EXCEPT
INTEGRATED SUSTAINABILITY

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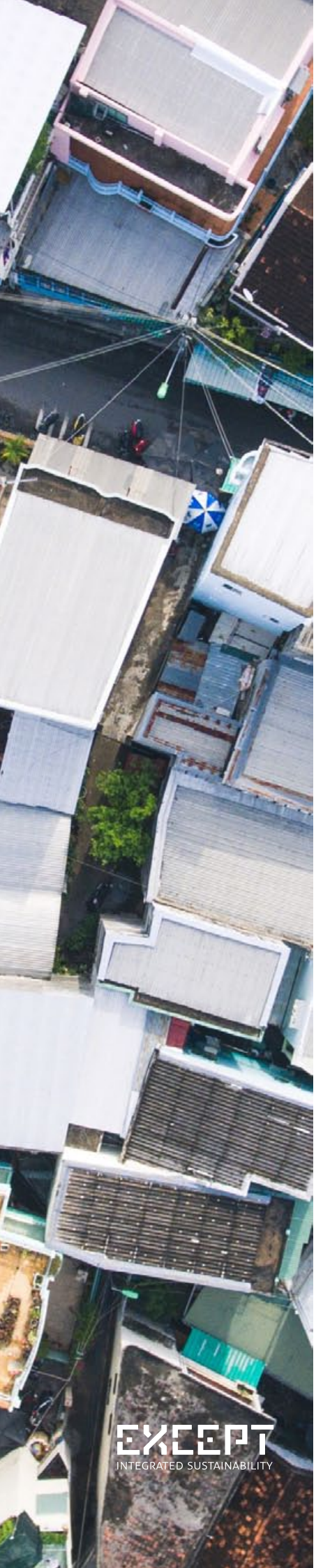
› CATALYTIC BUILDINGS

Tuning in to the construction sector's "music of tomorrow"

creating the foundations for a sustainable society



FOREWORD

"During the next century, we begin to see the effects of climate change, population growth, and urbanization on our existing cities. The majority of urban fabric at risk has already been constructed. Our focus therefore needs to be on converting the whole city to a sustainable state, not just individual new construction. What if we invented buildings that boost not just their own, but the performance of entire neighborhoods?

A catalytic building does just this. It enhances the sustainability of existing urban fabrics beyond its own performance. This realizes buildings that give back more than they take, and stretch beyond energy neutral, circular, LEED Platinum, or BREEAM Outstanding performance. At Except Integrated Sustainability, we've been investigating this approach for the last 8 years. It is a part of our mission to build the foundations of a sustainable society. Now, for the first time, I have the privilege to bring the concept of Catalytic Buildings into the light of day.

By no means do we assume this concept is refined or complete, but it is a step in the right direction. We have feasible, executable, and inspiring concepts, which we show you in this document. Much still needs to be done to realize them. There is a necessity and opportunity for all actors in the real estate development chain to contribute. Thus we are calling on all architects, urban planners, developers, municipalities and other smart city enthusiasts to help further develop the Catalytic Building design and approach.

We hope that this white paper brings energy, insight, and inspiration to the community, and that together we enter this new phase of sustainable urban development."

Tom Bosschaert

Founder & Director
Except Integrated Sustainability

CONTENTS

EXCEPT
INTEGRATED SUSTAINABILITY

creating the foundations for a sustainable society

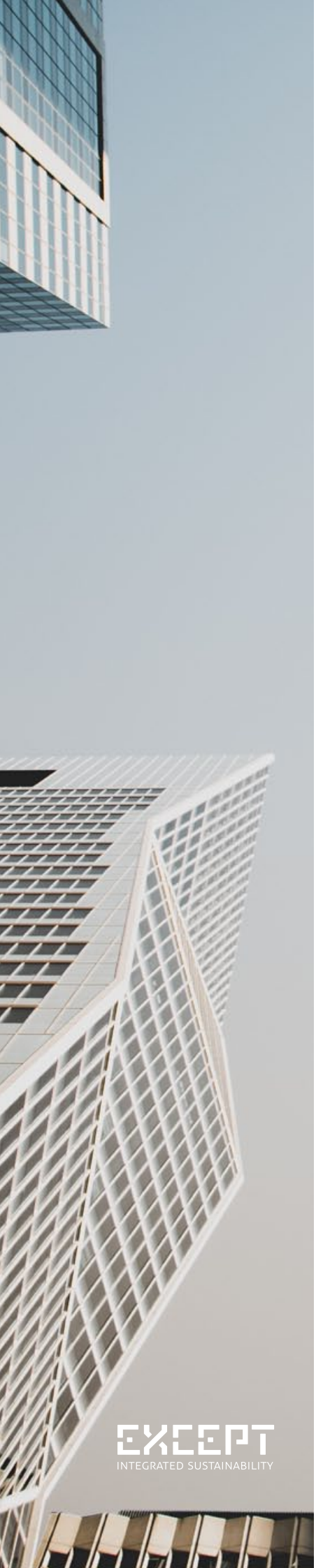
1. INTRODUCTION

Cities are in the spotlight in the global sustainability conversation: two-thirds of the global energy demand comes from urban centres, as well as the 70% of CO_2 emissions. Recent trends project that by the year 2050, 70% of global population will live in cities (UN, 2018). The building and construction sector accounts for 40% of worldwide energy use, 30% of energy-related greenhouse gas emission, nearly 12% of water use, and almost 40% of waste (Goh, Rowlingson and Wang, 2018; UNEP, 2019). In its latest report, the International Panel on Climate Change (IPCC) urges the most energy-intensive sectors - including industry, transport and construction - to reduce global carbon dioxide emissions by 45% by 2030, and the zeroing of net emissions by 2050 (Mangialardo, Micelli and Saccani, 2018).

The IPCC further highlights that "pathways limiting global warming to 1.5°C with no or limited overshoot would require rapid and far-reaching transitions in energy, land, urban and infrastructure (including transport and buildings)" (IPCC,2018). The greatest challenges for human development in the Anthropocene will take place in increasingly under pressure urban centers. The enhancement of the resiliency and sustainability of our cities is a priority, with planners and urban policy makers standing center-stage in the quest for sound solutions.

Green architecture, water-, energy- neutral buildings and, more recently, circular buildings are often identified as the silver bullets needed to steer the whole construction sector on the right track. The upscaling of renowned voluntary standards like BREEAM and LEED attests the acknowledgement of shared sets of principles and indicators for sustainable architecture across the globe. However, the realization that building-centric frameworks fall short in adequately reflecting the complexities of sustainable urban development is catching on. As more holistic approaches to sustainability are advocated for, cities and communities need to come into play in the process of integrating the building and urban scales (Goh, Rowlingson and Wang, 2018).

Tapping into peer-reviewed literature and authoritative reports, this paper makes the case for the pressing need to set the bar higher, turning to integrated perspectives when envisioning the future of high-performance, sustainable buildings. We start by giving it a name, introducing Catalytic Buildings.

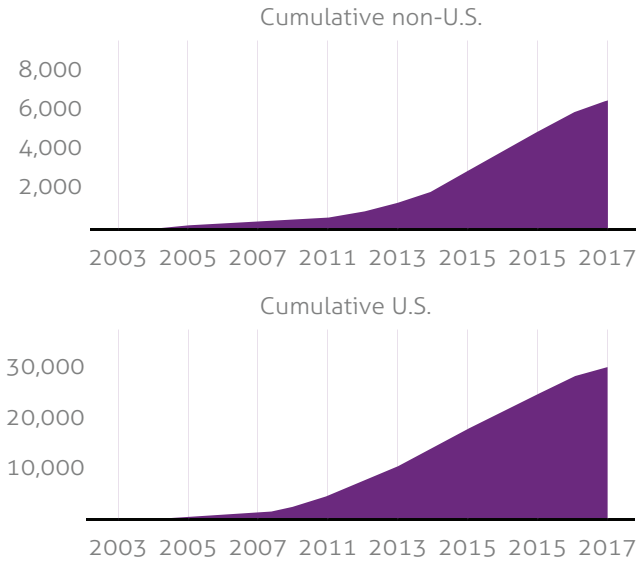


2. PROBLEM OVERVIEW: THE JOURNEY OF SUSTAINABLE ARCHITECTURE AND ITS SHORTCOMINGS ON THE CITY SCALE

Sustainable architecture is often championed as a high level solution in meeting goals of low resource consumptions and CO_2 emissions in the built environment. As the attribute "sustainable" is in itself broad, in the last decades the construction industry has been busy operationalizing and promoting what sustainability entails when applied to buildings. The United States Environmental Protection Agency, for instance, provided a definition of green building as "the practice of creating structures and adopting processes that are environmentally responsible and resource efficient throughout a building life-cycle: from siting to design, construction, operation, maintenance, renovation and deconstruction" (Goh Rowlingson and Wang., 2018).

More recently, this concept was further integrated and refined, as circular economy principles promoting the production of lower-impact building materials with secondary material input established itself firmly in the sustainability conversation (Nußholz, Rasmussen and Milios, 2019).

As these principles relentlessly made their way into the daily vocabulary of planners, architects, and urban policy makers, so did different sets of standards created to address a building's performance. In 1990, the Building Research Establishment Environmental Assessment Method standard (BREEAM) was founded in the UK with the aim of providing a model for the benchmarking of development and communities in sustainable construction, property, and infrastructure (Goh, Rowlingson and Wang, 2018).



› Number of LEED certifications worldwide from 2003 to 2017
Source: LEED, "Country Market Brief"

The World Wildlife Foundation's UK headquarters is built with responsibly sourced materials and in line with low-carbon sustainability standards. Natural light and ventilation, and low energy consumption rates gained the the building BREEAM Outstanding Certification in 2014.

› The WWF Living Planet Center in Woking (UK) by Hopkins Architects

The Leadership in Energy and Environmental Design (LEED) followed in 1993, formulated by the US Green Buildings Council (USGBC). Since then, these rating systems and other versions of them (Evaluation Standards of Green Buildings in China or Green Star in Australia) lead the way, embedding sustainability in the DNA of modern architecture practice across the globe. The World Wildlife Foundation (WWF) England HQ in Woking (UK), the King Abdullah University of Science and Technology (Thuwal, Saudi Arabia), and the Taipei 101 Tower (Taipei, Taiwan) are only a few of the brightest shining examples of top scoring LEED and BREEAM certified buildings worldwide.

However, while voluntary standards carry on along their journey to become the "business as usual" for the building sector, great socio-environmental threats urge for a broadening in perspective. This effort stretches beyond pursuing energy efficiency, resource efficiency or circularity in buildings. While highly detailing and scoring the physical and functional layout that constitute a green building, the assessments that formalize these principles into standards have a limited view of sustainability. A fundamental question to be addressed is then whether, and to which extent, social sustainability can be integrated, measured and scored in the construction or renewal of both buildings and neighborhoods (Stender and Walter, 2018).

3. SOLUTION: SHIFTING THE PARADIGM FOR SUSTAINABILITY IN THE BUILT ENVIRONMENT, BY ENVISIONING BUILDINGS AS SERVICES FOR THEIR SURROUNDINGS

Now more than ever before, construction stakeholders are called to work "beyond the individual building block, by entailing sustainable planning and design principles in the early stage of buildings, such as planning and feasibilities study" (Goh, Rowlingson and Wang, 2018). In order to overlook the individual, physical reality of a building, we propose to start envisioning buildings as services for the context they are embedded in.

This implies the application of neighborhood approaches to architecture, as individual buildings become tools for shared value that transcends their physical borders. While retaining their physical components (optimized to meet state of the art sustainability standards), buildings need to be integrated by a business model that encompasses their presence in a urban context they can interact with. This way, reactive prevention of negative impacts and proactive co-creation of shared social and environmental value can be organically integrated in the fabric of neighborhoods.

While echoes might resonate in the ears of landscape architects, circular economy practitioners and sustainability-minded urban planners, these concepts have still not merged under a sound definition and a shared language across the disciplines. Wearing these "goggles" to look at the very nature of buildings, as well as at their role in their neighborhood and the city as a whole, the first step is to provide different fields of practice with a common ground, by crafting a new vocabulary that bridges architecture, ecology, planning, and human geography. This starts from the inception of individual buildings, all the way to their realization. Of equal importance, buildings are conceived by design to become hubs that nurture a wide range of business models, turning into a service-based economic platform for the neighborhood.

"The traditionally building-centred approach of sustainable architecture needs to evolve into context-empowering, interactive business models."

› Tom Bosschaert

4. CATALYTIC BUILDINGS: NODES IN INTERCONNECTED URBAN FABRICS

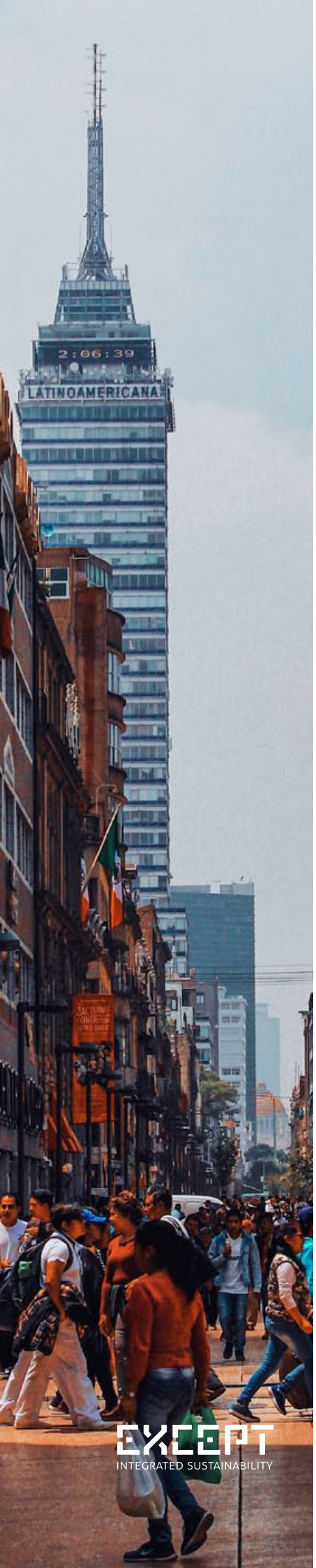
The term "catalytic" is borrowed from chemistry: a catalyst is a substance that increases the rate of a chemical reaction without itself undergoing any chemical change. Just by being there it accelerates phenomena, without degrading itself.

This metaphor sporadically appeared in previous attempts from both researchers and practitioners to envision the future of sustainable urban development: in some cases, cultural facilities were defined catalysts due to their potential for fostering knowledge and spilling development across their surrounding neighborhoods (Sternberg, 2002). Catalytic development was instead used to capture the process undertaken jointly by public and private actors to transition car-centered, suburban areas into more walkable places (Brookings Institution, 2018). While constituting key pieces in the jigsaw, these interpretations remain partial.

In order to address the urban challenges lying ahead, the global community of forward-thinking developers needs to craft an immediately recognizable snapshot of catalytic processes as applied to the built environment. Since 2005, through our work as a sustainability innovation firm based in The Netherlands, we at Except Integrated Sustainability have been working on new concepts for Catalytic Buildings worldwide. Our effort was always aimed at operationalizing the main features of these cutting edge urban transformers into a set of principles.

ENERGY NEUTRAL DEVELOPMENT

CATALYTIC BUILDINGS



Catalytic Buildings are the next big chapter for high performance buildings: not only do they boost energy performance, but also involve the full scope of sustainability challenges (including water, waste, materials, social program, economic development, and health). While not requiring to rewire the entire city fabric, they boost its environmental, social and economic sustainability one neighborhood at a time. They do so while generating long term investment value, using a whole neighborhood as a business model, and leveraging the investment.

Catalytic Buildings are designed to become a vital organ in the fabric of the surrounding city, using smart technologies and design to boost the performance of their own structure along with a range of structures surrounding them. They thrive on resources available in their direct surroundings such as waste streams, and transform them to valuable, shareable resources: this way, the perspective reaches far beyond the individual building, introducing the context in the equation.

4.1. WHAT ARE THE ADVANTAGES?

From our research, we sum up the main advantages of Catalytic Buildings into six core components:

- **Resilience**
  Increased resilience to changes in market and usage patterns, retaining their investment value longer due to their flexible nature.

- **Value retention**
  As an implication of their resilience, Catalytic Buildings secure a longer term value retention from financial and investments standpoints.

- **Operational costs**
  Lower resource use imply lower operational costs for Catalytic Buildings.

- **Health & Wellbeing**
  Increased health for tenants and the neighborhood. Better social connection, which supports the increase and the retaining of value.

- **Sustainability**
  Increased social and environmental shared value in the surrounding area, with direct involvement of the local community in the services it provides, waste metabolized and resource consumption optimized.

- **Performance**
  As the highest performing buildings available at the moment, they support a significant PR and marketing benefit.

"Catalytic Buildings are not only circular. Or energy neutral. They are that, and more. They are systemic thinking materialized into the built environment, by establishing buildings that significantly improve performance beyond their own physical borders. Catalytic Buildings are the next big chapter for high performance buildings."

› Tom Bosschaert

4.2. WHICH BUILDINGS CAN BE MADE CATALYTIC?

Rather than a fixed design or a technical blueprint, Catalytic Buildings embody an approach that can be applied to any building function, and to both new constructions and renovation programs. Embedding a catalytic building within an existing urban fabric reaps the maximum shared value they can provide.

While the planning and design stage for Catalytic Buildings are usually lengthier and more expensive, the actual intervention does not have to be,especially for renovation programs. Overall, in order to achieve the maximum positive impact on the physical, social and economic spheres, mixed-use programs are recommended. Among the different functions we have investigated and developed for Catalytic Buildings:

- **Apartment buildings**
- **Office buildings**
- **Hotels and hospitality**
- **Educational buildings and schools**
- **Transport hubs and parking garages**
- **Retail hubs and malls**

4.3. THE 8 PRINCIPLES OF CATALYTIC BUILDINGS

Along the research undertaken and projects developed, we formalized the main features of Catalytic Buildings into eight principles. These serve as a first draft for a performance measurement system.

1. Catalytic Buildings offer a profitable long term investment.
2. They give significantly more than they take in at least three categories of energy, water, waste, food, ecosystem, and/or socio-economic services.
3. They contribute significantly to the social, economic, health, biodiversity, and environmental performance of their local area, and actively prevent negative impacts.
4. They transform initially unwanted or undervalued local surpluses (waste streams) into valuable services or goods in their specific neighborhoods.
5. They facilitate connectivity between people in a community, and facilitate bottom-up entrepreneurship and small local businesses.
6. They maximize the efficient use of existing resources, such as real estate, materials, and energy flows, before relying on new ones.
7. They maximize resilience and long term adaptability of the neighborhood through reprogrammable spaces and flexible business models.
8. They report their sustainability performance, knowledge, and experience transparently, publicly, and freely.

5. CATALYTIC BUILDING CASE STUDIES

The Catalytic Buildings concept represents a recurring theme along our 20 years experience in project design and development in the built environment. Below we present a handful of case studies from our project portfolio in a nutshell. Although some of them remain on paper as concepts, they provide examples on how Catalytic Buildings can be conceptualized and designed.

› Schiphol Catalyst
Multi-tenant office ecosystem

› San Fransisco Transbay Center
Transformation of inner city transport hub

› Shanghai Urban Masterplan
Highrise catalytic towers empowering historic district

› Utrecht Community (UCo)
Healthy, circular & energy neutral listed heritage building

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5.1. SCHIPHOL CATALYST OFFICE CONCEPT

In 2015, we were challenged with the task of developing a concept for a healthy and sustainable multi-tenant office building at Amsterdam's Schiphol Airport. Given the rapid and large scale development of the airport, the aim was to make it as environmentally and socially sustainable as possible, while securing the retaining of its value for future decades.

The design process entailed the involvement of 70 stakeholders in a co-creation program. The result was a building design with an autonomously operating system in terms of energy, waste, water, and partial food production, resilient to market, culture, and future developments. The main features of the concept can be summed up into:

- **Performance beyond the building:** The healthy and inspiring environment is energy, water and waste neutral. A 10.000 m^2 building enhances the performance of the over 50.000 m^2 around it with new functions, spaces, office typologies, resource efficiency, and infrastructures.
- **Flexibility as driver for resilience:** The building blocks can be configured and designed however the tenants wish, ensuring expression and constant development. This becomes possible through the glass canopy that protects the flexible structures from rain and wind. The resulting lightweight and modular building blocks are set on columns, which keeps the park on the ground-level clear. The glass canopy also enables a true indoor biodiverse park system with mature trees, which would otherwise not be possible given restrictions for areas in proximity of an airport.
- **A business model rooted in people and health:** Research was undertaken on the relation between measures to increase health and productivity and the result in performance of employees, and the positive implications for financial value. The resulting concept design showed the ability to boost employee performance by more than 10%. Since employee costs are a large cost factor for tenants, this factor alone was able to return on investment for the development of the building as a whole.

5.2. SHANGHAI URBAN MASTERPLAN CONCEPT

For Expo 2013, we designed a masterplan to transform downtown Shanghai into a fully sustainable community in energy, food, water, and jobs. In addition, to counteract the degradation of the area, the concept integrates the re-development of Lilong housing districts. These traditional neighborhoods were built in the early 20th century, and consist of tightly packed row housing in closed gated communities, merging traditional chinese to western structural styles. The aging districts feature bad sanitation, with some of them on the brink of demolition, which puts the survival of their cultural heritage at risk.

By means of Catalytic Building approaches, the developed concept aims at tackling pressing problems in Shanghai - pollution, traffic, replacement housing, decreasing agricultural land, and runaway development.

- **Food, energy and clean water:** The urban vertical farms generate food and energy, filtering water collected by a highly polluted creek nearby and feeding it back into the system, enhancing sanitation to the adjacent neighborhoods. Methane is generated from composting biomass, which feeds cogenerators that produce electricity and heat.
- **Employment:** The vertical farms provide unemployed, highly skilled labor forces with revenues and improved livelihoods.
- **Regeneration of historical site:** The symbiosis between the new agricultural district and the Lilong city blocks entails the regeneration of the latter into liveable houses and food market. It provides the precondition necessary for upgrading the infrastructure of the whole historic district.

Read more about the Shanghai Urban Masterplan Vertical Farms here.

5.3. SAN FRANCISCO SALESFORCE TRANSIT CENTER

This project was designed to transform the old Transbay bus station in downtown San Francisco. The project started in 2006, Except collaborated with Pelli Clarke Pelli in the concept development phase, and construction started in 2010. The unique property of the design is the application of the world's largest ecosystem-powered rooftop park. Renamed Salesforce Park in 2017, the center is set to open later in 2019.

Water purification, air filtration, ecosystem services, improved biodiversity, and a brand-new green space in the center of the city lie amongst the innovations this hub was designed to bring. The transport center becomes a true ecological entity right in downtown San Francisco, providing spatial quality, health benefits, biodiversity, and economic value, far beyond its own structure.

This project showcases that it is possible, by means of smart business models, to provide for a public service such as a biodiversity enhancing park, and make a financially feasible project. The Transbay project does this by capturing part of the value increase of the surrounding properties. Since property values are higher when adjacent to a city park as opposed to a standard transit center, the introduction of the park boosted the values of these properties.

Read more about the San Francisco Transbay Salesforce Park here.

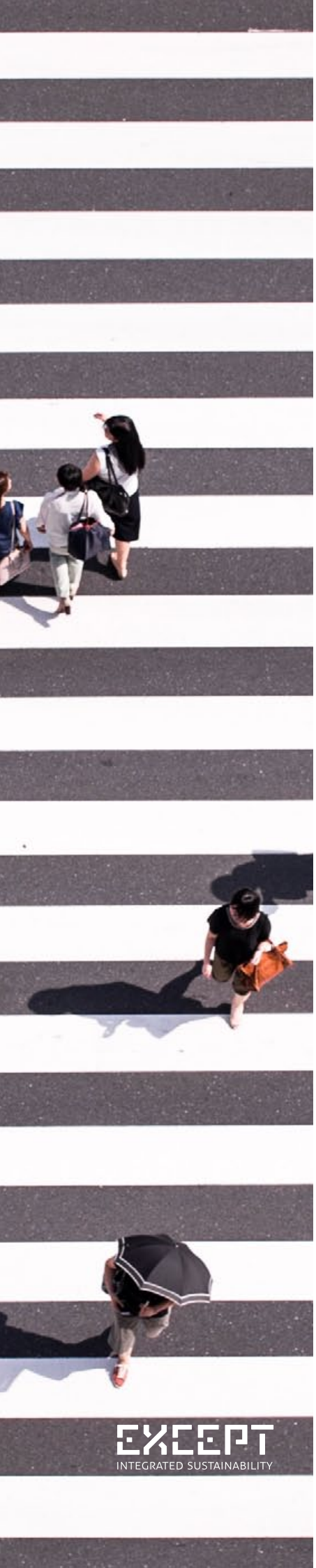
5.4. UTRECHT COMMUNITY CENTER (UCO)

The Utrecht Community Center (UCo) is a national center for sustainable entrepreneurship in the city of Utrecht (the Netherlands). Except developed UCo from the vision that cooperation between pioneering organizations and individuals serves as accelerator for sustainable development. This was used to fuel the business model to sustainably renovate a the listed heritage building.

UCo consists of a 1800 m² monumental train depot that served as a warehouse of the Dutch Railways until 2012. Except redeveloped the building into the world's first circular, healthy, and energy neutral listed heritage office building. Opened in 2017, UCo aims to become the main sustainability hub in the country. While the project did not meet all of its initial goals along the realization (for example, it also aimed at being water neutral), it is still the highest performing listed heritage building to date, globally.

Hundreds of plants and large trees populating the UCo workspace provide the building with aesthetic appeal, and provide tenants with constantly naturally-filtered air. Each piece of furniture in the co-working space showcases a different form of circularity. For example, direct waste recycling with desks made of reused wooden pallets, and remanufacturing cycles with refurbished furniture. A majority of the interior materials were salvaged from the building itself, and surrounding demolition projects. Materials for the renovation of the building are as toxin free as possible: the wood and carpets are specifically selected, the paints are natural oil-based, and al materials checked for carcinogenic volatile organic compounds. Newly created ceiling windows boost the amount of natural daylight, brightening the space, providing savings in artificial lightning energy costs of over 80%. As the community grows, UCo works to improve building performance in terms of circularity and energy. The main catalytic asset for UCo lies in its business model: UCo's content program works to accelerate sustainability-related innovations in the city, region, and country.

Read more about the Utrecht Community Building here.



6. THE PROCESS: IMAGINING, DESIGNING, AND EXECUTING A CATALYTIC BUILDING

What is left to address is the process of developing a Catalytic Building. How does one go about realizing one? At Except we established a distinct working process. The process integrates design thinking, smart urban planning, industrial ecology principles, and stakeholder driven co-creation. It is governed by an integrated form of systems thinking and systems planning, utilizing the Symbiosis in Development (SiD) framework. The following steps summarize the main phases in this catalytic building development process.

ASSEMBLE A MULTI-DISCIPLINARY TEAM

The start of the process is to assemble a team that combines science, business, design, and critical stakeholders. Different backgrounds, disciplines, and world views fuel the creative design process and result in a broad systemic overview. The involvement of private and public stakeholders and of the local community is pivotal in the process.

SYSTEM MAPPING

The first practical step the team executes is to gather data and mapping the system of the neighborhood the Catalytic Building is to be placed in. For this, we use the SiD ELSIA stack to form an integrated analysis. For each ELSIA category the supply and demand of the neighborhood is mapped, including energy, material flows, ecosystems, cultural, economic, labor, and social components. From this we learn what is in excess, and what is in short supply. This process brings to light the possibilities for the Catalytic Building to convert unwanted flows into valuable ones. The mapping process is made visual through graphic system maps that create an accurate picture of the structure, functioning, and resources of the system of the neighborhood.

SYSTEM SCENARIOS

With the system overview in hand, the team investigates the possible symbiotic relations between different resource flows. For example, a waste stream can be used to generate resources such as energy, heat, or other valuable matter. A list of conversion technologies is drawn up that help to turn waste streams into value. In this way, the social, economic, and ecological streams are cross-pollinated, and optimized.

DESIGN SCENARIOS

Once a complete set of these catalytic interventions are found, they are merged into a single design concept. A final business model is created that captures surplus values of upgrading the resource streams. Secondary benefits are also included into this model, such as increased real estate value through increased green spaces, and healthy living or working conditions increasing productivity, health and happiness. Architectural design is then leveraged to find suitable form, structure, and engineering to materialize the building.

7. BUILDING MOMENTUM: A CALL FOR PRACTITIONERS

With this white paper we hope to inspire forward-thinking developers, architects, and policy-makers to contribute to, and to further develop the Catalytic Buildings approach. We hope to have shown that practical application of systems thinking in real estate development allows us to achieve greater leverage in improving our cities for the long term. We can achieve tremendous results if we use individual buildings as tools to make our cities more resilient, smart, and equitable. We call on leaders in the field to further this approach, make it their own, and move the frontier of sustainable development forward.

At Except Integrated Sustainability, we embraced and addressed the complexity of urban systems for over 20 years. During this time, we witnessed the evolution of sustainable development applied to the urban planning and construction sector. With the two increasingly overlapping, the certifications and indicators which measure the sustainability of buildings have rapidly evolved. We see that thinking beyond the borders of our real-estate projects allows us to face the challenges our cities face more effectively.

Systems thinking in the built environment is a recent trend that is picking up, witnessing trends in the industry that support this. To name a few, energy positive buildings are overtaking a focus on energy neutrality (Powerhouse, 2019). On its part, LEED is currently developing a pilot focusing on neighborhoods and communities, with cities in the US, South Korea, and Italy already gaining certification (LEED, 2019). Additionally, the concept of catalytic development was recently introduced as a blueprint to encourage large-scale urban renovation, which promotes the creation of pedestrian-friendly urban districts (Brookings Institution, 2018).

However, as systemic approaches to urban challenges continue to be refined around the globe, still they don't comprehensively address the broader scope of urban challenges. The Catalytic Buildings approach confronts the reality that we must discard our traditional building-focused lens and design integrated solutions. One step further in applying systems thinking, into actual realization.

At Except, we offer our experience innovating in the built environment, from concept development and design, to project execution. We aim to propel the Catalytic Buildings approach into the mainstream vernacular of the built environment. We put forwards this report as a building block, to add to the public discourse on the future of sustainable urban development. We compel anyone to steal our ideas and put them into action. For those that enjoy collaboration, we invite you to contact us to see how we can move this goal forward together.

"The city is a fact in nature, like a cave, a run of mackerel, or an ant-heap. But it is also a conscious work of art. It holds within its communal framework many simpler and more personal forms of art. Mind takes form in the city; and in turn, urban forms condition the mind."

› Lewis Mumford

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COLOPHON

The Catalytic Building approach is developed the team of Except Integrated Sustainability, a specialized sustainability consulting, design, and development firm operating from the Netherlands. We've worked since 1999 to help establish the foundations of a sustainable society. All inquiries are welcome.

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