

Sweetwater Spectrum in Sonoma, Calif., is an innovative supportive residential community for adults with autism. It is designed as a replicable housing model that incorporates autism-specific design and supports environmental stewardship.

Finding THE Balance Point



BY MARSHA MAYTUM, FAIA; AND GWEN FUERTES, ASSOCIATE AIA

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ADULTS WITH AUTISM may experience a diverse range of sensory sensitivities. They may not be able to block out the hum of an HVAC unit or the movement of the blades of a ceiling fan. Sweetwater Spectrum is a new national model for supportive housing, designed to offer life with purpose and dignity for adults on the autism spectrum. The Sonoma, Calif., community integrates the latest research on autism specific design with universal design principles and complementary sustainable, energy-efficient strategies.

Sweetwater Spectrum is a nonprofit organization founded in 2009 by families, autism professionals, and community leaders; its mission is to provide adults with autism an innovative supportive residential community that challenges each individual to reach his or her highest potential. Autism is the fastest-growing developmental disability in the U.S., affecting one in 68 children. In the coming decade, some 500,000 children with autism will reach adulthood, yet few residential options exist for them.

The project includes four homes for 16 residents, a community center, therapy pools, and a farm. Autism-specific design strategies promote serene, legible spaces that create a safe, nurturing environment. Practical sustainable design strategies promote health and wellness, reduce energy consumption, and offer multiple long-term benefits to residents, staff, and the community.

The privately funded project was designed to exceed California Title 24-2008 energy standards by 30% and the AIA 2030 Commitment by 88%. It was designed to meet LEED Gold

standards, but the client elected not to proceed with final certification.

Designed for Net Zero

The Sweetwater Spectrum organization is committed to creating a replicable housing model with autism-specific design that also supports environmental stewardship. In most cases, the strategies used to design a low-carbon facility (*Figure 1*) went hand in hand with Sweetwater's project goals: to design a durable and flexible building that is sensitive to the climate and right-sized to the needs of the occupants.

Load Reduction. From the outset, passive strategies controlled major aspects of the orientation and architecture, and the techniques respond to the mild, marine climate of the Northern California inland coastal region. The buildings orient to the prevailing winds, allowing 100% of the primary residential and program spaces to be naturally ventilated.

Solar control and access to daylight are intrinsic to the buildings' design, with overhangs on the south façades and high clerestory openings to the north to deliver even light throughout the seasons. The envelope exceeds minimum requirements, with wall insulation that improves on the code baseline by 61%, and is constructed to minimize thermal breaks.

The 24 in. on-center wood frame construction was an economical and efficient enclosure method that allowed enhanced insulation and reduced construction waste. The glazing is comprised of high-performance windows, and the buildings have a window-to-wall ratio of 22%.

Efficient Systems. Designed to be a net-zero energy community, all mechanical equipment serving the buildings is electric. Low-energy heating and cooling systems were selected: hydronic slab heating and cooling, with low-flow ventilation based on demand and indoor conditions. A geothermal heat pump was considered, but ruled out early on as being cost prohibitive. Instead, the building team selected high efficiency air-to-water heat pumps that provide heating hot water and chilled water via a two-pipe system to the radiant systems and fan coil unit.

Lighting systems are comprised of linear fluorescent and LED lamps, with dimmers in certain areas. Sensors and controls are specifically designed for the needs of the users (see *Tailoring Systems Design*).



Produce from the farm and orchard is used daily by the residents and also sold at a weekend farm stand at Sweetwater's side entrance. Other produce is sold and used in local restaurants.

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On-Site Renewable Energy. Solar energy potential is plentiful in Sonoma, with partly cloudy skies 38% of the year on average. The buildings' roof areas are sized and oriented to maximize solar energy potential, and the design incorporates solar electric and solar thermal panels.

While the design was anticipating a full PV array on all buildings, in the end the project needed to eliminate half of the panels for financial reasons. The PV panels installed are designed to provide 82% of the total site energy, and the solar thermal panels are designed to provide 68% of the domestic hot water heating needs of the residences, with electric resistance backup.

Tailoring Systems Design

Beyond the project's low energy goals was the fundamental goal of establishing a new residential model for adults on the autism spectrum. A growing amount of research has resulted in the generation of design guidelines for those living with autism (or ASDs, autism spectrum disorders).

The design guidelines recommended by Arizona State University's Stardust Center, "Advancing Full Spectrum Housing," were a reference for the

project. The guidelines state that living situations for people living with ASDs should be optimized to ensure safety and security, minimize sensory overload, and foster health and wellness, among many other best practices.

At Sweetwater Spectrum, the design team sought to fulfill these goals across all stages and aspects of the project. This approach pervaded the decisions relating to systems design, from considering the heating and cooling system types to plumbing details in the residents' bathrooms.



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One purpose of Sweetwater Spectrum is to push residents to engage in activities and encourage choices. It is located in a residential area that is within easy walking and biking distance of the Sonoma Town Square.

BUILDING AT A GLANCE**Name** Sweetwater Spectrum**Location** Sonoma, Calif.
(33 miles NE of San Francisco)**Owner** Sweetwater Spectrum**Principal Use** Residential
Includes Therapy pools, farm**Employees/Occupants** 16 residents, 3 full-time staff, 8-12 contract employees
Percent Occupied 100%**Gross Square Footage** 16,315**Distinctions/Awards**
2015 AIA/COTE, Top Ten Green Building Award;
2014 AIA National, Housing Award**Substantial Completion/Occupancy** 2013**ENERGY AT A GLANCE****Annual Energy Use Intensity (EUI) (Site)**
42.8 kBtu/ft²
Electricity (Grid Purchase) 28.4 kBtu/ft²
Electricity (on-Site Solar or Wind Installation)
14.4 kBtu/ft²**Annual On-Site Renewable Energy Exported** 1.3**Annual Net Energy Use Intensity** 27.2**Annual Source (Primary) Energy** 103.7**Annual Energy Cost Index (ECI)** \$1.33/ft²**Annual Load Factor** 0.69**Savings vs. Calif. Title 24-2008 Design Building** 30% (modeled)**Heating Degree Days (Base 65°F)** 2,513**Cooling Degree Days (Base 65°F)** 445**Annual Hours Occupied** 8,760**WATER AT A GLANCE****Annual Water Use** 861,000 gallons: includes all four residences, community building and site irrigation except water used for the farm, which is well water and is not metered**KEY SUSTAINABLE FEATURES****Water Conservation** 100% of storm water managed on site; overall water use reduced by over 33%.**Recycled Materials** Over 10% of all materials are recycled, including fly ash in concrete, carpet, aluminum, countertops, and steel. 15% of all materials were regionally harvested and manufactured to reduce embodied energy. Rapidly renewable materials include cotton insulation, rubber base, and linoleum flooring.**Daylighting** 100% of the primary residential and program areas are day-lit. Overall, 93% of all buildings spaces use daylight as the primary light source.**Individual Controls** High-efficiency lighting is controlled by switches and timers rather than occupancy sensors due to the potential disturbance occupancy sensors could cause this specific population.**Carbon Reduction Strategies** 51 kW photovoltaic system on site; solar thermal collectors are designed to provide 68% of all domestic water heating needs.**Transportation Mitigation Strategies**
Estimated percent of occupants using alternative transportation: 40%**BUILDING ENVELOPE****Roof****Type** Standing seam metal and built up
Overall R-value 53.2
Reflectance 0.34
Emittance 0.87**Walls****Type** Wood 2 × 6 framing, 24 in. o.c.
Overall R-value 22
Glazing Percentage 22%**Basement/Foundation****Slab Edge Insulation R-value** R-7.5
Under-Slab Insulation R-value R-10**Windows****Effective U-factor for Assembly** 0.29
Solar Heat Gain Coefficient (SHGC) 0.28
Visual Transmittance 64**Location****Latitude** 38° N
Orientation SSW**BUILDING TEAM****Building Owner/Representative**
Sweetwater Spectrum, Sonoma, Calif.**Architect**
Leddy Maytum Stacy Architects, San Francisco**General Contractor**
Midstate Construction, Petaluma, Calif.**Mechanical, Electrical Engineer, Energy Modeler**
Timmons Design Engineers, San Francisco**Structural Engineer**
Structural Design Group, Santa Rosa, Calif.**Civil Engineer**
Adobe Associates, Inc., Santa Rosa, Calif.**Landscape Architect** Roche + Roche
Landscape Architecture, Sonoma, Calif.**Lighting Design**
Architectural Lighting Design, San Francisco

HVAC. While a typical low-energy residential unit in Sonoma might include ceiling fans to circulate air, this is an untenable technique for Sweetwater. Due to the issues related to sounds and visual patterns that fans create, the design team instead elected to deliver fresh air discretely using a low-velocity ventilation air system and visually unobtrusive slot diffusers throughout occupied zones.

Selection of a zoned hydronic radiant heating system was a clear choice from the outset, not only to support the project's low energy goals, but also because it serves as the cleanest, quietest, least cluttered option when seeing and experiencing a space, allowing for a quiet, calm and predictable environment.

Lighting. Similarly, motion-based lighting controls are considered startling to some individuals; instead, outdoor site lighting is controlled based on a day/night schedule, and interior lighting is controlled by switches and vacancy sensors in staff areas. For safety and durability, general area lighting fixtures are recessed or in a light cove—an affordable and effective method to deliver light that reduces glare and breakage. In bedrooms, general lighting is recessed in a cove, distributing even light across the ceiling.

Equipment. Energy Star rated appliances and induction cook tops are used for safety and energy efficiency.

Water Use. Some people with ASDs have patterns of using more domestic water than average. Bathrooms, kitchens and laundry rooms are designed to accommodate those potential patterns of activity, and focus on limiting wasted water and avoiding spilled water damage.

Durable low-flow plumbing fixtures are used throughout the project, and bathrooms are finished and plumbed to collect and dispose of water. The

“Since the autism spectrum is so broad, it was tricky to find a **balance point** in the design.”

— Marsha Maytum, FAIA, principal,
Ledy Maytum Stacy Architects

Right Heating and cooling systems are intended to support a quiet, calm environment: zoned hydronic heating and visually unintrusive slot diffusers with low-velocity air distribution met this need and contribute to the project’s low-energy goals.

Figure 1 Sweetwater Spectrum incorporates passive and active low-energy systems, leveraging the mild northern California climate.



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Figure 1 SUSTAINABLE STRATEGIES SECTION



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therapy pools use high efficiency filtration systems, solar hot water heating systems, and year-round pool covers to minimize water evaporation and heat loss.

Beyond Thermal Comfort

Designing for a population with heightened comfort sensitivity brought about new methods and challenges to consider in designing the buildings. Autism is a spectrum condition, meaning every individual is unique.

While one adult living with ASDs might be hypersensitive to stimuli and need to avoid certain audio/visual/

olfactory input, another may be hypo-sensitive—that is, to seek more input. Thermal, visual, and acoustic comfort issues had to be carefully tuned to align with the full range of the spectrum and provide healthy, supportive and safe environments.

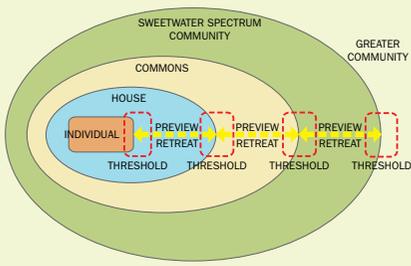
Control, Choice, Independence.

The ASU Stardust Center advocates for those with ASDs to have control over and options for how one experiences a space. The buildings and landscape at Sweetwater are organized as a series of thresholds, from the individual scale to the community

scale, with options to retreat within each space, and the ability to preview a space before entering the next area (*Figures 2 and 3*). In terms of systems designing, and in particular with the indoor-outdoor connections that are promoted by this approach, the subdivision of zones for heating/cooling and lighting were designed to promote a comfortable transition from one space to the next.

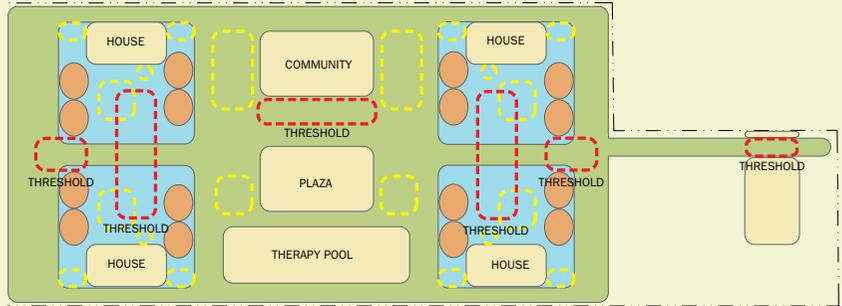
With respect to thermal comfort, people with ASDs experience wide comfort ranges not dissimilar to the average population, but heightened in some cases. The microclimates

Figure 2 CONCEPT DIAGRAM



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Figure 3 SITE ORGANIZATION



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Figures 2 and 3 The buildings and landscape at Sweetwater are organized as a series of thresholds, from the individual scale to the community scale, with options to retreat within each space, and the ability to preview a space before entering the next area.

Photos (clockwise from right) Integrating current research on autism spectrum design, spaces are designed to reduce sensory stimulation (ambient sound, visual patterns, odors, etc.), to connect to the natural world, and to create safe, comfortable, and predictable domestic environments.

Drought-tolerant native landscaping is used throughout the site with particular attention paid to plant toxicity due to the needs of the residents.

Social areas extend into the landscape, with a series of courtyards, active and contemplative spaces, therapy pool, and one-acre farm.



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created in the landscape—from the shade of the community terrace, to the warm sunny conditions at the urban farm, to the evaporative cooling effects of the therapy pool area—each zone contributes a unique thermal environment. Inside the residences, all windows are operable and each room is separately zoned.

Visual Comfort. Research suggests that access to daylight can have positive health effects for people with ASDs. Integrating proper orientation, well-positioned windows, and tubular skylights, 100% of the primary residential and program areas are day-lit. Overall, 93% of all buildings’ spaces use daylight as their primary

light source. 100% of regularly occupied spaces have views to the outdoors, with direct connection to outdoor areas including private patios, community terraces, and gardens. This connection to nature is a powerful driver to allow a sense of place and familiarity over time.

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Above Motion-based lighting controls can be startling to some individuals; instead, outdoor site lighting is controlled based on a day/night schedule, and fixtures are directed to illuminate surfaces and avoid intense bright spots in the field of vision.

Right Acoustic and olfactory sensitivity issues were carefully considered through the use of non-toxic and sound-absorptive materials, including no-VOC carpeting and formaldehyde-free acoustic wood ceilings in the living areas. The entire living facility is designed to allow access to daylight and views, with operable openings to maximize natural ventilation and take advantage of the mild Sonoma, Calif., climate.

At the same time, aspects of glare, bright colors, and strong contrast were avoided; daylight was tempered and diffused using shades, deep openings and providing options for interior blind control, and the rooms were finished with warm white and neutral tones, allowing the residents to have control to personalize their space at their discretion. Indoor and outdoor lighting fixtures were recessed rather than exposed, and

were directed to illuminate surfaces, to avoid uncomfortable bright spots in the field of vision.

Acoustics. Isolating undesirable acoustic stimuli was intrinsic to the layout and construction of the residences. The radiant floor heating/cooling system is virtually silent; laundry and mechanical and electrical closets are isolated at corners of the plan of the residences, and separated with acoustic wall assemblies with an air gap.

Bedrooms are also separated by this acoustic wall assembly, and solid core doors were specified to further mitigate noise transfer. Carpet was specified in living rooms and resident areas, to reduce reverberation time; a wood acoustic ceiling system was installed at living spaces to control noise.

Materials and Durability. To avoid hypersensitivity issues related to olfactory issues, and to ensure healthy indoor air quality, a variety of materials were specified including no-VOC paints, adhesives and sealers, formaldehyde-free insulation and wood products, and non-toxic, vinyl-free flooring. Carpet tiles were selected for their maintenance and replacement attributes, and impact-resistant

Figure 4
TYPICAL RESIDENCE ENERGY USE

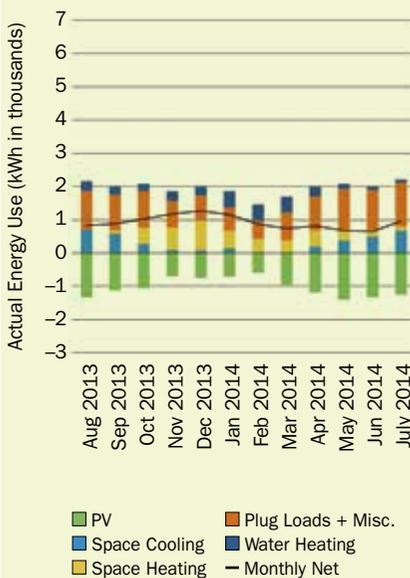
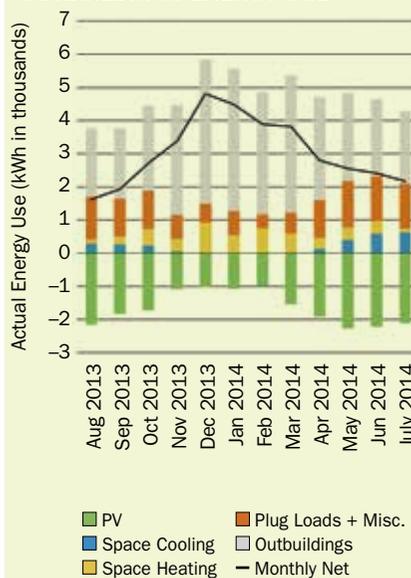


Figure 5
COMMUNITY BUILDING AND OUTBUILDINGS ENERGY USE





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Lessons Learned

- **“Solar Ready” Path to ZNE.** While zero net energy was a goal throughout the project, financial constraints eliminated the option to install PVs in the final construction documents. The massing and layout of the buildings were still optimized for maximum solar energy potential, and thanks to a power purchase agreement with Sonoma Clean Power, approximately half of the PV panels needed to reach ZNE were installed, with additional roof area available to meet ZNE goals in the future.
- **Energy Model Occupancy Defaults not Suited for Project Type.** Estimating occupancy patterns and plug load energy use in the design phase is notoriously difficult, and this was no exception in the case of Sweetwater. The default occupancy and plug load values in the energy modeling program, used for typical single family residences, did not anticipate the activity of the residents and staff in the buildings. Monitoring the plug loads and lighting activity energy use patterns in the residences can provide valuable feedback for other design teams developing living facilities for autism. However, no conclusions regarding resident energy use patterns are available at this time.
- **Unanticipated Energy Loads.** Programmatic elements tied to the operation of the farm, such as a greenhouse and a well pump, were added during design, which contributed to energy use

Although the project budget only allowed for the installation of half of the PV panels needed to meet the modeled energy load, the building roof areas are sized and oriented to meet the capacity to achieve zero net energy in the future.

that went beyond what the community building’s PV system was sized to offset. Fully anticipating the expansion of the energy needs for the farm would have helped the project get closer to reaching zero net energy.

- **Heat Pump Performance.** As part of the PG&E ZNE Pilot Program, Sweetwater benefited from a third party energy review over the course of 12 months. One finding from this study suggested that the primary-secondary piping design for the air-to-water heat pumps was potentially unnecessary given the variable speed capability of the heat pumps, and that one heat pump would be sufficient to carry the load of each of the buildings, which could improve the efficiency of the system.
- **Inconsistent Fan Operation.** Another finding from the PG&E ZNE Pilot Program assessment was that there was inconsistent fan operation throughout the 12-month study. The design called for demand-controlled ventilation using a CO₂ sensor, but the results of the study showed that the fan control strategy appeared to vary throughout the year with some continuous operation and some fan coil cycling coincident with heat pump operation. Operational improvements to better control fan operation were suggested and addressed at the close of the study.

gypsum board was specified for wall areas below 8 ft above finished floor, for durability.

Post-Occupancy Monitoring

While Sweetwater was originally designed to reach zero net energy, the project budget did not allow for the purchase of the photovoltaic solar panels as part of the initial project. The final construction bid for Sweetwater only included the installation of the domestic solar hot water system on each building and for the therapy pool and spas. However, a third party renewable energy service provider installed the photovoltaic solar panels as part of a power purchase agreement.

In addition to the benefit of reduced energy costs during the lease period, Sweetwater Spectrum has the option to take over the equipment at the end of the lease term for a fraction of the initial cost. The leased panels comprise a 51 kW system, and the project roof area is sized to meet the capacity for future PV panels required to achieve zero net energy.

Sweetwater’s energy goals anticipate a statewide goal set by the California Public Utility Commission, which will require all residential building new construction projects to be zero net energy by the year 2020. As a PG&E Zero Net Energy Pilot Project, these goals are supported through educational outreach and research.

Also, for certain ZNE projects, PG&E provides technical assistance during the design process and develops case studies based on best practices that can be transferred to broad application. Sweetwater Spectrum was selected to be one of these pilot projects, and benefited from a post-occupancy assessment of the buildings’ energy use.

From August 2013 to July 2014, the community building and one of the residences was monitored and analyzed to understand the extent to which the

project's energy goals were achieved (Figures 4 and 5, Page 20). During this period the net site energy use intensity for the entire complex, including PV contribution, was 27 kBtu/ft², while the gross EUI was 43 kBtu/ft².

In the residence, the monitoring assessment found that energy use had significant deviations from what was modeled, mostly due to higher lighting and plug loads. The residence that was monitored has a higher level of staffing requirement than other residences in the facility, and is staffed 24 hours per day. Over the course of a day, 10 people, including staff and visitors, may spend time in the building designed for four residents. (See *Lessons Learned*.)

Additionally, during the monitoring study, fans and the air-to-water heat pumps were found to be operating inconsistently. A retro-commissioning of these systems occurred after the study was completed to improve system functionality.

Sweetwater Spectrum has additional energy audits and project evaluations underway to study the replicability of this housing model. It is also partnering with Dominican University and the University of California San Francisco to conduct research on resident satisfaction and quality of life indicators for this residential community for adults with autism.

Conclusion

Sweetwater Spectrum has established new territory in architecture and systems design: an intersection of ZNE goals and autism specific design. This combination brings to bear a climate-sensitive, human-centric approach; passive techniques and load reduction goes hand in hand with a sensitivity to creating open thresholds and ability for residents to have options and control within their space—an approach that can serve as a model for other projects.

Weaving these spaces together with a sensitivity to solar access and low-energy systems demonstrates that achieving low energy goals does not compete with, but rather enhances the design of a generous environment that embraces calm, clarity and comfort. ●

Web Exclusive Q&A

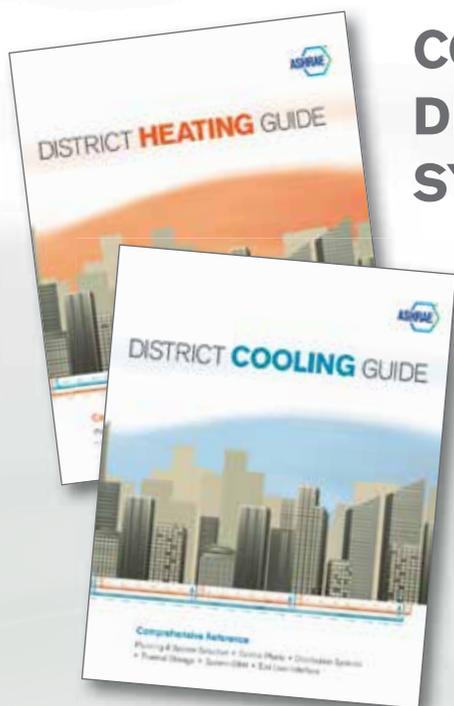
Learn more about how the authors approached this project and the challenges they encountered.

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ABOUT THE AUTHORS

Marsha Maytum, FAIA, LEED AP, is a principal at Leddy Maytum Stacy Architects in San Francisco.

Gwen Fuertes, Associate AIA, LEED AP, is with Leddy Maytum Stacy Architects in San Francisco.



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