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   The Biorefinery Expo
1. INTRODUCTION

CHICAGO (HISTORY) & INDUSTRIAL CORRIDORS
ANALYSIS ON CHICAGO & PILSEN NEIGHBORHOOD

RESEARCH BOOKS
GENERAL THEME: INDUSTRIAL CORRIDORS

1909 BURNHAM PLAN:
STRICT ZONING FOR INDUSTRIAL CORRIDORS

2016:
INDUSTRIAL CORRIDORS STILL EXIST TODAY, HOWEVER...

The Biorefinery Expo

Complex Projects | Pilsen - Chicago | P4 Presentation | Niels van der Salm | 2016
2. PILSEN (LOWER-WESTSIDE)
CURRENT-STATE OF PILSEN’S INDUSTRIAL CORRIDOR
Low-income neighborhood
mexican neighborhood (80-90%).
33,000 residents

The neighborhood is divided in two areas:
a residential neighborhood and an industrial corridor
SIMILAR PROBLEMS AS IN OTHER INDUSTRIAL CORRIDORS

22% OF LAND IS VACANT IN PILSEN’S INDUSTRIAL CORRIDOR.
UNDER-USED SPACE

ABANDONED BUILDINGS

CONTAINER YARDS

UNDER-USED SPACE
UNACCESSIBLE WATERFRONT & POLLUTION
Contamination of soil and water

Soil and waterways, like the sanitary canal are heavily polluted along the industrial corridors. Remediation is needed if these site’s want to be redeveloped for non-industrial uses.

Sewage overflow
OPPORTUNITIES
CLOSE PROXIMITY TO CITY CENTRE AND UNIVERSITIES

LOCATED ALONG RIVER’S WATERFRONT

20 min bicycle ride to city centre
12 min with public transport
8-10 min with public transport
to universities, hospitals and convention centre
3. URBAN STRATEGY
TRANSFORMATION INTO MIX-USE - SUSTAINABLE NEIGHBORHOOD
HOW TO TRANSFORM THE INDUSTRIAL CORRIDOR OF PILSEN?
TRENDS IN INDUSTRY - MANUFACTURING

DIGITAL FABRICATION

3D PRINTING

ROBOT MANUFACTURING

MASS CUSTOMIZATION

SUSTAINABILITY
CIRCULAR ECONOMY

ALLOW FOR BETTER INTEGRATION WITH URBAN ENVIRONMENT

• LESS POLLUTION, NOICE, SMELL
• RENEWABLE ENERGY
• SMALLER SCALE MANUFACTURING
• CIRCULAR ECONOMY - RECYCLING MATERIALS
CONCLUSION:

FUTURE INDUSTRIES PROVIDE OPPORTUNITIES TO BE MIXED FURTHER WITH URBAN NEIGHBORHOODS

SMALLER, CLEANER AND SUSTAINABLE
MAIN GOALS

CURRENT SITUATION
STRONG DIVISION BETWEEN RESIDENTIAL AND INDUSTRY

GOAL
INDUSTRIAL CORRIDOR BECOMES PART OF THE CITY
WORKING, LIVING & RECREATION MIXED
URBAN STRATEGY: 5 THEMES

1. NEW CONNECTIONS
2. USE EXISTING QUALITIES
3. NEW ECOLOGY
4. CREATING A MIX-USE CORRIDOR
5. SELF-SUFFICIENCY & SYMBIOSIS

create a self-sufficient neighborhood network
THEME 1: NEW CONNECTIONS

- Waterfront as connecting element to city centre & other neighborhoods
- Sustainable ways of transport: Bike - Water-taxi - Public transport

END OF CHICAGO RIVERWALK
AS PROPOSED

THE LOOP

20 MIN.
BIKE RIDE TO CITY CENTER
Theme 2: New Ecology

- Remediation of Soil
- Reedfilter park > Cleaning of river water
- Leisure - Recreation - Sports
- Parkroute towards city centre
FUNCTIONS OF GREEN INFRASTRUCTURE

- **Parkroute**
  - Bike and pedestrians

- **Leisure - sports - recreation**
  - Wetland park
  - Purification river water

- **Water retention**
  - Parkroute
  - Leisure - sports - recreation
  - Wetland park
  - Purification river water
THEME 2: RESPOND TO EXISTING

- Use existing subdivision of plots for development/phasing
- Develop the area strip-by-strip
THEME 1: RESPOND TO EXISTING

- Preserve & Transform industrial heritage
- Anchor-points for new development
- Respond to existing developments in art-district
PHASING FROM EAST TO WEST

- Start from the already vacant plots
- Transform industrial heritage first

Phase 1:
East part of Pilsen industrial corridor

Phase 2:
West part of Pilsen industrial corridor

Phases are possible to overlap depending on the real development process.

Later  Earlier
PRESERVE INDUSTRIAL HERITAGE
USE EXISTING SUB-DIVISION OF STRIPS TO
GRADUALLY REPLACE EXISTING DIRTY INDUSTRY

REMEDICATION OF SOIL
CREATION OF WATERFRONT PARK

TRANSFORMATION
NEW DEVELOPMENT
THEME 3: MIX-USE INDUSTRIAL CORRIDOR

• Mix-use program
• Creative industry
• innovative and clean (manufacturing) industry
• small and medium size enterprises
SEQUENCE OF FUNCTIONS
The program-mix RATIO can differ in each strip
The pattern of different function zones in each strip creates clusters at certain points where ecological, residential, industrial, and commercial functions come together.

**Interaction Between Functions**

**Different Atmospheres**
SELF-SUFFICIENT NEIGHBORHOOD

- Renewable energy
- Local waste & water-treatment
- Waste-to-energy & Resources
- Local Heat and Power grid
- Exchange of surplus heat and power
SOLAR ROOFS & GREEN ROOFS

- Solar Roofs
- Green Roofs
- Waste-to-energy
- Water-treatment
- Solar roofs & Green roofs
- Parking, Incl. charging stations
- Vehicle to grid
- Offices & public buildings
Different energy demands between functions during the day and year
- Exchange of surplus heat and electricity (Smart-grid)
- Vehicle-to-grid power storage to deal with intermittency
- Renewable energy generation > PV cells & Waste-to-energy
- Green infrastructure > Water retention
4. CIRCULAR / BIO-BASED ECONOMY

TRANSITION TOWARDS CIRCULAR ECONOMY; WASTE BECOMES A RESOURCE
WHY DOES WASTE AND WASTE WATER NEED TO BE TREATED IN A DIFFERENT WAY?
TRANSITIONS IN ECONOMY, INDUSTRY AND ENERGY

From fossil energy to renewable energy

From linear to circular economy

From products based on fossil-fuel chemicals to bio-based economy
Waste becomes a valuable resource
26% of the municipal waste consist of organic waste

“In lower-income neighborhoods like Pilsen this is even more, namely 32.6%, of which the largest part (19%) consist of food scraps”

Recycling rate: 8%

One of the worst in USA!
National average = 34.1%
LANDFILLS

ONLY 8% OF RESIDENTIAL WASTE IS RECYCLED WHICH MEANS THE OTHER 92% STILL ENDS UP IN LANDFILLS

Large distance transport of waste to remote locations
WASTE
BECOMES A VALUABLE RESOURCE
IN THE CIRCULAIR/ BIO-BASED ECONOMY

WASTE-TO-RESOURCES
WASTE-TO-ENERGY
OPPORTUNITIES FOR LOCAL WASTE & WATER-TREATMENT

- Water-use reduction & water-re-use
- Prevention of sewage overflows
- Cleaning the river
- Enable recreational-use of river
- Recovery of waste-heat
- Bio-gas production from sewage sludge & organic waste
- Extraction of fertilizers
- Algae production & refinery of bio-chemicals for products like bioplastics

Waste-water treatment

Organic waste-treatment
ANAEROBIC DIGESTION

SEWAGE SLUDGE
WATER-TREATMENT

ORGANIC WASTE
RESIDENTIAL AND INDUSTRY

BIOMASS FROM CUTTINGS
PUBLIC GREEN AND CONSERVATORY
CAN THESE FACILITIES BE PLACED NEAR URBAN AND RESIDENTIAL AREAS?
THE PROBLEM WITH CONVENTIONAL LARGE-SCALE UTILITY SYSTEMS

Smelly, dirty and polluting facilities outside the city
However...

Innovative technologies provide opportunity to bring those facilities closer to the urban environment.
ORGANICA WATER-TREATMENT SYSTEM

ODORLESS MEDIUM TO LARGE-SCALE WATER-TREATMENT WITH BOTANICAL PLANTS

3,000 species
8,000 – 12,000 mg/l biomass

Walkway and plant supporting rack
Plants on the supporting mesh
Root zone (up to 1.5m) as fixed film carrier
Engineered supporting media
Fine bubble aeration

ODORLESS COST AND SPACE EFFICIENT WATER-TREATMENT WITH PLANTS SUITABLE FOR DEPLOYMENT IN URBAN AREAS

THE WATER-TREATMENT FACILITY CAN DOUBLE-FUNCTION AS A PUBLICLY ACCESSIBLE BOTANICAL GARDEN, WHERE ALSO EDUCATIVE TOURS ARE HELD.
Black and grey-water from 250 households is separately collected and treated within the neighborhood.
BIOREFINERY INTEGRATED WITHIN NEIGHBORHOOD

Flow chart

Waste Recovery Hub

Biogas or Heat

Fertilizers

Agricultural land

Urban farming

Biofuels

Trucks

Clean water

Clippings

Biochemical

Bio-plastics

3.33

Heat

Bioenerg

Pilsen

Businesses & Industry

Food & Bioplastics (Biodegradable)

Organic waste

Waste water

Pilsen Residential Neighborhood

Organic waste

Improved Environment

* Leisure

* Recreation

Chicago River

Wastewater

Sewage outflow prevention
MAIN QUESTION:

HOW TO INTEGRATE A PUBLICLY ACCESSIBLE WASTE-RECOVERY-FACILITY INTO THE URBAN ENVIRONMENT OF PILSEN?
PROGRAM
BIO-REFINERY PROGRAM

- Waste Processing
- Anaerobic Digestion
- Bio-refinery
- Waste-to-Energy
- Waste-to-Resources
- Wastewater Treatment
- Botanical Garden
- Urban Farming
- Research & Innovation
- Swimming Pool
- Recreation
- Visitors Centre
- Expo - Education
The building is more than a waste-to-energy plant

Leisure - Recreation - Education - Social

Indoor community garden - Urban farming

Swimming pools - Sauna

Botanical garden

Indoor park

Visitors route

Educative functions - Workshops
VISITORS ROUTE: AWARENESS & EDUCATION

![Image of a bucket filled with various food scraps]

![Image of children observing plants]

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RESEARCH FUNCTION

RESEARCH LABS: RESEARCH AND DEVELOPMENT IN NEW TECHNIQUES FOR USE OF BIOMASS AS RESOURCE

ALGAE REACTORS

ALGAE GROW ON NUTRIENTS IN WASTE WATER

ORGANIC WASTE TO BIO-PLASTICS
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PRE-TREATMENT

1
Collection & Filtering

MAIN-TREATMENT

2
Biological Process

AFTER-TREATMENT

3
Filtering & UV-Treatment
STEP II: ORGANCIA FCR SYSTEM

- C-profile
- Carrier frame
- Biofiber media unit
- Fastening ropes
- Eye nuts

- Walkway and plant supporting rack
- Plants on the supporting mesh
- Root zone (up to 1.5m) as fixed film carrier
- Engineered supporting media
- Fine bubble aeration

- 3,000 species
- 8,000 – 12,000 mg/l biomass

- Inlet pumping station
- Sorted municipal solid waste
- Residual waste from industries
- Receiving station for solid organic waste
- Primary shredder
- Secondary shredder
- Magnet separator
- Pulper
- Pumpable industrial waste
- Biodigester
- Dewatering silo
- Biogas
- Biogas to gas storage
- Steam generator
- Thermal hydrolysis
- To waste water treatment
- Reject water treatment
- To reject water treatment
- Sludge strainer
- Sludge storage
- Screw press
- Electricity
- Gas engine
- Heat
- Gas boiler

- Step 1: ORGANIC FCR system

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PRE-TREATMENT

1

COLLECTION & FILTERING
SHREDDING

MAIN-TREATMENT

2

BIOLOGICAL PROCESS
ANAEROBIC DIGESTION

AFTER-TREATMENT

3

BIOGAS > POWER & HEAT
DEWATERING > FERTILIZER
WASTE RECEPTION

FILTERING & SHREDDING

Heavy fraction
Light fraction
Grit fraction
STEP 3 & 4: ANAEROBIC DIGESTION & AFTER-TREATMENT

- Anaerobic digesters
- Digestate dewatering centrifuge
- Biogas to Combined heat & power generator (CHP)
- Digestate collection
- Fertilizer for agriculture
SYNERGY BETWEEN FUNCTIONS

**UTILITY SYSTEMS**
- Organica Water Treatment + Botanical Garden
- Heat Exchanger: Waste Water +/- 15-20°C
- Sewage Sludge from Waste-Water (desilting)

**PUBLIC FUNCTIONS**
- Digestate used for research & monitoring: extraction of bio-chemicals
- Experiments in production bio-plastics
- Community Gardens & Urban Farming
- Fertilizer from digestate
- Food from Urban Farming

**RESEARCH FUNCTION**
- Algae Reactors

**INTERNAL USE OF HEAT AND POWER FOR WASTE WATER SYSTEMS**
- Bios to Power & Heat
- Food waste from restaurant
- Waste Water Vacuum-Toilets

**WASTE WATER MANAGEMENT**
- Internal use of heat and power for waste water systems
- Excess Water Waste Treatment + Nutrient Rich Water
- Food Waste from Restaurant
- Sewage Sludge from Waste-Water (desilting)
- Waste Water Vacuum-Toilets
- Digestate used for research & monitoring: extraction of bio-chemicals
- Experiments in production bio-plastics
- Community Gardens & Urban Farming
- Fertilizer from digestate
- Food from Urban Farming
- Algae Reactors
- Bios to Power & Heat

**THE BIOREFINERY EXPO**
Space requirements

TOTAL FOOTPRINT
9500 M2

ORGANIC WASTE-TREATMENT
2656 m2

WASTEWATER-TREATMENT
1245 m2

SWIMMINGPOOL
1780 m2

PUBLIC FUNCTIONS
804 m2

OFFICE - LAB
900 m2

PROGRAM BAR

Industrial - Private

Public - Recreation

Semi-public

ORGANIC WASTE-TREATMENT

WATER-TREATMENT

SWIMMINGPOOL

VISITORS ROUTE & RESTAURANT

LAB & OFFICE

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WHERE TO PLACE SUCH A FACILITY?

SITE
CURRENT SITUATION

PLOT NEXT TO FORMER FISK COAL POWER PLANT

LOCATION:
NEXT TO FORMER FISK COAL POWER PLANT
IN ONE OF THE GREEN FINGERS OF THE URBAN STRAEGY
SIDE CANAL + WATERFRONT PARK
ALONG BIKE-ROUTE TOWARDS CTA STATION
ONE OF THE FIRST VACANT PLOTS OPEN FOR DEVELOPMENT
CONNECTION TO SITE / SURROUNDINGS
INSTALLATIONS WASTE-TO-ENERGY

Organic waste-treatment
2656 m2

Wastewater-treatment
1245 m2
Inbetween space for logistics, maintenance, employees and visitors route
FLOORPLAN - CONFIGURATION FUNCTIONS

1. Waste reception - Truck station
2. Waste pre-treatment
3. Anaerobic digesters
4. After-treatment
   (biogas > energy & heat)
   (digestate > fertilizer)
5. Outgoing grit & fertilizers

A. Waste water from digester to water-treatment
B. Sewage sludge from water-treatment to digester
C. Waste heat (+/- 20°C) from sewage water recovered by heat exchanger for swimming pool heating

I. Pre-treatment
   - grit-removal
   - sludge-removal
II. Secondary treatment
    - Organica FCB system
    - water-treatment with plants
III. Tertiary treatment
     - sludge removal
     - UV-purification

Organic waste-treatment process
Water-treatment process
HEIGHT REQUIREMENTS INSTALLATIONS

WASTE-TREATMENT PROCESS  8 - 12 M HEIGHT REQUIRED

WATER-TREATMENT PROCESS  4 - 8 M HEIGHT REQUIRED

installations for water-treatment have lower height requirements
The organica system is publicly accesible
Views towards park & industrial heritage from terraces

Visual relations between public landscape & industrial process
PUBLIC LANDSCAPE ON TOP OF INDUSTRIAL PROCESS

Waste-treatment process
8-12 metres high

Water-treatment process
4-8 metres high

CONNECTION WITH PARK
BARCODE SEQUENCE FROM (PRIVATE) INDUSTRIAL FUNCTIONS
TO PUBLIC FUNCTIONS TO PARK (RECREATION)
ENTRANCE
Heat exchangers recover heat (± 20°C) from the treated waste-water at the end of the water-treatment process to use for heating the swimming pool's water.
MAINDECK

FROM THE MAINDECK ALL OTHER FUNCTIONS ARE ACCESSIBLE
VISTORS ROUTES

GREEN ROUTE
Botanical garden - community gardens - flower gardens - algae reactors

BLUE ROUTE
Educational Water-treatment tour - swimmingpool

BROWN ROUTE
Educational Waste treatment tour - Research labs
GREEN ROUTE

Flower gardens

Algue reactors - urban farming

Community gardens

Botanical garden

indoor park
PLANTERS INTEGRATED WITHIN FLOORS

Fragment plantenbak 1:20
Plantenbak geïntegreerd in Demontabel vloer-systeem

SMARTLINE floor - IPE 220mm
(Demontabel) beton-staal

Geprofileerde staalplaat

Worteldoek 6mm

Beschermlaag waterkerend 6mm

Beschermende laag 6mm

Drainage laag 110mm

Substraat (onder) grof 350mm- geexpandeerde kleikorrels

Substraat (boven) fijn 550mm- vulkanische lavakorrels (lichtgewicht 0-3mm)

Ventilaat toevoer - Holcon vloer

Staal-beton vloer

Ingestort wapenings vakwerk (demontabel)

Verankering (gebout) t.b.v. schijfwerking

Viskoosheid (vloeistof) t.b.v. aderwerk

Waterafvoer - Afdekplaat

(t.b.v. bereikbaar installaties en leidingen)

Waterafvoer

Ventilatie-tunnel

Kapersfilter-standplaat

Standaard boom - IPF 220mm

Demontabel- betonnen
COMMUNITY GARDENS - URBAN FARMING

Social interaction - enhancing community
Educative function - Healthy food & life style
CONNECTION RESTAURANT AND COMMUNITY GARDENS

- Fertilizer from waste-treatment
- Urban farming
  Community gardens
- Cooking workshops
- Restaurant
  Vegetables from urban farming
- Food scraps go back to waste-process
- Waste-treatment process

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WATER ROUTE

[Diagram of a water route in a building layout]
WATER ROUTE

A. Waste water from digester to water-treatment
B. Sewage sludge from water-treatment to digester
C. Waste heat (+20°C) from sewage water recovered by heat exchanger for swimming pool heating.

I. Pre-treatment
   - Grit removal
   - Sludge removal
II. Secondary treatment
   - Organics PCR system
   - Water-treatment with plants
III. Tertiary treatment
   - Sludge removal
   - UV purification

- Inlet pumping station
- Grit chamber
- Coagulation
- Flocculation
- Drum filter
- Buffer tank
- Al/Fe
- Polymer
- Internal recycling
- Sludge recycling
- Disc filter
- UV bank
- Biogas to gas storage
- Gas storage
- Steam generator
- Thermal hydrolysis
- To waste water treatment
- Reject water treatment
- To reject water
treatment
- Hygienisation
- Heat exchanger
- Sludge strainer
- Sludge storage
- Screw press
- Electricity
- Gas engine
- Heat
- Gas boiler
- Magnesium buffer tank
- Sludge recycling
- Internal recycling
STEP I: PRE-TREATMENT

I. Pre-treatment
   - grit removal
   - sludge removal
II. Secondary treatment
   - Organic FCG system
   - waste treatment with plants
III. Tertiary treatment
   - sludge removal
   - UV purification

Inlet pumping station → Grit chamber → Coagulation → Flocculation → Drum-filter

Al/Fe → Polymer
STEP II: MAIN TREATMENT WITH PLANTS
STEP II: ORGANCIA FCR SYSTEM
STEP III: AFTER-TREATMENT
BROWN ROUTE

WASTE & ENERGY
WASTE-TREATMENT ROUTE / PROCESS
Doorsnede 1:200 korte zijdev- zwembad - terras
Doorsnede 1:200 lange zijde
MATERIALIZATION & STRUCTURE

REFERENCE CONCEPT:
INDUSTRIAL CHARACTER VS. BOTANICAL GARDEN
STEEL VS. GREENERY

MFO Park - Zürich - 2002
Raderschall Landschaftsarchitekten AG + Burckhardt & Partner AG

Intesa Sanpaolo Office Building - Turin - Italy - 2015
Renzo Piano Building Workshop
MATERIALIZATION & STRUCTURE

REFERENCE: MIES VAN DER ROHE: STEEL EN GLASS > TRANSPARENCY

Toronto-Dominion Centre - Mies van der Rohe
DETACHABLE STRUCTURE

CIRCULAR ECONOMY

FLEXIBILITY

UNCERTAIN LIFE-SPAN OF INSTALLATIONS

DROGE VERBINDINGEN - DEMONTABEL - STANDAARD GRID 5,4 METER
HOLCON FLOORS

STEEL TRUSSES > GRID OF 5.4 METERS
COMMONLY USED GRID-SIZE

ETF E

DETACHABLE JOINTS
BIO-FOAM (??)
FACADES
Concept of becomes visible in Facade: terraces and public functions on top of industrial functions and separation between botanical garden and waste processing.
FAÇADE SUNSHADING
ETFE ROOF SUNSHADING