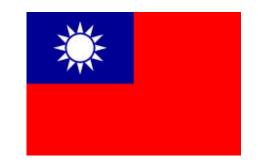
The impressive green roof projects

of Taiwan



Yi-Jiung (Eugenia) Lin

Executive Director/Academic Committee

台灣綠屋頂暨立體綠化協會

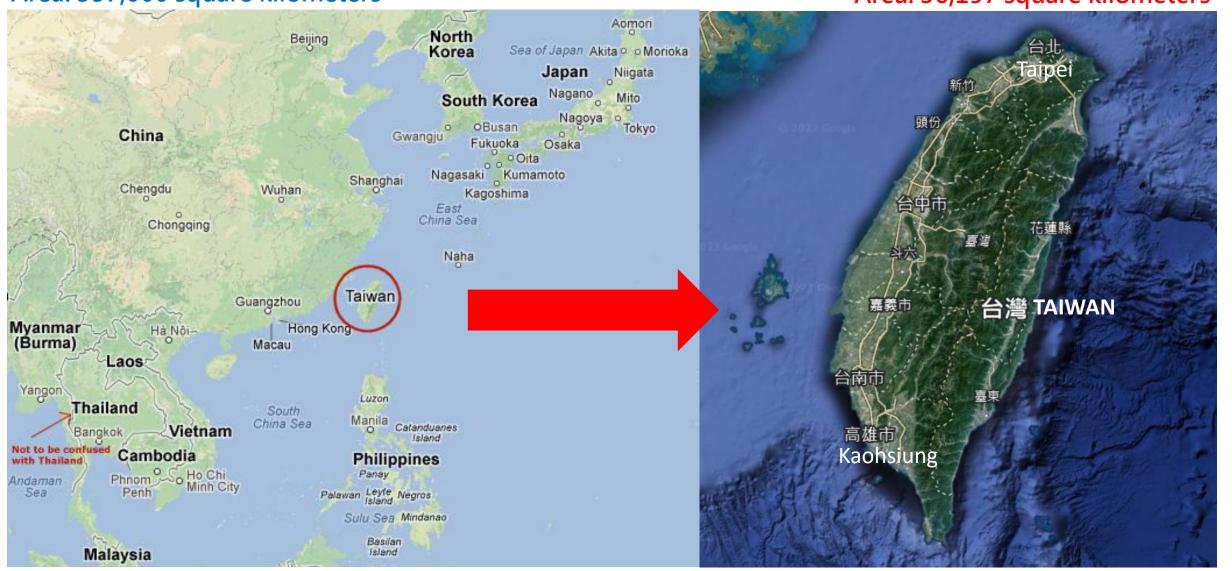
Taiwan Green Roof & Green Wall Association

Assistant Professor, Environmental Engineering and Science, Foo-Yin University
PhD. of Architecture, National Cheng-Kung University
Master of Landscape Architecture, ESF, SUNY, USA
Bachelor of Horticulture, National Taiwan University

Germany Population: 83.2 million (2021) Area: 357,000 square kilometers

Where is Taiwan?

Taiwan Population: 23.57 million (2020) Area: 36,197 square kilometers



Taiwan & Greening

• Land is precious: 36,197 square kilometers with 23.57 million population



Taiwan & Greening

• Climate change: summer flood / winter drought & air pollution





Advantages of Green Roofs

- 1. Stormwater management
- 2. Water retention
- 3. Filtering of air pollution
- 4. Mitigation of the urban heat island effect
- 5. Acoustical and heat insulation
- 6. Reduction in CO₂
- 7. Increase in the efficiency of photovoltaic cells (up to 16% more)
- 8. Biodiversity
- 9. Habitat restoration
- 10. Economic benefits
- 11. Aesthetics
- 12. Public education

We want them all

Green Building Rating System of Taiwan

EEWH:

Ecology

Energy Saving

Waste Reduction

Health



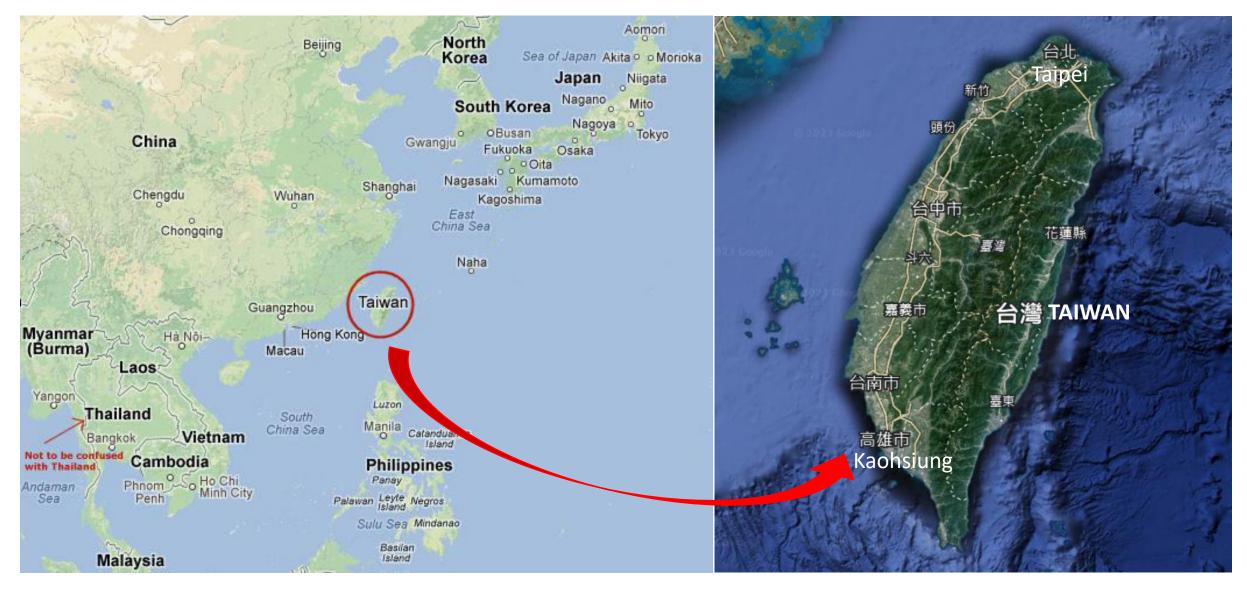


- Taiwan Green Roof & Green Wall Association (TGRWA) is established 12 years ago. We had completed many Events, Projects and Publications from 2011 to 2020.
- TGRWA do our best to make the advantages complete, such as mitigating the impacts of climate change and improving urban fabric for urban livability, biophilic design, stormwater management, rooftop agriculture, horticultural therapy, education and public participation etc.
- Every city has their Autonomous Ordinance on green building and green roofs here in Taiwan. These years the projects we dealt and assisted with Tainan and Kaohsiung government, the budget were around 100 thousand Euro per year. Sometimes the projects came from different bureau of a city.

Create A Healthy Five-Sense City with Butterflies, Bees and Earthworms' Green Roofs

Kaohsiung City, Taiwan

Where is Kaohsiung City?





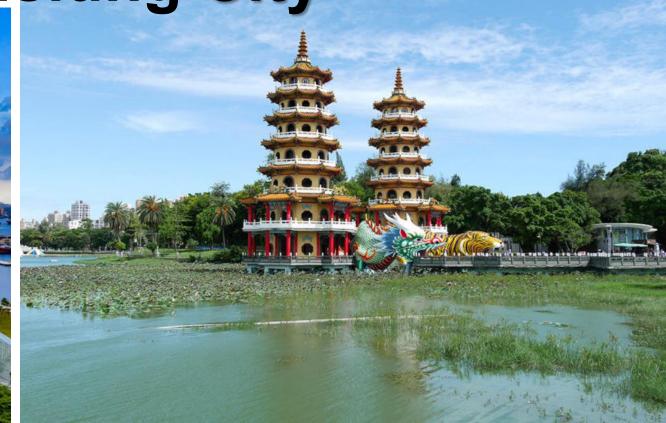






Kaohsiung City



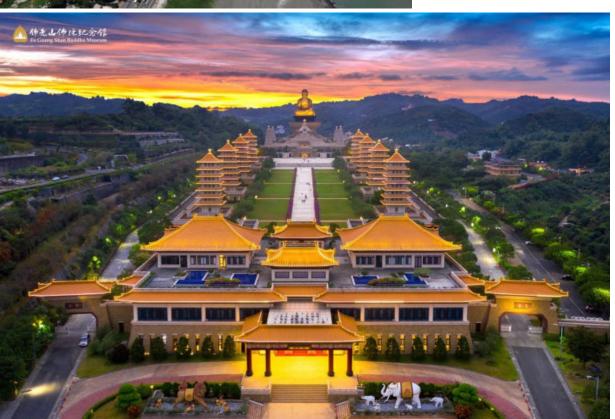




Kao hsiung



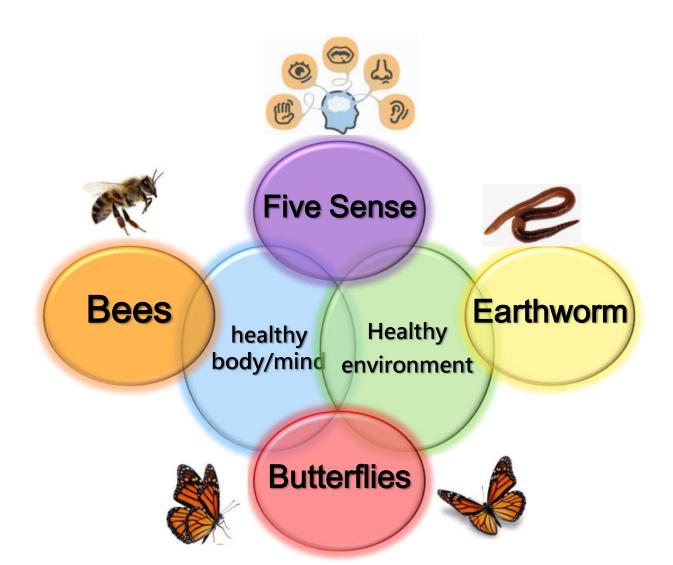




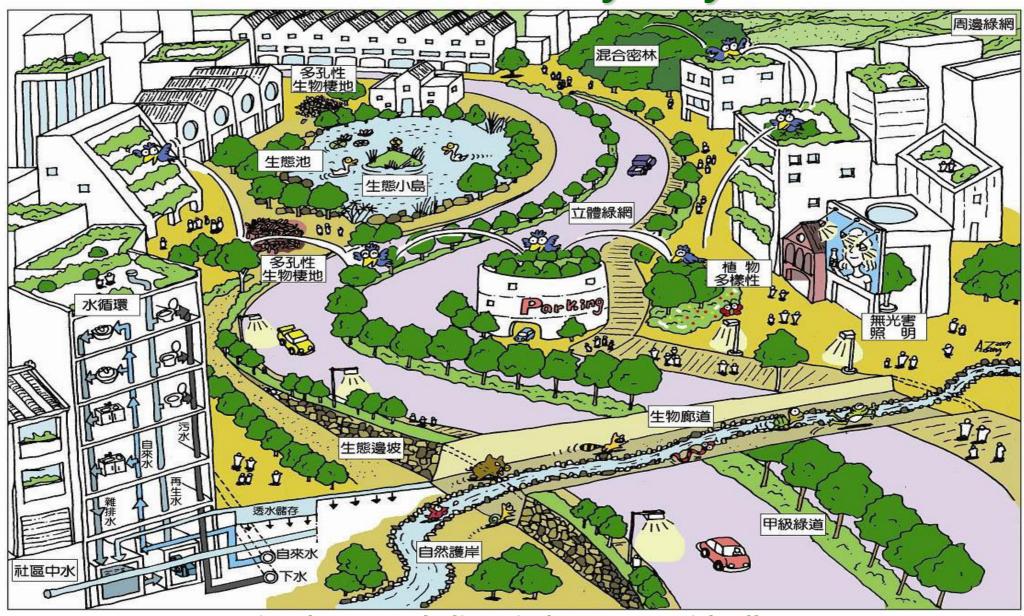


Green Roofs of Kaohsiung City

Mitigating the urban heat island effect, energy saving and carbon reduction, and living health".



A Biodiversity City



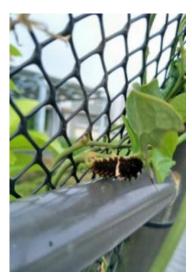
Create a city that people lives in harmony with all creatures.

Butterfly Restoration

Restoring butterflies in the city, in addition to appreciating their beautiful appearance and posture, we can also observe the complete metamorphosis process of butterflies, which is a very ideal nature and ecological education, so as to promote the restoration of a healthy environment. The butterfly restoration we promote is to use the rooftop space of the city to plant butterfly plants, which include host plants and nectar plants, to **create an environment suitable for butterfly laying and growth**.

In order to provide a healthy environment for native butterflies, we specifically emphasis on growing native host plants and nectar plants to attract them.



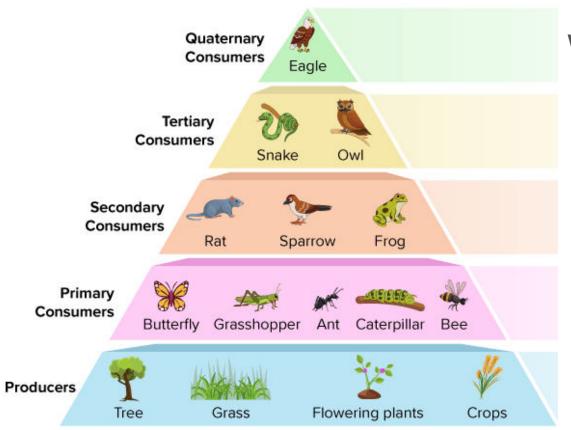






Butterfly Restoration

Biodiversity



When the flowers bloom, the butterflies will gather.



Ecological Pyramid

The diversity planting for different butterflies

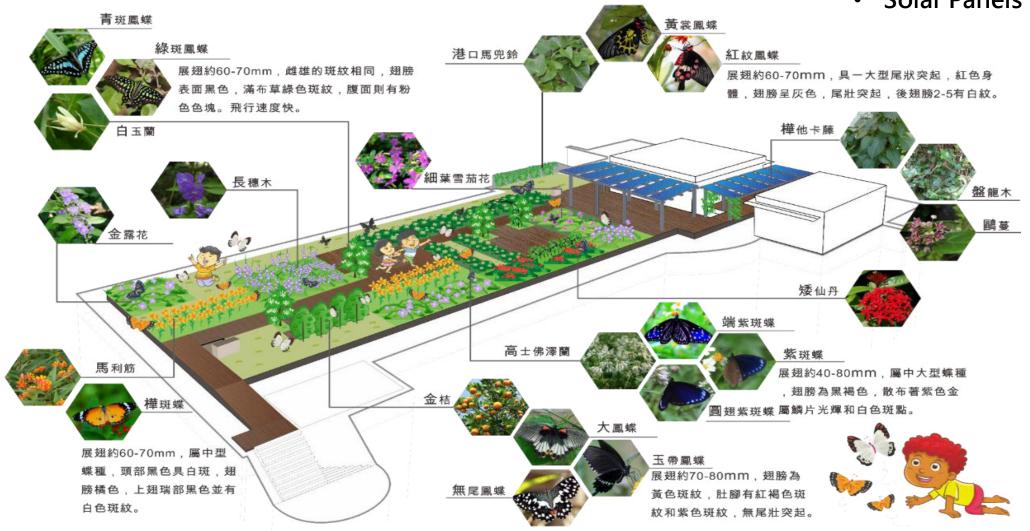
Singuang Elementary School "Rooftop Butterfly Garden"

Roof Area: 1000 m²

Green Roof Area: 801 m²

Budget: 255,647USD

Solar Panels: 144 m²





Urban Beekeeping

The Kaohsiung City Government built the city's first urban rooftop bee farm on the roof of Sanmin High school. Apart from assisting in the restoration of bees, it also led students and citizens from practically operating bee breeding, conservation of beerelated ecological knowledge, to caring for food and agriculture. Education and food safety issues, to enhance students and the public's attention to environmental ecology and land value, and then work together to create habitats suitable for bees and other creatures to live and reproduce in the city, so that humans, bees and even other creatures can live harmony together. This is the spirit of our promotion of urban

beekeeping.



































Earthworms Placing

Earthworms are natural "fertilizers" and can increase the air permeability of the soil. They were called by the biologist Darwin "the most valuable animals on earth". Earthworms can also reduce the carbon dioxide content in the atmosphere and slow down the greenhouse effect, which is an indispensable role in a healthy city. In order to promote non-toxic and organic rooftop farms, the earthworms were raised in the soil medium of the green roof, and food waste was fed to the earthworms through a tube feeder. In this way, vermicomposting has become the most natural fertilizer for green roof plants and vegetables and fruits at the same time, the food waste has been transformed into high-nutrition fertilizer, thoroughly implementing the concept of circular economy, and achieving the sustainable cycle concept of earthworms and vegetation symbiosis in a healthy city.













Mr. Lo won the 30th Malaysia ITEX International Invention Exhibition Environmental Energy Gold Medal, and Thailand International Best Invention Gold Medal in 2019.













1. 將土壤放進盆中。
Substrate placing



4. 將六個種好幼苗盆子組裝,或垂吊 Combining



2. 將紅蚯蚓放入土壤內。 Earthworms placing



5. 將生廚餘放進中間空管餵食蚯蚓, Food waste placing。



3. 移植蔬菜、花卉幼苗,或播撒種子。 Planting



6. 採收。 Harvesting









Chinese's medicine & Herbs Garden



Five-Sense Experiencing

Horticultural therapy, defined in a broad way, is "the process of using plants and horticultural activities to promote people's social, educational, psychological and physical adjustments and improve people's body and soul." In short, it is the use of plants and horticultural activities to help people heal, recover and promote their health and well-being.

When we promote the roof greening for Kaohsiung City, we brought the **Five Senses Experience Activity** to the public by using herbs and vegetables. Through the various DIY activities, people got to experience the feelings **of sight**, **hearing**, **smell**, **touch and taste**. So as to awaken and stimulate people's forgotten beauty in the unchanging life feeling. In addition to the benefit of preventing Alzheimer's disease, this kind of experience can also increase the neuronal connections of brain synapses, which can effectively prevent the brain hysteresis caused by 3C products, stimulate the body's five senses, and not only help the body health but also improve mental health.







Five-Sense Experiencing













Public Participation

6月14日(五)系列講座一(三民家商)-高雄市綠屋頂補助計畫說明會暨案例分享補助辦法進行說明,帶領本市市民共投入









6月25日(二)系列講座二(新光國民小學)-城市環境改善之道

從住家單元的屋頂綠化談起,說明小至自家屋頂花園大至城市規劃尺度,全球環境的改善與生活的關係密不可分。









Public Participation

7月4日(四)系列講座三(高雄醫學大學)-咫尺綠生活

介紹高雄醫學大學屋頂綠化談起,以分享方式說明案例的源起與規畫過程,以了解綠屋頂對環境與生活產生之效益,第二場則是說明綠化與生活,運用人體五感來感受植栽綠化所帶來的療癒效果,了解綠色生活離你我並不遠也不困難。









7月16日(四)系列講座四(三民區公所)-隱田於市

分享在高度發展的城市之中,也能有機會完成農居的休閒生活方式。



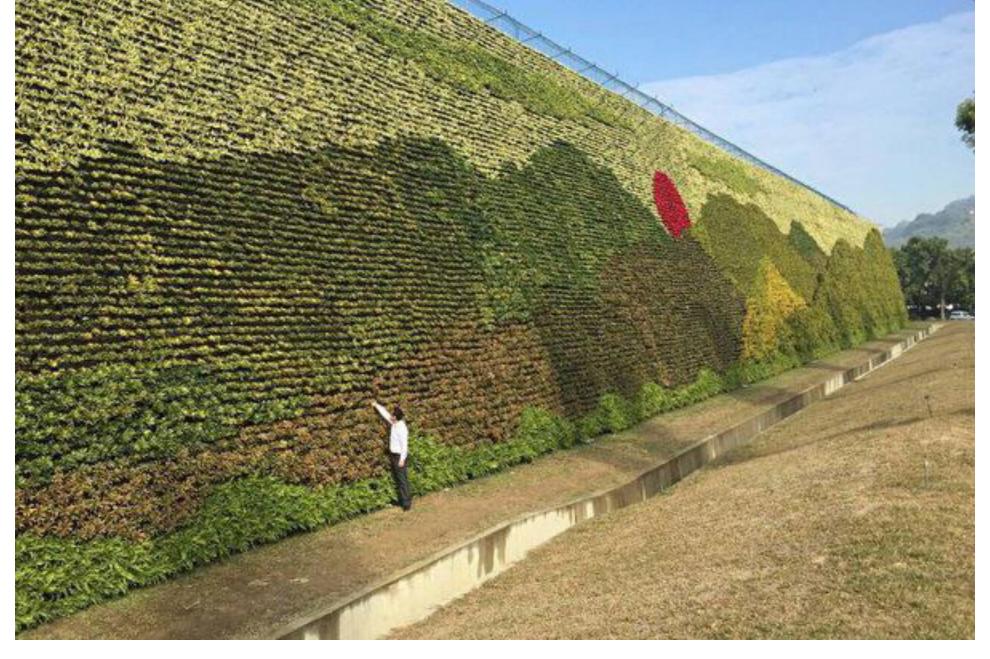






The impressive green roof projects of Taiwan



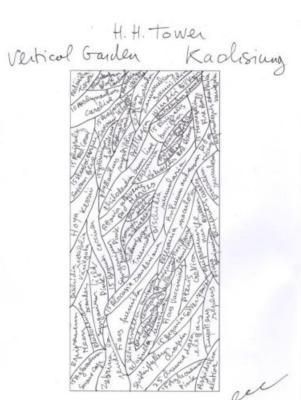


Guinness World Records: The largest vertical garden measures 2,593.77 m² (27,919 ft²) and was achieved by Cleanaway Company Limited and Shine Green Energy Enterprise Co., Ltd. in Kaohsiung, Taiwan on 29 June 2015.

Green Roof Projects from Members















Project Title: H&H Tower Completion: 2018

Project Location: Kaohsiung, Taiwan

Project Type: New Green Wall Vegetated Area: Total 50M²

Designer: Patrick Blanc

Landscape construction: HSIN LIN TING BOTANY GARDEN

Address: No. 142, Wencheng 3rd Rd., North Dist., Tainan City 704029, Taiwan

E-mail: hsinlinting@gmail.com



Project Title: H&H Tower Project Location: Kaohsiung, Taiwan Project Type: New Green Wall

Vegetated Area: Total 50M²

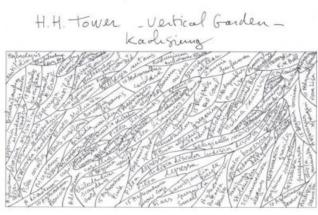
Designer: Patrick Blanc Landscape construction: HSIN LIN TING BOTANY GARDEN

Address: No. 142, Wencheng 3rd Rd., North Dist., Tainan City 704029, Taiwan

E-mail:

hsinlinting@gmail.com

Completion: 2018

















to 36.4°C), Solar panel output power may be increased via

green roof (increase 23.3% power generation).

Project Title: Rende Wastewater Treatment Plant

Project Location: Tainan, Taiwan Project Type: Retrofit Green Roof

Vegetated Area: 233.68M²

Designer: HSIN LIN TING BOTANY GARDEN

E-mail: hsinlinting@gmail.com

Address: No. 142, Wencheng 3rd Rd., North Dist.,

Tainan City 704029, Taiwan















Project Title: Rainbow Sky Garden

Project Location: Rainbow Hymn Culture & Creativity, Tainan, Taiwan
Project Type: Retrofit Green Roof Vegetated Area: Total 405.8M²

Designer: HSIN LIN TING BOTANY GARDEN

Address: No. 142, Wencheng 3rd Rd., North Dist., Tainan City 704029, Taiwan



- Wedding Venue
- Healthy Green Healing
- > Experience Activities
- > Handmade Course





Project Location: Rainbow Hymn Culture & Creativity, Tainan, Taiwan Project Type: Retrofit Green Roof Vegetated Area: Total 405.8M²

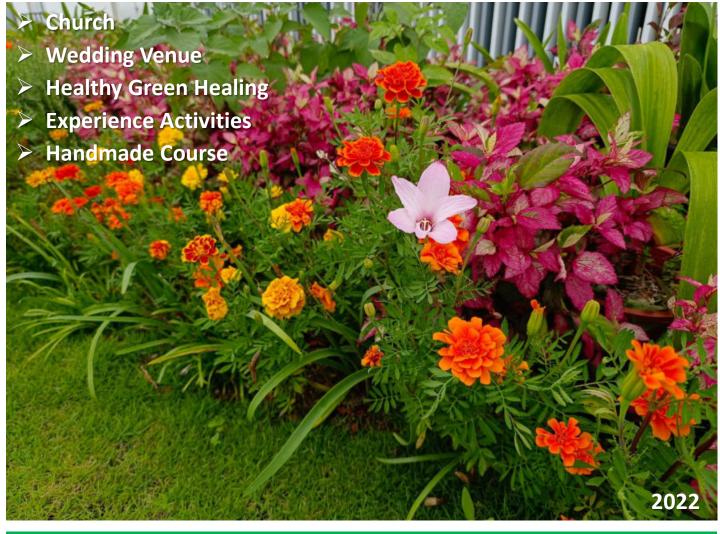
Designer: HSIN LIN TING BOTANY GARDEN

Address: No. 142, Wencheng 3rd Rd., North Dist., Tainan City 704029, Taiwan











Project Location: Rainbow Hymn Culture & Creativity, Tainan, Taiwan

Project Type: Retrofit Green Roof Vegetated Area: Total 405.8M²

Designer: HSIN LIN TING BOTANY GARDEN

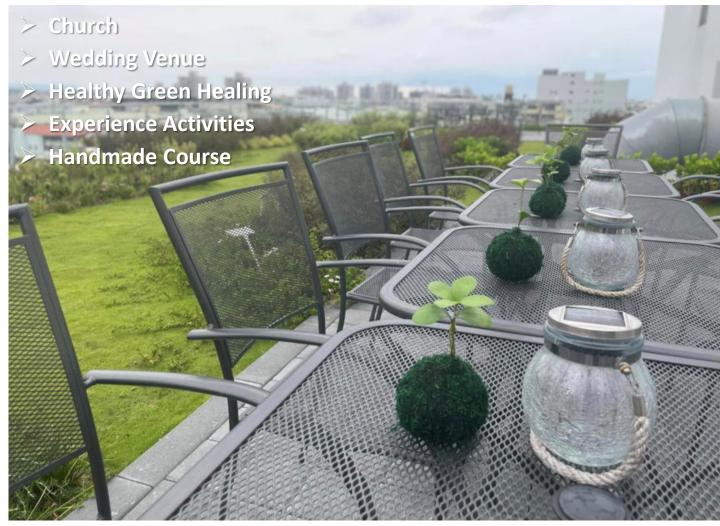
Address: No. 142, Wencheng 3rd Rd., North Dist., Tainan City 704029, Taiwan

















Project Title: Rainbow Sky Garden

Project Location: Rainbow Hymn Culture & Creativity, Tainan, Taiwan Project Type: Retrofit Green Roof Vegetated Area: Total 405.8M²

Designer: HSIN LIN TING BOTANY GARDEN

Address: No. 142, Wencheng 3rd Rd., North Dist., Tainan City 704029, Taiwan















Project Title: Shuijiaoshe Park Project Location: Tainan, Taiwan Project Type: Park (2.2hectare)

Designer: Motif Planning & Design Consultants

Landscape construction: HSIN LIN TING BOTANY GARDEN

Address: No. 142, Wencheng 3rd Rd., North Dist., Tainan City 704029, Taiwan

E-mail: hsinlinting@gmail.com

Completion: 2020

Jhong-Jheng Elemetary School Green Roof Green Wonderland





Project Title: Jhong-Jheng Elemetary School

Project Location: Kaohsiung, Taiwan

Project Type: Green Roof\Three-dimensional Greening

Vegetated Area: 615.7m²

Designer: TOP DESIGN ENGINEERING CONSULTATION CO.,LTD. **Landscape Construction**: GREEN EMPIRE INDUSTRIAL CO.,LTD.

Address: 6F-2,No.172-7,Sih Wei 4th Rd.,Linya Dist.,Kaohsiung City 80247,Taiwan

E-mail: top.bng@msa.hinet.net

Jhong-Jheng Elemetary School Green Roof Green Wonderland



Project Title: Jhong-Jheng Elemetary School

Project Location: Kaohsiung, Taiwan

Project Type: Green Roof\Three-dimensional Greening

Vegetated Area: 615.7m²

Designer: TOP DESIGN ENGINEERING CONSULTATION CO.,LTD. Landscape Construction: GREEN EMPIRE INDUSTRIAL CO.,LTD.

Address: 6F-2,No.172-7,Sih Wei 4th Rd.,Linya Dist., Kaohsiung City 80247, Taiwan

E-mail: top.bng@msa.hinet.net







Project Title: Singuang Elementary School

Project Location: Kaohsiung, Taiwan

Project Type: Green Roof\Solar Photoelectric

Vegetated Area: 390.4 m²

Designer: TOP DESIGN ENGINEERING CONSULTATION CO.,LTD. **Landscape Construction**: GREEN EMPIRE INDUSTRIAL CO.,LTD.

Address: 6F-2,No.172-7,Sih Wei 4th Rd.,Linya Dist.,Kaohsiung City 80247,Taiwan

E-mail: top.bng@msa.hinet.net

Vegetated Area: 390.4 m²





Project Title: Roof Garden of Singuang Elementary School.

Project Location: Kaohsiung, Taiwan

Project Type: Green Roof\Solar Photoelectric

Vegetated Area: 390.4m²

Designer: TOP DESIGN ENGINEERING CONSULTATION CO.,LTD. Landscape Construction: GREEN EMPIRE INDUSTRIAL CO.,LTD.

Address: 6F-2,No.172-7,Sih Wei 4th Rd.,Linya Dist.,Kaohsiung City 80247,Taiwan

E-mail: top.bng@msa.hinet.net



Kaohsiung Medical University "Garden of Luxury"









Garden of Luxury

Project Title: Kaohsiung Medical University

Project Location: Kaohsiung, Taiwan

Project Type: Green Roof Vegetated Area: 634m²

Designer: TOP DESIGN ENGINEERING CONSULTATION CO.,LTD. Landscape Construction: GREEN EMPIRE INDUSTRIAL CO.,LTD.

Address: 6F-2,No.172-7,Sih Wei 4th Rd.,Linya Dist.,Kaohsiung City 80247,Taiwan

E-mail: top.bng@msa.hinet.net





- 1. Project name: Yuanpei University of Medical Technology, Rooftop farm
- 2. Location: Hsinchu City, Taiwan
- 3. Landscape design unit/designer: Lansan Landscape Ltd.
- 4. Special facilities/construction methods: Polygreen Tray
- 5. Design unit Email: Lan,LiangWen (lansan8888@gmail.com)









- 1. Project name: Green roof of Industrial Technology Research Institue
- 2. Location: Hsinchu City, Taiwan
- 3. Landscape design unit/designer:Lansan Landscape Ltd.
- 4. Special facilities/construction methods: Polygreen Tray Application of Lightweight Soil
- 5. Design unit Email: Lan,LiangWen (lansan8888@gmail.com)



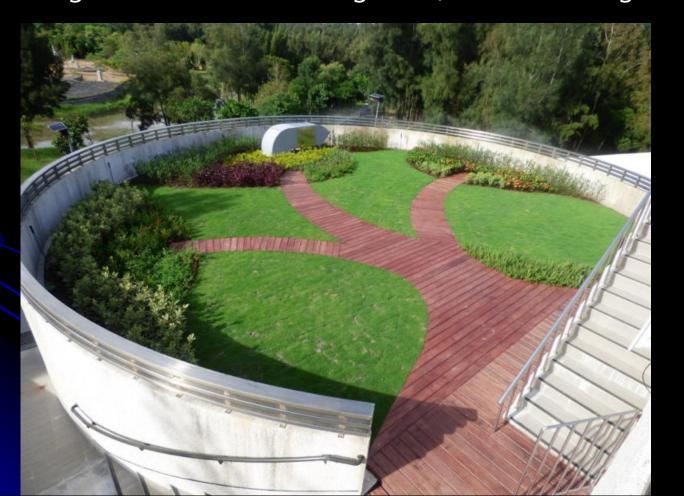




- 1. Project name: Low Carbon Exhibition Hall, Green Roof
- 2. Location: Kinmen County, Taiwan
- 3. Landscape design unit/designer:Lansan Landscape Ltd.

4. Special facilities/construction methods: Polyggreen Tray Application of Lightweight Soil

5. Design unit Email: Lan, Liang Wen (lansan 8888@gmail.com)









- 1. Project name: Residential roof greening
- 2. Location: Hsinchu City, Taiwan
- 3. Landscape design unit/designer:Lansan Landscape Ltd.
- 4. Special facilities/construction methods: 隔熱蓄排水板、Application of Lightweight Soil

5. Design unit Email: Lan, Liang Wen (lansan 8888@gmail.com)

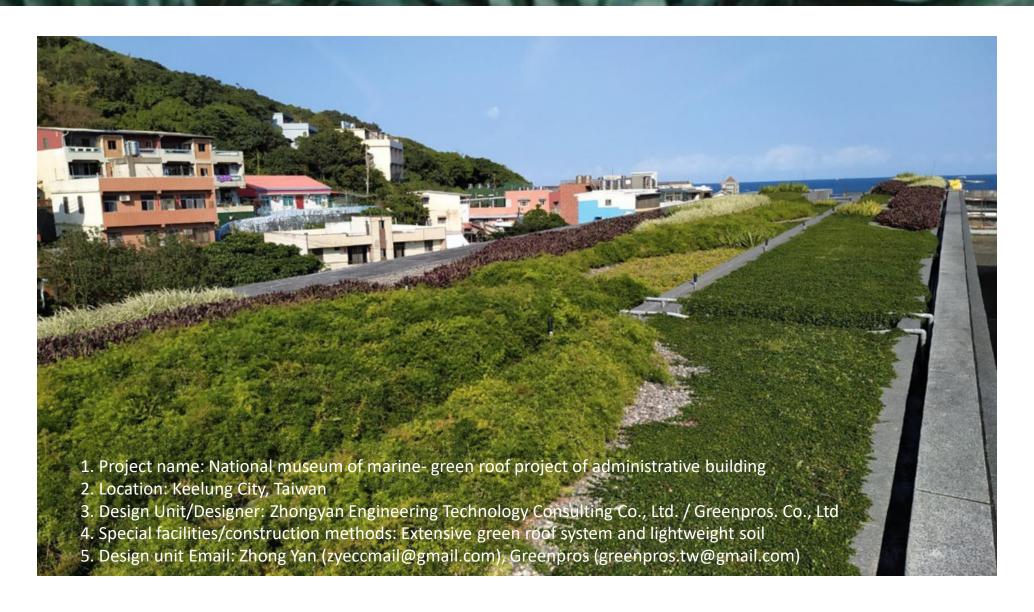








National museum of marine- Administration Building Green Roof



Construction process



ZinCo Root Barrier Membrane



Protection Mat



Drain board



Filter blanket



Lightweight soil



49 plants/m²



Maintenance

Choosing Ground Cover Plants for Coastal Climates



Choosing Ground Cover Plants for Coastal Climates



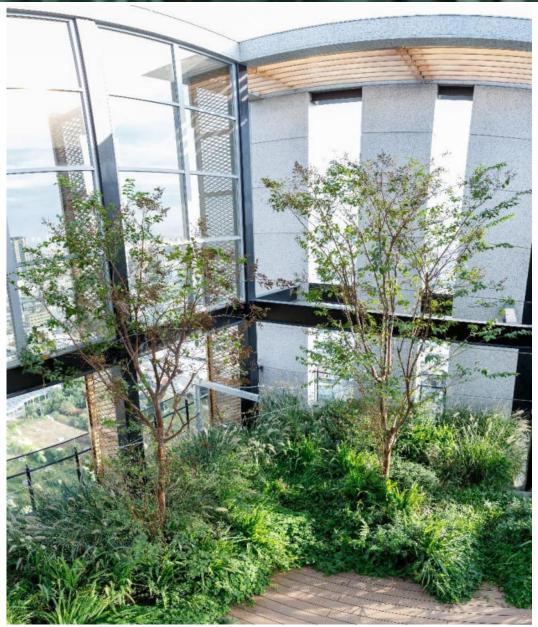
Chwangjan construction company - Moon Park Building

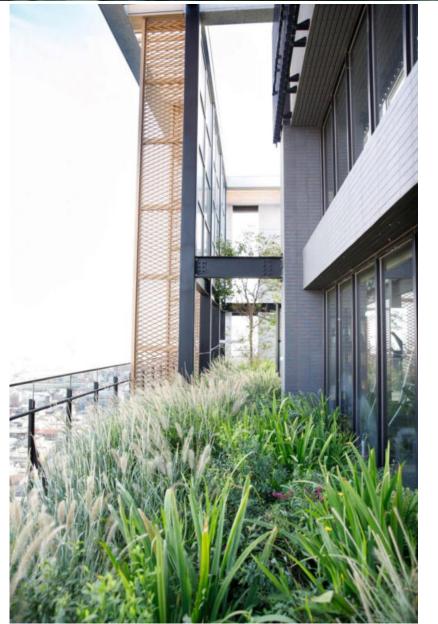




- Project name: Chwangjin Moon Park Residential Building
- 2. Location: Taichung City, Taiwan
- 3. Architectural Planning: WAA Architects
- Landscape design unit/designer: Motif
 Planning & Design Consultants/ Wu Shu-Yuan
- 5. Special facilities/construction methods: Tree Root Ball Fixing Method & Application of Lightweight Soil
- Design unit Email: Motif (motififlandscape@gmail.com)

Biodiversity planting design, creating a natural and casual style





Used lightweight soil and a fixed root ball for root growth



MOXA Factory



1.Project name: MOXA Factory

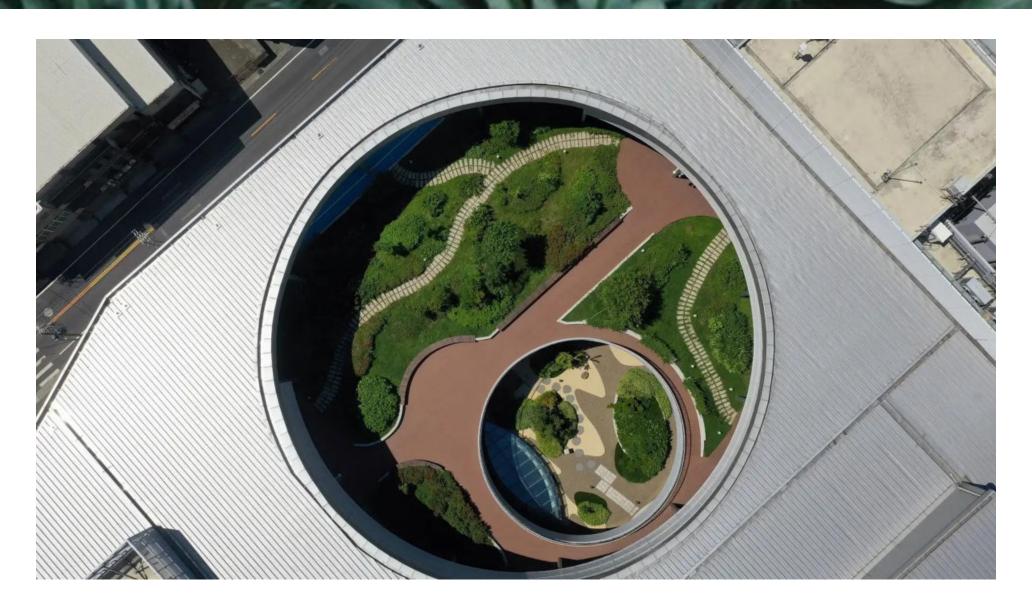
2.Location: Taoyuan, Taiwan

3. Architectural planning and landscape design: Bio-architecture Formosana (BaF)

4. Special Facilities/Construction Method: Intensive green roof design

5.E-mail of design unit: BaF (arch@bioarch.com.tw)

6F green roof - Many Taiwan native species are planted



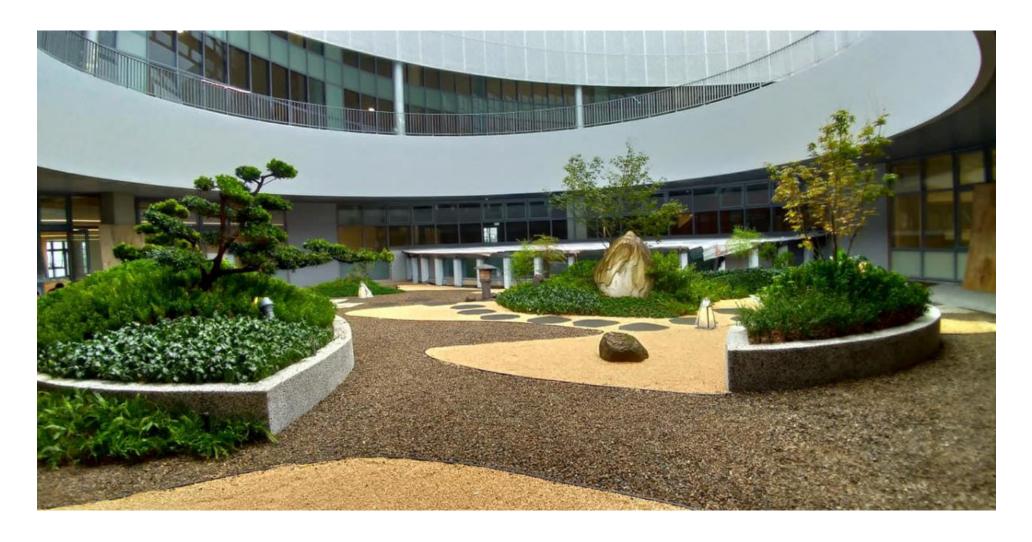
Plant many nectar plants for butterflies and bees







5F Green Roof



The fifth floor is designed as a rest garden, providing a place for employees to rest.

Neihu Flower Market DIY Green Roof Demonstration

Application of polygreen box



DIY of GreenRoog process



Lay the drainage board



Install the side panels



installation of carbonized bamboo boards/ Plants



Lay filter blanket and lightweight soil

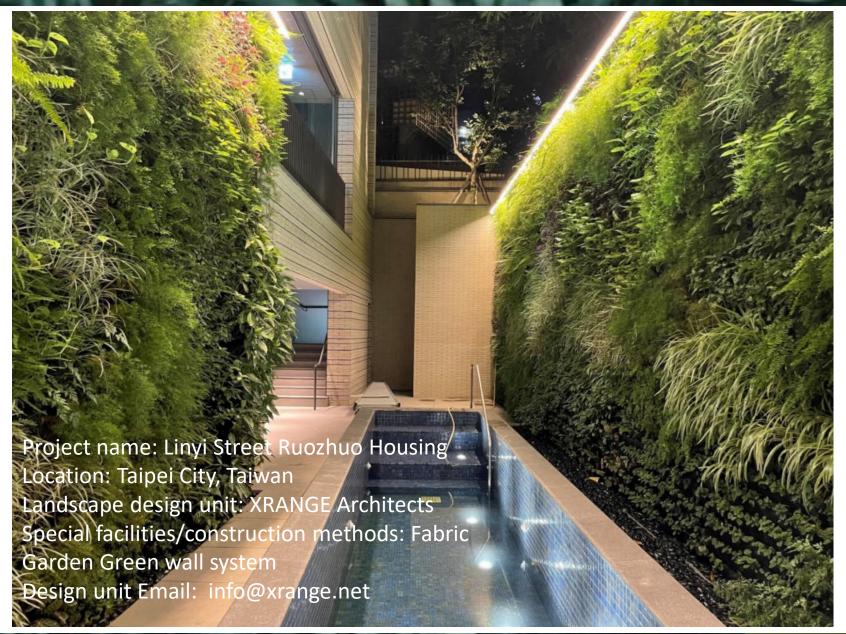
Yuanshan Exhibition Hall Green Roof DIY Demonstration







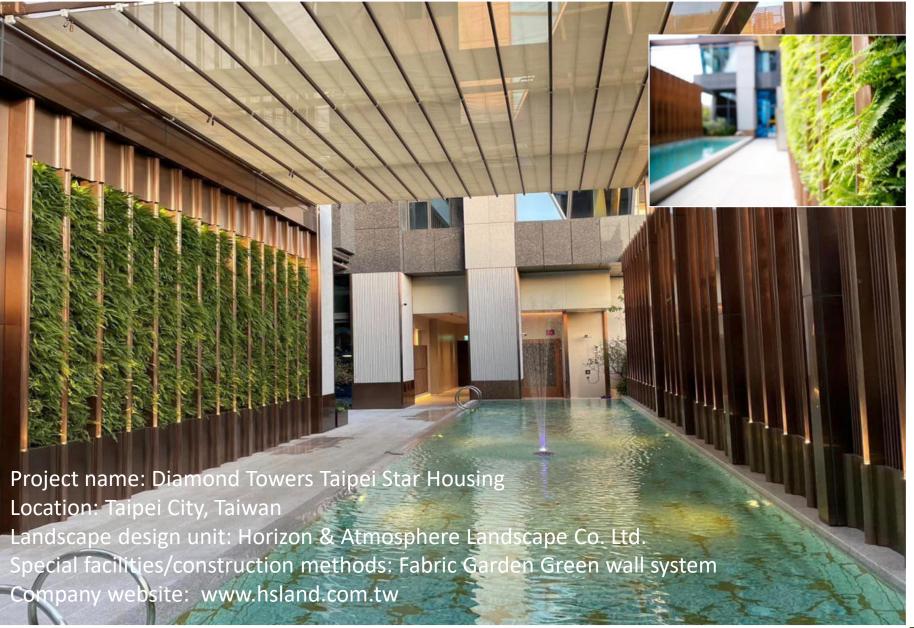
Linyi Street Ruozhuo Housing



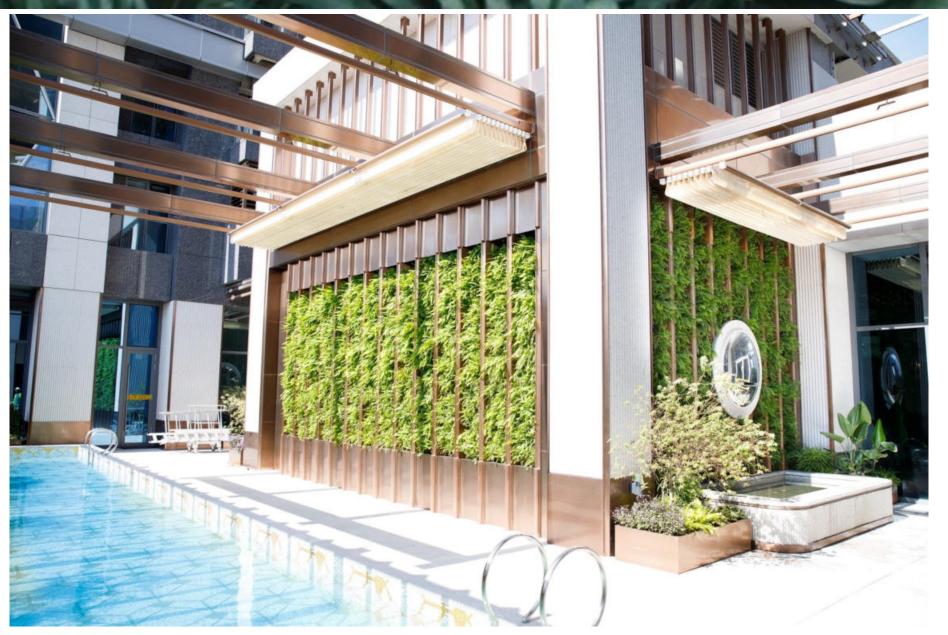
Linyi Street Ruozhuo Housing



Diamond Towers Taipei Star Housing



Diamond Towers Taipei Star Housing



Zhonghe tax office roof farmer garden



Project name: Zhonghe tax office roof farmer garden

Location: New Taipei City, Taiwan

Landscape design unit: Greenpros. Co., Ltd

Special facilities/construction methods: DIY Planter Box

Design unit Email: greenpros.tw@gmail.com

Project name: Farmer garden Location: Taipei City, Taiwan Planter: YIU TSAY Co., Ltd

Vegetable planter

Special facilities/construction methods: DIY Planter Box







無采共生 水耕箱 Hydroponic system

魚菜共生水耕箱簡單組裝,可有效利用水資源。當中層沉 澱池的水滿了,可經由過濾網回流至下層過濾盒,有效潔 淨水質,且只需重複清洗過濾海綿,就能持續使用,透過 沉水馬達將水抽回中層循環再利用,具備了省水、節能的

A simple hydroponics system is able to recycle precious water resources. The water overflows from the middle sedimentation tank, running through the bottom filtration box and return to the middle box in a pure and clean state via a submersible motor. With a simple rinse of the filter sponge, the water is recycled continuously presenting the benefits of water and energy conservation.

Rooftop Farm

Fruits farming

- 1. Is a sustainable system (Nimbolkar et al., 2016).
- 2. Is recognized for carbon storage because they can capture a large quantity of C in their vegetative organs for a longer period of time (Nardino et al., 2013)
- 3. Orchards soil is the primary terrestrial carbon sink globally (Hammad et al., 2020).
- 4. The carbon capture process can be done by different plant organs: trunks, branches, leaves, flowers, fruits, and roots (Henry et al., 2020).
- 5. The heavy bearing ability of fruit trees has a great tendency to increase carbon capturing from the atmosphere and store it in the form of cellulose (Patil and Kumar, 2017; Zade et al., 2020).
- 6. Fruit orchards can significantly contribute to sustainable fruit production under changing climate scenarios in tropical and sub-tropical areas (FAO, 2010; Nath et al., 2019).
- 7. Orchardists can derive their remuneration via carbon trading and gaining creditability (Page et al., 2011).

CO₂ absorbed by human?



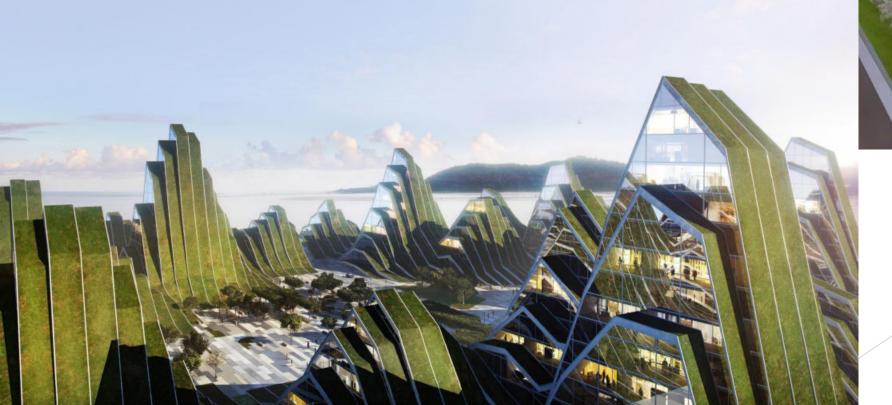
Project name: Vitality Village

Designer: Bjarke Ingels Group (BIG)

Areas: 27000m²

Height: 30m

Slope: 0 to 75 degree





Project name: Vitality Village

Designer: Bjarke Ingels Group (BIG)

Areas: 27000m²

Height: 30m







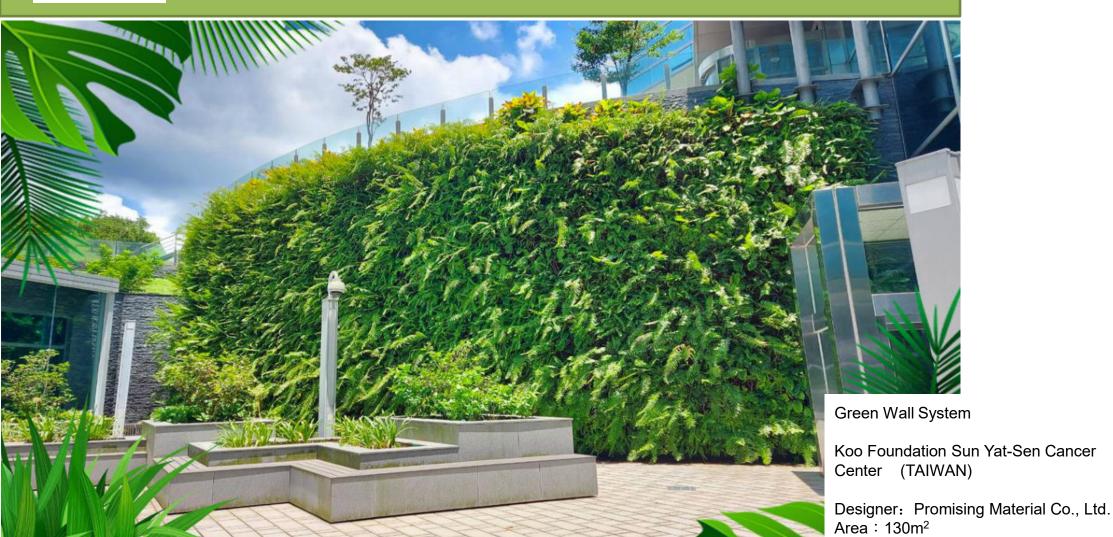






Green Wall Systems and Products

Date of completion: March 72017





Green Wall Systems and Products

Green Wall System - Maintenance records
Koo Foundation Sun Yat-Sen Cancer Center (TAIWAN)







August, 2017



February, 2018



October, 2018



September, 2019

80





February, 2020 • February, 2021

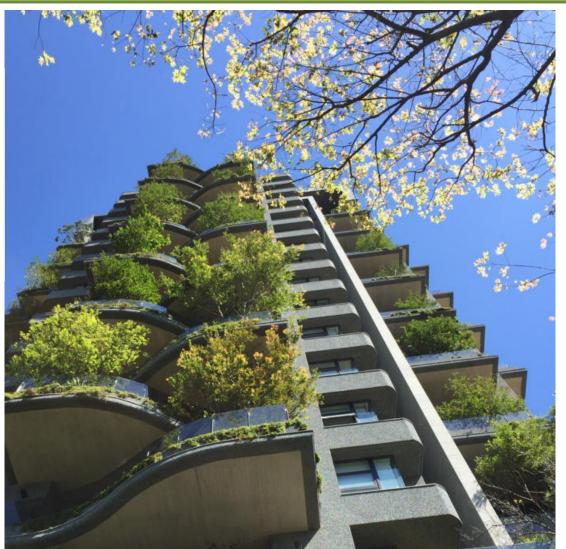


Vertical Greenery Project: Mountain I

2017 Banmu Tang 若山

Total Patio greening area: 4191m²
21 types of trees
144 types of shrubs and other plants
Highest tree is 7m
Green coverage rate is 150%
Carbon fixation rate is increased by
3.43 times.



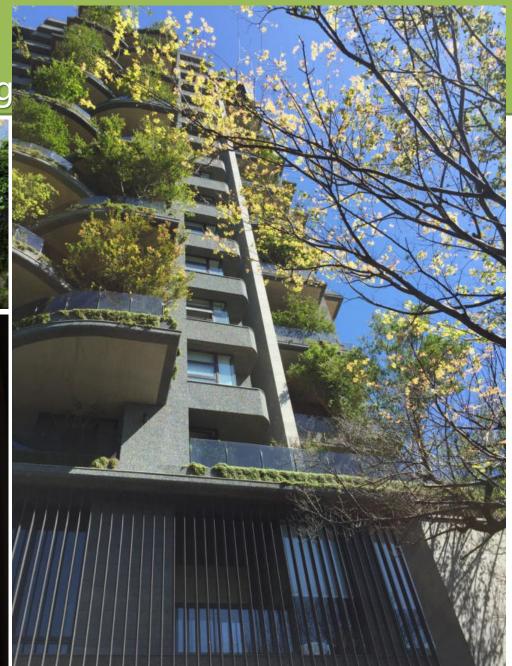




2017 Banmu Tang









Vertical Greenery Project: Mountain II

2018 Banmu Tang 若合山

Second example of collaboration with Banmu Tang for vertical greening. Plants and vines were selected based on micro climate simulations to ensure continual growth.





Vertical Greenery Project: Mountain II



Vertical Greenery Project: Mountain II



2018 Banmu Tang 若合L

Seasonal maintenance provides the residents with a small piece of nature where they can observe and understand how to live in harmony with nature.



Vertical Greenery Project





Vertical Greenery Project

2017 Pauian Archiland 富富話合

The design utilizes the tree crowns on each layered patios to create the image of a cloud.





Vertical Greenery Project





Pottery works from local Landscape Architect/Artist



- nt project Lu Ye
- 1. Project name: The comprehensive improvement project for the rural settlements including Rui Long in Lu Ye Township.
- 2. Designer: Jin Ying Yei Tao Pottery Ltd/Elegant lifestyle Co. Ltd.
- 3. Address: No. 21, Sec. 1, Ruijing Rd., Luye Township, Taitung County 955, Taiwan (R.O.C.))









