J. CRAIG VENTER INSTITUTE

LA JOLLA

PROJECT TEAM

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J. Craig Venter Institute

ARCHITECT / INTERIOR DESIGNER
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CONSULTANTS
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LIGHTING DESIGNER

KPFF Consulting Engineers, Inc.
CIVIL / STRUCTURAL ENGINEER

Jacobs Consultancy, Inc.
LABORATORY PLANNER

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LANDSCAPE ARCHITECTS

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BOOKLET DESIGN
ZGF Architects LLP

INSTITUTE MISSION

The Institute's unique design melds the environmental philosophies of our genomics research with the sustainability goals that, I believe, must be part of all of our lives. We had several things in mind with the design of the building, and one is that in biology form and function go together.

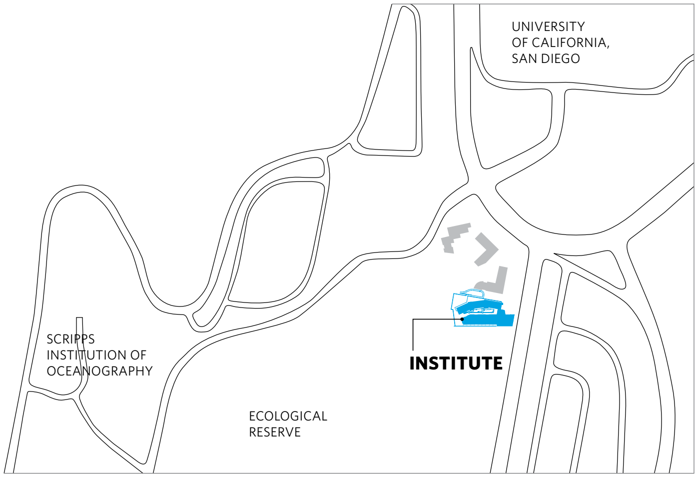
J. CRAIG VENTER, PhD, FOUNDER, CHAIRMAN, AND CHIEF EXECUTIVE OFFICER, J. CRAIG VENTER INSTITUTE

PREVIOUS Designed to achieve LEED-Platinum certification and a net-zero energy footprint, the building is the first net-zero energy biological laboratory in the world.

LEFT The mission was to create a highly collaborative research building for the 21st Century and to accelerate the learning curve in making net-zero energy today's standard.

J. Craig Venter Institute (JCVI) is a not-for-profit research institute located in La Jolla, California and Rockville, Maryland. It was founded in 1992 by J. Craig Venter, PhD and a small, multidisciplinary team of researchers with bold and innovative ideas. Today, JCVI continues to lead the world in genomics research with new programs to improve understanding in the areas of genomic medicine, infectious disease, plant, microbial and environmental genomics, synthetic biology and biological energy, and bioinformatics. JCVI researchers' unrivaled accomplishments include the first complete diploid human genome, the first human microbiome and environmental genomics programs, new and improved methods for isolation and detection of infectious disease agents, and construction of the first synthetic cell. JCVI's commitment to environmental stewardship initiated the challenge for ZGF to design and construct the first net-zero energy, carbon-neutral biological laboratory building for the Institute's new West Coast home on the campus of the University of California, San Diego (UCSD). The building is now a reality and the first of its kind. It contains some of the most innovative water and energy-efficient systems available, and, most importantly, is serving as a model for sustainable research buildings worldwide. This project also represents the seamless integration of scientific vision, purpose, and technology; it explores the ideal physical relationship between experimentalists and computationalists to address their diverse research functions.

DESIGN VISION

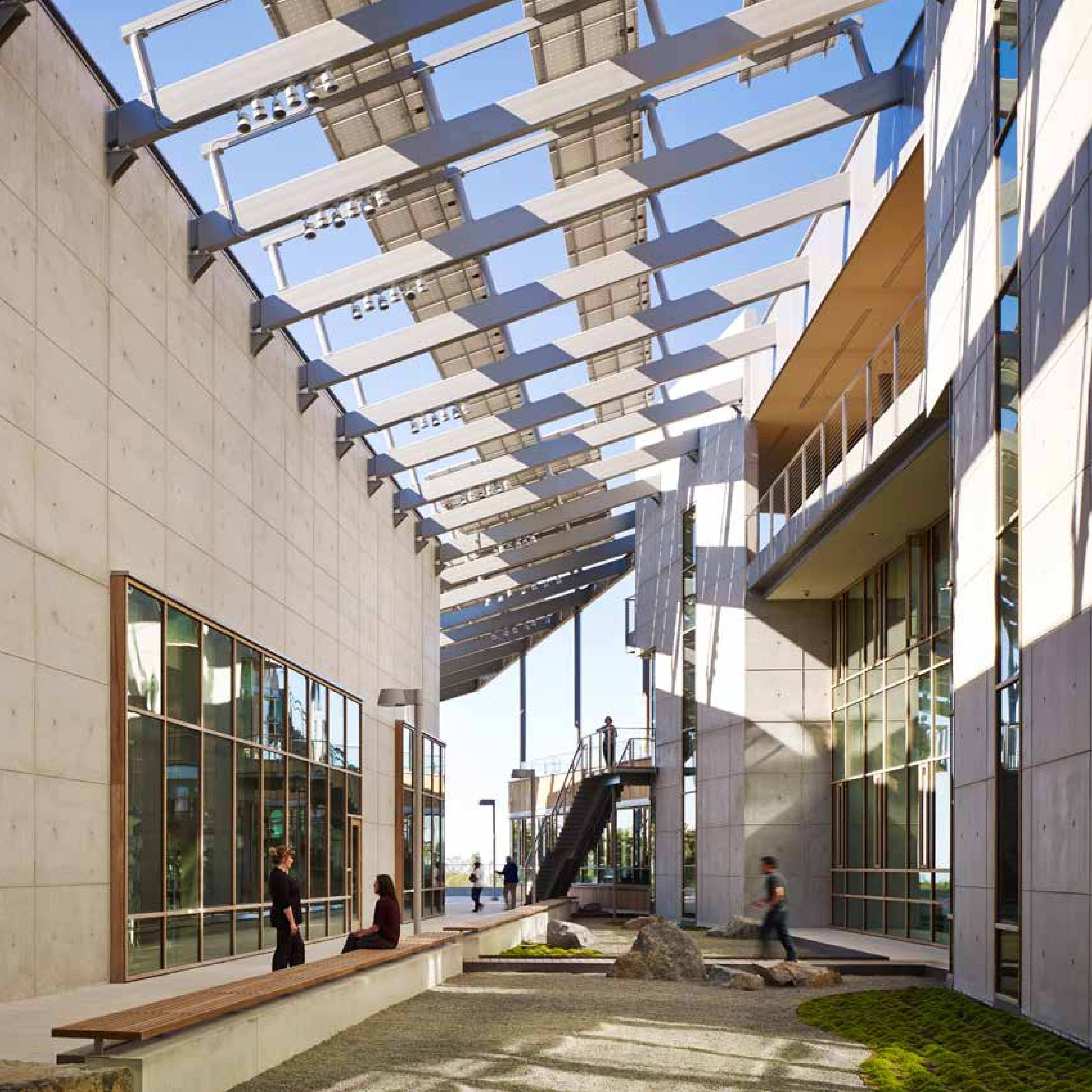


> Craig Venter came to us with the goal of designing the "Salk Institute of the 21st Century"—a place for collaboration and breakthrough research in a high-performance facility that would inspire the design of laboratory buildings in the future. From there, the idea of a net-zero energy laboratory building was born.

TED HYMAN, FAIA, LEED AP BD+C, MANAGING PARTNER, ZGF ARCHITECTS LLP

LEFT The building respects the architectural vocabulary of the UCSD and Scripps campuses, and the scale of the neighboring residential community.

The design was shaped by JCVI's remarkable site. Also of primary importance was accommodating the program, which called for both wet laboratories and offices—two very different types of spaces with distinct system requirements. The 44,607 SF building is comprised of a laboratory wing and an office / dry research wing that frame a central courtyard, all of which sits above a 42,682 SF below-grade parking structure for 112 cars. The facility was planned to foster collaboration between scientists at JCVI, UCSD, Scripps Institution of Oceanography, and other institutions, in order to further the Institute's goals in genomic research. The office environment was designed to support both administrative and research activities, with open and private offices, formal meeting areas, temporary stations for visitors, and informal open modular seating. Meeting areas can accommodate both large and small groups, as well as seminar events. The holistic approach to the design and meeting JCVI's environmental goals revolved around energy performance, water conservation, and a multitude of other sustainable efforts. The systems have been refined to be completely integrated and work together to achieve the energy performance goals.



Purposeful Architecture

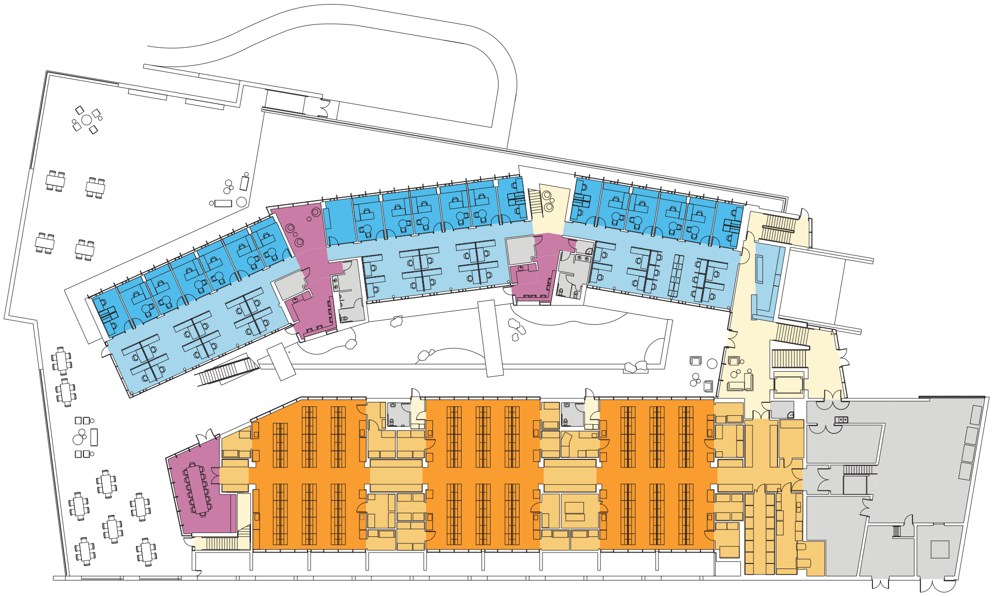
LEFT The photovoltaic arrays are used not only to generate power for the project, but also to provide a shade structure over the courtyard and reduce direct sun and glare into both the laboratory and office spaces.

BELOW The exterior wall of the office wing provides sun and glare protection, optimizing the ability for daylight harvesting. At the same time, the operable windows provide the opportunity for natural ventilation and views of nature.

Each material was considered for its contribution to the enhancement of the building's performance, resulting in a building that is both functional and artful in its simplicity. The project uses a modest palette of high-performing materials, all chosen for their contribution to the sustainability: high-performance glazing, Spanish cedar cladding, high-strength concrete, and rapidly renewable interior materials, such as bamboo, carpet fibers, and resilient flooring. The high-strength concrete mix design included 30% fly ash to maximize the amount of recycled content, while still providing the strength required. The use of glass was a balance between heat gain and daylight harvesting capability. The wood is from renewable forests, and it was left untreated. This way, there is no need for chemical finishes that are not good for the environment, and maintenance becomes easier and more sustainable.

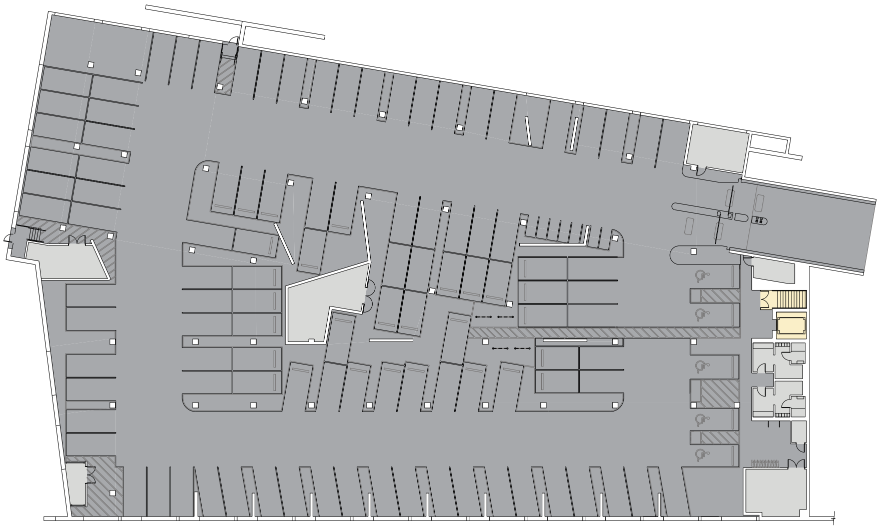
LEVEL 1

This level includes wet bench research space in one wing, and offices and dry research work spaces in the other, with a courtyard in between that visually connects the occupants.



PARKING LEVEL

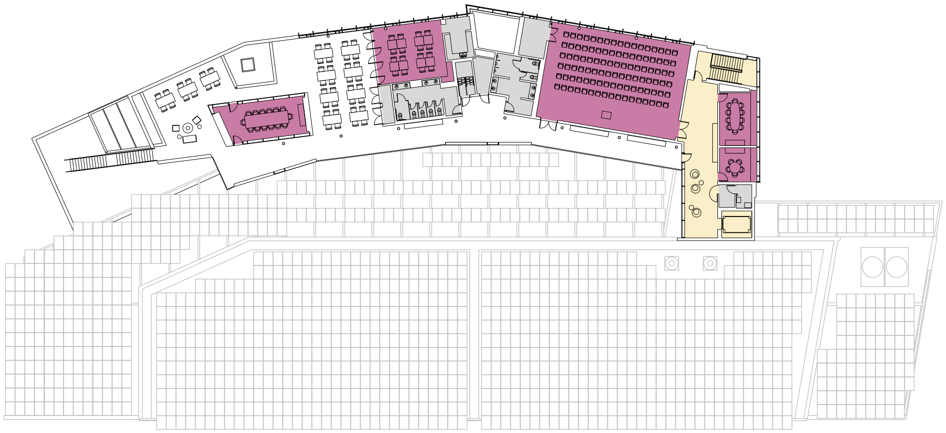
Not only is vehicle parking provided, but additional bike parking, restrooms, and showers encourage alternative transportation to JCVI.



- OFFICE / DRY RESEARCH
- OFFICE / DRY RESEARCH SUPPORT
- WET LABORATORY
- WET LABORATORY SUPPORT
- CONFERENCE
- CIRCULATION
- PARKING
- BUILDING SUPPORT

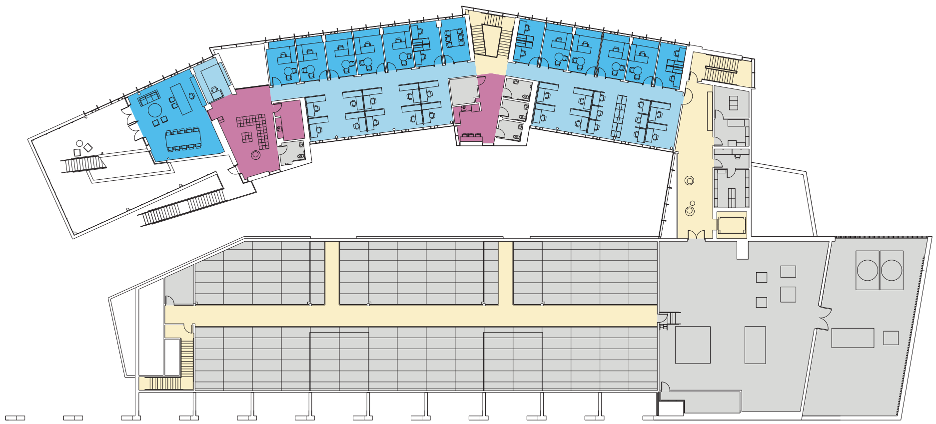
LEVEL 3

The top floor is reserved for more public spaces, including a large conference and seminar room, three smaller conference rooms, and a dining area that opens onto a terrace for outdoor meetings.



LEVEL 2

Level 2 includes offices for senior researchers, administrative space, a reading room, and archival storage for historic documents that chronicle the history of molecular biology. The HVAC equipment for the building is located in the interstitial space above the laboratory wing.



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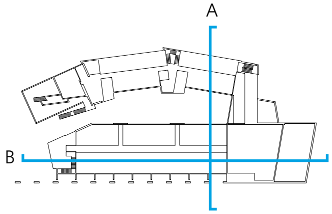
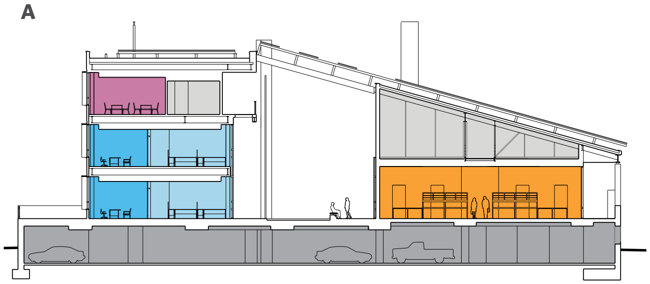
- PARKING
- BUILDING SUPPORT

SECTIONS

BELOW The need to provide parking for 112 cars drove the decision for a semi-basement parking level, while also maintaining height limits for the project and allowing the garage to be naturally ventilated.





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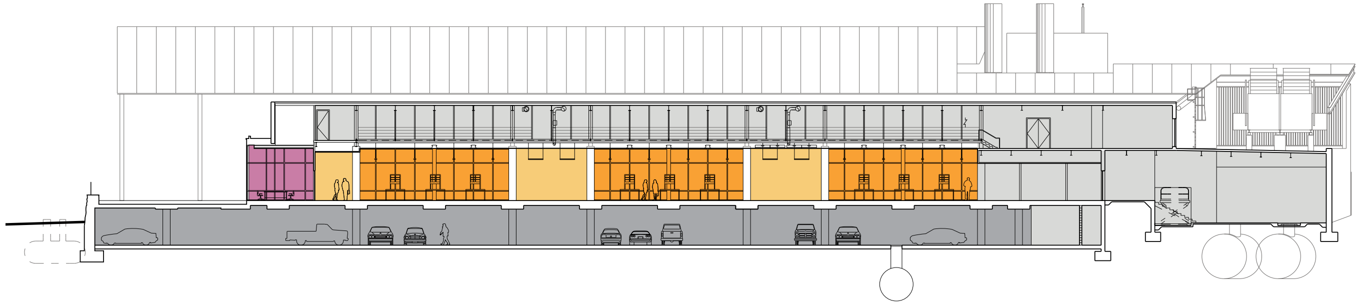


BUILDING ORGANIZATION

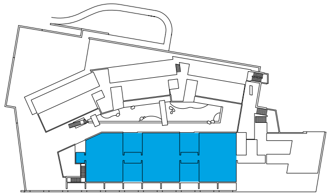
Every aspect of this building's design, in terms of visibility, density, and openness in the laboratories and offices, all fit with our goal to drive interaction and collaboration.

J. CRAIG VENTER, PhD, FOUNDER, CHAIRMAN, AND CHIEF EXECUTIVE OFFICER, J. CRAIG VENTER INSTITUTE

Buildings and environments change work habits. They change the way people interact. JCVI wanted the organization of the building to encourage interaction, yet it also needed to address the net-zero energy goals. Locating the office spaces and dry computational laboratories in one wing, and wet laboratories in the other, reduced energy loads and optimized the mechanical systems. Ground level wet laboratories utilize an easily reconfigurable "plug-and-play" casework system that encourages transparency and creates an environment that can be rearranged overnight. Movable furniture provides similar flexibility in the dry wing. The offices include a layout comprised of open and enclosed work areas. This environment is arranged to support both administrative and research activities, while providing informal meeting areas and temporary stations for visitors. Operable windows in the dry wing take advantage of the climate and further improve occupant comfort. Additionally, the two wings frame a protected courtyard, which allows natural light to penetrate both wings. The third level of the dry wing features an interactive conference center and dining spaces. Outdoor terraces on the ground floor and third floor and indoor interaction spaces are the building's collaborative hubs.

LEFT The main lobby provides an access point to laboratories, offices, and the courtyard.

Wet Laboratory Wing

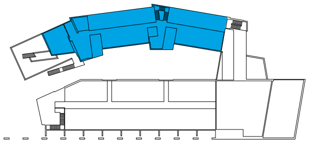


LEFT Because not all laboratory equipment needs to remain in operation 24-hours a day, equipment can be plugged into a green strip that automatically turns off at night.

ABOVE The “plug-and-play” system provides flexibility in the laboratories.

BELOW The laboratories feature reconfigurable furniture and infrastructure to support future flexibility.

Office / Dry Research Wing



LEFT Operable windows take advantage of the climate and improve occupant comfort.

ABOVE Open offices that overlook the courtyard comprise the south half of the office / dry research wing.

BELOW Dry spaces echo the wet laboratory's flexibility with movable and adjustable furniture and partitions.


HARLEY-
DAVIDSON

ADVANCING RESEARCH

There is a certain density of researchers that is optimal, where people really work well together. Seeing people, creates collaboration that results in innovation and breakthroughs.

J. CRAIG VENTER, PhD, FOUNDER, CHAIRMAN, AND CHIEF EXECUTIVE OFFICER, J. CRAIG VENTER INSTITUTE

This new building is the third facility that JCVI (including its legacy organization, The Institute of Genomic Research, TIGR) has built. The first, the original TIGR buildings in Rockville, MD, were traditional, smaller laboratories assigned to single or small number of Principal Investigators. Though the Institute's style of research has always been quite collaborative, with scientists working and interacting among several teams, the design of the laboratory itself did little to encourage such collaboration. The Institute's second major facility, also in Rockville, was designed with larger laboratories than the first buildings, which further encouraged a more collaborative style of research. However, even these larger laboratories on the same floor were isolated from each other by walls and doors. Offices for wet laboratory scientists were located adjacent to their laboratories. Offices for computational biologists were located on a separate floor. While this enhanced the collaboration among computational biologists on different teams, interaction between wet laboratory and computational biologists suffered. The design of the new building had many advantages for the organization. All the laboratories are on a single floor and they are very open. The work area of any laboratory team is easily accessible from any other. No staff offices are located within the laboratory wing; all offices are located on two floors in an adjacent wing. A large seminar room, conference rooms, and a common dining area are located on a third floor above the offices.

LEFT The courtyard which connects the laboratories and offices, also provides opportunities for informal interaction.

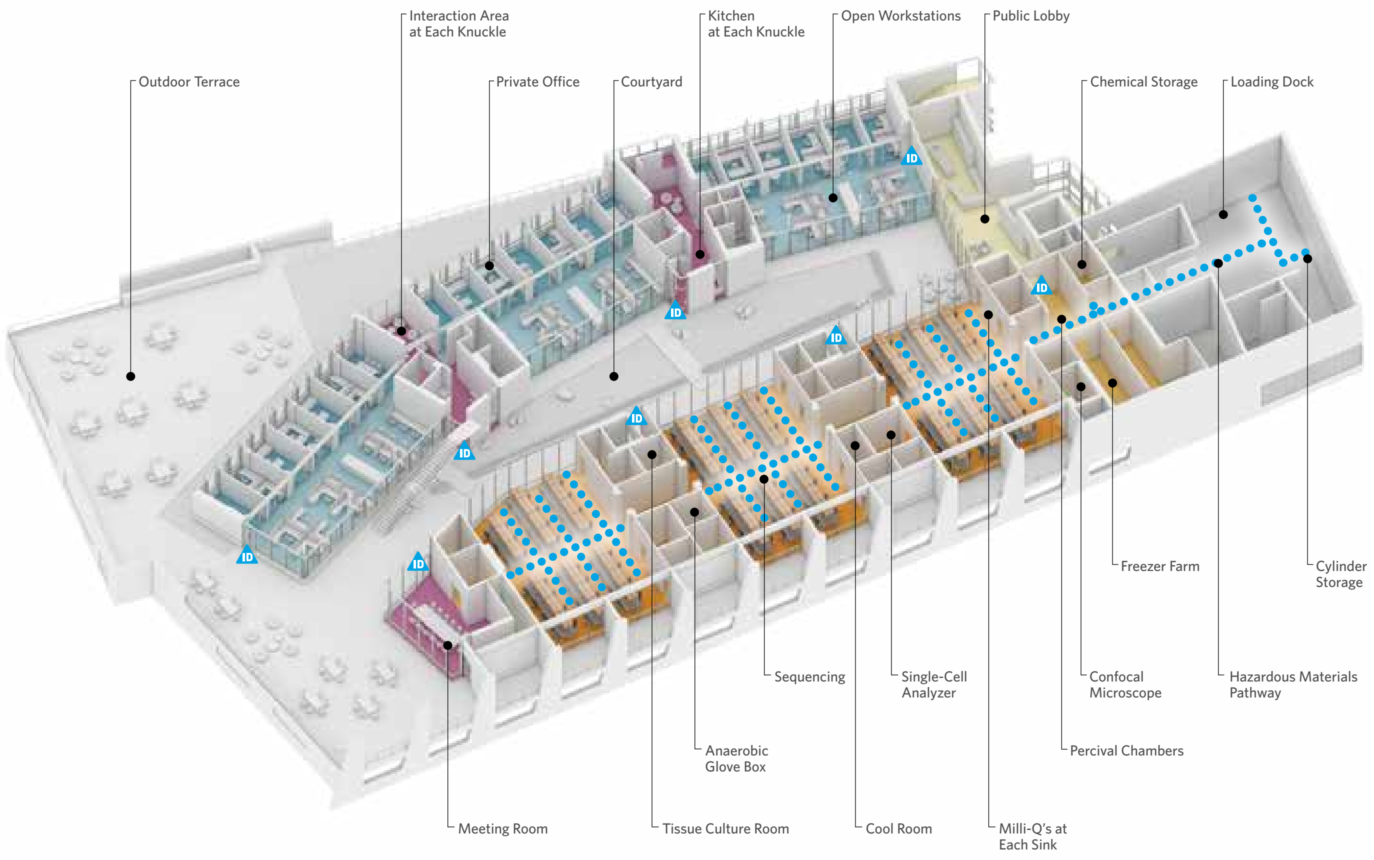
ABOVE The large open laboratory neighborhoods are designed to be easily modified as needed. Casework is on wheels and benches are easily moved or removed as needed. (Electricity and communications are supplied from above via quick-connect cables.)

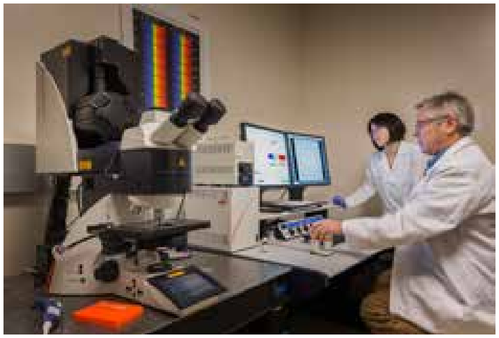
BELOW A mechanical mezzanine above the laboratory allows for maintenance and modification with minimized disturbance within the laboratory itself. An Aircuity chemical sensing system within the laboratory enhances biosafety in the event of a chemical spill, yet enables lowered heating and cooling energy consumption.

Planning Strategies

BELOW Commingling the offices of wet laboratory and computational biologists into one office wing enhances interactions among the entire scientific staff. As biology becomes more computational, this becomes crucial. Even the wet laboratory scientists who spend most of the day working at the bench must cross the courtyard for coffee breaks and lunch, leading to further chance interactions with computational colleagues throughout the work day. Materials flow directly into the laboratory wing from the loading dock.

The new building's open and accessible laboratory design has several advantages for JCVI. First, equipment is easily shared among groups, leading to more efficient use of scarce equipment dollars. Equipment-sharing results in the increased circulation of people within the laboratories, which leads to greater chance interactions among scientists in different laboratory groups. The long laboratory wing is divided into three large laboratory areas, divided by two groupings of support rooms. The large central corridor allows easy movement and visually connects the open laboratory areas. Shared equipment lines the corridor walls. The grouping of support rooms as partial laboratory dividers maximizes window area within the open laboratories, and along with 15 ft. ceilings, results in natural daylighting throughout much of the day.





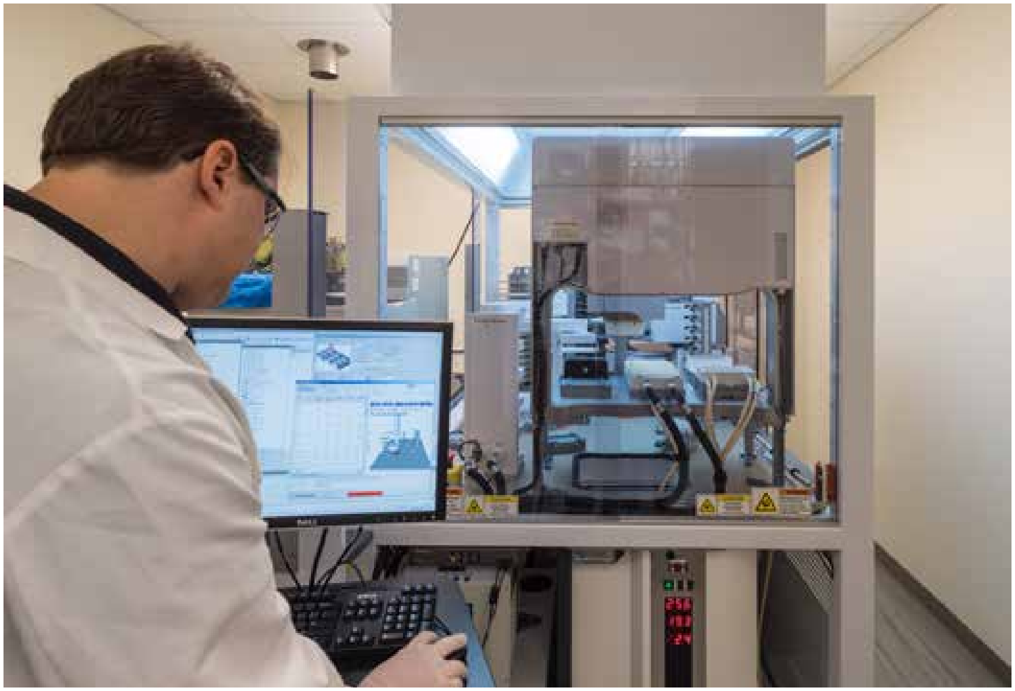
The building was intentionally designed with a minimum number of "unique support spaces" to accommodate a rapidly changing science.

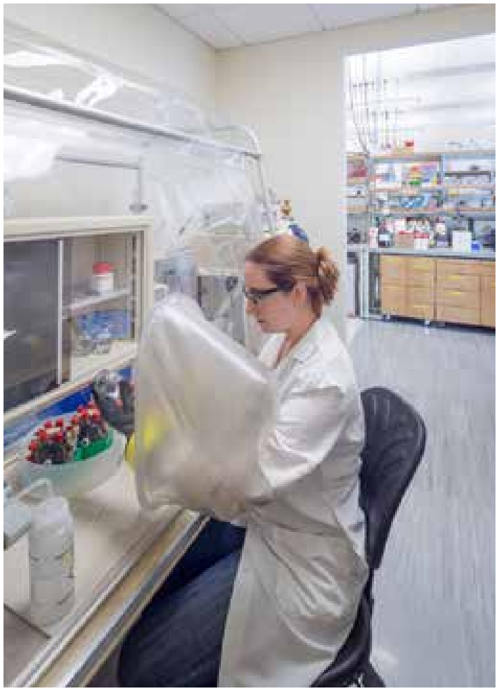
TOP LEFT A confocal microscope room housing a Zeiss fluorescent microscope and imaging analysis system was located to minimize vibration.

MIDDLE LEFT A Tissue Culture support space.

ABOVE RIGHT A phytoplankton "cool" room (18° C) that uses both the building's hydronic cooling system and a supplemental air conditioning unit supplied from the mechanical mezzanine. When no longer needed, the supplemental unit can be easily removed and the room can be converted for a different use.

BELOW One oversized support room that houses a one-of-a-kind, robotic single-cell analyzer that can extract, amplify, and analyze DNA from many thousands of individual cells per week.





ABOVE Rather than distributing traditional air-cooled, -80° C freezers throughout the laboratory area, the building features a "freezer farm" of water-cooled, -80° C freezers in a separate room at one end of the laboratory wing. The water-cooled freezers require less electricity to operate and provide the ability to collect and store the expelled heat within the building's thermal energy storage tanks. This system is used to heat the building when needed.

MIDDLE LEFT Instead of constructing traditional, built-in cold rooms, refrigerator size Percival Environmental Chambers are used for extra flexibility in experimental design, enhanced temperature and light control, and lower energy consumption.

BOTTOM LEFT For water efficiency, each of six laboratory "neighborhoods" has its own smaller Milli-Q Water Purification System. This allows each laboratory group to specify their own water quality requirements. Rather than installing a centralized vacuum system, distributed units are used in the few places they are required.

BOTTOM RIGHT An Anaerobic Glove Box support space.


NextSeq 500

Laboratory Flexibility

In fields changing as rapidly as genomics, it is impossible to forecast with any reliability the equipment and staffing needs a decade into the future (never mind over the lifetime of a building). Flexibility to use the laboratory in many different ways and ease of modification are crucial. A highly customized laboratory built today may be modestly more productive than a flexible design. However, as JCVI has learned from prior experience, the economic and scientific efficiency loss from not being able to rapidly and inexpensively adapt to dynamic scientific change can be substantial.

As an example, in 2006 JCVI celebrated a milestone, having analyzed 100 million "lanes" of DNA in its first three years of operation of a dedicated 45,000 SF sequencing center—the same size as the entire new building. This past month, JCVI acquired a new generation desktop DNA sequencer with a footprint of 4 SF that produces the same amount of sequence data in a single run of two days as the old facility produced in three years. The wet laboratory support requirements for DNA sequencing have vastly dropped; at the same time, computational support needs have dramatically increased.

Recruitment of new scientific talent is also crucial to future success. Given JCVI's size (both building and endowment), the Institute cannot offer the generous start-up packages, large laboratories, and equipment budgets that many large research universities offer today. The new open laboratories with shared equipment compensate to a large degree, but the open, airy, sun-filled work environment is a substantial recruiting advantage. Candidates and other visitors routinely comment, "You get to come to work here every day?!"

The Institute has also found that when arranging small group meetings with local scientific collaborators, scientists often prefer to come to JCVI's building, even though that means that they are the ones to take the extra effort to travel. The work environment attracts the types of scientific interactions that are so important to creativity.

LEFT The building was designed with the flexibility to accommodate ever-changing technology.

Enhancing Collaboration

LEFT The outdoor furniture on the ground floor terrace and third floor terrace near the dining area are well used collaboration spaces, as well. Staff bring their laptops and connect to the building's wireless network.

BELOW LEFT The pod seating areas on the first floor and the second floor lobby are primarily used as quiet areas for concentrated reading.

BELOW RIGHT Conference rooms scattered throughout the first and second floor are heavily used for video and impromptu meetings to explore new ideas.

Most of the scientists in the new building moved from an older rental facility that had no open workstations, though many worked in shared offices. Many of the shared offices had no access to natural daylight. The new open office layout brings obvious benefits: walls of windows replace the need for artificial lighting and operable windows allow for natural ventilation. Users enjoy those aspects. The enhanced visual and aural connection among co-workers leads to greater interactions among each of the scientific groups, which is a definite plus. While the open office layout has required some cultural change, with more employees using headphones to block ambient noise when they are performing tasks that require intense concentration, the open office layout has enhanced interactions between groups and between JCVI leadership and more junior scientific staff. People see each other not just in break rooms, but as they walk down the interior hallway. Craig Venter (JCVI's CEO) has even remarked that he now casually interacts with far more staff than before, just when walking through the building. More senior scientists in glass-walled offices easily see their colleagues in the open workstation areas and vice versa.

BUILDING PERFORMANCE

We talk about climate change and about a sustainable environment. But everything starts at home. Given the opportunity to build our own research building, we decided to put our ideas into action and walk the talk.

J. CRAIG VENTER, PhD, FOUNDER, CHAIRMAN, AND CHIEF EXECUTIVE OFFICER, J. CRAIG VENTER INSTITUTE

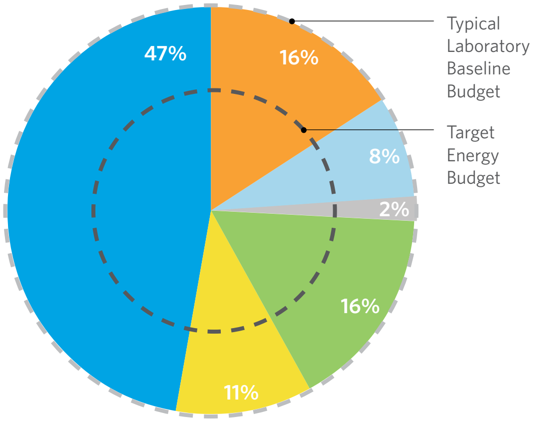
As one of the greenest buildings in the country, the new facility is designed to achieve LEED-Platinum certification and a net-zero energy footprint. Two arrays, comprising 26,124 SF of photovoltaic surface across 1,488 Sunpower E20 / 327 panels, were designed to meet building demand over the timeframe of a year—the first biological laboratory in the world to do so. Building occupants are responsible for reducing plug loads by 31% to achieve net-zero target. In terms of light energy, sensors detect when artificial lighting is required, but variable brightness settings ensure that no more lighting is provided than required. Instead of using air-cooling, the laboratory freezers use a more efficient water-cooled system that consumes less energy. Induction diffusers (active chilled beams) deliver minimum air change rates to meet Environmental Health & Safety requirements for laboratories and offices, but they also have a heating / cooling coil that delivers either hot water or cool water to heat or cool the building, eliminating any re-heating of the air supply. Virtually all site rainwater and air handler condensate is collected into three interconnected cisterns, and then UV-filtered and recycled for non-potable water functions within the building, which is expected to reduce the building's domestic water demand by 70 percent. Native low-water landscaping and terrace gardens help collect rainwater and keep the building naturally cooler.

LEFT Photovoltaic panels help power the building.

Achieving Net-Zero Energy

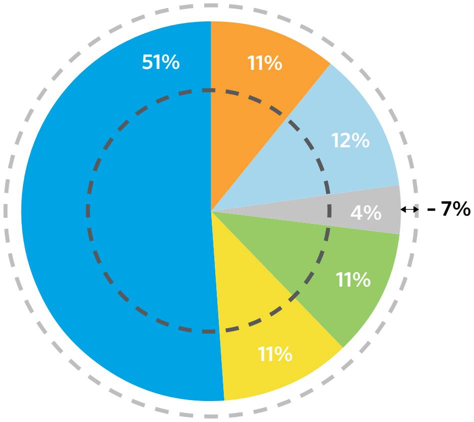
TYPICAL LABORATORY

The first step was to establish the typical laboratory energy demand, and then determine the energy budget based on the area for the photovoltaic array.



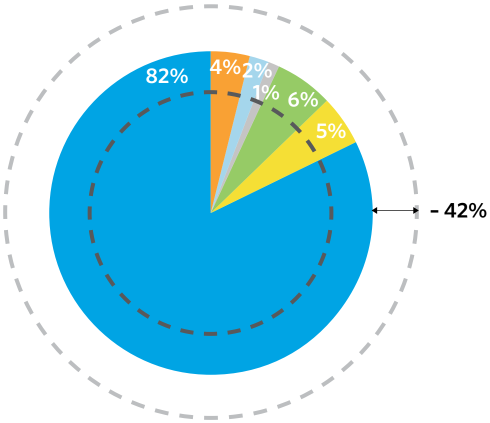
ARCHITECTURE

Initial reduction in energy use was achieved by architectural solutions (sunshades, building orientation, etc.).



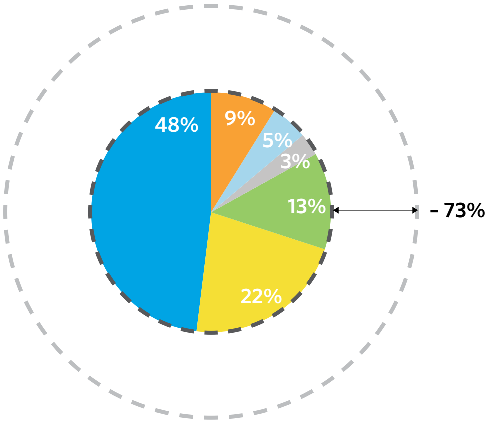
MEP SYSTEMS

Additional energy savings were achieved through improvements to HVAC and lighting systems.



PLUG LOADS

By changing the culture of research (laptops, water-chilled freezers, green plugs) and measuring usage in existing JCVI laboratories, a 73 percent overall reduction from the baseline was achieved.

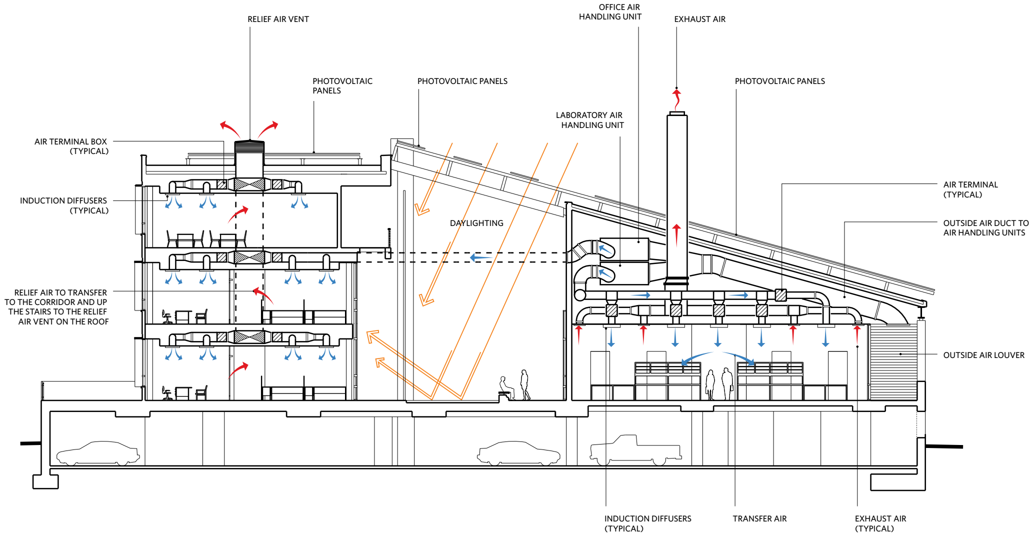


LEGEND

- Heating
- Cooling / DHW
- Pumps
- Fans
- Lighting
- Office / Laboratory Plug Loads / Freezers
- Available Energy Budget
- Typical Laboratory Baseline Budget

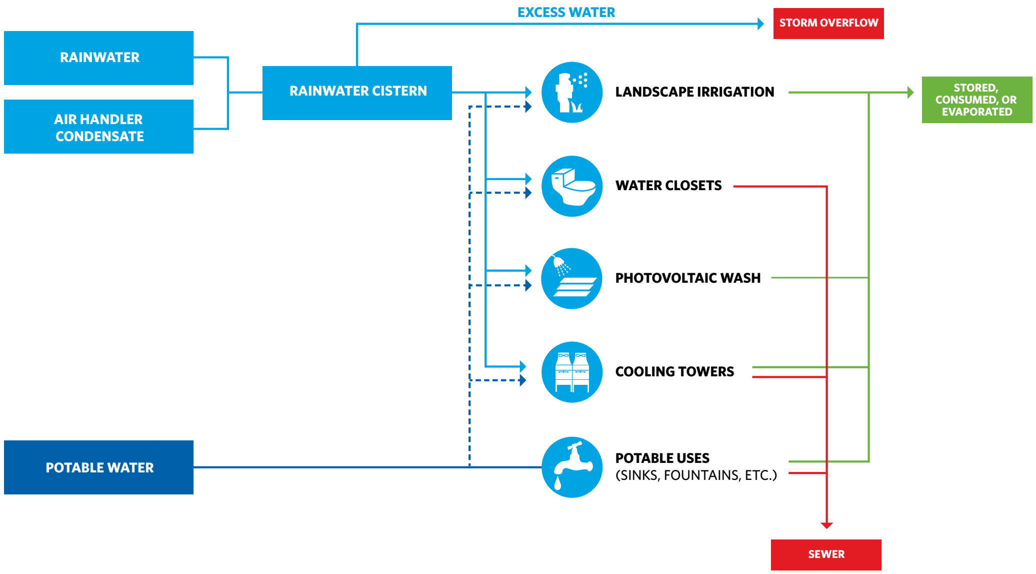
Daylighting and Air Flow

The integrated systems work in tandem. The photovoltaic array partially shades the courtyard, allowing some sunlight to penetrate the space and reflect back into the laboratory and office spaces. Heated air in the space is expelled out of the building, while fresh air from outside enters the building and is processed through the HVAC system.



Water Conservation

A complex water-balancing model was developed to understand the quantities, frequency, and demand times of water use. The result is a system that uses rain and recycled water, when available, for everything except potable water uses. Plans for a greywater connection to the building (purple pipe) have also been established to allow for use of reclaimed water in the future.



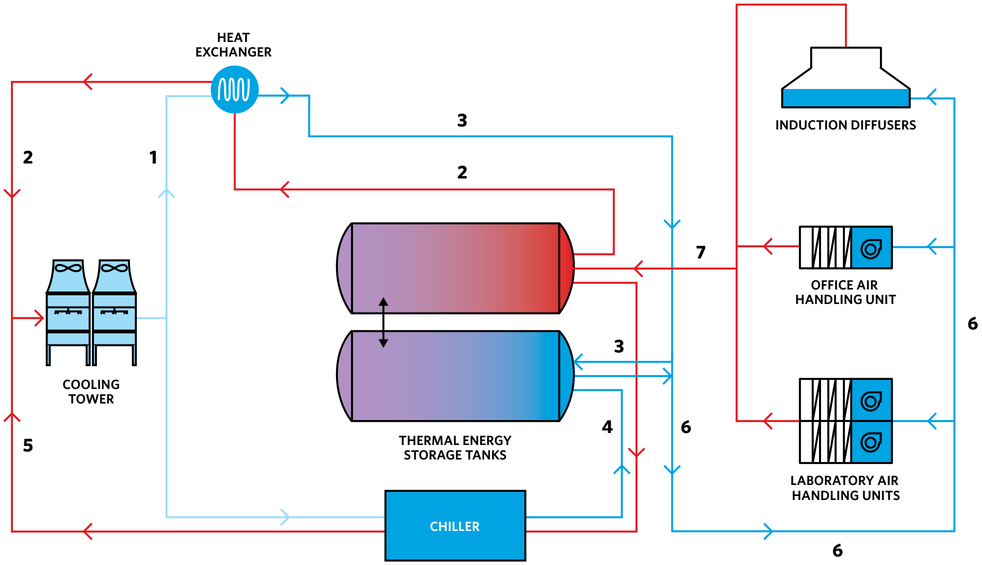
HVAC Systems

COOLING

Thermal Storage Tank Charging
1 The cooling tower (open loop system) generates cool water at night, which is supplied to the heat exchanger. **2** Heat from the building is carried back to the cooling tower through the heat exchanger. **3** Cool water (closed loop system) from the heat exchanger is used to charge the thermal storage tanks. **4** If tank temperature is not satisfied in the early morning (typically, only during hot summer periods), chiller can be used to charge the thermal storage tanks. **5** Heat from chiller operation is carried back to the cooling tower.

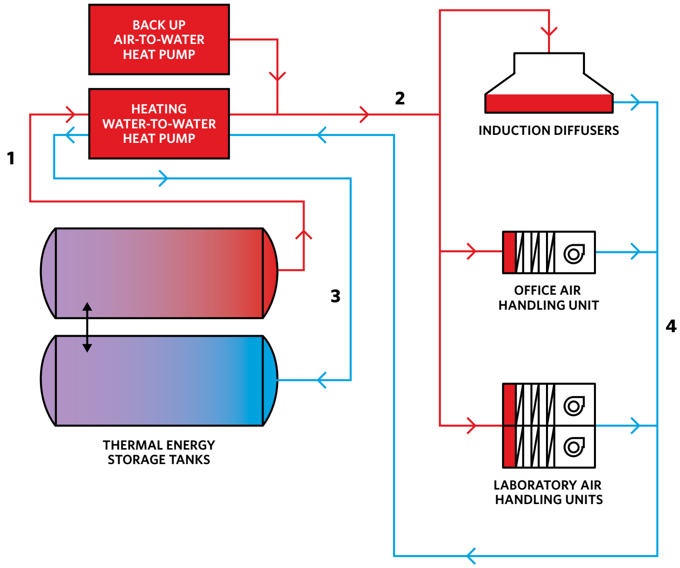
Thermal Storage Tank Discharging
6 During the day, cool water is drawn off the cool side of the thermal storage tanks for use in cooling the building by supplying the air handlers and induction diffusers. **7** Heat removed from the building is returned to the warm side of the thermal storage tanks.

This allows for cooling of the building during the winter months and most of the shoulder months of the year with minimal operation of the chiller.



HEATING

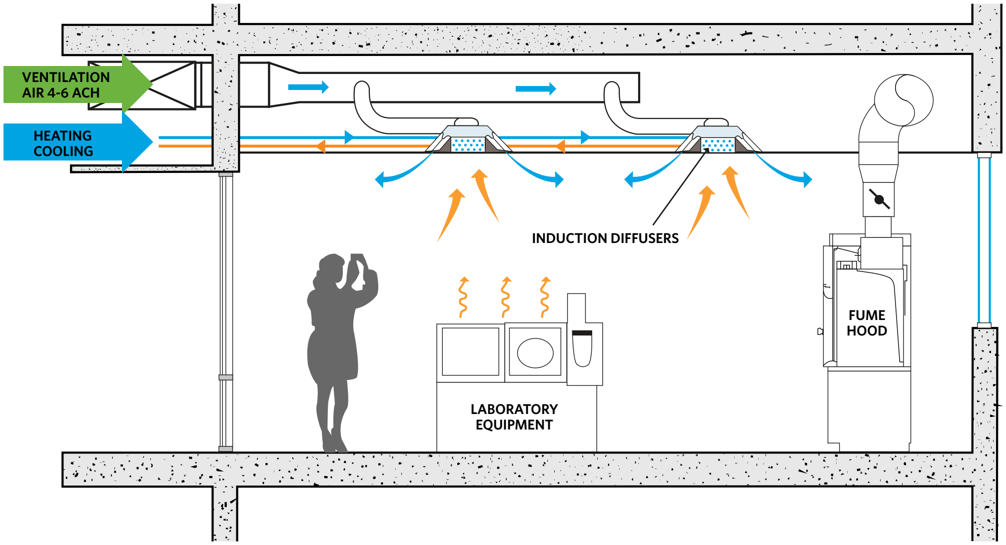
1 Warm water from the thermal energy storage tank goes to the heat pump to provide heating. **2** Heated hot water goes to the air handling units and the induction diffusers and provides a heat source for domestic and industrial water systems. **3** Cold water by-product from the heat pump goes back to the cold side of the thermal energy storage tank. **4** Cold water by-product from the induction diffusers and the air handling units go back to the heat pump to be reheated.



- Hot Water
- Warm Water
- Cool Water
- Cold Water

Variable Laboratory Air Changes

Reducing energy is only one feature of the JCVI mechanical system. Through the use of induction diffusers and an air monitoring system, laboratories are provided with 4 to 6 air changes when spaces are occupied, with the capacity to "ramp up" individual laboratories in the event of a spill. The minimum is 2 air changes for unoccupied times. In addition to energy savings and laboratory safety, the laboratories are quieter and more comfortable for the occupants than traditional laboratory HVAC systems.



Building Intelligence

The building systems were tied together through a unique intelligent building interface. With this the operations team can troubleshoot and optimize the building with a single user-friendly interface.