

*"Drawing on the Wisdom of our experts, real change comes from assisting clients who share our goal of moving swiftly towards an equitable, inclusive and Net-Zero world."*

## ARTISTA ENGINEERING

We are the sum of our collective Passion, Vision and Expertise. From our local beginning to our vast International presence today, ARTISTA has enjoyed continuous growth and enrichment of its service offering. ARTISTA is a globally recognized professional services firm providing strategic advisory, engineering and design services to clients in the transportation, infrastructure, environment, building, power, energy, water and resources sectors. Our more than 1500 trusted professionals are united by a shared goal: to create positive, long-lasting impacts on the communities we serve.

**WHAT WE STAND FOR** We believe that for society to thrive, we must all hold ourselves accountable for tomorrow. It inspires us to stay curious, act locally and think globally.

**OUR STORY** From our earliest roots in Nepal over 7 years ago to our vast international presence today, ARTISTA has enjoyed continuous growth and expansion.

**FUTURE READY** We see the future more clearly through key trends in climate change, society, technology and resources and challenge our teams to work with our clients to advise on solutions that are both ready for today and the years to come.

**RESPONSIBILITY** We have empowering culture and hold ourselves accountable which means acting responsibly in all areas of our business and managing it as if it were our own.

**GLOBAL LEADERSHIP** We are built on the strength of our people. In every region where we operate, our local experts guide the mission, drive the vision and uphold our collective beliefs.

*"There is something special about how people value their work, as well as an openness and enjoyment of working together globally," says Er. Dinesh Raj Bhattarai, Managing Director.*

Future ready puts ARTISTA at the heart of delivering a sustainable, prosperous, resilient society. Setting up apart. And bringing lower total ownership costs and peace of mind to our clients.



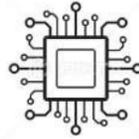
### CLIMATE

How will your project, infrastructure, or community hold up against the effects of global warming, flooding and rising sea levels, and more disruptive storms?



### SOCIETY

The way we move around our cities, the way we design our neighbourhoods, and the way we plan infrastructure are all impacted by changes in social and cultural norms.



### TECHNOLOGY

The speed of technological advancement has no historical precedent. It is upsetting that the depth of changes is transforming entire systems of production, management, and governance.



### RESOURCES

By changing our thinking on how we produce what we need, we can create an economy that allows us to do so much more, with less.

## FUTURE READY



## GLOBAL LEADERSHIP

The Global Property Sector must achieve two things by 2030, according to the United Nation's High Level Climate Champions. The UN has identified two breakthrough goals for the global built environment to be achieved by 2030. They are:

1. All New and Refurbished Buildings must be Net Zero in Operation
2. All New and Refurbished Buildings must achieve at least a 40% reduction in Embodied Carbon.

These Goals for 2030 are daunting, but they are tangible. Fundamentally, they have been designed to keep us and our world safe from catastrophic climate change. By taking action now, we will begin to see total emissions generated by the global built environment coming down.

## TRANSFORMING OUR WORLD: THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT

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### GOAL-6

Ensure Availability and Sustainable Management of Water and Sanitation for all



### GOAL-9

Build Resilient Infrastructure, Promote Inclusive and Sustainable Industrialization and Foster Innovation



### GOAL-11

Make Cities and Human Settlements Inclusive, Safe, Resilient and Sustainable

## CHANGE AGENT

We are a positive and bold agent of change in our communities.

## TRUSTED PARTNERS

Our professionals, clients, suppliers and shareholders seek us out.

## EMPLOYER OF CHOICE

We attract the brightest minds to solve our client's most complex challenges.

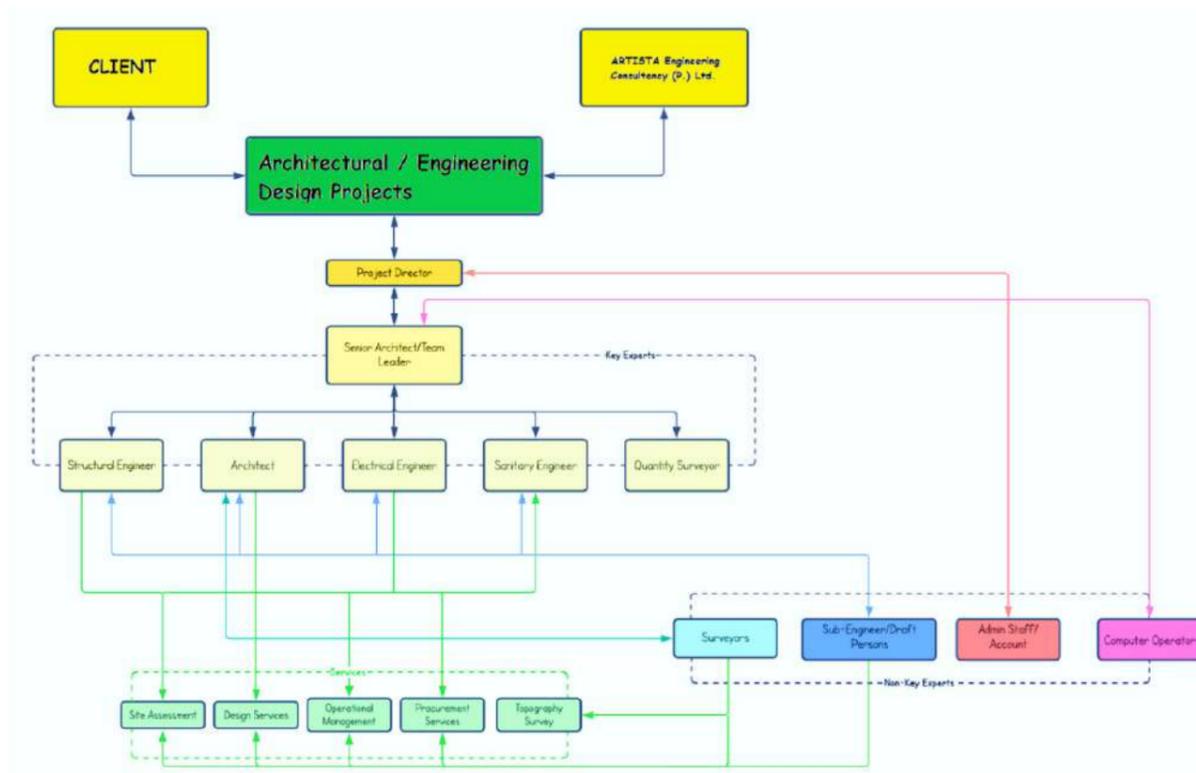
## DIVERSITY ADVOCATE

We raise up and empower the diversity of our communities.



"We have grown tremendously since the inception of Firm, and still get that feeling of working in a small company, but with big connections".

## OUR PROJECT MANAGEMENT STRUCTURE FOR BUILDING STRUCTURES



ARTISTA's project management structure for building projects is led by a Project Director and Project Manager, supported by a team of senior experts and technical staff. The Project Director manages the project budget and schedule, reporting to the client's Project Director, while the Project Manager oversees day-to-day operations, coordinates consultant disciplines, and manages communication within the team. Expert roles include Architect, Structural Engineer, Mechanical Engineer, Electrical Engineer, and other disciplines as needed, ensuring code compliance, building stability, and optimized building systems.

Technical staff, such as cost estimators, specification writers, and 3D modelers, support the experts team, overseen by administration staff who maintain clear communication and reporting to the Project Director. Regular meetings between client and consultant teams ensure efficient communication, timely decision-making, and alignment to deliver high-quality projects tailored to client needs. This adaptable framework ensures clear roles and responsibilities, efficient collaboration, and improved project quality across projects of varying size and complexity.



## OUR CODE OF ETHICS AND PROFESSIONAL CONDUCT

### COMMITMENT TO SERVING CLIENTS WITH DISTINCTION:

**INTEGRITY:** We uphold honesty and transparency in all our professional interactions and services.

**QUALITY:** We strive to deliver high-quality services that create meaningful impact for our clients.

**PROFESSIONAL BEHAVIOR:** We adhere to professional standards, laws, and regulations, maintaining accountability and integrity in our work.

**OBJECTIVITY:** We do not allow bias, conflict of interest, or inappropriate influence of others to override our professional judgements and responsibilities.

**COMPETENCE:** We use due care to match client needs with practitioners who have the competence required for their assignments.

**FAIR BUSINESS PRACTICES:** We respect our competitors and are committed to fair business practices.

**CONFIDENTIALITY, PRIVACY AND PROTECTION:** We protect and take measures to safeguard the confidential and personal information that we hold, collecting and handling it in compliance with applicable laws, professional obligations, and our own data management policies and practices.

### COMMITMENT TO INSPIRING OUR TALENTED PROFESSIONALS:

**RESPECT, DIVERSITY, AND FAIR TREATMENT:** We foster an inclusive and respectful working environment that promotes equal opportunity and values diversity.

**PROFESSIONAL DEVELOPMENT AND SUPPORT:** We invest in the growth and development of our people, providing resources and support for their personal and professional advancement.

### COMMITMENT TO CONTRIBUTING TO SOCIETY AS A ROLE MODEL FOR POSITIVE CHANGE:

**ANTI-CORRUPTION:** We oppose corruption and unethical behavior, ensuring integrity in all business dealings.

**RESPONSIBLE SUPPLY CHAIN:** We select suppliers through fair processes and support ethical practices throughout our supply chain.

**Social Responsibility:** We engage with non-profit organizations and support community initiatives to make a positive impact on society and the environment.

*"We meet regularly, we know each other, and at the end of the day, this gives us a huge advantage. We perform better, and we add value because we really connect with one another."*

## OUR SERVICES

We develop creative, comprehensive and sustainable engineering solutions for a future where society can thrive. Equipped with and intimate understanding of local intricacies, world-class talent and proactive leadership, we plan, design, manage and engineer long lasting and impactful solutions to uniquely complex problems.

### PROPERTY AND BUILDINGS

- Commercial & Mixed Use
- Culture
- Education
- Government
- Healthcare
- Heritage
- High-Rise
- Hospitality
- Mission Critical Facilities
- Residential
- Retail
- Science
- Sports and Stadia
- Telecommunications
- Timber
- Bamboo
- Steel
- Workplace

### SERVICES

- Advisory Services
- Design Services
- Digital Solutions
- Planning Services
- Project Delivery
- Safety and Security

### TRANSPORT AND INFRASTRUCTURE

- Asset Management
- Aviation
- BIM
- Bridges
- Cities
- Design-Build
- Maritime
- Waterways
- New Mobility
- PPP
- Rail and Transit
- Roads, Highways and Expressways
- TOD
- Transport Planning
- Tunnels

### ENERGY AND RESOURCES

- Energy
- Mining
- Oil and Gas

We specialize in offering a wide range of services across different sectors. In the property and buildings sector, they offer services in commercial, education, healthcare, and retail among others. They also provide transport and infrastructure solutions, such as asset management, bridges, railways, and tunnels.

Additionally, they cover areas of energy and resources, earth and environment, and water, offering services such as waste management, sustainability, and water supply. The firm's expertise covers industries such as aerospace, chemical, and food and beverage, among others. Overall, the firm provides advisory, design, planning, safety, and delivery services across various sectors.

### EARTH AND ENVIRONMENT

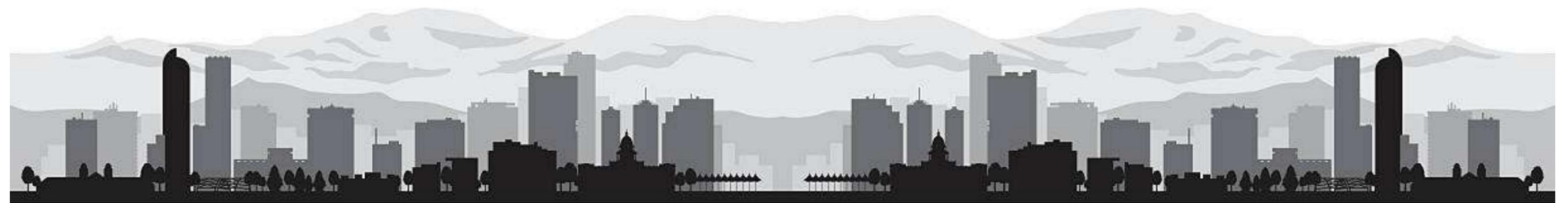
- Air Quality
- Archaeology and Heritage
- Biodiversity and Natural Capital
- Contaminated Land and Soil Remediation
- Environment, Health and Safety
- Environmental and Social Impact
- Environmental Compliance
- Environmental Due Diligence
- Geo-Technical and Ground Engineering
- GIS Mapping & Surveying
- Materials Engineering and QM
- Licensing & Permitting
- PFAS Management, Investigation and Treatment
- Strategic Environment Assessment
- Sustainability, Energy and Climate Change
- Waste Management

### INDUSTRY

- Aerospace
- Automotive and Battery Plants
- Chemical Industry
- Construction Products
- Consumers Product
- Food and Beverage
- Metal Industry
- Pharmaceuticals and Life Science
- Process Energy
- Pulp and Paper Sustainability, Energy and Climate Change
- Waste Management

### WATER

- Drinking Water Supply
- Industrial Water and Wastewater Management
- Water and Wastewater Treatment
- Water Resources
- Water Transmission and Wastewater Conveyance



## C O N T E N T S

01		B.P. Koirala Cancer Memorial Hospital	08
02		PRIMARY HOSPITAL TYPE B-1 (15-BED)	14
03		Nepal Korea Friendship Municipality Hospital	16
04		World Bank New Office	18

# 01

## B.P. KOIRALA CANCER MEMORIAL HOSPITAL

*Expanding Cancer Hospital Facilities: Incorporating a Nuclear Medicine Unit and an Academic Building for enhanced Diagnostic and Treatment Capabilities*



**PROJECT:**  
Design of Nuclear Medicine Unit and Academic Building in B.P. Koirala Cancer Memorial Hospital

**LOCATION:**  
Bharatpur-7, Chitwan, Bagmati Province, Nepal  
**YEAR:** 2023

The B. P. Koirala Memorial Cancer Hospital (BPKMCH) is a national center for cancer treatment and research in Nepal. The hospital provides a broad range of services for cancer prevention, diagnosis, treatment, and research. Despite its achievements, the hospital lacked a nuclear medicine facility which would significantly enhance its capabilities in the fight against cancer.

The BPKMCH did not have a nuclear medicine facility, which limited its ability to provide the best possible care to cancer patients. Patients had to travel to other hospitals or clinics for these services. This led to increased costs, delays, and loss of continuity of care. A nuclear medicine facility at BPKMCH would reduce the burden of cancer patients and provide timely and effective management of their disease.

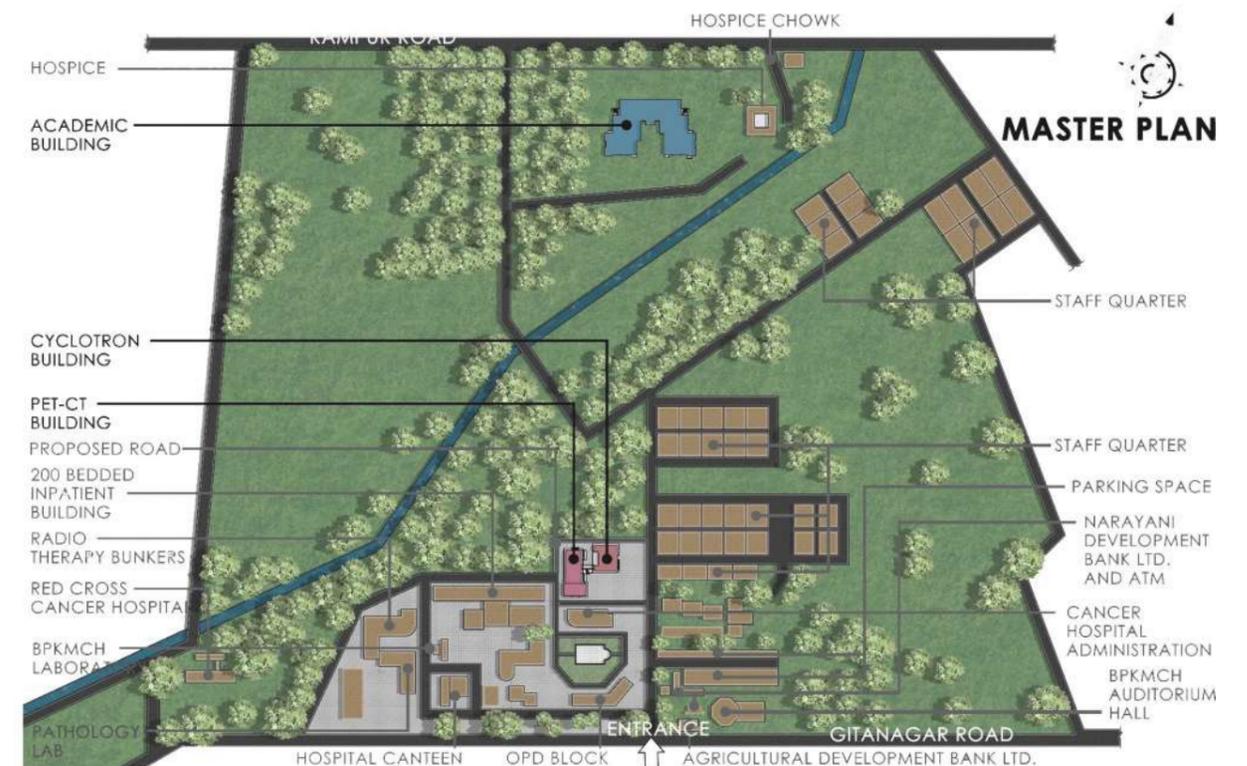
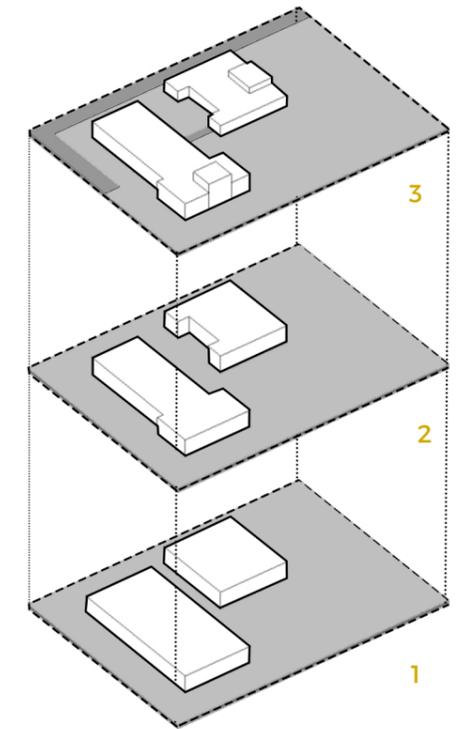
Nuclear medicine plays a vital role in the diagnosis and management of cancer. Nuclear medicine techniques use radioactive tracers to target specific organs or cells of the body, providing detailed images of their function and structure. This information is crucial for disease diagnosis, stage determination, and treatment planning. Nuclear medicine is also used for targeted therapy of cancers, where radioactive isotopes are delivered directly to cancer cells to kill them.

One of the technological advances are the PET-CT Scan Center and Cyclotron building, which require building infrastructure. The building will help the hospital to provide better and more accurate diagnosis and treatment of cancer, which would significantly benefit cancer patients in Nepal. They would also help the hospital to expand its research infrastructure.

The selected location for the PET/CT and Cyclotron facility is strategically chosen to maximize efficiency, accessibility, and safety while maintaining close proximity to other healthcare facilities. The surrounding natural environment is also favorable for the safe operation of the facility, with no high-risk zones nearby.

The selection of the location on the North-East side of the 200-Bedded Hospital and in close proximity to the Main Road makes it easier for the inpatients and outpatients to come for examination. There is already an access road to the selected site while another access road is proposed to make the cyclotron facility more accessible and time-efficient for deliveries to other facilities, if needed.

Additional features of the selected location include ample space for future expansion of the PET/CT and Cyclotron facility, as well as the availability of necessary infrastructure such as water, electricity, and waste disposal facilities.



## PET/CT SCAN CENTER

A PET-CT scan center is a medical facility that offers Positron Emission Tomography (PET) and Computed Tomography (CT) scans together as a combined imaging technique.

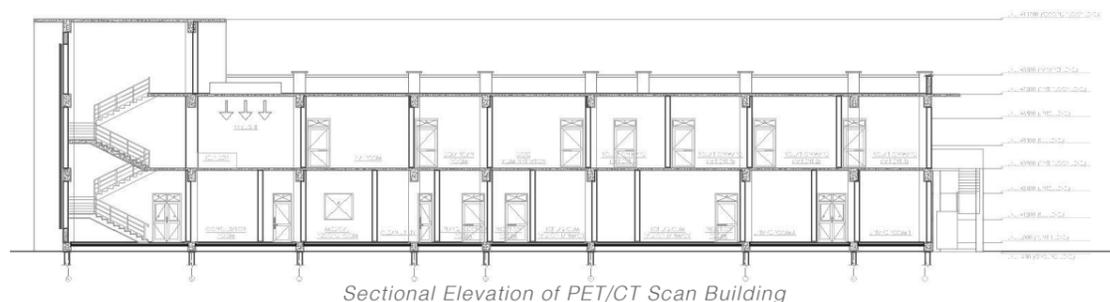


The B.P. Koirala Cancer Hospital plans to establish a PET/CT Scan Center with a Hot Area and a Cold Area. The areas are allocated based on the risk and level of radiation exposure. The Reception and Waiting areas are 'cold' areas, while the Hot Laboratory and Uptake Room are 'hot' areas. Radiopharmaceuticals are supplied from a Cyclotron facility within the campus.

The Scanning Room is the core of the facility. The PET/CT and SPECT/CT Equipment and Control Rooms adjoin for easier access and maintenance. The Expertise/Reporting Room is where examinations are checked and the images are transferred after the scan is finished. Overall, the plan includes features such as accessibility compliance, separation and access control, radiation shielding, and secure storage for radioactive waste.

A staircase and bed-lift are available to access the first floor. The PET/CT Scan Center includes office, staff, and meeting rooms in the 'cold' area for clinical, scientific, and technical staff. There is a help desk, waiting area, toilet, and janitorial room in the south-east of the building. The atrium in the foyer can be used for waiting space, and there is a provision for a Beverage Bay. The RIA room with adjacent DEXA scan room is allocated for bone density measurements.

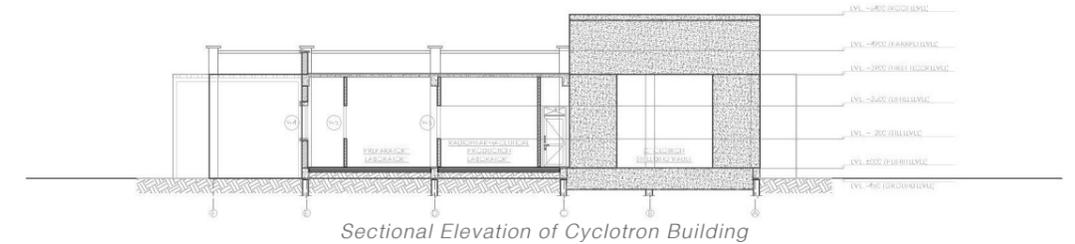
There are nurse stations and changing rooms with active toilets in the isolated wards, and the dose administration, radioactive waste storage, and contaminated linen storage are provided in the ward area. Access to patient rooms is restricted, and local regulations require the delay of radionuclide emission to the sewage system. An emergency exit is accessible from the isolation ward corridor.



Sectional Elevation of PET/CT Scan Building

## CYCLOTRON FACILITY

A cyclotron facility in a cancer hospital is a type of particle accelerator used to produce radioisotopes for various imaging and therapeutic applications.



The facility requires a nuclear medicine facility to produce radiopharmaceuticals based on short lived positron emitters. The facility has controlled and non-controlled areas, designed to ensure product and radiation protection. The controlled areas include a cyclotron, cleanrooms with hot cells for production and dispensing of radiopharmaceuticals, a laboratory for quality control, and storage space for radioactive waste. The non-controlled areas include administrative offices, storage rooms, and restrooms.

The flow of materials and people is designed to avoid potential mix-ups and achieve the desired level of protection for both people and the product. The controlled area has administrative and engineering controls, such as controlled access, interlocked doors, appropriate pressure gradients, and pass-through boxes. The radiation protection-controlled

area is only accessible through a personnel airlock and should have lockers for street garments, smocks, boots, and overshoes.

The cyclotron block of the nuclear medicine facility consists of four rooms, including a shielding vault for the cyclotron, a control room, a service room, and a power supply room. The radiopharmaceutical production block also has four rooms, including a personnel airlock, a cleanroom for FDG production, a preparatory laboratory, and a packing room. The cleanroom for FDG production would be minimum class D and located close to the cyclotron, with hot cells installed against the wall closest to the cyclotron to reduce losses of 18F. A QC laboratory for testing radiopharmaceuticals would also be included, along with a janitorial room for storing cleaning utensils.



## ACADEMIC BUILDING

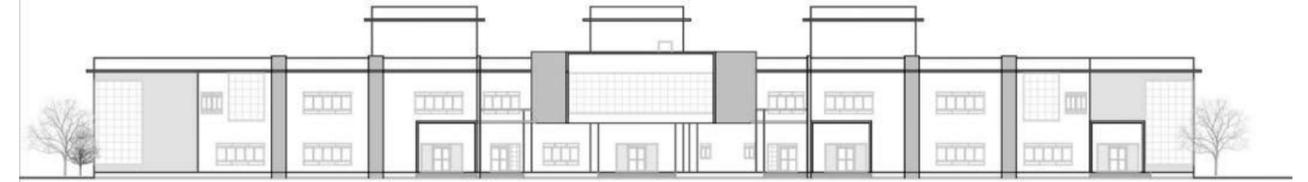
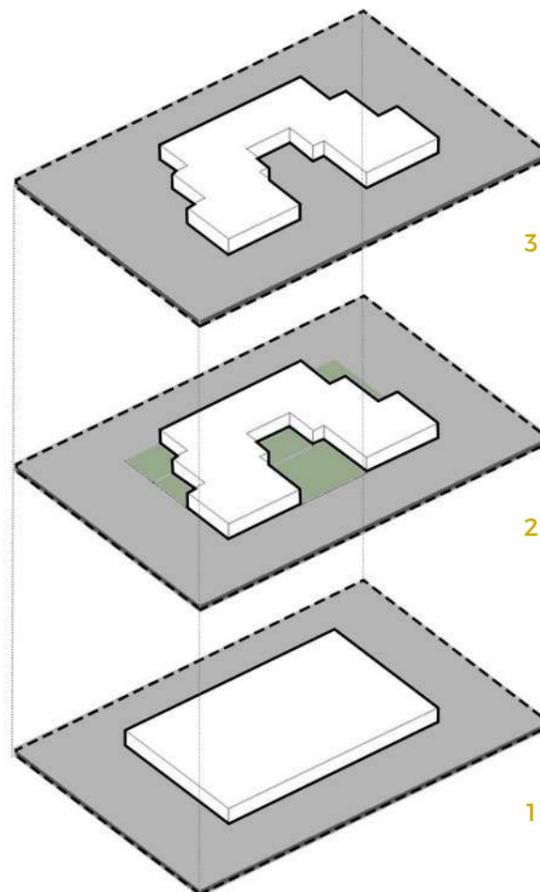
*Designing of an Academic Building to Enhance Research and Development Capacity at B.P. Koirala Cancer Memorial Hospital*



The conceptual planning is developed architecturally in such a way that it helps in the function of the academic institution and also helps in connectivity. ACADEMIC BUILDING, being a space for learning and interaction, is designed in such a way as to create pocket of spaces for private yet, public interaction with a good visibility relation created between different sectors with permeability and integrity.

The pocket of spaces at the rear of the building serves as a quiet area for private study and interaction. These spaces are intentionally located away from the hustle and bustle of the main entrance area to provide a peaceful environment for reflection and concentration. The entrance area features a large, open courtyard that serves as the focal point of the building.

The courtyard serves as a natural source of light and ventilation for the building's interior spaces. Additionally, the courtyard provides an outdoor space for students and faculty to gather, study, and socialize. This helps to foster a sense of community and collaboration within the academic institution. The building's overall design encourages connectivity and interaction while also providing opportunities for private study and personal reflection.



South Elevation of Academic Building (1:500)

The Academic Building at B.P. Koirala Memorial Cancer Hospital is designed as a specialized facility that meets the unique requirements of cancer care training and academic promotion. The building has two floors that are organized and optimized for academic and administrative activities.

The Ground Floor is dedicated to the classroom area, which includes a lecture hall, a laboratory, a multipurpose hall, a reception room, and a first aid room. The library is directly accessible and has a separate entry from the garden and corridor. The Cancer Museum/Archive and Canteen are separately allocated, with the pathway leading from the classroom corridor and the entry from outside the building.

The first floor consists of Executive rooms, Administrative rooms, Faculty rooms, Tutorial rooms, Lecture rooms, exam section, account section, meeting rooms, and a server room, including several additional facilities. A landscaped area breaks the monotony of the indoor workplace environment.

The building meets essential safety regulations, with two fire exits, a waiting area for emergencies. Overall, the design of the Academic Building promotes interactive learning and cooperative work environments that enable the hospital to sustain human resources and promote academic growth in cancer care.



Sectional Elevation of Academic Building (1:500)

# 02

## PRIMARY HOSPITAL TYPE B-1 (15-BED)

*Improving Healthcare Accessibility: Upgrading of Mauwa Health Post to Primary 15 Bed Hospital in the Contour Land of Doti*



**PROJECT:**  
Design of Primary Hospital (15-Bed) in the hilly sloped land of Doti

**LOCATION:**  
Aadarsha Rural Municipality, Mauwanagardah, Doti, Sudurpaschim Province, Nepal  
**YEAR:** 2022

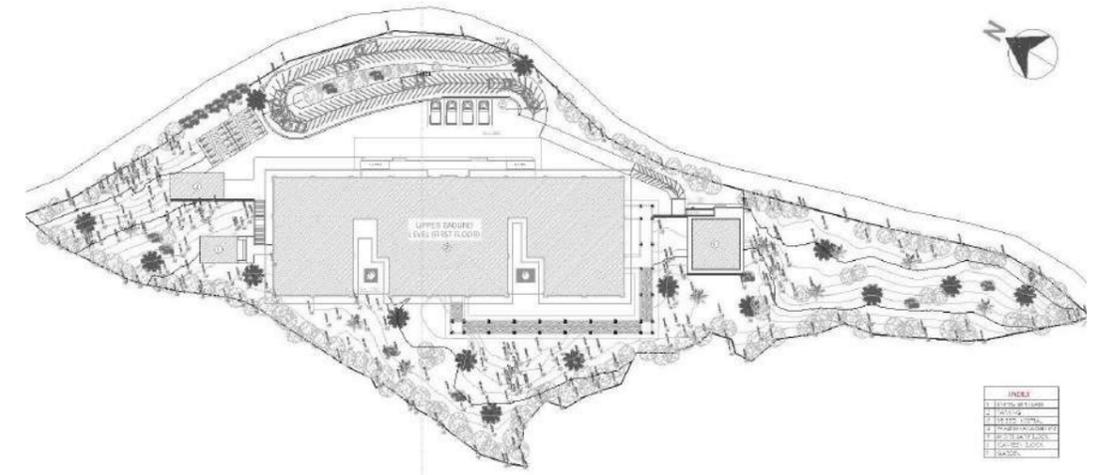
The 15-bed hospital in Doti includes a main building, parking facility, canteen block, mortuary block, waste management area, and garden area, with a slope ramping road for access and distinct areas for different medical facilities and administrative departments.

It is strategically designed to optimize its functionality and accessibility within the site's natural contours. The main entrance, located on the first floor, offers both ramp and staircase access, leading to a queueing area with registration and record rooms. The hospital's eastern wing houses essential services like nutrition, DOTS, outpatient departments, and washroom facilities, with alternative exterior access for certain clinics.

Moving inward, the central wing accommodates crucial medical services such as pathology labs, X-ray facilities, emergency ar-

eas, and operating rooms, ensuring efficient patient care pathways. Adjacent to the central wing, the western section serves administrative functions, including offices, meeting spaces, and support facilities like a library and pantry. On the ground floor, patient wards are segregated by gender, with direct access WWto washrooms and counseling areas.

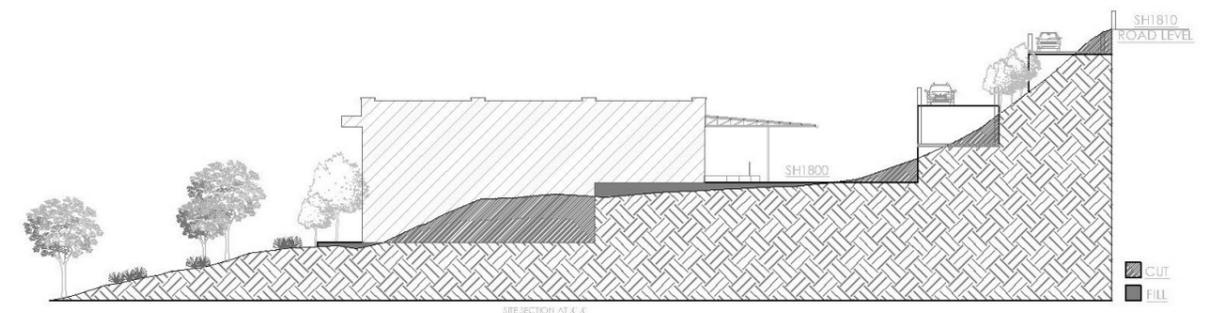
Visual access to the garden from the wards promotes patient well-being and recovery. Additionally, the ground floor hosts blood storage and administrative departments, with convenient access to the canteen. The mortuary block, situated in the east, provides necessary facilities for post-mortem examinations, ensuring the hospital's comprehensive service offerings. Overall, the hospital's thoughtful layout optimizes patient care, staff efficiency, and site utilization.



The design of the hospital incorporates the natural contours of the land by utilizing retaining walls on the ground floor. Courtyards are strategically integrated into the design to bring natural light and ventilation into the interior spaces which not only enhance the ambiance but also provide patients and staff with access to outdoor areas for relaxation and recuperation.

Skylights are strategically placed throughout the building to maximize natural light penetration into interior spaces. By harnessing daylight, skylights reduce the need for artificial lighting during the day, contributing to energy efficiency and creating a more inviting and comfortable atmosphere for patients and staff.

The incorporation of retaining walls, courtyards, and skylights in the hospital design not only addresses the challenges posed by the site's natural contours but also enhances the functionality, aesthetics, and sustainability of the facility, ultimately contributing to an improved healing environment for patients and a more comfortable working environment for staff.



# 03

## NEPAL KOREA FRIENDSHIP MUNICIPALITY HOSPITAL

*Enhancing Healthcare Infrastructure: Proposed Construction of a 150-Bed Facility with Comprehensive Services Supported by KOICA Funding*



**PROJECT:**

Capacity Building Of Medical Service To Achieve Universal Health Coverage For The Poor In Vulnerable Areas In Bhaktapur

**LOCATION:**

Madhyapur Thimi Municipality, Bhaktapur, Bagmati Province, Nepal

**YEAR:** 2023

The Nepal Korea Friendship Municipality Hospital, originally established in 1999 as the Kyung Hee Nepal Health Center, has been a pillar of healthcare in Madhyapur Thimi - 5, Bhaktapur, Nepal. With initial support from the Nepalese Government, the hospital evolved into a 50-bed general facility by 2009, thanks to the backing of the bill of right committee.

Notably, KOICA has been instrumental in providing both financial and technical assistance throughout its growth. Now, with plans for expansion, a new block boasting a 150-bed capacity, complete with multiple OPD functions, an OT with a delivery unit, and inpatient wards, is on the horizon. This expansion is crucial, considering the hospital's service to over 119,756 people in Bhaktapur and neighboring districts. Moreover, its strategic location between the Arniko Highway and Bhaktapur Road ensures accessibility for patients.

Committed to adhering to healthcare facility design guidelines, the proposed block will seamlessly integrate with the existing infrastructure, occupying a modest ground coverage of 33%, well below the 40% threshold set by the Health Institution Operation Standards.

The project aims to contribute to the improvement of healthcare services in Bhaktapur, Nepal, by building sustainable and inclusive healthcare infrastructure that prioritizes the needs of the poor and vulnerable populations, ultimately working towards achieving universal health coverage in the region. It involves overseeing the planning, design, and construction phases of a healthcare infrastructure project. The primary objective is to enhance medical services in Bhaktapur, Nepal, particularly focusing on vulnerable and underserved populations, to achieve universal health coverage.



The proposed construction incorporates various design elements to ensure functionality, sustainability, and compliance with standards. These include maximizing natural light and ventilation, ensuring standard widths for connecting spaces, and providing disabled-friendly features for accessibility.

The design also prioritizes environmental friendliness by using local materials and technologies and incorporating earthquake-proof and resilient design and technology. Additionally, provisions for emergency and fire-fighting systems, as well as fitting and fixtures adhering to government standards, are integral parts of the plan to ensure safety and efficiency in the facility's operations.

Sanitary, electrical, and plumbing systems are designed to meet high standards of functionality and safety, contributing to the overall effectiveness of the healthcare facility.



Front Elevation

# 04

## WORLD BANK NEW OFFICE

*Expanding Cancer Hospital Facilities: Incorporating a Nuclear Medicine Unit for enhanced Diagnostic and Treatment Capabilities*

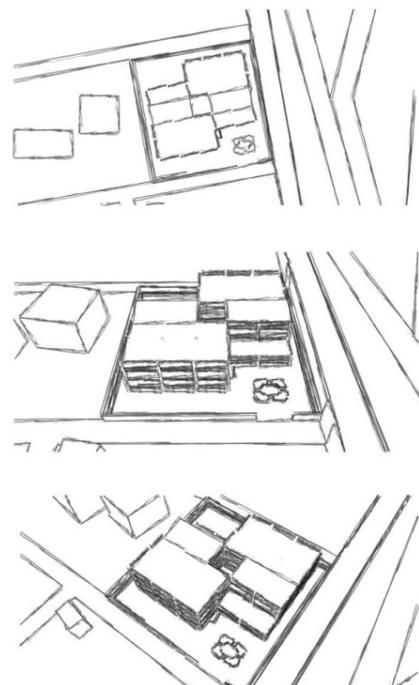


**PROJECT:**  
Conceptual Design of World Bank's new office in New Delhi

**LOCATION:**  
New Delhi, India  
**YEAR:** 2023

The proposed location for the World Bank's new office in New Delhi is situated in a dynamic and culturally rich area. To the north lies the Swami Narayan Mandir, a prominent Hindu temple known for its architectural grandeur and spiritual significance. To the south runs the bustling Yamuna Marg, a major thoroughfare bustling with activity and commerce. To the east, the office will be bordered by the historic Grand Trunk Road and to the west lies Kripa Narayan Marg, offering a tranquil residential setting amidst the vibrant urban landscape.

The key concept for the World Bank's new office in New Delhi revolves around maximizing sustainability through green building principles. The zig-zag building layout, coupled with open spaces in the NW and SE directions, harnesses natural ventilation from prevailing winds, while a central courtyard facilitates vertical ventilation, ensuring optimal daylight and airflow throughout the building.



The conceptual floor plan for the World Bank's new office in New Delhi features an open office layout on the ground floor, enhanced by two meeting rooms and utilities, with a central courtyard providing natural light and ventilation.

The upper floors follow a similar layout, with office areas, meeting rooms, and utilities, while vertical green roofs on the façade create additional green space and contribute to sustainability. The staircase placement, aligned from east to west in the south side, reflects adherence to Vaastu principles.



# GLOBAL FARMER INSIGHTS

McKinsey has surveyed 5,500+ farmers across the globe to better understand their mindsets and behaviors towards key topics shaping the future of agriculture. Economic pressures and the push toward more-sustainable practices are driving next-generation automation technologies, benefiting farmers, regulators, and consumers alike. The agriculture industry is under pressure. Dramatic cost increases for inputs and labor are putting farmers' profitability at risk. Globally, farmers report that prices for inputs such as fertilizer and crop protection chemicals have risen by 80 to 250 percent over the past few years. Climate change is also squeezing profits. A warmer climate is resulting in increased weather variability, more frequent acute weather events, longer droughts, and new invasive crops and pests, all of which reduce yields. In the American Southwest, for example, an ongoing megadrought is so severe that the past two decades have been the region's driest in at least 1,200 years.



Geographies covered and farmers surveyed

To navigate these challenges and remain economically viable, farmers must find innovative solutions. Automation shows considerable promise for reducing the impact of farming on climate change and helping growers adapt to its financial impact. Autonomous farming solutions exist on a spectrum, requiring varied levels of operator support. This ranges from semi-automated technology widely adopted today (e.g., assisted steering) to fully automated systems (e.g., weeding robots). Next-generation technologies use a combination of sensors, analytics, robotics, and equipment to help farmers make smarter decisions on the field and do more with less.

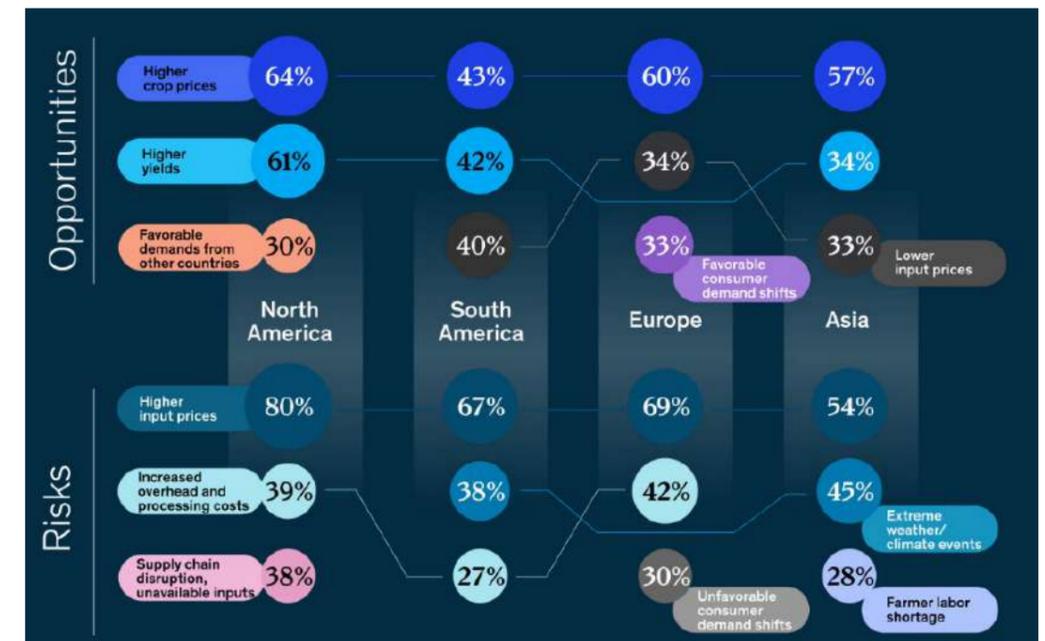
In addition, recent developments in generative AI present future opportunities to automate decision making using vast data sets that already exist. Potential examples include helping farmers develop strategic plans about what inputs (fertilizer, crop protection, and seeds) to apply, at what times and what rates, to best support a farm's profitability and sustainable practices. Automated technology can deliver significant value to both row- and specialty-crop growers. For instance, fully autonomous use cases across orchards and vineyards can deliver more than \$400 per acre per year in value, doubling to quadrupling returns on farmers' investment in automation.

## THEMES SHAPING FARMING GLOBALLY

It reveals that less than 5 percent of farmers across Asia, Europe, North America, and South America are using this next-generation technology, compared with 21 percent using farm management software.

### 1. WILLINGNESS TO INNOVATE DESPITE MACRO UNCERTAINTY

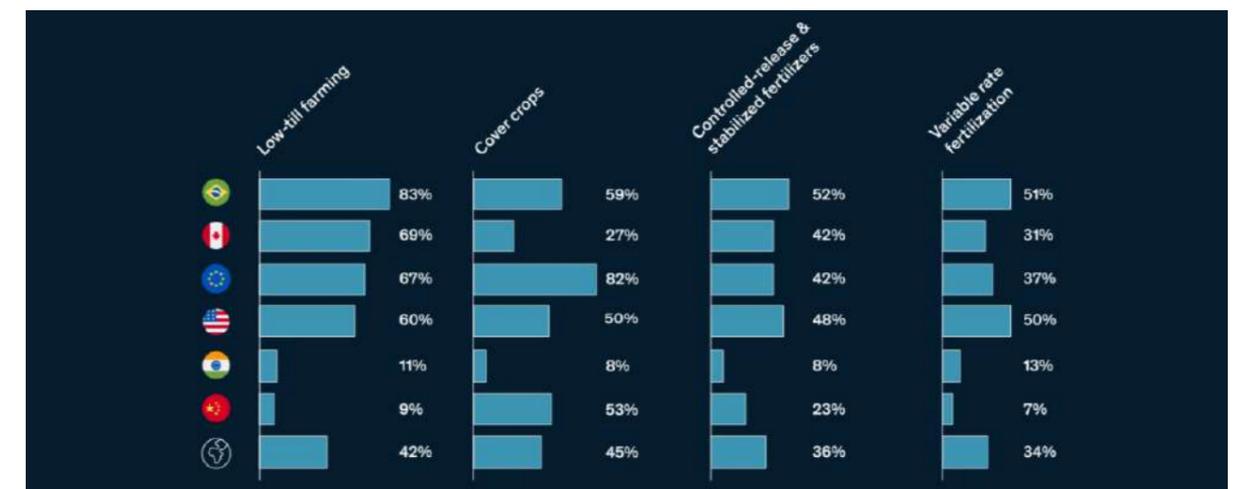
70% of farmers expect profits to remain stable or increase. Many intend to try new products to capture the current high crop price opportunity.



Top 3 risks and opportunities to profits over the next 2 years (Source: McKinsey's Global Farmer Insights, May/2022)

### 2. WHITE SPACE IN THE ADOPTION OF HOLISTIC SUSTAINABILITY PRACTICES

Global adoption of sustainable practices is still <50%. Brazil is ahead, followed by Europe; only 5% of farmers participate in carbon programs with Canada having the highest participation.



Sustainability practices adoption and willingness to adopt

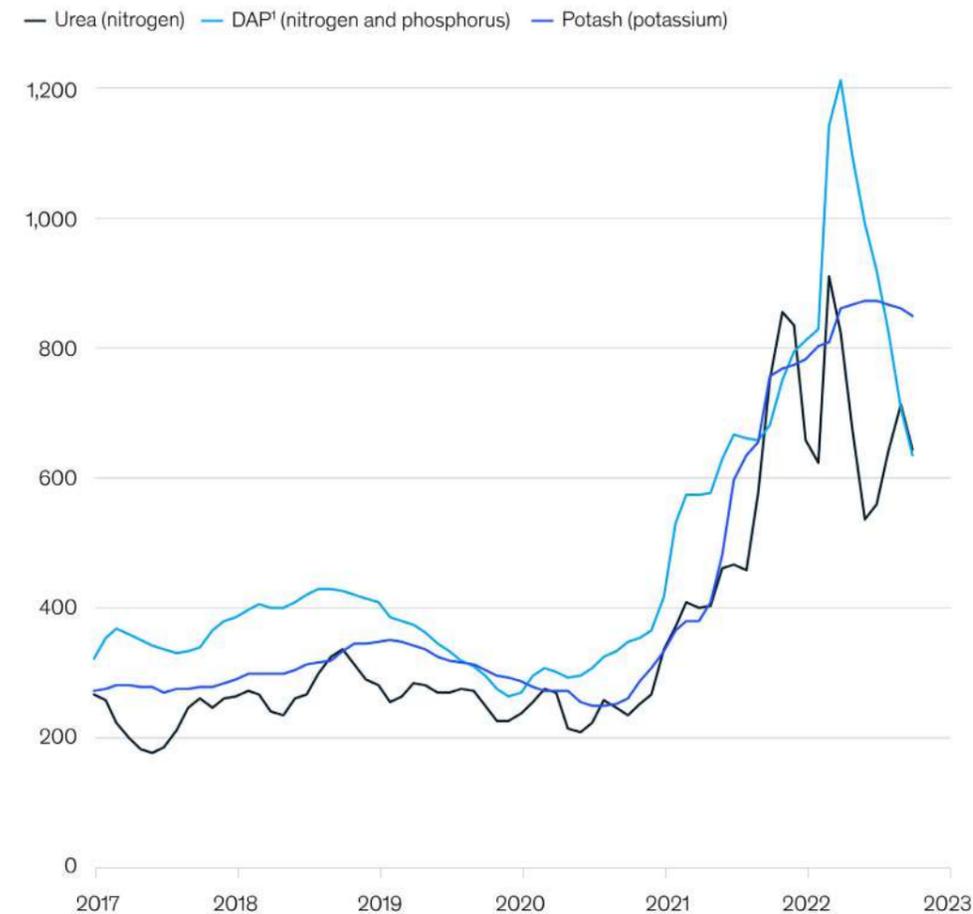
## FARM ECONOMICS

Farm automation can help address two problems that have plagued farmers for several years: rising chemical costs and labor challenges.

### INPUT COSTS

Supply chain disruptions and geopolitical challenges have pushed up the prices of widely used fertilizers (for example, urea, diammonium phosphate, and potash) by more than 15 percent per year over the past five years.

North American fertilizer prices,<sup>1</sup> \$ per metric ton



In the past five years, fertilizer prices have risen by more than 15% per year, spiking after 2021 (Source: Fertecon)

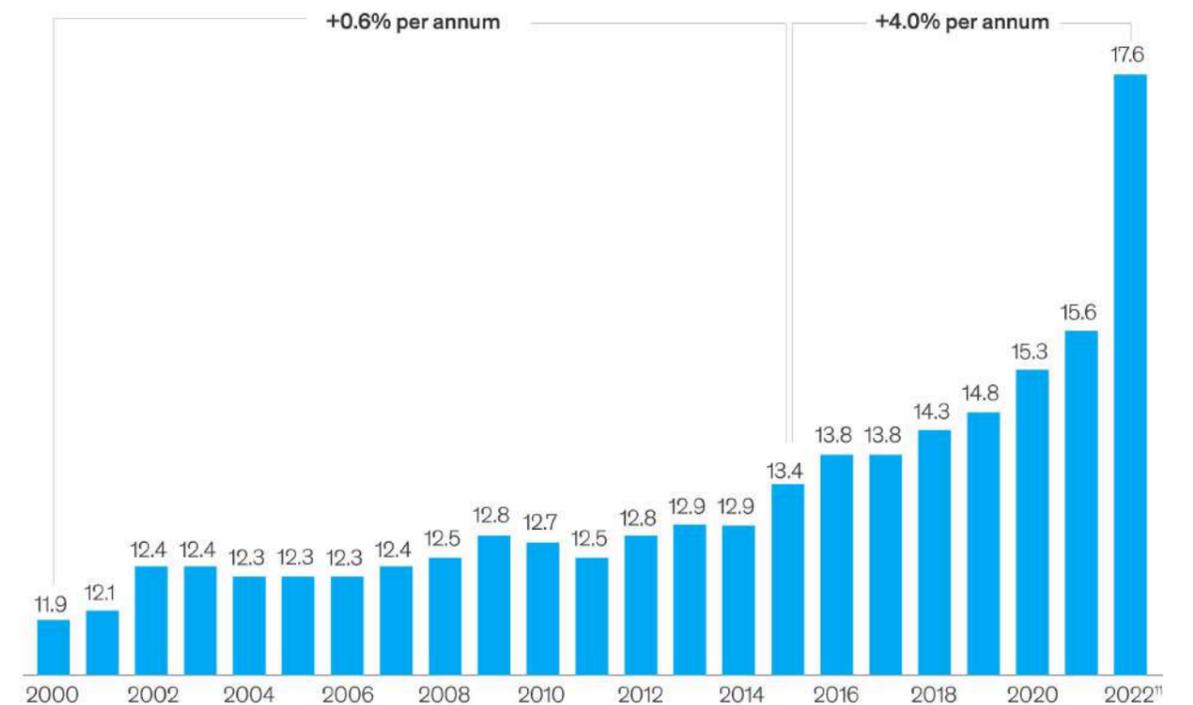
Automation can help reduce these costs by enabling farmers to use pesticides and fertilizers more efficiently. For example, automated precision spraying enabled by sensors and field data (both stored and in real time) can sense gaps between crops and adjust the volume and timing of chemical sprayed accordingly, using fewer chemicals. Some herbicide application technologies use computer vision to selectively spray weeds and avoid crops. On large US corn farms, these solutions have been shown to reduce herbicide costs by 80 percent, creating a value of \$30 per acre and a payback period of two years.

Similarly, fertilizer application robots enabled with sensors can control the amount of fertilizer that is directly applied onto individual seeds during the planting process. This can save more than 93 million gallons of starter fertilizer annually across US corn farms alone.

### LABOR CHALLENGES

Labor is also a persistent pain point for farmers. Farmworkers are at high risk of injuries and have the highest rate of fatal occupational injuries in the United States. In the United Kingdom, for instance, more than 22 million pounds of fruits and vegetables were wasted in 2022 because of a shortage of workers to pick crops. Such labor shortages and demands from workers to be compensated for adverse work conditions have accelerated an increase in farmworker wages. In the United States, wages rose 4 percent annually between 2015 and January 2022, compared with less than 1 percent annually between 2000 and 2014.

Real wages for US nonsupervisory farm workers, \$ per hour



Farm labor wages have increased at a faster rate than in previous years, increasing economic pressure on farmers. (Source: US Department of Agriculture)

Automation can help ease these challenges in several ways. It can improve working conditions on the farm, lower the operating skills required by workers, and reduce a farm's labor costs. For example, semiautomated technology such as assisted steering systems guides tractors to reduce overlap between passes, making equipment operation less physically taxing. Fully autonomous equipment takes this a step further. Instead of sitting in a cab doing hazardous activities such as spraying, machine operators can serve as fleet managers who oversee multiple machines.

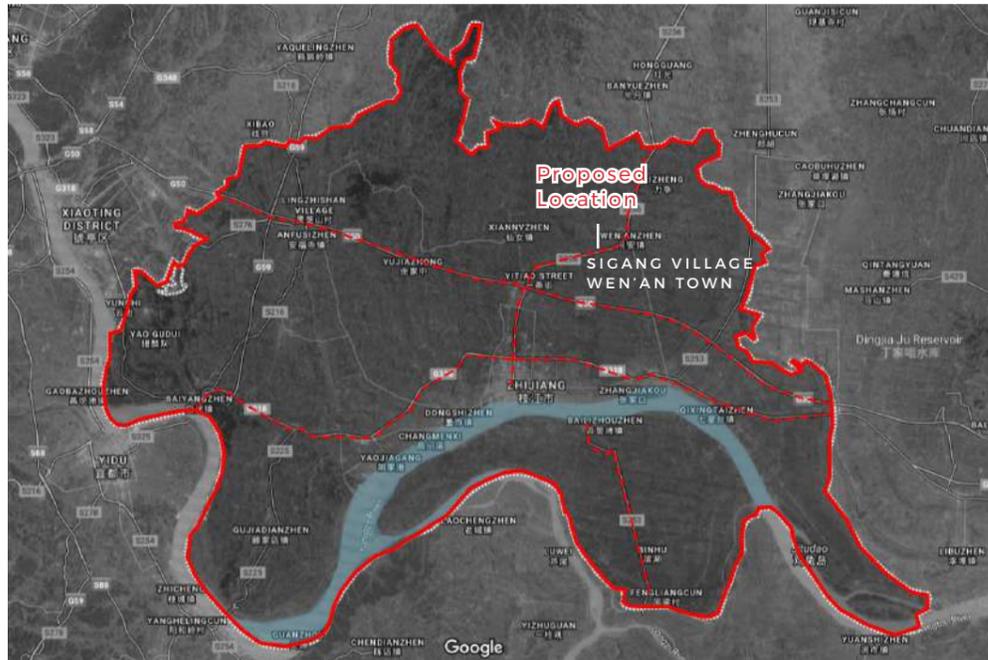
This also enhances worker productivity and reduces labor costs. In a scenario in which automation enables one worker on a US corn farm to manage four machines, the savings amounts to \$15 to \$20 per acre, which can unlock up to about \$1.5 billion in value annually across all US corn farms.<sup>11</sup> For US specialty crops, for which labor is a larger cost driver, the value potential for growers is even greater.

For example, in the same scenario in which one worker manages four machines, automated weeding and mowing alone could generate \$30 per acre in labor savings on US vineyards. Automation could also help reduce herbicide costs while maintaining yields due to the ability to complete mechanical weeding more frequently given relaxed labor requirements (savings of \$100 per acre).

# DESIGN APPROACH

## ACADEMY OF AGRICULTURAL SCIENCES

Revitalizing Agriculture: Transforming Yichang Municipality's Agriculture Sector through Innovative Modernization



Source: Google Maps

**PROJECT:**  
Zhijiang Experimental Station of Yichang Academy of Agricultural Sciences

**LOCATION:**  
Sigang Village, Wen'an Town, Zhijiang City

ARTISTA commends the Asian Development Bank loan for the Hubei Yichang Rural Green Development Project, which aims to modernize the agriculture sector in Yichang Municipality. The Academy of Agricultural Sciences sub-project is a crucial component of this project, which involves two categories of agricultural industry development construction projects and rural living environment improvement projects. We understand that the agricultural scientific and technological innovation center construction project will play a vital role in driving sustainable agricultural development in the region.

The project will involve the construction of a new agricultural digital center, an experimental research and development building, a field experimental building, an agricultural

storage center, and other supporting facilities. The establishment of an agricultural and rural big data information platform and the purchase of various equipment will enable the center to conduct advanced research and develop innovative solutions tailored to the local context. We also appreciate the agricultural infrastructure improvement project, which entails the construction of an intelligent greenhouse and the transformation of land and ponds, among other activities.

This project's implementation will create a conducive environment for efficient and productive agricultural activities, leading to improved livelihoods for rural inhabitants. The scientific research transformation capability enhancement project is an essential component that seeks to facilitate the development of many agricultural technology research projects and training for approximately 6,000 people. It aligns with the broader objectives of the Hubei Yichang Rural Green Development Project, and we are ready to provide our expertise to support its successful implementation.

## CONCEPTUAL CONSIDERATIONS

Artista proposes a holistic approach to sustainable building design, integrating climate-smart and low-maintenance solutions into every aspect of the project. Here's an outline of our conceptual solutions:

### 1. UN SUSTAINABLE DEVELOPMENT GOALS

Artista views green building as a multifaceted solution to global challenges, contributing to health and wellbeing, access to clean energy, economic growth, resilient infrastructure, sustainable communities, responsible consumption, climate action, biodiversity preservation, and global partnerships.

By integrating these concepts into our designs and practices, we aim to create buildings that not only reduce environmental impact but also empower communities and drive positive change towards a sustainable future.



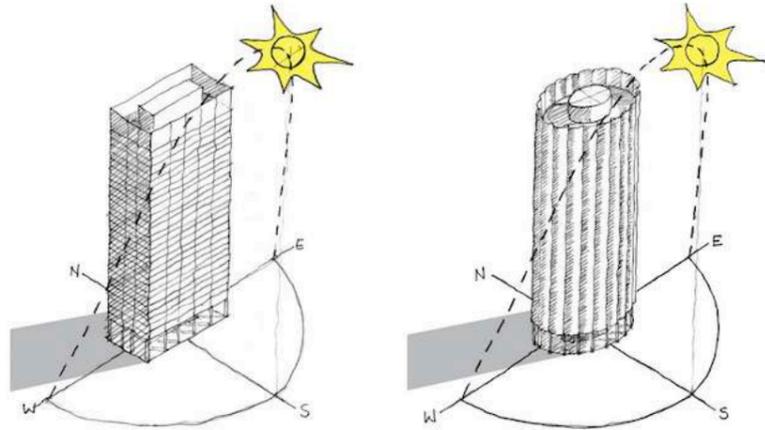
Source: World Green Building Council

In the conceptual planning for the construction of a new agricultural digital center, experimental research and development building, field experimental building, and agricultural storage center, Artista prioritizes green building principles to create sustainable and innovative facilities. Our focus on features such as energy efficiency, sustainable materials, and improved indoor environmental quality aims to enhance the productivity and wellbeing of researchers and staff working in the facilities.

We also prioritize the resilience of the facilities to withstand natural disasters and the impact of climate change. Our inclusive approach to employment opportunities promotes economic growth and supports local communities while promoting environmental stewardship. To fully support the facilities, our plan includes the construction of supporting facilities such as water supply and drainage, electrical, fire protection, heating, ventilation, and outdoor engineering, including greenhouses, animal epidemic experimental base, a new high-altitude corn ecological variety base with many scientific research transformation capability enhancement projects. Overall, our green building principles for agricultural facilities align with global goals for economic development and sustainability.

# DESIGN APPROACH

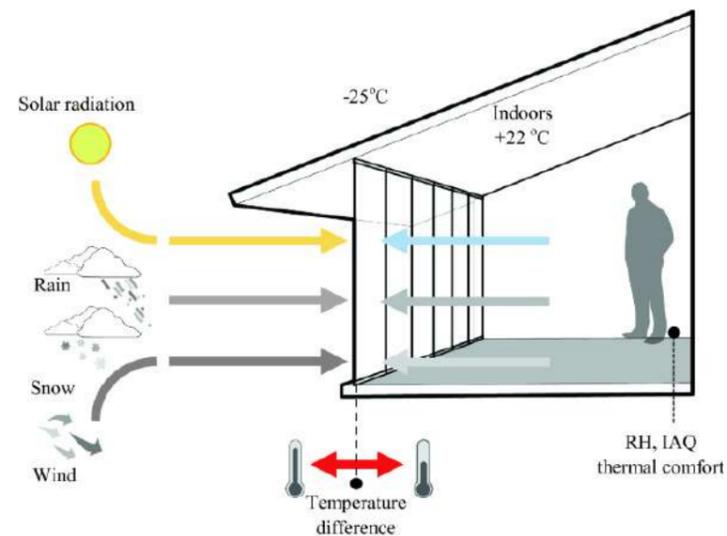
## 2. PASSIVE DESIGN STRATEGIES



Artista integrates passive design strategies to create a nurturing and energy-efficient environment. The building is carefully oriented to optimize natural daylighting, fostering a bright and uplifting atmosphere that promotes healing and well-being while reducing reliance on artificial lighting.

High-performance building envelope materials with superior thermal insulation properties can be selected to minimize heat transfer, ensuring comfortable indoor temperatures year-round and reducing the need for excessive cooling.

By prioritizing these passive design elements, our conceptual plan not only enhances the healing environment for the agricultural scientific and technological innovation center construction project but also contributes to energy efficiency and sustainability, aligning with our commitment to holistic and environmentally conscious architectural solutions.



## 3. TAILORED ENVIRONMENT FOR AGRICULTURAL INNOVATION CENTER

In the design of an agricultural innovation center, Artista focuses on a tailored environment that incorporates design thinking principles to create innovative solutions for the sector. Our approach prioritizes the needs of farmers, consumers, and the environment, and encourages collaboration and experimentation to address challenges such as food security and sustainability. Artista's design approach also considers the user experience, ensuring that farmers and researchers have access to the tools and resources they need to develop new technologies and processes that improve agriculture. Additionally, our focus on sustainable and cost-effective solutions aligns with global goals for economic and environmental sustainability. Overall, our design of an agricultural innovation center using design thinking principles offers a user-centered approach to tackling complex challenges in the agriculture sector.

In the design of an agricultural innovation center, Artista leverages SAP Design Thinking principles to create a tailored environment that fosters innovation. Our approach involves understanding the needs and pain points of farmers and other users, defining the problem, and ideating solutions that address specific challenges in the agriculture industry. By focusing on human-centered design, our approach ensures that prototypes and solutions are developed with user feedback and thoroughly tested before implementation. This approach results in innovative, sustainable solutions that meet the needs of farmers, researchers, and the environment.



Source: World Green Building Council

**EMPATHIZE:** In this phase, the design team seeks to understand the user's needs, feelings, and motivations.

**DEFINE:** In this phase, the design team synthesizes the information gathered in the empathize phase to define the problem they need to solve.

**IDEATE:** In this phase, the design team generates ideas for solutions. They use techniques like brainstorming, mind mapping, and sketching to generate a wide range of ideas.

**PROTOTYPE:** In this phase, the design team creates prototypes of the most promising solutions.

**TEST:** In this phase, the design team tests the prototypes with users to get feedback and refine the solutions further.

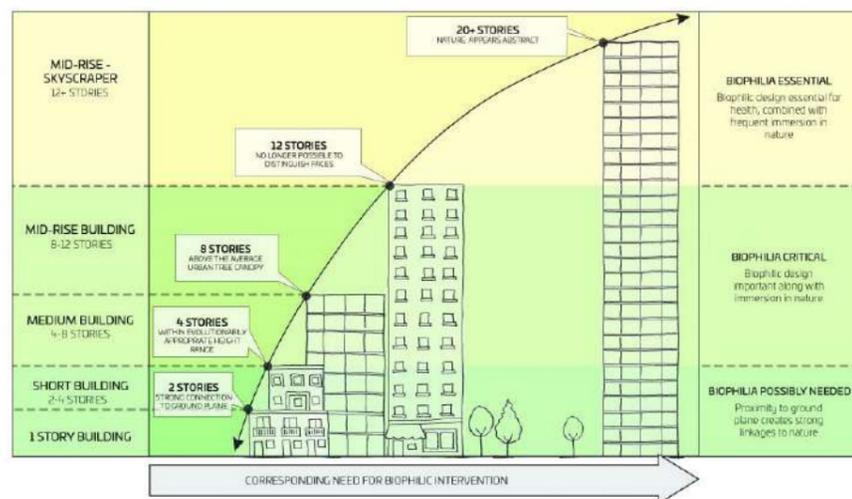
# DESIGN APPROACH

## 4. GREEN SPACES AND BIOPHILIC DESIGN



ARTISTA envisions a design that integrates sustainability and innovation in the construction of a new agricultural digital center, experimental research and development building, field experimental building, agricultural storage center, fire pump house, and supporting facilities in Wen'an Town, Zhijiang City. The design incorporates biophilic elements by using vegetation on green roofs and the surrounding landscape to promote sustainable agriculture practices while minimizing the environmental impact. The complex promotes a holistic approach by showcasing a nurturing environment with direct connections to outdoor spaces for field experiments, research development, and storage, evoking a sense of tranquility and connection to nature.

The supporting facilities such as water supply and drainage, electrical, fire protection, heating, ventilation, and outdoor engineering greenhouse aim to provide a comfortable and safe environment for researchers, staff, and the agricultural products. Overall, ARTISTA aims to design a sustainable and innovative complex that fosters growth and harmony with the surrounding environment, inspiring the next generation of agriculture advancement.

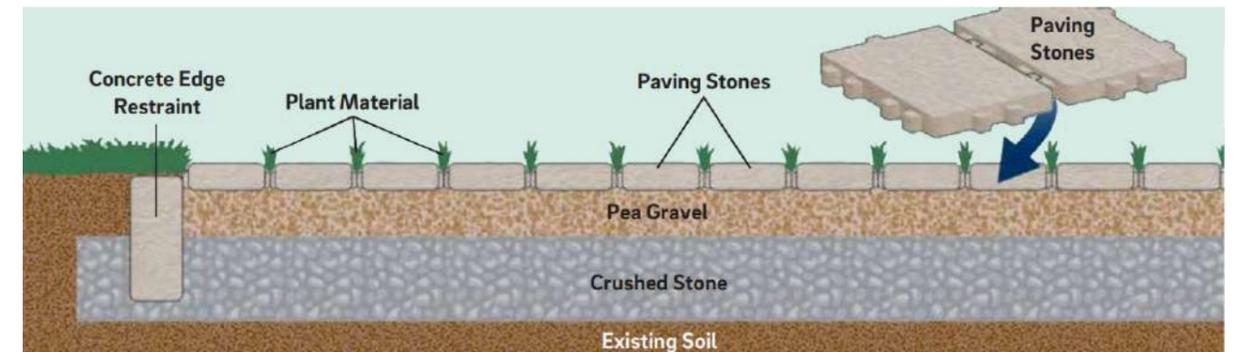


## 5. STORMWATER MANAGEMENT

We envisioned a site design that incorporates permeable paving for walkways and parking areas, green roofs on the buildings which strategically places rain gardens throughout the landscape. These features work together to absorb and filter rainwater, reducing the risk of flooding and erosion while improving water quality. ARTISTA envisions the implementation of a stormwater management system to reduce the risk of rural infrastructure to the impacts of extreme weather events and climate change.

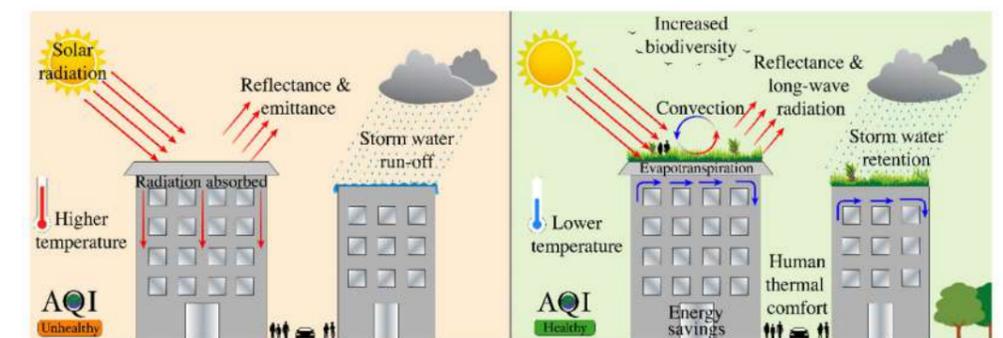
The system will include the use of nature-based solutions such as ecological wetlands that will enhance flood and water management capabilities in the catchment area. This approach will promote the restoration of riverbanks and the use of bioengineering and river regulation to manage flood risk while also mitigating the impact of climate change. Overall, ARTISTA aims to design a sustainable stormwater management system that enhances the resilience of rural infrastructure to the impacts of climate change while promoting gender equality and social inclusion.

### PERMEABLE PAVEMENT



Permeable pavement allows rainwater to infiltrate through the surface and into the ground, reducing the volume of runoff that would otherwise contribute to flooding and erosion. Permeable pavement can contribute to a safer environment by reducing the risk of surface water accumulation and potential slip hazards during heavy rainfall.

### GREEN ROOF AND RAIN GARDENS

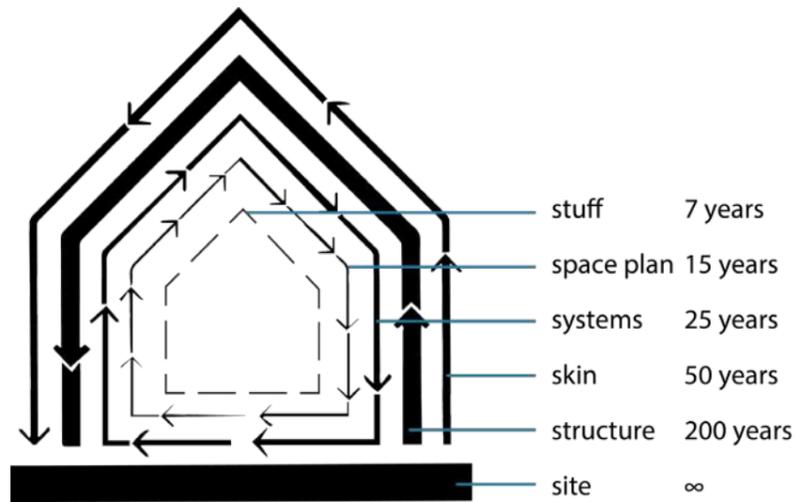


Schematic representing the diverse processes involved in conventional roofs and GRs (AQI—Air Quality Index)

Implementing green roofs and rain gardens demonstrates a commitment to environmental sustainability and responsible land use practices. These green infrastructure elements contribute to biodiversity, improve air quality, and reduce the urban heat island effect, creating a healthier and more sustainable environment for all.

# DESIGN APPROACH

## 6. ECO-FRIENDLY ADAPTATION



The importance of sustainability has become increasingly apparent in recent years, and it is no different when it comes to space designs in the building sector. With more and more businesses looking to reduce their carbon footprint, sustainable building design has become a top priority for many companies. Some eco-friendly ways to apply in our design, which transforms the workspace into a sustainable space, includes:

**Use Energy-Efficient Lighting:** One of the simplest ways to make the space more sustainable is to use energy-efficient lighting. Switching to LED bulbs can help reduce the energy consumption significantly, as they use up to 80% less energy than traditional incandescent bulbs. Additionally, installing motion sensors in areas that are not frequently used, such as storage rooms and restrooms, can help further reduce the energy consumption.

**3R (Reduce, Reuse, and Recycle) Principles:** Implementing the principles of reduce, reuse, and recycle in the spaces can have a significant impact on reducing the environmental footprint of the space. Here are some ways in which these principles can be applied:

### REDUCE

The design of the agriculture innovation center by ARTISTA prioritizes the concept of “REDUCE” by implementing sustainable measures to reduce environmental impact, minimize energy waste, and promote social and environmental sustainability.

### REUSE

The design of the agriculture innovation center by ARTISTA emphasizes the concept of “REUSE” by integrating circular economy principles through the use of recycled materials and water conservation measures to promote sustainability.

### RECYCLE

The design of the agriculture innovation center by ARTISTA integrates the concept of “RECYCLE” into the design of the agriculture innovation center by implementing sustainable waste management practices and promoting the use of recycled materials to reduce waste and environmental impact.

## 7. NET ZERO CARBON BUILDING

When we design a highly efficient building with good passive design principles, efficient systems and controls, and produce on-site renewable energy such as from PV, we are taking all the steps to achieve a Net Zero Carbon Building. A Net Zero Carbon Building is defined as a highly energy-efficient building that produces, or buys, enough renewable energy to meet the annual energy consumption of the building for its operations. Net refers to the sum total of carbon emissions over a year. If the amount of carbon the building is releasing is net zero, it does not mean it has zero emissions. Rather, it means it is balancing the total emissions from the building with renewable energy or offsets over the course of the year.

By incorporating passive design principles, efficient systems and controls, and on-site renewable energy sources such as solar panels, ARTISTA aims to achieve a Net Zero Carbon Building for this agricultural center. The emphasis will be on creating a highly energy-efficient building that produces or buys enough renewable energy to meet the annual energy consumption of the facility for its operations. ARTISTA plans to employ sustainable waste management practices, promote the use of recycled materials, and implement water conservation measures to reduce environmental impact and promote sustainability in the construction and operation of this agricultural center. Overall, ARTISTA aims to create a model for sustainable agricultural practices, that prioritizes energy efficiency, renewable energy, and environmental responsibility.



### STEPS TO ACHIEVE ZERO CARBON BUILDINGS

The best way to achieve a Net Zero Carbon Building is through step-by-step interventions. EDGE allows users to explore the best way. Examples of such interventions include:

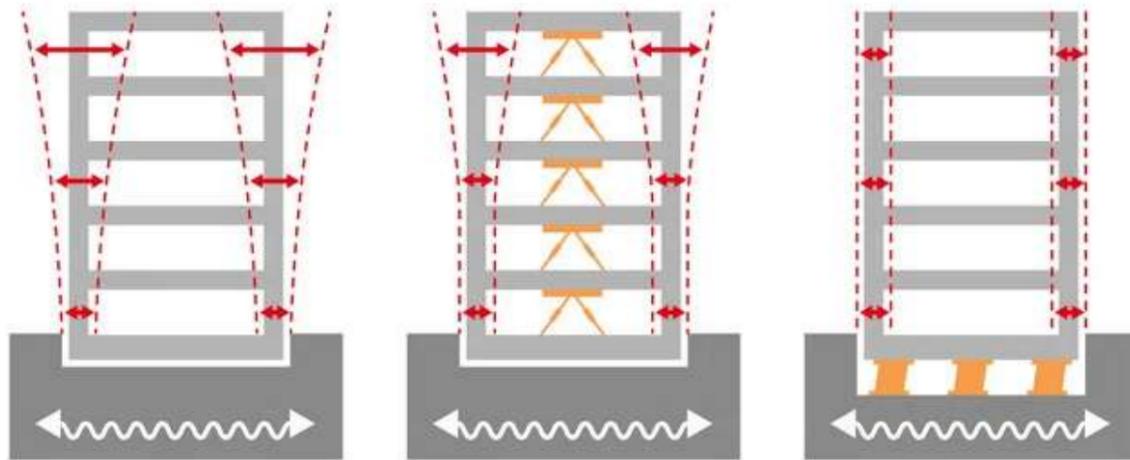
- Combine efficient design with sensors, controls and renewable energy onsite and off-site to achieve ultra-low-energy buildings
- Procure carbon credits where sufficient PV may not be feasible

Note that even if we can't produce solar energy on site, we can still achieve a Net Zero Carbon Building. This is possible through the procurement of off site renewable energy and carbon offsets. ARTISTA helps its client to get certificates of approval for Green Design from the recognized international organizations which differentiate one from the market and helps in attracting the investors which ultimately saves the operating costs throughout its life cycle.

*"In the behaviour of structures, truth can usually be found only by testing and observing genuine structural members built with the materials as they are, with imperfections which cannot be avoided."  
Fritz Leonhardt, 1976*

## STRUCTURAL CONSIDERATIONS

How do our Structural Engineers Design Earthquake Proof Buildings?



The National Earthquake Information Center reported 20,000 earthquakes across the world every year. Sixteen of these were disastrous ones that took the lives of many people and cost millions of dollars. Therefore, Structural Engineers come up with new designs to resist such catastrophic incidents from harming the building.

The advancements in technology have enabled newer methods of construction that are immune to natural forces. But, how do structural engineers design earthquake-proof buildings? Before stepping into the various steps through which a structural engineer constructs seismic-resistant buildings, we need to know about the following issues.

### HOW DOES AN EARTHQUAKE INFLUENCE STRUCTURAL INTEGRITY?

During an earthquake, the shockwaves travel in all directions in tiny, rapid bursts of energy. Generally, all buildings can handle vertical pressure. But, horizontal forces can be a problem. It sends shocks through the walls, columns, beams and connectors. Therefore, there will be a significant difference between the sideways and the top movement. This shock puts the frame under massive pressure and the structure collapses after a certain level.

### HOW EARTHQUAKE-RESISTANT BUILDINGS ARE DESIGNED?

Since, the earthquake pushes the building from one end, the idea is to oppose the forces from the other side. This effect will keep the structure stable.

Considering the following steps we can make buildings seismic-resistant.

### DESIGNING A FLEXIBLE FOUNDATION:

Most structural engineering companies will lift the building to isolate it from the ground forces. The building is constructed on top of a flexible foundation made of rubber, steel, and lead. In the event of an earthquake, the pads in the foundation absorb the seismic waves and keep the structure steady.

### OPPOSING FORCES WITH DAMPING:

Every vehicle would have a shock absorber. Likewise, engineers use it to reduce the external pressure on the building. It is done by vibrational control devices and pendulum dampers.

### VIBRATIONAL CONTROL DEVICES:

A damper is placed on every floor between a beam and column. Dampers are cylinders with silicone oil that is fitted with piston heads. During an earthquake, the energy is diverted to these dampers that push the head against the oil. This force converts into heat and thus releases the additional force.

### PENDULUM DAMPERS:

This form of damping is used by structural design companies in skyscrapers. A large ball is suspended from a building connected through a hydraulic system and steel cables. When an earthquake strikes, the ball sways in the opposite direction and creates balance for the structure.

### PROTECTION FROM VIBRATION:

Plastic and concrete rings underneath the building channel the energy and take the force away from the structure. Once the seismic waves hit the outer band, it is deflected and any remaining force is mitigated as they pass further layers of the ring. Therefore, the waves do not even touch the structure.

### REINFORCE THE STRUCTURE:

A structure must distribute the force to protect itself against earthquakes. Therefore, a structure engineer uses cross braces, diaphragms, shear walls, and moment-resisting frames to strengthen the building.

All these enhancements will improve the structural integrity of the building and ensure its safety during natural disasters.



# CASE STUDIES

## ON ACADEMIC BUILDINGS

### GEORGE D. AIKEN CENTER AT THE UNIVERSITY OF VERMONT



George D. Aiken Center at the University of Vermont (Maclay Architects)

**PROJECT:**

Design of George D. Aiken Center At The University Of Vermont that embodied the mission of the school of environment and natural resources

**LOCATION:**

Burlington, Vermont, United States

**PROJECT SIZE:** 40,000 sf (37,400 renovated, 2,600 new construction)

**BUILDING TYPES:** Institutional/ Academic

The Aiken Center on the University of Vermont campus is a model energy efficient renovation. The expressed goals were to exemplify responsible use of natural resources, develop an interactive living building, and inspire future generations of learners. The building received a full face-lift, including the addition of a south-facing double height solarium, and a transformation also took place under the surface. The building envelope was significantly improved with added insulation and moisture control.

On the surface, large windows allow daylight into the previously dark building, offering naturally lit classrooms, offices and gathering areas. Adjacent to the main south entry, water flows through the EcoMachine as it cleans 100% of the building's wastewater beside plants thriving in the daylight of the solarium. Local boulders, including ones discovered on the project construction site, anchor the building to the Earth and offer casual loca-

tions for students and faculty to pause. FSC certified wood paneling, sourced from UVM's sustainably managed research forest, ribs the interior walls. These natural elements physically link the building and its inhabitants to the School of Natural Resources' educational mission. The concept of experiential learning drove the building design and resulted in a laboratory of living systems.

Located next to a campus green and on the main pedestrian circulation spine through the UVM campus, it is a model for a sustainable future and a "green beacon" for the University, the Burlington community, and its visitors. Local boulders found on the construction site anchor the building to the Earth and offer casual locations for students and faculty to pause. The organization of the school building was envisioned as an ecosystem with informal gathering areas and visible building systems which function to support a collaborative learning environment and community.

### Overall Project Goal/ Philosophy



Building Section Breakdown (Maclay Architects)

The Aiken Center is a sustainable and environmentally conscious building that serves as the home for the Rubenstein School of the Environment and Natural Resources community at the University of Vermont. The building was designed to be durable and energy-efficient, with a living organism concept that models an ecosystem and engages building occupants in learning about sustainability.

It features local and natural materials, net-metered PV system, sustainable research forest wood, and recycled content terrazzo floors that represent earth, land, water, and air. The deep-energy retrofit resulted in a 63% reduction in energy consumption, and the building retains the history of the original structure but operates like a new building. The ventilation system provides fresh air with the lowest energy consumption, and the added windows significantly improve natural light and productivity.

### Overview of Process

**PRE-DESIGN/ PLANNING/ DESIGN ACTIVITIES**

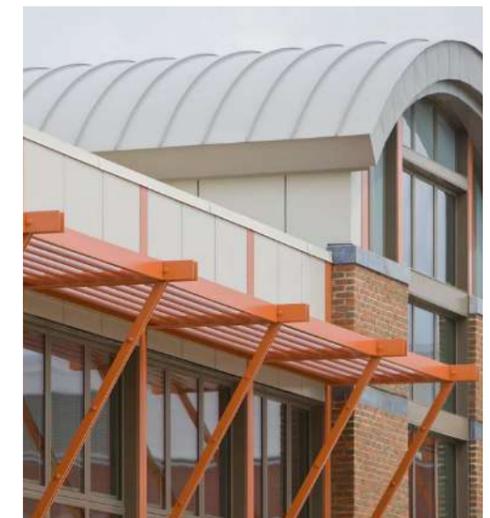
Over 400 students played a crucial role, including one who served as the lead designer of the EcoMachine, in the sustainable and collaborative design process.

**CONSTRUCTION ACTIVITIES**

It was closely monitored to ensure that it conformed to detailed specifications, and final testing showed that it met low air infiltration standards and was one of the most energy-efficient buildings of its size in Vermont.

**OPERATIONS/ POST-OCCUPANCY EVALUATION**

With over 200 embedded sensors to monitor energy and building system performance, ongoing student involvement, and the use of the building as a living laboratory for research and learning, the Aiken Center building at the University of Vermont showcases a commitment to sustainability.



George D. Aiken Center (Maclay Architects)

## PRODUCTS AND SYSTEMS

The design for the Aiken Center followed LEED (version 2.2) for New Construction and Major Renovation guidelines and received a LEED-NC&MR Platinum rating in 2013. Material selection for the building was based on life-cycle cost analysis. Much of the existing ductwork was reused for heating, cooling, and ventilation. The mechanical system utilizes outdoor air, when possible, to supplement heating and cooling from the University's central plant and reduce energy loads. More than 200 sensors and meters in the building measure everything from heat and chilled water consumption from the central heating and cooling plant, to water and electricity use. Additionally, a research green roof includes eight separate water sheds for testing micro-watershed strategies for storm water management.



Green Roof at George D. Aiken Center



The Eco-Machine (Photo Credit: Jim Westphalen)

In the paradigm of a living building, water usage and water savings are as important as energy savings, particularly given the School's natural resource and environmental focus. An EcoMachine® mimics the natural wastewater treatment of a wetland ecosystem. Greywater, an end product of this system, is reused in the building's toilets and urinals. Water savings for the Aiken Center are estimated at 75% better than a minimum code building, with 100% of wastewater treated on-site. Also, the water leaving the building and entering the town sewer system is of greywater quality, reducing the chemicals required to clean the water in the traditional water treatment process. Any wastewater from the building will have reduced phosphate levels, benefiting the Lake Champlain ecosystem.

## INDOOR ENVIRONMENT APPROACH

The living building, with its connection to natural systems, generates a healthy environment for occupants. Daylight and views are maximized, and operable windows allow natural ventilation when outdoor air conditions are appropriate. Indoor air quality is further controlled by mechanical ventilation tied to CO2 sensors, adapting to changing occupancy levels. Materials and finishes with low or no-VOC content were selected. Users are able to control their environment through shades, light reflecting blinds, and operable windows.

Through careful consideration, planning, design, and implementation, this building proves that it is possible and cost-effective to produce renovation projects that are as high performing as the best new building projects, with a lighter footprint.



Terrazzo floors which suggest earth, land, water, and air flow from the stairwell down to the solarium. (Photo Credit: Jim Westphalen)

## ENERGY USE DESCRIPTION

The Aiken project is expected to achieve a 63% reduction in energy consumption over the existing building, reducing the total building load from 89 kBtu/SF-yr to 33 kBtu/SF-yr, with the addition of air-conditioning. This reduction in energy consumption is attributable to the reconstruction of the building enclosure and a reduction in mechanical equipment size. Key components include R-5 glazing, R-32 walls, R-54 roof, and a continuous combined air, moisture, and vapor barrier.

The University installed a PV tracker near the building entrance for demonstration purposes, and 17- 4kW PV trackers offsite. In 2011 these trackers produced 102,075 kWh and in 2012 produced 110,329 kWh, which account for more than 25% of Aiken's projected energy consumption and further reduce the EUI to 24 kBtu/SF-yr.



Floor Plan (Maclay Architects)

### ANNUAL ENERGY BY END USE

- Heating: 82,919 kWh, Btu, MJ
- Cooling: 49,404 kWh
- Fans & pumps: 28,196 kWh
- Lighting: 92,680 kWh
- Domestic Hot Water: 12,511 kWh
- Plug loads & equipment: 121,442 kWh
- Other end use: 1,445 kWh DDC Controls

### ANNUAL ENERGY USE BY FUEL

- Electricity: 294,985 kWh
- Gas: 3,189 (therm) = 93,438 kWh
- Fuel Oil: 0
- Biomass: 0
- Other fuel: 0
- Total: 388,423 kWh

### ANNUAL ON-SITE RENEWABLE GENERATION

- PV: 110,329 kWh (2012 data)
- Solar thermal: 0
- Wind: 0
- Micro-hydro: 0
- Biomass electricity: 0
- Biomass thermal: 0
- Other renewable: 0
- Total: 110,329 kWh

### PEAK USE

- Peak Electricity Demand: 70.7 kW
- Peak natural gas demand: 762.3 kBtu/hr
- Peak cooling: 0.013 kW/m2
- Connected lighting load: 0.98 W/ft2

# CASE STUDIES

## ON ACADEMIC BUILDINGS

### MORRIS & GWENDOLYN CAFRITZ FOUNDATION ENVIRONMENTAL EDUCATION CENTER



Morris & Gwendolyn Cafritz Foundation Environmental Education Center

**PROJECT:**  
Design of The Morris & Gwendolyn Cafritz Foundation Environmental Education Center

**DELIVERY METHOD:**  
Design-Bid-Build

**LOCATION:**  
Accokeek, Maryland, United States

**PROJECT SIZE:** 3000 sf

**BUILDING TYPES:** Environmental Education Center

The Morris & Gwendolyn Cafritz Foundation Environmental Center (Cafritz Environmental Center), a 3,000 sf day-use education and events building, is designed to work together with other new campus structures to achieve net zero energy and water targets. The symbiotic buildings include The Cafritz Center (our sun seeking Grass Building), the Moss Lodge (a 7,000 sf dormitory building with classrooms), two sleeping cabins and a wetlands boardwalk.

Challenging site conditions encouraged the design team to look to nature for design solutions to address abundant groundwater and sub-par solar access. As a result, the Cafritz Center was conceived as an elongated blade of grass nestled on a woodland edge and the neighboring overnight lodge as dense moss under tree cover. With construction completed in October of 2015, the Cafritz Environmental Center is one of the first 15 buildings to achieve the greenest, most energy effi-

cient, high-performance building standard anywhere in the world today: the Living Building Challenge.

This beautiful and inspiring state-of-the-art education building is averting emission of 70,000 pounds of CO2 per year (100% of the building's annual energy requirements). It is producing more energy than it consumes and it is managing its own waste on site. It is closing the water cycle and educating thousands of students and visitors who visit the building. It is also demonstrating the power of owner advocacy to achieve change in the manufacturing sector. It is a prototype for the future and is one of a handful of buildings in the world to have achieved full "Living Building Challenge" certification. In keeping with the Foundation's mission, this high-performance green building works in harmony with nature, allowing it to make use of the sun and rain to achieve net zero energy, net zero water, and carbon-neutral facilities.

### Overall Project Goal/ Philosophy

SECURE/ SAFE GOAL	SUSTAINABLE GOAL	FUNCTIONAL GOAL
ACCESSIBLE GOAL	AESTHETIC GOAL	COST-EFFECTIVE GOAL
PRESERVATION GOAL		PRODUCTIVE GOAL



Site plan. Rather than working independently, the sunny "Grass" and shady "Moss" buildings were designed to work together to achieve Net-Zero Energy and Water targets

The Morris & Gwendolyn Cafritz Foundation Environmental Center is an exemplary building that has achieved full "Living Building Challenge" certification. The project goals for this high-performance green building included minimizing impact on the environmentally sensitive site, being adaptable, and incorporating green building strategies as teaching tools. The building has also achieved net zero energy, net zero water, and is carbon-neutral. The structure is safe and resilient, made with solid cast-in-place foundation walls, engineered and heavy timber framing, and SIPs roofs. The Alice Ferguson Foundation has also developed this building to meet Sustainable, Functional, Accessible, Aesthetic, Cost-Effective, and Historic Preservation Goals. The team was engaged collaboratively to produce a refined and efficient building that meets the set goals while maximizing energy conservation measures.

### Overview of Process

The Morris & Gwendolyn Cafritz Foundation Environmental Center is a highly sustainable and energy-efficient building that has received the Living Building Challenge certification, becoming the 13th Living Building in the world. The building was designed through a collaborative process with staff and stakeholders, aiming to promote occupant physical and psychological well-being while using sustainable materials that require less maintenance.

The building provides diverse exterior spaces that allow for four-season education and enjoyment of the natural setting. It is powered entirely by a rooftop solar array, geothermal wells, and solar thermal, while an interactive energy dashboard tracks real-time usage to optimize management. The Alice Ferguson Foundation, which operates the building, promotes responsible stewardship, including recycling, composting, farming, and conserving energy.



Exterior spaces designed for four-season enjoyment

## PRODUCTS AND SYSTEMS

All materials, building components, and products installed into this building were scrutinized under the LBC lens for material toxicity, embodied carbon footprint, responsible harvesting and manufacturing, regionalism, and conservation and reuse. A major emphasis was placed on natural and durable materials, from the reclaimed solid wood floors, to the heavy timber wood trusses, and the reclaimed wood columns on the breezeway. Natural stone was used in the construction of the masonry fireplace, and a substantial standing seam metal roof was chosen for aesthetics, durability, and ease with which to mount the PV panels. Particular attention was paid to selecting materials with reduced maintenance, such as the prefinished cement fiberboard siding and the use of salvaged plastic/wood decking.



Closed loop water system. Water in = water out



Lush plantings

While some of the materials may have had a premium associated with them due to their character or lack of toxic ingredients, their life-cycle cost and environmental impacts were generally lower as they will last longer, require less maintenance, and can be recycled. For example, the metal roof with superior coating was more expensive than other roof options, but the product will last much longer than most roofing materials and will require very little maintenance. To meet Net-Zero Water targets, composting toilets and low-flow plumbing fixtures were selected to reduce overall usage by 94%. This allowed for the use of a grey water drip irrigation field. Lush plantings create soft edges around the angular building and are part of an aggressive stormwater management strategy that infiltrates 100% of the 10-year storm on-site.

## INDOOR ENVIRONMENT APPROACH

On the interior, each of the 450 materials used were vetted to be free of the hundreds of chemicals of concern that are identified on the Living Building Challenge Red List. In keeping with the Owner's environmental mission and desired 'lodge' aesthetic, the wood flooring, ceiling treatment, and wainscoting were all milled from downed trees on-site, and exterior posts were salvaged from an Amish farm. All materials were very low VOC emitting or had zero VOC emittance. A construction IAQ management plan was implemented to protect workers on the site and prevent residual problems with indoor air quality. 100% outside air is provided to the interior of the building via ERV units for superior ventilation and IAQ testing was conducted twice in the first year to prove that the indoor air quality goals were being achieved.

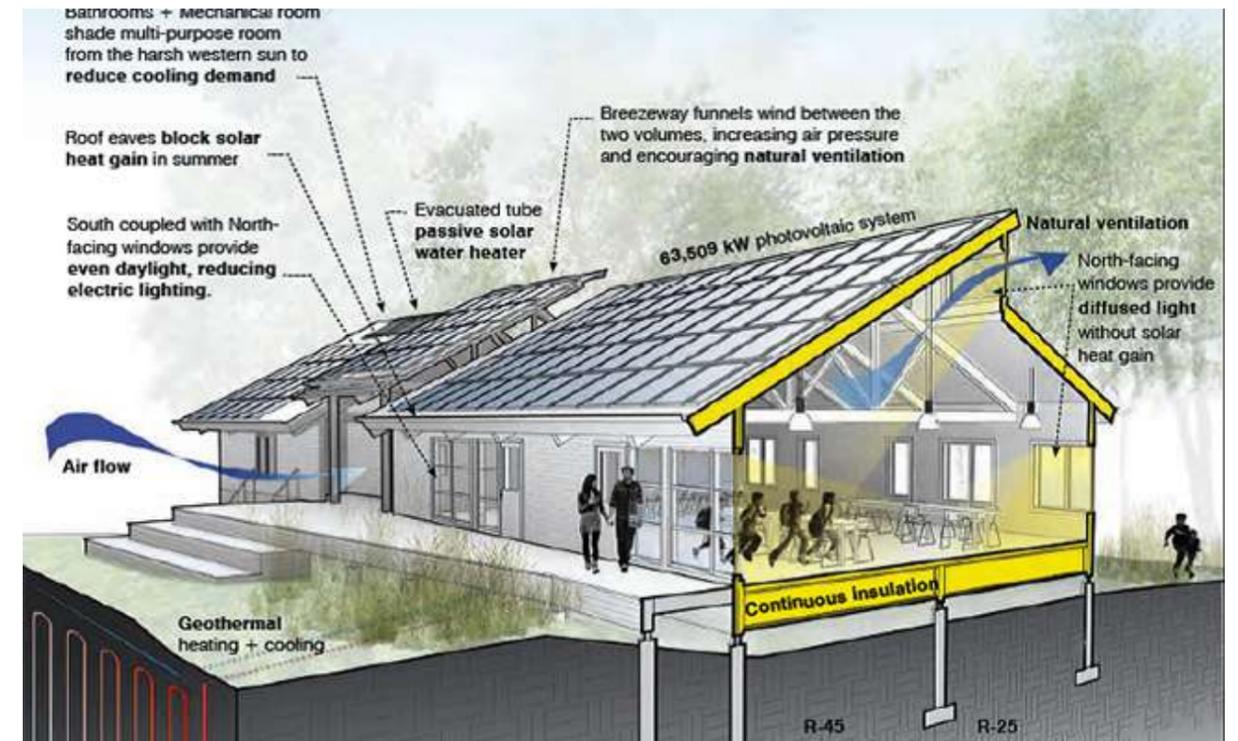


Wooden flooring of classroom with "lodge" aesthetics  
(Photo Credit: Re:Vision Architecture)

## ENERGY USE DESCRIPTION

The building is oriented to maximize solar and daylighting benefits. The building generates more energy than it uses via a rooftop 47kW solar array, solar thermal panels, and geothermal wells with very efficient heat pumps. An interactive energy dashboard tracks real-time usage to optimize management and serves as an innovative and inspirational teaching tool.

The building enclosure is well insulated and air sealed, and all lighting is low wattage LED or fluorescent. Operable windows and ceiling fans were strategically placed to rely on low energy ventilation techniques to condition air on moderate days.



Net Zero Energy, Water and Waste Diagram

### ANNUAL ENERGY BY END USE

Heating & Cooling: 16,489 kWh  
Equipment & Site Lighting: 26,917 kWh  
Lighting & Plug Load: 3,579 kWh

### ANNUAL ENERGY USE BY FUEL

Electricity: 46,986 kWh  
Total: 46,986 kWh

### DATA SOURCES AND RELIABILITY

Based on simulation? No  
Based on utility bills? Yes

The strategies that were selected for this project were evaluated through several methods and lenses, from LEED certification. After collecting and analyzing 12 months of operating data, it verified its Net Zero Energy performance and net zero water performance.

### ANNUAL ON-SITE RENEWABLE GENERATION

PV: 54,377 kWh  
Solar Thermal: not tracked

### PEAK USE

Peak Electricity Demand: Feb | 8,361 kWh  
Connected Lighting Load: The values used in the energy modeling were calculated as follows (all values in W/ft<sup>2</sup>)  
Basement = 0.58  
Common Area = 0.73  
Kitchen & corridor = 1.16  
Pantry = 1.34  
Bathrooms = 0.68  
Storage = 0.70

# CASE STUDIES

## ON NET ZERO BUILDINGS

### IRRAD Gurgaon, India

IRRAD (Integrated Renewable Energy and Rainwater Harvesting Demonstration) in Gurgaon, India, epitomizes sustainable architecture by achieving a net-zero energy footprint. Through a combination of renewable energy sources and rainwater harvesting systems, the building generates as much energy as it consumes while efficiently managing water resources. Solar panels adorn the rooftops, harnessing sunlight to power the facility, while innovative energy management systems optimize consumption.

The integration of green building technologies ensures minimal environmental impact while prioritizing occupant comfort and well-being. IRRAD serves as a pioneering example of sustainable construction in India, showcasing the feasibility and benefits of net-zero buildings in urban environments. Wood is used instead of aluminum for doors and windows. With these materials, it eliminates 30% of carbon emissions. 35KWh of electricity is generated by photovoltaic panels on the roof that supports the basic electrical load of computers, lighting, fans and mechanical ventilation.



The design of the building incorporates various energy-saving and sustainable features, including reduced window-to-wall ratio, solar shading, and narrow plan depth coupled with internal courtyards for daylight and ventilation.

Additionally, energy-saving heating and cooling systems are implemented, such as insulation of walls, integration of ducts with beams and columns for thermal mass cooling, and supply of air-conditioned air near the floor to reduce cooling requirements.

Water-saving measures include the use of water-efficient fittings, collection of rainwater for cooling systems, and provision for recycled water for irrigation and flushing toilets, ensuring efficient water management and sustainability.

### Ecoloft Jababeka Cikarang Apartments, Indonesia

Ecoloft Jababeka Cikarang Apartments, located in Indonesia, stands as a remarkable example of sustainable urban living with its net-zero energy status. Through meticulous design and advanced technology, the complex generates as much energy as it consumes, minimizing its environmental impact.

The integration of renewable energy sources like solar panels and energy-efficient systems ensures efficient energy utilization. Additionally, innovative features such as natural ventilation, daylight optimization, and water conservation measures further enhance its sustainability credentials. Ecoloft Jababeka sets a new standard for eco-friendly residential developments, demonstrating the possibility of sustainable living without compromising comfort or convenience.

The building's design integrates numerous energy-saving features to minimize its environmental footprint and reduce operational costs.



The features include a reduced window-to-wall ratio, external shading devices, and effective insulation of both the roof and walls to optimize thermal performance. An air conditioning system boasting a high COP (Coefficient of Performance) enhances energy efficiency, complemented by an energy-saving lighting system to further reduce electricity consumption. Renewable energy sources such as solar hot water collectors and photovoltaic panels contribute to sustainable energy generation.

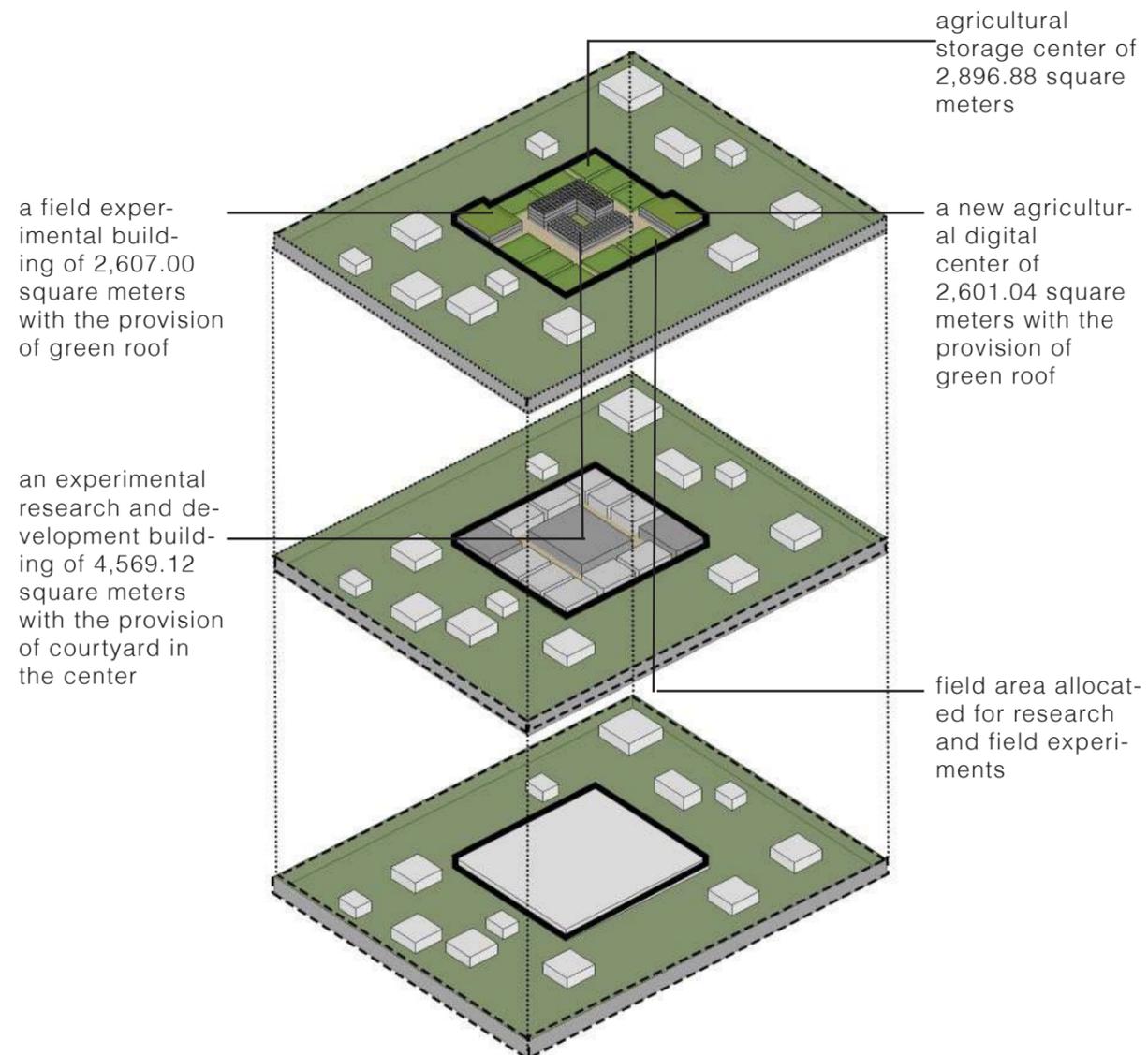
Water-saving measures, such as low-flow faucets and dual-flush water closets, are implemented to conserve water resources and promote responsible usage. Additionally, the use of sustainable materials like cellular lightweight concrete blocks for walls, UPVC window frames, and parquet finishes not only enhances durability but also aligns with eco-friendly construction practices, ensuring a holistic approach to sustainability in the building's design and operation.

# SITE SPECIFIC APPROACH

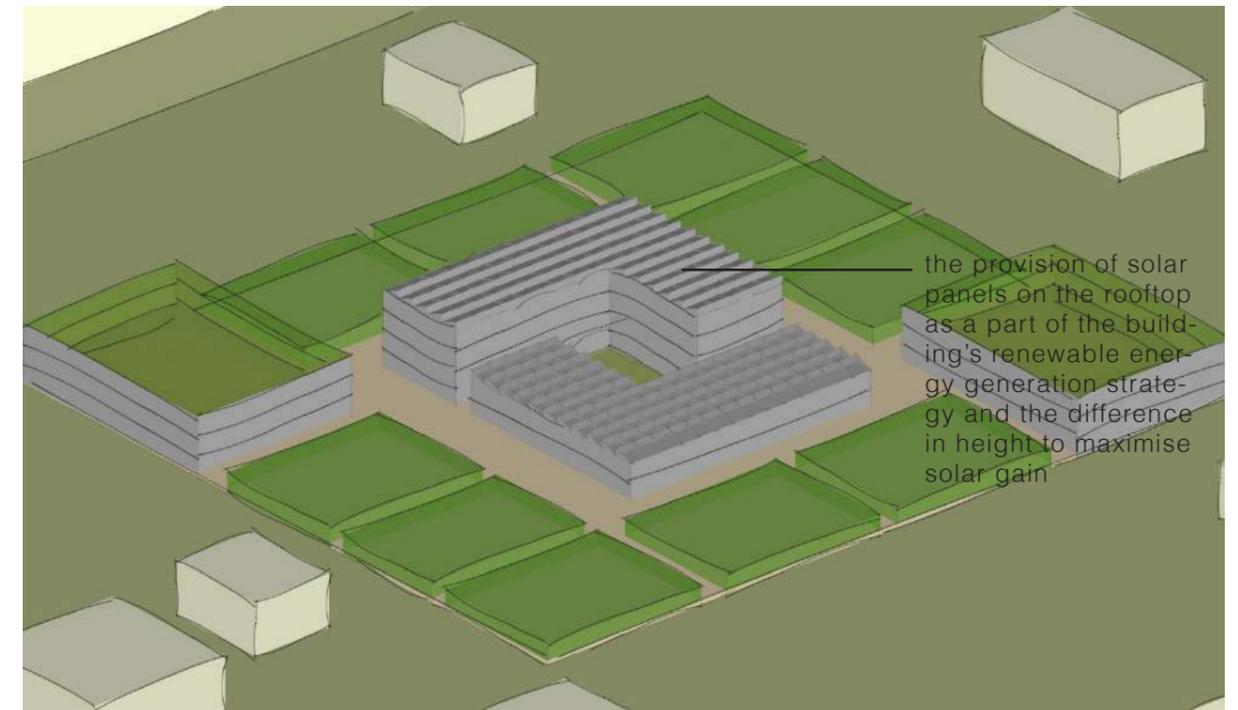
## CONCEPTUAL DEVELOPMENT

The conceptual development of a new agricultural digital center, an experimental research and development building, a field experimental building, and an agricultural storage center, and fire pump house will focus on creating a sustainable, energy-efficient, and innovative design that meets the needs of modern agriculture. The agricultural digital center and the field experimental building will be designed with a biophilic approach, which emulates nature and creates a connection between the built environment and the natural world.

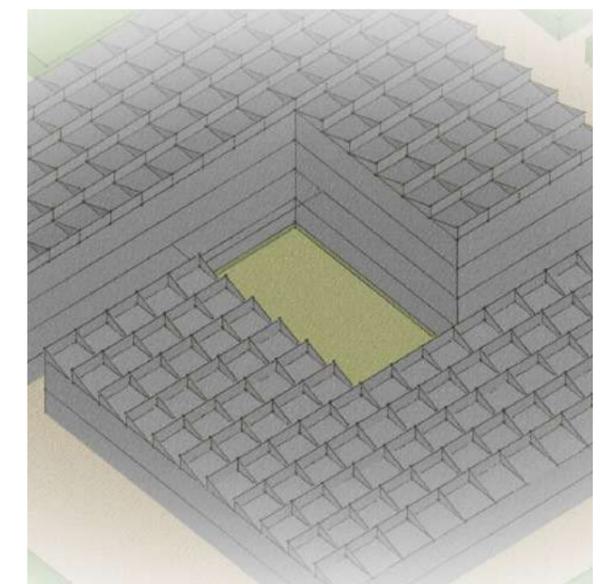
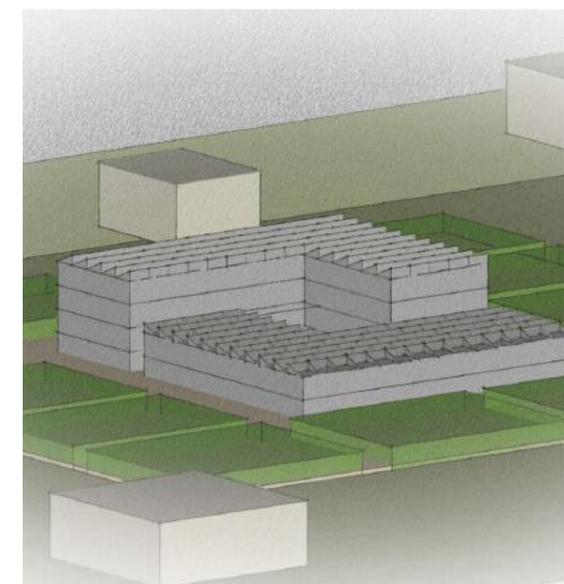
Both buildings will feature green roofs and will be surrounded by fields for experiments to create a sustainable and productive ecosystem. The agricultural storage center will feature smart storage systems with integrated sensors and low-energy consumption refrigeration units to maintain optimal conditions for stored produce.



## SUSTAINABLE APPROACHES



The experimental research and development building will be designed with a courtyard to create a social hub and promote interaction between researchers and visitors. The building will feature a difference in height to maximize solar gain and reduce energy consumption through passive means. Additionally, the building will feature renewable energy systems such as a rooftop solar array, which could help to achieve net-zero carbon emissions. All buildings will feature sustainable and energy-efficient HVAC systems, including natural ventilation and radiant heating and cooling systems, to reduce energy consumption and lower operating costs. Additionally, energy-efficient lighting and water-saving fixtures will be included in the design to further reduce energy consumption and promote sustainable practices. The conceptual development of these buildings will prioritize sustainability and innovation to create a world-class agricultural research and development center that is in harmony with nature and promotes sustainable agricultural practices.



## INTELLIGENT GREENHOUSE

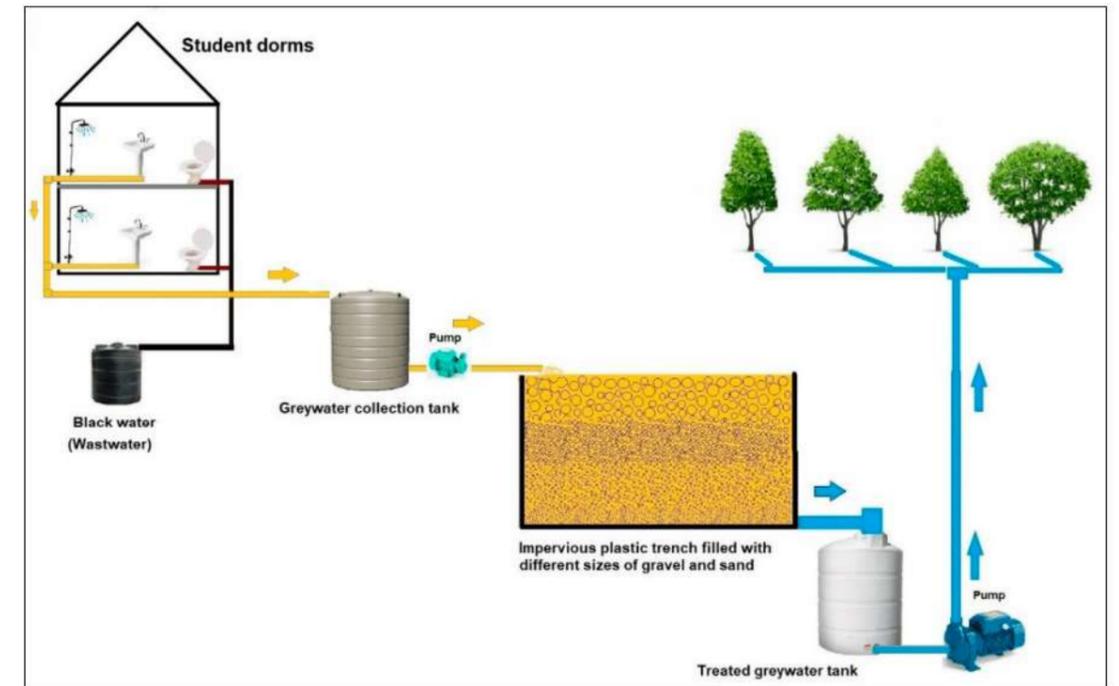
ARTISTA proposes to establish a cutting-edge CEA greenhouse using combined infrared solar energy capture and desiccant cooling technologies. The greenhouse will provide a stable contained environment for horticulture and maximize biomass productivity. The infrared harvesting transparent solar panels will allow photosynthetic active radiation to penetrate transparent glass surfaces for photosynthesis while reducing the heating effect, ensuring optimal growth conditions for plants. Passive cooling will be achieved by passing hot external humid air through highly saline liquid desiccant solutions in porous matrices which adsorb air moisture, releasing dry, cooler air due to the vapor pressure difference.

Additionally, the greenhouse will employ high density hydroponic cultivation concepts and combined algae photobioreactors for intensified biomass production. Macroalgae farming will also be incorporated into the design, utilizing managed pools on land or in the surrounding sea for nutrient removal and increased biomass production. ARTISTA will cultivate plants that are naturally tolerant or those that can be bred/ engineered for salinity tolerance, using locally available sea water resources to minimize fresh-water requirements. Sustainable energy generation by traditional photovoltaics and wind turbines will be combined to support the energy requirements of the greenhouse, creating a model for sustainable and energy-efficient agriculture in China village.



A low-energy glasshouse concept for future agriculture in coastal MENA regions.

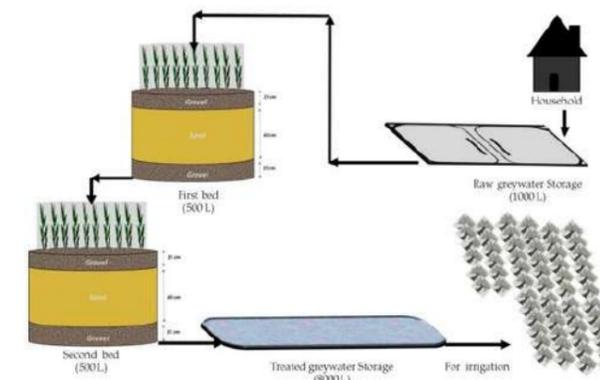
## USE OF GREY WATER TO IRRIGATE CROPS



Schematic diagram for the greywater treatment unit

In the conceptual design of the Agriculture Innovation Center, a Net-Zero Water approach will be adopted to reduce overall water usage by 94%. Composting toilets and low-flow plumbing fixtures will be selected to achieve this target. This will allow for the use of a grey water drip irrigation field to irrigate crops. The grey water will be treated and reused on-site for non-potable uses, reducing the demand for fresh water and conserving precious resources. In addition, a stormwater management system will be incorporated into the design of the center.

All stormwater will be filtered through a series of planted bioretention fields and rain gardens with native plantings. Lush plantings will create a soft edge around the building and will be part of an aggressive stormwater management strategy that infiltrates 100% of the 10-year storm on-site. This approach will help to minimize runoff and prevent erosion, while also providing a natural habitat for local wildlife. Overall, the Agriculture Innovation Center will be designed with a sustainable and holistic approach to water management that prioritizes the conservation and reuse of water resources.



Scheme of greywater treatment unit

# SELECTION OF MATERIALS

## SELECTION OF MATERIALS

A key objective is to promote sustainable practices such as reducing material toxicity, minimizing operating energy and on-site renewable energy production. Choosing building materials for a new facility is a crucial decision that affects the performance, sustainability, and maintenance of the facility. We can suggest building materials that are sustainable and environmentally-friendly such as energy-efficient, water-efficient, renewable, recyclable, or biodegradable as well as, cost-effective. The selection of such materials can help minimize the agricultural innovation centers' and supporting units' environmental impact, reduce greenhouse gas emissions, waste generation, and resource consumption while enhancing indoor air quality and occupant health. The approach towards implementing these measures will help contribute to the facility's overall environmental sustainability in the long run.

The biggest hurdle may come from the elimination of harmful chemicals on the ILFI's "Red List". As this may be quite a challenging task, one suggestion to aid this effort is to explore alternative materials that are cost-effective and can provide similar performance capabilities while adhering to eco-friendly standards. Additionally, ensuring that all products and materials used in the center and supporting units remain compliant with regulation and standards such as LEED certification may aid in the selection process. The collaboration with project stakeholders and suppliers will also be critical in evaluating the most environmentally-friendly solutions. Effective communication and forward planning will be essential to ensuring that all aspects align with environmental sustainability standards and principles, making the agricultural innovation center a model of eco-friendly infrastructure for the community.

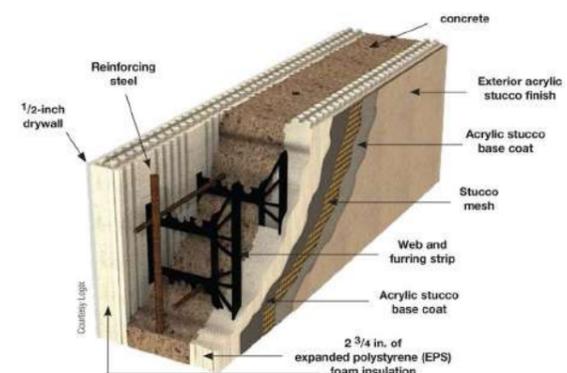
Some of the suggestions for the selected materials include:

### 1. INSULATED CONCRETE FORMS (ICFs)

ARTISTA suggests considering the use of insulated concrete forms (ICFs) in the design of agricultural innovation centers and their supporting units. ICFs comprise a combination of expanded polystyrene and concrete, which results in a highly durable and well-insulated building envelope.

Implementing ICFs can contribute to promoting energy efficiency, reducing heating and cooling costs, and eliminate the need for additional insulation layers. The benefits of using ICFs include the reduction of air infiltration, providing improved indoor comfort throughout the year.

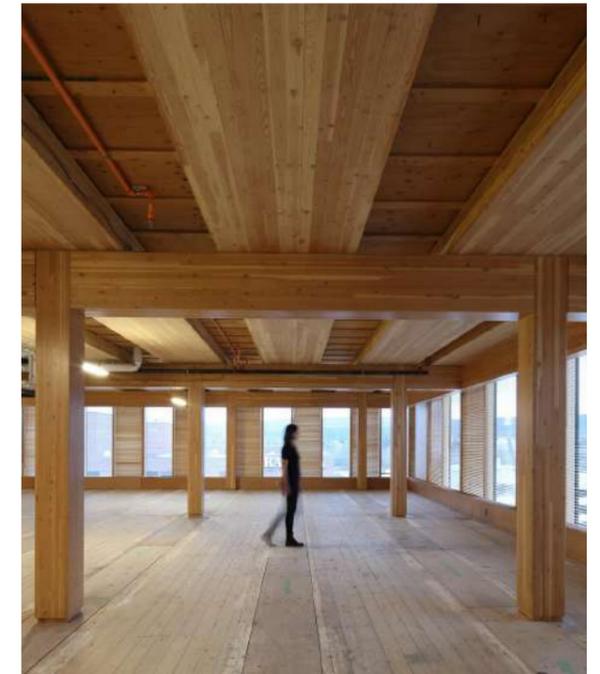
The durability of ICFs is an attractive feature as they are less susceptible to damage from inclement weather, fire, and insects, which makes them a renowned alternative to conventional building materials. Utilizing ICFs can provide a sustainable infrastructure for agricultural innovation centers while reducing the carbon footprint and promoting eco-friendly construction techniques.



### 2. RECLAIMED WOOD

ARTISTA recommends considering the use of reclaimed wood products in the design of agricultural innovation center structures and their supporting units. Utilizing reclaimed wood products reduces the need for new timber harvesting, which promotes environmental protection, decreases logging impacts, and preserves precious resources. Apart from being environmentally friendly, reclaimed wood offers unmatched aesthetic beauty and unique textures.

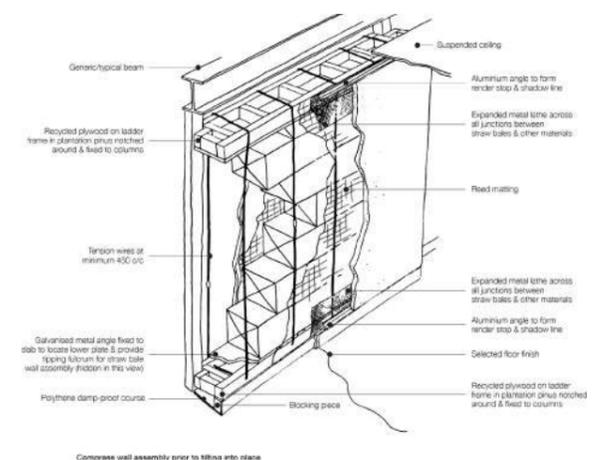
In addition to the unique beauty of reclaimed wood, using this material significantly reduces the carbon footprint of the structure. Choosing reclaimed wood for construction demonstrates a shared commitment to sustainability and eco-friendliness. With reclaimed wood materials, agricultural innovation center structures and supporting units can promote responsible and environmentally conscious construction practices.



### 3. STRAW BALE

Artista is considering using straw bale for the design of their agricultural innovation center and supporting units. Straw bale buildings are an eco-friendly alternative to traditional materials and are highly energy-efficient. The high R-value of straw bale walls means the material can better maintain a conducive indoor environment in the hottest summers and the coldest winters, saving money on heating and cooling bills. Straw bale walls have excellent acoustic insulation properties, making them effective at blocking sound and reducing noise levels in the building. Straw is a renewable resource that is readily available in the agricultural land of China.

The cost of building a straw bale building is much lower than traditional building methods. Contrary to popular belief, straw bale buildings have a longer lifespan, with the potential to last over 100 years. The design of straw bales used for construction makes them fire-resistant, with a fire-resistance rating of 120 to 135 minutes. Straw bale buildings are a sustainable choice that supports environmental conservation. Using straw bales in construction reduces carbon dioxide emissions compared to conventional building methods. Straw bale buildings are just as safe and durable as traditional wooden houses.



# ESTIMATION

## COST ESTIMATING

Throughout a project's planning, design, construction, and operations and maintenance phases, Cost Estimating is employed as one of the main tools of successful Cost Management. Once an initial budget has been established, it is important to test its assumptions by employing a series of increasingly precise cost estimating techniques that coincide with further development of design and construction details. A sound understanding of the most common types of estimates, tools for estimating, historical database sources, and formats of estimates forms the basis of the more sophisticated methods of estimating. Estimating is typically concerned with the initial costs—or first costs—of accomplishing new construction or renovation projects, although it also plays a large part in life-cycle costing of design alternatives.



## ESTIMATING FORMATS

Work Breakdown Structure (WBS) is an important component of cost estimation for any project, providing a framework for the distribution of costs. The two most commonly used WBS formats are MasterFormat and Unifomat, each providing a hierarchical breakdown of costs. MasterFormat currently provides WBS into 16 trade/materials-based divisional categories, while Unifomat represents costs according to a hierarchy of system elements. MasterFormat is generally used during the construction design phase, while Unifomat is used in the planning and early design stages. Successful cost estimation requires accurate data and effective WBS categories that allow for cost management and comparison to previous estimates.

### PRELIMINARY ESTIMATES

In the planning stage of a project, owners and designers must agree on anticipated costs. Preliminary estimates match programmatic requirements and budget constraints to establish project scope and quality expectations. The recommended WBS format is systems-based, categorizing building elements. Estimate comparisons evaluate feasibility of alternatives such as new construction or renovation. A design contingency of 10-15% is included as design is not fully developed yet. Risk analysis should be carried out at every stage, particularly in planning stage, to mitigate risks.

### INTERMEDIATE ESTIMATES

Intermediate Estimates are utilized in various stages of project design to maintain accountability for initial budget projections and evaluate competing construction assemblies, systems, and materials. A construction manager or estimator may be employed to continually update project estimates and provide feedback on budget impact. Risk assessment and contingency factors should be updated, with design contingency typically being reduced as risks are mitigated. Earned Value Analysis is commonly used to track costs and determine if the project is on track according to schedule and budget.

### FINAL ESTIMATES

A detailed pre-bid estimate is prepared as the design is completed, with the design contingency typically reduced to zero. However, a small bidding contingency may still be included if there is still risk surrounding the project. The estimate is organized in the same WBS as required of bidders, often CSI MasterFormat. This allows for a comparison of the final estimate with bids received and assists in negotiating with the lowest bidder. Cost databases can also be developed by re-sorting CSI bid data into a Unifomat WBS.

## ESTIMATING METHODS

There are four primary methods used to estimate construction costs. Those methods are known as Project Comparison Estimating or Parametric Cost Estimating, Area & Volume Estimating, Assembly & System Estimating, and Unit Price & Schedule Estimating. Each method of estimating offers a level of confidence that is directly related to the amount of time required to prepare the estimate (Fig. A).

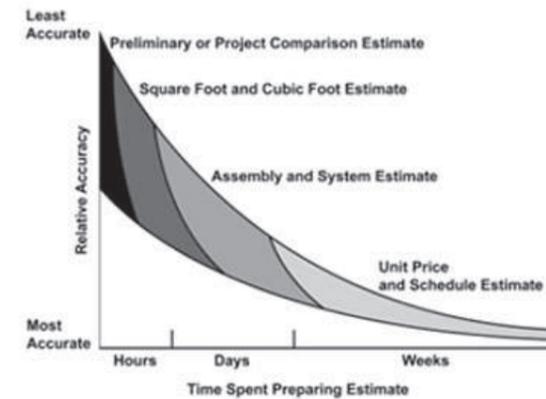


Fig. A: Relative accuracy of estimate types. Courtesy of: From Concept to Bid...Successful Estimating Methods by John D. Bledsoe

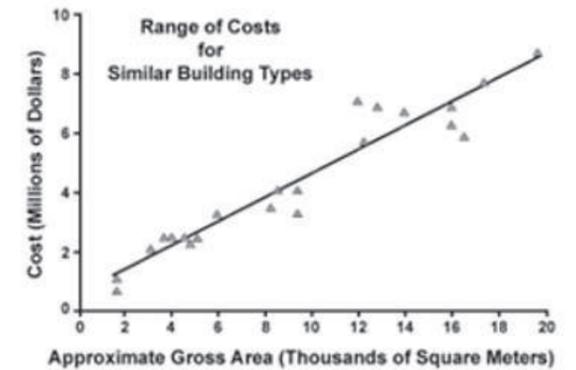


Fig. B: Project relative accuracy of estimate types. Courtesy of: From Concept to Bid...Successful Estimating Methods by John D. Bledsoe

There are various methods of cost estimating in construction projects. **Project Comparison Estimating** uses historical data from similar projects to provide a preliminary estimate with an accuracy of 15-25%. Fig. B illustrates an example of regression analysis used to develop a project comparison estimate. The scattered points in the figure show the combinations of overall project size and cost. The line shown is the "best fit" of a linear relationship between size and construction cost and may serve to predict a preliminary budget. The distances between the line and the points give a visual impression of the statistical confidence of the estimate.

**Square Foot and Cubic Foot Estimates** involve measuring the area and volume of proposed spaces and using historical cost databases to provide estimates with a 5-15% accuracy. **Assembly and Systems Estimates** group together work from different trades or disciplines and rely on historical cost guides to provide estimates with a 10% accuracy. **Unit Price and Schedule Estimating** breaks down the work into small increments and applies a unit cost to each increment to provide a highly accurate estimate of construction costs. The methods become increasingly accurate as the design progresses from preliminary to detailed and the amount of available information increases. The accuracy of the estimates is also subject to external factors such as market supply and demand.

## HISTORICAL DATABASES AND ESTIMATING SOFTWARE

There are several historical databases available that provide current values for estimating costs of the various units of work for a project. These databases are compiled from actual project costs and on-going supplier quotes and are available in various formats. However, blindly applying database prices can lead to inaccurate estimates. Each line item price should be reviewed to determine its applicability to the specific project being estimated. Location factors should also be carefully considered and applied only after determining where the bidders will come from. This could result in bids that are much higher than the factor would indicate because wages will be based on another location and bidders may need to pay accommodation and travel costs for some workers. The size and nature of the project also need to be considered in determining location factors. The professional estimator should ensure that these factors are appropriately taken into account to avoid bid busts and inaccuracies.

# ESTIMATION

## VALUE ENGINEERING (VE)

Value Engineering is a conscious and explicit set of disciplined procedures designed to seek out optimum value for both initial and long-term investment. First utilized in the manufacturing industry during World War II, it has been widely used in the construction industry for many years. Value Engineering is not a design / peer review or a cost-cutting exercise. VE is a creative, organized effort, which analyzes the requirements of a project for the purpose of achieving the essential functions at the lowest total costs (capital, staffing, energy, maintenance) over the life of the project.

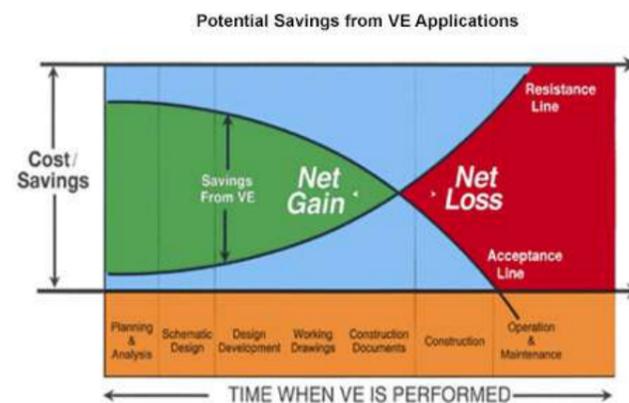
Through our group investigation, using experienced, multi-disciplinary teams, value and economy are improved through the study of alternative design concepts, materials, and methods without compromising the functional and value objectives of the client. Value Engineering can be applied at any point in a project, even in construction. However, typically the earlier, it is applied the higher the return on the time and effort invested. The three main stages of a project and VE's application are described below:



## PLANNING

At the planning stage of a development project, holding a value engineering workshop with an independent team has several benefits. The team can review the program, perform a functional analysis of the facility, define key criteria and objectives, and validate the proposed program.

They can also offer alternative solutions and verify if the budget is adequate. This helps to minimize changes, redesigns, and delays during the project, as well as provide fresh perspectives from outside the project team. Overall, a value engineering workshop can lead to a more efficient and effective development process.



## DESIGN

This is the stage that most VE participants are used to becoming involved, when the design has at least made it to the schematic stage. Most government agencies require at least one VE session at the design stage on projects over a certain \$ size. The primary tool available to the VE team is the Workshop—typically a 40-hour session (or less for smaller or less complex projects).

The Workshop is an opportunity to bring the design team and client together to review the proposed design solutions, the cost estimate, and proposed implementation schedule and approach, with a view to implementing the best value for the money. The definition of what is good value on any particular project will change from client to client and project to project.

## METHODOLOGY AND APPROACH

During the actual Workshop portion of the VE study, the five-step Job Plan is followed, as prescribed by SAVE International. The VE Job Plan follows five key steps:

### 1. INFORMATION PHASE:

At the beginning of a value engineering study, it is important to review the project history and define the key functional and owner objectives to establish a foundation for the project.

### 2. SPECULATION (CREATIVE) PHASE:

In the creative phase of a value engineering study, the team generates a large quantity of ideas for providing the necessary function within the project area with a reduced cost, which are screened in the following phase.

### 3. EVALUATION (ANALYSIS) PHASE:

In the evaluation phase of a value engineering project, the team works with the client and users to define evaluation criteria, analyze and judge generated ideas, discard impractical ones and develop those with potential cost savings for further consideration.

### 4. DEVELOPMENT PHASE (VALUE MANAGEMENT PROPOSALS):

During the development phase of a value engineering study, generated ideas are expanded into workable solutions that include detailed descriptions, evaluations, cost comparisons and calculations, and sketches where necessary.

### 5. PRESENTATION PHASE (REPORT/ORAL PRESENTATION):

The final phase of a value engineering study involves presenting recommendations in written and oral forms and the process provides benefits such as exploring alternatives, addressing value and function, clarifying objectives, identifying and prioritizing value objectives, implementing proposals, and providing feedback.

## CONSTRUCTION

During this phase value engineering is still possible through the use of Value Engineering Change Proposals (VECP). Contractors can be provided monetary incentives to propose solutions that offer enhanced value to the owner, and share in the financial benefits realized. Clearly the owner must consider contractor-generated proposals very carefully, from a life-cycle perspective and a liability perspective. The A/E team must be brought in to the decision-making process to agree to the proposed change as not having any negative impact on the overall design and building function. The evaluation of a VECP is treated similarly to any change order during construction, with issues such as schedule and productivity impacts being considered along with the perceived cost savings generated.

In contrast the Value Engineering is not only beneficial, but essential because, (i) The functionality of the project is often improved as well as producing tremendous savings, both initial and Life-Cycle Cost (ii) A "second look" at the design produced by the architect and engineers gives the assurance that all reasonable alternatives have been explored (iii) Cost estimates and scope statements are checked thoroughly assuring that nothing has been omitted or underestimated & (iv) Assures that the best value will be obtained over the life of the building. ARTISTA ensures the best overall value for money, taking into account quality, cost, and other factors as needed.

# SMART GREEN AGRICULTURE

## SMART GREEN AGRICULTURAL PRACTICES

The sustainable solution to the outputs of this project is to promote and encourage the adoption of smart green agriculture practices, such as the use of renewable energy, water-efficient irrigation systems, and climate-resilient crop varieties. It is also crucial to educate and train farmers on sustainable agriculture practices and encourage the adoption of circular economy practices to reduce waste and environmental degradation.

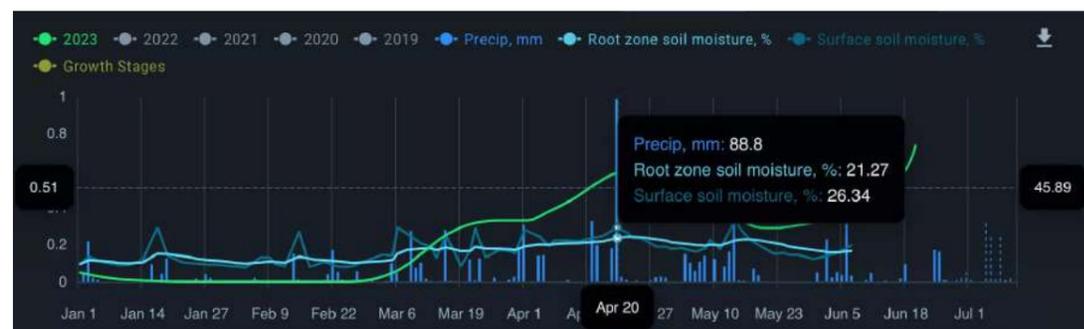
Additionally, increasing awareness and demand for organic and sustainably produced food can also contribute to reducing the use of fossil fuel fertilizers and synthetic pesticides. Overall, a shift towards sustainable agriculture practices and a circular economy can contribute to the reduction of carbon emissions, reduce pollution, and enhance resilience to climate change while promoting equitable economic growth.



## WATER-MANAGEMENT

Precision irrigation, drip irrigation, and collecting rainwater are all examples of effective climate smart agriculture strategies that can be used to maximize water consumption efficiency and reduce negative effects on the environment. In times of drought or erratic precipitation, these methods guarantee crops receive enough water with minimal wastage.

When it comes to a climate smart agriculture approach to managing water, the EOSDA Crop Monitoring platform is an excellent tool. We use satellite images and weather data from reputable sources to provide vital information for monitoring and decision-making, such as surface and root zone soil moisture, daily and cumulative precipitation, and more. To prevent nutrient leaching and water stress on your crops, fine-tune your irrigation plan based on soil moisture and rainfall data.



A soil moisture graph helps farmers timely adjust their watering schedules.

## REFERENCES:

- “UVM’s Aiken Center earns LEED platinum, highest scoring building in Vermont”, Vermont Business Magazine, September 23, 2013
- “Once Drab and Outdated, U. of Vermont Building is Now A Sustainability Showcase”, by Scott Carlson. The Chronicle of Higher Education, March 4, 2012
- “Morris & Gwendolyn Cafritz Foundation Environmental Center” Case Study on the ILFI website International Living Future Institute
- “13th Project in the World to Achieve Full Living Building Challenge Certification” Southern Maryland Online, August 2017.
- “Solar Case Study: Living Learning Center” Energy & Infrastructure Magazine, February 2016.
- “Living Building is a Net Zero Energy Education Center” Engineering.com, December 2015.
- “Beyond Green: Sustainability and The “Living Building” Challenge” Kojo Nnamdi Show, WAMU 88.5, November 2015.
- “Accokeek environmental center set to come “alive” Gazette.Net, Maryland Community News Online, May 2013 ER 1110-3-1300 Military Programs Cost Engineering by U.S. Army. 1999.
- Historical Cost Analysis Generator (HAG)—Used by the Tri-Services to collect historical costs on awarded military construction projects
- Micro Computer-Aided Cost Engineering Systems (MCACES) by U.S. Army Corp of Engineers.
- P-442 Economic Analysis Handbook by NAVFAC. 2013.
- TI 802-02 Construction Cost Estimates by U.S. Army.
- Techniques of Value Analysis and Engineering, 3rd ed. by L.D. Miles. New York, NY: McGraw-Hill, 1972.
- “The Dread of VE: Understanding Why It’s Not Used More” in Value World by Scot McClintock. Vol. 11, No. 4, Jan./Feb./Mar. 1989, pp. 12-14.
- Value Engineering: Practical Applications for Design, Construction, Maintenance, & Operations by Alphonse J. Dell’Isola. Kingston, MA: R.S. Means Company, Inc., 1999.
- Value Engineering Theory, Revised Edition by Donald E. Parker. Washington, DC: The Lawrence D. Miles Value Foundation, 1995.
- Value: Its Measurement, Design, and Management by M. Larry Shillito and David J. De Marle. New York, NY: John Wiley & Sons, Inc., 1992.
- Value Management Practice by Michel Thiry. Sylva, NC: Project Management Institute, 1997



ARTISTA Engineering Consultancy (P.) Ltd. | Dhumbarahi-4, Kathmandu, Nepal

[www.artistaengineering.com.np](http://www.artistaengineering.com.np) | [artistaengineering@gmail.com](mailto:artistaengineering@gmail.com)