Future Cities

Urban Networks to face climate change

A concept on Arnhem

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Future Cities: A concept on Arnhem

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All GasPlas related images are a courtesy of:

Introductory remarks

This project will present a design for the placement of an environment-friendly industrial structure on the 'Koningspleij-Noord'. The structure in question is a hydrogen fuelling station of the company 'GasPlas'. The presented design will be a purely visual representation. This project will also asses the involved green innovations and show their relation to and use in the placement of the GasPlas station.

The company, location and all involved innovations exist. The location (Koningspleij-Noord) will be converted into an industrial estate. This provides a realistic scenario for this project.

Future Cities

As the global temperature rises, the need for green innovation grows. Cities get warmer than their surrounding areas; this phenomenon is called the urban heat island effect (UHI). Future Cities is a project that aims at making city regions in Northwest Europe fit to cope with the predicted climate change impacts. It also aims to reduce the number of or intensity of urban heat islands. There are eight participation organisations, from five European countries (Belgium, England, France, Germany and the Netherlands) in total. The city region Arnhem/Nijmegen is one of the pilot locations for Future Cities. An environment-friendly hydrogen station would be one step this city region could make to help face climate change.

Source: futurecities.org.uk

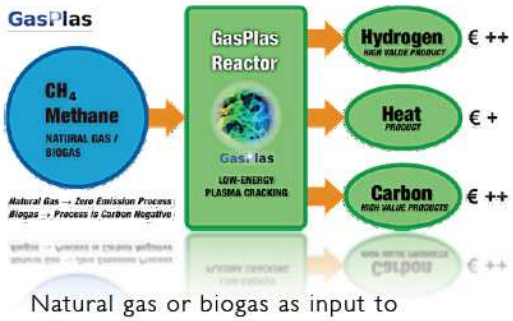
Urban heat island effect

The urban heat islands (UHIs) are urban areas that are significantly warmer than their surrounding rural areas. At times this difference may reach up to 10°C. Flat dark surfaces such as asphalt on roads or concrete buildings are the main contributors to the creation of UHIs; they absorb a great amount of heat from solar radiation and take a long time to release it. Thus the effect of an UHI is also present at night. This can have effects on the health of city inhabitants, think of sleeplessness for example. It makes life in urban areas far less comfortable.

Today, many buildings are very well isolated in order to maintain warmth in winter and therefore cut costs on heating, but in summer the costs of cooling methods, such as air-conditioning, are ever rising. The increased use of these methods is bad for the environment.

Involved GasPlas Technology

Value Concept



Natural gas or biogas as input to GasPlas reactor which converts it to pure hydrogen and carbon powder

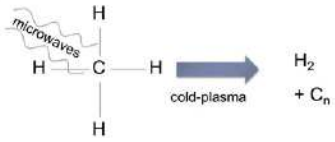
Advantages

- No CO_2-emissions
- High energy cracking efficiency
- Scalability (small to industrial scale production)
- Low capital and operating expenses
- On-demand or continuous production
- Low operating temperatures
- Operation under normal atmospheric pressure
- Few and no moving components
- Good control over carbon structure

Basic Principle of GasPlas Technology

Plasma is the fourth state of matter and is by far the most common one in the universe both by mass and volume. Its properties are quite different from solids, liquids and gases. For plasma to exist, ionization is necessary. The degree of ionization of plasma is the proportion of atoms or molecule, which have lost (or gained) electrons. Since plasma is highly conductive, magnetism and electrical free electrons will affect it. By using microwaves the electrons and molecules in the gasses will loosen.

This is the basic principle behind GasPlas cold plasma cracking:



Hydrogen Production

Mobile Hydrogen Refueling Station

- The GasPlas plasma reactor gives the prospect of a truly mobile refueling station dispensing on-site hydrogen with zero emissions, low cost facility, on-demand and on-site production
- Using existing natural gas infrastructure solves barriers of storage and distribution of hydrogen
- GasPlas mobile gas station concept with on-site hydrogen production:

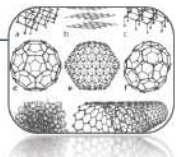
Fertilizer Enhancer

Soil Additive

- Carbon with high surfaces boosts microbacterial activity in soil
- Estimated plant growth improvement by > 20%
- Carbon can replace 20% of fertilizer
- Carbon fertilizer market value (up to 600$/t)
- Scalable reactors enables local production
- Integration with biomass / biogas applications make carbon negative fertilizer possible
- The GasPlas concept have introduced a new term called CCU - Carbon Capture and Use (or `Utilisation`)

Carbon Production

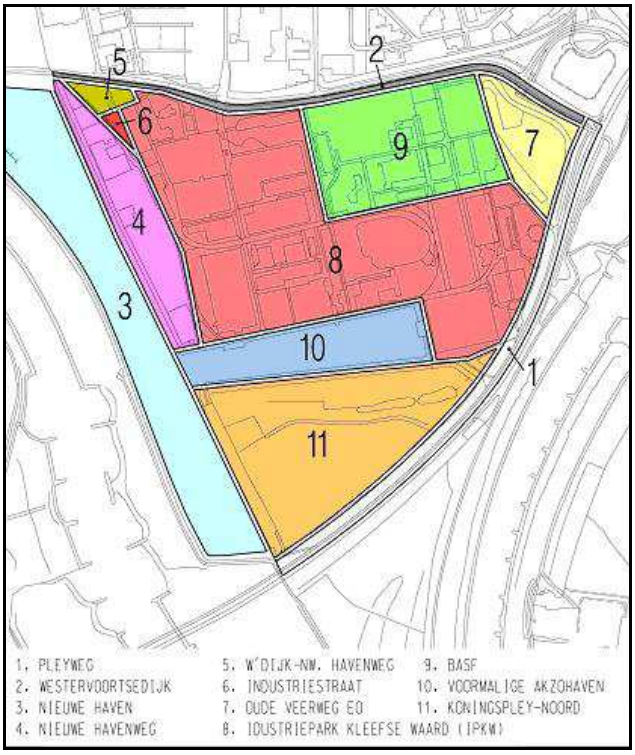
A Variety of Carbon Products



- GasPlas solution gives high purity carbon, low environmental impact, low cost facility, on-demand and on-site production
- Carbon to soil - Fertilizer application
- Carbon blacks (CB) - Used in tyres, plastics, paint, cables and other large processes industries
- Activated carbon - Purification, medical applications
- Carbon fibers - Enhanching compounds to strengthen materials e.g. bullet proof wests
- Carbon nanotubes and Graphene - Used in a variety of advanced materials and applications

The design: Location

The chosen location for the hydrogen station is the Koningspleij-Noord



Source: Arnhem city council

The Koningspleij-Noord (11) is situated beside the Kleefse Waard (8) industrial estate which, together with the Akzohaven, borders it on the north side. The south end is enclosed by the Nieuwe Haven and pleij-route.

The Koningspleij-Noord could be made accessible by connecting it to the Westervoortsedijk on the north side of the Kleefse Waard. In its construction the access road would only need to be lengthened from the roads already in existence. Constructing an entrance and exit connecting directly to the pleij-route on the south-eastern side would take up an enormous amount of space on the whole of the Koningspleij.

The Koningspleij-Noord is currently used as agricultural land. The Koningspleij-Noord will be used as an additional industrial estate. Plans in making it suitable for building are already being made, the entire area will be raised about 3 metres and will be enclosed against flooding.

The design: Requirements

There are some parties that have requirements to bet met. The most important two are the company Gasplas and the Arnhem city council.

The Arnhem city council wishes to:

-maintain the view from the pleij-route onto the Akzo building

This will limit the building height, depending on where the structure is placed.

-good access to the Koningspleij-Noord

This will be provided by connecting either the Westervoortsedijk or the pleij-route to the Koningspleij-Noord

The Gasplas fuelling station will require:

-road access

This will be provided by connecting the pleij-route to the Koningspleij-Noord

-access to natural gas (a pipeline)

This is possible and can be provided by the regional gas network.

- There is a 6” pipeline with a pressure of 40 bar in existence along the pleij-route

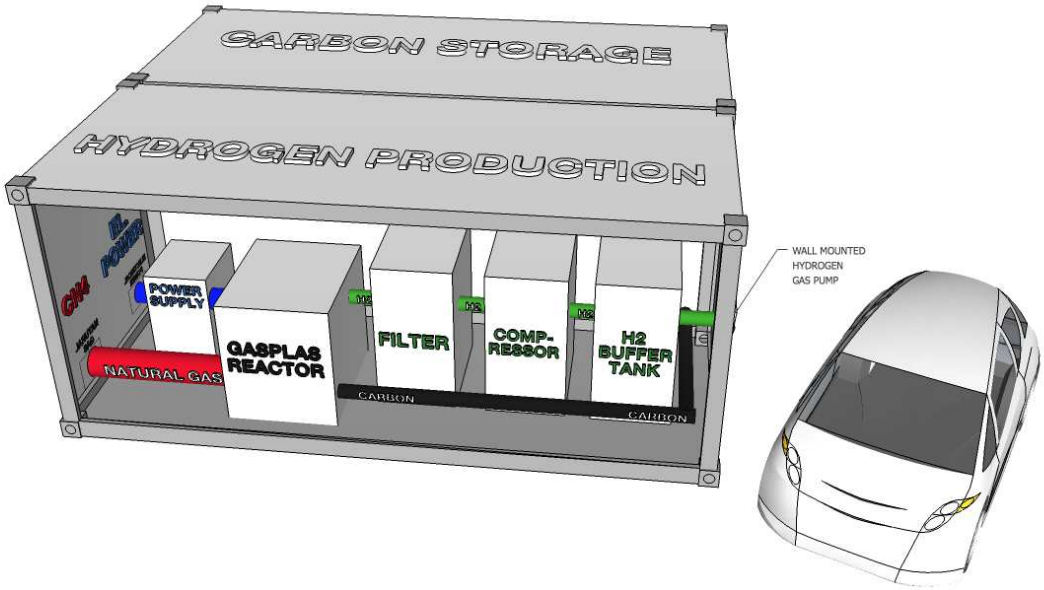
-access to electricity

This is possible and can be provided by the regional electricity network.

- Depending on the scale any amount of (high) voltage can be provided.

The design: Dimensions

Essentially a Gasplas cold plasma cracking reactor and its related components could fit into two 20ft containers (each with the dimensions of 6.06m x 2.44m x 2.59m (or 2.89))

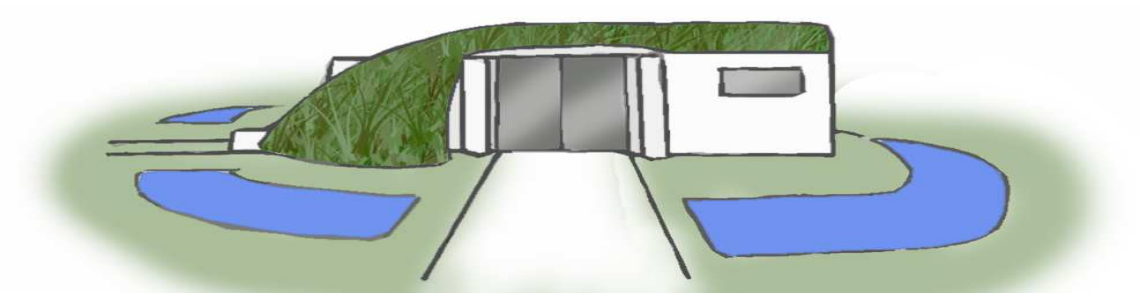


If we were to take an additional space of 6.06m x 2.44m x 2.59m (or 2.89m) to accommodate a workspace/staff area, increase the 6.06 metre length with a metre for easier maintenance access and choose the higher 2.89m option, the entire volume of the building would come down to 7.06m x 7.22m x 2.89m.

The hydrogen pump service will be placed on a separate lot next to the reactor building this will have a layout similar to that of a regular fuel station as seen in the image below.

Source: Stock photo

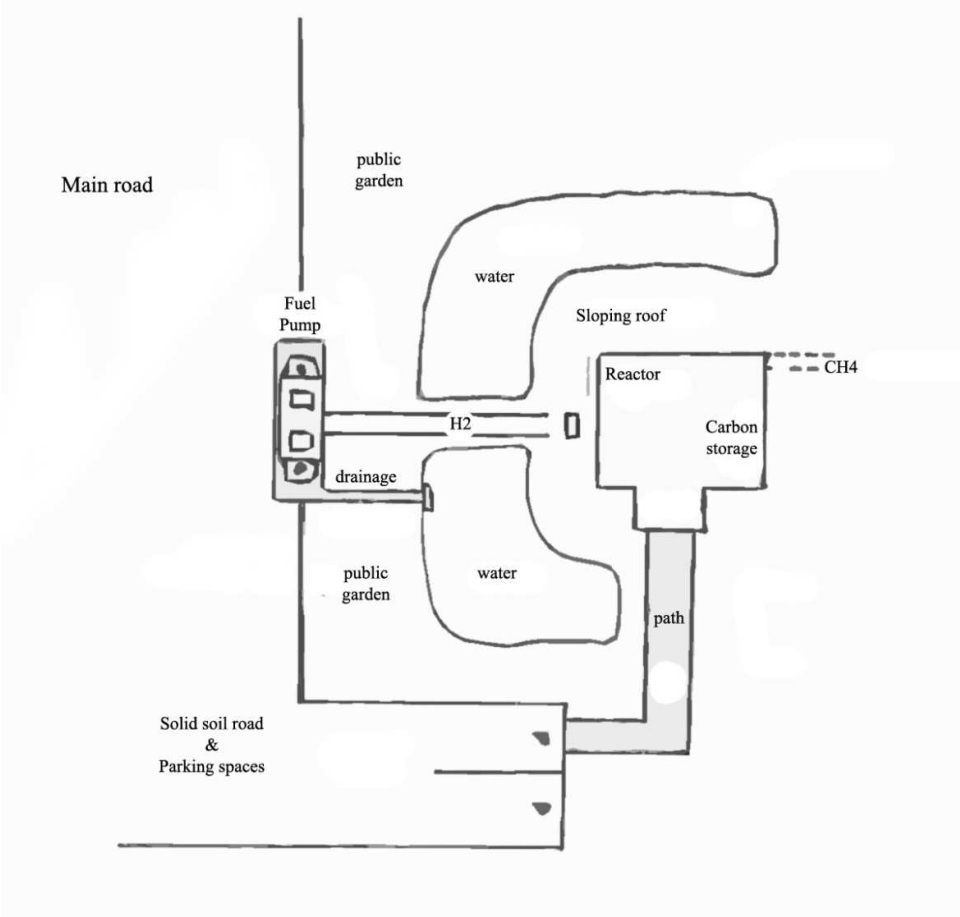
The design: Visualisation



Above we see a front view of the building that will house the GasPlas Reactor. The green roof slopes down toward the north side. This green roof will look like a gentle slope but beneath the growing medium a 'step' style terrace is placed in order to prevent substrate slide-off. The body of water surrounding the building will add a 'blue' element and might be fitted with fountainheads in order to increase the aesthetic value and to increase cooling of the area.

Below is the Birdseye view of the complex (reactor building and fuel pumps) the body of water on the southern side has been left out so the required plot of land is smaller and expansion of the building is easier.

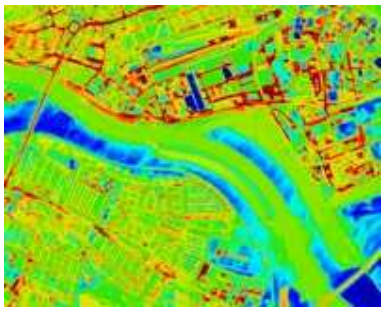
The main road is to the north and lies on the edge of the Kleefse Waard.



Involved innovations and methods

Strategic placement

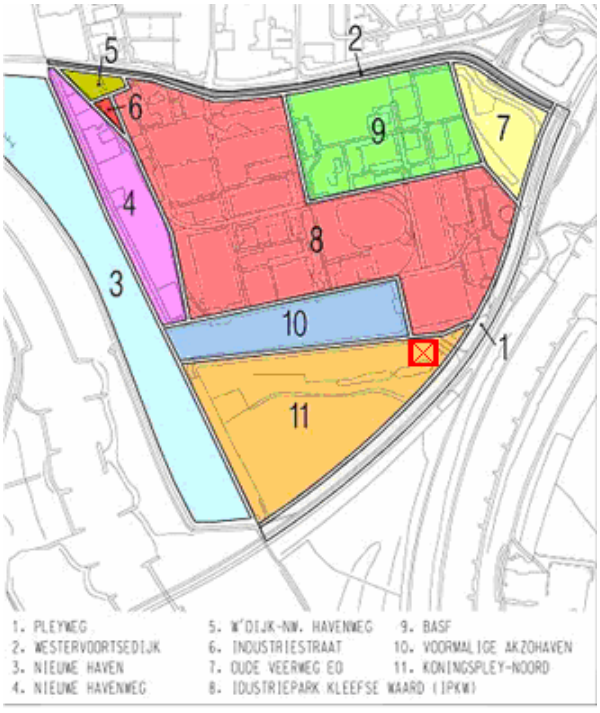
The location of a building plays a very significant role in the heat the area will emit. Nearby bodies of water in combination with wind can cool down areas. Therefore a buildings height, size, location and elements such as wind and water have to be taken in consideration. The Koningspleij-Noord lies relatively low compared to the surrounding area.
A remnant of the river Ijssel runs through the Koningsplij-Noord and although it remains dry in summers it may still provide a significant cooling effect. This riverbed is worth preserving, keeping it intact will maintain a part of the natural buffer zone that the Koningspleij currently is. Flora and fauna may still traverse the area and their populace will not be endangered by construction.



Source: Dakwacht Arnhem

Dakwacht made a flight over Arnhem and Nijmegen last summer. They successfully made heats scans of both urban areas. These scans are currently being studied by researchers of Wageningen University and Research Centre (WUR). These scans may reveal more about the present situation of heat radiation on the Koningspleij.

From an economic perspective the fuelling station is best placed on the northeast corner of the area. This would make it more easily accessible by motorists and leave sites along the Nieuwe Haven open to companies which require access to the waterways. In this specific location the building would not obstruct the view of the Akzo building and would connect to the road leading onto the Koningspleij-Noord.



Source: Arnhem city council

Building materials

There are two ways in which a material may affect the forming of an UHI. Firstly there is heat absorption or storage. This depends on the material itself. Wood for example, becomes warm on its surface, but as a whole it doesn't absorb much heat. Concrete on the other hand takes up much heat as a whole and is therefore a large contributor to heat storage.

Then there is reflection. This is down to the reflective capability of the material, often determined by its colour. Darker materials carry more pigment and more pigment more warmth, because the incident sunlight that is absorbed is converted into heat. Light surfaces on the other hand reflect most of the incoming light, which is thus not converted into heat.

As stated previously; large, flat and dark surfaces give more heat. Reflective surfaces on the other hand less so. The measure of reflection is called the albedo. On a global level this might be the great expanses of ice on the poles which reflect much warmth and therefore carry a large albedo. More reflection and therefore less absorption is one of the factors which may help prevent or decrease UHI effects.

In the design of the GasPlas building the walls will be constructed of white brick. (Institutions are however developing dark pigments which produce less heat.)
The actual hydrogen pumps will also be white. For the fuelling 'platform' a liquid soil solidifier will be used. This innovative liquid allows the natural soil or any decorative soil to be solidified to a point where it is stronger and more durable than asphalt.

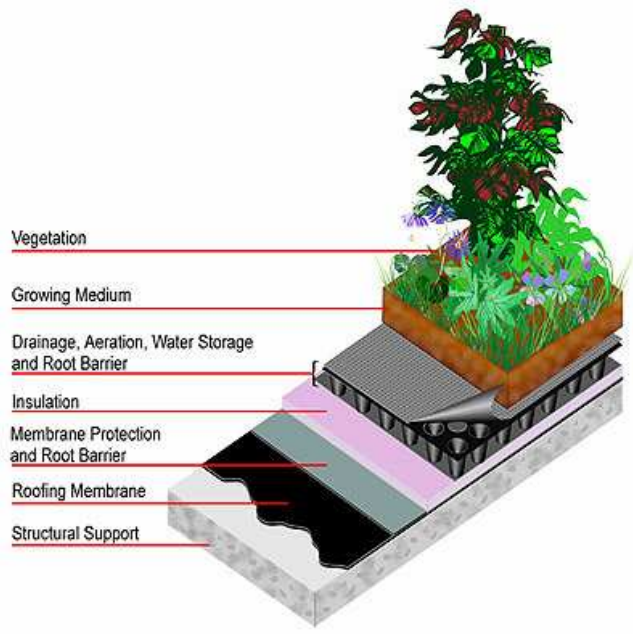
Sand particles **before**

Sand particles **after**
(source: Polysoils)

In order to prevent flooding of certain spots a drainage system will be installed around the hydrogen pumps this system will lead back to the body of water around the reactor building. Besides being stronger and more durable a solidified soil would also absorb less heat than asphalt and will look more in place with the surrounding landscape.

Green roofs and walls

Vegetation can be installed on roofs and walls of buildings. Doing this provides multiple benefits to the environment and also helps to reduce UHI effects. Vegetation moderates temperatures around it. When installed on a roof or wall it also reduces the temperature extremes inside and outside of the building. In summer the inside temperature remains cooler and in winter the vegetation acts as isolation thus conserving warmth. In this way green the vegetation conserves energy all year round and reduces pollution through radiators and air-conditioners. These innovations also reduce water runoff during heavy rainfall by absorbing a large part of the water on the structure.



The make-up of a green roof protects the underlying roofing by multiple membranes including a root barrier, which might double the lifetime of a roof. Roofing types may vary depending on the strength of the underlying roofing structures. Where specially constructed balconies may even support large bushes, most green roofs hold low vegetation such as mosses, grasses and weeds. Planting is not necessary. When a growing medium is present, local vegetation will settle on the roof over time. This may also conserve plant species which would disappear out of the area if there were no green roofs.

Source: Great lakes water institute

Besides the previously named benefits, green roofs and walls also have a high aesthetic value in urban areas in the same way that parks and tree lanes do. The presence of green structures gives an urban area a more habitable look and altogether more comfortable feel.

Source: Stock photo

More Green

In the same way that green roofs and walls regulate the temperature so do parks and lakes. They absorb solar radiation before it has a chance to heat up the surrounding surfaces. Researchers in Singapore have studied two city parks and concluded that they cool down their surroundings both during day and night time. Furthermore they found that the denser the vegetation, the cooler the park. Thus more trees and bushes are beneficial. A park with mainly concrete pavements and walking areas might cause the opposite effect and may even be a heat island in itself. Also repetitive greenery has proven to be far more effective in cooling down a city, that is to say; it is better to place many small parks throughout the city than to place one great central park. A central park still carries benefits. A study in Chapultepec in Mexico City has proven that its 500 acre park still has a cooling effect 2 km away.

Source: Stock photo

Another additional use for green is the lining of roads with trees. Not only do trees absorb heat and provide shade, they also take up carbon dioxide and filter a lot of chemicals out of the air and thereby reduce air pollution. Still plans must be well considered, because the placement of trees might also block out wind, which in turn might prevent the air pollution to get away and thus remain in relatively high concentrations.

In order to put this green to use we will create a strip of public garden between the reactor building and the pump area. This garden will exist of shallow rooted bushes and plants to prevent any problems with the hydrogen pipe or tube and the drainage system.

Credits

Special thanks to:

Mr. R. Rijkers	for coordinating and finally grading my project
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