Name:	<input type="text" value="Marin"/>
Agency Name1:	<input type="text" value="Community Development Agency"/>
Agency Name2:	<input type="text" value="Building and Safety Division"/>
Address:	<input type="text" value="3501 Civic Center Drive, #308"/>
Address2:	<input type="text"/>
City:	<input type="text" value="San Rafael"/>
Zip Code:	<input type="text" value="94903"/>
Phone Number:	<input type="text" value="415-473-6550"/>
WebSite:	<input type="text" value="http://www.co.marin.ca.us/building/"/>
Personnel:	<input type="text" value="Mr."/> <input type="button" value="v"/>
Contact Last Name:	<input type="text" value="Kelley"/>
Contact First Name:	<input type="text" value="William 'Bill'"/>
Contact MI:	<input type="text"/>
Contact Suffix:	<input type="text"/>
Contact Title:	<input type="text" value="CBO"/>
Contact Email:	<input type="text"/>

SHAKING TABLE EXPERIMENTS



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Unattached PV Solar Arrays

Rooftop arrays where ballast, self-weight, and friction provide wind resistance.

THE ADVANTAGE:

- Overall reduced project costs
 - Installation
 - Penetrations, flashing, etc.
 - Maintenance

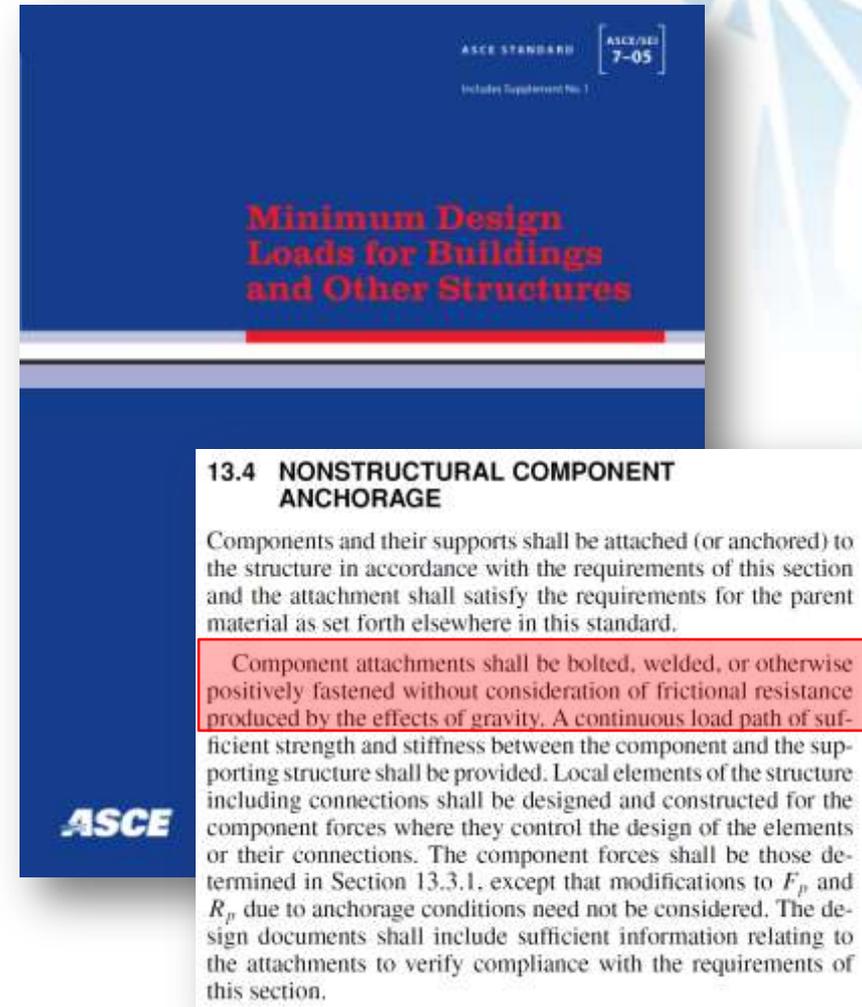
THE CHALLENGE:

- Seismic design in high seismic areas
 - Code-level “life safety” performance



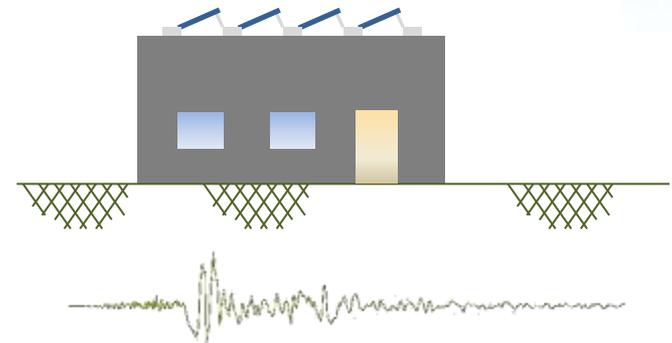
U.S. Building Codes

- Seismic design per ASCE 7
- Chapter 13 prescriptive requirements for building equipment in high seismic areas:
 - “...bolted, welded or otherwise positively fastened ...”

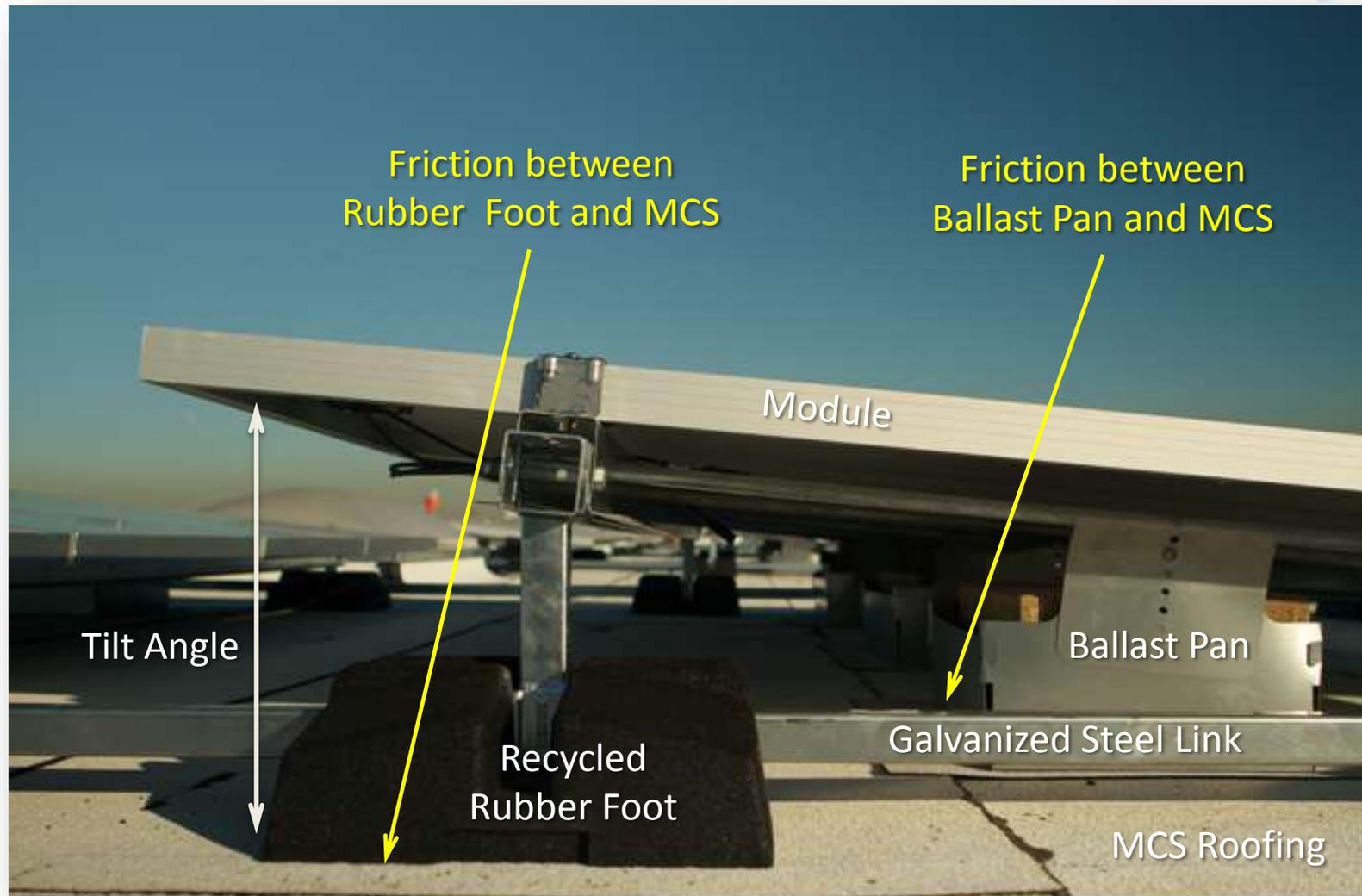


Part 1 - Structural Analysis

1. Build structural analysis models that accurately capture the parameters that influence seismic behavior
2. Determine a set of appropriate earthquake roof motions to be used as inputs to the analyses
3. Run analyses and record sliding displacement demands
4. Develop design tables so that the engineer can look up sliding displacements for different SDS, COF and roof slope values

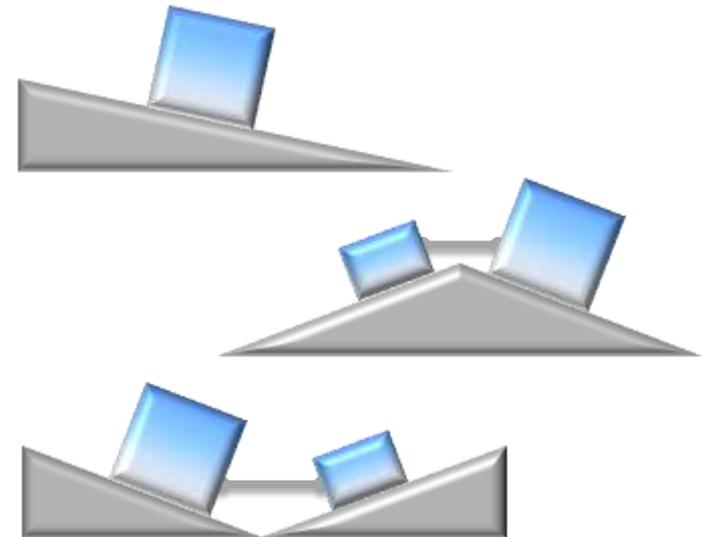
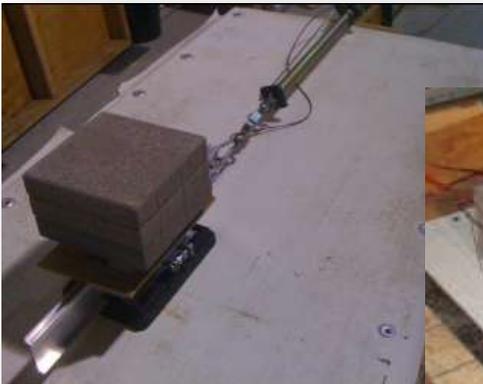


Development of Analysis Models



Development of Analysis Models

- Friction is assumed to be constant (Coulomb friction) and is determined from pull-tests of the feet and ballast pans
- Due to the low CG sticking and sliding are the primary modes of response (no rocking, no uplift)
- Model arrays in plane w/o vertical dimensions or as lumped masses w/o internal flexibility
- Internal damping of the solar array structure is conservatively ignored



Selection of Earthquake Roof Motions

- Use roof accelerations from CSMIP database
- Use only 3-component roof motions
- Select 7 roof motions
 - different earthquakes
 - geographical locations
 - soil conditions
 - building types

CSMIP Automated Building Response Analysis and 3-D Visualization System

Select a Building

Case	City	Stories	Type	No. of Frames	Design Date	Site Geology
24582	Los Angeles	16	Office	16	1980	Rock (bedrock)
24571	Pasadena	9	Commercial	16		Deep Alluvium
24579	Los Angeles	9	Office	16	1923	Alluvium
24581	Los Angeles	2	Five Columned Dkt.	16	1980	Rock (bedrock)
24581	Los Angeles	12	Commercial/Office	16	1980	Alluvium
24625	Los Angeles	17	Residential	16	1980	Rock (bedrock)
24602	Los Angeles	53	Office Building	20	1980	Alluvium Over Understory Rock
24505	Los Angeles	7	Hospital	24	1990	Rock (bedrock)
24609	Livermore	5	Hospital	32		Alluvium
24623	Los Angeles	54	Office	32	1980	Alluvium over bedrock soil
24643	Los Angeles	18	Office	16	1987	Deep Alluvium
24710	Los Angeles	18	Faculty Structure	14	1970	Deep Alluvium
47261	Holbrook	5	Warehouse	12		Alluvium

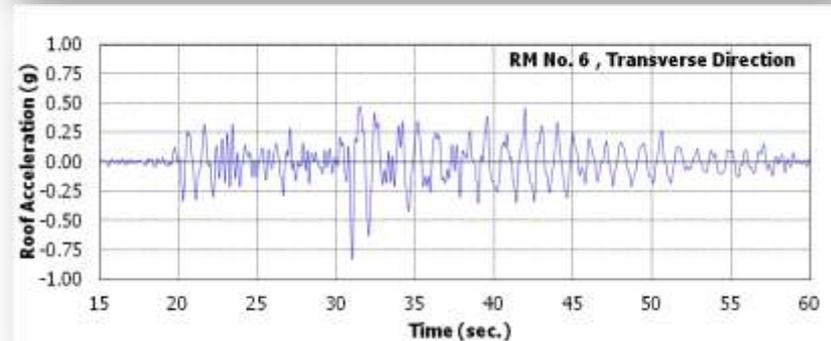
Select an Earthquake

Event	Year
Northridge	1994

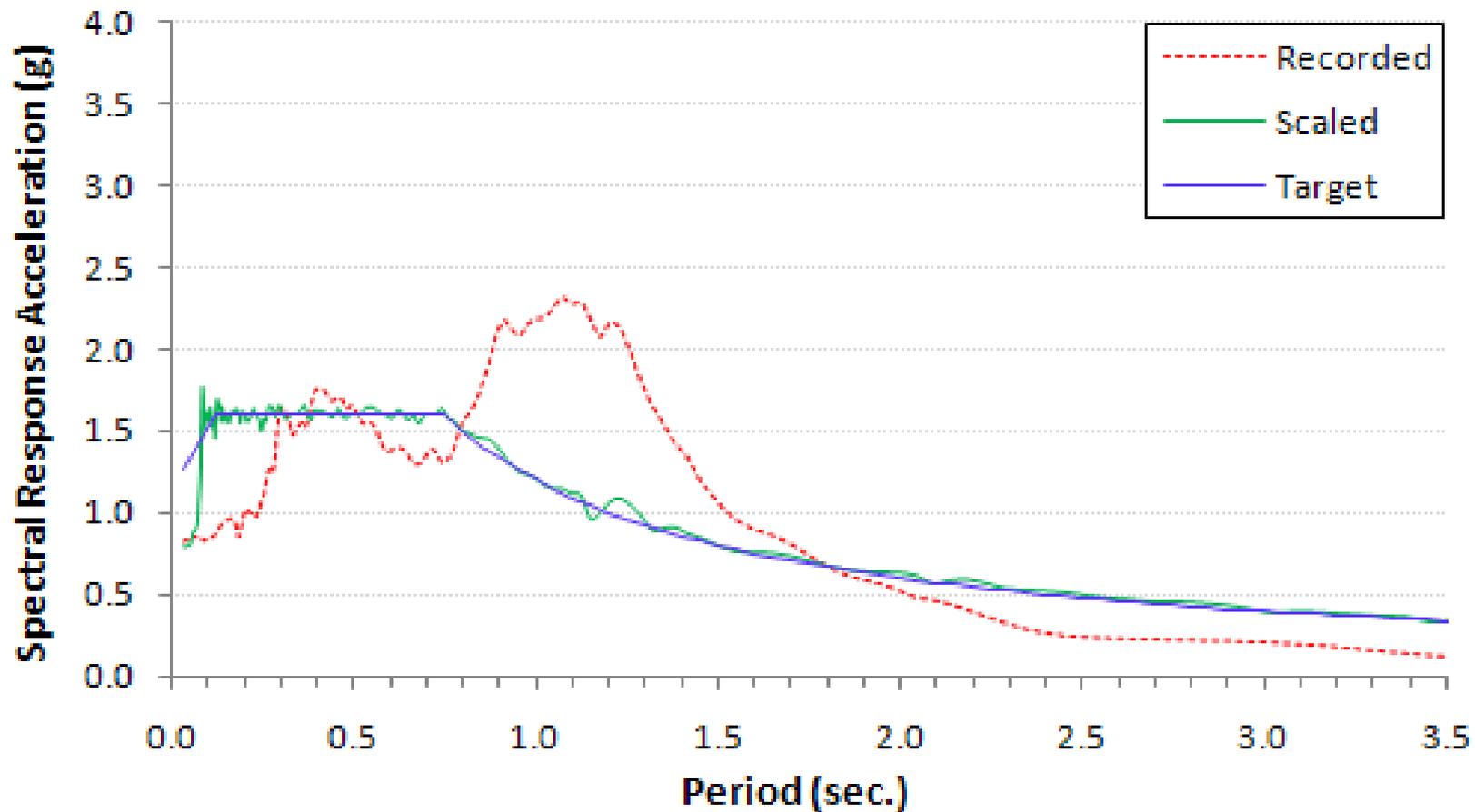
Latitude: 34.012N Longitude: 118.289W
Plan Shape: Rectangular Width: 306 ft. Length: 259 ft.
Vertical Load System: Concrete slabs supported on precast concrete beams and columns.
Lateral Load System: Six cast-in-place concrete shear walls in the N-S direction and two cast-in-place concrete shear walls in E-W direction.
Foundation Type: Drilled concrete columns.

[Click Here to Continue](#) [Click Here to Exit](#)

Data Preparation Status:
Initiating and Preparing Files:
This File: _____
All Files: _____



Effect of Scaling and Spectral-Matching



Roof Motion 6: Transverse Direction

Shaking Table Testing

- Needed a real-world experiment to validate and calibrate the nonlinear computer analysis models developed in phase 1



PEER Earthquake Shaking Table Facility

- Table = 20 ft x 20 ft
- Largest 6 DOF shaking table in U.S.
- Can test structures, weighing 100,000 lbs, to horizontal accelerations of 1.5 G
- +/- 5 inches horizontal displacement capacity
- +/- 2 inches vertical displacement capacity
- +/- 40 inches/sec velocity capacity



Roof Surfaces



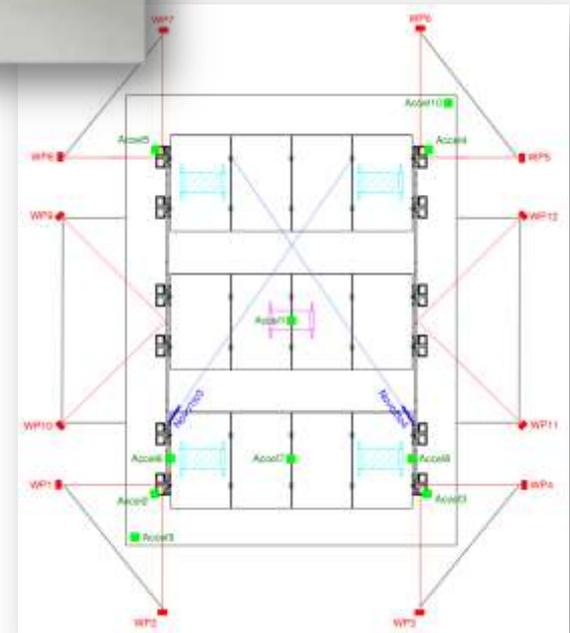
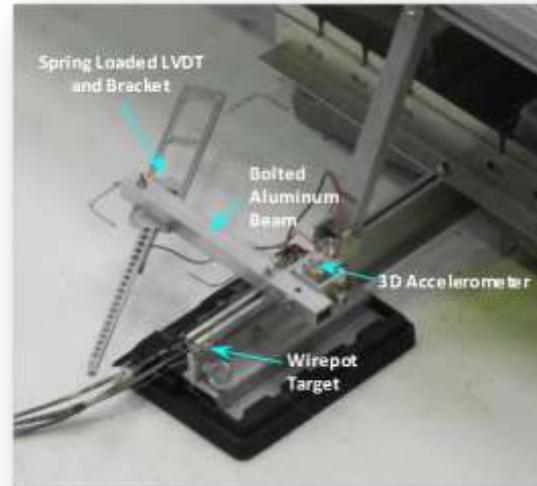
Testing the CORE System on a 4%
Incline Polyvinyl Chloride (PVC)
Roof



Switching to the Mineral Cap
Sheet (MCS) Roof

Instrumentation Setup

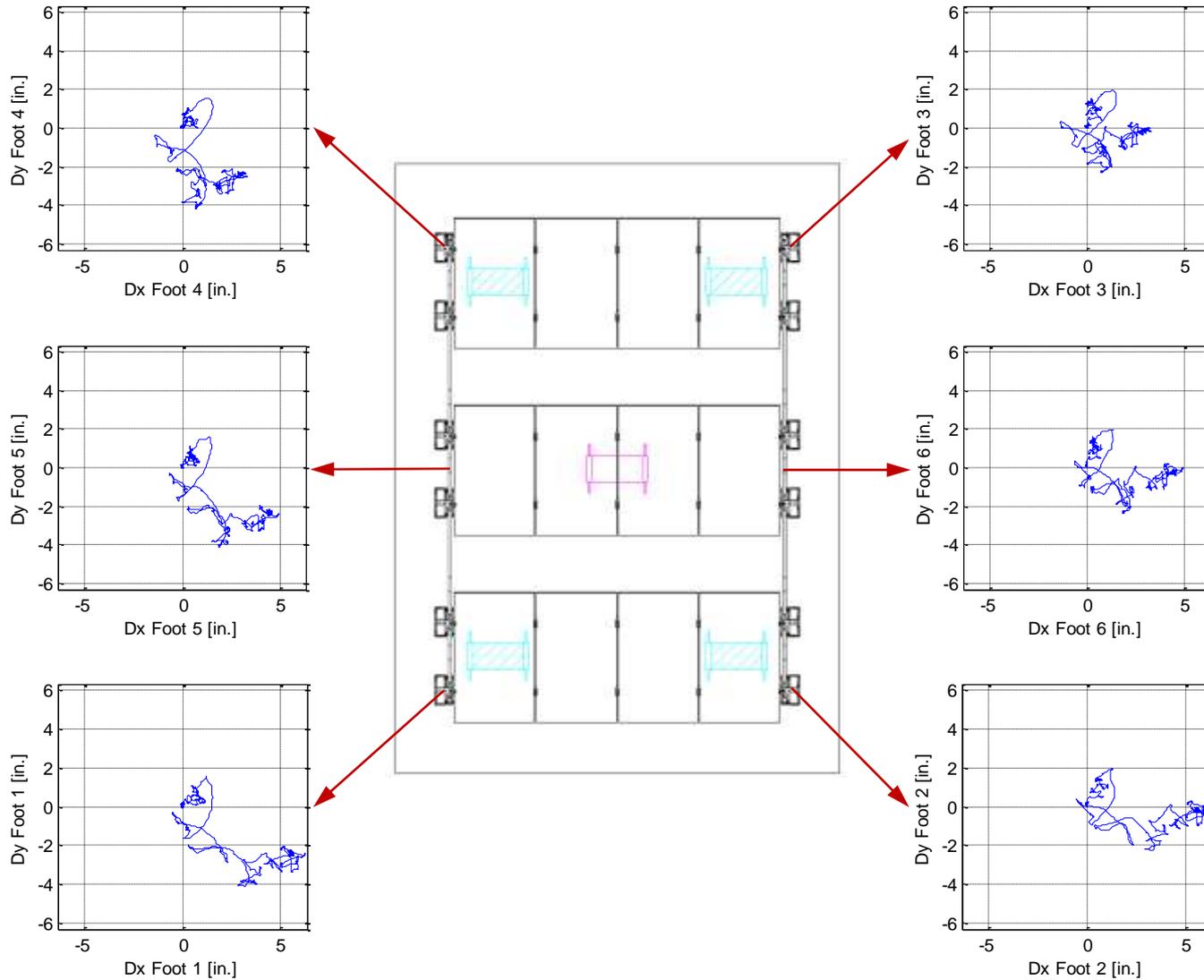
- 12 Wire Potentiometers
- 2 Linear Variable Displacement Transducers
- 10 Accelerometers
- 60 DAQ Channels
- Approximately 1.4 million data points/test



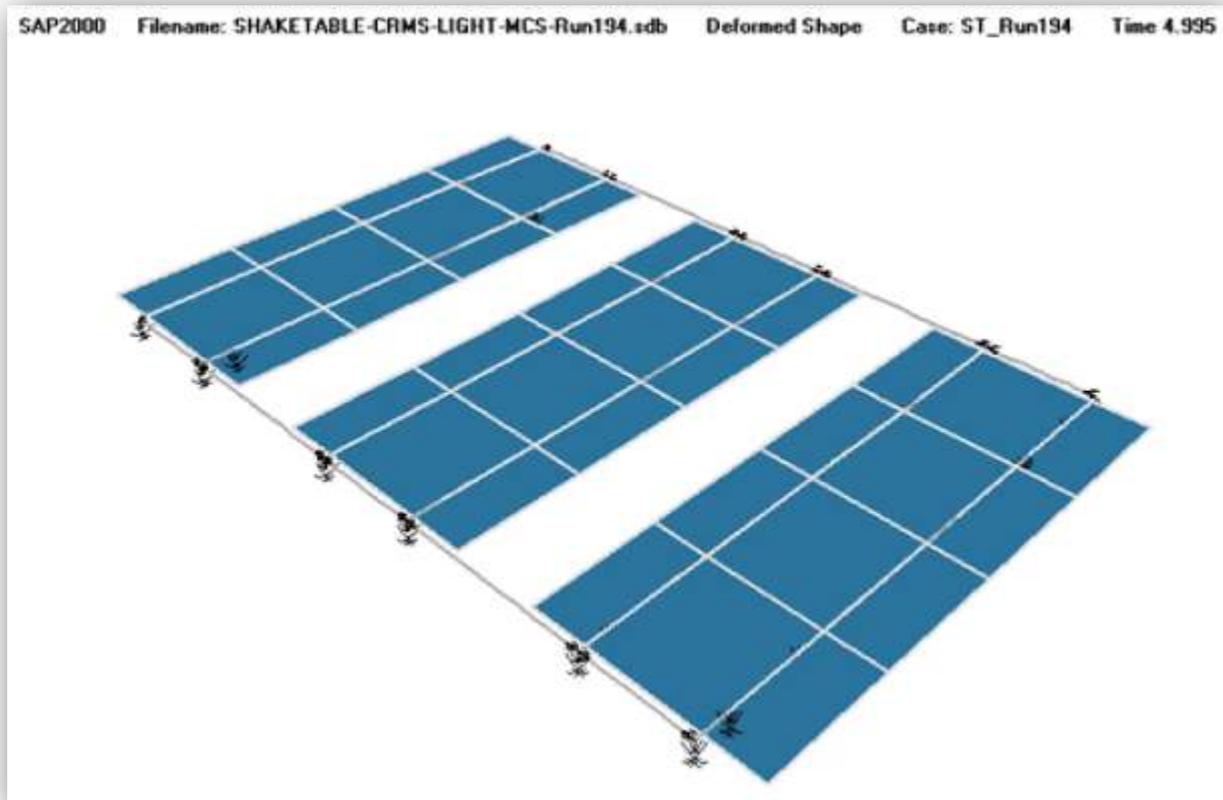
Shaking Table Video



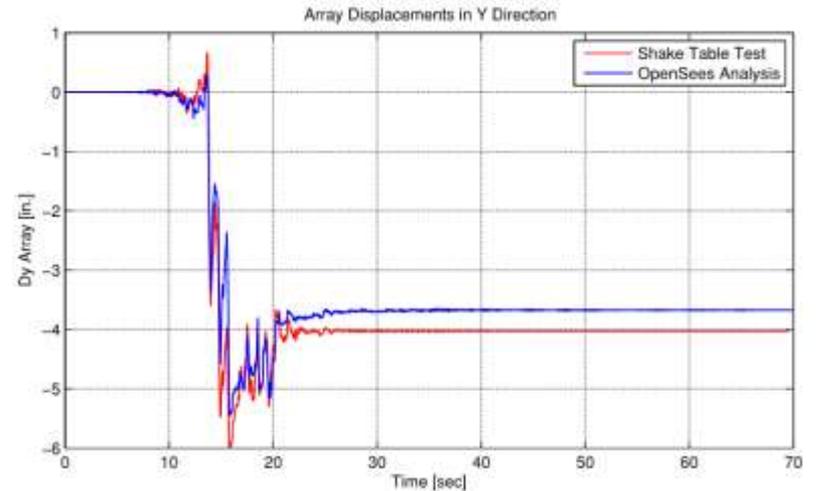
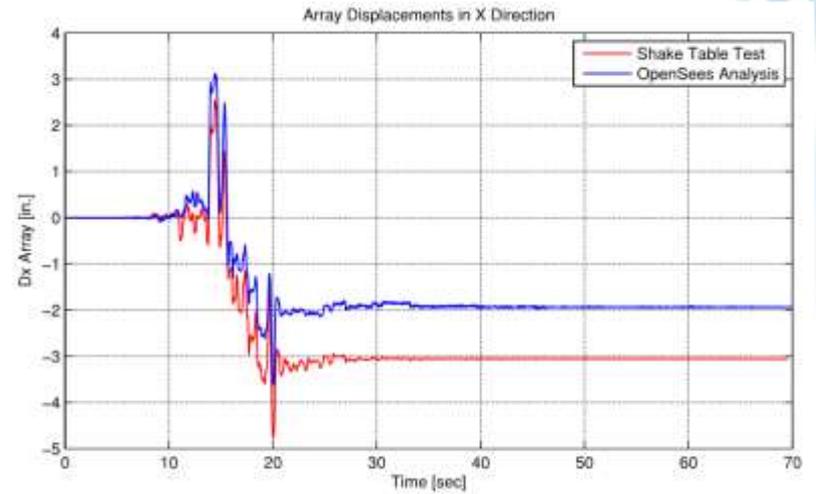
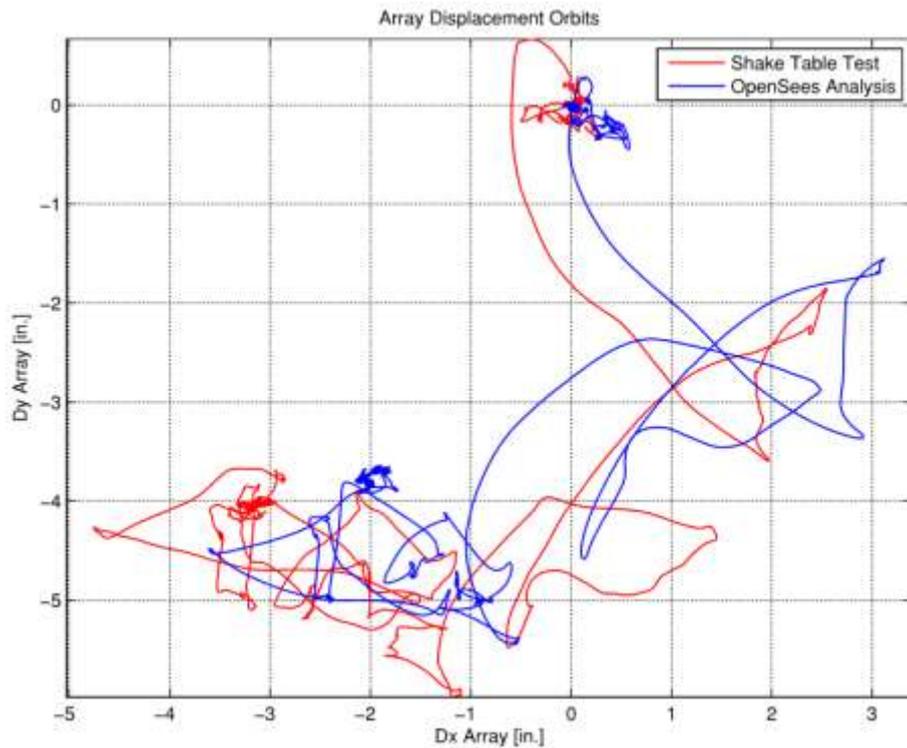
Data Acquisition and Processing



Animation of Analysis Results



Data Collection and Comparative Analysis



SEISMIC R&D FINDINGS



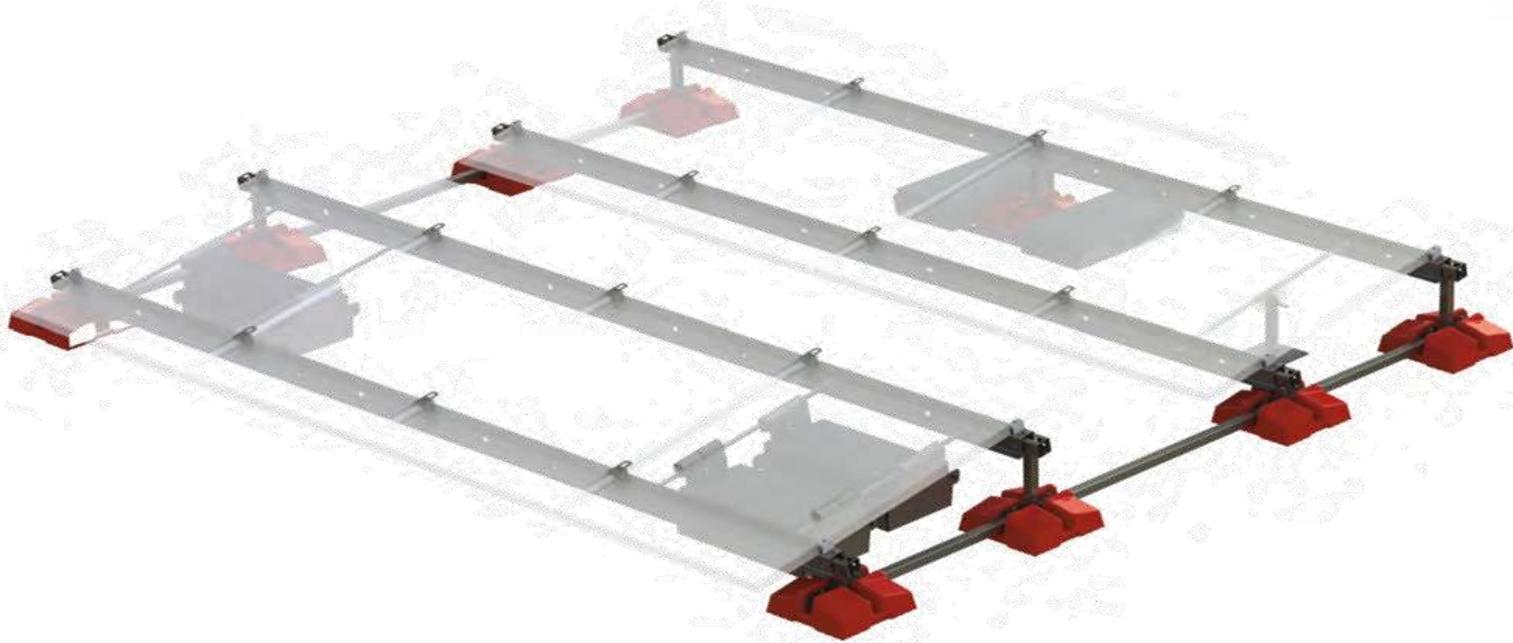
SUNLINK[®]

System Movement

System movement during high seismic events is smaller than many think, and is manageable.



Friction



Friction plays a role in restraining forces during seismic events.

Roof Integrity



**After 100
earthquakes each:
No roof damage.**

Read the full report at
www.sunlink.com/seismictesting.

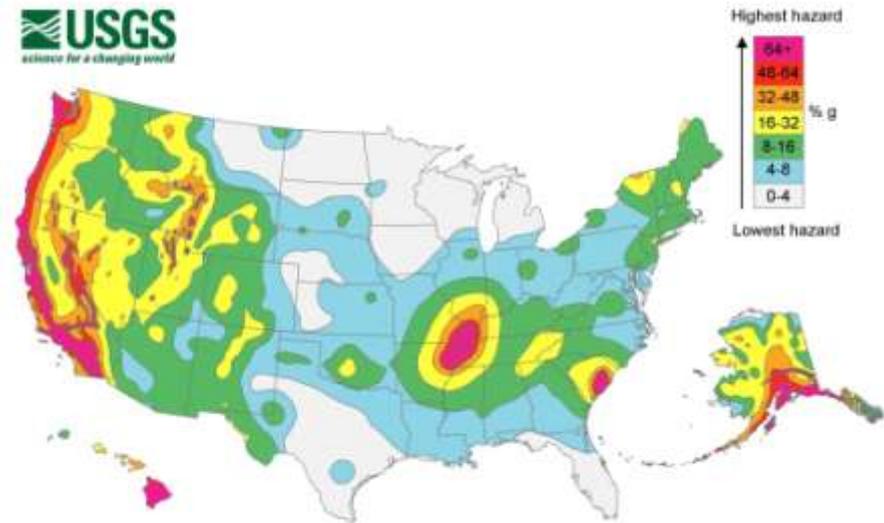


A large, stylized graphic of a leaf or plant branch in various shades of blue, positioned on the left side of the slide.

PUBLIC BENEFITS TO CALIFORNIA

Seismic R&D Benefits

- Greater Solar Penetration
 - Decreased system and installation cost of unattached systems
 - Potential for projects on building roofs previously considered unsuitable
- Furthering the conversation toward permitting unattached systems in seismic regions



A large, stylized graphic of a leaf or plant branch in various shades of blue, positioned on the left side of the page. The graphic consists of several overlapping shapes, including a large teardrop-like leaf and a fan-like structure at the bottom left.

INDUSTRY PUBLICATIONS

SunLink Publications

- CSI RD&D program
- Technical conferences
- SunLink white papers and webinars
- Trade journal articles
- Peer-reviewed journal papers

SEIAC 2012 CONVENTION PROCEEDINGS

Seismic Behavior of Unattached Solar Arrays on Flat Roofs: Analysis, Shake Table Testing, and Proposed Requirements

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Abstract

Solar photovoltaic arrays are an increasingly popular and expensive source of renewable energy, and a significant portion of new solar projects consist of large arrays installed on existing flat or low-slope roofs. These provide building owners and solar installers typically prefer to use solar panel support systems that do not require structural modifications to the building because penetration through the roof membrane can be costly to install and not lead to waterproofing issues.

The basic practice, unattached isolated structural connections to existing buildings, is shown to require a demonstration that such systems can withstand earthquake shaking and uplift with common building codes. The paper describes:

- structural analysis to investigate the seismic behavior of unattached solar arrays;
- shake table testing to complement analytical models;
- proposed building code requirements developed by SEIAC to address the issue.

Thirteen separate failure analysis and shake table testing activities that are either shown on CD or described in detail. Photos illustrate the solar array supports and the roof structure elements that are displaced during the tests when subjected to seismic shaking. The measured nonlinear and the experimental data are recorded and contrast from joint mechanisms, identified according to design options and tested in different directions of design earthquake shaking. The authors are confident of the results obtained from experimental pull-out of solar array supports around failures.

Based on the findings of these and other investigations, the SEIAC Solar Photovoltaic Technical Committee is developing a document titled "Seismic Behavior Requirements and Connections for Roof (SEIAC) 2012". The requirements for specific prescriptive provisions 1) and 2) appear in an introduction.

Introduction

The solar photovoltaic a portion of new solar projects installed on top of slope roofs such as steep. To minimize roof load, type of connections, a typical practice to use is begin penetrating the

SHAKE-TABLE TESTING OF UNATTACHED ROOFTOP SOLAR ARRAYS

Final Report
CSI Subtask 4.2

July 2012



Prepared for:
California Solar Initiative Technical
Investigation and Deployment Program Grant Task Order No. 2
Project Title:
Building California's PV Resource of System Cost by Automating
Design, Design, Engineering and Construction Delivery
Principal Investigator:
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Bob Wang, S.E.
Norma Davis
Kath Talbot, S.E.

Tech Transfer 1

Trade Journals and Press

Carlsen, R. "[U.C. Berkeley's PEER Center Hosts Shake Test for Alternative Solar Racking System](#)," Engineering News-Record, March 19, 2012

Riddell, L., "[Sunlink studies seismic effects on solar](#)," San Francisco Business Times, March 6, 2012

Ward, R., Miller, K., "[Ballasted Solar Systems in High Seismic Areas](#)," Solar Novus, 24 October 2012

Technical Conferences

Holland, R.H., Miller, K., and Schellenberg, A. "Approach to Parametric Analysis of Wind Load Effects on PV Solar Roof Bearing Arrays Using OpenSees" PEER OpenSees Days presentation, 16 August 2012.

Schellenberg, A., Fathali, S., Maffei, J., Miller, K., "Seismic Behavior of Unattached Solar Arrays on Flat Roofs: Analysis, Shake Table Testing, and Proposed Requirements," Proceedings Structural Engineers Association of California / Structural Engineers Association of New Mexico Convention, Santa Fe, NM September 2012.

Tilley, C., "Accelerating BOS Cost Reduction through Integration," 4th PV Power Plants Conference, Phoenix, AZ, November, 2012

Williams, J. M., "Engineering Challenges for Photovoltaic Power Systems," 2nd International Conference for Sustainable Design, Engineering and Construction, Fort Worth, TX, November 2012.

Tech Transfer 2

Trade Shows

Tilley, C., "Standardization of Codes for Solar Project Development," Solar Power International Orlando, FL, September 2012

SunLink White Papers

SunLink Seismic Testing Roof Integrity Report

SunLink Webinars

Miller, K., Ward, R., "[Designing for Earthquakes](#): Lessons from SunLink's Full-Scale Shaking Table Experiments," September 25, 2012

Peer Reviewed Journals

Maffei, J., Fathali, S., Telleen, K., Ward, R., and Schellenberg, A. (2012). "Seismic Design of Ballasted Solar Arrays on Low-Slope Roofs." Submitted to ASCE Journal of Structural Engineering, 2012

Technical Committees

Structural Engineers Association of California Solar Photovoltaic Systems Committee, "Structural Seismic Requirements and Commentary for Rooftop Solar Photovoltaic Arrays" SEAOC PV1-2012 August 2012.

Structural Engineers Association of California Solar Photovoltaic Systems Committee, "Wind Design for Low-Profile Solar Photovoltaic Arrays on Flat Roofs" SEAOC PV2-2012 August 2012.

University Lectures

Mike Williams – Stanford University – Civil and Environmental Engineering – Spring 2011 and Spring 2012

Mike Williams – UC Berkeley – Civil Engineering – Fall 2011

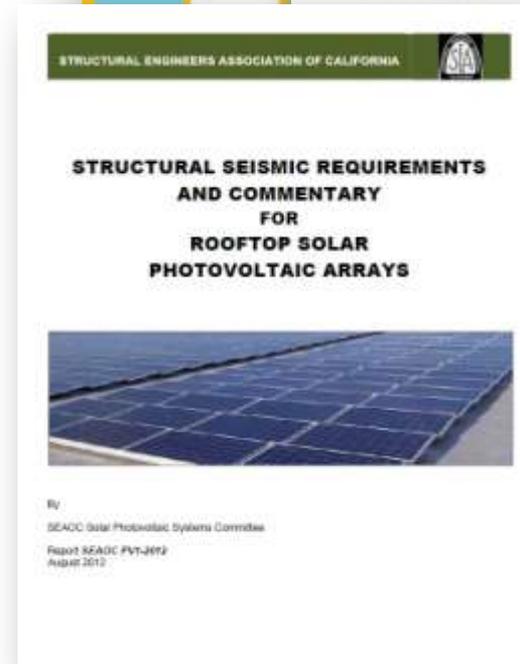
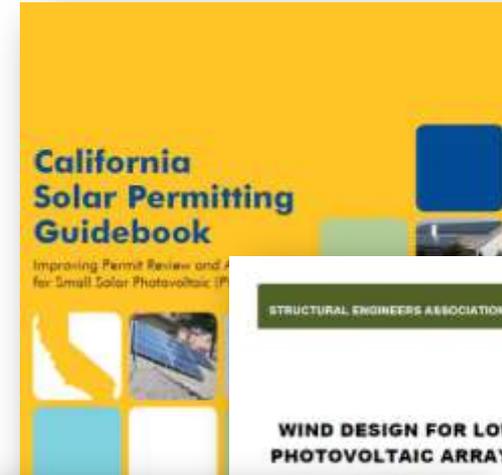
A large, stylized sunburst graphic in shades of blue, positioned on the left side of the slide. It features a central point from which several lines radiate outwards, some ending in larger, teardrop-like shapes.

CALIFORNIA BUILDING CODE DEVELOPMENT

New 2012 California Guidelines

1. GOPR Solar Permitting Work Group:
California Solar Permitting Guidebook
 - Residential and smaller systems
2. SEAOC PV1 – *Structural Seismic Requirements and Commentary for Rooftop Solar Photovoltaic Arrays*
3. SEAOC PV2 – *Wind Design for Low-Profile Solar Photovoltaic Arrays on Flat Roofs*

www.seaoc.org



STRUCTURAL ENGINEERS ASSOCIATION OF CALIFORNIA

WIND DESIGN FOR LOW-PROFILE SOLAR PHOTOVOLTAIC ARRAYS ON FLAT ROOFS

STRUCTURAL ENGINEERS ASSOCIATION OF CALIFORNIA

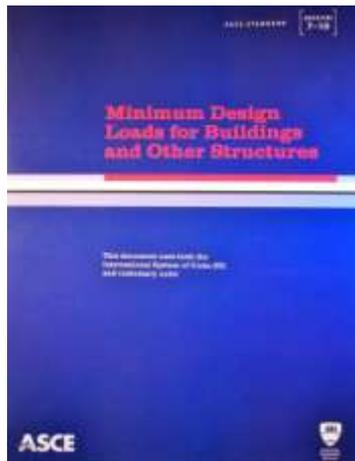
STRUCTURAL SEISMIC REQUIREMENTS
AND COMMENTARY
FOR
ROOFTOP SOLAR
PHOTOVOLTAIC ARRAYS

By
SEAOC Solar Photovoltaic Systems Committee
Report SEAOC PV1-J912
April 2012

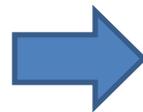
Path to the 2019 CBC

ASCE	ICC	CBSC
ASCE 7-05 →	2009 IBC →	2010 CBC
ASCE 7-10 →	2012 IBC →	2013 CBC*
ASCE 7-10 →	2015 IBC* →	2016 CBC
ASCE 7-16* →	2018 IBC →	2019 CBC

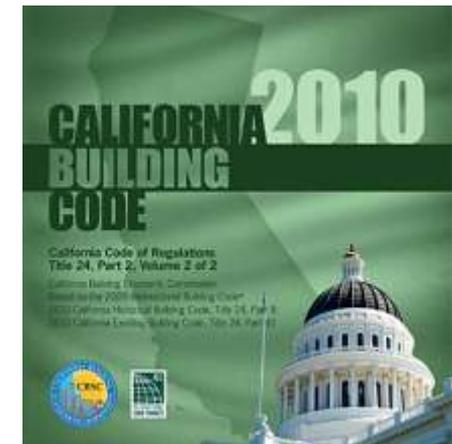
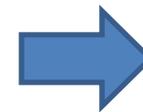
* in progress



www.asce.org



www.iccsafe.org



www.bsc.ca.gov

California Code Development

- **2013 California Building Code:**
 - Housing and Community Development: requirements for ballasted systems on residential roofs up to 1:12 slope.

- **DSA IR 16-8**
 - Incorporates SEOAC Guidelines from PV-1 and PV-2

California Department of General Services · Division of the State Architect · Interpretation of Regulations Document

**SOLAR PHOTOVOLTAIC AND THERMAL
SYSTEMS REVIEW AND APPROVAL
REQUIREMENTS**

IR 16-8

National Code Development

- **2015 International Building Code:**
 - Proposed language for ballasted systems on residential roofs up to 1:12 slope.
- **ASCE 7-16:**
 - SEAOC Guidelines Presented to Subcommittee on Rooftop PV Wind Loads



SUMMARY & CONCLUSIONS



SUNLINK[®]

The Impact of SunLink's Project

- **Design optimization tools**

- Layout and Design Tools

- Better customer communication
- Lower cost of PV systems by quickly automating multiple layouts
- Reduce design time for both SunLink and its customers
- Deliver projects with less opportunity for error

- **Documentation tools**

- Document Management

- Established Document Management systems can play a vital role in creating organizational efficiencies and reducing errors
- Our work serves as a starting point for solar organizations to pursue document management
- Identified and reviewed DMS products
- Identified key functionality and features worthy of consideration as DMS selection criteria

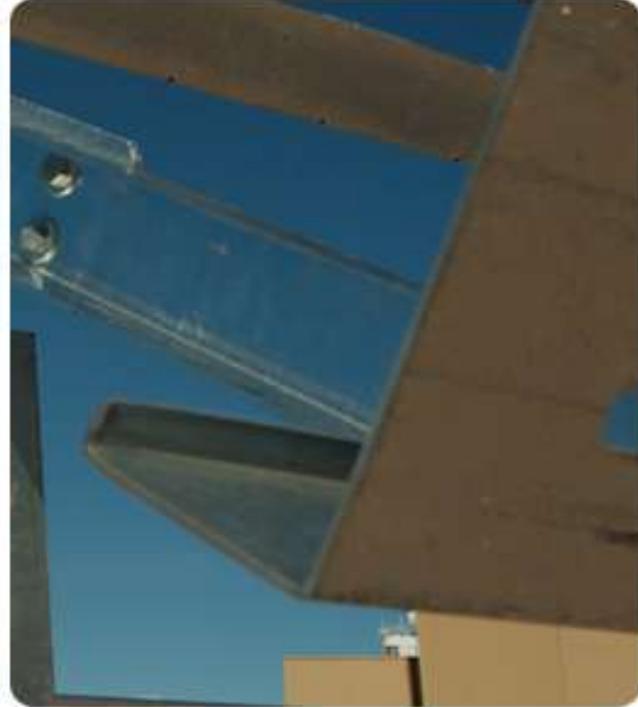
- **Consistent state-wide acceptance criteria:**

- Permitting Database

- Seismic Research

- Decreased system and installation cost of unattached systems
- Potential for projects on building roofs previously considered unsuitable
- Furthering the conversation toward permitting unattached systems in seismic regions

- Industry Publications



Thank You

Questions?