Sustainability and Urban Regeneration
Transformation of an old factory site in Guimarães
Acknowledgement

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Students:
- Javier Angel Rodriguez
- Daniel Bornmann
- Sherilyn Crali
- Stephanie Gruner
- Agust Ismoyo
- Rahel Kasaye
- Ismail Khater
- Franz Kiehl
- Tobias Kraft
- Ramón Osório
- Lucy Price
- Safi Rashid
- Lital Shelef Dori
- Liana Stoica
- Tugce Tosun
- Diego Weber Rodriguez

Supervisors REAP:
- Dipl.-Ing. Anke Jurleit
- Dipl. Ing. Sonja Schelbach
- Prof. Dr. Wolfgang Dickhaut

Supervisors University of Minho:
- AP Paulo Mendonça

Introduction

Sustainability and Urban Regeneration
Transformation of an old factory site in Guimaraes, Portugal

Every semester, the Resource Efficiency in Architecture and Planning (REAP) Master’s Programme at the HafenCity Universität, has a major project component. This year the task assigned was to assess an old industrial site and propose solutions for its regeneration, paying special attention to the areas of Energy, Water, Noise, and Materials. This booklet is the culmination of work done over the third semester by the REAP Master students.

It is the result of a collaborative effort between students of the HafenCity Universität and the Minho University in Portugal as a beginning of further Erasmus partnership between the REAP Masters in HCU and Integrated Master of Architecture at Minho University.

The industrial site chosen for the project is located in the northwestern part of Portugal in the town of Guimaraes. The historic city, also referred to as “the birthplace of Portugal”, has rich cultural roots, earning it the title of European Cultural Capital 2012 by the European Commission. The project site, as the host to four 100-year-old textile factories, embodies the European Cultural Capital 2012 goals to revitalize the historic architecture of the city in vibrant new ways. The site itself is located just outside the city centre to the south, bound by the streets Caldeirão, Colégio Militar, Manuel Eduardo de Almeida and the Avenues Conde Margaride and D. Afonso Henriques. Numerous amenities surround the site, including the main train station, Vila Flor Cultural Center and a balanced mix of commercial and residential buildings.

This document is the result of work done in three phases: the Analysis Phase, the Concept Phase and finally the Design Solutions. In the first phase, the situation in the site was analyzed with specific focus on the REAP aspects, namely Energy, Material, Water and Noise. In addition, the benefits of urban regeneration and being the European Capital of Culture were also analyzed. The HafenCity Universität students conducted a site visit to gain a first-hand understanding of the project area and to exchange information with the students of the Minho University. The second phase saw the presentation of several ideas for the possible regeneration of the site taking into consideration the results from the Analysis phase. The final phase was the presentation of the solutions in the form of a poster. A similar presentation was also done by the Minho University students.

REAP Master’s Programme

The Masters’ Programme Resource Efficiency in Architecture and Planning is a Master of Science Degree programme offered by the HafenCity Universität Hamburg. It started in 2009 and has just welcomed its third group of students in the 2011/2012 winter semester.

The programme focuses on the efficient use of resources and sustainability in architecture and urban development in different geographic and cultural contexts. It welcomes students from a variety of professional and academic backgrounds, countries and cultures.

The approach can be seen as very international and interdisciplinary and it is all brought together under a single unifying language: English.
European Capital of Culture & Urban Regeneration

European Capital of Culture

Every year, two cities in Europe are selected as European Capitals of Culture (ECoC) - for 2012, the choice came down to Guimarães and Maribor, Slovenia. The selection is based on the cities’ future plans for that year, and must meet some specific criteria. This initiative started in 1985, and has become the stage for some of the most high-profile cultural events in Europe. According to the European Commission, the purposes of this initiative are:

- highlighting the diversity and richness of the various European cultures;
- emphasizing the cultural ties between all Europeans;
- the promotion mutual understanding and encourage contacts between cultures;
- nurturing a feeling of European citizenship.

A study by an independent expert about the 1995-2004 European Capitals of Culture (cf. Palmer/Rae Associates, 2004) showed that the vast majority of organizing felt the event had been beneficial to the cities both from a cultural point of view and for their long-term development.

Additionally, many studies conducted over the years (e.g. Sapsford & Southern, 2000; Neri et al., 2006; Defrin & Labianidis, 2005) have shown that the event can be a driving force, giving an opportunity to regenerate the cities, raising their international profile and boost tourism, enriching the cities’ cultural lives, and enhancing the cities’ self-image in the eyes of their inhabitants.

Evidently, it is part of the participating cities expectation that the event and concomitant funding can serve as a catalyst for urban development projects and urban regeneration in a broader sense. The Southern, 2007; Herrero et al., 2006; Deffner & Labrianidis, 2005) have shown that the event can be a driving force, giving an opportunity to regenerate the cities, raising their international profile and boost tourism, enriching the cities’ cultural lives, and enhancing the cities’ self-image in the eyes of their inhabitants.

Culture and Urban Regeneration

Urban regeneration can be defined as the “transformation of a space that has displayed the symptoms of physical, social and/or economic decline breathing new life and vitality into the area (and) bringing sustainable, long-term improvements to local quality of life“ (Evans, 2005: 967).

In the context of the ECoC initiative, the concept of culture-led urban regeneration is focused. It assumes that culture and cultural activities can be a driver, catalyst or key player regarding urban regeneration, and may serve as “an insurance policy against future decline” (Shaw & Evans, 2006: 6) and value-added distinction. Culture also acts as collective remembrance and societal identification.

Birns (2005) distinguishes three models of culture-led urban regeneration:

- cultural production, which focuses on investing in cultural and creative industries in order to create jobs and prosperity;
- cultural consumption, relying on flagship infrastructure and event hosting to provide a knock-on effect for the rest of the economy;
- community arts programmes, following a bottom-up approach to build social capital and a sense of community.

Abandoned in a prime location

The study area of this project is situated in the south of Guimarães. In the east, it borders the Av. Dom Afonso Henriques, which is a direct connection between the historic City Centre and the train station. The southern border is the Av. Dom Joao IV, which joins the highway N105 after about half a kilometer. Thus, the overall area serves as an important gateway as it offers quick access from the main train station to the historical city center. Apart from the proximity to the train station and city centre, a cultural centre, a hotel, and design school constitute interesting types of use in the surrounding area.

These models, however, face certain limitations and weaknesses.

- They primarily focus on economic aspects, partly because social impacts are difficult to measure and the data basis is often fragmentary.
- Furthermore, top-down programs can lead to gentrification and cultural alienation, while participatory arts programs may not tackle physical deterioration and social infrastructure.

Considering the Guimarães 2012 main goals (http://www.guimaraes2012.pt/index.php?cat=15), it becomes apparent that all three models of culture-led urban regeneration were at least to a certain extent part of the underlying deliberations. With view to the present project, this provided several aspects and inspirations to be considered in the development of solutions for the project site.

Urban Context
Climate zone: Cdb (temperate, mesothermal climate)
- Air temperature: 14°C annual average temperature. Warmest and coldest month average between -3°C and 18°C.
- Humidity: Summer dry, the driest month has precipitation less than 60 mm.
- Wind velocity and direction: 4 m/s average wind velocity from all directions more or less consistently throughout the year.
- Radiation: 1971 kWh/m² annual global radiation on horizontal surface, 1197 kWh/m² vertically, 90°, 1813 kWh/m² at 35° (best angle).
- Climate responsive architecture: most important design rules are allowing for passive solar direct gains, high thermal storage mass, sun shading of windows (Climate Consultant 5.2).

Solar Potential
The shading analysis illustrates, that even on the darkest day of the year (Dec 21), most of the roof surfaces are entirely exposed to sunlight or only little shaded. Most of the areas are tilted at an optimum angle of 30°-35° facing south (5470 m²), others range between 10°-20° (3641 m²). The flat roof surfaces (1126 m², mostly building D) are less suitable due to partial shading and less radiation on horizontal surfaces. For building AB and C alone a total harvesting potential of around 1,200,000 kWh per year can be expected (with monocristaline PV-modules, efficiency of 12%).

Energy Supply
Energy is needed for different functions of the site. While buildings need to be heated in winter months, a lot of cooling energy is required in summer. Following the aim to reduce heating and cooling demand of buildings by specific measures towards zero energy buildings, thermal energy becomes a smaller share of the energy balance. Accordingly, electricity, that is often connected to cooling devices, and for ventilation and lighting as well, starts to dominate. Looking beyond buildings, the field of traffic, where electricity could play a more important role in the future, is of importance.

The Electricity Production in Portugal is mainly based on coal, gas (since 1997 natural gas was introduced) and oil (together 66%) and hydropower comprises a wide extent, as it covers 16% (IEA 2008). Other renewable sources are waste, biomass and wind which makes up 13% (boom in wind generation since 2004). From this situation, it can be concluded that the decentralized electricity production has potentials. According to IEA 2008, heat in Portugal is mainly generated by and gas and oil. Here the possibility of co-generation becomes aware. However Portugal is highly dependent on electricity imports. Hydropower comprises a wide extent, as it covers 16% (IEA 2008). Other renewable sources are waste, biomass and wind which makes up 13% (boom in wind generation since 2004). From this situation, it can be concluded that the decentralized electricity production has potentials. According to IEA 2008, heat in Portugal is mainly generated by and gas and oil. Here the possibility of co-generation becomes aware. However Portugal is highly dependent on electricity imports.

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The Project Site is a hub of activity - from the bustling central train station, to the cultural center and numerous residences surrounding the periphery. A product all of this activity results in various levels of noise emissions, all of which impact the site in various ways. Noise can heavily effect the environment and health of those around it, causing annoyance and in some cases, irreversible health damage.

The Site

Regulations
In 2006, the European Directive 2002/49/CE introduced a decree-law n°146/2006, introducing new acoustical parameters for urban occupation, including three reference periods of the day: (day (7 h – 20 h), evening (20 h – 23 h) and night (23 h – 7 h), strategic noise mapping, action plans and lastly, obligatory public information and participation. (Rocha & Carvalho, 2007)

Portuguese noise legislation approved the new requirements in the 3rd Portuguese Noise Code January 2007 (RGR – Decree-Law n°9/2007) to better harmonize acoustical parameters. This means the project sites’ day-time levels, along the main arterial road, can at times exceed the limits, as set out in the legislation (detailed in the chart below).

SWOT
In terms of noise protection, the project site already hosts a few attributes working it its favor. A major contribution to noise reduction is provided by existing buildings onsite, namely Building A and Building D. The former blocks noise emission from the main arterial road, while the latter, Building D, lines the eastern border shielding the site from light traffic noise. Additional strengths include the site’s dense greenery coupled with the location of residential buildings in the northern area, resulting in 30-35 dB, roughly as quiet as the average library. It should come as no surprise, the site’s major weakness stems from two major noise sources: automobile transport on the surrounding roads, and rail transport from the adjacent railway. The weakest point of the site is the southwestern corner, where wide gaps between buildings allow noise to penetrate the site. Noise levels there, range from 60-70 dB. As revealed in the following sections of the brochure, opportunities to integrate noise protection in responsible urban planning manifolds. Closing the gaps between the buildings and the incorporation of additional noise barriers at the north and western border constructed as natural berms or with reused material can reduce noise while conforming to the site’s environmental caliber and tone. On the receiver end, modifying floor layouts can significantly mitigate noise, in turn avoiding the threat of irreversible health effects.

Noise

A.1: WEST FACADE OF BUILDING A

A.2: AVENUE DOM AFONSO HENRIQUES
Water

Current Situation
Annual average precipitation in the city of Guimaraes is 1315mm/year (NASA, 2002). The study site has 39,000m² of open/permeable area. Runoff storm-year (NASA, 2002). The study site has 33,000m² of non-permeable surface area. Annual average precipitation in the city of Guimaraes is 1315mm/year (NASA, 2002). This group operates 12 WTP, 570km of water mains. (Oliveira, Lima, & Vieira, 2005)

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The fact that the site has over 50% permeability (totally unsealed space and 33,000m² of non-permeable surface area. Runoff storm-year (NASA, 2002). The study site has 39,000m² of open/permeable area. Annual average precipitation in the city of Guimaraes is 1315mm/year (NASA, 2002). This group operates 12 WTP, 570km of water mains. (Oliveira, Lima, & Vieira, 2005)

Legal Instruments
The EU Water Frame Directive (WFD) came into force in October 2000 with the aim to improve the aquatic environment of all member states. The WFD promotes decentralized waste and rainwater management with instruments such as the taxation system, which gives incentives to use water resources more efficiently. In terms of sustainable water management, Portugal launched the National Program for Efficient Water Use (PNEA) in 2005. However, the country still needs to fulfill the EU regulations (EU, 2007). Some waste treatment plants operate inefficiently and potable water quality also does not always fulfill European standards. Furthermore, there is still under construction and most waste goes to landfill rather than to composting, recycling or incineration plants. Waste separation is practically nonexistent and the capacity of the bins in the city is limited. On the site itself there is a high risk, due to the former use for textile and leather production, that the buildings and surrounding soil are contaminated. Furthermore, the buildings have no improvements such as insulation and are still in the same situation since the 1900’s.

Situation in Portugal
Building materials should be suitable and adaptable to the local conditions of the building/site. Portugal has many natural resources such as cork, iron ore, copper, zinc, silver, gold, marble, clay, gypsum etc. 40% of the world’s raw resources are consumed by buildings. At the same time, buildings are one of the main producers of waste, harmful air and CO2 emissions (Maibritt, Pedersen, Zari). Therefore the choice of building materials to be used, as well as their disposal/recycling, is very important.

On-site situation
When analyzing the project site, its main advantages regarding materialsthe high concentration of reusable materials and the diversity of locally produced building materials. Although only a small part of the four buildings is still in use, a considerable part of the buildings’ structure is in good shape. On the other hand, the waste management system in Guimaraes is still under construction and most waste goes to landfill rather than to composting, recycling or incineration plants. Waste separation is practically nonexistent and the capacity of the bins in the city is limited. On the site itself there is a high risk, due to the former use for textile and leather production, that the buildings and surrounding soil are contaminated. Furthermore, the buildings have no improvements such as insulation and are still in the same situation since the 1900’s.

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Legal instruments
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Materials

A.4: LOCAL BUILDING MATERIALS: GRANITE | CERAMIC | COPPER | BAZALT | LIMESTONE | MARBLE

A.3: WATER COLLECTION IN STA. ÁGUEDA, IDANHA-A-NOVA

Current Situation
Annual average precipitation in the city of Guimaraes is 1315mm/year (NASA, 2002). The study site has 39,000m² of open/permeable area. Runoff storm-water from the site flows primarily into the northern underground Couros River, tributary of the Aver River Basin, which covers a total area of 458 km² (Oliveira, Lima, & Vieira, 2005)

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Guimarães was once the heart of Portugal’s largest textile-manufacturing industry until global competition drove business elsewhere (Wilder, 2011). The site echoes the city’s traditional significance as the host of four textile factories, three of which (Building B, C and D) are no longer in use. Building B & C exhibit a largely destroyed roof structure, from rapid deterioration, while Building A is still in use as a storehouse for textiles. In addition to the site’s historical industrial architecture, the site encompasses one of the largest green areas in the city. The dense vegetation and lack of access points keep the area fairly unserviceable. The site is located 1km south of the city center, between the central train station, the main arterial road and the Vila Flor cultural center. Many amenities are within walking distance (see table below). The surrounding area serves as a cultural and transportation hub, frequented by numerous tourists and locals alike.

The poor condition of the unoccupied factories, high potential of the site, in order to achieve the vision and objectives. The assessment led to the decision to conserve the site's ecological systems, while restoring the deteriorated natural environments and habitats. The outcome being an improved quality of life for the community achieved with the connectivity of outdoor and indoor spaces. Alternative water and energy sources were identified, as well as efficiency measures to complement passive design. Additionally, a whole-life-cycle material approach was pursued.

The Layout

In the first phase approaching the project site it was vital to have the multi-disciplinary team analyze all the potential and weaknesses of the site, in order to achieve the vision and objectives. The assessment led to the decision to conserve the site's ecological systems, while restoring the deteriorated natural environments and habitats. The outcome being an improved quality of life for the community achieved with the connectivity of outdoor and indoor spaces. Alternative water and energy sources were identified, as well as efficiency measures to complement passive design. Additionally, a whole-life-cycle material approach was pursued.

Methodology

The strategy developed for the transformation of the site was determined through the use of assessment tools offered in the REAP MSc program, as well as onsite analyses and data provided by the University Melho students and relevant literature. A major emphasis of the revitalization of the project is placed on material disassembly and the integration of onsite materials in new ways. The next focus lies on the proposed new residential building: its design and function were based on Climate Consultant data and improved water saving technologies were implemented using the WiseWater tool (Climate Consultant, 2011; Wise Water, 2011). In order to assess the value and benefit of its modifications, the Green Building rating system SB-Tool was applied. Lastly, to evaluate the economic performance of the PV-facility, the project analysis software RETScreen was consulted.

Noise Barrier

The noise barrier built as a screen for the park blocks both rail and main arterial road emissions, lowering noise levels by 13dB. The addition of a 2.5m high, 470m long, 100% recycled granite stone barrier reduces noise below 58dB, improving health and encouraging recreation.

Social Objectives

New Residential Build

Before and After

The Layout

Building B

Building phase until 1940

Clay tiles

Timber

Granite stones

Concrete

Building C

Building phase after 1950

Concrete

Timber truss

Rubblestone

Building A

Demolished

Fitness Corner

Bird Habitat

Toilets

Bicycle Racks

Kitchen Garden

Water Body

Tree Species

Lowest point of the area.

Building B

Concrete

Timber truss

Rubblestone

Concrete

Building C

Concrete

Timber truss

Iron sheet

Granite stones

Concrete

Building D

Timber

Concrete

Timber truss

As some of the invasive plants draw a tremendous amount of water, reduce soil quality and disturb the ecosystem, they will be removed, and replaced by native plants.

Material Disassembly and Recycling of Buildings B and C

Onsite textile factory Buildings B and C have been out of commission for years and rapidly deteriorated. Based on their condition and structure, potential for reuse was deemed incompatible with achieving our vision. An economical and sustainable alternative was incorporated to disassemble B and C and recycle all usable materials on site. To prepare this, the working group conducted an analysis and quantification of the main material fractions present. Building B & C each had at least two distinct building phases. The facades date back to an architectural period pre-1950s, characterized by granite masonry, timber trusses and clay tiles. Features of the post-1950s second phase include plastered brick masonry, concrete foundations and gypsum board. The roof consists of steel trusses and clay tiles, whereas the majority of tiles from Building C have been removed. The available materials were assigned to the following reuse:

• Concrete recycling for the residential building
• Granite stones for the noise barrier
• Granite chips for the Park Pathway
• Masonry chips for the drainage layer of the green roof
• Off-site recycling of timber, steel and gipsy

The recycling of materials conserves natural resources, avoids transportation and landfilling, as well as decreases emissions and saves energy and costs (RFN, 2011). The largest recycled fraction of Building B and C is concrete. Recycling concrete alone can save at least 10% energy as well as 10% of CO₂, NOx and SO₂ emissions (Heyns & Mettle, 2010).
New Residential Building

**Showcase Guimarães 2020**

The new “Showcase Guimarães 2020” residential building will provide affordable high quality housing. Additionally, it will serve as one of the first sustainable best practices for the region, thereby attracting broad-based attention and creating value for the municipality. The building has a wide range of implemented features (see sketch), which aim to attain the sustainability goals through an integrated building design approach in accordance with the REAP guidelines and the “Matosinhos SHE” building best practice example.

The new residential building will host 101 dwellings. Improved modifications include a green roof, PV & solar-thermal panels, rainwater catchment systems, an energy efficient building envelope and water efficient appliances. Through efficient financing, fundraising and public participation, low cost housing will be achieved.

**Social Scale**

Residents of the Showcase building will uphold sustainability through social and cultural networks provided by themselves. Participatory activities are upcoming events and outings, which will be organized through monthly meetings, which will include environmental awareness raising topics such as sustainable user behavior and participation in building maintenance such as tending to the green wall system.

As the building is adjacent to the Showcase Guimarães building, residents will have an opportunity to participate in planning local events such as speakers, music and cultural activities for local residents and tourists in the park. The park will also host as a meeting place for a weekly market with an emphasis on regional products ranging from organic agriculture and produce to furniture and household items. The venue provides additional potential for residents of the Showcase building to buy, sell or trade items, as well as participate in the planning of the market itself.

**Technical Scale**

The new Showcase Guimarães building is able to achieve an A-certificate. With implementing the measures mentioned below, the Showcase Guimarães residential building is able to achieve an A-certificate.

In order to assess features regarding energy and economic performance, the working group turned to the plot “Matosinhos SHE” project in Porto, 40km away from Guimarães. The best practice project was incorporated in the Sustainable Housing in Europe (SHE) initiative funded by the European Commission (SHE, 2008).

**SBTOOL®**

**The Local Assessment**

To ensure the building’s sustainable performance the SBTool (Sustainable Building Tool) was implemented. This tool has been initiated by the international initiative for Sustainable Built Environment (ISBE) and adapted to the Portuguese context in 2009. It aims to “evaluate the performance of buildings in relation to the three dimensions of sustainable development: environment, society and economy” (SB-Tool, 2009). In relation to two national reference levels (best-practice and standard practice), it incorporates 25 parameters. With implementing the measures mentioned below, the Showcase Guimarães residential building is able to achieve an A-certificate.

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**Conclusion**

As a result of all the mentioned measures, it is possible to transform the former industrial area into a socially valuable space for living, recreation and cultural activity. Environmental, social and economic benefits were created through the use of reclaimable materials from buildings B and C for site improvements such as a noise barrier, path, green roof systems and the new Showcase building. In light of the European Cultural Capital goal to revitalize heritage through the sustainable development of the built environment, the working group’s vision provides residents with a new public space through the integration of a park. The urban greenery and visualized water catchment systems benefit the environment and the residents’ quality of life. Additionally, the site’s architectural and cultural heritage will be preserved through the modernized textile factories buildings D and A. The former will serve as a cultural hub, while the latter will continue to preserve the Portuguese tradition of the textile industry while providing social and economic value for the local residents. Last but not least, the A-rated Showcase Guimarães residential building offers high level of sustainability, affordability and quality of life.

**Assessment**

RETScreen®

**Project Power Analysis**

“RETScreen is an Excel-based clean energy project analysis software tool that helps decision makers quickly & inexpensively determine the technical and financial viability of potential renewable energy, energy efficiency and cogeneration projects.” (RETScreen, 2011). RETScreen has been applied to evaluate the Photovoltaic facility on the roof. 2940 poly-silicon PV units from Mitsubishi Heavy Industries require an initial investment of roughly €1.7 million with €365 of annual operating and maintenance costs. Assuming a price of €18 cents per kWh, a 25 year life span and a discount rate of 3%, there is a facility pay back period of 7 years (see figures, RETScreen, 2011). Furthermore, it will save over 600k of CO2 per year, equal to around 1400 liters of crude oil saved.
Viscosity of sustainability

In various sustainable developments, one of the most significant factors in their success is the visibility of their sustainable aspects, making it accessible to all. This visibility enables an ongoing process of education and progress. The newly-created fabric is interwoven with references to the past industry, the culture and the history of Guimarães.

We see Jardim das Fabricas, with its urban location and natural conditions, as a possible catalyst for such a process. Through various tectonic, intellectual and cultural experiences, people gain knowledge that would further advance them towards sustainable living:

- the sustainability playground, illustrating energy and water cycles and exhibiting actual electricity production;
- an arts and crafts school referring to the historic textile industry while reverting even farther back to ancient dyeing practices;
- a regional sustainability center with a reuse/recycle center;
- restoration/re-establishment of natural habitats.

Dye Cycle

Textile and leather have been dyed since ancient times. Historically, the most widely used dyes were grown locally, later replaced by imports and artificial dyes. Natural dyes create no hazardous waste when produced and used, and in some cases may have a good influence on human health.

Growing these local dye-producing plants - such as weld, madder and woad - on site, has several benefits:

- restoring locally grown plants;
- enabling local production of natural dyes for textile;
- revival of ancient craftsmanship skills;
- exhibition of natural cycles through the production processes.

The traditional dyeing process requires relatively large amounts of water; we propose to reuse this water in the process and to connect it to the complete water cycle of the park. The mordant we propose to use is alum, which also used for water purification.

2.1: ENTRANCE'S VIEW

2.2: COURTYARD, ARTS & CRAFTS SCHOOL

2.3: SUSTAINABLE PLAYGROUND
Design for the Cycle

**Water**

The annual rainfall in Guimarães is around 1115mm, and storm-water management will be taken care of by the buildings and the park. On the buildings, green roofs and are incorporated on ~16% of the roof areas, retaining 50% of the rainfall and allowing evaporation. The rest of the runoff is collected into water tanks, used for the various water features in the park, irrigation, the dyeing process, and sanitary uses in the buildings.

In the park, 40,000m² are permeable surfaces. Three retention ponds collect rainwater and have a role in water purification using phytoremediation, and trench soak-ways provide infiltration. The park plays a part in making this cycle visible by exhibiting real-time updated production values. Specially designated playground equipment powered by the visitors will produce energy and provide a solution for the surrounding area as well.

Greywater will be collected and treated with phytoremediation.

**Energy**

The average annual irradiation in Guimarães is ~1792 kWh/m². This is potential energy that can contribute to site productivity, and cover the estimated energy demand (estimated according to standards for office use at 1,300 GWh/a for the park and the buildings).

Photovoltaic panels are located on all south-facing rooftops, supplying an estimated 2.3 million kWh/a, and 30 solar trees are placed in advantageous locations throughout the park, supplying additional 91,000 kWh/a. Surplus electricity will be fed into the grid, which will also cover peak demands when needed.

The sustainability park plays a part in making this cycle visible by exhibiting real-time updated production values. Specially designated playground equipment powered by the visitors will produce energy as electricity, and illustrate energy production uses.

**Materials**

Excavated soil from the ponds and underground parking will be used to create a berm for noise mitigation on the south-west corner and for living walls. Timber from the cleared, forest will be used for landscape features, such as decks and furniture.

Deciduous matter will be composted, used in the ‘living walls’ and fruit orchards. Demolished building parts will be either recycled on-site or transferred to a recycling facility. Some materials can be used for ‘recycled art’, displayed in the sculpture garden, or for the playgrounds.

After recycling off-site, there are even more possibilities: steel used for ‘living walls’ structure, wood upcycled into new furniture, plastic used for new box containers. Brick, clay tiles and concrete, after crushing, can be used for park paths and for green roof substrates.

Experience Sustainability

Relating to the cultural context while connecting it to the everyday industry offers a new reference layer, enriching the experiences of visitors, students and residents alike. The Jardim das Fabricas illustrates this connection, creating a landscaped public park drawing its inspiration from the textile industry while implementing innovative sustainable practices. The functions of the buildings surrounding the park further enhance the ideas of production/culture/insertion - the Arts and Crafts school, the Sustainability Center, the student dorms, the Living/Working complex, the library and the museum - all offer opportunities for interrelations and encounters and promote stewardship. We see the Jardim das Fabricas as the new ‘Fabric’ connecting the the past, present and future, while offering a best-practice example of sustainable treatment.

Conclusion

Experience Sustainability
Group 3

General Concept

The general concept proposed focuses on enlightenment with regards to material flows and how someone may participate in ‘closing the material cycles’. This is developed within the site by the provision of a Museum, which deals exclusively with visual explanations of material processes and flows, a Park with an interactive learning path, an open-air ‘puppet’ theater, and a ‘playing/learning ship for the children to explore.

Living Material: Building D

Building D will be renovated to be a multi-functional building: hosting a Museum, a Library and a Hostel. The Museum will be specific to material technologies and life cycles. The hostel and the library will also focus on ways of dealing with materials with the library being an academic source for books dealing with material production, LCA and waste and the hostel being more practical and hands on. The promotion of the concept of material recycling is enhanced by having the hostel in the same building so museum patrons as well as the hostel guests can see directly how the separation of waste and water streams work and the benefits.

In the building construction itself, the environmental impact is kept to a minimum by reusing the existing building structure and using recycled material for the additional walls and movable partitions added. These materials will come from Building B and C which are going to be demolished as a part of the closed material cycle to be implemented in the site. The added interior partitions can be disassembled providing flexibility and reducing the waste at the end of the building life.

The building is positioned as a ‘gateway’ connecting the Cultural Center with the Park through the open Atium that lures people into the park. There is also the possibility of connecting the two under the street from the parking located below the Cultural Center.

Material Flow & Impact Assessment

Environmental Impact Assessment

SBTool-PT, The Portuguese local building sustainability assessment tool was used to rate the buildings: sustainability performance and thus assess the feasibility of the proposed building D design. The tool assesses three sustainability dimensions: environmental, social and economic: The level of building performance is to be reached under this tool is scaled in six levels; from E (less sustainable to A+ (green or more sustainable). The following analysis is only concerned with the environmental aspects, specifically categories: C1-climate change and outdoor air quality and C4-material and solid waste, weighing 13% and 29% respectively of the overall environmental performance of a building. The result reached is presented in the table below.

The estimated quantity of material from the demolished buildings B & C and that existing on-site are shown in the left column. The quantities on the flow lines indicate the estimated, potential amount of recycled materials available. The right column shows possible destinations for the materials.

In summary, the evaluation of the environmental parameters indicate that our focus building D’ attains a green sustainability building performance with regards to major environmental categories, material and solid waste as well as climate change and outdoor air quality. This was achieved through efficient reuse of existing building components, recycling material on-site and by providing suitable conditions of solid waste storage during building use phase.
While the Museum is tailored more for the adults, the Park is created especially for the children: the idea is to have a fun yet stimulating environment that teaches about material cycles and how to reduce, re-use and recycle. It is designed with curving pathways made from recycled concrete, that wind in and around the new trees planted to replace the eucalyptus that were removed. At strategic points along this path are interactive exhibits that inform about trees, their processing into other materials and their environmental effects. Located in the centre of the Park is the main attraction, The Ship which is a prime example of a nearly closed material flow loop that with a little effort and ingenuity, can be replicated in the average household. The Park also features a Puppet Theatre with shows featuring the children's favourite puppet/cartoon characters doing their bit to reduce and reuse materials to help create a better environment. In addition there are remodelled tree stumps for sitting, public tennis courts and open areas for sports activities and drop-off stations where household material for recycling can be placed. Finally there is a man-made pond created in the lower half of the site to serve as a water catchment area as well as for recreational purposes.

**O Navio - The Ship**

As the main attraction, a life sized ship is used not only because it symbolises a near complete closed material cycle, but because in addition to cork and textiles, the shipping industry is very important to the Portuguese economy. It is a multi-functional exhibit, visible from all parts of the park. It provides a ‘how can I recycle everyday items in my environment’ platform, by showcasing the dual uses of items as part of the ships interior fittings. As seen in the fig below, items such as broken tile can be made into mosaic table top, or old cupboard doors into, table tops, and old cooking pots into plant pots. Also since ships at sea must find creative solutions to deal with their waste, the exhibit provides the platform for people to view these systems directly. The ship also serves as a playground for children which is safe and has medium supervision. It is a learning platform for the children, since they can take the ideas they see in the ship and implement them at home.

**The Learning Path**

The learning path as seen in the figure on the right, is created within the park. It comprises three repeated stations, situated at points along the pathways.

Station 1 lets you virtually participate in the conversion of logs into timber by choosing the process and product. Interesting facts are imparted visually and verbally by the station.

Station 2 allows for either the planting or cutting of a user specified holograph tree. During the process, facts about trees and their CO2 contribution are made visible.

Station 3 is a journey through the making of paper pulp and paper. At the end of which samples of pulp are available for users to actually see and touch. Energy consumption figures are shown depending on the method and other criteria selected by the user.

**The Open-air Puppet Theatre**

This theatre has dual functionality: it educates the children about recycling of materials in a fun environment and also acts as a water catchment area for normal and the 100 year peak run-off. The seating is made with recycled concrete from the demolition of building B & C. The stage has recycled aggregates in the slab and the canvas cover overhead is supported by recycled steel elements.
Environment and Context

Following the motto „cultural intervention“, the project deals with the old existing buildings and natural structures and tries to preserve the identity of the place to a wide extent. Of the four buildings, building A especially has a strong connection to the textile manufacturing, because it is still in use for textile storage. The area is not being maintained, so that wild plants cover much of the inner area of the site. Therefore the project deals with the greenery on site and the natural local conditions as well. Cuts and interventions in the built-up and the green area are done only in specific places, in order to highlight certain aspects, e.g. the connection between building A and D as well as the connection to surrounding buildings. The facade towards the Cultural Centre just next to the site defines the accesses to the place by „carving through“ building D. Thus, an important feature of the design is the interaction with other places within the city centre. The topography of the place is dominant, reaching from a relatively high point down to the city centre. So the site can be seen as an opposing attraction to the castle on the other side of the city centre, embracing the cultural heart of Guimarães. In the context of mobility, there will also be a link to the city. The concept uses the good accessibility by buses and a regional train and improves alternative traffic means, e.g. bicycles which are rarely seen except uses the good accessibility by buses and a regional train and (City of Guimarães, 2012). Within the festival programme, the development of an open space and the refurbishment of the old buildings on site constitute an important contribution. In relation to the museum concept for building A, the whole site will be designed as an open exhibition space.

Spatial structure

Because building A and D are especially worth maintaining, the design focuses on these buildings. While building D forms a kind of entrance building with access to the site (providing necessary space for parking and an innovative mobility system, as well as other facilities such as a café and a library). Building A is transformed into a museum - a cultural highlight offering multifunctional workshop spaces. The focus lies on this museum building - the development of the internal museum concept as well as the development of the outer space. Building B could become a School of Tourism or Art so that the whole concept contributes to the topic of education as well. Out of building C, or instead of it, residential studio houses could be developed along the northern border of the plot, as the actual owner of the plot years for residential space.

Except for the identity as a textile manufacturing site, building A (around 6000 m²/16.000 ft²) offers several advantages for museum use: it has several big halls, offering both room heights of about 6 meters and enormous distances. The roof consists of tilted shed lights, which are oriented to north and let natural daylight in. Additionally, it has some characteristics (facades) which are worth conserving, although it is an industrial building.

Social and cultural aspects

The overall concept for the site is to create a sustainable public space for inhabitants and visitors of Guimarães. It is expected that many new visitors will be attracted in 2012, as there will be a series of events and cultural activities during the whole year (City of Guimarães, 2012). Within the festival programme, the development of an open space and the refurbishment of the old buildings on site constitute an important contribution. In relation to the museum concept for building A, the whole site will be designed as an open exhibition space.

Thus the open space design offers attractions such as art pieces and fractions of the sustainability topic (e.g. reuse of deconstruction material as semi-permeable ground covering), creating recreation spaces for old and young. The aim is to hold events and create a space for social interaction and communication that fulfils its aims on a long term basis as well, not only during the cultural capital year. In addition to recreation, it is important to involve the people in the concept. Social sustainability is often ignored, but is one of the main aspects of a sustainability. So one of the social components is an awareness-raising campaign, which goes along with the exhibition concept. The sustainable treatment of waste and materials forms one main focus of this programme. Traditionally used materials and new materials should be experienced with all senses in the exhibition as well as outside in the landscape design.

Material concept

The main material concept relies primarily on maintaining and reusing existing buildings and nature wherever possible. Waste should be reduced, then reused and then recycled. Since building B and C are in a bad condition, there will be tons of construction and demolition waste that can be recycled and reused on site, creating pavements, sculptures or gravel for the water management systems and the urban design in a creative way. A system of modular interior partitions walls is designed to create a flexible exhibition concept. The advantages are that such a system can first be prefabricated and then reused so that it reduces waste.

The project strongly follows the aim to raise awareness regarding material cycles. So the idea of how to treat materials is not only shown in the exhibition, but also applied when retrofitting the museum building. Therefore an analysis of appropriate sustainable materials has been carried out, e.g. for insulation materials. Those materials have to fulfil several sustainable criteria: local production, recyclability and low embodied energy.

For different wall types cork, cellulose and cotton have been chosen (according to Green Public Procurement, 2010 and PASSIVhaus-Bau- teilkatalog, 2008) so that u-values can be improved to a wide extent. Those “new materials” and their cycles make up an important part of the exhibition and a first step for the energy concept. The museum, dedicated to Sustainability, Arts and Crafts and Textile, will also show the history (with its traditional processes) and the identity of the site.
4.5: ROOF DESIGN: WINDOWS ON THE NORTHERN ROOFS / PHOTOVOLTAIC PANELS ON THE SOUTHERN ROOFS OF BUILDING A

Energy concept
Thermal and electrical energy must be used efficiently, as resources are steadily decreasing. This can be done by using new technologies or by optimising the building using passive measures. The focus lies on a sustainable restoration approach integrating all material visions expressed before. As an example, the energy concept was calculated for building A. Its energy demand consists of thermal energy for heating and cooling and electrical energy for light and ventilation.

To optimise the energy demand and to develop the building towards a zero energy building, renewable energies such as photovoltaic or geothermal energy are introduced. A comparison between the simulated total energy demand (as electricity) and the estimated possible solar power by PV considering non-shaded roof areas (global radiation on a horizontal surface of 1558 kWh/m²/a is quite high in Portugal) on an annual basis shows that the demand of the existing building is higher than the possible supply: 829 MWh/a > 649 MWh/a.

If an additional geothermal system is used to cover the demand of heating and cooling energy (calculated out of the daily peaks: 102 boreholes), only one third of the annual demand has to be covered by electricity to run the system. Thus 538 MWh/a < 649 MWh/a and can be covered by the renewable electricity on the annual basis.

But such a concept only works on an annual basis if summer surpluses can be fed into the electricity grid and if electrical energy can be taken in winter, when there is less solar radiation available. Such concepts are not yet developed in Portugal, so a self-sufficient situation should be developed. Therefore the solar radiation of all months has to cover the specific demand of this month, what would not be the case with the energy demand of the existing building, especially for the winter months.

Therefore the building is optimised according to measures explained in the section about climate protection. When applying the insulation materials mentioned, the energy demand for heating, cooling, light and ventilation is reduced by about 50%, using a geothermal system and PV-427 MWh/a < 649 MWh/a. The daily peaks in the optimised version require about 13 boreholes. In this concept, the solar harvest is defined by the demand in the winter month.

Therefore, infiltration of storm water has to be ensured, so that it can be used to recharge e-bikes and/or cars on site.

Water Sensitive Urban Design
One of the largest green spaces in Guimarães is found on the site, allowing the opportunity to create public green areas in the city. Although some of the wild greenery is carved through to create access paths, most of the trees stay as-is and fauna and flora generally protected. To use the open space for bigger events, there have to be some seated and semi-permeable surfaces in the open space design. Nevertheless, infiltration of storm water has to be ensured, so that it would no longer be necessary to use a combined sewer system.

The average amount of precipitation in Guimarães is 1315 mm annually (J.N.M.G., 1991). During rainfall events, the water will be guided through the topography of the site passing by infiltration swales, open trenches and little ponds to a retention pond on the lowest level in the north, where there is a controlled overflow into a little natural stream. Some of the storm water is also stored in the buildings to compensate fresh water for e.g. toilet flushing, especially for the residential houses.

Climate
To reduce emissions and save energy, the best solution is to use passive design rules to adapt buildings to the climate (in this case C (acc. to: Köppen classification, meaning a temperate, mesothermal climate). The electricity demand for daylight can be reduced by appropriate window sizes and placements; natural ventilation can cover most of the ventilation needs. Required heating and cooling energy can be limited by e.g. internal gains or insulation layers. Therefore the basic data regarding solar radiation, sky cover range, wind velocities and directions and temperatures are of importance and have to be considered when planning. Obviously, those options are limited when dealing with existing buildings; nevertheless they are applied to a certain extent in the optimized simulation version.

The aim is to retrofit the buildings to a certain extent so that they function self-sufficiently over the year and, because of the climate, produce surplus energy in summer.

Comfort and Health
The project area is the largest green area in the city centre but it is like a ‘jungle’ that cannot be used as a public space. Our project proposal creates comfortable and nice public spaces by carving that green area like a sculpture without ruining the trees as much as possible. Moreover, natural materials containing no hazardous substances are proposed for the retrofit of the buildings, and the buildings are re-designed to have a more accessible, lighted and environment-friendly urban area.

Development potential
The focus of the project was sustainable urban development with a focus on energy and material concepts. Low-waste construction and renovation processes were shown to have a closed material cycle and cause less harm to the environment. However, the common practices of states and user behaviour are the most important factors that can lead to an overall sustainable development. Therefore, awareness raising campaigns for the society and state policies should be developed in parallel with the environmental concerns.

4.6: MONTHLY ENERGY DEMAND AND SUPPLY SCENARIOS
In developing the project concept, initially the most appropriate uses were considered to give a clear character of the spaces within and around the site. The morphology diagram identifies three major uses in the area such as cultural, residential and services/office and landscape use. These were all to be enhanced and brought back into use.

The proposal creates new routes and enhances existing floor patterns at an urban design level, while providing significant architectural and landscape features which will attract new life into the area.

Healthy, supportive, diverse and sustaining relationship between natural and man-made space

Concerning the environmental aspects, the project inspires delight and expresses human design symbiotic with nature. The Guimaraes southern city gate seeks to be a life support system in harmony with energy and water flows, human experiences and other living things. This is to be achieved by street and green area design features which harvest the energy of the sun, sequester greenhouse gases, harvest and distill water, transform waste water to energy, and provide habitat.

Water Concept

Regarding stormwater, the slope of the site suggests to reduce and retain runoff. The resulting water concept involves rooftop rainwater harvesting on-site, and sustainable urban drainage features in the redesigned streetscape to retain and infiltrate street runoff. The harvested stormwater is used for toilet flushing. Yellowwater and greywater from the buildings is channeled to constructed wetlands situated in the northern, lower part of the site and eventually discharged into the creek. Blackwater and organic waste from kitchen sink grinders is directed to a small biogas plant. Since most areas on-site are sealed, some stormwater infiltrates the soil. Excess stormwater from street runoff is also eventually discharged into the creek.

Energy Concept

The underlying principle of the energy concept is to showcase the integration of water and energy aspects. It consists of two parts: a small-scale biogas digestion plant run by blackwater and organic waste, and a pump-storage hydroelectric plant which stores electricity from PV panels on the on-site buildings. The potential PV production vastly exceeds - on an annual basis - the on-site consumption. Along with the topography of the site, this enables the installation of a pumped-storage hydroelectric plant, serving as a showcase facility for the balancing of fluctuating renewable energy production. With two 3,000,000 L storage tanks in the southern and the northern area (height difference of 30m) and a pump-generator, 212 kWh can be produced over a period of 5h, while 231 kWh are initially required.
Green connectivity

Visibility of Sustainability

Street design
The Guimarães southern city gate is a typical transit space to the city center. Everyone moves from A to B - but can it be more?
The streets on the site form a network around the vast, diverse green area by the Guimarães main train station. Landmarks for culture, business and recreation are positioned as attractive nodes between them.

Green Belt - Avenida Dom Alfonso Henriques
In terms of city level accessibility Avenida Dom Alfonso is one of the main streets on the site providing direct access from the main train station (city entering point) to the historical city center (main attraction point).
The street character was changed from mixed use (auto and pedestrian) to pedestrian use with limited access for auto traffic (only for delivery service and residents). The street design provides a vision for a pedestrian and bicycle route that will connect and access new and rehabilitated public spaces such as the existing cultural center and further existing public institutions as well as a proposed museum, cafés and restaurants.
Permeable (grass surfaces) and impermeable spaces (granite floor) merge into each other giving dynamic to the street layout. The street floor is punctuated with water elements which collect stormwater, partly infiltrating it to the soil and channeling excess water to the creek. Varying water levels leave an impression of constant change and serve as an eyecatcher. Street lighting shows the movement flows direction and also indicates the area that can be crossed by auto traffic. The street lighting in the cultural space plaza consisting from energy generation floor tiles gives life to the area in the evening or night.
The various design elements in the street layout combined give sustainability a human face.

Blue Belt - Rua da Caldeirão
The key design feature of the Blue Belt was re-emerging the natural element of the street, Couros river, which was culverted and runs under the Guimarães city. Making the Couros river visible along the street reinforces pedestrian activity in conjunction with the constructed wetlands by providing an inviting environment.

Park as a living system
In the Guimarães park the existing value of the landscape is the actual attraction. The quality of the landscape is therefore preserved and enhanced. Only soft interventions in terms of re-creating pathways and clearing the underground are performed. The park becomes a living organism in the city, a place where interaction of matters are made visible. Rain water is collected in detention ponds and with varying water levels the experience of the park is constantly changing. Timber made bridges (constructed with local materials) are crossing the park and small local plazas, resting areas are placed freely like islands floating on the undulating surfaces.

Only finding efficient solutions to functional problems is not the final demand on actual urban design approach. The demand for unique and sensuous experiences remains at the core strategy of the project. The project’s simple goal is to maximise the green amenities in the green area in the middle of the site, transforming it into a big urban garden accessible and visible from everywhere, and giving the buildings which surround it a green skyline. From the upper level one can enjoy the view of a lush and beautiful landscape, terraces and water features. At the upper level, the sensuous exploration of the green area starts with the water collection tank which is made visible within the new building design. Part of the water basin is designed to be transparent, showing the water level growing and declining as an easily perceptable display meter for the stored electricity. The next big attraction is represented by the constructed wetlands which collect and purify waste water from the surrounding buildings. The last water attraction point of the flow of water design spaces is the Cou-ros river which is now made visible along the street by unculverting, reinforcing the desired land use in the area.
Summary and Outlook

As presented in this booklet, five groups from third semester REAP Master's programme students proposed different measures in the old industrial urban space in Guimaraes to reach sustainable development. The analysis phase on material, noise, water and energy set the initial objectives of the proposals. Even though the methodology had variations in each proposal, they were generated to achieve stable and successful solutions to ensure sustainability in this unique urban green space of Guimaraes.

Sustainable Regeneration

All of the five groups developed strategies to ensure stable sustainable growth. In each case, the focus area or topic was different but the main goal was the same.

The majority of the project area was composed of a green space, which was more like a ‘jungle’ instead of urban greenery. All of the proposals took advantage of these already existing green elements. Green open space design was integrated with other sustainability measures. Decentralized rainwater management could be handled in the project site with increased natural infiltration. Also, proposals to make this greenery a public space are developed. For example, urban farming areas, Botanical Park or open sustainable material exhibition spaces were able to be introduced.

There were mainly two different approaches to handle with the existing industrial buildings on site. First approach was to keep the buildings as much as possible and to retrofit them to ensure energy savings. The second approach was to demolish the buildings which are in a bad condition and reuse/recycle these materials to retrofit the old buildings or building new ones. Either way, it was tried to provide sustainable material and water cycles. Integration of green roofs, electrical energy production by solar panels, utilization of local building materials, implementation of energy-efficiency measures were also the common features of the proposals.

Guimaraes, European Capital of Culture 2012

Guimaraes, being the European Capital of Culture in 2012 shaped the outcomes in a positive way. Public participation through cultural events, workshops and campaigns were encouraged. By the same token, in each proposal, there was an attempt to integrate people to the redevelopment project by means of education and awareness rising programs. Likewise, all the proposals dealt with visibility of sustainability, which can also facilitate behavioral changes, improving the site quality in long term. In addition to the European Capital of Culture organizations, many activities and events were offered in the project site. It is important to provide persistence in those activities, especially after the year 2012.

Outlook

The project site is unique greenery with a high potential to be transformed into a green open public space. It is in proximity with public transportation stations and cultural centers. The outcomes presented in this booklet, represents five different views to utilize these potentials; they may not be viewed as either the best or the worst. Nevertheless, it is our view that urban regeneration projects should exhibit best applicable measures to provide cities of tomorrow for the next generations.

In order to assure a sustainable development, a holistic approach is needed considering all aspects. Progress in the national strategy is also needed for this achievement. In case of Portugal, energy and waste management policies should be improved by sustainability and efficiency measures, striving for the best practice in urban scale.


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**Group 5:** all own figures
Contact

Students:
Javier Angel Rodriguez
Daniel Bornmann
Sherilyn Croal
Stephanie Grümer
Agust Ismoyo
Rahel Kassaye
Ismail Khater
Franz Kiehl
Tobias Kraft
Ramón Osório
Lucy Price
Saif Rashid
Lital Shelef Dori
Liana Stoica
Tugce Tosun
Diego Weber Rodriguez

Supervisors REAP:
Dipl.-Ing. Anke Jurleit
Dipl. Ing. Sonja Schelbach
Prof. Dr. Wolfgang Dickhaut

Supervisors University of Minho:
AP Paulo Mendonça

www.hcu-hamburg.de

javier.rodriguez@hcu-hamburg.de
bornmann.daniel@hcu-hamburg.de
sherilyn.croal@hcu-hamburg.de
stephanie.gruemer@hcu-hamburg.de
agust.ismoyo@hcu-hamburg.de
rahel.kassaye@hcu-hamburg.de
ismail.khater@hcu-hamburg.de
franz.kiehl@hcu-hamburg.de
tobias.kraft@hcu-hamburg.de
ramon.osorio@hcu-hamburg.de
lucy.price@hcu-hamburg.de
saif.rashid@hcu-hamburg.de
lital.dori@hcu-hamburg.de
liana.stoica@hcu-hamburg.de
tugce.tosun@hcu-hamburg.de
diego.rodriguez@hcu-hamburg.de

anke.jurleit@hcu-hamburg.de
sonja.schelbach@hcu-hamburg.de
wolfgang.dickhaut@hcu-hamburg.de

mendonca@arquitectura.uminho.pt

www.hcu-hamburg.de