deltasync
WATERBASED URBAN DEVELOPMENT

FLOATING **PAVILION**

information brochure

Introduction

In the center of Rotterdam lies an eye-catching building: a floating complex made of three sphere-like structures, attached to a floating square. Being a pilot project it consists of state-of-the-art techniques in the area of floating and sustainable development. It paves the way for climate proof urbanization on the water.

In this brochure you will find all sorts of information about the Floating Pavilion project. What makes this building so special? Why was it built in the first place? This brochure provides you with information on history, research, development strategy, starting points and realization.

Colophon

This brochure is developed by DeltaSync BV

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Project history

In 2006 Royal Haskoning, a Dutch engineering firm which operates internationally, issued the Royal Haskoning International DeltaCompetition to commemorate their 175th anniversary. A group of civil engineering and architecture students from Delft University of Technology joined forces and won the competition with a design and development strategy for a floating city in the IJ-lake, near Amsterdam.

In the report of the panel of judges, the combination of technical innovation and societal processes was appreciated:

> *"Their paper "Floating city IJmeer, accelerator for delta technology" is not only highly visionary, but also provides us with a pragmatic management approach to realize their long-term, sustainable solution to typical urban pressure in a typical delta - the IJmeer in the Netherlands. Moreover, their innovative floating city concept addresses a very urgent need to meet urbanization needs in the Amsterdam-Almere region. We believe that this paper is fine reading material for decision makers and stakeholders currently involved in this process. It combines technical solutions with a management approach based on transition theory, which is currently very popular in (public) management sciences. Finally, the paper is very accessible and the team has worked out inspiring graphical displays of their floating city. All in all, this paper is a highly innovative solution to an urgent problem in a typical delta area without losing sight of practical applicability by integrating technical, environmental, social, economic and public administration knowledge. It is not surprising that the panel of judges came to a unanimous decision to award the first prize of the DeltaCompetition to "Floating city IJmeer"*

The innovative and visionary design and pragmatic management approach received much societal attention. Early in 2007 the students were invited to present their work to the Chief Spatial Planning of the city of Shanghai. Because of the great interest in their work, the students founded the company DeltaSync.

SHANGHAI WORLD EXPO

To create more support for the idea of the floating city the newly founded company DeltaSync started a campaign to found a committee of recommendation. Distinguished and leading individuals from engineering and design consultants, construction companies and public sector, foundations and government organizations joined and expressed their support to the project. DeltaSync also closely involved professors and the board of management of the Delft University of Technology in the project.

Windows of opportunities opened when the prime minister of the Netherlands, J.P. Balkenende, visited China and the Dutch ambassador in China became the president of the Delft University of Technology. Eventually DeltaSync convinced the Mayor of Rotterdam to support the concept of floating urbanization and to write a letter of intent for the Floating Pavilion in Shanghai that would also be Rotterdam's exhibition on the Urban Best Practices area of the World Expo.

After DeltaSync's mission in Shanghai, it appeared that the best possibilities to build a floating pavilion were in Rotterdam. The municipality of Rotterdam and the Port Authority were positive about exploring the possibility of a floating city. The Floating Pavilion would be a perfect first step for this future development.

NATURE OF THE PROJECT

The city of Rotterdam is the lowest-lying delta metropolis in Europe. As a consequence, the city will be affected by climate change and sea level rise. Therefore, the municipality of Rotterdam is taking action on climate adaption and mitigation. At the same time the Port of Rotterdam is constantly transforming. Port activities move from the center to the west, to allow for larger ships to dock. As in many other ports in the world, the old port areas and sites will lose their functions, leaving a vast area directly near the city center for redevelopment. This area of 1600 ha is located outside the dikes and will be one of the main locations for the future urban expansion of the city.

The concept of floating urbanization introduces an interesting strategy for Rotterdam to deal with these challenges. Floating urban development presents the opportunity to create new urban space in the vast area of the old ports that will become available. Moreover, it makes for a flexible and climate proof solution that can cope with uncertain future scenarios. In terms of cultural heritage it offers a non-destructive approach to redevelopment of the old ports in Rotterdam, while keeping the historical legacy in place. And compared to alternatives such as land reclamation, floating structures have a lower impact on the local environment. Land reclamation can have serious environmental consequences, such as reduction in biodiversity, erosion and pollution.

The floating city exhibition in Shanghai

PROJECT FACTS

Location:	Rijnhaven, Stadshavens area; Rotterdam, the Netherlands
Size:	The project consist of the Pavilion and a public square. The building has a size of 1000 square meters, the square has a size of 550 square meters.
Function:	Currently, the pavilion is in use as a conference and exposition center. It is also the seat of the Dutch National Water Center, where national and international delegations, representations and offices are received and informed about the Dutch delta technology.
Finished:	June 2010

Analysis and location

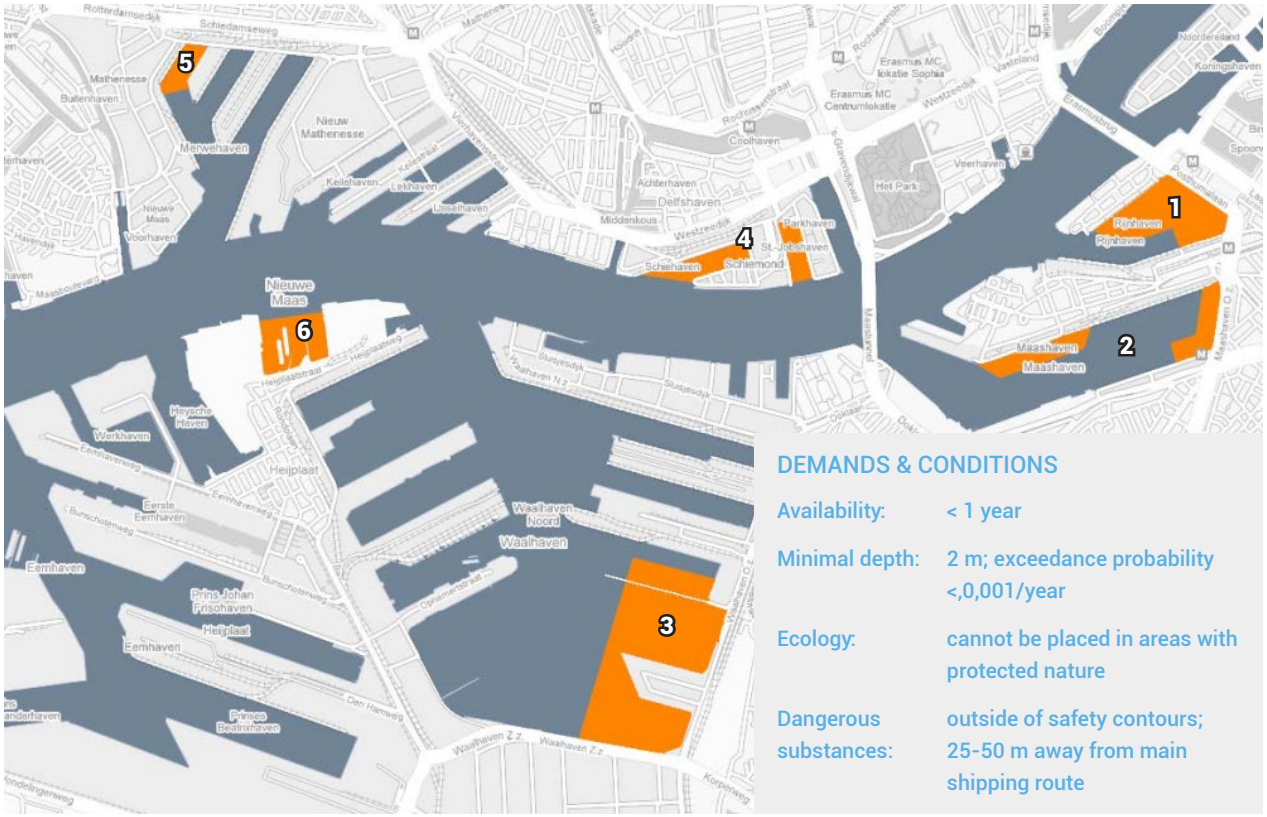
In the preliminary phase of the project the Stadshavens area was analyzed and tested against several demands and conditions. The Stadshavens are the port areas within the city's boundaries which will be developed into new urban space. The analysis resulted in a map of possible locations for the Floating Pavilion, as seen on the right.

Some demands and conditions were applied. The location for instance had to be available within a year. The availability was determined by looking at ownership, active lease contracts, ship routes, harbor activity, current projects and visions, events and temporary functions in the harbor. Other conditions applied, regarding the depth of the harbor, areas with protected nature and safety contours.

From this analysis a list of possible locations was derived. These locations are Rijnhaven (1), Maashaven (2), the east side of Waalhaven (3), St. Jacobshaven or Schiehaven at Lloyds Quarter (4), Merwehaven (5) and Dokhaven at the RDM Campus (6).

Next a top 3 of suitable locations was made by doing a multi-criteria analysis. This form of analysis uses a set of criteria or relevant characteristics to test the location's suitability. The criteria included aspects like livability, technical complexity, accessibility and facilities.

The location and thus its suitability is highly dependent on the function of the floating iconic building. Because of this, next to a location analysis, also a function analysis was performed. In order to investigate how the chosen functions would come into their own the criteria were weighted differently for each function. A restaurant for example would benefit from positive environmental factors, while accessibility may be less important. A conference center however needs to be accessible, preferably by car and public transport.



Possible locations for the Floating Pavilion, based on the demands and conditions

POSSIBLE FUNCTIONS

1) *Leisure/exhibition*
   - Swimming pool
   - Spa/Wellness
   - Sports facilities
   - Large events or disco
   - Exposition
   - Casino
   - Marina or dive center

2) *Catering industries*
   - Restaurant
   - (Grand) Cafe
   - Hotel

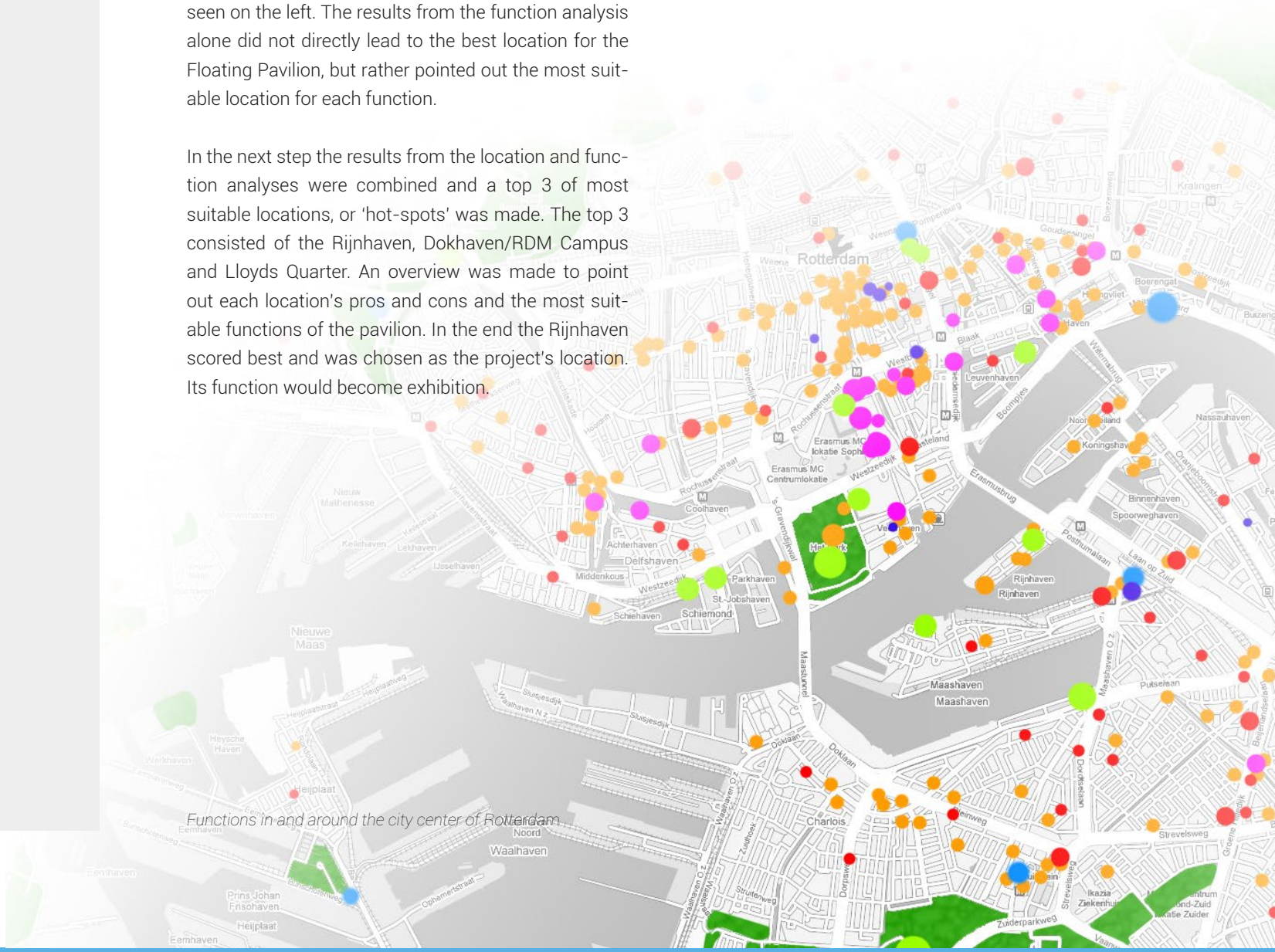
3) *Offices*
   - Offices
   - Conference center
   - Meeting center

4) *Shopping*
   - Shopping mall
   - Mega store

5) *Parking*
   - Parking garage

A lot of functions in different categories were tested, as seen on the left. The results from the function analysis alone did not directly lead to the best location for the Floating Pavilion, but rather pointed out the most suitable location for each function.

In the next step the results from the location and function analyses were combined and a top 3 of most suitable locations, or 'hot-spots' was made. The top 3 consisted of the Rijnhaven, Dokhaven/RDM Campus and Lloyds Quarter. An overview was made to point out each location's pros and cons and the most suitable functions of the pavilion. In the end the Rijnhaven scored best and was chosen as the project's location. Its function would become exhibition.

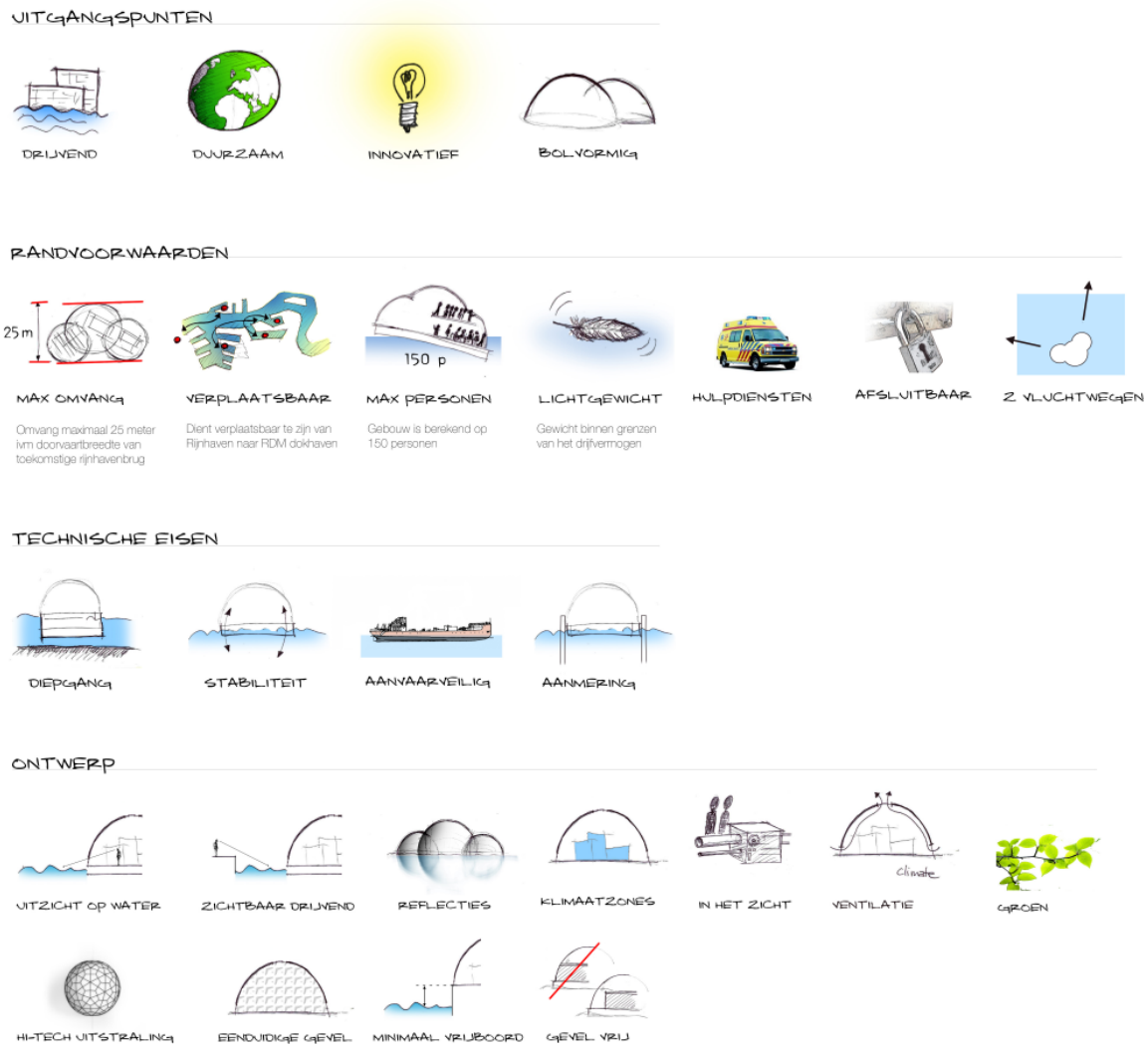


Functions in and around the city center of Rotterdam

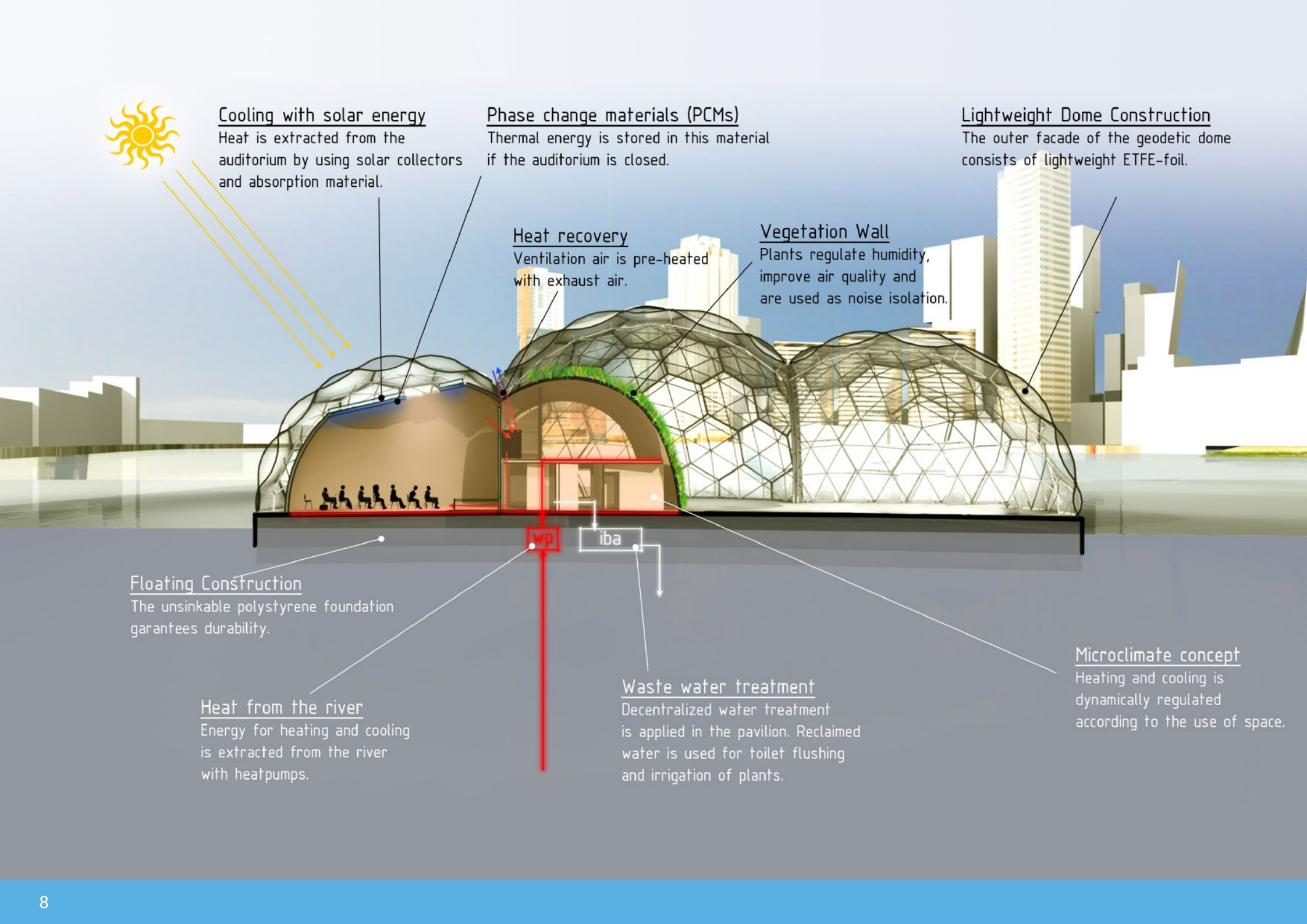
Strategy

The design of the Floating Pavilion is based on a clear strategy which includes starting principles, conditions, technical demands and design wishes. The main goal was to create a flexible, self-sufficient building, which demonstrates the state-of-the-art technologies that are implemented in the pavilion's design. Key design principles were aspects like the view on the water, the high-tech appearance and the sphere-like shape of the building.

An important starting principle was self-sufficiency. The goal was to create a building that uses a minimum amount of resources both in production and during operation. Also, the building needed to be able to move to other locations, as the Rijnhaven was thought to be only a temporary location. Therefore it needed to be adjustable to different conditions (e.g. orientation to the sun, accessibility options). Connections to the shore needed to be flexible.



Starting principles, conditions, technical demands and design wishes


Cooling with solar energy
Heat is extracted from the auditorium by using solar collectors and absorption material.
Phase change materials (PCMs)
Thermal energy is stored in this material if the auditorium is closed.
Lightweight Dome Construction
The outer facade of the geodetic dome consists of lightweight ETFE-foil.
Heat recovery
Ventilation air is pre-heated with exhaust air.
Vegetation Wall
Plants regulate humidity, improve air quality and are used as noise isolation.
wp
iba
Floating Construction
The unsinkable polystyrene foundation garantees durability.
Heat from the river
Energy for heating and cooling is extracted from the river with heatpumps.
Waste water treatment
Decentralized water treatment is applied in the pavilion. Reclaimed water is used for toilet flushing and irrigation of plants.
Microclimate concept
Heating and cooling is dynamically regulated according to the use of space.

Design

The Floating Pavilion consists of three components: the floating foundation, the facade system and technical installations.

Floating foundation. In the Netherlands multiple floating foundation systems are available. These systems are made of a concrete shell, steel pontoons, fiber-reinforced plastic or EPS with concrete. All systems were compared and tested on aspects like technical lifespan, maintenance, modularity, stability and suitability for dome constructions. The concrete shell and EPS-concrete were very similar. However, the latter was still very new and not much was known about its resistance to fire. Because of this the concrete shell system was chosen for the floating foundation.

Concrete shell

+ cheap
+ lot of experience
+ very stable
+ accumulating cap.
- heavy
- needs more draft

Steel pontoons

+ small draft
+ factory manufactured
+ suitable for domes
+ cost-reducing
- lot of maintenance
- high material costs

Fiber-reinforced plastic

+ small draft
+ innovative
- not very stable
- expensive
- little competition
- little experience

EPS-concrete

+ average draft
+ manufacturing on water
+ low maintenance costs
+ innovative
- not very stable
- expensive
- little competition

Facade system. One of the pavilion's design principles was the dome construction. Also the construction had to be modular, in order to be able to expand the pavilion in the future. In other words, the building needed to be adaptable and dismountable. Because of aspects like time, costs and building speed, the basic pavilion however was made non-modular, but at a later stage it would be possible to expand the building with new modular shapes.

A lightweight construction is essential to building on water. This condition requires the efficient use of materials. Therefore the facade was made of a transparent skin consisting of ETFE membrane cushions. These cushions weight only about 1% of the alternative in glass. The cushions consist of 3 layers of ETFE foil and are inflated with low-pressure air to provide insulation and to resist wind loads.

Technical installations. To reduce and minimize the use of natural resources during the operational phase, an energy efficient and demand-driven climate control strategy was developed. For the most part the building's climate control is based on passive solar design and passive stack ventilation that the dome's geometry provides. These are low-tech solutions that rely on natural principles. Only specific areas with high cooling demands, such as the auditorium, have additional climate control measures. In those areas solar energy is used for cooling, using technology that in many respects resembles 'desert cooling': a liquid that is evaporated by solar heat, draws energy from its surroundings. In addition, phase change materials (PCMs) were used to temporarily store energy, thereby increasing the effect of night cooling.

By using local sources of water and energy, the Floating Pavilion uses 60% less energy than a comparable building with the same function and volume. As such, it responds to the collective climate objectives of Rotterdam to reduce CO2 emissions by 50% in 2030.

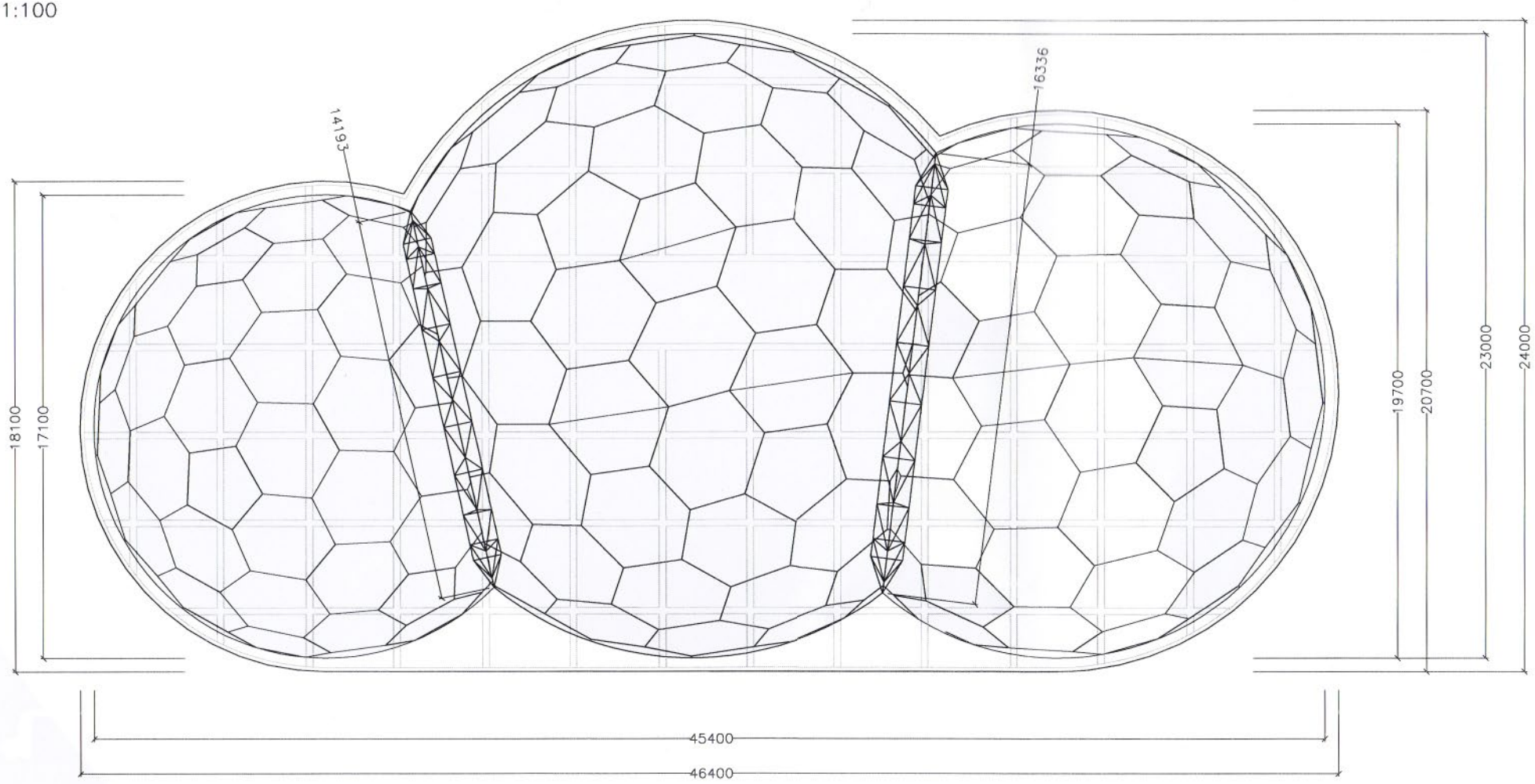
Because of its function as an exposition center LEDs are used to light the pavilion. LED is compact, energy efficient and is very suitable for lighting objects.

Shutters provide natural ventilation

systemlines of the steelwork structure

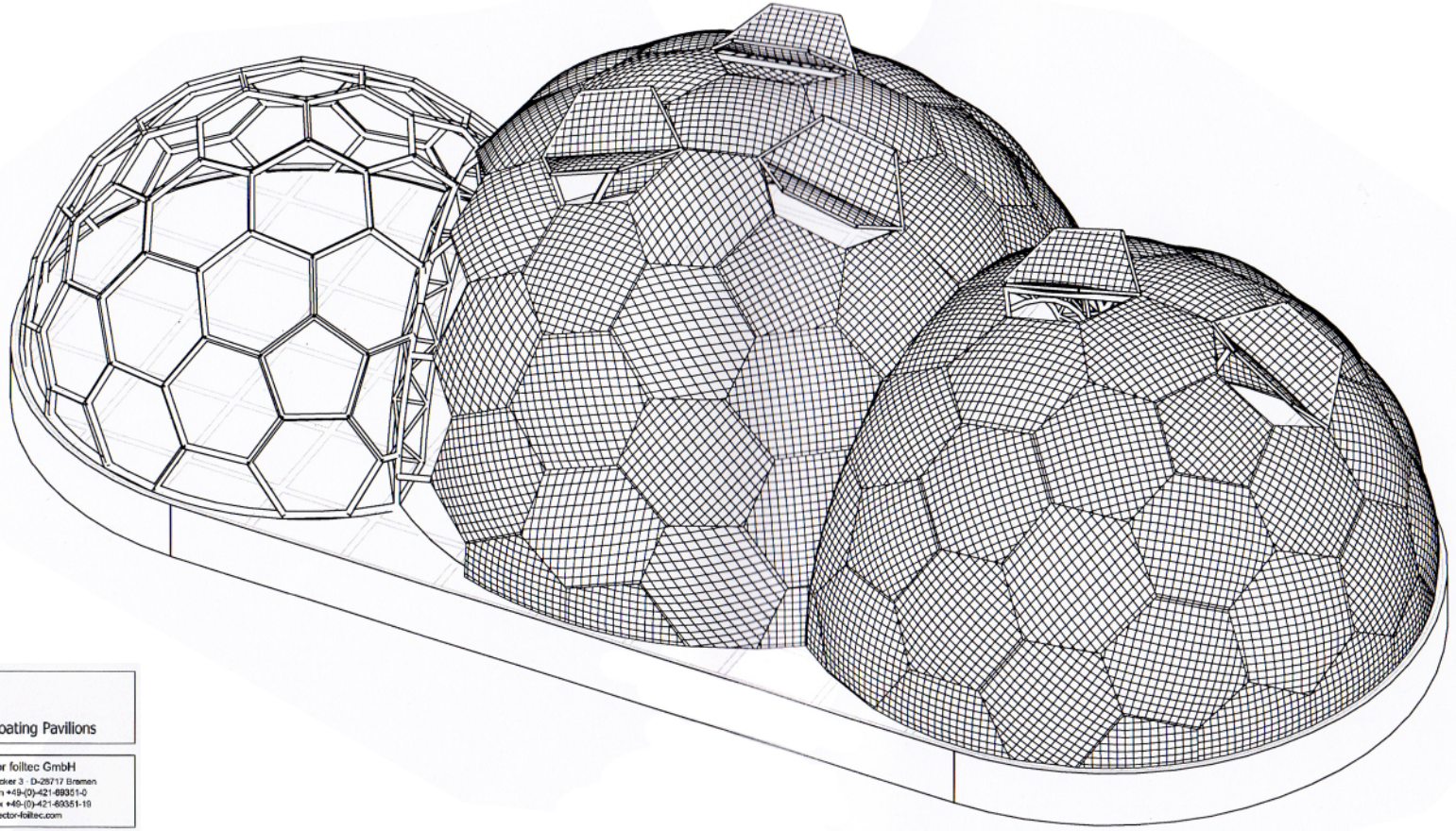
top view

M 1:100



steelwork structure and etfe-cushions

isometric view



PROJECT : NL - Rotterdam - Floating Pavilions

CONTRACTOR: vector foiltec

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Änderung / Revision	Datum / Date

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Zeichnung / Drawing	systemlines of the steelwork structure
Zeich.-Nr. / Draw.-No.	z101

Process

The process was remarkable in many ways. It was approached as an integrated project that was carried out by a design and construction team. The team consisted of a main contractor, the design team and the municipality of Rotterdam (Public Works department). Because the municipality had a seat in the construction team, the project is in many respects similar to a Public-Private partnership. The direct participation of the municipality enabled the integration of permits and regulations, legislation, policy and urban planning aspects at an early stage in the design process. It allowed the team to remain in control with regard to the balance between building costs, quality, sustainability and construction time. At the same time the construction team acted along the lines of a Design & Build contract or Integrated Project Delivery. The advantage was that specialist knowledge, in terms of floating structures, engineering and building installation design was available from the start and could be aligned with the architectural objectives. The project has contributed to knowledge development and transfer. The process also facilitated the building of coalitions among multiple stakeholders. In terms of creating critical mass for adaptation to the challenges of climate change the Floating Pavilion is already a success. The press attention was overwhelming: attracting journalists from all over the globe and influential scientists and policy makers have gathered here in several water-related conferences.

DEVELOPMENT TEAM

Client: City of Rotterdam

Main contractor: DURA VERMEER

Architect: deltasync WATERBASED URBAN DEVELOPMENT; PUBLIC DOMAIN ARCHITECTEN

Installation consultant: DWA installatie- en energieadvies

Floating foundation: FlexBase

Dome construction: vector foiltec

Structural engineer: Advin

Installations: unica installatiegroep

Lessons learned

FLEXIBLE PRODUCTION

Floating construction offers an ideal opportunity of separating the construction site from the place where the floating pavilion is to be located. Floating buildings are movable, and they can be constructed on an industrial scale, under controlled conditions. This offers unprecedented opportunities for innovation in the building industry, reducing inconvenience from building activities for residents. Moreover, it offers opportunities to successfully introduce new concepts like cradle to cradle.

Because of the flexible construction process, we found that the design, construction and implementation was possible within one year.

DIFFICULTIES REGARDING LEGISLATION

During the process several legal obstacles had to be overcome. First, there was the discussion whether floating buildings are to be regarded immovable or movable assets. The difference between the both has a significant influence on regulations, insurance and mortgage and financial laws. In the end, the building was defined as an temporary immovable asset (building) rather than a movable asset (boat). The pavilion complies with Dutch construction standards. The projects has yielded much knowledge regarding the implementation of floating buildings within the Dutch construction standards. The project knowledge has been largely incorporated in the construction guidelines of the Dutch Standardization Institute. This in a Dutch Technical Agreement which i 2011. The agreement includes aspects s health, design, accessibility and utilities. tate technology diffusion and further upt technology and concepts by the constru

COMMUNITY INVOLVEMENT

The Floating Pavilion already has becom landmark and has recently been awarded Dutch National Water Centre. The buildi role in strengthening stakeholder aware resilient urban development. Multiple education institutions collaborated in the as Delft University of Technology, Rotterd of Applied Sciences, Albeda College, Era sity Rotterdam - Dutch Research Institu tions(Drift) and Urgenda. Students from fields were given the opportunity to d structural and architectural design asp able building development, and to ser during the construction process. Sever meetings for stakeholders, citizens ar were organized. Stakeholder and comm pation feedback was carefully incorporat ning and design. As a result, the desig improved and the societal support for th increased.


DHG

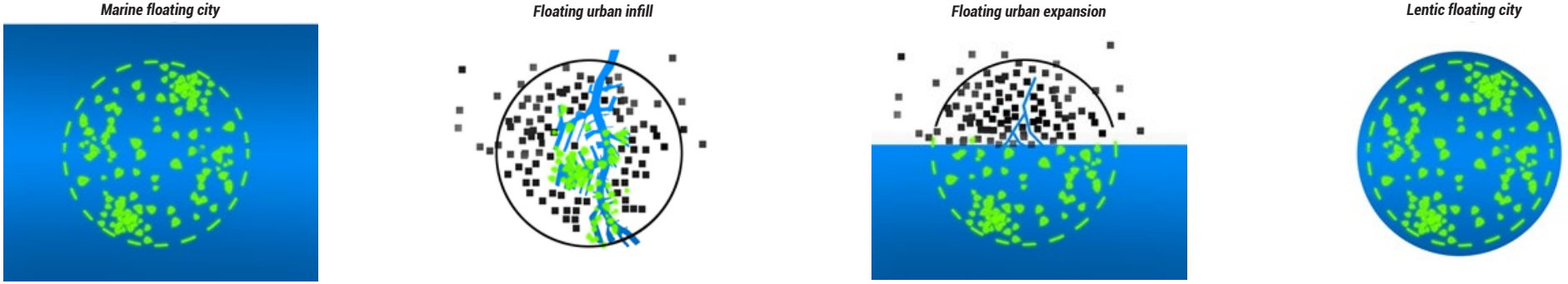
Replicability

Floating city technology has the potential to reduce vulnerability of coastal cities worldwide. As stated before, the degree of urbanization is expected to rise further towards 70% in the 21st century. This growth will for a considerable part take place in low-lying deltas that are vulnerable to flooding and the impacts of climate change. Moreover, floating construction creates a new dimension of urban planning by multifunctional use of space. As in Rotterdam, in many cities it is important to show the possibilities of floating urbanization with examples and icons, such as the Floating Pavilion. Floating urbanization potentially offers opportunities for different types of water cities such as ocean cities, districts in old port areas, cities on lakes and coastal cities. Therefore, demonstration projects such as the Floating Pavilion could be useful for a wide variety of location all over the world. The Rotterdam example demonstrates that such a project can function as catalyst for further urban development on the water.

CONTRIBUTION TO SUSTAINABLE URBAN DEVELOPMENT

Concerning urban planning policy it is a great advantage that floating development is not an irreversible intervention. Urban planners have the opportunity to remain actively involved in the shaping of floating developments even after implementation. In this sense the concept of floating urbanization introduces a new approach to urban planning and development. The mobility of floating buildings enables a dynamic and flexible urban fabric. As a consequence, floating urban planning can focus more on organic growth strategies than traditional blueprint spatial planning. The floating district can be easily adapted to the ongoing changing requirements of the community and changing circumstances, such as the rise in sea level but also changes in economical and spatial requirements.

The economic value of real estate and the location can be separated. Both components can be sold separately and can be designated for a new function. This prevents premature demolition, keeps the economic value of the buildings intact and enables responding to uncertain developments on the real estate market.



Options for floating cities in different contexts

About DeltaSync

VISION

Currently, for the first time in human history the amount of people that live in urban areas is larger than the amount that live in rural areas. The degree of urbanization is expected to rise further towards 70% in the 21st century. This growth will for a considerable part take place in low-lying deltas that are vulnerable to flooding and climate change. Already there is a shortage of space and cities rely completely on external sources for food, water and energy. With the increasing scarcity of resources there is a growing need for cities to be more self-sufficient. Therefore there is a great need for new sustainable flood-proof concepts for urbanization of delta areas. Constructing floating buildings is a promising solution. It enables multi-functional use of space in densely populated areas, without further increasing flood risk. A good example of such a concept is the floating city. This concept can only be developed by investigating different scale levels in conjunction, ranging from building level, neighborhood level to city level. To ensure that it is actually implemented, it is important that the feasibility, spatial integration and social aspects are fully included in the analysis and design.

MISSION

DeltaSync's mission is to design and develop the first self-sufficient floating city in the world. The realization of the Floating Pavilion in Rotterdam, the largest public floating building in the Netherlands, is the first milestone towards achieving this mission.

CORPORATE VALUES

DeltaSync reflects the following values:

- *Sustainability*

DeltaSync recognizes its responsibility towards our planet and acknowledges that preservation of the world's resources and ecosystems for present and future generations is of major importance. Sustainability is therefore an integral part of all projects. DeltaSync strives to create a balance between the needs of the users and the environment and develops innovative techniques and concepts to provide buildings with local water and energy resources.

- *Creativity and Innovation*

Creativity and innovation play an important role in the company. Innovation and the search for new unexpected solutions are important drivers in DeltaSync's work. Problems are analyzed from different viewpoints and the solutions integrate water management, sustainable development, architecture and spatial planning into multidisciplinary proposals.

- *Collaboration*

DeltaSync believes in collaboration between researchers, designers, entrepreneurs and government agencies to obtain new insights and solutions in order to contribute to the challenges that cities in delta areas are facing. Partners will be involved already in the early stages and consortia are formed. Within these partnerships, integrated and multidisciplinary knowledge is developed.

KNOWLEDGE AND EXPERTISE

DeltaSync has specialized in all aspects of floating urbanization. The past years we have developed specialist knowledge in several areas. We excel in the integration of water management, design and technology. Examples of our expertise with respect to floating construction and flood proof development are the following:

Technology and engineering

- Floating and flood proof construction
- Structural design
- Building technology
- Water management

Architecture and design

- Architectural design
- Strategic visions
- Spatial integration
- Concept development

Socio-economic

- Feasibility and business cases
- Legal aspects, legislation and regulation
- Collective private commissioning

Environmental

- Energy and water supply
- Sustainable development
- Water and mobility

Founders

Karina Czapiewska

director project development

Karina Czapiewska is a specialist in the field of multidisciplinary area development, project management and sustainable development. She graduated at the faculty of Architecture at Delft University of Technology with a minor in Sustainable development (TIDO) and is responsible for business development, sales and consultancy on feasibility studies, flood proof area development and living on water. Since she first learned about the posibility of floating cities during her study she committed herself to realize the first self supporting floating city in the world.

Bart Roeffen

creative director

As principle architect at DeltaSync he was in charge of the design and construction supervision of the Floating Pavilion in Rotterdam. This is considered to be one of the leading floating projects and a milestone in the technological development of floating urbanisation. Advanced 3D technology was adopted in order to translate spatial concepts to reality and optimize complex shapes. Roeffen is driven to innovate construction industry in terms of production methods and attention for sustainable development.

Rutger de Graaf

managing director

Rutger de Graaf is civil engineer and specialist in the field of floating urbanisation and sustainability. He graduated cum laude at the faculty of Civil Engineering of Delft University of Technology. In 2009 he finished his Ph.D. thesis (cum laude) on innovations in urban water management to reduce the vulnerability of cities. At Rotterdam University of Applied Science he works as part-time professor Adaptive Urban Development. At the company he focuses on water management, strategy and innovation, and sustainable urbanization combined with floating constructions.

In the news...


Discovery
15 van de 20 megasteden
liggen momenteel aan de kust.
DeltaSync


interview/offshore
Drijvend bouwen is alternatief voor verstedelijking deltagebieden
Rotterdam op de Maas

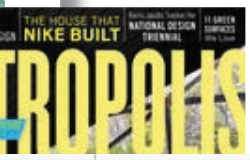

de Volkskrant
HUIS 15
'Geen project met futuristische freakgebouwen'


NOS
Zoeken binnen NOS.nl
NOS.nl
Nieuws
Binnenland
Buitenland
Politiek
Economie
Sport
Binnenland
Overzicht
Nieuwsarchief
Video & audio
Journaal 24
Politiek 24
Dossiers
Drijvend gebouw naar Rijnhaven gesleept
NOS.nl

'Vervoer over het water met de boot gaat drie keer zo snel'
We moeten ons niet langer van het water afkeren


Akkoord van Rotterdam
Drijvend icoon voor de stad in Rijnhaven
In de Rijnhaven komt komend jaar een opvallend nieuw bouwwerk: een complex van drie drijvende halve bollen. Het krijgt een hoogte van 12 meter, een totaal vloeroppervlak van vier tennisbanen en is in zijn geheel verplaatsbaar. De eerste vijf jaar zal het klimaatbestendige paviljoen dienstdoen als expositie- en ontvangstruimte.
Drijvende stadswijken


Deltasync developed a Floating Pavil
Their concept for a Floating City is based on their housing project built on the IJmeer between Amsterdam and Almere in 2007.


THE HOUSE THAT NIKE BUILT
METROPOLIS


OBSERVED
At Home on the Water
The prototype pavilion (below) was towed into Rotterdam in May. The Floating Utility Unit (bottom) illustrates how utilities can be delivered to water-based communities.
"Although we already have house-boats on the canals, this is the first floating structure in a harbor, which is subject to tidal conditions," Molenaar and infrastructure, making it possible to go farther from the shore," Roeffen says. Instead, it incorporates a smart, use-adaptive climate-control system, passive solar energy, and a wastewater system that recycles and self-purifies.
DeltaSync, the water-based urban-development firm formed by Roeffen and his university colleagues, has conceived a plan for a group of six self-sufficient two-and-a-half-story houses sharing a single utility plant in a canal in neighboring Delft. Perhaps unsurprisingly, they ran into the issue of how to regulate this new type of real estate: "It was funny—the notary did not know whether to say we were selling the water or how to document it," Roeffen says. "In the end, it was defined as the underlying land, so they don't have to adjust the regulations." It was just the first step toward charting a course for this brave new water world.

ENERGY AND ENVIRONMENT
THE SUNDAY TIMES
thesundaytimes.co.uk/environment
26.12.10
7
Greenhouse stand-off hits investors
Riding the tide
Dutch architects have designed a new generation of floating buildings
Cooling
Heat from the sun is absorbed by solar collectors
Vegetation wall
Plants help regulate humidity and aid noise insulation
Lightweight materials
The dome facade is made of lightweight, durable foil
Robert and Ellen Stravers, pictured with their daughter Mijke, live in a floating home near Amsterdam
Floating base
Polystyrene construction guarantees buoyancy
Heat from the river
Energy is extracted from river water using heat pumps
Waste treatment
Reclaimed water from filtration system is used for toilets
Microclimate concept
Temperatures can be changed and regulated between the domes
Beat the floods, build a house on the water
Dutch architects are trying to drum up interest in buoyant homes, reports Tom Bawden


4 Duurzaamheid
dinsdag 8 september 2009
SPITS


deltasync
WATERBASED URBAN DEVELOPMENT