
# Enabling Space; Enabling Knowledge

**April 8, 2022**

**Towards a Resilient Ciutadella Knowledge Campus**

Universitat Pompeu Fabra

International Master CITY RESILIENCE Design and Management | uic barcelona

# ABOUT THE REPORT

This report was created by the students in the City Resilience Design and Management master's programme at the Universitat Internacional de Catalunya. The report is a product of the workshop: Resilience, sustainability and university campuses: concepts and inspirational guidelines for *Mercat del Peix* and *La Ciutadella del Coneixement* conducted from March to April in 2022. The purpose of this report is to propose resilient strategies that respond to Pompeu Fabra University's call for designs for a development at the Ciutadella campus in Barcelona, Spain. Guiding questions for the workshop included:

- How should resilience be applied within the planning, design and management of a campus?
- How should  sustainability be applied beyond its technological and design components, addressing the district scale, beyond the new campus buildings?
- How a campus could lead and contribute to a whole city district in order to boost culture, knowledge, quality of life and equity? And in the case of the UPF Campus, how could it contribute to the implementation of the Knowledge District implementation?

# Executive summary

The Pompeu Fabra University jointly with the Center for Evolutionary Biology and the Barcelona Institute of Science and Technology is expanding with three new buildings, repurposing a car park located south of the existing UPF campus, and southeast of Parc de la Ciutadella.

The site faces a number of urban challenges, including poor accessibility, climate change hazards, urban blight and disconnected socio-ecological networks. The three new buildings, which will be home to leading and innovative research organizations, offer an opportunity for wider urban regeneration, bringing the surrounding area and campus back to life. The UIC team worked on identifying the site specific challenges that the new campus will need to respond to, and the strategies necessary to respond to these challenges through a resilience lens.

Through a concept of "Enabling space, enabling knowledge" the UIC team recommends a new way of imagining the new campus space and surroundings, with a focus on maintaining diversity and redundancy, enhancing connectivity, encouraging learning and broadening participation within and beyond the boundaries of the campus. Four strategic priorities are identified to create a resilient campus: Active Ground, Circularity, Re-energising, and Connecting Ecosystems. Within each priority our team proposes specific design solutions to turn UPF into a center for urban transformation.

Our team proposes the following resilience vision for UPF:

> *The UPF campus is a Mediterranean hub for knowledge sharing and active learning – drawing upon the rich history of the region and universities to innovate, inspire and create resilience for communities using a framework of planetary welfare.*

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# Who we are

## Meet the team

# Let's meet!

We're a multidisciplinary team of 14 students from all over the world with backgrounds that range from architecture and engineering to urban planning and geography. Studying the timely field of urban resilience – or the study of how to make cities more capable of coping with shocks and stresses – we're passionate about making urban centers more flexible and durable despite rising challenges, such as the global climate crisis, pandemics and geopolitical conflicts.

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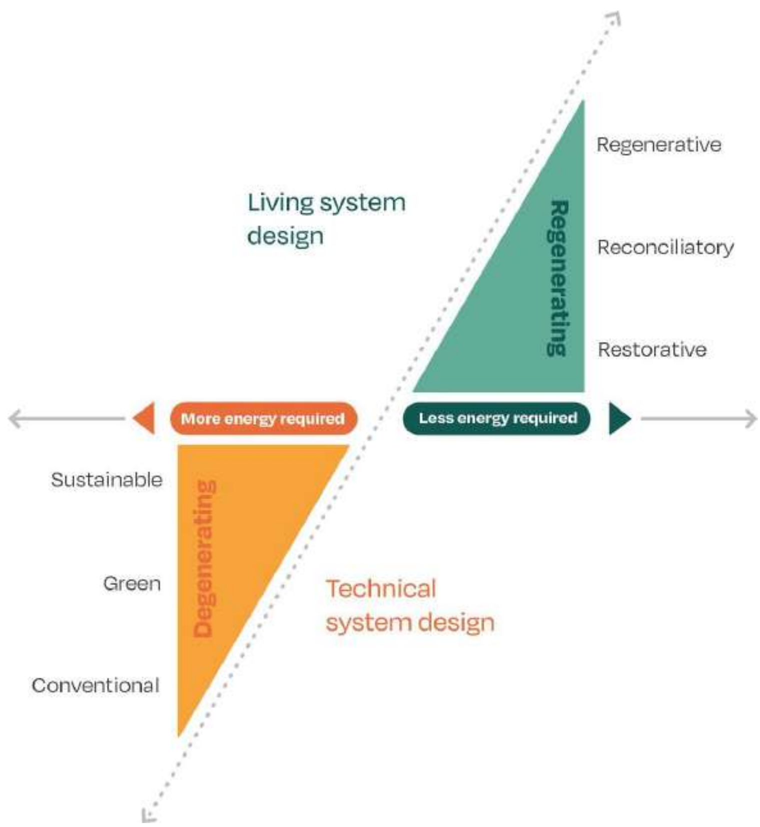
# Why urban resilience?

## Resilience theory & principles

# A brief introduction to resilience

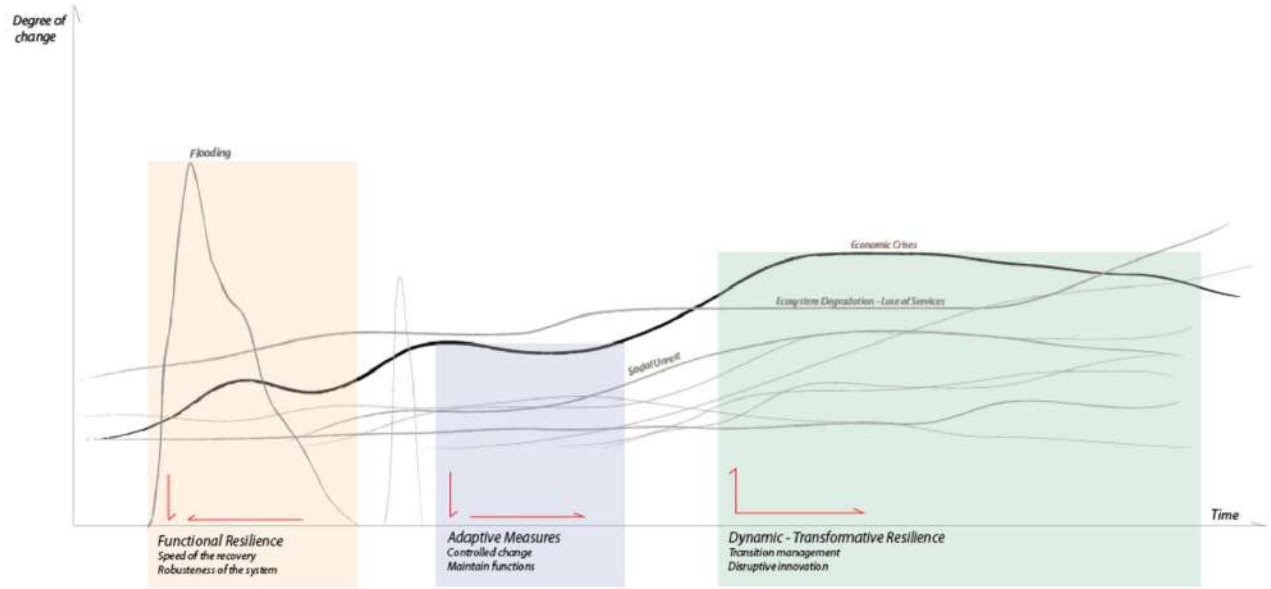
The world is changing, and so must the ways countries, cities, and campuses respond to the many shocks and stresses that disrupt the status quo. The graphic below, adapted from researcher Bill Reed, uses a systems thinking approach that moves past sustainability into resilient and regenerative systems that reconcile human actions with the environment so that both thrive. Resilience goes beyond sustainability principles by meeting the needs of the present and future generations, by creating adaptive systems and urban environments that foster regeneration. Sustainability in comparison to resilience is often focused on technical design and does not always integrate the urban environment with nature.

The more regenerative a system, the more resilient. Living systems are complex and dynamic. This means that humans need to play a creative, hands-on role in our natural systems. So what does this mean in practice? How does a system become resilient in the face of many significant challenges? This report will briefly describe what 'urban resilience' is, what it looks like, and how it can be applied to campus contexts.




1) *Shifting from Sustainability to Regeneration (Reed, 2007)*

While the terms 'urban' and 'resilience' are frequently discussed and criticised, one useful definition from [Defining urban resilience] by Sara Meerow, Joshua Newell and Melissa Stults states, "Urban resilience refers to the ability of an urban system – and all its constituent socio-ecological and socio-technical networks across temporal and spatial scales – to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity."




*2) Degree of change through different approaches to shocks and stresses (Chelleri, 2016)*

How can resilience support UPF turn into a thriving campus that enables space and knowledge? Resilience as a concept has the ability to function as a 'boundary object', or something that can cross disciplines and provide value in many different scenarios. Resilient campuses are capable of not only adapting to shocks and stresses, but leveraging them to grow stronger as institutions, creating systems that are more inclusive and adaptive. Any evaluation of resilience begins with a holistic look at capacity and risk, which can be directly applied to the campus context. UPF has many strengths that can be leveraged to address challenges, improving the quality of life, physical environment, and reducing the impact of shocks and stresses.

# Methodology

Our team drew from our range of professional expertise to devise resilient campus strategies that not only meet the needs of UPF's innovative and knowledge center, but improve the quality of life for the surrounding communities and city.

The methodology consisted of the below steps:

1. **Site visit and analysis of:**
    a. Socio-cultural context
    b. Ecological context
    c. Physical context

2. **Literature & case study review (found throughout Chapter 5)**

3. **Collective brainstorm to**:
    a. Identify site challenges
    b. Determine community needs
    c. Highlight city and university goals
    d. Outline set of core strategies

4. **Four resilience principles were identified that were most relevant to the UPF campus:**
    a. Maintaining diversity and redundancy
    b. Managing connectivity
    c. Encouraging learning
    d. Broadening participation

5. **Four resilience based strategic priorities were identified:**
    a. Active Ground
    b. Circularity
    c. Re-energizing UPF
    d. Connecting ecosystems

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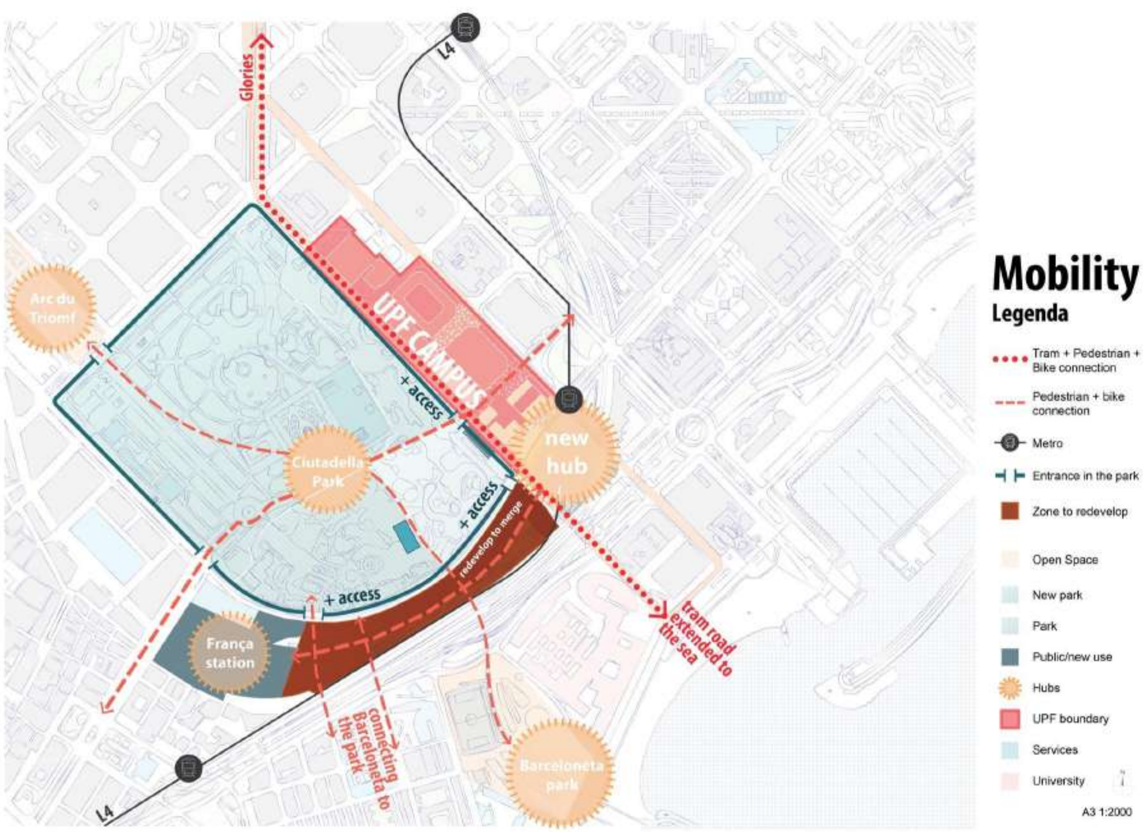
# The campus today

## Challenges and leverage points

# Relationships & interconnections to the surrounding areas

The UPF Campus de la Ciutadella is located on the eastern side of the Ciutadella Park in Barcelona. It bears proximity to the Barcelona Zoo, Parliamentary building, and Estacion de Francia, a major railway station that dates back to the mid-1800s.

The new campus development site is part of a string of universities facilities and departments lining the park but transportation passages traversing the area and walls enclosing the Parc de la Ciutadella isolate the campus from two main arteries at the west and south. Access to the sea is limited, with one bridge at Passeig de Circumval-lacio to cross the railway and highway Ronda Litoral. This layout adds to a feeling of insecurity in certain surrounding areas due to lack of maintenance and landscaping around the rail tracks.




*Key nodes, connections, transportation paths, and access points explored in analysis.*

# Challenges & leverage points

The surrounding area of the campus is marked by a number of challenges that undermine the openness, mobility and connectivity to important social and ecological nodes in the area. Here, we outline the major challenges of the campus and its context, as well as the opportunities that lay just ahead.

## LAYER 1: The Socio-cultural Context

The socio-cultural character references the people, histories and collective stories of all communities. For UPF's Mercat del Peix knowledge campus, analysis considered the layered histories and important social, cultural and economic spaces surrounding the campus that create leverage points for a campus that thrives 24 hours a day, 7 days a week.

**Key resilience factor**: remove boundaries of access to the campus with a special focus on vulnerable populations and activate spaces to change behaviors and public perceptions of safety.

| | |
|---|---|
| **Challenge 1**<br>Creating inclusive and open campus that fosters lifelong learning for people of all genders, age and socio-economic background. | **Leverage Point**<br>Build a campus culture that integrates diverse perspectives to support positive behaviour change, awareness for planetary wellbeing and builds social capital. |
| **Challenge 2**<br>Neglecting the stories and layers of history that make the area unique. | **Leverage Point**<br>Incorporate context sensitive design that connects the rich history of the area (ie. Mercat del Peix) and use symbolism to convey the area's stories. |
| **Challenge 3**<br>Lack of connection to local services, commercial activity and wider knowledge district. | **Leverage Point**<br>Integrate knowledge hubs to create a stronger intra-urban network through activities, shared spaces and collaboration. |

## LAYER 2: The Ecological Environment

The ecological setting references the natural environment, ecosystem services and climatic characteristics that influence the experience of people in and around the campus. For UPF's Mercat del Peix knowledge campus, there is significant potential to improve the ecosystem networks and integrate the campus within its socio-ecological context to create a living system.

**Key resilience factor**: consider the connections between socio-ecological nodes in the surrounding area to increase diversity of ecosystems and social interactions.

| | |
|---|---|
| **Challenge 1**<br>Spatial barriers to access open space and the cooling effects of green-blue infrastructure. | **Leverage Point**<br>Connect to Parc de Ciutadella and the sea, drawing on the proposal for connected green corridors outlined in the Ciutadella masterplan. |
| **Challenge 2**<br>Designing for variable Mediterranean climatic conditions. | **Leverage Point**<br>Incorporate adaptive, vernacular design, native or naturalised species and materials that reduce risk and exposure to extreme climatic events (ie. heavy rains during a short period). |
| **Challenge 3**<br>Disconnection between ecosystem services. | **Leverage Point**<br>Create connections between local habitats, green spaces, while increasing biodiversity and mainstreaming ecosystem services through design and management policies. |

# LAYER 3: The Physical Setting

The physical setting references core aspects of the built environment and hard infrastructure, the movement networks and barriers that define the physical cohesion of the context. For UPF's Mercat del Peix knowledge campus, there is an opportunity to break-through the physical, and in turn the functional, barriers to create a campus that blends with and draws from its context.

**Key resilience factor:** consider harvesting local resources and integrating functions of core infrastructure and leverage the urban metabolism of surrounding areas.

| | |
|---|---|
| **Challenge 1**<br>Physical barriers that limit connectivity and mobility | **Leverage Point**<br>Increase permeability by reclaiming space through universal design measures to create new linear pathways for active transit |
| **Challenge 2**<br>Obstacles that limit safety and inclusivity of spaces for people of all genders, age and socio-economic backgrounds. | **Leverage Point**<br>Improve the experience for women, children and other marginalised populations by implementing 'safety by design' best practice (i.e. passive surveillance and active building facades) and designing inclusive spaces. |
| **Challenge 3**<br>Lack of integrated resource networks. | **Leverage Point**<br>Connect to existing alternative resource networks (ie. The Districlima heat and cold network) that run close to the site and develop new ones. |
| **Challenge 4**<br>Mono-functionality of uses that limit activity from day to night. | **Leverage Point**<br>Diversify land uses and activities through multifunctional spaces and programmes that operate across different times of the day and week. |

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# What does a *resilient* Ciutadella Knowledge Campus look like?

## A framework for actions

# The Big Picture

Our team looked at different ways to enhance the resiliency of UPF's campus and surrounding areas in order to expand the impact of the Mercat del Peix knowledge campus. In order to reach UPF's goal of creating an innovation and knowledge hub in the center of Barcelona, it is integral to create a space that simultaneously enables movement and enables knowledge.

***"Enabling Space; Enabling Knowledge"***

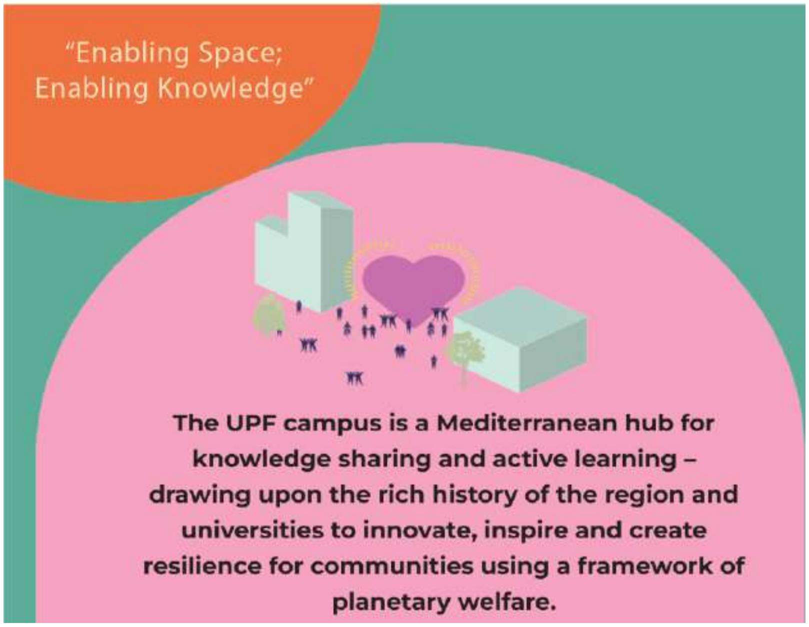
Our team's vision centers on:

- Erasing limitations
- Expanding reach
- Reimagining community

By adhering to the above priorities, our team's vision considers the ***three buildings, the surrounding campus and the greater city***, and offers a ***set of cohesive and holistic resilient strategies*** that not only address the needs of UPF, but the needs of the local area and community too.

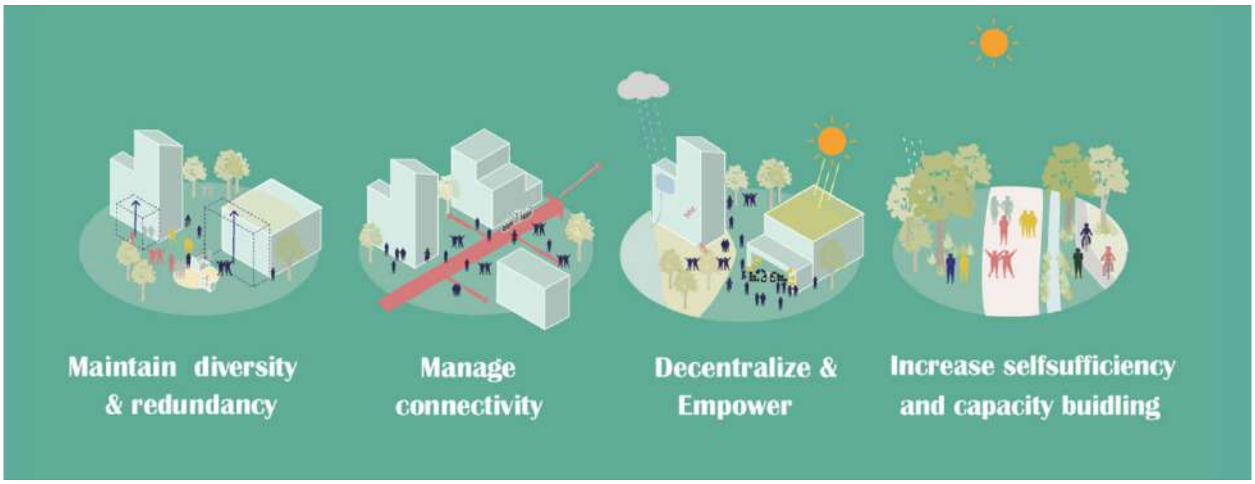
In parallel, our team  encourages UPF to connect the new campus to the **metaverse** and **virtualize** the school's academic landscape, thereby presenting a model of education that reflects the **spirit of the age**.

## Vision Statement



# Guiding principles of urban resilience

Principles of urban resilience range and can be project specific. Based in research done by the Stockholm Resilience Center's seven principles for building resilience in social-ecological systems, four were identified that relate to the UPF's Resilient Campus, including:




**Maintaining diversity and redundancy** encourages resilience by allowing different components to respond to any shocks or stresses in varied ways.

**Managing connectivity** is key for well-connected systems, as they have the ability to respond quickly to disturbances but require a poly-centric nodal network to ensure that one disturbance doesn't topple the entire system.

**Decentralize & Empower** aligns with UPF's goals of stimulating and sharing knowledge, with collaboration at the core of this principle.

**Increase self sufficiency and capacity building** facilitates trust and shared understanding, which are key to collective action and collaboration on any programs or projects that include multiple stakeholders.

Our framework acknowledges wider conditions and challenges related to social, environmental and economic sustainability affecting Barcelona and the Catalonia region.

The key challenges specific to the site context and surroundings were identified as follows:

- Perception of safety and inclusivity
- Lack of socio-ecological connectivity
- Urban blight
- Accessibility and spatial barriers
- Climate change
- Energy insecurity
- Siloed resource networks
- COVID-19 pandemic


Railway tracks in the direction of Estacio Francia acting as a barrier for pedestrian access

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# How do we get there?

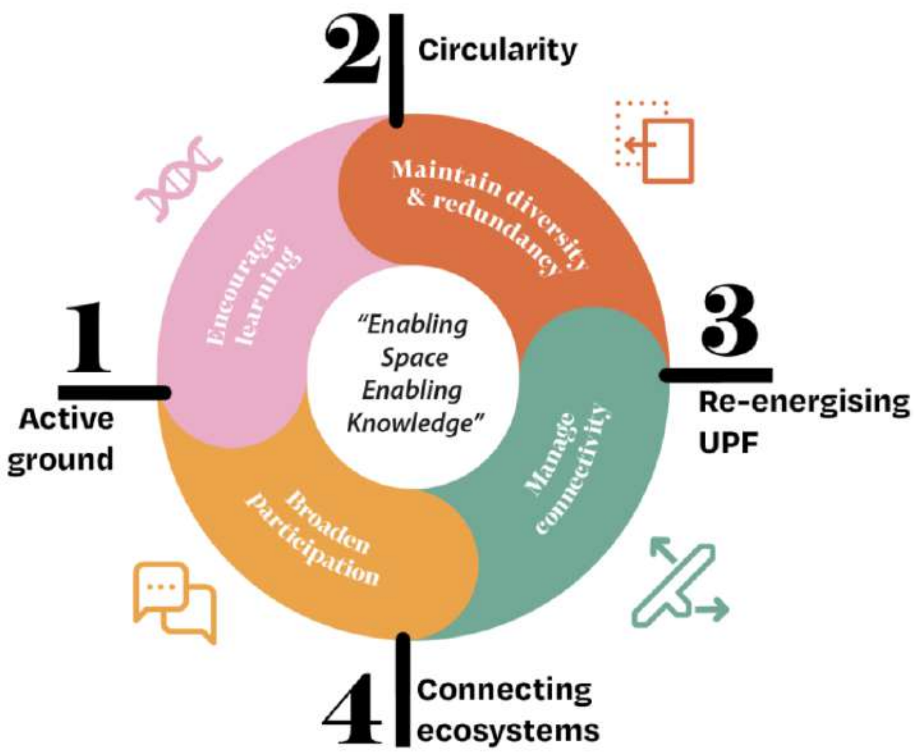
## Design solutions for resilience

# Overview of the implementations

Translating our team's vision into specific implementations was done through a systematic evaluation of resilience principles and challenges specific to the UPF campus, culminating in four strategic priorities based around the central vision for UPF resilience:

1. Active Ground
2. Circularity
3. Re-Energizing UPF
4. Connecting ecosystems

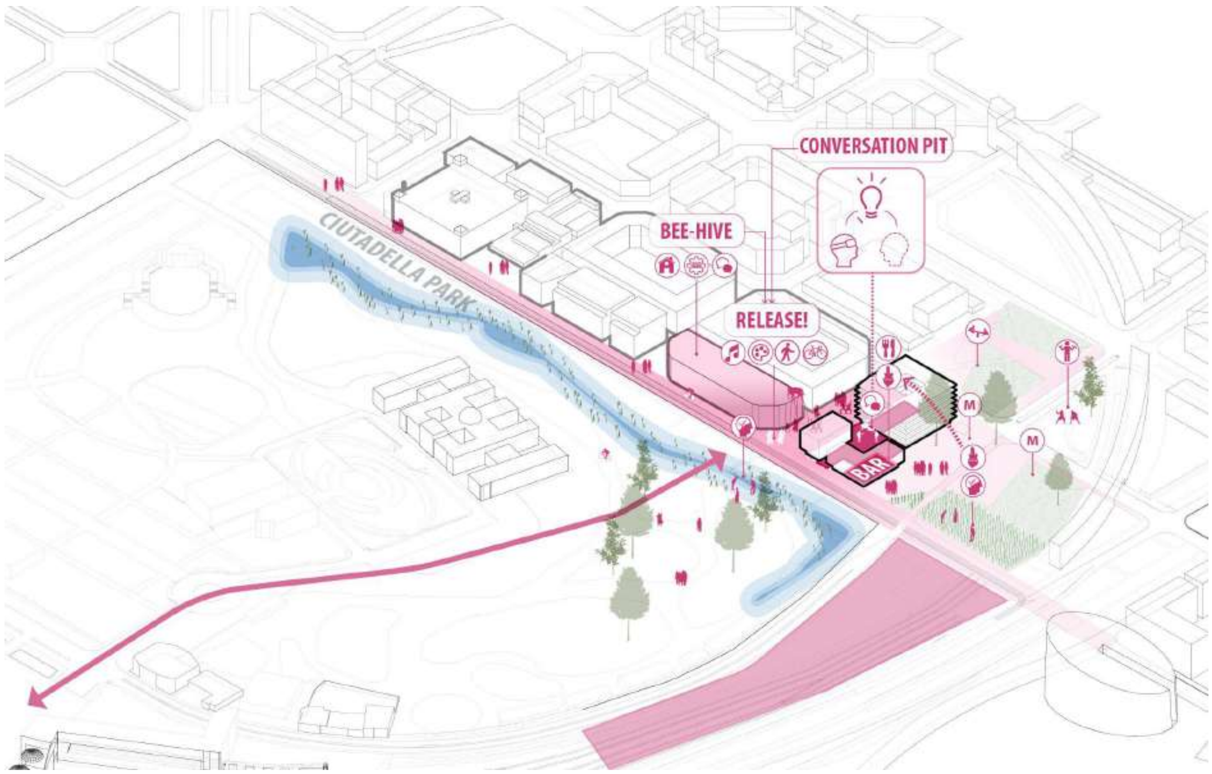
These four priorities are enhanced by ensuring that all design implementations integrate virtualisation, something that will be a part of all future-thinking campuses, as well as a direct response to the challenges made apparent during the COVID-19 pandemic.




*Rresilience principles and four axes for an open connected campus (Author`s work)*

# Priority 1: Active ground

Activating the ground floor of campus merges the existing campus and the new buildings by invigorating key outdoor areas. Furthering these ideas of connection, virtual innovation will help create a unique school identity while supporting the university as a hub for inclusivity and accessibility.




## Design components

A key objective of the active ground strategic priority aims to merge the existing campus and the new buildings by activating key areas. The connection of spaces within the site reflects the freedom of movement and knowledge within the campus through vibrant design. The activation of these spaces helps to create a unique identity while supporting the university as a hub for knowledge sharing. Through both policy and design, the active ground is an essential element for creating a resilient UPF campus.

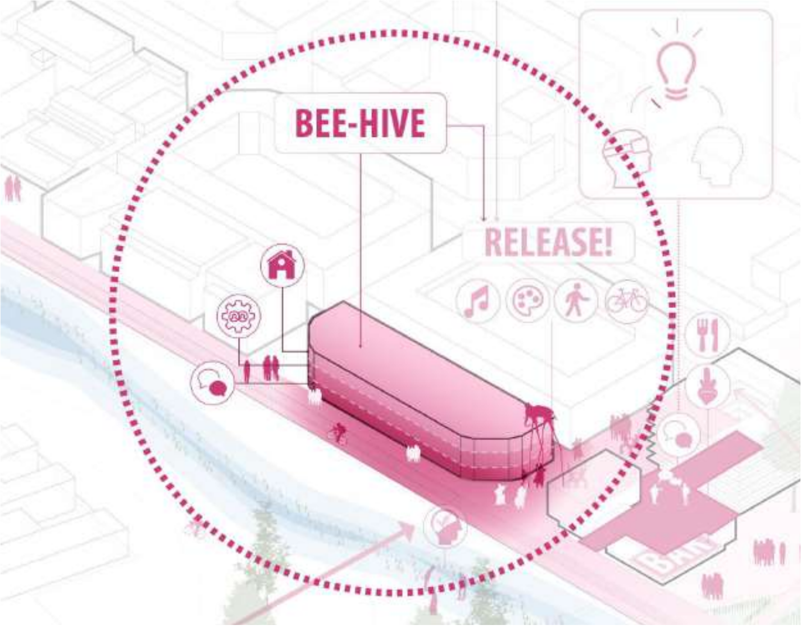
# Project 1: Beehive

T project aims to provide an innovative and inclusive hub in the heart of the new UPF campus. The building highlighted on the map above, formerly a residential building, the new beehive incorporates inclusive uses bringing the neighborhood's spirit to life while generating positive synergies between the students and the community.

The Beehive is designed to support and promote an active ground on the campus. Its physical centrality and the historical connection the building has to the neighborhood makes it a key place to host innovative activities through the generation of a constant active flow and social mixture, aiming to reach inclusivity, innovation, and community building.

The project is organized through different layers going from an active ground floor to a flexible second layer and ending with the residential stories.

The ground level will foster a social mixture through sustainable retail and recreational events such as pop-ups, art expos, music, tastings, courses, and gatherings for creatives and entrepreneurs. In the second layer, a coworking space and open lab will create the scenery for cooperatives and entrepreneurs to try new sustainable solutions enabling virtual technologies to shape community learning. Finally, the last layers will provide the foundations to address accessible housing targeting not only UPF students but the community in general ensuring diversity and broadening participation in this new knowledge hive. The addition of a residential aspect to this building supports passive surveillance of the area at different hours of the day, therefore increasing safety throughout the wider campus.




# Project 2: Conversation pit

As it currently stands, the internal space between the new proposed buildings has been designed to include open green space with pathways throughout the area. This project proposes to supplement the design with the addition of a 'conversation pit' that will provide a multi-use, interactive space. The design of the area will follow the flower pattern seen throughout Barcelona to connect this new development to the rich history of the city.

## Principles and Challenges

The principles and challenges have informed the decision to include the 'conversation pit', with the name symbolizing principles to include learning and broaden participation while addressing challenges like inclusivity and spatial barriers. Another central component of this project is the merging of the 'Science and Society' concept from the BIST building with an outdoor space. By weaving a motif through the indoor and outdoor spaces, a connection can be built that reflects the desire of the campus to increase accessibility and collaboration.

## Management

The management of this area will be shared between the three principal partners of the buildings (UPF, BIST, IBE). This is to ensure collaboration and accessibility which is central to both the design and management of this space.

## Integrating Innovation / Why is it resilient

It is essential that each element of this project is approached from a multi-faceted perspective that considers economic, environmental, and social factors. This conversation pit combines aspects of water catchment, social cohesion, and digital event space while not only maintaining a strong identity but providing future opportunities for adaptation. Drawing on examples from the Benthemplein 'Water Square' in Rotterdam (See image 3) and Tokyo's Plaza Omotesando (See image 4), the conversation pit and wider square area demonstrate aspects of environmental and social resilience. The integration of green aspects and water catchment within the wider design allows the space to be more than just a square for people, but a place where people and nature mix to produce co-benefits.


*3 - 4) Benthemplein Square, Rotterdam & Plaza Omotesando, Tokyo*

## Digitisation and Virtual Opportunities

This area provides an opportunity to incorporate virtual technologies in an outdoor space  by having curved projection panels to showcase art and projects. This increases the visual attractiveness of the space while providing multi-functional opportunities for outdoor learning and events. An active ground layer supports learning and accessibility by adding access to power and water sources for events. Encouraging events in this space through digitisation is fundamental for long-term success of this square. Without virtual/digital integration the space can act as a passive space during off-peak hours, therefore providing unintendented challenges for management.

# Project 3: Release space

*"If we care about having a **happy, resilient, healthy and wealthy society**, we really should care about **building social connections**"* - Charles Montgomery "The happy city experiment" TEDxVancouver 2014

The space between the existing and new campus buildings is meant to be the place where the knowledge produced at the campus gets released to the street. A pedestrianized area that blends the campus and the public space is characterized by flexibility that allows diverse users to shape its form and function to fit their needs. The use of moveable urban furniture provides a space for fairs, markets, concerts and living labs that facilitates social cohesion through dynamic and free activity. Permeability and accessibility of the Release Space opens the walls of the citadel of knowledge to the neighborhood and the city.

## Principles & Challenges

This design feature is linked to the open campus principle as it promotes the flow of knowledge between those of the academic community and local residents, therefore removing perceived social barriers and siloed spaces. Planetary wellbeing starts with local wellbeing. For this reason, it is essential to consider the spaces between buildings within the design to enhance inclusivity, the feeling of safety by social mixing and the quantity and quality of activity outside of university working hours.

## Management/Governance

The management should be shared between the principal partners of the buildings. However, the area is meant to be used by different stakeholders as an event space - student associations, local activists, scientific partners etc.

## Integrating Innovation / Why is it resilient

This project does not employ radical innovation rather takes a humanistic approach in order to consider the often 'left out space'. Through intentional design, the space allows for knowledge spillovers that facilitate innovation. By breaking the glass ceiling of top-down sustainable solutions the release space acts as a pilot project for regenerative design. There are many references to show the activation of street space like Open Street Ząbkowska in Warsaw

(See images below) and this exemplifies the positive changes in the perception of safety through design and social mixing.

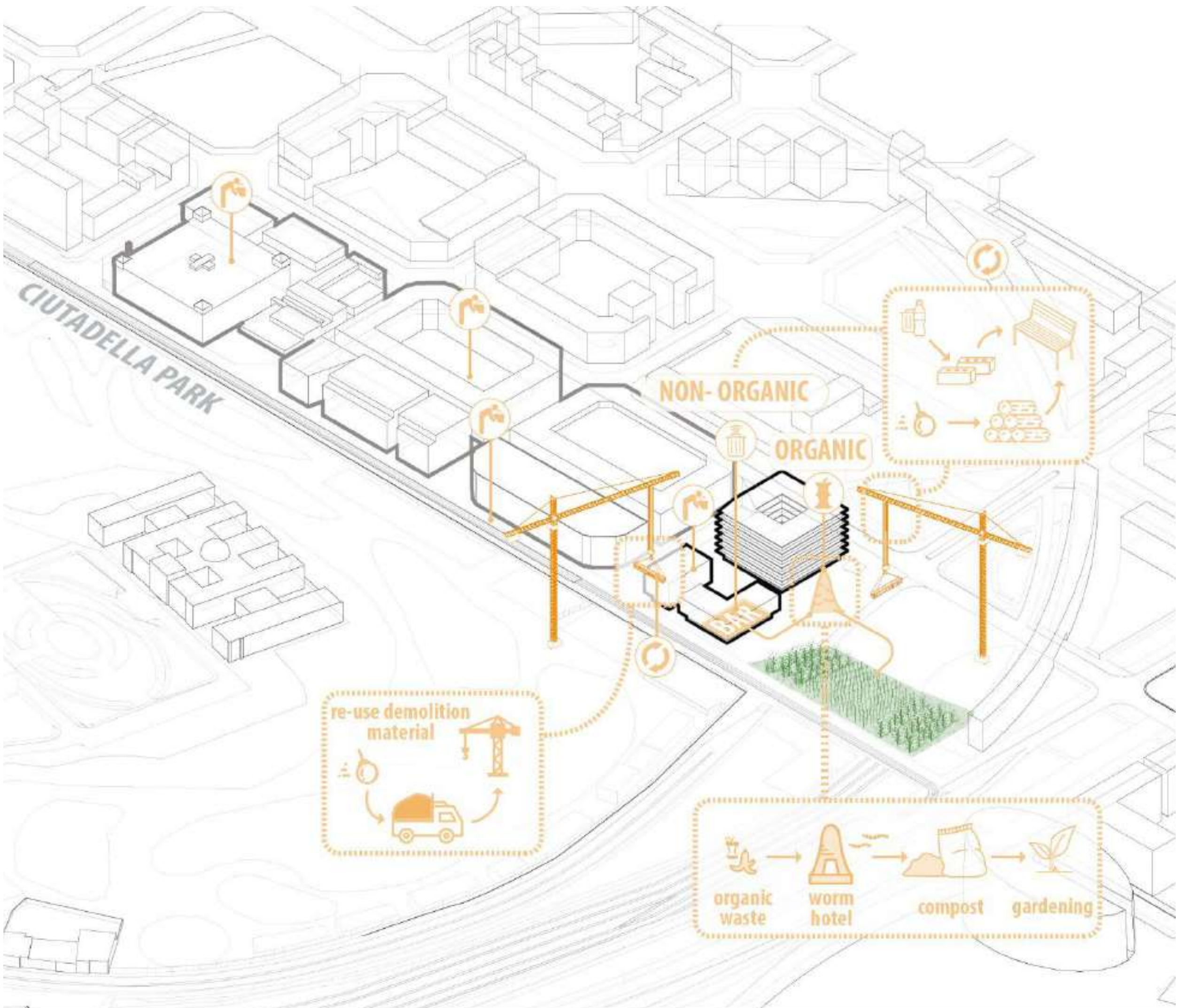
Performance indicators:

- Active hours / day
- Frequency of events and their outcomes
- Social mixing - the space is meant to be safe and welcoming for everyone regardless of their age, gender, ethnicity, economic status

*5) Streets of Ząbkowska*

# Priority 2: Circularity

A circular economy is one that takes a systematic, restorative approach to enable space for its best use and to untie knowledge from current constraints. To go beyond sustainability, circularity must be addressed through multiple dimensions while building on the strengths of each partner involved. The proposal incorporates circularity into waste, food and construction for both the development and management of a UPF campus that can be a 'Citadel of Knowledge' for Barcelona and the world.



# Project 1: Zero waste policy

Applying circularity through a systemic approach has many ramifications. For waste, we first must "do no harm" and ensure that we are not contributing unnecessary waste to the system. Although systems will vary from simple behavior changes like reusable cups to more technologically advanced trash bins that can help with compositing, the goal is a zero waste policy.

For food, we want circularity to be included not just with vegetables themselves but with comanagement of biodiverse and active green space. This, ideally, means IBE taking the lead of the comanagement of surrounding green space to ensure it is actively used in research and with people for everyday functional uses.

## Principles and Challenges

Since the best waste is that which is not produced, the first challenge is to reduce the amount of waste used and therefore emitted by the campus. This can be done by changing the type and/or source of products sold on campus, with the goal of moving towards zero waste. Concerning the waste that cannot be avoided, the challenge is to recycle it as much as possible. Organic waste can be composted and reused as natural fertilizer and thus feed a cycle. Other waste must be sorted and recycled efficiently.

## Management

Zero waste policy should be managed by the university with a strong focus on campus cafeterias and restaurants. Help for management and operation can be found by cooperating with existing zero waste movements.



*6) Zero waste cups and strategies*

# Project 2: Food systems

Food systems have the particularity to be connected to every other major sector (environment, health, social justice, economy). Most represented food systems today in Barcelona and worldwide are industrial and therefore harmful and vulnerable. Aiming to be an exemplary campus in the face of the challenges of our time, UPF's food proposals must be exemplary and should be an integral part of its community's educational experience.

## Principles & Challenges

The first principle would be to stop contributing to industrial food systems. Firstly, by questioning the University's current contracts and collaborations And by Breaking every contract with multinationals, and starting to support better initiatives.

Secondly, The campus's food proposal should provide and inspire its community to consume better food. A better food proposal could be organized as a university canteen that supports a more sustainable and fair food system by working with local producers and adapting its menu. The new offer can remain economically accessible by reducing the number of options, promoting plant proteins and respecting sustainable food criteria (local, seasonal, etc).

*7) University canteen in Bruxelles*

The challenges here are to move away from the harmful and vulnerable food systems we are currently dependent on. It is the whole system that needs to be reviewed in order to move towards resilient models, that is to say, models that meet the need for food security in a redundant manner, while reducing its environmental impact and remaining economically viable. Fortunately, these alternative models are already developing in other countries and can serve as inspiration.

### Management

Managing a sustainable and committed university canteen can be done by a handful of people. The example of La Turbean, ULB, Brussels, Belgium, demonstrates a model that serves 200 dishes per day, run by three full-time members of a non-profit organization and a team of 5 students. The management of the UPF campus canteen could be done by university staff coordinated or trained in sustainable food or by external staff already trained. For both, the inclusion of the student community in the management is beneficial at all levels.

Performance indicators:

- Number of meals sold
- Weight of food purchased
- Number of jobs created
- Turnover of the canteen
- Weight of waste

## Project 3: Waste to furniture

Even with zero waste produced at the campus, we still need to manage the waste from the outside. Smart waste management using Internet of Things technology can significantly improve the recycling rate and give a chance to reuse the material on the site e.g. for outside furniture.

### Management

Smart waste management needs to be supervised by a dedicated body that would cooperate with the municipality, in order to track the performance to see if the project can be extended behind the campus

*8) Furniture from recycled materials*

# Project 4: Research-based sustainable development with locally based materials


This project is seeking to apply a research -based sustainable development approach to a potential residential or mixed-use development using locally based material. This development could occur on UPF's existing lot or surrounding area. This development ensures that each of the universities are more than just adjoining campuses on the same piece of land but are actively collaborating on both the development and management of an innovative structure.

## Principles & Challenges

- Sourcing material including dirt, trees, and materials from local demolition into the design and construction of the facility.
- The development is designed in a research based way that allows each university to use its strengths to improve individual wellbeing, produce robust research insights, and influence planetary policy.
- A place where BIST would help design the development specifically to help 65+ individuals with a highly prevalent disease. IBE would help with the sourcing of material, and UPF the overall management and policy implications.
    - Imagine a research study of 65+ individuals where one group gets the best practices treatment with recommendations on healthy eating etc. while the other group is invited to live in a place that was built to encourage these healthy behaviors.
- QR codes at each place where materials are sourced to educate the public.

## Management/Governance

- Inopocating an annual design student process in how the local material is used each year and a strategy for the future use of where the material was sourced

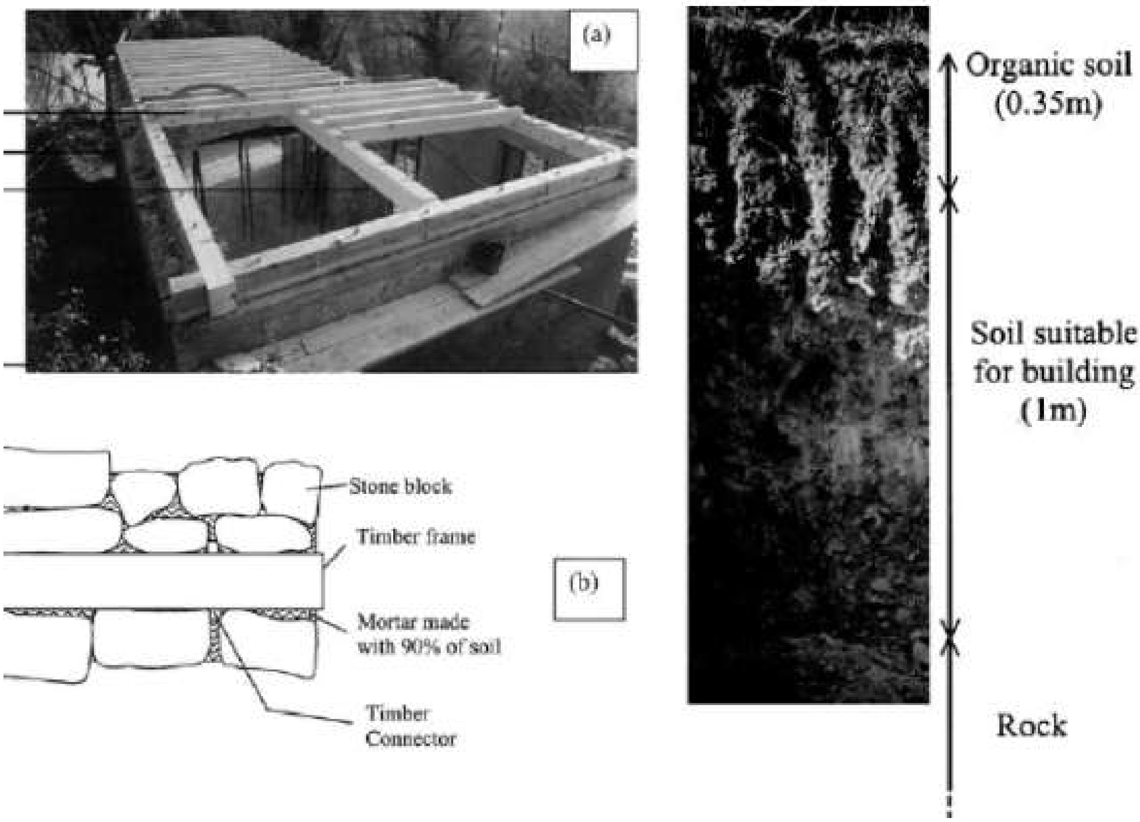
- All residents being connected the surrounding area through initiatives like community gardens
- A research structure that balances residents' privacy and rights with robust data, grants, & research insights that can prove the benefits of this type of design and management.

## Integrating Innovation / Why is it resilient

This proposal is reflective as the development is designed in such a way to combat known risk factors that hurt healthy aging. In the case of damage many materials are easily accessible and relatively inexpensive which helps the proposal to be resourceful, redundancy, and robust. Finally the proposal highlights the principle of integration within the universities and the broader public.

## Performance indicators

| Social (Healthy Aging) | Economic | Planetary |
|---|---|---|
| • Reduce Social isolation<br>• Reduce Depression<br>• Increase Physical Activity<br>• Increase activities of daily living (ADL)<br>• Promotes a high Diet Quality Index International (DQI) score<br>• Reduce likelihood of falls<br>• Access to green space, affordability | • Cost Reduction vs. alternatives via labor<br>• Cost reduction via material<br>• Assees policy impacts that hurt & help the type of development and time it takes to develop | • GHG reduction on LBM reduces env. impact vs. “traditional” & other alternative development?<br>• Research on what kind of plant species can be cultivated for future development<br>• Env. benefit of University co management vs. city management of green space (example: zoo) |

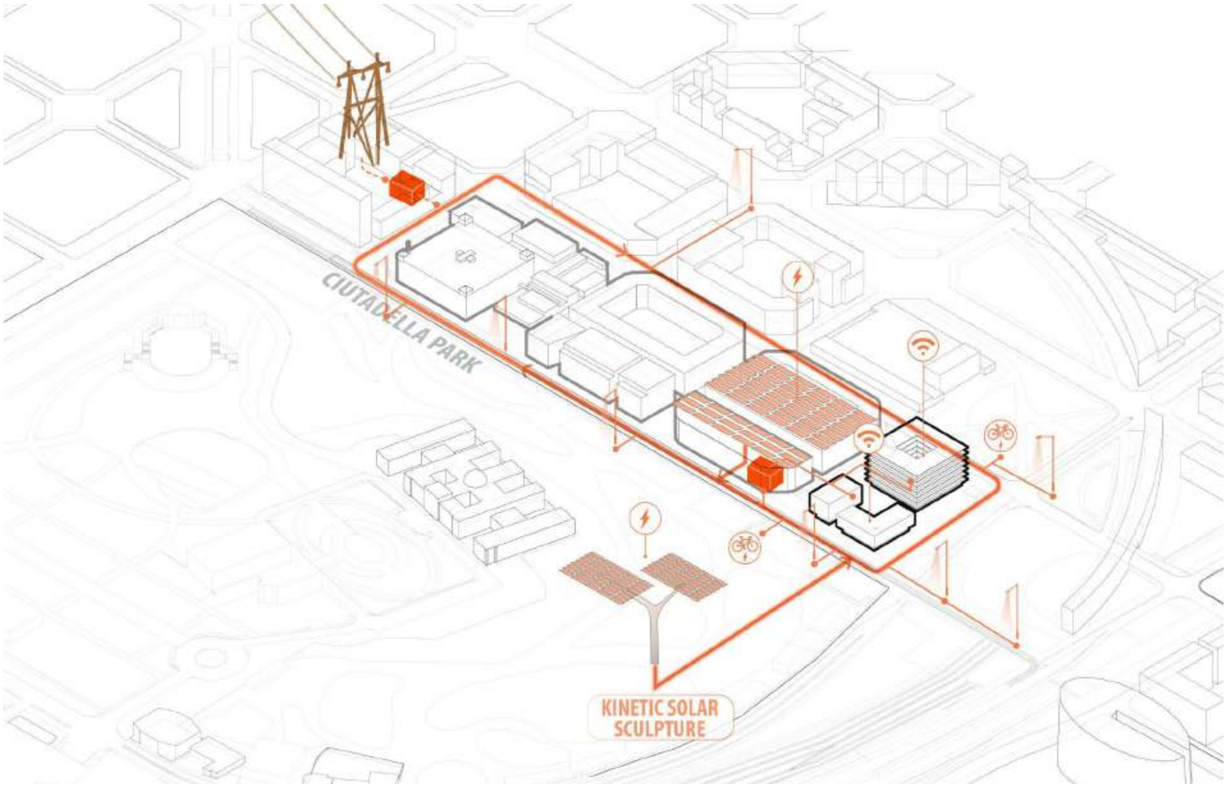



*9) Example of Locally Based Material Study:*

*“By adopting local materials the amount of energy used in building decreased by up to 215% and the impact of transportation by 453%.” (Tedeschi et al., 2015)*

# Priority 3: Re-energizing UPF

By connecting new and old campus buildings through an integrated smart energy and monitoring system, UPF creates redundancy and diversifies its energy systems. Connectivity is enhanced by enabling applied research and knowledge generation of distributed energy systems to be shared with communities and research centers.




The centrality of the Ciutadella Campus and the construction of high performing buildings at the Old Fish Market provide a new opportunity to deploy a microgrid with clean, renewable technologies that will increase the energy resilience of the campus through improved energy planning (ex. Energy efficiency upgrades), self-sufficiency (ex. Solar PV) and open grid connections to areas around campus. The connection of campus buildings to a microgrid, the development of an Energy Management Information System, and deployment of renewable energy and storage systems will provide an opportunity for research to support the development of microgrids in rural areas where there is the greatest impact. A microgrid can provide further synergies with a distributed water management system through the supply of energy to water pumps through on-site renewable energy, and advanced monitoring of performance utilizing the functions of an energy management information system. The establishment of a microgrid, in particular an Energy Management Information System, enables the university to establish basic utility functions which can evolve to provide energy to the surrounding community through distributed energy systems.

## Principles

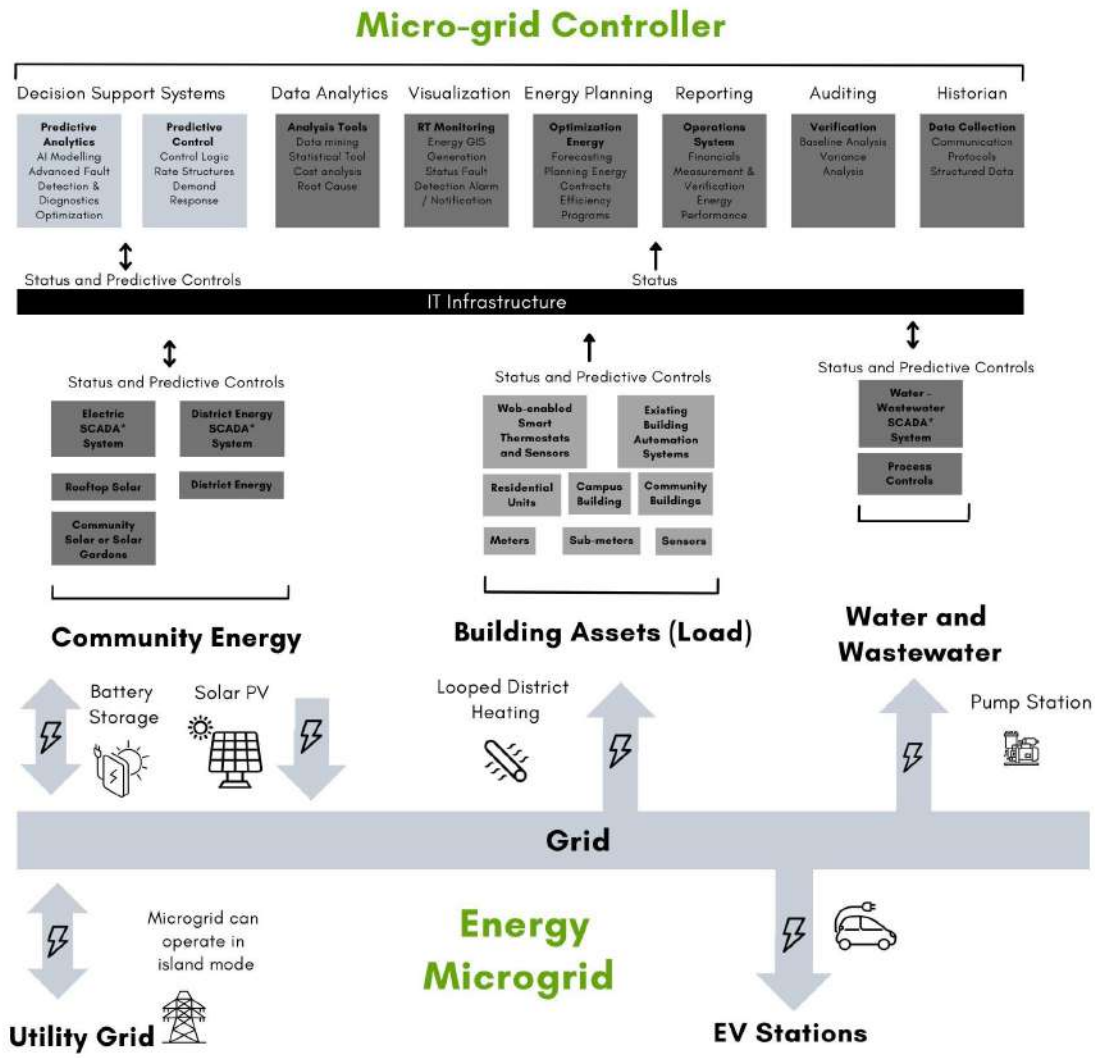
Manage connectivity: the deployment of a microgrid enables integrated grid management of energy supply (solar PV) and energy demand (buildings, EV chargers) and extends the energy sufficient design principles of new campus buildings to existing campus buildings and beyond.
Encourage learning: a microgrid provides an opportunity for the university to undertake applied research in an emergent field and develop institutional knowledge and capacity in energy management that can be applied in regions where microgrids are becoming an important technology for managing uncertainties around climate change.

## Challenges

The University has taken several steps in the last several years towards sustainable energy consumption but still faces numerous challenges driven by uncertainties caused by climate change. Energy consumption declined 25% in the last five years as a result of electrification, energy efficiency measures, and the installation of 25 kilowatts of solar panels on the Mar campus roof. Further studies have been conducted to determine the efficacy of installing 230 kilowatts of solar panels on the Ciutadella campus. UPF is also a member of Autonomous Basic Energy Services which provides advisory services for setting up solar pv systems in rural areas. However, as with the rest of Barcelona, UPF faces several short and long term energy challenges that arise from aging infrastructure, rising electricity costs, and climate change uncertainties such as increasing temperatures and flood-risk. Of particular importance is air-conditioning which currently accounts for 60% of the university's total energy consumption and expenditure. Use of air-conditioning is expected to increase in the next several years due to an increase in the incidences of heat waves. The university estimates that a 1 ˚C temperature increase in summer can represent up to a 10% increase in energy consumption. Resilient energy systems address many of these challenges by reducing the risk of long electricity outages that can occur due to extreme weather events, limiting the impact of outages when they do occur, efficiently managing energy demand and supply during peak demand, and rapidly restoring energy after there is an outage.

## Integrating Innovation/ Digitisation / Virtualisation

The deployment of a microgrid would establish UPF as a prosumer that generates, consumes and stores energy. A microgrid can be defined as an aggregation of distributed energy resources (DER) of small size (solar PV etc.), able to efficiently supply end-users utilizing power production control strategies and advanced demand response (DR) policies which can be determined by an Energy Management System. A microgrid can be more resilient than large-scale power systems through the implementation of quick restoration or islanding from a larger grid.



# Project 1: Energy Management Information System

Energy management information systems (EMIS) are software tools that monitor, analyze, and control building energy use, energy storage, and distributed energy production. An EMIS can support energy performance by increasing the visibility of data for facility managers and using performance equations that are compared with an organization's energy targets. More on Energy Management Information Systems can be found in the Management section.

# Project 2: Solar PV Farm

According to energy management data from UPF, the Ciutadella campus consumes around 7,118.767 kWh/year of 100% renewable certified energy for building functions drawn from the grid. Despite already sourcing energy for this portion of the campus from renewables, solar PV installation provides an opportunity to create a more resilient system through use as a backup system in case of grid failure or power outage. Solar energy plays an important role when combined with energy storage systems and other technologies to provide energy to critical infrastructure when it is needed. The Barcelona Energy Resources Map compiled by Barcelona City Council demonstrates that several campus buildings have a high energy-generating potential for solar PV. Space limitations on campus mean that the installation of rooftop solar may be the most feasible option, such as on the roof of the Roger de Llúria building. The specifications for a solar rooftop installation at this site are as follows based on data compiled by the City of Barcelona:

| | |
|---|---|
| Incident Solar Radiation | High |
| Sun-covered area [m2] | 1659 |
| Usable area [m2] | 1410.15 |
| Installable power potential [kW] | 133.26 |
| Generated energy [kWh / year] | 166573.97 |
| Greenhouse gas emissions savings [kgCO2eq / year] | 59966.63 |
| Estimated investment [€] | 466410 |
| Estimated maintenance cost [€ / year] | 1000 |
| Estimated economic savings [€ / year] | 19989 |

*10) Specifications for a solar rooftop installation in Barcelona*

## Project 3: Battery Storage System

Energy storage is an essential infrastructure for microgrids to maintain reliability of power supply during critical loads and for managing intermittent energy supply from renewables. Battery energy storage is not critical for UPF from an operational perspective because of connections to the local electrical system that ensure energy is accessible during peak periods of demand. However, to increase the redundancy of energy supply during power outages a battery system would provide value in addition to back-up generators, particularly for critical functions of the university. Further, the installation of a battery energy storage system would provide an interesting opportunity for UPF to undertake applied research into the functions of a battery system as a component of a microgrid combined with solar PV and EV charging stations. The size of a battery system is contingent on the capacity of installed solar PV and the amount of back-up energy required to maintain critical functions of certain facilities.

## Project 4: EV Charging Stations

According to the Pla de Mobilitat Sostenible i Segura de la UPF 2015-2020, trips by car to the university represent around 15% of the mode share, or 2,647,346km traveled by car annually (source: Presentació Informe Petjada Carboni 2018). Car as a mode of transport therefore represents one of the largest sources of carbon emissions derived from the Ciutadella campus. UPF has taken steps towards electrifying its fleet, launching a fully electric van to make the University's internal mail travel more sustainable and reduce costs in fuel consumption. Further electrification of the university's vehicle fleet and the installation of charging stations would reduce GHG emissions, increase air quality in and around the campus, and enable electric cars to function as battery systems for energy storage.

The emergence of electric vehicles (EV) as the future mode of transport is a major trend, combined with distributed electricity production in the form of distributed renewable forms of energy. The installation of EV charging stations provides a further opportunity for the university to undertake applied research and analysis on how the EVs and the EV charging stations operate as loads on a distributed microgrid. Research areas could include demand modeling and stochastic modeling of EV arrivals, utilization and analysis of parking lot occupancy in microgrids, environmental assessments, and how to optimize the configuration of the microgrid.

## Management / Governance

Microgrids present implementation challenges such as variable solar photovoltaic generation, ups and downs in the market price (selling back to the grid), and controlling different loads (campus buildings and EV charging stations). An energy management information system can address these challenges, offering several solutions to minimize the greenhouse gas (GHG) emissions, maintenance costs, and peak load demands of the microgrid infrastructure. Energy management systems provide an additional function of supporting energy managers in the implementation of energy management plans and the monitoring and reporting of energy consumption. An energy management information system requires  a network of connected sensors and sub-meters to monitor energy and water infrastructure to provide management functions of energy monitoring, forecasting, and control. General management functions provided by an Energy Management Information System include:

- gather information on energy consumption
- gather information on the useful outputs that result from the consumption of energy
- gather information on any other factors that may affect energy consumption
- contain analysis routines that allow you to compare between energy consumption and utility drivers
- build and display energy performance reports

## Innovation

Microgrids are innovative resilience solutions because they address distribution and infrastructure challenges faced by large, centralized energy systems and combine software and technology to optimize distributed energy systems. Energy management information systems in particular provide data to support and automate complex decision making processes such predictive analytics (ex. Fault detection) to mitigate system failures, and support long term planning. The implementation of a microgrid at university would provide utility functions that could enable the university to transform its role as a research institution into a micro utility that sells energy to residential and institutional customers, breaking the definition of a utility. There are many practical implementations of a microgrid that are innovative such as islanded operation (disconnected from the utility grid), reduction in consumer energy cost through energy management, and a $CO_2$ reduction that results from renewable energy and energy efficiency gains.

## Performance indicators

UPF has established several indicators for energy management primarily focused on energy consumption and GHG emissions. An energy management information system would enable the university to conduct real-time performance measurement to understand whether targets related to cost, GHG emissions, and overall energy consumptions are being achieved. Suggested indicators are as follows:

- Total energy consumption by sector for electricity (GJ)
- Total KwH capacity of solar PV installed
- Energy production as percentage of total energy consumption (by campus)
- Annual energy consumption (by campus)
- Heating degree days (HDD), cooling degree days (CDD)
- Total Energy Savings since Baseline Year (MMBtu/year)
- Annual Improvement in Energy Intensity for Current Year (%)
- Total Baseline Primary Energy Consumed (MMBtu/year)

## Reference Project 1: Energy Management Information System at the University of Genova, Savona campus

The Smart Polygeneration Microgrid at the University of Genova was the first microgrid to be built in Italy and acts as a test-bed facility for research, testing and development of smart grid components. The smart grid consists of a Smart Polygeneration Microgrid (SPM) that supplies energy to several buildings on campus, a Smart Energy Building (SEB) connected to the microgrid, an Energy Management System (EMS) controlling the Campus generating units, thermal and electrical loads. The system contains two charging units, two electric vehicles, and two electric bikes as well as a photovoltaic solar plant. The micro-grid was designed to optimize contributions from renewable sources and high-performance cogeneration processes, and minimize electric and thermal consumption. Genova provides a good reference point for UPF in that a strong program for energy management can be leveraged by researchers for knowledge production and transfer. Additionally, new campus buildings at the Old Fish Market site will rely on both thermal and electric energy. The smart grid at the University of Genova may provide insight into managing different thermal and electrical loads using an Energy Management Information System.

## Reference Project 2: Energy-Water Microgrid at University of Arizona's Biosphere 2 Facility

The Biosphere 2 (B2) facility at the University of Arizona features both energy and water systems that are capable of operating as a microgrid, or connected to the local electrical grid. The grid serves industrial, commercial, and residential loads providing an interesting example of how UPF could expand its role as an energy provider to the surrounding community. The campus has become a centre for research, education, and tours, and insights from an energy water microgrid are used to determine applicability to other campuses with these loads. The facility at University of Arizona serves as a model that can be built upon for identifying relevant energy-water microgrid data, analytical requirements, and operational challenges associated with development of future energy-water microgrids. The development of a microgrid at the UPF campus could serve a similar purpose for understanding how to improve energy and water resource management for islands, rural communities in Spain and the Mediterranean, and parts of the world that lack centralized infrastructure.

*11) The Biosphere 2 complex in Oracle, Arizona*

# Priority 4: Connecting ecosystems

Connecting ecological corridors and rewilding green spaces enables movement for all living beings and creates opportunities for transdisciplinary knowledge production on environmental and social interactions. Urban water harvesting through rainwater catchment, groundwater connections, and wetland systems allows for co-management opportunities between diverse actors.

Green corridors will be created that will provide runoff management, noise buffering, air pollution reduction, and will make the park and campus resilient to heat waves and flooding. These arteries will have a double function, regreening the space and providing social interactions with increased mobility, encouraging sustainable modes of transport, and pedestrian pathways. This socio-ecological design will address challenges of safety, inclusivity, connectivity, accessibility, ecosystem services and climate change.

The four resilience principles identified at the start of the report are addressed in this project of social-ecological corridors, with design components (including sustainable drainage systems) ensuring diversity and redundancy, arteries managing connectivity and fostering learning, and co-management strategy encouraging a broad participation.

This section draws on existing projects, such as the Albano resilience campus in Stockholm, Les Glories canopy design and Passeig de St Joan in Barcelona.

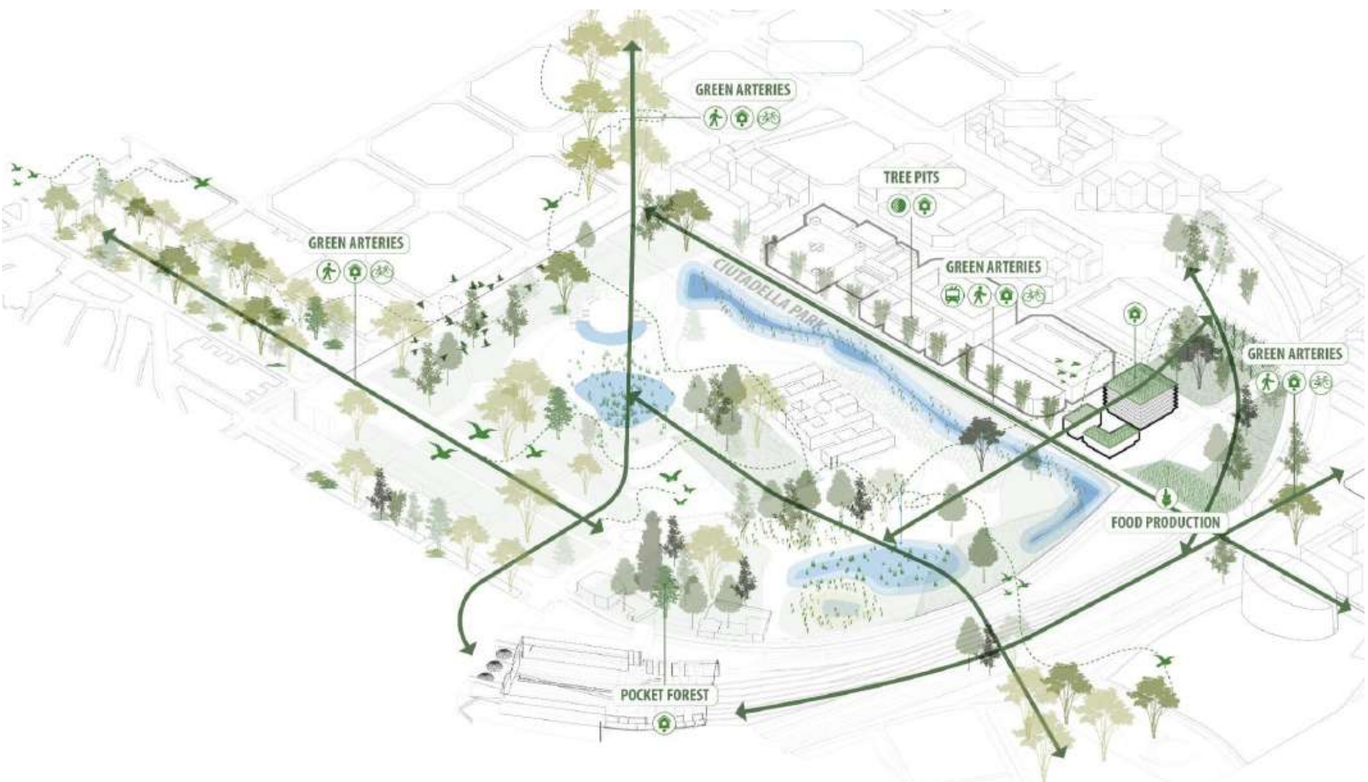
12) Barcelona Green Plan, 2020

## Project 1: Green arteries

What are green arteries? Based on the Albano resilient campus project in Stockholm, green arteries will be used as *passages to ensure access to and routes through the area for different means of transportation*. They will be used for connections and encounters between all entities. Each green artery would provide bike lanes, ecological corridors, and promenades for pedestrians bordered with greenery. They will increase permeability, mobility, and social interactions, encouraging walkability the whole neighbourhood, leading to increased levels of wellbeing and multiple other benefits for users and residents.

The green arteries linking the campus and parc de la Ciutadella would extend from:

- Arc de Triumph to the south, with an ecological bridge linking to parc de la Barceloneta
- El Born Estació de França to Ciutadella Vila Olimpica station, following the train tracks
- Parc de Les Glories, Avinguda Meridiana, to carrer de Wellington at the west of the campus, and towards the sea.



## Transform the park's barriers to connectivity

The existing walls at the east and south of the Parc de la Ciutadella segregate the park from the UPF campus. This project will replace the walls by- using *performative borders* (Albano case study) in the form of bioswales, or vegetated ditches.

The swales will act as open boundaries that provide additional functions, such as allowing infiltration, managing runoff and improving the quality of groundwater through filtering, while reducing heat stress, air and noise pollution.

They will form part of one of the key arteries (Les Glories to the sea), and play part of the ecological connection zone between the park and the campus.

*13) Bioswales, Kronsberg, Hannover, Germany*

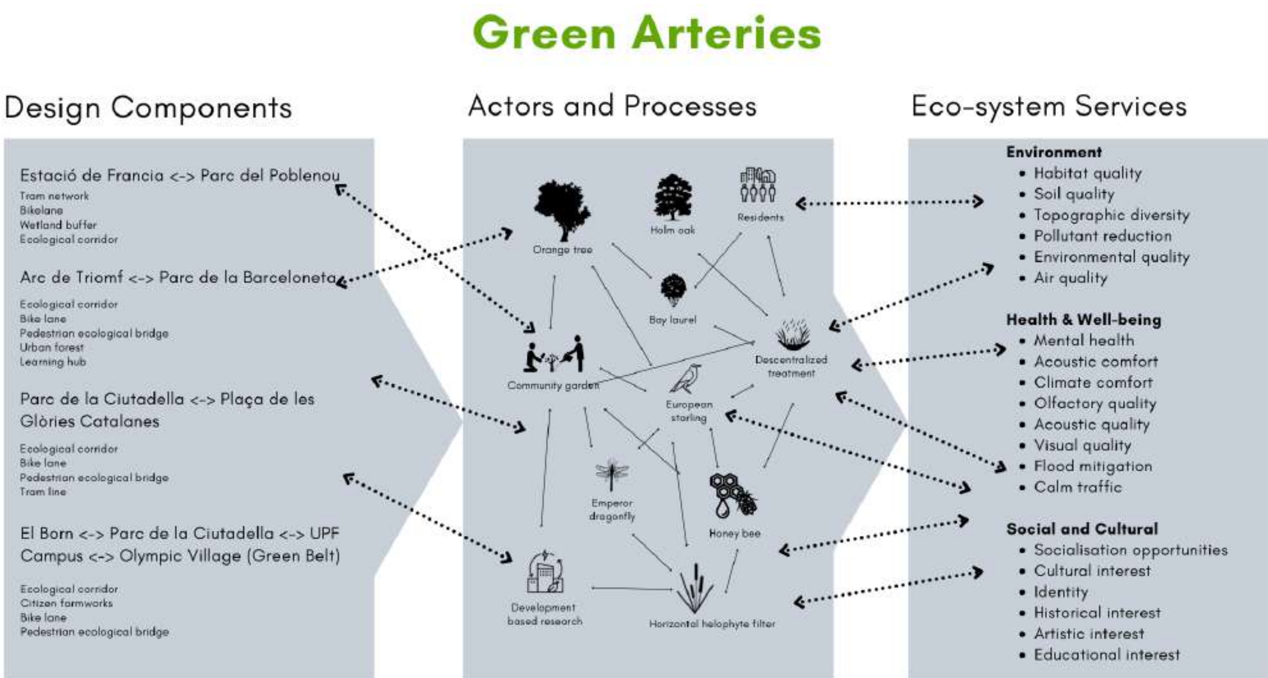
## Socio-ecological design components

The green arteries will comprise varied design components that compose socio-ecological design, encouraging social interactions, enhancing transport features non reliant on cars, and providing the features required for ecosystems to flourish. Key components are listed below (list non exhaustive):

- Ecological design components: tree pits, pocket forest, wetland, ditch, green rooftops at the campus, ecological bridge, permeable areas including permeable paving, shrubs, rain gardens.

- Social design components: bike lane, pedestrian piazza, benches, tables, recreational zones, playgrounds, communal gardens, open spaces for sport/yoga, research hub, tram line.

The below diagram aims to identify the relations between key design components, actors and processes and ecosystem services for socio-ecological corridors, based on Albano case study.




*Links between design components, actors and processes, and ecosystem services in green arteries (Author`s work)*

## Layers of forest

The design of the green arteries will comprise different heights of vegetation, and varied species of shrubs and trees to ensure diversity.
Similarly to the remaking of Passeig de St Joan, a double scale of trees could be considered, central pedestrian pathway and cycle lane, and permeable paving and tree pits for runoff management. The area of natural shade will accommodate new recreational and rest zones, terraces and playgrounds. Soil area available for trees will be maximized, and local shrubs will also be part of the vegetation to contribute to enriching subsoil biodiversity.
The different uses will coexist and extend the new urban green zone to the south of Parc de la Ciutadella down to the sea.

## Canopies and nodes

Arteries will pass through nodes of vegetation or blue zones, which could be pocket forest, communal gardens or wetland. The ecological bridge will also act as a node, facilitating the mobility of the species making up the ecosystem of the parks.

Vegetation will be continuous through tree canopies. This will ensure:

- better provision of ecosystem services (e.g. microclimate regulation by ensuring better airflow)
- to prevent biodiversity fragmentation. Research shows that green corridors, especially wider and with more forest cover, natural and semi-natural present a larger number of species.
- to connect habitat patches spatially. Close proximity between ecosystems will help preserve biodiversity, as species can easily migrate between varied vegetation (avoid metapopulation, i.e. one large habitat but isolated).

## Variety of species

The selection of species is crucial to ensure ecosystems thriving, and the key principle to do so is to create diversity.

Shrubs for pollinating insects (including wild bees), small mammals, and birds, will be planted, along with a mix of trees for green arteries. A colour coded vegetation landscape could be provided to attract different species. Wooden bird boxes and bee nesting houses will be installed along the green corridors. These habitats could be built as part of a workshop in the campus lab, or as a regular open air activity proposed by students to educate the public on the importance of pollinators and birds, and show them how to make their own for their gardens.

Another challenge is to choose the right tree species that will adapt to the urban microclimate and future climate change impact. It is proposed to have a mix of native species and other species resistant to climate change to ensure resilience. The following species could be considered:

- London plane tree: though not local, these trees have interesting resilient characteristics: they grow fast, are tolerant of atmospheric pollution and root compaction, and amenable to various soils. With their resistance to urban challenges, they could form part of the tree canopy.

- Southern nettle tree: native species and the second most common species in Eixample.
- Palm tree
- Other mediterranean species such as oak trees (*quercus ilex*, *quercus suber*), or native shrubs such as Laurestine (*viburnum tinus*).

## SuDS

Sustainable urban Drainage Systems, or SuDS, are proposed for ecosystem services to flourish within the campus, parc de la Ciutadella and direct surroundings. They are designed to drain developed areas in a more natural way, using the infiltration and storage capacities of semi-natural devices such as infiltration trenches, swales and ponds, where feasible. There are a number of both environmental and social benefits that arise from SuDS application. These include:

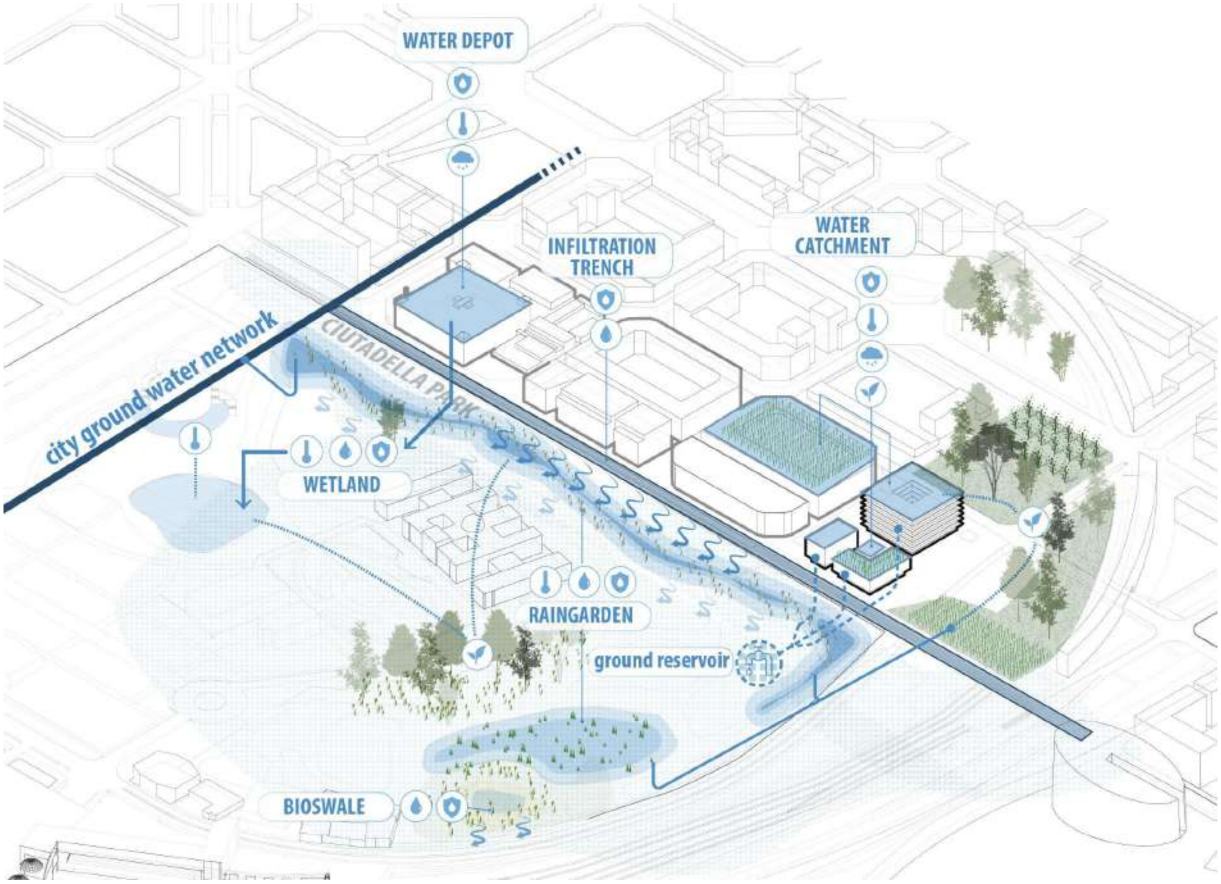
- Habitat creation through the incorporation of urban watercourse.
- Protection and enhancement of water quality – improved water quality leaving site through on-site attenuation, mechanical filtration and biological filtration.
- Amenity space creation through developing open green spaces.

The onsite surface water will be managed in a sustainable manner to mimic the surface water flow arising from the site prior to the proposed development. This management strategy will aim to reduce flood risk to the site itself as well as elsewhere in the catchment while taking the influence of climate change into account.

The geology of the Park de la Ciutadella and campus is sands, gravels, clays and silts (superficial deposits composition). A sand and gravel soil is suitable for infiltration techniques. A ground investigation will need to be conducted on campus and in the park to assess the infiltration rate. Would the rate be found low to moderate, consideration could be given to attenuation techniques including a crate system below ground and vegetation, to hold the surface water runoff and allow a gradual discharge to the nearby sewer through a piping network.
SuDS will be spread across the park and campus open spaces, in order to create a water management strategy that is circular and resilient.
The following SuDS have been considered:

- **Bioswales** to break urban, solid barriers and improve connectivity. These ditches described previously act as retention tanks and boundaries. This will also help the wind flow in the area near the campus & parc de la ciutadella. *See Appendix*
- **Wetlands** used as a water reservoir with reedbeds for filtration and to mitigate heat waves. The wetlands will be located at the north (existing ponds to be extended) and south (dolphins basin to be extended) of the Parc de la Ciutadella. Water will be used for irrigation around the park. *See Appendix*
- **Rain Gardens** (park and campus). *See Appendix*
- **Infiltration Trench** (park). *See Appendix*
- **Tree pits** (green arteries)
- **Permeable paving** (green arteries, pedestrian piazza and campus)
- **Soakaways on campus**

Vegetable plots, though not categorized as SuDS, will help increase the permeability in the studied area.



## Management

Based on the Albano resilient campus case study, it is proposed to create a framework of co-management (polycentric structure) for the Parc de la Ciutadella and new campus ecosystem services. This will ensure that different local actors and users share responsibilities and that they connect in different places, such as vegetable gardens, wetlands or other designated shared spaces. The ownership of each area will be given to local groups that will be responsible for the management of the green/blue space and for organizing activities to promote connectivity. A steward or facilitator will be appointed for each group to organize the management of the spaces and regular cleaning. A public tool shed will be made available for gardening and management of the spaces.

A “system of sponsors”/”adopt a plot” strategy will be put in place to strengthen public participation. Each university could have their own green space (e.g. climate change garden, allotment garden, “teeming” wetland) allocated in the Parc, and this could serve as space for experiments and interactions with other students from other campuses and with the public. This system will reduce overall management costs and will responsibilize individuals, creating a sense of community that is currently lacking in the neighborhood.

To increase learning in the area, public participation in management will be promoted, for example pedagogical lessons about man’s dependence on ecosystems or stormwater management best practices at wetlands. Wetlands will have an informative, pedagogic role for visitors on ecological function, water treatment and SuDS learning. The system will be part of knowledge development for the visitors and students, plus the ecosystem's diversity will be interesting to use for the biology and planetary wellbeing students.

Ecological field studies will be combined with different educational activities at the campus to investigate how the ecological design may be improved over time through continuous monitoring and evaluation. Regular activities such as gardening, bees keeping, furniture making, and experiments organized by the students or external facilitators will be conducted in dedicated spaces in the park and on campus through day and evening to revitalize and regenerate the area.

## Innovation

The socio-ecological corridors and open outdoor spaces in the park can be excellent places for experiments and innovation.

Examples are listed below to give ideas on what could be introduced, and show the potential of the ecosystem services that would serve the free learning of students and visitors with exciting inventions:

Harvest solar energy:

Installing a pergola with solar photovoltaic panels could be done around the campus and in the park to harvest solar energy. Paints absorbing sun rays could also be used for lighting.

*14) Agrovoltaic farm in Africa*

A new concept of "agrivoltaics" has been recently put into practice in Africa. Instead of being mounted close to the ground like traditional solar arrays, these panels are constructed several meters high, with gaps in between them. This allows crops to be grown underneath, protected from heat stress and water loss.

*"Mounted solar panels shade crops growing underneath them" (University of Sheffield)*

Studio Roosegarde (The Netherlands) developed a photo-luminescent paint for a glow-in-the-dark road. The paint absorbs energy from sunlight during the day and lights the road at night for up to 10 hours.

Bioluminescence

Bio-luminance plants are a way for mitigating not only energy savings and light pollution, but also waste disposal from the used lamps and luminaires.

*15) Glowing bike path inspired by Van Gogh*

Engineering trees could contain bioluminescent qualities of jellyfish or mushrooms to help replace some of the artificial light outdoors.

Energy production

Kinetic energy (from movement) can be used to produce electricity.
Implementing a project like Pavegen, using walking to produce energy, could serve as a pilot/study project for the universities.
The electricity produced could be used to power the LED for lamp posts nearby or green wall lightings, or other features.

*16) Tiles generating electricity while walking*

## Performance Indicators

To measure ecosystem development, visual observations will be made regularly, along with drawings and written recordings to be done by owners of the plots.

For water management, different sensors and receptors will be used at water bodies to measure water levels, record water composition (measure of chemical quality and biological elements). In conjunction with the microgrid, sensors will be used to monitor the water use at the campus (annual water consumption), to optimize water use and determine what savings can be made yearly.

# Overarching priority: Virtualisation

Redrawing the academic landscape is a multi-step strategy to be implemented to achieve the bigger picture. It includes multi-dimensional learning through virtualisation, as well as regenerative development.


*17) Jacob`s Virtual University*

## Multi-dimensional learning through virtualisation

Multi-dimensional learning involves a customized collection of 3D environments universities, schools and organizations that may be utilizing space and facilities on campus. It refers to mixed-realities (a blend of virtual, augmented and physical) within all aspects of campus life and the resulting academia.

Virtualisation is guided by resilience principles such as enhancing connectivity, encouraging learning and broadening participation. Research also indicates that virtualisation of data allows it to be more easily recoverable in the events of shocks and stresses, particularly with the availability of an on-site IT team that manages the ebbs and flows of digitisation, such as tech malfunctions. For example, virtualisation allows students and teachers to access their ‘virtual desktop’ from any computer in the event of a computer shut down. Among the many challenges that it resolves, one of the most notable benefits is its ability to increase accessibility to classrooms, learning spaces, laboratories as well as public spaces around the world through virtual touring. It thereby diminishes language, culture and geopolitical barriers.

| How it looks | Benefits |
|---|---|
| Virtual classrooms (or real classrooms with virtual access) | Greater public accessibility (locally, regionally and internationally) and enables distance learning. Can be a virtually designed classroom, or a real classroom with virtual access. |
| Virtual field trips, access to spaces such as real hospital wards | Allows deeper knowledge exchange as students and lecturers are able to make use of more spaces (they are not geographically limited) |
| Virtual avatars & hologram lecturers | Promotes active learning, as students and lecturers are able to engage more with each other and their virtual classrooms |
| Virtual training in labs and workshops with hologram implementation | Reduces risk and consequence of mistakes made during training operations (particularly in medical labs). Research also suggests that virtual training also deepens the knowledge |
| Campus app with recorded lectures | Recorded lecturers, access to Diminishes language barriers for international students |
| Digital artistry performances in real spaces | Connecting with artists around the world that |

## Management

While students are typically required to obtain and maintain their own devices (VR sets, computers and smartphones), UPF will need IT specialists, tech advisors, classroom coordinators, as well as storage space for large computers that can retain the wealth of data that will be accumulated through virtual learning.

However, with virtualisation, there is no need to manually install or update the operating system, applications, and other software on each endpoint. It can all be done with ease, from a central location, thus making management easier.


*18 - 19) Help Island & Orientation Island*

## Performance indicators

- Number of classrooms accessed virtually
- Transition from the 'Zoom Classroom' to the MR Classroom
- Increase in international student population
- Increase in number of international lecturers
- Integration of hologram technology into laboratories and workshop spaces

# 6

# A CAMPUS MODEL FOR BUILDING RESILIENCE

Where do we go from here?

# Building a resilient UPF Campus

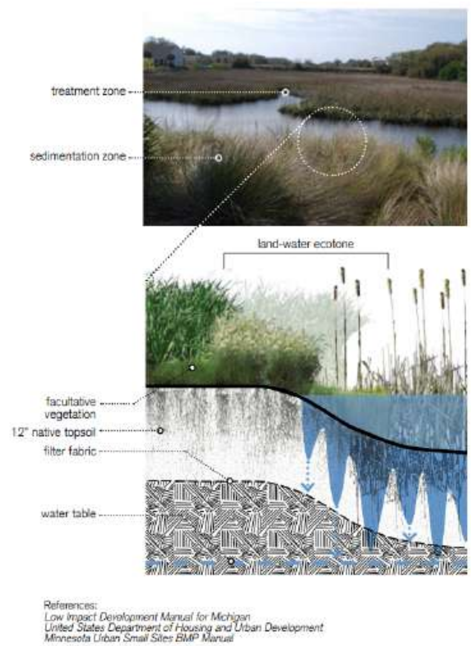
The guiding principles of urban resilience act as a foundation for our three main strategic priorities that will enhance the resilience of the UPF campus in specific and impactful ways. This report acts as a resource for identifying other initiatives that can be used as inspiration and “gaps” that can be addressed in existing documents and plans.

Our team recognizes there are political, financial, time and cultural limitations to the implementation of the proposed strategies, however, this report can act as a guide for how UPF can move from sustainability to resilience. The combination of principles, projects, and strategies proposed in this report will enable UPF to consider a wide range of directions in its future plans at the Mercat del Peix knowledge campus.

The vision presented in this report erases limitations, expands reach, & reimagines at the center of community connections. Beyond resilience, this proposal is designed to enhance this campus’s ability to be a “citadel of knowledge” for the city and to the world.

# Appendix - SuDS and water management

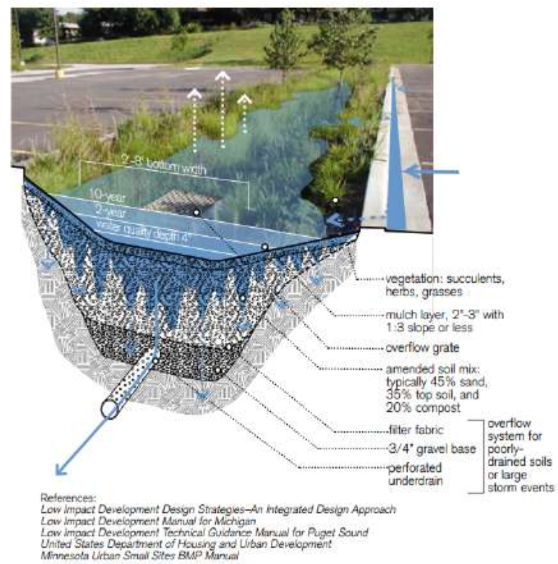
**Constructed Wetlands**
Wetlands act as natural filters, removing sediment and toxins from the water. The primary way that wetlands filter water is through their role in water flow. As sediment-containing water passes through wetlands, the water flow slows. Sediment will drop out of the water and become part of the ground layer. In this way, the water becomes clearer and sediment is removed, which would otherwise create cloudy water conditions. This project also connects to the concept of restoration and regeneration, as it intends to preserve the natural ecosystem, also through co-management and participation.

| | |
|---|---|
| **Constructed Wetland Scheme** |   |
| **Optimal Level of Service** | Retention/filtration/infiltration/treatment |
| **Key Features** | Constructed wetlands have a permanent pool of water designed to treat polluted stormwater. Plants and wetland geometry reduce water velocity, allowing sediment to settle out. |
| **Location in LID Network** | End-of-line facility, upstream of receiving water bodies |
| **Scale** | It can manage from 10 to 25 acres of watershed runoff |

| | |
|---|---|
| **Management** | Inspect quarterly during the first two years for nuisance vegetation. Inspect inlets and outlets quarterly or after large storms for evidence of clogging and accumulation of debris/litter. Inspect also for evidence of erosion and subsidence. |

based on Huber et. al (2010) and Landscape Institute (2014)

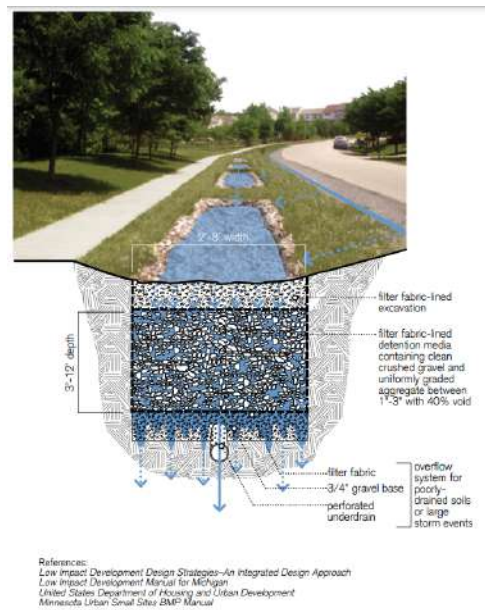
### Bioswale

| | |
|---|---|
| **Bioswale Scheme** |  |
| **Optimal Level of Service** | Filtration/infiltration/treatment |
| **Key Features** | Pollutant mitigation occurs through phytoremediation by facultative vegetation. Bioswales combine treatment and conveyance services, reducing land development costs by eliminating the need for costly conventional conveyance systems. The main function of a bioswale is to treat stormwater runoff as it is conveyed. |
| **Location in LID Network** | Downstream of filtration components, but upstream of larger detention, retention, or treatment facilities |
| **Scale** | 2'-8' wide with 2"-4" optimal water depth |
| | Mow in the first year to prevent establishment of |

| | |
|---|---|
| **Management** | weeds. Ideal grass height: 100mm.<br>occasional removal of trash and pruning of vegetation |

based on Huber et. al (2010) and Landscape Institute (2014)

**Infiltration Trench**

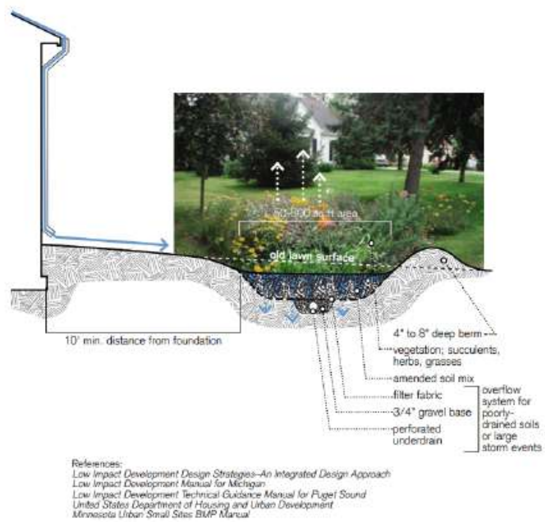
<table>
<tr><td>Infiltration Trench Scheme</td><td>


</td></tr>
<tr><td>Optimal Level of Service</td><td>infiltration/treatment</td></tr>
<tr><td>Key Features</td><td>Runoff gradually percolates through an engineered trench with amended soil over a period of days. Infiltration trenches filter particulates as stormwater runoff moves through the media. These facilities promote algae growth that serves as pollutant digesters. Since the maximum catchment area for infiltration trenches is two acres, it may be necessary to incorporate supporting LID facilities into the stormwater management plan.</td></tr>
<tr><td>Location in LID Network</td><td>Downstream of filtration components, but upstream of major treatment facilities</td></tr>
<tr><td>Scale</td><td>From a small strip to a sand field with a maximum catchment area of two acres</td></tr>
</table>

| | |
|---|---|
| **Management** | Stabilise the base and sides with a dense turf of water tolerant grass immediately after basin construction. Seed in early spring and during autumn. Additional vegetation recommended to enhance appearance, create habitat, prevent erosion and slow flows enhancing infiltration. Plant with native wildflower mixes to reduce maintenance |

based on Huber et. al (2010) and Landscape Institute (2014)

**Rain Garden**

| | |
|---|---|
| **Rain Garden Scheme** |  |
| **Optimal Level of Service** | Filtration/infiltration/treatment |
| **Key Features** | Commonly known as a bioretention facility. Stormwater pollutant mitigation is accomplished through phytoremediation processes as runoff passes through the plant and soil community. Rain gardens combine layers of organic sandy soil for infiltration, and mulch to promote microbial activity. Native plants are recommended based upon their intrinsic synergies with local climate, soil, and moisture conditions without the use of fertilizers and chemicals. |
| **Location in LID Network** | Downstream of filtration facilities, but upstream of primary treatment facilities |

| | |
|---|---|
| **Scale** | 500 sq ft, to allow for adequate irrigation between small storm events |
| **Management** | Mowing frequency; height. Timing and frequency of cutting plants back. Dead plant removal. Incorporate observation pipe securely capped to prevent vandalism. |

Source: based on Huber et. al (2010) and Landscape Institute (2014)

## Images References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