



Green Roofs, Green Schools and Green Education

綠化屋頂、綠色學校及綠色教育



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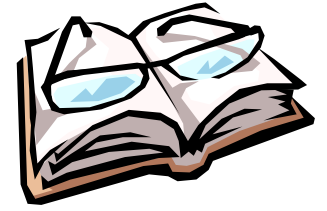
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Introduction 前言



- Problems in HK city 香港城市面對的問題
 - Urban heat island 熱島效應
 - Lack of greenery space 缺乏綠化空間
 - Stormwater management 雨水排洪管理
- Green roofs can help to mitigate the adverse effects 綠化屋頂可以幫助減輕不利影響
 - Bring the nature back 把大自然帶回來
 - Make better use of roof space 更好地利用屋頂空間



Examples of green roofs in Hong Kong 香港屋頂綠化的例子



HK Wetland Park 濕地公園



EMSD Headquarters 機電署總部



Parklane, TST 尖沙咀柏麗大道



A school in San Po Kwong
新蒲光某小學

(Photos taken by Dr Sam C M Hui)

Examples of green roofs in the world 國際屋頂綠化的例子



Solar Campus Jülich, Germany (11 Jul 2001)



IBN-DLO Wageningen, the Netherlands (2 Jul 2001)



Putrajaya Int. Conven. Centre, Malaysia (30 Jun 2006)



Beitou Taipei Library, Taiwan (6 Aug 2007)

(Photos taken by Dr Sam C M Hui)

Examples of green roofs in Singapore 新加坡屋頂綠化的例子



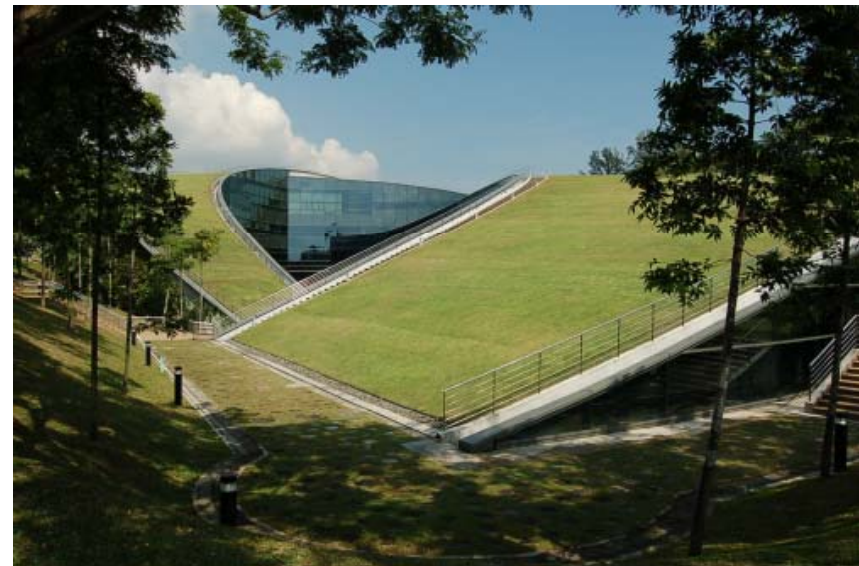
Carpark roof of public housing (modular green roof)



Carpark roof of housing estate (built-in green roof)



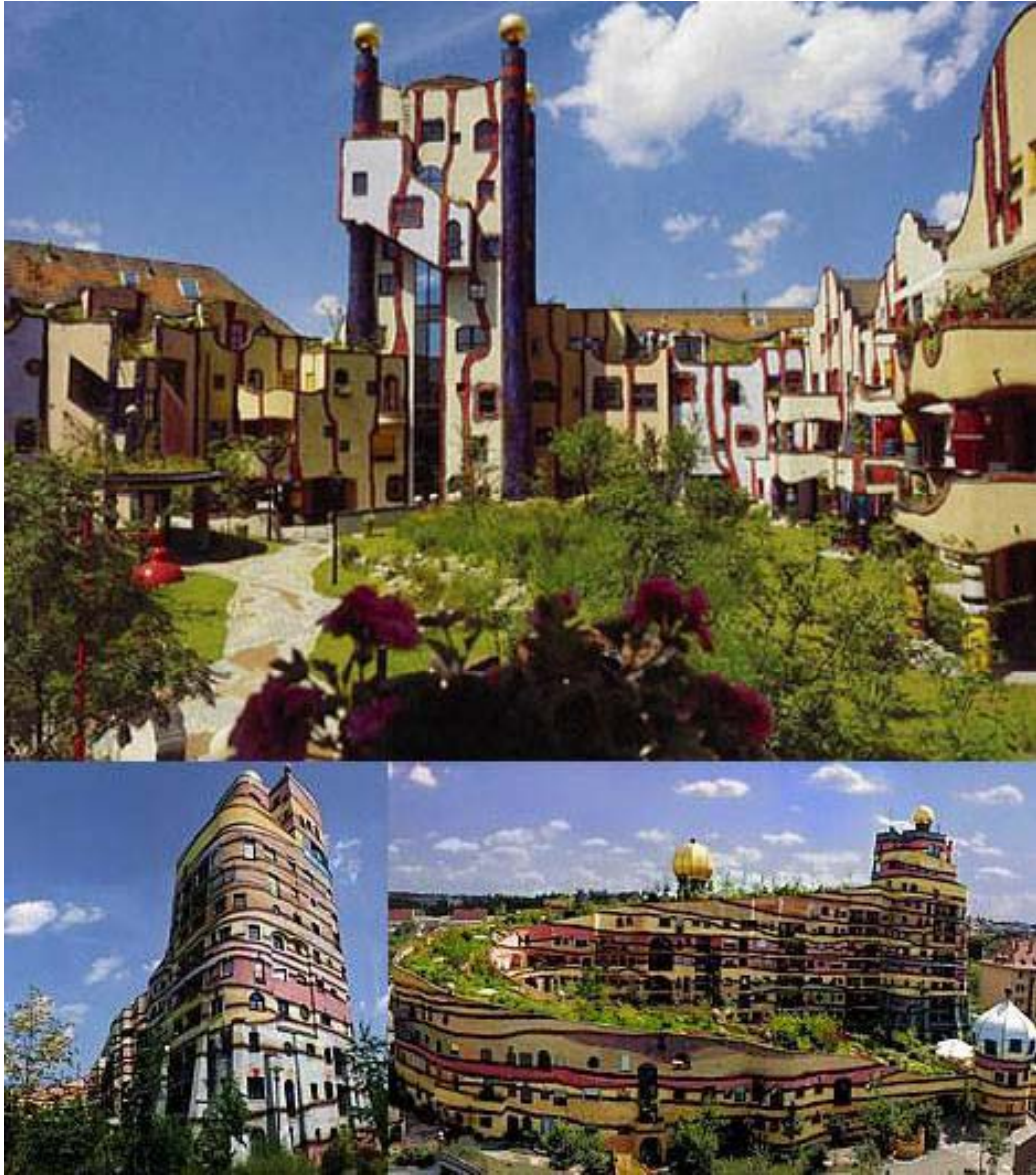
Carpark roof of public housing (intensive green roof)



Lawn green roof (Nanyang Techn. Univ.)

(Photos taken by Dr Sam C M Hui, 29 May & 1 Jun 2009)

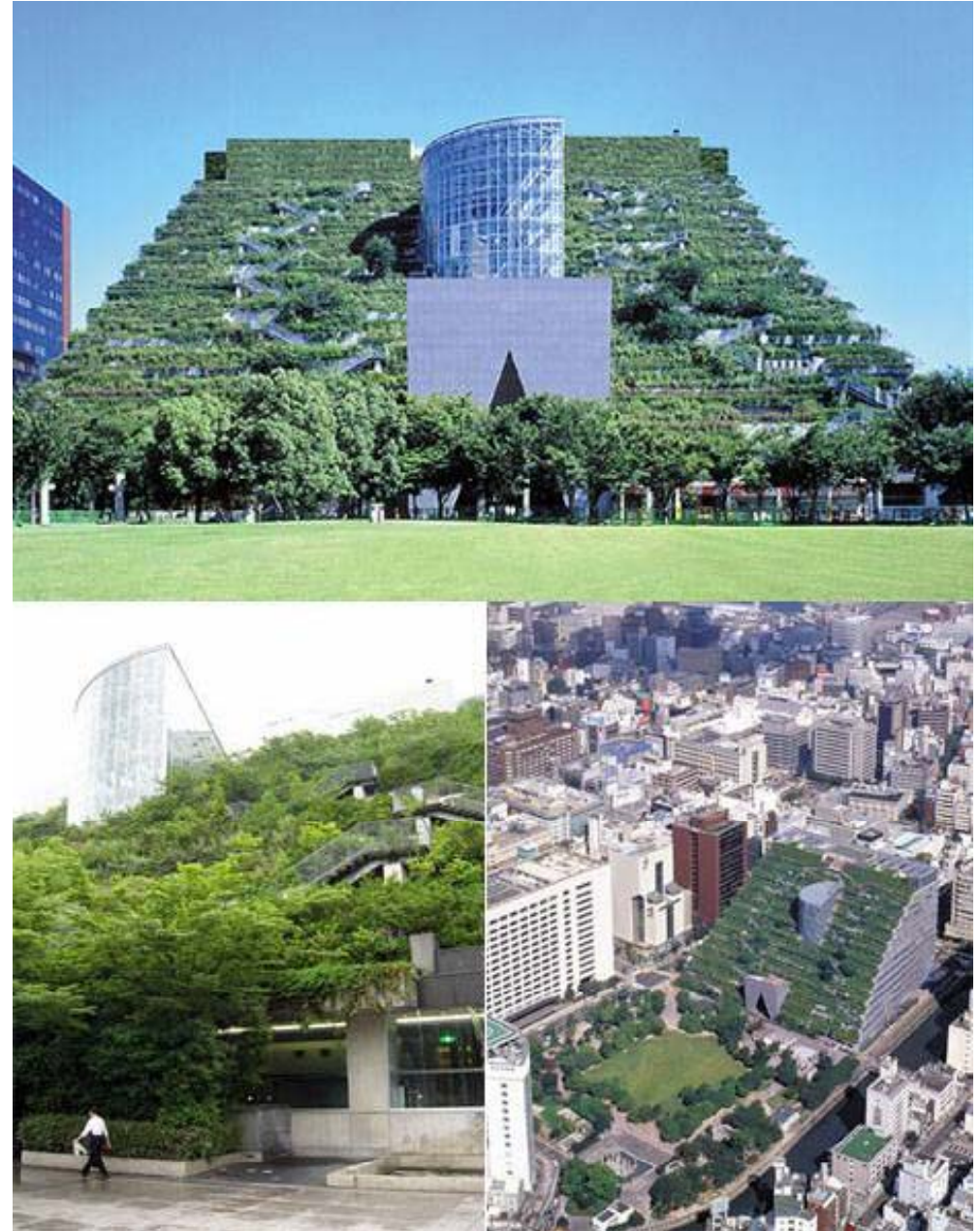
Green roofs in Germany (2000)
(Hundertwasser Building, Darmstadt)



德國屋頂綠化的例子

(Source: <http://weburbanist.com>)

Green roofs in Japan (1995)
(ACROS Fukuoka building)



日本屋頂綠化的例子

Green roofs and urban farming in Osaka, Japan (Namba Parks) (2003)

日本大版南波中心的屋頂綠化及都市耕種



(Source: www.treehugger.com & www.toho-leo.co.jp)

Green roofs 綠化屋頂



- Major types 主要類型 (see Table 1)
 - Extensive 粗放型
 - Semi-intensive 半密集型
 - Intensive 密集型
- Roof gardens 天台花園:
 - Usually intensive greening with other features such as potted plants, pond, etc. 通常為密集型 + 其他特徵
 - Sky gardens 高空花園 (e.g. > 15 storeys high)

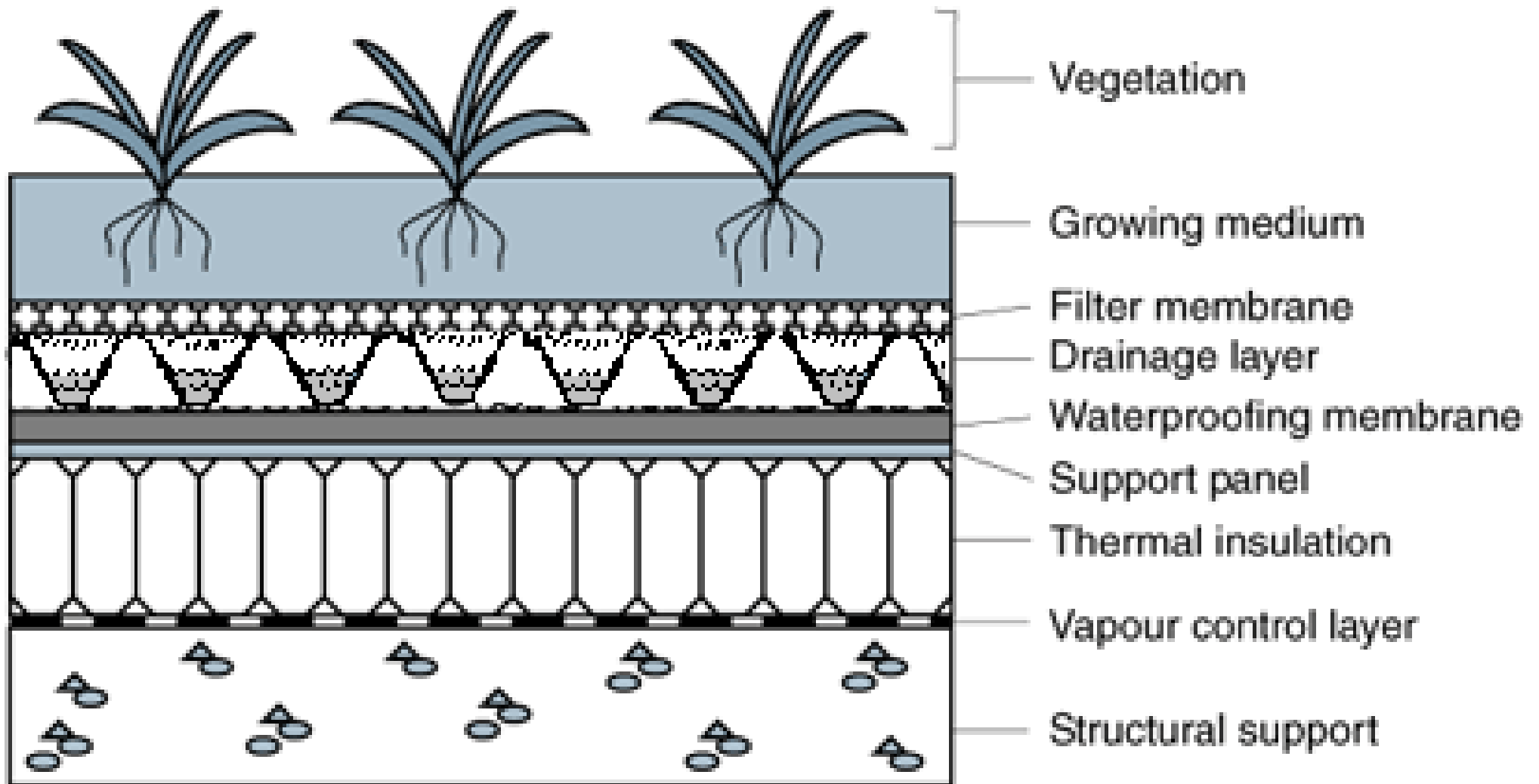


Table 1. Major types of green roofs and their characteristics

表1：主要類型的屋頂綠化及其特點

Characteristics	Extensive 粗放型	Semi-intensive	Intensive 密集型
Depth of material	150 mm or less	Above and below 150 mm	More than 150 mm
Accessibility	Often inaccessible	May be partially accessible	Usually accessible
Fully saturated weight	Low (70-170 kg/m ²)	Varies (170-290 kg/m ²)	High (290-970 kg/m ²)
Plant diversity	Low	Greater	Greatest
Plant communities	Moss-sedum-herbs and grasses	Grass-herbs and shrubs	Lawn or perennials, shrubs and trees
Use	Ecological protection layer	Designed green roof	Park like garden
Cost	Low	Varies	Highest
Maintenance	Minimal	Varies	Highest

Typical structure of extensive green roof 粗放型綠色屋頂的典型結構



Green roofs 綠化屋頂



- Classify green roofs 分類綠化屋頂:

- Built-in green roofs
固有綠化屋頂



- Modular green roofs
模塊化綠化屋頂





Vegetated mat system 草本墊系統 (www.elteasygreen.com)

Modular Green Roofs 模塊化 綠化屋頂



Tray system 托盤系統 (www.liveroof.com)



Sack system 袋系統 (www.greenpaks.com)

Green roofs 綠化屋頂



- Key factors for planning 主要規劃因素
 - Structural loading 結構負荷
 - Accessibility 能否容易到達
 - Waterproofing 屋面防漏水
 - Drainage 排水渠務
 - Maintenance 維護保養
- Other design considerations 其他設計考慮
 - Selection of plants (e.g. hardy plants) 選擇植物
 - Stakeholders' involvement & support 參與支持





Green schools 綠色學校

- A school with emphasis on environmental protection
一所重視環境保護的學校
- Whole school participation in environmental education
全校參與環境教育的校本計劃
- Focus on environmental protection in management
在管理上，綠色學校注重環境保護
- Resources for environmental education
添置有關環境教育的資源
- Integrated with curriculum & school activities
配合學校課程和課外活動
- Foster students' civil concepts
培養學生的公民意識



Environmental
citizenship

Sustainable
development

政策 統籌 課程 活動

綠色學校

行為 環境 資源 培訓



環保公民

意識 態度 行動



可持續發展

經濟 社會 環境

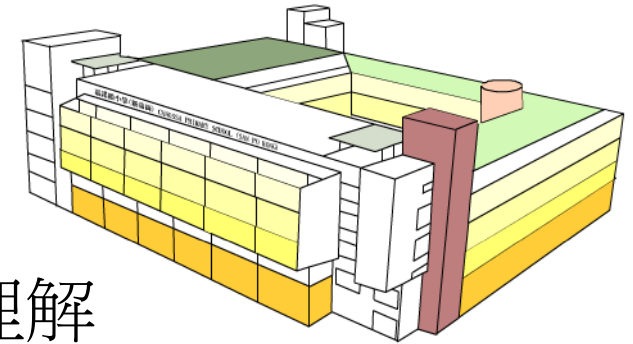
Green school



Green schools 綠色學校



- School buildings in HK 香港學校建築
 - Different designs & ages 不同的設計及年齡
 - Roofs for greening 屋頂綠化:
 - Classroom buildings 教室
 - Assembly halls 禮堂
 - Covered walkways 有蓋行人道
 - Limitations & barriers 限制與障礙
 - Lack of budget (\$\$) 缺乏預算
 - Knowledge & understanding 知識與理解
 - Accessibility & technical issues (e.g. water leakage fear) 無障礙及技術問題（如恐懼漏水）





Green schools 綠色學校

- Some school green roof projects 一些學校綠化屋頂項目

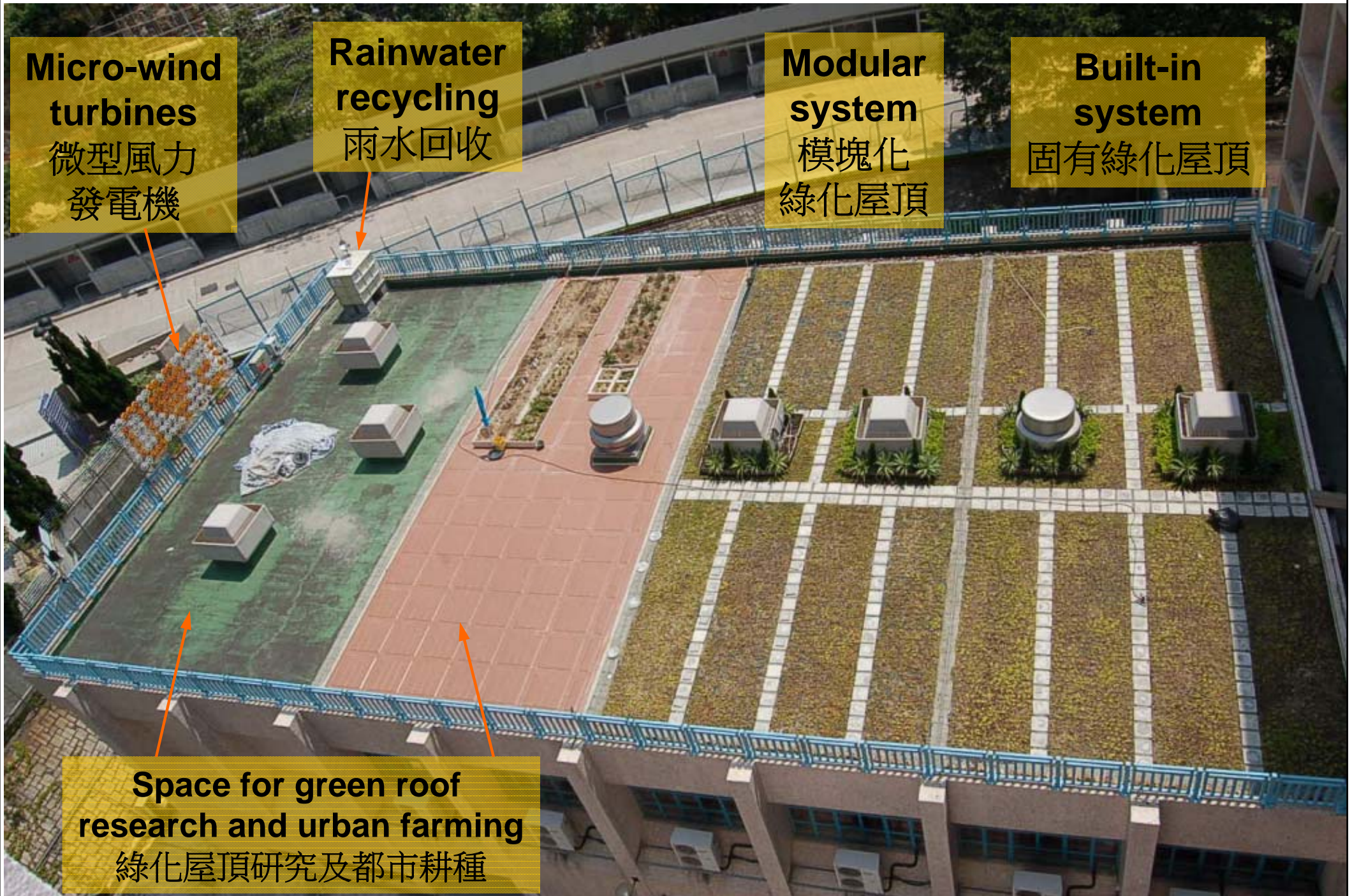


A school in San Po Kwong
新蒲光某小學



A school in Tsang Kwan O
將軍澳某小學

A green roof project with integrated systems 綠色屋頂項目的綜合系統



St. Bonaventure Catholic Primary School 聖文德天主教小學



Student farmer 小農夫



Vegetables grown in carpark 在停車場種植蔬菜



Vegetables grown in greenhouse (water-based)
在溫室種植蔬菜（水基）

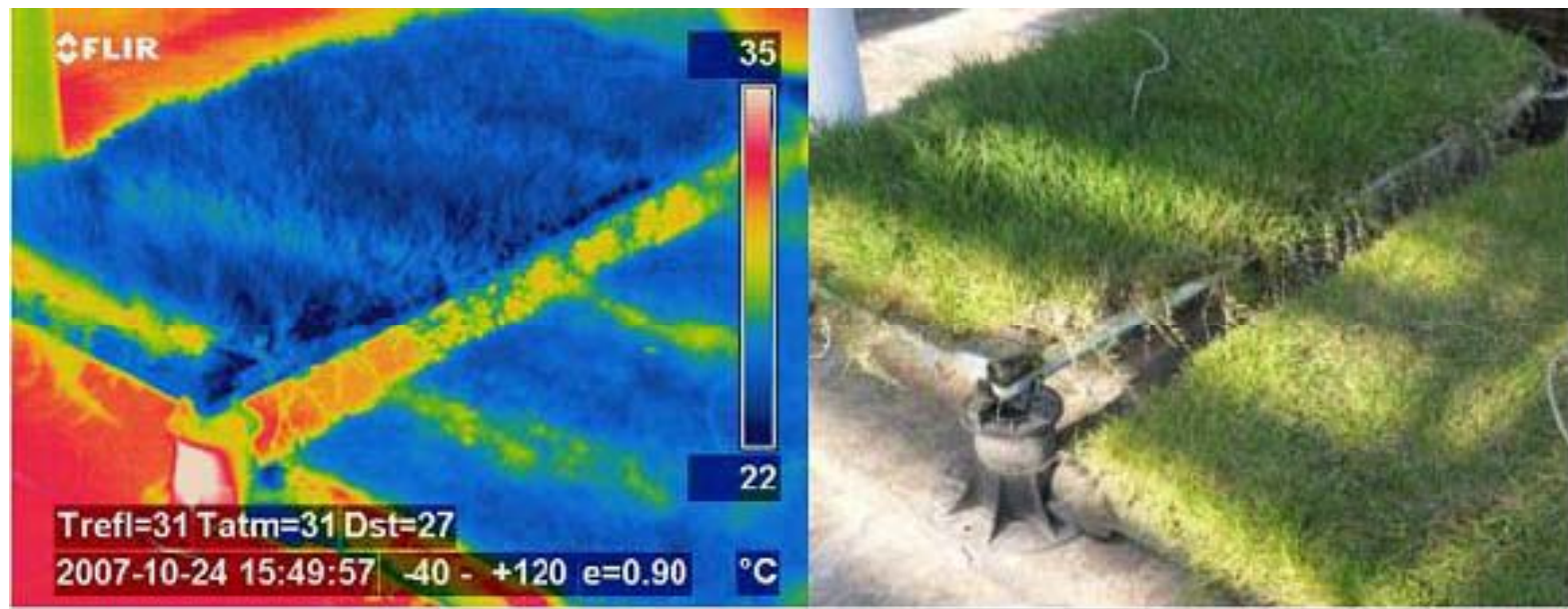


Herbs & vegetables grown on roof
在屋頂種植香草和蔬菜



Green schools 綠色學校

- Aims of our green roof research 我們綠化屋頂研究的目標：
 - Knowledge of green roof technology 科技知識
 - Assessment and design guidelines 設計評估
 - Practical green roof application 實際應用
- Why school buildings? 為何在學校？
 - They have good potential 學校有很好潛力
 - Demonstrate benefits & issues 展示各樣優點
 - Influence community & students 影響社區及學生
 - Serve many education purposes 很多教育作用



Infrared photo for assessing thermal effects
紅外光熱效應的評估



Typical hardy plants (sedums) used for green roofs
用於屋頂綠化的典型耐寒植物（景天科佛甲草）

Table 2. Public and private benefits of green roof systems
綠化屋頂系統的公共好處和私人好處

Public benefits: 公共好處	Private benefits: 私人好處
<ul style="list-style-type: none"> - Mitigate urban heat island - Reduce dust and pollutant levels - Stormwater retention - Natural habitat for animals/plants - Cities and landscapes - Nature look (aesthetic) 	<ul style="list-style-type: none"> - Increase roof life expectancy - Reduce noise levels - Enhanced thermal insulation - Heat shield - Better use of space - Reduced risk of glare for surrounding buildings

Green schools 綠色學校



- Other benefits 綠化屋頂的其他好處
 - Urban farming 都市耕種 (e.g. growing vegetables)
 - Make best use of roof space; may be organic
 - Education 教育
 - Integrated with school curriculum
 - Community and social functions 社區活動
 - Exercises & hobbies for children, adults & elderly
 - Horticultural therapy 園藝療法
 - Sensory, meditation effects; manage emotion/stress

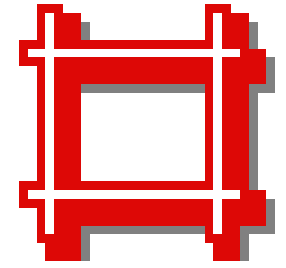


Urban farming & education
都市耕種及教育



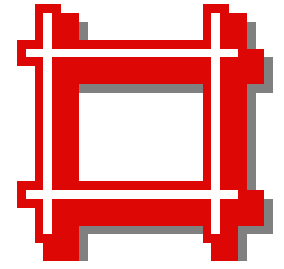
Horticultural therapy &
social functions
園藝療法和社區活動

Green education 綠色教育



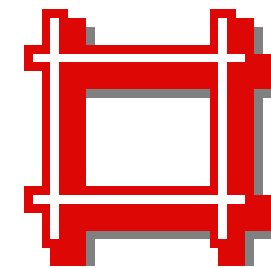
- School green roof projects 學校綠化屋頂
 - Allow school principal, teachers, students, parents, etc. to participate 容許校長、老師、學生、家長等參與，親身體驗感受綠化屋頂維護工作
 - They see, feel & help to maintain the green roof
 - Form part of the learning activities or school curriculum for students 組成學生或學校課程部分的學習活動
 - Provide space/opportunities for other functions e.g. urban farming & community activities 提供空間及機會作其他職能，例如都市耕種和社區活動

Green education 綠色教育



- Education functions 教育功能
 - Environmental 環保
 - Improve environmental awareness 加強環保意識
 - Learning from planting 讓學生從栽種體驗中學習
 - Scientific 科技
 - Enhance science education 加強科學教育
 - Liberal study 公民
 - Facilitate community involvement 促進社區參與
 - Horticulture 園藝
 - Allow natural functions 親近大自然活動

Green education 綠色教育



- Possible learning topics 可學習的題材
 - Biodiversity 生物多樣性
 - Building & roof construction 建築及屋面施工
 - Energy conservation 節約能源
 - Gardening & horticulture 園藝
 - Natural habitat 自然棲息地
 - Thermal insulation 熱能絕緣
 - Urban heat island 城市熱島
 - Water conservation 水源節約



Innovative green roof designs 創新的綠化屋頂設計



(Source: Havard University)

Examples of green walls 綠化牆體的例子



D.I.Y. vertical garden (Albert Quek)



Vertical greening (panel type)



Vertical greening (net & pack type)



Various types of vertical greening

(Photos taken by Dr Sam C M Hui, 1 Jun 2009)

Conclusions 總結



- Green roofs can provide many benefits to mitigate environmental problems in cities
- 屋頂綠化可以提供很多好處，以減輕環境問題的城市
- When applied to school buildings, green roofs can achieve both environmental and educational purposes
- 當用於校舍，綠化屋頂可以實現環境和教育目的

Conclusions 總結



- More efforts and research are needed in Hong Kong to develop design guidelines & practical experience for green roof application
- 需要更多的努力和研究，在香港制定綠色屋頂應用的設計準則和實際經驗



THANK YOU 謝謝 !!

The green roof volunteers in Hong Kong
香港綠色屋頂的志願者



(Our green roof research information can be found at: www.hku.hk/bse/greenroof/)