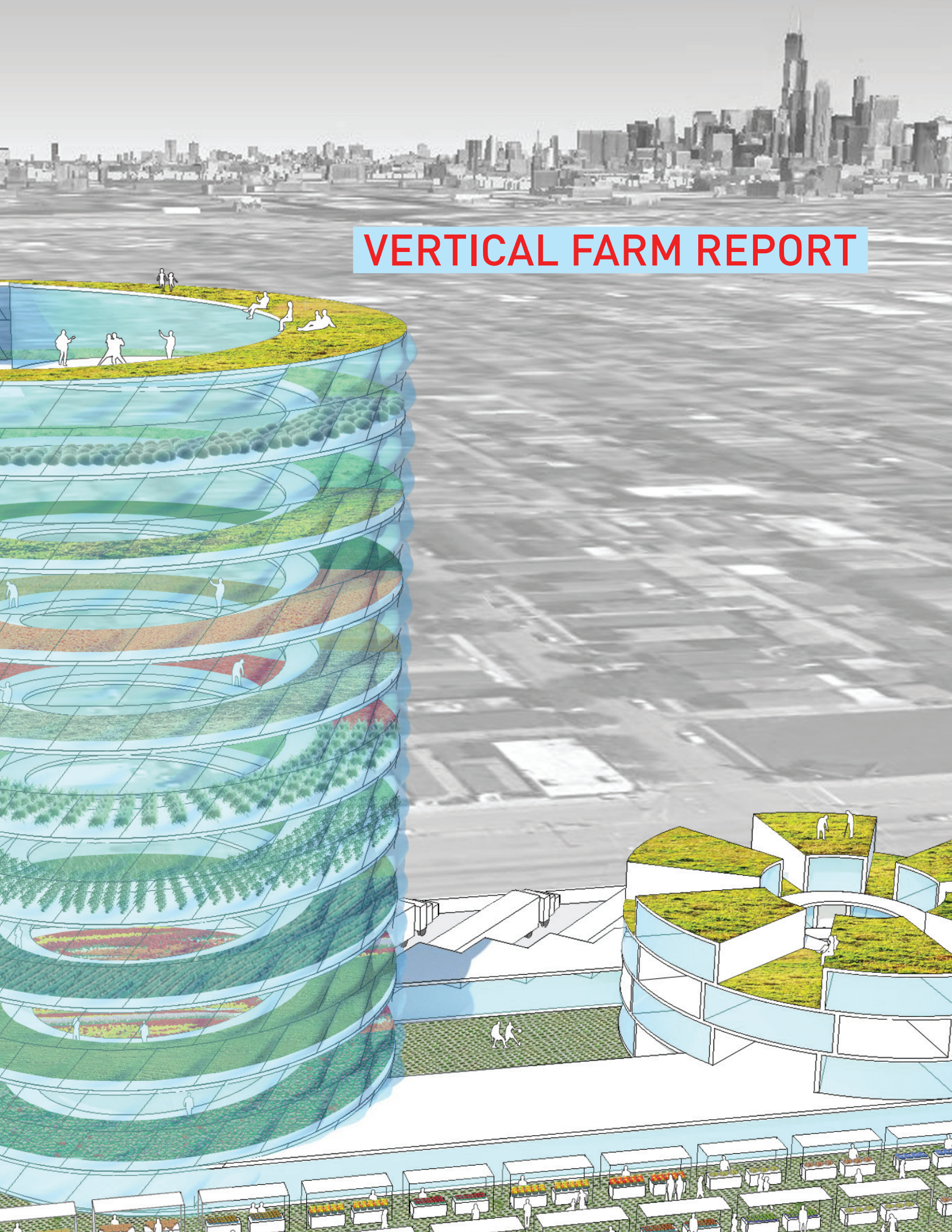
VERTICAL FARM REPORT



VERTICAL FARM REPORT

CITY OF CHICAGO
DEPARTMENT OF ENVIRONMENT

MAY 04, 2011

PREPARED BY:
URBANLAB
www.urbanlab.com

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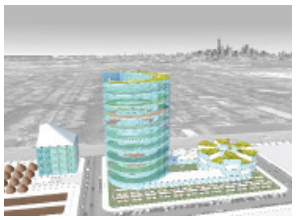
EXECUTIVE SUMMARY

The Need to Farm Vertically

Vertical farming modernizes traditional open land farming practices by building (or renovating) structures for growing food at high capacity in interior farms within cities. Dickson Despommier, renown proponent of the vertical farm concept, and Co-Chair of the Chicago Vertical Farm Task Force has noted that traditional methods of farming will need to double by 2030 in order to meet the rising global demand for food. Yet at present, throughout the world, over 80% of the land that is suitable for raising crops is already in use. An estimated 1 billion hectares of new land (about 20% more land than is represented by the country of Brazil) will be needed to grow enough food to feed an increasingly urban population (3 billion more people by 2050, the majority living in sprawling cities). This land will need to be converted despite existing worldwide water shortages that are predicted to worsen, and global climate change that is already affecting seasonal growing cycles. Vertical farming promises a more environmentally and economically viable way to cultivate plants and animals to meet rising demands within urban centers. However, Vertical farms require significant start-up capital, and because they are commercially unproven, they will likely require some measure of legislative support. Without such support, vertical farms will have difficulty developing in the near term; a time when traditional farming practices are already stretched to their limit because of unprecedented energy price and global temperature increases.

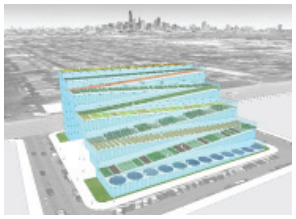
Four Vertical Farm Models for Chicago

To address these seemingly intractable challenges, the Chicago Vertical Farm Task Force identified four vertical farms models that could be built or are already built (or currently under construction) in Chicago. The objective of the Task Force was to document each of the four models by discussing and examining several parameters of each model including: Ownership, Business Plans, Partnerships, Components, Financial Incentives, Sites, Collaborations, Case Studies, Costs of Model, and Barriers/Obstacles. The ultimate goal of the Task Force was to envision a path toward simultaneously realizing constructing multiple types of vertical farms in Chicago.



Model 1: Vertical (Production) Farm

To date, no vertical production farms have been built, but several are in the design/planning phases in various cities around the world. Because none have been built, the greatest challenge to build one is securing capital investment and financing for an unproven concept. In order to properly catalyze the vertical farm concept, a public or private (or public/private consortium) “angel” investor must be identified to support initial development stages. In addition, because significant energy usage in the vertical farm (for both electricity and heat) is predicted, energy independence (or at least energy security) is vital. While no single well-funded corporation or organization (such as a University) is planning to build a vertical production farm in the foreseeable future, multiple groups of underfunded Chicagoans are investigating the financial feasibility of the concept, and at least one team (FEWZ, LLC) is vigorously developing a holistic business plan to pursue the realization of a vertical production farm in Chicago. In all likelihood, this realization will require a robust public/private partnership to develop and build a multifaceted proof-of-concept prototype.



Model 2: BioTech Incubator

To date, no BioTech Incubator vertical farms have been built, and the Task Force can find little evidence to suggest one is under development anywhere in the world. This new vertical farm concept would house R&D driven companies active in Life Sciences, Agro Tech and Bio Energy. The BioTech Incubator would be a business incubator targeted towards helping startup companies, especially those that would uniquely benefit from access to a vertical farm in downtown Chicago. Like a business incubator, the BioTech Incubator business model would be designed to accelerate the successful development of entrepreneurial companies through an array of business support resources, services and infrastructure (especially the vertical farm), developed and orchestrated by incubator management. The BioTech Incubator would likely require a public/private/academic partnership to realize the proof-of-concept prototype. The Task Force examined several potential tenants for a BioTech Incubator vertical farm— three potential tenants are discussed in detail below.

Model 3: Edible Greenroof

To date, multiple Edible Greenroofs have been built in Chicago and several other cities in the United States and the world. Edible rooftop farms, typically installed in single story greenhouses, take advantage of natural light to reduce energy requirements to grow plants (greenroofs also reduce energy usage within buildings). Adding a single story (rather than a multistory vertical farm) to an existing building as an edible greenroof potentially reduces initial investments. Enclosed edible greenroofs work on a twelve-month, closed-cycle, rooftop growing system that can be built on appropriate urban rooftops of any size. Owners of edible rooftop farms are comprised of either established food retailers (such as Zabars or Whole Foods Market), or urban agriculture non-profits or entrepreneurial startups (such as the Gary Comer Youth Center or Gotham Greens in New York City).

Model 4: Renovated Commercial Building

To date, multiple multi-story commercial buildings have been renovated in Chicago and several other cities in the United States and the world to house urban agricultural and vertical farm initiatives. Specifically in Chicago, a small but growing number of these urban agriculture initiatives combine adaptive reuse of commercial buildings with aquaponics (growing plants and fish simultaneously) and community development. The broad goal of this vertical farm model is to repurpose old multistory buildings in innovative new ways to grow food, cultivate micro-economies and help clean the urban environment. A substantial number of owners redeveloping buildings into vertical farms are do-it-yourselfers who have a deep general knowledge of building, agricultural and energy systems. The ventures rely on substantial sweat equity and volunteerism to help renovate facilities and add brainpower to the initiative.

Obstacles

A common obstacle for each of the four vertical farm models is a lack of permissible zoning and land use ordinances to support their realization in Chicago. For example, the term “aquaculture” – the sustainable food production system underpinning many vertical farms models -- is not mentioned in the zoning code. Additionally, city and state health codes restrict raising live animals and fish in Chicago for commercial purposes. City officials in the Department of Zoning and Land Use Planning recently reported that new rules will arrive shortly that are aimed at “nourishing urban agriculture” and vertical farming, but some of Chicago’s urban farmers (including members of this Task Force) believe they will prevent some types of vertical farming projects from taking shape. The lack of clarity around zoning codes prevents food production and food sales from taking place on-site in neighborhoods around the city where different scales of vertical farming could be beneficial to the health and economic vitality of community members. And the lack of clarity around health and licensing codes prohibits commercial aquaculture from legally taking place (including large scale composting) in Chicago. Eliminating bureaucratic and regulatory obstacles around zoning, health and licensing codes will help Chicagoans develop innovative ways of growing food in their own neighborhoods for their own communities.

Funding and Legislative Context

The “Food, Energy and Conservation Act of 2008” (Public Law 110– 246; “Farm Bill”), has established a goal of modernizing food production, increasing energy efficiency and increasing conservation and ecosystem reclamation. The Bill appropriates $20 billion annually, from 2008 to 2012. The Bill was implemented to maintain several programs through which vertical farming funding could be applicable such as the Farmland Protection Program, Conservation Stewardship Program, and Environmental Quality Incentives Program. Each of these programs, and the Farm Bill in general, requires further research and investigation to determine if potential funding streams are available. Additionally, because vertical farms promise to significantly reduce the oil-to-food relationship by mitigating the majority of transportation costs associated with food production, a number of U.S. Department of Energy programs have potential to be appropriate sources of funding. For example, The Office of Energy Efficiency and Renewable Energy (EERE) invests in clean energy technologies that strengthen the economy, protect the environment, and reduce dependence on foreign oil. Again, further research and investigation is required. Each of the four vertical farm models (elaborated below) includes a section documenting additional potential funding sources, and financial incentive and assistance programs.

Findings

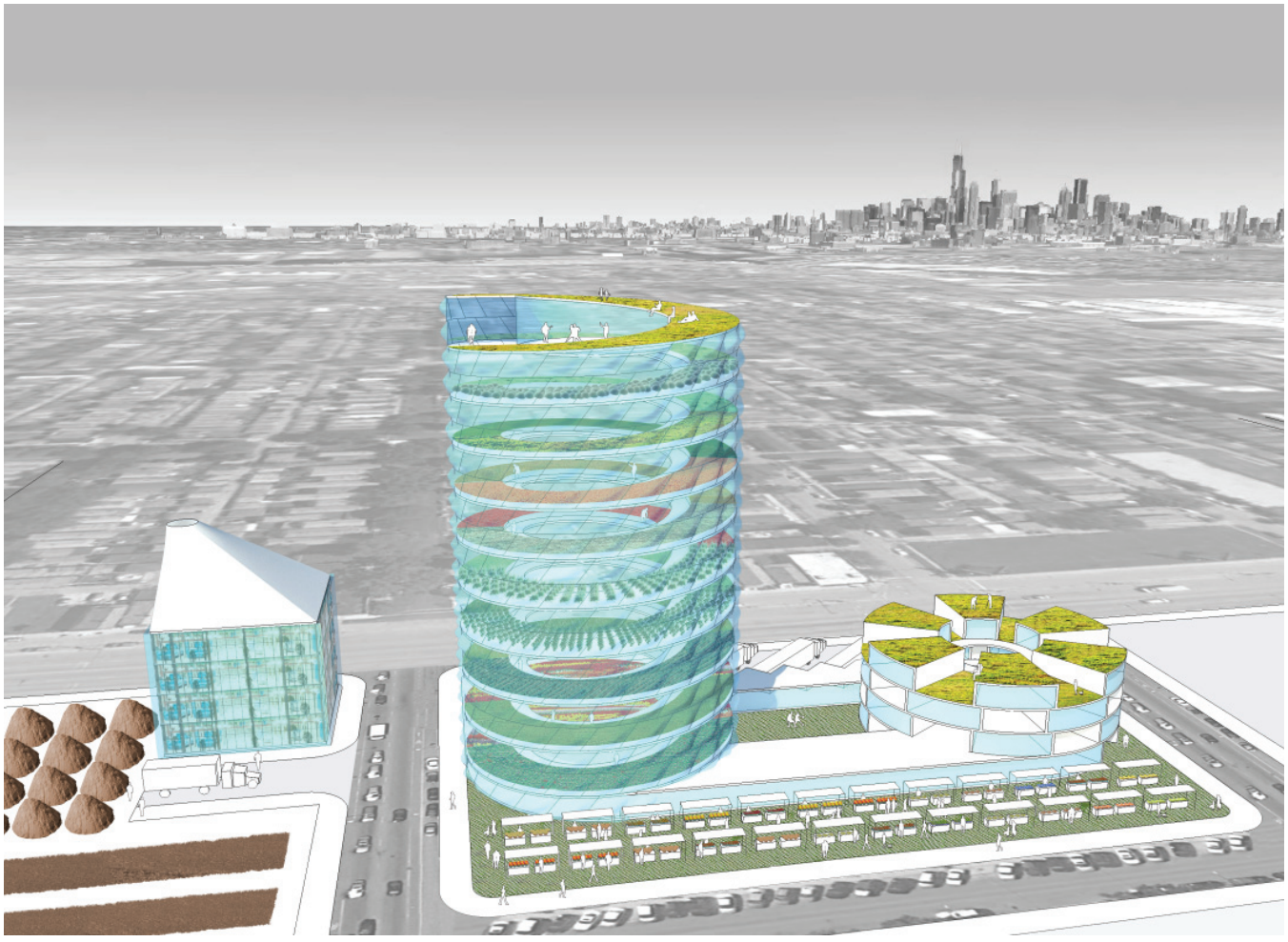
The effectiveness of large scale vertical farming in cities is still an unproven concept. But, because vertical farming is based on techniques and technologies that are proven and exist today, there is good reason to believe that vertical farming holds a great deal of promise. Greenhouses have been efficiently and economically feeding great numbers of people for centuries. And for many years, organizations such as NASA have been developing technologies to govern highly controlled environments in order to grow food in resource strained terrains. Combining the two – greenhouses with cutting edge environmental control systems – in the middle of urban communities would achieve multi-layered local and even global benefits. Though vertical farm start-up capital costs are daunting, the potential food and energy security benefits combined with potential (direct and indirect) economic profitability are significant. However, for vertical farming to realize its potential anytime soon, federally driven incentives and development assistance (similar to those stimulating alternative energy technologies) will likely be a necessity. Otherwise, the transition from resource inefficient, remote traditional farms to high yield, resource efficient urban vertical farms will take generations to realize.

Next Steps

To realize commercially scaled vertical farming in Chicago and beyond, a demonstration prototype of a vertical production farm must be built. One of the first steps is to identify a site: several sites for each of the four vertical farm models are documented in the following pages. Sites are typically based on potential partnerships and community based resources such as identifiable infrastructures and collaborators. A select set of recommendations for next steps, and optimal partnerships for achieving those next steps concludes each of the four vertical farm models as elaborated below.

MODEL 1:

VERTICAL (PRODUCTION) FARM



VERTICAL (PRODUCTION) FARM

★ *DESCRIPTION*

A vertical production farm would be an urban tower for growing plants at high capacity year-round indoors, mainly for food or pharmaceutical use. Using advanced greenhouse technology such as hydroponics and aeroponics, the vertical farm would produce vegetables, fruit, fish and poultry. The building would function for commercial food production, research and educational purposes, tourism, and green job training.

The transparent building itself would likely be circular in plan, using space more efficiently and allowing maximum light into the center. Floors would be stacked to create a continuous spiral of circulating water/nutrients from the green roof to the ground floor. The building façade could be coated with titanium oxide-glass panels that collect pollutants and let rain slide down the glass instead of beading; this would allow for better light filtration and pollutant cleansing. The entire vertical farm would be regulated from an environmental control room, which would allow for minimal resource inputs (especially energy and water), and year-round, 24-hour agriculture free of herbicide and pesticides. Traditional agricultural runoff would be eliminated because the building would recycle grey and black water.

Vertical production farming would utilize existing technologies in conceptually new ways by combining state of the art sustainable greenhouse technology with proven high-tech artificial environment technology (developed by organizations such as NASA). To date, no such high-rise urban farm exists.

★ *OWNERSHIP*

- New “Vertical Farm Corporation”

  or

- Existing Corporation (i.e. Kraft, Abbott, etc.) or University

★ *BUSINESS MODEL OF A NEW “VERTICAL FARM CORPORATION”*

Plant crops would yield high-value organic produce such as greens, herbs, vegetables, specialty mushrooms, and strawberries, which would be sold locally for profit. Raising fish in the vertical farm would complement the sustainable food production system and increase cash flow: combining aquatic animals with hydroponics (cultivating plants in water) would create a sustainable, symbiotic growing environment (reducing input expenditures for water, energy, etc.).

The largest physical cost component of a vertical production farm would be new building and infrastructure expenses. These new components (see graphics below) would be specifically required in order to maximize produce yields and the creation of early cash flow. A handful of preliminary feasibility reports studying the costs and benefits of a new vertical production farm indicate that the investment would have the potential to yield modest to significant annual net operating income. For example, CNNMoney.com reported that the construction of a 21-story vertical farm would cost about $84 million to build, $5 million in operating costs each year, and would have revenue of $18 million a year. These feasibility reports weigh the total expenditures

-- such as costs of energy required to grow and ship produce remotely -- against the potential savings of growing food locally utilizing high intensity hydronponic, aeroponic and aquaponic systems. As Dickson Despommier has shown in his studies, growing food hydroponically indoors can be four to thirty times more efficient than growing food outdoors. With increased research and technological development enabled by the construction of a vertical production farm, even higher efficiencies and yields will likely increase over time.

The largest operational cost component of the vertical farm would be the energy expenditures. In addition to designing the vertical farm to be as energy self-sufficient as possible using solar, wind and other alternative energy production methods, energy generation must be part of the design solution. LED lighting is expensive to run and no financial incentive programs exist (locally or nationally) to offset vertical farm energy costs. Therefore energy independence (or at least energy security) is a must.

To significantly reduce energy costs, a renewable and emissions-neutral energy plant could be constructed adjacent to the vertical farm tower. Energy could be generated using (1) anaerobic digestion, (2) ethanol or (3) biosolids.

1. Anaerobic digestion uses microorganisms to break down biodegradable waste material (in the absence of oxygen) to release energy. The digestion process produces a methane and carbon dioxide rich biogas suitable for energy production. The nutrient-rich digestate which is also produced can be used as fertilizer. Grass clippings, wood chips, and restaurant food waste are a few examples of biodegradable materials. The end result of the digestion process is an energy source for the vertical farm, a reduction in landfill material, a decrease in methane gas release from landfills, and an economic engine for the vertical farm (via fertilizer sales and tipping fees from organic waste collection).
2. Ethanol can be produced (distilled) from biodegradable material as a motor fuel using a wide variety of plant and organic waste products. Regional companies such as Caterpillar and Waukesha make a variety of internal combustion combined heat and power engines that run on ethanol (and digested biogas).
3. Biosolids could be supplied (for example) by the Metropolitan Water Reclamation District (see below: Energy Case Study: Human Waste to Energy).

In general, the single largest challenge of stimulating vertical farming is the high capital investment, which can be unappealing to Venture Capital and Private Equity Investors. In order to properly catalyze the vertical farm concept, a public or private (or public/private consortium) “angel” investor must be identified to support initial development stages. For example, The Chicago Clean Energy Trust “...was created to accelerate the development of Midwest clean energy businesses by connecting entrepreneurs, researchers and early stage companies with the expertise and capital needed to become sustainable.” The secret seems to lie in finding or making a match between public/private entrepreneurs and the vertical farm investment opportunity.

A Chicago based start-up named FEWZ, LLC (www.FEWZION.biz) is in various drafts of a business plan focusing on The Food Energy Water Nexus, the primary initial effort of which is to build a prototype vertical production farm in Chicago, which will incorporate German Waste to Energy technology. Founded by veteran commercial real estate consultant, Michael Hoadley, FEWZ (Food Energy Water Zone) is seeking early stage investment equity in order to complete cost estimation and secure permanent

financing. Mr. Hoadley has explored several financing strategies reliant partially on traditional commercial real estate valuation models as well as the potential benefits of Federal Loan Guarantees. Inspired by presentations at The 2005 Richard J. Daley Urban Forum, he has done extensive research on pioneering this new asset class of real estate. He has identified prospective public and private sector educational and research partners (both foreign and domestic), made specific pricing & revenue analyses, investigated preliminary rough construction & engineering cost estimates, crafted two sales and marketing strategy options, and is regularly augmenting competition and market analysis. Further proprietary information on FEWZ is available upon request including the FEWZ business plan, management team, expertise, funding initiatives, partners and expected timelines.

R/D TECH PARTNERSHIPS

Partner Industries	**Breakthrough Tech Opportunities**
Agriculture Industry	Hydroponics, Aeroponics
AgroChemical Industry	Develop Chemically Defined Diets for Vert Farm Crops
Building Materials Industry	Building Skin: Recycled Plastics as Glass Alternatives
Certification Industry	“Chicago Vertical Farm” Certification
Computing Industry	Systems Monitoring, Smart Grid Monitoring
Energy Industry	(Human/Plant/Animal) BioWaste to Electrical Energy
Electronics Industry	LED and OLED Lighting
Environ Remediation Industry	Brownfield Bio/Phyto Remediation
Fabrics Industry	Clothsheets used as Matrices for plant roots/seeds
Fiber Optics Industry	Distribution of Sunlight to Interior Plants
Financial Industry	Carbon / Water Pollution Trading
Food Industry	Urban Production, Storage, Distribution
Genetics Industry	Re-introduce select farm animals to city
Geothermal Energy Industry	Heat Pump for both cooling/heating, large scale
Hydrobiology Industry	Develop commercially viable plant species (seeds)
Manufacturing Industry	Value Added techniques to process/ship food
Modular Building Industry	Vertical Farm Pre-Fabricated Modules
Restaurant Industry	Locally sourced, secure food
Tourism Industry	First Vertical Farm
Vertical Farming Industry	Scale-up currently available indoor vertical farm tech
Waste Management Industry	Biosolids and organics recycling
Water Industry	Filtration, Evapotranspiration, Pipes/Pumping
Water Industry	Scale-up passive energy bio-cleaning technology

✸ *COMPONENTS OF "VERTICAL FARM CORPORATION" MODEL*

New Building

- Vertical Farm
- Energy Plant (Ethanol or Biosolids to Electricity and Heat)

✸ New or Existing Building(s)

- Nursery
- BioPods
- Spray Booths
- Misting Chambers
- Seed Drying
- Seed Cleaning
- Long Term Seed Storage
- Growth Chambers
- Vernalization Chambers
- Prep Rooms
- Cleaning Rooms
- Laboratories
- Integrated Control Center
- Business Services
- Equipment Rooms

✸ *POTENTIAL FUNDING SOURCES AND FINANCIAL INCENTIVES TO ASSIST OWNERSHIP*

- Guaranteed Federal Loan (to trigger private Venture Capital)
- USDA Grant: Agriculture and Food Research Initiative Competitive Grants Program (AFRI)
- President Obama's Healthy Food Financing Initiative and the Federal New Markets Tax Program, which enables companies to get federal tax credits for investing in projects in economically distressed communities, to increase food options while generating economic development
- Legislative programs such as The "Food, Energy and Conservation Act of 2008" or The Office of Energy Efficiency and Renewable Energy (EERE)
- Financially favorable sale or long-term lease agreement for developable land/building(s) between the City of Chicago and ownership
- City of Chicago Ordinance Supporting Incentives for Economic Development and Rehabilitation Projects
- State or Federal tax credits (i.e. Illinois Economic Development For a Growing Economy Tax Credit Program, or EDGE)
- Tax Increment Financing

POTENTIAL SITES

Stockyards

Site is in close proximity to existing commercial food distribution networks such as agribusinesses (Testa Foods, The Plant, etc), rail infrastructure, and highway access for trucks. The site is closely located to neighboring universities. The Back of the Yards neighborhood has an available and willing work force for urban agriculture initiatives.

Existing Corporate Campus or University

If an existing corporation (i.e. Kraft, Abbott, etc.) or University finances the vertical farm for proprietary usage, siting the vertical farm on a corporate/academic campus could become potentially advantageous.

Stickney (Metropolitan Water Reclamation District land)

In 2008, at considerable expense, the MWRD opened a new biosolids processing plant, which converts sewage-treatment byproducts into nutrient-rich pellets that potentially can be used as a renewable energy source. Siting the vertical farm adjacent to the MWRD plant would be beneficial to reduce transportation costs of shipping biosolids to a remote energy generation site.

US Steel (Calumet Area Industrial Corridor)

Site is in close proximity to rail infrastructure and barge shipping, especially for shipping biosolids directly from MWRD. A vertical farm could help stimulate commercial and industrial renewal of the new development area. Demonstration of the vertical farm concept directly on Lake Michigan as a best practice model for the Great Lakes is potentially advantageous.

COLLABORATION OPPORTUNITIES

Local Corporations

Chicago businesses would benefit from various R/D opportunities, especially partner industries listed above (see R/D Tech Partnerships).

Local Universities

Universities such as IIT, the University of Chicago, UIC, Chicago State U, and City Community Colleges could benefit via unique research opportunities to study advances in building-integrated sustainable agriculture.

Local Green Job Training Initiatives

Green Job training could help organizations such as Chicago Green Jobs for All and the Chicago Workforce Investment Council fulfill their missions of preparing Chicagoans for jobs that are created by, or transformed through, the Chicago Climate Action Plan.

CASE STUDY EXAMPLES

No vertical farm currently exists, but several are in the design/planning phases, including:

Newark Vertical Farm

The Newark Vertical Farm is both a demonstration project and a laboratory. It is envisioned to be a flexible armature for uses related to vertical farming, urban agriculture, sustainable design and energy efficiency. The vertical farm component is designed as a stacked greenhouse with an associated research block, separated by a full height atrium. The vertical farm greenhouse is flexible and adaptable. It can demonstrate the stacked, indoor growing concept to the public on the ground floor, and serve as an agricultural laboratory on the upper

floors. The research block is conceived as a series of spaces which can adapt as needs evolve to provide space for laboratories, classrooms, and offices. The ground floor can be more public in its use, while the upper floors can be isolated for use as research laboratories associated with the greenhouse functions.

✶ *COSTS TO BUILD*

The vertical production farm illustrated in this report is predicted to cost:

- 10 Story, one acre vertical farm ($41,577,500)
- New biosolids energy plant ($8,065,600)
- New accessory building ($16,049,700)
- Site and infrastructure improvements ($12,472,000)

Total = $78,164,800

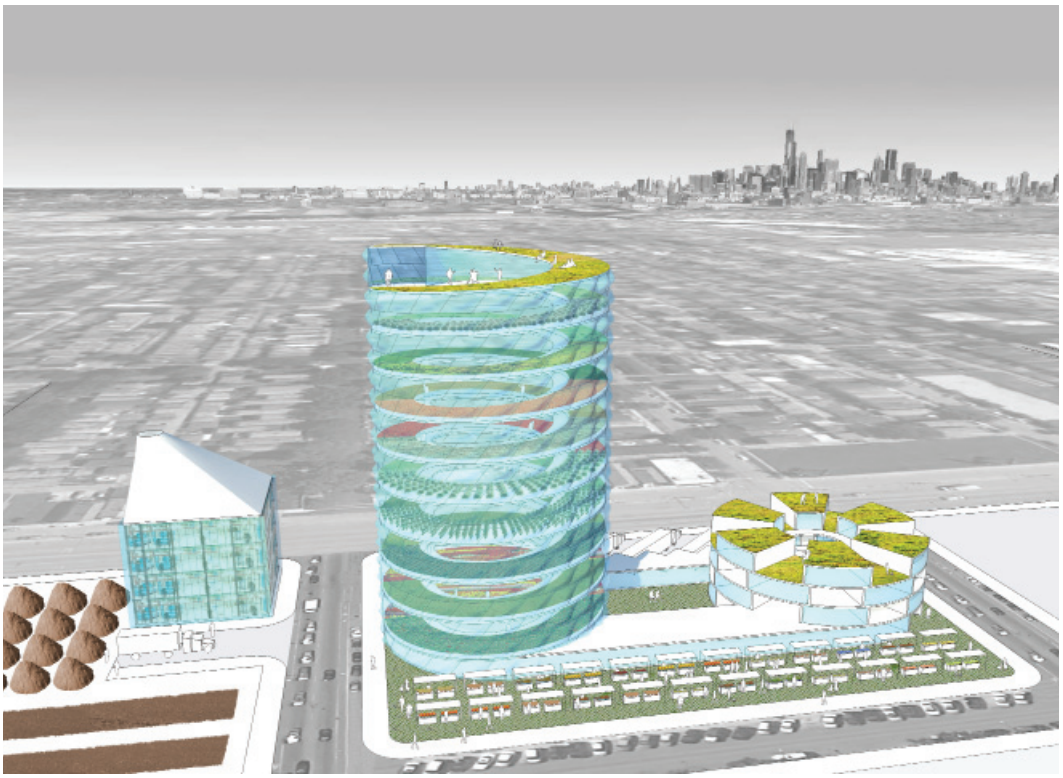
✶ *OBSTACLES AND BARRIERS*

- A detailed cost analysis of start-up costs, operation costs, and revenue for the Vertical Farm + Bioenergy concept has not been done
- The additional costs of lighting, heating, and powering the vertical farm may negate any of the cost benefits received by the decrease in transportation expenses
- Policies unsupportive of vertical farms: zoning (for aquaponics and related farming activities), plumbing, water reuse, food processing, etc.
- Proponents of the larger scale vertical farms models (vertical production farm and BioTech Incubator) believe their project zoning issues could be best addressed through the well established and widely understood Planned Development Process, rather than seeking any permanent change in The Zoning Code to establish a new “as of right” category.

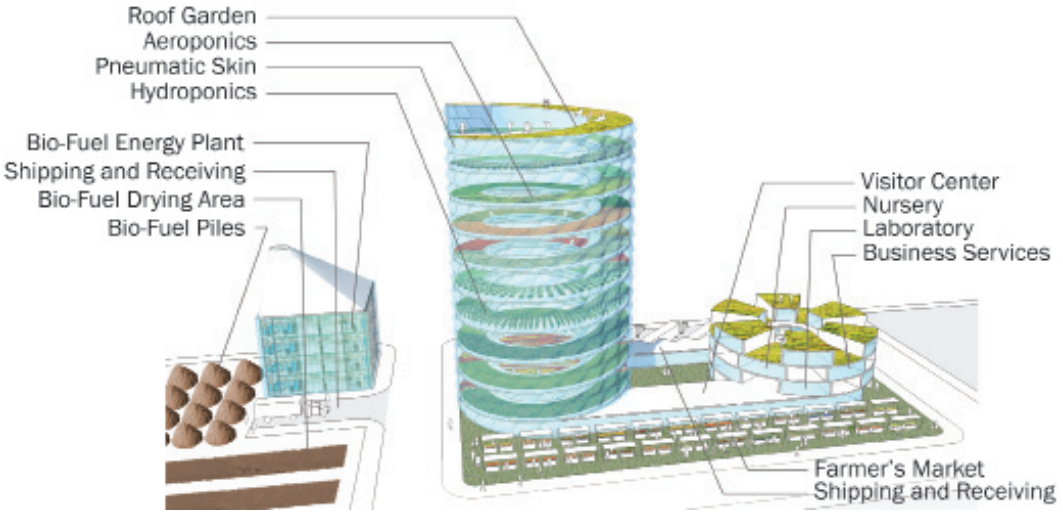
✶ NEXT STEPS: RECOMMENDATIONS AND OPTIMAL PARTNERSHIPS

- Establish a public and/or private Working Group to assess applicability of Federal and State Legislative financial assistance and incentive programs in order to assist private sector efforts in securing adequate early capital
- Expand the Working Group to include a consortium of potential owners and investors
- Offer access to the City’s federal funding experts and lobbying talent in D.C. to assist private sector investment groups
- Provide land, infrastructure and technical assistance for projects as they are identified
- Address code and licensing barriers at City and State levels

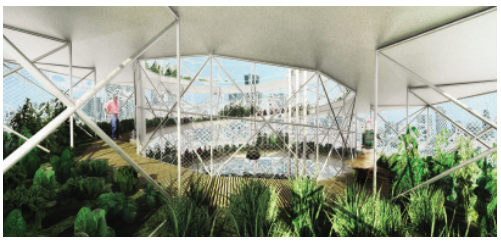
POTENTIAL VERTICAL FARM DESIGN



COMPONENTS

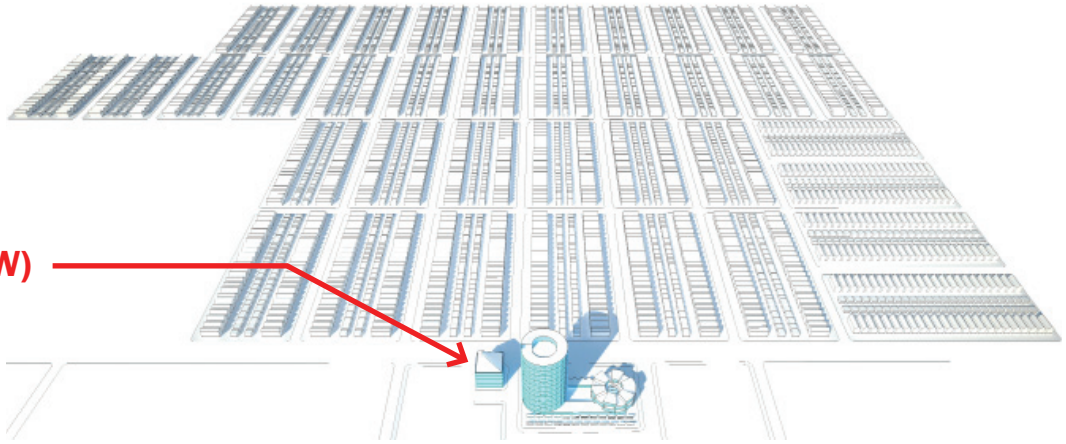


INTERIOR VIEWS



ENERGY CASE STUDY

RENEWABLE BIO-ENERGY (HUMAN WASTE → ENERGY)



Power Plant (4mW) would run the vertical farm and 1600 adjacent houses

✶ *BIO-INPUTS*

The power plant is a multi feedstock thermolysis facility which makes energy from any combination of the following input materials:

- Sewage sludge/waste
- Municipal Solid Waste/Bio-garbage/ Restaurant-food waste / Domestic refuse
- Any woody biomass or agricultural biomass waste (including plant residuals)
- Animal manure, other animal wastes like carcasses
- Paper recycling refuses, plastic waste, hospital waste
- Energy plants (e.g. miscanthus), sugar cane, bagasse
- Natural gas as auxiliary fuel to start process

✶ *PRIMARY OUTPUT*

The primary output material is a high quality gas. The gas typically consists of 50% hydrogen - H2, 25% carbon dioxide - CO2, 20% carbon monoxide - CO and 5% methane - CH4.

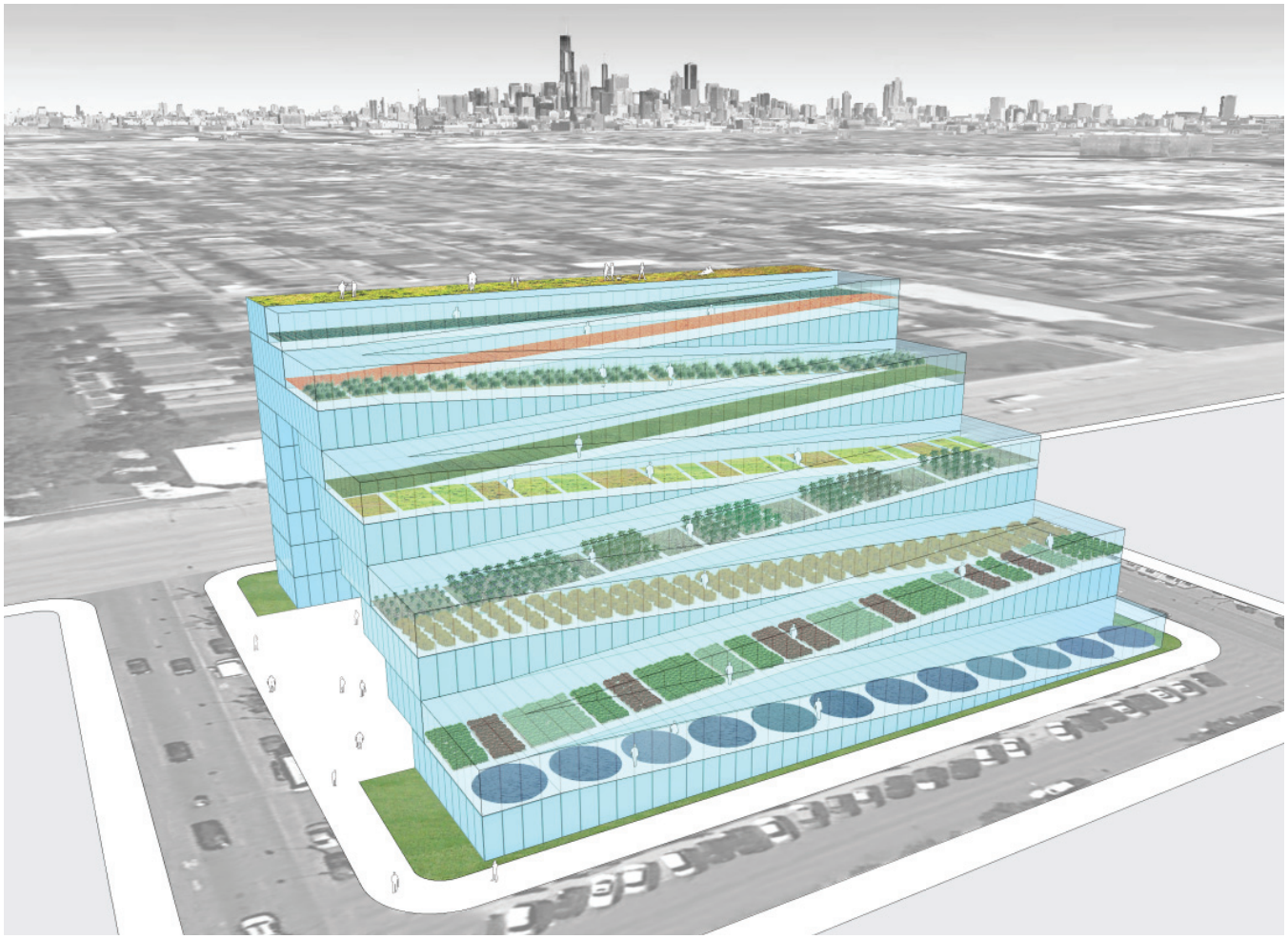
This gas has a calorific value (energy value) of 12 - 14 MJ/Nm3 and can be used in conventional gas motors, boilers, turbines etc. to generate electricity.

✶ *BI–OUTPUT*

- Power
- Clean Water
- Ash (used in fertilizer & construction industry)
- BioChar
- Heat for conversion of further energy – Kalina / ORC
- Heat for producing hot water
- Heat for cooling / cooling water – air conditioning

MODEL 2:

BIOTECH INCUBATOR



BIOTECH INCUBATOR

✶ *DESCRIPTION*

The BioTech Incubator would house R&D driven companies active in Life Sciences, Agro Tech and Bio Energy. The BioTech Incubator would be a business incubator targeted towards helping startup companies, especially those that would uniquely benefit from access to a vertical farm in downtown Chicago. Entrepreneurs with feasible projects would be selected and admitted into the incubator, where they would be offered a specialized menu of support resources and services to jump-start their new business ventures.

✶ *OWNERSHIP*

The BioTech Incubator could be sponsored by one or more of the following typical sponsors of business incubators:

- An Economic Development Organization (i.e. U.S. Economic Development Administration)
- Governmental Entity: City of Chicago, Cook County, (etc)
- One or more Academic Institutions
- Private Investors (in 2006, just 6% of incubators were strictly for-profit in the US)

✶ *BUSINESS MODEL*

Like a business incubator, the BioTech Incubator business model would be designed to accelerate the successful development of entrepreneurial companies through an array of business support resources, services and infrastructure (especially a vertical farm), developed and orchestrated by incubator management and offered both in the incubator and through its network of contacts. Successful completion of a business incubation program increases the likelihood that a start-up company will stay in business for the long term: historically, 87% of incubator graduates stay in business. Ostensibly, entrepreneurial businesses throughout the country (perhaps beyond) could be approached to participate in this one-of-a-kind BioTech Incubator model.

The business model for the BioTech Incubator could tap into a historic economic strength of the State of Illinois: agriculture. The facility could be designed specifically for advanced research in plant breeding, genetics, horticulture, entomology, plant pathology and plant nutrition items that are important to agriculture statewide. Additionally, opportunities exist for a mix of new/existing biotech or life science start-up companies and entrepreneurs as stated below.

R/D TECH PARTNERSHIPS

Partner Industries	Breakthrough Tech Opportunities
Agriculture Industry	Hydroponics, Aeroponics
AgroChemical Industry	Develop Chemically Defined Diets for Vert Farm Crops
BioTech Industry	Pharmaceuticals derived from plants
Building Materials Industry	Building Skin: Recycled Plastics as Glass Alternatives
Computing Industry	Systems Monitoring, Smart Grid Monitoring
Electrical Energy Industry	(Plant/Animal) Waste to Electrical Energy
Electronics Industry	LED and OLED Lighting
Environ Remediation Industry	Brownfield Bio/Phyto Remediation
Fabrics Industry	Clothsheets used as Matrices for plant roots/seeds
Fiber Optics Industry	Distribution of Sunlight to Interior Plants
Genetics Industry	Re-introduce select farm animals to city
Geothermal Energy Industry	Heat Pump for both cooling/heating, large scale
Hydrobiology Industry	Develop commercially viable plant species (seeds)
Manufacturing Industry	Value Added techniques to process/ship food
Medical Industry	Human eating patterns- education materials
Microbiology Industry	Develop microbes to bioremediate sludge
Waste Management Industry	Biosolids and organics recycling
Water Industry	Filtration, Evapotranspiration, Pipes/Pumping
Water Industry	Scale-up passive energy bio-cleaning technology

✶ ***COMPONENTS OF MODEL***

New Building

- Vertical Farm

New or Existing Building(s)

- Nursery
- Controlled Environment Facility
- BioPods
- Spray Booths
- Misting Chambers
- Seed Drying
- Seed Cleaning
- Long Term Seed Storage
- Growth Chambers
- Vernalization Chambers
- Prep Rooms
- Cleaning Rooms
- Laboratories
- Integrated Control Center
- Business Services
- Equipment Rooms

Potential tenants of the BioTech Incubator may also require a “Controlled Environment Facility” in addition to the vertical farm greenhouse. A Controlled

Environment Facility consists of plant growth chambers. Chamber controls include light intensity, temperature, relative humidity, photoperiod and plant irrigation systems. Additionally, the facility could contain specialized units, such as a dew chamber for virus and pathogen inoculation, a chamber that controls CO2 levels within the chamber up to 2500 parts per million, a chamber for low temperature [-10C] experiments, a chamber with a specialized lamp canopy, and a chamber equipped with a chemical air drier for low humidity studies. Chambers can be equipped with custom watering systems for irrigation and fertilization.

Additionally, the research facility could have pods devoted to bio-security level II and III projects, something that many existing greenhouse systems do not provide. Plus, the facility could offer an increased level of environmental reliability to any research work that is being conducted. For example, most greenhouses are designed with a temperature variability of 10 to 12 degrees, but with specialized energy control mechanisms in place the range could be limited to only 1 to 1.5 degrees.

The environmental system could be assisted with a computer controlled weather station that would allow the vertical farm greenhouse to respond real-time to weather related data. For instance, if the outside temperature started to go up fast and the weather station detected intense sunlight, the greenhouse control system would respond by starting evaporative coolers and unrolling the shade cloths in the ceiling, which themselves could account for about a 10 degree F lowering of the temperature. And if environmental conditions fell out of the prescribed range in any of the chambers, sensors could sound an alarm that could be transferred to a cell phone or laptop on a 24-7 basis.

✶ *POTENTIAL FUNDING SOURCES AND FINANCIAL INCENTIVES TO ASSISTS OWNERSHIP*

- Legislative programs such as The “Food, Energy and Conservation Act of 2008” or The Office of Energy Efficiency and Renewable Energy (EERE)
- USDA Grant: Agriculture and Food Research Initiative Competitive Grants Program (AFRI)
- Financially favorable sale or long-term lease agreement for developable land/ building(s) between the City of Chicago and ownership
- Long-term lease agreement for developable land between an academic institution and ownership (recurring incentives such as reduced tax and resource costs would be available on an academic campus)
- City of Chicago Ordinance Supporting Incentives for Economic Development and Rehabilitation Projects
- Tax Increment Financing

✶ *POTENTIAL SITES*

Stockyards

Site is in close proximity to existing commercial food distribution networks such as agribusinesses (Testa Foods, The Plant, etc), rail infrastructure, and highway for trucks. The site is closely located to neighboring universities. The Back of the Yards neighborhood has an available and willing work force for urban agriculture initiatives.

Academic Campus
Illinois Institute of Technology, the University of Chicago and the University of Illinois at Chicago have land available on their campuses to site a Biotech Incubation vertical farm. Existing laboratories and other R/D infrastructure on campus would be advantageous (and reduce startup expenditures).

✶ *POTENTIAL TENANTS WITHIN THE BIOTECH INCUBATOR*

See Potential Tenant Case Studies below.

✶ *COLLABORATIVE OPPORTUNITIES*

Local Corporations:
Chicago businesses could benefit from R/D startups housed in the BioTech Incubator via technology commercialization, accelerating growth of local tech clusters, and the identification of potential spin-in or spin-out business opportunities.

Local Universities:
Universities such as IIT, the University of Chicago, UIC, Chicago State U, and City Community Colleges could benefit via unique research opportunities arising from the BioTech Incubator. Perhaps departments within universities could be potential tenants?

✶ *CASE STUDY EXAMPLE*

San Jose BioCenter
The San Jose BioCenter provides a new generation of specialized facilities, capital equipment, laboratory services, and commercialization support for emerging science and technology companies. The BioCenter is a new, time and cost efficient model to commercialize innovation for emerging science and technology companies. Since inception, the life science and clean technology companies of the BioCenter have raised more than $1B in capital and have created more than 800 direct jobs.

✶ *COSTS TO BUILD*

New biotech incubator vertical farm ($31,680,000 - $63,040,000.00)

Site and infrastructure improvements ($3,728,000)

Total = $35,408,000 - $66,768,000

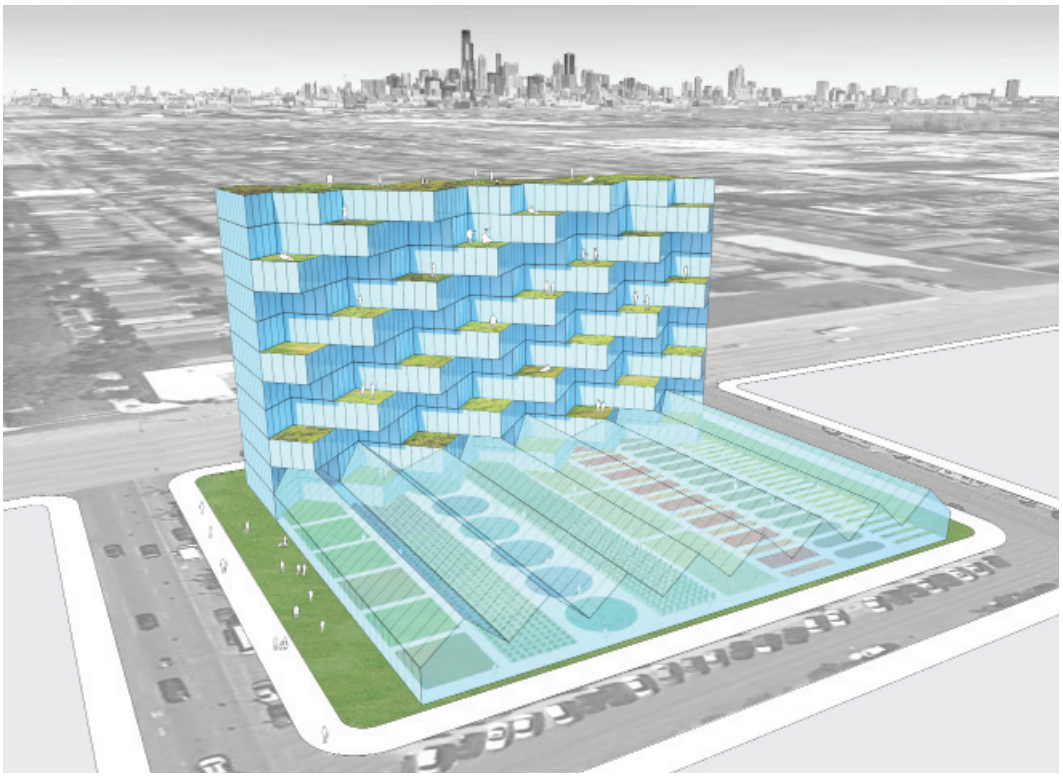
✶ *OBSTACLES AND BARRIERS*

- Unproven vertical farm investment component of incubator business model
- Policies unsupportive of vertical farms: zoning (for aquaponics and related farming activities), plumbing, water reuse, food processing, etc.
- Proponents of the larger scale vertical farms models (vertical production farm and BioTech Incubator) believe their project zoning issues could be best addressed through the well established and widely understood Planned Development Process, rather than seeking any permanent change in The Zoning Code to establish a new “as of right” category.

NEXT STEPS: RECOMMENDATIONS AND OPTIMAL PARTNERSHIPS

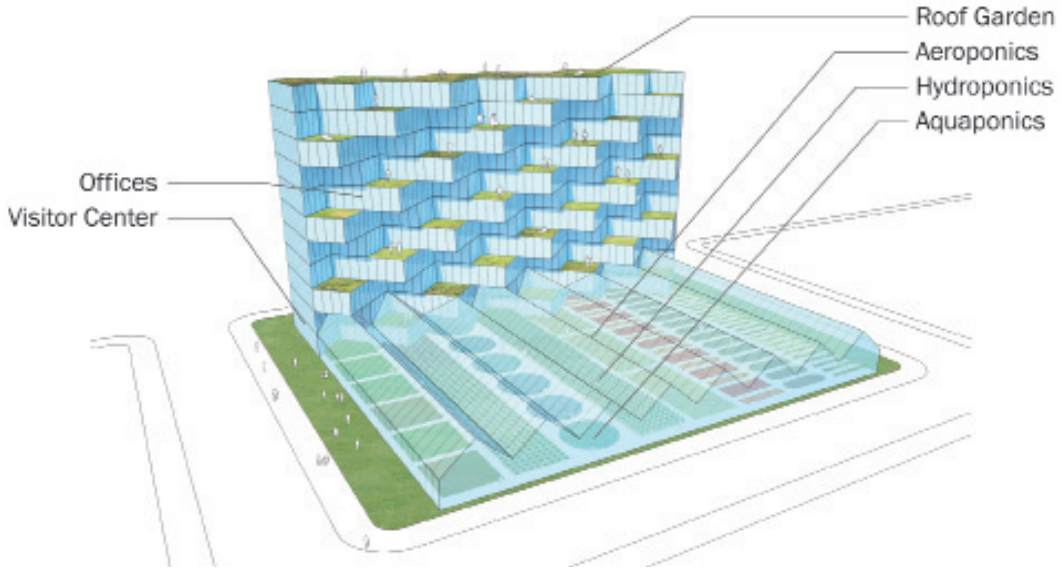
- Identify the various existing incubation efforts throughout Metro Chicago
- Conduct a market analysis and identify potential tenants (regionally and globally)
- Establish a public and/or private Working Group to assess applicability of Federal and State Legislative financial assistance and incentive programs in order to assist private (including academic) sector efforts
- Expand the Working Group to include a consortium of potential owners, investors and tenants
- Offer access to the City's federal funding experts and lobbying talent in D.C. to assist private sector investment groups
- Provide land, infrastructure and technical assistance for projects as they are identified
- Address code and licensing barriers at City and State levels

POTENTIAL BIOTECH INCUBATOR DESIGN SCHEME 01

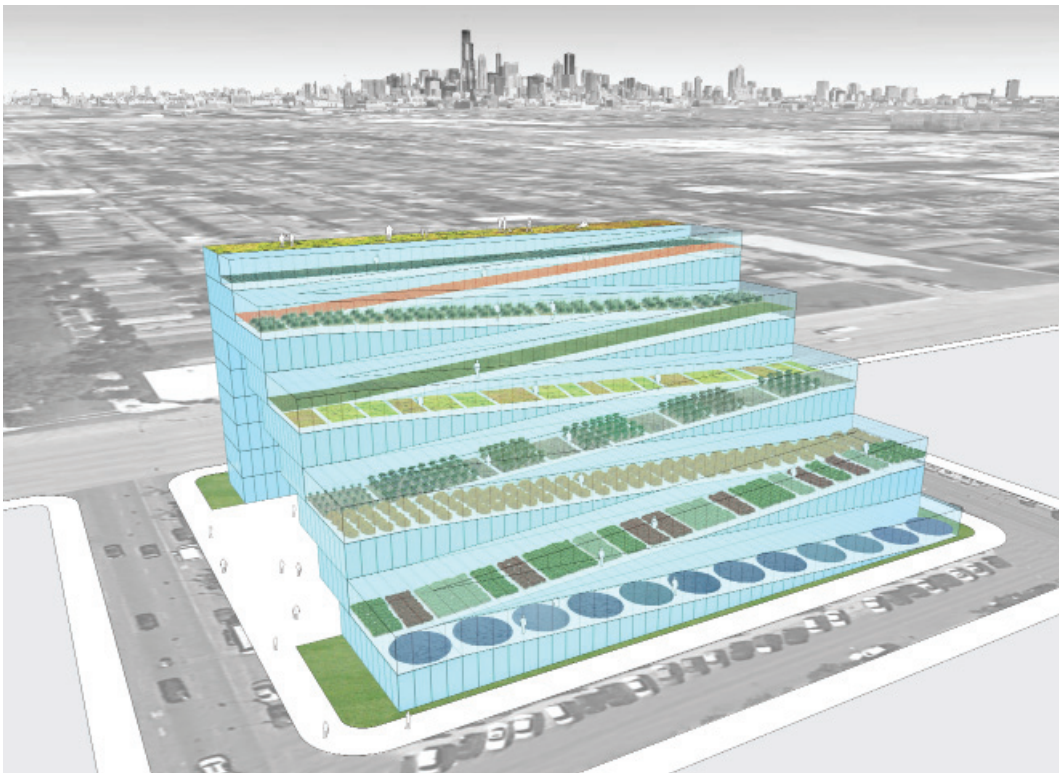


Start-Up businesses overlook approximately one acre of environmentally controlled R/D green houses.

COMPONENTS

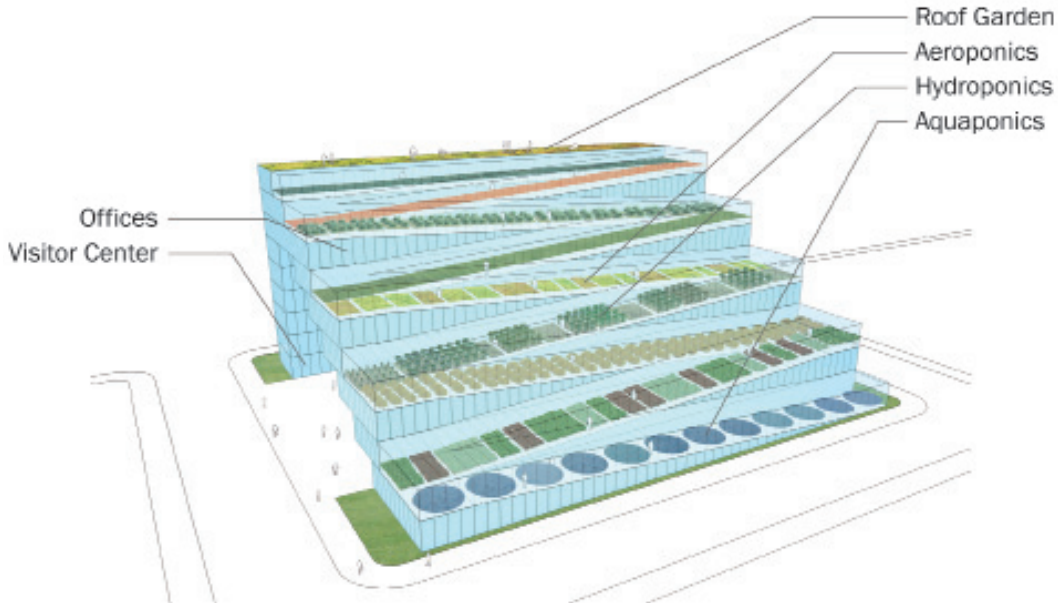


POTENTIAL BIOTECH INCUBATOR DESIGN SCHEME 02

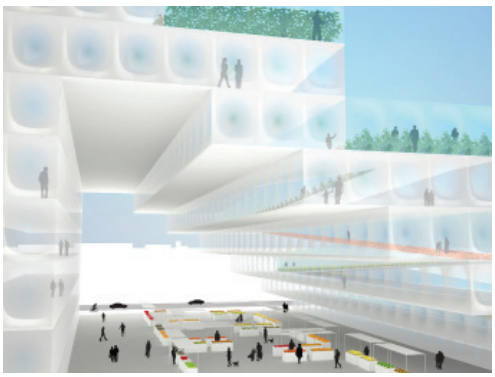


Start-Up businesses are adjacent to approximately one acre of environmentally controlled green houses on one continuous R/D surface.

COMPONENTS



INTERIOR VIEW



CASE STUDY: BIOTECH INCUBATOR

ILLINOIS SCIENCE + TECHNOLOGY PARK

The Illinois Science + Technology Park has its origins as a distinguished former drug research and production complex (with advanced laboratory, testing and related facilities) for a major pharmaceutical company. Due to a buy-out and consolidation of the company, the complex closed and the vacant facility was purchased by Forest City Science + Technology Group and is now being transformed into a state-of-the-art research and technology park situated in the heart of northeastern Illinois' growing life science and pharmaceutical cluster.

The Illinois Science + Technology Park will serve as a catalyst to transform Illinois from a scientific research hub to an economic engine for bioscience technologies. Strategically located near the Chicago area's major universities, teaching research hospitals, and pharmaceutical/medical device companies, the Park will play an integral role in creating the coveted, high-quality scientific jobs that are driving the 21st Century economy, and provide much needed and readily available research space for companies to develop and grow.

CASE STUDY: BIOTECH INCUBATOR

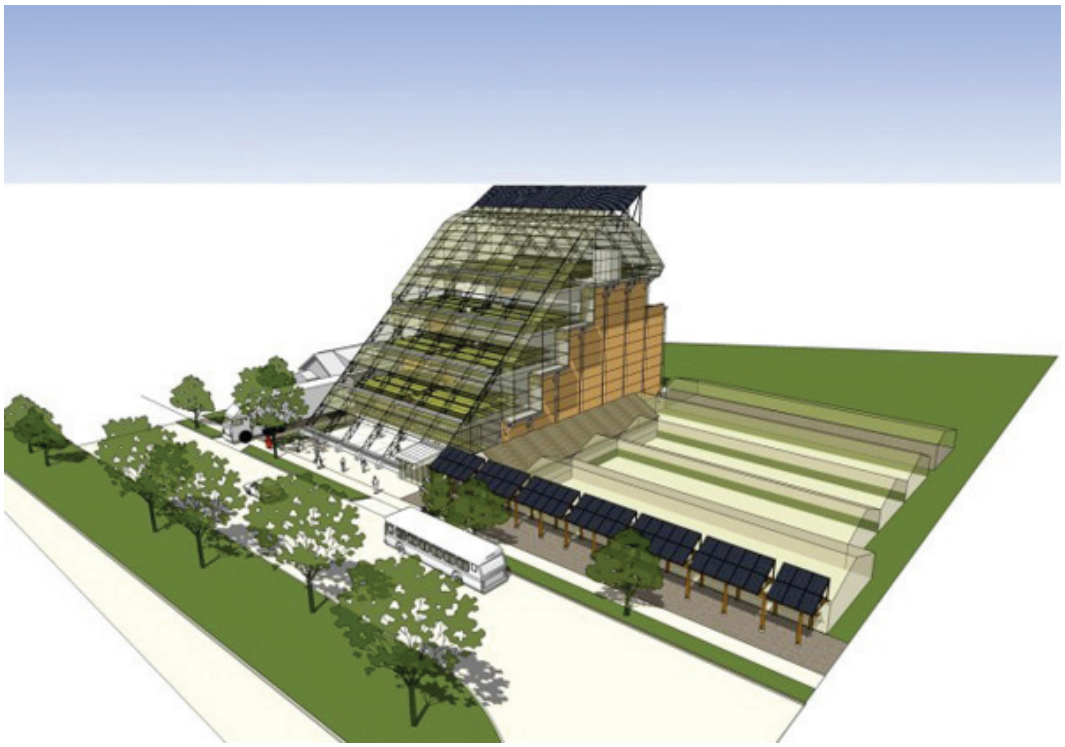
RESEARCH GREENHOUSES UC DAVIS

There are 17 research greenhouses at the Orchard Park facility, as well as two lath houses, a contained outdoor growing space and three headhouses. At the Core Greenhouse Complex, Plant Growth Facilities oversees two state-of-the-art greenhouses. This complex also includes a large headhouse.

CONTROLLED ENVIRONMENTAL FACILITY UC DAVIS

The Controlled Environment Facility maintains a total of 151 plant growth chambers in two separate locations on campus. Chamber controls include light intensity, temperature, relative humidity, photoperiod and irrigation systems. There are also many specialized units, including 15 for precise control of carbon dioxide levels.

CASE STUDY: VERTICAL FARM

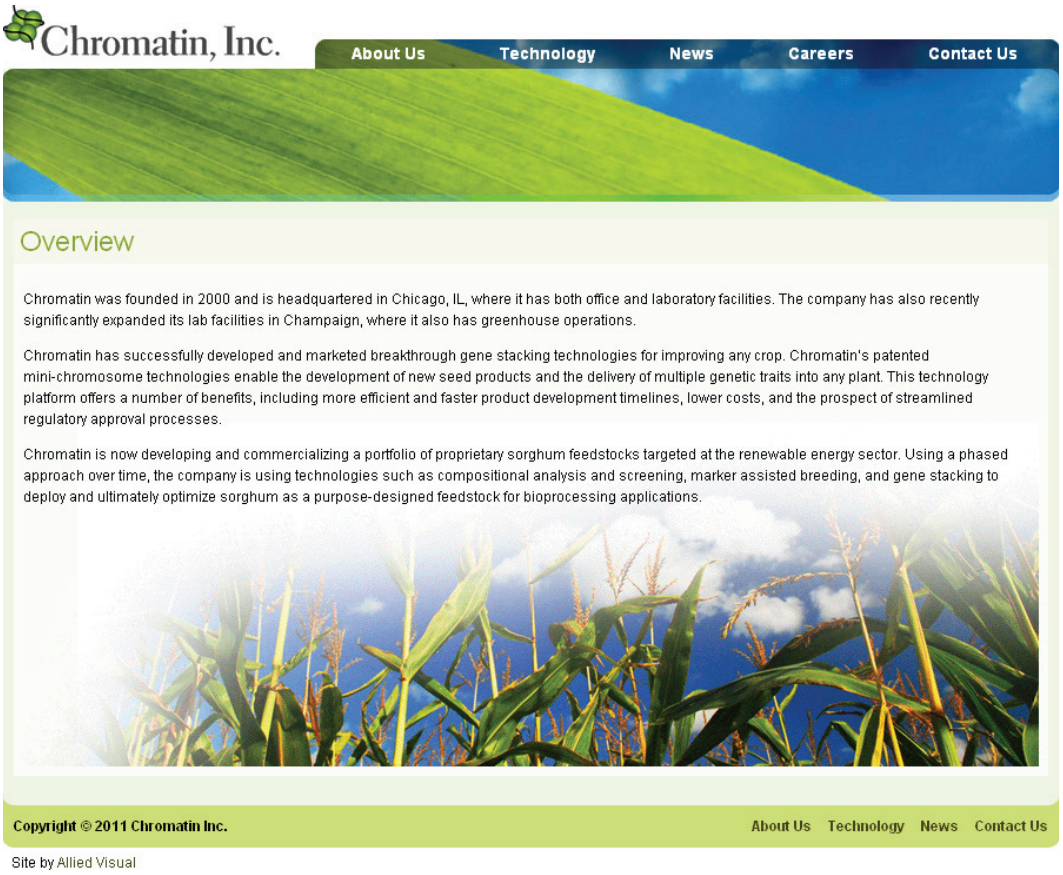


VERTICAL FARM GROWING POWER, MILWAUKEE, WI

Growing Power is a national nonprofit organization and land trust supporting people from diverse backgrounds, and the environments in which they live, by helping to provide equal access to healthy, high-quality, safe and affordable food for people in all communities. Growing Power implements this mission by providing hands-on training, on-the-ground demonstration, outreach and technical assistance through the development of Community Food Systems that help people grow, process, market and distribute food in a sustainable manner.

The vertical farm will expand and improve Growing Power's greenhouse and aquaponics operations currently spread over a two-acre site located in the City of Milwaukee. Five stories of south-facing greenhouse areas will allow production of plants, vegetables, and herbs year-round. Expanded educational classrooms, conference spaces, demonstration kitchen, food processing and storage, freezers, and loading docks will further support Growing Power's expanding mission as a local and national resource for learning about sustainable urban food production.

POTENTIAL TENANTS FOR BIOTECH INCUBATOR



CHROMATIN, INC. CHAMPAIGN, IL

Currently, Chromatin has its corporate office in Chicago, and green house facilities in Champaign, IL.

Chromatin is a biotech company developing and marketing innovative technologies and products that benefit the agricultural, energy, chemical, nutritional, and pharmaceutical sectors. Chromatin is unlocking the potential of plants to produce greater value and meaningful products for consumers, growers, seed producers, and bioprocessors. Chromatin is commercializing solutions which proactively address key societal challenges such as improving agricultural productivity and increasing renewable energy resources.

The company's mini-chromosome technology simultaneously introduces multiple genetic traits into plants, reducing the time and cost required to develop improved and novel crop-based products, such as medicines, biomaterials, textiles and nutritionally improved foods. Mini-chromosomes also provide unprecedented precision and control of new traits at every point in a plant's life cycle, from seed to field and beyond. Chromatin's gene stacking technology enables these products to be developed while allowing growers to enjoy the benefits of the most up-to-date agronomic traits, such as herbicide tolerance, pest resistance, and diseases resistance. Furthermore, these technologies will benefit the environment through decreased use of pesticides and fertilizers.

POTENTIAL TENANTS FOR BIOTECH INCUBATOR

BARTLETT TREE EXPERTS

Currently, Bartlett Tree Research has a corporate office in Chicago and green house facilities in North Carolina.

At its North Carolina research facility Bartlett Tree Research has a fully equipped laboratory with an extensive library, an education center, an arboretum containing about 2,000 species of trees and plants, several working test plots, and a bird sanctuary. The Bartlett Tree Research Laboratories is capable of evaluating plant samples, culturing and identifying disease-causing organisms, identifying insects and performing complete soil analysis services. Staffed with scientists in fields such as plant pathology, entomology and botany, the labs advise their arborists on the latest advances in arboriculture for the benefit of their customers.

POTENTIAL TENANTS FOR BIOTECH INCUBATOR

ARGONNE NATIONAL LABORATORY ARGONNE, IL

Currently, Argonne National Laboratory has collaborative offices in Chicago and green house facilities in Argonne, IL.

Argonne National Laboratory is one of the nation's leading federally funded research and development centers.

Argonne National Laboratory, one of the U.S. Department of Energy's oldest and largest national laboratories for science and engineering research, employs roughly 3,200 employees, including about 1,000 scientists and engineers, three-quarters of whom hold doctoral degrees. Argonne's annual operating budget of around $630 million supports upwards of 200 research projects, which are broadly described below. Since 1990, Argonne has worked with more than 600 companies and numerous federal agencies and other organizations.

Argonne's mission is to apply a unique mix of world-class science, engineering and user facilities to deliver innovative research and technologies; and create new knowledge that addresses the most important scientific and societal needs of the nation.

Argonne actively seeks opportunities to work with industry to transfer technologies to the marketplace through licensing, joint research and many other collaborative relationships.

MODEL 3:
EDIBLE GREENROOF

EDIBLE GREENROOF

DESCRIPTION

Edible rooftop farms, typically installed in single story greenhouses, take advantage of natural light to reduce energy requirements to grow plants (greenroofs also reduce energy usage within buildings). Adding a single story (rather than a multistory vertical farm) to an existing building as an edible greenroof potentially reduces initial investments. Enclosed edible greenroofs work on a twelve-month, closed-cycle, rooftop growing system that can be built on appropriate urban rooftops of any size.

OWNERSHIP

Grocery Stores

- A number of local and national food retailers such as Zabars and Whole Foods Market have begun or are planning to build edible rooftops gardens in city locations.

For-Profit Urban Farmers

- A number of urban agriculture startups (such as Gotham Greens and Better Food Solutions, both in New York City) are developing business plans to build working farms on existing and new buildings with at least 5,000 square feet of rooftop.

BUSINESS MODEL

Either a grocery store itself or an urban farm business designs, finances, would build and operate hydroponic rooftop greenhouses. Greenhouses could be built on either grocery store roofs or flat roofs near grocery stores—both examples eliminate time, distance and cost from the food chain. Savings would yield profits for either the grocery store or urban farmers. A 15,000 square foot rooftop greenhouse facility would annually produce over 30 tons of premium quality, pesticide-free, sustainably-grown, vegetables, fruit, and culinary herbs. The grocery store or farmer would typically combine (or at least attempt to combine) technically sophisticated Controlled Environment Agriculture (CEA) techniques with energy saving innovations. If the produce is grown by an urban framer, it would be sold under their proprietary brand at grocery stores and farmer's markets, as well as restaurants across the city. Several grocery stores and urban farmers are eager to realize commercial scale rooftop farms today.

R/D TECH OPPORTUNITIES

Breakthrough Tech Opportunities

Hydroponics, Aeroponics
Develop Chemically Defined Diets for Farm Crops
Natural Ventilation Controls
Building Skin: Recycled Plastics as Glass Alternatives
Systems Monitoring, Smart (Micro/Macro) Grid Monitoring
Urban Food Production, Storage, Distribution
Develop commercially viable plant species (seeds)

Filtration, Evapotranspiration, Pipes/Pumping
LED and OLED Lighting
Clothsheets used as Matrices for plant roots/seeds
Vertical Farm Pre-Fabricated Modules

COMPONENTS OF MODEL

New Rooftop Greenhouse on new or existing buildings

POTENTIAL FUNDING SOURCES AND FINANCIAL INCENTIVES TO ASSIST OWNERSHIP:

- Local or national grocery stores
- Zoning Benefits (i.e. higher FAR, reduced parking spaces requirements) for Grocery Stores willing to build Edible Greenroofs
- Financially favorable long-term lease agreement for rights to use rooftops owned by City of Chicago (as building owner) and urban farmer
- President Obama's Healthy Food Financing Initiative and the Federal New Markets Tax Program, which enables companies to get federal tax credits for investing in projects in economically distressed communities, to increase food options while generating economic development
- Legislative programs such as The "Food, Energy and Conservation Act of 2008" or The Office of Energy Efficiency and Renewable Energy (EERE)
- City of Chicago Ordinances Supporting Incentives for Economic Development and Rehabilitation Projects
- Tax Increment Financing

POTENTIAL SITES

Buildings throughout Chicago

COLLABORATIVE OPPORTUNITIES

- Grocery Stores could work directly with urban farmers to grow food in Chicago
- Educational opportunities for local schools and job training programs

CASE STUDY EXAMPLES

Zabars, New York City

In 1995, Eli Zabar began building greenhouses atop his two- and three-story brick buildings on the Upper East Side. These greenhouses, covering nearly a half-acre in area, are producing greens, tomatoes, berries, and even figs that are sold in his markets downstairs: Zabars' goal is to create farming that is intertwined with the urban landscape.

COSTS TO BUILD

New edible greenroof greenhouse on existing building ($100 - $300 / SF)

✶ *OBSTACLES AND BARRIERS*

- Structural capacity of existing flat roofs must be investigated and/or strengthened before use. Relocation of existing HVAC and other roof-top equipment requires consideration.
- Exiting and egress per code requirements on existing roofs is costly if not previously built (applicable roofs must have at least two fire exists to public grade)
- Heating/Cooling and additional Lighting Costs of Greenhouse (dependent on site)
- Policies unsupportive of vertical farms: zoning (for aquaponics and related farming activities), plumbing, water reuse, food processing, etc.

✶ NEXT STEPS: RECOMMENDATIONS AND OPTIMAL PARTNERSHIPS

- Identify and map the various existing and future efforts throughout Metro Chicago
- Establish a public and/or private Working Group to assess applicability of Federal and State Legislative financial assistance and incentive programs in order to assist private (including academic and non-profit) sector efforts
- Expand the Working Group to include a consortium of potential owners, partners and investors
- Offer access to the City's federal funding experts and lobbying talent in D.C. to assist private sector investment groups
- Provide infrastructural and technical assistance for projects as they are identified
- Address code and licensing barriers at City and State levels (for example: water reuse and composting)
- Explore zoning and building permit incentives for grocery stores and restaurants to install projects on new and existing buildings (for example: higher FAR densities in exchange for building roof top farms)

CASE STUDY: EDIBLE GREENROOF

GARY COMER YOUTH CENTER CHICAGO, IL

The Gary Comer Youth Center Roof Garden is an after-school learning space for youth and seniors in a neighborhood with little access to safe outdoor environments. Last year alone, it produced over 1,000 pounds of organic food used by students, local restaurants and the center's café. Sleek and graphic, it turns the typical working vegetable garden into a place of beauty and respite.

Located in Chicago's Grand Crossing neighborhood, the Gary Comer Youth Center offers a safe, welcoming after-school space for indoor activity. Its 8,160-square-foot green roof is a model for using traditionally underutilized space for urban agriculture and exceptional in its balance of an aesthetic vision with practical needs. The garden provides the crowning touch to an award-winning building recognized for its bold architecture.

The landscape architect worked closely with the architect and donor to develop a vision for a green roof to include a flower and working vegetable garden, and suggested that the center employ a full-time garden manager to enhance educational program development and manage maintenance. The result is a garden used in extremely creative ways for horticultural learning, environmental awareness, and food production.

CASE STUDY: EDIBLE GREENROOF

ELI'S VINEGAR FACTORY NEW YORK CITY, NY

Eli Zabar, the owner of E.A.T. restaurant and the Vinegar Factory food emporium in New York City, attempts to produce good, out-of-season tomatoes, herbs, and lettuce. He erected three greenhouses on top of the Vinegar Factory's ten-thousand-square-foot roof. The largest of the three greenhouses is twenty-six by eighty feet, while the two smaller houses are twenty by sixty feet; all of them are kept warm by piped-in heat recycled from his bread ovens below.

Eli grows his vegetables in soil rather than hydroponically, a growing technique that uses other mediums, such as water. According to Eli, using real soil is integral to the good flavor of the tomatoes, baby greens, fig trees, and fraises des bois (wild strawberries) he grows to use in his restaurant and sell in the market. In an effort to keep all the processes of planting, growing, and harvesting as organic as possible, Eli brought in bees to fertilize the plants and ladybugs to eat aphids.

The greenhouse operates during the fall, winter, and spring months, shutting down during the summer when seasonal produce is easy to find. During the growing cycle, Eli tends to eight hundred tomato plants, including some eighteen heirloom varieties, such as Coustralee, Anna Russian, Old German, and Brandywine, and many beds of mustard greens, lettuces, and kale. When his greens, such as red Russian kale and arugula, bibb, and red romaine lettuces, are ready for harvest, his gardeners cut them with scissors and keep them fresh in ice water.

MODEL 4:

RENOVATED COMMERCIAL BUILDING

RENOVATED COMMERCIAL BUILDING

DESCRIPTION

In Chicago, a small but growing number of urban agriculture initiatives combine adaptive reuse of commercial buildings with aquaponics (growing plants and fish simultaneously) and community development. The broad goal of this vertical farm model is to repurpose old multistory buildings in innovative new ways to grow food, cultivate micro-economies and help clean the urban environment.

OWNERSHIP

To date, a substantial number of owners redeveloping buildings into vertical farms (or more generally into urban agriculture projects) are do-it-yourselfers that have a deep general knowledge of building, agricultural and energy systems. The ventures rely on substantial sweat equity and volunteerism to help renovate facilities and add brainpower to the initiative.

BUSINESS MODEL

The building itself that is undergoing renovation into a vertical farm is often the center of all business activities for the owners, and rent and/or client fees account for substantial operating revenues. For example, The Plant in Chicago is a 93,500 square foot multistory facility that is being developed largely for food-based green and sustainable manufacturing use. Current plans for use of the building include brewing beer, manufacturing living walls, and food business incubating. Another example is a project by City Micro Farms (currently in Design Development Phases), which is an adaptive re-use of a lower level 30,000 square foot space in a 1950's post-industrial building. City Micro Farms is planning to operate aeroponic and aquaponic systems.

A primary or secondary revenue source is produce/fish grown in the vertical farm and sold under proprietary brands at grocery stores and farmer's markets, as well as restaurants across the city.

Chicago, like many Mid-Western cities boasts an abundance of post-manufacturing industrial buildings. In many cases these buildings are located in close proximity to Central Business Districts or high density commercial and residential neighborhoods. The cost of entry for the Renovation of Commercial Buildings is far lower as compared to the construction of new high-rise vertical farm structures and also allows for much faster project delivery. Post-industrial buildings are often cast-in-place concrete structures with heavy floor loads, masonry exterior walls (good insulation), high ceilings, loading docks and have large floor plates.

R/D TECH PARTNERSHIPS

Because of limited startup capital, collaborations are often based upon academic research and open source intellectual exchange. Collaborations necessary to scale-up this vertical farm model include:

Partner Industries	Breakthrough Tech Opportunities
Agriculture Industry	Hydroponics, Aeroponics
AgroChemical Industry	Develop Chemically Defined Diets for Vert Farm Crops
Building Materials Industry	Building Skin: Recycled Plastics as Glass Alternatives
Certification Industry	"Chicago Vertical Farm" Certification
Computing Industry	Systems Monitoring, Smart Grid Monitoring Energy
Industry	(Human/Plant/Animal) BioWaste to Electrical Energy
Electronics Industry	LED and OLED Lighting
Environ Remediation Industry	Brownfield Bio/Phyto Remediation
Fabrics Industry	Clothsheets used as Matrices for plant roots/seeds
Fiber Optics Industry	Distribution of Sunlight to Interior Plants
Financial Industry	Carbon / Water Pollution Trading
Food Industry	Urban Production, Storage, Distribution
Genetics Industry	Re-introduce select farm animals to city
Geothermal Energy Industry	Heat Pump for both cooling/heating, large scale
Hydrobiology Industry	Develop commercially viable plant species (seeds)
Manufacturing Industry	Value Added techniques to process/ship food
Modular Building Industry	Vertical Farm Pre-Fabricated Modules
Restaurant Industry	Locally sourced, secure food
Tourism Industry	Urban Vertical Farm
Vertical Farming Industry	Scale-up currently available indoor vertical farm tech
Waste Management Industry	Biosolids and organics recycling
Water Industry	Filtration, Evapotranspiration, Pipes/Pumping
Water Industry	Scale-up passive energy bio-cleaning technology

✸ ***COMPONENTS OF MODEL***

Existing Building(s) Renovation

- Multi-tiered single-story interior farming components
- Nursery
- Laboratories
- Integrated Control Center
- Equipment Rooms
- Kitchen, coolers and shared eating spaces

✸ ***POTENTIAL FUNDING SOURCES AND FINANCIAL INCENTIVES TO ASSIST OWNERSHIP:***

- Financially favorable sale or long-term lease agreement for developable building(s) between the City of Chicago and ownership.
- President Obama's Healthy Food Financing Initiative and the Federal New Markets Tax Program, which enables companies to get federal tax credits for investing in projects in economically distressed communities, to increase food options while generating economic development.

- Legislative programs such as The “Food, Energy and Conservation Act of 2008” or The Office of Energy Efficiency and Renewable Energy (EERE).
- City of Chicago Ordinance Supporting Incentives for Economic Development and Rehabilitation Projects.
- Tax Increment Financing.

SITE

Commercial Buildings in the City of Chicago

The feasibility of using an existing underutilized building will largely be determined by real estate and renovation costs. The scale of the overall operation will be dependent upon the size of the facility relative to capital, and existing infrastructures available on site for use.

Academic Buildings

Perhaps a local university, community college or high school would be interested to transform an existing building into a vertical farm. Existing laboratories and other R/D infrastructure on campus would be advantageous (and reduce startup expenditures). Expertise and work from faculty and students would be beneficial.

COLLABORATIVE OPPORTUNITIES

For-profit ventures often spawn parallel Nonprofits

For-profit vertical farm ventures sometimes start a nonprofit organization as an offshoot of themselves (for example: for-profit Sweetwater Organics in Milwaukee recently began the nonprofit Sweetwater Organics Foundation to educate the surrounding community about the overall health benefits of their urban agriculture business venture). Nonprofits place an emphasis on engaging and activating communities via educational programming, job creation workshops, environmental awareness initiatives and network building.

CASE STUDY EXAMPLE

Sweetwater Organics, Milwaukee

In 2008, Sweet Water Organics began the transformation of an abandoned industrial building into a showcase of potential living technologies and urban agriculture. Within the re-purposed industrial building grows fresh, safe produce and fish for local Milwaukee residents, restaurants and groceries. Sweet Water is a volunteer and community supported business. Sweetwater Organics strives to become a resource for job creation and re-use of urban settings.

COSTS TO BUILD

Existing building(s) renovation: $50 to $80/sf (far lower than new construction)
New vertical farm + new accessory building(s)

OBSTACLES AND BARRIERS

- Light capital
- Energy and associated operational costs
- Policies unsupportive of vertical farms: zoning (for aquaponics and related farming activities), plumbing, water reuse, food processing, etc.

✶ *NEXT STEPS: RECOMMENDATIONS AND OPTIMAL PARTNERSHIPS*

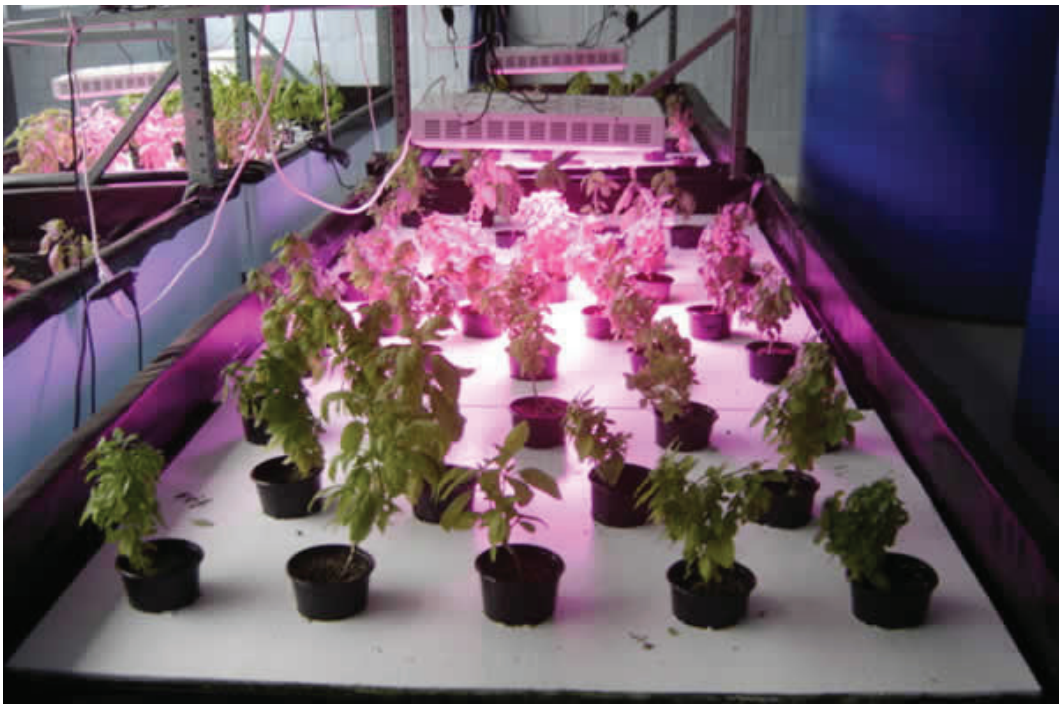
- Identify and map the various existing and future efforts throughout Metro Chicago
- Establish a public and/or private Working Group to assess applicability of Federal and State Legislative financial assistance and incentive programs in order to assist private (including academic and non-profit) sector efforts
- Expand the Working Group to include a consortium of potential owners, partners and investors
- Provide infrastructural and technical assistance for projects as they are identified
- Address code and licensing barriers at City and State levels (for example: commercial aquaculture practices)
- Explore zoning code, and building and business permit incentives (for example: begin a quick-permit program for vertical farms, or allow produce to be sold onsite in residential parts of neighborhoods with food access challenges)
- Establish a public/private Focus Group to assess policy barriers, make policy recommendations, and predict future public policy needs of vertical farmers

CASE STUDY: RENOVATED COMMERCIAL BUILDING

THE PLANT CHICAGO, IL

Plant Chicago, a new non-profit operating in the facility, works to discover innovative ways to integrate sustainable urban agriculture and manufacturing in disused industrial structures by closing energy and waste loops in the built environment and by directing the waste output of one process into the material or energy input of another. Ultimately, through anaerobic digestion and a combined heat and power system, the facility will operate at net-zero energy. The anaerobic digester will consume all of the waste produced in the facility from brewing, aquaponics and food production businesses. Neighboring industries have been approached about consuming food wastes and fatty acids from their production processes as well. The anaerobic digester and combined heat and power system will convert 18 tons of biomass per day to approximately 300 kWh of electricity and sufficient heat to operate the entire facility and rooftop greenhouses while providing process heat for brewing. While the facility is already heavily insulated, the efficiency of existing mechanicals will be improved and the building will be retrofitted to bring it up to high-performance standards with recycled and locally manufactured materials.

CASE STUDY: AQUAPONICS FACILITY



AQUAPONICS FACILITY CHICAGO STATE UNIVERSITY

The project consists of raising tilapia fish in a controlled continuously circulating water system. The effluent of the fish holding tanks are circulated through growbeds, providing nourishment where plants will be grown hydroponically (this integrative process between aquaculture and hydroponics is known as aquaponics). The facility provides a hands-on learning environment supporting the development of Chicago State University's Urban Agriculture/Ecology track option. Benefitting those matriculating at the university, area high school students, and the community at large, the Aquaponics Center serves as a resource and training center addressing nutrition and health issues facing inner city communities and green workforce preparedness.

CASE STUDY: AEROPONICS & AQUAPONICS

HARVESTED HERE CHICAGO, IL

According to Harvested Here (www.harvestedhere.com), a vertical farm urban agriculture initiative in Chicago located in a renovated commercial building:
"We have big plans. Because we knew there had to be a better way. Truth be told, our current agricultural system is broken. There's something wrong when the lettuce in your market has traveled further than you have. And not to mention, it got splattered with pesticides while it was growing and it was picked before it was perfect to allow travel time. Call us crazy, but we've always believed that produce ripened better while still attached to its roots rather than attached to a wooden pallet in the back of a truck."

ADDITIONAL REFERENCES

**GROWING POWER, INC.
CHICAGO, IL**

Iron Street Urban Farm
Established 2010
Located at 3333 S. Iron Street, Chicago, Illinois 60608.

Iron Street Urban Farm is located in Chicago's Bridgeport neighborhood. The vision for the urban farm is to "grow" healthy soil and energy, using closed loop ecological practices in order to produce local, healthy, and sustainable food year-round for Chicago. The seven-acre site will included:

- 10 hoop-houses to grow fresh produce year-round
- aquaponics systems, which will produce healthy Tilapia and Yellow Perch
- vermicomposting
- small ruminant husbandry, including chickens, ducks, and rabbits
- urban apiary with six bee hives
- urban orchard and vine fruit production
- green roof production and research
- the training an employment of over 40 youth
- the vision for the site is that it will also include an anaerobic digester to not only create nutrient-rich compost, but renewable energy as well

(www.growingpower.org and www.ironstreetfarm.com)

SAGE BOTANIC MEDIA

A for profit company utilizing vertical gardens as a marketing medium to tranform urban grey space into lush green vertical walls. Sage Botanic media is in collaboration with a UK based international, award-winning designer named BioTecture, specializing in vertical landscapes, ecological water systems and urban design. This brand is now being globalized via their work with Chicago-based Sage Botanic Media. (www.sagebotanicmedia.com)

**BENJAMIN N. KENNEDY
IIT THESIS**

Graduate Architecture Thesis Titled "Vertical Urban Farming: Growing a Better City with Urban Agriculture"
(www. kennedyarch.com/vertical-farming.php)