



**Architecture & Engineering Services
Supporting the Solar Energy (PV)
Construction Industry**

- Structural Engineering for Roof and Ground-Mounted Arrays
- Permits and Entitlements from Public Agencies
- Roofing and Waterproofing Interface Consultation
- Design of Ancillary Facilities and Structures
- LEED® and Sustainable Design Consultation



Architecture & Engineering Services Supporting the Solar Energy (PV) Construction Industry

INTERACTIVE RESOURCES provides a full range of consulting services for photovoltaic (PV) array design and construction. Most PV arrays are rooftop mounted, often on existing roofs. Typically, the permitting authority having jurisdiction requires structural calculations indicating that the existing structure is adequate to resist gravity, wind and seismic loads resulting from the installation of PV arrays, including connections to the existing structure. A related challenge is providing a mounting strategy that provides adequate structural attachment without penetrating the roof membrane or providing a penetration design that will preserve the integrity of the roof membrane.

Interactive Resources has provided structural engineering services for dozens of large and small projects, totaling over 50 megawatts, mainly in New Jersey and California where economic incentives generate interest. Solutions for attachment include adhesives, anchors, and steel cables tied back to parapets.

1 MW ground-mount array – Limoneira Company, Santa Paula, CA

One megawatt ground-mount photovoltaic array – Limoneira Company, Santa Paula CA



Limoneira Company is the largest citrus fruit producer in North America.

6,400 ground-mounted Mitsubishi PV panels covering 5.5 acres and providing 1 megawatt of solar power.

Project team included Interactive Resources and Perpetual Power.

- *Structural design: solar installation & inverter building / visitors center*
- *Architectural design*
- *LEED consulting*
- *Landscape design (sub-consultant)*

250-275 kW rooftop array – Kohls, Various locations, NJ

For most stores, the output ranged between 250 to 275 kW of roof-mounted photovoltaic array – Kohl's department stores throughout New Jersey



Kohl's is a department store chain featuring clothing, footwear and housewares.

These projects provided between 1,350-1,500 roof-mounted Sharp PV panels (1.6 megawatts) on several stores in New Jersey.

Project team included Interactive Resources and SunEdison.

- *Structural analysis / pre-qualification*
- *Structural design of solar installation*
- *Permit drawings*



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11 kW building-integrated PV shingles – Council Chambers, Novato, CA

The designed output range is 11 kW of roof-mounted photovoltaic array – Council Chambers, Novato, CA



Originally built in 1896, **901 Sherman Avenue** is a historic building located in Novato, CA. It will serve as the City Council Chambers and a community events hall.

Design provided 717 roof-mounted Atlantis Energy System Sunslates™ PV panels (10.4 kW).

Project team included Interactive Resources, Winzler & Kelly, City of Novato, and RGDL.

- Structural Engineering and Architecture for entire project, including integrated PV “sunslates” shingles

225-275 kW rooftop array – Safeway Stores, Various locations, NJ

Output typically ranged between 225 to 275 kW of roof-mounted photovoltaic array – Safeway Stores, Various locations, NJ



Safeway Stores is North America’s third largest supermarket chain

Provided between 1,100-1,300 roof-mounted Sanyo PV panels (2.42 megawatts) on several stores in New Jersey.

Project team included Interactive Resources, SunLink, Conergy and Spectrum Energy.

- Structural analysis / pre-qualification
- Structural design of solar installation
- Permit drawings

1.6 MW rooftop array – Google, Mountain View, CA

1.6 megawatts roof-mounted photovoltaic array – Google Main Campus, Mountain View, CA



Google is one of the largest search engines available on the internet.

5,317 roof-mounted Sharp PV panels (1.6 megawatts).

Project team included Interactive Resources, Blue Oak Energy, EI Solutions, SunLink and Cupertino Electric.

- Structural analysis. / pre-qualification
- Structural design of solar installation
- Permit drawings



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600 kW rooftop array – Estee Lauder, Oakland, NJ

600 kilowatt roof-mounted photovoltaic array – Estee Lauder Aramis Facility, Oakland, NJ



Estee Lauder is a world leader in cosmetic manufacturing since 1946.

3,456 roof-mounted SolarWorld PV panels (600 kilowatts).

Project team included Interactive Resources, DT Solar and MMA Renewable Ventures.

- Structural analysis / pre-qualification
- Structural design of solar installation
- Permit drawings

845 kW rooftop array – Manufacturing Plant, South Gate, CA

845 kilowatt roof-mounted photovoltaic array – manufacturing plant, South Gate, CA



A manufacturing plant that produces a variety of large metal forgings for the aerospace market.

4,335 roof-mounted BP Solar PV panels (845 kilowatts).

Project team included Interactive Resources, SunLink and Solar Monkey (developer/integrator).

- Structural analysis / pre-qualification
- Structural design of solar installation
- Permit drawings

100 kW rooftop array – Washington Elementary School, Berkeley, CA

Design for solar project for Berkeley Unified School District (BUSD) Washington, Elementary School, Berkeley, CA



Berkeley Unified School District serves nearly 9,000 students and has 14 schools.

Providing architecture and engineering services for the installation of a 100 kilowatt photovoltaic generator.

Interactive Resources was prime design consultant for this project.

- Structural engineering and architectural design to prepare bid documents and permit approval through DSA (Division of the State Architect)



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147 kW rooftop array – Macy’s, East Brunswick, NJ

147 kilowatt (1 of 2 projects) roof-mounted photovoltaic array – Macy’s, East Brunswick, NJ



Macy’s is a national brand delivering fashion and affordable luxury to customers coast to coast.

2,940 roof-mounted BP Solar PV panels installed on two stores (500 kilowatts total).

Project team included Interactive Resources, SunEdison and SunLink.

- Structural analysis / pre-qualification
- Structural design of solar installation
- Permit drawings

Multiple projects – Walgreens, CA and NJ

63 kilowatt (1 of 7 projects) roof-mounted photovoltaic array – Walgreens, CA & NJ



Walgreens is the nation’s largest retail pharmacy

3,240 roof-mounted SolarWorld PV panels installed on seven stores (567 kilowatts total).

Project team included Interactive Resources, SunEdison and SunLink.

- Structural analysis / pre-qualification
- Structural design of solar installation
- Permit drawings

5 MW rooftop array – San Francisco Sunset Reservoir, San Francisco, CA

5 MW roof-mounted photovoltaic array – San Francisco Sunset Reservoir North Solar Project, San Francisco, CA



When completed, the **San Francisco Sunset Reservoir** 5 Megawatt system will be the largest in California and the largest municipal solar project in the county. The completed project will include 25,000 solar panels on the rooftop of the eight-block reservoir.

Project team included Interactive Resources, Bass Electric and Sunlink Corporation.

- Structural analysis / pre-qualification
- Structural design of solar installation
- Permit drawings

Photo courtesy of Bass Electric



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209.5 kW rooftop array – US Postal Service, San Jose, CA

209.5 kilowatt roof-mounted photovoltaic array – USPS, San Jose, CA



USPS processes and delivers 213 billion pieces of mail per year.

1,164 roof-mounted Sharp PV panels (209.5 kilowatts).

Project team included Interactive Resources, SunLink and Chevron Energy Solutions.

- *Structural analysis / pre-qualification*
- *Structural design of solar installation*
- *Permit drawings*

68.4kW rooftop array – Food Bank of Solano & Contra Costa Counties, Concord, CA

68.4 kilowatt roof-mounted photovoltaic array – Food Bank of Solano and Contra Costa Counties, Concord, CA



Food Bank of Solano and Contra Costa Counties raises public awareness and distributes food in an effort to alleviate hunger.

360 roof-mounted Kyocera PV panels (68.4 kilowatts).

Project team included Interactive Resources, SunLink and Team Solar.

- *Structural analysis / pre-qualification*
- *Structural design of solar installation*
- *Permit drawings*

42 kW rooftop array – AT&T Park, San Francisco, CA

42 kilowatt roof-mounted array – AT&T Park, San Francisco, CA



AT&T Park is an open-air ballpark located in San Francisco and the home of the San Francisco Giants baseball team.

200 roof-mounted Sharp PV panels (42 kilowatts).

Project team included Interactive Resources, SunLink and SunTechnics.

- *Structural analysis / pre-qualification*
- *Structural design of solar installation*
- *Permit drawings*



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250 kW rooftop array – Bishop Unified School District, Bishop, CA

250 kilowatt roof-mounted photovoltaic array – BUESD, Bishop, CA



Bishop Unified School District's schools include Bishop Elementary, Home Street Middle School, Palisade Glacier High School, and Bishop High School.

1,700 roof-mounted PV panels (250 kilowatts).

Project team included Interactive Resources, Conergy and SunTechnics.

- *Structural analysis / pre-qualification*
- *Structural design of solar installation*
- *Permit drawings*

47.52 kW rooftop array – Los Angeles City College Los Angeles, CA

47.52 kilowatt roof-mounted photovoltaic array – Los Angeles City College, Los Angeles, CA



LA City College's Science Technologies Building roof-mounted solar panels will supply 10 percent of the building's energy needs.

150 roof-mounted PV panels (47.52 kilowatts).

Project team included Interactive Resources, Chevron Energy Solutions and the Smith Group.

- *Structural analysis / pre-qualification*
- *Structural design of solar installation*
- *Permit drawings*

411.6 kW rooftop array – Gunderson High School, San Jose, CA

411.6 kilowatt roof-mounted array – Gunderson High School, San Jose, CA



Gunderson High School, located in San Jose, California, serves grades 9-12 in the San Jose Unified School District.

2,352 roof-mounted Sharp PV panels (411.6 kilowatts)

Project team included Interactive Resources, Chevron Energy Solutions and SunLink.

- *Structural analysis / pre-qualification*
- *Structural design of solar installation*
- *Permit drawings*



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149 kW Solar Carports – Union Sanitary District, Union City, CA

149 kW Solar Carport Structures – Union Sanitary District, Union City, CA



Union Sanitary District is an independent special district which provides wastewater collection, treatment and disposal services to the residents and business of the cities of Fremont, Newark and Union City, in Southern Alameda County, California.

676 roof-mounted PV panels (149 kilowatts).

Project team included Interactive Resources, Eshone Energy and Overaa Construction.

- *Structural analysis / pre-qualification*
- *Structural design of solar installation*
- *Design inverter anchorage & foundations*
- *Permit drawings*

84 kW Solar array – Emerson Elementary School, Berkeley, CA

84 kilowatt roof-mounted photovoltaic array – Emerson School, Berkeley, CA



Emerson Elementary School in Berkeley, CA is included in the Berkeley Unified School District and is within blocks of the University of California, Berkeley. Emerson serves 275 students from kindergarten through fifth grade.

266 roof-mounted PV panels (84 kilowatts)

Project team included Interactive Resources, Winzler & Kelly and Eshone Energy.

- *Structural analysis / pre-qualification*
- *Structural design of solar installation*
- *Design inverter anchorage & foundations*
- *Permit drawings*

National Renewable Energy Laboratory (NREL) – Solar Feasibility Roof Structural Assessments, Alameda & Contra Costa Counties, CA

Ongoing up to 24 sites solar feasibility roof structural assessments



NREL is responsible for the Solar America Showcase technical management efforts. NREL is the only federal laboratory dedicated to the research, development, commercialization and deployment of renewable energy and energy efficiency technologies.

Project team included Interactive Resources.

- *Structural rapid engineering analysis*
- *Structural Feasibility Report*



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239 kW Solar array – Deer Island Treatment Plant, Boston, MA

239 kilowatt solar ground-mount array – Dear Island Treatment Plant, Massachusetts Water Resources Authority, Boston, MA



Massachusetts Water Resources Authority

is the Massachusetts public authority that provides wholesale water and sewer services to the metropolitan Boston communities.

837 Solon PV panels (239 kilowatts).

Project team included Interactive Resources and Perpetual Power.

- *Structural analysis / pre-qualification*
- *Structural engineering services to determine ballast requirements for a ground mounted solar array*

46.1 kW Solar array – Victor Valley Community College, Victorville, CA

46.1 kilowatt roof mounted array – Victor Valley Community College, Victorville, CA



Victor Valley Community College is a community college located in the high desert on Bear Valley Road in Victorville, CA that has approximately 4,000 students.

196 Sharp PV panels (46.1 kilowatts).

Project team included Interactive Resources and Borrego Solar.

- *Structural analysis / pre-qualification*
- *Structural design of solar installation*
- *Design inverter anchorage and foundations*
- *Permit drawings*
- *DSA Approval*

1 MW Solar array – Port of LA Berth 93, San Pedro, CA

1 megawatt roof mounted array – Port of LA Berth 83, World Cruise Terminal, San Pedro, CA



Port of LA World Cruise Terminal is located in the Port of Los Angeles' World Cruise Center. Is the Homeport of the television series "The Love Boat" (1977 to 1986), the cruise center is the premier gateway to Los Angeles and Southern California.

5,140 monocrystalline PV panels (1 Megawatt)

Project team included Interactive Resources and Cupertino Electric.

- *Structural analysis / pre-qualification*
- *Structural design of solar installation*
- *Design of a self-ballasted racking system*
- *Permit drawings*



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853.2 kW rooftop array – Tony’s Fine Foods, Sacramento, CA

853.2 kilowatt roof-mounted array – Tony’s Fine Foods, West Sacramento, CA



Tony’s Fine Foods has provided top-quality food services and products for more than 50 years.

4,102 roof-mounted Sharp PV panels (853.2 kilowatts).

Project team included Interactive Resources, SunLink, Solar Development and Team Solar.

- Structural analysis / pre-qualification
- Structural design of solar installation
- Permit drawings

495.6 kW rooftop array – San Francisco International Airport, San Francisco, CA

495.6 kilowatt roof-mounted array – San Francisco International Airport Terminal T-3, San Francisco, CA



San Francisco International Airport (SFO)

is a world-class airport serving tens of millions of passengers annually.

2,832 roof-mounted SunTech PV panels (495.6 kilowatts).

Project team included Interactive Resources, SunLink and Bass Electric.

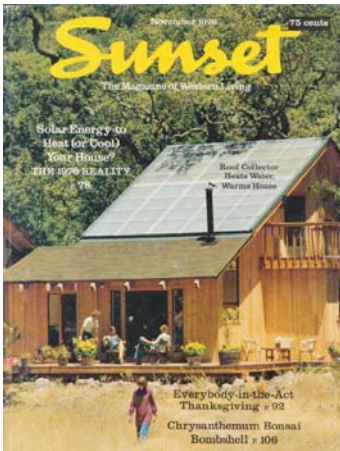
- Structural analysis / pre-qualification
- Structural design of solar installation
- Permit drawings

In the design and installation of photovoltaic systems, Interactive Resources has worked with a number of contractors and integrators, including *SolarCraft, SunEdison, Blue Oak Energy, Borrego Solar, Solar Development, Inc., Chevron Energy Solutions, Sunpower, Perpetual Power, GenSelf, Bleyco Incorporated, iPower, Bass Electric, Sunlink, Conergy, Field Lining Systems, Siliken, Solar Power Partners, Recurrent Energy, Sunwize Technologies, Alteris Renewables, American Capital Energy, NREL, Cupertino Electric, Rosendin Electric and Solar Craft*. Module manufacturers include *Kyocera, Sharp, BP Solar, SolarWorld, Sunpower, SunTechnics, SunTech, Yingli, Mitsubishi and Siliken*.

Interactive Resources brings a specialized and highly experienced knowledge base to solar project teams in the structural design of roof and ground mount applications, and particularly in challenging projects that involve complex roofs or sites or school projects that are subject to review by DSA. Our experienced and responsive staff can be a tremendous asset to any solar project team.



Interactive Resources & Renewable Energy A Return to Our Roots



When *Interactive Resources* formed in 1973, the energy crisis resulting from the Middle East oil embargo was already in full swing. Responding to widespread panic characterized by long lines at service stations and rapidly rising energy prices, Interactive Resources quickly gained a reputation for energy-efficient design and alternative energy applications.

The firm erected the first (and at the time, also the largest) wind generator to feed power into an electrical grid in California. Fully instrumented by PG&E, it became a research project that paved the way for commercial wind power in California.

Some of the first “solar” homes in California were designed by Interactive Resources. In 1975, Interactive Resources organized and implemented the first statewide California Solar Energy for Buildings Conference, repeated in 1976 and 1977 with hundreds of building industry professionals attending.

*In 1975,
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Top Photo: 6 kilowatt wind generator erected by Interactive Resources (IR) in Point Richmond was first in California to cogenerate. It was extensively instrumented and monitored by PG&E.

Bottom Photo: Home designed by IR using solar water and space heating featured on cover of *Sunset Magazine*



A Return to Our Roots (continued)



Until well into the 1980's Interactive Resources remained a leading consultant in alternative energy applications and energy conservation in building, designing hundreds of projects incorporating passive and active solar heating and cooling, including six U.S. Government-sponsored grants for research or demonstration projects in solar energy, including the AIA Research Corporation Grant (sponsored by HUD) for Phase II Development of Energy Performance Standards for New Building, 1978, and the Willow Park II Community Center Case Study, a DOE Research Project, 1983.



Interactive Resources' work in California in the 1970's and early 1980's influenced subsequent state energy conservation legislation and sped the incorporation of energy conservation considerations into the mainstream of California architectural practice. In the early 1980's, the tax incentives and high energy costs that had made solar energy applications and energy efficient design a strong market began to fade. Energy efficient design was no longer a pioneering specialty; it had been institutionalized into building codes. In the 1970's Interactive Resources co-founded Sun Light & Power, a Berkeley contractor that has become a principal player in the photovoltaic market. Although there is no longer any connection between Interactive Resources and Sun Light & Power, we are proud to have helped spawn one of the oldest solar contractors in the United States. ■



Photos from Top: In the early 1980's, Interactive Resources experimented with high temperature solar-thermal applications with this project at **Lawrence Berkeley Laboratory** that used solar heated water to drive absorption chillers used for air conditioning.

Interactive Resources designed an earth sheltered entry for the cave complex at **Stag's Leap Wine Cellars**.

The **Contra Costa College Student Services Center** used a number of energy efficient design strategies, including underfloor HVAC air distribution, sunshades, light shelves for daylighting, and a cool roof



C O N T A C T

Paul Westermann, SE, Structural Engineer

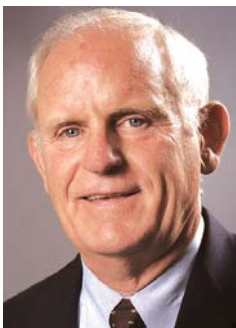
Phone: 209/736-2079 E-mail: paul.westermann@intres.com



Paul has more than 30 years of structural engineering experience and has been responsible for overseeing the structural design of all roof-mounted and ground-mounted PV arrays from conception to completion of construction. Conforming to code requirements for wind and seismic forces is the basis of permitting for jurisdictional agencies. Often, the local fire marshal will also have requirements for access. Paul typically visits the site to assess existing conditions, reviews as-built drawings of existing buildings, if available, and provides verification of load capability and design of attachment. For K-12 and community college projects in California, plan check is the responsibility of the Division of the State Architect (DSA), which has its own unique set of requirements.

Tom K. Butt, FAIA, President, CEO

Phone: 510/236-7435 E-mail: tom.butt@intres.com



Tom is the president and principal-in-charge of Interactive Resources. He is a licensed architect with more than 41 years of experience. Mr. Butt founded Interactive Resources in 1973 during the energy crises and quickly became one of the leading alternative energy and energy conservation consultants in the United States. His early work in the alternative energy field set the pace in California, influencing subsequent state energy conservation legislation and speeding the incorporation of energy conservation considerations into the mainstream of California architectural practice.

Often, PV projects involve other building components, such as roofs and roof drainage, rooftop equipment, access and ancillary spaces that result in larger design issues. Interactive Resources provides the architectural design and assembles and coordinates whatever consultants are required to resolve these issues and provide construction drawings and specifications. Ground mounted arrays can include roads, landscaping, equipment structures and fences. Tom is the go-to guy to handle complex projects that are more than mounting panels and installing electrical equipment.

Photo montage images ©2009 Aric Crabb taken at the San Francisco Bay National Wildlife Refuge Complex, the first urban National Wildlife Refuge.



In addition to providing structural services for photovoltaic (PV) array design and construction, Interactive Resources is a full-service A&E firm providing the following services:

- Architectural design
- Programming & value engineering
- Civil engineering
- Design review
- Structural engineering
- Seismic analysis & retrofits
- Sustainable design
- Accessibility
- Surveys for ADA/Title 24 compliance
- Cost estimating
- Historic rehabilitation & restoration
- Architectural lighting
- Space planning
- Construction administration
- Building reviews & assessments
- Feasibility studies
- Facilities master planning
- Technical specifications & construction documents
- Procurement methodology
- Entitlement processing
- As-built / existing conditions survey
- Remodel / rehabilitations/expansions
- Retrofit & facility upgrades
- Multi-discipline consultant coordination
- Project management
- Roof designs & repairs
- Solar photovoltaic

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Post-Construction

- Accessibility surveys & improvements
- Building evaluations
- Diagnostic / forensic architecture & engineering
- Expert witness services
- Water infiltration testing & repair

Bidding & Construction

- Bidding & negotiation
- Construction administration
- Construction review

Interactive Resources is certified as a Small Business Enterprise (SBE) with the Small Business Administration (SBA-Federal) and the State of California, Department of General Services.



INTERACTIVE
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Architects and Engineers