CIBSE Hong Kong Branch AGM

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Benefits and potential of vertical greening systems

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Introduction

- CIBSE-HKB research projects
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- Results and outcomes
  - Technical reports
  - CIBSE(UK) publications
  - Conference/journal papers
  - Oral presentations

CIBSE

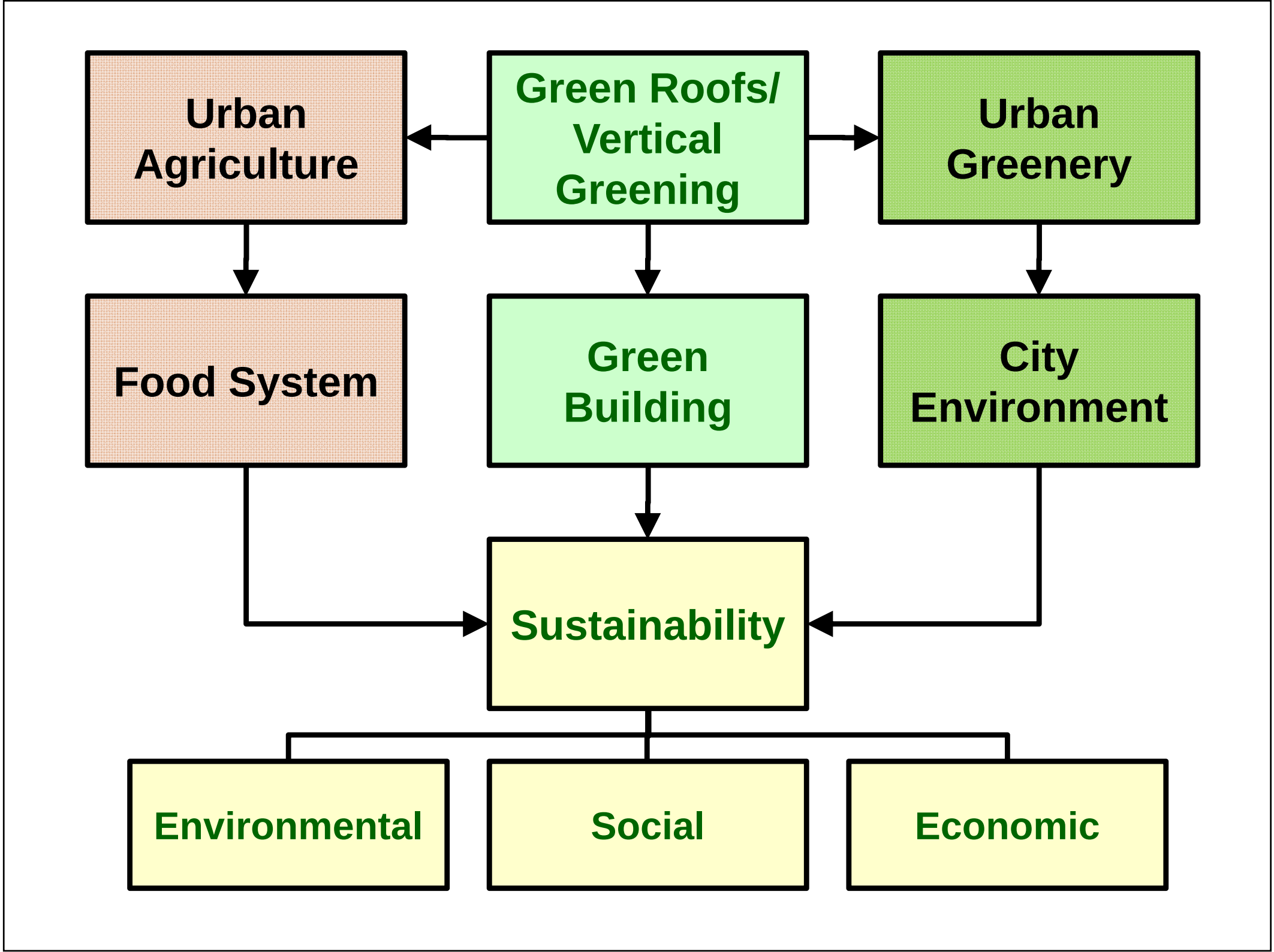
Introduction

- Research on ***vertical greening systems***
- Objectives:
  - 1. To study and evaluate the current knowledge and technologies on vertical greening and green/living walls in the world
  - 2. To assess the potential benefits and key design factors for vertical greening systems in Hong Kong
  - 3. To develop technical guidelines and information for planning and design of vertical greening systems in Hong Kong

Hong Kong 香港

The Need for Greenery

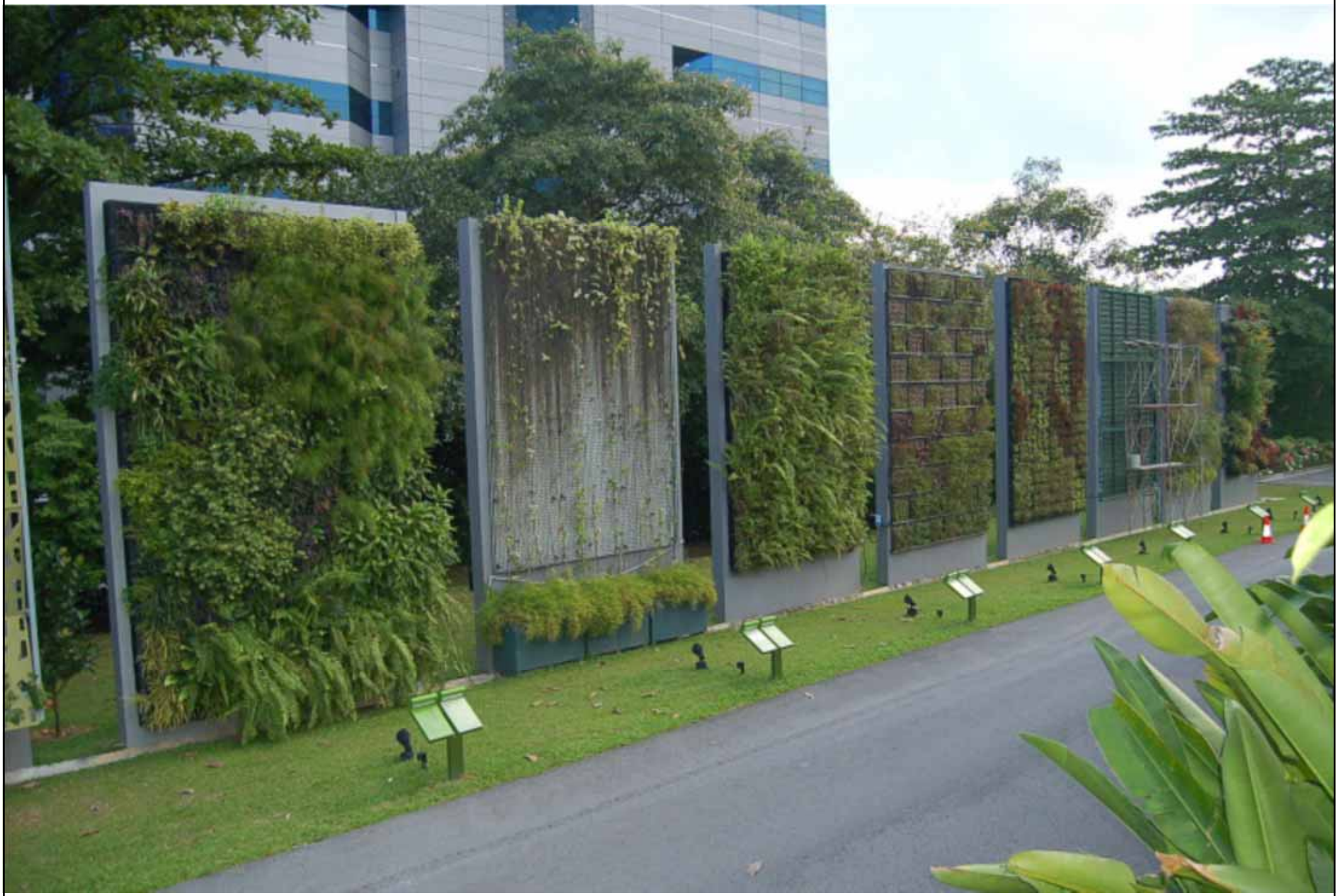
- Hong Kong 香港
  - Land area: 1,104 km^2
  - Population: 7.06 millions
  - Population density: 6,480 persons/ km^2
- High urban density to meet population growth
  - Urban heat island and lack of greenery space
- Promote green roofs and vertical greening to achieve urban sustainability


Urban Agriculture
Green Roofs/ Vertical Greening
Urban Greenery
Food System
Green Building
City Environment
Sustainability
Environmental
Social
Economic

The Need for Greenery

- Conventional greening methods
  - Tree planting and urban parks
- Greening initiatives in buildings
  - Roof gardens
  - Sky gardens
  - Green roofs
- How to maximise the greening effects?
  - Vertical greening on wall surfaces
  - Three dimensional greening

Testing of vertical greening systems (Singapore HortiPark)



(Photo taken by Dr. Sam C. M. Hui)

D.I.Y. vertical greening systems (Singapore HortiPark)

(Photo taken by Dr. Sam C. M. Hui)

Three dimensional greening (in Singapore)

(Photo taken by Dr. Sam C. M. Hui)

The Need for Greenery

- Green or living walls
  - An emerging technology to integrate vegetation
  - Saving in land and space for greenery
- Vertical greening technology
  - Increase greenery in urban area
  - Developed from green roof technology
    - Can offer an ecological benefit complementary to green roofs as the vertical density of ‘plantscaping’ can be enhanced over a building’s façade system in addition to its roof area

Vertical Greening Systems

- ***Vertical greening*** – descriptive terms
  - Green walls, living walls, bio-walls, living wall/ cladding, green facades, vertical green, vertical gardens, vegetated wall surfaces
- Possible applications:
  - 1. Building façades or outdoor vertical surfaces
  - 2. Interior walls or indoor vertical surfaces
  - 3. Noise barriers (e.g. along the roads)
  - 4. Slopes

An example of vertical greening

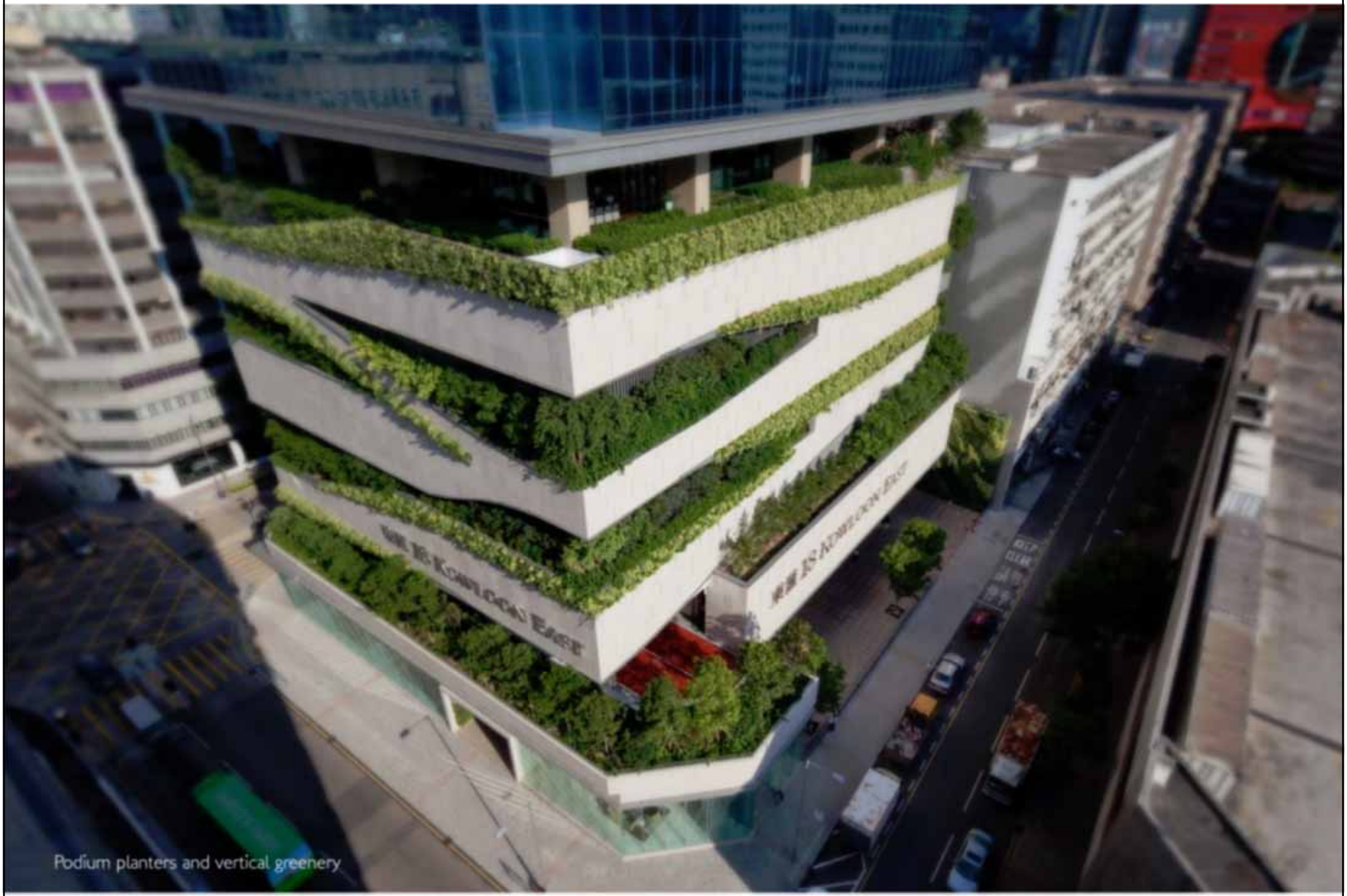
(Source: CityWalk, Tsuen Wan, www.citywalk.com.hk)

An example of vertical greening

(Source: CityWalk, Tsuen Wan, www.citywalk.com.hk)

A green wall in Central

A green wall project in Kowloon Bay



(18 Kowloon East)

A green wall project in Wanchai

(The Hennessy)

Green wall for exhibition function

(Source: www.greening.gov.hk)

Government demonstration projects

For a housing estate

For a school building

For a government building (EMSD Headquarters)

(Source: www.greening.gov.hk)

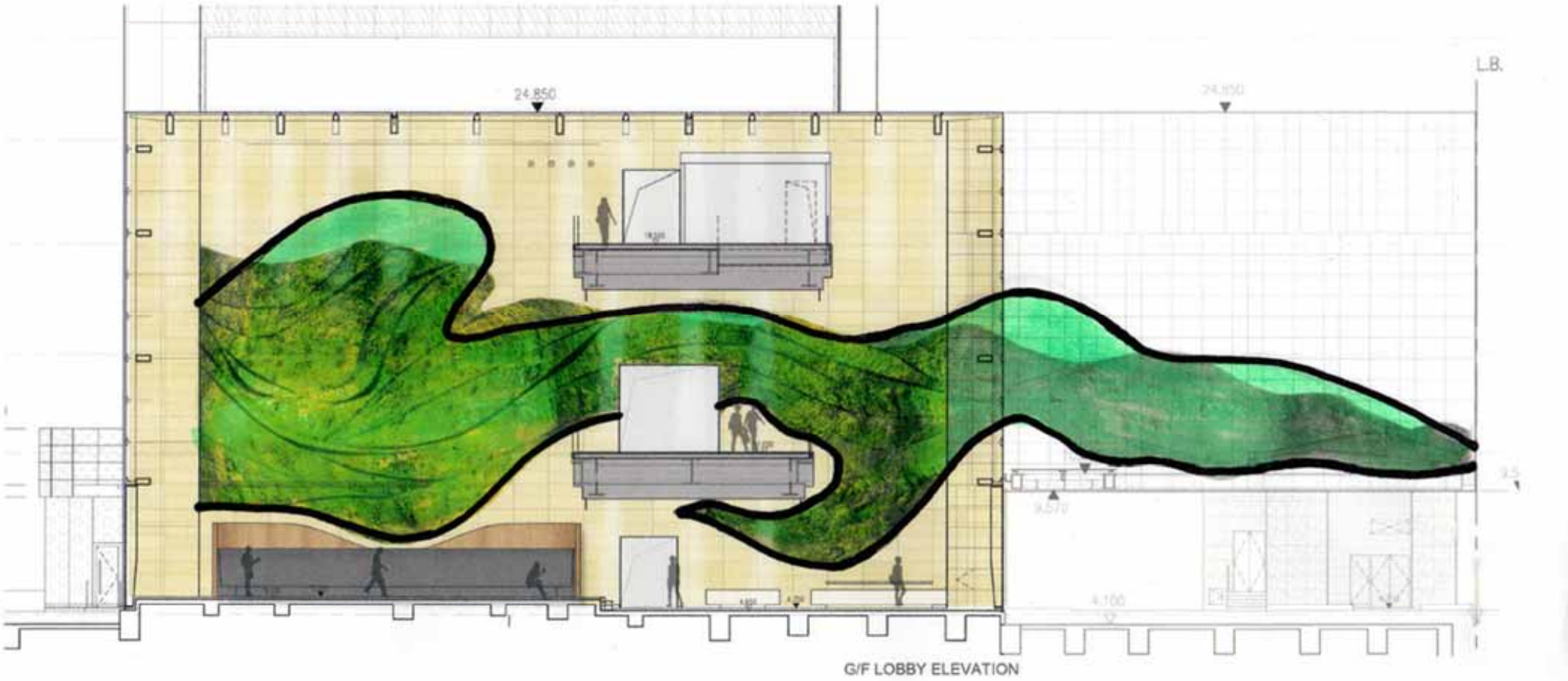
A school green wall project

(Source: www.everplant.com.hk)

An example of indoor green wall in Hong Kong (at a hotel)

PolyU University
Hong Kong

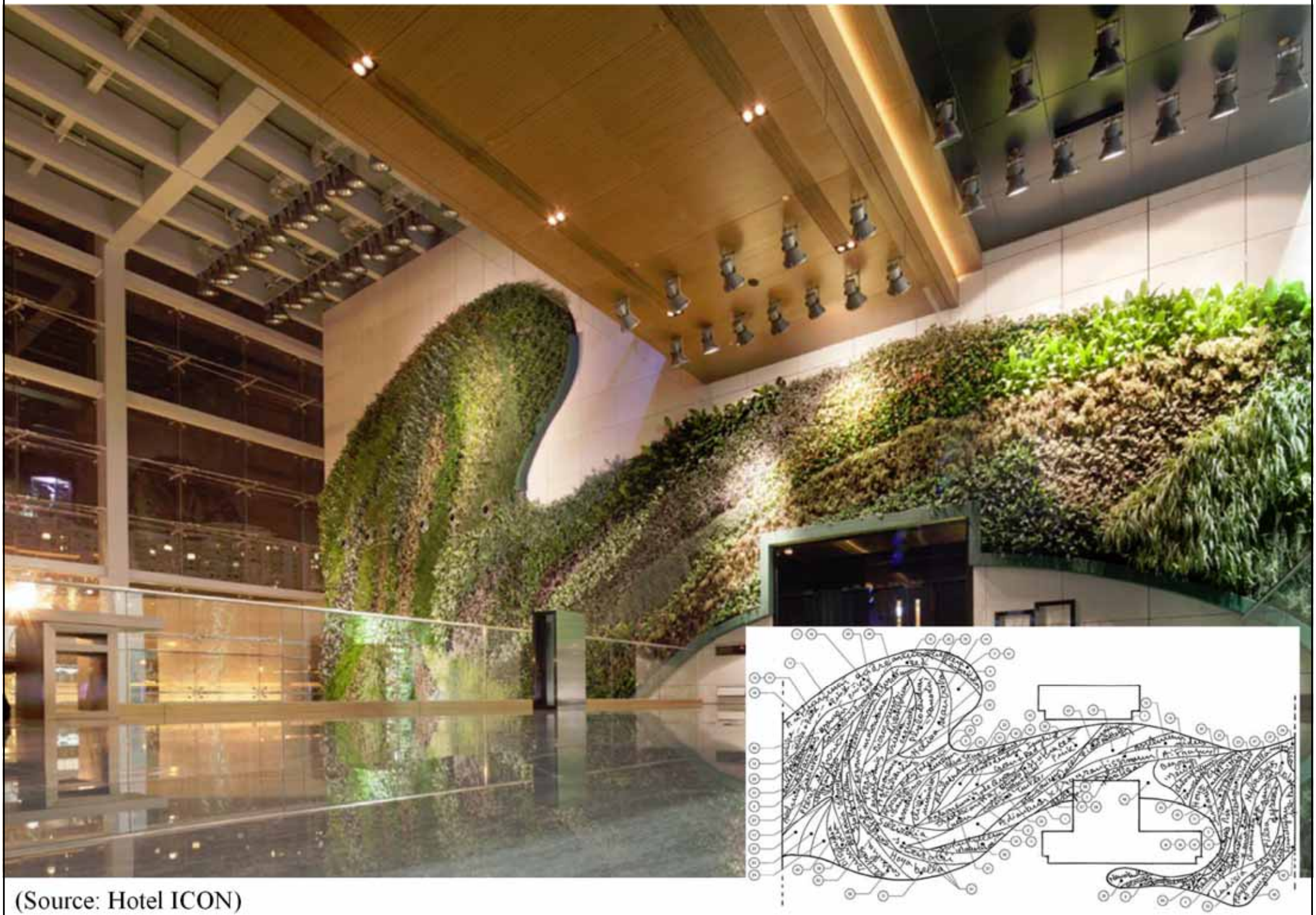
8/1/10



(Source: www.verticalgardenpatrickblanc.com)

An example of indoor green wall in Hong Kong (at a hotel)

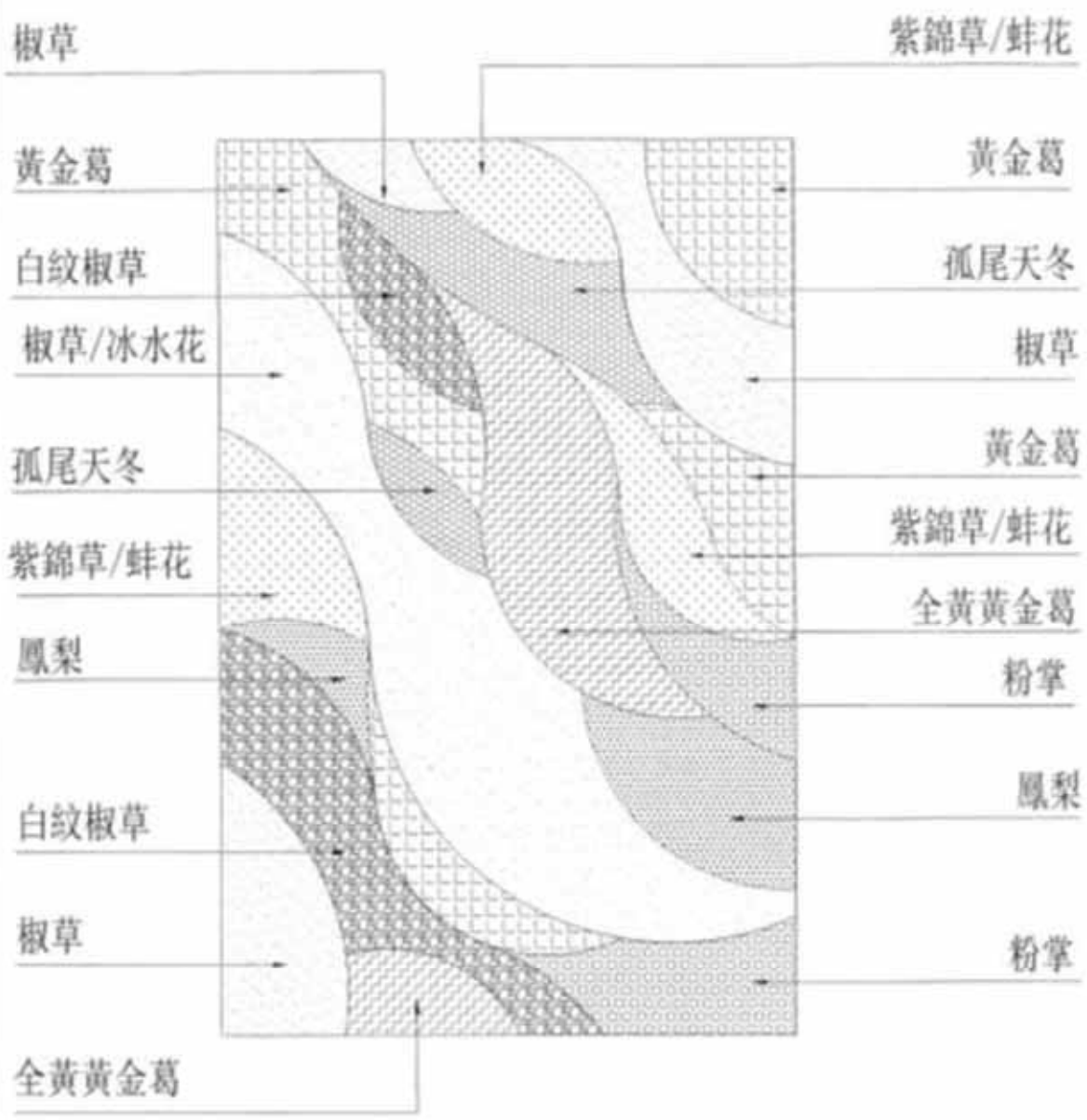
An indoor green wall in a hotel



(Source: Hotel ICON)

Indoor green wall

Indoor green wall



1 ELEVATION
Scale: 1:50

(City Walk 2, Tsuen Wan)

Indoor green wall

(International Commerce Centre)

(Photos taken by Dr Sam C M Hui)

(International Finance Centre)

Indoor green wall in a subway station (Taipei)

(Source: Mr. Eddie Tse)

Indoor green wall in a subway station (Taipei)

(Source: Mr. Eddie Tse)

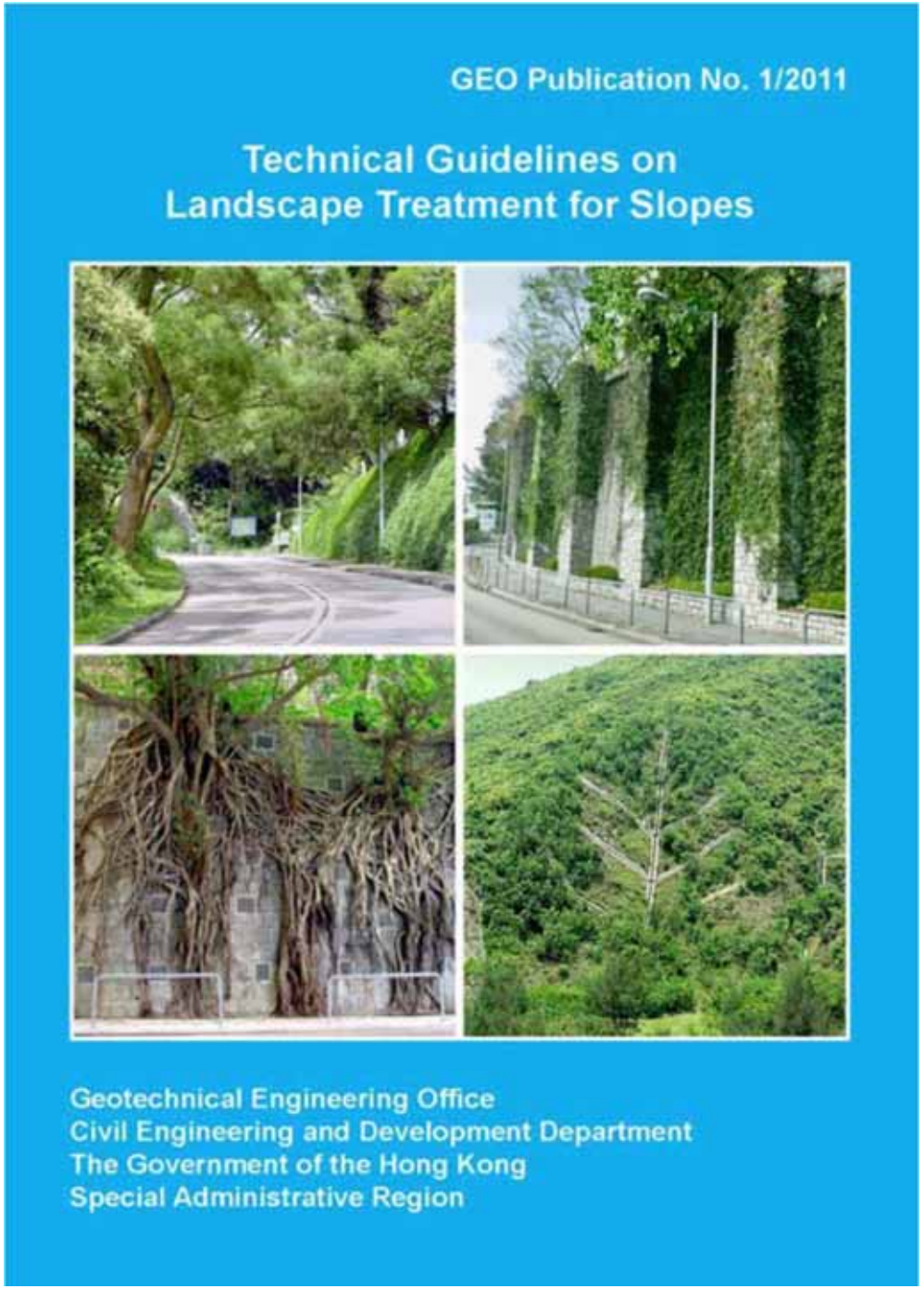
Green noise barrier

(Source: Highway Department, HK)

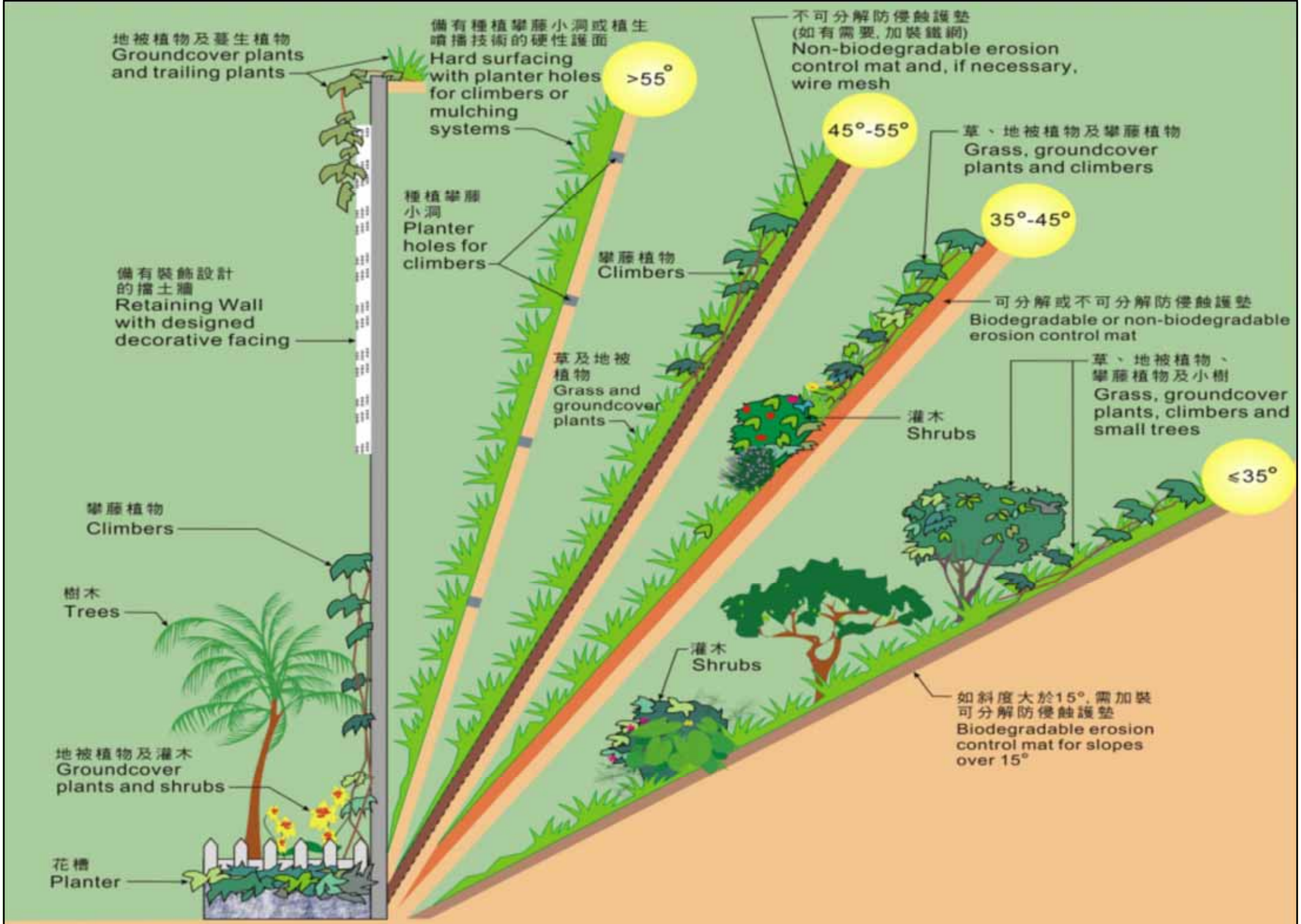
Greening on highway structures

(Source: Highway Department, HK)

Greening on slopes



(Source: Civil Engineering and Development Department)



(Source: Civil Engineering and Development Department)

Types and Classification

- Types of vertical greening systems:
  - 1. Green façades
    - Climbing plants, trellis systems, modular trellis panel system, cable and wire-rope net system
  - 2. Living/Green walls
    - Modular green wall, vegetated mat wall
  - 3. Interior green walls
  - 4. Spontaneous living walls

Types and Classification

- 1. Green façades
  - Climbing plants or cascading ground covers are supported on specially designed structures
  - The plants are either grown in the ground or in elevated containers where they are watered and fertilised
  - The ‘sucker’ roots system of self-clinging plants that attaches to the wall can damage the wall surface

Types and Classification

- 1.1 Trellis systems
  - A series of wires or cables is attached to structure , allowing the climbing plants to grow up the cables to create a plant screen/wall
  - These structures can be attached to the building envelope or can be free standing

Types and Classification

- 1.2 Modular trellis panel system
  - A rigid, light weight, three-dimensional panel made from welded steel that supports plants both on the face grid as well as the panel depth
  - This system is designed to keep the green facade off the wall surface so that the plant material cannot attach to the building

Types and Classification

- 1.3 Cable and wire-rope net system
  - It uses either cables and/or wire net
  - Cables are usually designed for faster growing climbing plants, whereas wire-rope nets are used for supporting slower growing plants that need support at closer intervals
  - Both systems use high tensile steel cables, anchors and supplementary equipment

Types and Classification

- 2. Living/Green walls
  - Constructed from pre-vegetated panels, vertical modules or planted blankets (vegetated mat wall) that are fixed to structural framework or to a wall
  - Made from steel framework, plastic, expanded polystyrene and synthetic fabric to support a variety of diversity and density of plant species
  - Tend to require more maintenance such as fertiliser and water than green facade systems that are planted into the ground

An example of living wall (Taipei)

(Source: www.sa-space.com)

Types and Classification

- 2.1 Modular green wall
  - Consist of panels that hold growing media to support the plant material
  - Usually pre-grown, providing an instant effect after installation
  - Require irrigation at different levels along the wall using gravity to move the water through the growing media; similarly nutrient and fertilising is carried out through this method

Types and Classification

- 2.2 Vegetated mat wall
  - This system, pioneered by Patrick Blanc, is composed of two layers of synthetic fabric with pockets filled with the plants and growing media
  - The fabric walls are supported on a framework and backed by a waterproof membrane against the building wall
  - Nutrients and water are delivered through an irrigation system at the top of the wall

A living wall in a museum (Paris)

(Source: www.verticalgardenpatrickblanc.com)

Types and Classification

- 3. Interior green walls
  - Interior living walls can be constructed from any of the previous systems
  - Designed for interior purposes, called the Biofiltration system (Bio-wall)
  - With indirect access to light and ventilation
  - Biophilic qualities that contribute to better health and air quality

Types and Classification

- 4. Spontaneous living walls
  - These are living walls that occur in the urban area where seeds germinate wherever they can and start growing, usually in hostile environments
  - These plants are often garden escapees or weeds that create a new urban habitat or environment to support greater biodiversity in the cities

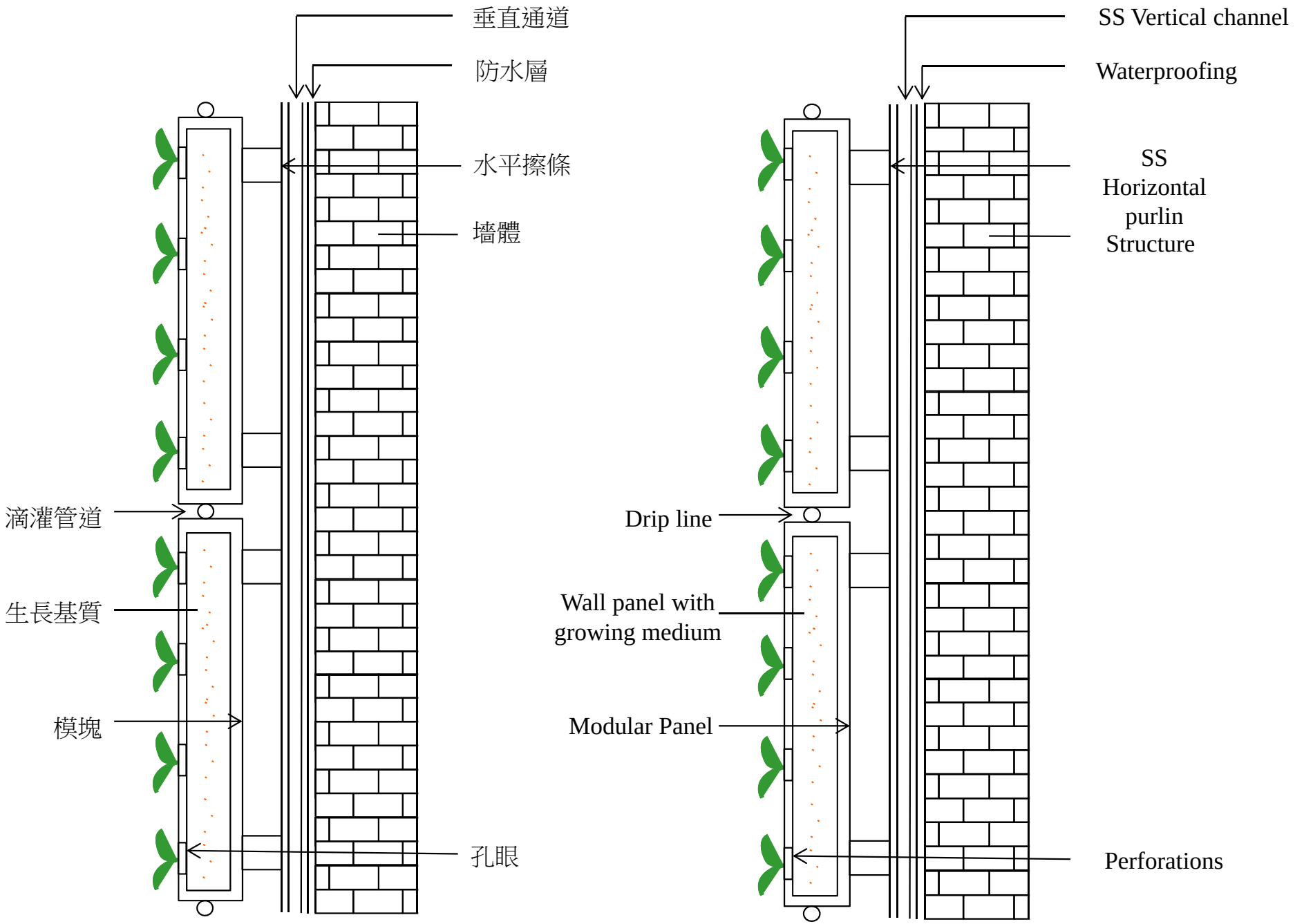
Types and Classification

- Two major categories:
  - Rooted into the ground (climbers; with or without supporting systems)
  - Rooted in artificial substrates or potting soil (modular hydroponic prefab systems)
- Two application forms:
  - Direct greening: the greening system uses the façade as guide to grow upwards
  - Indirect greening: the greening system and the façade are separated with an air cavity

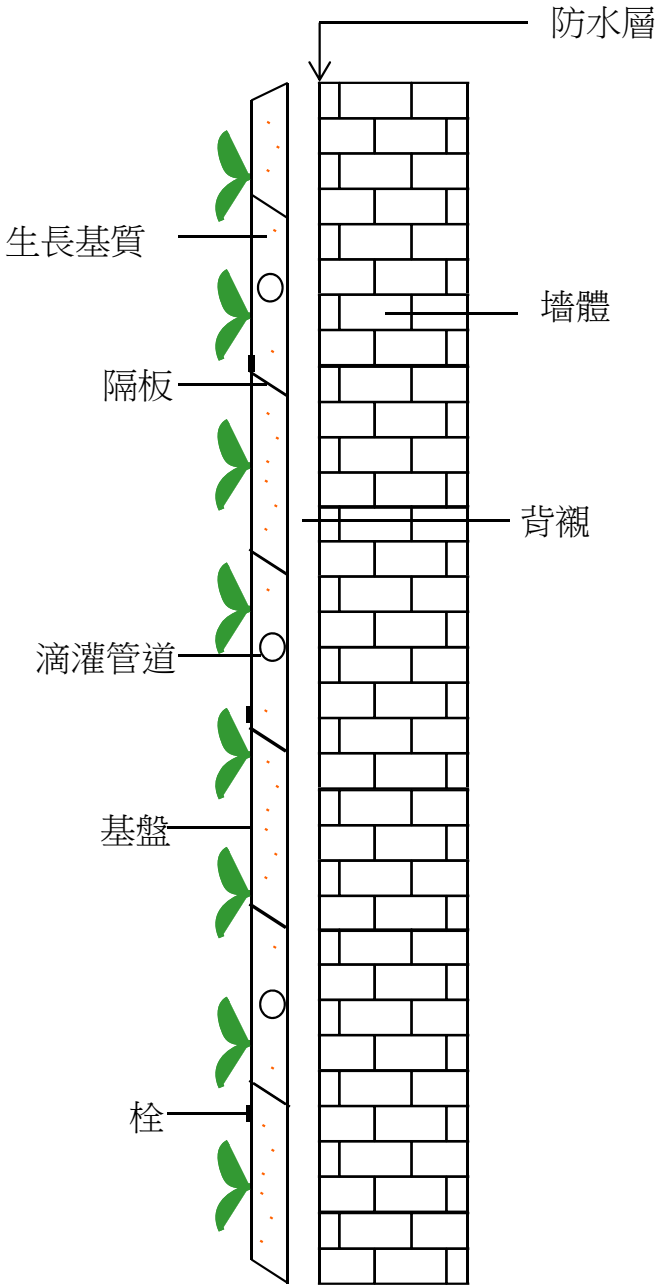
Types and Classification

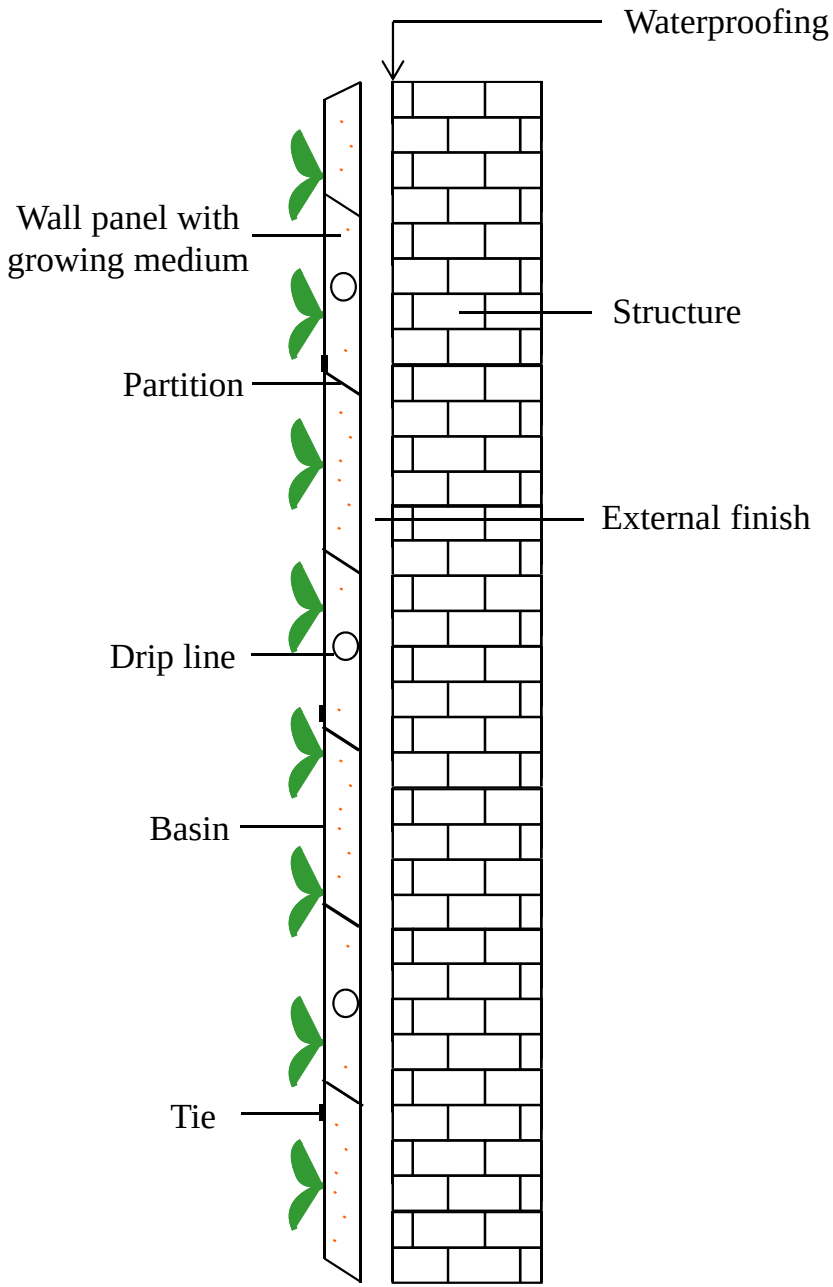
- Classification: (proposed)
  - 1. Modular panel system
  - 2. Paving system
  - 3. Climbing or hanging system
  - 4. Flower pot system
  - 5. Bag or felt system
  - 6. Trough system
  - 7. Climbing or hanging system with trellis
  - 8. Cable and wire-rope net system

1. 模塊式/Modular Panel System

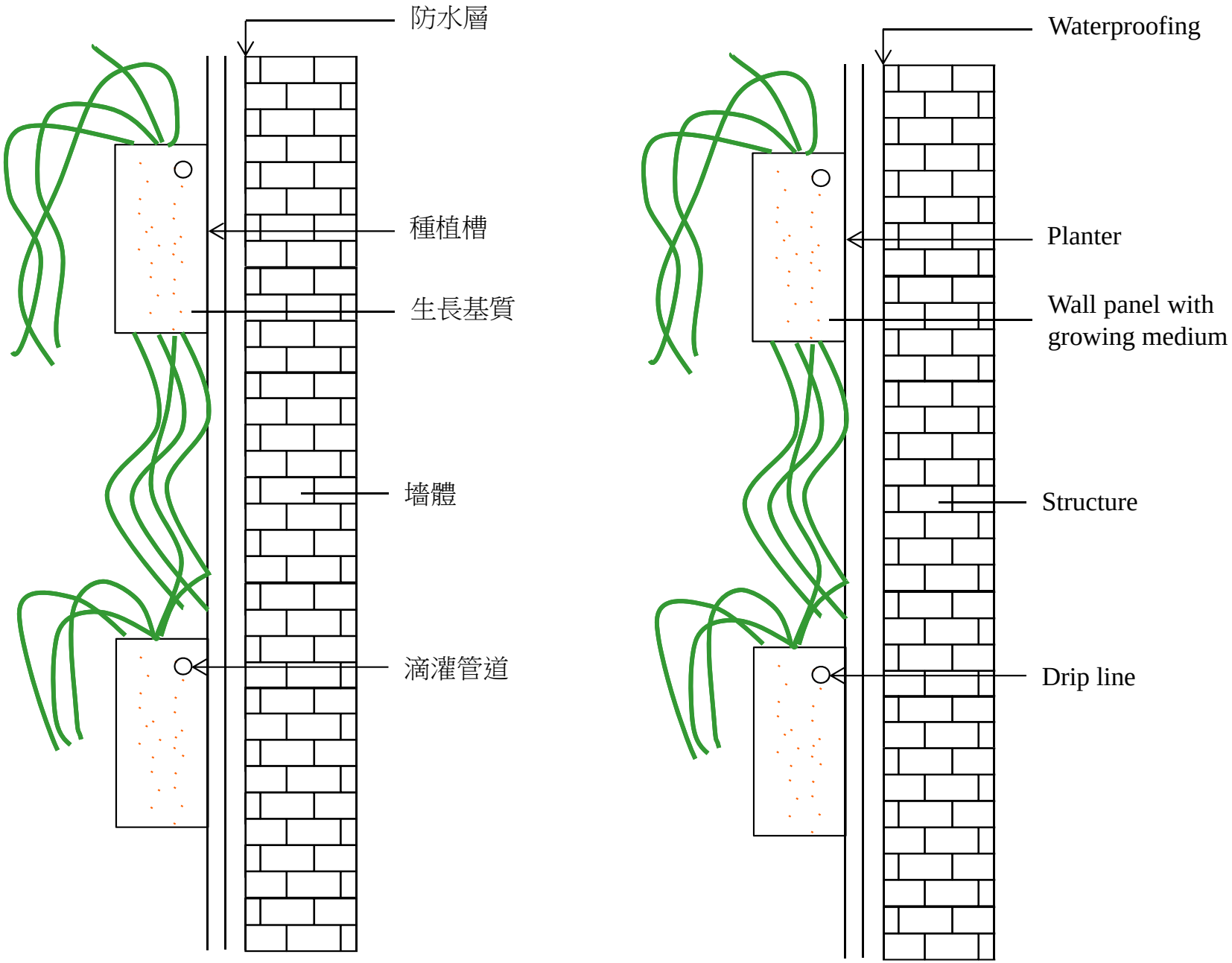


2. 鋪貼式/Paving System

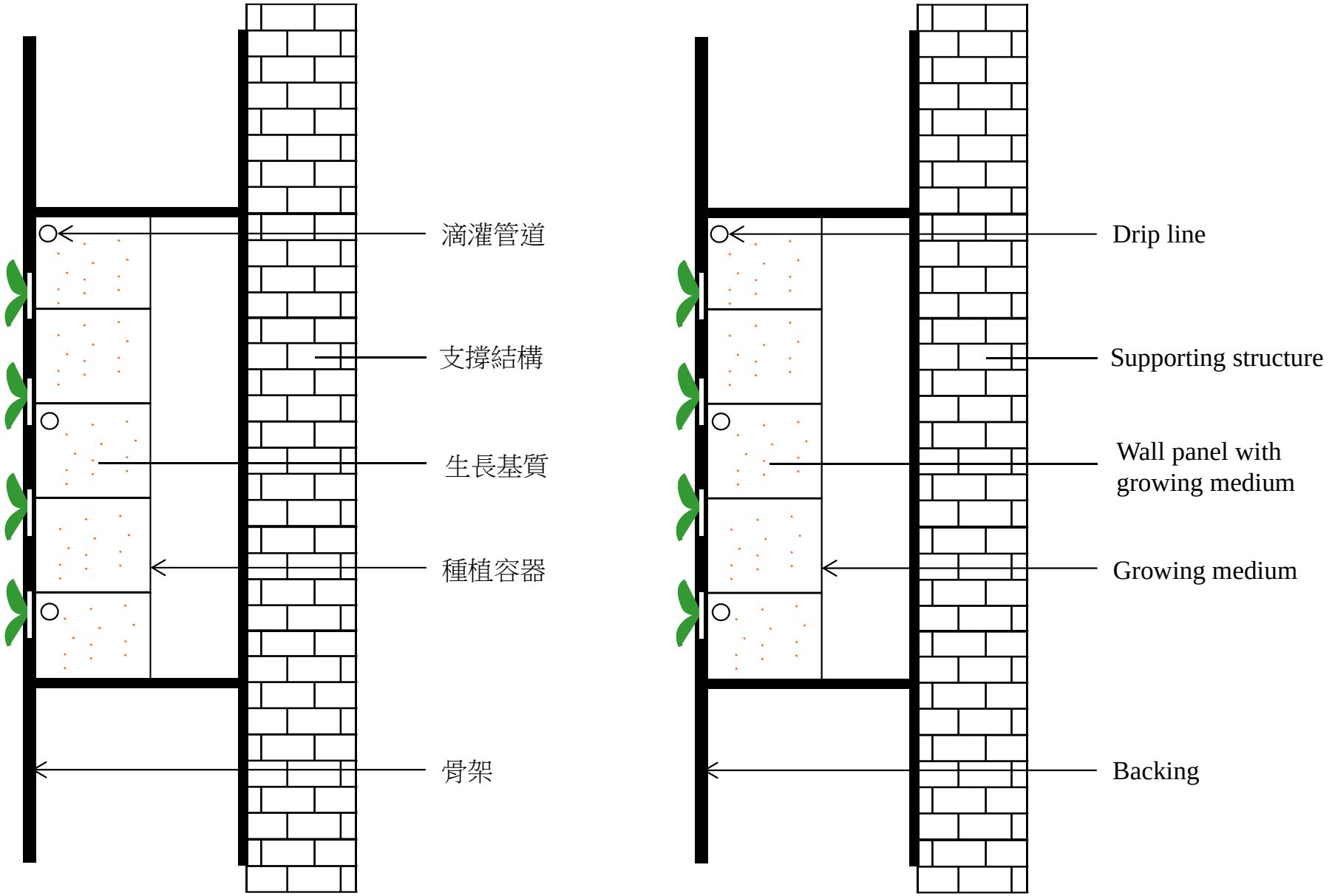




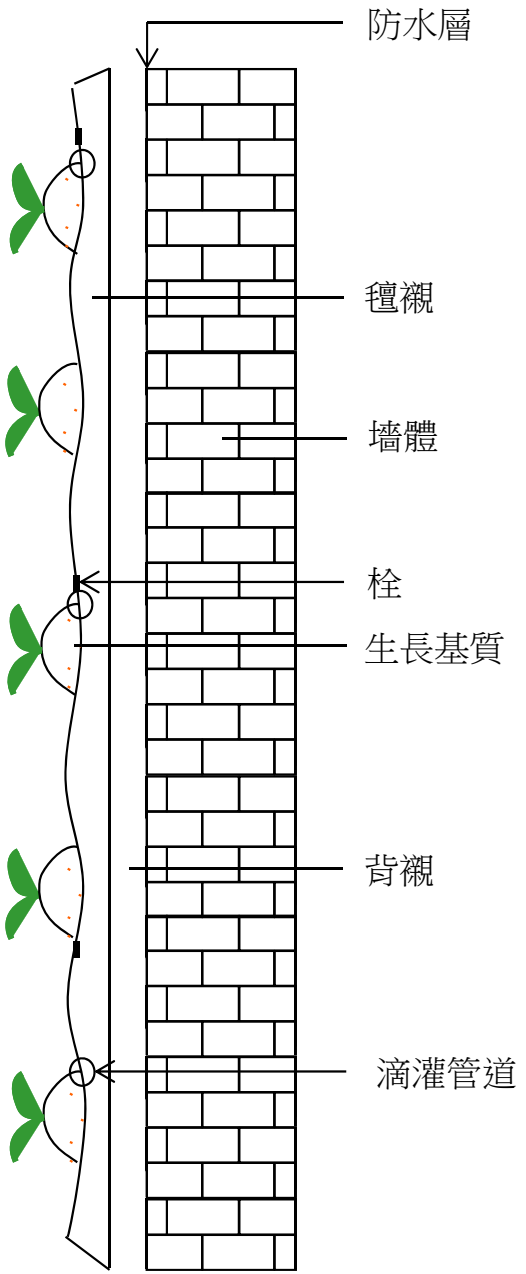
3. 攀爬或垂吊式/Climbing or Hanging System

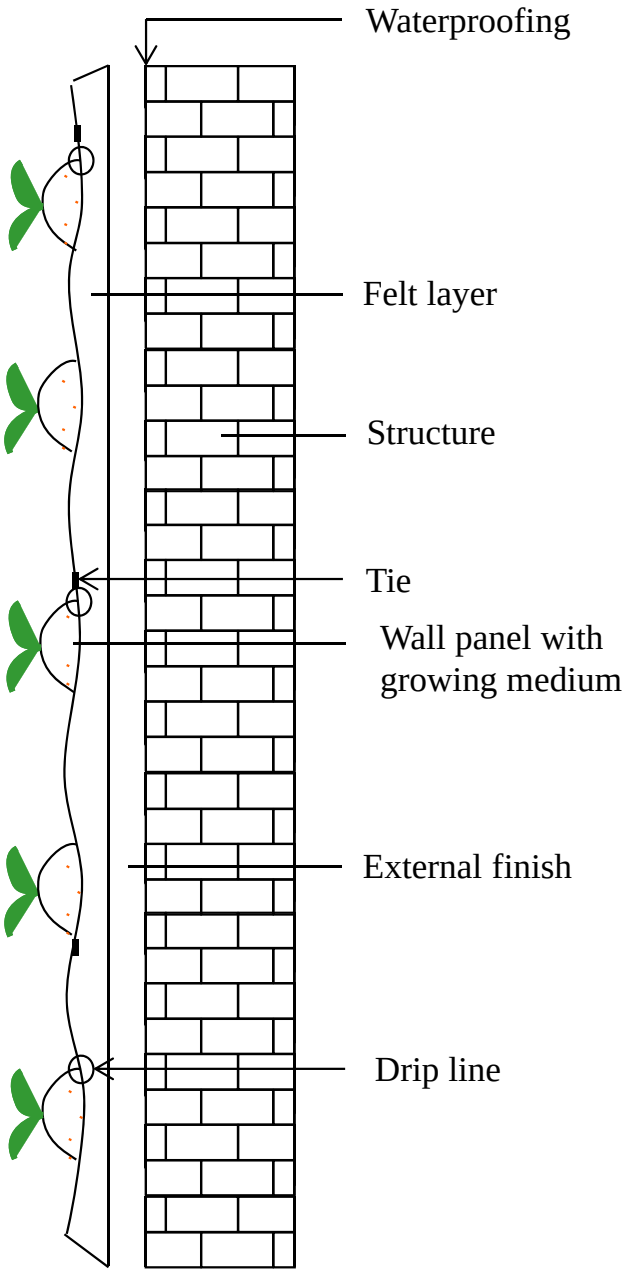


4. 擺花式/Flower Pot System

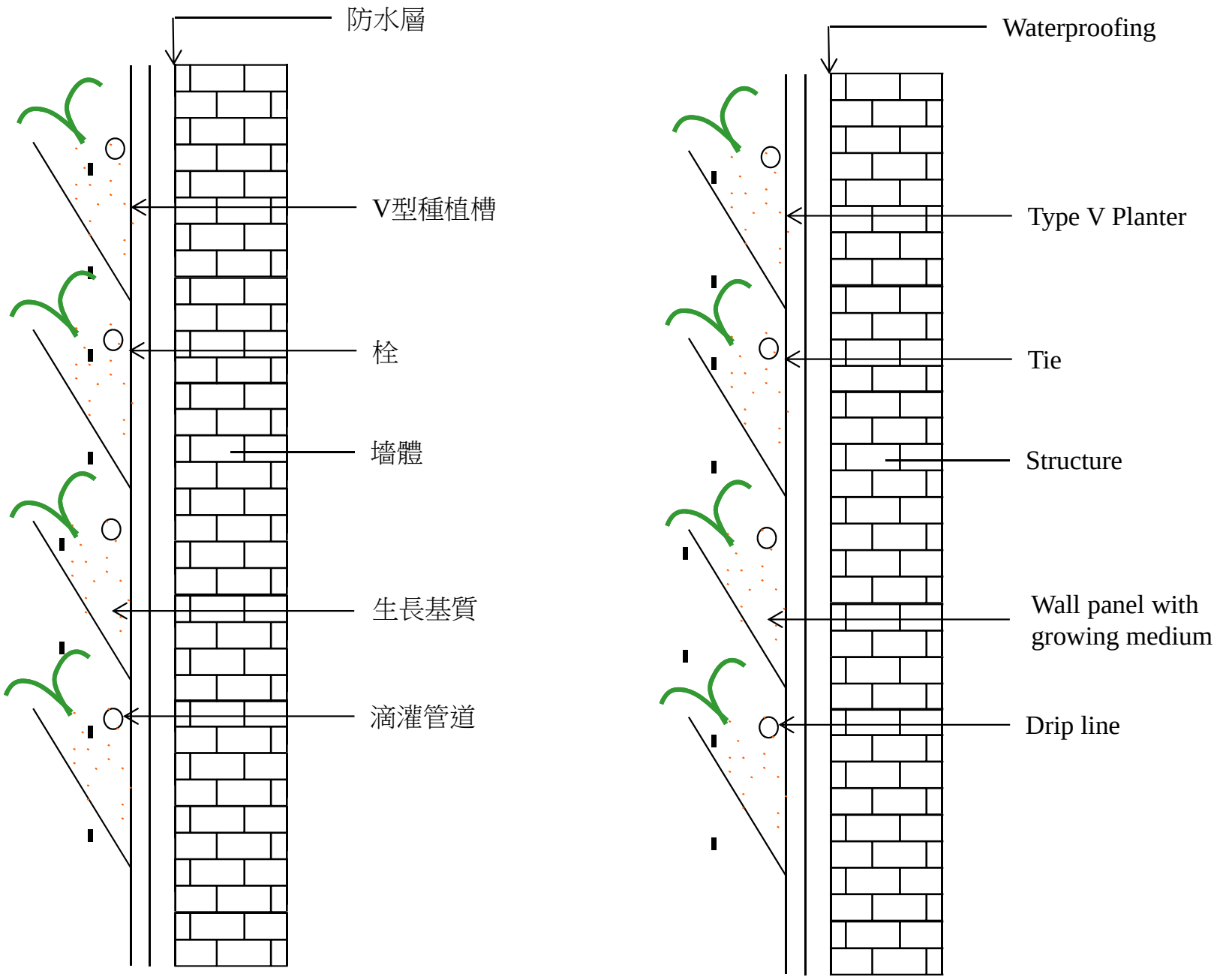


5. 布袋式/Bag or Felt System

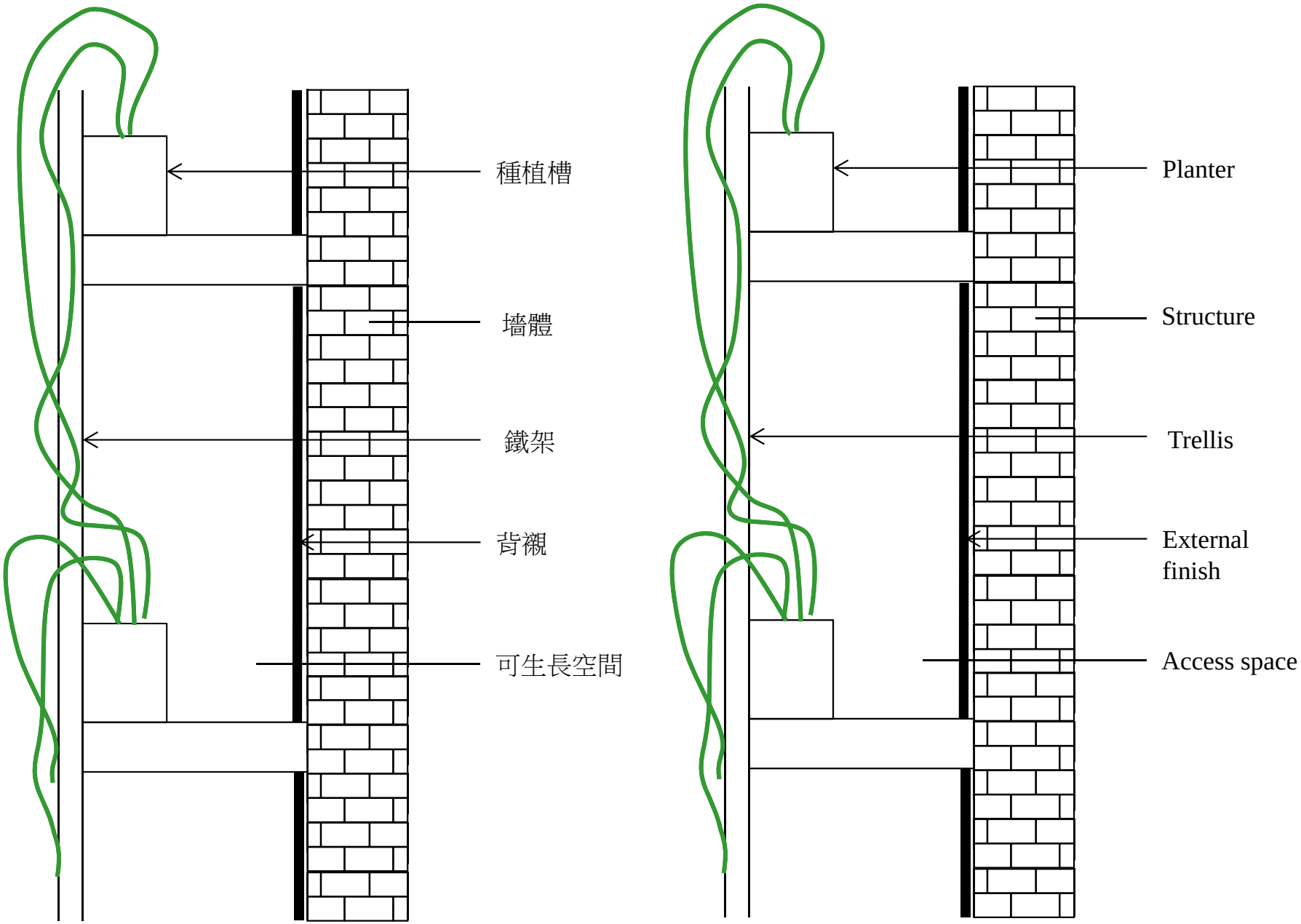




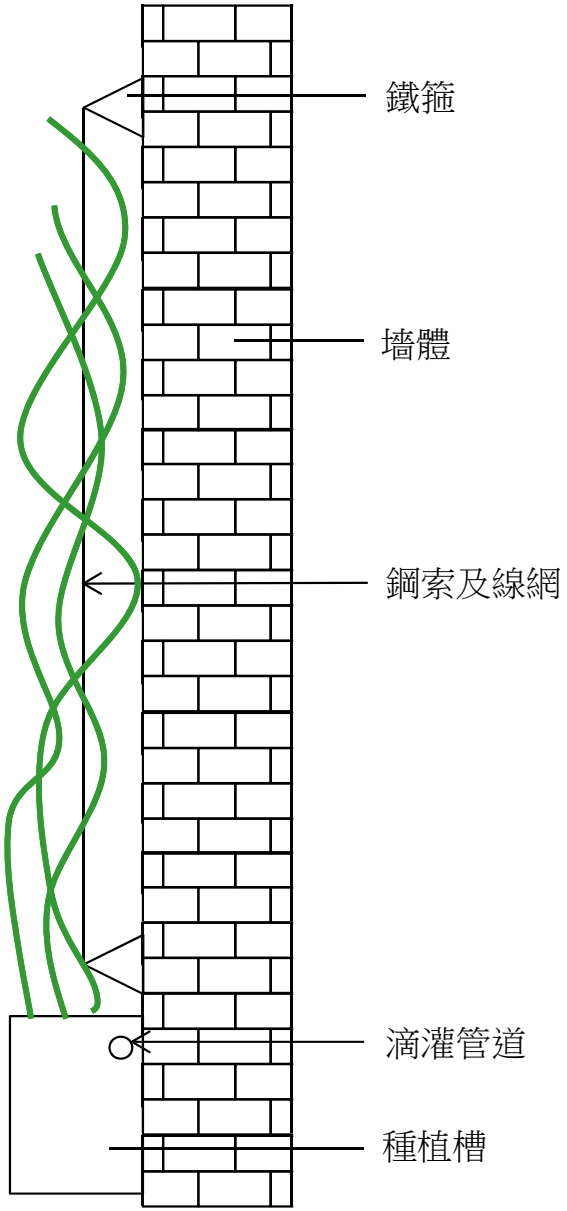
6. 板槽式/Trough System

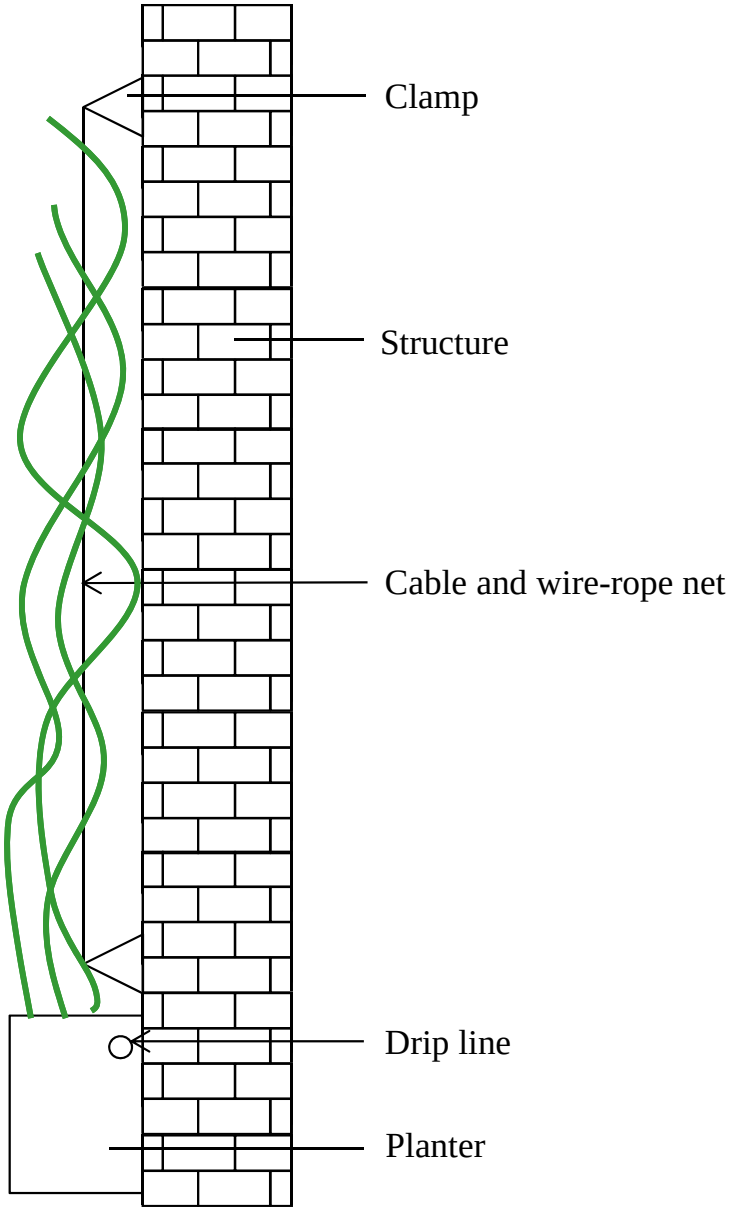


7. 鐵架攀爬或垂吊式/Climbing or Hanging System with Trellis



8. 鋼索及線網式/Cable and Wire-Rope Net System



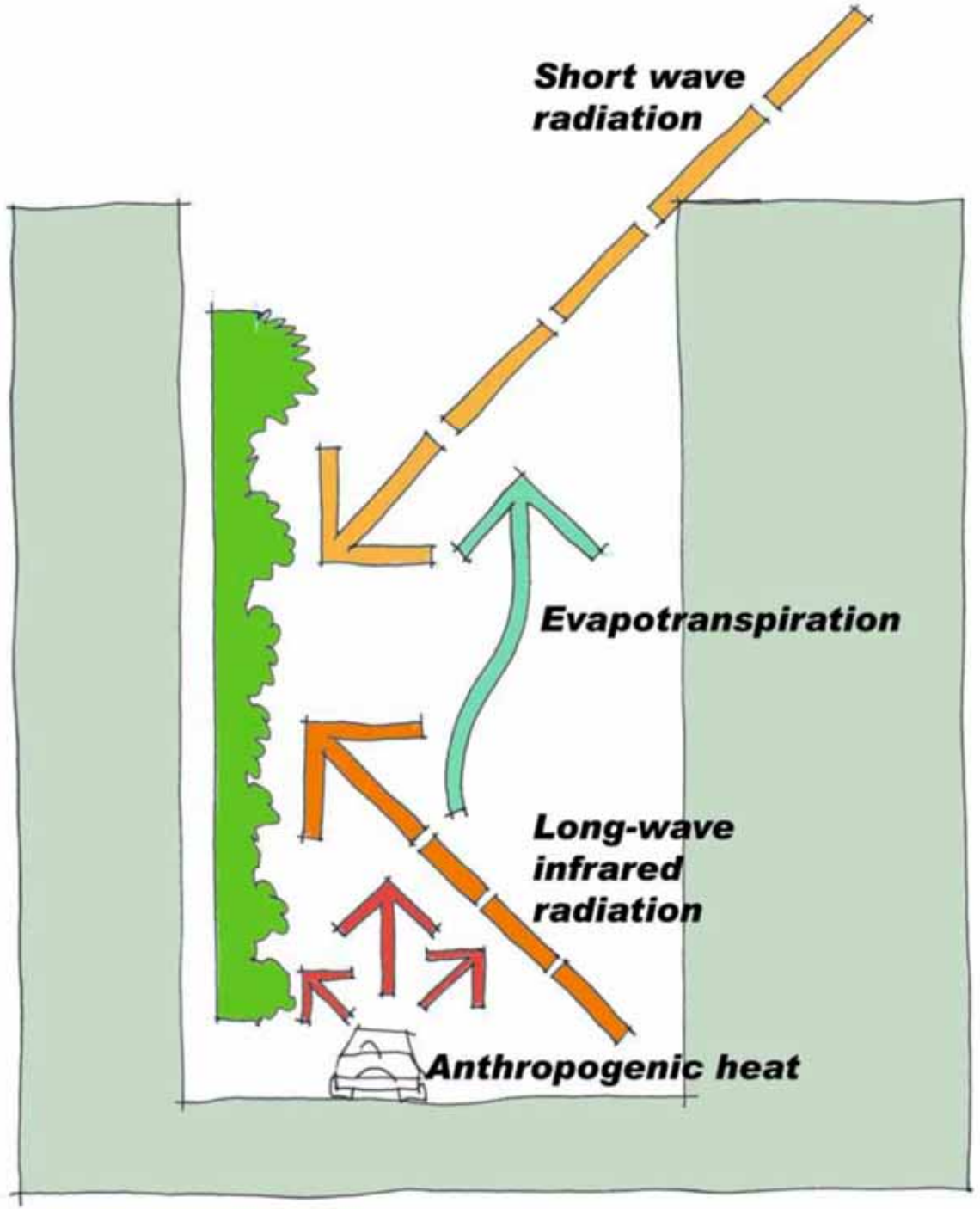


Possible Benefits

- Benefits of greenery in urban areas
  - Air temperature control
  - Air pollution
  - Biodiversity & habitat protection
  - Stormwater management
- Green roofs & vertical greening
  - Building integrated vegetation
  - Green infrastructure
  - Urban cityscape

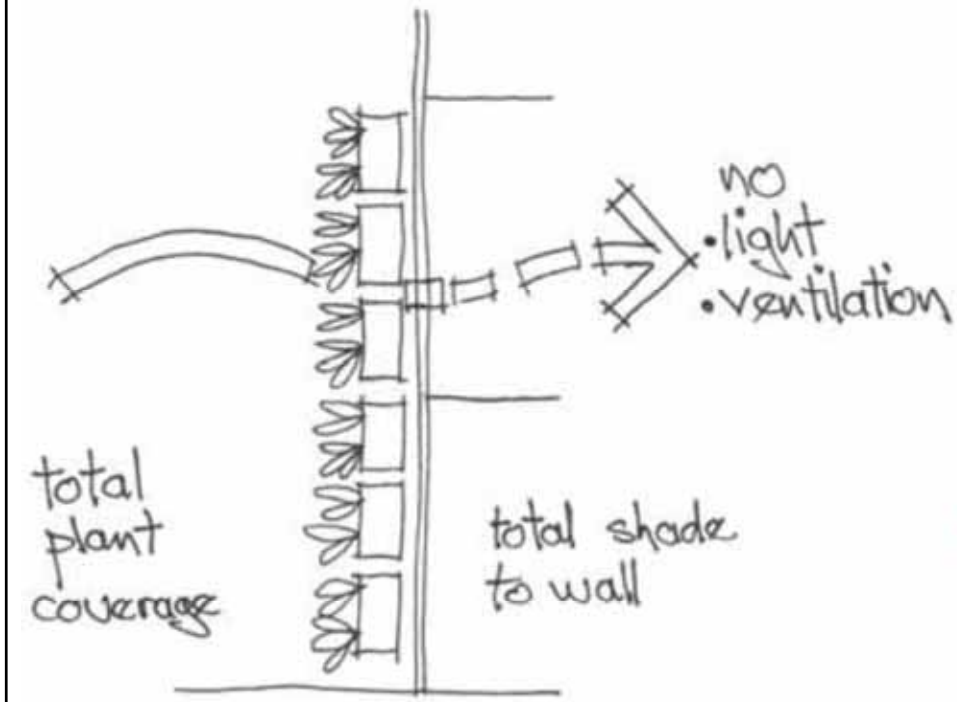
Possible Benefits

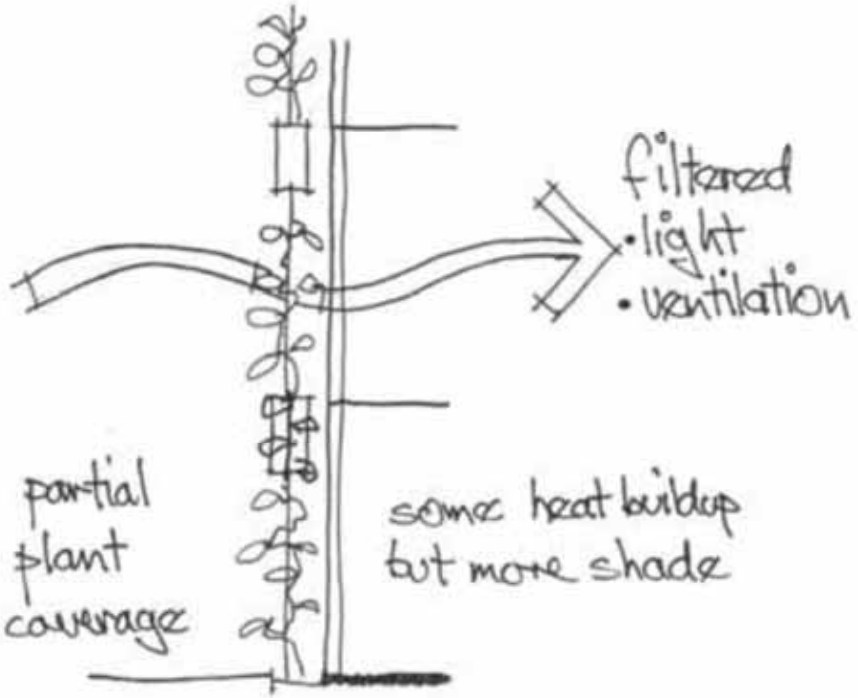
- Public benefits
  - Mitigate urban heat island (UHI)
  - Regulate microclimate & temperature
  - Improve exterior air quality
  - Urban aesthetic improvements
  - Provide ecological habitats
  - Increase biodiversity
  - Positive effects on hydrology
  - Possible urban food production

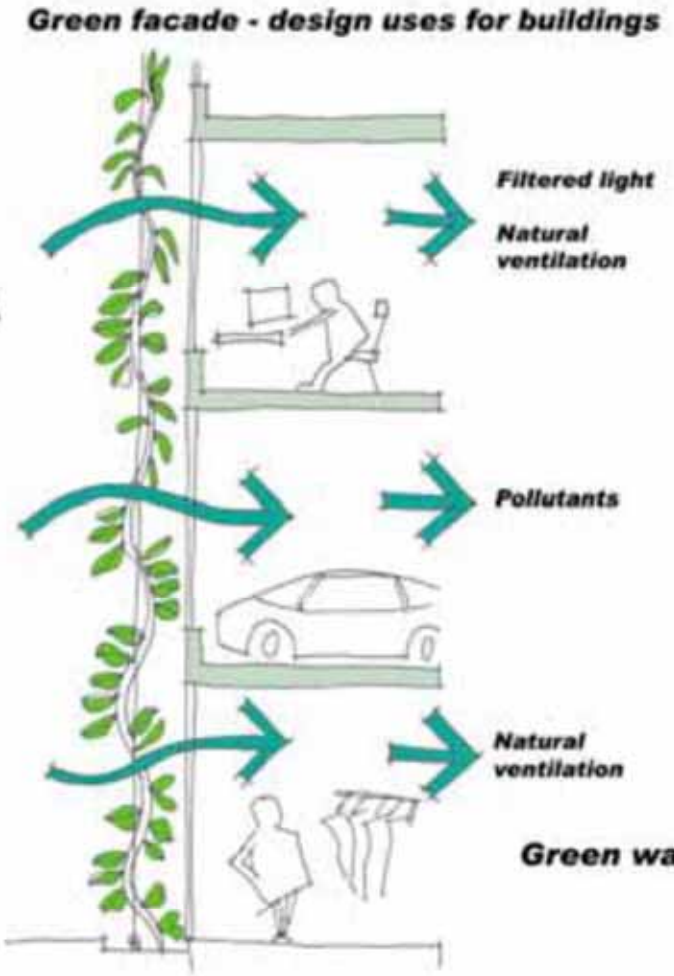


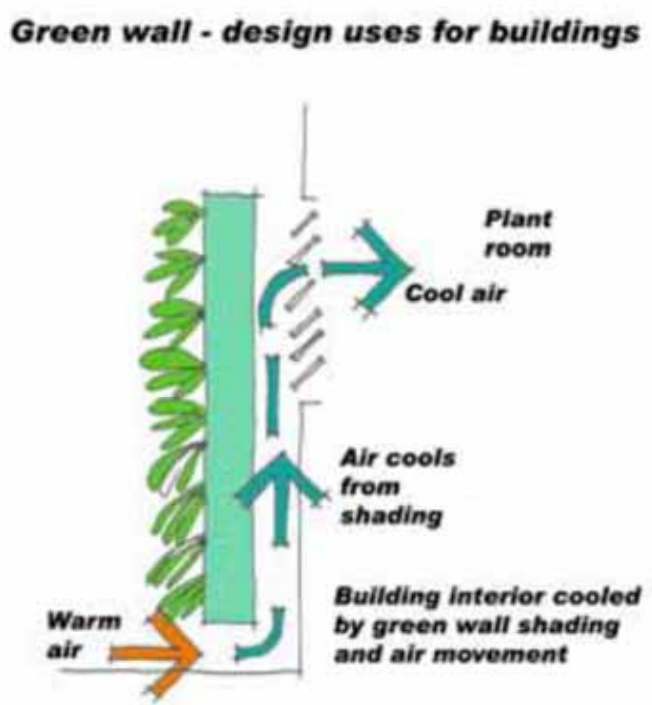
Urban canyon with living wall

(Source: University of Adelaide)



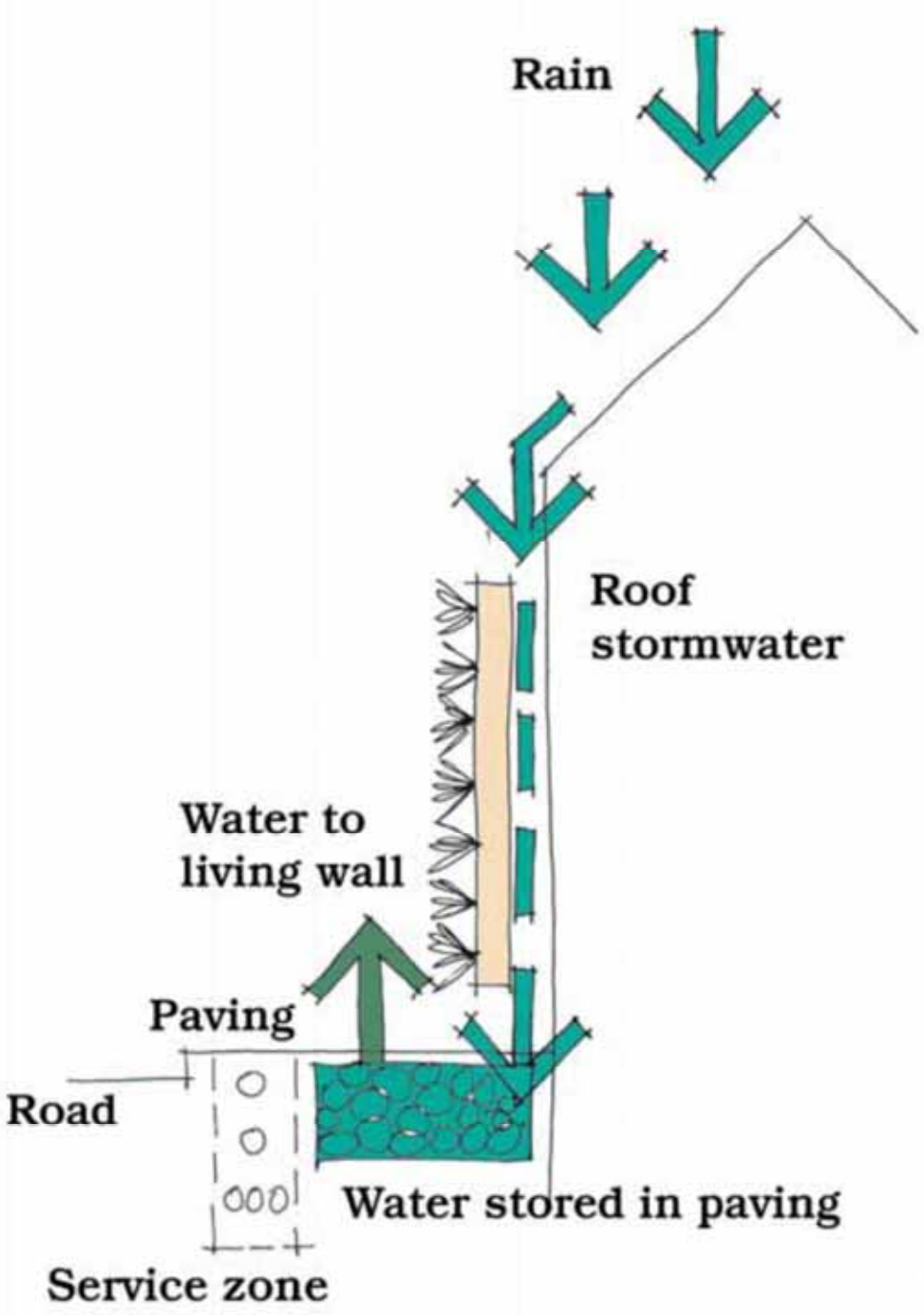


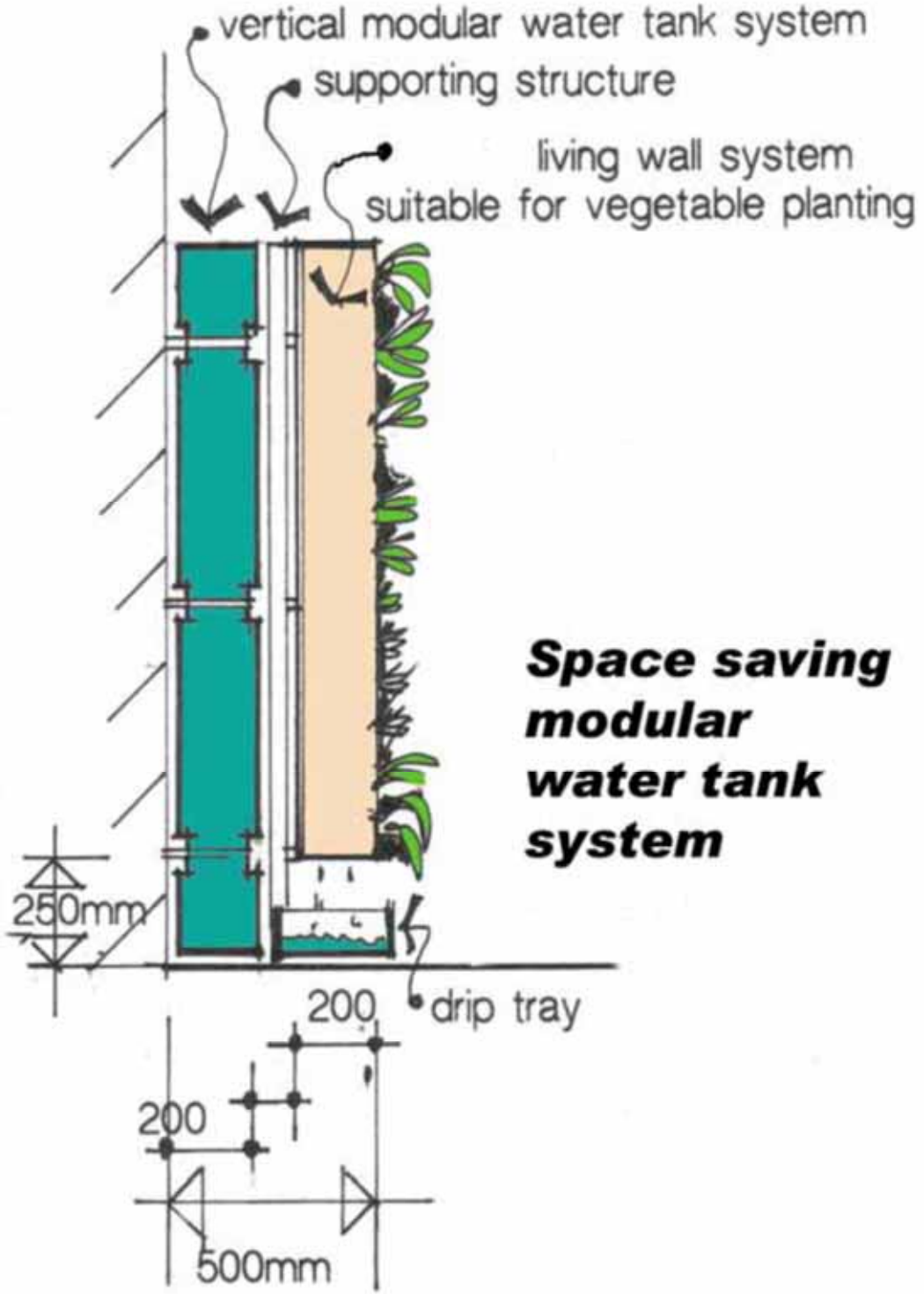




(Source: University of Adelaide)

Rainwater harvesting and storage





(Source: University of Adelaide)

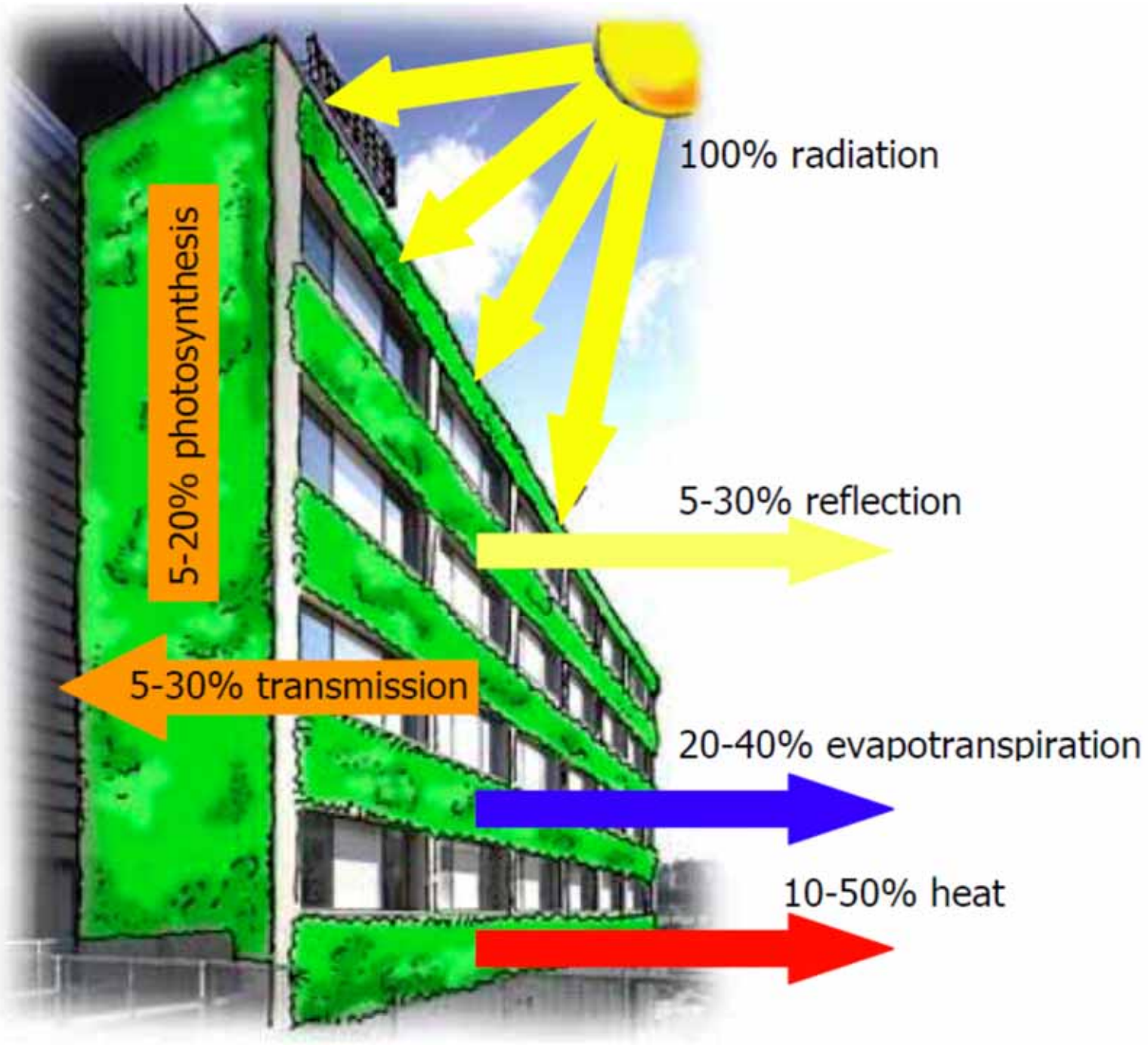
Edible vertical garden

(Source: www.lifeisagarden.com.au)

Possible Benefits

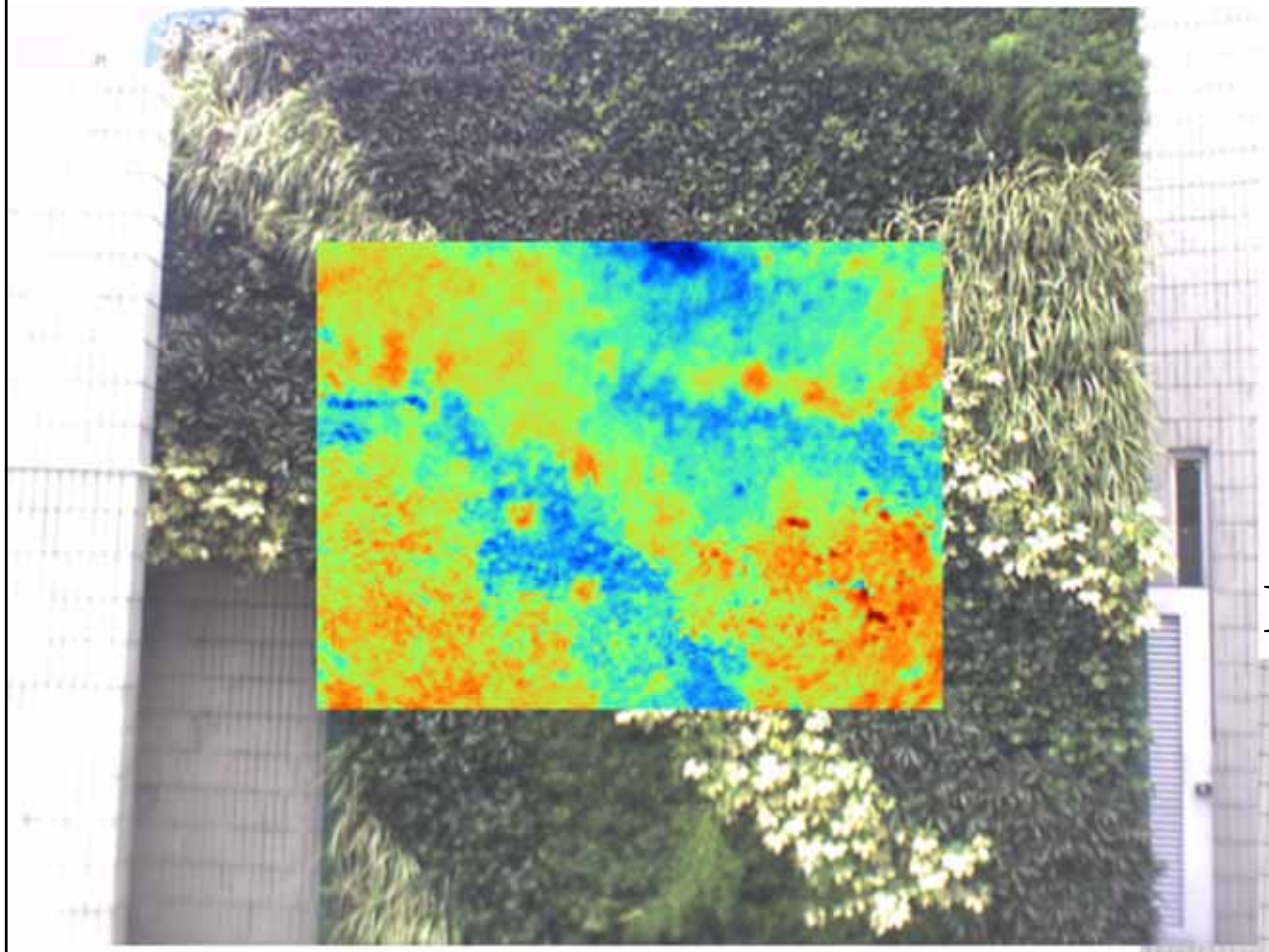
- Private benefits
  - Aesthetic effects
  - Marketing & green image
  - Improved thermal insulation & energy efficiency
  - Reduce cooling energy
  - Protect against solar radiation & rain
  - Improved indoor air quality
  - Sound absorption & noise reduction
  - Credit points for green building assessment

Energy balance for a green wall



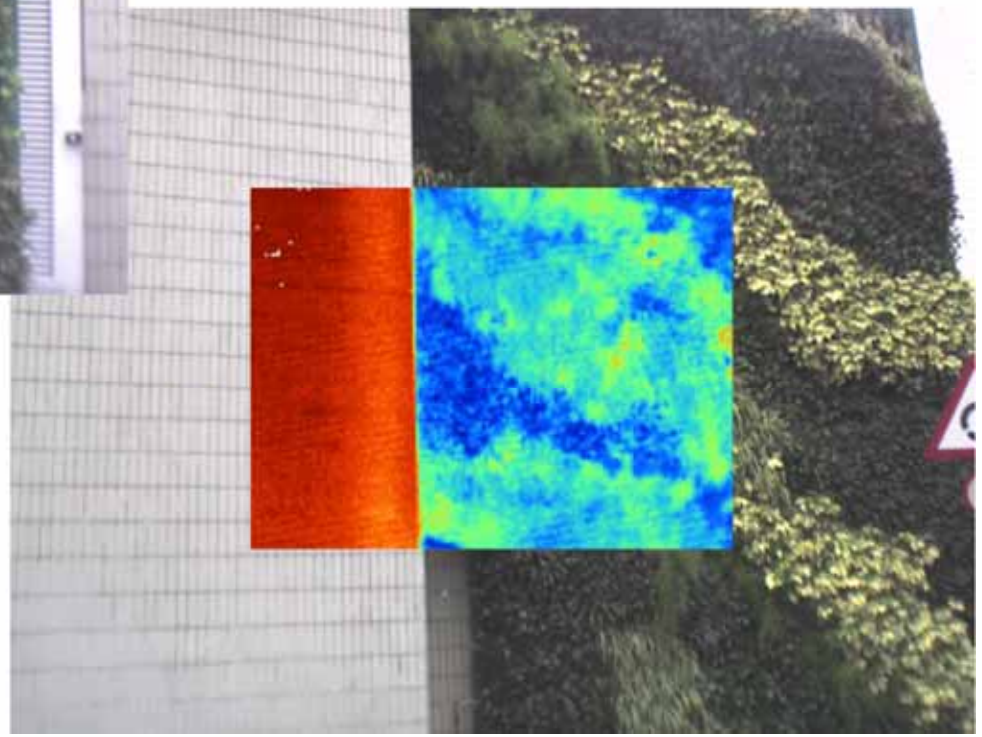
(Source: Ottelé, M., 2011. *The Green Building Envelope: Vertical Greening*, PhD Thesis, Technical University of Delft, The Netherlands.)

Infra-red photos of vertical greening (at EMSD Headquarters)



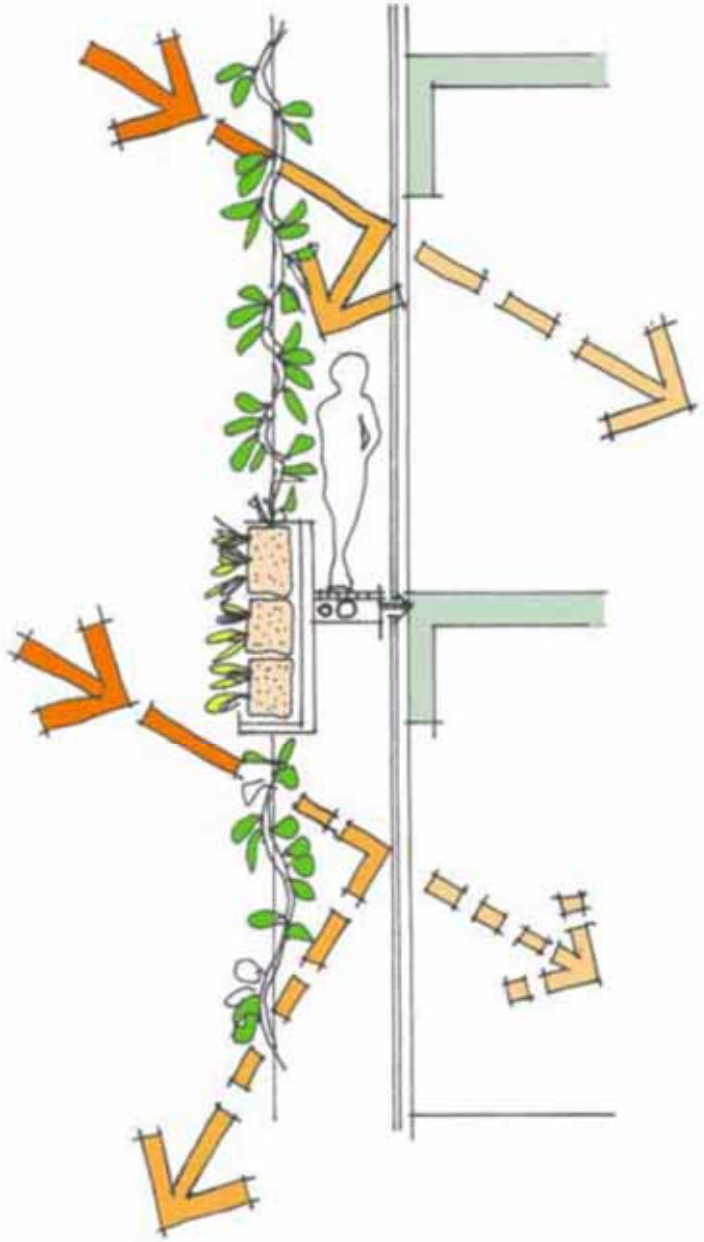
Temperature of different types of plants

Bare wall Green wall



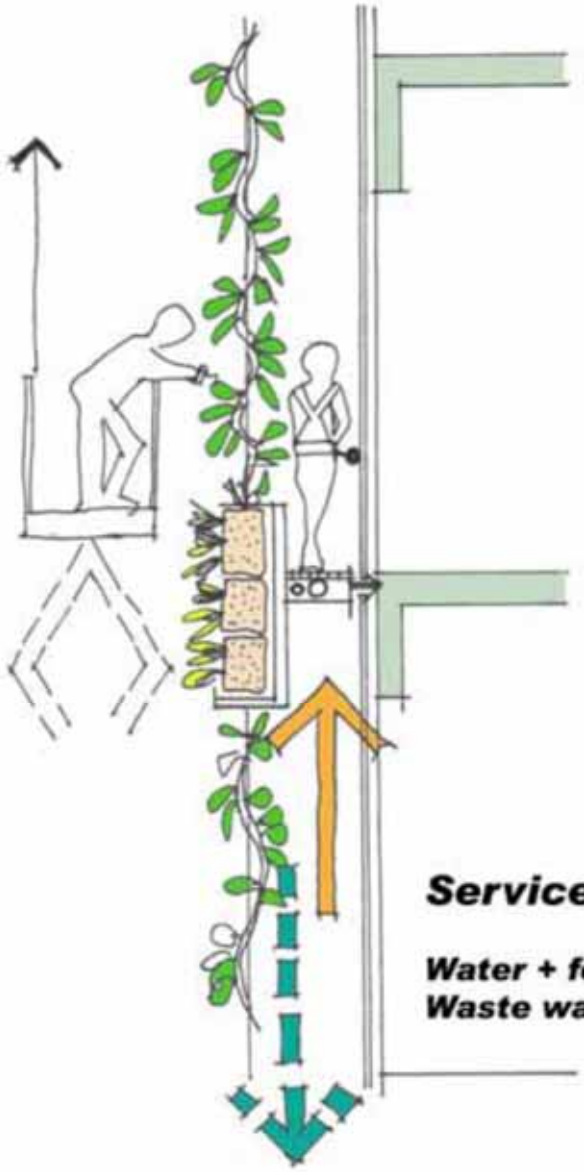
Key Considerations

- Design factors:
  - Orientation
  - Structural support and safety
  - Selection of plants and system
  - Irrigation and moisture issues
  - Damage to wall and deterioration
  - Maintenance
  - Building design integration



Glazing issues

Light penetration
Reflectivity - heat
- various wavelengths



Maintenance issues

Methodology
Built in
External

(Source: University of Adelaide)

Key Considerations

- Implications
  - Increased capital & maintenance costs
  - Consideration for routine maintenance
  - Habitat for insects
  - Orientation & exposure
- Environmentalists
  - Criticised vertical greening systems for excessive use of water, energy and chemicals for fertilisation
  - They can also be difficult to maintain

Key Considerations

- Factors for successful ***green façades***:
  - Attachment to building envelope
    - How the system will be secured to the building or freestanding structure
  - Calculation of structural loads
  - Plant selection for wind and light exposure, hardiness zones, and amenity context
  - Realistic expectations related to plant aesthetics and growth – some systems require 3 to 5 years

Key Considerations

- Factors for successful ***green façades***: (cont'd)
  - Plant maintenance and/or long term maintenance plan to secure the health of these living systems
  - Appropriate plant selection for the geographic region, correct plant spacing for desired coverage, and release from the temporary support structure used by the nursery

Key Considerations

- Factors for flourishing ***living walls***:
  - Irrigation (establish appropriate levels of watering and appropriate levels of nutrients)
  - Plants correctly specified for hardiness zone and geographic location
  - Consider the microclimates that may have different impacts on one part of a living wall relative to another (e.g. varying light, heat, humidity conditions)

Key Considerations

- Factors for flourishing ***living walls***: (cont'd)
  - Growing medium must be designed to sustain chosen plants and to provide the correct nutritional needs
  - Indoor applications need to determine correct light for plant survival
  - Check with manufacturers who may have registered or specially trained installers that will be able to complete the project successfully

THANK YOU 多谢 !!

(More information: www.mech.hku.hk/bse/greenroof/)