SUSTAINABILITY REDEFINES ARCHITECTURE

Prof Dr. SN Pollalis

Vertical Forest / Stefano Boeri Architects / Milan

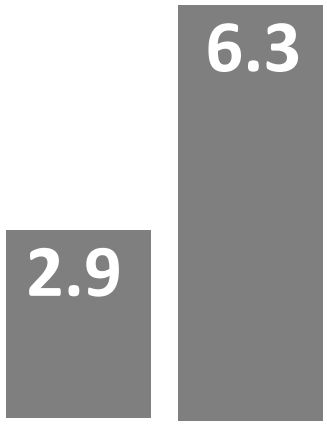
SUSTAINABILITY CHALLENGE

Urbanization

High living standards in urban centers in the developed world combined with rapid urbanization on the developing world bring increased resource consumption and waste production.

Urban centers face:

- Lack of resources
- Overloaded infrastructure
- Pollution
- Extreme weather phenomena



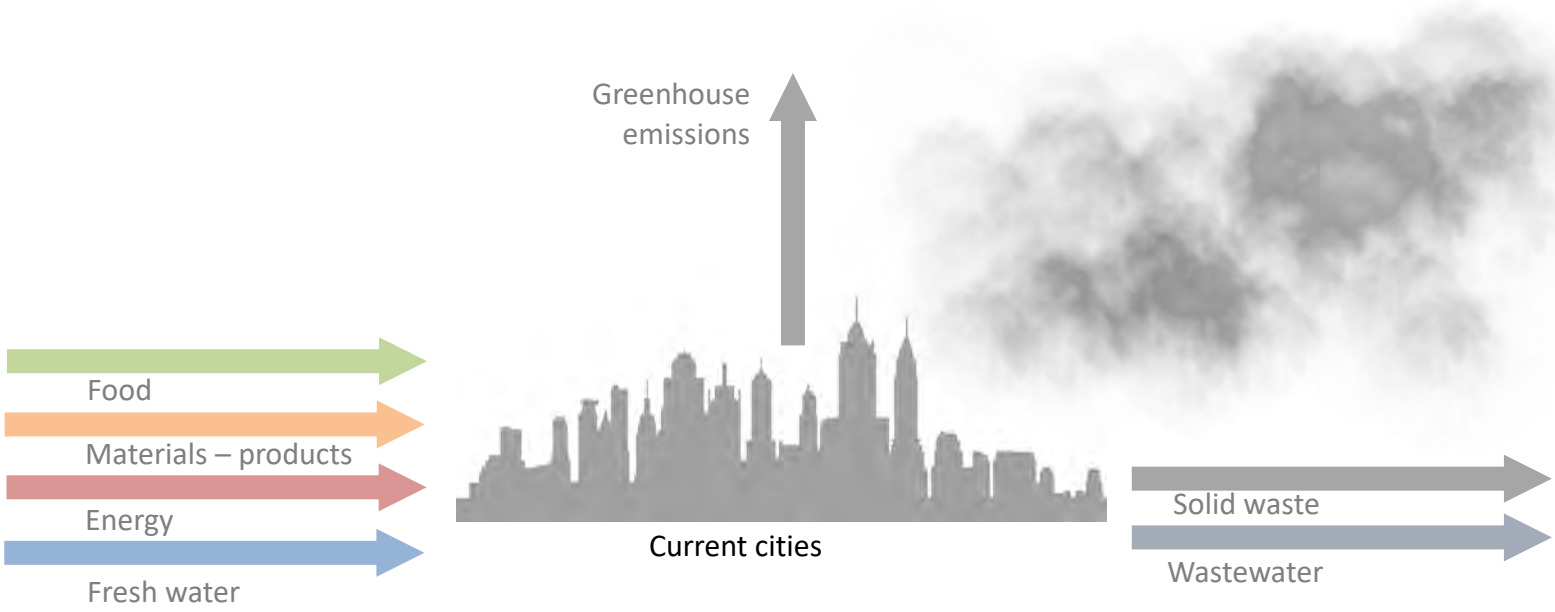
Urban Population (billions)

TODAY: 1 out of 2 people lives in a city

IN 2050: 2 out of 3 people will live in a city

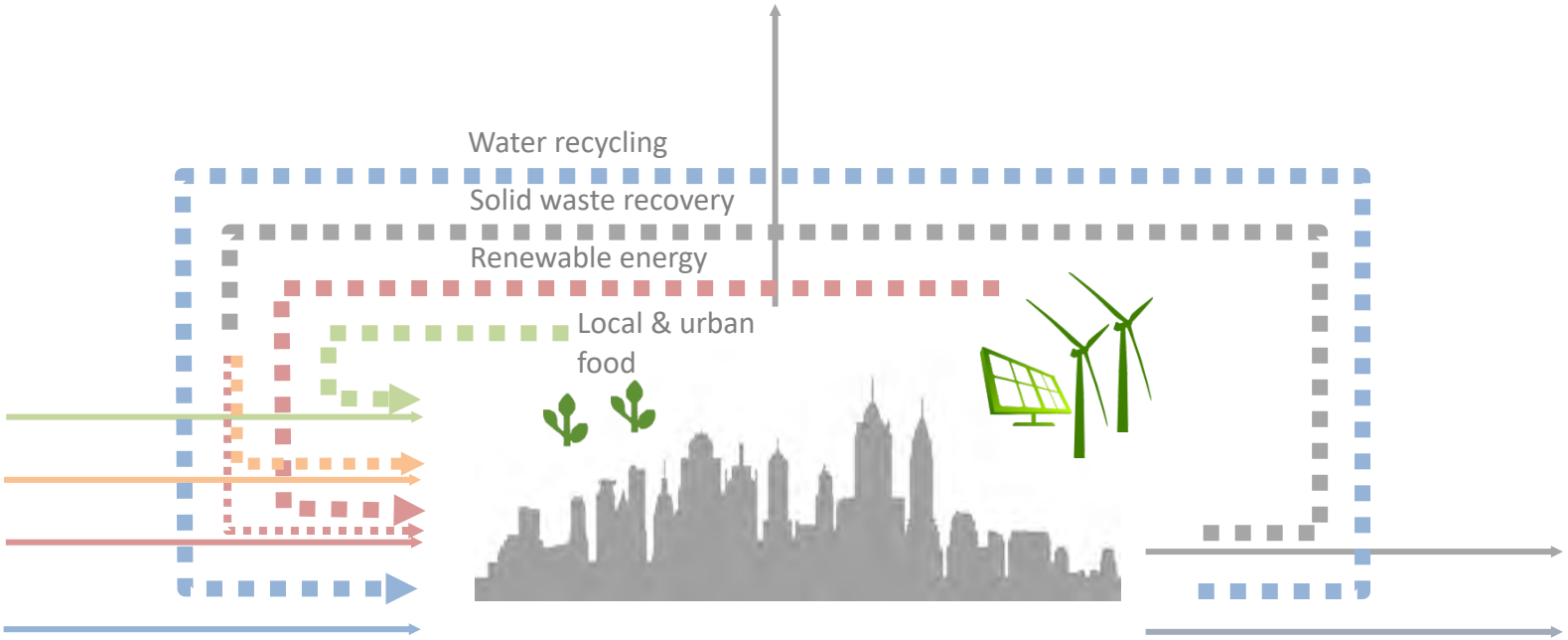
Source: Living Planet Report 2012, WWF

Sustainability vision - **Current cities**



Current cities consume a vast amount of resources while polluting the natural environment and downgrading quality of life

Sustainability vision – **Sustainable city**



Sustainable city should be able to work as a ‘closed circuit’ recycling and reusing resources through **integrated infrastructure planning**

THE ZOFNASS PROGRAM

The Zofnass Program for Sustainable Infrastructure

The Zofnass Program was **established in 2008** at **Harvard's Graduate School of Design**

The mission of the Program is to develop and promote methods, processes, and tools that quantify sustainability for infrastructure and cities

Its goal is to facilitate the adoption of sustainable solutions for infrastructure projects and systems, and expand the body of knowledge for sustainable infrastructure.

Harvard University
Graduate School of Design

ZOFNASS PROGRAM
FOR SUSTAINABLE INFRASTRUCTURE

The Zofnass Program prides itself on the collaborative nature of its research efforts and has achieved the unique **collaboration of academic experts and industry specialists**.

Industry participation:
(SIAB members)

ARCADIS
AUTODESK.
HNTB
Golder Associates
ch2m.
GRANITE
NV5
POWER ENGINEERS
IDB Inter-American Development Bank
Stantec
exp.
MWH®

Harvard participation:

Harvard University Graduate School of Design
HARVARD Kennedy School
JOHN F. KENNEDY SCHOOL OF GOVERNMENT
HARVARD BUSINESS SCHOOL
HARVARD SCHOOL OF PUBLIC HEALTH
Harvard University Center for the Environment

The Zofnass Program for Sustainable Infrastructure

The Zofnass Program **develops** know-how, tools and methodologies for planning and evaluating urban infrastructure. It **focuses on** the integration of sustainable **infrastructure** and **urban** planning.

The program's approach focuses on **5 categories of impact:**

And **7 infrastructure systems:**

ENERGY	WATER	FOOD	WASTE	TRANSPORTATION	LANDSCAPE	INFORMATION
-Wind -Solar -Biomass -Other	-Potable Water Distribution -Capture &Storage -Water Reuse -Storm water Management -Flood Control -Other	-Eco-Agriculture -Food Distribution -Imported food -Self sufficient small farms -Indigenous Fruit Nurseries -Other	-Solid Waste -Recycling -Hazardous Waste -Collection and Transfer -Other	-Roads -Highways -Biker/ Pedestrian -Railways -Public Transit -Other	-Public Realm -Parks -Ecosystem -Services -Other	-Telecom. -Internet/Phone -Satellites -Data Centers -Sensors -Other

THE ENVISION RATING SYSTEM

The collaboration of academic experts and industry specialists has led to the development of the Zofnass Rating System, that has been integrated into the **Envision™** system of the Institute for Sustainable Infrastructure.

ZOFNASS PROGRAM
FOR SUSTAINABLE INFRASTRUCTURE
Graduate School of Design
Harvard University

RESEARCH

&

INSTITUTE FOR SUSTAINABLE INFRASTRUCTURE
I S I

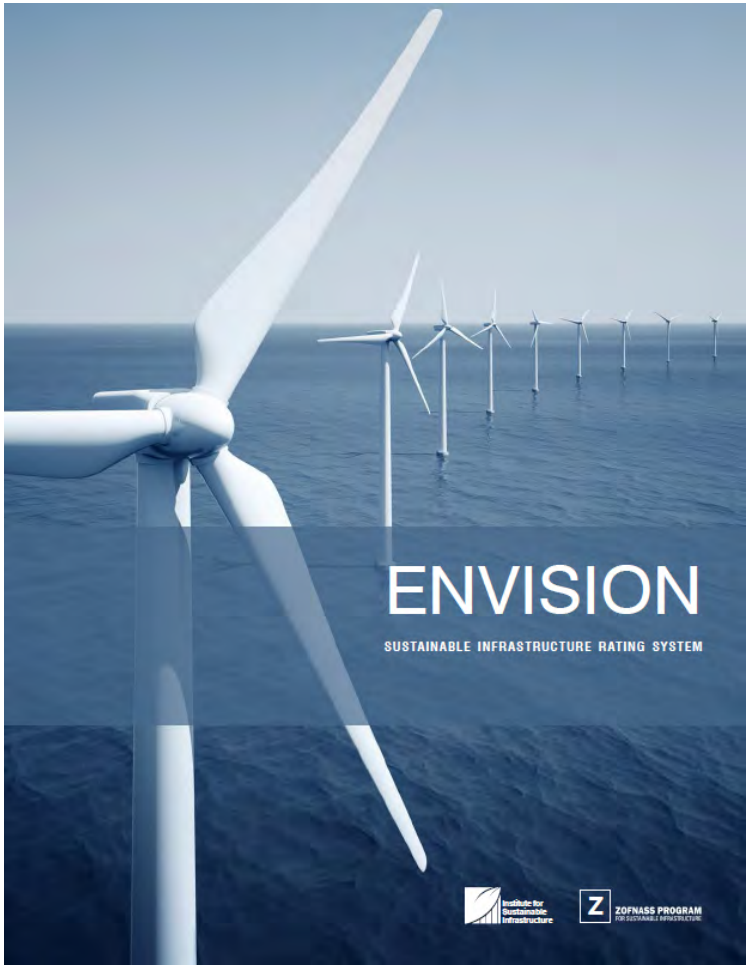
APWA ASCE ACEC

DISSEMINATION

- American Public Works Association
- American Council of Engineering Companies
- American Society of Civil Engineers

What is Envision?

Envision™ provides a holistic framework for evaluating and rating the community, environmental, and economic benefits of all types and sizes of infrastructure projects.



What LEED™ has done for building-scale sustainability, **Envision™** aims to do for infrastructure:

- educate citizens and increase public awareness,
- provide a means to quantify sustainability in infrastructure,
- facilitate the adoption of sustainable design for infrastructure.

The Role of Envision

- The Envision™ Rating System is designed to help users **identify ways** in which **sustainable approaches** can be used to **plan, design, construct and operate infrastructure projects**.
- The goal is to **improve the sustainable performance of infrastructure projects** in terms of not only the technical performance but also from a **social, environmental and economic perspective**.
- Envision™ provides an opportunity for infrastructure owners and designers to provide **higher performing solutions** by using a lifecycle approach, by **working with communities**, and by using a **restorative approach** to infrastructure projects.

ENVISION™

The **Envision™** rating system focuses on the Zofnass five categories of impact:

QUALITY OF LIFE

LEADERSHIP

RESOURCE ALLOCATION

NATURAL WORLD

CLIMATE AND RISK

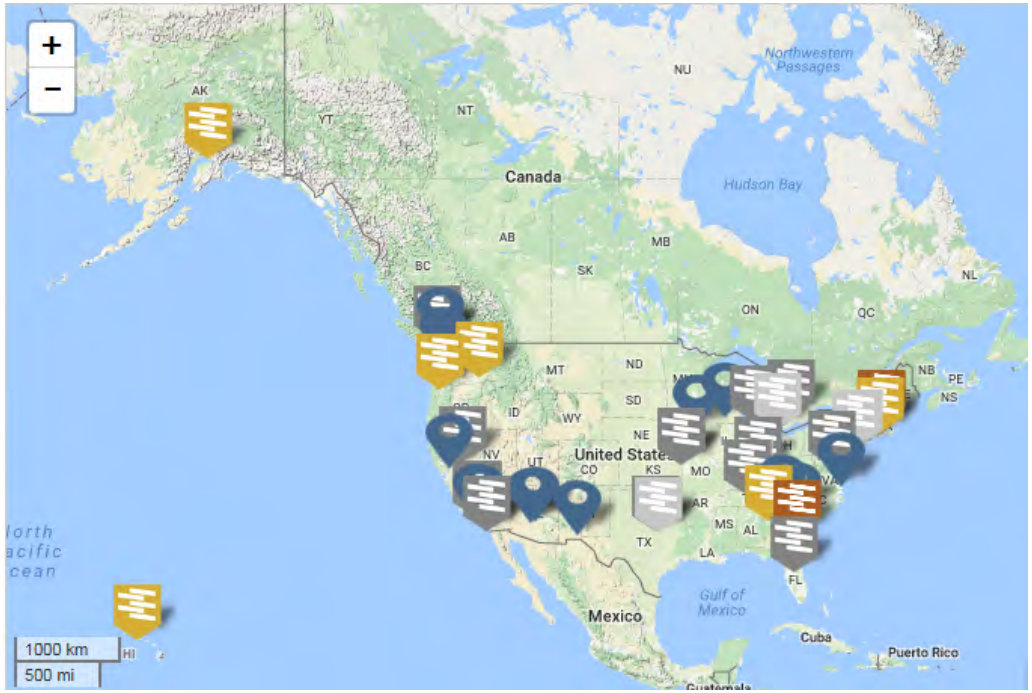
60 Credits (sustainability criteria) are organized in those 5 categories & corresponding subcategories

CATEGORY
↳ SUBCATEGORY
↳ CREDIT
- description + instructions for how to earn credit
- point value

TABLE OF POINT VALUES

			Improved	Enhanced	Superior	Conserving	Restorative
1	QUALITY OF LIFE	QL1.1 Improve community quality of life	2	5	10	20	25
2		QL1.2 Stimulate sustainable growth and development	1	2	5	13	16
3		QL1.3 Develop local skills and capabilities	1	2	5	12	15
4		QL2.1 Enhance public health and safety	2			16	
5		QL2.2 Minimize noise and vibration	1			8	11
6		QL2.3 Minimize light pollution	1	2	4	8	11
7		QL2.4 Improve community mobility and access	1	4	7	14	
8		QL2.5 Encourage alternative modes of transportation	1	3	6	12	15
9		QL2.6 Improve site accessibility, safety and wayfinding		3	6	12	15
10		QL3.1 Preserve historic and cultural resources	1		7	13	16
11		QL3.2 Preserve views and local character	1	3	6	11	14
12		QL3.3 Enhance public space	1	3	6	11	13
			13	27	62	150	151
13	LEADERSHIP	LD1.1 Provide effective leadership and commitment	2	4	9	17	
14		LD1.2 Establish a sustainability management system	1	4	7	14	
15		LD1.3 Foster collaboration and teamwork	1	4	8	15	
16		LD1.4 Provide for stakeholder involvement	1	5	9	14	
17		LD2.1 Pursue by-product synergy opportunities	1	3	6	12	15

Envision covered a gap on the sustainability assessment of infrastructure projects. It has been widely adopted - especially on North America - both for self-assessment and for third-party project verification and the awards application program.



Over 4,000 qualified professionals around the globe

Envision awards in North America

ZOFNASS PLANNING GUIDELINES

The Zofnass Program – Expanding on city-scale

The Zofnass Program for Sustainable Infrastructure, after the development of the Envision Rating System for sustainable infrastructure projects (2008-2012), possessed a **strong foundation and experience** to **expand the research to city scale**.

Cities as problems

VS

Cities as solutions

Cities may have **high impact** but also have **high potential**

As a response to the complex sustainability challenges urbanization provokes the **Zofnass Planning Guidelines** were created.

The Planning Guidelines refer to high-level, city scale planning. Their main objective is the development of cities through a **unified, high level and cross-disciplinary process.**

The **Planning Guidelines** were developed for sustainable infrastructure systems to be integrated with sustainable planning of:

- **EXISTING**

- **EXPANDING**

- **and NEW URBAN DEVELOPMENTS**

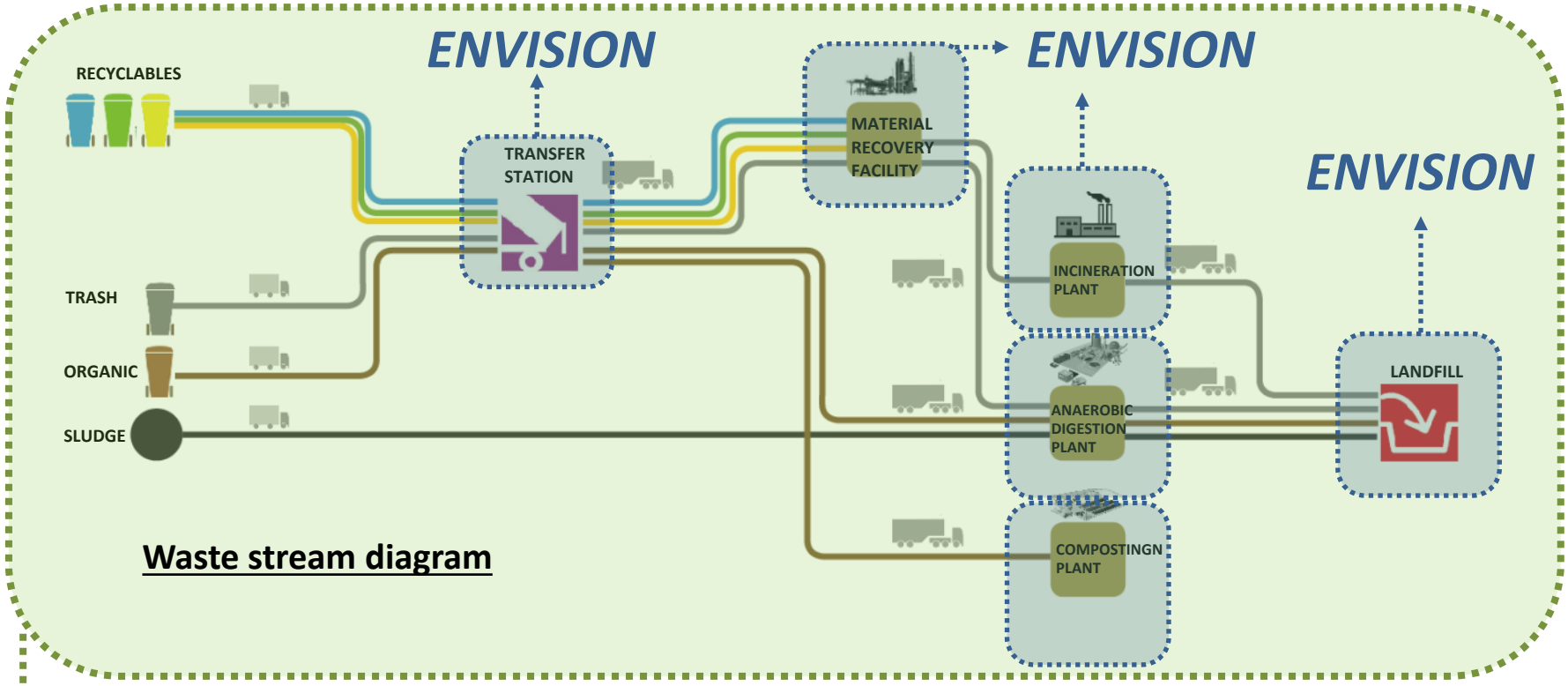
Zofnass Planning Guidelines focus on the five impact categories:

And 7 infrastructure systems:

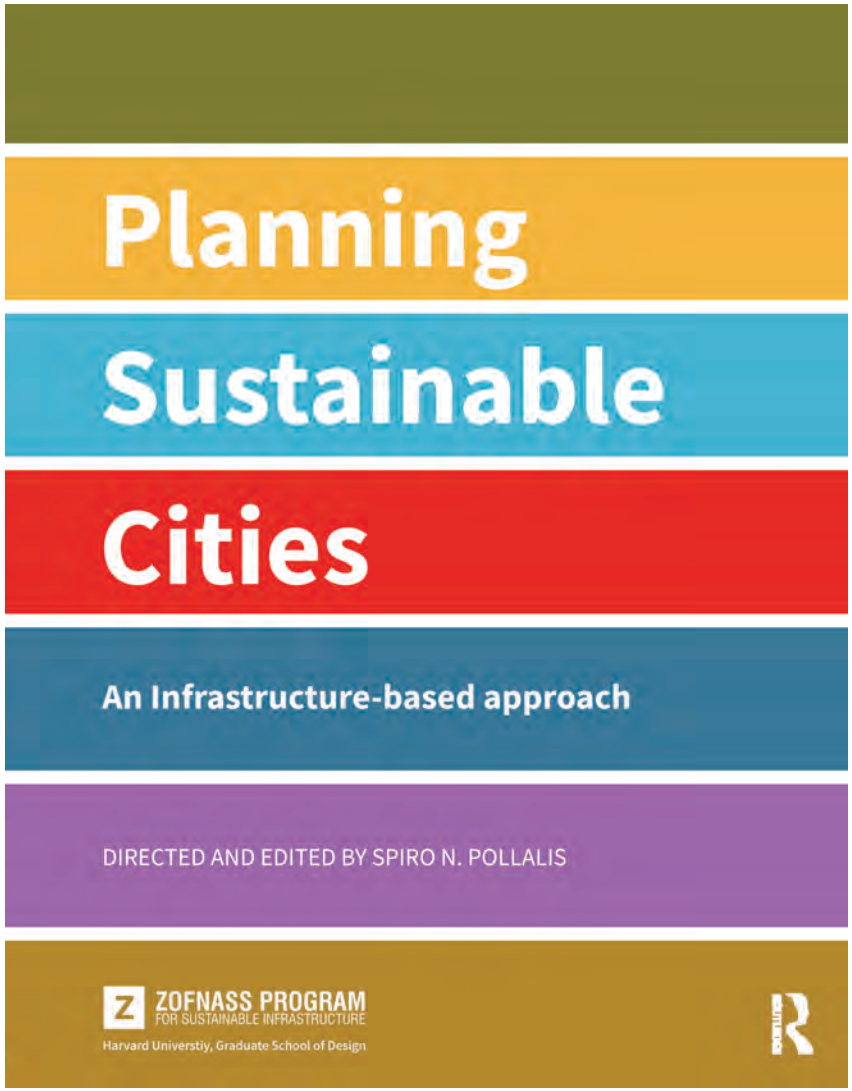
Energy	Water	Food	Solid Waste	Transportation	Landscape	Information
-Wind -Solar -Biomass -Other	-Potable Water Distribution -Capture &Storage -Water Reuse -Storm water Management -Flood Control -Other	-Eco-Agriculture -Food Distribution -Imported food -Self sufficient small farms -Indigenous Fruit Nurseries -Other	-Solid Waste -Recycling -Hazardous Waste -Collection & Transfer -Other	-Roads -Highways -Biker/ Pedestrian -Railways -Public Transit -Other	-Public Realm -Parks -Ecosystem -Services -Other	-Telecom. -Internet/Phone -Satellites -Data Centers -Sensors -Other

Relation between Envision and the Zofnass Planning Guidelines

The ZOFNASS program creates a **city scale** sustainability framework for a whole **infrastructure system**, ensuring good Envision performance for each individual entity, not only answering to the question **"are we doing the project right?"** but also ensuring that **"we are doing the right project".**



Zofnass Sustainable
Planning Guidelines



The research for Zofnass Planning Guidelines resulted to the publication of the book/manual "**Planning Sustainable Cities: An Infrastructure-based approach"**

This publication:

• **fills a gap between the professions of planners and engineers**, both contributing to the fundamental process of planning and building infrastructure for cities.

•is intended to form the foundation of a **common collaborative platform**, primarily among public authorities, planners, and engineers, enabling those who have traditionally functioned in silos to **work closely together** in infrastructure planning.

SUSTAINABLE CITIES + BUILDINGS

What makes a city sustainable?

The long-term objective of Prof.DR.S.N.Pollalis Inc. is to provide a **framework for developing sustainable cities**, subject to the local conditions: weather, topography, economy, history, culture, and religion. The new cities besides being sustainable should have cutting-edge amenities and be **competitive and networked** with the rest of the world.

Buildings are the main components of a city and the main users of infrastructure systems. Besides sustainable urban planning and sustainable infrastructure systems a truly sustainable city needs also **sustainable buildings**.

What makes a city sustainable?

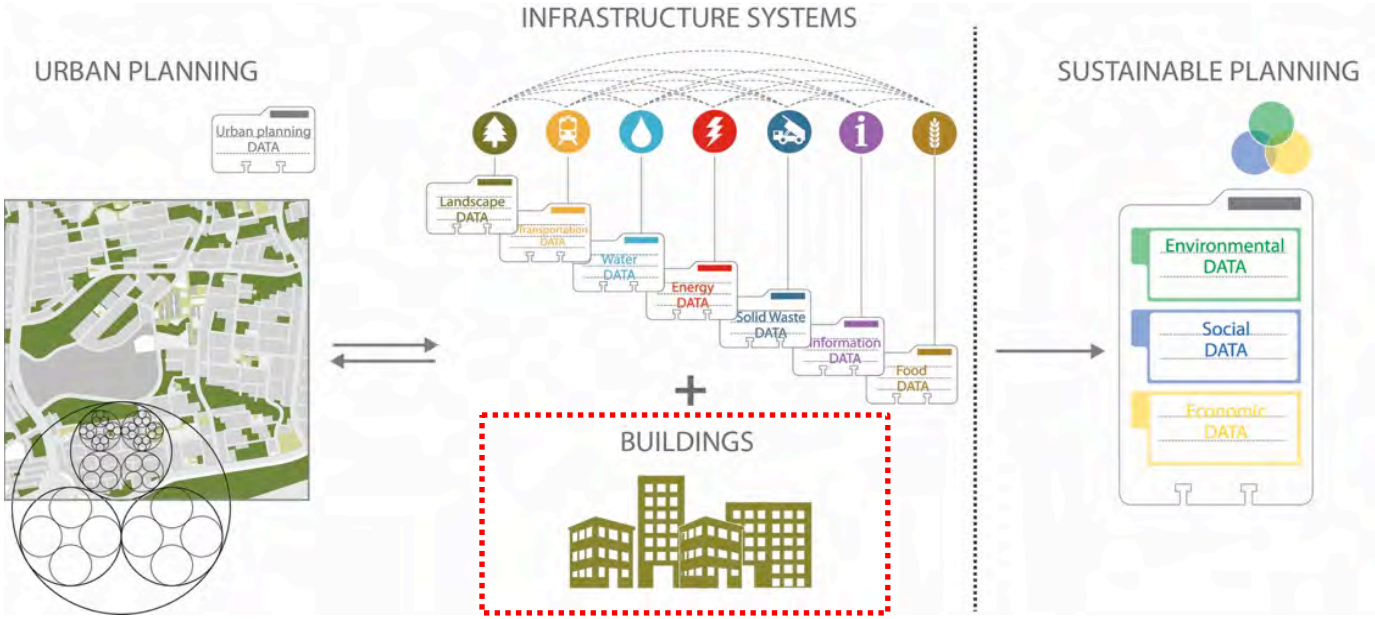
A city is a project, and as such its sustainability is also defined in these five dimensions

Decomposing the **city as a project**, we distinguish three distinct parts that affect its **sustainability**:

- **the planning of the city**
- **the infrastructure systems of the city, and**
- **the buildings (constructed facilities) of the city**

A sustainable city

The planning of the city, its land use and the anticipated distribution of buildings, and the planning of infrastructure are **fully integrated**.



A non-linear process

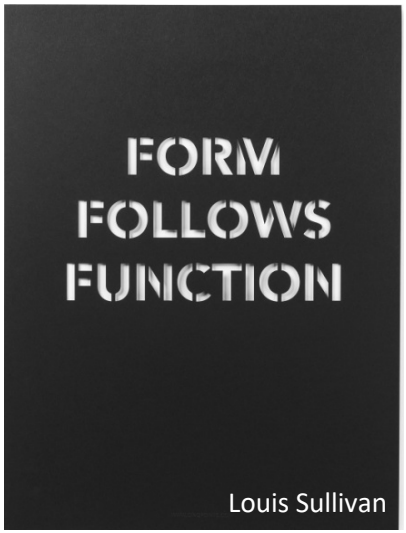
The size of infrastructure systems depends on the demand and the location of the city's occupants, which translates to the demand from buildings and from the other infrastructure systems. For the cities of the past, it can be argued that this was an ordinary linear process. However, it becomes an iterative nonlinear process in planning the new sustainable cities of today.

“FORM FOLLOWS FUNCTION”

The iconic modernist architecture phrase/leitmotif

“form follows function”

has led the practice of architecture for decades



‘Form follows function’

Technological advances and prosperity freed architecture from the limitations of the past and created an international architectural language.

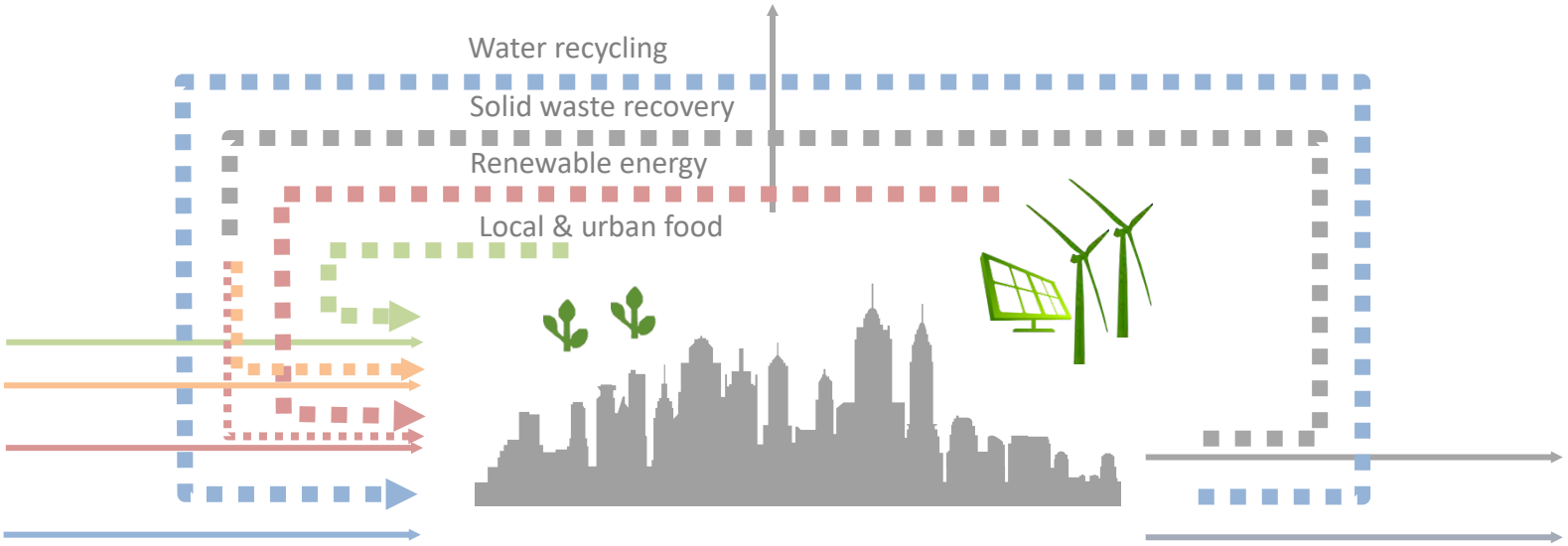
Architectural composition mostly focused and has been defined by:

- function
- program, and
- aesthetics/style

That was not the case until very recently

Vernacular architecture especially on harsh climate environments was defined by and adjusted to local weather conditions and the scarcity of resources

Nowadays, sustainability establishes new functions with a wider impact, as the building becomes a component of a larger system.



The new functions, driven by sustainability considerations:

- The building is a system component of the infrastructure.
- The building becomes a resource saving entity, contributing to efficiency.
- The building becomes a producer of resources, aiming and even exceeding self-sufficiency.
- The building is contextually related to the climate and integrated to the natural world.
- The building assists urban compactness through mixed use and reduction of space.

‘NEW FUNCTIONS’

1. The building is a system component of the infrastructure.
2. The building becomes a resource saving entity, contributing to efficiency.
3. The building becomes a producer of resources, aiming and even exceeding self-sufficiency.
4. The building is contextually related to the climate and integrated to the natural world.
5. The building assists urban compactness through mixed use and reduction of space

In a sustainable city, buildings become important components of the infrastructure systems

Buildings are based and surrounded by landscape infrastructure

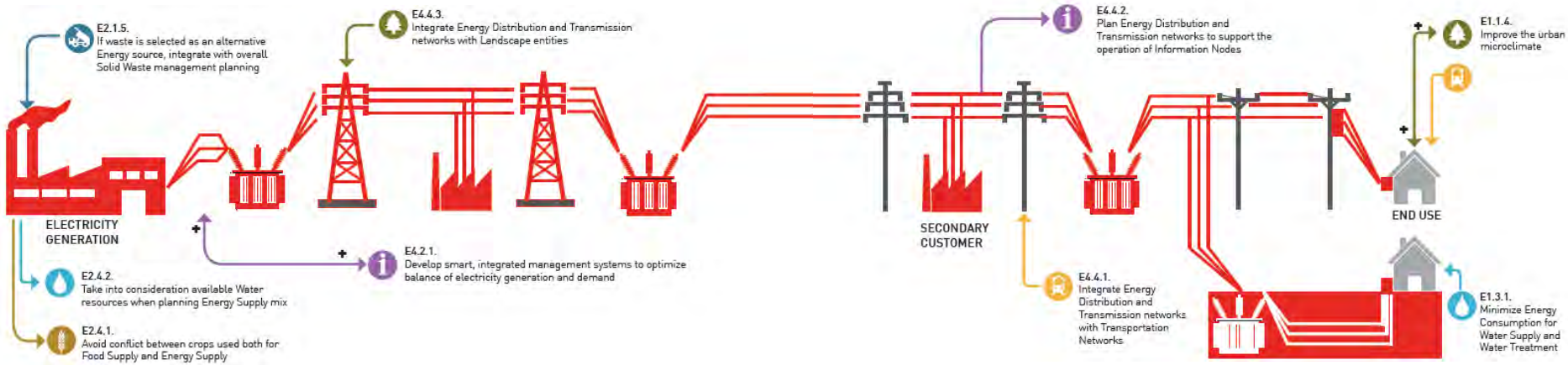
Buildings are the main end users for energy, water, information and food infrastructure

Buildings are the main generators of waste

Buildings are the main starting and ending points of transportation infrastructure

1. The building is a system component of the infrastructure

Architectural design should examine and reflect the integration of buildings in the sustainability of infrastructure systems

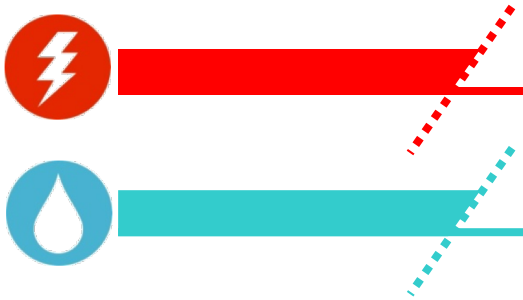


Buildings should be envisioned as part of the whole infrastructure system

2. The building becomes a resource saving entity, contributing to efficiency

Resource saving features should be integrated during the design process. Architectural design should aim for efficient/high performance buildings.

Buildings should be equipped with energy and water saving features



Sustainable architecture should aim for zero energy buildings and the minimum consumption of fresh water

Architects should change their perception over greenfields and natural landscape and consider them as a valuable natural resource.

Waste generation reduction should start from building scale

Sustainable architecture should promote designs with the minimum intervention on natural world.

2. The building becomes a resource saving entity, contributing to efficiency

Architectural design should pursue synergies among infrastructure systems and how can improve buildings' efficiency

For example: Using landscape infrastructure to mitigate **heat island effect** results in reduced energy consumption and more efficient storm water management

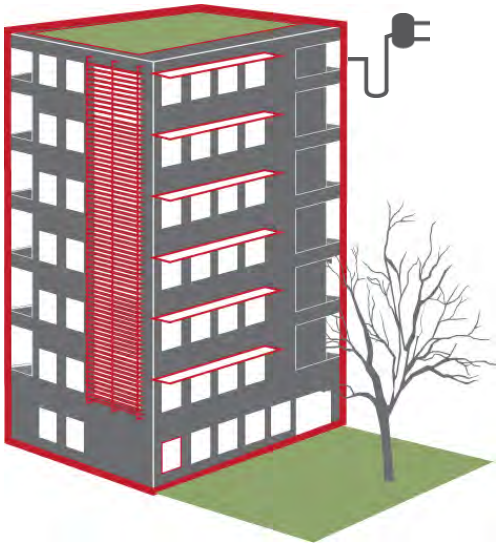
Trees and permeable materials improve microclimate and shade parts of the building reducing energy consumption

More efficient storm water management

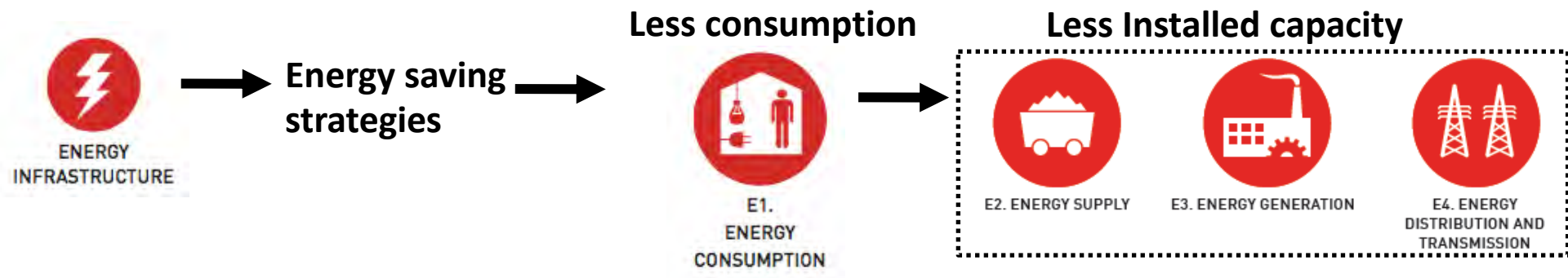
Food and organic waste can be re-used on site for compost production

Besides environmental benefits
Landscaped gardens improve quality of life and social sustainability

2. The building becomes a resource saving entity, contributing to efficiency

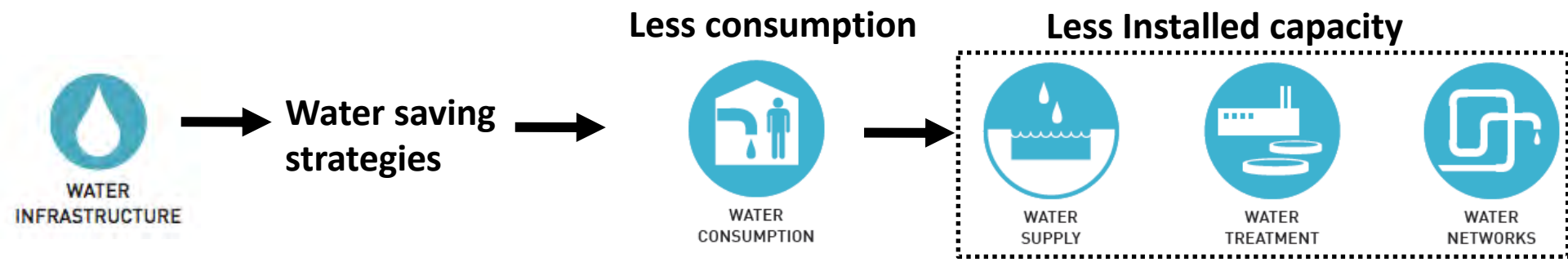


Energy conservation features not only reduce the building's resource consumption but also reduce the installed capacity of the whole infrastructure system



2. The building becomes a resource saving entity, contributing to efficiency

Similar to energy, water conservation features not only reduce the building's consumption but also reduce the installed capacity of the whole infrastructure system



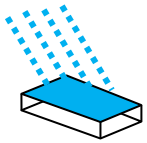
3. The building becomes a producer of resources, aiming and even exceeding self-sufficiency

Buildings should not only be efficient but also produce their own resources aiming and even exceeding self-sufficiency

<u>Resources that buildings can produce include:</u>

- Renewable energy

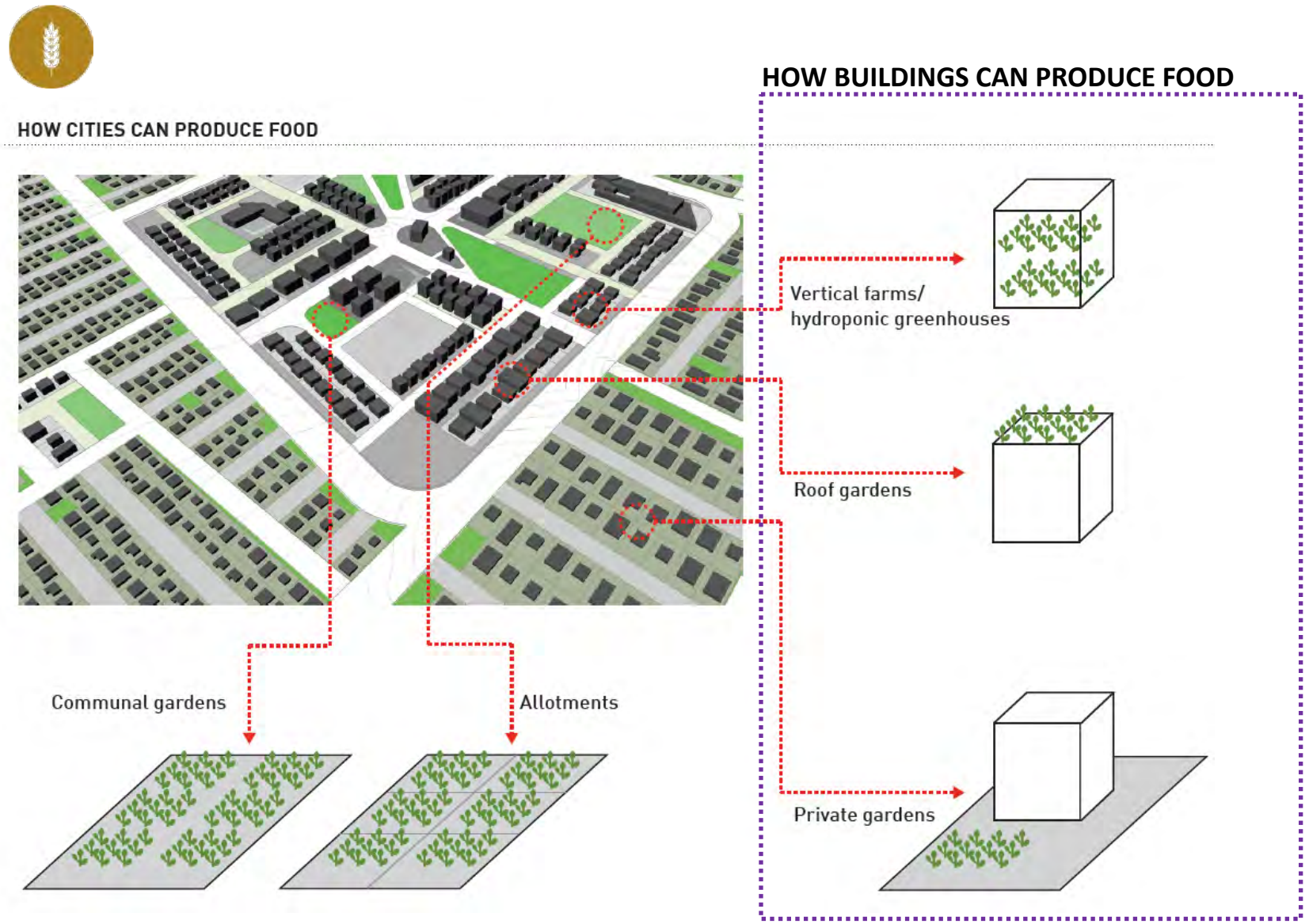
- Water through rain harvesting or through grey water recycling



- Food through urban agriculture

- Compost through organic waste recycling

3. The building becomes a producer of resources, aiming and even exceeding self-sufficiency



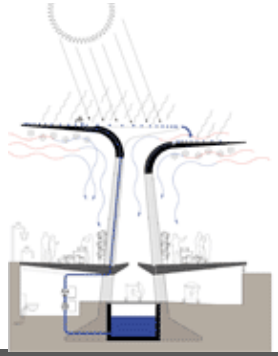
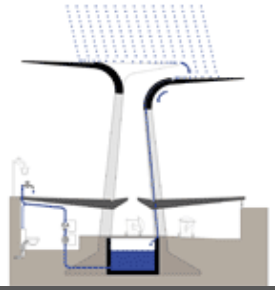
3. The building becomes a producer of resources, aiming and even exceeding self-sufficiency

Resource producing features should be integrated and be part of the architectural concept, not something added later, as it is often the case.







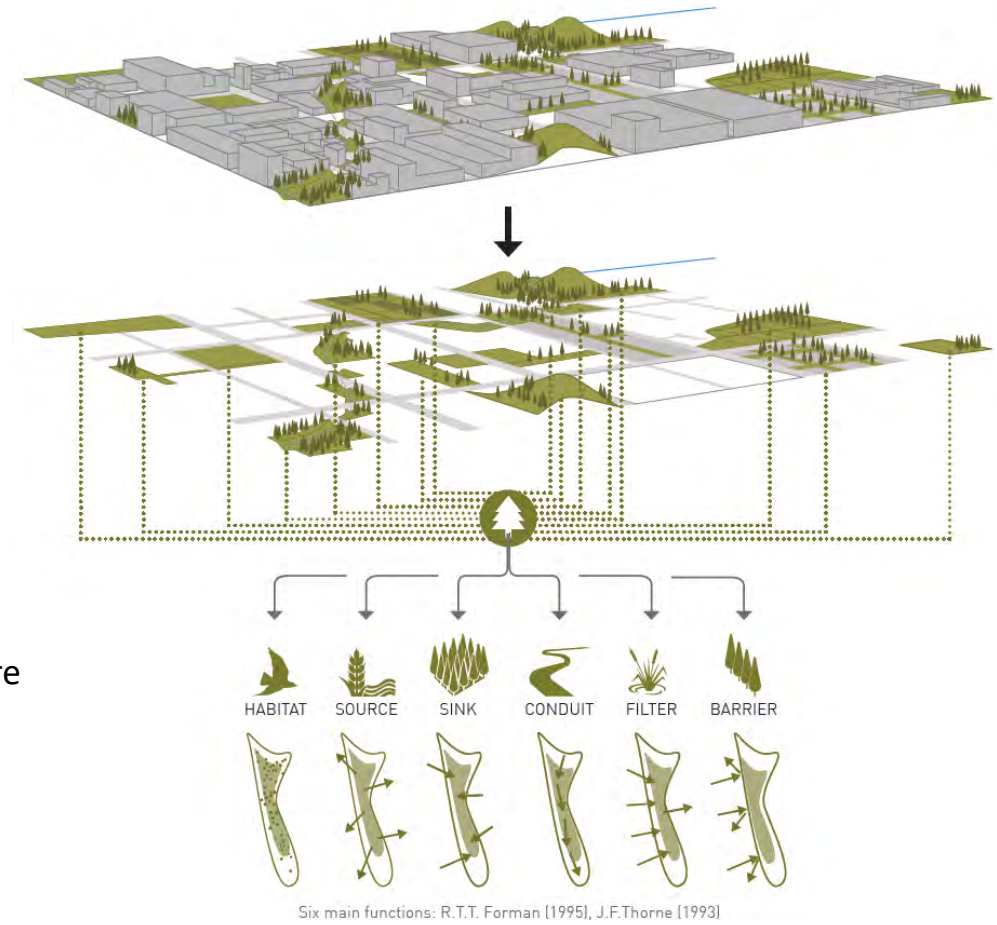




4. The building is contextually related to the climate and integrated to the natural world

Adaptation to local context is crucial for environment, social and economic sustainability.

Sustainable buildings should:

- Adjust to local climate conditions
  - optimize levels of thermal insulation
  - take advantage of prevailing winds
  - provide natural ventilation and daylight
- Minimize disruption on natural world
  - protect or restore natural habitats
  - minimize disruption on water cycle
  - adjust to topography/ minimize cut & fill
- Re-invent 'locality'
  - learn from the past / vernacular architecture
  - source local materials
  - re-use local materials



Six main functions: R.T.T. Forman (1995), J.F.Thorne (1993)

Adjust to local climate conditions

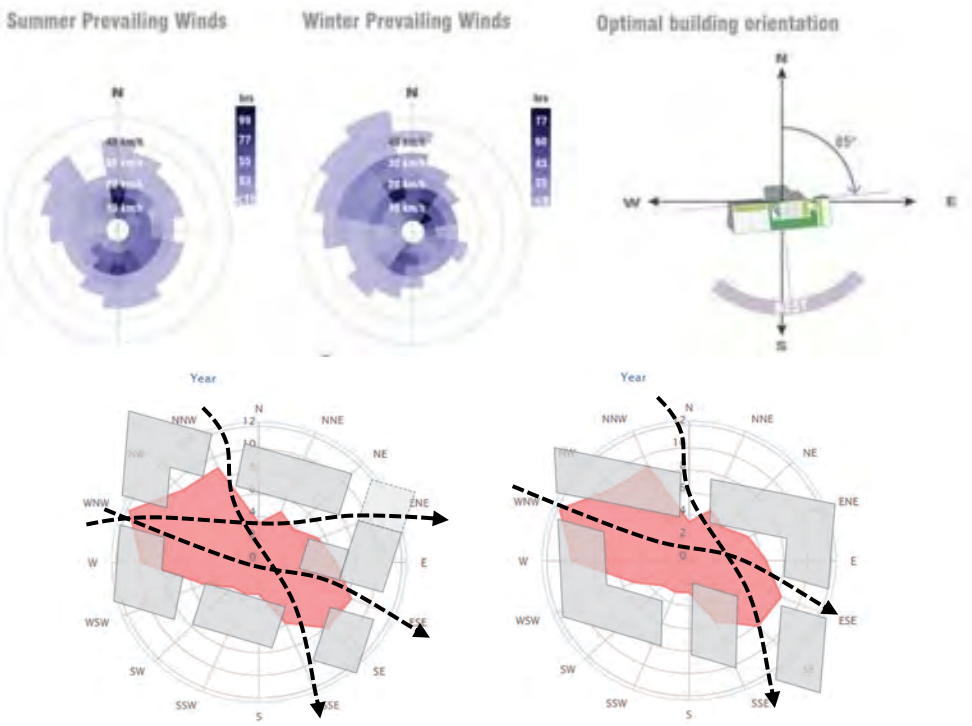
Example of a system of sun shades

Sun control strategy that through its design concept can define the building façade character and offer to a static structure functional dynamism

Kiefer Technic Showroom / Ernst Giselbrecht + Partner / Austria

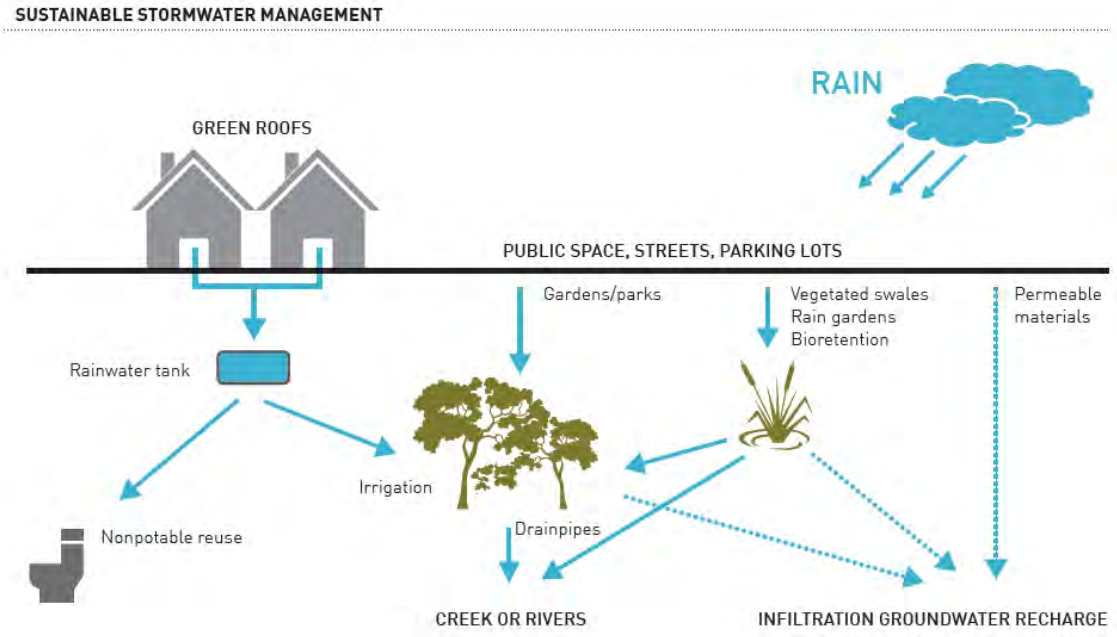
Adjust to local climate conditions

Proper sizing of the building's footprint considering prevailing wind patterns for natural ventilation



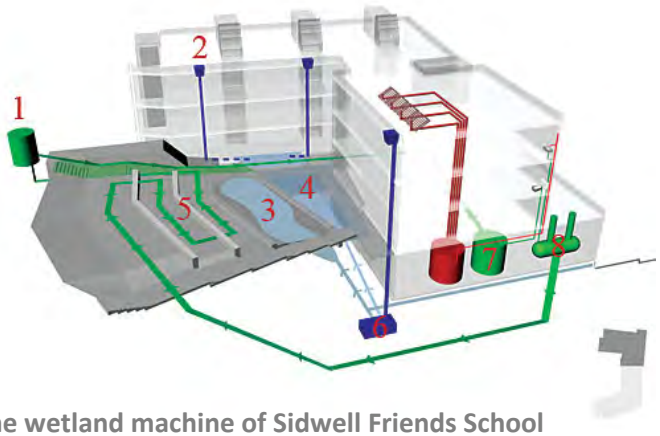
Daylight-optimized building footprint in relation with orientation

Minimize disruption on natural world



Minimize disruption on natural world

Example of building scale on-site grey water treatment through a constructed wetland integrated on architectural and landscape design



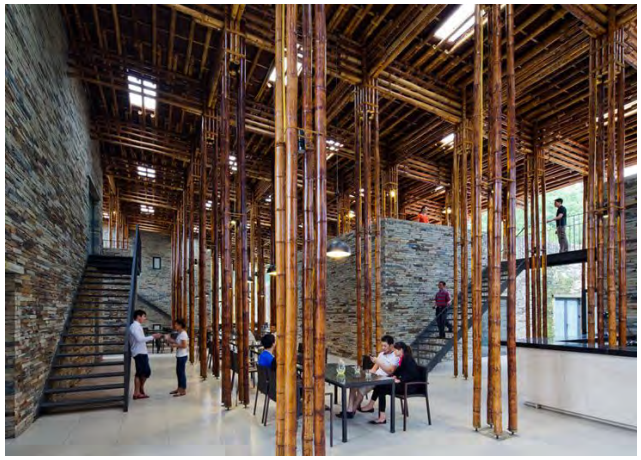
The wetland machine of Sidwell Friends School

by Andropogon Associates, Kieran Timberlake Associates and Natural Systems International

4. The building is contextually related to the climate and integrated to the natural world

Re-invent ‘locality’

Use references from vernacular architecture and locally sourced materials



5. The building assists urban compactness through mixed use and reduction of space

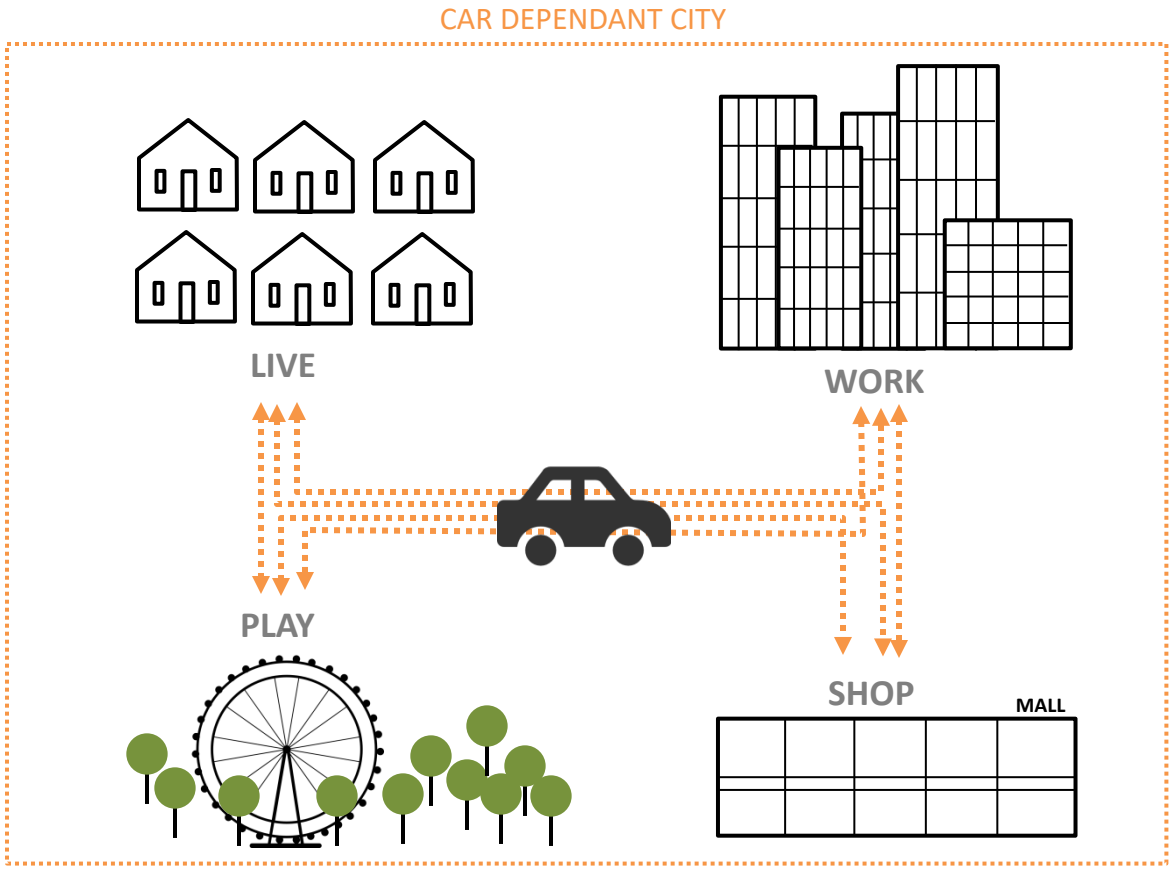
Architecture is affected by the rapid population growth and the need for compact, high density cities

Accommodating the world's urban growth by 2030 at Los Angeles' density would cover almost half of the European Union. At Hong Kong's density, the global urban population would take up less than half of Italy.

Source: LSE Cities

5. The building assists urban compactness through mixed use and reduction of space

Architecture is re-shaped by the need for higher density, urban proximities and mixed land use



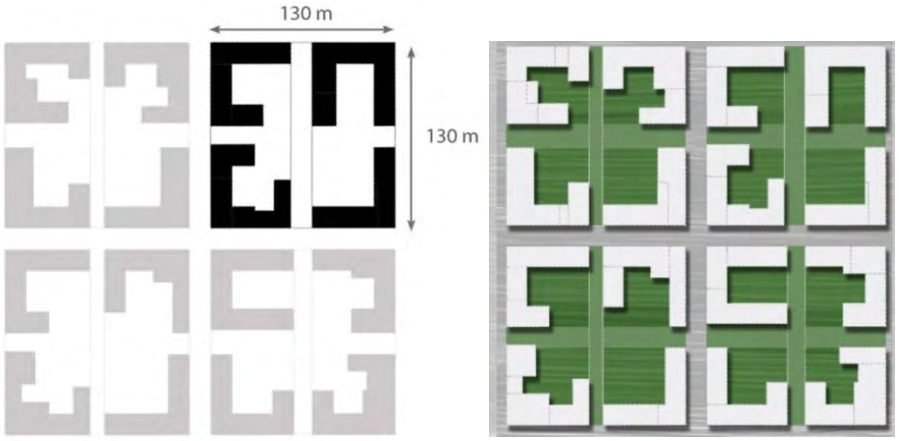
5. The building assists urban compactness through mixed use and reduction of space

The private car dependent city, should be replaced based on the principles of a pedestrian friendly and mixed use city.

MIXED USE – PEDESTRIAN FRIENDLY CITY

5. The building assists urban compactness through mixed use and reduction of space

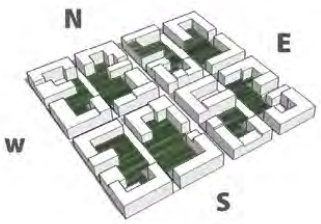
Architecture will have to adjust and promote new urban typologies that tackle the environmental challenges of rapid urban growth



For example **ecoblocks** is a new typology of urban blocks that housing units are organized around a semi-private courtyard

<u>Characteristics:</u>

- Plot coverage up to 50 - 60%
- Medium building height
- Variables of Hard surfaces vs. Soft surfaces %
- Transverse circulation

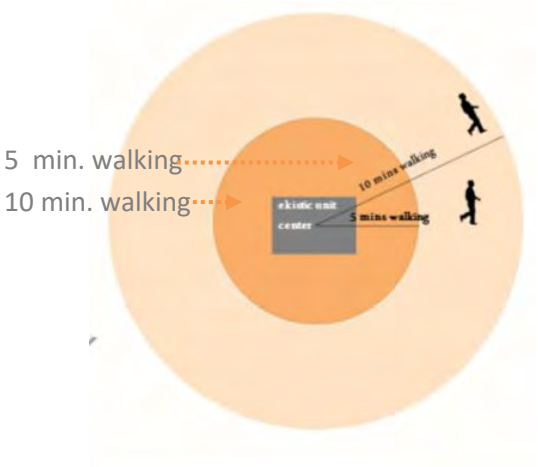


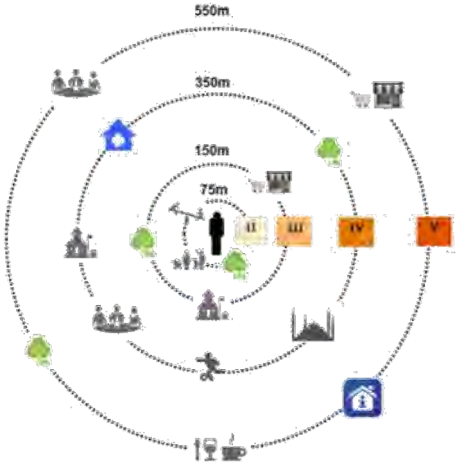
<u>Benefits:</u>

- Mixed use development
- Maximize benefits of open space
- Mitigate heat island effect
- Create compactness
- Reduce green house emissions
- Create variations of space

5. The building assists urban compactness through mixed use and reduction of space

Besides other environmental benefits, planning with emphasis to proximities and mixed landuse results in less installed capacity for all infrastructure systems and especially transportation infrastructure.





Architecture should rapidly evolve and adjust to these five functions in order to contribute to a sustainable future

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