SUSTAINABLE SEAWEED FARM
FOR SUSTAINABLE FOOD PRODUCTION IN THE NETHERLANDS
1 PROJECT AIM
2 FUNCTION & CONTEXT
3 DESIGN CONCEPT
4 MATERIALS
5 BUILDING TECHNOLOGY
6 ACHIEVEMENTS

SUSTAINABLE SEAWEED FARM
FOR FOOD PRODUCTION IN THE NETHERLANDS
NATURE
AS INSPIRATION AND SOLUTION
Climate change caused by pollution of a growing population

A growing population demands more space for food production

This project is concerned with...

Negative environmental impact through building related CO2 emission

- Processing
- Transportation
- Operating
- Disposal (Waste)
SUSTAINABLE SEAWEED FARMING IN THE NETHERLANDS

LOCAL AVAILABLE NATURAL BUILDING MATERIALS IN THE NETHERLANDS

TECHNICAL RESEARCH
SUSTAINABLE SEAWEED FARM
FOR FOOD PRODUCTION IN THE NETHERLANDS
MAKE USE OF THE SEA FOR AGRICULTURE.
SHIFT TO A MORE PLANT BASED DIET.

MORE SUSTAINABLE WAY OF FOOD PRODUCTION +
NO WASTE of DRINKING WATER for GROWING FOOD +
NEW VAST EXTRA SPACE FOR FOOD PRODUCTION +
PURIFICATION OF WATER +

SUSTAINABLE SEAWEED FARMING
JACOBHAVEN - OOSTERSCHELDE - ZEELAND
SEAWEED FARM HAS BEEN TESTED
CLEAN AND NUTRITIOUS WATER
GOOD INFRASTRUCTURAL CONNECTION
A LOT OF TOURISM
NEIGHBOUR COMPANY WITH SUSTAINABILITY FOCUS

THE NETHERLANDS - ZEELAND - JACOBHAVEN
EXPANSION seaweed farm
BUILDING SITE

JACOBAHAVEN - ZEELAND - THE NETHERLANDS
CULTIVATED SEAWEED

**SEAWEED CULTIVATION**

**OAR WEED**
Laminaria Digitata  
large brown algae

**SEA BELT**
Saccharina Latissima  
brown algae

**SEA LETTUCE**
Ulua Lactuca  
green algae

**SUMMER**
(spring > September)  
FAST GROWING & LIGHT

**WINTER**
SLOW GROWING

Growing process  
green algae

Growing process  
brown algae
SEAWEED CULTIVATION

SEAWEED PROCESSING

SEAWEED DEVELOPMENT

PRODUCTION PHASES
FUNCTION - SEAWEED CULTIVATION

CURRENT HARVEST

Tausends of kilos of fresh seaweed

Summer: 7 plants per rope (vertical - 2.5 m under water)

Winter: 200 plants per meter (horizontal - 1 m under water)

FUTURE EXPANSION

To maximum 2ha = 205,000 kg fresh seaweed

Processing facility is planned for about 500,000 kg
SEAWEED - PROCESSING PHASES

1. Harvest of fresh seaweed
2. Washing of seaweed
3. Cutting of seaweed
4. Packaging of seaweed
5. Drying of seaweed
6. Freezing of seaweed
7. Dry storage of dried seaweed
8. Cold storage of frozen seaweed
9. Distribution of dried, fresh, and frozen seaweed
PROCESSING SPACES
permanent, 375 m²

WET ROOM
130 m²
12 °C

DRYING ROOM
45 m²
> 20 °C

DRY STORAGE
40 m²
> 20°C no windows

PACKAGING ROOM
120 m²
A) 12 °C high humid
B) 20 °C low humid

FREEZER ROOM
40 m²
- 5 °C to - 25 °C

DISTRIBUTION
LOADING ZONE OUTSIDE

SEAWEED PROCESSING SPACES
PROGRAMME SEAWEED FARM

DEVELOPING SPACE
230 m²

OFFICE
290 m²

PROCESSING SPACES
375 m²

BOATHOUSE
100 m²

STORAGE

DEVELOPMENT
- WORKSHOPS
- BAR/RESTAURANT
- SALE

ORGANIZATION
- EXHIBITION
- SALE

PROCESSING FARM
TOTAL 1000 m²

+ 2 ha CULTIVATION
+ OUTDOOR SPACES

WASHING / CUTTING
DRYING
FREEZING
PACKAGING
STORAGE

TU Delft
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SUSTAINABLE SEAWEED FARM
FOR FOOD PRODUCTION IN THE NETHERLANDS
DESIGN CONCEPT
CONCEPT - FLOWING STRUCTURE
INSPIRATION SEAWEED LAMINARIA
FLOWING STRUCTURE
INSPIRATION SEAWEED LAMINARIA
ORIENTATION
SOUTH SUN - VIEW - ACCESS
1. STAFF CLOAK ROOM
2. STAFF LOUNGE
3. ARCHIVE
4. OFFICE SPACE
5. OFFICE
6. MEETING ROOM
7. DEVELOPMENT KITCHEN
8. WASHING SPACE
9. COLD STORAGE
10. STORAGE
x. BATHROOM
A. RECEPTION & SHOP
B. CLOAKROOM
C. PRESENTATION SPACE
D. EXHIBITION
E. WORKSHOP KITCHEN
F. RESTAURANT WITH TERRACE

LEVEL 0
OFFICE & DEVELOPMENT
LEVEL -1
PROCESSING

-1.0 staff room / changing room
-1.1 staff shower
-1.2 wetroom
-1.3 packaging room
-1.4 drying room
-1.5 dry storage
-1.6 freezer room
-1.7 storage room
-1.8 building equipment
-1.9 delivery area
-1.10 distribution
-1.11 loading zone
-1.12 staff parking
-1.13 boathouse storage

-2.0 storage space
-2.1 storage room
-2.2 harvest room

BOATHOUSE
1. WET ROOM: WASHING
2. WET ROOM: CUTTING
3. PACKAGING ROOM
4. DRYING ROOM
5. DRY STORAGE
6. FREEZER ROOM
7. STORAGE SPACE
8. DISTRIBUTION
9. DELIVERY AREA
10. BUILDING EQUIPMENT

11. BOATHOUSE STORAGE
12. BOATHOUSE HARVEST
A. STAFF ROOM
B. CHANGING ROOM
x. BATHROOM

LEVEL -1 & LEVEL -2
PROCESSING
VISITOR EXPERIENCE
FLOWING STRUCTURE - OUTSIDE
FLOWING STRUCTURE - INSIDE
FLOWING STRUCTURE - RAMPSYSTEM
EXHIBITION

STEG

CULTIVATION

LEARN

SEE

TOUCH

TASTE

RESTAURANT DEVELOPMENT

EDUCATIONAL ADVERTISING
VISITOR EXPERIENCE - ENTRANCE
VISITOR EXPERIENCE - START OF EDUCATIONAL PATH
VISITOR EXPERIENCE - VIEWPOINT ON CULTIVATION
VISITOR EXPERIENCE - WORKSHOP KITCHEN
VISITOR EXPERIENCE - RESTAURANT
OFFICE SPACE

RECIPE DEVELOPMENT

SEAWEED HARVEST

OFFICE

OVERVIEW

DEVELOPMENT

KITCHEN

PROCESSING

CULTIVATION

WORKERS EXPERIENCE
WORKERS EXPERIENCE - OFFICE AREA
WORKERS EXPERIENCE - OVERVIEW PLATFORM
DESIGN CONCEPT
Footbridge based on carriage beams, 200x400 mm (a) with triangulation members (b) to ensure lateral rigidity, resting on structural pillars 200x200 mm. Cross-joints, 100x300 mm (c) rest on the carriage beams and provide a support for the handrails posts 50x100 (d). Longitudinal runners 50x100 (e) rest in turn on the cross-joints, providing support for the planks 15x100 (f).

Source: Ross, Downes, Lawrence (2009) TRADA technology, timber in contemporary architecture.

Decking of spaced planks with grooved upper face.

Material: European oak
Main origin: Western Europe
Strength & density: High
Durability: Durable
Moisture movement: Medium
Cost: High
Common uses: Structure, interior joinery, cladding, decking

* Exudes tannin on first year or so when used externally
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SUSTAINABLE SEAWEED FARM
FOR FOOD PRODUCTION IN THE NETHERLANDS
EMBODIED ENERGY OF A MATERIAL

MINIMALLY PROCESSED
LOCAL AVAILABLE
EASY AND SAFE
ADJUSTED TO PURPOSE
RENEWABLE, REUSABLE or RECYCLABLE

processing - little energy & waste
transportation - no CO2 emission
construction - little energy & waste
operation - good energy efficiency
disposal - little waste & energy

SUSTAINABLE MATERIALS
RAW NATURAL BUILDING MATERIAL

GRADUATION STUDIO
SUSANNE HOFER
TUDelft
RAW NATURAL BUILDING MATERIALS

RAMMED EARTH CONSTRUCTION

TIMBER FRAME CONSTRUCTION

FLAX

SAND

GRAVEL

SILT

CLAY
RAW NATURAL BUILDING MATERIALS

- THERMAL MASS
- SOUND INSULATOR
- LOADBEARING
- AESTHETIC

AESTHETIC SUITS DESIGN CONCEPT

MOISTURE RESISTANT

- FLAX
- SAND
- GRAVEL
- SILT
- CLAY
MIXTURE OF SAND, GRAVEL, SILT & CLAY IS COMPRESSED IN A FORMWORK

- LOADBEARING
- MINIMUM WALL THICKNESS of 20 cm
- PROTECTION FROM RAIN IS NECESSARY

RAMMED EARTH WALLS

- SAND (0.06-2mm): 30% - 45%
- GRAVEL (2 - 20 mm): 20% - 30%
- SILT (0.002 - 0.06 mm): 12% - 21%
- CLAY (< 0.002 mm): 8% - 14%
QUALITIES

+ GOOD THERMAL MASS
+ GOOD SOUND INSULATOR
+ AESTHETICS
+ LOCAL AVAILABLE
+ LOW EMBODIED ENERGY (UNSTABILIZED 0.02 MJ/kg)
+ STABILIZES INDOOR HUMIDITY
+ LONG LASTING
+ BIODEGRADABLE
+ REUSABLE if not stabilized

RAMMED EARTH WALLS
STRUCTURAL FRAMING
CLADDING
INTERIOR FINISHING

TIMBER FRAME CONSTRUCTION
LAMINATED TIMBER
QUALITIES

+ AESTHETICS
+ MOISTURE RESISTANT
+ LOCAL AVAILABLE
+ ORGANIC
+ LOW CARBON EMISSIONS
+ EASY TO WORK WITH
+ BIODEGRADABLE
+ RENEWABLE
+ REUSABLE & RECYCLABLE

TIMBER FRAME CONSTRUCTION
LAMINATED TIMBER
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SUSTAINABLE SEAWEED FARM
FOR FOOD PRODUCTION IN THE NETHERLANDS
LOADBEARING STRUCTURE:
LAMINATED TIMBER

GROUND TOUCHING ELEMENTS:
CONCRETE

LOADBEARING STRUCTURE
**LOADBEARING STRUCTURE:**
LAMINATED TIMBER

**FACADE:**
TIMBER, OAK

**DOUBLE GLAZING WITH E-COATING & ARGON GAS**

**MATERIALS**
BUILDING STRUCTURE

- LOADBEARING STRUCTURE: 160x80
- Facade: 200x400
- Secondary beams: 100x300
- Connected with timber anchor bolts
- Load bearing structure made of FSC certified European oak

**HOLLOW HEAT-EXCHANGING FOUNDATION PILES**
BUILDING ENVELOPE - TIMBER FACADE
SUNSHADING

SOLAR RADIATION
GREEN ROOF

1. HEMP ROOF INSULATION

2. TIMBER SUNSHADING FACADE

3. TIMBER FLOORING

4. OPEN STRUCTURE LAMINATED TIMBER

5. INTERIOR RAMMED EARTH WALLS

MATERIALIZATION

1. HEMP ROOF INSULATION
2. TIMBER SUNSHADING FACADE
3. TIMBER FLOORING
4. OPEN STRUCTURE LAMINATED TIMBER
5. INTERIOR RAMMED EARTH WALLS
BENEFIT CALCULATIONS
RAMMED EARTH VERSUS CONCRETE
CLIMATE COMPARTMENTS
GROUNDLEVEL

N  NATURAL VENTILATION  M  MECHANICAL VENTILATION
Since the local mean temperature of the soil in the Netherlands is about 10 to 11 degrees it is possible to use the soil in summer as natural pre-cooler and in winter as pre-heater. Pipes of 22 cm diameter are laid 1.5 m below the foundations in sand and are falling towards a air collection pit, from where the air is distributed in the building.
When the hollow foundation piles are filled with water they function as heat exchangers with the soil (in the sand layer) both pile and soil act as thermal mass. With this system a low-tech, low-pressure water circulation is possible for the storage of thermal energy. This system is connected to a heat pump for heating and cooling the building.
SUSTAINABLE ENERGY
FROM NEIGHBOURING WINDTURBINES
SUSTAINABLE SEAWEED FARM
FOR FOOD PRODUCTION IN THE NETHERLANDS
CLIMATE CONTROL
- Greenroof
- sunshading facade
- ventilation and heating with soil energy

PROGRAMME
- more sustainable food production (no fertilizers)
- seaweed purifies the ocean
- reduction of seaweed import
- no waste of drinking water
- reuse of current agricultural space for public use

MATERIALIZATION
- renewable & reusable building structure
- little waste & emission
GOOD EXAMPLE
of POSITIVE INTEGRATION of INDUSTRY in the coastal area
of use of SUSTAINABLE CLIMATE SYSTEM
of building with SUSTAINABLE NATURAL RAW BUILDING MATERIALS

PIONEER PROJECT
that provides for the first time a
SPACIAL PROGRAMME FOR A SUSTAINABLE SEAWEED FARM
THANK YOU FOR YOUR ATTENTION

QUESTIONS