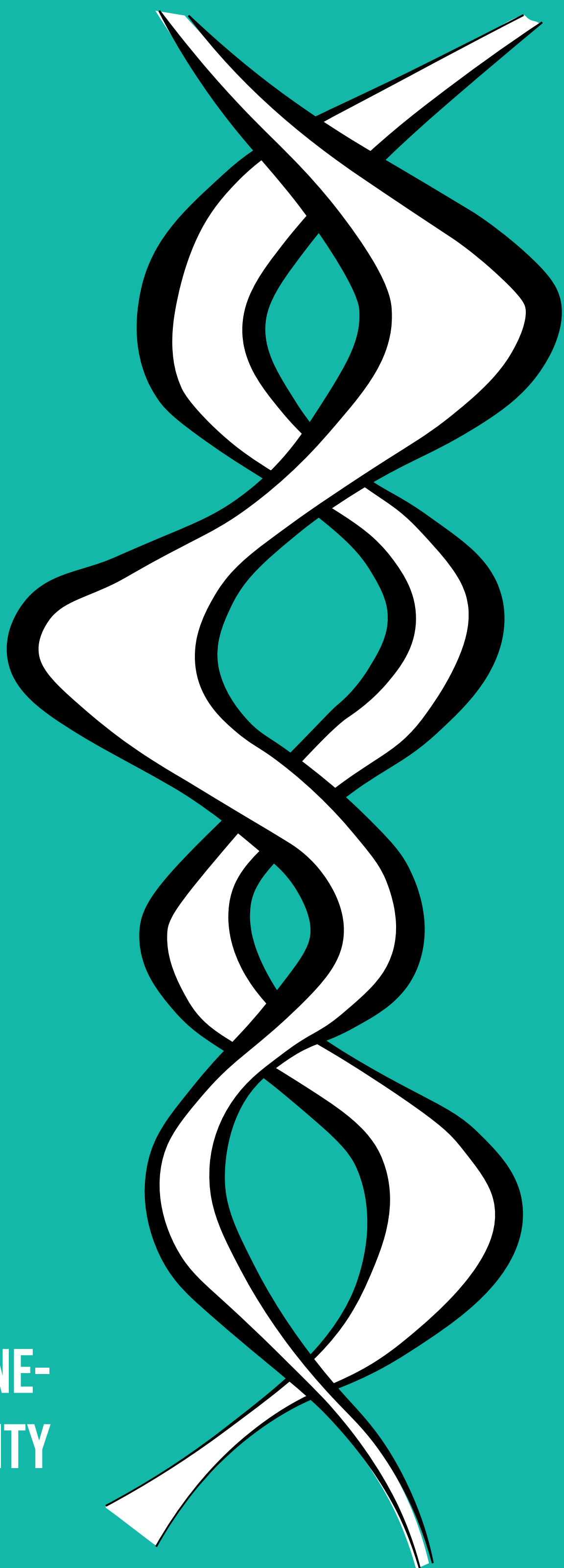
STRINGS OF LIFE



CIRCULAR ECONOMY IN DETROIT, MICHIGAN, USA

RECOVERY PLAN FOR DETROIT'S INCINE-RATOR AREA TO KNOT AGAIN THE CITY THROUGH ENERGY & FOOD.

Politecnico di Torino

Corso di Laurea
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Sessione di Laurea Luglio 2021

Strings of Life

Circular Economy in Detroit, Michigan, USA

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Vorrei ringraziare la mia famiglia, per avermi permesso di studiare con grandi sacrifici e per avermi supportato e sopportato in tutti questi anni, nonostante la mia personalità a volte volubile.
Grazie a mia madre Yvonne, a Silvano e a Benny, cuore mio spero che un giorno anche tu possa realizzare i tuoi sogni.

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Grazie Pelle, Rugge, Erni, Poetz, Carne, Biglia, Lollo, Alin, Pollo, Frunder, Gian, Gas, Alex, Big, Beppins, Sandro, Giusi, Balma.
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DETROIT NEVER LEFT

Abstract

Ever since its first appearance, the incinerator has been a very controversial object which people don't easily trust. Taking into consideration progress and the evolution of technology which have both made this instrument much more sustainable for green development, the collective imagination has never shifted from those original opinions. Moreover, issues like trash disposal and fresh food production in the United States are growing increasingly serious. We have to re-think a new living model that will concentrate on all these problems and try to find an adaptive solution with the structures that we already have at our disposition.

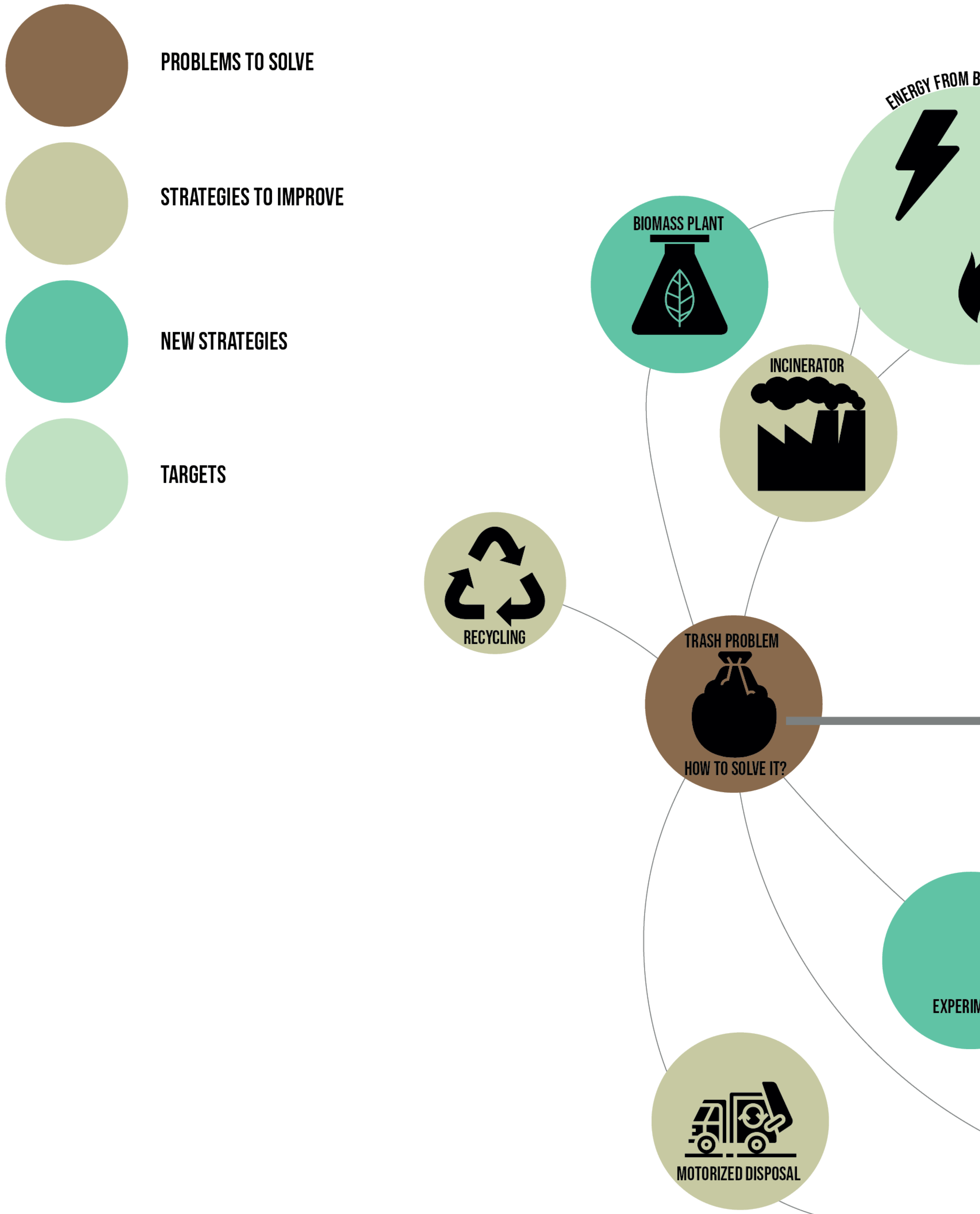
Is it possible to create a replicable model for a performing instrument that receives energy from trash in 2020, using it to generate fresh food products that people need?

It is the driving question behind this thesis, following a cognitive path that will outline these kinds of energy facilities: starting from the sociologic history of incinerators and all the issues that ensue, inherent to the recent history of Detroit and all the associations and protests against it, passing through new technologies and methods for trash disposal maximizing returns, reducing the issues of smell, and dissecting whatever other problems which are created within the community as a result.

The final aim of this thesis is to generate an energy cycle starting from waste, reinvesting it within high-tech structures for fruit, vegetables production for Detroiters. This could be useful for an underlying and very hidden problem in the United States, especially in Detroit, which is the issue of food desertification. It is a major wide-spread problem in the whole of Wayne County.

The last purpose of this project is to raise the level of the quality of food and, at the same time, reduce trash produced by packaging thanks to the km0 market hub of this project. The cycle closes its path with trash sorting, where the organic portion will be sent to a new biomass plant, while the other parts will be divided between incinerator and recycling facilities. These are currently in operation in two areas near the Detroit Renewable Power Area. Energy remnants will be used by the citizens with a district heating network which is already used to lower the very high existing energy bills of the city.

The hypothetic scenario for Detroit could be a possible shrinking city thanks to these punctual interventions regarding energy and food, so the county can reduce the energy waste more steadily. This project would be an example of how a city, drastically crippled by economic crisis – the auto-motive crisis of 2010 to 2013- can recover once more with a very clear and solid idea of how to do it. The City of Detroit cannot depend exclusively on the automotive industry, but needs to divide its investments, in particular in sustainable energy, and to improve the welfare and quality of life, starting with food production.


PROBLEMS TO SOLVE
STRATEGIES TO IMPROVE
NEW STRATEGIES
TARGETS
ENERGY FROM B
BIOMASS PLANT
INCINERATOR
RECYCLING
TRASH PROBLEM
HOW TO SOLVE IT?
EXPERIM
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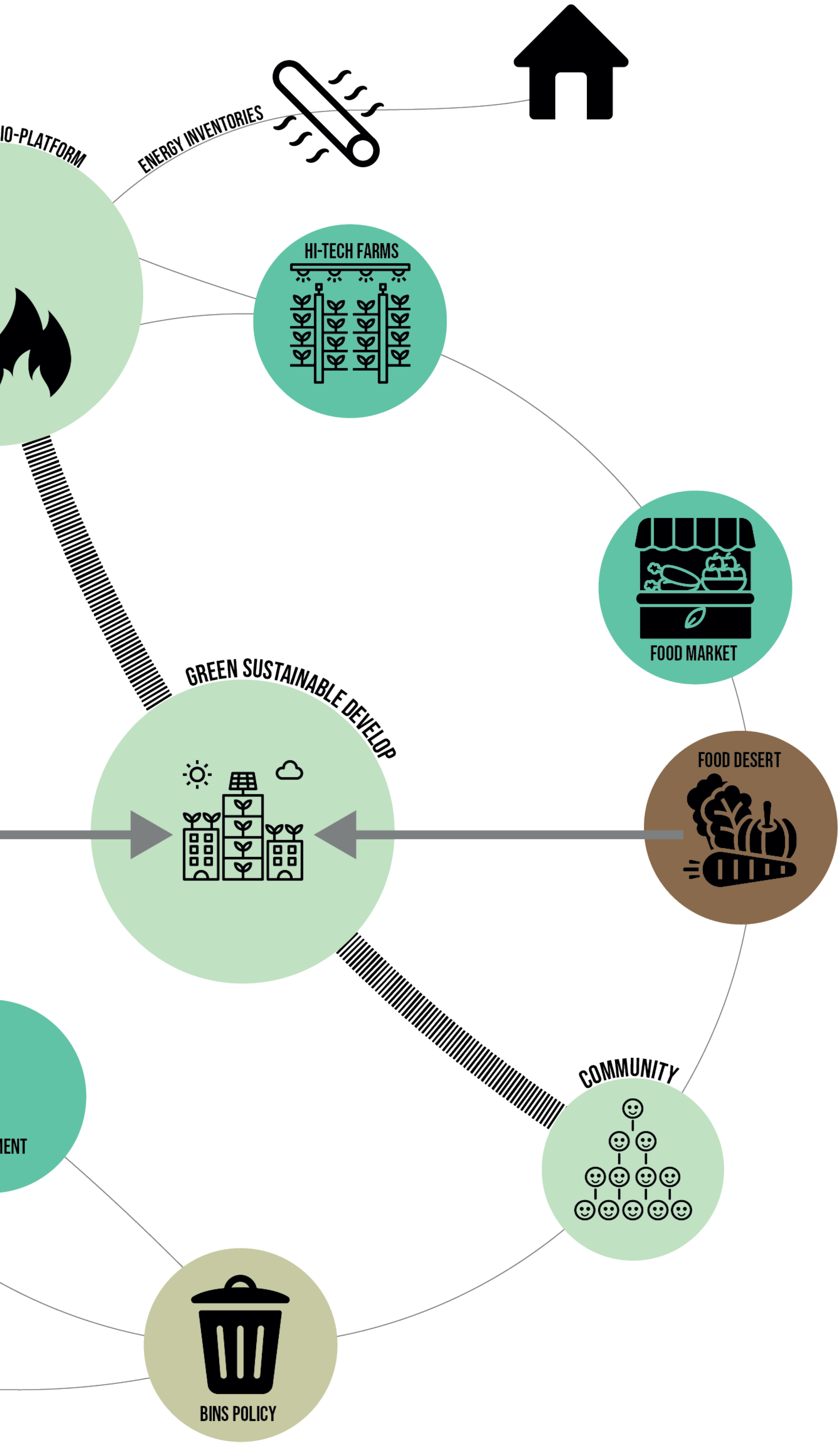
IO-PLATFORM
ENERGY INVENTORIES
HI-TECH FARMS
FOOD MARKET
GREEN SUSTAINABLE DEVELOP
FOOD DESERT
IENT
COMMUNITY
BINS POLICY

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ACKNOWLEDGEMENT.

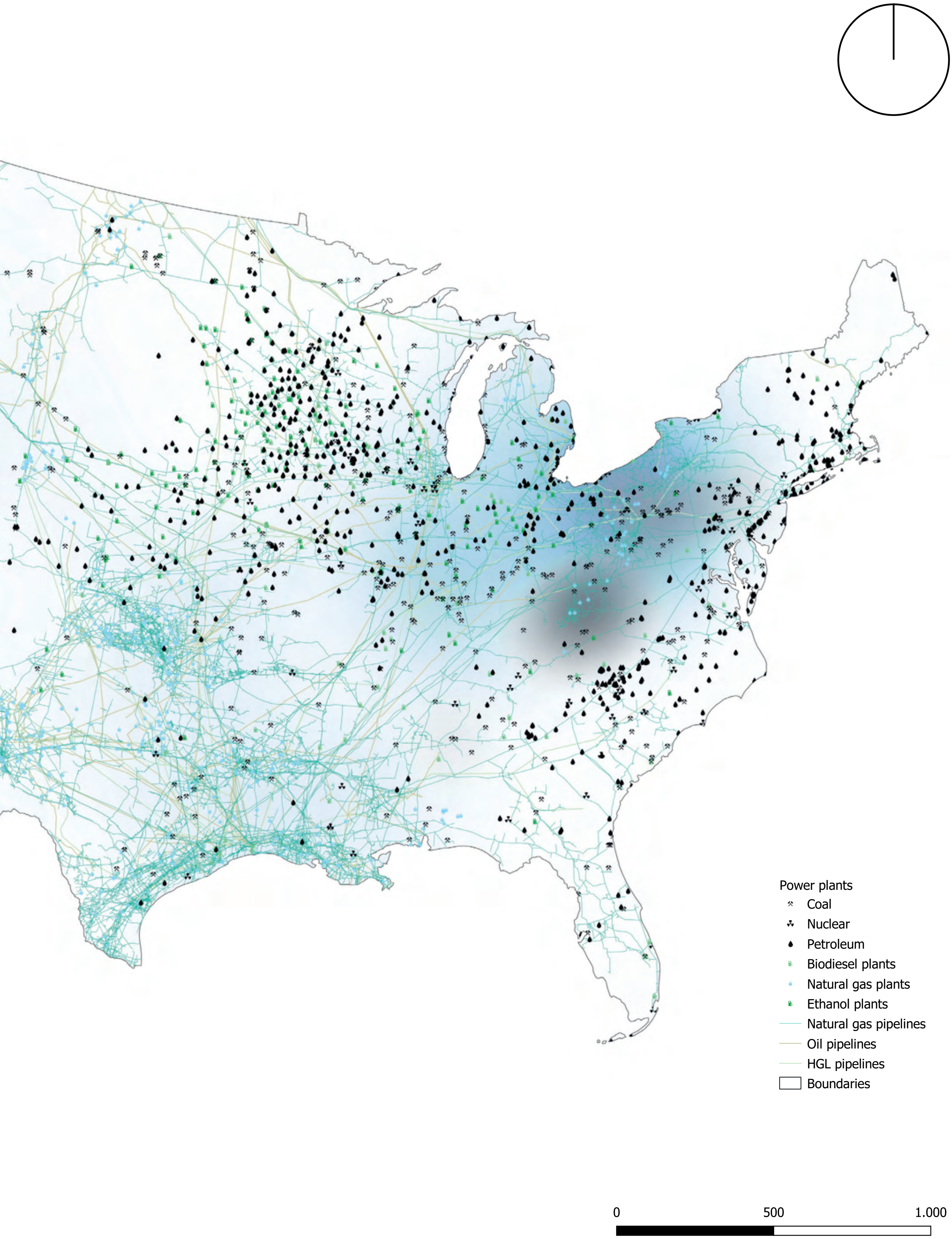
Acknowledgement

Over the last few years, U.S policy regarding energy has often been contradictory. Questions about renewable and un-renewable energy are fundamental for a country that has one of the biggest reserves of raw materials in the world. Government is too busy increasing economic power at the cost of the environment, community, health from pollution, and climate. (“American First Energy Plan”, SVG International, 2017).
In its last five years with Trump as president, the government continued its energy plan of non-renewable power using coal, oil and gas. That’s because the United States has still got a huge supply, especially in its central states. The world market of energy is, instead, moving towards sustainable energy like solar and wind power, … (Il Sole 24ore, 2017). Investing in non-renewable power takes away from the funds that sources like solar and hydroelectric might need to make a big jump in the economy.
The scenario could be so very different for a country where its vast spaces and differing climates are important resources, keeping renewable energy at the forefront. Using national funds to develop these kinds of plants is much more responsible, also considering the economic aspect. What will we do when every raw material in the world is destroyed? It remains one of the biggest questions of the century. Technology moves progressively, but we have to make it work within the economy, evaluating the yield of its processes. Is it possible to live exclusively with sustainable power in 2020? Is technology advanced enough and industrialized enough for such a shift?
The answer is yes, but it is necessary to combine various sustainable sources, assess locations and exposition, choose the best combinations to resolve specific problems. Michigan for example, has one of the greatest natural gas reserves of U.S.A, but at the same time has geo-morphologic features that allow for high-speed winds. These flows can generate huge amounts of energy that

can sustain many states. Another source is trash, which is not a proper sustainable supply, but it could be used as such. The state of the Midwest is one of the first three U.S state importers, which also includes Canada, amongst other countries. Currently most waste is disposed of in landfill, which pollutes water supplies, the ground and the entire ecology of the state. Why not use all the potential energy of trash to produce an energy supply for the city? And how can changes to the city be compared? These questions are the foundation of this thesis. Energy supply has been the number one question of the new millennium since the first industrial revolution.

Government decisions have cut out Detroit, and the whole of Michigan, from the main U.S energy flow over past years. Oil and gas pipes come from the south, areas which are historically richer in raw materials. In fact, Michigan imports 97% of its oil requirements and 100% of coal from other states and countries. Energy for Michiganders is still heavily reliant on thermoelectric plants powered by coal. This has two consequences: the first destroys resources; the second produces immense pollution from the burning process of coal. Despite these issues, it remains a commodity, and also an economic waste to keep electricity. On the other hand. renewable power reaches almost 8% of the state energy requirement, half from wind power (EIA, May 2019). Obviously, it isn't enough to cover the whole state at the moment. According to external assessments, if government invested massively in renewable power, cities could be self-sufficient within 30 years.

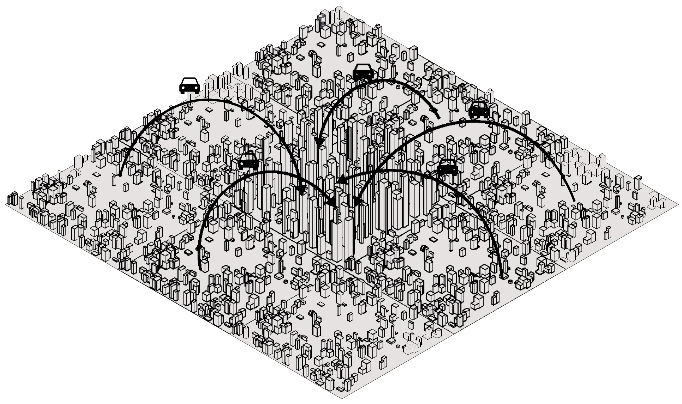
Being left out of these energy routes and dynamics, Michigan doesn't have the resource capacity such as states like Texas and Louisiana, ... so, it must modify its approach to energy independence, aiming for renewable power as they are already doing with wind energy. Every country or state has its weak points. These features must be transformed into strengths. For example, huge landfills of disposed trash, could be used as "fuel" to produce energy, or sludge treatments turned into biomass centers, phytol-depura-



United States energy resources and infrastructures.
Map realized by the graduate with Q-Gis.

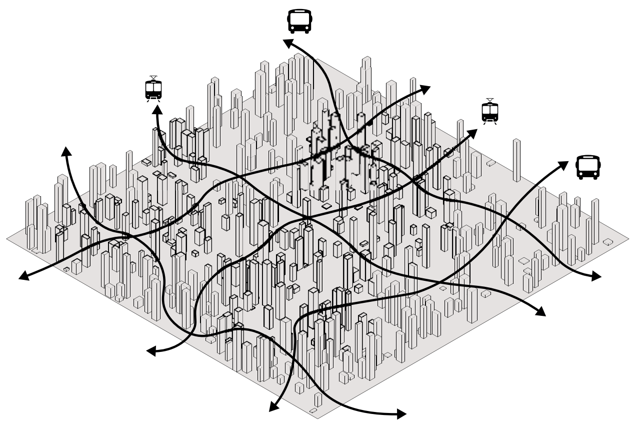
tion, ...
The increasingly sparse availability of energy sources combined with climate change will have this global phenomenon transforming our way of life over the next 30-50 years. The reason for this scarcity of food production, which will change drastically on the planet, is due to land submerged by oceans, consequently reducing field availability. (Energy [R]evolution ,2015). How will architecture develop under such circumstances?
Architects will face many difficulties in light of this changing world vision, according to the phenomenon that changes it every day. How will food production infrastructure transform after these events and how will we supply meat and fish, if we eat much more than we can actually produce? This analysis tries to offer a hypothetic resolution taking into consideration all these conditions. There are many studies regarding future city development; some of them are trying to envision a city that is so dense and vertical, so as to reduce waste, and increase yields. Meanwhile, at the same time, cities, especially in U.S, are characterized by urban sprawl, an urban planning phenomenon born in the XX century that diffuses cities in huge spaces forming suburbs. This is the cause of many pros and cons of the modern American city, like higher property values, development of transport systems, and including the dependance on cars, increased air pollution and lower quality of life, amongst others (Shrinking Cities, 2017).
These transformations will bring a major necessity for cities to choose new paths for energy supplies, and for agriculture and 0km food distribution. Global food market chains will probably shrink too, returning to healthy eating structures, depending on what each country or state has to offer its community. The process will possibly start from self-sustaining production within cities rather than foreign markets (Principles and Criteria of Bioenergy, Energy [R]evolution ,2015). Energy will be saved as much as possible and have immediate added benefits. Every city will have a Waste to Energy program, taking advantage of all possible energy sources from trash, too. “The mission of the Waste

Present_Sprawl city



.Viability

Future_Stratified city



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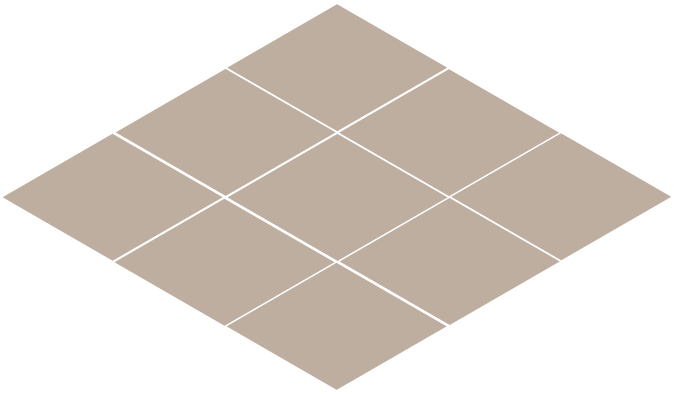
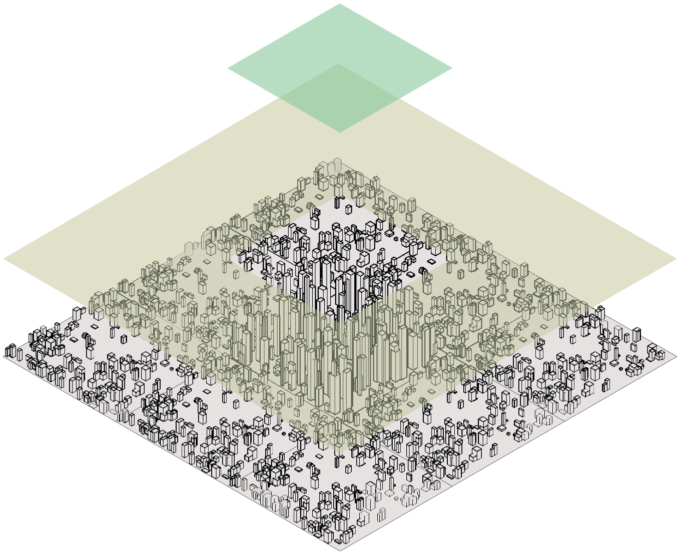
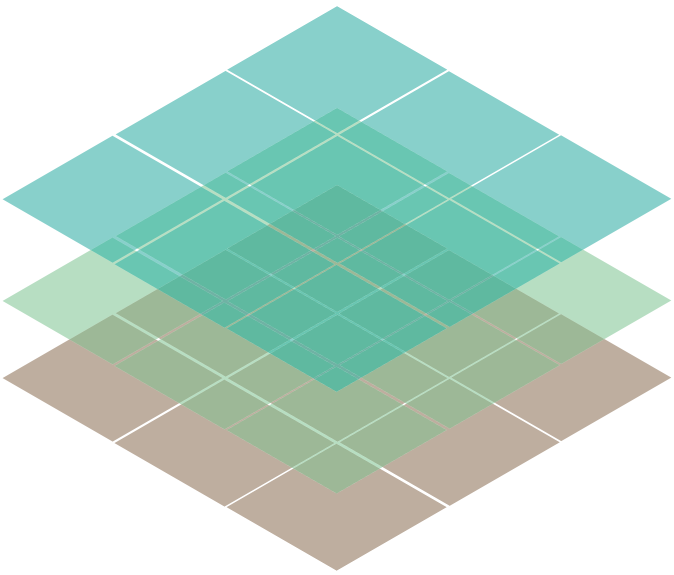


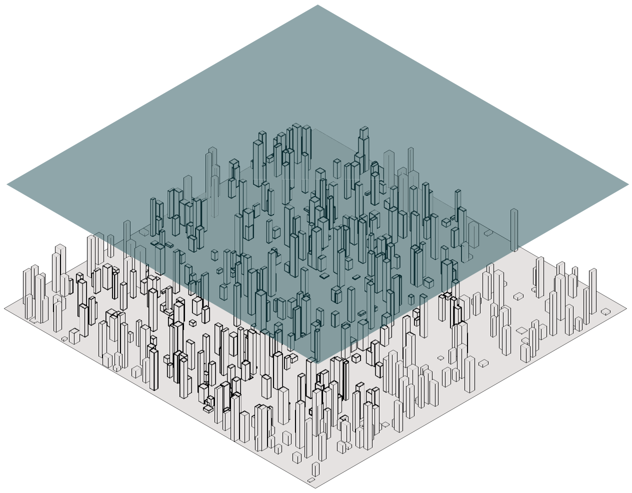
.Neighbourhood grid



.Social & Economic development



. Stratified sectors grid

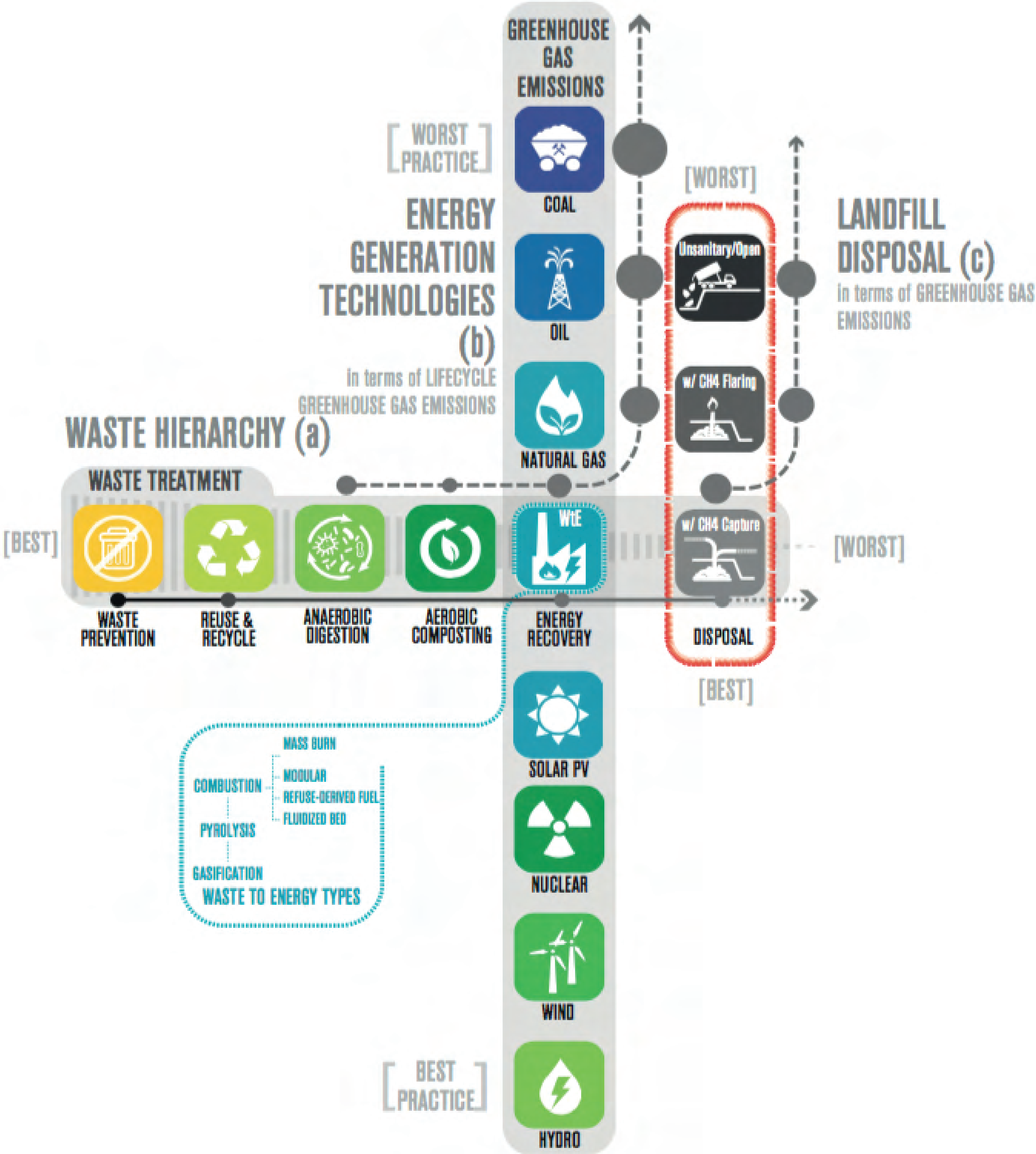


.Social & Economic development

Sprawl city vs future stratified city.
Model and diagrams realized by the graduate.

to Energy Design program is to rethink the relationship between architecture and waste, though research and design. Architecture and design currently play a minor role in the design and construction of industrial building types, and the Design Lab seeks to re-engage interdisciplinary design and architecture with industrial buildings and facilities." (WTE Design Lab, Harvard's Graduate School of Design, 2014-2016).

Urban design, according to these programs, brings many transformations to city infrastructure, trying to centralize energy facilities. It's imperative to reduce losses as much as possible, in order to approach energy utilities like the primary sector, and industries, ... Agriculture and animal breeding will be condensed to small areas like Vertical farms, or meat labs where chemists develop invitro meat supplies (Green Cities, 2014). Finally, trash cycles will also transform, passing from consummation to landfill, "from consummation to transformation" through WTE facilities that recycle reusable trash, with the remaining part being sent to incinerators or onto biomass plants to be converted into heat or electric energy. As a consequence, a city should reshape itself according to these new flows based on this centralized model.



Comparison of WtE facilities greenhouse gas emissions to those of other energy generation technologies; the waste hierarchy including WtE energy recovery process; and landfill disposal practices ranked by greenhouse gas emissions.
Source: WtE Design Lab, Harvard University

1.1. HOW TO SOLVE TRASH PROBLEM?

1.1.1. WTE PLANT'S HISTORY

WASTE

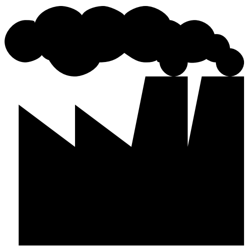
ENERGY

1.1.1.Waste to Energy plant's history: from first incinerators to BAT

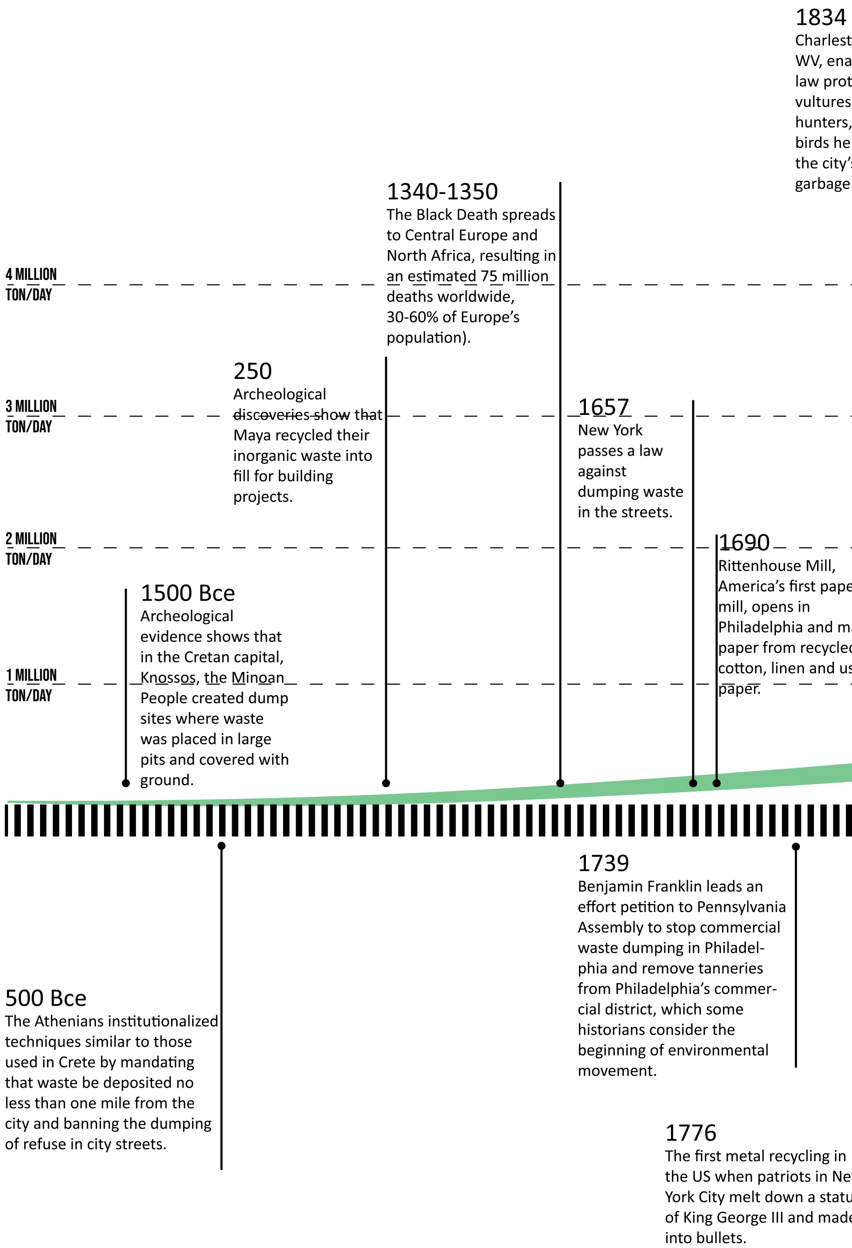
First structures able to burn trash made their first appearance in Europe, at the end of XIX century. In 1885, Manlove, Alliott & Co. Ltd. made the first ancestor of incinerator. Technology used was rudimentary and so obsolete than grill oven technology. This technique will revolutionize waste burning's field. Obviously at that time was not present energy recovering from trash, neither emission treatment, which has upset the global environmental balance (with industrial processes, ...). The main reason why in the XIX century was important burning waste was related to diseases diffusion and epidemic. Huge population increases due to industries had flooded the cities with waste (AdnKronos, 2016). At the same time "the US Army built the first solid waste incinerator in the US on Governor's Island in New York Harbor in 1885. In the same year, the City of Allegheny, PA, built the first local government-owned incinerator. Other US cities quickly followed Allegheny's lead. US incinerator designs drew heavily from European technology, but US experiences were not overly successful primarily because of the higher moisture content of US refuse" (MSW Management, 2001).

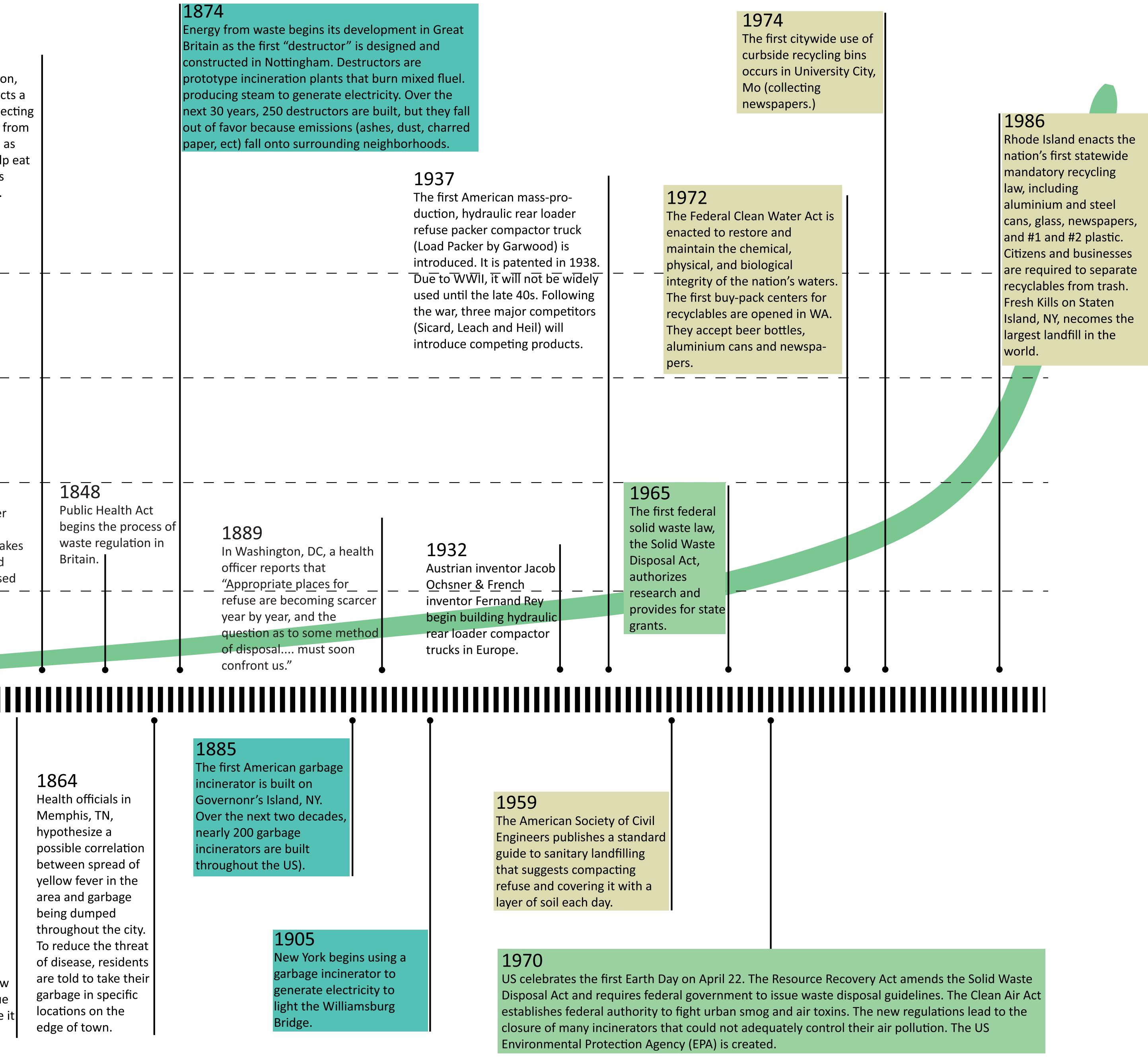
Large scale diffusion of that kind of plants, needs to wait the economic boom of 50's. Landfills are every year less sustainable for the communities and people start to worry about environment. Moreover, these structures take many spaces during years where cities are in full expansion, as well as strong environment impact. At the same time technologies usable for incineration plants are improving exponentially. More clean about emission and a cheap alternative in economic terms compared to landfills.

Grill oven technology revolutionizes the way to practice incineration because allows a fluid, continue intake raising efficiency, mostly energetic. This process transforms obsolete incinerator into Waste-To-Energy plant, but



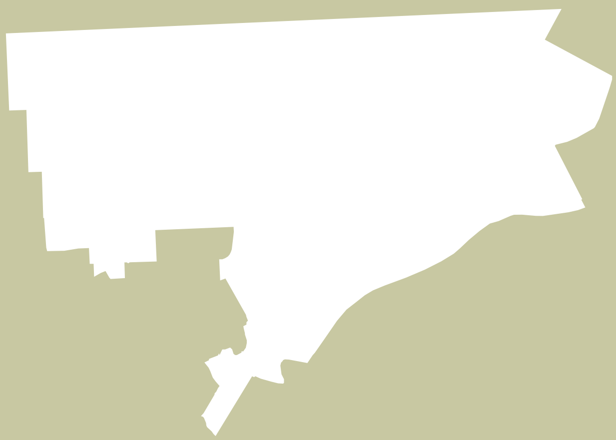
allows a fluid to continue its intake, raising efficiency energetically. This process transforms the obsolete incinerator into a Waste-To-Energy plant, but burning solid waste under controlled conditions (incineration) is not a modern idea. Recovering the energy released from burning waste materials is not a new idea either. In the 1700s waste paper was used for heating and cooking (Phillips, 1998). Used vegetable oils were used in lamps in the 1700s. In 1876, the English burned waste, in a unit they called a "crematory," solid waste for fuel to generate steam to produce electrical power. There are reports of the successful use of refuse-derived fuel (RDF) in Japan around 1897 (Phillips, 1998). Burning solid waste as a disposal method came to the US soon after the English experience noted above (MSW Management, 2001). Over the following years filters were added and treatments for smoke emission - more for harmful emissions, like HCl – hydrochloric acid, SO2 – sulfur dioxide- produced by the process (AdnKronos, 2016). The most advanced model at the moment is in Northern Europe thanks to a simple way of thinking, which places WTE facilities in urban centers, and designing them with the Best Available Technologies – herein referred to as BAT. These techniques allow cities to insert big energy facilities according to the best smoke filters and pollution reduction that reduce heavy metals like dioxin and particle emissions to a minimum, or utilizing washing towers that transform gases, also known as scrubbers. Furthermore, in the last decade, ash stock problems were solved by beneath the surface oven deposits. These ashes can be reused for infrastructures like walkways or in buildings. Most advanced plants nowadays allow to recover 90% of energetic potential from trash (AdnKronos, 2016). Northern Europe has directed its policies to recovering this kind of trash disposal recovering energy for many years now, which has become the distinctive benchmark of waste management. Many territories in Germany and Scandinavia include WTE facilities in their town planning, which gives energy to huge districts of heating networks in cities





Time line of waste management.
Re-drawn diagram.
Source: WTE Design Lab, Harvard University

1.1.2. WHERE:
WITHIN THE CONTEXT OF DETROIT

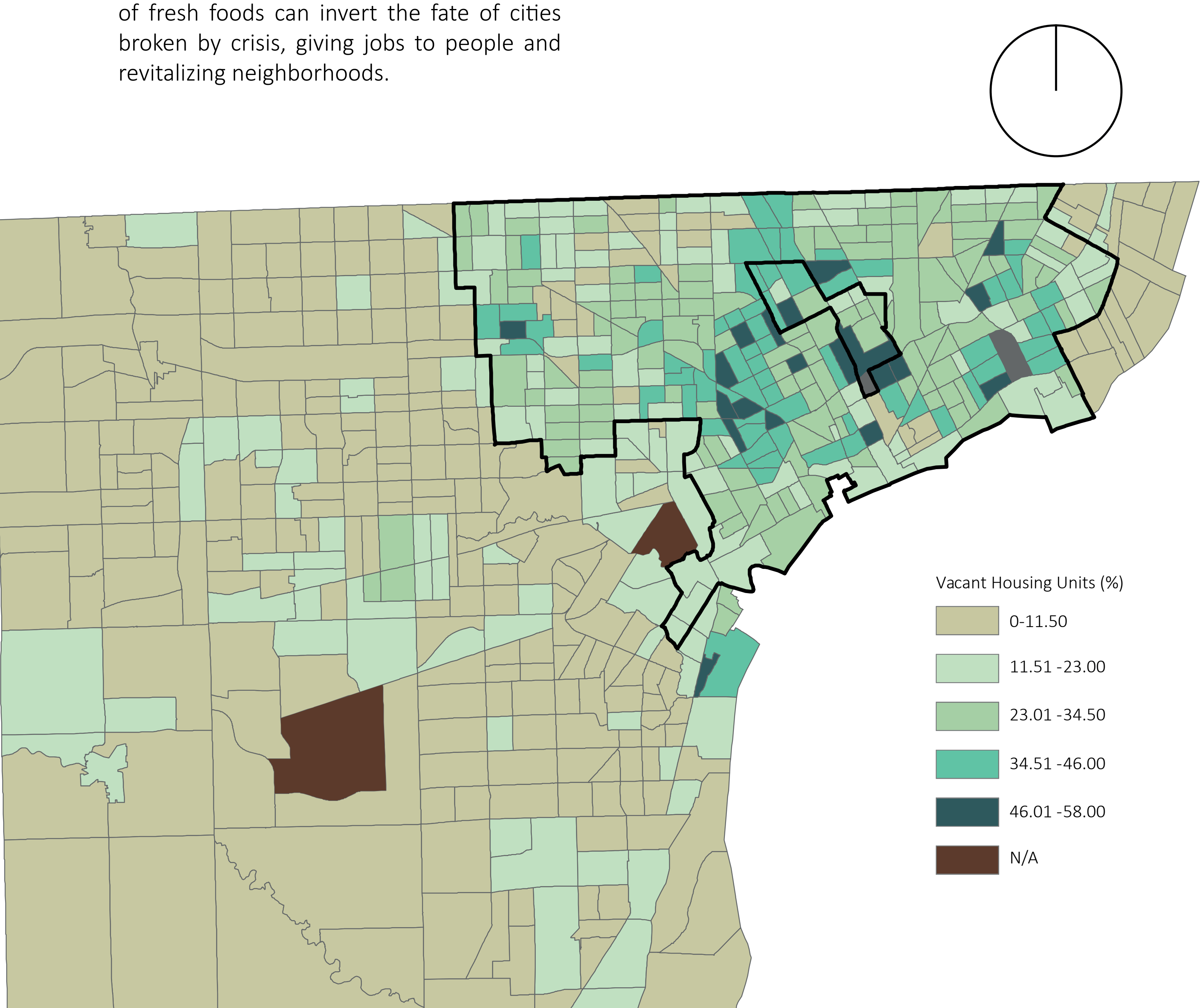


1.1.2. Where: Within the context of Detroit

The city of Detroit is famous worldwide for its automotive industry, music and much more. On the urban level, instead, city planning is distinguished by big radial roads that start from Downtown and tie the city horizontally, simultaneously solving and creating urban sprawl problems. Neighborhoods started to develop with low density blocks and the city became so large that it was necessary to make the freeway network in order to make the moves from home to work easier. The presence of giant freeways to cross the city made it unnecessary to pass through suburbs that had become nothing more than large dormitories for commuters, often leaving big areas of the town in isolation with rising crime and poverty. This caused years of crisis and an explosion of the real estate bubble, with too many properties to sell and no one who could afford to buy them. Detroit had a very heavy crisis period between 2010-2015, where houses abandoned by owners who had left Detroit were sold in auctions for only a few thousand dollars, causing a real estate market slump.

These sprawling suburbs created public mobility problems, especially for the poor who did not own a car, and who had to travel large distances to get from one side of the city to the other. To assess this statement, let's compare Turin and Detroit. Numbers show a population density in Turin three times that of Detroit (6700 ab/km2 against 1819 ab/km2) (Wikipedia, 2020). The consequence of this are service shortages, with longer distances to facilities that supply groceries and marketable goods. Currently, public transport systems are almost useless and include huge network management costs to Detroit. Public transport is used by low-income families, whereas better-off families can afford two or three cars, the production and disposal of which place a heavy environmental burden on the city. If the city were denser and services more concentrated, surely all these problems could be improved. Encouraging citizens to use improved transport systems and alternative modes of transport such as cycling, would only elevate the quality of life.

Urban planning issues must include urban void themes, which Detroit represents symbolically. Over the last 40 years, huge areas with factories and houses have been literally abandoned, reducing parts of the city to deserted and soulless lots. What can be done with these lots? There are many solutions, the first being to occupy them and to encourage a process of city growth. Combining these two solutions, the city could truly change. On the one hand, urban voids and abandoned buildings can be reused, thus avoiding added expansion. Furthermore, big infrastructure projects, for example for food or energy, can attract people, reducing urban sprawl and encouraging jobs and better living. Adding functions like trash disposal, energy transformation and production of fresh foods can invert the fate of cities broken by crisis, giving jobs to people and revitalizing neighborhoods.



- 60 %

POPULATION

Detroit passed through a very hard period with automotive industry failure, that was the only sector of Detroit, people changed their life in other places. Many people died too with no sanitary assurance, etc

≥ 70000

ABANDONED BUILDING

Crisis period pushed Detroit's citizens to flee from the Motor city, destinations as Chicago, NYC,..

Percent of vacant housing units by Census Tract in Wayne County (2011)
Map by: Roman Yanke, University of Illinois Urbana-Champaign
Date of map production: 11/19/2013
Projection: Great Lake Basin Albers Conic
Central Meridian: 83.25° W
Standard Parallels: 42.25° N , 42.30° N
Source: American Community Survey (ACS), 2011

1.1.4. DETROIT RENEW. POWER. PROJECT LOTS

1.1.4. Detroit Renew. Power Project lots

Area under study is located near the Detroit's center. Precisely town's incinerator is in the Northern part of Midtown, transformation hood where are traditionally all the universities of the city. Moreover, there are many commercial activities, residential condos, … so is one of the part of the city more needful of energy. Project spaces are sum of parcels where are present many facilities related to the incinerator like recycling stocks for metals, transformation plants for recycling property of U.S Ecology. Moreover, there are many urban voids and abandoned buildings that can be used for adaptive reuse interventions.

Detroit Renewable Power Area was built in 1986 and "it was lauded by the city's government and citizens as it was expected to bring economic prosperity to Detroit." (ZeroWaste Detroit, 2006). "Is permitted to process over 1 million tons of solid waste per year. According to a national directory of incinerators prepared by the Energy Recovery Council, the Detroit incinerator is the largest facility of its kind in the country. It is also the fifth largest solid waste disposal facility in the state of Michigan. The major part of solid waste burned at the incinerator comes from outside of the city of Detroit (THE DETROIT INCINERATOR PRIMER: Construction, Design, and Operation, 2014).

"In 1975, the city of Detroit established a resource recovery task force, which was led by the Department of Public Works, to find a suitable site for a solid waste incinerator. At the time, the city of Detroit wanted to find a long-term solution for its solid waste disposal needs. It was hoped that building a publicly owned incinerator would provide long-term economic stability and predictability regarding solid waste disposal. A publicly owned incinerator would allow Detroit to avoid paying increased disposal fees, which were predicted to result from a shortfall in landfill capacity by 1990." (THE DETROIT INCINERATOR PRIMER: Construction, Design,

and Operation, 2014).
“The facility was initially constructed and operated by Combustion-Engineering, Inc. and owned by the city of Detroit. Its design and basic functions have remained largely unchanged since its construction. Waste is received at a 4,000-ton tipping floor. From there, it is fed into one of three identical processing lines where it is shredded into refuse derived fuel (RFD). Once processed, it is conveyed to a 3,600-ton RFD storage area. From there, RFD is conveyed from the secondary storage area to one of three boilers for incineration. Each boiler is a waterwall unit, which means that each boiler is lined with a layer of water that converts to steam during operation. The steam produced during incineration is used to power a 68 mega Watt turbine generator and is diverted for distribution to the steam loop for heating and cooling purposes.” (THE DETROIT INCINERATOR PRIMER: Construction, Design, and Operation, 2014).
Incinerator’s position is strategic because is in proximity of a freeway junction, at the intersection of I-94 and I-75 at 5700 Russell Street, that is useful for trash trucks to move easier through the city even to far neighborhoods. The facility shutted down in 2019 for many protests and class action from people and City of Detroit, because emissions and bad smells were on every day, with danger of lung diseases related to long exposure by citizens of Midtown and nearest neighborhoods. Obviously, a plant opened in 1986 had obsolete technologies, and the same City of Detroit first, then the private company who bought the facility, they should have updated technology and processes over time. To re-open a big facility like that, removing it from abandonment as the other thousands of buildings in the city, it’s necessary to set a retrofit design to fix these problems and bring the incinerator into 2020, with different burning methods (dividing trash before) and raising up yields (ZeroWaste Detroit, May 2019).
“The incinerator is permitted to process 20,000 tons of garbage per week and 1,043,000 tons per year. The amount of wa-

2d aerial google maps view.
Highlight on the project area and Joe Louis Greenway.

ste received by the incinerator varies, but is generally around 800,000 tons per year. According to reports submitted by the owners of the incinerator to Wayne county, in 2017 the incinerator received 822,579 tons of waste and incinerated 789,933 tons of the waste that it received" (THE DETROIT INCINERATOR PRIMER: Construction, Design, and Operation, 2014). In 1986 was praised from U.S government because would bring economic prosperity to Detroit and was the biggest municipal WTE plant ever built in the world.

Fig. 1: Detroit Renewable Power area. Southern front.
Image courtesy of Francesca Fera personal collection.

Fig.2: Old railway on Joe Louis Greenway near incinerator.
Image courtesy of Francesca Fera personal collection.

Fig. 3: Albert Kahn's building at 1950 East Ferry Street.
Detroit, Michigan (USA).
Image courtesy of Francesca Fera personal collection.


Amen!!!

1.1.5. PEOPLE AGAINST.

1.1.5. People against

People ever liked the presence of the plant, for one simply reason. An incinerator works well if trash is divided and burned by material. Moreover, burners have to be calibrated at particular temperatures for every material to not create bad emissions like dioxin and combustion products. Detroit's incinerator worked always in a bad way because waste management and policy about recycling are not defined, today too.
Controversy and protests has been raised over the years from people and associations, till the closing in 2019. ""What a glorious day for the city of Detroit and its residents," Sandra Turner-Handy, co-supervisor of Zero Waste Detroit, told the Free Press. The decades-old incinerator has been a source of ire and frustration for many nearby residents who have complained for years about pungent odors and noise from the facility, near the interchange of I-75 and I-94, northeast of downtown. "(Detroit Free Press, March 27th 2019). The true question is, why this model can not work in Detroit while in other parts of world (like North Europe) it's an integrant part of the city and gets energy, economy advantages for citizens? Answer is simple: vanguard technologies, waste management (recycling) and facility management.
There are two big problems to solve to make people happy: first is trash's smell located in the plant, second it's about emissions, surely dangerous for human beings. Smell problem it's caused by trash staying in the facility for a long time, so trash input and output should be the same to avoid that problem. It means, at this time, that incinerator need to be upgraded, reduce trash produced by the city, or dividing it in more facilities. Reducing trash production can be solved by marketing, information for people, acting a strong recycling policy. Dividing waste in more facilities is easy if incinerator, recycling plant and a new biomass plant can co-work together to create a big BIOPLATFORM. Emissions problem, instead, is more complex but solvable. This problem concerns about Best Te-

chnologies Available method, structure policy where building are completely dependent from technology, always looking for new processes less impacting on environment. Denmark, Germany, Sweden, Netherlands are a model to follow in this field. It's important to recover this building and not letting him abandoned as the rest of the city (resume from part of interview with Dale Lane, ex Engineering Manager for Detroit Thermal LLC, June 2020).
Synthesis of problems exposed by associations as Breathe Free Detroit, Zero Waste Detroit, ... become solvable issues through this kind of design too, participation of the community in the process, understanding problems and organizing discussion tables with stakeholders, bringing forward BAT concept.

21927

PEOPLE

Living on near areas of Detroit Renewable Power.

71%

LOW INCOME

People that are living near incinerator are in economic difficulties.

800000 TONS/YEAR

INCINERATOR WASTE BURNING

Effective amount of trash burned each year. 20% from City of Detroit

367 TONS/YEAR

CARBON DIOXIDE EMITTED

Data from "THE DETROIT INCINERATOR PRIMER: Construction, Design, and Operation
A Report Provided by Breathe Free Detroit.
Authors:Nicholas Leonard
Staff Attorney Great Lakes Environmental Law Center

1.1.6. INCINERATOR'S FALLOUT ON CITY.

TESTIMONIES OF EXISTING PLANTS

Incinerator’s fallout on city
Testimonies of existing plants

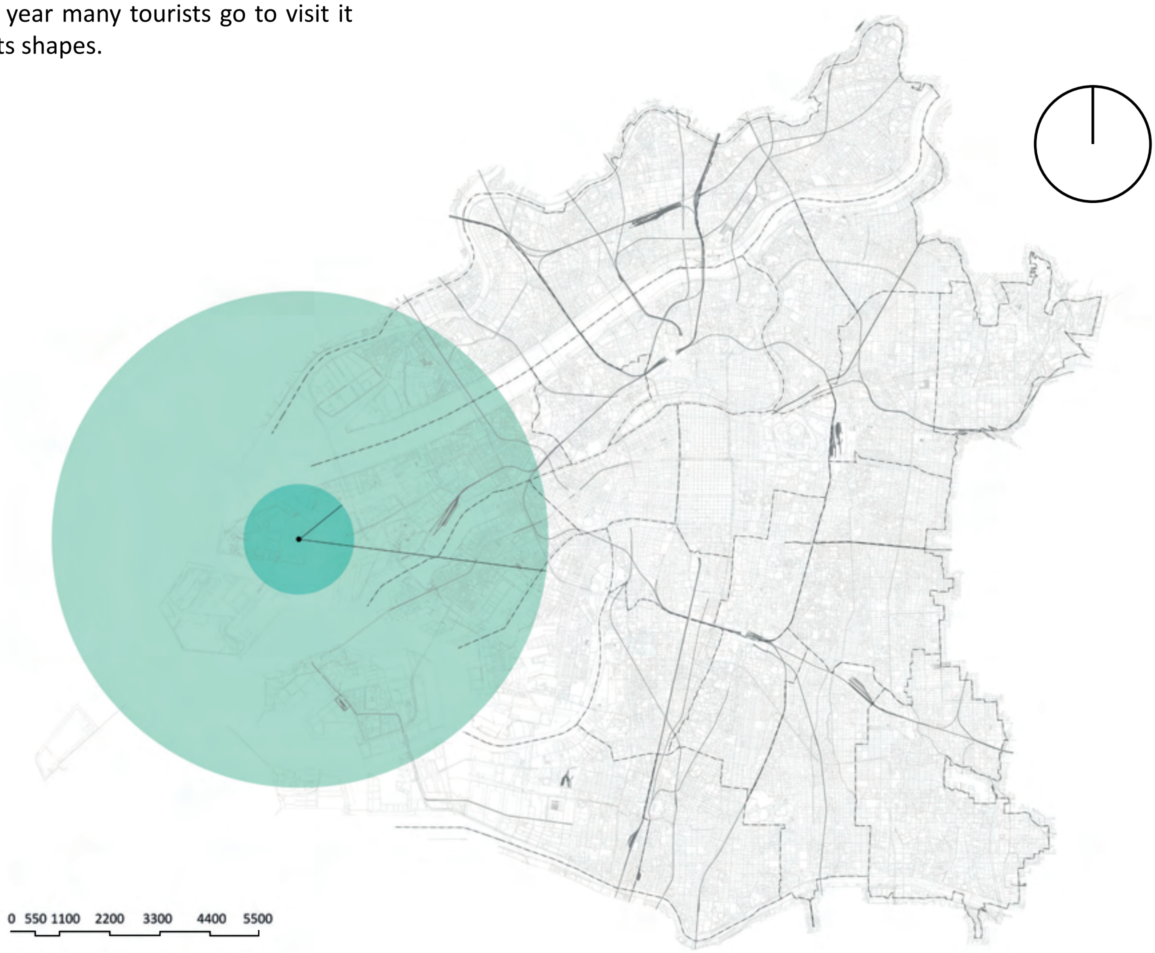
“Living next-door to a waste incinerator was never a problem for us. It was clean and silent, and to be honest, we hardly ever noticed it. Except, of course, when the heating bill arrived.” Camilla Reimann, former Hørsholm resident (Compendium for the Civic Economy, May 2011). Horsholm’s case in Denmark shows how facilities can be green and have a positive outcome on a city and its people. “Hørsholm now sends only special categories of waste (less than 6% of the total) to landfill: 60% is recycled, 33% is incinerated and 1% is hazardous waste that goes on to special treatment. The local waste-to-energy plant generates 80% of Hørsholm’s heat and 20% of its electricity. People living close to an incinerator generally enjoy heating bills which are 30% lower than the national average. […] Together with high recycling rates, this process significantly benefits carbon reduction by substituting fossil energy sources. Moreover, the landfill charge to Denmark’s households is amongst the lowest in the EU” (Compendium of the Civic Economy, 2011).

“Just when you think Japan cannot shock you anymore … think again,” reads one review. […] “Only Japan could make a waste disposal plant look like Disneyland.” (ABC News, May 2018). Every year, the Maishima plant in Osaka brings thousands of tourists who want to see its weird and unique design to the city. The concept is by Friedensreich Hundertwasser, an Austrian-born New Zealand artist. His very beautiful design hides however, the fact that the facility burns about 900 tons of trash every day. Wasting terrain for landfill is a huge mistake in Japan because national surfaces are already reduced, and population density is high. “We need to reduce the amount of landfill so our future generations can keep using it — rubbish becomes one-twentieth of [its size] when it’s incinerated. Furthermore, you can recycle some of it into slag and use it as cement” (ABC News, May 2018). The city reuses trash to the best of its capacity, generating energy for its citizens, converting it into ashes instead of sending it to landfill sights. "At the same time, all of the small size incinerators which were not able to burn at high temperatures were shut down, as they generated dioxins," Waste Economist Shusaku Yamaya said. [...] "Japan now has large-scale incinerators which cover large areas and [removed] the dioxin problem. [...] "But it cost a huge amount of money to build incinerators, so it was inevitable that the waste management cost went up." (ABC News, May 2018). Obviously, these waste management techniques have high costs, but recover the gap with power and health care.

"It does away with the idea of a power plants – or industrial buildings in general – as clinical monoliths thar are hard on the eye" (Design and Build review, 2018). Bjarke Ingels and his new Wte facility changed people's view, at least in Denmark, and those who know about his work. "As a power plant, CopenHill is so clean that we have been able to turn its building mass into the bedrock of the social life of the city – its façade is climbable, its roof is hikeable and its slopes are skiable," Bjarke Ingels, said in a statement. "A crystal-clear example of Hedonistic Sustainability – that a sustainable city is not only better for the environment – it is also more enjoyable for the lives of its citizens." (Architect News, 2019). Architect's vision of the future is very enthusiastic when it comes to social sustainability, as well as environment and pollution. "Some green groups, including Brussels-based Friends of the Earth Europe (FOEE), fear that burning trash for power stunts efforts to encourage recycling. The only way to reduce CO2 emissions when it comes to waste policy is by preventing, reusing, and recycling," said Ariadna Rodrigo, a FOEE resource use campaigner. But WTE proponents argue that extracting power from waste goes hand in hand with recycling efforts. "There does not have to be a choice between the two solutions. We're very much into recycling," said Rasmus Meyer, also of ARC. Moreover, CEWEP claims, 100 percent recycling is not possible." (National Geographic, 2013).

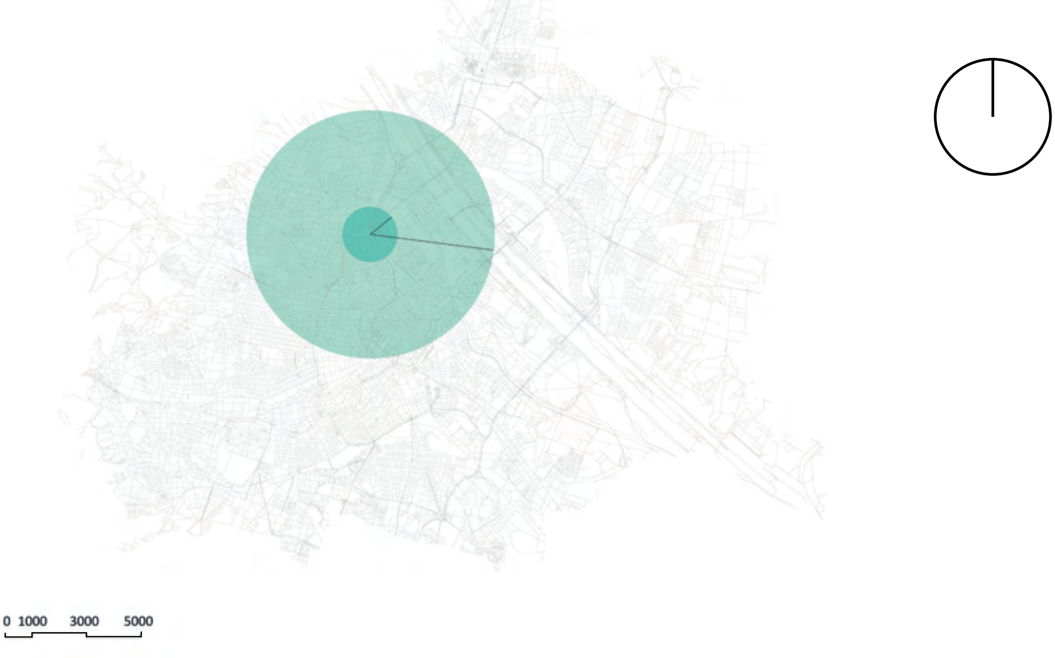
The case of Osaka:
Incinerator is located on a little island on the coast. Every year many tourists go to visit it because of its shapes.

FACILITY AS OBJECT



The case of Wien:
Incinerator is located in the middle of the city, as a landmark for the capital. People learned to live with it and appreciate his work for the community.

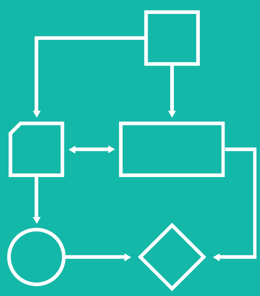
FACILITY AS INSTRUMENT



Both maps realized by the graduate with Q-Gis.

1.1.7. ENVIRONMENTAL CONSEQUENCES.

PROBLEM SOLVING



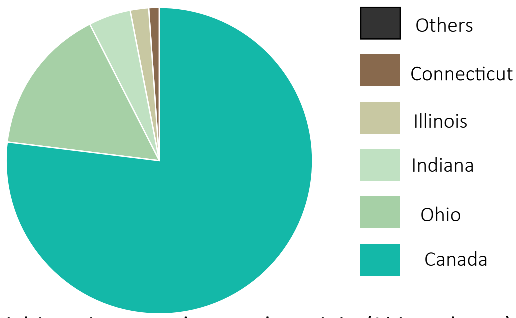
Environmental consequences
Problem solving

“Waste-incineration technology, in general, and emission control in particular has improved substantially over the past years. The technologies and practices for controlling and processing the waste stream, for incinerating waste, and for controlling and managing the emissions and ash output have changed substantially in the last two decades. Today, in many cases, incineration takes place in the context of waste prevention (to reduce both the volume and the toxicity of the waste generated), recycling, and composting. Such activities affect the types and quantity of waste incinerated and emissions generated” (The National Academies Press, 2020). Upgrading technology allows us to reduce the problems for the eco-system. Using waste as “fuel” for new sources of power is up to now, one of the best ways to dispose of rubbish. Detroit, instead, until the shutdown of its plant, was emitting toxic substances.

“The pollutants that are emitted from the incinerator can be broken down into two broad categories: “criteria pollutants” and “hazardous air pollutants.” Criteria air pollutants are air pollutants that are commonly present in all environments. They can irritate airways, harm the respiratory system, aggravate respiratory diseases such as asthma, contribute to wheezing, and cause breathing difficulties that result in hospitalization. Long-term exposure to criteria air pollutants may contribute to the development of asthma and increased susceptibility to respiratory infections. Children and the elderly are the most susceptible to these health effects. The specific criteria air pollutants that the incinerator emits are particulate matter, sulfur dioxide, nitrogen oxides, and carbon monoxide. Hazardous air pollutants are toxic air pollutants that are commonly classified as probable or known carcinogens. The specific hazardous air pollutants emitted by the incinerator are cadmium, chromium, lead, mercury, and dioxins and furans. Many volatile organic compounds are considered ha-

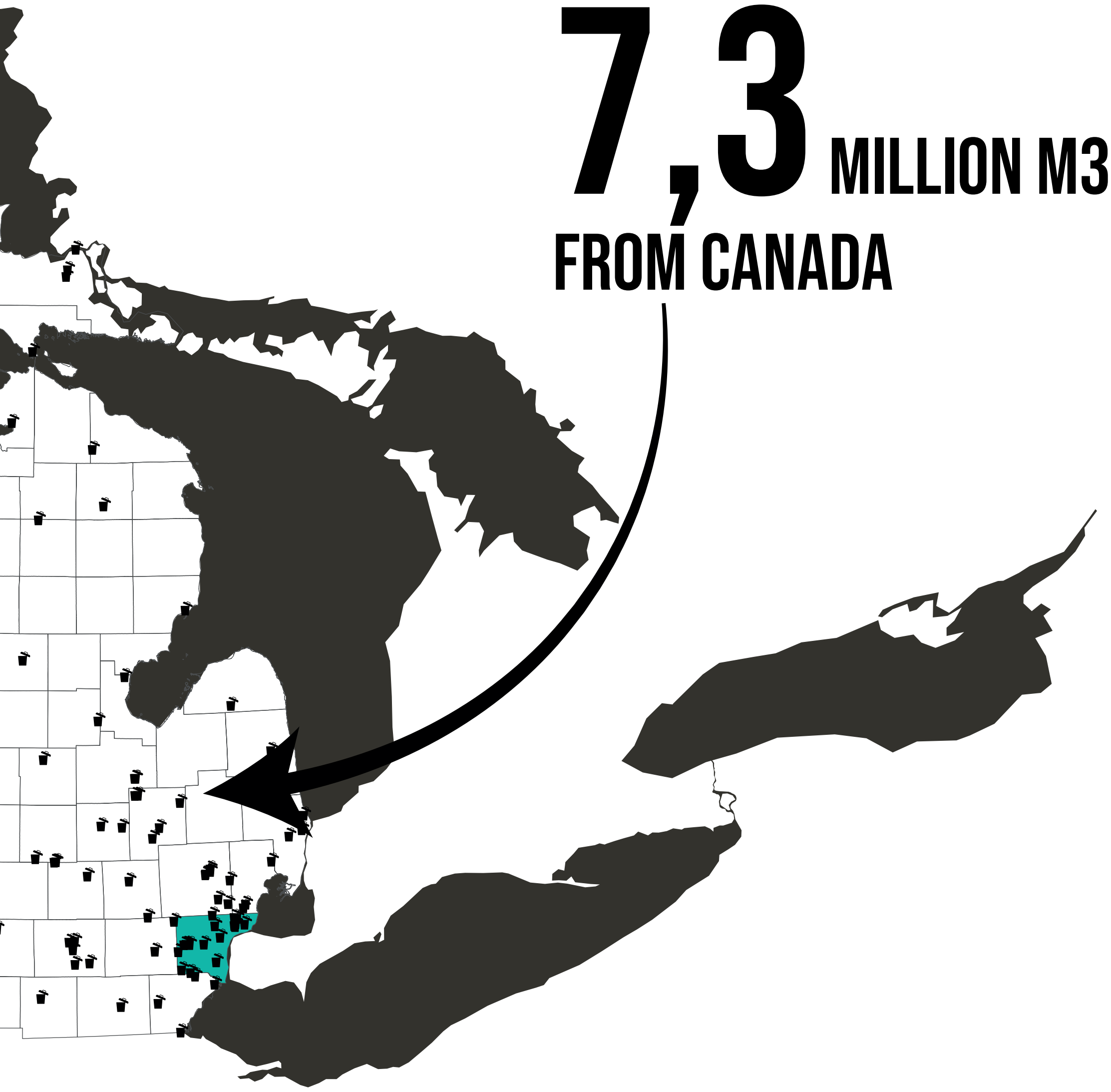
zardous air pollutants" (Breathe free Detroit, report, 2018).
The DRP (Detroit Renewable Power) Area needs a retrofit intervention to conform with modern BAT technologies. There had been a plan to develop an upgrade of the incinerator to reduce smells and emissions but remained in document form because of closure (DRP Process Building Odor Neutralizer Drawings, received from Dale Lane, Detroit Thermal LLC). Moreover, after years of protests and actions against it, the incinerator needs to have a new image, a friendlier version, attracting people rather than pushing them away. It can be done. Denmark, Norway, and Japan have already proven this.
Environmental questions can be solved starting from our knowledge of trash: what percentage of each material arrives at the facility? This is important because it can be designed as waste flows to the incinerator, onto recycling, and onto biomass. First of all, the plant in Detroit, and in Michigan in general, received and disposed rubbish from other states such as Ohio, Illinois, and other countries too, including Canada (Report of Solid Waste landfilled in Michigan, 14th Feb 2020). Moreover, Wayne County landfills under the Detroit jurisdiction, receive tons of waste that could be used to produce energy. The following data was taken from the Report of Solid Waste Landfilled in Michigan, 2019.
Trash growth trends continue to rise even as the government tries to develop food and waste policies, people are still consuming more every year. In 2019 alone, in Michigan, obtaining data conversion from cubic yards to tons, trash disposed in landfills were about 15,040,253.88 tons (12 million tons in 2010); 77.8% came from Michigan, 17.1% came from Canada, and the remaining percentage, from other states. A good WTE system could obtain huge quantities of power from this waste, starting with that collected in Detroit. Using the incineration, recycling and biomass processes, it would be possible to close most landfills, reducing the volume to about 85-90% with ash, as demonstrated in Japan, and supply power to Michigan, so desperately needed to sustain citizens, with a 20-30% lower cost on energy bills (data taken from the Hørsholm case).
Regarding data of Wayne County, Detroit must dispose of approximately 10,400,000.00 m3 of rubbish every year, about 2,315,668.77 tons. Moreover, Michigan is the state which disposes of more trash per person in landfill, the fourth for open landfills in the US with 46 active plants; the first is California with 118 (EPA, Landfill Methane Outreach Program & U.S. Census, 2019). Major questions and dilemmas of pollution are certainly raised, but it's also a matter of time disposal. Trash demand nowadays is far too high, and landfills no longer solve the problem. That's why it is imperative to invest in other disposal systems.

15 MILLION TONS/YEAR
WASTE DISPOSED IN LANDFILL
Michigan is one of the states of U.S who take more trash to bury in soil.



Michigan imported waste by origin (% in volume)

7,3 MILLION M3/YEAR
FROM CANADA



Michigan counties and landfills map.
Realized by the graduate with Q-Gis.

1.1.8. CASE STUDIES

Case studies

Amager Bakke, Denmark
Bjarke Ingels

“Designed to replace the neighboring 50-year-old waste-to-energy plant, the 41,000-square-meter CopenHill — also known as Amager Bakke — boasts state-of-the-art technologies in waste treatment and energy production. BIG, which won the 2011 international competition for the power plant, drew inspiration from the industrial waterfront of Amager” (Lucy Wang, Inhabitat, 2019). “Amager Bakke Waste-to-Energy Plant is far more than the sum of its rather remarkable features. As an urban “destination in itself” and a landmark in environmental design, it’s one of the most radical representations of architecture as a means of public engagement of our time” (Vanessa Quirk, Archdaily, March 5th, 2013). This mix of style and useful functions are surely the strengths of this project. That is why, even though it is a facility that solves the energy problems of Copenhagen, it adds value to tourism, sports and hobbies which attract people and try to change the image of the “incinerator” and “industry”, that has ruined people’s vision over the years.

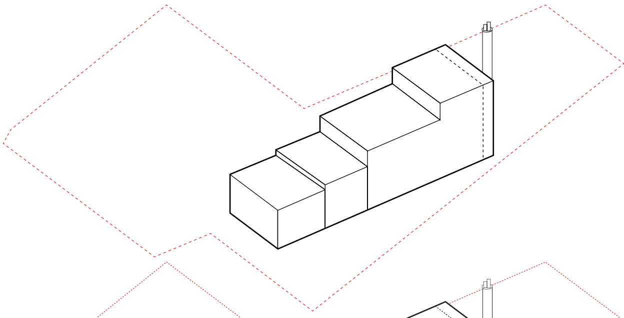
“The project to create an attractive and green activity rooftop park on top of Amager Bakke has been very challenging,” [...] “Not only because of the extreme natural – and unnatural – conditions of the site and the rooftop itself, which put severe stress on plants, trees and landscape. But also because we’ve had to ensure that the rooftop’s many activities are realized in an accessible, intuitive and inviting manner. The goal is to ensure that Amager Bakke will become an eventful recreational public space with a strong aesthetic and sensuous city nature that gives value for all Copenhageners- all year round” (SLA Partner Rasmus Astrup, according to Archdaily. Design & Building Review, 2019). The gardening project of the rooftop is by SLA with a concept which is trying to crea-

Hovedstaden region, Denmark.

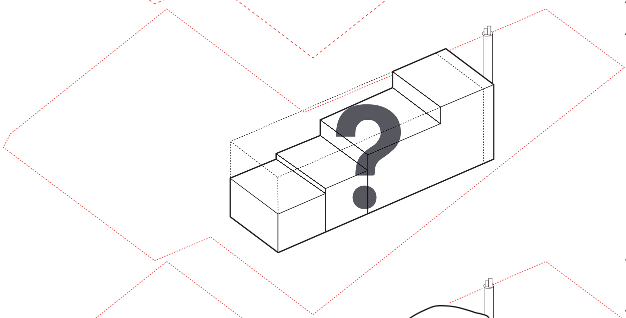
te a micro-climate and optimal wind conditions to reproduce a mountain environment. “Amager Bakke’s nature roof park and hiking trail invites locals and visitors to traverse a mountainous landscape of plants, rockscapes, 7000 bushes and 300 pine and willow trees atop the world’s cleanest waste-to-energy plant. It also acts as a generous ‘green gift’ that will radically green-up the adjacent industrial area. Copenhill becomes the home for birds, bees, butterflies and flowers, creating a vibrant green pocket and forming a completely new urban ecosystem for the city of Copenhagen.” (Rasmus Astrup, Partner in SLA).

This project in its entirety is important for the concept idea of the new DRP bio-platform. The project area will be an intermodal node with incinerator, hi-tech farm, urban gardens, adding functions and attractive hobbies for the community just like the BIG design. Crossed by a Dequindre Cut that will link this area to the Detroit riverfront and its cycle paths, it can close a ring made by abandoned greenway railway undergoing restructuring by the city administration over the next years. Link Incinerator – cycleway is important and could be solved with pathways high on the streets, taking inspiration from freeways already present in Detroit. Dividing flows, downward flows for trucks and services, and upward flows for people, cyclists and hobbies would be the only solution for an area with so many active services. DRP will host sports spaces and hobbies for the city of Detroit, just as Amager Bakke WTE does its ski slopes and trails.

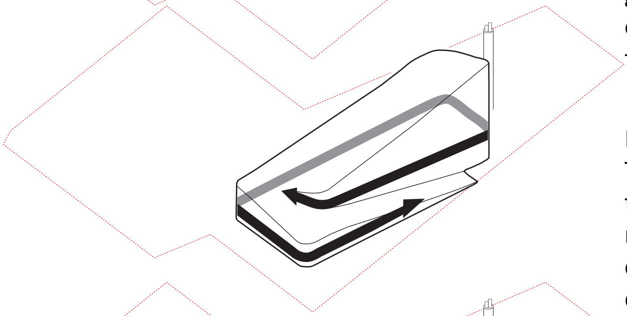
Re-drawn schemes of Amager Bakke WTE plant.
Source: Bjarke Ingels Group



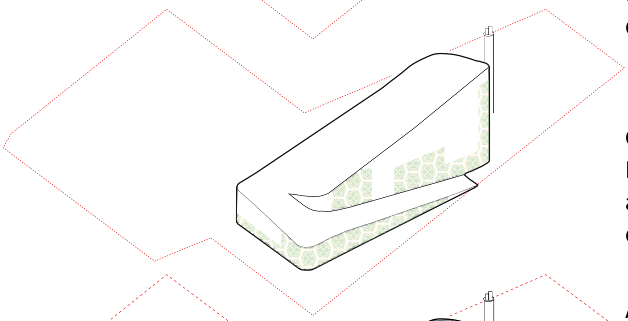
PROGRAM
The internal volumes of the new WTE plant have been determined by enginreering and technical criteria. Due to the sheer size and requirements for the precise positioning, the primary structure of the building is to be integrated with the machinery.



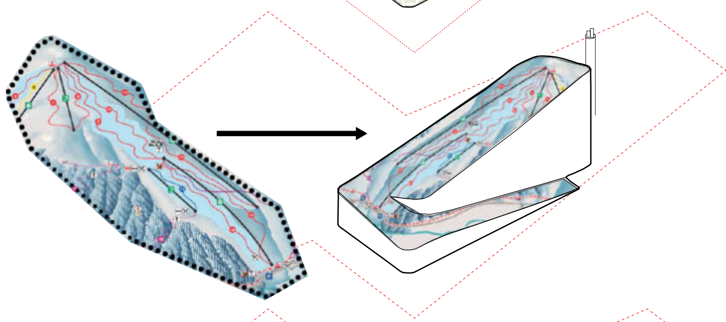
FUN FACTORY?
Bjarke Ingels propose a new breed of Waste to Energy plant, one that is economically, and socially profitable. Instead of considering Amager Resource Center as an isolated architectural object, he considers the assignment to design a facade as an opportunity for the local context.



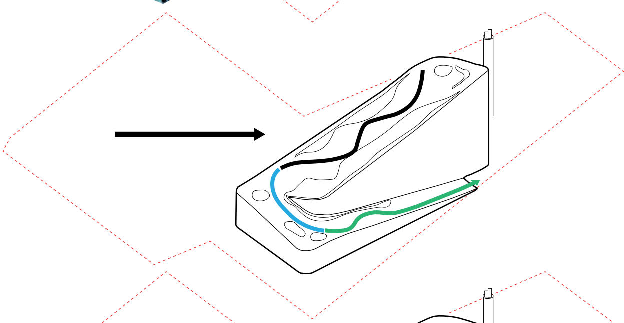
FACADE
The building is gently wrapped with a continuous facade made out of stacked aluminium bricks. The openings between the bricks are letting cascades of daylight into the deep process hall and the administration space.



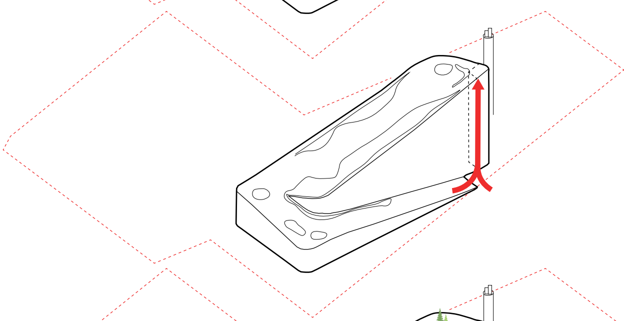
GREEN WALLS
Bricks on the facade functions as planters, creating a green facade and turning the building into a green mountain from afar with a white mountain top.



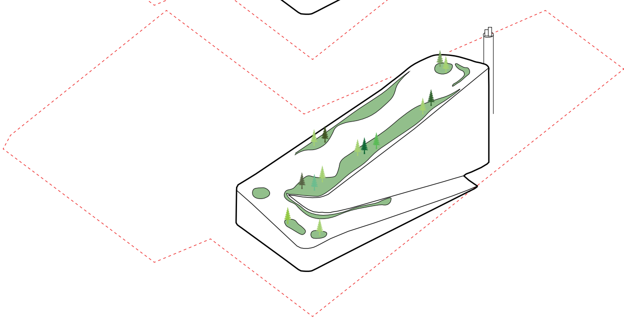
ALPINE SKIING IN COPENHAGEN
Bjarke Ingels propose to turn the roof of the new Amager Resource Center into an artificial ski slope for the citizens of Copenhagen, where it will be possible to ski all year round! The slope will be ecological, upending the convention of the energy intensive indoor or alpine ski resort.



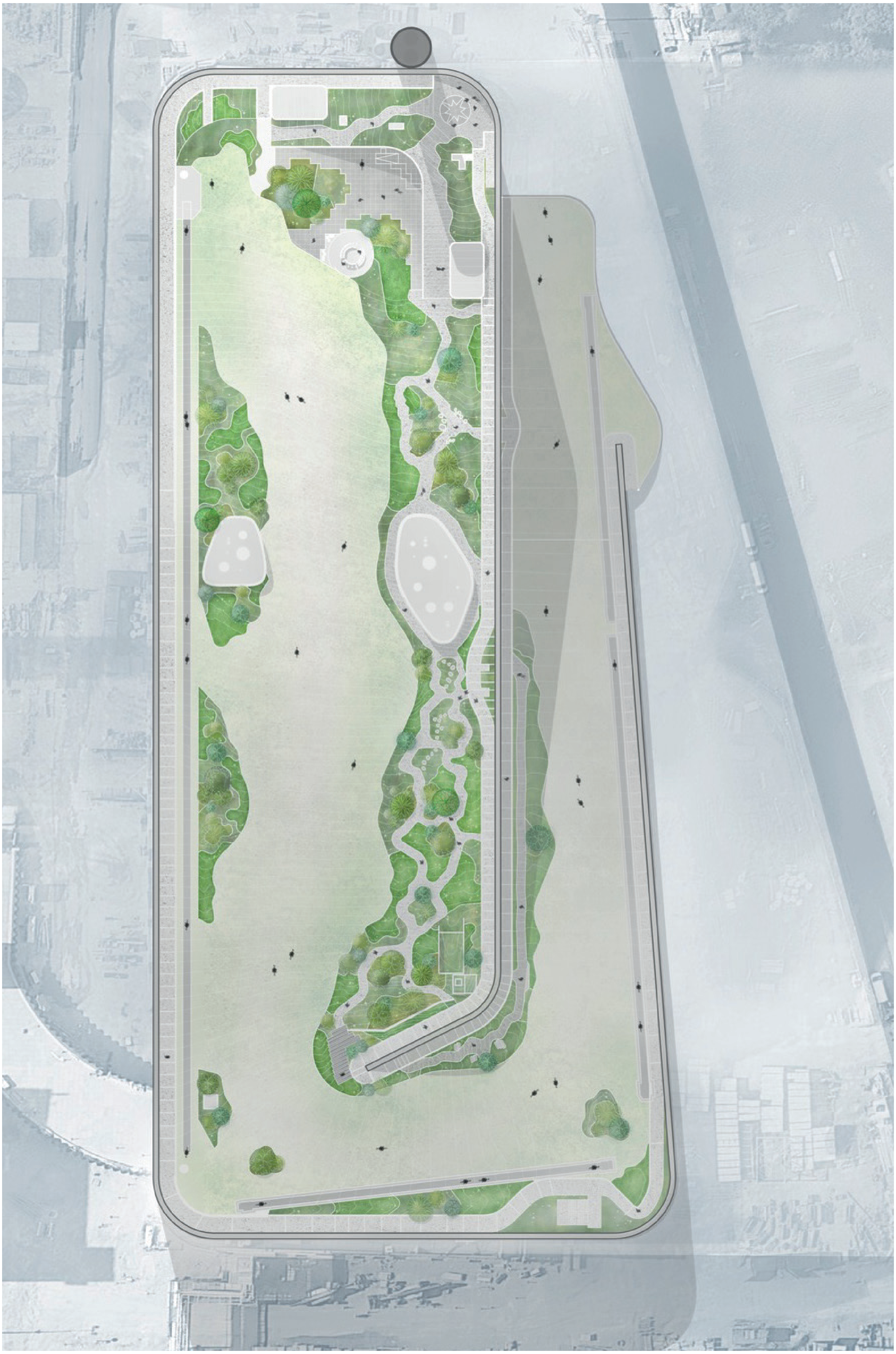
THREE PISTS
The geometry of the roofscape supports three slopes of different gradients. This will accommodate skiers with a broad range of experience, from novices to pros. There will be a total of 500m + of ski runs and a terrain park.



SLOPE ACCESS
Access to the ski paths is through an elevator adjacent to the smokestack. The elevator has a glass wall facing the interior of the plant, allowing recreational buffs and sightseers to have a glimpse into the internal workings of the plant. There will also be 2 platter lifts and 2 carpet lifts.



TAKE A WALK IN THE PARK
Roof is not only going to function as a skislope, but like a real mountain with a green forest areas, hike trail, climbing walls and maybe even a mountain bike rail. On top of the slope there will be a viewing plateau and a little cafè.



Plan. Image Courtesy of SLA Architects

Story by BIG - Bjarke Ingels Group
Photo: Tomas Majewski

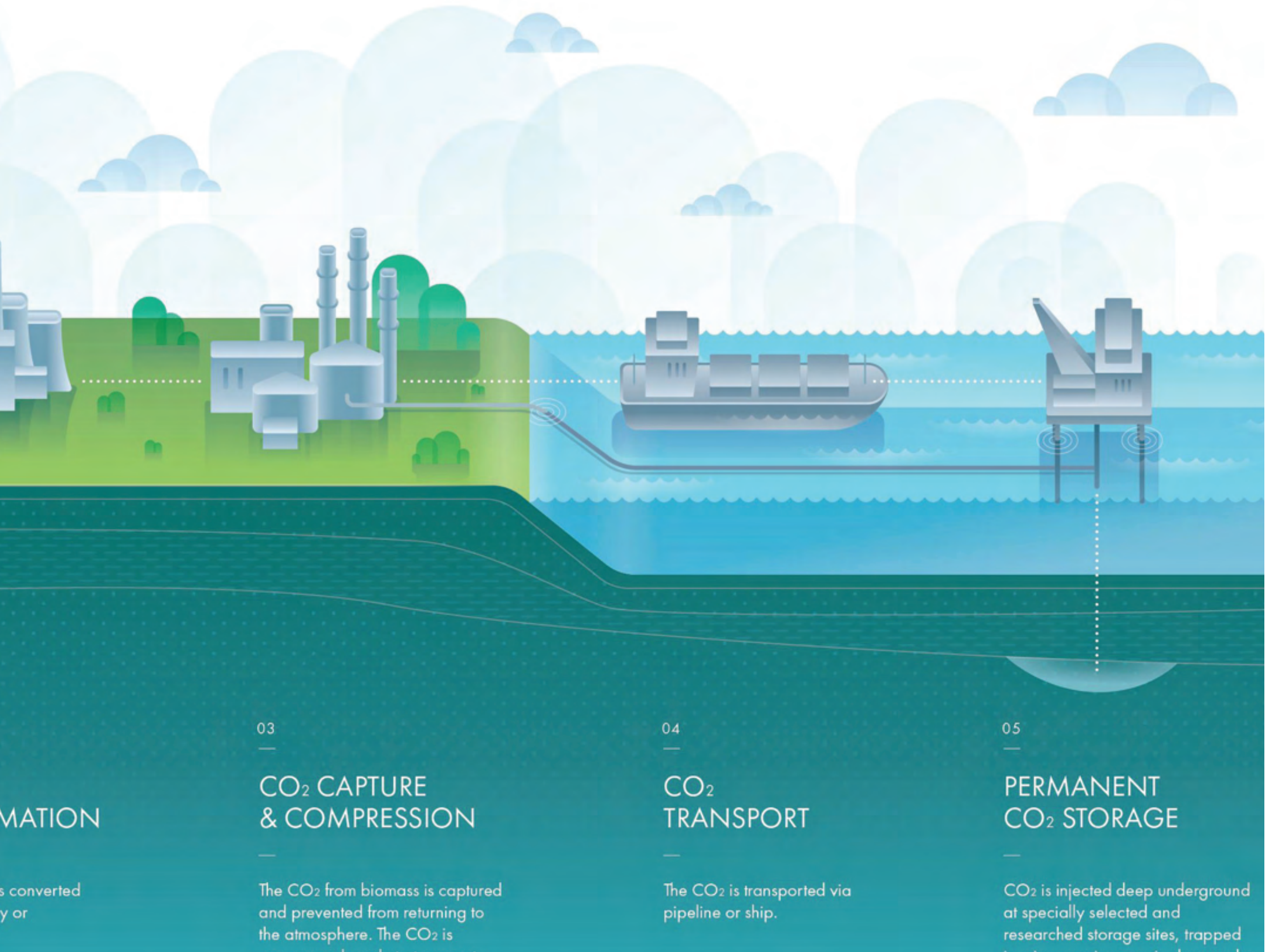
Fortum Oslo Varme, Klemetstrud

This facility points its strengths to one simple concept: by creating a cycle-based waste management, recycling where possible, when not energy-recovering. This system of facilities acts as a precise rubbish sorting. "Food waste is recovered and transformed into bio-fertilizer for the agricultural industry and into biogas used as fuel. Plastic waste is recovered into new plastic products, and the residual waste is incinerated and used in the production of environmentally friendly district heating and electricity. This philosophy enables the City of Oslo to efficiently utilize all its waste resources, while simultaneously reducing the use of fossil fuels" (TrackMyElectricity, copyright 2020). Management is solved by three macro-arguments:

- Trash sorting, with extensive source sorting, optical recognition plants and one biogas plant
- Burn phase, with two WTE plants and heat pumps, wood pellets, bio-oil,
- District heating and sorption cooling.

The very revolutionary thing of this project is capturing CO2 in storage. By doing this, it can be reused, and when possible, solve the biggest problems of current times: waste management and climate change. Emissions from the plant are already free of dioxins: NOX and CO with CO2 are captured, and the storage process becomes CARBON – NEGATIVE. Norway is trying to be a pioneer in the field of Carbon Capture & Storage, "and to have a leading role in the development of technology related to the capture and storage of CO2 emissions from waste-to-energy plants. Carbon capture from renewable energy contributes toward a more sustainable waste management, as well as a green circular economy and can potentially increase the sustainable performance of the Klemetsrud plant." (TrackMyElectricity, copyright 2020). Currently, Oslo's government wants to stock this CO2 under the seabed. That is potentially dangerous for eco-systems near stocks, but there are many other ways to reuse carbon dioxide, for example:

Østlandet region, Norway.

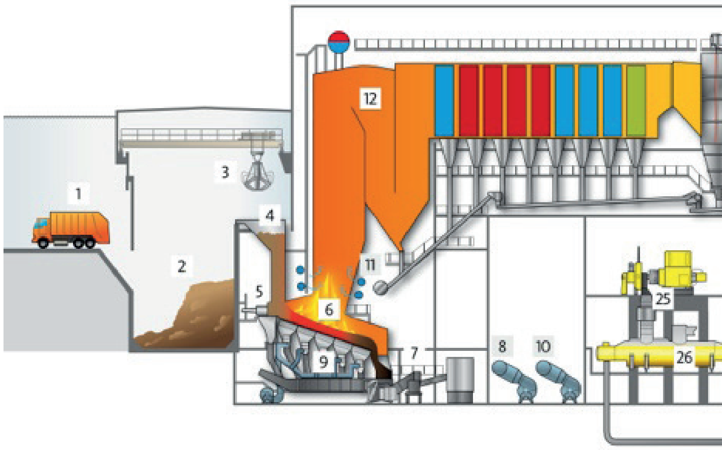


Process of CO2 disposal. Source: Nordicenergy.com

- Turn it into rock,
- Make cement out of it,
- Feed it to algae to make carbon fiber,
- Turn it into insulation foam for housing,
- Feed it to algae to revive oyster reefs,
- Turn it into fuel.

Most useful process could transform carbon dioxide into fuel because it would solve many problems of fuel supply. “We demonstrated, as far as we know, for the first time that we can directly reduce captured CO2 into carbon monoxide and hydrogen using specialised liquid materials that make the CO2 more soluble and allow the carbon-capture medium to be directly introduced into a cell for electrochemical conversion to synthetic natural gas,” says Tedd Lister, the leader of the team behind the new process from US Department of Energy’s Idaho National Laboratory. (Tereza Pultarova, Engineering and Technology, 2019).

“Also for chemical conversion short and long-term storage opportunities are possible: production of methanol, polymers, etc. is considered short term use, while mineralisation for building materials and olivine weathering are seen as long term storage.” (CO2reuse.com, 2019) Uses like insulation foams or feed for eco-system algae are important, too. The process in the first case is so complex and energy-expensive, that any life-reducing cycle costs of the materials would be too great. Secondly, it is important for the environment, already destroyed by surfactants and other pollutants.



Schematic section of the plant.
Source: Hitachi Zosen INOVA

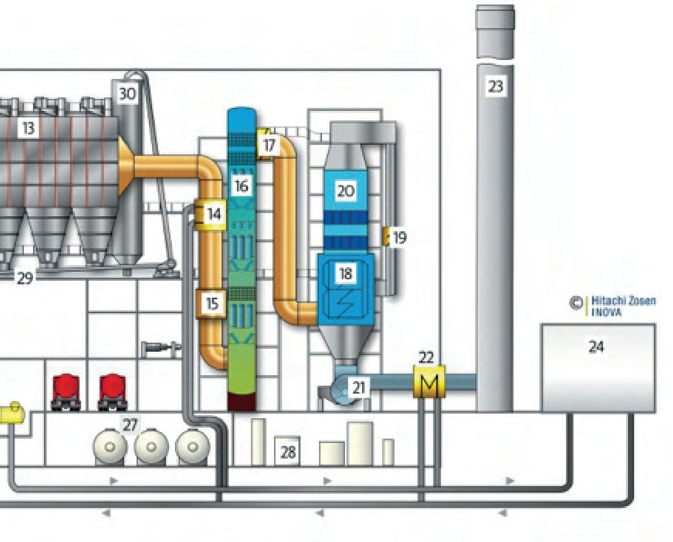
WASTE RECEIVING AND STORAGE
1. Tipping hall
2. Waste pit
3. Waste crane

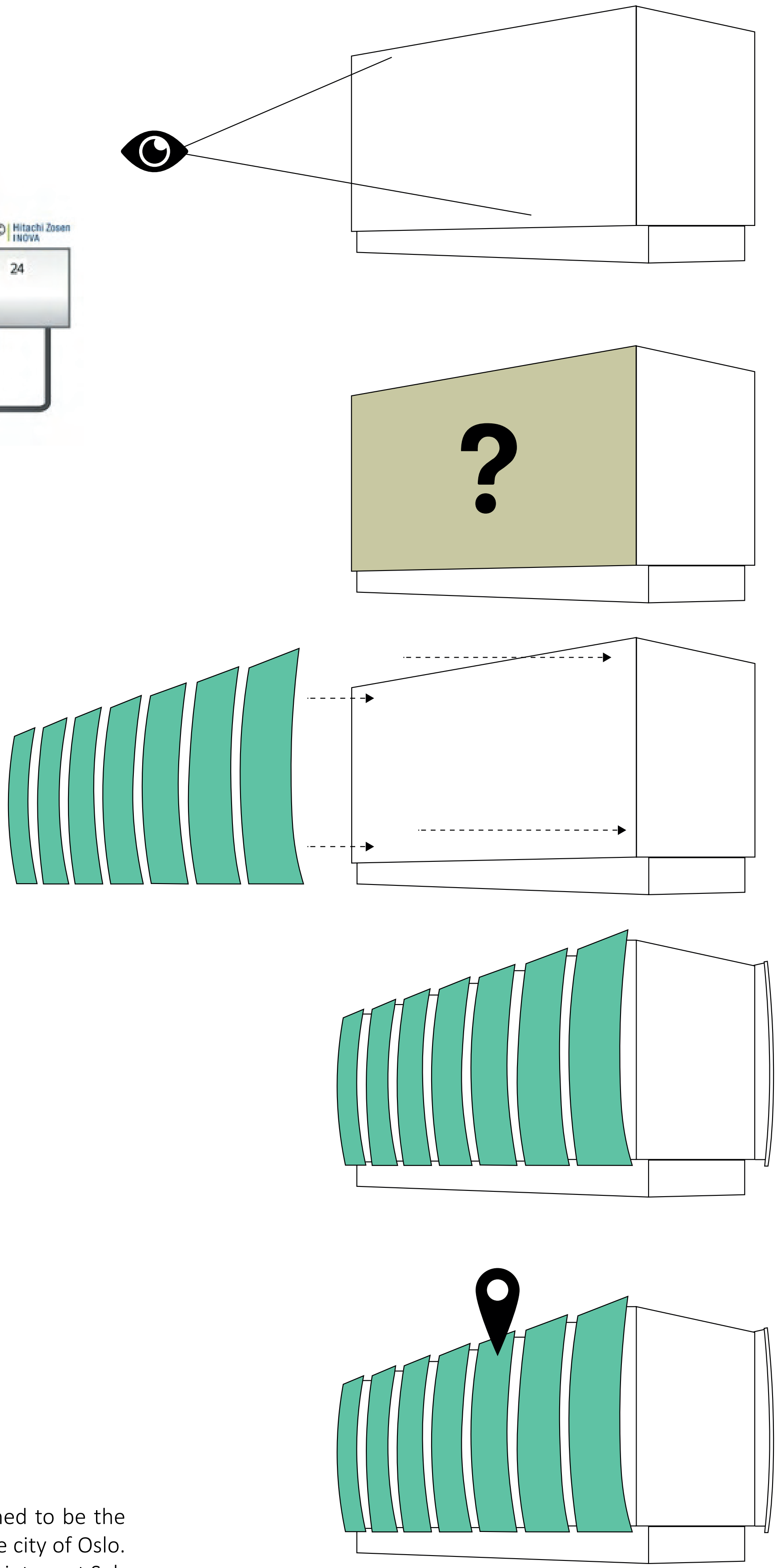
COMBUSTION AND BOILER
4. Feed hopper
5. Ram feeder
6. Hitachi Zosen Inova grate
7. Bottom ash discharger
8. Primary air fan
9. Primary air distribution
10. Secondary air fan
11. Secondary air injection
12. Four-pass boiler

FLUE GAS TREATMENT
13. Electrostatic precipitator
14. Economiser 1
15. Quench
16. Wet scrubber (4 stages)
17. Flue gas reheater 1
18. Gas/ gas heat exchanger
19. Flue gas reheater 2
20. SCR-Catalyst
21. ID-fan
22. Economiser 2
23. Stack

ENERGY RECOVERY
24. District heating system
25. Extraction condensation turbine
26. Hot water condenser

RESIDUE HANDLING AND TREATMENT
27. Waste water tanks
28. Waste water treatment
29. Ash conveying
30. Ash silo





The new furnace room it's been designed to be the landmark building at the entrance of the city of Oslo. It follows, in particular, a sculpture of an intern at Selberg Architects, Martin Øverbø Schulte.

Concept of the new facade of the facility. From an illustration by Selberg Arkitektkontor AS (re-drawn and developed).

View of the plant.Photo by Selberg Architekter.

1.2.BIOMASS

1.2.1. ENERGY FROM ORGANIC WASTE, HOW?

Biomass: energy from organic trash
How?

“Biomass is renewable organic material that comes from plants and animals. Biomass was the largest source of total annual U.S. energy consumption until the mid-1800s. Biomass continues to be an important fuel in many countries, especially for cooking and heating in developing countries. The use of biomass fuels for transportation and for electricity generation is increasing in many developed countries as a means of avoiding carbon dioxide emissions from fossil fuel use. In 2019, biomass provided nearly 5 quadrillion British thermal units (Btu) and about 5% of total primary energy use in the United States.” (EIA, last updated: August 28th, 2020).
The benefits of Biomass are varied and many. It reduces greenhouse gas emissions. “Burning biomass releases about the same amount of carbon dioxide as burning fossil fuels. However, fossil fuels release carbon dioxide captured by photosynthesis millions of years ago—an essentially “new” greenhouse gas.” (U.S Department of Energy, 2020). Merging this problem with new CSS technology could essentially solve it and CO2 could be reutilized with it. This energy transformation process can lower dependence on foreign oil supplies too because biofuels would become the only available liquid transportation fuel. Finally, it is crucial to the agricultural and forest product industry as a support system. “The main biomass feedstocks for power are paper mill residue, lumber mill scrap, and municipal waste. For biomass fuels, the most common feedstocks used today are corn grain (for ethanol) and soybeans (for biodiesel). In the near future—and with NREL-developed technology—agricultural residues such as corn stover (the stalks, leaves, and husks of the plant) and wheat straw will also be used. Long-term plans include growing and using dedicated energy crops, such as fast-growing trees and grasses, and algae. These feedstocks can grow sustainably on land that will not sup-

port intensive food crops." (U.S Department of Energy, 2020).

Biomass sources for energy include:

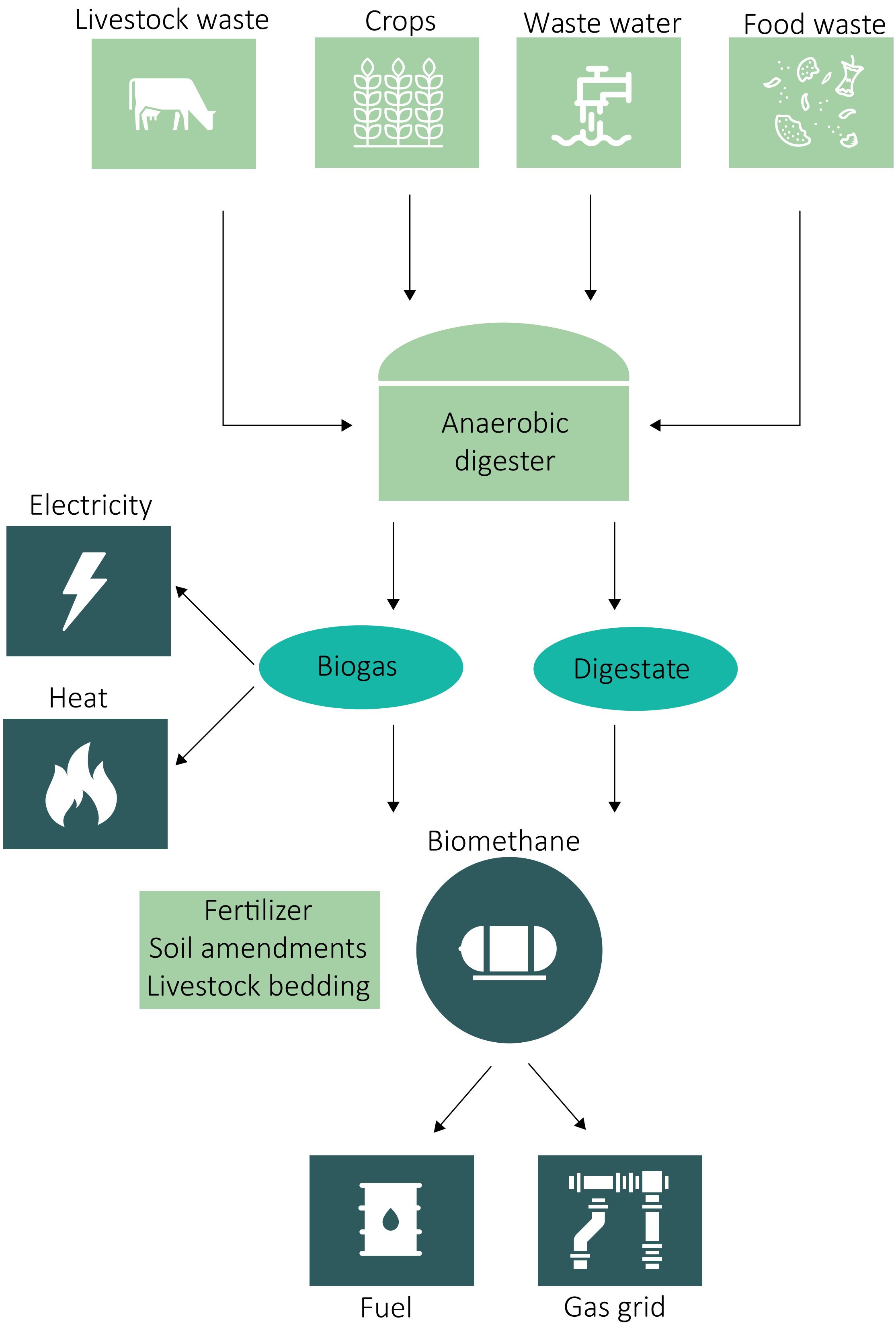
- Wood and wood processing wastes—firewood, wood pellets, and wood chips, lumber and furniture mill sawdust and waste, and black liquor from pulp and paper mills,
- Agricultural crops and waste materials—corn, soybeans, sugar cane, switchgrass, woody plants, and algae, and crop and food processing residues,
- Biogenic materials in municipal solid waste- paper, cotton, and wool products, and food, yard, and wood wastes,
- Animal manure and human sewage

((EIA, last updated: August 28th, 2020).

"Different types of energy are created through direct firing, co-firing, pyrolysis, gasification, and anaerobic decomposition. Before biomass can be burned, however, it must be dried. This chemical process is called torrefaction. During torrefaction, biomass is heated to about 200° to 320° Celsius (390° to 610° Fahrenheit). The biomass dries out so completely that it loses the ability to absorb moisture, or rot. It loses about 20% of its original mass, but retains 90% of its energy. The lost energy and mass can be used to fuel the torrefaction process. During torrefaction, biomass becomes a dry, blackened material. It is then compressed into briquettes. Biomass briquettes are very hydrophobic, meaning they repel water. This makes it possible to store them in moist areas. The briquettes have high energy density and are easy to burn during direct or co-firing." (National Geographic, Resource Library, November 2012).

Pyrolysis

Pyrolysis is one of the methods that heats biomass. Substances are heated to 200° to 300° in an anaerobic atmosphere. This condition does not allow material to combust and lets biomass to be chemically altered. The process produces pyrolysis oil, a synthetic gas named syngas and solid residue as biochar. These components are all used for



Anaerobic digestion process (Graphic by Sara Tanigawa, EESI) energy:

- Pyrolysis oil: bio-oil or biocrude too, is something like tar. It burns to generate electricity or is used in fuels or plastics. Recent studies are verifying that bio-oil could be a possible alternative to petroleum,
- Syngas is an acronym of synthetic natural gas. It can be transformed in methane and replace it,
- Biochar is a carbon-rich charcoal which is very useful to agriculture. “Biochar enriches soil and prevents it from leaching pesticides and other nutrients into runoff. Biochar is also an excellent carbon sink. Carbon sinks are reservoirs for carbon-containing chemicals, including greenhouse gases.” (National Geographic, Resource Library, November 2012).

Gasification

This process allows to convert biomass directly to energy. Feedstock (usually MSW) needs to be heated to > 700° Celsius, checking oxygen percentage and quantity in a controlled atmosphere. When molecules reach their break down T°, they produce syngas and slag. As a consequence, syngas is devoid of sulfur, particulates, mercury, other pollutants, therefore, without its harmful substances it can be burned for electricity and heat, or be processed in fertilizers, chemicals and biofuel. “Slag forms as a glassy, molten liquid. It can be used to make shingles, cement, or asphalt.” (National Geographic, Resource Library, November 2012).

Anaerobic decomposition

“A process that occurs in nature, involving the anaerobic decomposition of organic matter, is used to produce a combustible mixture of gases called biogas, that contains about 55 to 65 percent of methane. The biogas is produced in a digester or vessel usually made of sheet metal or concrete, with the fermenting material at the bottom, and the generated gas stored in the upper portion. Gas may be withdrawn under pressure from an outlet at the top, while the digested sludge (which is a valuable fertilizer) is drawn off from the bottom." (Mohan Munasinghe, in Energy Analysis and Policy, 1990). The process functions with microorganisms as bacteria which decompose material in the absence of oxygen (the same thing that happens in landfills. "anaerobic decomposition can also be implemented on ranches and livestock farms. Manure and other animal waste can be converted to sustainably meet the energy needs of the farm." (National Geographic, Resource Library, November 2012).

CHP – Cogeneration

Combined heat and power use gas engines fueled by biogas, hydrogen, syngas or biomethane to achieve energy saving approximately 40% compared to purchases from the electricity grid.

"Combined heat and power plants are typically embedded close to the end user and therefore help reduce transportation and distribution losses, improving the overall performance of the electricity transmission and distribution network. District energy schemes use combined heat and power plants to generate both electricity and heat for a group of residential or commercial buildings. For power users where security of supply is an important factor for their selection of power production equipment and gas is abundant, gas-based cogeneration systems are ideally suited as captive power plants (i.e. power plants located at site of use)." (ClarkeEnergy, Cogeneration, 2020)

The situation is also similar in the study area. Organic waste can be stocked to break down into digesters and then sent on to gas cycles. The availability of District Heating already presented on site is an incentive to develop a more expensive plant, but with higher yields despite other processes of biomass transformation.

Heat can be used in various ways. "Low grade heat from the cooling circuits of the gas engine, typically available as hot water on a 70/90°C flow/return basis. For anaerobic digestion plants that use a CHP engine, there are two key types of heat:

- High grade heat as engine exhaust gas (typically ~450°C),
- The low-grade heat is typically used to heat the digester tanks to the optimum temperature for the biological system.

Mesophilic anaerobic digesters typically operate at 35-40°C. Thermophilic anaerobic digesters usually function at a higher temperature between 49-60°C and hence, have a higher heating requirement." (Clarke Energy, Combined biogas, 2020).

There are many advantages in using cogeneration to transform biomass in energy. Firstly, money savings is a consequence of less fuel consumption. Environmental impact is less than other processes because emissions are reduced, and heat emitted in the atmosphere is less because it is reused with district heating. The consequence is therefore less waste of energy with the distribution on the national grid. Finally, substituting supply channels with low levels of efficiency like industrial and home boilers, the environment impact will be reduced.

- The low-grade heat is typically used to heat the digester tanks to the optimum temperature for the biological system.

Mesophilic anaerobic digesters typically operate at 35-40°C. Thermophilic anaerobic digesters typically operate at a higher temperature between 49-60°C and hence have a higher heating requirement." (ClarkeEnergy, Combined biogas, 2020).

There are many advantages in using cogeneration to transform biomass in energy. First of all money savings consequence of less

1.2.2. DESIGN OF URBAN BIOMASS PLANTS: SPACES

Design of urban biomass plants: spaces

It being established that often cogeneration is the best way to get energy from biomass. However in this particular site is not so advisable because there is already a cogeneration plant in the incinerator. That could create much problems because are big facilities that need much energy, and are too much close each others. Solution can be found in the middle, transforming biomass in biogas (bio-fuel) and using it for the buildings and if there are unsold it can be added on the national grid. This way to transform energy can be useful for circular economy obtaining directly fuel without burning it on site and avoiding questions about smells and emissions that could be a problem, mostly for community.

Starting from what is possible to realize, there is the area in the northern part of the study lots that shows around 72000 square meters able to be transformed. On the other hand there are a lot of volumes available for vertical farming in the nearest building at 1950 East Ferry Street, but for energy questions will be able to design only the central shaft for Vertical Farms and other spaces to co-working and others. So there are able 850 square meters for 7 of 9 floorplans to vertical farm. Final volume is around 20350 cubic meters for VF. Now it can be find the total consumption, valued, for each year.

Yields to produce lattuce: 80-120 kg/m2/ year

Electric consumption to produce lattuce: 250 KWh/kg/year

Data Source: Avgoustaki D, Xydis G (January 1st 2020) "How energy innovation in indoor vertical farming can improve food security, sustainability, and food safety?". Europe PMC (e-journal) Available at: https://europepmc.org/article/pmc/pmc7516583 (last access November 18th 2020);

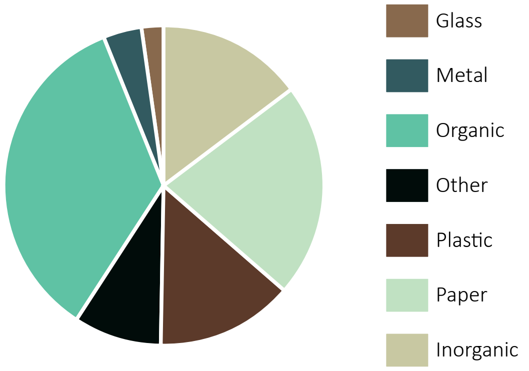
These data related with surfaces allows to find that VF in this project can produce almost 600.000 kg/year of fresh food for Detroiters, with an energy consumption of

almost 150 milions KWh/year. That means facilities like VF can be developed only with huge production of renewable power to be sustainable for communities.
"The average calorific value of biogas is about 21-23.5 MJ/m³, meaning that 1 m³ of biogas corresponds to 0.5-0.6 l diesel fuel or an energy content of about 6 kWh. However, due to conversion losses, 1m³ of biogas can be converted only to around 1.7 kWhel." (EnergyPedia, April 20th 2016). With this data converter VF needs almost 90 milions cubic meters/year to sustain itself in every aspect.

How can we get this huge amount of gas?
There is already an incinerator that, if it works well, can sustain the major part of energy needs for Detroit. Farming technologies are so expensive in energy terms so it needs a source for itself. Burners can incinerate MSW waste, while plastics, paper, metal,.. can be recycled. So it is possible to use organic waste that can be transformed from biomass. In the table there are data from Wayne County waste and diagrams show percentage of trash divided on materials. From these informations is possible to valuate dimensions of the new biomass plant digesters, compared to VF needs, about 20% of organic waste amounts.
575 milions -> 20% = 115.088.160 m3/year
TOTAL CAPACITY

Valuating volumes for digesters it's direct consequence of this data, finding daily amount of biogas and multiplicate it for HRT (Residence Time, valued in 14 days according to thermophilicity condition).
Data taken from:
ANDREA BORDONI - La filiera del biogas, Aspetti salienti dello stato dell'arte e prospettive pp 8-9,;
Total volume of digesters will be so almost 4.5 millions cubic meters. According to design considerations and questions about process of biogas design, there will be 4 digesters, 2 medium, 1 large and the last small. Will be necessary to bury a big part of the digesters to solve height problems.

Michigan Solid Waste Composition
(mean % by weight)



Organics in Michigan MSW Composition
(mean % by weight)

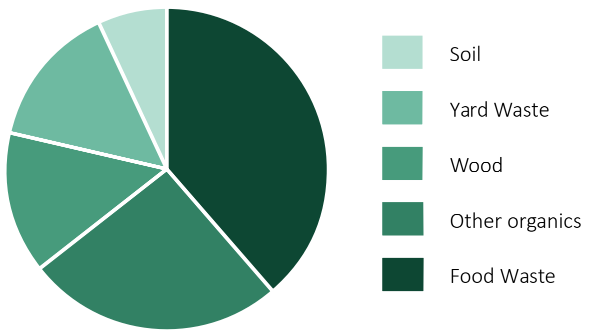
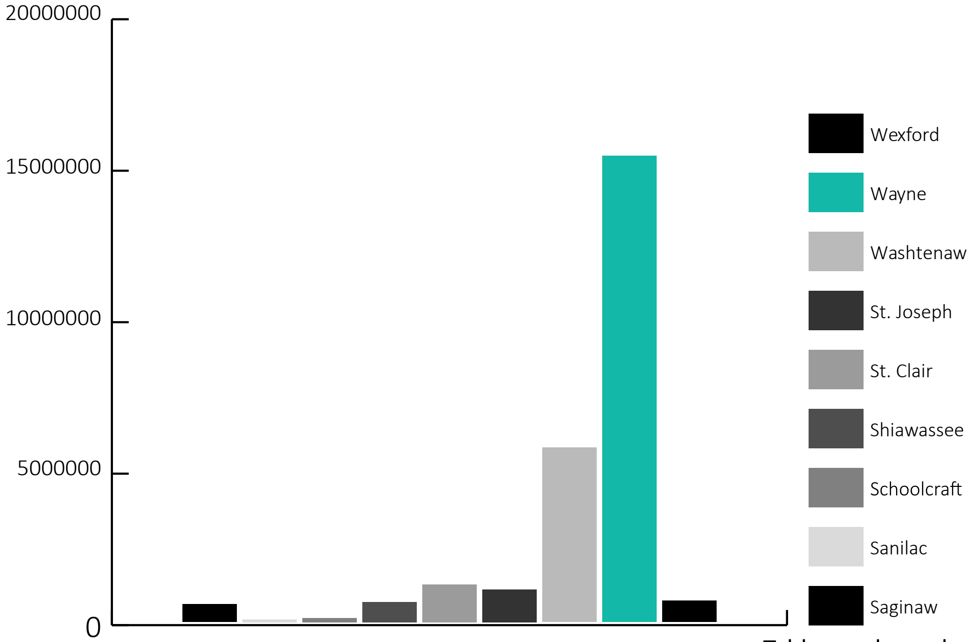


Table 6A
Total Waste disposed by County - FY 2019
(Volume in Cubic Yards)



Tables re-drawn by the candidate.
Source: Economic impact potential
and characterization of municipal solid waste in Michigan. 2016

A biomass plant needs control building, torch, technic building, anaerobic digesters designed according to volume data, and an upgrading unit to convert gas. All these building can be boxed or not in a single building, so is a design choose to do.

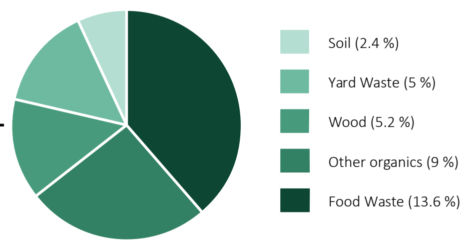
Biomass power plant scheme.
Source: Shaw Renewables UK.

PLANT DESIGN

Data: 15,488,813 cubic yards -> 4,181,979.50 tons
35% Organic

Material	Quantities (tons)	Resa (m3/ton)	m3/year (biogas)
Other	376,378	400-600	188,189,000
Yard waste	209,098	350-400	73,184,650
Soil	100,367	-----------	-----------
Wood	217,463	-----------	-----------
Food waste	568,749	400-600	284,374,500
	1,154,225		545,748,150

Source: "Economic impact potential and characterization of municipal solid waste in michigan." 2016



Source: Nextville, Energie rinnovabili ed efficienza energetica.
https://www.nextville.it/index/559

Material	Quantities (tons/year)	Density (kg/m3)	m3/year (biogas)
Food waste	284,374,500	638	445,728,056
Yard waste	73,184,150	583	125,530,274
Other	188,189,000	384	490,075,520
			1,061,333,850

Plant working 8000 hours/year.

Biomass plant design process re-visited by the graduate.
Source: MAZZEO SERGIO (October 2018) - Progettazione ed analisi tecnico-economica di un impianto a digestione anaerobica per la produzione di biometano. Politecnico di Torino.

$$\frac{Area}{floor} = 850\ m^2\ (shaft)$$

$$7\ floors$$

Farm design dimensions.

$$A_{tot} = 850 \times 7 = 5950\ m^2$$

$$V_{tot} = 850 \times 23{,}96\ (h_{tot}) = 20{,}366\ m^3$$

$$V_{digester} = \pi\, r^2 \times h = \pi \times 50^2 \times 35 = 274{,}889.35\ m^3 \times 4\ (n.digesters) = 1{,}099{,}557.4\ m^3$$

$$Q/_{day} = \frac{V_{digesters}}{HRT} = 78{,}539.81\ \frac{m^3}{day} \rightarrow m^3/_{year}\ 365 \times 78{,}539.81 = 28{,}667{,}032.2\ m^3/_y$$

HRT: Permanence time in digester: 14 days.
Thermophilicity 50-55 °C.

Energy conversion

$$1\ m^3\ biogas \rightarrow 6\ kWh\ HEAT$$
$$1\ m^3\ biogas \rightarrow 2\ kWh\ ELECTRICITY$$

40 % Electric Power

60 % Heat Power

$$40\%\ Q/_{year} \times Yield\ \left(2kWh/_{m^3}\right) = 22{,}933{,}625.60\ kWh/_{year}$$
$$60\%\ Q/_{year} \times Yield\ \left(6kWh/_{m^3}\right) = 103{,}201{,}315.20\ kWh/_{year}$$

$$Q/_{year\ available} = 103{,}201{,}315.20 + 68{,}000\ (Incinerator\ actual\ power) = 103{,}269{,}315\ kWh/_{year}$$

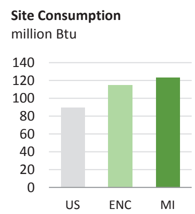
Useful to produce electricity for farm, market,...
ENERGY DESIGN of the farm chapter 2.2.1

$$(556.8 + 66.6) \times (4 \times 3) \times 117.10 = 876{,}001.68\ kWh/_{month}$$
$$(556.8 + 66.6) \times (3 \times 3) \times 65.26 = 366{,}147\ kWh/_{month}$$

$$Tot_{consumption}/_{year} = (876{,}001.68 + 366{,}147) \times 12 = 14{,}905{,}784.16\ kWh/_{year}$$

Household Energy Use in Michigan

$$\cong 123{,}000{,}000\ BTU \rightarrow 36{,}047.74\ kWh/_{family}/_{year}$$



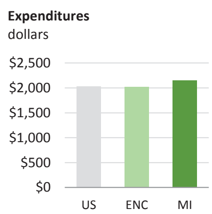
Household (U.S Census 2020, Detroit)
263,688

$$Tot_{consumptions} = 263{,}688 \times 36{,}047{,}74 = 9{,}512{,}476{,}041\ kWh/_{year}$$

Low income families: 30% in Detroit (citydata.com)

$$30\%\ Tot_{consumptions} = 2{,}853{,}742{,}812\ kWh/_{year}$$

$$\%\ bills\ recovered = \frac{Tot_{usable\ energy}}{Tot_{consumptions\ LOW\ income}} = 0{,}036 \rightarrow 3{,}6\ \%\ recover\ on\ energy\ bills$$



$$\cong 202{,}322\ people$$
$$\cong 79{,}106\ households$$
$$\cong 5{,}880{,}000\ \$\ recovered\ every\ year$$

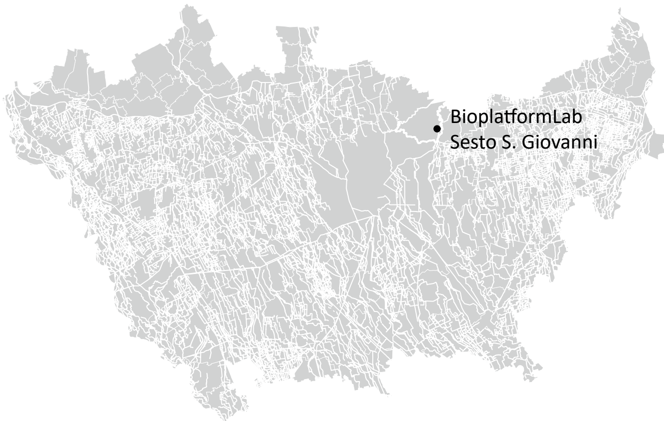
Diagrams about Energy consumption by households in Michigan and bills.
Source: Residential consumption reports, 2009. EIA.gov.

1.2.3. CASE STUDIES

BIOPLATFORMLAB, Sesto San Giovanni (MI)

"Converting a large industrial plant is never simple, both in economic and environmental terms. The challenge is made all the more difficult when the structure in question is an incinerator in a highly urbanised area, just a few miles away from homes and schools. In a case such as this, direct consultation with the public is a vital step." (Daniele Lettig, Renewable Matter Magazine, November 2th 2019). The project cam out from a participative process with 5 municipalities around Sesto San Giovanni, in the interland of Milan. The new innovation hub for sludges want to be a center for experimentation on waste waters, capable to integrate last technologies in the sector, contemporarily with other national and international partners, research centers, etc…

"The new bioplatform will be structured along two lines. Respectively, these will treat sewage from the Councils that are part of CORE and wastewater derived from Gruppo CAP's purification plants. The plant, according to figures provided by the company, will process 65,000 tonnes per year of wet waste (equal to just over 14,000 tonnes of dried sewage). Three quarters of these will be used to generate district heating, with a yearly output of 11,120MWh. The remaining 25% will be turned into phosphorus to be used as fertiliser, while the purified water will be reintroduced in the Lambro river or used for irrigation in parks in the surrounding area. The Council's wet waste treatment line (Forsu), on the other hand, will process 30,000 tonnes of material per year, which will be used to produce biomethane" (Daniele Lettig, Renewable Matter Magazine, November 2th 2019). Flow chart of the plant is simple, materials start to be dumped in foredeeps. Then, sludges are valorized and put in FORSU digesters (Organic Fraction of Municipal Solid Waste). Treatments become from a linear way "to pursuing sustainable circularity, focusing on ecodesign, recovery of waste materials and the industrial redesign of products and processes. It will be the result of a



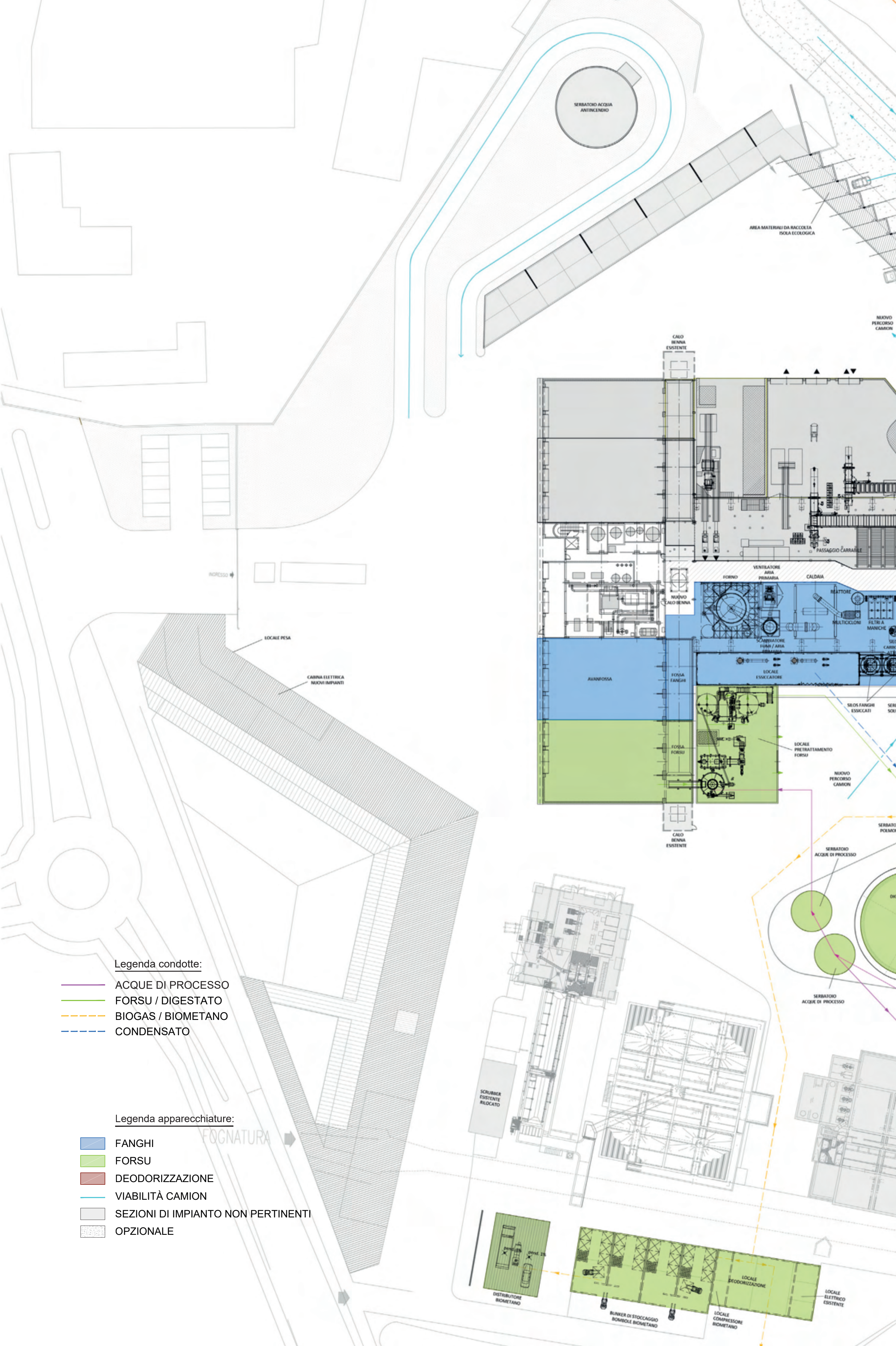
Milan Metropolitan Area, Italy

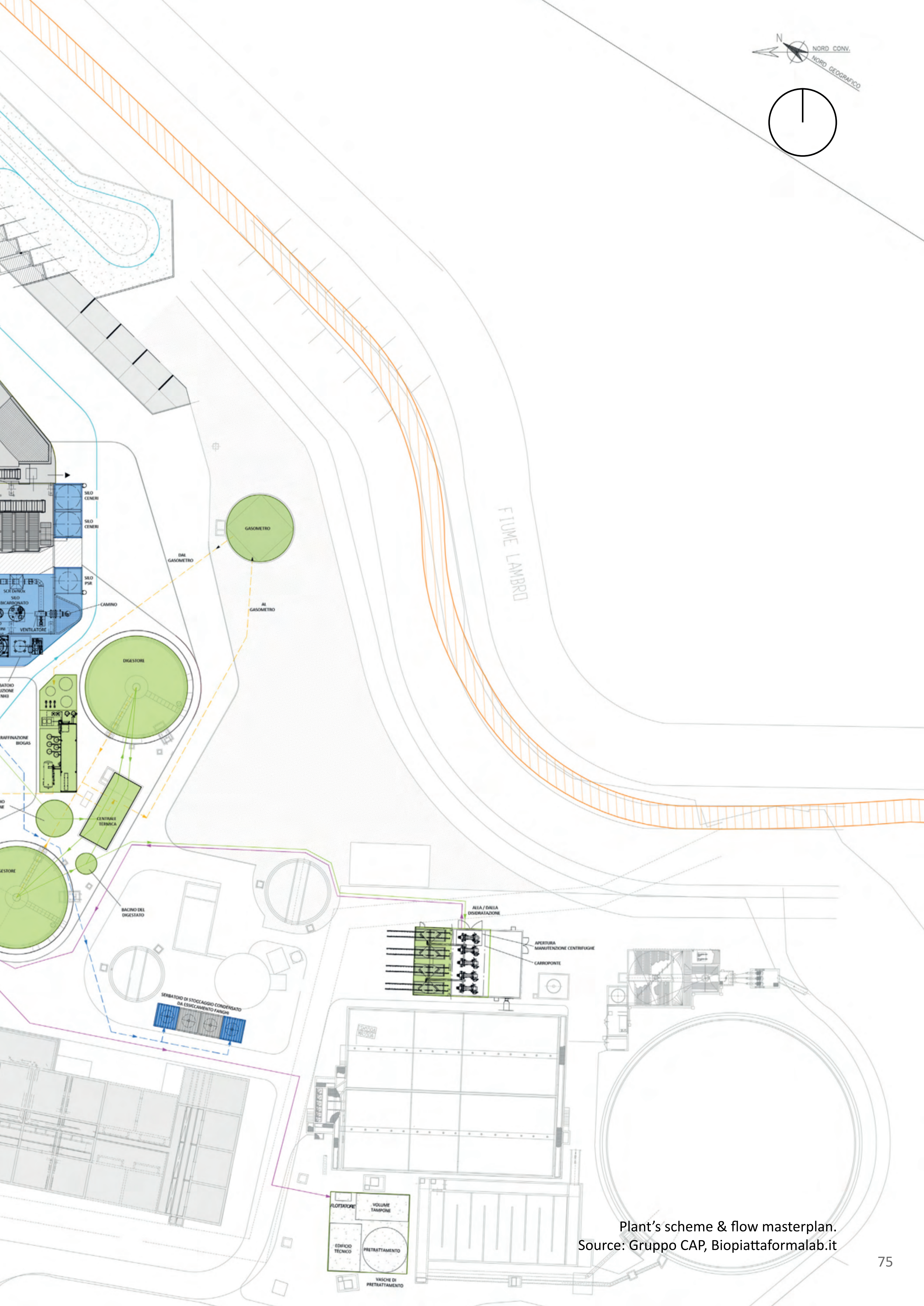
structured, cross-sectorial path that puts citizens, local committees and associations at the centre of the planning process." (Daniele Lettig, Renewable Matter Magazine, November 2th 2019).

Territorial classification of the plant.
Source: Gruppo CAP, Biopiattaformalab.it

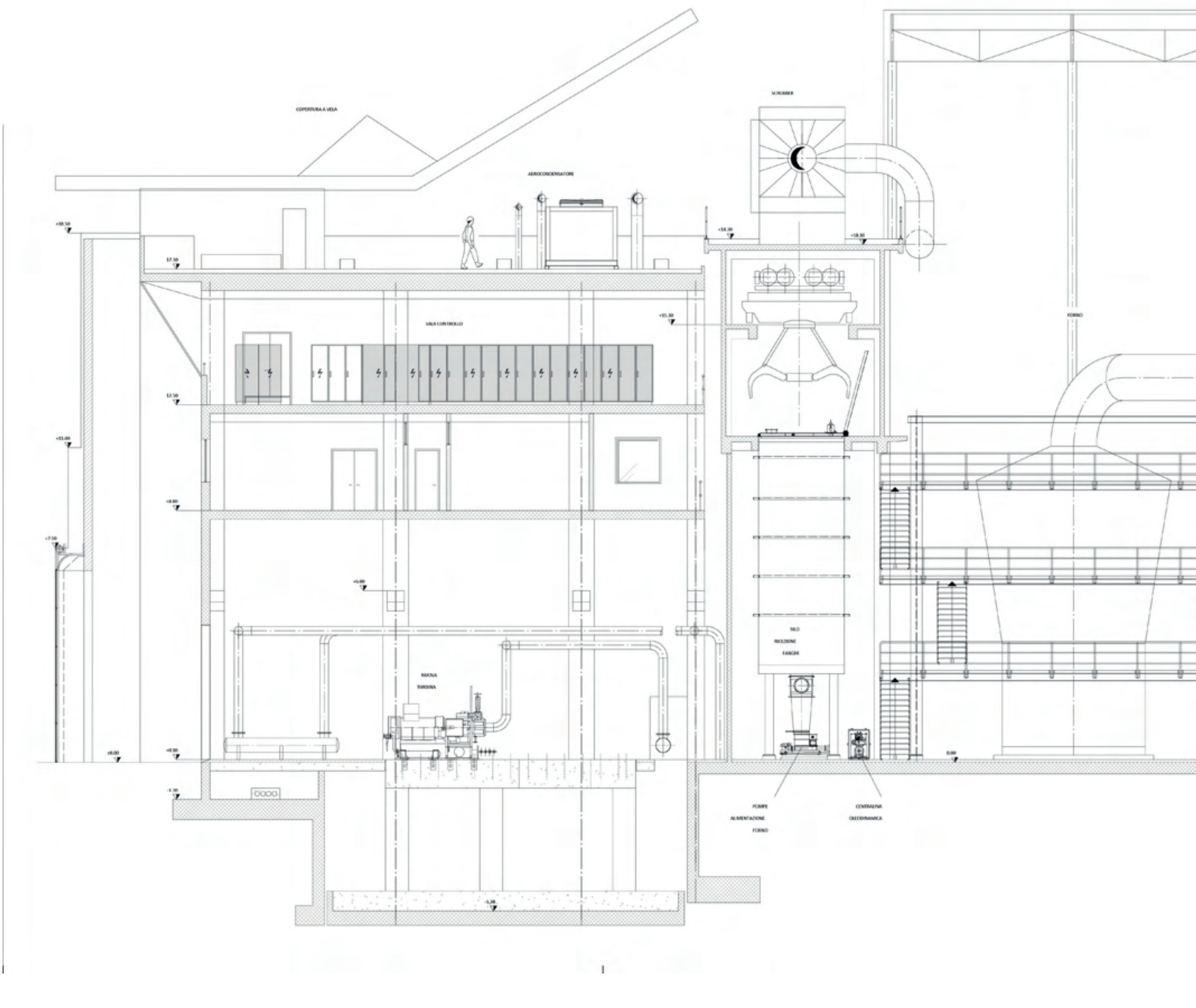
Via Nicolò Copernico
Via Daniele Manin
1. ingresso Polo
2. attesa automezzi
3. piazzale di manovra
4. avanfossa e fosse
5. isola ecologica
6. valorizzazione fanghi
7. pesa
8. locale pesa
9. pretrattamenti FORSU
10. CAP - impianto di depurazione
11. area umida - fitodepurazione
12. uffici
13. deodorizzatore / scrubber rilocato
14. ingresso di servizio
15. stazione di distribuzione biometano
16. parcheggio esterno per visitatori
17. digestori FORSU
18. cabina elettrica nuovi impianti
19. vasche di pretrattamento
20. bunker di stoccaggio biometano compresso
21. locale odorizzatore biometano
22. cabina elettrica depuratore
23. locale compressore biometano
24. cabina RE.MI. / area a disposizione per il gestore della rete gas
25. raffinazione biogas
26. gasometro
27. vasca acqua antincendio
28. locale disidratazione digestato (FORSU)
29. serbatoi di stoccaggio condensato da essiccamento fanghi
30. edificio sala controllo
31. area a disposizione per il gestore della rete gas
perimetro area impianto CAP - CORE
percorso ciclo - pedonale

General plant plan.
Source: Gruppo CAP, Biopiattaformalab.it


SERBATOIO ACQUA ANTINCENDIO
AREA MATERIALI DA RACCOLTA ISOLA ECOLOGICA
NUOVO PERCORSO CAMION
CALO BENNA ESISTENTE
PASSAGGIO CARRABILE
FORNO
VENTILATORE ARIA PRIMARIA
CALDAIA
REATTORE
NUOVO CALO BENNA
MULTICICLONI
FILTRI A MANICHE
SCAMBIATORE FUMI / ARIA PRIMARIA
LOCALE ESSICCATORE
LOCALE PESA
CABINA ELETTRICA NUOVI IMPIANTI
AVANFOSSA
FOSSA FANGHI
FOSSA FORSU
SILOS FANGHI ESSICCATI
LOCALE PRETRATTAMENTO FORSU
NUOVO PERCORSO CAMION
CALO BENNA ESISTENTE
SERBATOIO ACQUE DI PROCESSO
SERBATOIO ACQUE DI PROCESSO
SCRUBBER ESISTENTE RILOCATO
FOGNATURA
DISTRIBUTORE BIOMETANO
BUNKER DI STOCCAGGIO BOMBOLE BIOMETANO
LOCALE COMPRESSORE BIOMETANO
LOCALE DEODORIZZAZIONE
LOCALE ELETTRICO ESISTENTE
Legenda condotte:
ACQUE DI PROCESSO
FORSU / DIGESTATO
BIOGAS / BIOMETANO
CONDENSATO
Legenda apparecchiature:
FANGHI
FORSU
DEODORIZZAZIONE
VIABILITÀ CAMION
SEZIONI DI IMPIANTO NON PERTINENTI
OPZIONALE



Plant's scheme & flow masterplan.
Source: Gruppo CAP, Biopiattaformalab.it


COPERTURA A VELA
AEROCONDENSATORE
SCRUBBER
SALA CONTROLLO
FORNO
SILO
RICEZIONE
FANGHI
POMPE
ALIMENTAZIONE
FORNO
CENTRALINA
OLEODINAMICA

242 M3/HOUR BIOMETHANE

30000 TONS/YEAR FORSU LINE

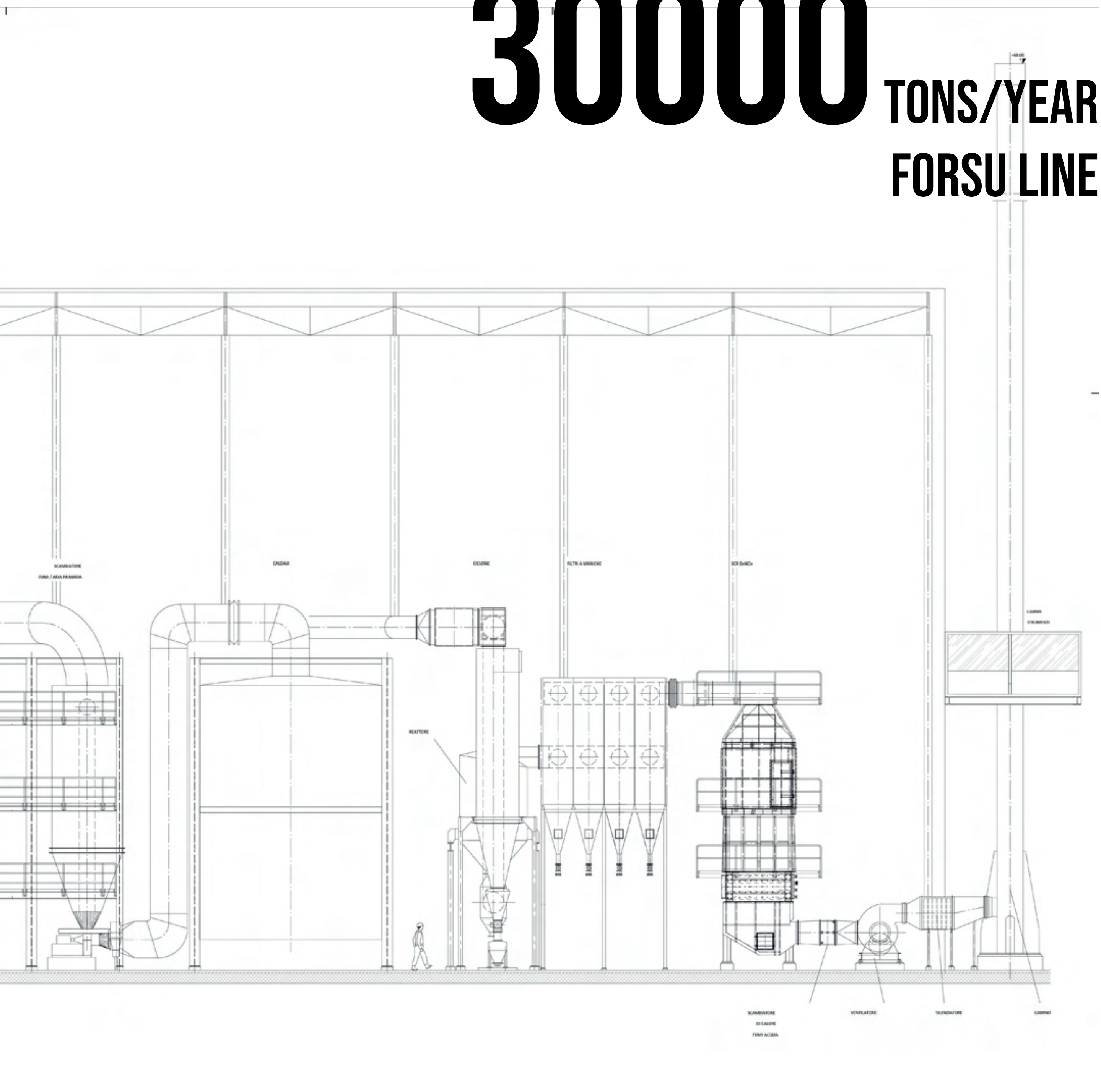


Fig. 1 : Longitudinal section MUD line.
Source: Gruppo CAP, BiopiattaformaLab.it

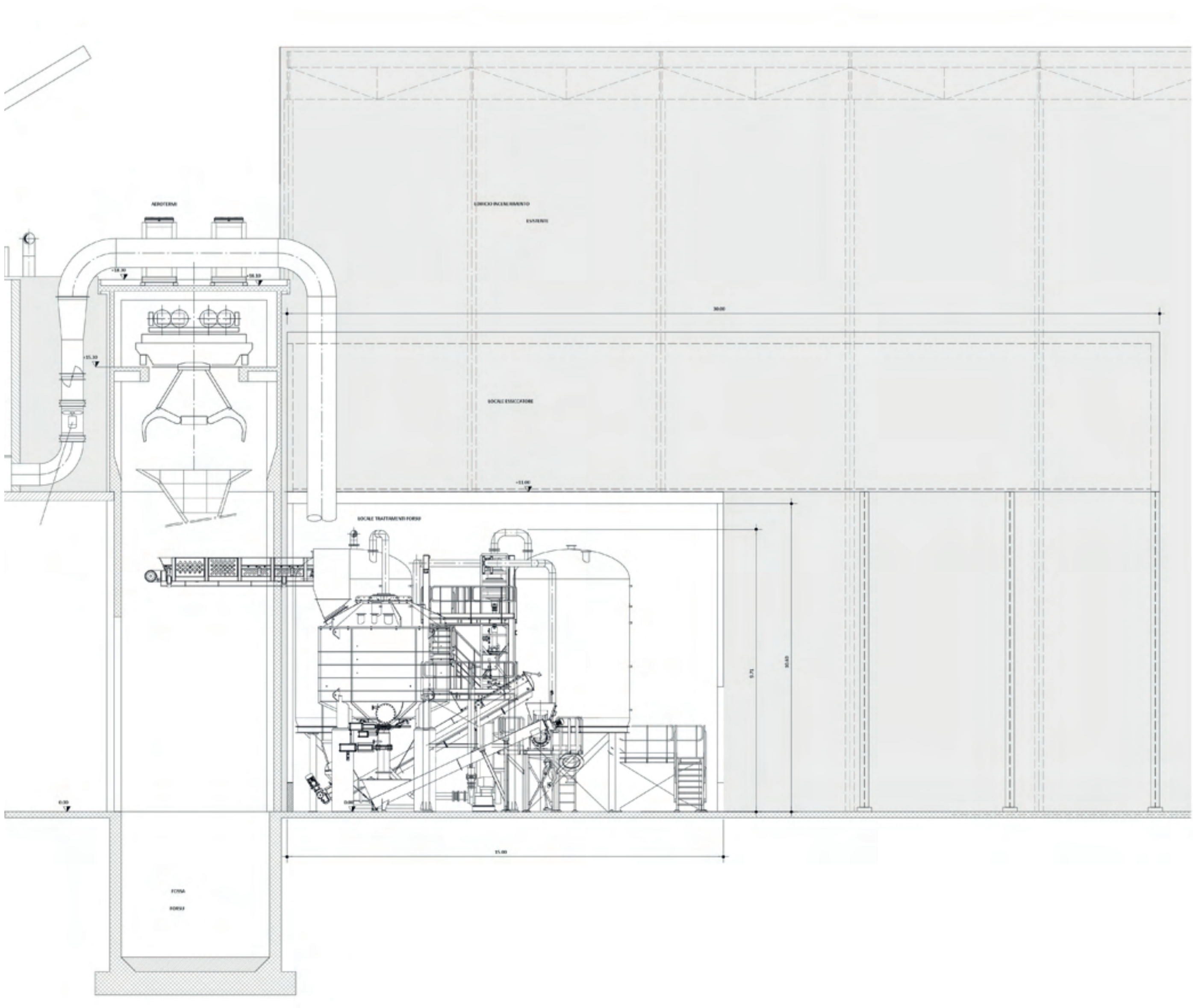


Fig. 1: Longitudinal section FORSU line.
Source: Gruppo CAP, BiopiattaformaLab.it

Fig. 1: New plant render - South view Rev. 1.
Fig. 2 : New plant render - Park view Rev. 1.
Source: BiopiattaformaLab.it

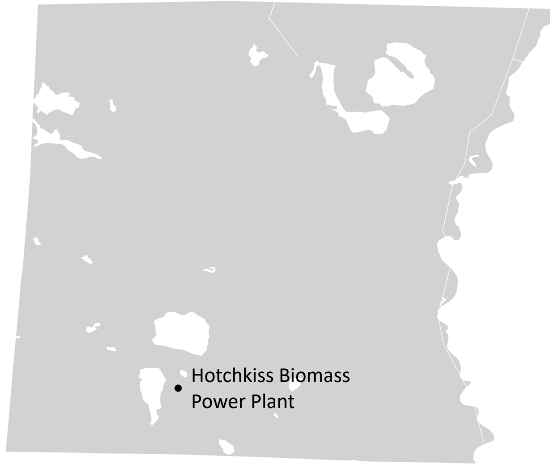
Hotchkiss Biomass Power Plant. Centerbrook Architects. Lakeville, Connecticut.

"The Hotchkiss School is a boarding private school, sitting on 827 acres of woods, fields, and farmland in one of the most extraordinary landscapes in the Northeast. The School's state-of-the-art facilities combined with these surroundings" (Hotchkiss, 2016). "The school is a member of EPA Green Power Partner (Environmental Protection Agency) and Green Schools Ally. Hotchkiss requires all campus buildings to acquire LEED certification and as of 2009 uses 34% green power" (Wikipedia, 2016).

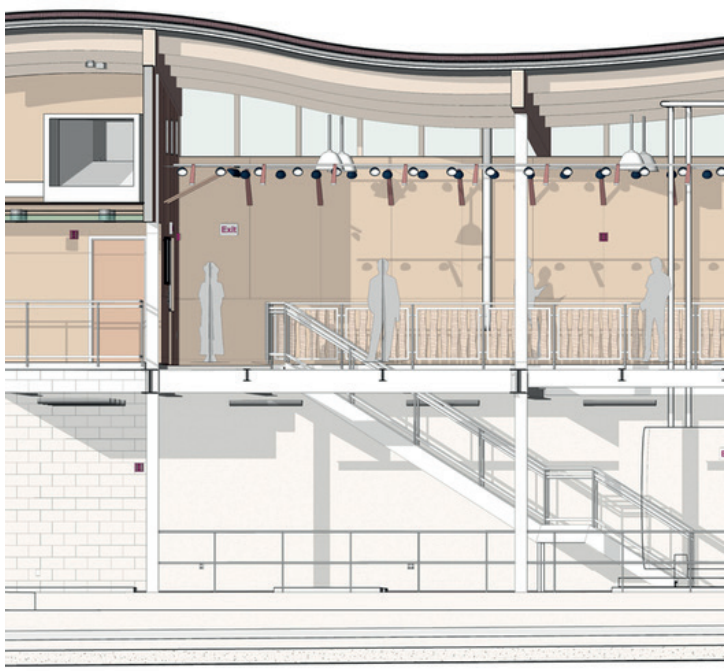
"Centerbrook designed this Central Heating Facility to heat all 1.2 million square feet of the 85 buildings that comprise the campus. It burns woodchips and replaces an oil-fired boiler plant, reducing greenhouse gas emissions by a third to nearly a half. The building houses two biomass boilers. Four truck bays feed wood chips into a 17,500-cubic-foot storage bin capable of supplying a week's worth of fuel. The facility was designed to do three incongruous things at once:

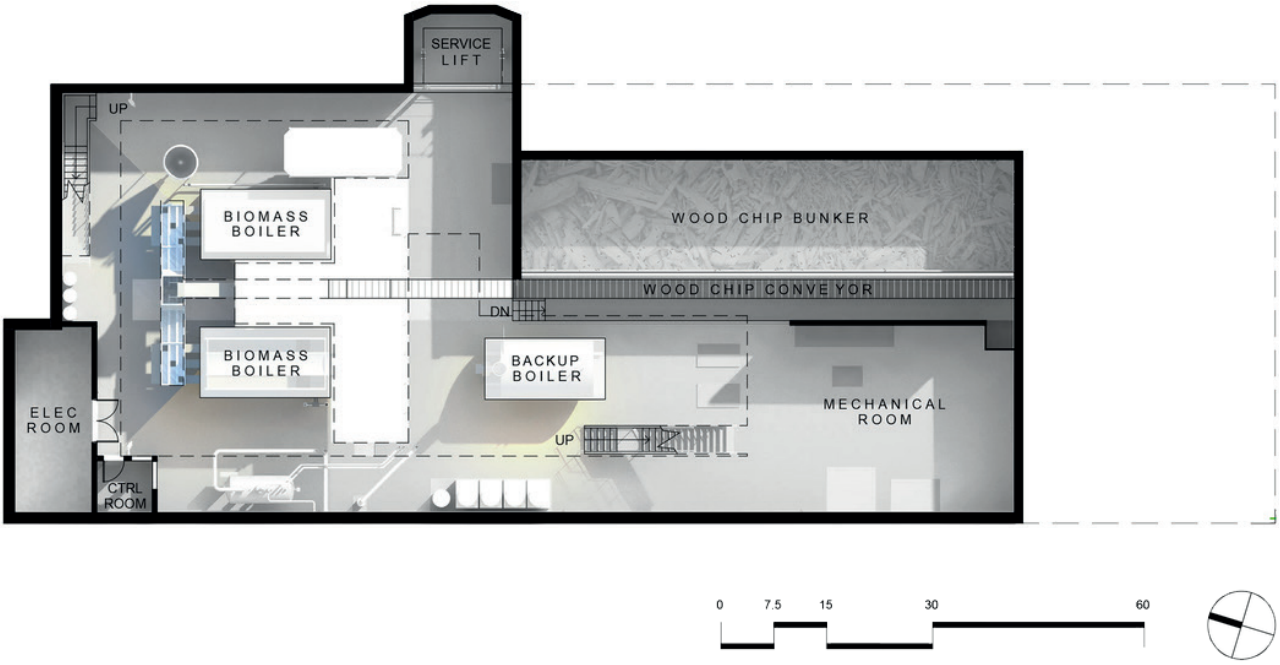
- It was to be, foremost, an iconic landmark signifying the school's commitment to becoming a carbon-neutral campus by 2020.
- It was also meant to gently merge with the landscape in a genial display of ecological principles.
- It was to be not only a heat plant, but also a classroom for the advancement of ecological awareness. (Centerbrook Architects, 2020)

"The case study is a biomass central heating facility. Biomass is organic matter derived from living organisms. Biomass can be used as a source of energy and it most often refers to plants or plant-based materials that are not used for food or feed. As an energy source, biomass can either be used directly via combustion to produce heat, or indirectly after converting it to various forms of biofuel. Conversion of biomass to biofuel can be achieved by 3 types of methods: thermal, chemical, and biochemical methods. In this case, the method is thermal" (Source: Wiki-



Salisbury County, Connecticut, USA





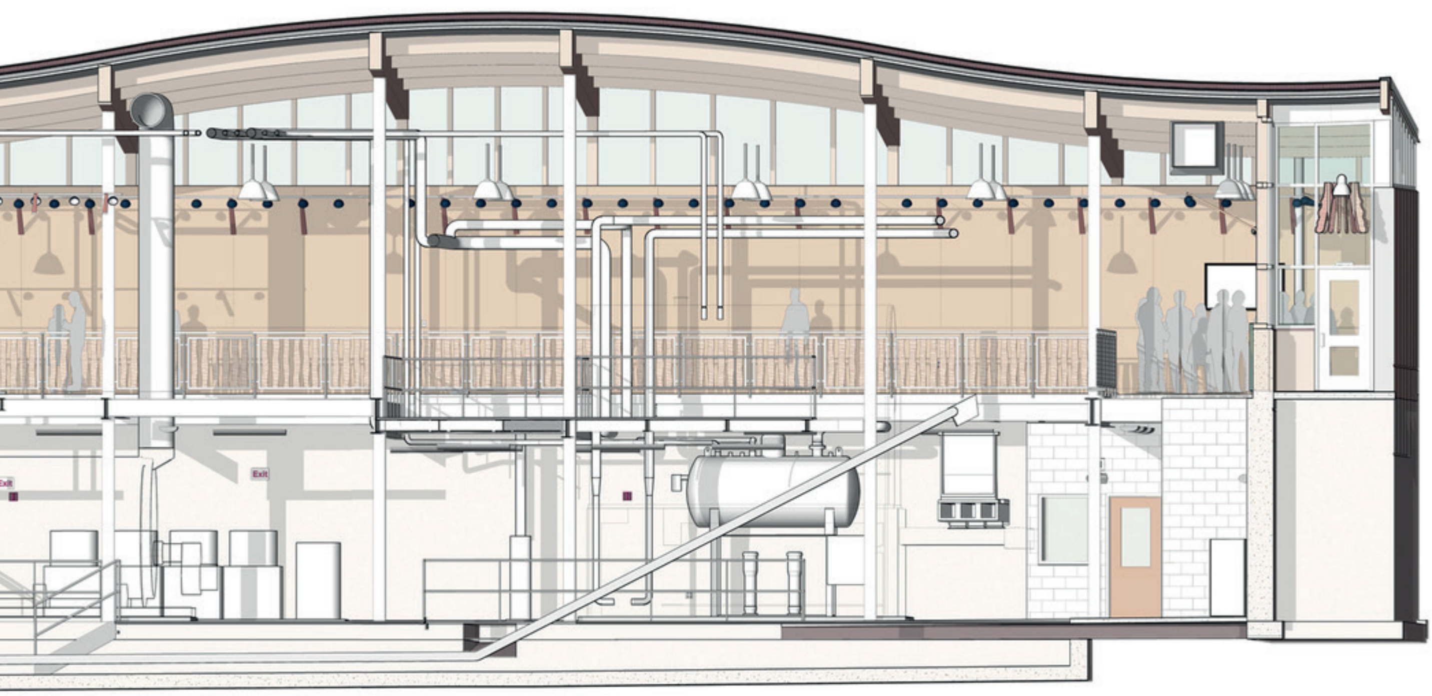


Fig. 1: Heating plant plan.
Fig. 2 : Interior section.
Source: Centerbrook Architects, Archdaily

pedia, Biomass).

“The plant burns around 5,500 tons of wood-waste chips annually. The wood chips are the biomass in this case. After preparation and processing procedure, the biomass enters 2 boilers. After the fire boiling, some parts are exhausted, some turn to the ash. The waste ash from the burning is used as vegetable fertilizer around the school. The rest energy is converted to the electricity and used by the school and other buildings. The 16,500-square-foot building burns locally sourced wood chips—a byproduct of FSC forests(Forest Stewardship Council)—and serves 85 buildings, 1.2 million sf, aka about 600 residents” (Urban Ecology CMU, Wordpress, Paul Moscos Oriofrio, 2016).

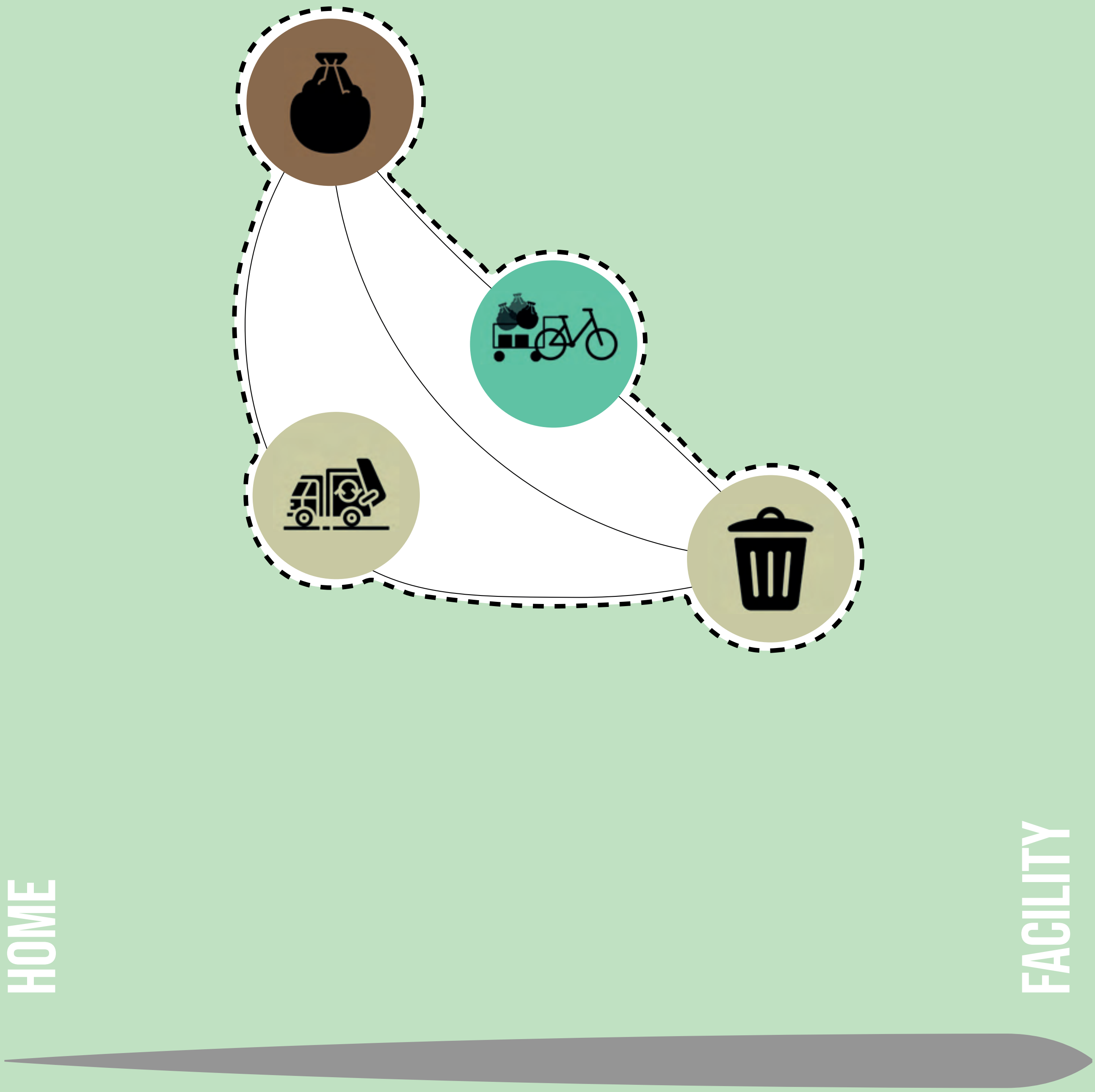
“This facility is a living classroom for students that burns sustainably-harvested woodchips to heat the campus. Its undulating green roof blends into its surroundings while standing out as an iconic landmark.” (Centerbrook Architects, 2020)

Interior of the plant.
Photos by David Sundberg

Fig. 1: Photo of the complex.
Source: Centerbrook Architects, Archdaily.

1.3. RECYCLING & PICK UP

1.3.1. BIN'S POLICY: WHY IS NOT ENOUGH UPGRADING FACILITIES



Bin's policy: why are not enough facilities

Cogeneration and biomass plants are important in saving energy that is lost from trash. That, however, is not enough. The United States in particular, has a problem with trash when it comes to volume and quantity pro capita. Landfills are almost full, Michigan itself is full of trash disposed in special facilities. How long will it take before water and soils become permanently polluted? And another question: how much energy can be recovered from trash? The answer comes with a clear bin policy. Yields of these kinds of plants are valued on how much we can divide the raw materials. So, if everyone divided trash correctly, the cost and yields of incinerators and biomass plants, etc. would consequently be very affordable. That is why it is important that the trash program in Detroit be changed. Most people do not recycle in the home environment, and recycling is simply separating different bins from the MSW. It is not enough that every family divide plastic, paper, glass, MSW, and organics if the City of Detroit does not change and improve its trash disposal system. Trucks should go by every day to pick up trash which produces pollution. In many parts of the world, there is a thriving business that allows garbage collection to be developed in different ways, avoiding the problem altogether. There are many start-up associations and governance projects of these kinds of activities.

"Waste management is one of the most daunting challenges facing modern cities. The United States produced 262.4 million tons of municipal solid waste in 2015, recycling only about 67.8 million tons of that total, composting 23.4 million tons, and burning 33.57 million tons for energy. That leaves about 137.7 million tons of solid waste to collect in landfills over the course of the year." (Kayla Matthews, Planetizen, February 2019).

"The metaphor of urban metabolism sees the city as a living organism with flows of resources going in and out of the city, actors intervening in the transformation and consumption of these recourses, and with related services and product outputs. This is a systems perspective of the city, where social processes, spatial form, and the material and energy metabolism are equally connected and interwoven” (Swyngedouw E, December 20th, 2017). “Urban metabolism analysis studies the entry, transformation and storage of materials and energy and the discharge of any kind of waste and unwanted products. Here, infrastructures and services play crucial roles in maintaining cities and providing for the residents. Cities surely are complex systems. With a dynamic and cyclical perspective applied to planning and development, this approach shows where cities are not livable, are unhealthy and unsustainable or are unjust and inequitable” (Newman P, Jennings I., Island Press 2008).

Two different ways to approach waste collection pick-up.
Fig. 1 Compost Pedallers.
Source: Vicky Gan, BloomBerg CityLab, 2015.

Two different ways to approach waste collection pick-up.
Fig. 2 Solid waste collection by trucks.
Source: City of Melbourne, Public Works & Utilities, 2021.
(by chance is the same of one of the two corporation of Detroit)

1.3.2. THEORY & HYPOTHESIS

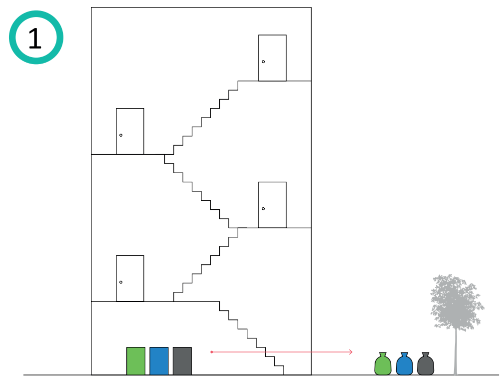
Theory & Hypothesis

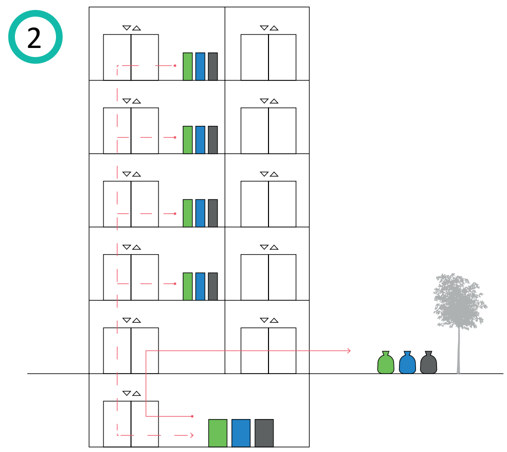
It is possible to fight the waste urbanism challenge not just in a formal way. For example, "the bulk of material recovery in the global South is informal, grassroots and involves a wide spectrum of domestic reuse of bottles, cans, plastics, paper, cardboard and many other discarded materials. Yet, its role is largely unrecognized in waste management and by city authorities. In Delhi, India 15–20% of the MSW (daily 1,275 to 1,700 tons) is collected by informal recyclers. The waste pickers also redirect 200 tons per day of separated organic material to a large-scale composting plant. They collect organic waste from households in the affluent neighborhoods, where they compost it in a series of community composting pits" (CHINTAN, 2009). The important thing is to design a governance project with the participation of several associations on the 313 territory. Volunteers for filing and scheduling should make it possible to aim for many goals when it comes to reducing energy waste and the cost of the trash transportation net. "The success or failure of governments is linked to how they deal with waste and to the responses society is already producing. Waste governance is more than just having the right laws and policies in place and having institutions enforce policies. It is also about levels of democratic participation, recognizing other forms of knowledge, and understanding the links between waste, value and society in order to tackle broader social, political, cultural and economic issues that affect the urban agglomerations." (Jutta Gutberlet, December 2017).

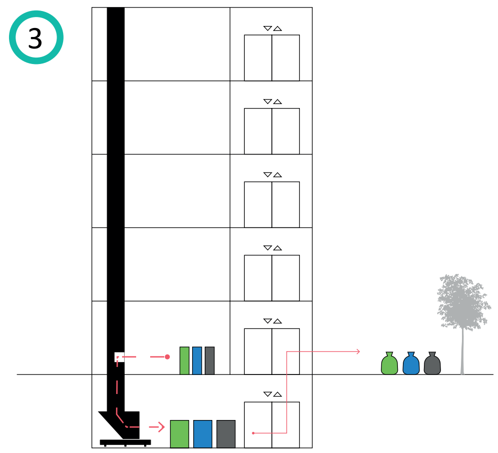
Urban planning based on waste is divided into three fundamentals:

- GARBAGE AS MOVING ITEMS: "Garbage is not a pile of something you see on the street. It is something that moves. And movement, as we know from physics, has a cost. Each step of the way has significant consequences in terms of trucking trips, and diesel emissions, and public health, and so on. So, there are lots of costs and frictions, and we need to plan for that movement so we can minimize the overall economic and environmental costs.” (Vanessa Quirk, How to Design a City for Waste, 2018).

- CONNECTIONS IN THE SYSTEM: “every piece of the system is connected to the next. You can’t think about any one component without thinking about how it all fits together. How waste leaves the building, how it’s stored, how it’s sorted, what categories, what it’s put into, when it’s moved to the street, how often it’s moved to the street, what collects it. All of these things fit together.” (Vanessa Quirk, How to Design a City for Waste, 2018).
- INTEGRATION: “Garbage collection has two parts that are very different. The front end and the back end. The front end is not rocket science, it’s people. And we have to design for how people interact with this stuff. We want to make it simple, and we want to make it convenient. We want to make the rules unchanging, whether you’re at work or at home, so that you can just develop habits. The back end [the facilities where waste and recycling are processed] is the part that has to change — because the materials in our waste stream change, the technology for handling them changes, and the commodity prices for recyclables fluctuate enormously.” (Vanessa Quirk, How to Design a City for Waste, 2018).







We can only change the tail end of garbage collection. People might try to be more conscious about trash problems, but it is the designer, architect, and engineer’s job to improve structures, facilities, and the overall system itself, starting with making trash collection easy for the people. There are different ways in achieving this goal such as designing appropriate spaces and structure inside buildings to collect trash, dividing materials at the first step of the garbage disposal process. Moreover, politicians should make necessary uniform laws on garbage collection to encourage new habits in the people. Buildings design, according to its functions of both commercial and residential use, must be thought of in a way that can render trash collection and classification easier.

1. Central Location:
In the simplest scenario, residents bring waste to a central waste area. The area may be interior (at grade level or in the cellar) or exterior (in front of the building within the property line, on the sidewalk or in a side yard).

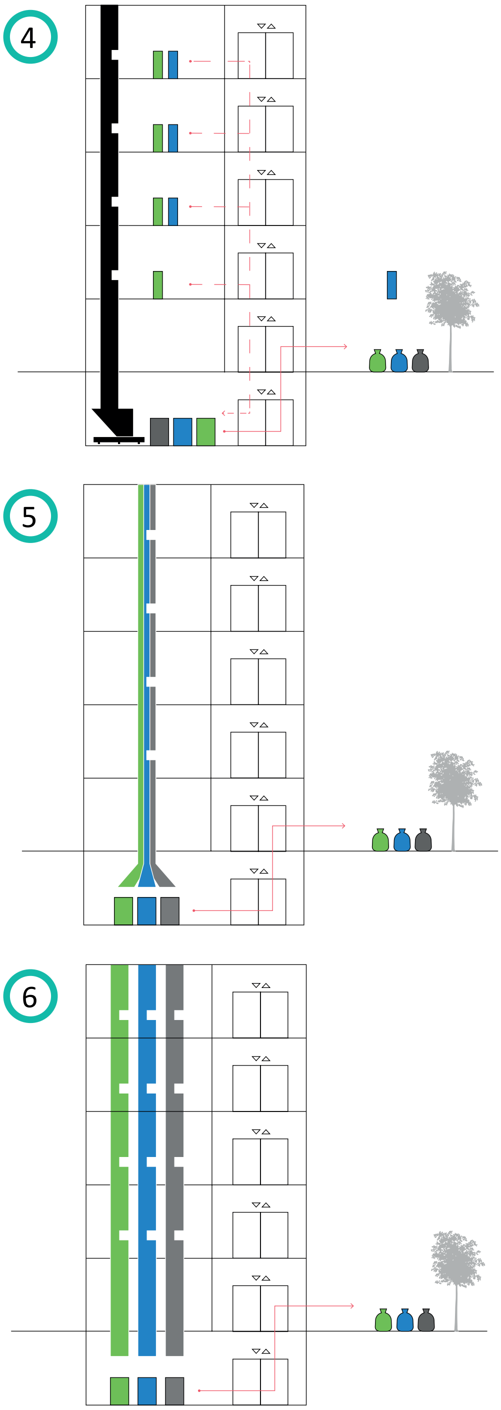
2. Service corridor:
Findable in large apartment buildings, often cooperatives, with doormen and staff who service the building through its separate service circulation. Residents generally place their waste in bins or bags, as well as bundled cardboard, directly outside the service door to their apartment.

3. Corridor chute with central recycling:
Findable in larger apartment complexes or city housings, this system often consists of a narrow chute that previously emptied into an incinerator. The chute door is in the egress corridor, or alongside the elevator, making it against code to add co-located bins for recycling or organics. Recycling is located in a central area.

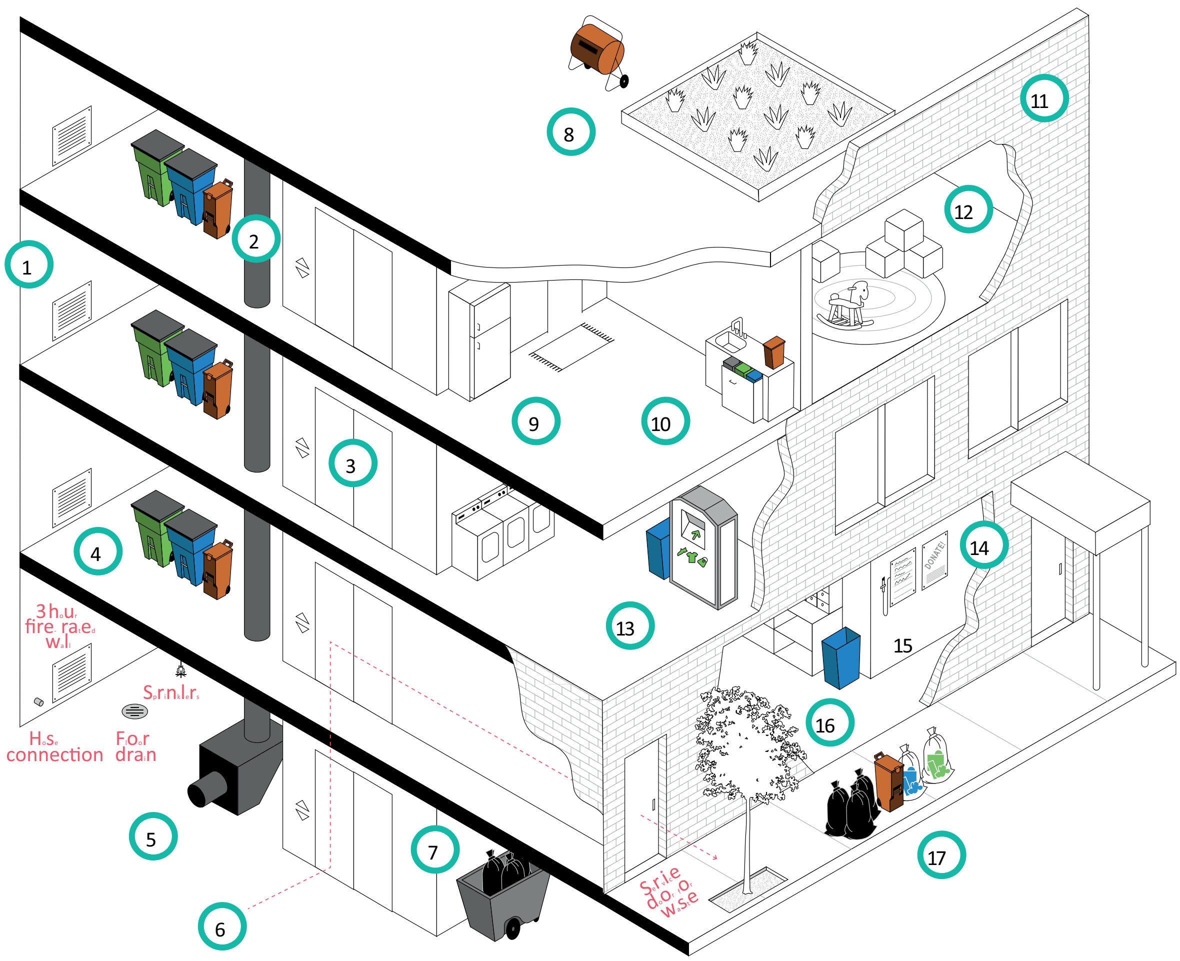
4. Trash room with chute and bins:
Typical of multifamily buildings. Trash goes down the chute to a compactor, and MGP and paper recycling is put in bins in the trash room. Sometimes there is also space for cardboard, or there may be another designated area. The trash room is often small and unventilated with just enough space for small recycling bins.

5. Singole chute with sorter:
Sorter systems allow use of a single chute for multiple waste streams. Before opening the chute door, residents press a button to choose the waste stream. The sorting equipment directs the trash into a compactor and the recycling streams into containers. The building code requires a chute access room (for buildings over 5 stories and 9 units), even though no storage space is required for recyclables.

6. Multiple chutes:
Multiple chutes allow for co-located disposal of multiple waste streams without mechanized sorting systems. Typically residents enter a trash room with three chutes: one leading to a compactor, one for MGP and another for paper. Cardboard must be left in the trash room or taken to a central location. There are variations on this setup: Some buildings may collect glass separately within the trash room while other buildings have just trash and MGP chutes and collect paper and cardboard separately in a recycling bin.



Residential typologies.
Source: ZeroWasteDesign, ZeroWaste GuideLines 2017



1. Waste room: consider area, ventilation, lighting, signage.

2. Chute and disposal of recycling on every floor required

3. Consider how waste travels vertically (by chute, by residents or by building staff in regular/service elevator)

4. Provide co-location disposal for all waste streams including organics. Consider other waste streams that may block chutes, e.g., cardboard, textiles, hangers.

5. Trash compactor required

6. Consider path of waste to curb and staff time required.

7. Waste storage room. Use containers unless room is ratproof and fireproof. Consider area required, ventilation, and washing of containers.

8.Compost can be made and used on-site in gardens.

9. Shallow refrigerators and shelves to reduce "lost food," or smart refrigerators.

Residential buildings design considerations.
Source: ZeroWasteDesign, ZeroWaste GuideLines 2017

9. Shallow refrigerators and shelves to reduce "lost food," or smart refrigerators.

10. Pull-out cabinet with bins (all waste streams) and counterop organics bin.

11. Consider impacts of building materials selection and construction process. Optimize material usage, consider end of life.

12. Consider amenities that reduce material consumption (e.g., children's play areas with toys, shared goods library, cleaning service with vacuums).

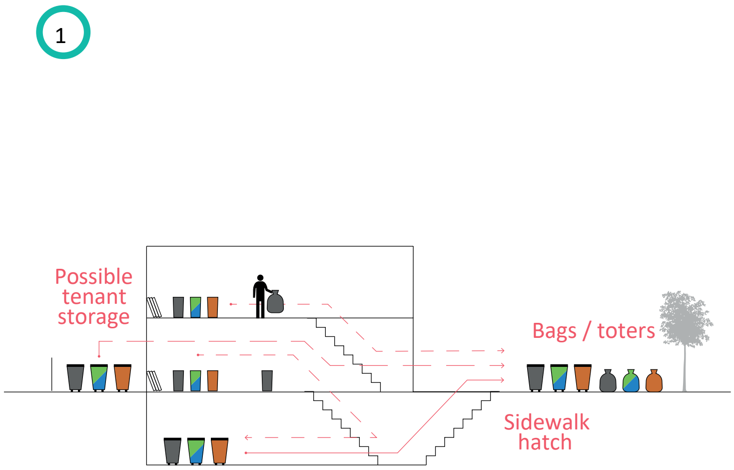
13. Provide textile recycling and plastics recycling in laundry room.

14. Consider possibilities for reuse such as online bulletin boards and donation refrigerators.

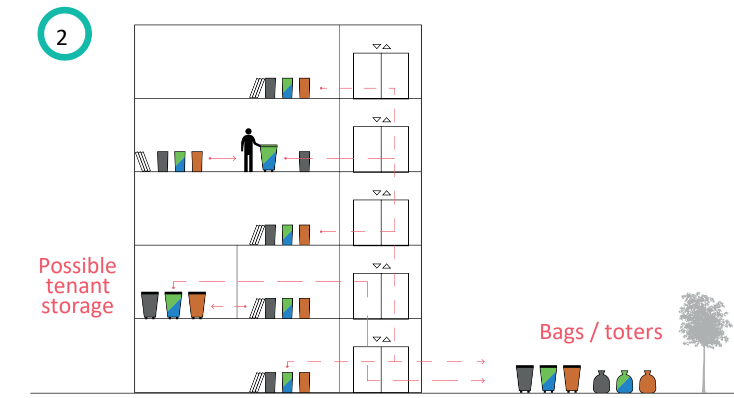
15. Provide feedback on waste generation to residents and staff to change behavior. Consider how to incorporate SAYT back to resident.

16. Provide paper recycling in mail room and cardboard collection in parcel room.

17. Provide set out area, coordinate with street, trees, furniture, curb cuts and entrance.

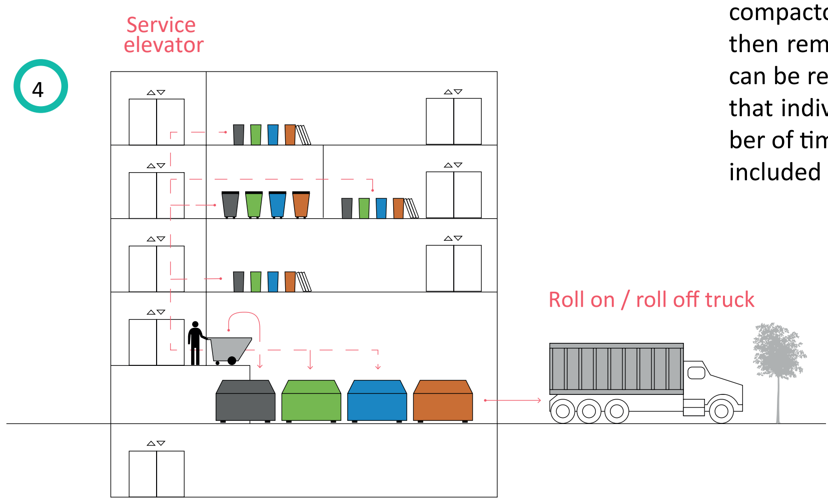


1. Stairs or ramp to sidewalk:
In the simplest scenario, businesses bring waste straight to the sidewalk, sometimes through a sidewalk hatch. There may be some storage in wheeled bins in a backyard or within the tenant space, but trash and recycling is generally set out in bags while organics are generally brought to the curb in two- or four-wheel bins.



2. Elevator to sidewalk:
This typology is common in multi-tenant office buildings with elevators but no shared storage space. Before being taken to the street for setout, waste is stored in the tenant area, moved by the tenant or collected by building staff at a set time in bins on dollies or tilt trucks. Floors are serviced daily via the service or passenger elevator. Facilities or cleaning staff members generally use one bin to transport all streams, so standardized procedures need to be followed to appropriately separate types of materials at the curb to avoid contamination. Setout for refuse and recyclables is typically in bags, while organics are generally set out in wheeled bins.

3. Elevator to shared storage:
Some large multi-tenant buildings, such as those with office, hotel, university or retail uses, provide shared storage space. Waste is collected from tenant areas, placed in transport bins and taken by service or passenger elevator to the shared storage space where there may be balers. Waste can be brought to the storage space by building maintenance staff or tenants. Setout may be in 1–2 cu yd containers, wheeled bins or bags.



4. Service elevator to shared compactor containers:
The ideal situation for large multi-tenant buildings is shared compactorcontainers, which may be exterior or in an interior loading area. Waste is collected from tenant areas, placed in transport bins and taken by service elevator to the shared container compactors and other bins. Building or tenant maintenance staff can bring waste to the storage space. Automatic pressure detection can tell the hauler when the compactor is almost full and ready for collection; it is then removed by truck and returned empty. ID tags can be required for opening the compactor doors so that individual tenants can be charged for the number of times the compactor is used, or a scale can be included to charge by weight.

Commercial typologies.
Source: ZeroWasteDesign, ZeroWaste GuideLines 2017

1.3.3. CASE STUDIES

Many situations, all on different scales, are being developed around the world. One such singular project is in the city of Northampton (Massachusetts), where there is a co-op "that offers bike-powered grocery delivery, moving help, yard care and waste, recycling and compost collection services." (Waste 360, 2017). Since 2002, they have made almost 340,000 pickups. With fees and timetables needed in order to organize every pickup, it's a big opportunity to improve employment of people and to find a sustainable solution to garbage collection. "Since June 2007 we've had a contract with the City of Northampton to pick up trash from the 80+ public trash and recycling receptacles downtown. We collect the trash downtown seven days a week and consolidate it in nearby compactors. We also collect the trash in downtown Florence". (Pedal people Cooperative, 2013). The matter brings up questions about distances to travel. The above-mentioned model needs recycling centers where bikers can use them as deposits rather than having trucks working exclusively to collect waste. Detroit is too extended to solve the problem through pedal power only. A hybrid solution would be an optimum solution.

Another brilliant example of recycling through bike power is a collaboration of the Worcester Polytechnic Institute and Polytechnic of Namibia in Windhoek, the capital of the African country. "Unemployment and inefficient recycling practices are significant problems in Namibia. Our project goal was to model the integration of informal waste collectors into the formal collection system through collecting recyclables using bicycles, which could reduce the use of fossil fuels and generate jobs in Windhoek. We tested this idea through a pilot program utilizing an informal waste collector volunteer. Our recommendations aim to help the Polytechnic of Namibia move forward with the model of recyclable collection by bicycle." (Anne Jacobsen, Malick Kelly, Logan Roche, Evan White, Polytechnic of Namibia, 2014). These models deal with the logistics of a system made for bikes, and the real construction and test of carts hooked up to bikes. The important thing is how this system might actually work elsewhere. Detroit is much bigger than these two cities, but it's possible to replicate this organization in a big city, too. Subdividing the city in sectors would be easy enough to do, just like Windhoek, and creating Collection Centers that are linked by trucks to the plants in the Eastern Market, so emissions can be cut down in transport, would make it equally efficient.

1.3.4. MAPPING THE CITY MASTERPLAN

313 AREA: JOE LOUIS GREENWAY

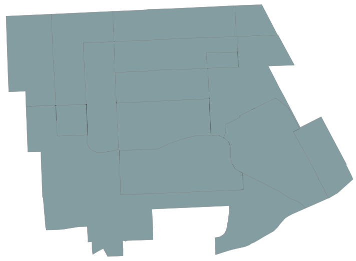
Map showing Joe Louis Greenway and relationship with the city.
Drawing not in scale, realized by the graduate.

MAPPING THE CITY MASTERPLAN

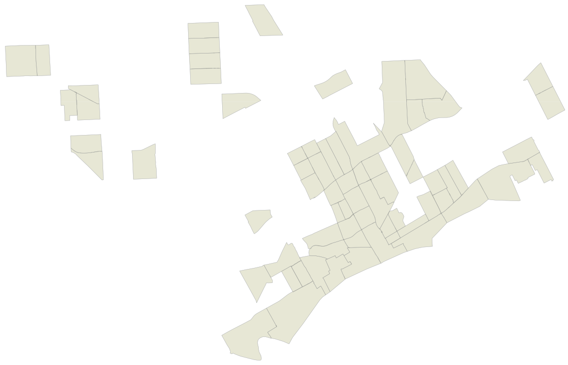
“The Joe Louis Greenway is a pathway that will unify Detroit’s neighborhoods, people and parks. Through this greenway, we strive to honor Joe Louis by providing equitable spaces through arts, programming, and economic opportunities for all.” (City of Detroit, 2020) With these words the Municipality talks about the big urban project (named after the legendary boxer and Detroiter Joe Louis), a huge 27.5-mile-pathway that winds around the center neighborhoods of the city, almost as a green belt for Detroit. “What’s a Framework Plan? The Framework Plan is a way of gathering community input and evaluating existing conditions before creating any final designs. It will:

- Consider at existing land uses in the half-mile corridor on either side of the Greenway;
- Include recommendations for land use, zoning, wayfinding and green infrastructure such as natural landscaping and effective stormwater management techniques;
- Determine the trail’s alignment, access points, connections to nearby destinations, trails, public transit, and the new Gordie Howe International Bridge;
- Identify the best pedestrian and bicycle design practices that make up a signature greenway;
- Determine a phasing and implementation plan;” (Detroit Greenways Coalition, 2020)

It’s a design process with the participation of the community which included 48 active meetings at the end of 2019. This project is also important for another reason, “pointing out that 46,000 Detroiters currently don’t have access to a park within a 10-minute walk of their home. This is going to be a new way to connect them and help bring them down to the riverfront. It’s the kind of catalytic project that has every possible avenue of import, and it’s just about holding all of those pieces together and making it happen the right way” (Jena Brooker, Planet Detroit, 2020).

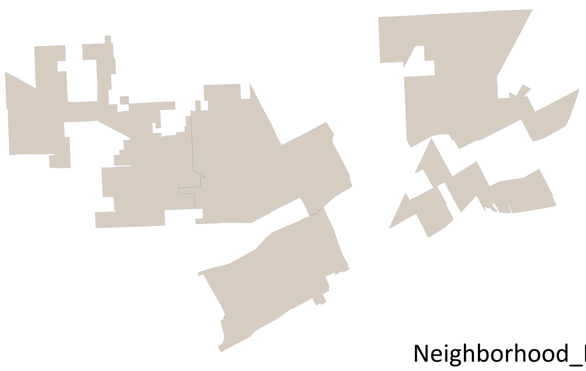


Recycling zones.



Opportunity zones.

Neighbourhood stabilization program_III



Neighborhood_Revitalization_Strategy_Areas_NRSA

Maps of Detroit’s features.
Realized by the graduate with Q-Gis.

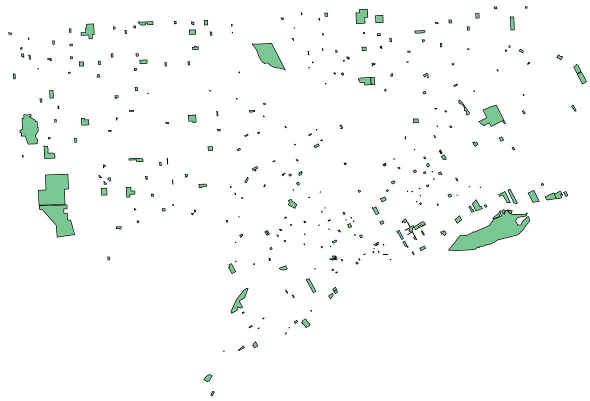
“Strings of Life” sets its own starting point renewing the city of Detroit. It will be developed in individual parts of the bigger project, carrying forward piece by piece in the years, to complete the Joe Louis Greenway. It’s important to describe the principal functions which could be solved:

- People moving, by bike and on foot (no cars, trucks);
- Light infrastructure for waste collection and fresh food delivery as well with associations;
- Parks for the city, multiple pieces of land being developed as parks for those who are unable to reach urban parks within a short distance;
- Connection point between the urban life and farm life, with greenhouses and cultivated fields.

The final goal of the project is to re-connect the people of Detroit, as well as developing an improved way of life around the entire greenway. It would be the beginning of a process of bettering the neighborhoods one by one. At the moment, there are many industrial areas that are often disused around the pathway, and these could be re-functionalized with ecological and sustainable aims. Detroit could be re-imagined with a huge green belt around the Joe Louis Greenway with parks, pedestrian and cycle pathways, urban farms and markets to encourage the purchase of fresh foods all around the city. At the end of this process, the green belt would exchange the purpose of land use between urban life and the pleasure of the countryside living, overall improving its lifestyle with healthy food and active movement and sport around the city.

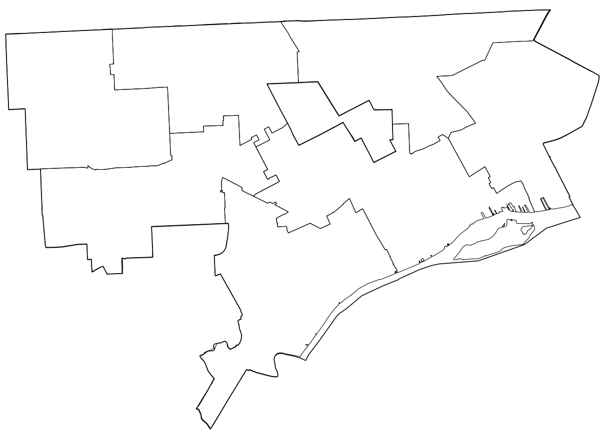
“Detroit isn’t just a disaster involving industrial decline; it’s about urban decline, which isn’t the same thing. If you like, urban sprawl has killed Detroit by depriving it of the kind of environment that could incubate new sources of prosperity.” (Paul Krugman, New York Times, July 2013).

NEZ_NR_Districts



Parks.

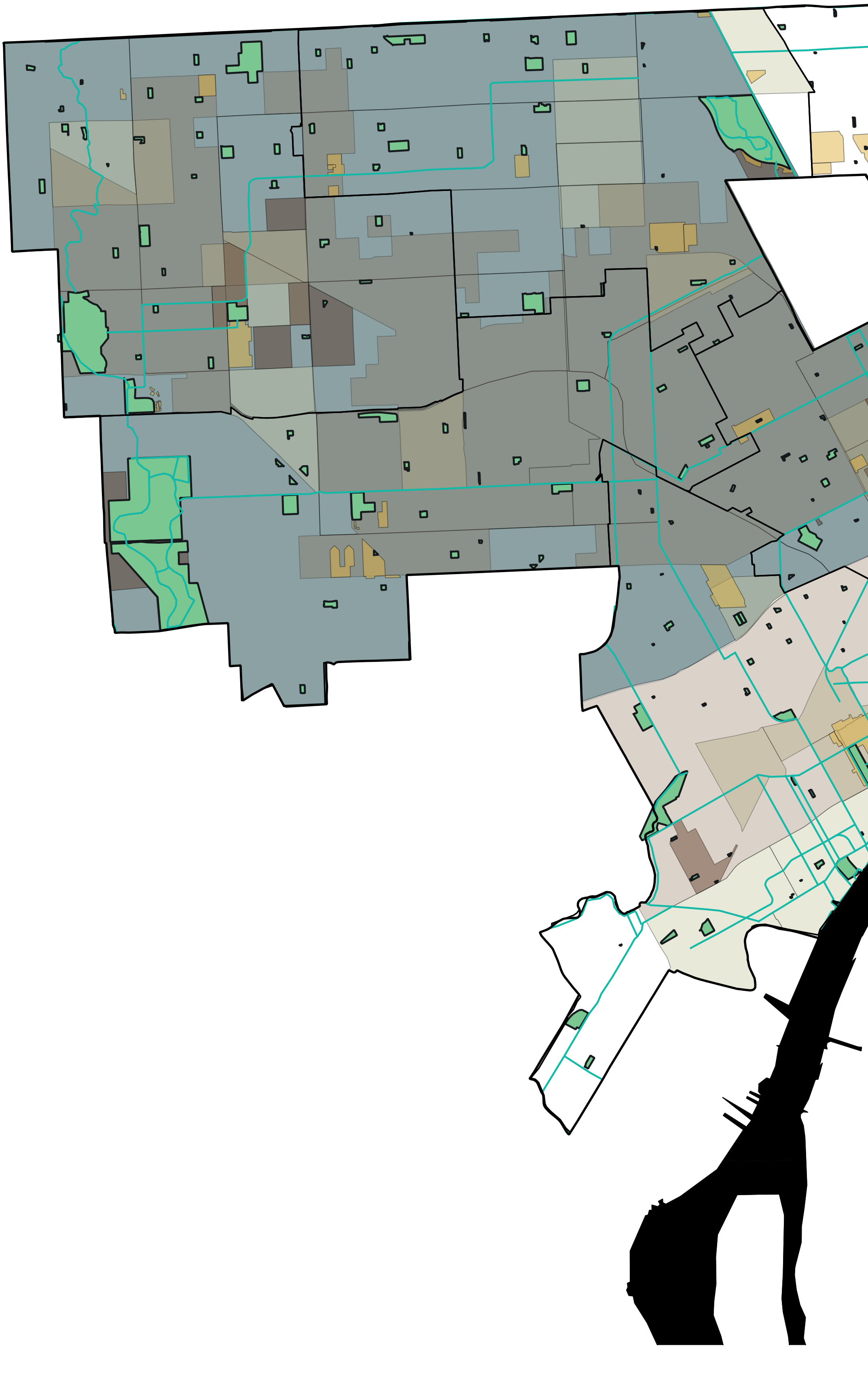
Greenways.

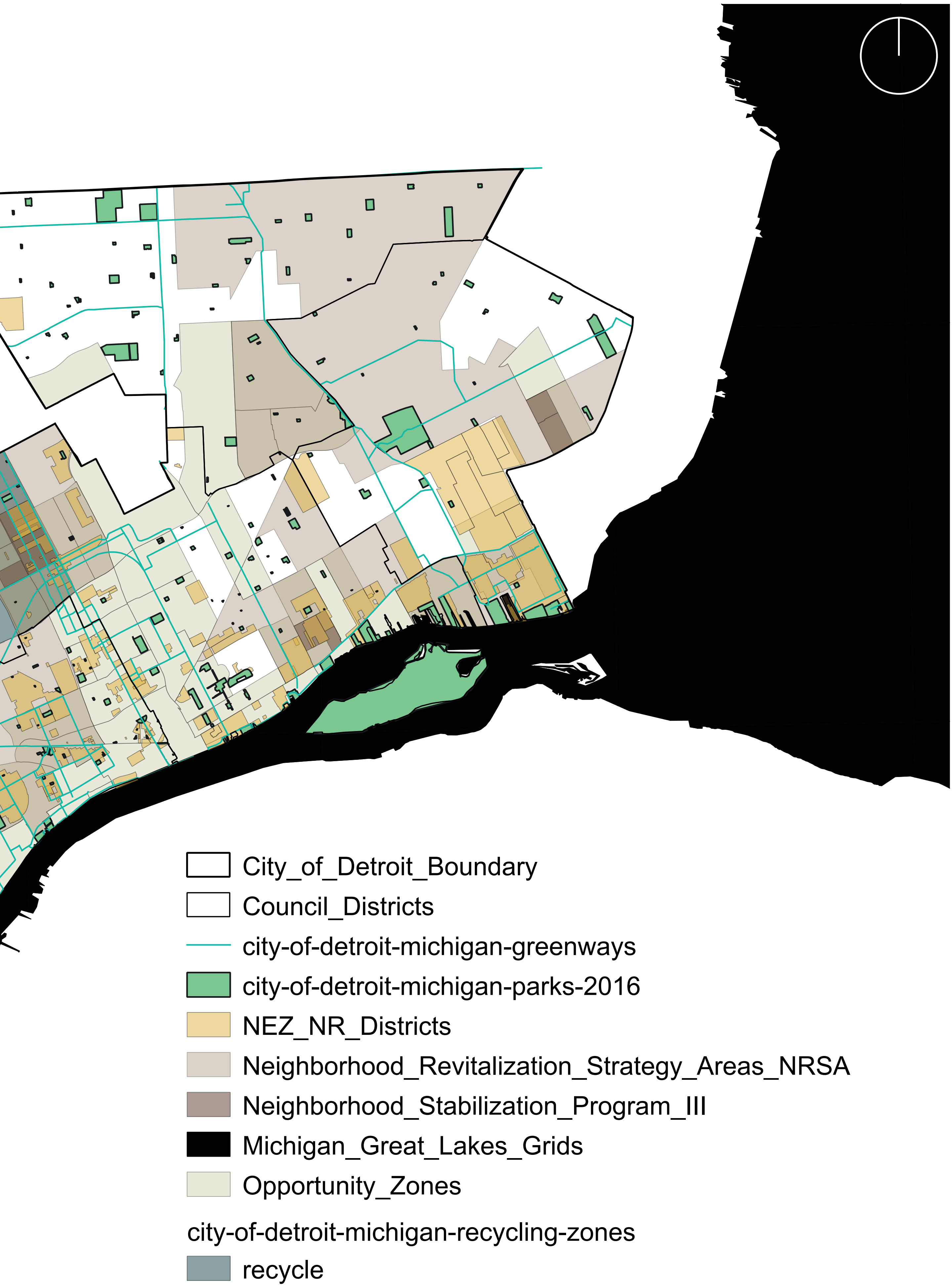


Boundary an neighbourhoods of Detroit.

Maps of Detroit’s features.
Realized by the graduate with Q-Gis.

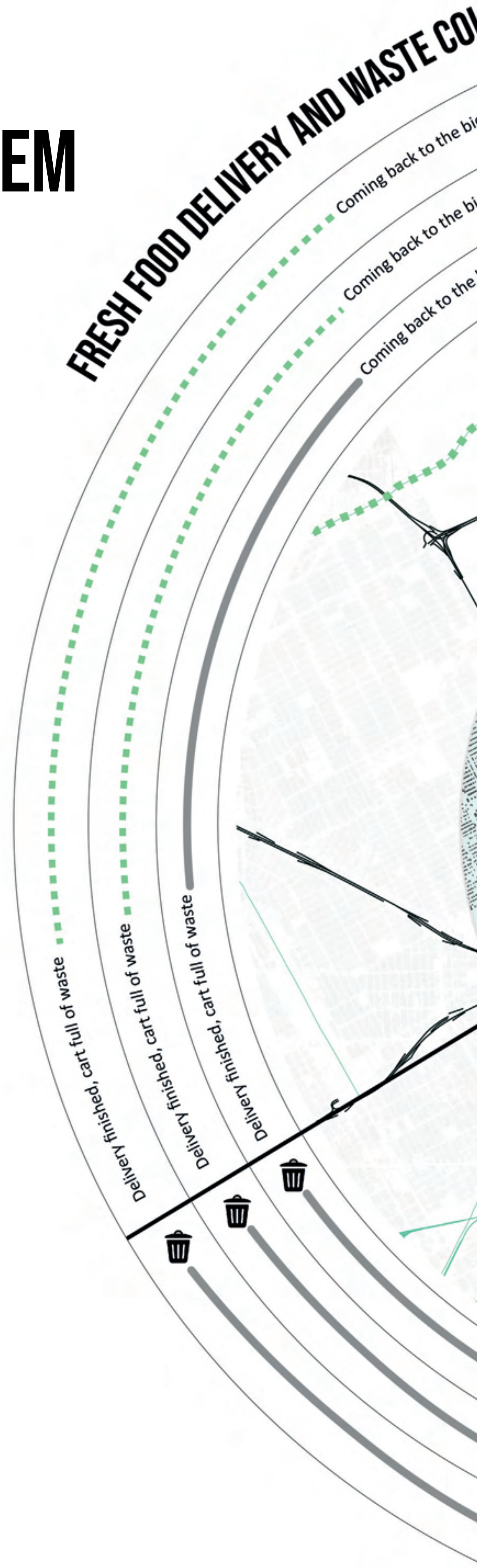
OPPORTUNITIES IN 313 AREA





Map of opportunities in Detroit.
Realized by the graduate with Q-Gis.

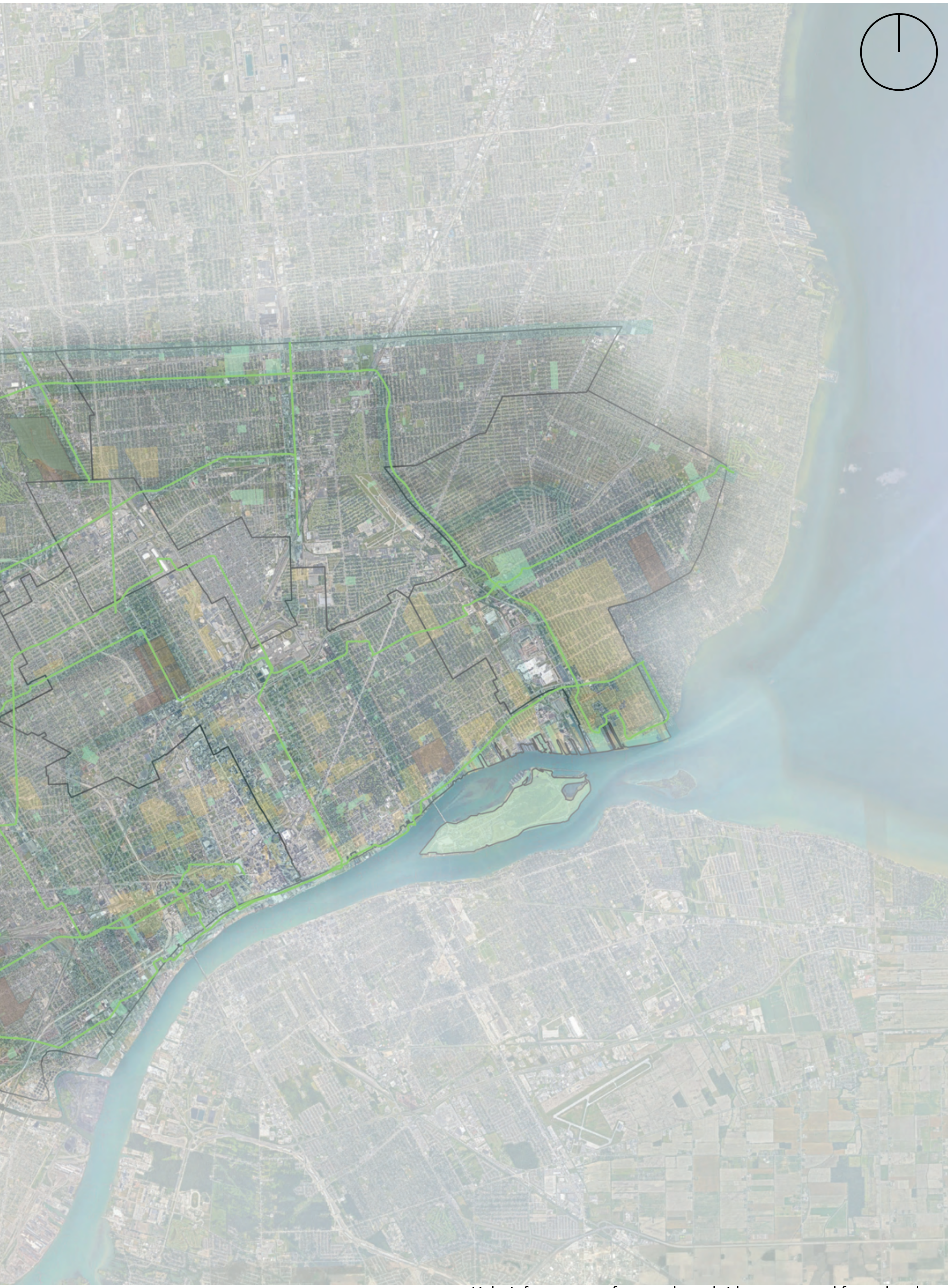
FRESH FOOD DELIVERY
& WASTE COLLECTION SYSTEM



Scheme of rider streams for food and rubbish exchange.
Riders start their shift from Food Hub loading fresh foods packages. They simply deliver at homes like any other delivery company but they take garbage bringing it to biomass plant. This reduce emissions of CO_2 and maximize worker yield recovering one way, otherwise lost.
Scheme realized by the graduate.


LLECTION NET SYSTEM
3
2
1
oplatform full of waste to dispose
oplatform full of waste to dispose
bioplatform full of waste to dispose
Rider starts his task full of fresh food, empty of waste
Rider starts his task full of fresh food, empty of waste
Rider starts his task full of fresh food, empty of waste
20 min by bike
Starts food delivery and waste colletcion by cart-bikes
Starts food delivery and waste colletcion by cart-bikes
Starts food delivery and waste colletcion by cart-bikes
POLETOWN EAST - 5 min track
HAMTRANCK - 15 min track
DOWNTOWN - 20 min track
LEGEND
Roads
Joe Louis Greenway

CITY LIGHT INFRASTRUCTURES MASTERPLAN

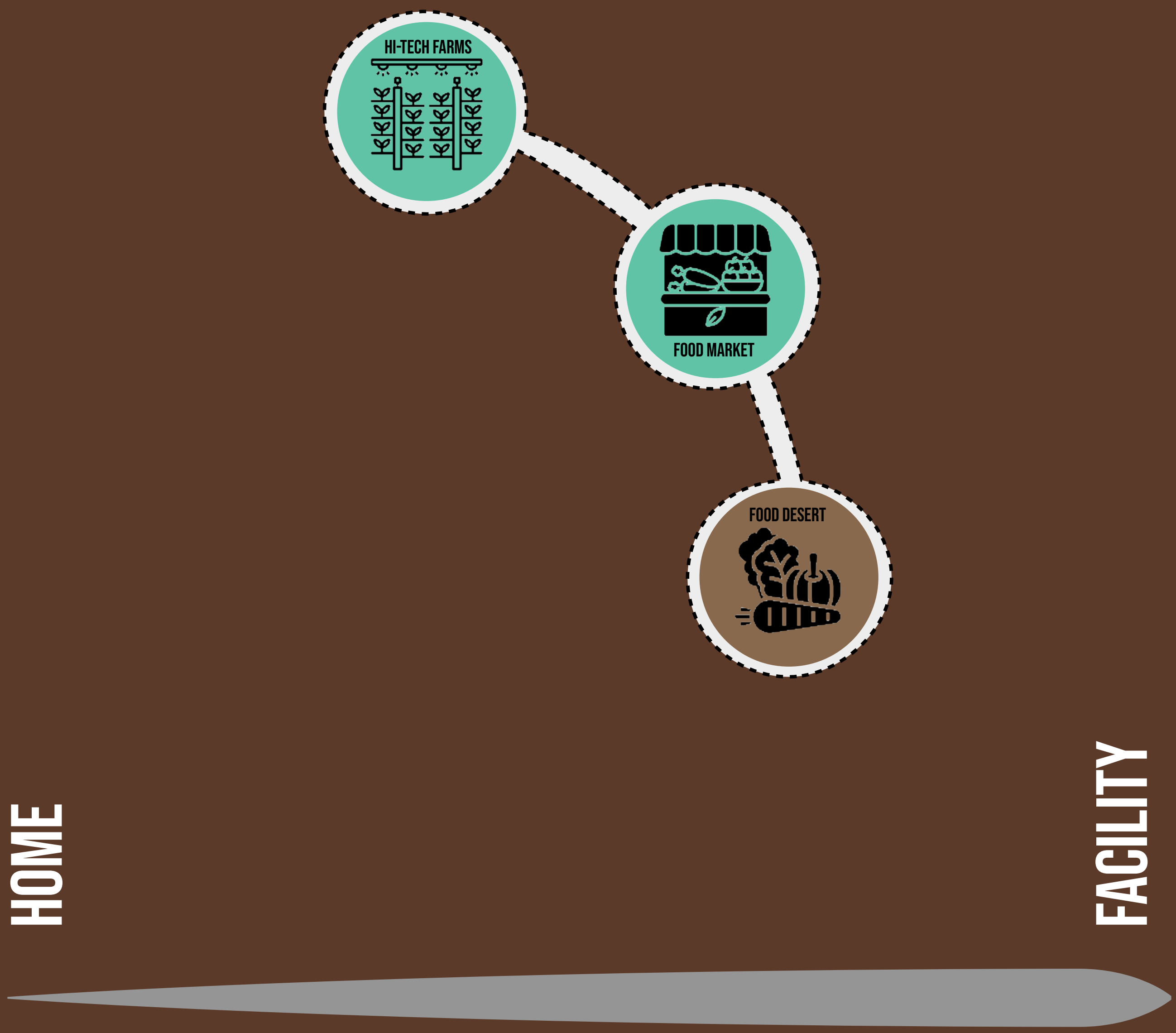


Light infrastructure for people and riders recovered from the abandoned rails network in Detroit.
View from Google Earth

2.1. HOW TO SOLVE FRESH FOODS SUPPLY?

THEORY

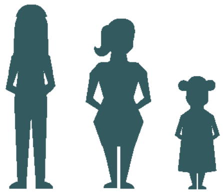
2.1.1. DETROIT FOOD SYSTEM



"Food is a multi-layered and complicated topic. It touches many elements of people's individual and family lives, including entertainment, personal wellness and nutrition, and household economics. In a larger sense, food plays a significant part in overarching concepts of community and economic development. The entities, actors, and organizations involved in the supply chain that gets food from production to end user have great impacts on our collective economy, environment, and health" (Lee Huang, ECONOMIC ANALYSIS OF DETROIT's FOOD SYSTEM, 2014).

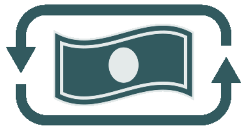
Even if it is a problem for society overall, there are many differences from city to city, so it's more direct to shrink the research field to an urban scale. "Detroit is a city known for many things— automotive innovation, music that has moved generations, a rich agricultural history, and vibrant food culture." [...] "Detroit was also the first city in the U.S. to offer urban farming programs to help the homeless and assist city residents facing economic hardship. In the 1890s, Mayor Hazen Pingree invested $3,000 in an urban gardening program targeting vacant lots to feed residents and increase the food supply during an economic depression. In 1970 Mayor Coleman Young started the Farm-A-Lot program that provided residents with flower and vegetable seeds, as well as the permission to plant gardens on city-owned vacant lots. Though the program officially ended in 2005, many residents, schools, churches, and community groups still reclaim vacant land in this way" (Lee Huang, ECONOMIC ANALYSIS OF DETROIT's FOOD SYSTEM, 2014).

"Detroit is an important food system to study, as it has been in the center of research and policy discussions about food access for more than a decade. It has been a part of a debate over whether "food desert" is the appropriate term to describe areas that have limited or no access to supermarkets, and whether depopulated and deinstitutionalized inner-city areas can attract and retain full-line grocery stores. Detroit is also a city with vibrant food movements centered around issues of healthful food and social ju-



FOOD IS SOCIAL AND POLITICAL

"Food is one of our most social resources, and it is rarely a solitary activity. Humans are responsible for food, from its production to consumption; it is based on relationships, knowledge, existing power structures, governance and regulatory contexts, and community agency. Access, nutrition education, and equity are key social and political concepts that affect our connections to food."



FOOD IS ECONOMIC

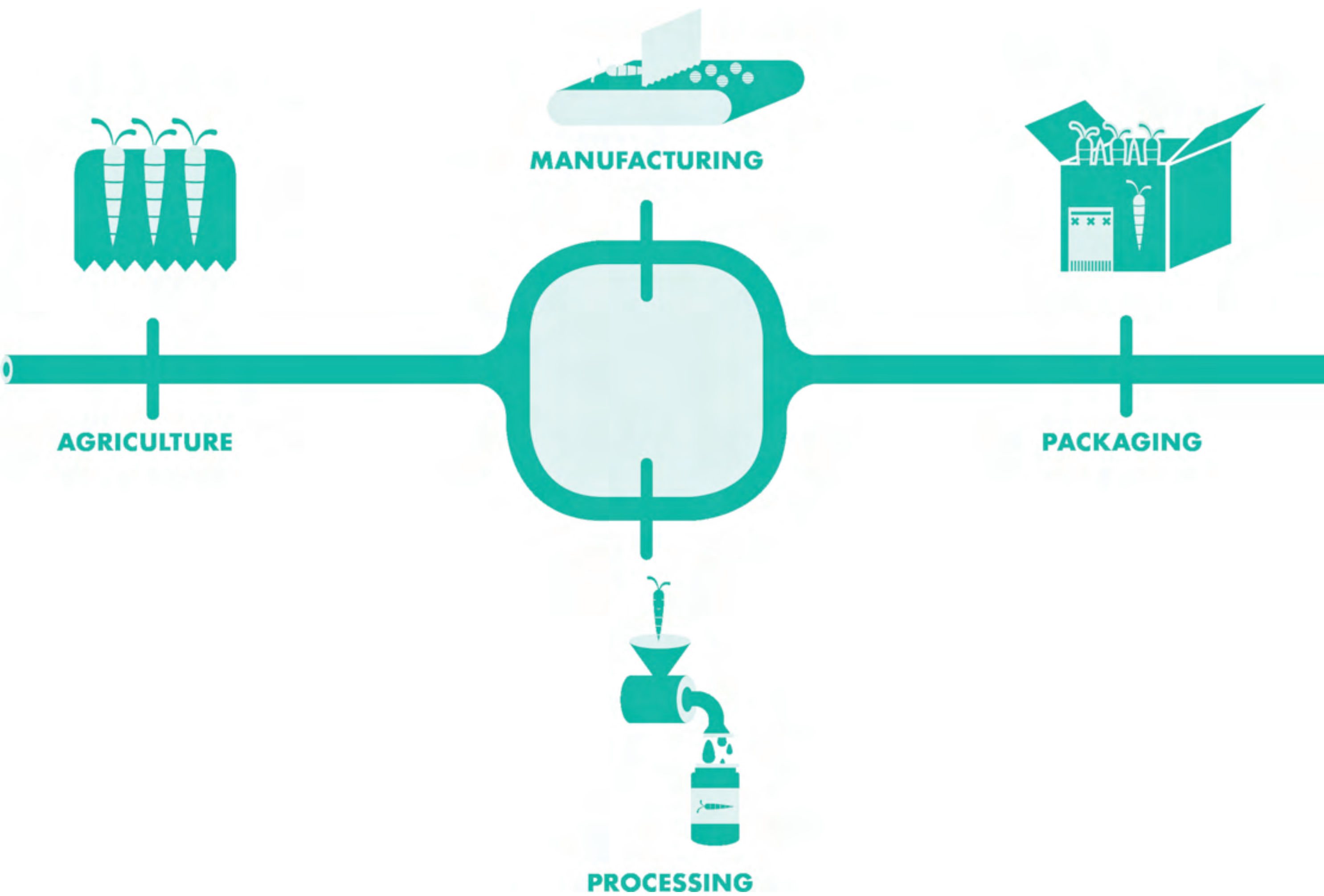
"Food related industries are an important sector of regional and local economies. Food-related businesses and other entities employ city residents, contribute tax revenue to municipalities, and build and connect regional infrastructure. They also result in the creation of other support and ancillary industries that contribute to the local economic ecosystem of places."

FOOD IS ENVIRONMENTAL

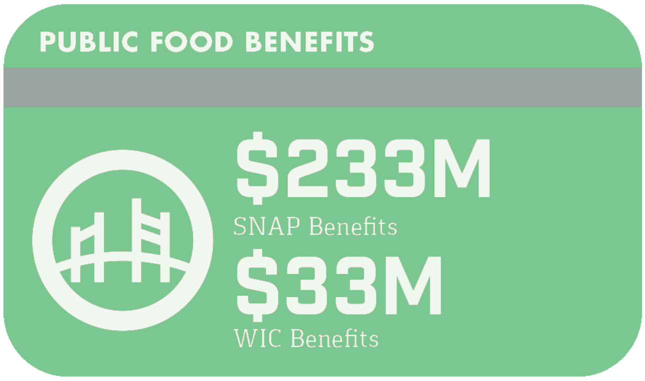
"The production, distribution, and consumption of food rely on other essential resources, such as energy and water. These processes affect the use of land, impact our natural and built environments, and result in the production of waste and other outputs that are meaningful in light of changes to our climate and natural ecosystems."

Source: ECONOMIC ANALYSIS OF DETROIT'S FOOD SYSTEM

stice, which further enhances its utility as a model food system" (Dorceta E. Taylor and Kerry J. Ard, 2015).
"The Great Recession, officially lasting from December 2007 to June 2009, had a dramatic and sustained impact on work, earnings, and poverty in most communities in the United States. Even though the recession officially ended in 2009, the effects of the downturn persist for many low-income households whose work opportunities and earnings have not returned to prerecession levels. In particular, unemployment and poverty rates have remained above prerecession levels longer than they have after any other recession in modern times" (Scott W. Allard, Maria V. Wathen, Sandra K. Danziger, and H. Luke Shaefe, 2015).
"Since the Great Recession there also has been a great deal of interest in the effect of spatial context on household food insecurity and food shopping choices. Much of the research to date has been focused on the presence of "food deserts," areas without large supermarkets or grocery chains that are key sources of affordable and fresh food. Living in food deserts or areas distant from



food retailers is thought to make it difficult for households to purchase adequate food and healthy food items, which should lead to lower levels of household food security" (Scott W. Allard, Maria V. Wathen, Sandra K. Danziger, and H. Luke Shaefe, 2015).
One of the most important features is the position of the food sources compared to the middle-final customer. "Proximity to local food resources, which include food retailers, restaurants, nonprofit organizations, and public agencies, may shape a variety of household food shopping behaviors, experiences of food insecurity, and decisions to enroll in food assistance.5 While there are many different types of food resources that may be relevant to household food choices and outcomes, here we focus on access to food assistance programs and local food retailers" (Scott W. Allard, Maria V. Wathen, Sandra K. Danziger, and H. Luke Shaefe, 2015).
"Small groceries and convenience stores (including liquor stores and party stores with mini marts, and gas stations that sell food) dominate the grocery sector, constituting nearly one-third of all food outlets. Of these,



Data about food system economy.
Source: ECONOMIC ANALYSIS OF DETROIT'S FOOD SYSTEM

Flow of raw materials to consumption.
Source: ECONOMIC ANALYSIS OF DETROIT'S FOOD SYSTEM

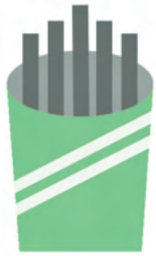
food retailers is thought to make it difficult liquor and party stores account for 13 percent of all food venues, 11 percent are gas stations, and 8 percent are small groceries, convenience stores, or corner stores. Although there is a tendency to categorize all of these stores as unhealthful food outlets, more research is needed to find out which actually sell healthful foods. Restaurants and other food service venues are the most ubiquitous, accounting for over one-third of the food outlets studied. About half of these are full-service restaurants and about 30 percent serve fast food. Other food service providers counted were bars, clubs, caterers, and coffee or other beverage shops" (Dorceta E. Taylor and Kerry J. Ard, 2015).

"In Detroit, given the low population density relative to other major cities and the high concentration of vacancy in particular areas of the city, along with interviews and focus groups with Detroit residents that suggest many people are supportive of expanding food production in the city but not entirely comfortable abandoning the traditional cityscape (Colasanti, Litjens, & Hamm, 2010), it may be most feasible to move toward developing distinct agri-food districts as a way to expand urban agriculture to the farm scale." (Kathryn J. A. Colasanti, Michael W. Hamm, "Assessing the local food supply capacity of Detroit, Michigan", November 2010).

"Comparable metropolitan areas were selected due to similarities in population size, demographic and socioeconomic make-up, and historical and political contexts vis-a-vis Detroit. Detroit's food system output place it in the middle of the pack of our comparable areas in terms of absolute size, which makes sense given the relative size of the population and area of the MSAs. Oakland and Newark are high performers relative to their size and socio-economic status due to proximity to fertile production food shed, a distribution infrastructure built for export, high incomes and wealth in surrounding municipalities, and the presence of San Francisco and New York City, respectively within the region." (Lee Huang, ECONOMIC ANALYSIS OF DETROIT's FOOD SYSTEM, 2014).

TOP 3 FOOD SYSTEM SUB-INDUSTRIES

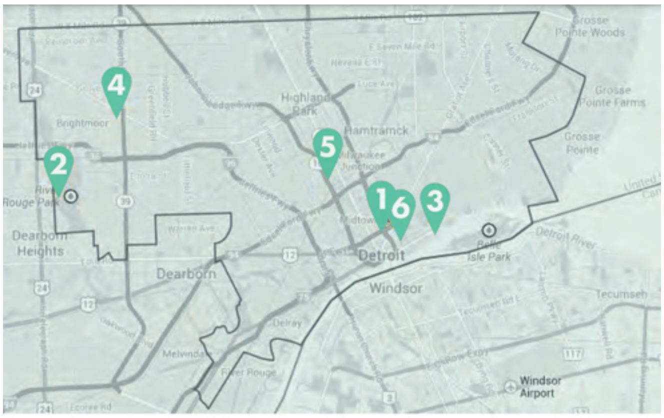
Soft drink manufacturing



Limited service restaurants

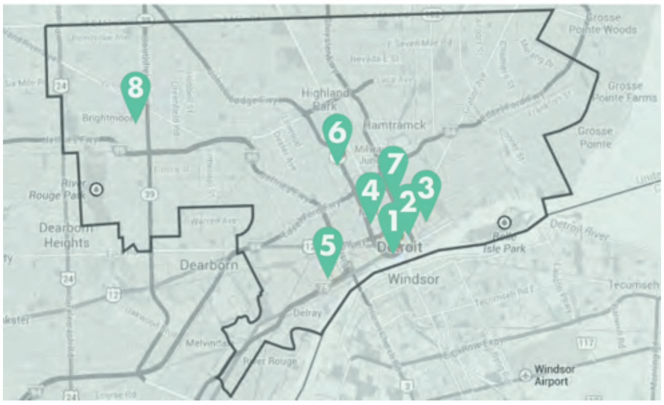
Snack food manufacturing

PRODUCTION
1 Greening of Detroit Market Garden-market garden
2 D-Town Farm-community farm
3 Earthworks-hoop house
4 Northwest Detroit Farmer’s Market-farmer’s market
5 CDC Farm and Fishery-fishery
6 Berry and Sons-slaughterhouse

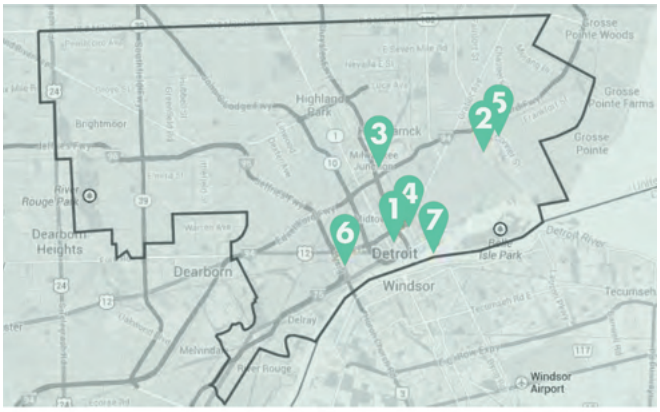


RETAIL/RESTAURANT

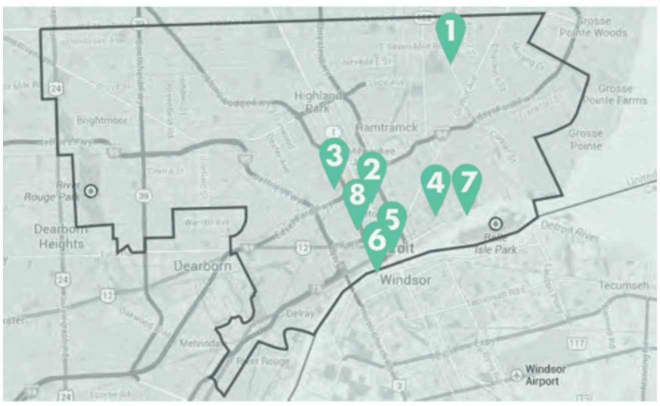
1 Lafayette Coney Island-fast casual restaurant
2 Colors-sit down restaurant
3 Russell Street Deli-deli
4 Avalon-bakery
5 Cafe Con Leche-coffee shop
6 Peaches and Greens-grocery store
7 Eastern Market-public/food market
8 Metro Foodland-supermarket



MANUFACTURING/DISTRIBUTION
1 Wolverine Packing-factory facility
2 Atlas Wholesale Food Co.-Distribution facility
3 McClure’s Pickles-co-packing facility
4 Eastern Market-aggregation point/food hub
5 Edibles Rex-commercial kitchen
6 Two James-distillery
7 Atwater Brewery-brewery



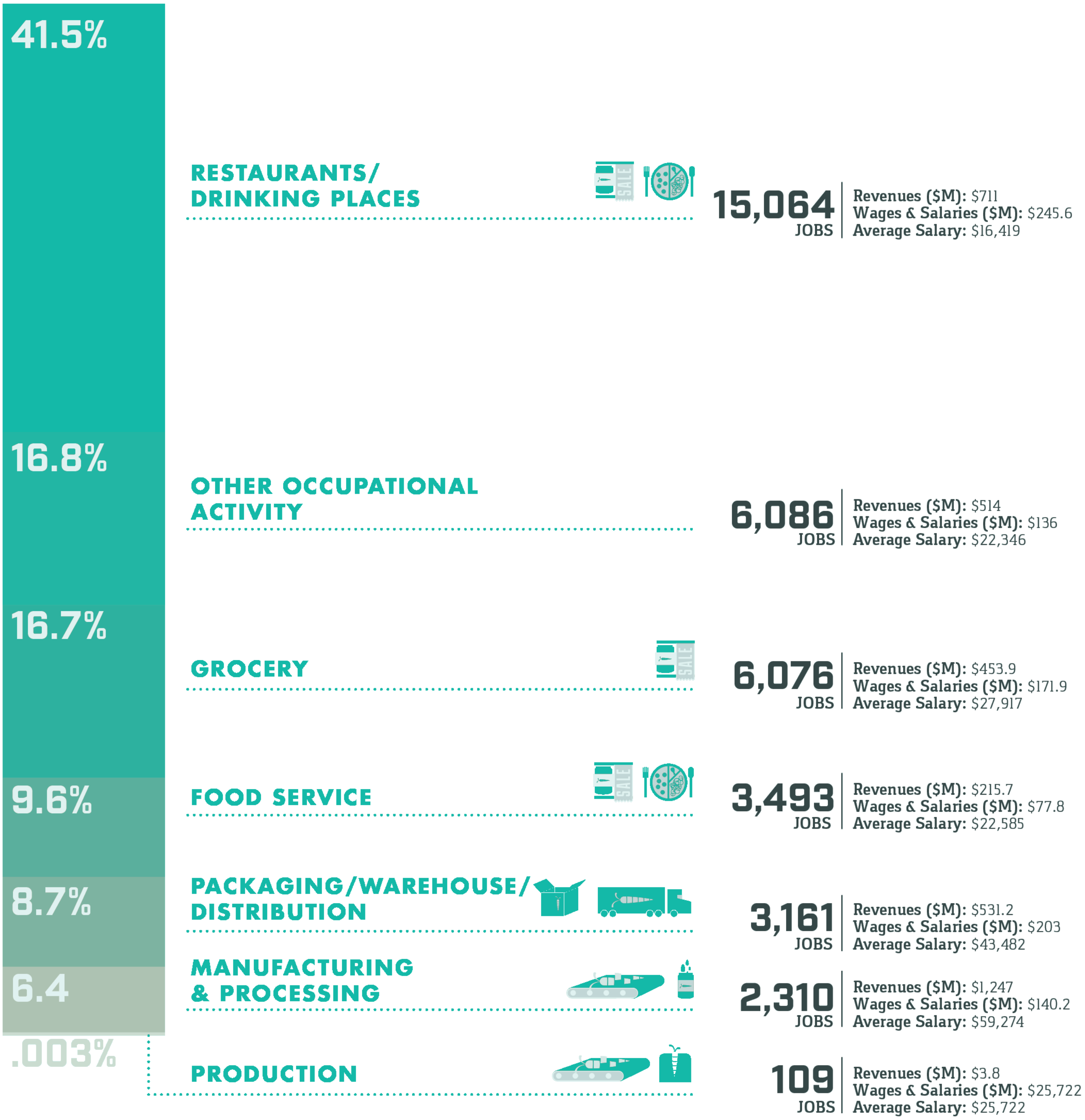
USER CONSUMPTION
1 Osborn High School-school
2 Wayne State University-university
3 Henry Ford Hospital-hospital
4 Capuchin Soup Kitchen-soup kitchen/food bank
5 Compuware World-Headquarters office
6 Joe Louis Arena-sports stadium
7 Greektown Casino-casino



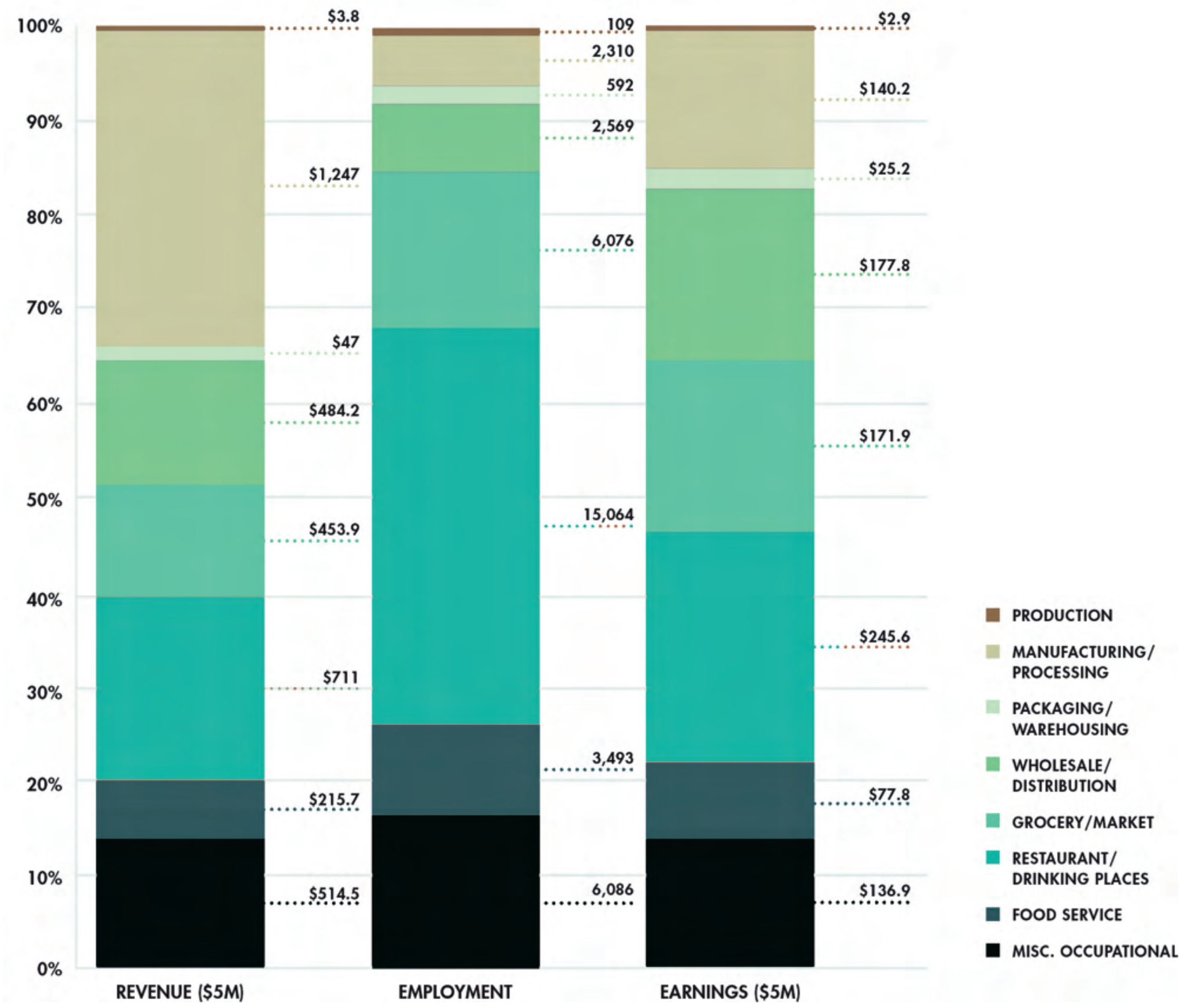
Locations of food system. Production, restaurants, manufacturing, user consumption. Detroit.
Source: ECONOMIC ANALYSIS OF DETROIT’S FOOD SYSTEM

SUB-SECTORS AT A GLANCE

ECONOMIC ACTIVITY, CITY OF DETROIT



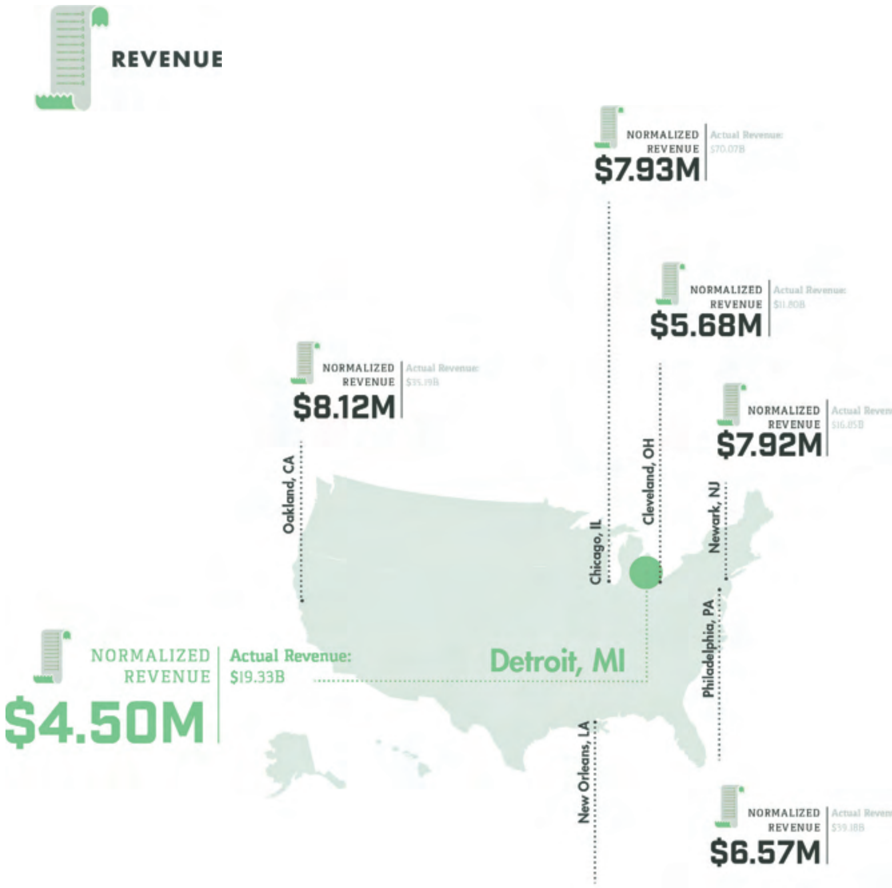
Economic activity.
Source: ECONOMIC ANALYSIS OF DETROIT'S FOOD SYSTEM

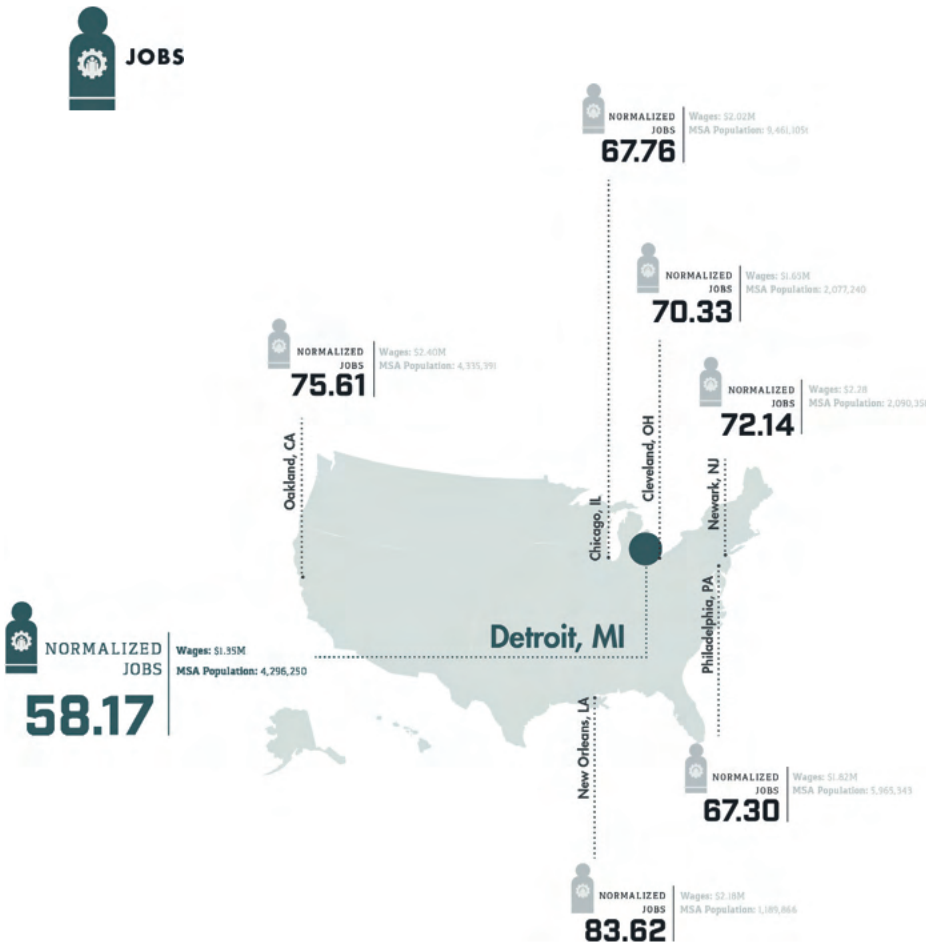


Percentage of revenues, employment and earnings in Detroit.
Source: ECONOMIC ANALYSIS OF DETROIT'S FOOD SYSTEM

Detroit, shown by analysis, is one of the cities with the least number of jobs and revenues in the food sector in the USA. The city in the northern part of USA with its seasonal climate, has faced bankruptcy which laid a fatal blow to an economy that now needs to be rebuilt. How important is the food sector when it comes to the employment ratio? At the current time, Detroit needs to differentiate its sectors. The food system could be very important in employing many Detroiters, whether specialized or not. This project could involve engineers, biologists, as well as salesman, carriers, and many other professionals well beyond the workers in the energy sector of the incinerator and biomass power plant. It could lead to a true change for the city, drawing people to the center to work and live while at the same time attempting to shrink the huge surface area of the city.
The city of Detroit can reboot its food and energy system to employ its citizens, diversifying occupation from the automotive sector and avoiding another economic collapse. All this while improving the quality of life, both environmental and social, and giving employment and life purpose to people who can contribute to the success of the city. And last but not least, trying to develop a healthier lifestyle without expensive costs for single families. This project is all about this single objective: producing fresh food with low costs for families, and using clean energy. The design of it can become part of the food system in a very different way from other activities. A stratified complex of buildings that will include production, packaging, sales venues, and delivery.

Moreover, employment and revenues are important, but not essential. This study is trying to formulate a hypothesis on the dilemma of fresh foods, an important issue that affects many areas of United States. There are only a few territories that can handle the whole American food system, whereas the rest must import from the limited numbers of suppliers. Detroit can be classified as an import zone because the area can-



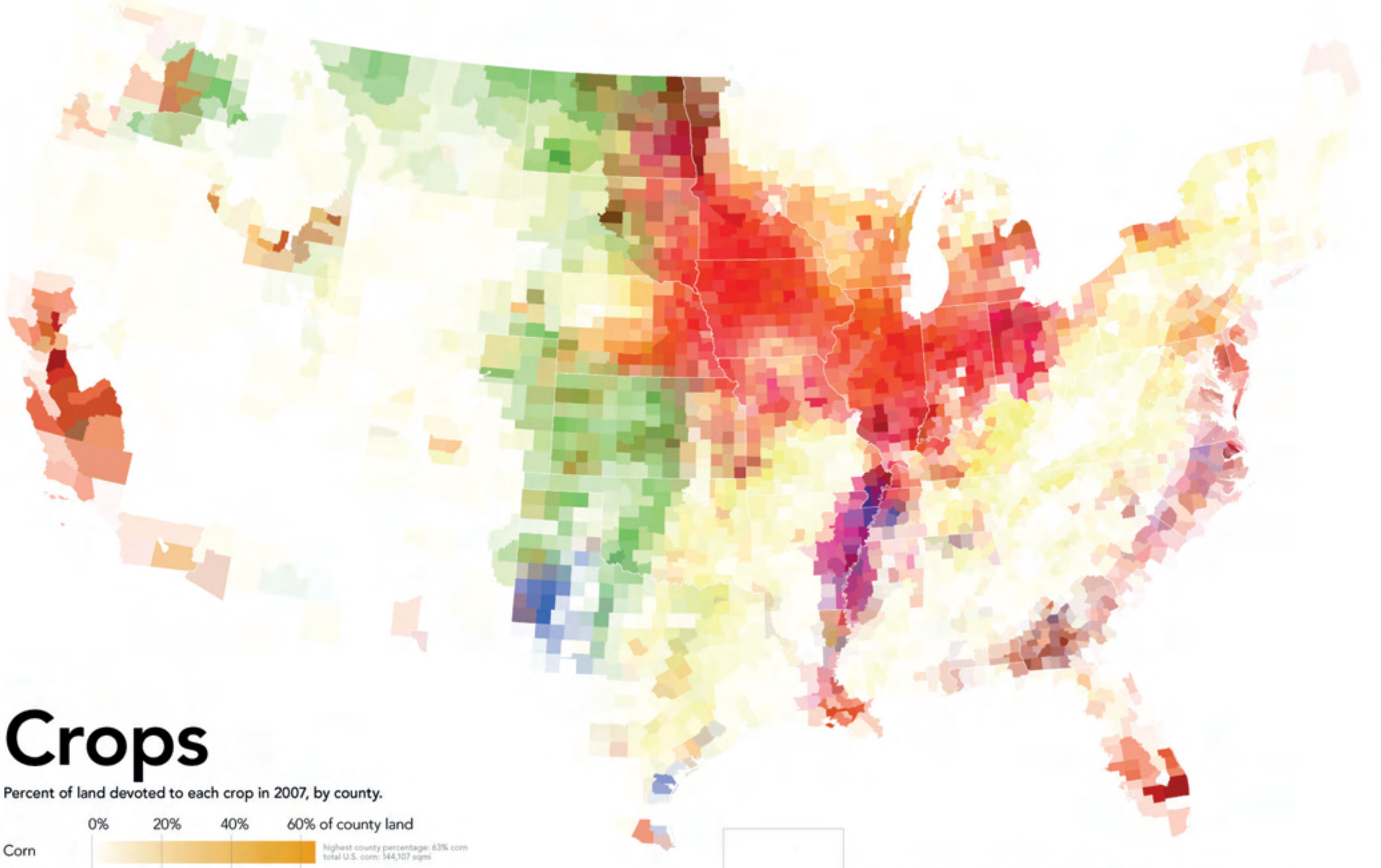


Food business in the USA.
Source: ECONOMIC ANALYSIS OF DETROIT'S FOOD SYSTEM

not supply the demand of fresh foods. This in turn affects the habits of its people who are of the low-income bracket because supply is limited and prices are high. The only way to reach a balance is to improve production, improving the infrastructure of packaging, distribution, etc.
“Detroit suffers from two disparate problems. Some neighborhoods simply lack any full service grocery stores, and are instead serviced by convenience stores, dollar stores or other fringe food outlets. Other neighborhoods have full-service grocery stores, but these establishments may not always provide the selection or quality that neighborhood residents demand. Various factors can be considered responsible for these current conditions” (Jane Shallal, Warren Disch, Detroit Fresh Food Access Initiative, August 2008). There are many factors responsible of this situation, such as:

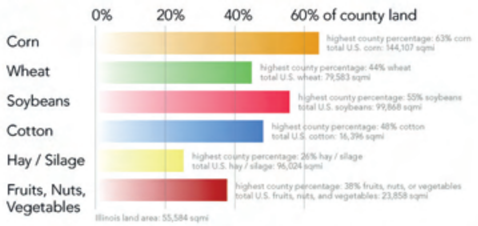
- Perceptions about Market Strength. “Many retailers believe that the City of Detroit lacks the density and income necessary to sustain full-service grocery stores. [...] Some retailers also express concern about the demand for fresh food and vegetables. It is their perception that youth in particular may be unfamiliar with the preparation of some fruits and vegetables. While demand for healthy foods is difficult to quantify, handshake’s market research referenced earlier suggests that reports of low demand may be influenced by Detroiters’ lack of knowledge about where to purchase quality fresh foods” (Jane Shallal, Warren Disch, Detroit Fresh Food Access Initiative, August 2008);
- Impact of Food Stamp Cycle (low-income issue). “Grocers in neighborhoods with high concentrations of food stamp customers often suffer the boom-bust cycle associated with food stamp distribution. In Michigan, food stamps are distributed during the first nine days of the month, concentrating grocery store traffic during that time-period. As a result, many grocers suffer from reduced traffic at the end of the month, which impacts their ability to provide a quality, fresh product at those times, and

Maps of the U.S crops and Value of livestock agricultural products in 2007, by county.
Source: Vox.com. Data fro 2007 U.S Census of Agriculture Map by Bill Rankin, 2009.



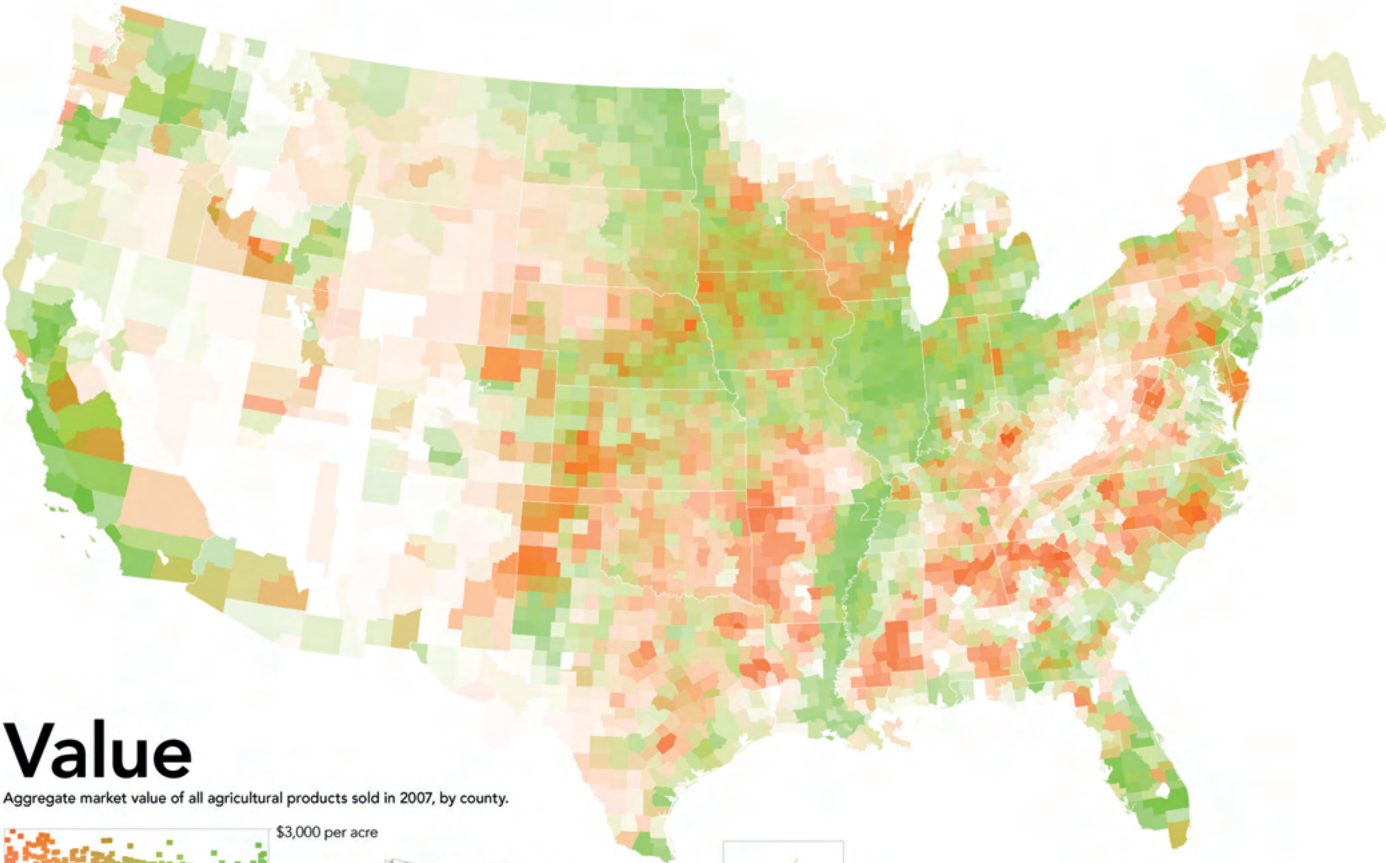
Crops

Percent of land devoted to each crop in 2007, by county.



All maps shown at the same scale using equal-area projections. Data from the 2007 U.S. Census of Agriculture. Map by Bill Rankin, 2009.

No cartographically meaningful agriculture in Alaska. Only inhabited islands shown.



Value

Aggregate market value of all agricultural products sold in 2007, by county.

Goverment payments as percent of market value.

All maps shown at the same scale using equal-area projections. Data from the 2007 U.S. Census of Agriculture. Map by Bill Rankin, 2009.

No cartographically meaningful agriculture in Alaska. Only inhabited islands shown.

prevents consistent staffing throughout the month." (Jane Shallal, Warren Disch, Detroit Fresh Food Access Initiative, August 2008);
- Difficulty in Capturing Existing Market (matter of presentation). "Many Detroit residents report shopping for groceries outside of the city. Customers often associate store appearance with perceptions about food quality. Store appearance can be impacted by poor store infrastructure, including worn floors, poor lighting, and old refrigeration equipment, or by the processing of returnable bottles and cans at the front of stores, making it difficult to keep these areas clean, pleasant, and inviting. [...] Many Detroit grocers, particularly in mixed income neighborhoods, have difficulty providing the appropriate blend of products for upper and lower-income clientele— a problem aggravated by the small sales floor. This leads to some customers' decisions to shop outside of their neighborhood in order to purchase the products they desire. [...] Finally, in many Detroit neighborhoods, residents have limited or no access to personal transportation. Customers without cars tend to buy fewer items per trip because of the difficulties associated with transporting groceries on bus or foot, even if home is just a mile away" (Jane Shallal, Warren Disch, Detroit Fresh Food Access Initiative, August 2008);
- Increased Business Costs. "Urban operators report a number of increased or disparate business costs that affect their profitability. The most significant of these relates to "shrinkage," or the loss of merchandise, and security issues associated with crime prevention. Like in the suburbs, urban store shrinkage occurs because of shoplifting or backroom theft" (Jane Shallal, Warren Disch, Detroit Fresh Food Access Initiative, August 2008);
- Development Challenges. "Modern supermarket developments within suburban-style shopping centers are difficult to create in Detroit. Such developments require assemblage of dozens of parcels of land— an expensive and time-consuming task. [...] In addition, many sites in Detroit, like in most urbanized areas throughout the state, have brownfield issues. Further, Detroit's development process, from navigating zoning and site plan review to obtaining the necessary building inspections, can be perceived as complicated and lengthy. Perceptions of this process can deter new investor" (Jane Shallal, Warren Disch, Detroit Fresh Food Access Initiative, August 2008);
- Hiring challenges. "The retail industry in general has a difficult time hiring and retaining good workers. In Detroit, the perception about poor workforce quality can impact grocer interest. In addition, some Detroit residents suffer from challenges like lack of transportation or family issues that can impact their reliability and tenure at the store" (Jane Shallal, Warren Disch, Detroit Fresh Food Access Initiative, August 2008).
stice, which further enhances its utility as a model food system" (Dorceta E. Taylor and Kerry J. Ard, 2015).

CONCLUSIONS

"The well-being of almost one million Detroiters and their neighborhoods rests on the improvement of fresh food access" (Jane Shallal, Warren Disch, Detroit Fresh Food Access Initiative, August 2008).
Having ascertained this, no private individual can currently solve the problem, but public and cooperative intervention is needed. There are many associations in Detroit that can put their efforts together to sustain a strong project to improve Detroit food system, and the DFFAI (Detroit Fresh Food Access Initiative) would be essential in developing a governance project and crowd funding to handle this change. "This issue impacts not only the health of children, families, and elders, but also that of the neighborhoods they live in. Improvements in grocery store quality and access can help increase neighborhood property values, access to jobs, perceptions of the neighborhood, and individual health" (Jane Shallal, Warren Disch, Detroit Fresh Food Access Initiative, August 2008).

Fruit stand in Eastern Market, Detroit.
Photo courtesy of Francesca Fera.

2.1.2. HI-TECH FARMS

What is vertical farming? “Vertical farming seeks to ensure the sustainability of our cities proactively by addressing food security to the world’s ever-increasing urban population. In principle, it is a simple concept; farm up rather than out” (Kheir Al-Kodmany, University of Illinois at Chicago, February 2018). “Conventional agricultural areas are rare in congested urban areas and traditional farming is only possible to a limited extent. The future is the direct cultivation in cities. By this means, high transport costs and CO^2 emissions can be avoided. The machines used in vertical farming work in a highly sensitive environment” (Robert Löbach, IGUS: plastics for longer life, 2021). The dealbreaker in this sector is being able to reduce from 30 to 70 % soil use for agriculture which would have to include no longer spreading pesticide, lessening the soil pollution problem. Moreover, this kind of farming does not require the use of poisons for insects and parasites because every plant is regularly checked, and the environment is one that is carefully controlled. “The body of literature on the subject distinguishes between three types of vertical farming. The first type refers to the construction of tall structures with several levels of growing beds, often lined with artificial lights” (Kheir Al-Kodmany, University of Illinois at Chicago, February 2018). The first stage is the recovery of old tall buildings and such, to cultivate plant life inside with artificial lighting and any other necessary equipment. Second kind of farms use rooftops of new buildings of grocery stores and residential blocks which receive solar energy from the sun. In the end, there is also a third model based on multi-story buildings. “In the past decade, we have seen an increasing number of serious visionary proposals of this type. However, none has been built. It is important, however, to note the connection between these three types, the success of modestly sized vertical farm projects and the maturation of their technologies will likely pave the way for the skyscraper farm” (Kheir Al-Kodmany, University of Illinois at Chicago, February 2018). According to market estimations, the vertical farming sector will reach

9.9 million dollars by 2025. In 2015, it was 1.2 million dollars. (Maria Teresa Manuelli, Sole 24ore, April 2021). The economy is already investing, and they will be much higher over the next years. Moreover, technology is constantly being developed to raise yields and break down the consumption of energy and water.

Why is it important to develop these kinds of facilities? "Food security has become an increasingly important issue. Demographers anticipate that urban population will dramatically increase in the coming decades. At the same time, land specialists (e.g., agronomists, ecologists, and geologists) warn of rising shortages of farmland. For these reasons, food demand could exponentially surpass supply, leading to global famine" (Kheir Al-Kodmany, University of Illinois at Chicago, February 2018). "If vertical farms were to become widely adopted as a new method of urban agriculture, then the following advantages over traditional urban food production would immediately be realized:

1. Open land savings (one indoor farm production area is equivalent at least 6-24 times that of outdoor farms, depending on the number of floors and stacked planting levels on each floor);
2. Year-round crop production;
3. No crop loss from severe weather events;
4. No agriculture run-off;
5. Less 70% water usage and no agricultural chemicals;
6. Remediation of grey water;
7. Repair of damaged ecosystems by returning farmland to nature, allowing it to cure itself;
8. Supply fresh produce for local city dwellers;
9. Create new employment opportunities;

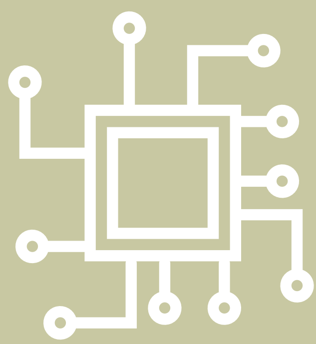
Production of bio-fuels or plant derived drugs."

and investments will be much higher in the next years. Moreover technologies keep developing to raise yields and break down consumption (energy, water, ...).

(Despommier and Ellingsen, 2008)

Vertical sprawl. Art work by Jay Crum.
Source: jaycrum.com

2.1.3. TECHNOLOGIES



TECHNOLOGIES

“Researchers have advanced myriad methods of urban and vertical farming in the hopes of contributing to sustainable food production. Advanced farming methods could provide greater yields and use far less water than traditional farming. The design, layout, and configuration of these high-tech farms would provide optimal light exposure, along with precisely measured nutrients for each plant. Designed to grow in a controlled, closed-loop environment, these farms would eliminate the need for harmful herbicides and pesticides, maximizing nutrition, and food value in the process. Indoor farmers could also “engineer” the taste of produce to cater to people’s preferences” (Kheir Al-Kodmany, University of Illinois at Chicago, February 2018).
Many projects have been made with great labs and huge productions of fresh foods, but it is only over these last few years that technology has made a true jump ahead to allow the practicality of this kind of facility. “The vertical farm concept may have a little futuristic some 20 years ago. However, it is now entirely practical, since most technologies it employs are currently being used. Soil-less culture technology is the fundamental technology that makes indoor farming possible and effective” (Timothy Heath, Yan Zhu, Yiming Shao, University of Nottingham, 2012).
Different kinds of cultivation consent the development of crops to grow faster. “Hydroponics [...] involves using a suitable “fastening” system to hold the plants in place, so that it develops its roots in a liquid medium (nutrients dissolved in water) without any type of substrate or solid support for anchoring the roots” (Echeverria, 2008).
Instead, “aeroponics involves growing plants suspended in a closed or semi-closed environment by spraying the plant’s dangling roots and lower stem with an atomized or sprayed, nutrient-rich water solution” (Stoner and Clawson, 1998). Obviously, aeroponics saves much more water, approximately 95% compared to soil-based cultivations, but it’s more experimental, and its results

are not yet proven on a large scale.

"Aquaponics is a sustainable food production system that combines a traditional aquaculture (raising aquatic animals such as snails, fish, crayfish or prawns in tanks) with hydroponics in a symbiotic environment. These three new planting methods contribute a number of advantages such as being lightweight, high density, recycling water, as well as delivering clean produce, all of which help to enable agriculture to transfer from the ground into high-rise buildings" (Timothy Heath, Yan Zhu, Yiming Shao, University of Nottingham, 2012).

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HYDROPONICS

The first major difference from soil-based cultivation is that there is no soil in the process, but only water recipients with mineral nutrient solutions. "One of the primary advantages of this method is that it could eliminate or at least reduce soil-related cultivation problems (i.e., the insects, fungus, and bacteria that grow in soil. The hydroponic method is also relatively low-maintenance as well, insofar as weeding, tilling, kneeling and dirt removal are non-issues" (Kheir Al-Kodmany, University of Illinois at Chicago, February 2018).

This method also reduces maintenance when it comes to weeding, tilling, kneeling, and dirt removal. Less labor allows for larger areas of production to be monitored with less workers which reduces the costs. "Furthermore, it may offer a cleaner process

A vertical farming setup from farm .one .
Photo courtesy of farm.one

given that no animal excreta are used. Furthermore, the hydroponic method provides an easier way to control nutrient levels and pH balance" (Kheir Al-Kodmany, University of Illinois at Chicago, February 2018). In conclusion, with this kind of method, many uncontrolled factors like temperature, microorganisms, moisture, oxygen levels, which can be lost in soil, are simply injected into the solution and there will be better yields and a day-by-day checked combination of substances that plants need.

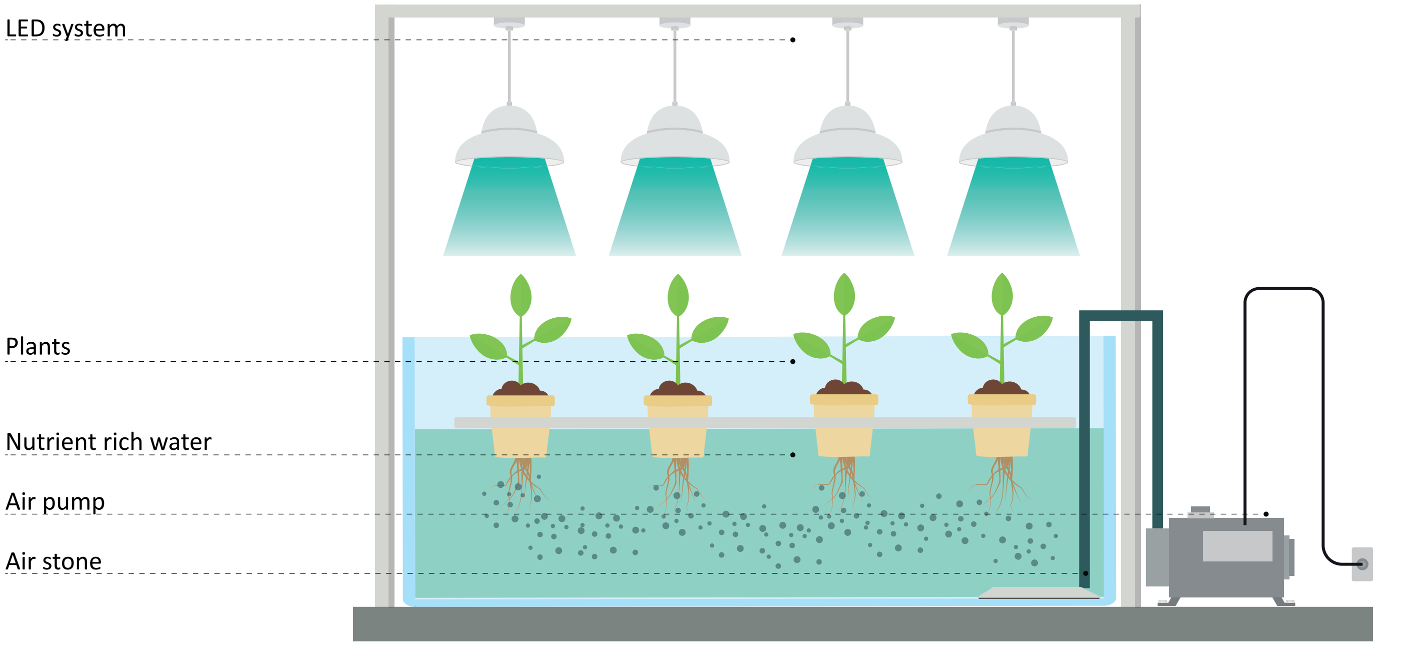
Furthermore, there are different systems to apply to hydroponics such as cylindrical growing systems and ultrasonic foggers. The first one consists in a rotary wheel where plants are positioned atop, and it spins powered by a low-horsepower engine run by solar panels and wind turbines. In the middle of the wheel there are induction lights and plant roots pass across nutrient solutions positioned at the bottom of the wheel. "Turning at a constant rate allows the plants to take advantage of orbitotropism (based on the impact of gravity on growth) to grow bigger, stronger and faster". "The Volksgarden system also provides a compact arrangement for the plants' roots in rockwool, thereby allowing the plants to grow more quickly than in traditional hydroponics". (Kheir Al-Kodmany, University of Illinois at Chicago, February 2018).

"By redesigning and assembling the vertical growing system in a horizontal manner, the new improved growing system is a multi-tier cylindrical hydroponics system equipped with RB LEDs and recirculating drip irrigation system designed to improve productivity. Cultivating the plants in cylindrical manner and stacking them above one another vertically managed to increase the planting density by 47% when compared to the rotary system". (Chow Kheong Keat, Chithrameenal Kannan, Tamil Nadu Agricultural University, 2015). Compressing cultivation density is one of the aims of this study, so the cylindrical method could be a valid option to reach this target. Another important thing is focused on artificial light which can upgrade cultivation times and improve final product upgrade cultivation times and improve final product quality. "Plant growth could be enhanced if the plants were positioned closer to the light source (i.e., at 10 cm or less), as received significantly higher irradiance without any foliage damage from heat generated from the diodes. However, physical damage to the leafy crops was encountered especially on mature plants, when it brushed against the LED tubes during the wheel rotation" (Chow Kheong Keat, Chithrameenal Kannan, Tamil Nadu Agricultural University, 2015).

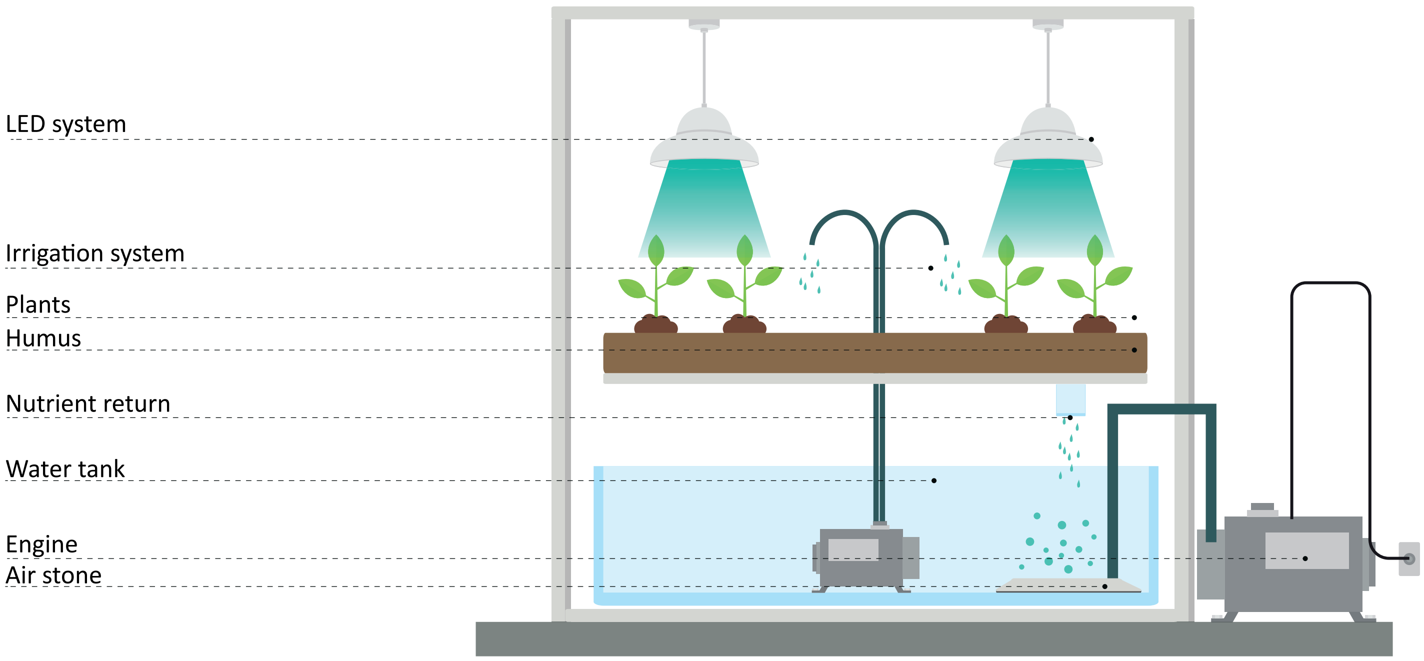
Together with the cylindrical system, there is a new method designed by scientists that promises to break down maintenance and speed up yields. The benefits are:

1. Fog penetrates root tissues, equalizing moist, and feeding plants while avoiding decay;
2. Increasing plant capacity to produce tiny new roots to improve surface exchange to absorb water and release gases;
3. Use of water reduced up to 50 % and nutrients too;
4. No problems regarding sublayers which are expensive and unwieldy;
5. Remote control and very high compactness to feed the cultivation;
6. Hydroponics plus ultrasonic foggers become closer to the aeroponic method.

DEEP WATER CULTURE



DRIP SYSTEM

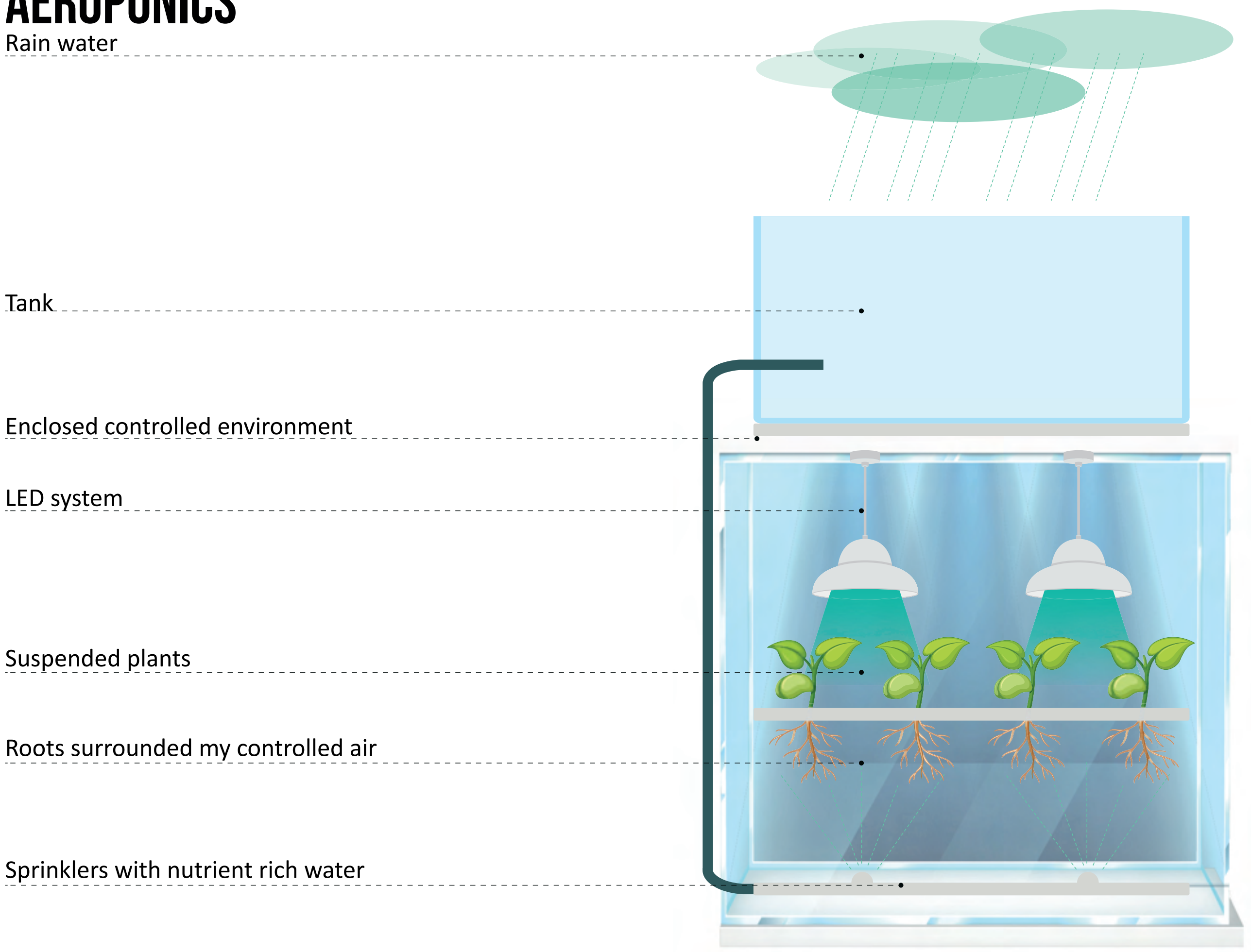


Deep water culture and drip system.
Scheme realized by the graduate, collage.

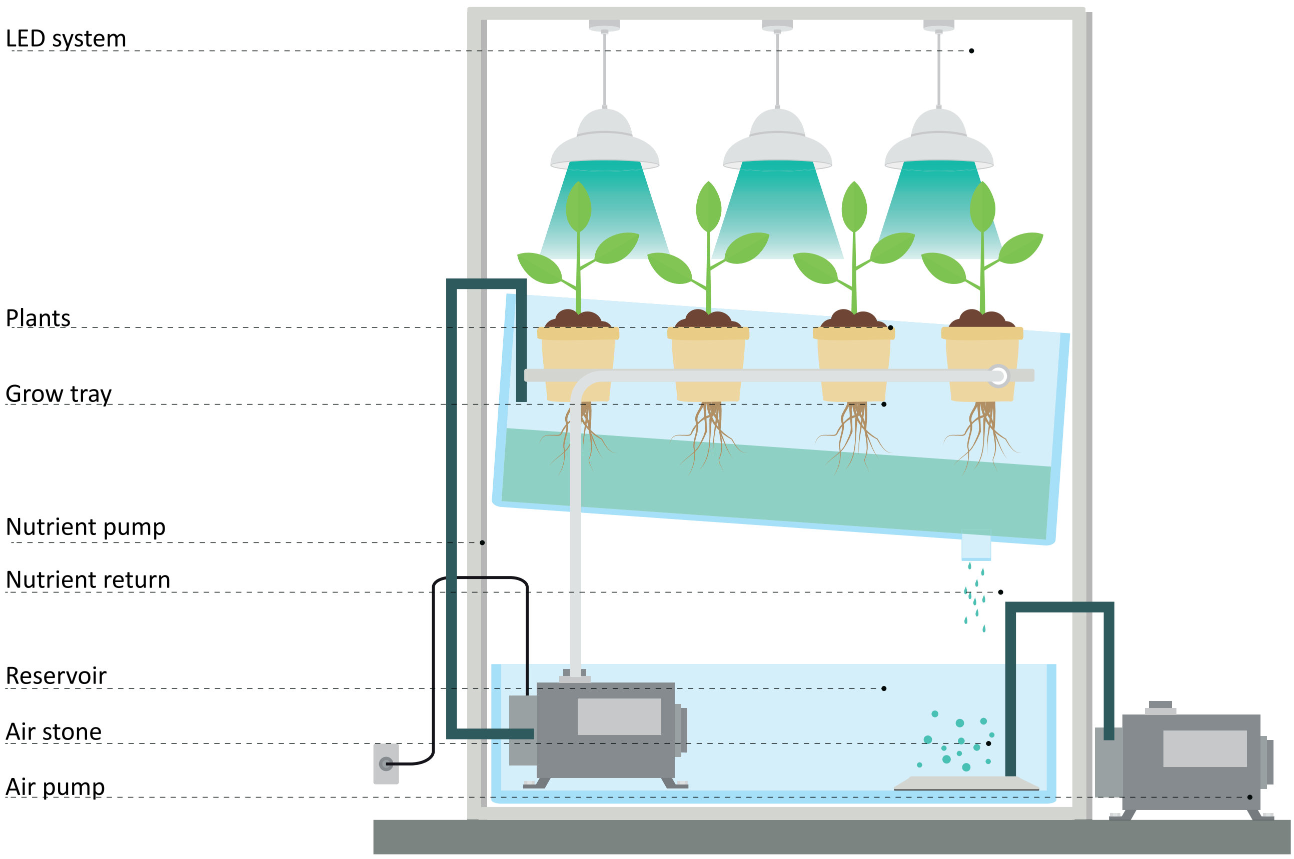
AEROPONICS

“Aeroponics is a sub-category of hydroponics that suspends the roots in the air instead of in water. A mist of nutrient solutions is sprayed onto the roots to utilize up to 95% less water than traditional farming methods in a minimal amount of space” (Carly Sills, Isaac Serbin, VERTICAL FARMING: A REVOLUTION TO SUSTAINABLE AGRICULTURE, 2018). “Aeroponics uses mist or nutrient solutions instead of water, so it does not require containers or trays to hold water. It is an effective and efficient way of growing plants for it requires little water (requires 95 percent less water than traditional farming methods) and needs minimal space. Plant boxes can be stacked up in almost any setting, even a basement or warehouse” (Kheir Al-Kodmany, University of Illinois at Chicago, February 2018). “Such a factory would essentially eliminate common constraints and risks to productivity, including heat and drought, pests, seasonality, and transportation costs from remote locations. Volatility in markets can be addressed because production can be planned according to demand” (Kurt Benke, Bruce Tomkins, Informa UK Limited, trading as Taylor & Francis Group, 2017). Aeroponic cultivations are very important for the research, as well as the preservation of species too. Its system allows plants more strength than classic soil cultivation, and allows the study of roots, too. “The ability to precisely control the root zone moisture levels and the amount of water delivered makes aeroponics ideally suited for the study of water stress. Hubick (Research School of Biological Sciences, Australian National University) evaluated aeroponics as a means to produce consistent, minimally water-stressed plants for use in drought or flood physiology experiments” (J.M Clawson, A. Hoehn, L.S. Stodieck, P. Todd, University of Colorado, 2000). This particular feature is fundamental for a city like Detroit which in all likelihood will be besieged by rising water levels, since it is on a river bottleneck. It could become a research field for many universities, too, and the food hub could be further developed as a research center.

AEROPONICS



NUTRIENT FILM TECNIQUE



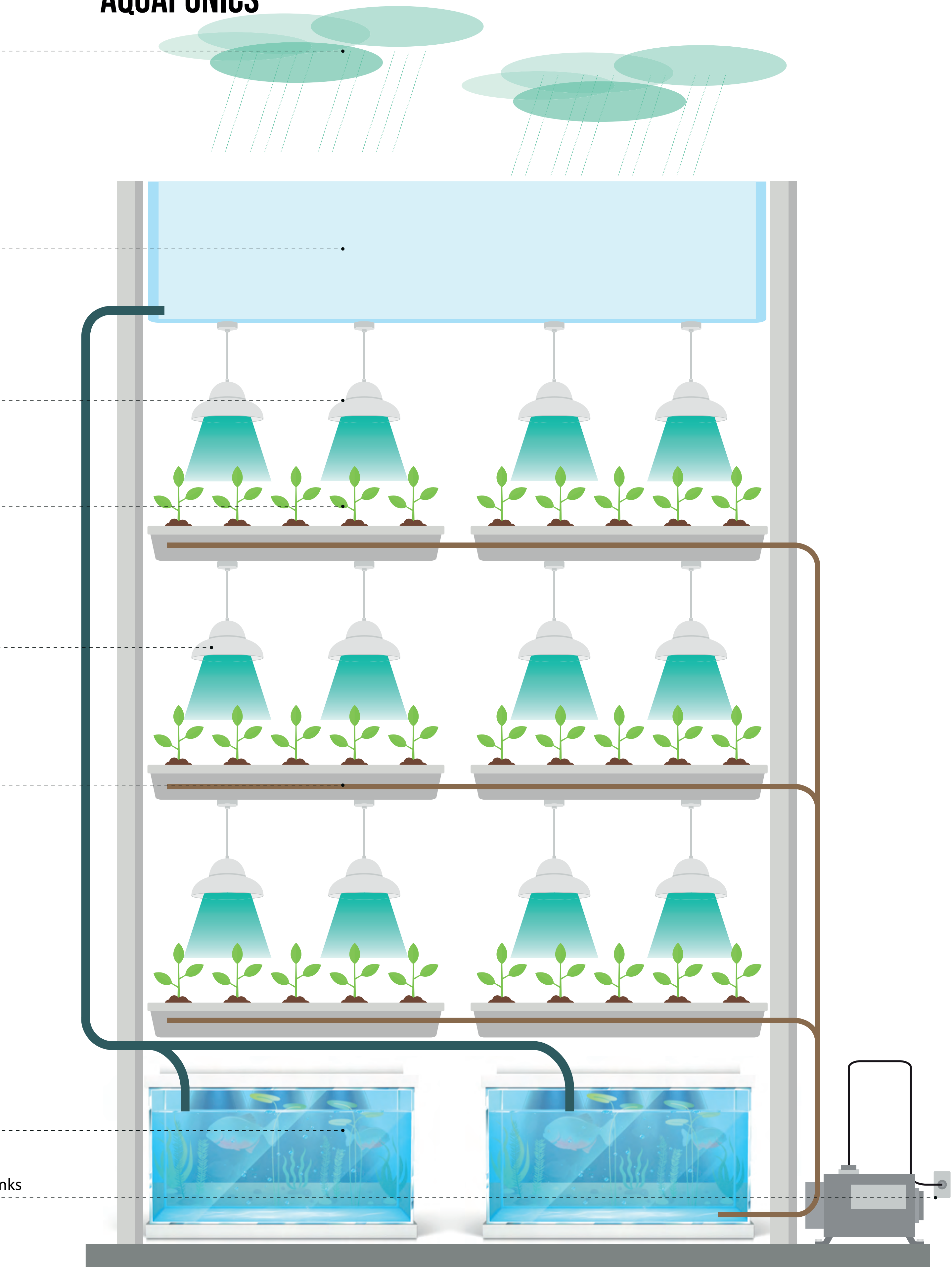
Aeroponics and nutrient film tecnique method.
Scheme realized by the graduate, collage.

AQUAPONICS

“Aeroponics is the process of growing plants in an air/mist environment without the use of soil or an aggregate media” (J.M Clawson, A. Hoehn, L.S. Stodieck, P. Todd, University of Colorado, 2000). This way of cultivating plants has allowed us to develop extended knowledge in many study areas, such as “root morphology, nutrient uptake, drought and flood stress, and responses to variations in oxygen and/or carbon dioxide root zone concentrations” (J.M Clawson, A. Hoehn, L.S. Stodieck, P. Todd, University of Colorado, 2000). Feeding plants is easier because aquaponics uses an enclosed system, so it is fully sustainable and the nutrient mix is completely recyclable, as well as water that can be saved and re-used for ulterior purposes. Moreover, the aquaponics method allows plants to be pesticide and fertilizer free. “research has revealed that this high-density planting method makes harvesting easier and provides higher yields. For example, one of the aeroponic experiments with tomato in Brooklyn, NY, resulted in quadrupling the crop over a year instead of the more common one or two crops” (Kheir Al-Kodmany, University of Illinois at Chicago, February 2018).

Aquaponics is a more sustainable solution compared to hydroponics and aeroponics because “the symbiotic relationships counteract the weaknesses of both hydroponics and aquaculture. They allow the system to become a closed loop, reducing waste and water usage while growing both fish and plants” (Carly Sills, Isaac Serbin, VERTICAL FARMING: A REVOLUTION TO SUSTAINABLE AGRICULTURE, 2018). The biggest issue regarding hydroponics, for example, is the large amount of water wasted because it has to be periodically replaced. The only waste that remains is the leftover solid fish waste left undecomposed by bacteria. There is more than one way to reuse this waste as composting material. The most important thing is to be as sustainable and profitable as possible at every step of the process, and aquaponics is the future of supplying fresh food for the planet.

AQUAPONICS

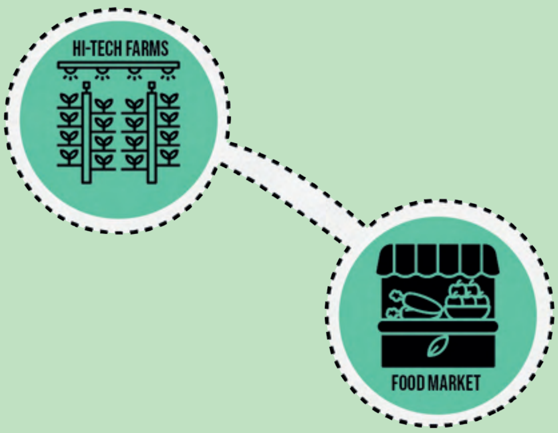


Aquaponics method.
Scheme realized by the graduate, collage.

2.2. HOW TO SOLVE FRESH FOODS SUPPLY?

APPROACH

2.2.1. HOW TO DESIGN INDOOR LABS



APPROACH

CASE STUDIES

DESIGN

"The basic concept of a VF is a multilevel modular building that uses state of the art climate control technologies and advanced agricultural systems to grow crops. This notion is closely related to the Plant Factory with Artificial Lighting (PFAL) described in Kozai 2015, which defines the PFAL as an indoor plant production system that uses artificial illumination" (Conrad Zeidler, Daniel Schubert, Vertical Farm 2.0, 2017).

Having already a defined space where it supposed to be designed the new farm lab is quite an advantage because it's only to be designed the interior and spaces. Concentrating the attention on the lab, it needs a space where it can be disposed a network of racks with pipes, cables, etc to pump water from the roof, and remote controlling the system.
"The general design flow includes: the plant production process, the climate management components, nutrition delivery system (NDS) elements and, the structure itself. Inputs into the system include: seeds, energy (light & heat/cooling), carbon dioxide and irrigation water with nutrients. The returned intermediate outputs, are the water coming from the runoff or the reclaimed water vapor and the heat surplus in the air management system (AMS)" (Conrad Zeidler, Daniel Schubert, Vertical Farm 2.0, 2017). Outputs will be only waste and fresh foods products that will be sold or delivered by the network already designed.
To reduce consumptions of energy there will be a hi-tech roof where will be positioned tanks, pipes and pumps where workers can balance nutrients in the water to reach the fertigation, a combination of irrigation and fertilization at the same time. This way allows to optimize time and money and get a better control of the entire complex. Using gravity and capillarity is a crucial choice to increase yields of the farm. Water will be collected from the biomass power plant digesters and stored in tanks. When there are water needs in the food hub building (espe-

cially for the farm) water is moved to the roof and used.

The farm design is very simple and follows the water streams. Starting from the top, there is the control room of the entire farm where workers can check with webcam, computers and sensors all the condition of the interior environment. Pipes will run through floors and reach every plant with different methods developed and explained in the previous chapter.

EquipmentP	ower requirement in W per 1 m²	Electricity consumption over 30 days with additional illumination of 14.4 hours in kWh per 1 m²
LED lamps	90 watts	= 90 * 14.4 * 30 = 38.88 kWh
Air conditioning	90 watts	= 90 * 14.4 * 30 = 38.88 kWh
Computer,...	= 200 W / 1000 m² = 0.2 W	= 0.2 W * 24 hours * 30 days = 0.144 kW * h
Osmosis=	1.5 kW / 1000 m² = 1.5 W	= 1.5 W * 6 hours * 30 days = 0.27 kW * h
Fertigation	= 1.2 kW / 1000 m² = 1.2 W	= 1.2 W * 6 hours * 30 days = 0.216 kW * h
Pump	= 740 W*10 irrigation zones/1000 m²=7.4 W	= 7.4 W * 2 hours * 30 days = 0.444 kW * h
Dehumidifier	= 4pcs * 5kW / 1000 m² = 20 W.	= 20 W * 20 hours * 30 days = 12 kW * h
Humidifiers	= 4 pieces * 300 W / 1000 m² = 1.2 W.=	1.2 W * 0 = 0 kW * h
Controllers automation	0.3 watts	= 0.3 W * 24 hours * 30 days = 0.216 kW * h
Workroom lamps	0.4 watts	= 0.4 W * 10 hours * 30 days = 0.12 kW * h
Webcams	0.02 watts	= 0.02 W * 24 hours * 30 days = 0.014 kW * h
TOTAL, per m² of growing area	152.22 W=	65.26 kWh / Month

EquipmentP	ower requirement in W per 1 m²	Electricity consumption over 30 days with additional illumination of 14.4 hours in kWh per 1 m²
LED lamps	180 watts	= 180 * 14.4 * 30 = 77.76 kWh
Computer,...	60 watts	= 60 * 14.4 * 30 = 25.92 kW * h
Osmosis=	1.5 kW / 1000 m² = 1.5 W	= 1.5 W * 6 hours * 30 days = 0.27 kW * h
Fertigation	= 1.2 kW / 1000 m² = 1.2 W	= 1.2 W * 6 hours * 30 days = 0.216 kW * h
Pump	= 740 W*10 irrigation zones/1000m²= 7.4 W	= 7.4 W * 2 hours * 30 days = 0.444 kW * h
Dehumidifier	= 4pcs * 5kW / 1000 m² = 20W	= 20 W * 20 hours * 30 days = 12 kW * h
Humidifiers	= 4 pieces * 300 W / 1000 m² = 1.2 W	= 1.2 W * 0 = 0 kW * h
Controllers automation	0.3 watts	= 0.3 W * 24 hours * 30 days = 0.216 kW * h
Workroom lamps	0.4 watts	= 0.4 W * 10 hours * 30 days = 0.12 kW * h
Webcams	0.02 watts	= 0.02 W * 24 hours * 30 days = 0.014 kW * h
TOTAL, per m² of growing area	272.22 W=	117.10 kWh / Month

Consumption data tables.
Source: I-Farm, https://ifarm.fi/blog/2020/12/how-much-electricity-does-a-vertical-farm-consume

$H_{floor} = 3\ m \rightarrow 3\ {}^{levels}/_{floor}$

$A = 850\ m^2$

7 Floors

$Tot_{levels} = 7 \times 3 = 21\ cultivation\ levels.$

Racks design:

Rack area: 34.80 m^2

n°. racks: 16

2 irregular racks each 33.30 m^2

$$Tot_{cultivation\ area} = [(34.8 \times 16) + (33.30 \times 2)] \times 21 = (556.8 + 66.6) \times 21 =$$
$$= 13{,}091.4\ m^2\ cultivation$$

Data source: I-Farm

$$Lettuce_{growth\ consumption} = 65.26\ {}^{kWh}/_{month}$$

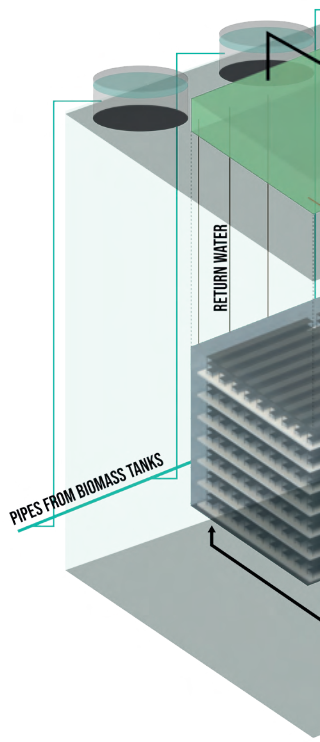
$$Strawberries_{growth\ consumption} = 117.10\ {}^{kWh}/_{month}$$

Design example: 3 floors lettuce // 4 floors strawberries

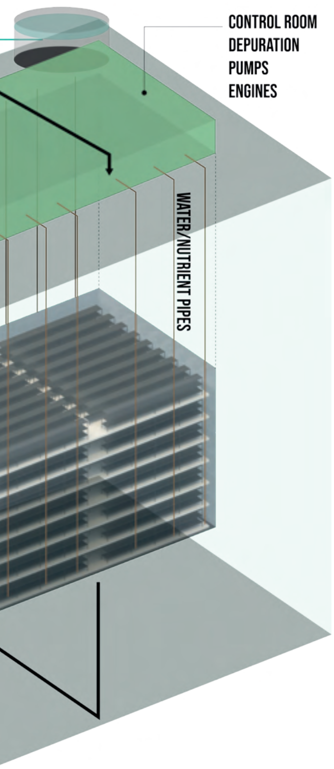
$$(556.8 + 66.6) \times (4 \times 3) \times 117.10 = 876{,}001.68\ {}^{kWh}/_{month}$$

$$(556.8 + 66.6) \times (3 \times 3) \times 65.26 = 366{,}147\ {}^{kWh}/_{month}$$

$$Tot_{consumption/_{year}} = (876{,}001.68 + 366{,}147) \times 12 = 14{,}905{,}784.16\ {}^{kWh}/_{year}$$



Design process of the farm.
Source: Vertical Farm 2.0: Designing an Economically Feasible Vertical Farm - A combined European Endeavor for Sustainable Urban Agriculture.



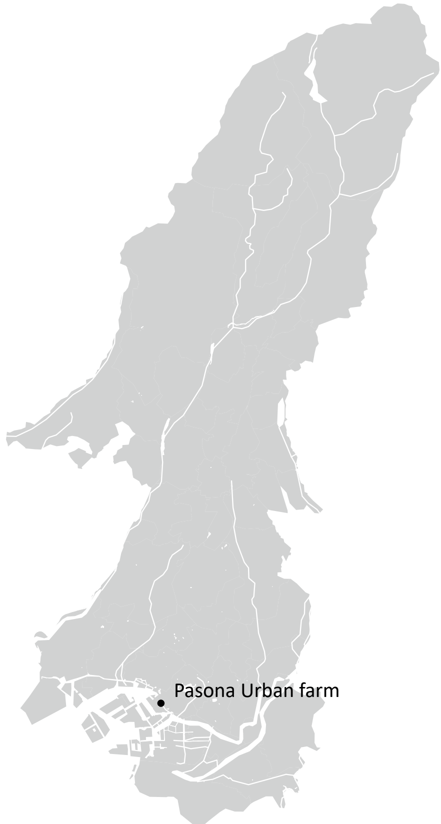
Sky Greens system in all its glory.
Source: Inhabitat

2.2.2. LABORATORIES: CASE STUDIES

1950 EAST FERRY ST

PASONA URBAN FARM

“New York firm Kono Designs created the urban farm in 2010, in a nine-storey office building in Tokyo to allow employees to grow and harvest their own food at work” (Kate Andrews, Dezeen, 2013). “Located in downtown Tokyo, Pasona HQ is a nine story high, 215,000 square foot corporate office building for a Japanese recruitment company, Pasona Group” (KONO Design, 2020).
It’s a renovation project made with a new double skinned facade and a roof garden. Moreover there are offices, cafe, auditorium and a urban farming facility. Total green face surfaces cover 43,000 square feet (about 4000 square meters) with cultivation of over 200 species as fruits, vegetables, rice with crops every year and served within the building food facilities. “It is the largest and most direct farm-to-table of its kind ever realized inside an office building in Japan” (KONO Design, 2020).
“The design focus was not on the imposed standards of green, where energy offsets and strict efficiency rates rule, but rather on an idea of a green building that can change the way people think about their daily lives and even their own personal career choice and life path” (Kate Andrews, Dezeen interview with KONO Design, 2013).
“Despite the increased energy required in the upkeep of the plants, the project believes in the long term benefits and sustainability in recruiting new urban farmers to practice alternative food distribution. Using both hydroponic and soil based farming, in Pasona HQ, crops and office workers share a common space. For example, tomato vines are suspended above conference tables, lemon and passion fruit trees are used as partitions for meeting
spaces, salad leaves are grown inside seminar rooms and bean sprouts are grown under benches” (Catarina Vitorino, ECOSYSTEM

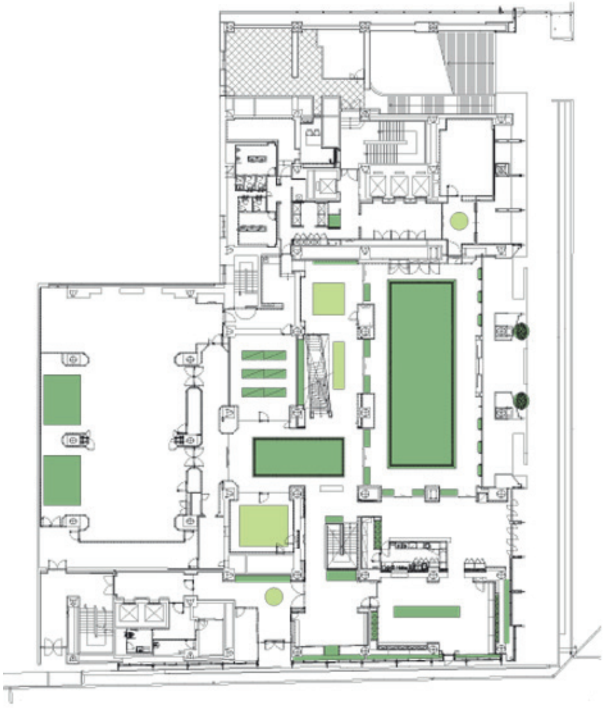


Metropolitan area of Tokyo, part of Kanto prefecture

INTEGRATION: RESEARCH QUESTIONNAIRE 2014).

Plants are known for capturing carbon dioxide where they are dense. This emission reduction let workers doing better with their jobs, increasing productivity by 12 % reducing discomfort and absenteeism by 23%.

Participation to the maintenance and crop harvesting by the workers (helped by specialists) allows to a higher social interaction, that aims to rise teamwork on the office jobs.



Type plans of the building.
Source: Kono Designs

Interiors of the mixed use offices.
Source: Kono Designs

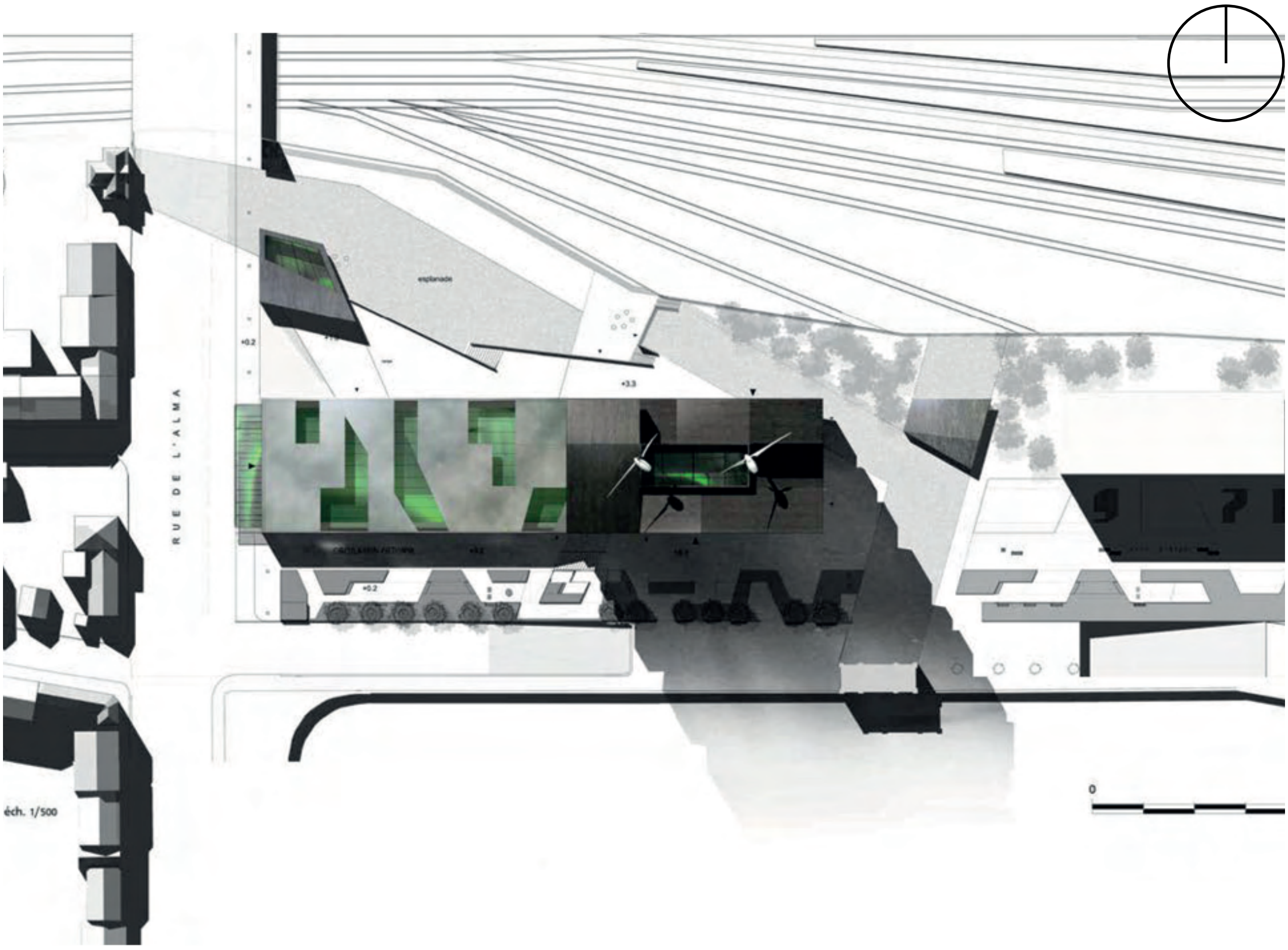
Part of the farm inside the building.
Source: Kono Designs

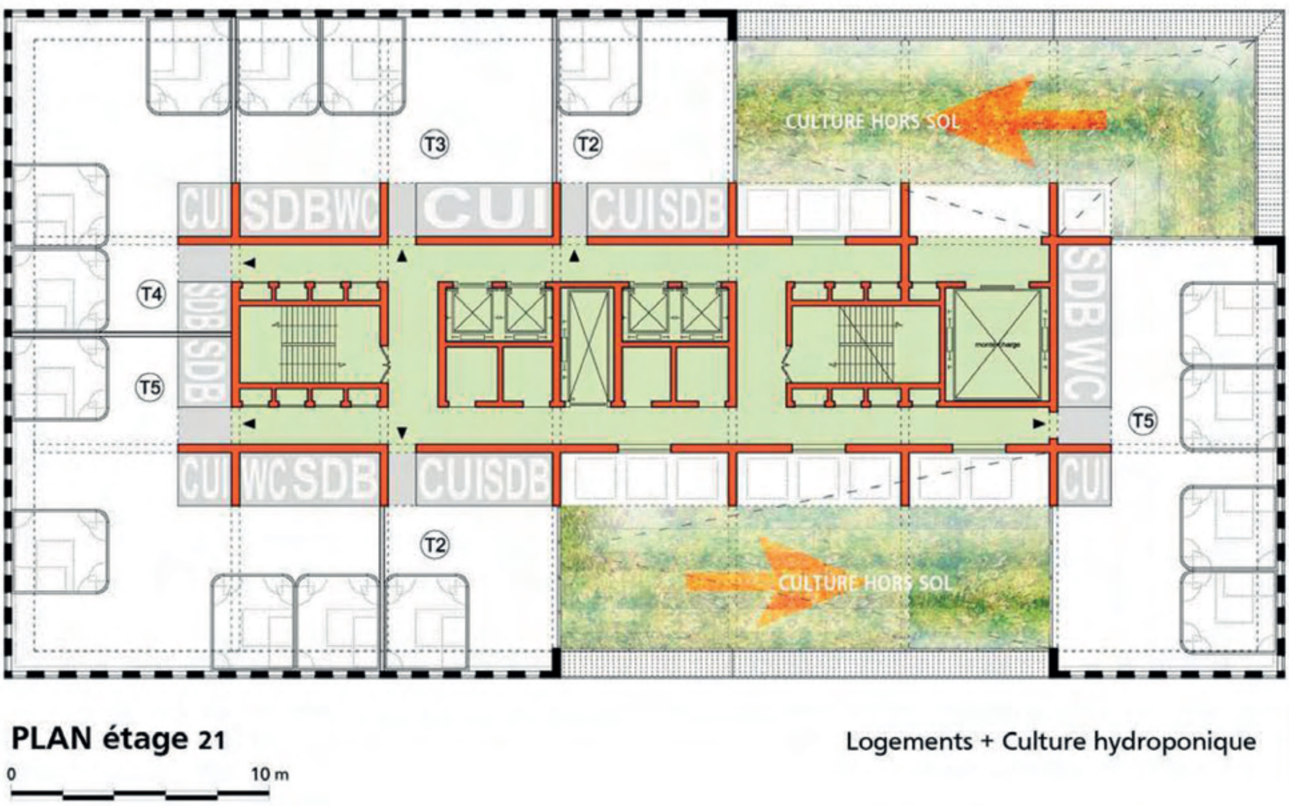
Common zones with green that enter the spaces.
Source: Kono Designs

LIVING TOWER - SOA ARCHITECTS (UNBUILT PROJECT)

“The concept of the Tour Vivante aim is to associate the agricultural production, dwelling and activities in a single and vertical system. This system would allow to make the city denser meanwhile a greater autonomy could be gained reliance in agricultural plains, reducing the need of transportation between urban and extra-urban territories. The yet unusual superimposition of these programs finally makes it possible to consider new practical and energetic relations between agricultural culture, tertiary spaces, housing and trade inducing a very strong energy saving” (SOA Architects, Press, 2006).
Agritecture is powerful when solutions are truly integrated. For example housing, offices and agriculture in the same building with an efficient use of water cycles, light and space, that makes an aesthetic sense visible both inside and outside. Moreover it’s important to find sustainable energy and water sources to improve functionality, efficiency and reducing waste by living the architecture daily.
Another important thing with this mix of uses is that human being is trying to take back the connection with nature and the food production, that has an high social impact on people making them more responsible too for their lives.
The architecture concept is quite simple with “the core of 8m X 30m which includes vertical circulations and allotment of the floors. The proportion of this core with double skin matches with the outline of the tower from a practical point of view” (SOA Architects, Press, 2006). The huge external structure creates the vertical links with stairs that become greenhouses and a true farm.
“The idea of an opposition between full spaces (offices and residences) and unfilled spaces (greenhouses) requires to build a tower without peripheral weight-beariers” (SOA Architects, Press, 2006).

Rennes Metropole, France.

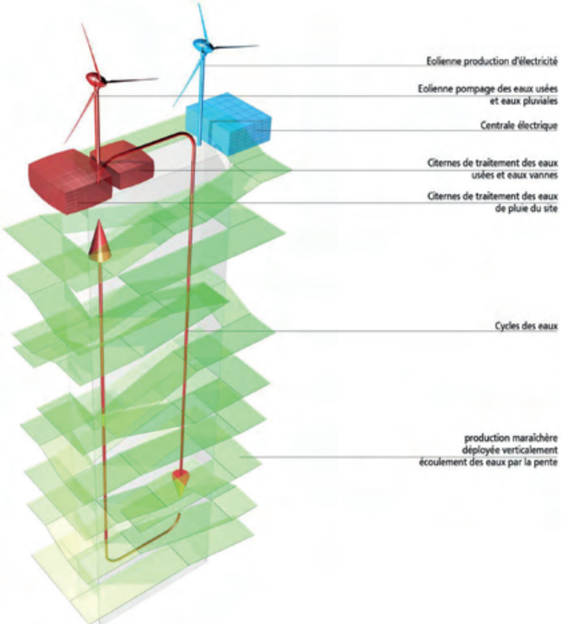


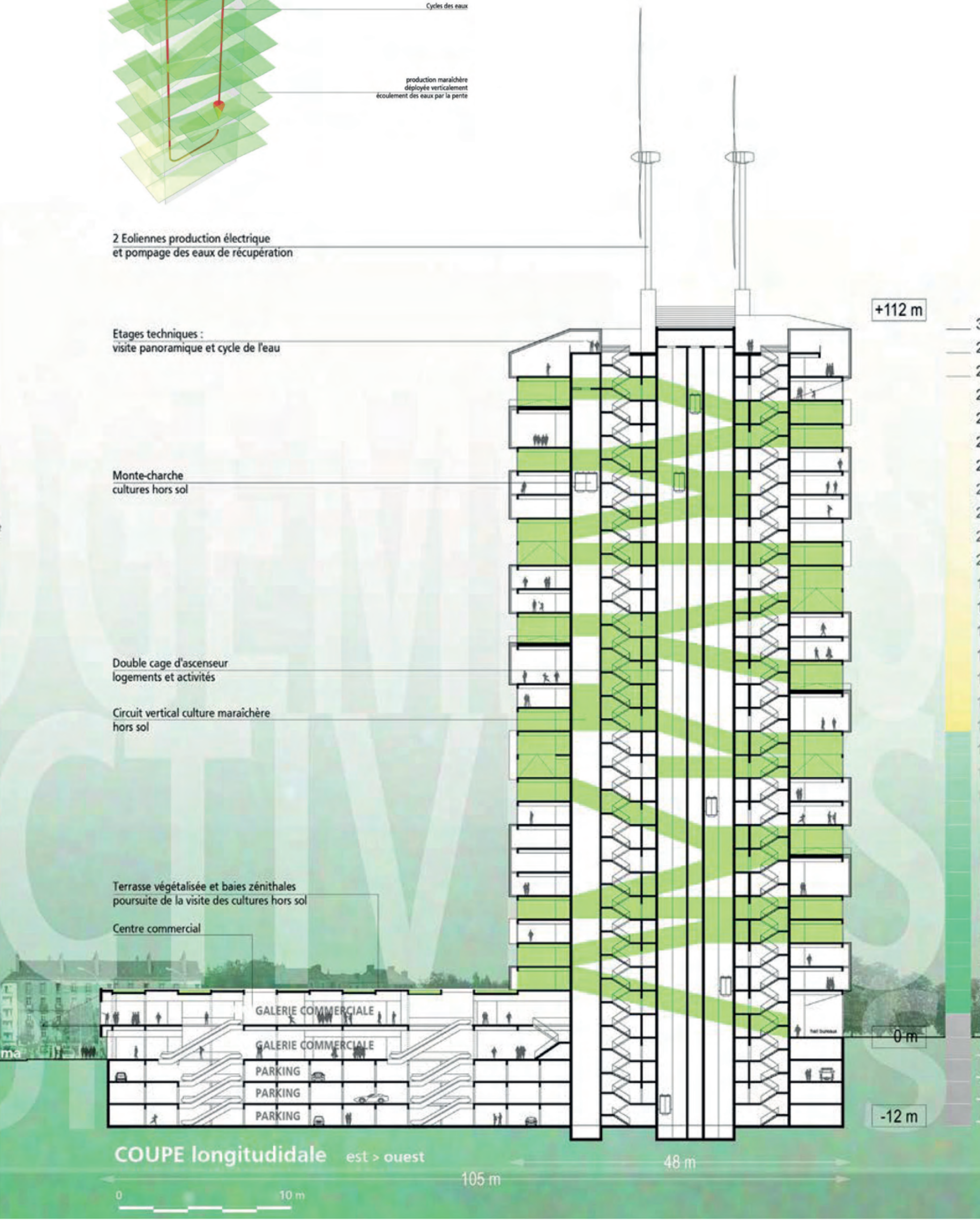


Masterplan and plan of the tower.
Source: SOA Architects


Interior rendering of the farm and co-working spaces.
Source: SOA Architects

3d model and section.
Source: SOA Architects

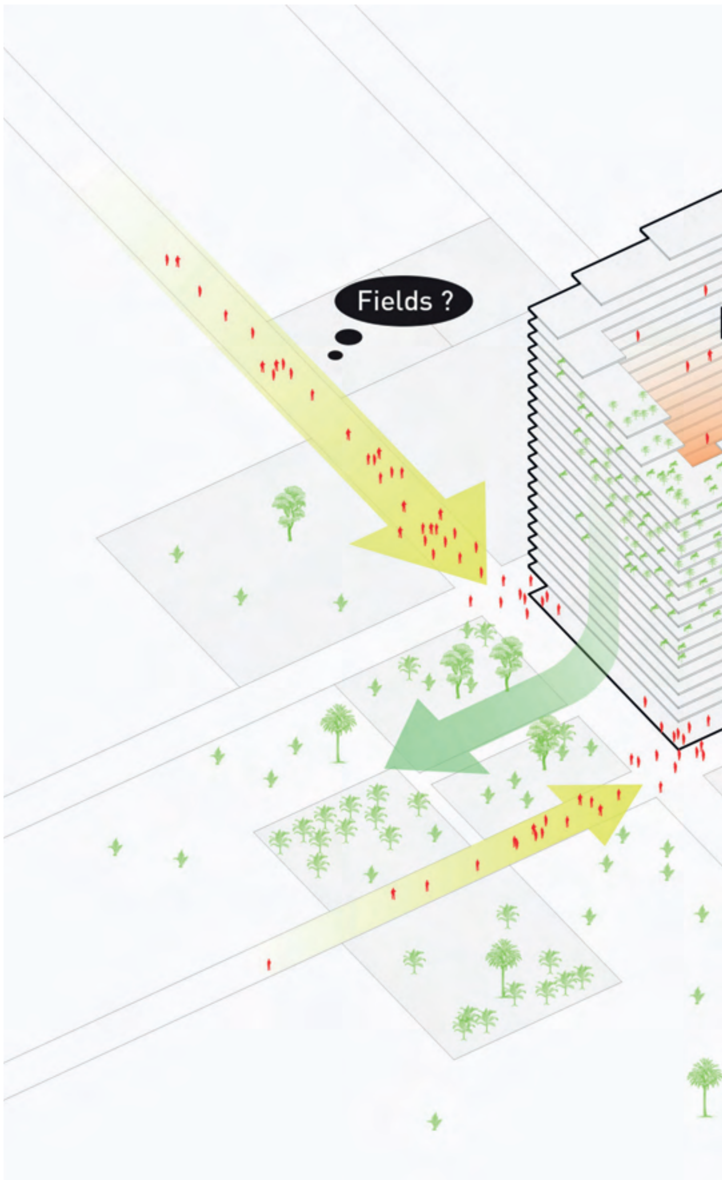


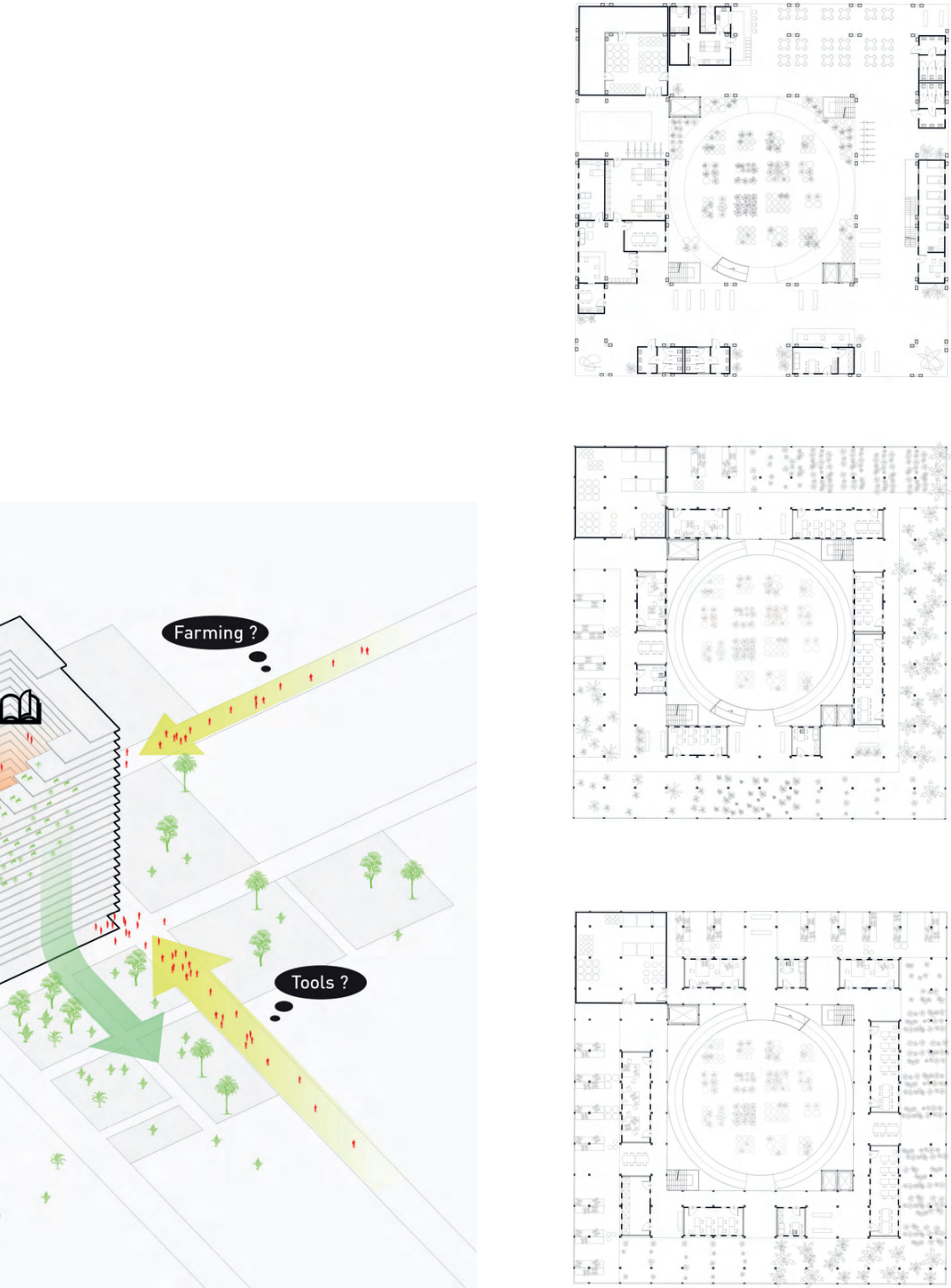


MASHAMBAS SKYSCRAPER

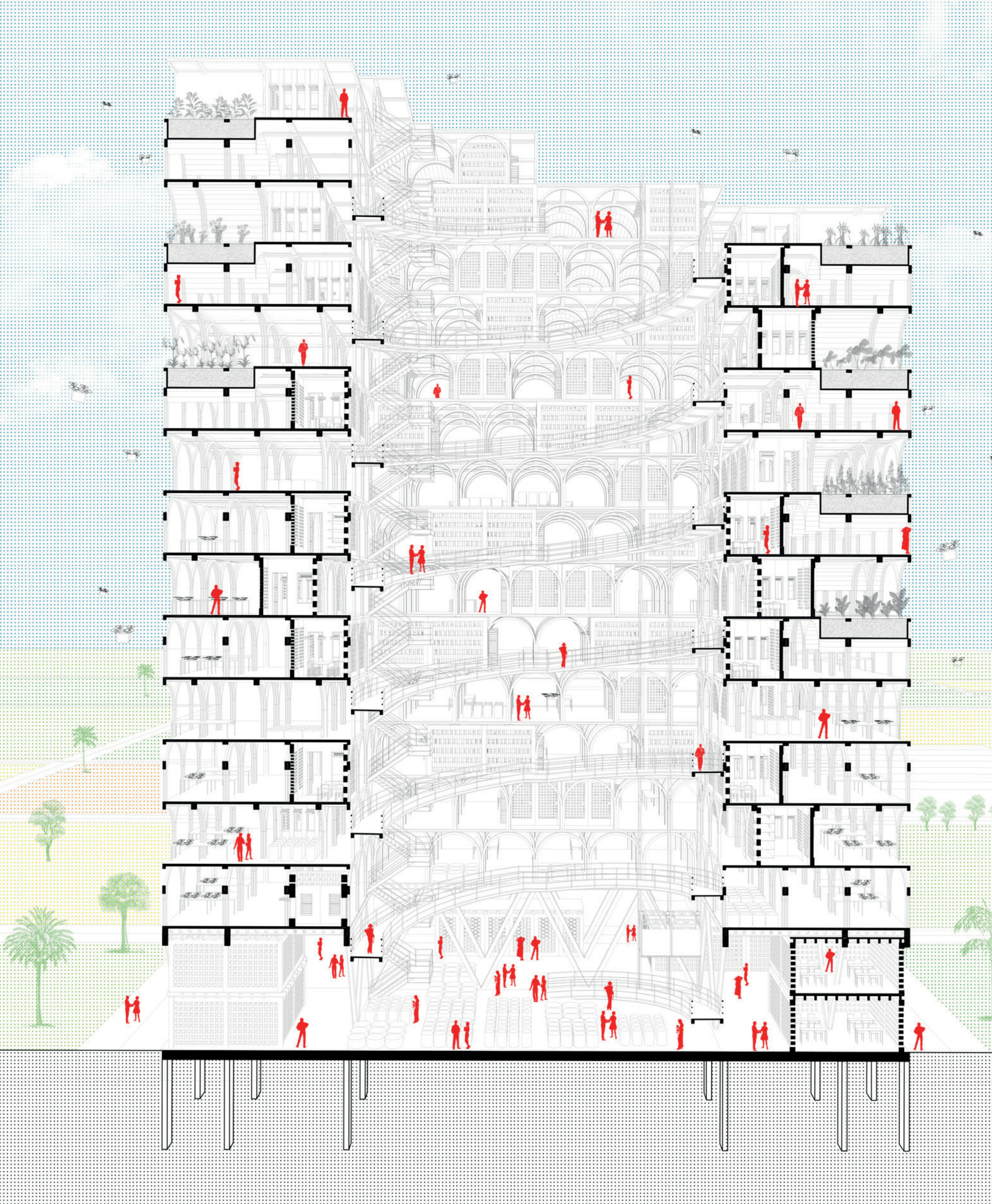
“The modular, scalable tower would move to areas of the continent that suffer from poor soil quality or drought, and that require help introducing fertilisers and increasing crop yields” (Jenna McKnight, Dezeen, 2017). “The structure is made with simple modular elements, it makes it easy to construct, deconstruct and transport. Modules placed one on the other create the high-rise, which is a form that takes the smallest as possible amount of space from local farmers” (eVolo Admins, 2017).
This project, even if unbuilt, is important for the concept and its use of the light and space on the interior. The huge square hole in the middle allows sunbeams to reach every floor of the building. Moreover this modularity allows to reply different shapes in order to the needs of the case. It’s very important the relationship with the exterior, in particular the food exchanges with the fields and farming into the market. “The tower would grow produce on the upper floors and would come with fertilizer and seeds. The other floors would feature kindergarten classrooms, a doctor’s office, and even a docking port for drones that would deliver food to hard-to-reach areas. The ground floor would include an open-air market, where farmers could sell their crops” (Leanna Garfield, Business Insider, 2017).
Plans show how the modularity can be dynamic too alternating public spaces with cultivation areas, markets, workshop zones. Moreover there are several vertical links with stairs and spiral ramps through the height of the skyscraper. Being an new project this agree to have a very comfortable way to move machineries, food carts, ...

Undefined area in Africa. Movable project.

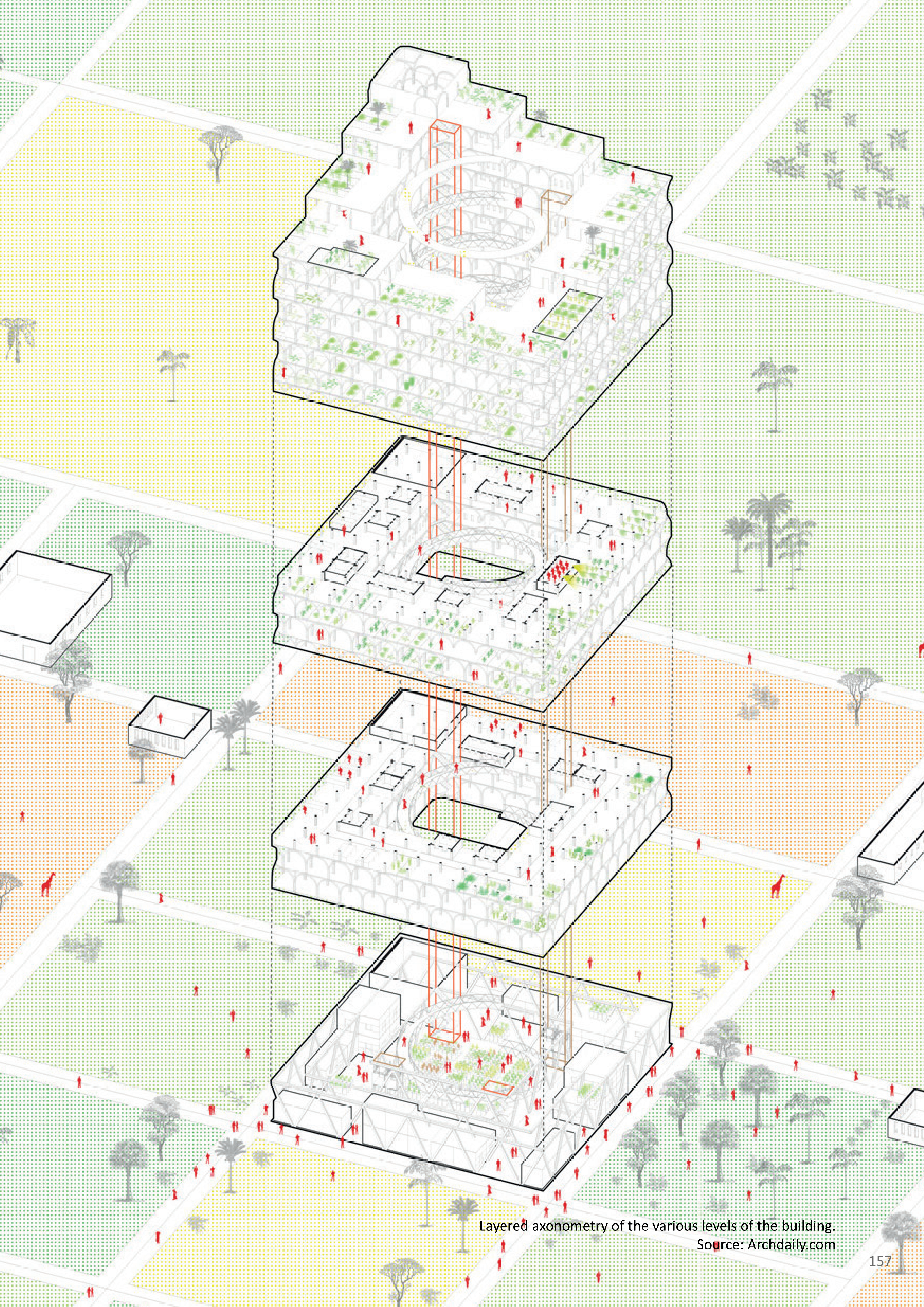




Axonometry and type plans.
Source: Archdaily.com



Complex section.
Source: Archdaily.com



Layered axonometry of the various levels of the building.
Source: Archdaily.com

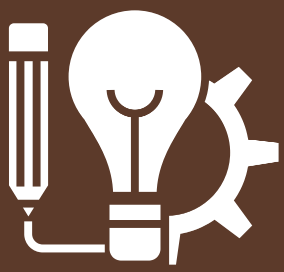
Rendering of the interior proposal. Light is a key element in the project.
Source: Archdaily.com

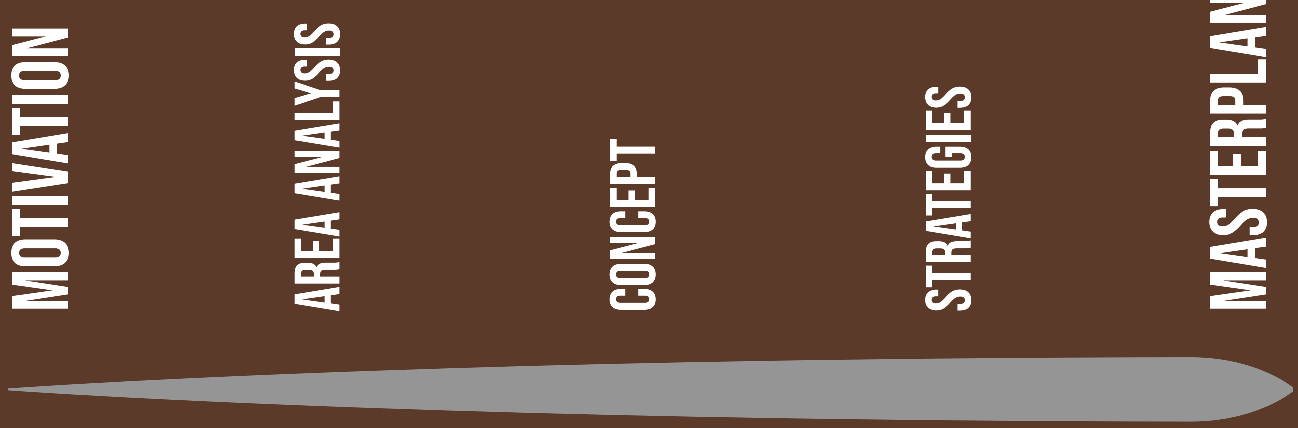
Exterior rendering from the fields.
Source: Archdaily.com

3.1. PRELIMINARY PROJECT

MOTIVATION, ANALYSIS & CONCEPT

3.1.1. MOTIVATION



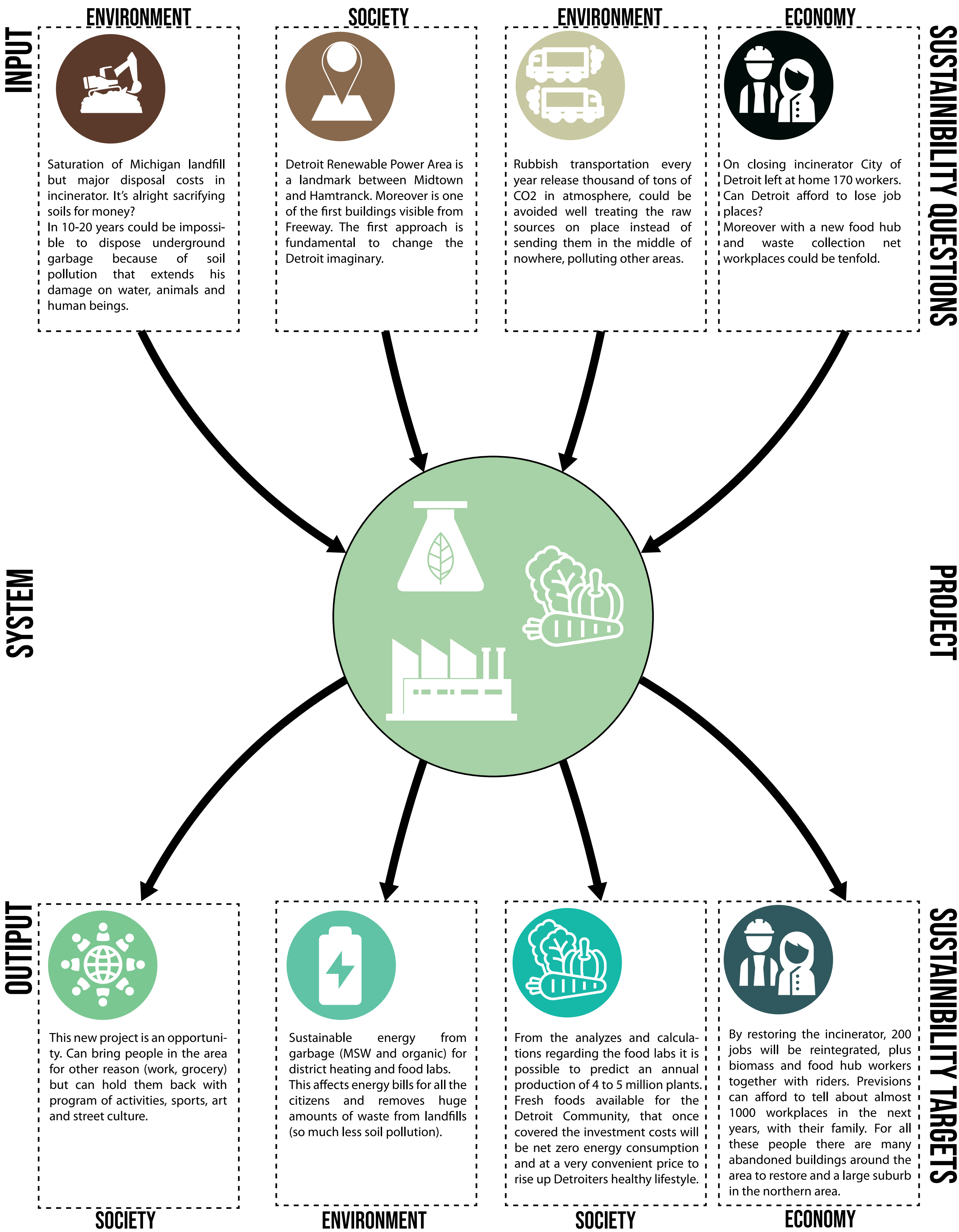


MOTIVATION

“The big problem for the energy from waste plant is landfilling is so cheap in Michigan and the plant couldn’t compete against the landfill disposal costs. Pollution / air emissions, including odors, dioxins & furans (real nasty), are issues but can be controlled if plants are operated properly, and don’t have to compete with cheap landfilling costs.” (from a private e-mail exchange with Dale Lane, Detroit Thermal Systems’s engineer, 2021).
First of all, the Detroit incinerator (and Michigan mostly) received and disposed waste not only from the state but also mainly from Ohio, Illinois and Canada (REPORT OF SOLID WASTE LANDFILLED IN MICHIGAN, Feb 14th 2020). In addition, Wayne County’s landfills each year take in huge amounts of waste that could be used to generate energy in the most appropriate ways.
As already said, Detroit incinerator was shut down in 2019 after a long court, protests, ... but there are many disadvantages that people have to consider about his closing. First of all, the pollution problem is only delocated in landfills areas, but fouling up soils than water will be contaminated. So, as Scandinavian countries already done many years ago, the only choose is using the best technology reducing at the minimum damages and, if possible, obtain the best from garbage. For that reason, is important to revitalize the facility, but not the only.

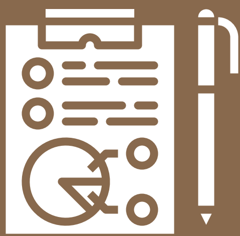
Another important question is about the over 200 jobs that the incinerator alone generated. Upgrading the incinerator with a biomass plant could be possible to, at least, double up the number. Moreover, with a new Food Hub planned, needs highly specialized personnel for indoor laboratories, but also salesmen for the market, commercial activities within the hub, and there will be co-working spaces for all the Detroiters. All those activities will attract many workers, not considering the huge amount of work that the waste collection/ food delivery will bring in the area.

All those activities will attract many workers, not considering the huge amount of work that the waste collection/ food delivery will bring in the area.
These assumptions are favored by the fact that the area is located near an area with possible residential expansion, and many buildings around near Midtown are waiting for a new destination. So in the next 30 years City of Detroit could be able to place all these workers plus their family. All these areas are pretty close to Midtown and its schools and services, therefore very desirable.
Every step is a consequence of the other, and the waste collection / food delivery net add to the areas a very important upgrade. People who want to live in a sustainable way will be attracted with the high quality food, the organization behind trash collection and the lovely neighbourhood, in contact with Joe Louis Greenway that allows to reach by bike with no danger many places around the city.



Project problem solving with input-output system.
Scheme realized by the graduate.

3.1.2. AREA ANALYSIS



AREA ANALYSIS

Lowering the motivations in the reality of the neighborhood, on the scale of blocks, there are many features that catch the eye.
First of all, that area is in the middle of many other activities, abandoned buildings, industries, blocks,...
It could be named a filter area, between Midtown / Downtown and residential/working areas of Detroit in the North-East side.
Moreover, its proximity to Hamtranck makes Poletown East a new possible home (with all the amenities) for other GM Assembly workers in the Northern area.
Another important data that comes out from studies and research is that all the block is rounded by several activities in waste disposal. From ferrous processing to recycling center, passing through DTE buildings for energy and the huge net of district heating, built and linked around the very incinerator. It can also be called an energy district, so the entire project follows its vocation, keeping up waste issues and developing a better way to re-use it. The important thing besides all those activities are the large amount of abandoned buildings on the greenway and around the block who can be reused to receive more people and their families around the starting project. The aim to shrink the city to a "more human" scale, passes through this process of thickening.
Focusing on the waste process area, the incinerator has itself rigid flow ways, that could be modified only for some parts. The Waste Department Offices area is pretty "locked" so the project will be concentrated in the right part and the entire upper lot, more free and more useful for the target of this research.

KEY-WORD THEMATIC MAPS

1. Whole map

First map encloses all the lecture key of the area. From the incinerator to the GM Assembly, passing through abandoned areas and bigger Detroit neighbourhoods. Starting from this brainstorming, there will be developed other map analysis on the area.

2. Filter area

This thematic map shows how the research area is located between big different parts of the city. On a side, there is the city center with Downtown and Midtown, core of the financial and commercial activities, with skyscrapers, universities,.. On the other side there are big neighbourhoods (or better Hamtranck is a city itself) and big industries like General Motors and other automotive facilities. It’s important, not only for the project but for the future of the city, to design filter areas that merge the two different features of the city, showing a slight change in moving through the city.

HAMTRA

Tematic maps/schemes.
Realized by the graduate.

3. Waste facilities

All the blocks around the incinerator and the whole lot are plenty of waste facilities, like metal depots, recycling centers,... plus the connection between all these activities is insured bu the Joe Louis Greenway, that links several of these through its path. That information is so important because if it's necessary to design waste hotspots all along the greenway in the future, could be possible through these very facilities. The project continues to develop itself also after the completion of the "first step".

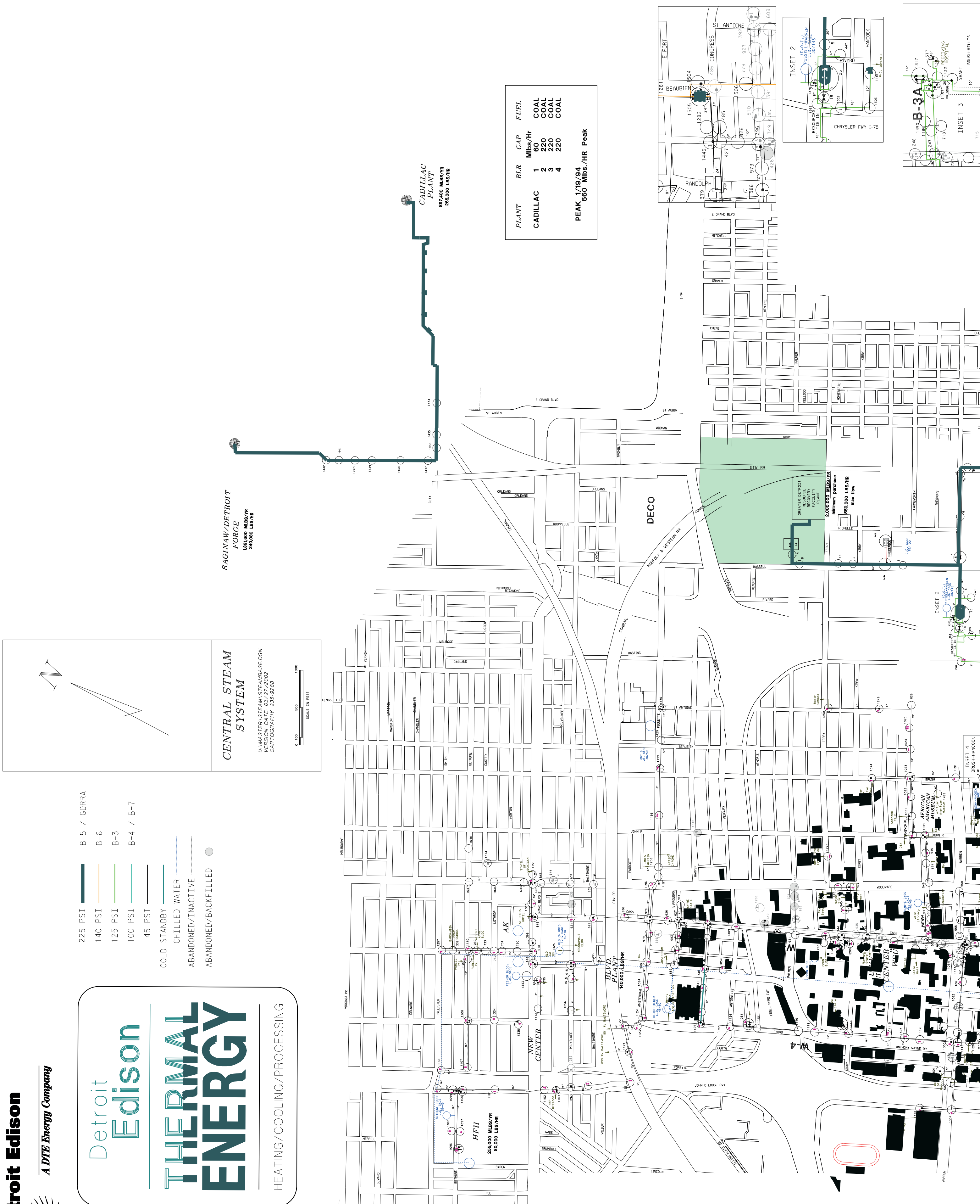
4. Abandoned buildings

The very Detroit Renewable Power Area at the moment is abandoned (since 2019). But it's not alone in this analysis. There are several buildings and lots left to their fate and in need of a new destination. In that case could be possible to transform these huge buildings in new residential loft, letting the space to green parks for a more quiet living, even if in a city. It would be an incentive for the city if a residential-commercial belt were formed around the modernized incinerator and along the greenway, realized step by step by spot designs that through the years could reconnect a sprawled city as Detroit is.

JOE L

DT

Tematic maps/schemes.
Realized by the graduate.



Steam Central System around incinerator, Midtown and Downtown Detroit.

Source: Detroit Edison & Detroit Thermal Energy, private material files sent by Dale Lane, engineering manager of Detroit Thermal Energy (2020).


PLANT BLR CAP FUEL
BEACON 1 475 GAS
2 475 GAS
3 500 GAS
4 475 GAS
BLVD HTG PLANT 7blr 140 TOTAL
HENRY HTG PLT 4blr 80 TOTAL
WILLIS 5 180 OIL
7 100 OIL
RRF 11 275
12 275
13 275
PEAK 1/19/94 1,565Mlbs./HR
WILLIS HEATING PLANT
INSET 1
INSET 3
INSET 4 BRUSH-HANCOCK
New Center Chilled Water Island
Federal Buildings Chilled Water Island
GREEKTOWN
THEATRE DISTRICT
GM CENTER 200,000 LBS/HR MAX LOAD
HENRY PLANT 80,000 LBS/HR
COBO HALL
JOE LOUIS ARENA

3.1.3. CONCEPT

CONCEPT

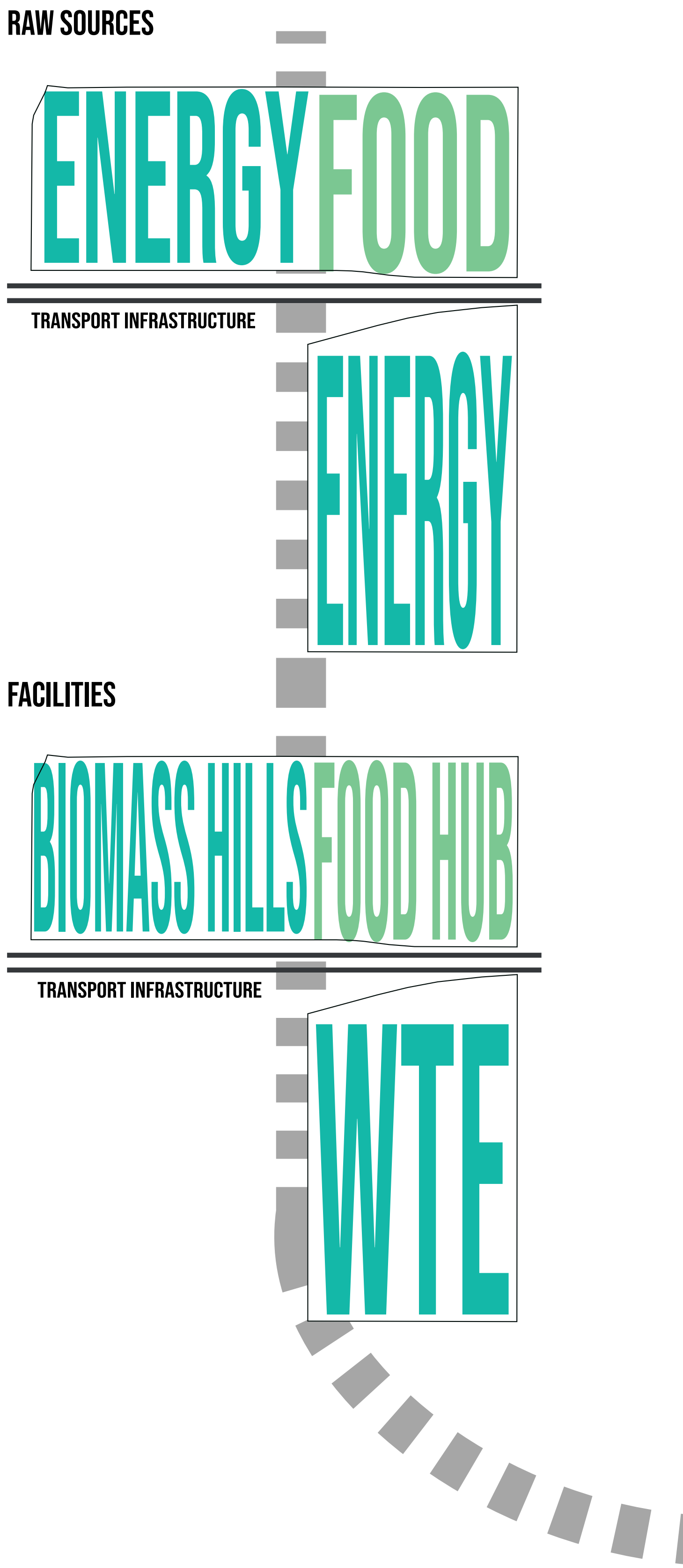
Concept idea is a six step path to the core of the project. After the research and the area analysis what the project needs is a new biomass plant, and a building that produce, exchange, etc... food. So, on the upper surface of the merged lot there is already a big manufactured designed by Albert Kahn in the late 1920s, a classic regular concrete structure building currently abandoned by private owners (Arte Express).

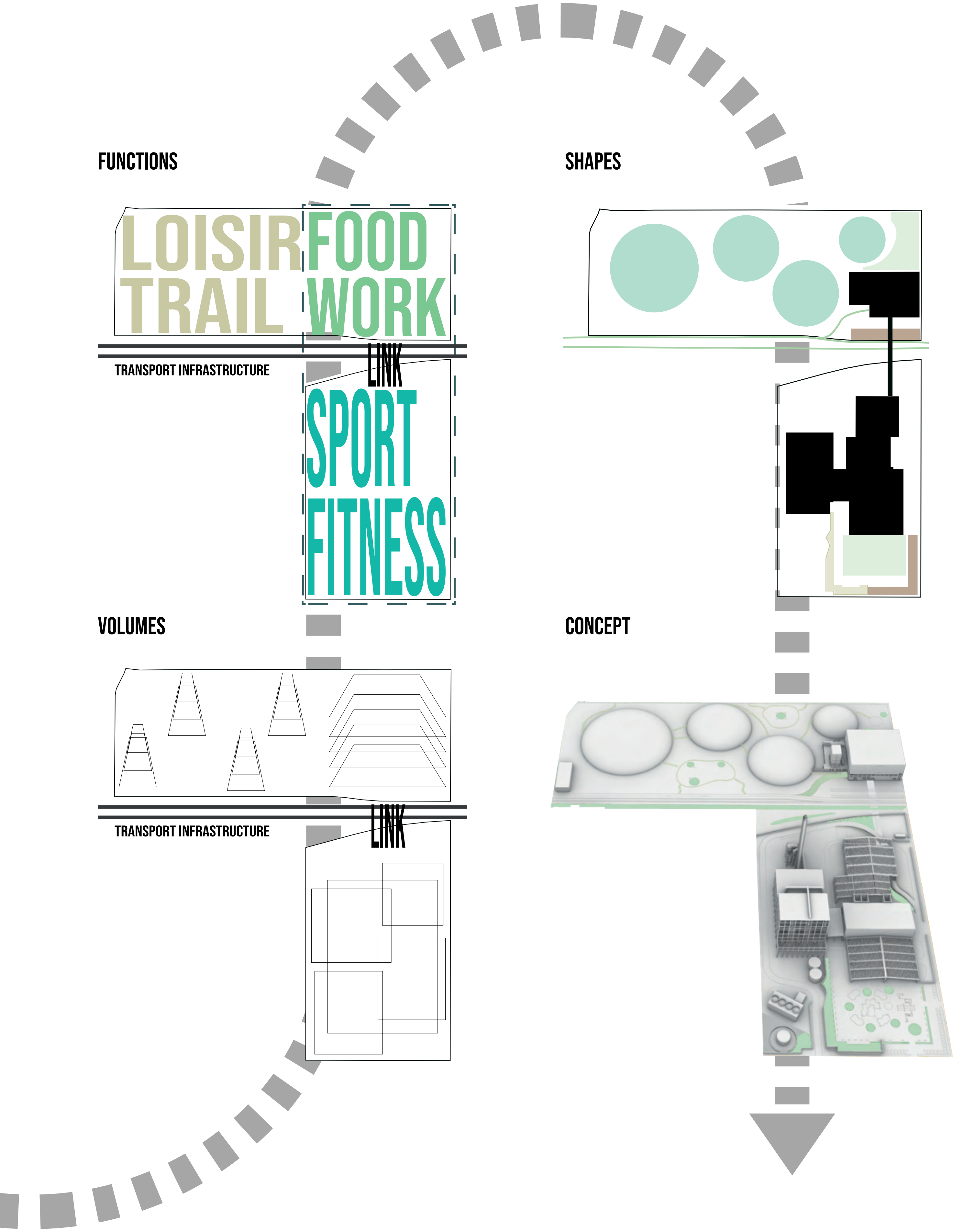
"The ten-story, 528,000-square-foot industrial warehouse sits in the shadow of the GM-Hamtramck Poletown Assembly Plant, north of Eastern Market and east of the Cultural Center" (Aaron Mondry and Jay Koziarz, Curbed Detroit, 2019). This warehouse and cold storage it's on sale for five million dollars on real estate and is a mixed use zone (code M4). That could be a real opportunity for the City of Detroit to recover a huge building that also offer a wonderful view on Midtown, Downtown, the riverfront and Canada coasts too.

The other part of the lot is occupied by Schlafer Iron & Steel Inc., a "ferrous Processing & Trading Company specializes in the processing and redistribution of both ferrous and non-ferrous scrap metal products" (...), "was established in Pontiac, Michigan in 1904, but has since moved its national headquarters to Detroit." (Manta Media Inc., 2019). This company could be glad to move only to a near lot to continue their work, so useful to the whole project as a recycling center. There are many areas close to U.S Ecology (another recycling center in the South of Grand Trunk Warehouse & Cold Storage).

Starting with the concrete thoughts about the concept, there will be two areas used for energy, and one building as food factory. This choice allows to divide the two energy flows, biomass will be only for the food hub(that consumes huge amount of clean energy for the vertical indoor farms) and the incinerator will transform the energy for the district heating to break down energy bills for Detroiters, but with no more emissions and smells problem upgrading to BAT the facility.

Carrying on with concept definition, every part will be materialized as its building-kind. Biomass will be developed with an underground plant. The covering will be punctured in corrispondence of digesters (to recover rain water and use digesters as water collection surfaces, then using it to sustain the botanical garden inside and the leftovers pumped back to the farm. Incinerator remains a Waste to Energy Plant and the Grand Trunk Warehouse will become the Food Hub that Eastern Market and the whole Detroit needs. Each part has different functions, mostly the two buildings which will become layered factories.
Stratified not by chance because they are pretty divided in the two dimensions, vertical and horizontal. On the food hub, will be FOOD & WORK activities, as co-working, food labs, fresh foods market, etc.. Meanwhile on the incinerator roofs, given the huge available surface, will be located all the SPORTS, FITNESS and loisir amenities.
The final aim is to have simply a self-sufficient complex that allows the customer to work, buy fresh foods, relaxing, doing sports in the same “building” because the two will be linked by a pathway.





Six steps concept from raw sources to spaces.
Scheme realized by the graduate.

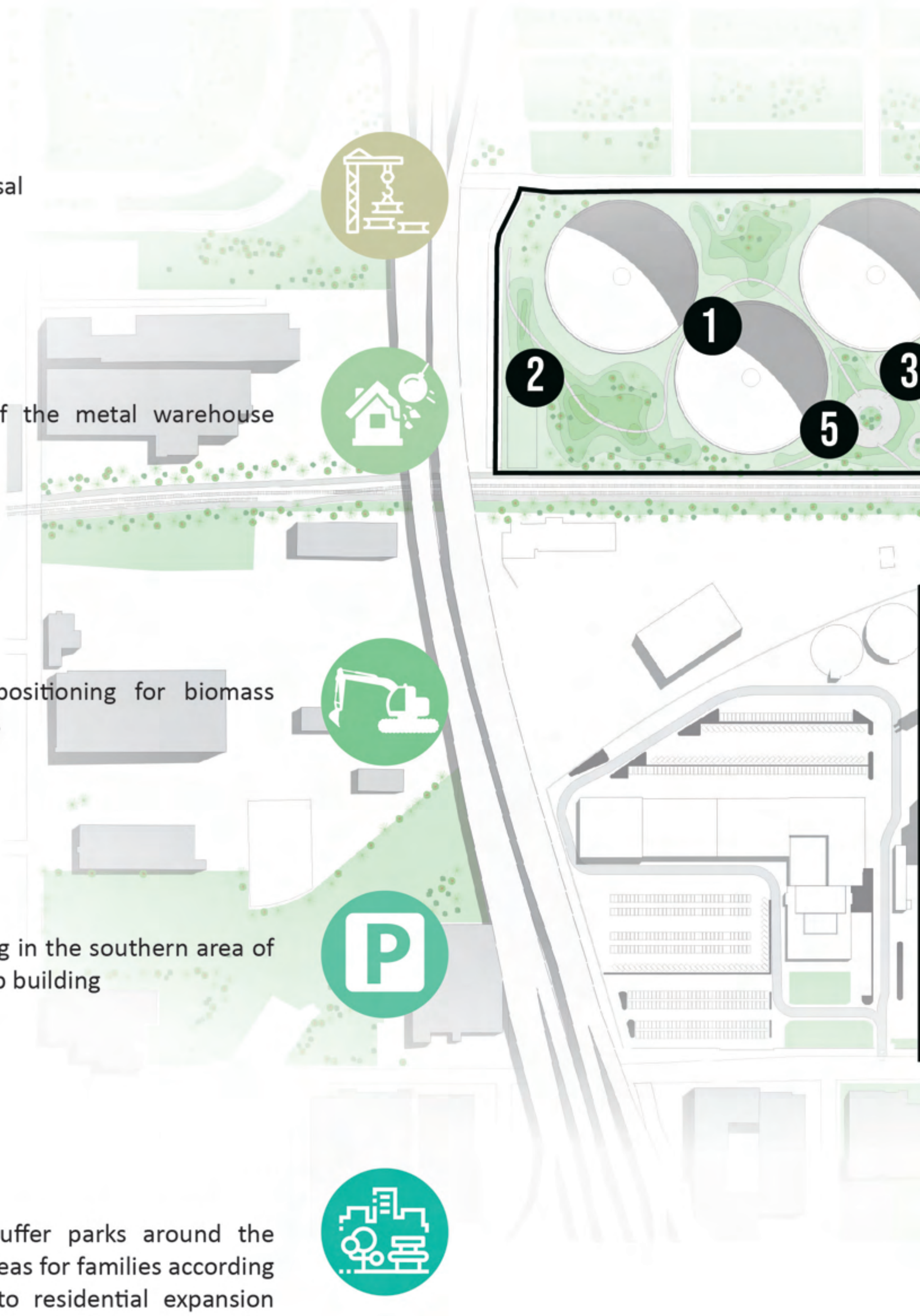
3.1.4. MASTERPLAN STRATEGIES

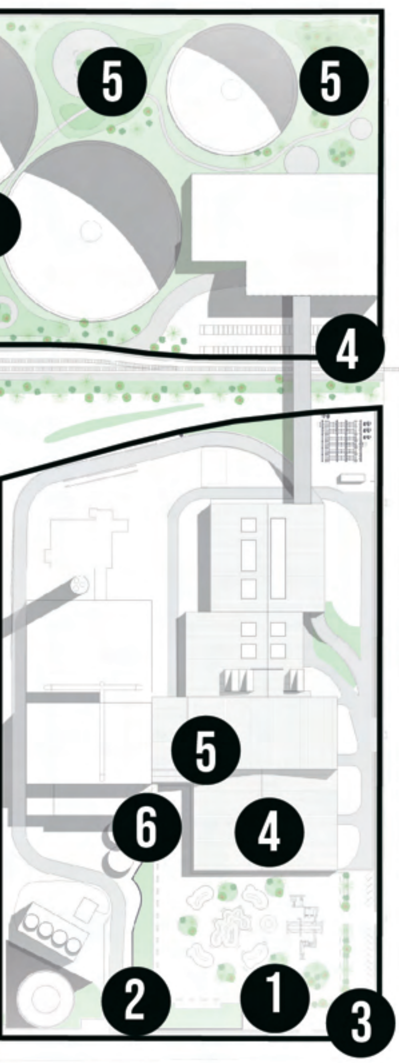
MASTERPLAN STRATEGIES

Masterplan strategies are a simple consequence of the concept ideas previously illustrated. Starting from the upper lot, to be able to develop the construction of the biomass plant the first thing is dispose all the metal depot elements. All the raw materials collected to clean the upper lot could be disposed in the close Recycling center (U.S Ecology), or the many other Metal depot around near Eastern Market. Moreover, should be necessary to tear down part of the manufactured used to dispose the metal waste by the company. The other part should be useful as an organic waste loading mouth for the biomass digesters.
Than there will be important ground moves to let the space to the new biomass plant. There are already calculated the volumes of the digesters so there will be only the add of the service spaces.
On the lower lot instead, will be demolished the administration building and moved the whole offices to the Department of Waste building (in the North-West part of the Detroit Renewable Power Area). In its place and in general in the South corner of the area will be developed a different kind of intervention that welcomes people in the new renovated incinerator area. First of all the service area will be divided from the new by a wall, to reduce the sight and the noise from the trucks moving area. The very wall become a space where street artists can develop their works and create a kind of open air museum of street art. In Detroit is a very deep culture and could continue the Graffiti Tour that starts around Eastern Market. (to create a strong connection between the two neighbourhoods). Moreover, will be designed a youth park with rails, bowls,... to make the area a new (and one of the few) skate park in Metro Detroit. There are only two verified skatepark in a radius of 5 miles. Importance of this buffer zone is to attract people to go upstairs by lift and enjoying sports, fitness or the rooftops of a very important landmark of the city.

LOT SCALE PROJECT STRATEGIES

1. Metal Depot disposal
2. Part demolition of the metal warehouse building
3. Excavations and positioning for biomass digesters and pipes
4. Provision of parking in the southern area of the future food hub building
5. Construction of buffer parks around the biomass domes, areas for families according to the proximity to residential expansion areas (to the North-East)





Administration building demolition **1**

Construction / extension of incinerator partition wall for open air artistic exhibitions **2**

Arrangement of the parking area on the South-West / South-East side **3**

Skate park construction **4**

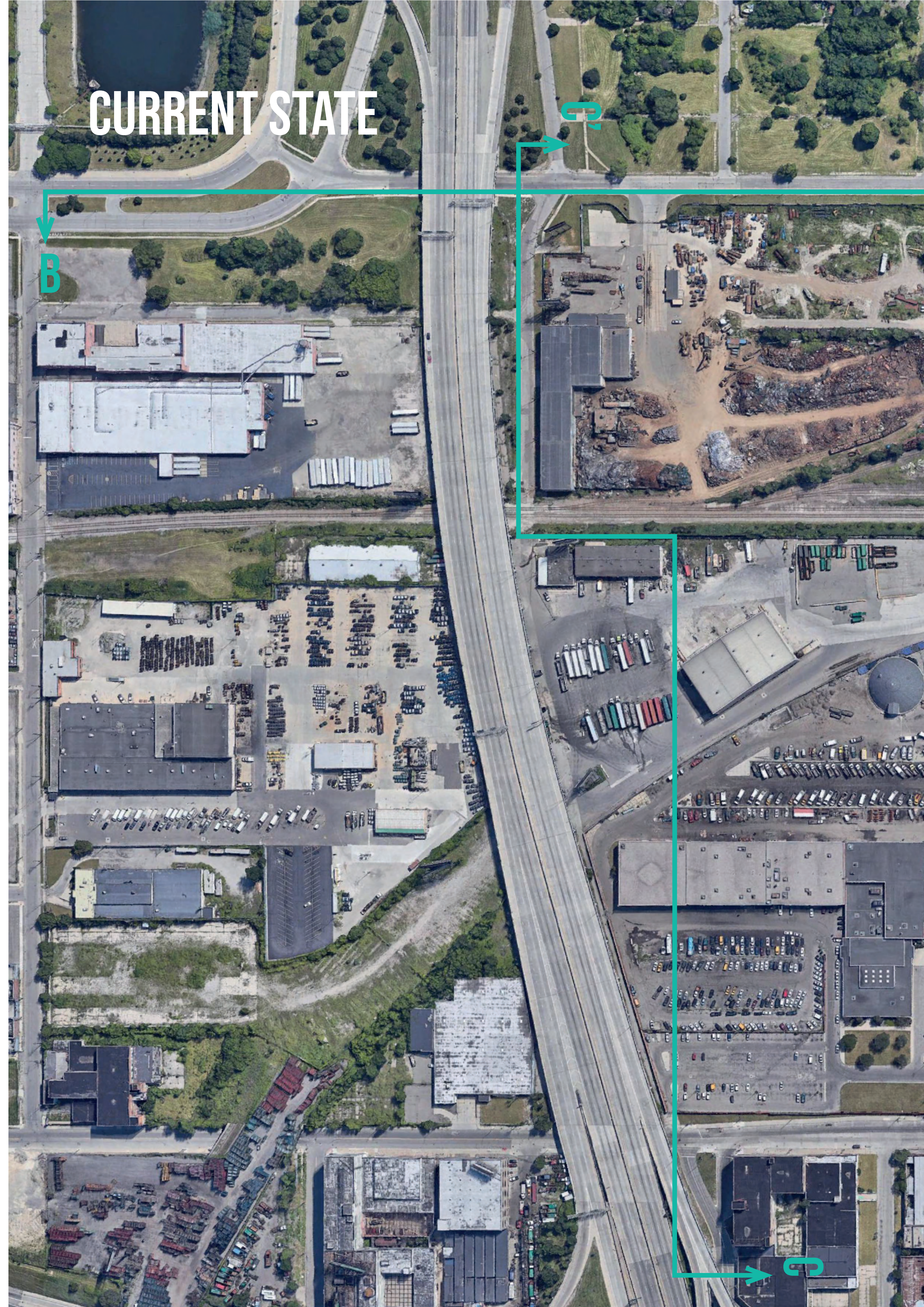
New volume with greenhouses and street-art museum. **5**

Construction of a new elevator that distributes the flows vertically by connecting the buffer space to the various floors of the incinerator roof **6**

3.1.4. MASTERPLAN

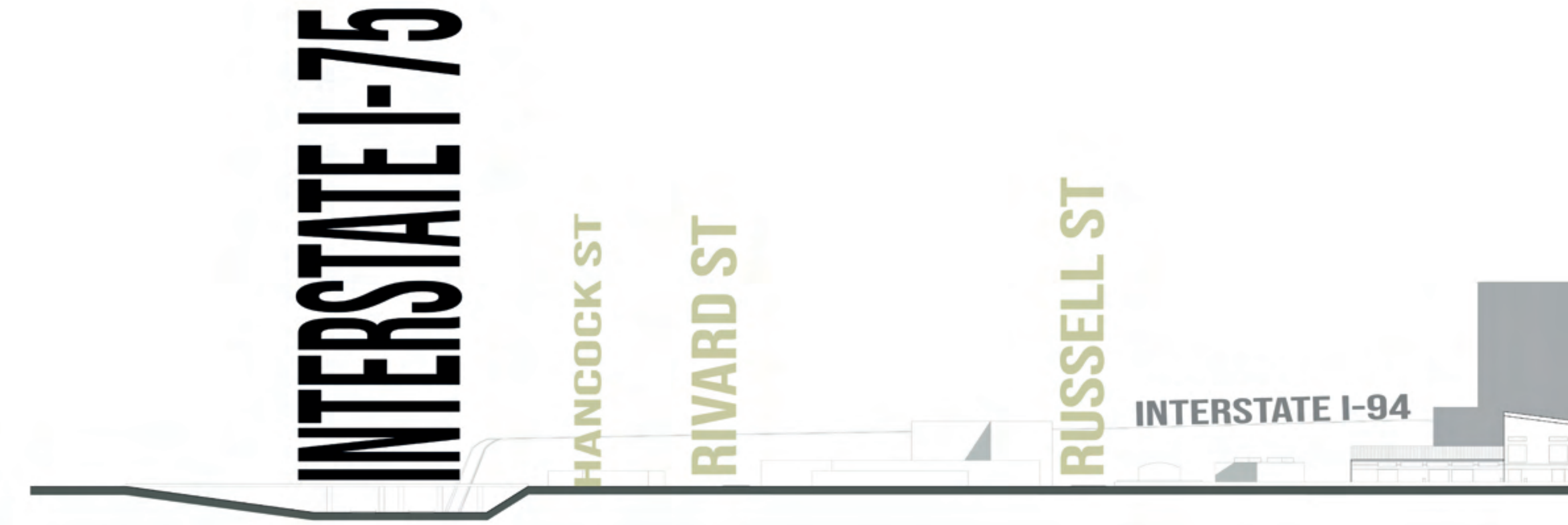
MASTERPLAN

Masterplan's idea is bound by the restrictive flows network of the incinerator, its shape and the fact both the Detroit Renewable Power Area and the Albert Kahn building on Ferry Street have already their structure, shapes,... Moreover side building on incinerator area is used as office for the Waste Department too.
The North-East lot is totally private, so could be necessary a state expropriation to be able to transform the upper area, but the project is for public interest so should be easy after City of Detroit, or any other federal organization, find the necessary funds to develop this circular economy project.
To respect the originary function of the incinerator, it's required to modify the flow of rubbish trucks to allow the passage of people to the buffer zone (skate park and open air gallery) and more important to the lift that agree access to the incinerator's roof, and its activities. Thus freeing the South-West area, it's the only area free-to-use to give back to the city a link between people and this industry. The reason is inherent in the problems that led to its closure, explained in the chapter about "people against".
The upper area instead is, for most of the surface, free. The fundamental question, however, is that's mostly green so it's important to keep it as much as possible, despite a new drawing plan. Biomass digesters are positioned in that area for a detailed motif. It's important for people to reconnect with their industry, but is also a lecture key keeping it on another landscape layer for the people who live day by day close to facilities. So the biomass digesters will be covered by gasometer structures, walkable, to hide the big volumes of the facility and leaving to the citizens space for trails, relax and sports.
Plant it's linked to the Albert Kahn buildings, where will be positioned the control unit of the whole plant.


CURRENT STATE
B
C'
C

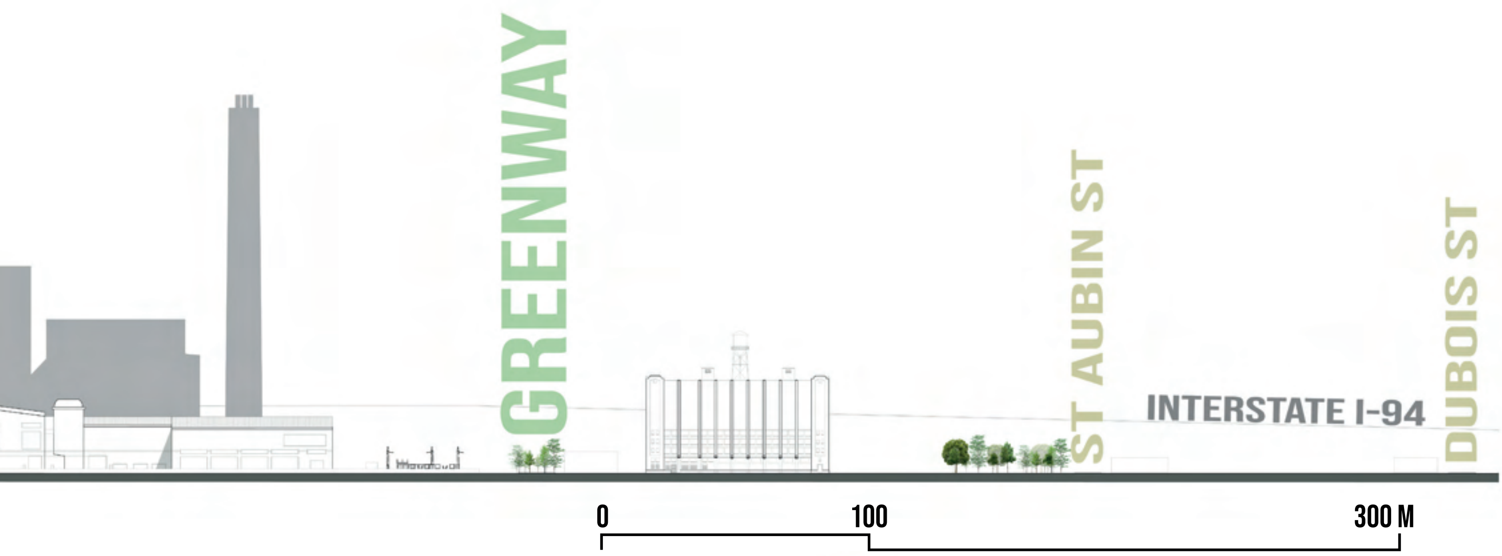
Google Earth satellite view.

SECTION A-A’



SECTION B-B’

SECTION C-C’


GREENWAY
ST AUBIN ST
INTERSTATE I-94
DUBOIS ST
0
100
300 M


GREENWAY
E EDSEL FORD SERVICE DR
INTERSTATE I-94
INTERSTATE I-94
E GRAND BLVD
TROMBLY ST
0
100
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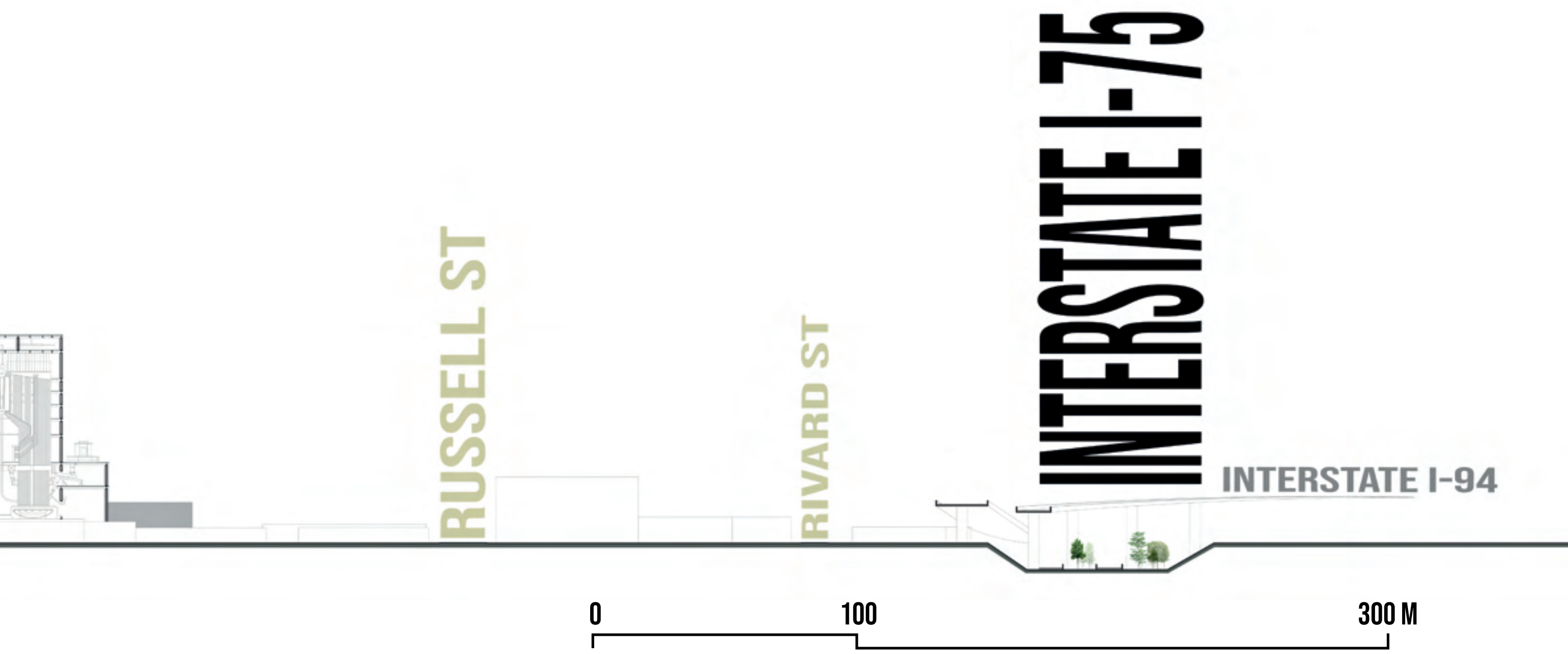
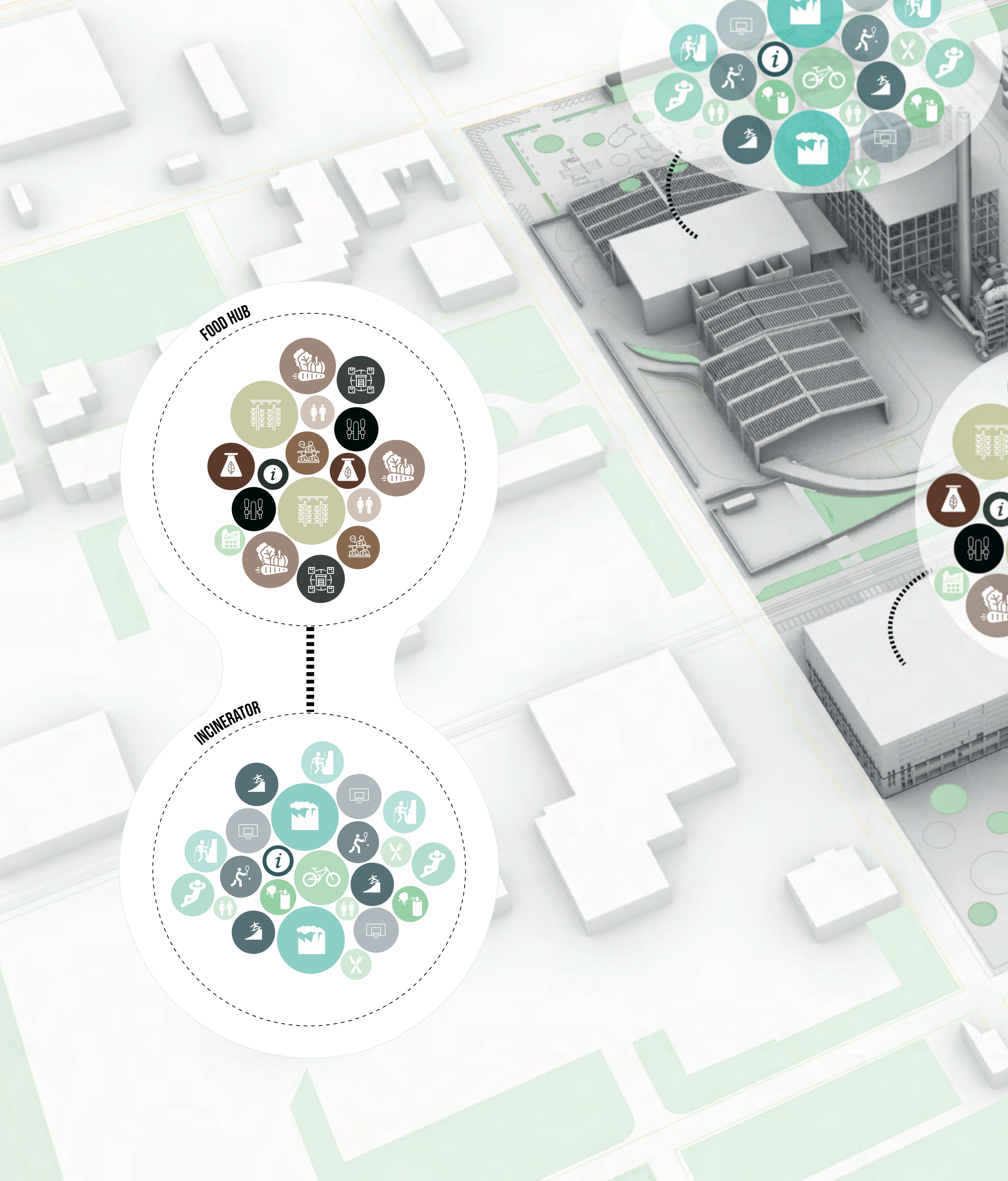
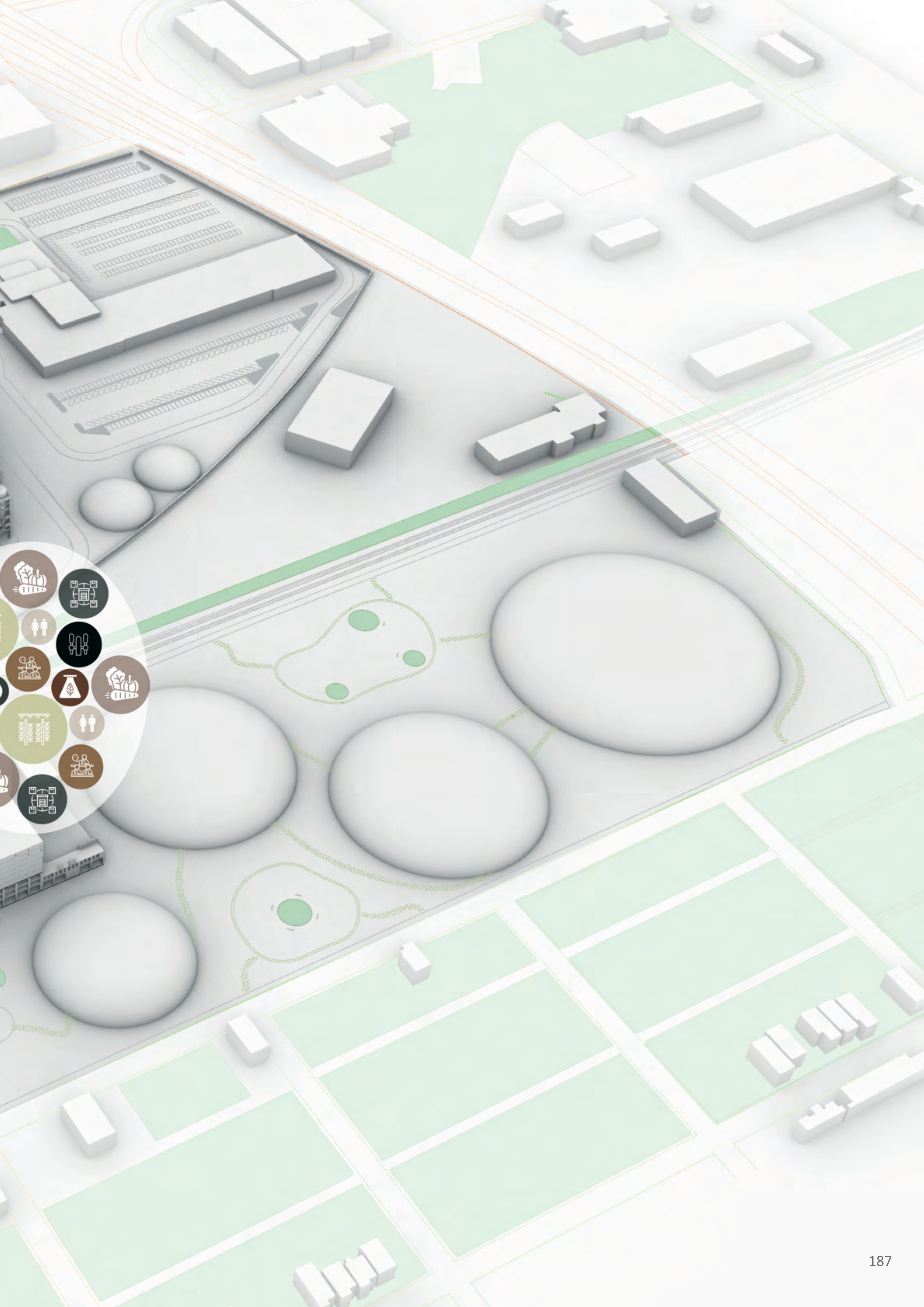
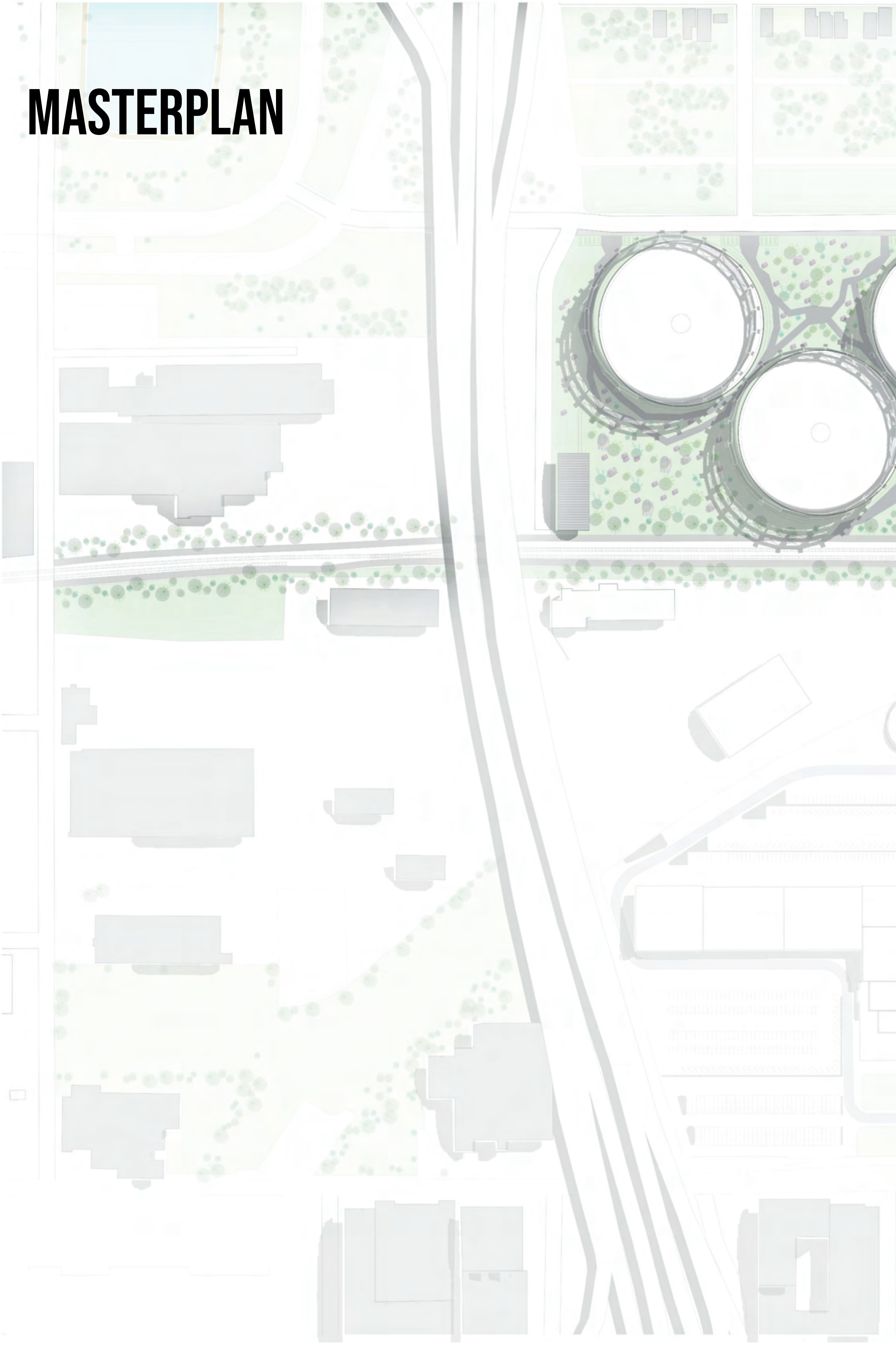

RUSSELL ST
RIVARD ST
INTERSTATE I-75
INTERSTATE I-94
0
100
300 M

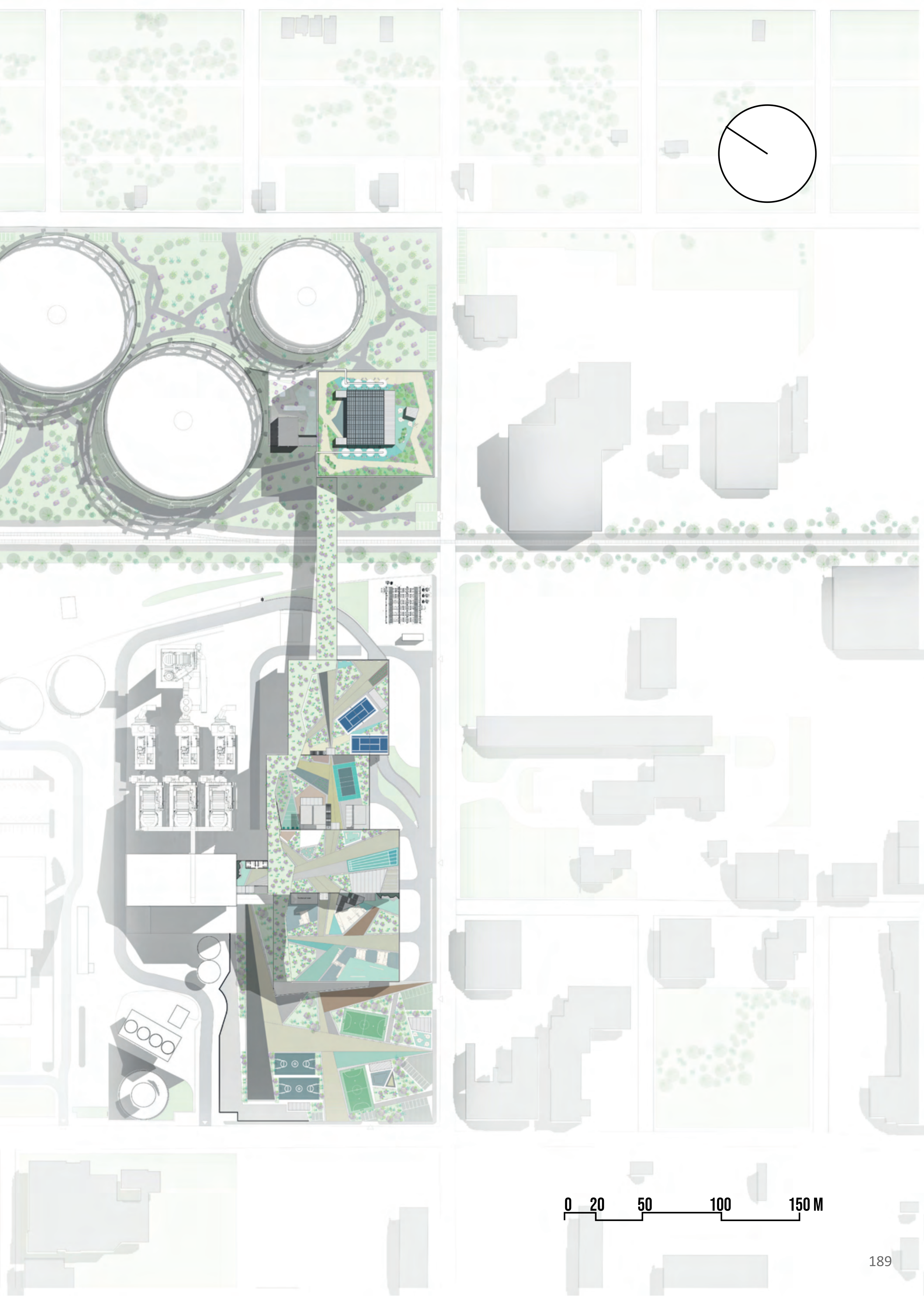
CURRENT STATE + BIOMASS AND USE DESTINATIONS





MASTERPLAN




0
20
50
100
150 M

3.2. BUILDING SURVEY

DOCUMENTS, DRAWINGS, ...

3.2.1. BUILDINGS DOCUMENTS

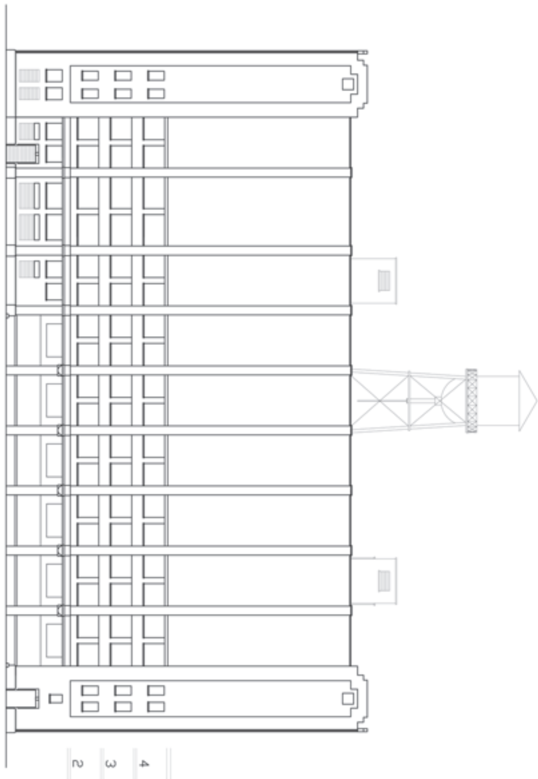
1921 EAST FERRY STREET

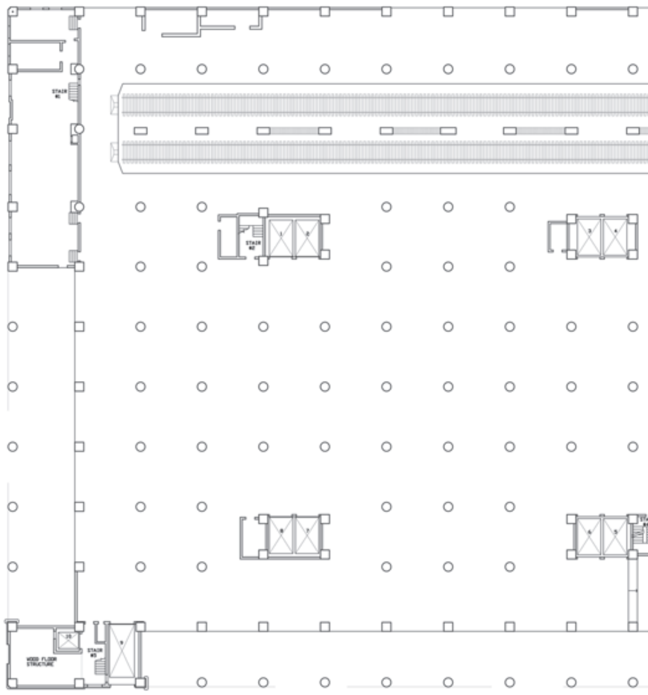
Buildings documents give the most important informations about the buildings. The Warehouse on Ferry St is an Albert Kahn Associates project, built in 1946. During its lifecycle had function of frozen foods deposit. Since 2002 is abandoned and ruined by fires, years of vandalism,... The structure in reinforced concrete has a pillars network that makes a structural frame very static.
A very important feature of the building could be the volumes. Starting from a ground block two volumes extrude from it forming a cube and a little tower. The construction has a huge basement too that will be used as entrance for the biomass power plant. Moreover the floor plan is elevated from ground for circa 1 meter, giving the opportunity to design a glass-steel-concrete project that allow users to have an interesting elevated point of view of the surrounding area.
Vertical links are located in four points of the building, with stairs and lifts, precisely 8 elevators. To simplify the flows in the project will be divided by people and by service.
Facades are pretty simple and have an opening reduction from the first plans to the roof. On the two corners of the front street elevation there are two kind of ramparts that will be removed to minimalize the weight of the facade.
Landlord is Arte Express in the person of Fernando Palazuelo (the same landlord of Packard Plant, that's very close to) and its total assessment is $ 1,364,200, but the requested offer appears to be of $ 5 M. Is part of the opportunity zone and its area extends by 2.34 AC (circa 9500 square meters).

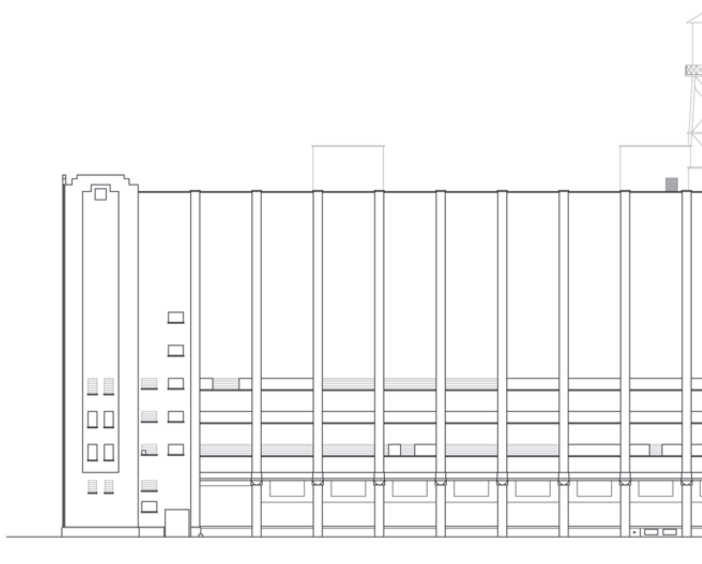
DETROIT RENEWABLE POWER AREA

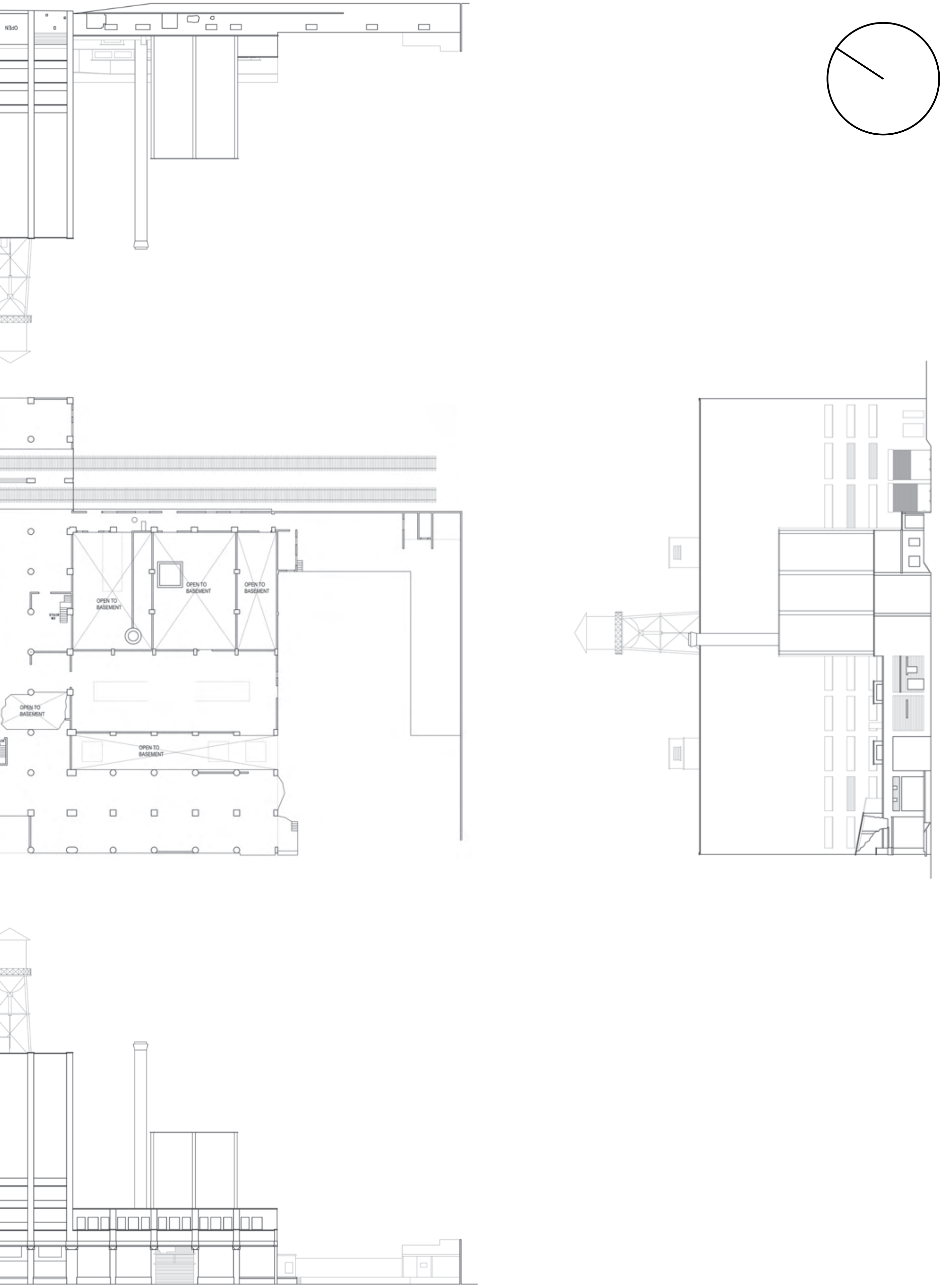
Detroit's incinerator is one of the largest municipal facilities in the world. Built in 1986 had the capacity to burn 1 million tons of trash every year.
Is a very old facility and needs to be restorated and retrofitted, mostly for the structure and facades. Frame is made by series of portals that allows to have a free space under the roof with no pillars, but needs to be redesigned to secure its safety and making a flat walkable roof.
The area is composed by the incinerator itself with processing rooms, burning rooms, etc... and another building with the office of the Waste Department. There are many constraints in the area because of waste flows within the facilities, this makes difficult giving a uniform feature to the whole area.
Landlord is private right now owned by Detroit Thermal Energy (was public before, than city had huge issues and was passed from hand to hand), and there are talks with the city to upgrade it and re-open, because is very important for the whole Michigan (due to the continuous unfolding of the soil in landfills).
In the end the facility needs a big upgrade with Best Technologies Available to be reopened. Now there are many issues about emissions and smells that need to be fixed for the safety of the citizens, but the very city can't solve the waste problem without it, and it's important to save money for energy recovering it from trash. The aim of the research is giving a new life to this building, with the hope that some engineer student or studio could take this work and upgrading it with an in-depth research and analysis from the engineering point of view of the improvement of the incinerator to the modern facilities.

1921 EAST FERRY ST

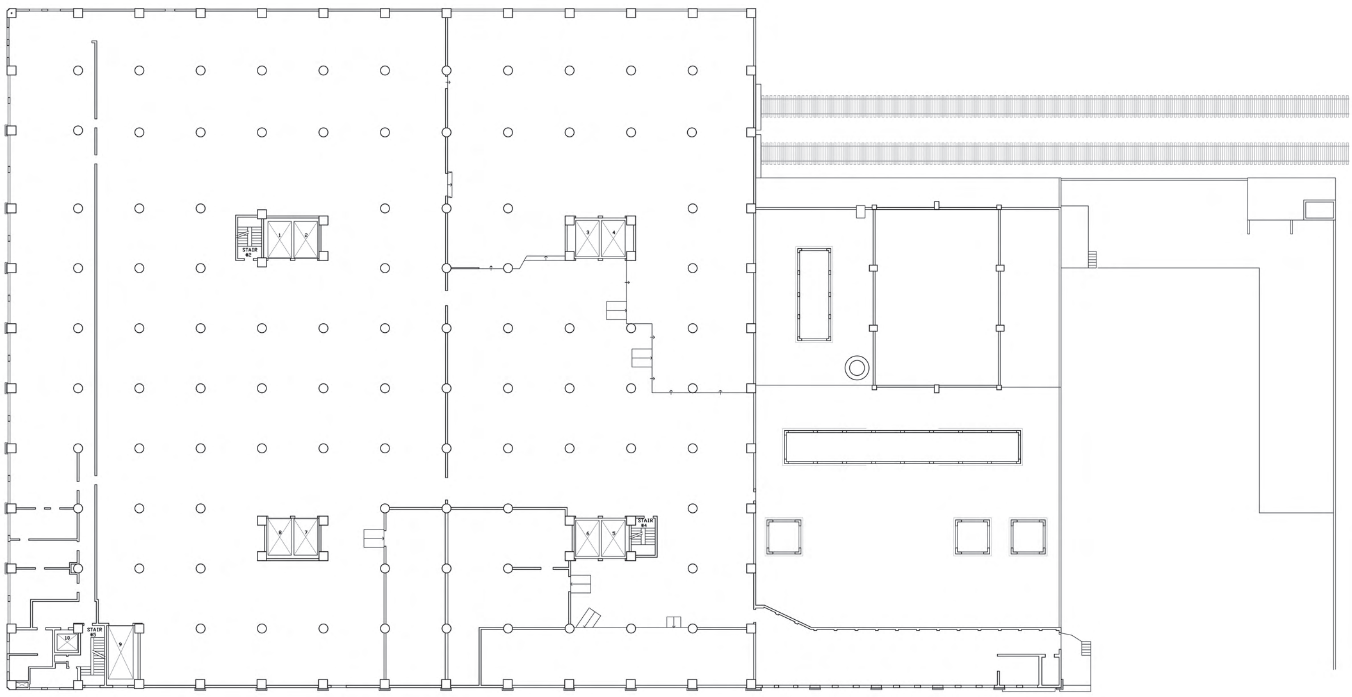


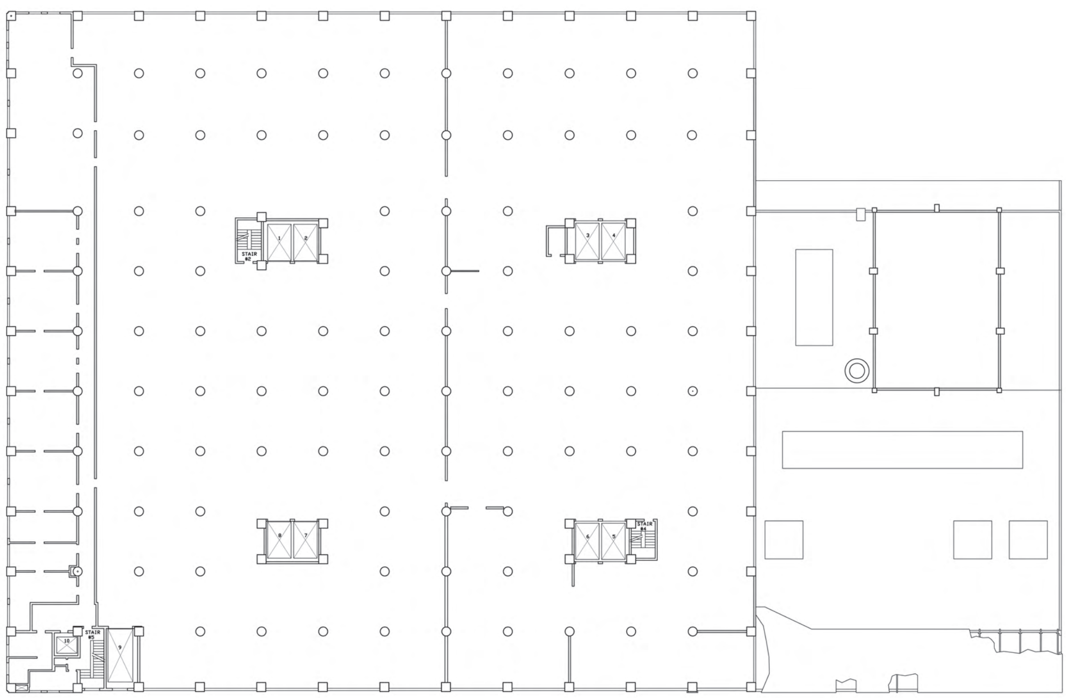






Plans source: Arte Express, living around Art.
E-mail: info@packardplantproject.com





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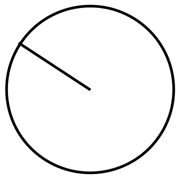
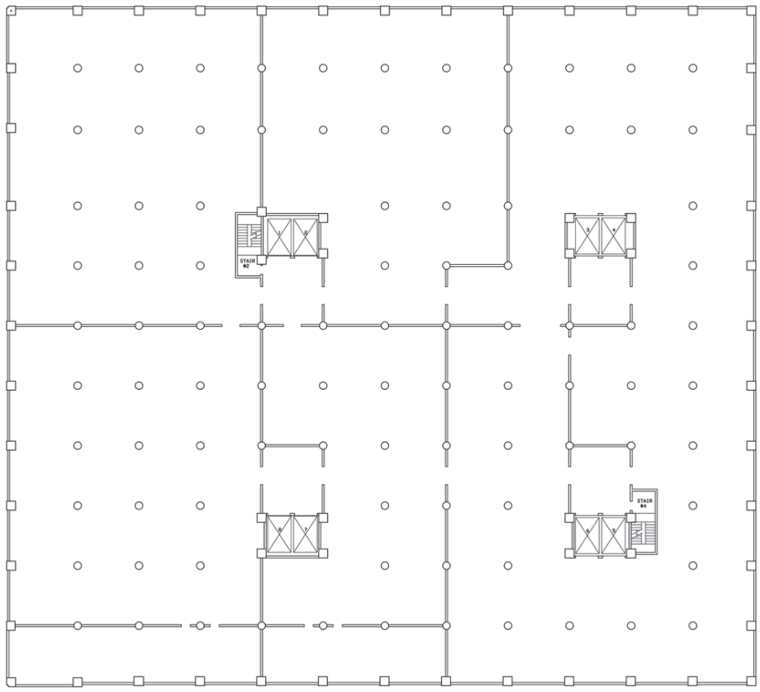
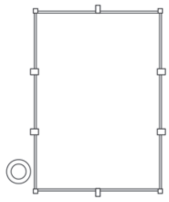
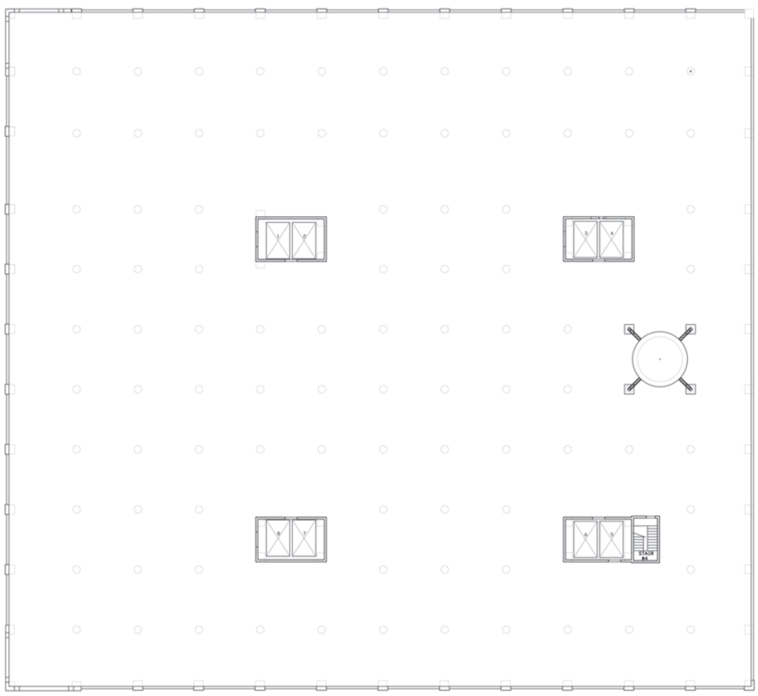
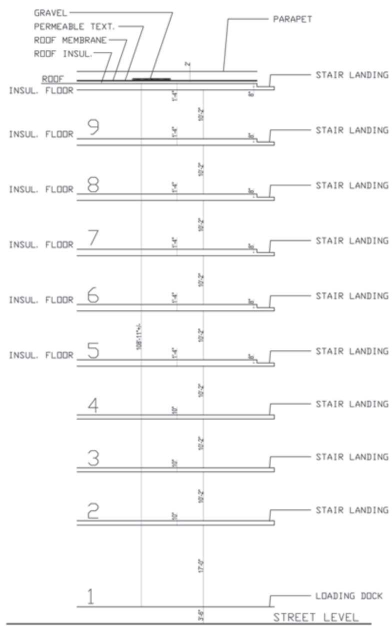




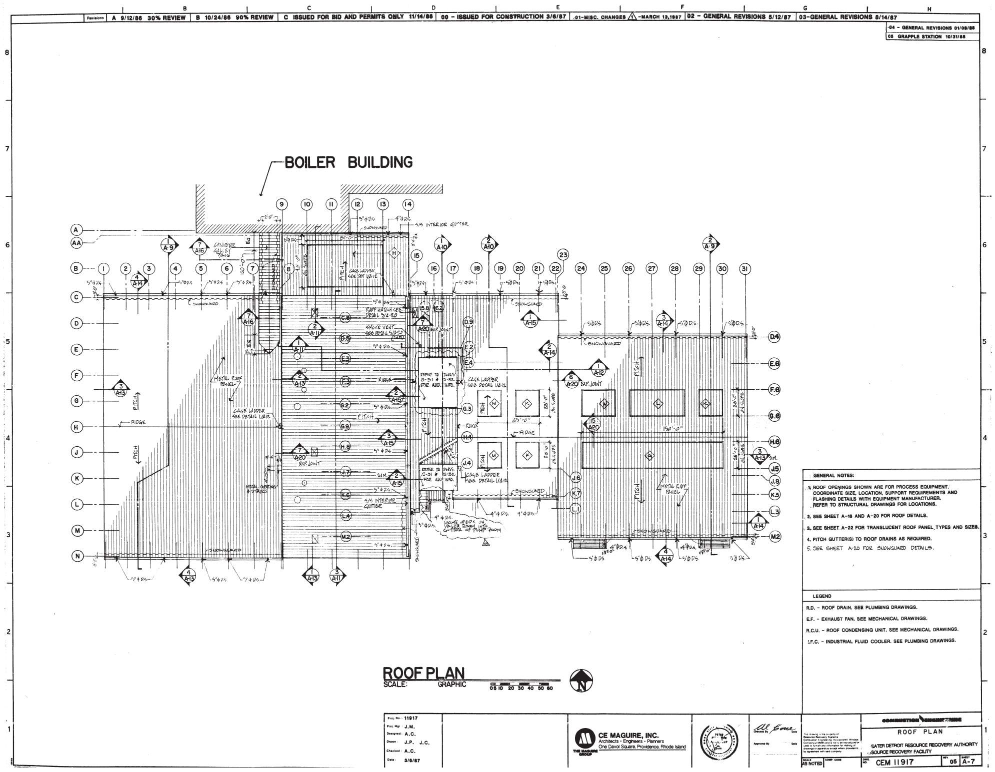


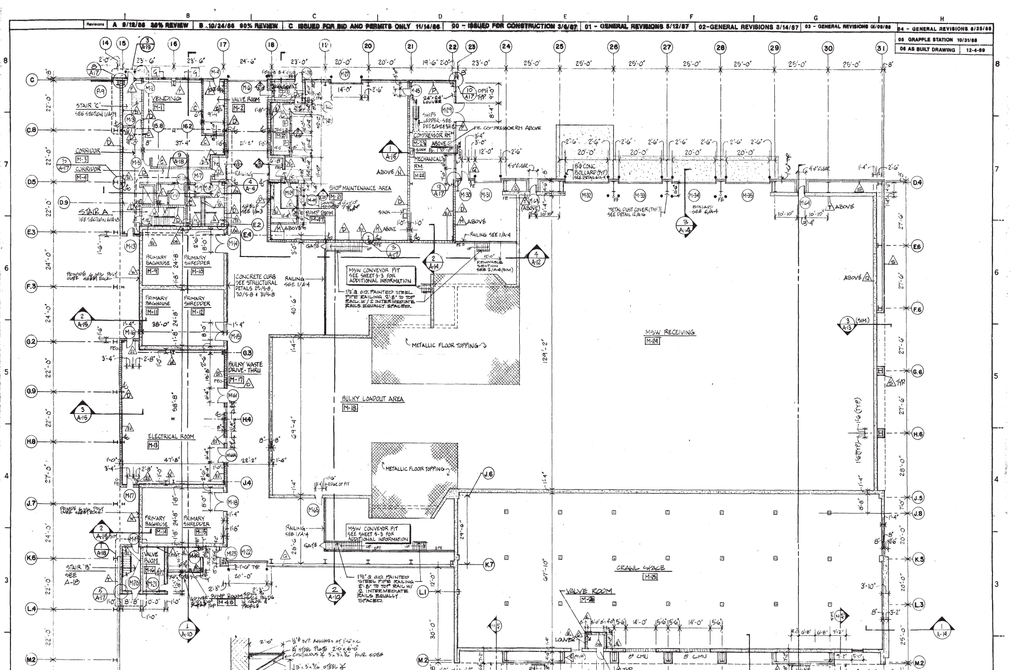


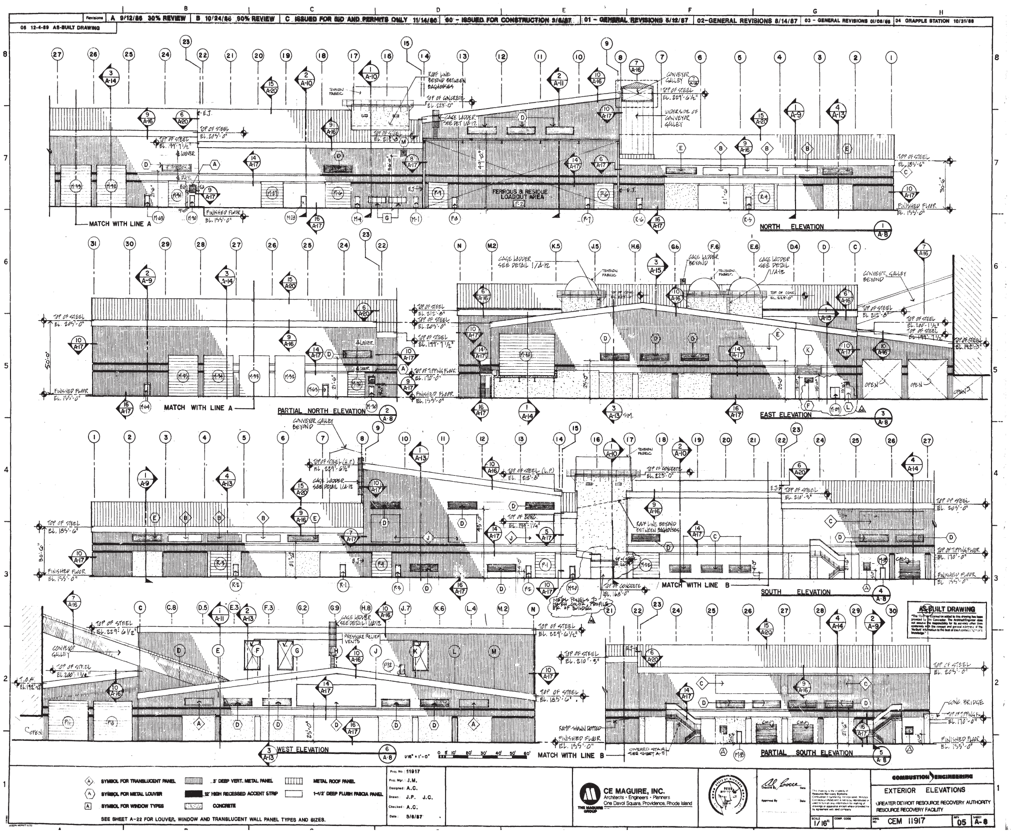


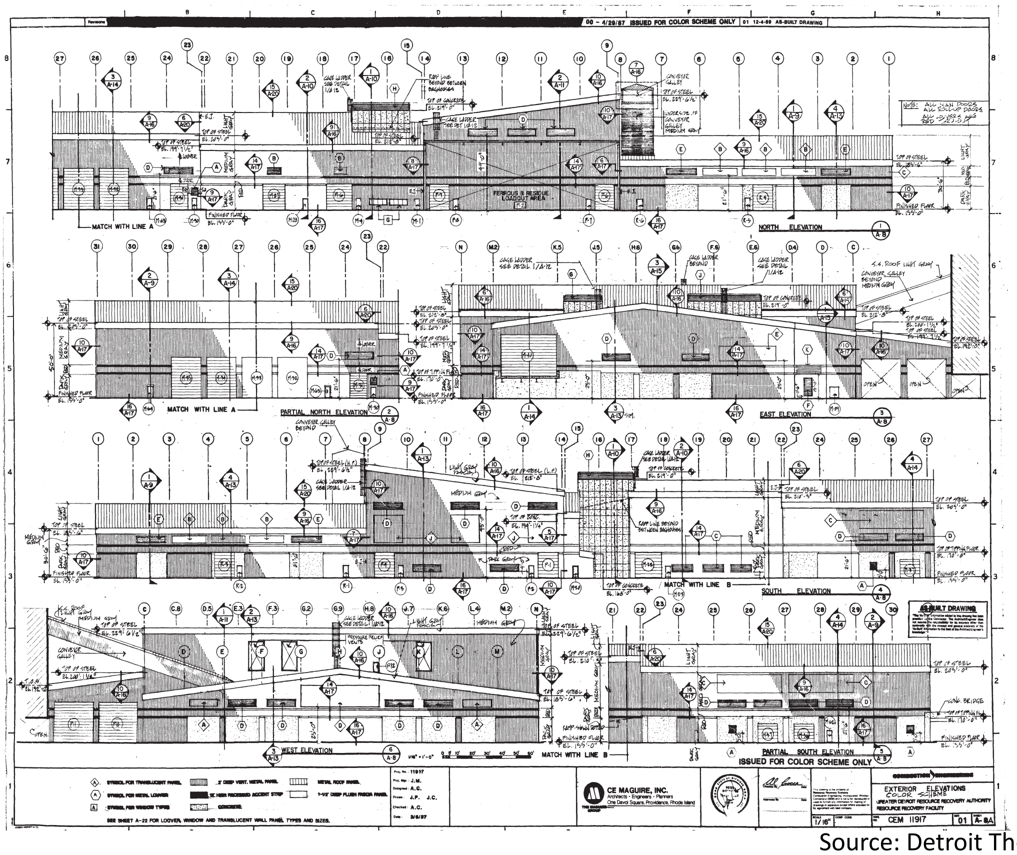
Source: Arte Express, living around Art.
E-mail: info@packardplantproject.com

DETROIT RENEWABLE POWER AREA: INCINERATOR

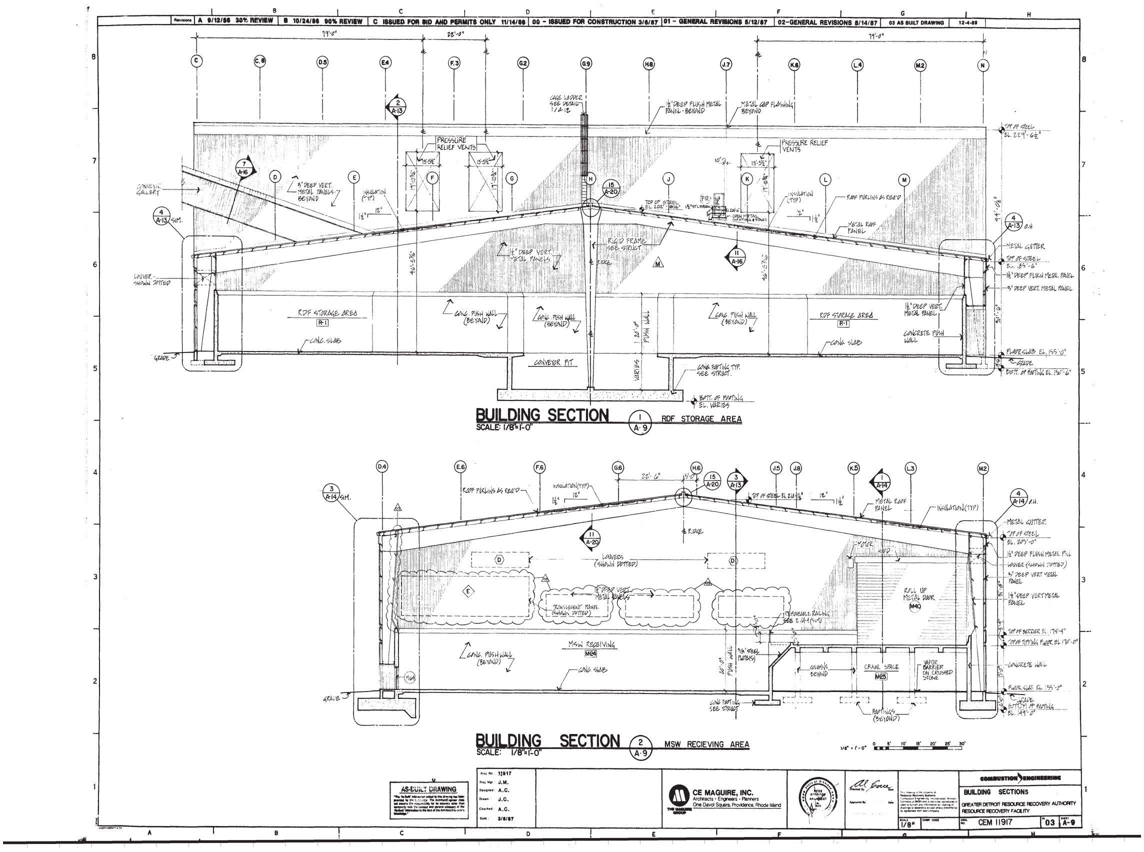


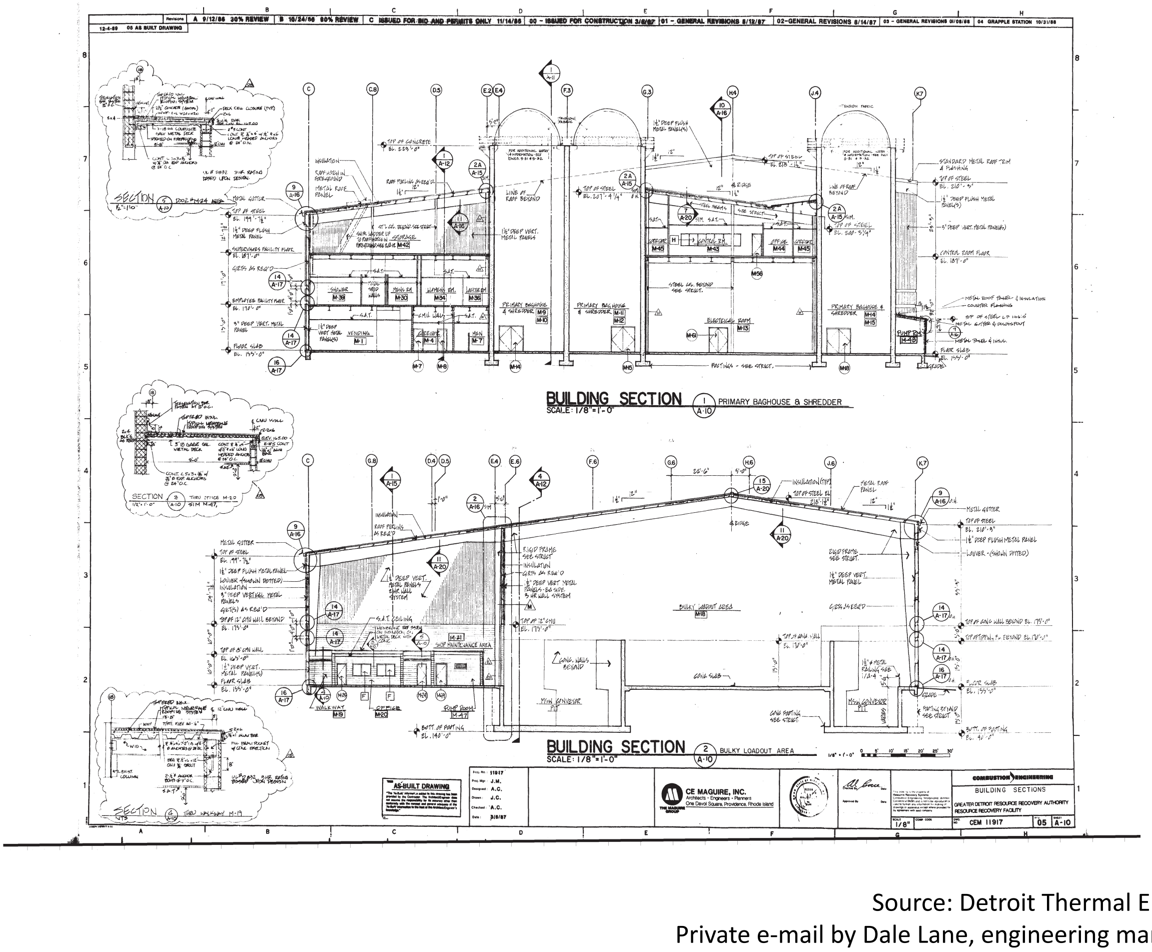






Source: Detroit Thermal Energy
Private e-mail by Dale Lane, engineering manager
E-mail: dlane@detroitthermal.com





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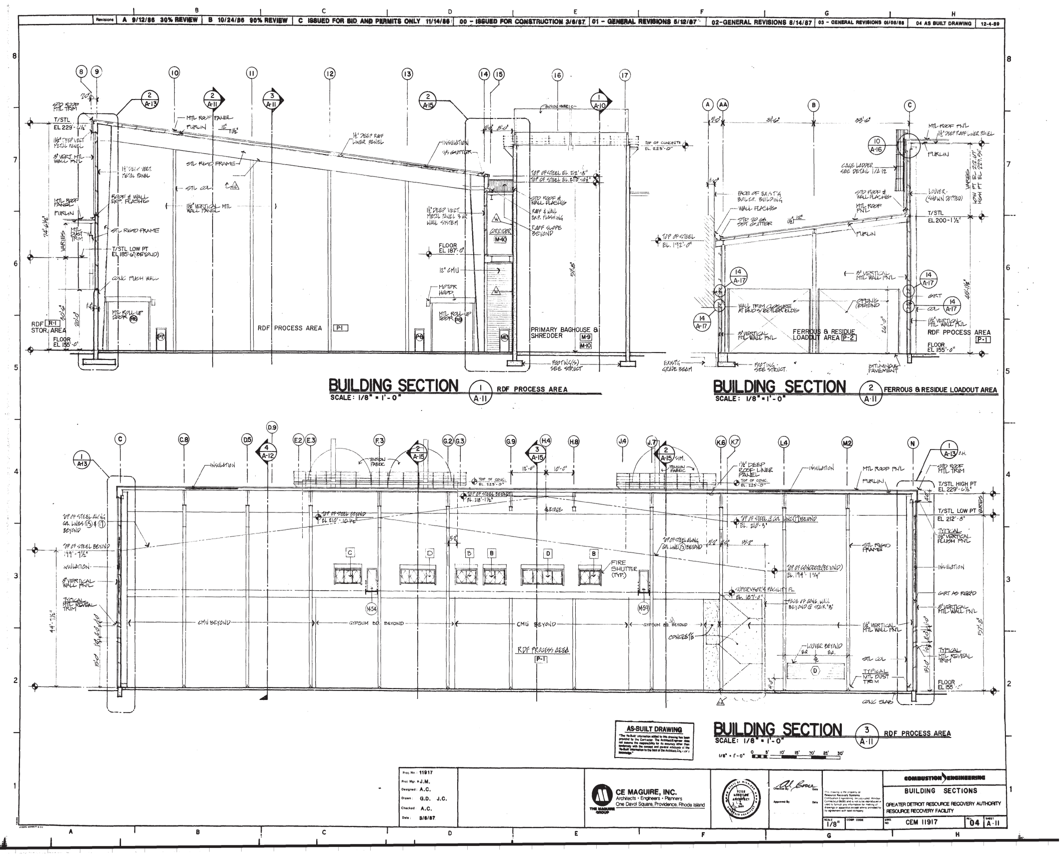

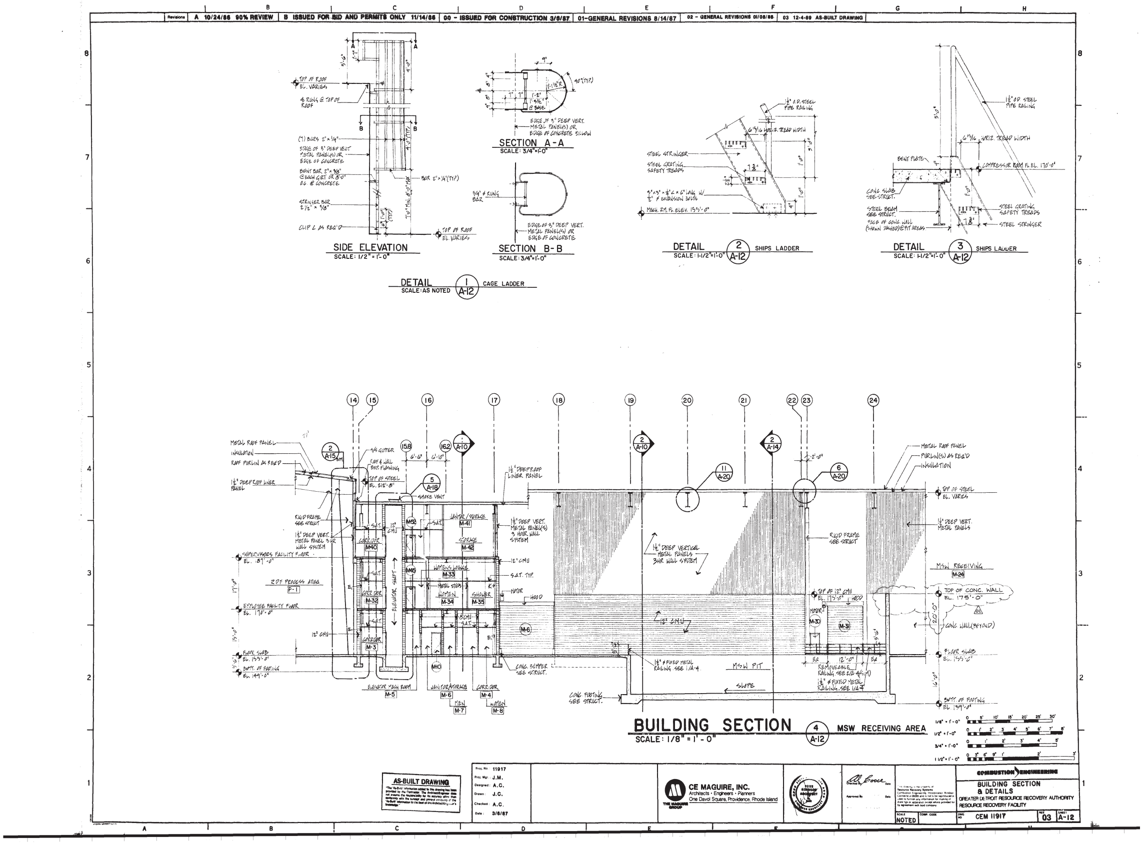

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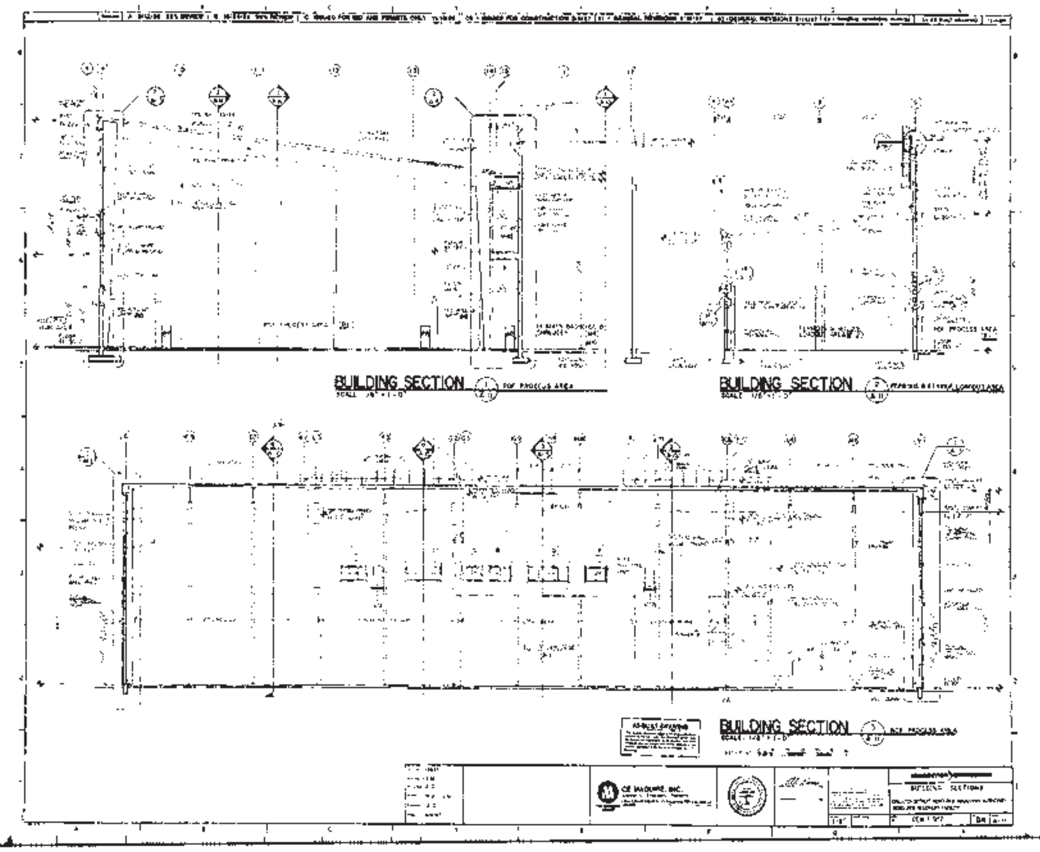

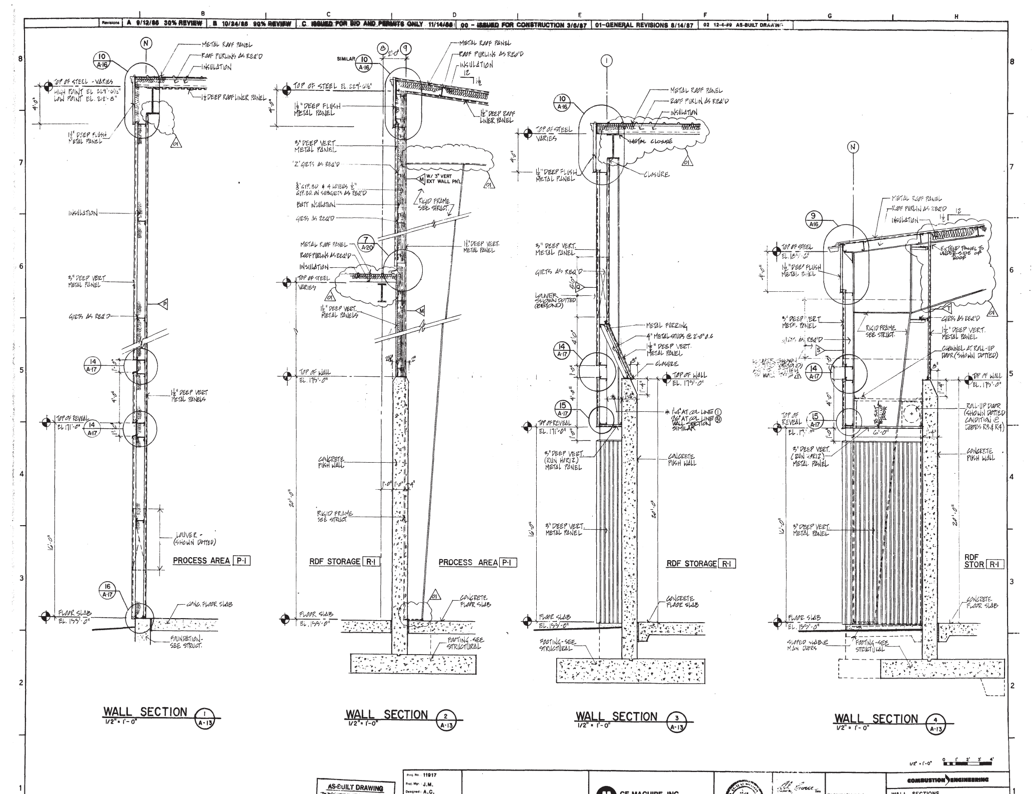

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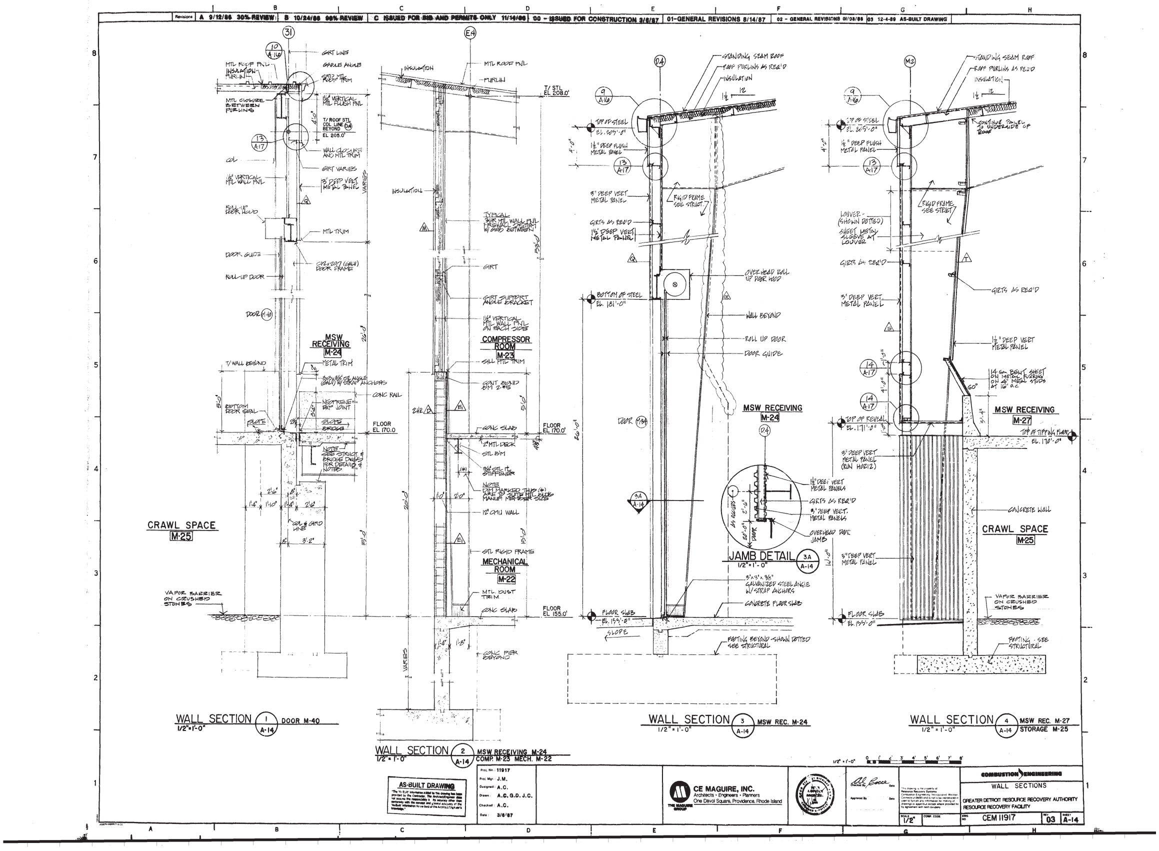
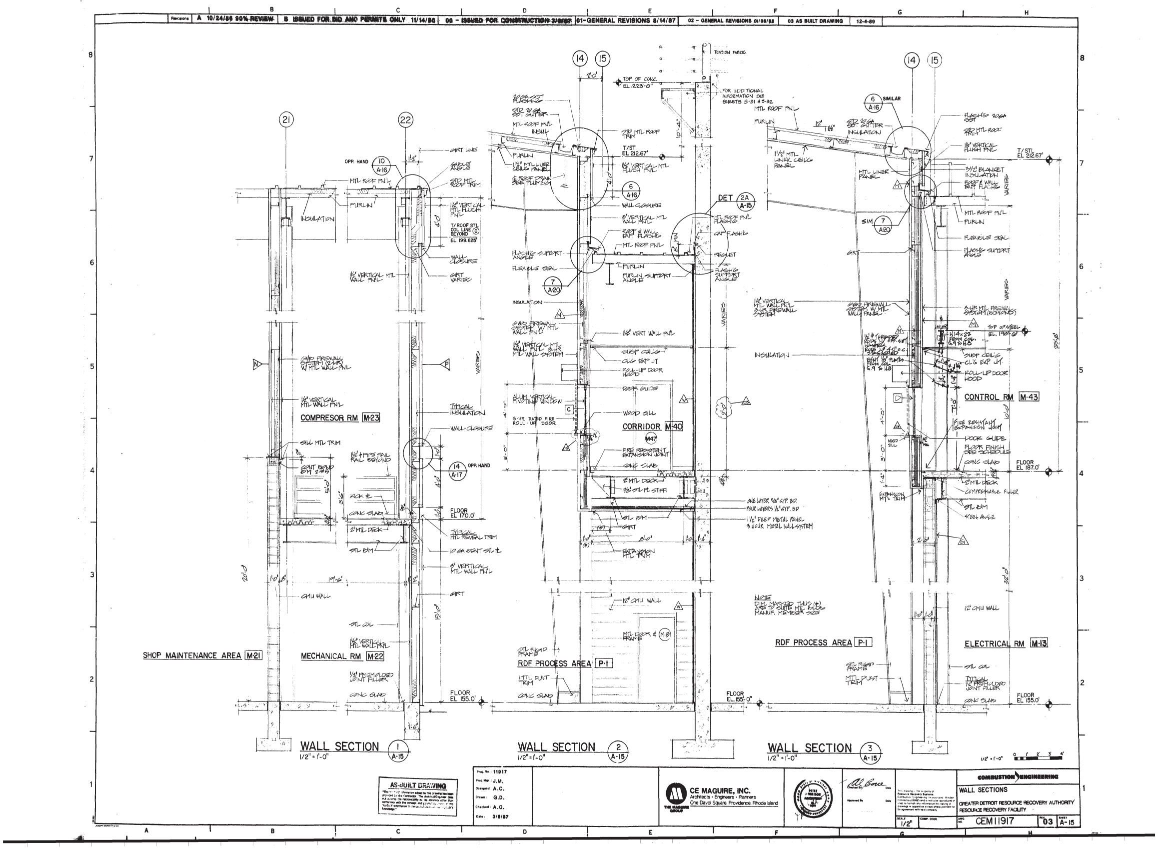


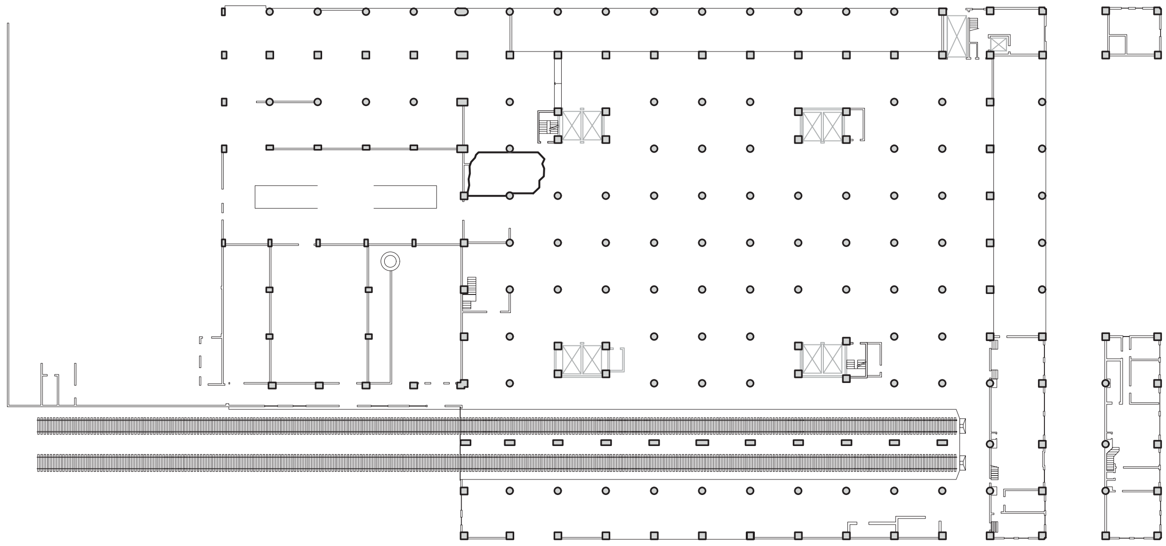


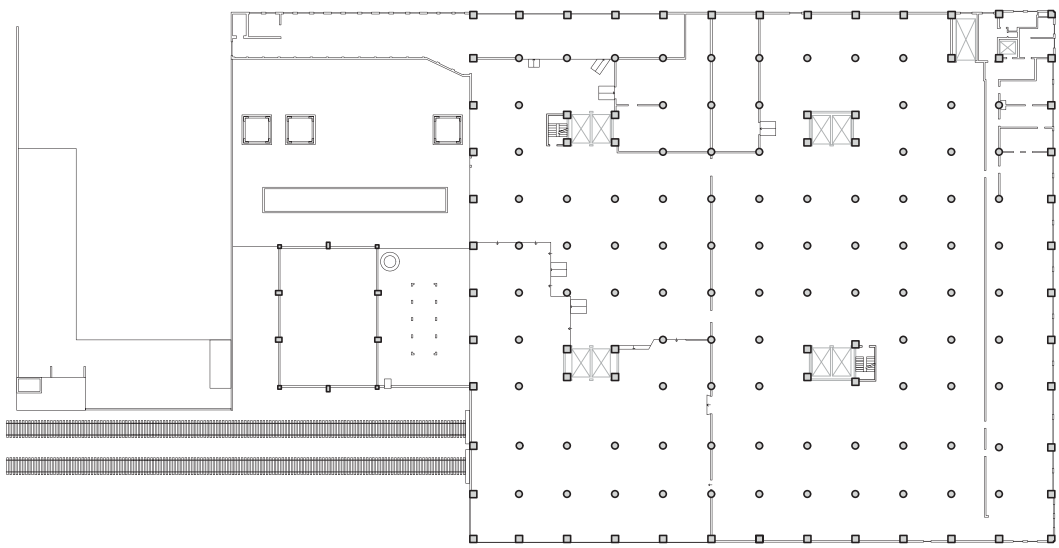
Source: Detroit Thermal Energy
Private e-mail by Dale Lane, engineering manager
E-mail: dlane@detroitthermal.com

3.2.2. CURRENT STATE DRAWINGS

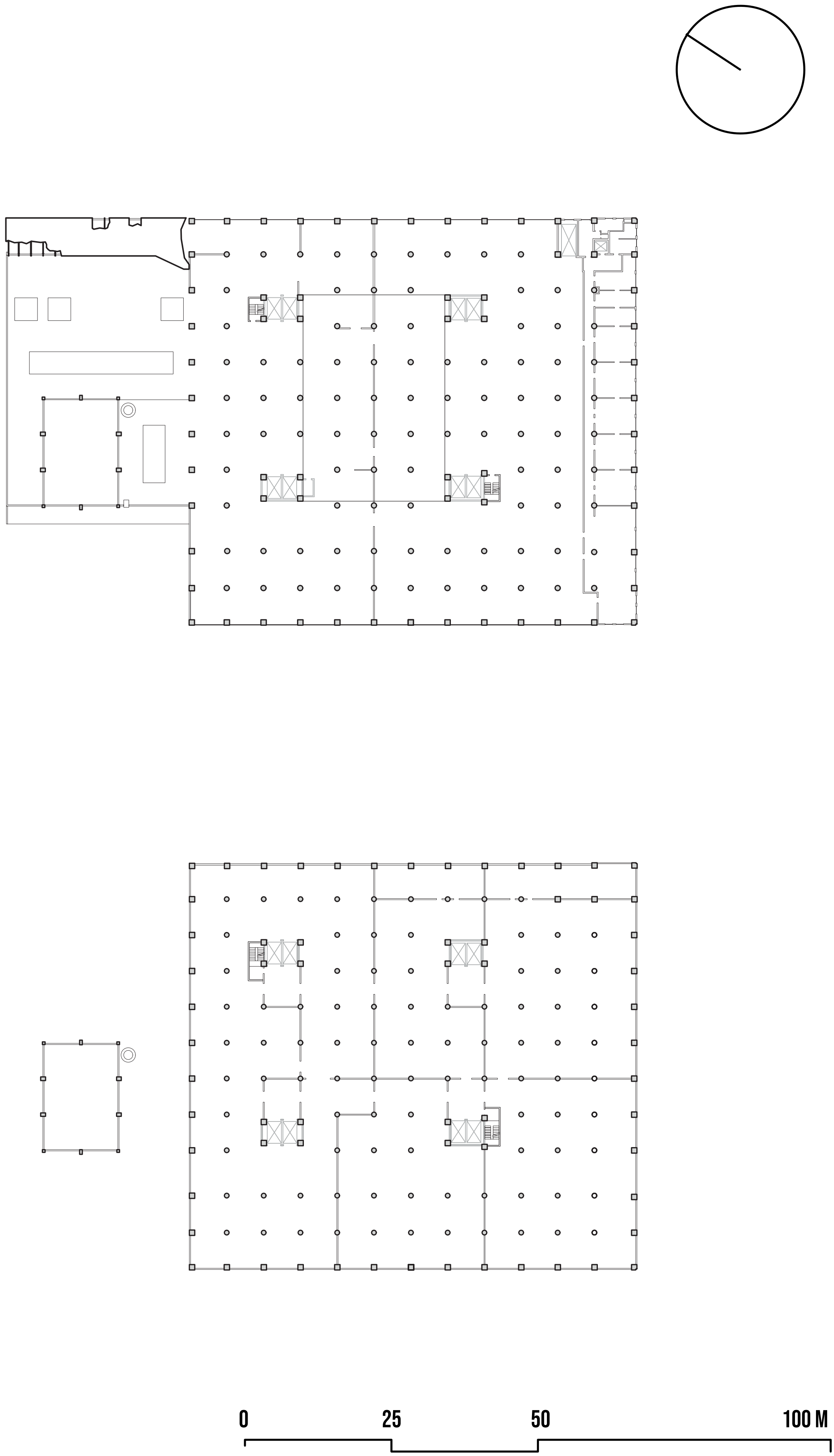
Drawings of the current state of the buildings were needed to have a solid base to start the architecture project.
Sources were quite easy to find for the Warehouse, being that Arte Express (landlord) has many digital channel to connect. For the incinerator was more difficult because this kind of facilities and their plans are hidden to public for public safety reasons. With the help of the chief engineer of Detroit Thermal Energy Dale Lane it was possible to get the drawings, even if they are from 1986 so drawn by hand and re-drawing work was hard also because the American system of measures is very different from the common one.
From sections and elevations it appears that there are many levels on the incinerator roof usable for many activities to reconnect the citizen with the facilities. It's too easy build facilities faraway from people, much harder is connecting the city with them.
Plans on Ferry Street are very static and it's necessary a new design that can move the view of the building, maybe with holes, terraces, etc..
In the following pages there are many of the drawings of buildings, not all because some of them were repetitive.

1950 EAST FERRY ST





Drawings redrawn and adjusted with Autodesk AutoCAD by graduate.



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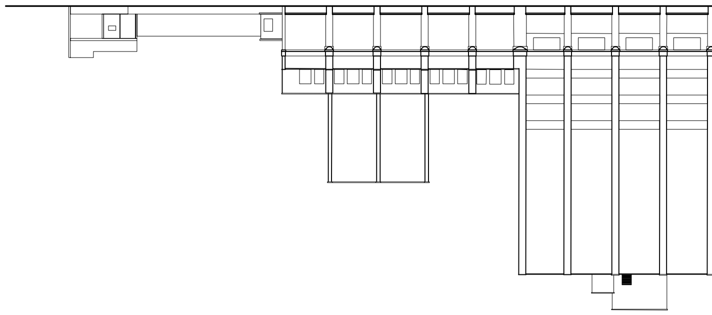
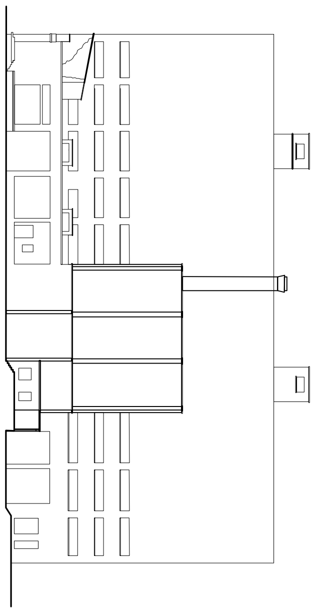
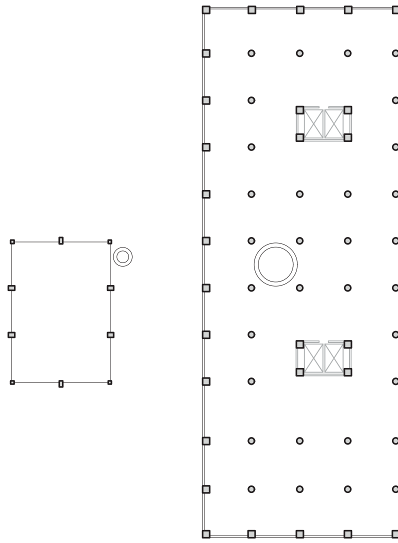
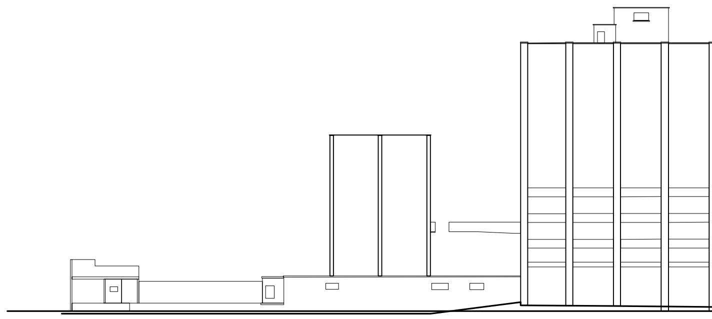
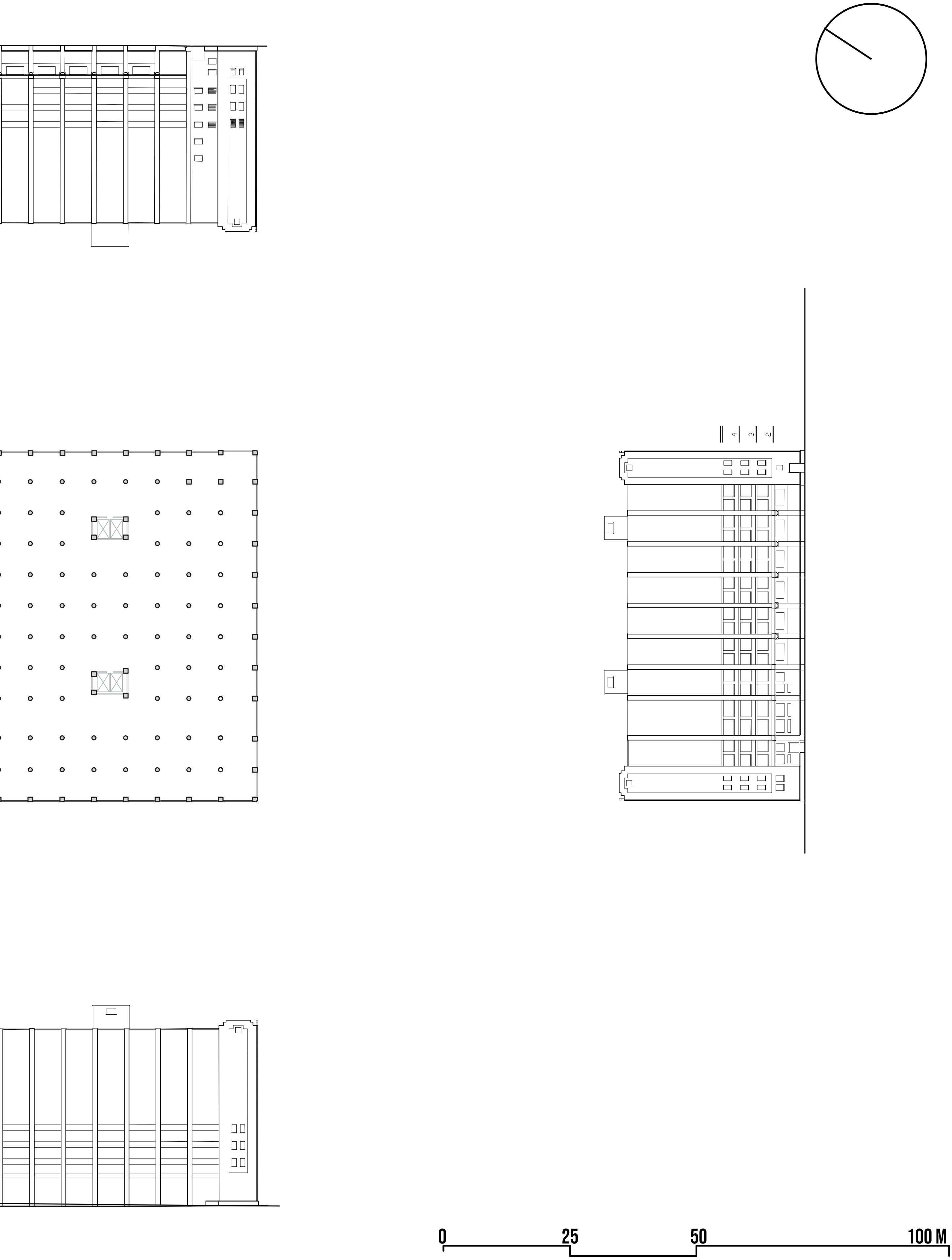




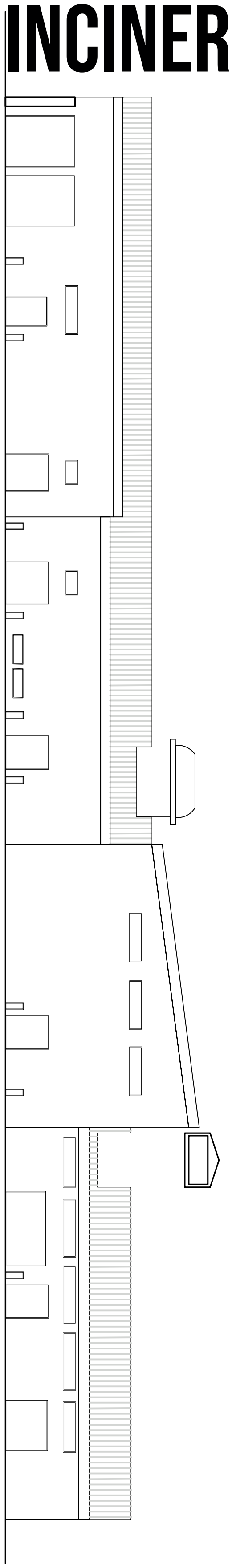




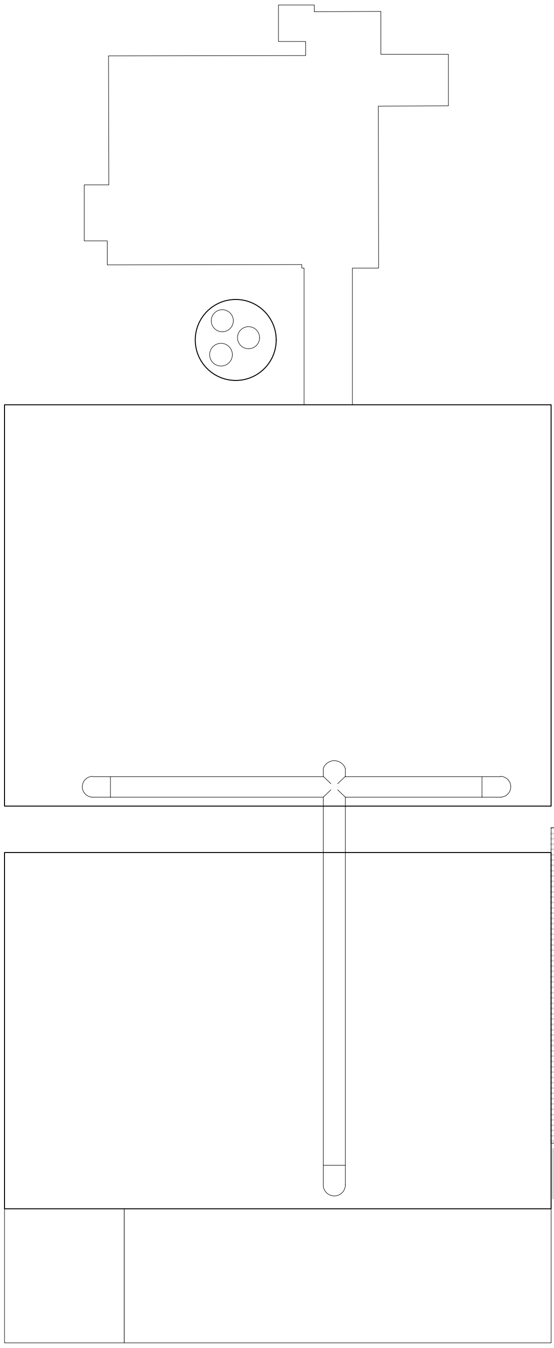


Drawings redrawn and adjusted with Autodesk AutoCAD by graduate.

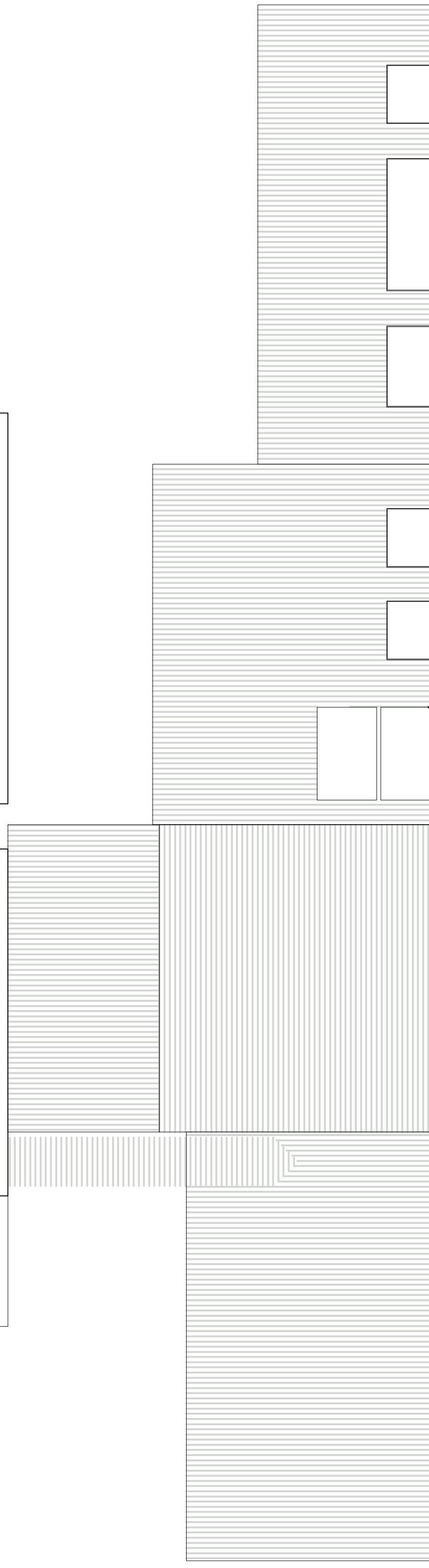
DETROIT RENEWABLE POWER AREA: INCINERATOR. ROOFPLAN & ELEVATION

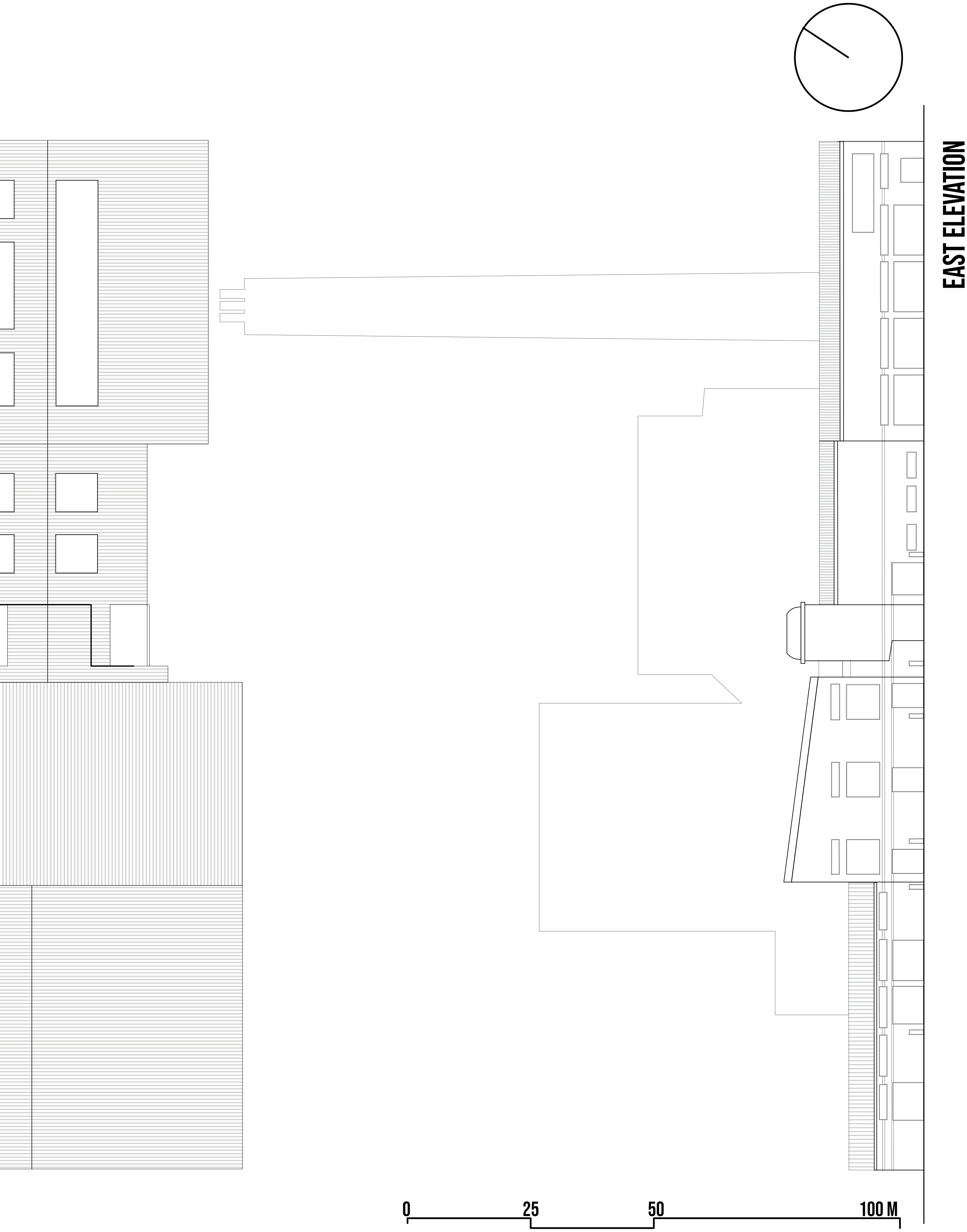


WEST ELEVATION



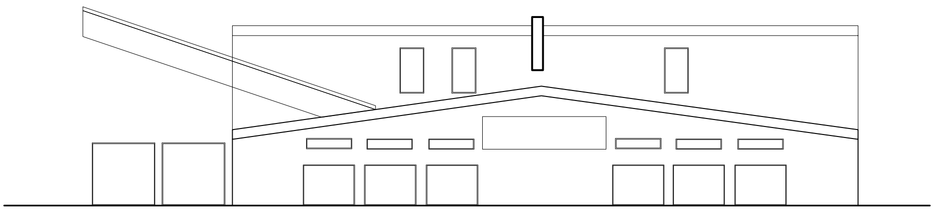
ROOF PLAN



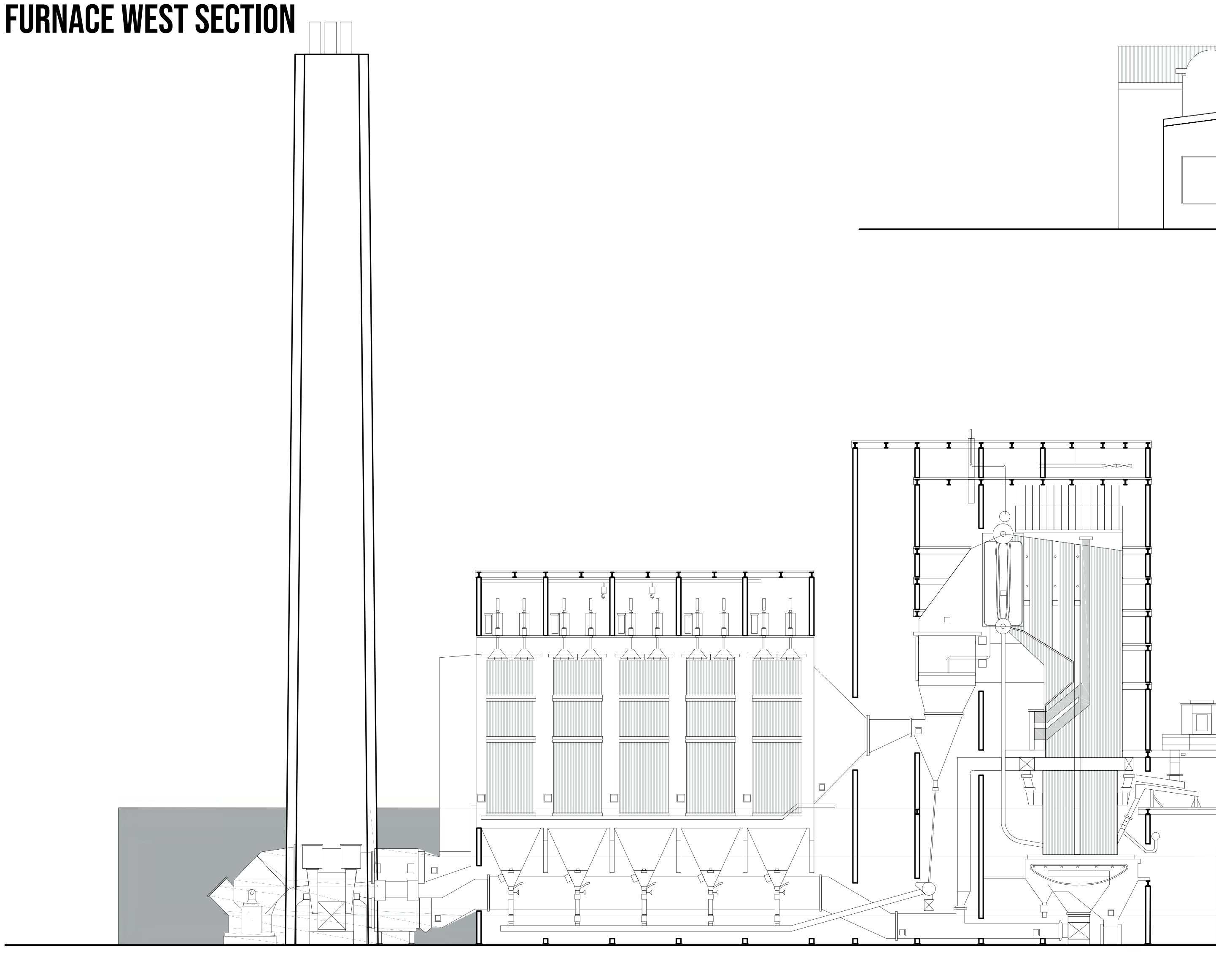


Drawings redrawn and adjusted with Autodesk AutoCAD by graduate.

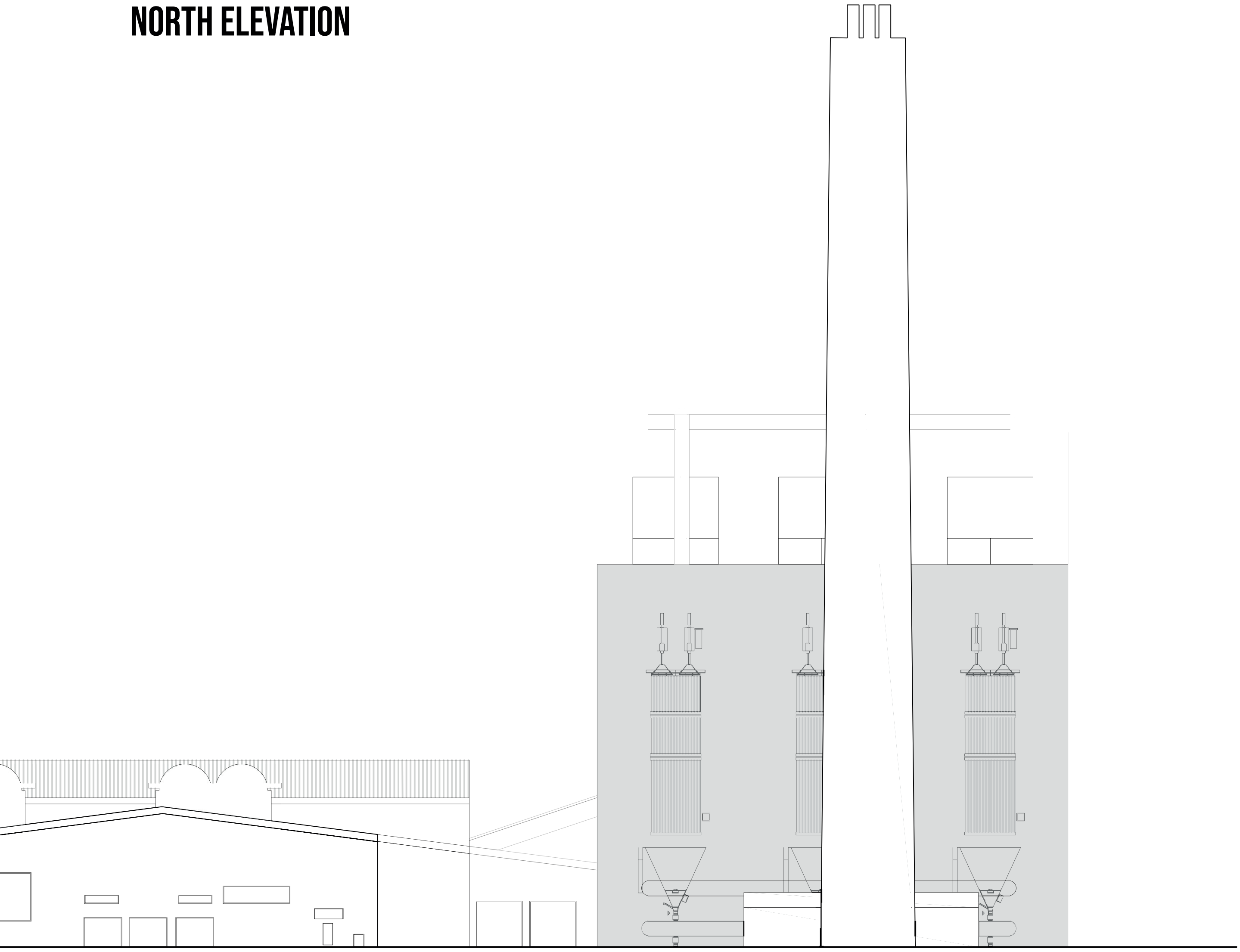
PROCESSING BUILDING SOUTH ELEVATION

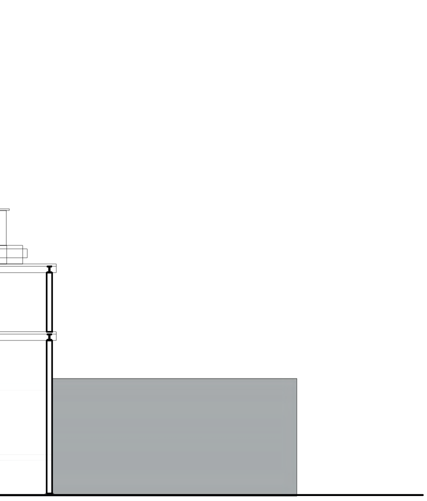


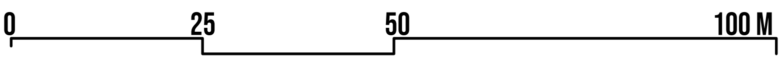
FURNACE WEST SECTION



NORTH ELEVATION

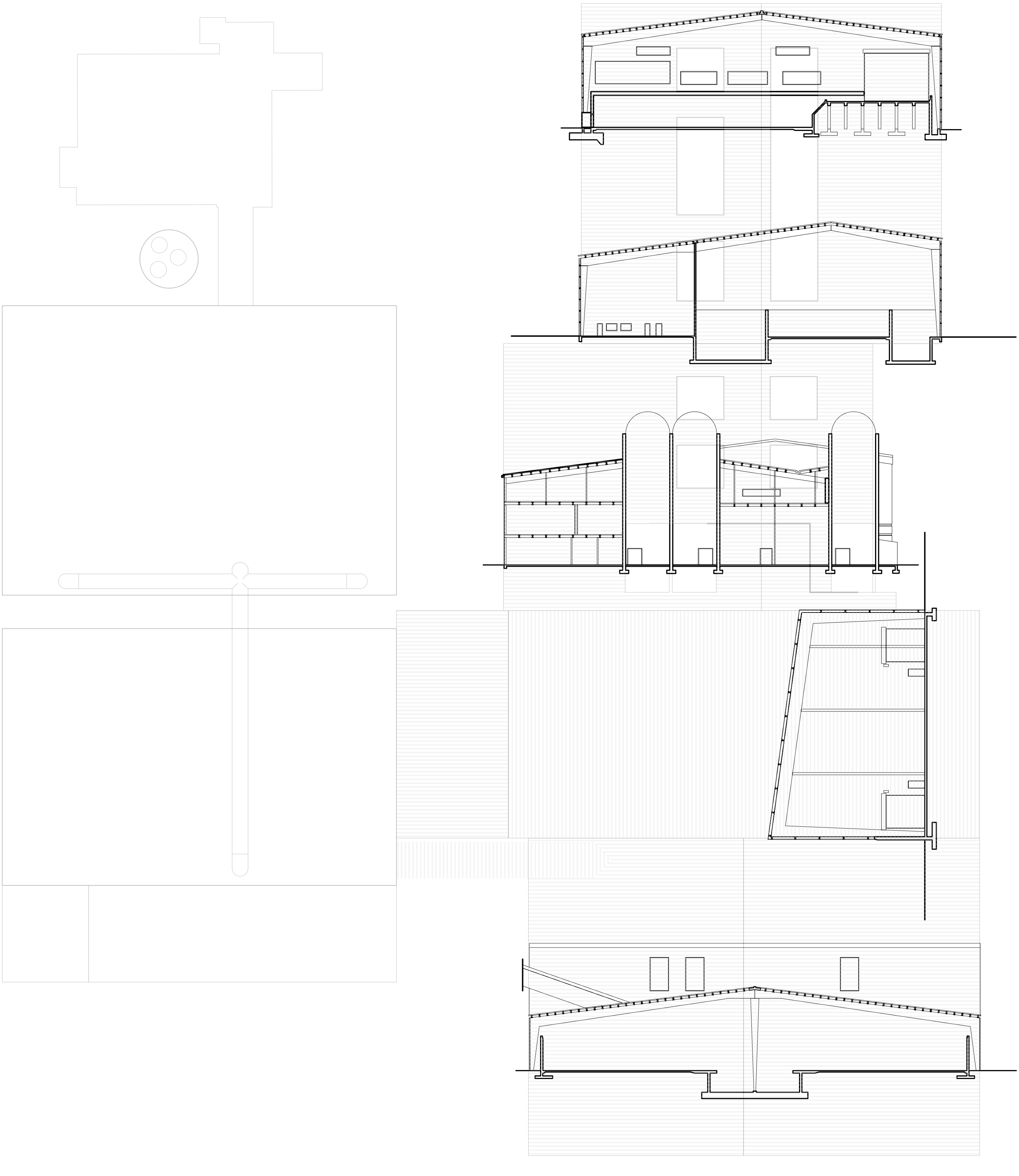


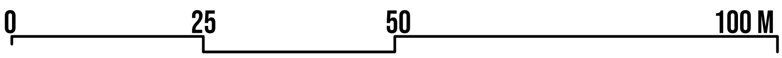




Drawings redrawn and adjusted with Autodesk AutoCAD by graduate.

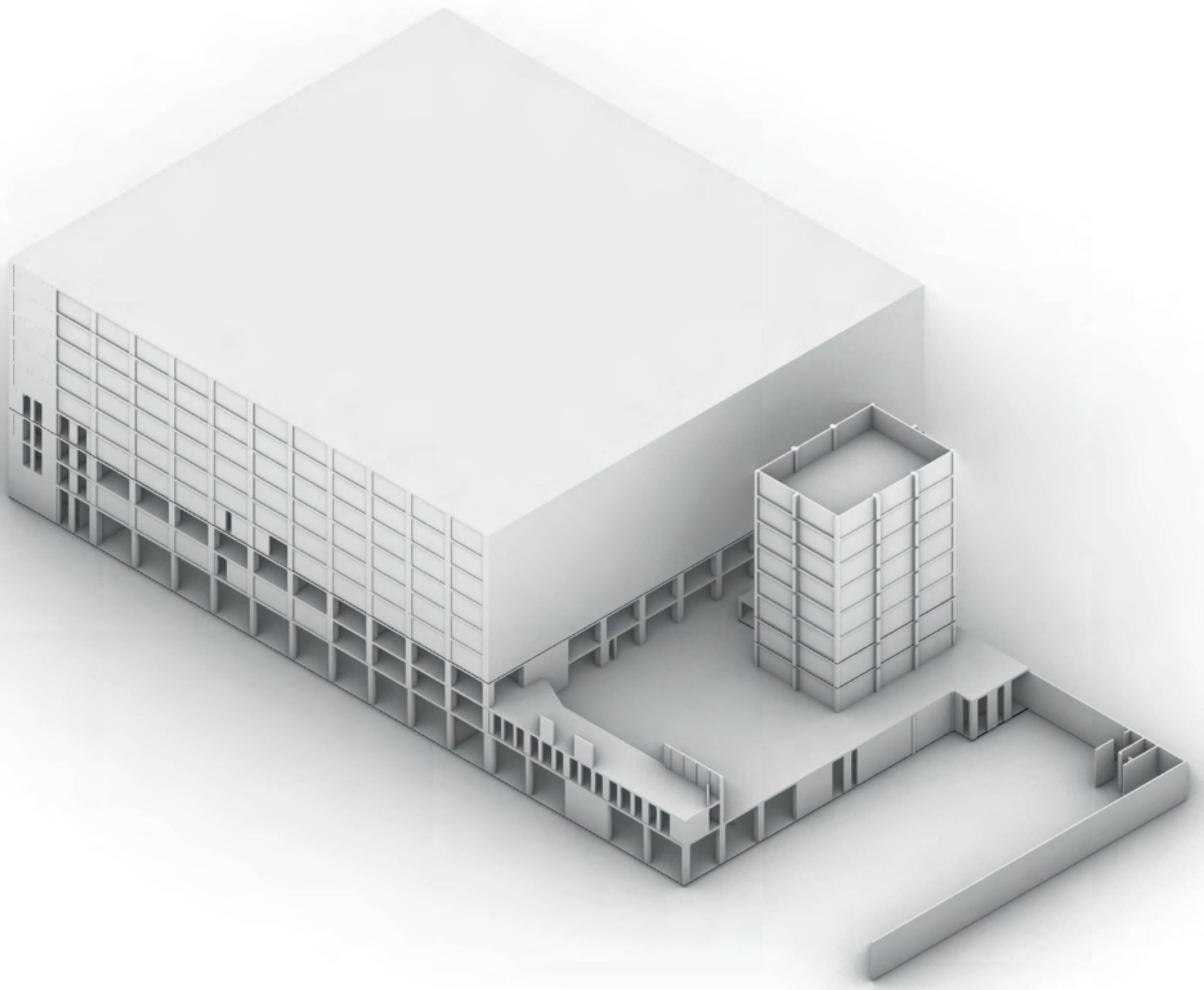
PROCESSING BUILDING SECTIONS





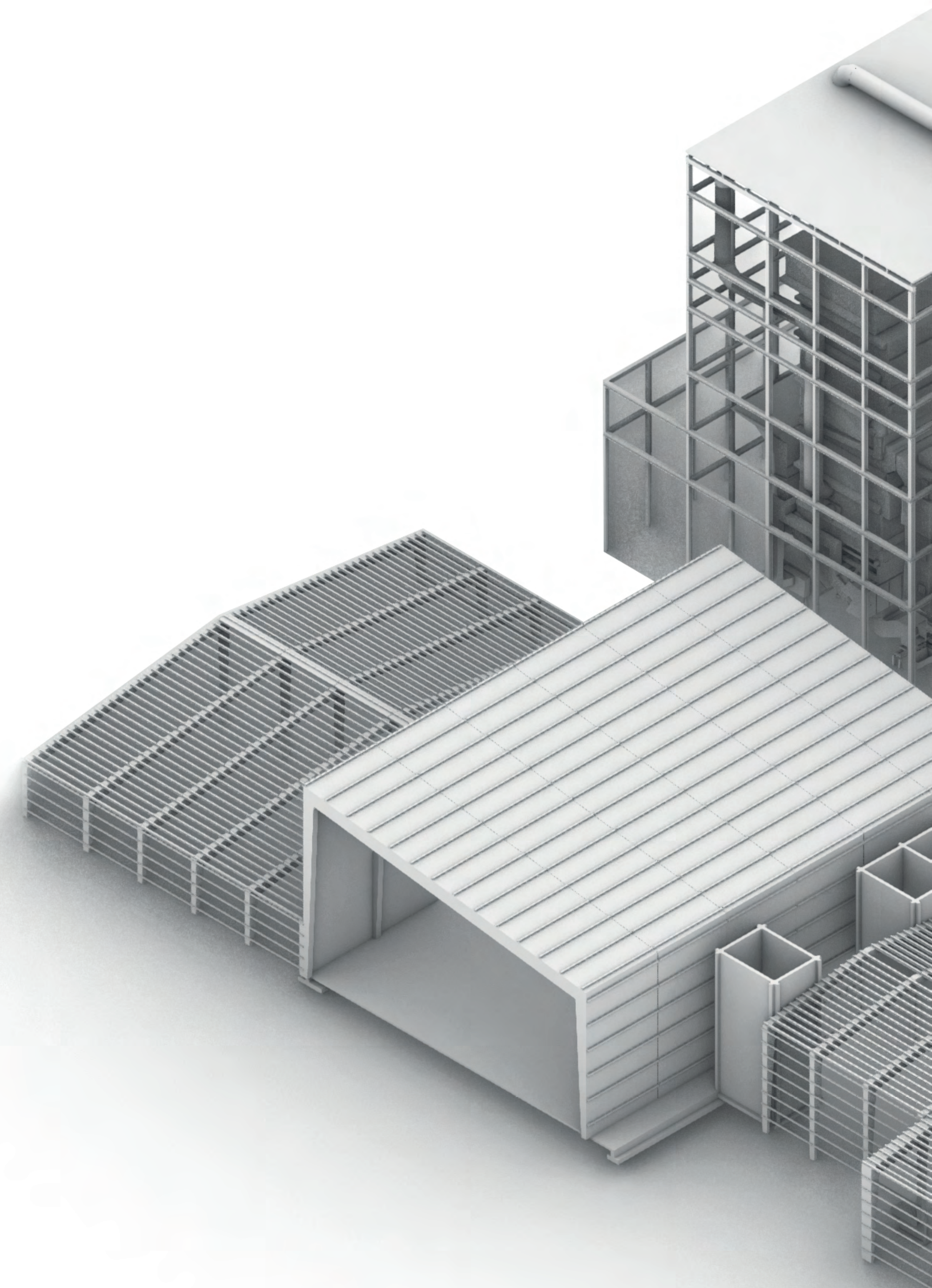
Drawings redrawn and adjusted with Autodesk AutoCAD by graduate.

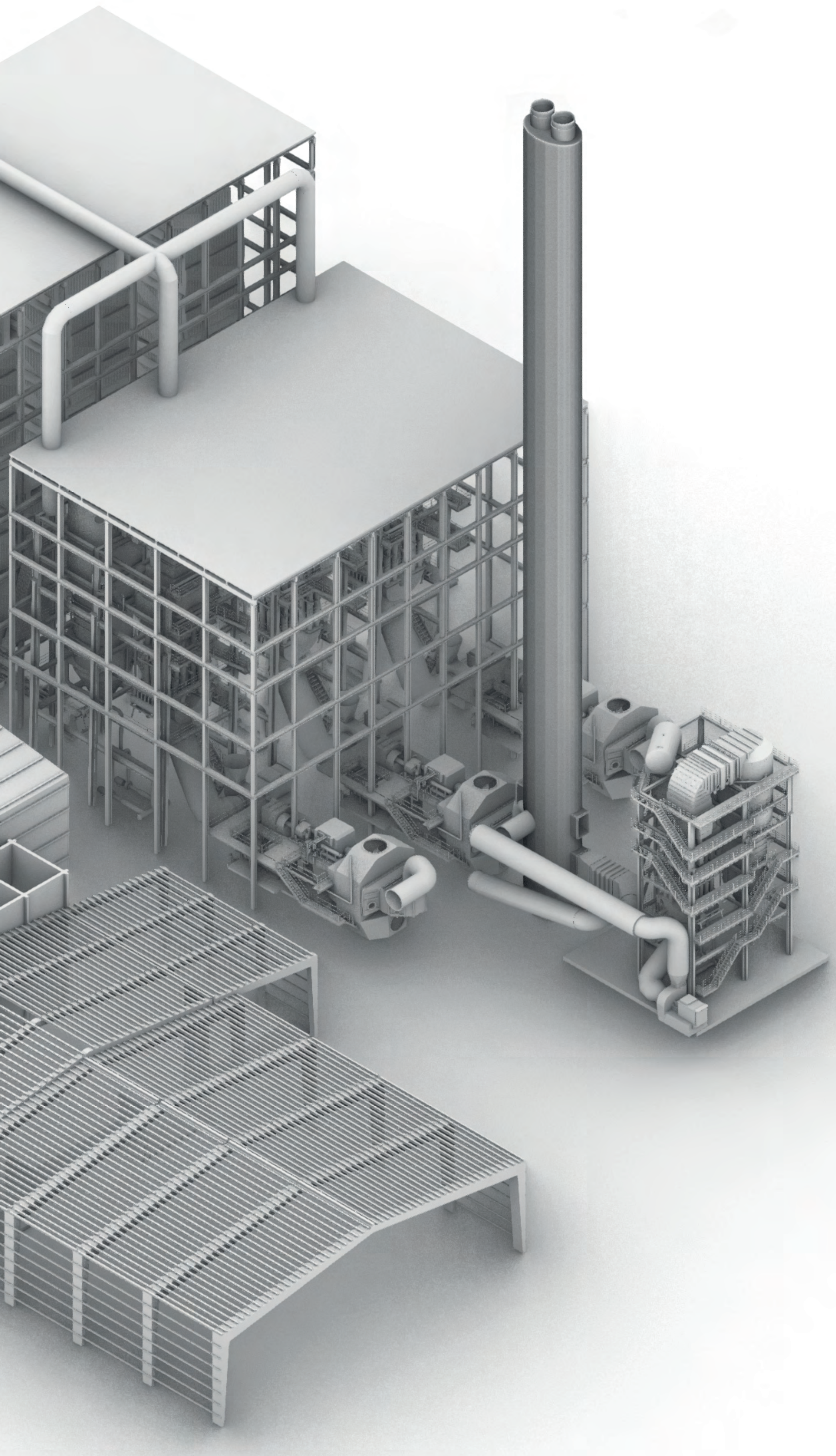
3.2.3. CURRENT STATE 3D MODEL



1921 East Ferry St. The Grand Trunk Warehouse & Cold Storage in Poletown, Detroit. 3d model

VOLUME STRUCTURE CURRENT STATE (FROM 1986)

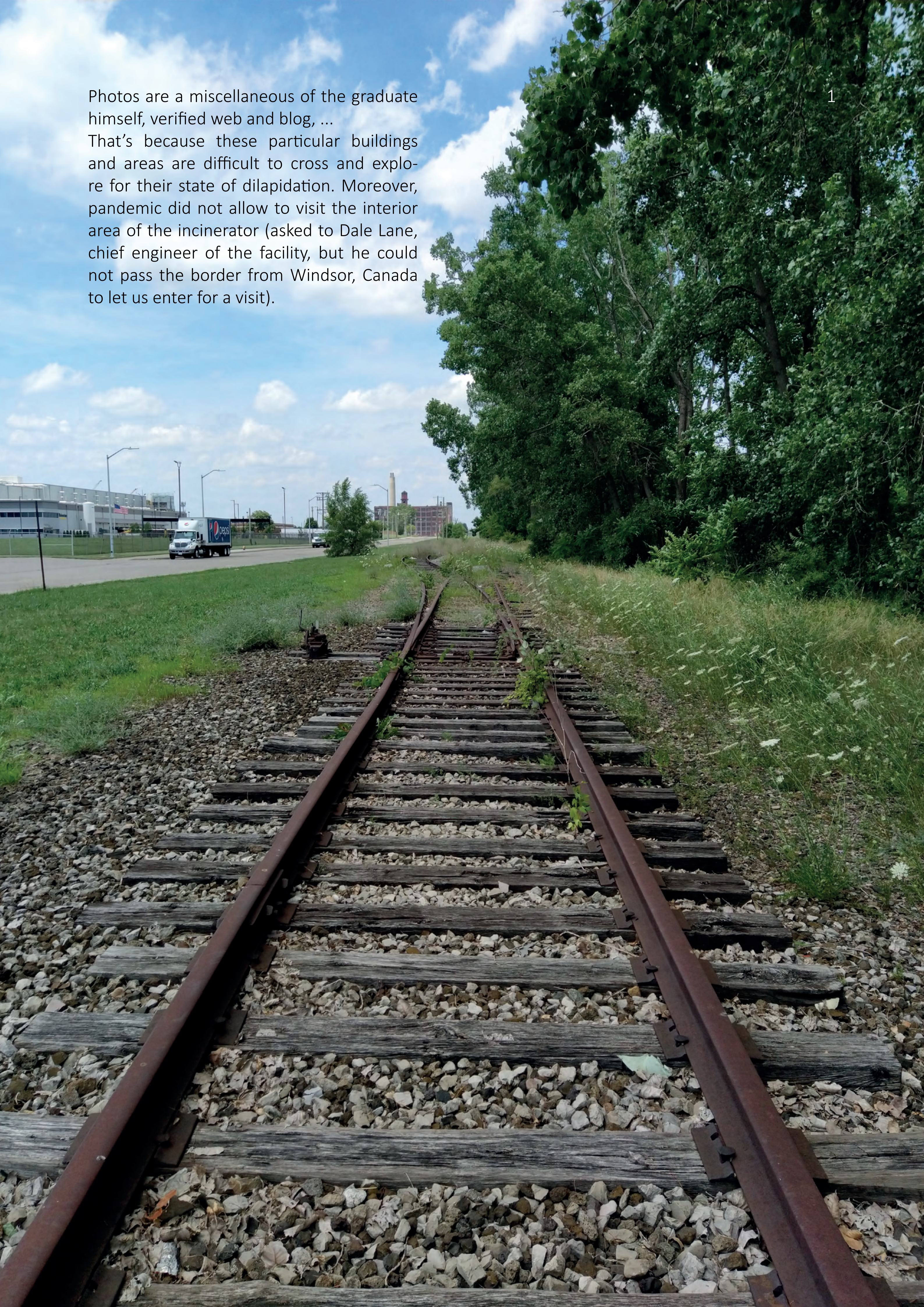




Detroit Renewable Power Plant, 3d model of the structure.

3.2.4. PHOTO SURVEY

Photos are a miscellaneous of the graduate himself, verified web and blog, ...
That's because these particular buildings and areas are difficult to cross and explore for their state of dilapidation. Moreover, pandemic did not allow to visit the interior area of the incinerator (asked to Dale Lane, chief engineer of the facility, but he could not pass the border from Windsor, Canada to let us enter for a visit).



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313-963-1001
GEORGE FLOYD

5


NDR
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FOR SALE
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NewDetroitRealty.com
Pierre LeBlanc · Broker

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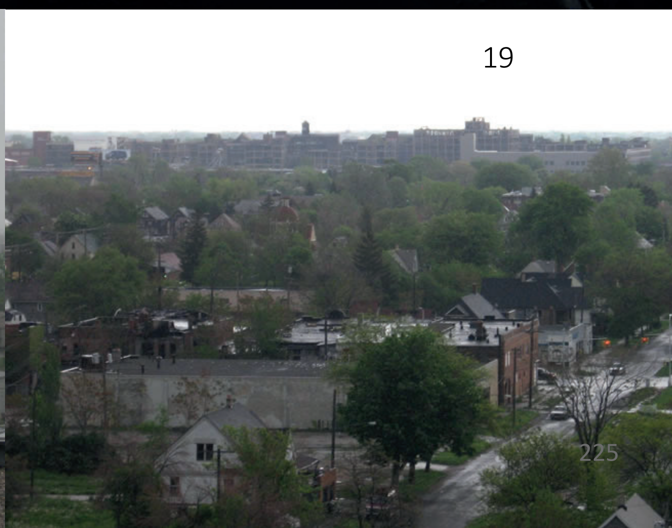

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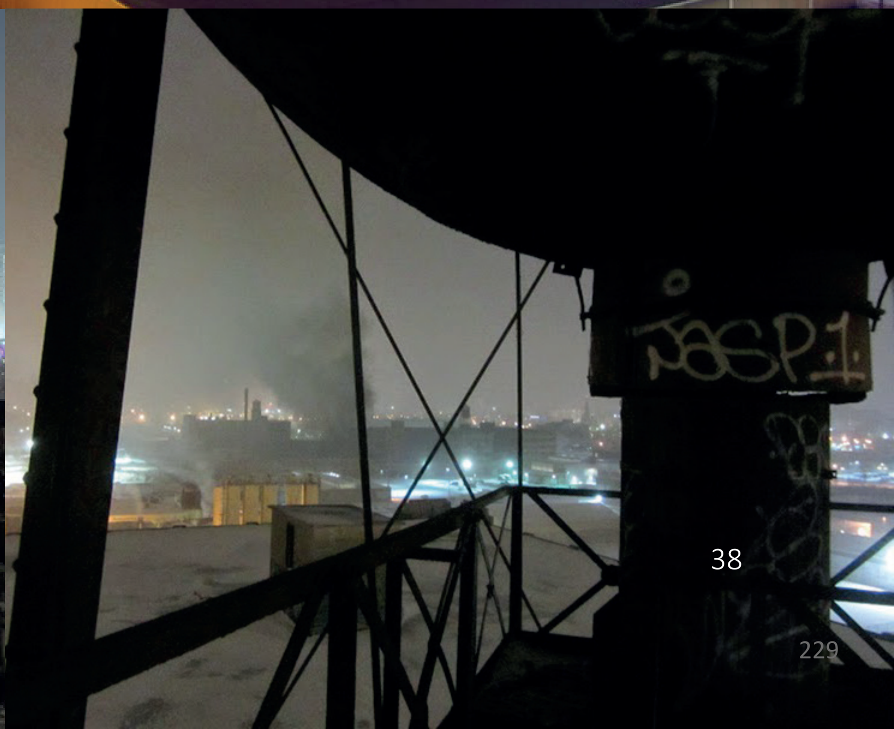

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CEI CUSTOM ECOLOGY INC.
Custom Ecology
RAILROAD CROSSING
STOP ON RED SIGNAL

40

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44

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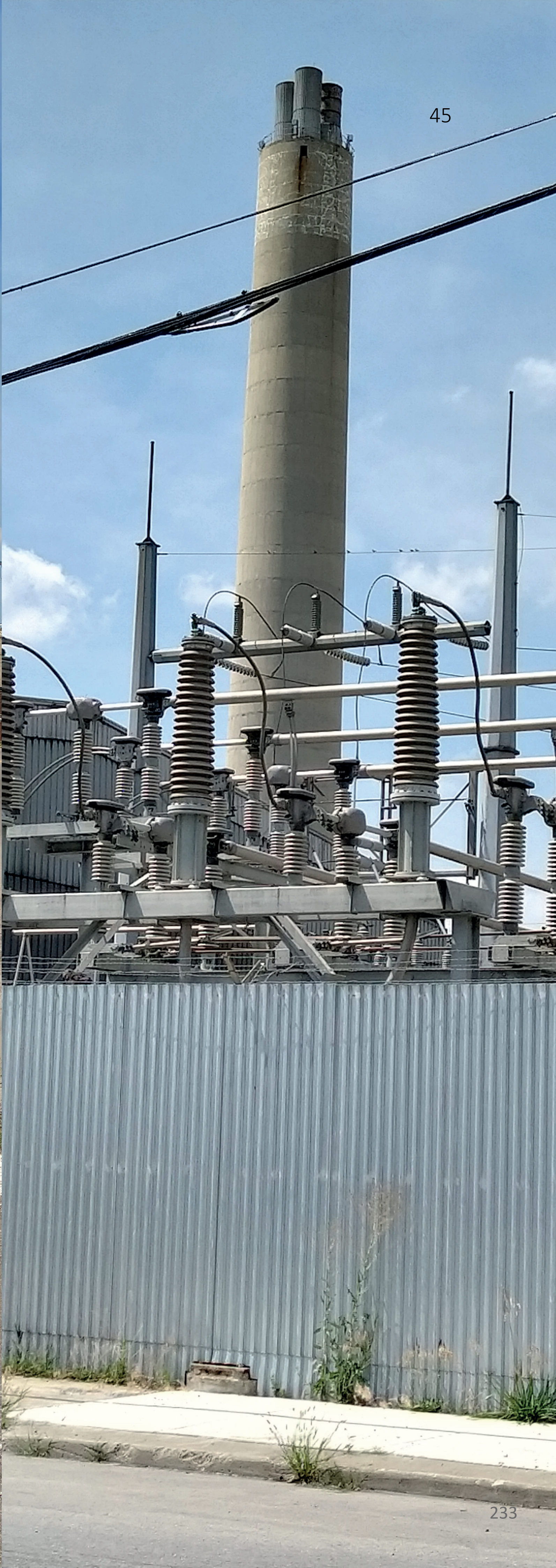

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Wallside Windows
wallside.com
MADE IN MICHIGAN FOR 75 YEARS
LAMAR

Photo survey legend

1. Rails close to Detroit Renewable Power Area.
Courtesy of Francesca Fera personal archive.

2. View of Grand Trunck Warehouse, 1921 E Ferry Street.
Courtesy of Francesca Fera personal archive.

3. View of Grand Trunck Warehouse, 1921 E Ferry Street.
Courtesy of Francesca Fera personal archive.

4. View of Grand Trunck Warehouse, 1921 E Ferry Street.
Courtesy of Francesca Fera personal archive.

5. View of Grand Trunck Warehouse, 1921 E Ferry Street.
Courtesy of Francesca Fera personal archive.

6. View of Grand Trunck Warehouse, 1921 E Ferry Street.
Courtesy of Francesca Fera personal archive.

7. View of Grand Trunck Warehouse, 1921 E Ferry Street.
Courtesy of Francesca Fera personal archive.

8. View of Grand Trunck Warehouse, 1921 E Ferry Street.
Courtesy of Francesca Fera personal archive.

9. Back of the warehouse.
Source: Marathon Pundit blogspot. https://marathonpundit.blogspot.com/2015/09/photos-detroits-abandoned-grand-trunk.html

10. View of the old lettering and roof water tank.
Source: Nailhed.com . https://www.nailhed.com/2014/11/endurance-test.html

11. Ground floor view.
Source: Nailhed.com . https://www.nailhed.com/2014/11/endurance-test.html

12. View from the current terrace.
Source: Nailhed.com . https://www.nailhed.com/2014/11/endurance-test.html

13. Interiors.
Source: Marathon Pundit blogspot. https://marathonpundit.blogspot.com/2015/09/photos-detroits-abandoned-grand-trunk.html

14. Interiors.
Source: Marathon Pundit blogspot. https://marathonpundit.blogspot.com/2015/09/photos-detroits-abandoned-grand-trunk.html

15. Interiors.
Source: Nailhed.com . https://www.nailhed.com/2014/11/endurance-test.html

16. Interiors: concrete pillars structure.
Source: Nailhed.com . https://www.nailhed.com/2014/11/endurance-test.html

17. View from the current terrace.
Source: Nailhed.com . https://www.nailhed.com/2014/11/endurance-test.html

18. View from Grand Trunk Warehouse roof.
Source: Nailhed.com . https://www.nailhed.com/2014/11/endurance-test.html

19. View from Grand Trunk Warehouse roof.
Source: Nailhed.com . https://www.nailhed.com/2014/11/endurance-test.html

20. View on incinerator. Grand Trunk Warehouse.
Source: Nailhed.com . https://www.nailhed.com/2014/11/endurance-test.html

21. View from the current terrace.
Source: Nailhed.com . https://www.nailhed.com/2014/11/endurance-test.html

22. View from Grand Trunk Warehouse roof.
Source: Nailhed.com . https://www.nailhed.com/2014/11/endurance-test.html

23. Hole in the wall. Grand Trunk Warehouse.
Source: Marathon Pundit blogspot. https://marathonpundit.blogspot.com/2015/09/photos-detroits-abandoned-grand-trunk.html

24. View from the current terrace.
Source: Nailhed.com . https://www.nailhed.com/2014/11/endurance-test.html

25. View from the current terrace.
Source: Nailhed.com . https://www.nailhed.com/2014/11/endurance-test.html

26. View from the current terrace.
Source: Nailhed.com . https://www.nailhed.com/2014/11/endurance-test.html

27. Stairs. Grand Trunk Warehouse.
Source: Nailhed.com . https://www.nailhed.com/2014/11/endurance-test.html

28. Interior view.
Source: Nailhed.com . https://www.nailhed.com/2014/11/endurance-test.html

29. Porch view.
Source: Nailhed.com . https://www.nailhed.com/2014/11/endurance-test.html

30. View on Joe Louis Greenway. Grand Trunk Warehouse.
Source: Nailhed.com . https://www.nailhed.com/2014/11/endurance-test.html

31. View on Joe Louis Greenway. Grand Trunk Warehouse.
Source: Nailhed.com . https://www.nailhed.com/2014/11/endurance-test.html

32. View of the roof, Grand Trunk Warehouse.
Source: Nailhed.com . https://www.nailhed.com/2014/11/endurance-test.html

33. View from the roof, Grand Trunk Warehouse.
Source: Nailhed.com . https://www.nailhed.com/2014/11/endurance-test.html

34. Interior view, warehouse.
Source: Nailhed.com . https://www.nailhed.com/2014/11/endurance-test.html

35. View on U.S Ecology from the roof, Grand Trunk Warehouse.
Source: Nailhed.com . https://www.nailhed.com/2014/11/endurance-test.html

36. View of the roof, Grand Trunk Warehouse.
Source: Nailhed.com . https://www.nailhed.com/2014/11/endurance-test.html

37. View on Downtown Detroit from the roof, Grand Trunk Warehouse.
Source: Nailhed.com . https://www.nailhed.com/2014/11/endurance-test.html

38. Water tank, roof of Grand Trunk Warehouse.
Source: Nailhed.com . https://www.nailhed.com/2014/11/endurance-test.html

39. Street view Grand Trunk Warehouse.
Courtesy of Francesca Fera personal archive.

40. Joe Louis Greenway rails.
Courtesy of Francesca Fera personal archive.

41.
Street view on incinerator.
Courtesy of Francesca Fera personal archive.

42. Joe Louis Greenway rails.
Courtesy of Francesca Fera personal archive.

43. Incinerator front on Ferry Street.
Courtesy of Francesca Fera personal archive.

44. Incinerator front on Ferry Street.
Courtesy of Francesca Fera personal archive.

45. Incinerator’s chimney.
Courtesy of Francesca Fera personal archive.

46. Landscape view on incinerator and Grand Trunk Warehouse.
Courtesy of Francesca Fera personal archive.

47. Google maps view from the I-75 freeway.

48. Google maps view from the I-75 freeway.

4.1. DRAWINGS

4.1.1. CONCEPT

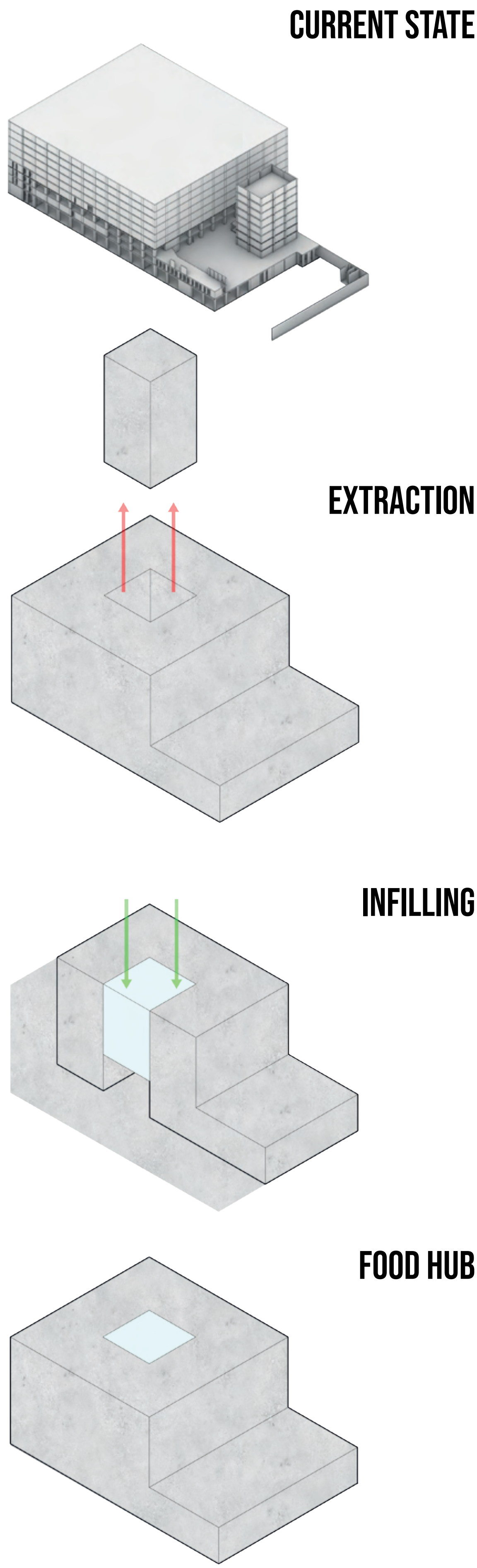
CONCEPT

CASE STUDIES

BUILDINGS STRATEGIES

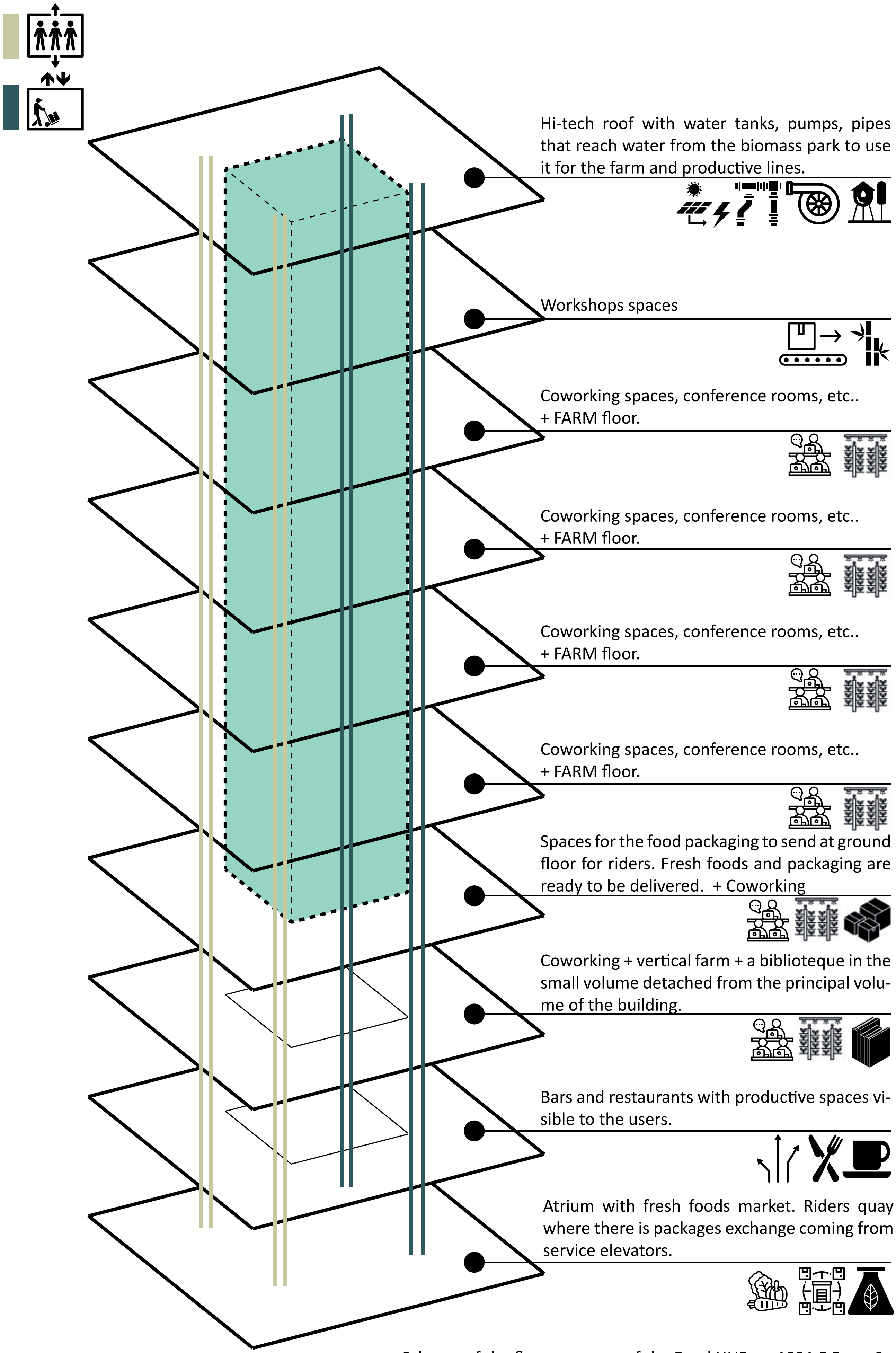
1921 EAST FERRY STREET

Dividing the building in two visions, the interior (floors, etc...) and the vision that could be right for the whole building from the outside, there are two ways followed to reach the aim.
To realize the big hi-tech farm within the building is necessary to create a “new volume” where cables, pipes can be moved easily without clipping the whole structure. So the concept is creating an empty in the center of the warehouse, a true hole, and replacing it with a steel & glass structure supported by 4 four steel blades made integral with the four lift shafts. In this way the big hall at the ground floor has a high semi-transparent ceiling where visitors can see farm workers doing their own and realizing a connection people - business, very important for the identity of the building.
Another element that concept would like to enhance is the structure itself and the volume detached from the main. Framework of pillars is very binding for the elevations so giving some air on the basement backing away the ground floor for only one span makes the building lighter following one of the five points of architecture by Le Corbusier. Moreover, to improve the impact of the structure as a skeleton, curtain walls will be removed and replaced by full height windows, but backed off behind the first line of pillars to giving back the vision of the structure to the user, creating a sort of concrete network.
Plan by plan the activities and functions within the building alternate from true work as farm, biomass plant, etc to relax spaces to eat, reading, or chill. Users and workers in the building will be able to find a quiet place in their break from work, study, doing groceries. Ground floor divides itself between the control room of the plant, the food quay for riders, a big grocery where people can buy fresh foods from the farm. On the first floor there are many productive areas and restaurant for the users. Moreover there will be a big space as terrace on the roof of the control room with a coffee bar, usable from the library user of the subsequent floors.



Concept for the FOOD HUB project.
Scheme realized by the graduate.

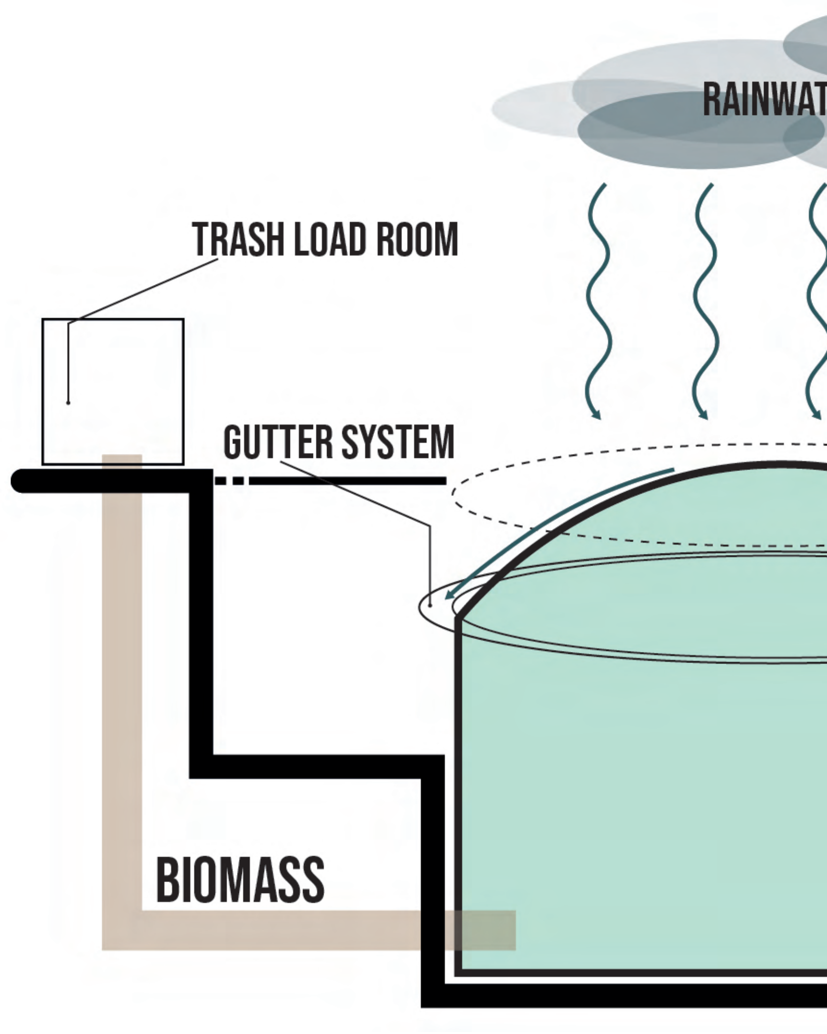
Following the floor progress, at the third floor in proximity of the link with incinerator, start co-working spaces and study areas. This plan become the pivot point of the HUB because people above and below will cross this floor as a transition way from or to the incinerator roof. In particular workers of the HUB can finish work, eating and than moving to tennis, basket, volley fields,... on the Detroit Renewable Power roof, merging work and loisir in a mesmerizing way through the link. Moreover there is an horizontal link to the library in the small volume apart.
Starting from the fourth floor to the roof, there will be the vertical farm with co-working spaces, workshop areas, etc.. Placed in the core of the building, farm is the light inside the skeleton of the building, a green heart to start to revive the building. Many companies or colleges could purchase a floor of the hub to receive their students / workers to work within, following the modern vertical factory model (Vertical Urban Factory, Nina Rappaport, 2019).
All these spaces are not one function only, but they merge together, and users can take a break, or chill on the terraces, views on the city,... To change the imaginery of the people "this is a workplace - this is a pleasure space". It's very important this transition because the modern building is a sinergy of many uses.

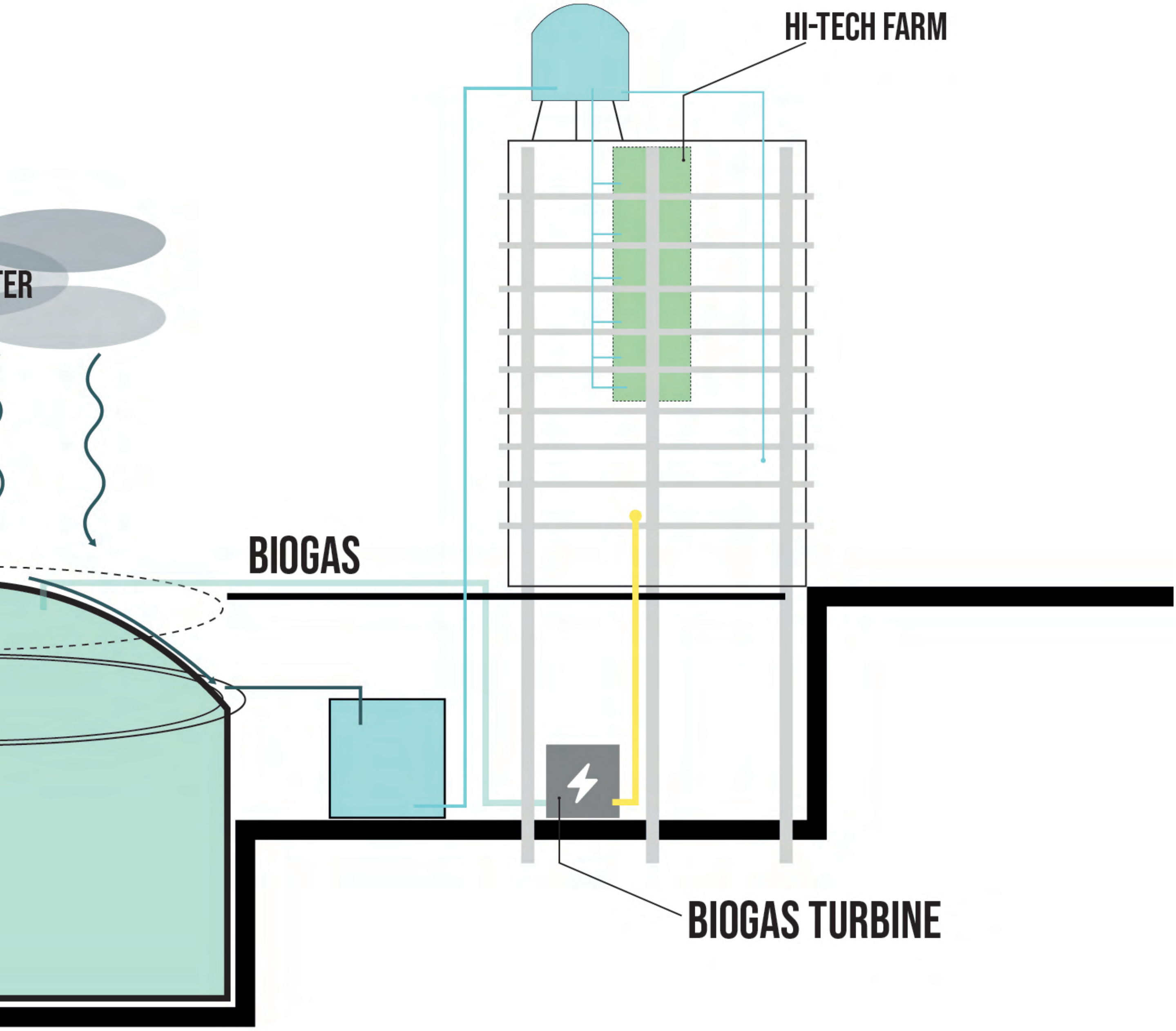


Scheme of the floor concepts of the Food HUB on 1921 E Ferry St.
Scheme realized by the graduate.

BIOMASS POWER PLANT

The huge power plant aims to solve energy supply and tries to reduce the Michigan soil pollution issue together with incinerator. The facility becomes a trail park for the riders, runners or walking people and families around the new energy district and linked with the city by the Joe Louis Greenway. Is covered by metal structures where are placed digesters, to reach the rain water that can be collected, stored and reused for the entire building.
The scheme on the right simplifies the waste flow from trucks, riders, to the energy conversion and its use. Digesters keep raw materials for 14 days to generate biogas used for electric turbines. At the same time water is collected with digesters domes and stored with gutters and pumped up to the vertical farm.
In the end the structure not only covers energy needs of the complex, but is designed to reduce energy bills of a big percentage of the Detroiters, especially who has low income. That means people will have more money every year, they could eat better, maybe reducing trash buying low-plastics packaging favoring bio-degradable packagings, to reach one day some kind of 0 impact living. Society is faraway from this condition but this research aims to put people in condition to do it, not the final solution because technology needs other steps in research.



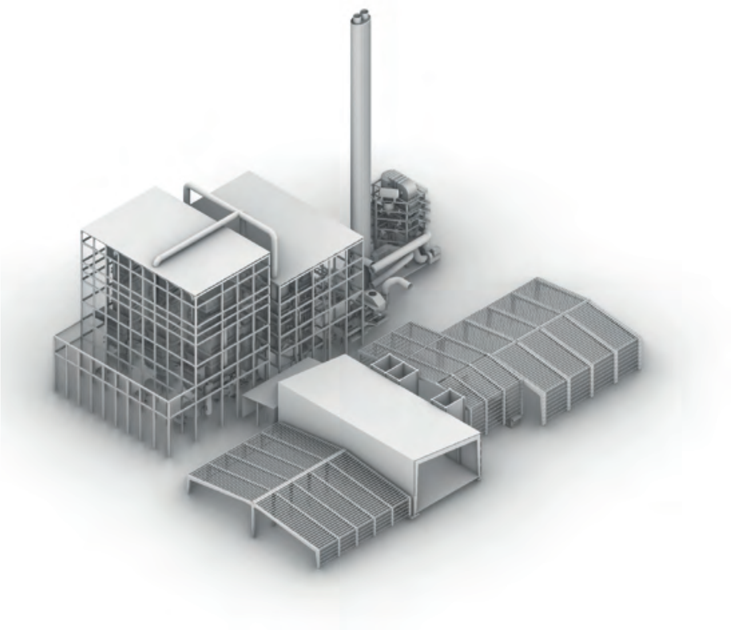


Scheme of the Biomass Power Plant with waste and water flows.
Scheme realized by the graduate.

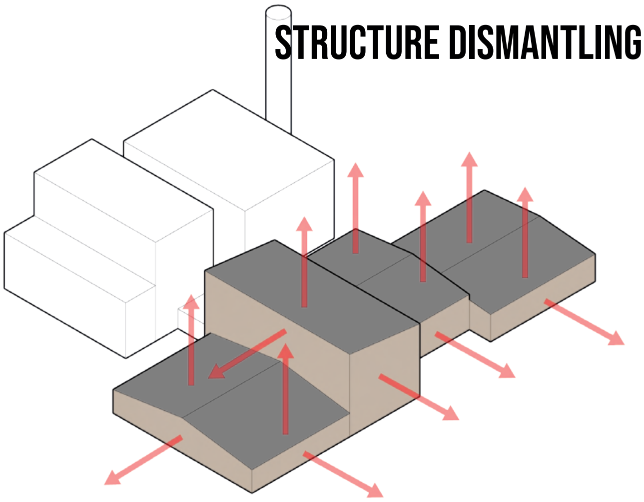
DETROIT RENEWABLE POWER AREA

The incinerator area is a very complex model where there are many constraints, input and output that make difficult every transformation of the site.
First issue is about the structure of several buildings that needs a retrofit intervention, so will be removed and replaced with a metal frame that could be dismantled at occasion. Moreover, there is an administration building devoid of any architectural interest that can be demolished and the offices moved to the Waste Dept. building. The area left by demolition will become a buffer area with many activities as football, basket fields and open air graffiti museum for the people of Detroit and internationals. This circa 200 meters wall can be a true canvas for many artist from all over the world, organizing art festivals and events. The atmosphere urban - industrial can be the perfect mood for this kind of activities.
Vertical distribution is another challenge for this multilevel building, solvable finding a "center" of the building where there are basic activities and linking that with the other levels. To reach a clear vision of the pathway to follow, the optical cones method was chosen to direct the user to the various destinations. From the buffer area with these cones people are redirected to lifts through the park, enjoying sports or relax on benches. From the main level of the roof the user can have a coffee in the bar/ cafè, or moving to the skatepark on the right. There is also a gym accessible from ground level or arriving from the food hub through the link. Important is the mix of sports and activities in this concept with climbing walls, yoga spaces, archery, volley fields. Moreover, at the entrance to the walkway towards Food HUB following the roofs, there will be a modern art gallery that can collaborate as a detached section of the Detroit Institute of Arts dedicating that to urban culture, from graffiti to sculptures to entire neighbourhoods as Heidelberg Project, not far from the site. It's important to keep the heritage of the urban culture, specially in a country as United States.

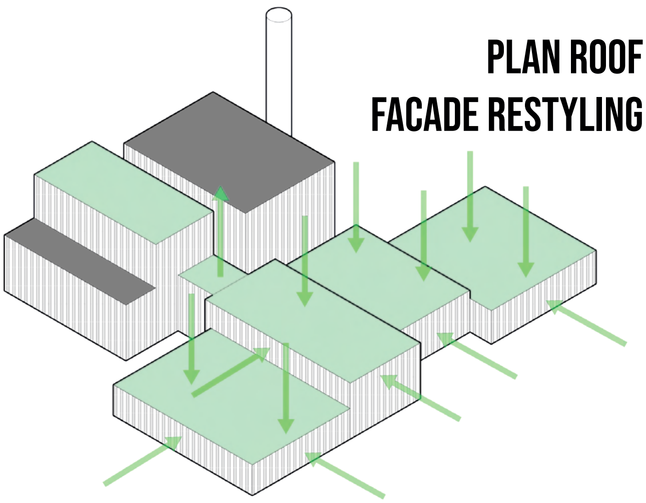
CURRENT STATE



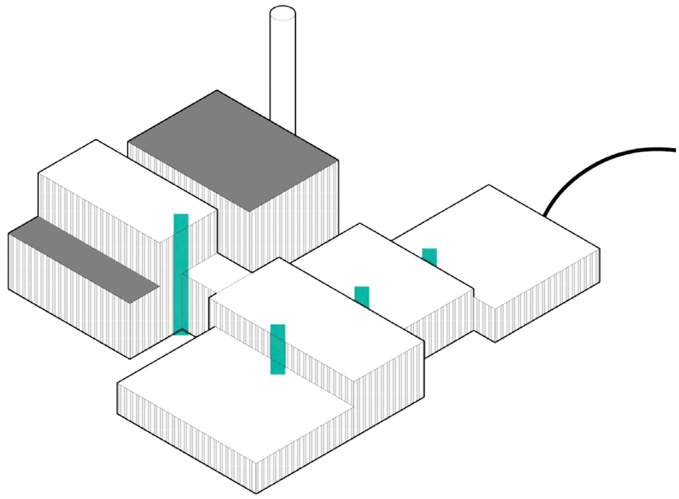
STRUCTURE DISMANTLING



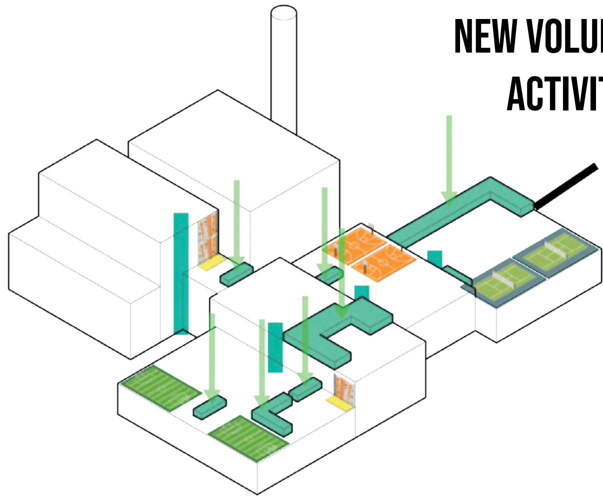
PLAN ROOF
FACADE RESTYLING



VERTICAL DISTRIBUTION



NEW VOLUMES
ACTIVITIES



Concept for the INCINERATOR project.
Scheme realized by the graduate.

4.1.2. CASE STUDIES

1921 EAST FERRY ST

HAMILTON'S FARMERS MARKET, CANADA.
RDH ARCHITECTS + DAVID PREMI ARCHITECTS

Hamilton's farmer market is a restoration of the historical food market in the town of Hamilton, Canada. Renovation puts together the mart and the public library, getting a stratified building with different spaces, functions and activities.

As the Albert Kahn building in this research thesis project, this building was a mass of raw concrete, kind of brutalist architecture. The main strategy is to take back the building to its structural skeleton and cleaning it. This aims to enhance the aesthetic quality of the environment with air ducts at sight and polished pavements.

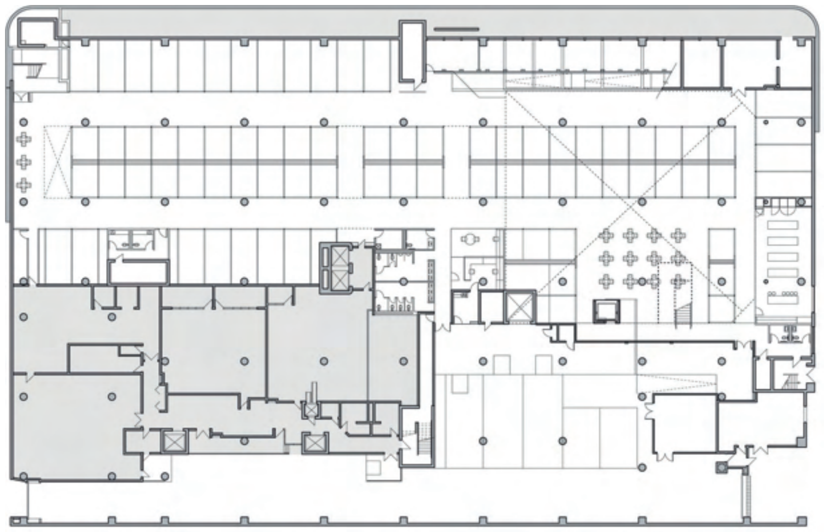
The new glass facade envelop the structure and improves energy efficiency, giving a plastic shape to the old regular. Moreover is designed with LEDs that create a dynamic facade based on the sidewalk on the ground floor.

The six story tower of Hamilton is dedicated to the function of public library. With this "horizontal tower" made by the new glass facade the tower has a huge basement to elevate from, where there are many activities in addition to the market, as coworking, collective spaces, ...

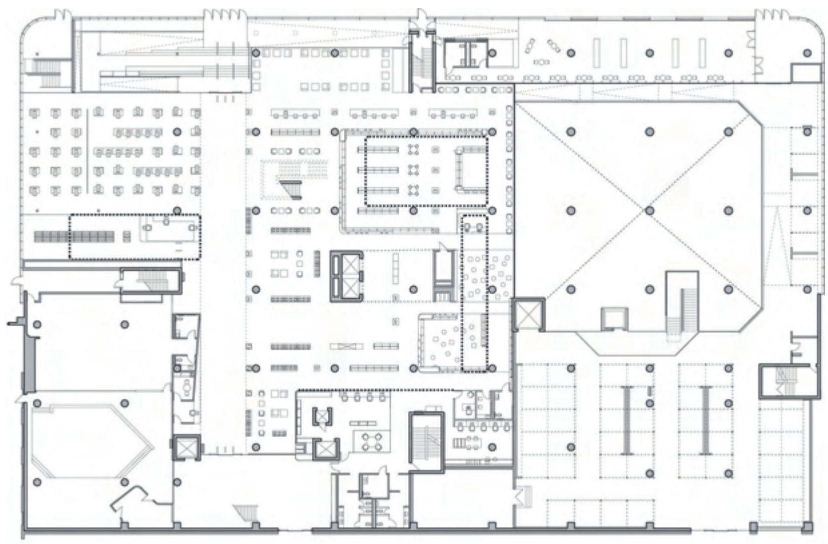
The analogies with Grand Trunck Warehouse on Ferry St are many, from the materials to the regularity of the structure framework, the two buildings can be solved in the same way. Instead of bringing out the facade, however, will be maintained at sight the concrete skeleton and will be used glass to make it shine. Regularity of plans and floors will make a "green glassed cage" where within there will be glass volume for the farm, a box in the box.

City of Hamilton, Ontario, Canada.

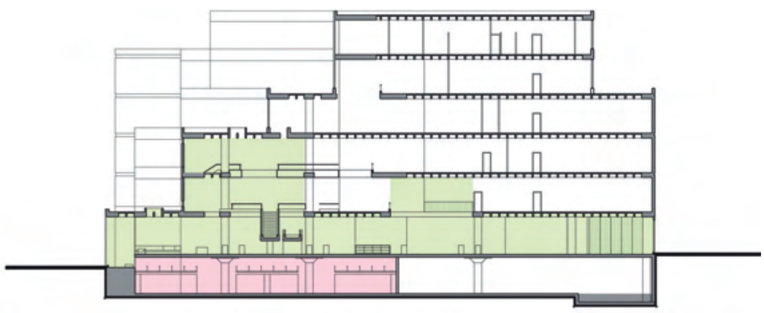
PLAN 0



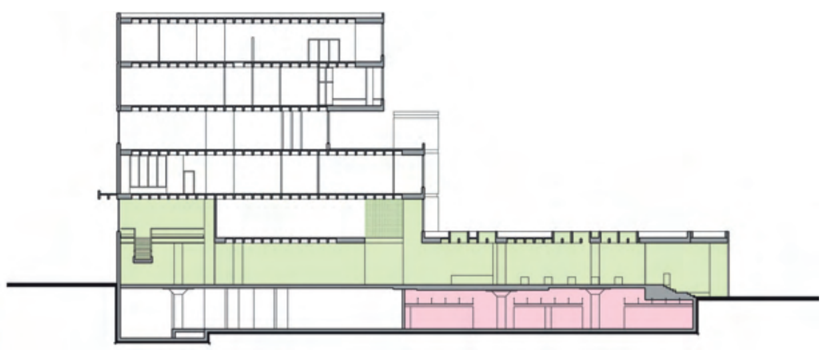
PLAN 1



SECTION 1



SECTION 2



Drawings of the building, plans and sections.
Source: Archdaily.com

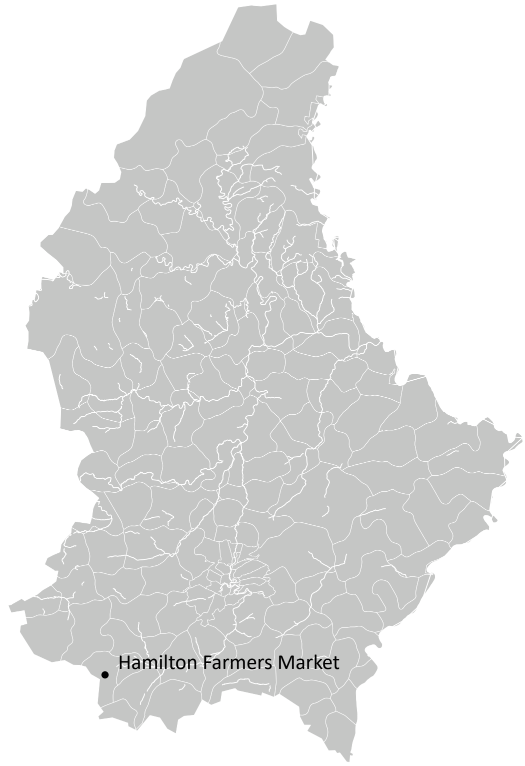
Interior of the market.
Source: Archdaily.com

Offices.
Source: Archdaily.com

Interior of the market.
Source: Archdaily.com

ICÔNE, OFFICE COMPLEX IN BELVAL, LUXEMBOURG.
FOSTER + PARTNERS

This office complex project (will be ultimated in 2022) is a multi function building that welcomes inside many features for the workers and visitors. In this case returns the regularity of the building, imposing entrances tell to the users that this space is a place of respect and work.
The entire building is emptied and crumbled on itself creating balconies, terraces, floating pathways that give to the building a sense of huge "exterior". The same concept is adoptable to the workplaces, the original idea is to design airy spaces to work and where people can also connect each other.
There is an important contrast exterior / interior, first is very formal and regular with imponent entrances, the second instead is a very fluid work space with many community features to favor also here a better connectivity between users.
Dimensions of the office building are more ore less 18,800 square meters, but immersed in a green environment crossed by light studied in a very smart way. From the exterior is possible to see glimpses of the interior green environment thanks to punched volumes intersected with frame network structure. The same facade has double aim, structural and responsive to have a better control on the interior climate of the building.
This case study is important for the environmental collectivity concept, designing spaces of co-working and together co-living in the same workplace, with balconies, overhangs,... that way can design a fluid space in a regular framed building as Grand Trunck Warehouse.

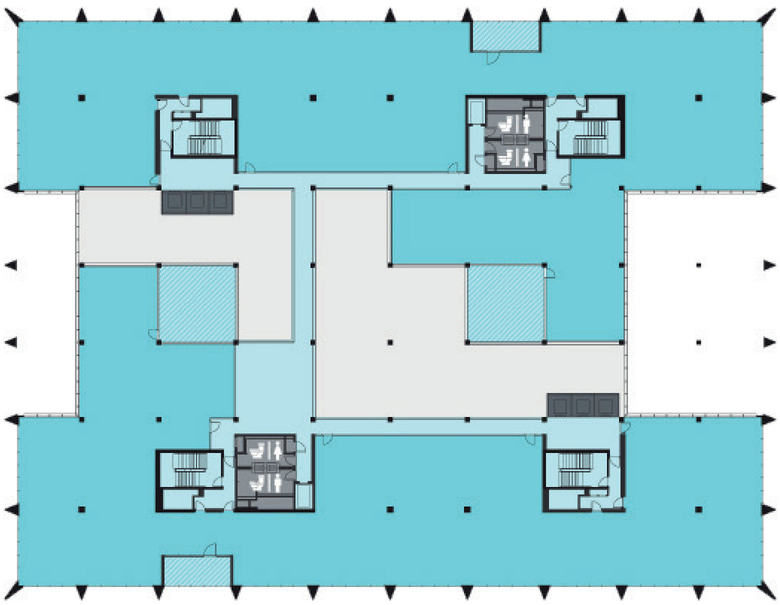


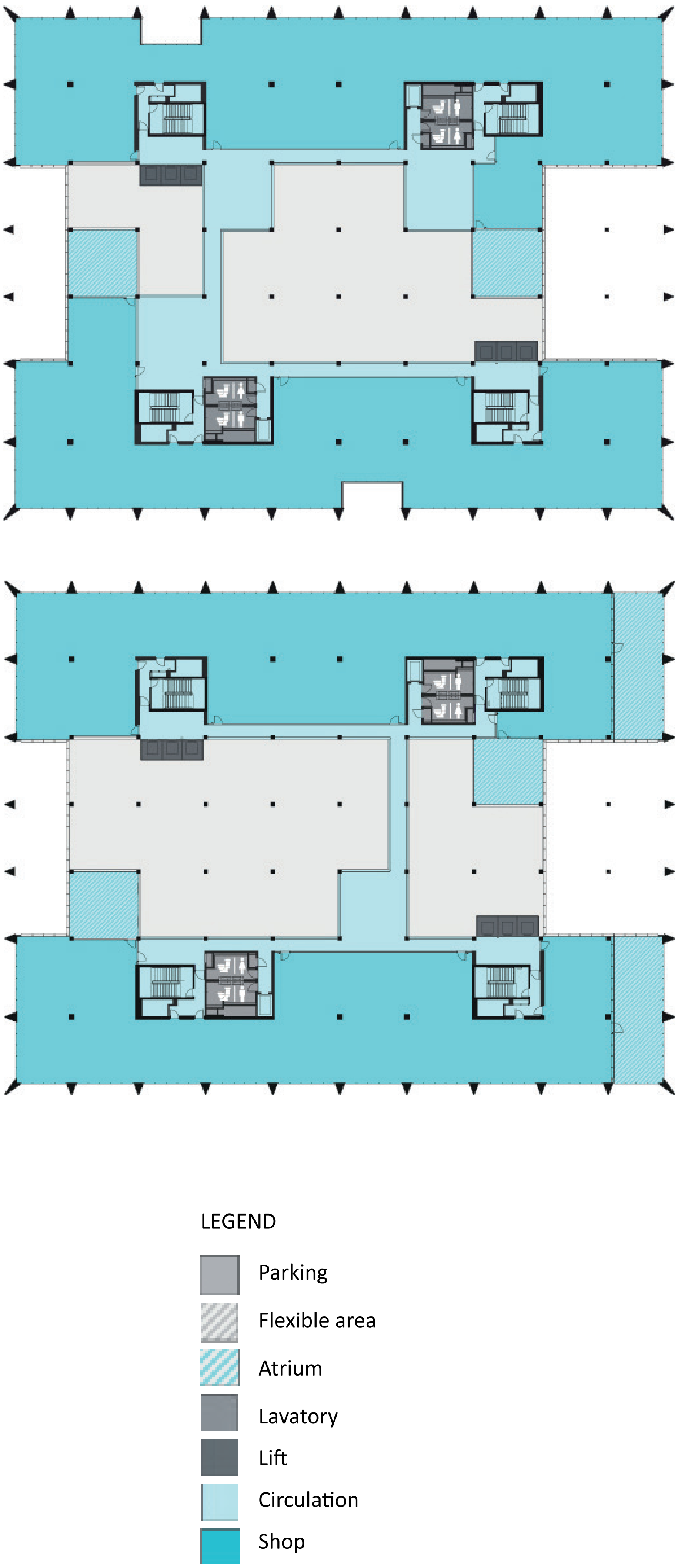
City of Hamilton, Ontario, Canada.

Perspective section of the building.
Source: Group Seco


602 SQM
620 SQM
270 SQM


281 SQM
281 SQM





Plans of the structure.
Source: Iconeoffices.lu

Interior views of spaces. Work, community, whole building.
Source: Foster & Partners.


100% ORGANIC


Front view of the facade.
Source: Foster & Partners.

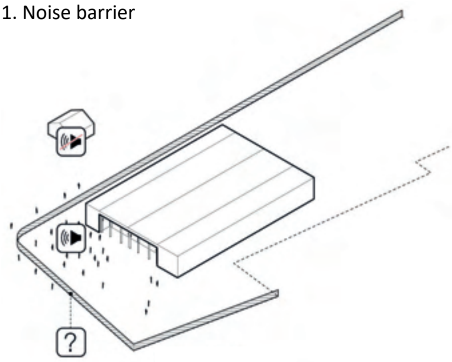
DETROIT RENEWABLE POWER AREA

GAME STREETMEKKA, VIBORG. DENMARK
EFFEKT ARCHITECTS

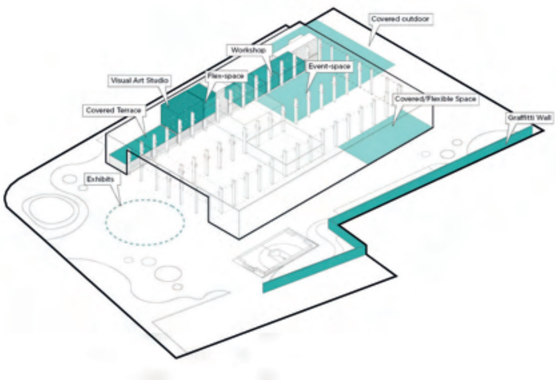
This case study is a very organic example of how to design an exterior-interior common environment. Is also an experimental restoration of an engine depot became a youth culture center that improve the sociality in the city of Viborg and the connectivity between different social groups.
Project surface is 4000 square meters interior, 6000 square meters exterior masterplan. There are many features in the complex very related to street culture and sports, as skateboard park, graffiti walls, but also basket fields,...
The true important upgrade in the project is the remaking of the facades, from a concrete wall to a translucent skin (made in polycarbonate) that gives a unique light inside and let the articial interior light to come out in the evening/night. This particular intervention will be used for the incinerator, wrapping all the structure with material because is a 24/7 structure and needs to become a landmark of the neighbourhood, at night too. The same material will be used in the food hub to maintain a visible continuity in the whole complex.
At a planimetric level there are many little rules that give order to the whole plan (inside and outside), the same rules will be used in a different draw for the buffer zone and the park on the roof of the Detroit Renewable Power Area. The shapes of the skatepark are reported inside and outside bending masterplan's lines and the same will be for the incinerator but with optic cones reported every where to define a clear aim.

City of Viborg, capital of Midtjylland region, Denmark.

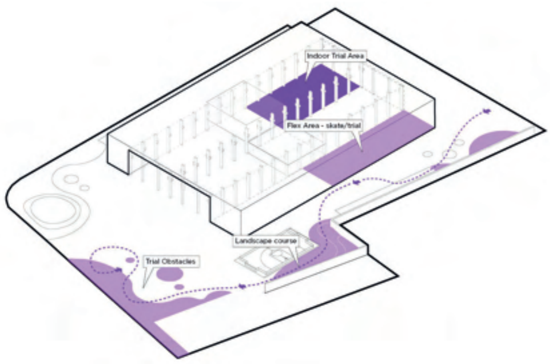
1. Noise barrier



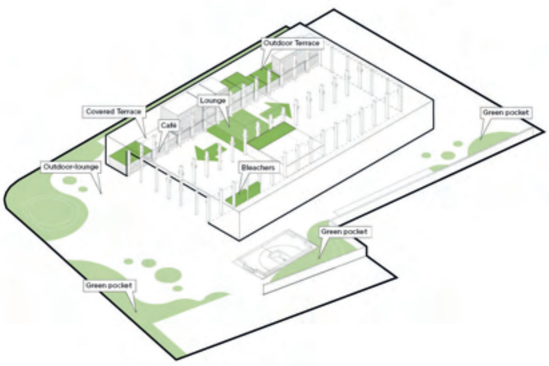
2. Street art, visual, workshops



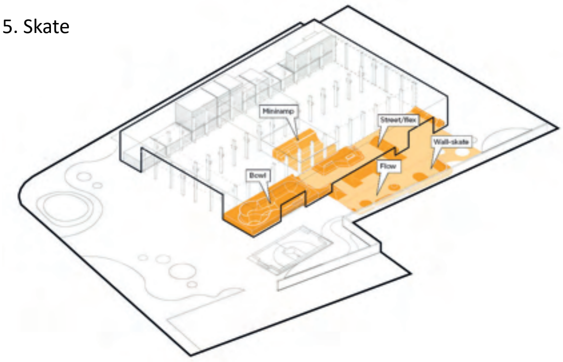
3. Mountain bike trials



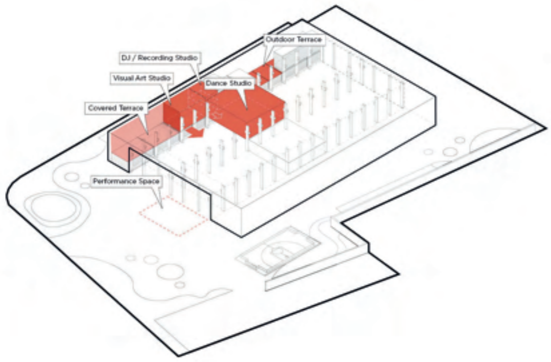
4. Hangouts and social zones



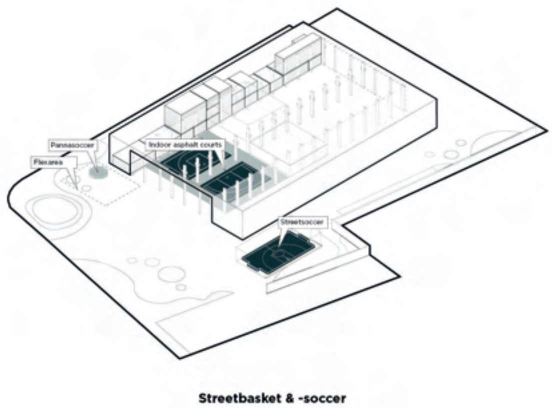
5. Skate



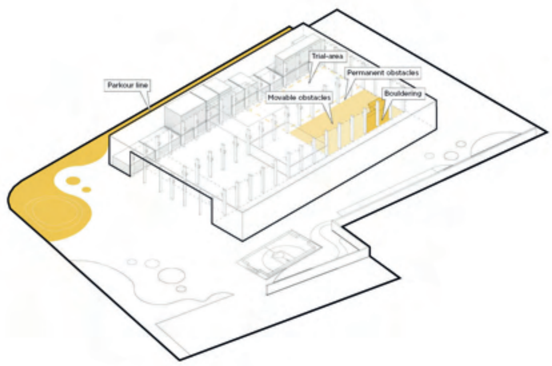
6. Street dance & Audio/Visual art



7. Streetbasket & Soccer

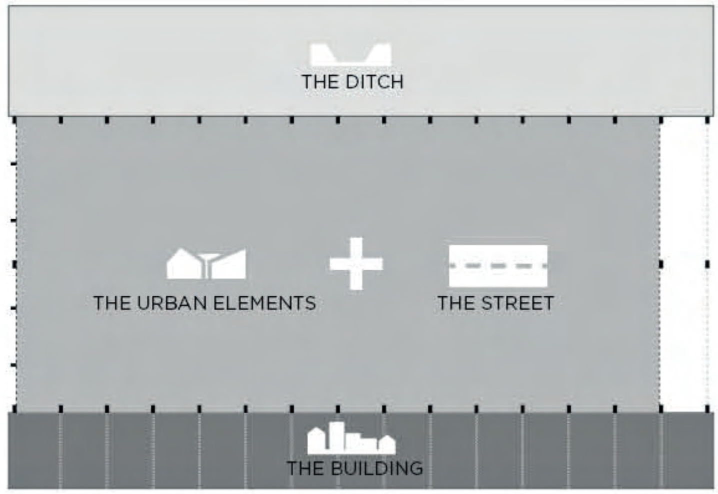


8. Parkour / Bouldering

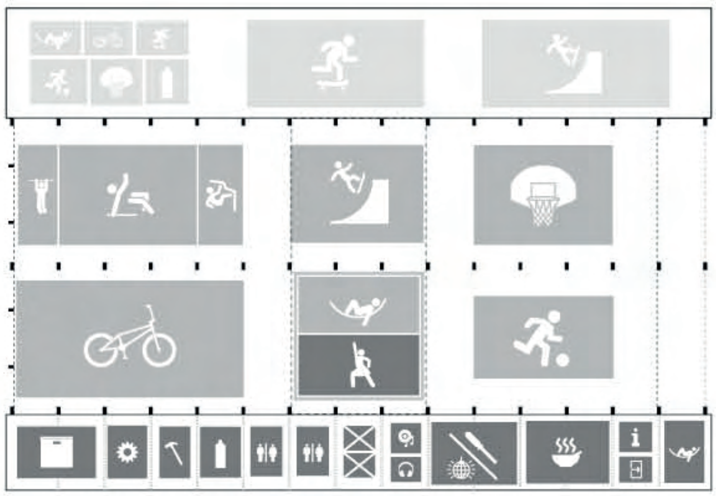


Spaces design & concept.
Source: Effekt Architects

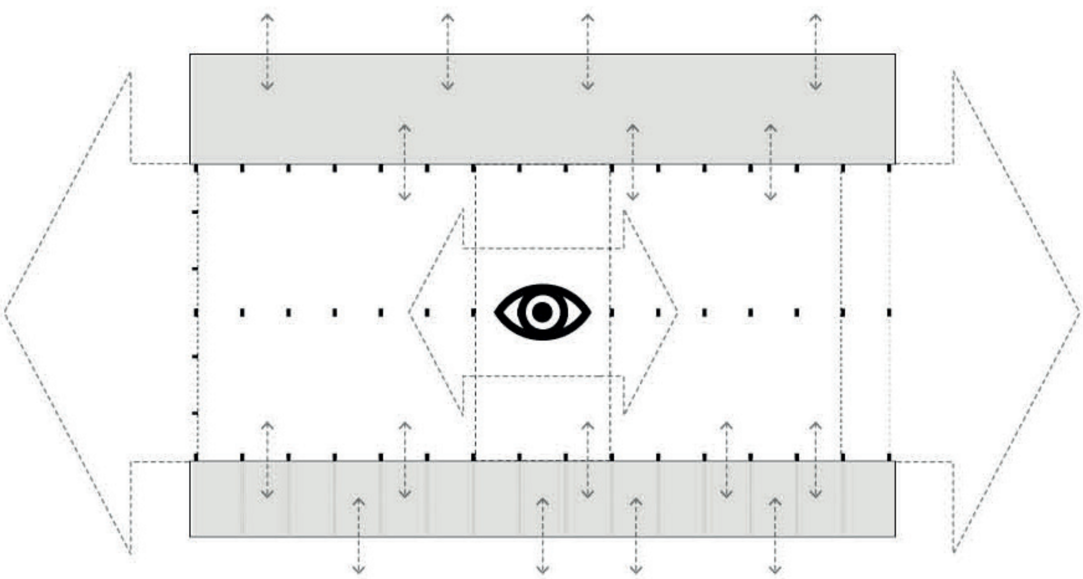
Zones



Program allocation

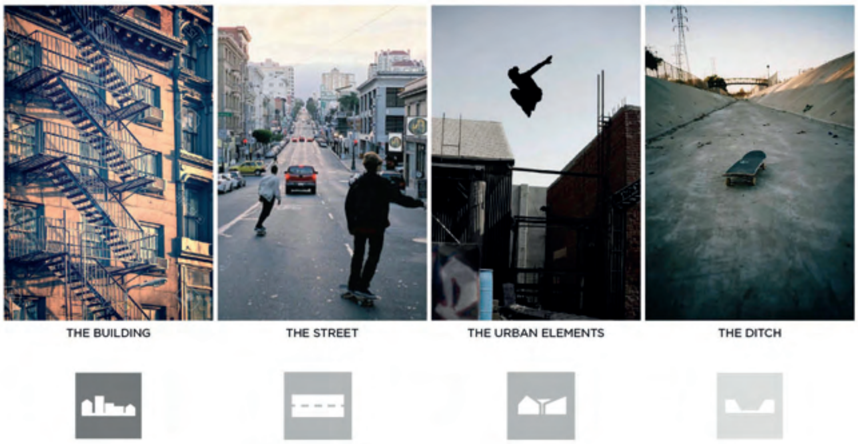


Program proximity and view



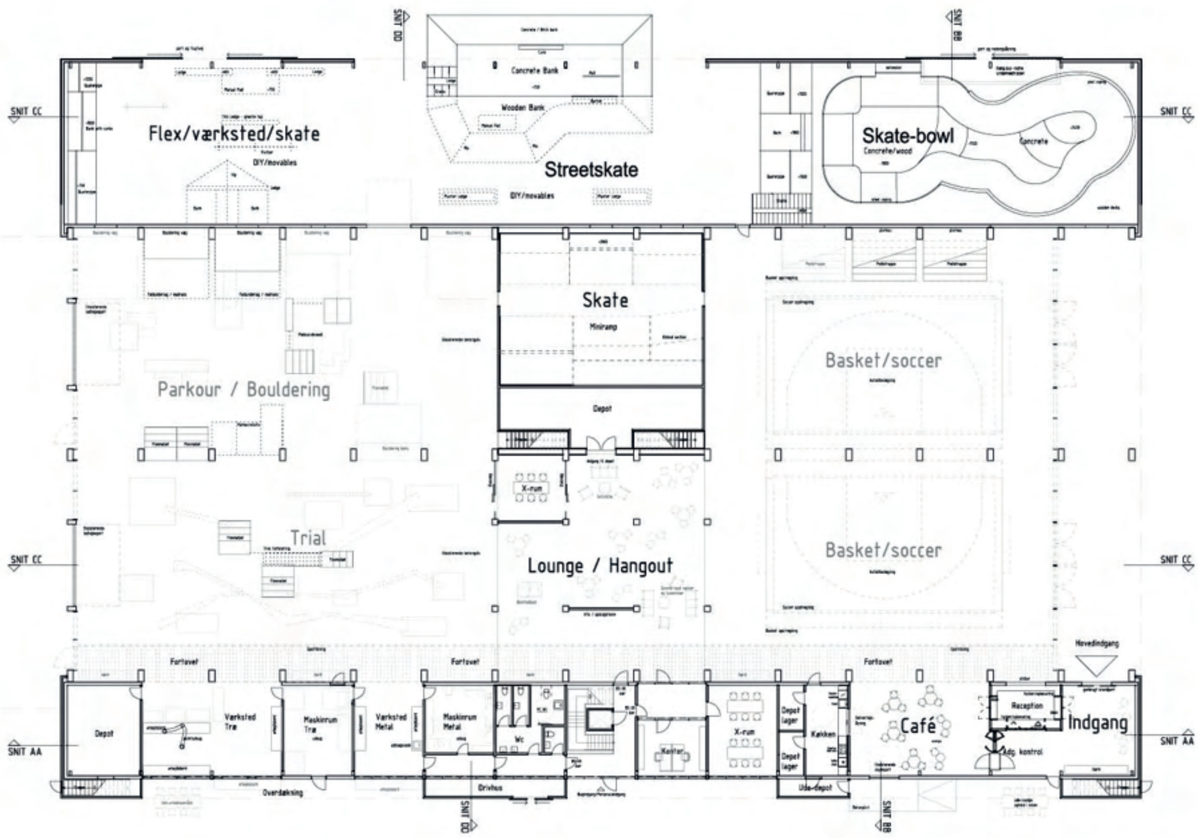
Concept & program.
Source: Effekt Architects

Program concept



Taking inspiration from the streetscapes that shaped street culture, the program is organized in accordance with the different types of streetscapes and corresponding functionality.

Interior plan



Above: Program concept.
Below: Plan of the structure.
Source: Effekt Architects

Interior /exterior views of the skatepark.
Source: Effekt Architects


Game

Exterior daily view of the building.
Source: Effekt Architects

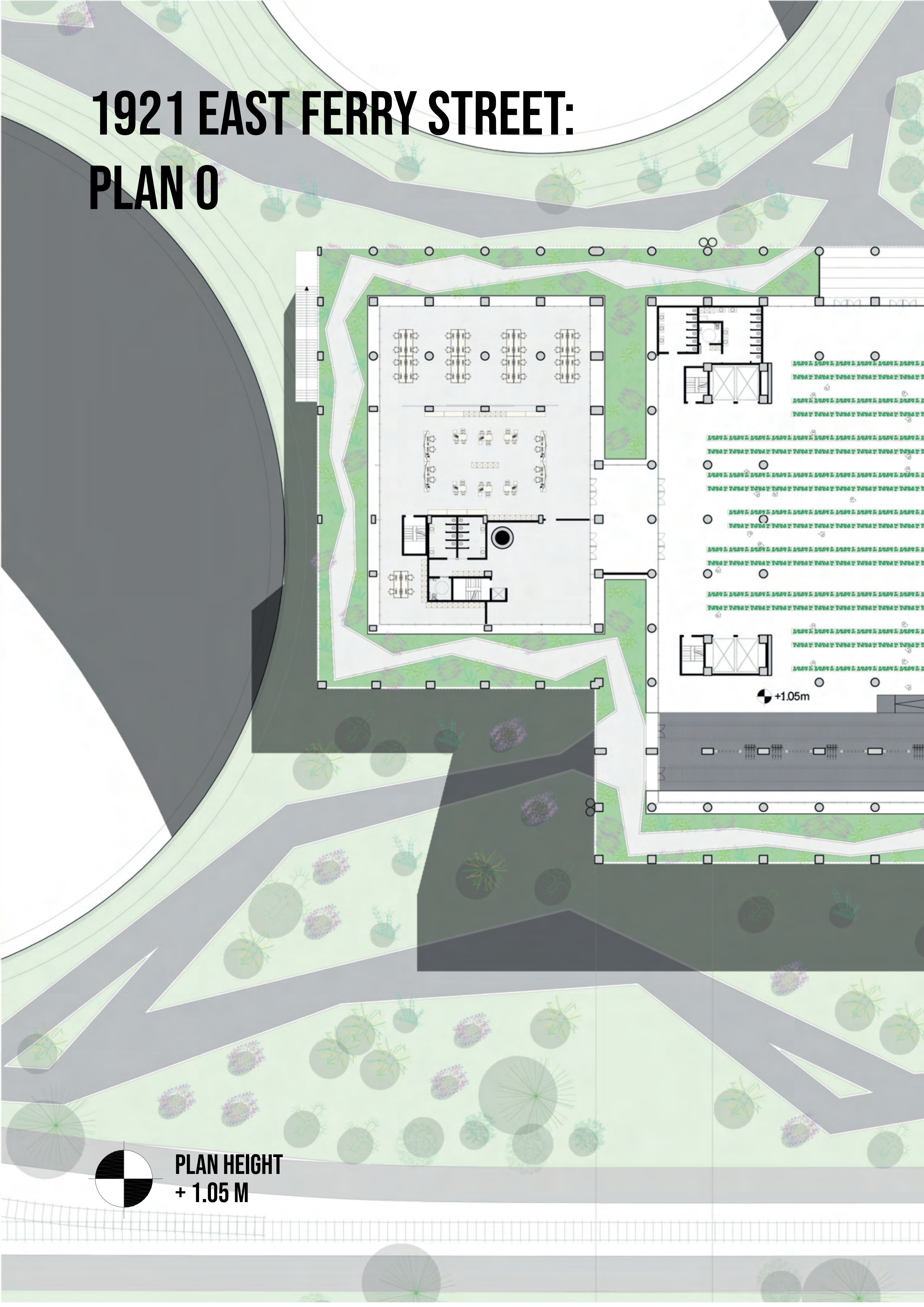
LOVE

Illuminated night view.
Source: Effekt Architects

4.2. VISIONS

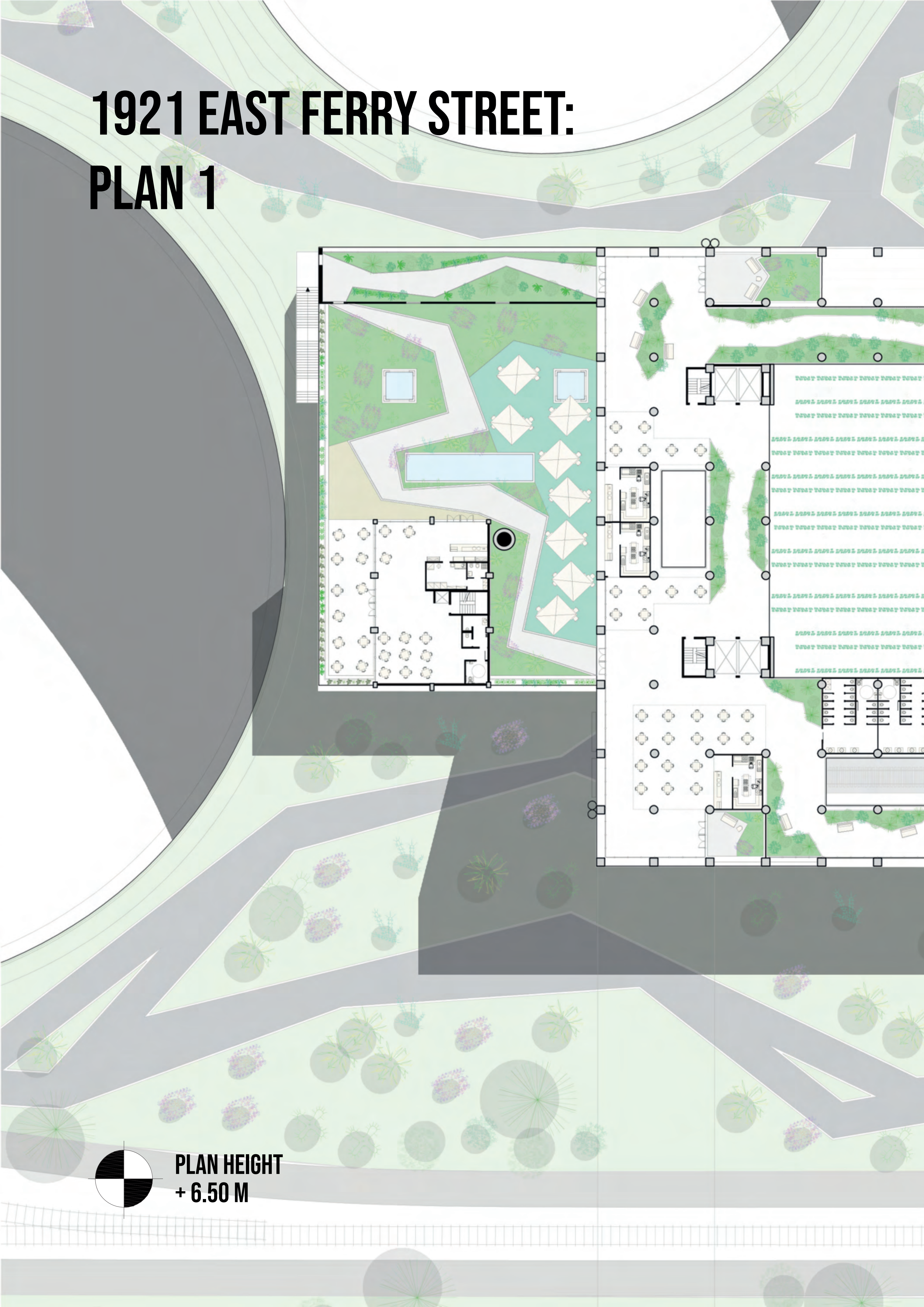
4.2.1. PLANS

1921 EAST FERRY STREET:
PLAN 0



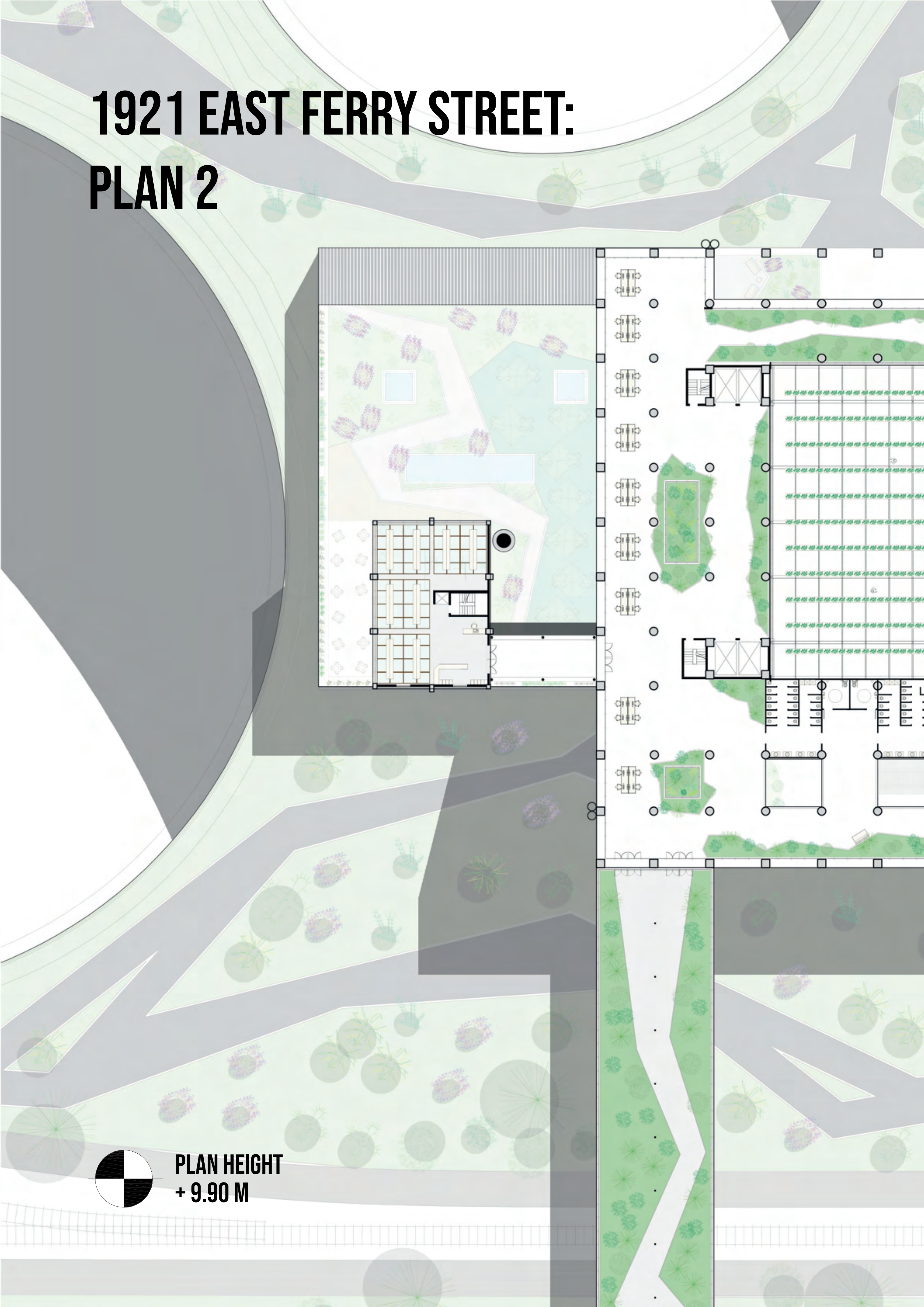

+.0m
Chill area
Food exchange
Entrances
Hall
Vertical links
Power plan control room
Toilettes
0
10
20
50 M

1921 EAST FERRY STREET: PLAN 1



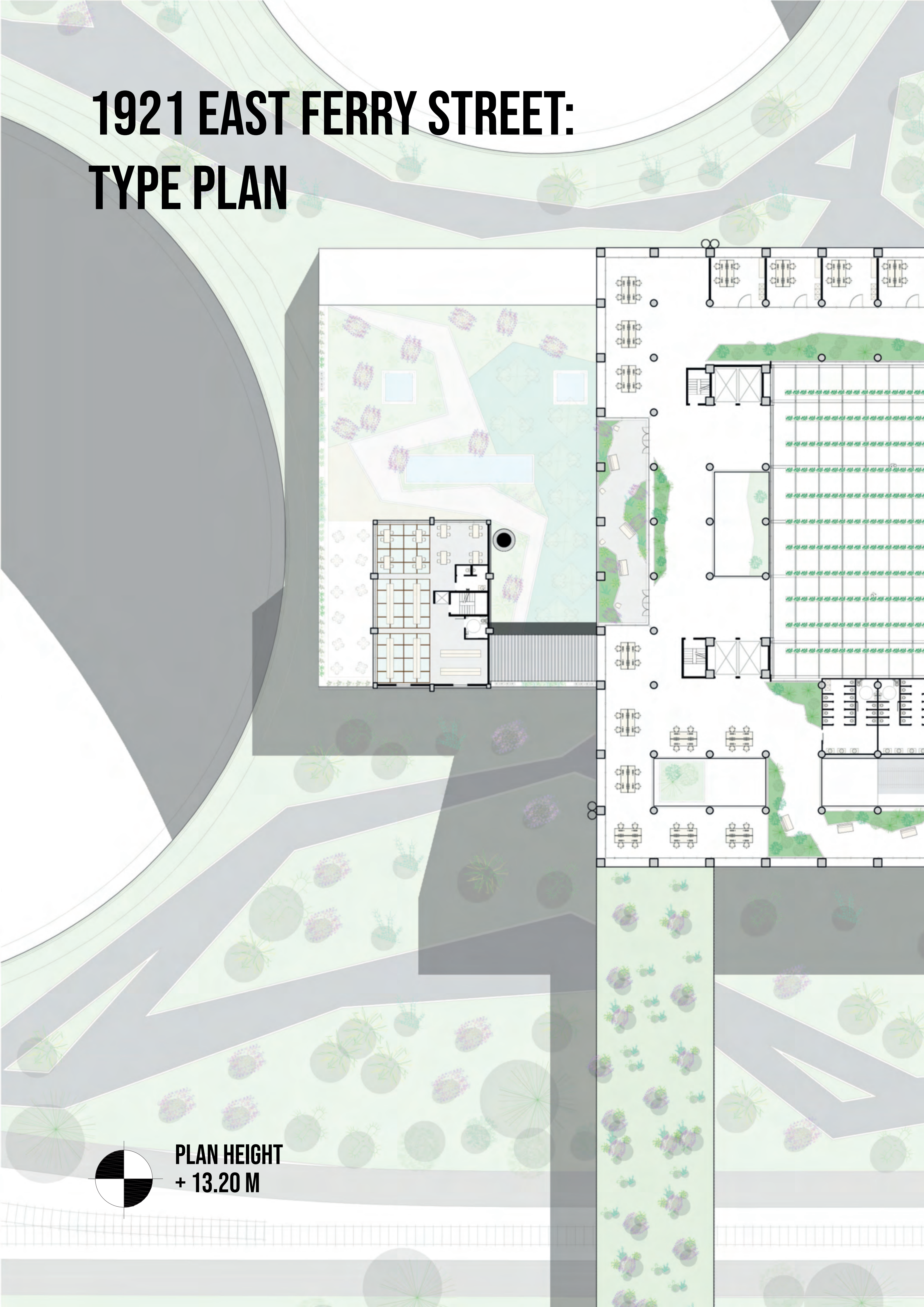

Chill area/ Terrace
Cafè
Fresh foods market
Vertical links
0
10
20
50 M

1921 EAST FERRY STREET:
PLAN 2



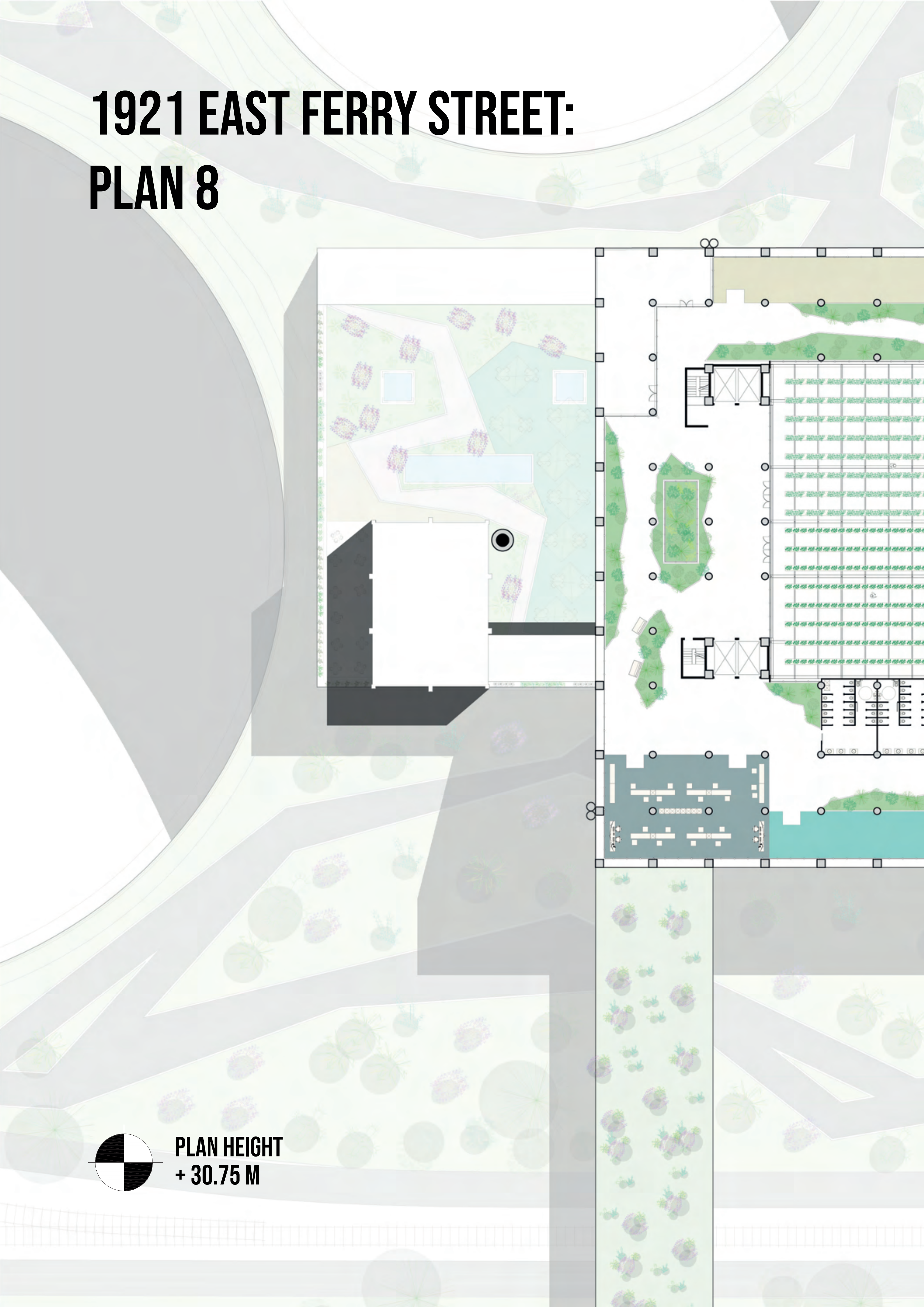

Chill area/ Terrace
Food area/ Restaurants
Vertical links
Library
Toilettes
0
10
20
50 M

1921 EAST FERRY STREET:
TYPE PLAN

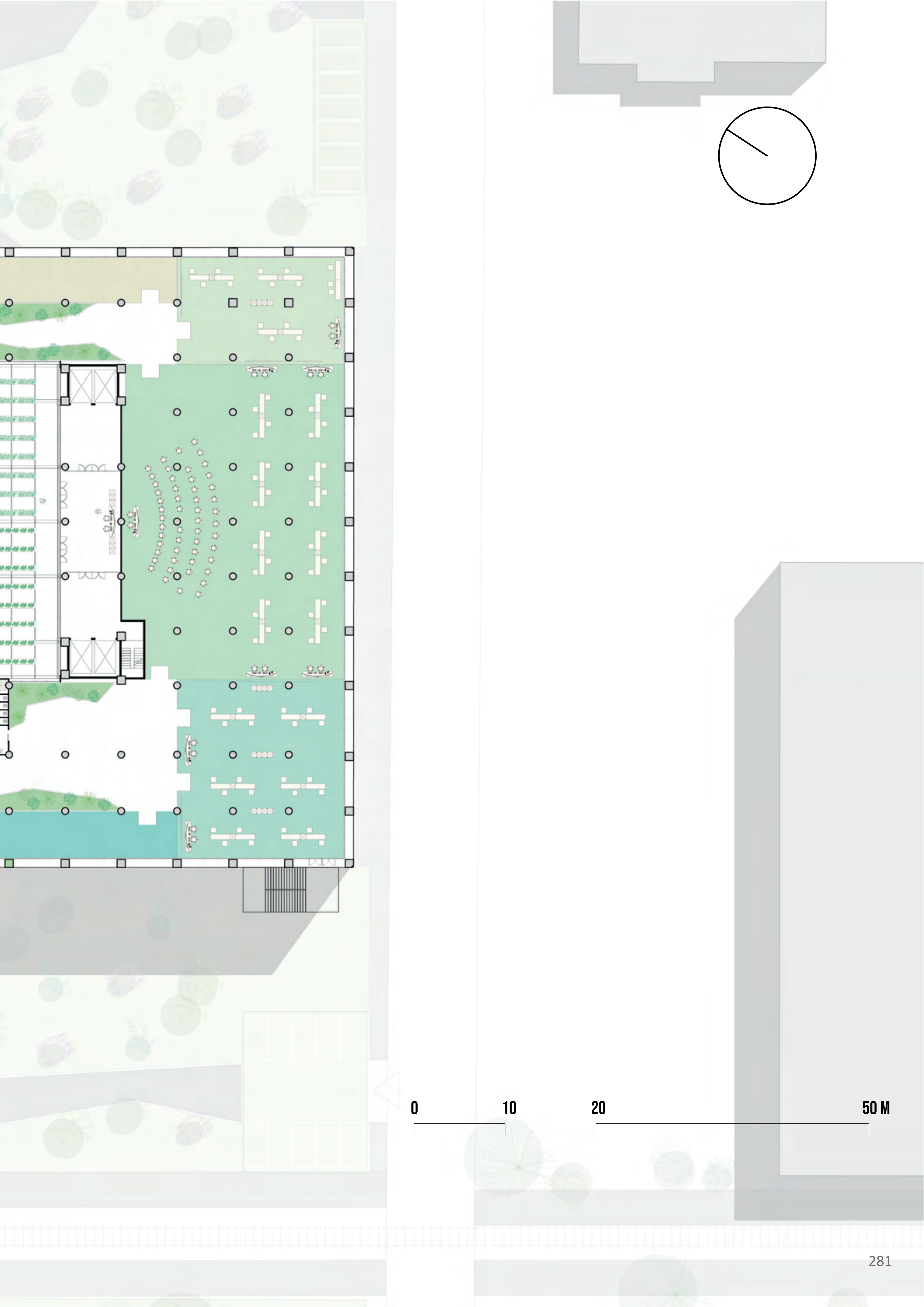



Chill area/ Terrace
Coworking
Offices
Vertical farm spaces
Vertical links
Library
Toilettes
0
10
20
50 M

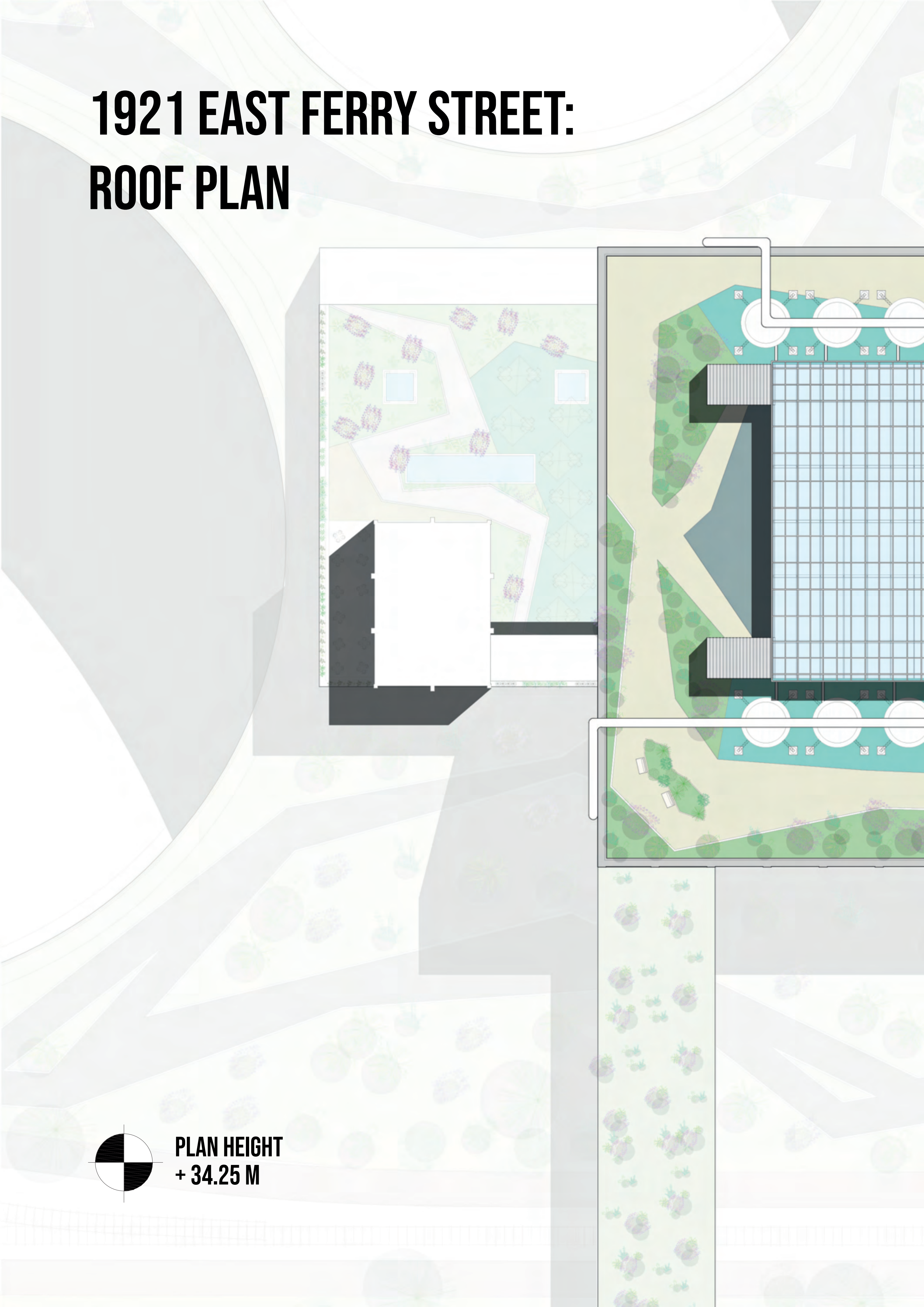
1921 EAST FERRY STREET:
PLAN 8



PLAN HEIGHT
+ 30.75 M


0
10
20
50 M

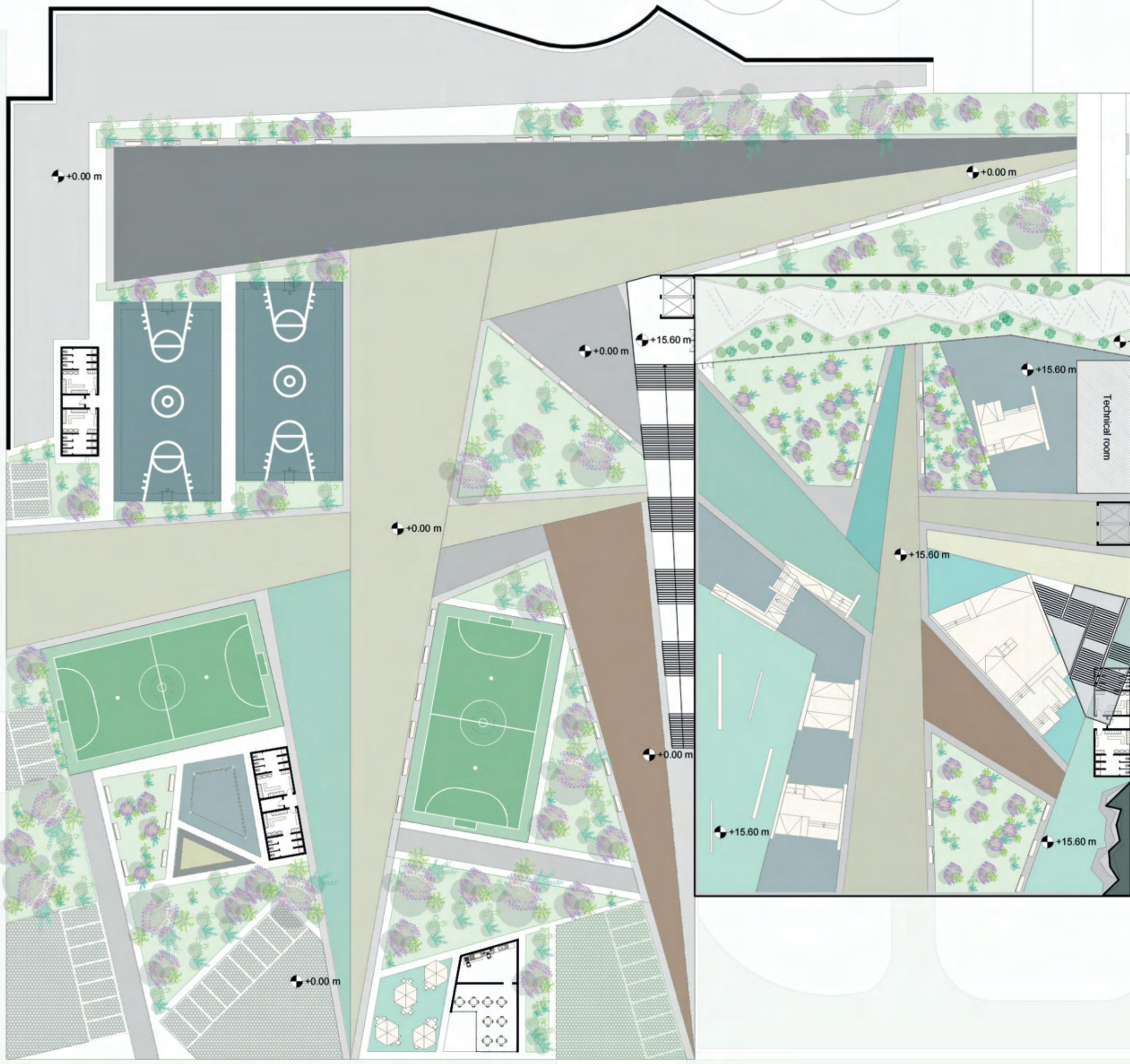
1921 EAST FERRY STREET:
ROOF PLAN

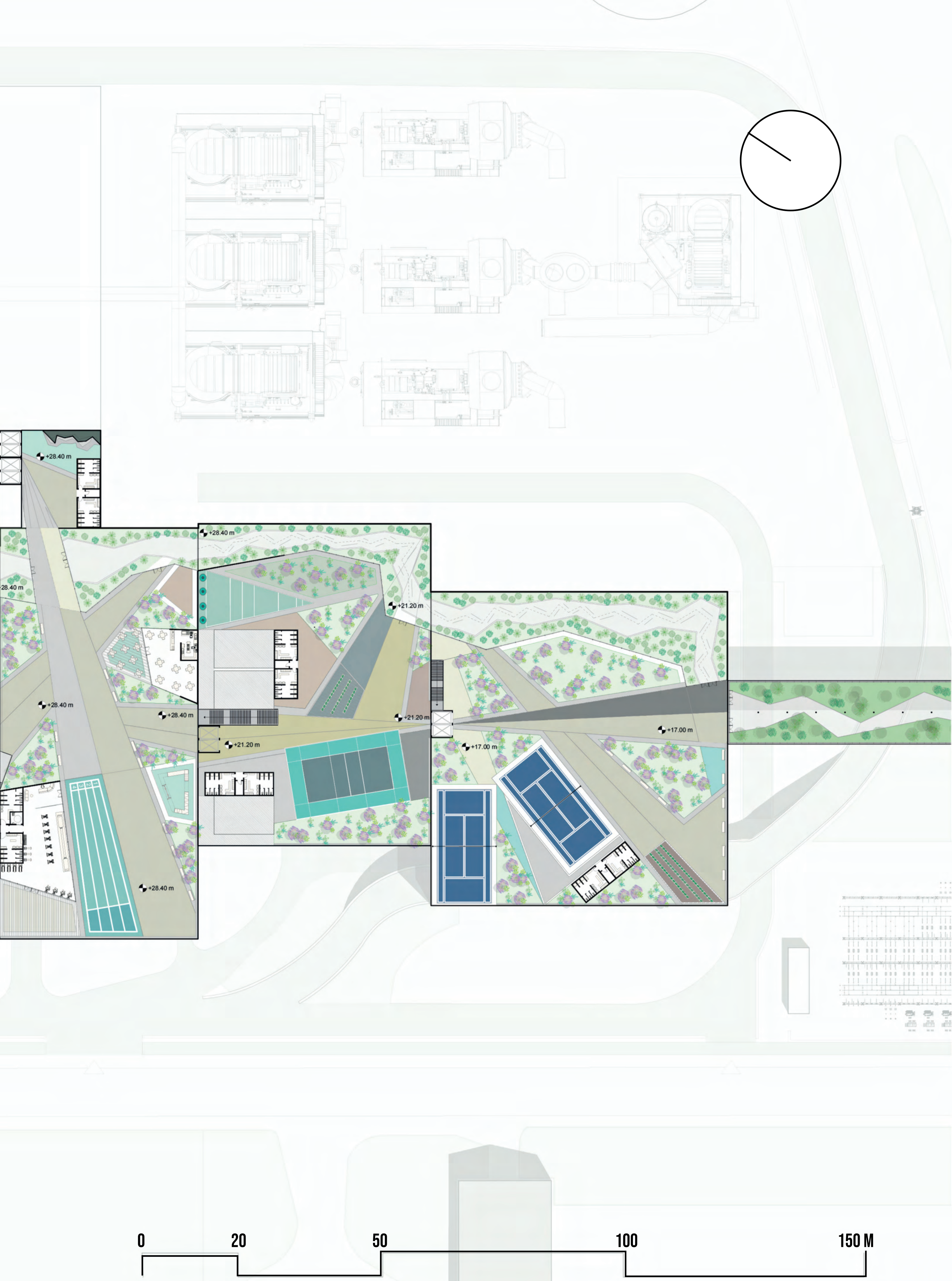


PLAN HEIGHT
+ 34.25 M

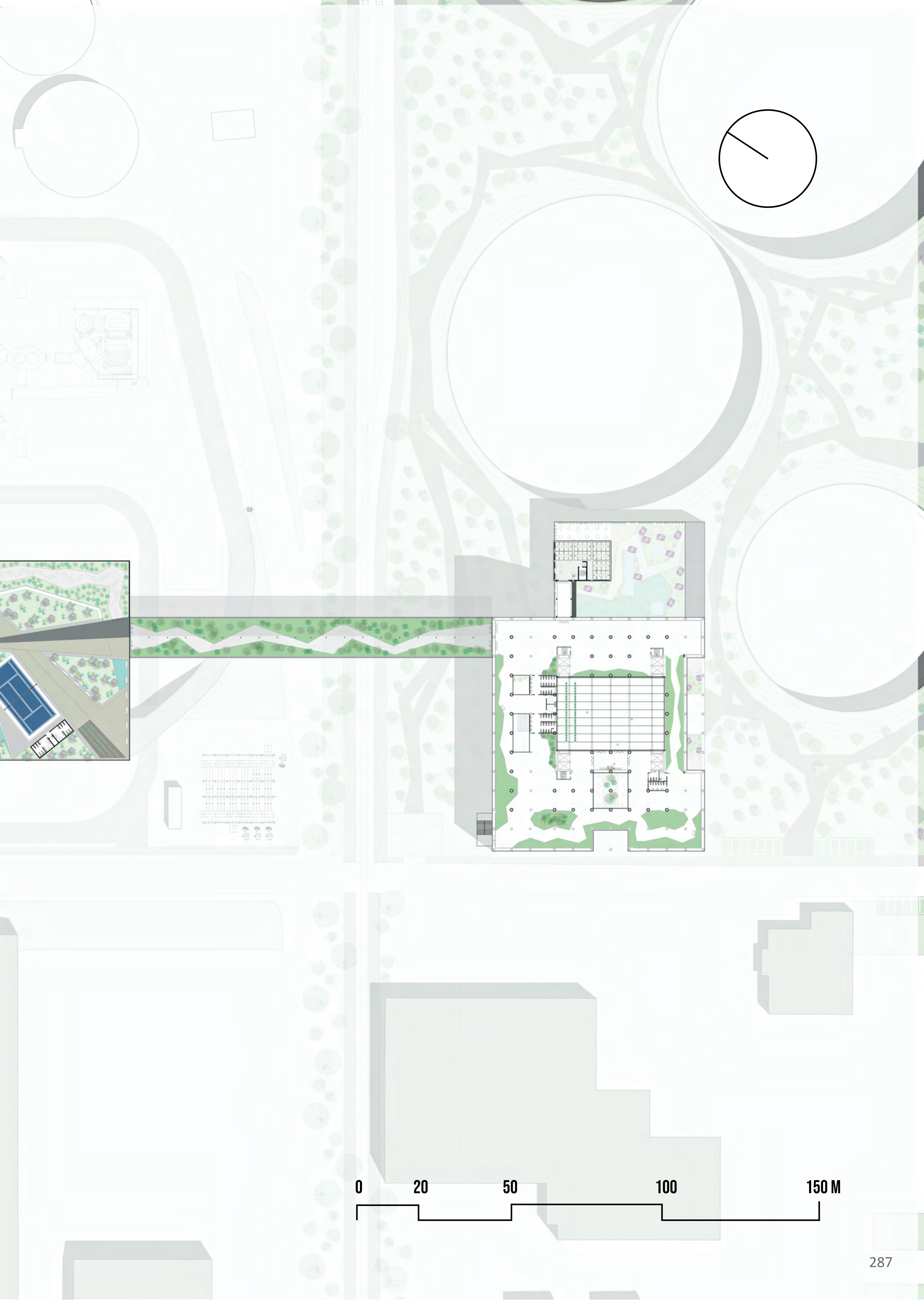
0 10 20 50 M

DETROIT RENEWABLE POWER AREA: FUNCTIONAL ROOF




+28.40 m
28.40 m
+28.40 m
+28.40 m
+21.20 m
+28.40 m
+21.20 m
+21.20 m
+17.00 m
+17.00 m
+28.40 m
0
20
50
100
150 M

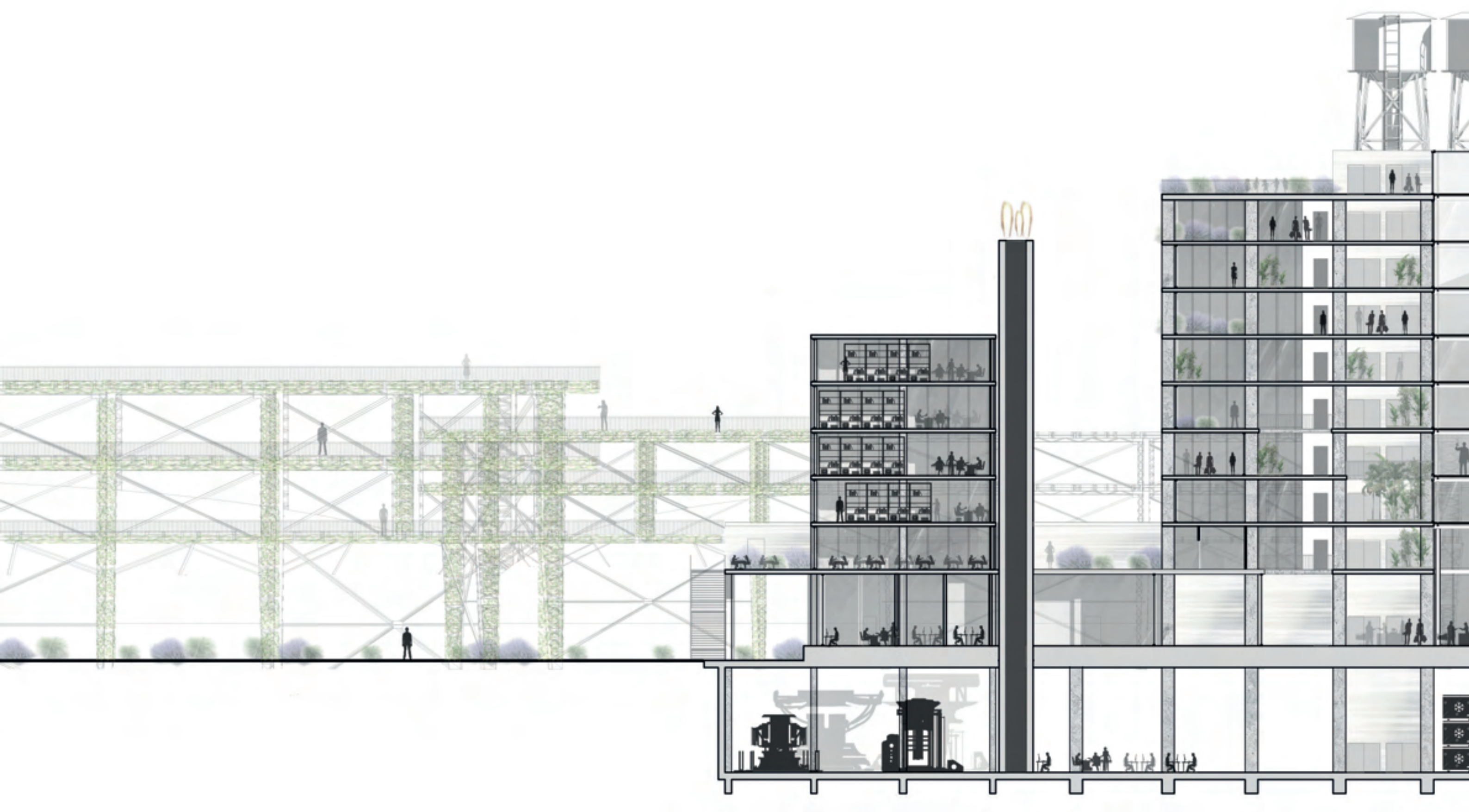
GREENHOUSE LINK

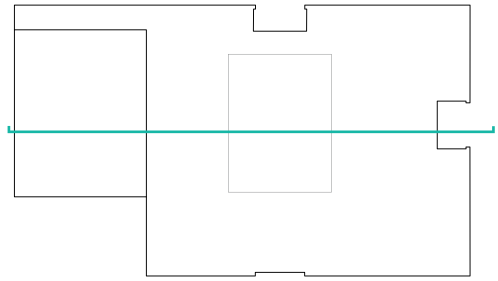

0
20
50
100
150 M

4.2.2. ELEVATIONS

SECTIONS / ELEVATIONS

1921 EAST FERRY STREET:
LONGITUDINAL SECTION



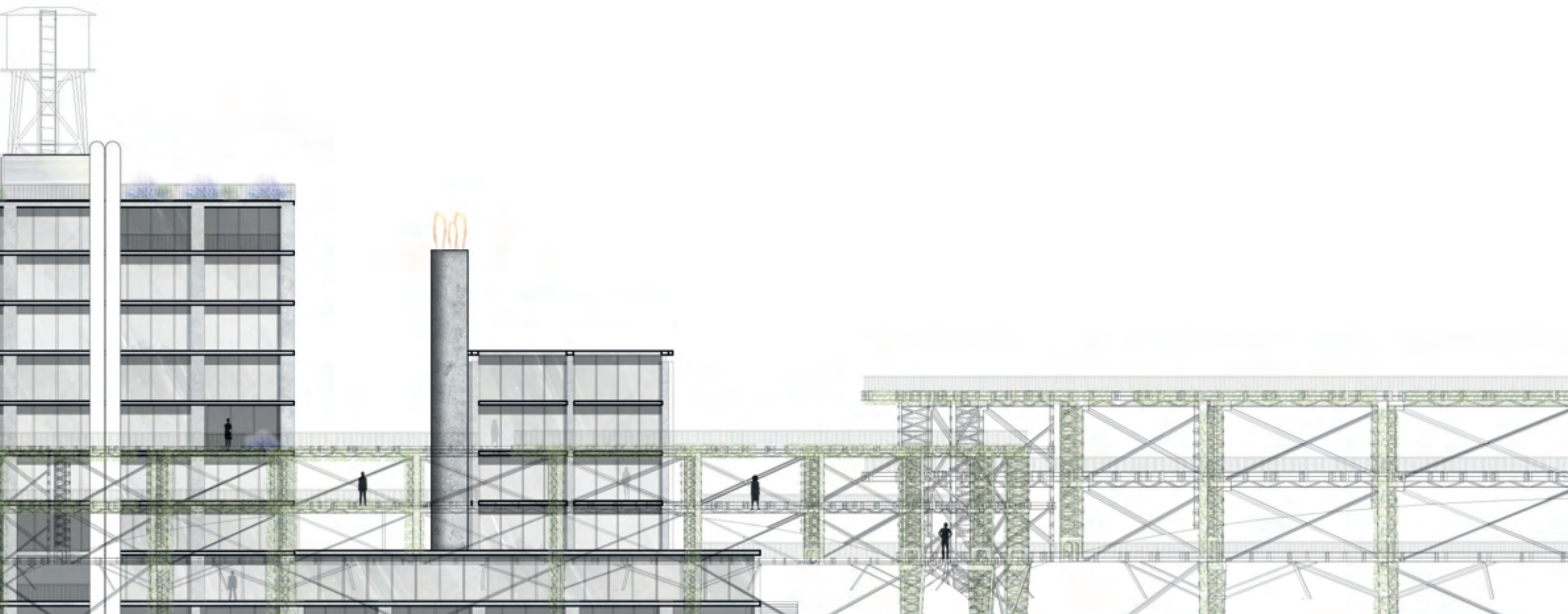



EAST FERRY STREET


0
10
20
50 M

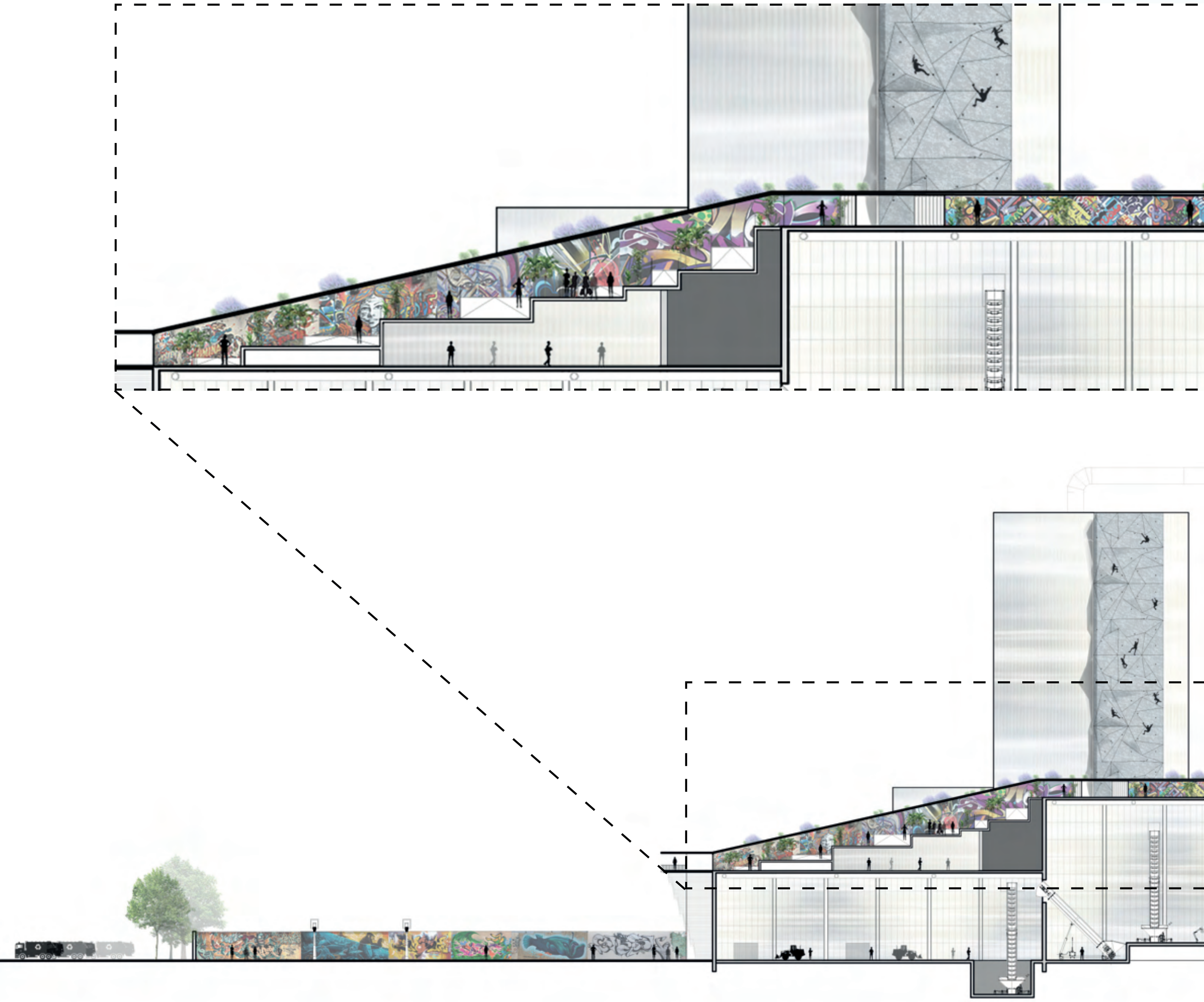
1921 EAST FERRY STREET: FRONT

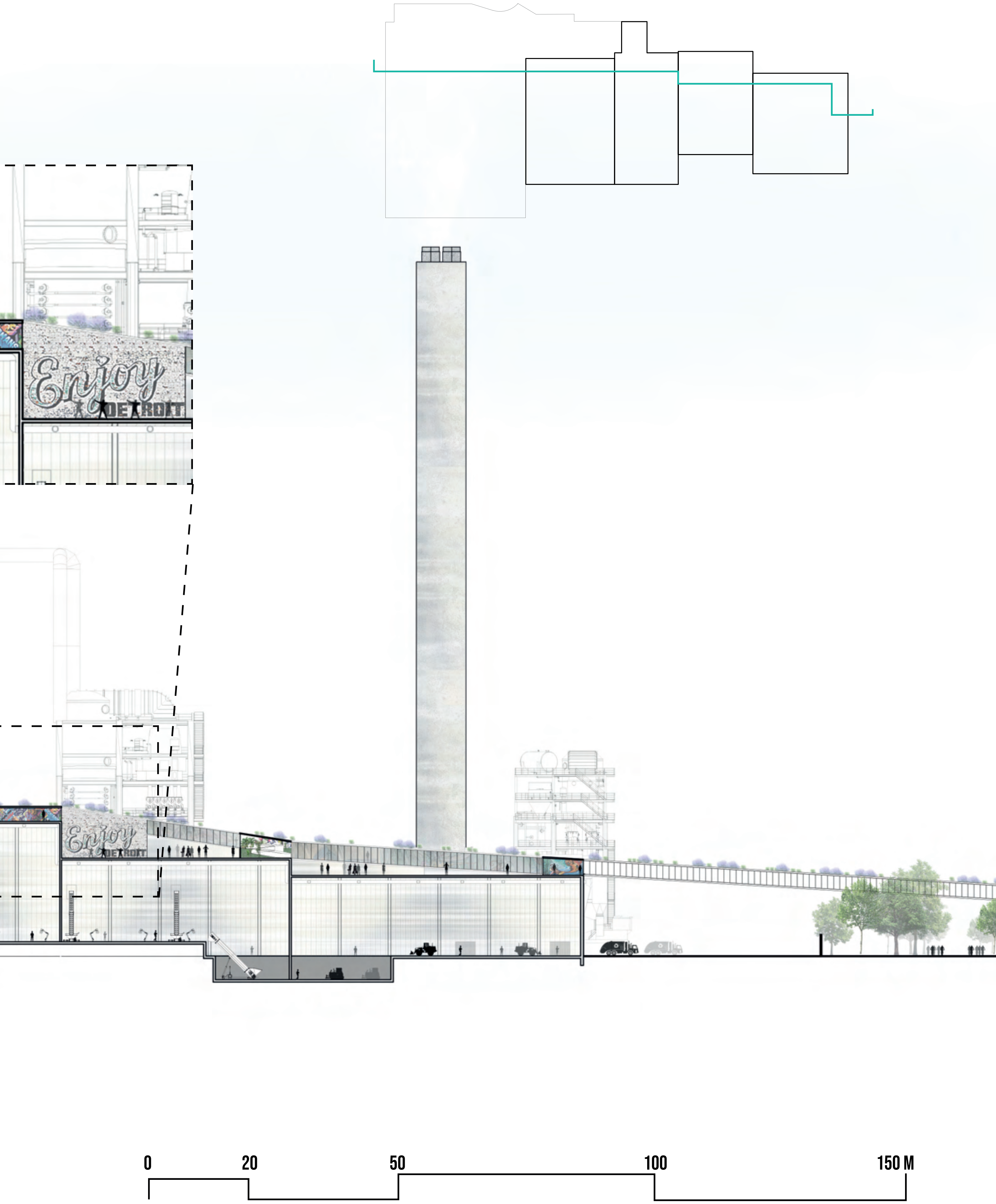
1921 EAST FERRY STREET: SIDE



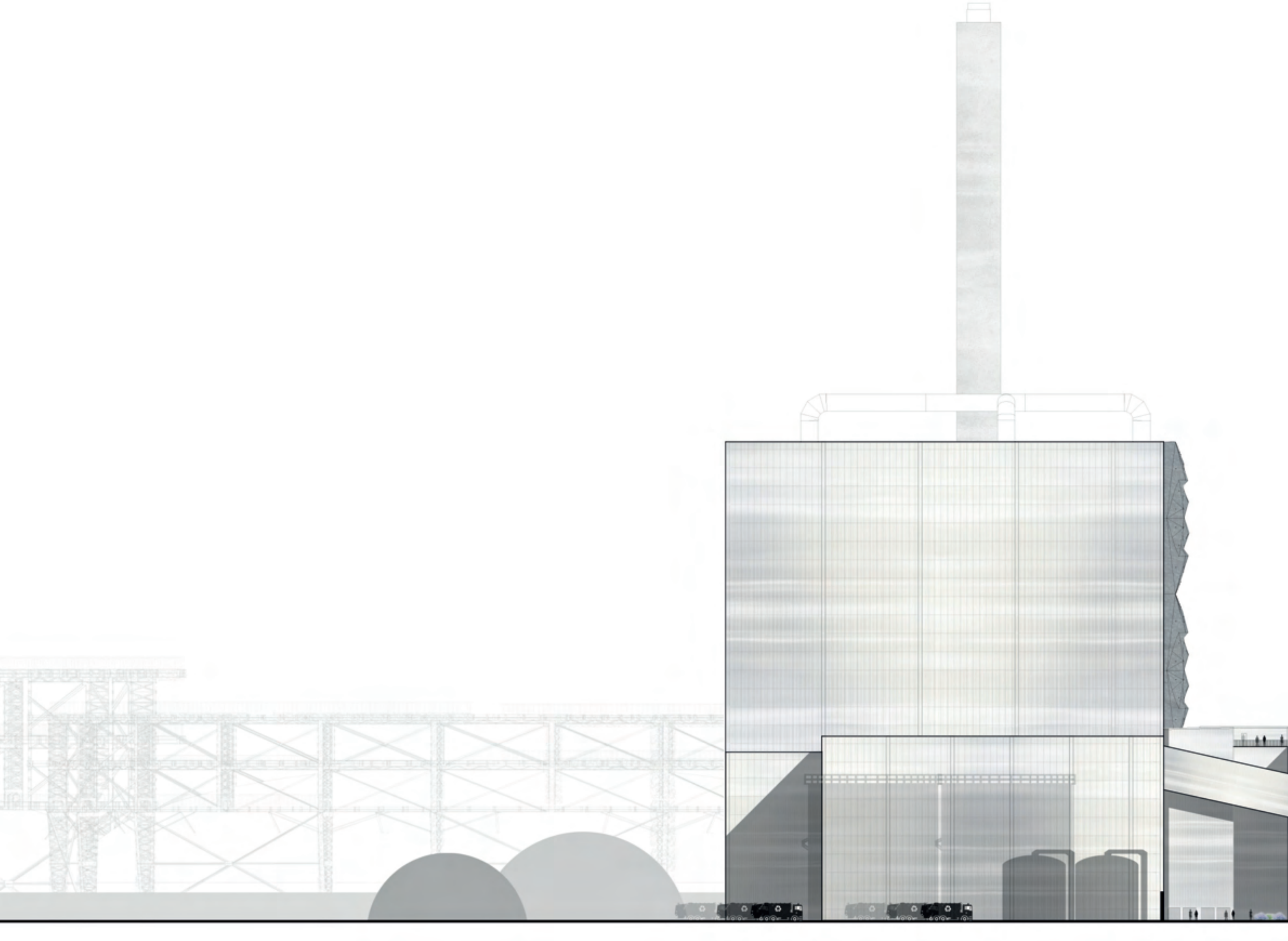
0 10 20 50 M

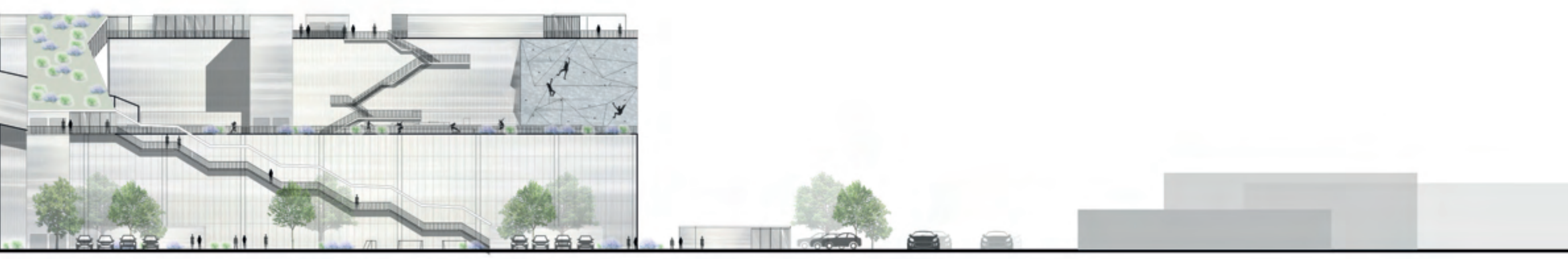
DETROIT RENEWABLE POWER AREA: SECTION

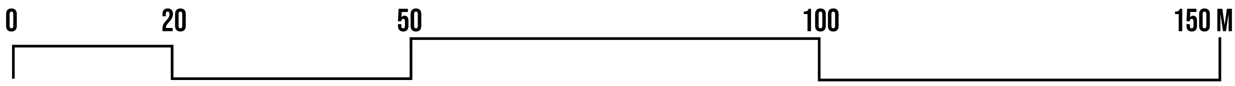



Enjoy
DETROIT
0
20
50
100
150 M

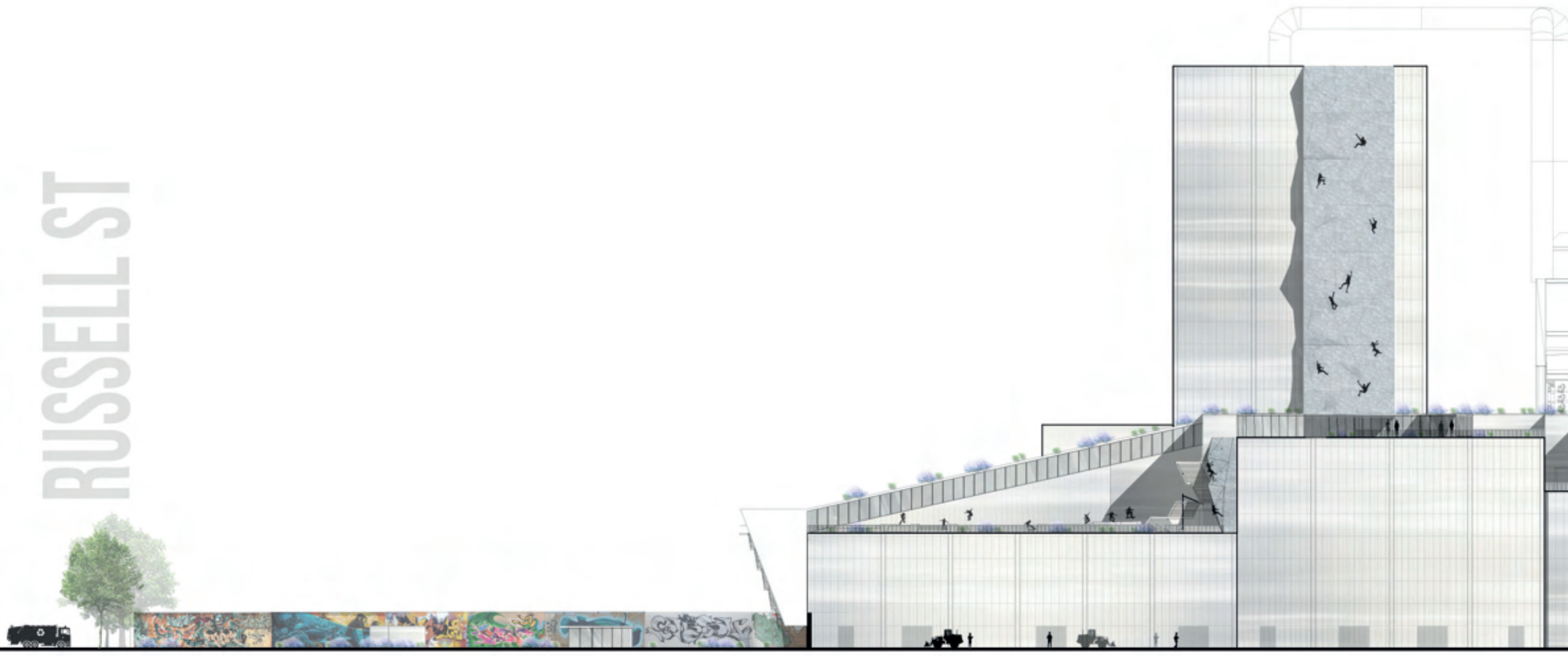
DETROIT RENEWABLE POWER AREA: ENTRANCE FRONT






0
20
50
100
150 M

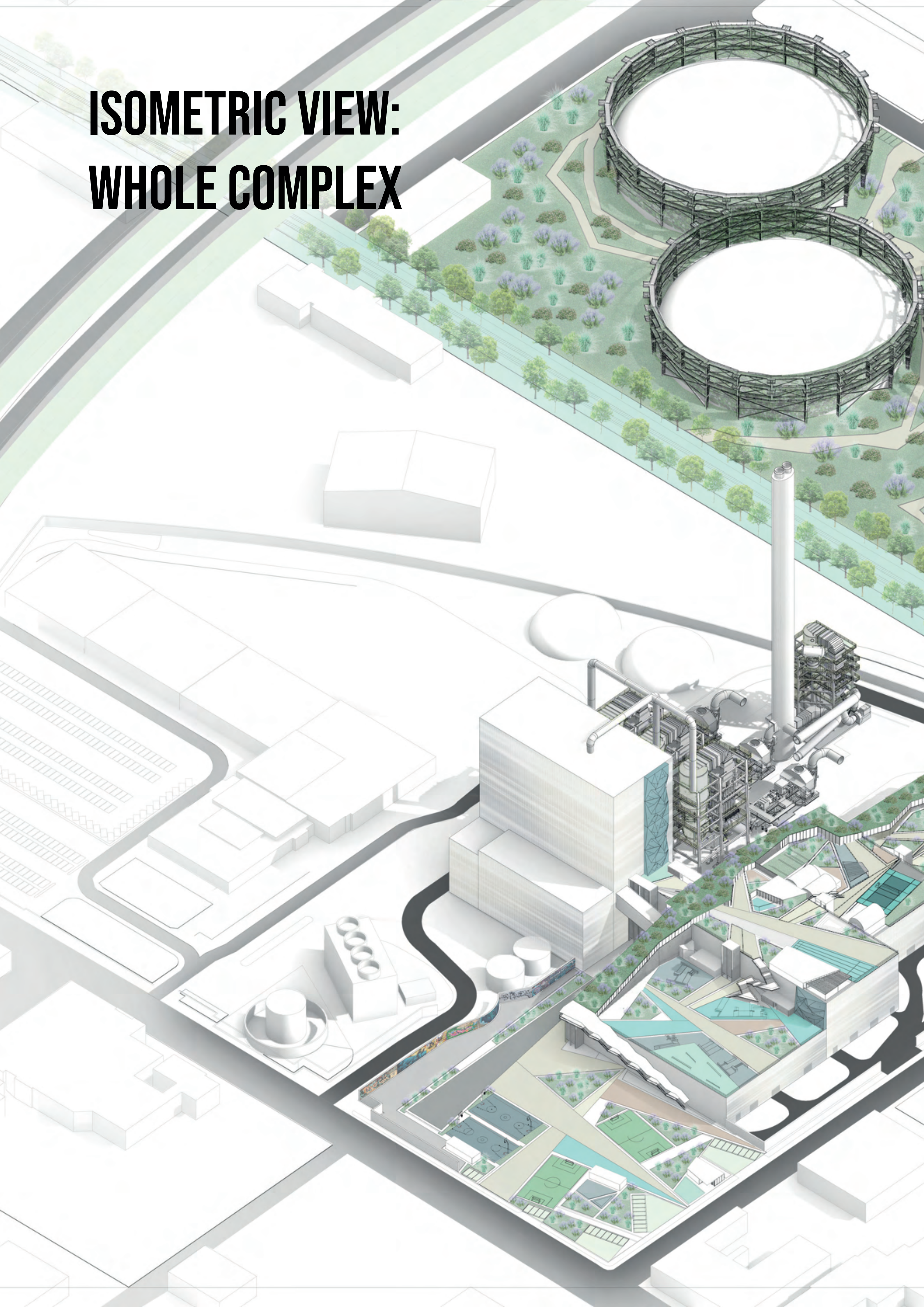
DETROIT RENEWABLE POWER AREA: SIDE

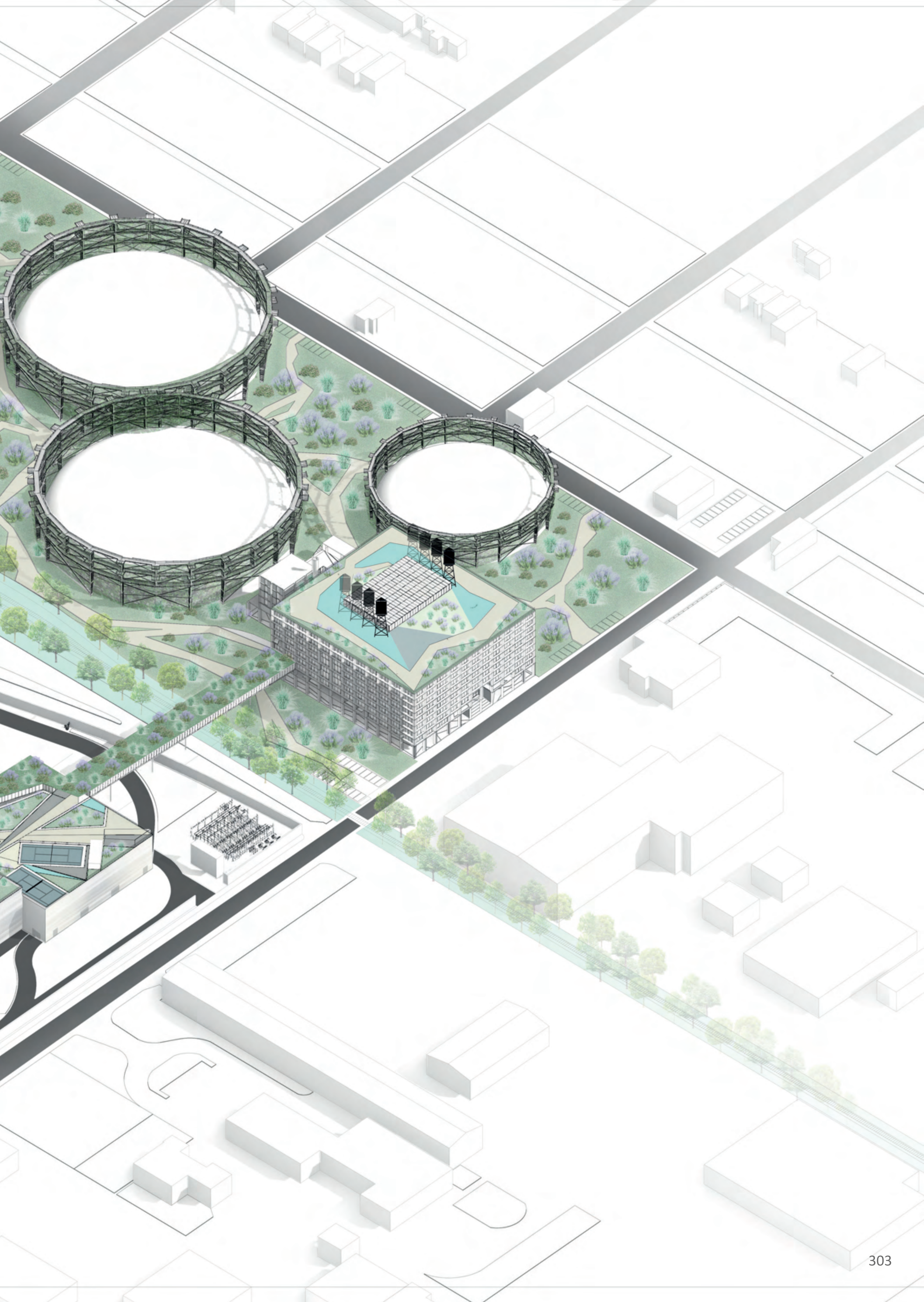



JOE LOUIS GREENWAY
0
20
50
100
150 M

4.2.3. AXONOMETRY

ISOMETRIC VIEW:
WHOLE COMPLEX

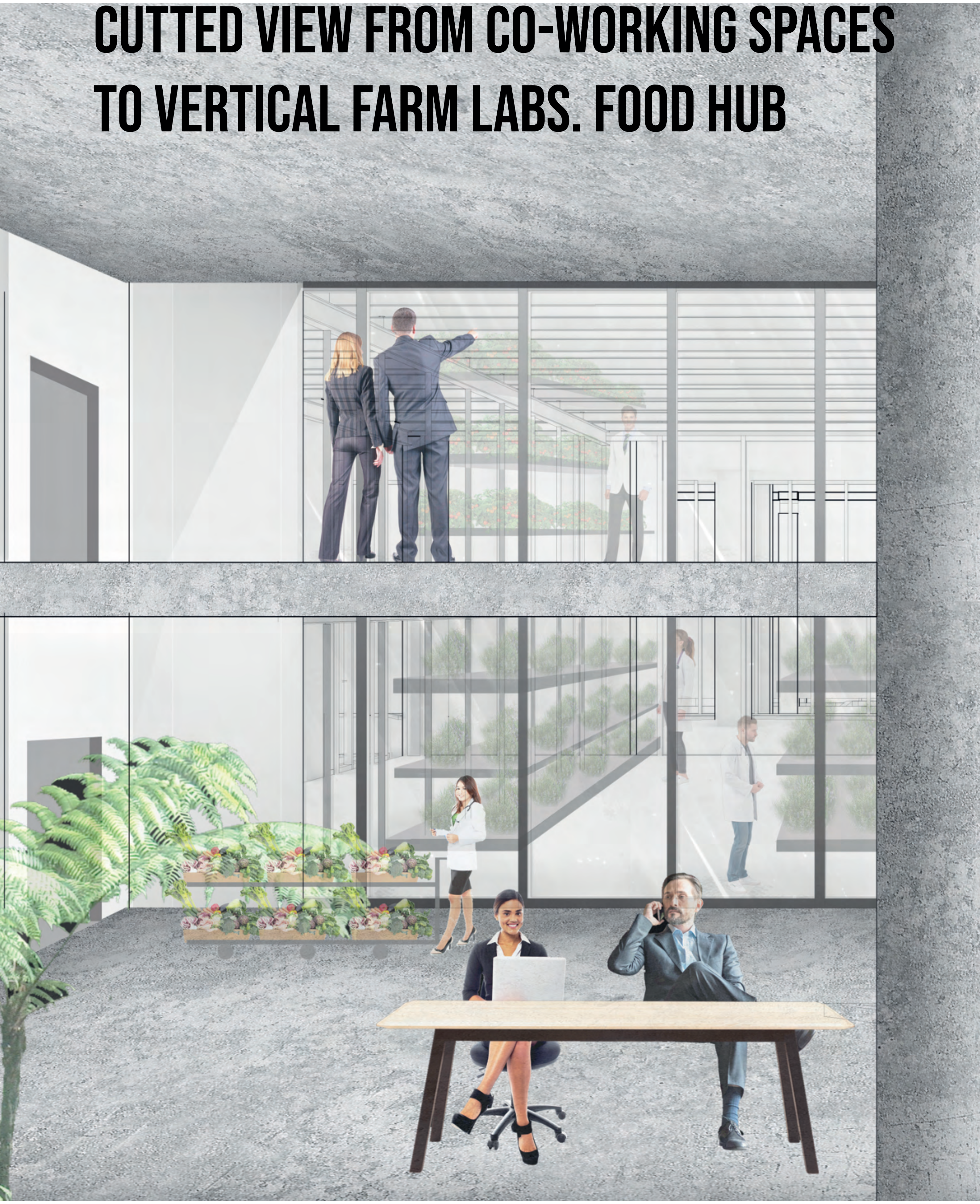




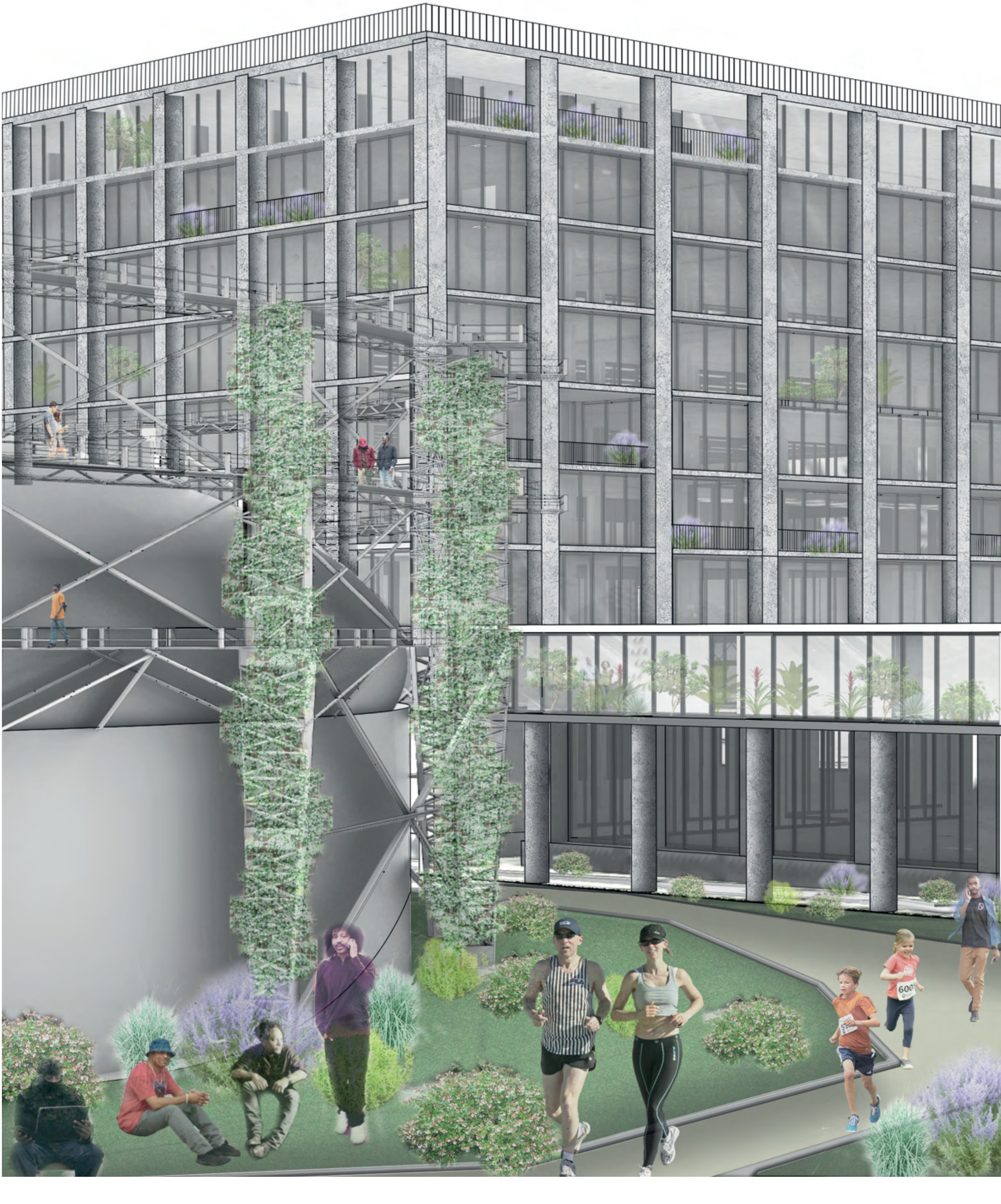
4.2.4. VIEWS

VIEW FROM THE STREET-ART GALLERY ON THE SKATE-PARK. INCINERATOR ROOFTOP

CUTTED VIEW FROM CO-WORKING SPACES TO VERTICAL FARM LABS. FOOD HUB



VIEW FROM BIOMASS PARK TO THE FOOD HUB



4.2.5. CONCLUSIONS

Resuming interventions and strategies, this study takes a very green look at the future and despite big investments in the sector to allow for massive energy production and the recovery of two buildings, it can give a lot in terms of green features and natural habitats to the community of Detroit. Starting from architectural design and landscaping on 116,000 square meters of land surface which is totally devoid of greenery, the design would recover 45,000 square meters, turning them into green areas with trees, shrubs, and parks. Heat islands would also be avoided with an increase of approximately 40% of breathable surfaces. Of these, about 2,350 out of 14,000 square meters would be redesigned to green spaces in the buffer zone, a proposed park at the entrance of the incinerator. On the facility roof there is 2,325 out of 15,815 square meters to be used as a park with plants, shrubs and lawns. In the end, the biomass park will sustain about 40,000 square meters on 86,500 of the whole area, including a further 38,000 square meters of biomass digesters. Closing the landscape issue, more than 2500 plants, shrubs, and trees will be planted in the open area. Plants such as Perovskia atriplicifolia, Trachelospermum jasmonoides, Abelia x grandiflora, thyme and Carex have been chosen to be part of the landscape as they are very resistant plants to temperature changes between summer and winter, and grow luxuriantly without the need for much maintenance.
Regarding the architecture project, it has recovered about 15,800 square meters from the roof of the facility, and approximately 49,200 square meters has been dedicated to the redesigning of the Grand Trunk Warehouse, at 1950 E Ferry St. The only addition to the existing volume is the link between the two facilities and its continuation on the incinerator roof which contains a combined function of greenhouses and street art museum with exotic plants. Any modifications will be as sustainable as possible, also in terms of cost. The food hub project consists in utilizing the structure by demolishing all the useless walls and emptying the core of the building to make space for the vertical farm. The incinerator design, instead, consists in a restructuring of the process rooms, making the roof flat (the old structure is 50 years old), and wrapping the whole facility with polycarbonate panels that allow daylight to penetrate, but also allow the internal light to illuminate the structure and make it a landmark for the neighborhood at night, having the incinerator operating all year round. Interiors are simple in design, creating voids with double height to let the building breathe together with the users, designing views and spaces for study and co-working on some floors, productive and refreshment areas on others, to create a whole experience through vertical farms, demonstrative greenhouses, and green pathways to improve the quality of life inside the food hub.
Finally, concluding with the energy data, five digesters will be positioned in the area, currently occupied by a metal deposit. This biomass plant can achieve power through the incinerator, of 103,200,000 kWh/year. This means it can sustain the whole vertical farm which needs about 15,000,000 kWh/year. The extra energy will be used for the entire complex and, in collaboration with district heating, distributed to Detroiters. This could reduce energy bills for low-income families (about 78,000), recovering $ 6,000,000 per year which can be put towards the improvement of conditions and the quality of life.
The vertical farm, then, with its 13,000 square meters used for cultivation, will produce an amount of 1,300 tons of fresh food every year, resulting in a yield of 100 kg/m2.
All that food would be sold in the market, or delivered by a rider network using the Joe Louis Greenway and other railway or paths currently being proposed and planned in recent years in Detroit, bringing fresh food directly to the people and encouraging more organic trash and recycling. This project is an hypothesis of how to combine energy facilities with food production areas in order to create new districts where people will be drawn, avoiding urban sprawl in favor of a newly, future shrunken cities.

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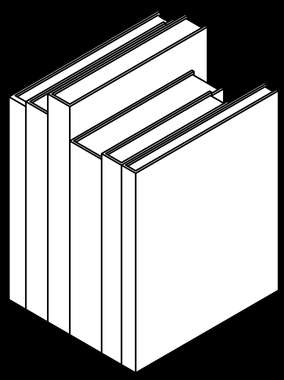

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