高雄市政府公務出國報告書
（出國類別：參與研討會）

香港2017全球永續建築國際研討會(WSBE17)
論文發表及參訪

服務機關：高雄市政府工務局
姓名職稱：趙建喬 局長、黃志明 總工程司
謝志昌 課長、涂展晟 幫工程司
出國地區：香港
出國期間：106年6月4日至6月9日
報告日期：106年8月29日

高雄市政府及所屬各機關公務出國報告書審核表

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<tr><td colspan="4">出國報告書名稱：香港 2017 全球永續建築國際研討會(WSBE17)論文發表及參訪</td></tr>
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（2 人以上，以 1 人為代表）</td><td>職稱</td><td>服務單位</td></tr>
<tr><td colspan="2">趙建喬</td><td>局長</td><td>高雄市政府工務局</td></tr>
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■2.格式完整（本文必須具備「目的」、「過程」、「心得」及「建議事項」）
■3.無抄襲相關出國報告
■4.內容充實完備
■5.建議具參考價值
■6.送本機關參考或研辦
■7.送上級機關參考
□8.退回補正，原因：□不符原核定計畫 □以外文撰寫或僅以所蒐集外文資料為內容 □內容過於簡略 □未依規定格式 □未登錄上傳資訊網
□9.本報告書除上傳至出國報告資訊網外，將採行之公開發表：
□辦理本機關出國報告書座談會（說明會），與同仁進行知識分享。
□於本機關業務會報提出報告書
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說明：

一、 本表由主辦機關填寫審核意見並核章，惟二級機關、學校應先送一級機關審核，加蓋首長職章後，報府核定。

二、 若主辦機關係一級機關，僅需於右欄處核章。

系統識別號：

高雄市政府及所屬各機關公務出國報告書提要

出國報告書名稱：

香港 2017 全球永續建築國際研討會(WSBE17)論文發表及參訪

出國主辦機關/聯絡人/電話

高雄市政府工務局/建築管理處/涂展晟/07-3368333#2282

出國人員姓名/服務機關/單位/職稱/電話

趙劍喬/高雄市政府工務局/局長/07-3368333#2433

黃志明/高雄市政府工務局/總工程司/07-3368333#3229

謝志昌/高雄市政府工務局/建築管理處/課長/07-3368333#2280

涂展晟/高雄市政府工務局/建築管理處/幫工程司/07-3368333#2282

出國類別：

□1 考察□ 2 進修 □3 研究 □4 實習 □5 洽辦業務 □6 參觀訪問 ■7 出席國際會議 □8 其他______________

出國期間：106 年 6 月 4 日至 6 月 9 日

出國地區：香港

報告日期：106 年 8 月 29 日

分類號/目：都市計畫/住宅政策/永續建築/綠建築

關鍵詞：高雄厝，永續建築，綠建築

內容摘要：

高雄市政府工務局為持續推動高雄市政府相關創新政策與法令能與國際最新趨勢連結，並同步關注全球永續建築領域之發展，參與永續建築（SB）系列國際性會議(WSBE 17)，本會議是目前國際上先進的永續環境、綠色建築、節能減碳、綠色能源、 綠建材等研究成果發表交流的主要場合，在永續建築環境相關學術領域具有重要地位。本屆主題強調創新、整合與行動的重要性，故本府由工務局趙建喬局長參加本次會議，並在「高性能綠色建築政策」的平行會議中發表演說，分享高雄厝政策的推動緣由與綠建築相關具體成效，並分享因應各項氣候變遷議題上，高雄市所做的努力與成果，此外，希冀能夠藉由創新政策作為，在國際活動中受到矚目，更顯示台灣積極參與全球性議題上的成果。

摘要：

為持續推動高雄市政府相關建管法令更新與國際最新趨勢連結，並同步關注全球永續建築領域之相關發展，持續參與永續建築（SB）系列國際性會議，每三年舉辦一次的全球永續建築會議，今年於 106 年 7 月 5 日~8 日在香港舉辦，「2017 全球永續建築環境國際會議」為國際上永續建築環境相關議題之重要研討會，其涵蓋之議題範圍廣泛及參加之國家及論文發表人數眾多，是許多國際上先進的永續環境、綠色建築、節能減碳、綠色能源、 綠建材等研究成果發表交流的主要場合，在永續建築環境相關學術領域具有重要地位。

今年工務局參與發表共計 4 篇，參與口頭發表 2 篇及海報論文 2 篇；分別為**口頭發表**：1.「高雄厝計畫的緣起-高雄面臨的挑戰」 A Discussion on the Benefits of Environment Performance of the Promotion of Kaohsiung Green Building Specialties Policy.；2.「高雄市太陽光電政策的推行與效益分析」Strategic Study on the benefit evaluation of solar photovoltaic promotion policy in Kaohsiung.，**海報論文**：1.「因應區域環境需求的能源效率設計研究-以高雄厝美濃菸樓為例」 Study on the energy efficiency of the climatic based passive design by Meinong Tobacco Barns in Kaohsiung.；2.「高雄綠色建築專業政策環境效益研究-高雄市集合住宅為例」 A Discussion on the Benefits of Environment Performance of the Promotion of Kaohsiung Green Building Specialties Policy -the Case Study on Residential Building in Kaohsiung City.，本年度「2017 全球永續建築環境國際會議」共計有 57 個國家、1800 多人參與，發表約 472 篇論文與創新成果，參與者包含了全球相關領域的學者、各地方政府的官員、產業界的專家及研究人員。

本屆香港 WSBE 17 主題是「Transforming Our Built Environment Through Innovation and Integration: Putting Ideas into Action」，強調創新、整合與行動的重要性。工務局趙建喬局長於 6 月 5 日下午在「高性能綠色建築政策」的平行會議中發表演說，分享高雄厝政策的推動緣由與具體成效，在因應各項氣候變遷的議題上，高雄市所做的努力與成果；趙局長在會議中表示，自高雄推動全台綠建築自治條例、建築物設置太陽光電設施辦法以來，已領先全國；階段成果已達成總減碳量 5,045 噸(約 1165 萬棵喬木固碳量)、設置 339,290m3 的雨水貯集設施(約 180 座國際標準泳池)、太陽光電綠電設置約 18,611kWp(約 17.9 座世運主場館設置量)、全齡通用化空間已有 17673 戶住宅採用通用化設計浴廁、立體綠化量合計 265,139 平方公尺(約 40 座國際標準足球場面積)；本次更藉由高雄厝創新政策的實踐，與全球各界共同分享與討論，也讓台灣目前外交困境上，能夠藉由創新政策作為，在國際活動中受到矚目，更顯示台灣積極參與全球性議題上的成果。

目　　錄

一、參加緣由

多年來，地球環境的不斷變異早已引起全球的關注，而探討永續建築的發展歷程應先從「環境永續發展」的觀點來看，「永續發展」概念起源於1972年「聯合國人類環境會議」，而在1987年聯合國世界環境與發展委員會(WCED)具體提出我們共同的未 來，其本意為「能滿足當代需求，而同時不損及後代子孫滿足其本身需求發展」；1992年6月聯合國於巴西里約熱內盧舉辦的地球高峰會議(Earth Summit)中，提出「21 世紀議程」(Agenda 21) 報告，促請世界各國遵循永續發展的原則；而於1999年的聯合國成立環境規劃署 (UNEP) 並發表「2000 年全球環境展望」。由這些國際趨勢發展可見「永續發展」的重要性。

我國做為氣候變遷衝擊第一線的海島國家，且二氧化碳排放量全球第 21 名，面對嚴峻國際環境課題當前，為確保國家永續發展並維持國際競爭力，著手研擬減緩與調適方案以即早因應氣候變遷的衝擊。行政院環保署自 2006 年即提出之「溫室氣體減量法 (草案)」，終於在2005年6月15日經立法院三讀通過並修正為「溫室氣體減量及管理法」，7月1日正式公告生效，訂定2050年長期減量目標，並規劃擬定階段性管制目標，使我國逐漸與國際管制腳步接軌，包括溫室氣體總量管制與排放交易，以邁向低碳綠能的時代。

本次高雄市政府工務局參與本國際性研討會，不僅代表高雄創新政策作為，受到國際重視，更讓全球各界瞭解台灣面對永續環境劇變的議題上，台灣是從不缺席，並積極發揮全球公民的責任，主動提出減緩地球暖化政策，同時提供更適宜高雄在地性的永續建築策略，透過高雄厝執行效益經驗進行分享受到與會城市及專家學者高度讚賞。

先進國家在加開的全球高峰會會中，討 論議題都跟建築產業息息相關，因此於 1990 年後，國際上陸續召開許多與建築相關的國際型會議。1998 年於加拿大溫哥華舉行第一次綠建築國際會議（GBC，Green Building Challenge），每三 年舉辦一次，由2000~2017 年各界舉辦城市與國家如表 1 所示。且陸續定期召開，探討以跨國界、跨領域的合作方式，以全球規模提出進行永續建築的因應方案，並提出未來應走的方向。

表 1 WSBE 各屆舉辦國家與城市

年度	舉辦國家/城市	年度	舉辦國家/城市
2000	荷蘭 / 馬斯垂克	2002	挪威 / 奧斯陸
2005	日本 / 東京	2008	澳洲 / 墨爾本
2011	芬蘭 / 赫爾辛基	2014	西班牙 / 巴塞隆納
2017	中國 / 香港	2020	瑞典 / 海德堡

為持續推動高雄市政府相關建管法令更新與國際最新趨勢連結，並同步關注全球永續建築領域之相關發展，持續參與永續建築（SB）系列國際性會議，每三年舉辦一次的全球永續建築會議，今年於106 年 7 月 5 日~8 日在香港舉辦，「2017 全球永續建築環境國際會議」為國際上永續建築環境相關議題之重要研討會，其涵蓋之議題範圍廣泛及參加之國家及論文發表人數眾多，是許多國際上先進的永續環境、綠色建築、節能減碳、綠色能源、 綠建材等研究成果發表交流的主要場合，在永續建築環境相關學術領域具有重要地位。

工務局趙建喬局長將於 6 月 5 日下午在「高性能綠色建築政策」的群組中發表演說，分享高雄厝政策的推動緣由與具體成效，在因應各項氣候變遷的議題上，高雄市所做的努力與成果

高雄地區傳統以加工出口、 金屬製造與石化材料等重工業為主要產業，藉由高雄港之 便擴展外銷，是過往帶動台灣經濟起飛的重工業焦點區域。陳菊市長自上任以來，市政府很努力在面對氣候變遷議題的在地化調適策略的因應，並首創綠建築自治條例與高雄厝辦法，且長期透過國際組織的交流合作並與 WSBE 創始主辦機構 iiSBE 國際永續環境促進會執行長「尼爾拉森(Nils Larsson)」簽署合作備忘錄(MOU)；圖 1 為 WSBE17HK 工務局局長與尼爾拉森(Nils Larsson)於會議午宴時交流合照，WSBE17 今年度主題為如何經由創新概念來轉變建設環境，並藉由永續概念來付諸行動。來自全球各界永續建築研究人員及相關單位齊聚香港，共同分享推動永續建築議題上的創新成果。

圖 1 工務局局長與尼爾拉森(Nils Larsson)於會議午宴時交流合照

二、參加目的

1. 藉由本府推動高雄厝計畫、綠建築法令成效，及永續發展創新政策的成果與績效，與國際永續建築相關人士，進行經驗分享與交流。

2. 行銷本府推動高雄厝計畫及各項永續推動理念，並瞭解國際間永續建築發展之成果，及最新產官學各項創新理念。

3. 參訪香港地區相關永續建築、綠建築及居住政策等案例，拓展國際視野，作為本府於高雄厝、綠建築、立體綠化等業務推動之參考借鏡。

三、會議內容(2017 全球永續建築環境國際會議)

1. 會議時間、地點

- 會議時間：2017 年 6 月 5 日~7 日
- 會議地點：中國/香港

香港（英語：Hong Kong，縮寫：HK）是中華人民共和國兩個特別行政區之一，位於南海北岸、以及珠江口東側，北接廣東省深圳市，西隔珠江與澳門及廣東省珠海市相望，其餘兩面與南海鄰接。全境由香港島、九龍、新界等 3 大區域組成，其中香港島是全港的發展核心；地理環境上則由九龍半島等大陸土地、以及 263 個島嶼構成，人口約 737 萬人（2016 年底）。

香港是全球重要的國際金融、服務業及航運中心，連續多年蟬聯全球最自由經濟體，並以優良治安、廉潔社會、簡單稅制和健全的法律制度而聞名於世，因此有「東方之珠」的美譽。「亞洲國際都會」則為官方定位的香港品牌。香港同時為全球其中一個最安全、經濟最發達、生活水平最高、競爭力最高、最適宜居住及人均壽命最長的大都會。空氣污染、貧富懸殊、政制發展等則為該地主要的社會問題。

香港會議展覽中心（簡稱會展；英語：Hong Kong Convention and Exhibition Centre，縮寫：HKCEC）是香港的主要大型會議及展覽場地，位於香港島灣仔北岸，是香港地標之一；由香港政府及香港貿易發展局共同擁有，由新創建集團的全資附屬機構香港會議展覽中心（管理）有限公司管理。每年舉辦 7 項亞洲最大規模及 4 項世界最大規模展覽。

圖 2 香港會議展覽中心外觀

2. 大會主題/會議議程

本屆香港 WSBE 17 主題是「Transforming Our Built Environment Through Innovation and Integration: Putting Ideas into Action」，強調創新、整合與行動的重要性。本屆 WSBE 17 主要包含五個部分：主會議、平行會議、展覽、晚宴以及生態之旅。在主會議及平行會議中，多位學界專家與政府代表針對不同主題發表演說與討論，其中包含巴黎協議（Paris Agreement）主要推手 Christiana Figueres、香港行政長官梁振英，展覽的部分則有許多政府部門及業界代表參與，包含 AECOM、SWIRE、ARUP 等主要贊助商，晚宴共計有 400 多位來自不同國家的專業人士，涵蓋政府、學者、建商、設計師、專業顧問及其他業界領袖，藉由晚宴進行另一種形式的交流與分享。在 100 多場平行會議中，主要分為四個主題：Mainland China sessions, Regional sessions, Paper sessions – Conference track, Special sessions，在為數最多的 Paper sessions 中，共有 300 多篇來自 50 個國家的論文以不同形式發表，包含來自台灣的學者與政府代表，透過演說闡述研究成果或政策發展，例如高雄市政府分享高雄厝的推動與成效、屏東縣政府發表城鄉發展等施政議題。

圖 3 本會議大會提供相關會議資料

WSBE 是全球重量級的永續研討會之一，主要目的是每三年集結所有專家檢討過去三年的成果並修正未來的方向，唯一的目標是人類與環境的永續發展。本次國際會議議程如表 2~4 所示。

表 2 WSBE17 2017.06.05 議程

<table>
<tr><td>日期 / 時間</td><td colspan="5">2017 年 6 月 5 日（星期一）</td></tr>
<tr><td>08:00-9:00</td><td colspan="5">會議報到</td></tr>
<tr><td>09:00-0:00</td><td colspan="5">開幕式</td></tr>
<tr><td>10:00-0:30</td><td colspan="5">專題演講 1.
張建忠 香港特別行政區 政務司長</td></tr>
<tr><td>10:30-1:00</td><td colspan="5">專題演講 2.
蘇雲山 中國住房和城鄉建設部 建築科技節能總局副長</td></tr>
<tr><td>11:00-1:20</td><td colspan="5">中場休息</td></tr>
<tr><td>11:20-1:50</td><td colspan="5">專題演講 3.
Ms Christiana FIGUERES, 氣候與能源全球市長公約 副主席</td></tr>
<tr><td>11:50-2:00</td><td colspan="5">贊助商_專題分享：Mr Sean CHIAO（AECOM）亞太區總裁</td></tr>
<tr><td>12:00-3:30</td><td colspan="5">交流午宴</td></tr>
<tr><td rowspan="4">13:30-5:00</td><td colspan="5">專題會議 1</td></tr>
<tr><td>Session 1.1
中國大陸會議-中國現有建築綠化改造綜合實施方案</td><td>Session 1.2
區域會議-捷克共和國，意大利，瑞典和瑞士</td><td>Session 1.3
先進的建築元素</td><td>Session 1.4
高性能綠色建築實踐與回顧</td><td>Session 1.5
SBE 評估-綠色社區（1）</td></tr>
<tr><td>Session 1.6
綠色政策和微氣候標準的推動與創新</td><td>Session 1.7
永續社區的願景：虛構與必要條件（論壇）</td><td>Session 1.8
居住者福祉的創新（1）</td><td>Session 1.9
綠色建築管理實踐與方法（1）</td><td>Session 1.10
SBE 中的綠色基盤設施-香港案例</td></tr>
<tr><td>Session 1.11
SBE 中的過程、設計、工具和方法（1）</td><td>Session 1.12
城市空間的社區再生</td><td></td><td></td><td></td></tr>
<tr><td>15:00-5:20</td><td colspan="5">中場休息</td></tr>
</table>

<table>
<tr><td>15:20-6:20</td><td colspan="5">圓桌會議 1：改造建築環境的創新觀點
主持人：Thomas LÜTZKENDORF 教授
德國 卡爾斯魯厄 理工學院
住房和房地產永續管理中心 主任
演講人：
1. 台麗祥 世界生物倫理委員會主席
2. Serge SALAT 城市形態與復雜系統研究所校長
3. Arno SCHLUETER 蘇黎世建築系統 ETH 教授 /新加坡 ETH 中心 城市實驗室首席調查員
4. 陸炳榮 Ronald LuRonald 公司 副總</td></tr>
<tr><td rowspan="4">16:30-8:00</td><td colspan="5">專題會議 2</td></tr>
<tr><td>Session 2.1 中國議題_摩天大樓的生態設計與施工</td><td>Session 2.2 區域會議-土耳其、希臘、埃、阿聯酋</td><td>Session 2.3 先進的建築系統</td><td>Session 2.4 高性能綠色建築政策（1）</td><td>Session 2.5 SBE 評估 - 綠色社區（2）</td></tr>
<tr><td>Session 2.6 促進綠色政策和標準的創新-碳評估</td><td>Session 2.7 分享深度節能和其他創新綠色措施的商業建築成功案例-在香港，中國大陸和海外(論壇)</td><td>Session 2.8 居住者福祉的創新（2）</td><td>Session 2.9 綠色建築管理實踐與方法（2）</td><td>Session 2.10 轉換 SBE 的作法-能源管理（1）</td></tr>
<tr><td>Session 2.11 SBE 中的過程、設計、工具和方法（2）</td><td>Session 2.12 城市再生過程</td><td>Session 2.13 啟動智能城市</td><td>Session 2.14 德國 BNB 系統建立建築綠色採購的永續評估方式</td><td></td></tr>
<tr><td></td><td colspan="5"></td></tr>
</table>

圖 4 大會開幕現況

表 3　WSBE17 2017.06.06 議程

<table>
<tr><td>日期
時間</td><td colspan="5">2017 年 6 月 6 日（星期二）</td></tr>
<tr><td>08:00-9:00</td><td colspan="5">會議報到</td></tr>
<tr><td>09:00-1:50</td><td colspan="5">主題：全球氣候變化與可持續發展</td></tr>
<tr><td></td><td colspan="5">演講者：
Mr WONG Kam-sing, 香港特區政府 環境局局長
Ms Christiana FIGUERES, 氣候與能源全球市長公約 副主席
Mr Gregor HERDA, 聯合國人類住區規劃署（人居署） 顧問
Mr John DULAC, 國際能源署技術政策建設 部門主管
Mr Nils LARSSON, 國際永續建築環境促進會 執行主任
Mr Pekka HUOVILA, 10YFP 永續建築與建築（SBC）計劃協調員
Ms Christine LOH, 香港特區政府環境部 副部長</td></tr>
<tr><td>11:50-2:00</td><td colspan="5">贊助商_專題分享：Dr Raymond YAU 總經理，太古地產</td></tr>
<tr><td>12:00-3:30</td><td colspan="5">交流午宴</td></tr>
<tr><td rowspan="4">13:30-5:00</td><td colspan="5">專題會議 3</td></tr>
<tr><td>Session 3.1
中國論壇 －中國低碳經濟發展，綠色金融和投資</td><td>Session 3.2
國際青年競賽（1）</td><td>Session 3.3
先進的建築系統-發電系統（1）</td><td>Session 3.4
高性能綠色建築政策（2）</td><td>Session 3.5
綠色建築效益評量（1）</td></tr>
<tr><td>Session 3.6
創新促進更環保的政策和標準-實踐與回顧</td><td>Session 3.7
高性能交通樞紐:其關鍵作用和要件</td><td>Session 3.8
居住者福祉的創新-生物氣候設計</td><td>Session 3.9
綠色建築管理實踐與方法（3）</td><td>Session 3.10
轉換 SBE 的作法-能源管理（2）</td></tr>
<tr><td>Session 3.11
永續發展的 BIM（1）</td><td>Session 3.12
永續建築環境中的創新實踐</td><td>Session 3.13
社區賦權（1）</td><td>Session 3.14
人與環境的互動式建築</td><td></td></tr>
<tr><td>15:00-6:20</td><td colspan="5">中場休息</td></tr>
</table>

<table>
<tr><td>15:20-6:20</td><td colspan="5">圓桌會議1：永續建築環境
主持人：Ms Christine LOH 香港特區政府環境部 副部長
演講者：
1. Dr George BAIRD, Victoria University of Wellington 名譽教授
2. Mr Douglas WOO, Wheelock and Company Ltd. 主席兼總經理
3. Prof. Greg FOLIENTE, 墨爾本大學
4. Mr TAN Tian-chong, 建築環境研究與創新所 副所長
5. Mr Lincoln LEONG, 地鐵公司 執行長</td></tr>
<tr><td rowspan="4">16:30-8:00</td><td colspan="5">專題會議4</td></tr>
<tr><td>Session 4.1
中國論壇 -健康綠色建築綜合評估和專業實踐</td><td>Session 4.2
國際青年競賽（2）</td><td>Session 4.3
先進的建築系統-發電系統（2）</td><td>Session 4.4
高性能綠色建築政策（3）</td><td>Session 4.5
綠色建築效益評量（2）</td></tr>
<tr><td>Session 4.6
綠色建築技術（1）</td><td>Session 4.7
待公布</td><td>Session 4.8
友善的創新生態設計</td><td>Session 4.9
提供低碳生活的的合作機制</td><td>Session 4.10
轉換SBE的作法-能源管理（3）</td></tr>
<tr><td>Session 4.11
永續發展的BIM（2）</td><td>Session 4.12
健康建設，人體舒適與健康</td><td>Session 4.13
社區賦權（2）</td><td>Session 4.14
綠色平台：活力社區的催化劑</td><td></td></tr>
<tr><td></td><td colspan="5"></td></tr>
</table>

圖5 大會現場現況

表 4　WSBE17 2017.06.07 議程

日期 時間	2017 年 6 月 7 日（星期三）				
08:00-9:00	會議報到				
09:00-9:30	專題演講 4. Prof. Peter GUTHRIE, 劍橋大學永續發展中心主任				
09:30-0:00	主題演講 5. Prof. Thomas AUER, 慕尼黑理工大學建築科技與氣候中心 教授				
10:00-0:30	中場休息				
10:30-2:00	專題會議 5				
	Session 5.1 區域會議-加拿大、巴西、葡萄牙、荷蘭、德國和塔林赫爾辛基	Session 5.2 瑞典高性能建築和永續社區	Session 5.3 SBE 智能主動式措施（1）	Session 5.4 深入翻新-政策與標準	Session 5.5 SBE 評估-綠色建築政策
	Session 5.6 綠色建築技術（2）	Session 5.7 促進更環保政策和標準的創新-評估、分析與建模（1）	Session 5.8 永續社區-案例研究回顧（1）	Session 5.9 綠色市場轉型綠色經濟（1）	Session 5.10 零耗能
	Session 5.11 SBE 中的流程、設計、工具和方法（3）	Session 5.12 綠色建築的居住者評估	Session 5.13 利益相關者的合作	Session 5.14 永續生活的智能數位化改造	
12:00-3:30	中場休息				
13:30-5:00	專題會議 6				
	Session 6.1 區域會議-澳大利亞、中國大陸、新加坡、南韓和菲律賓	Session 6.2 SBE 城市挑戰：評估方案和案例研究	Session 6.3 SBE 智能主動式措施（2）	Session 6.4 深入翻新-實踐與績效評估	Session 6.5 SBE 評估-設計過程
	Session 6.6 綠色建築材料（1）	Session 6.7 促進更環保政策和標準的創新-評估、分析與建模（2）	Session 6.8 永續社區-案例研究回顧（2）	Session 6.9 綠色市場轉型綠色經濟（2）	Session 6.10 改革 SBE 的創新實踐（1）

	Session 6.11 SBE 中的流程、設計、工具和方法（4）	Session 6.12 綠色建築-居住者的觀點	Session 6.13 地方決策--一體化設計流程	Session 6.14 BEAM^{+}社區-從理論到實踐	
15:00-5:10	中場休息				
15:10-6:40	專題會議 7				
	Session 7.1 改革 SBE 的教育和培訓	Session 7.2 SBE 建築挑戰：評估方案和案例研究	Session 7.3 SBE 智能主動式措施（3）	Session 7.4 深入翻新-流程與方法	Session 7.5 SBE 評估 -實踐評估
	Session 7.6 綠色建築材料（2）	Session 7.7 創新促進更環保的政策和標準-智能措施	Session 7.8 永續的社區-過程和應用	Session 7.9 轉變綠色市場-供應鏈	Session 7.10 改變 SBE 的創新實踐（2）
	Session 7.11 SBE 中的流程、設計、工具和方法（5）	Session 7.12 城市再生政策的多層面思考	Session 7.13 定位-實踐審查	Session 7.14	
16:50-7:20	專題演講 6. Dr Raymond COLE, 哥倫比亞大學 建築與景觀設計學院教授				
17:20-8:00	閉幕儀式				

圖 6 大會專題討論與報告現況

3. 參與發表與投稿說明

今年工務局參與發表共計 4 篇，參與口頭發表 2 篇及海報論文 2 篇；分別為口頭發表：1.「高雄厝計畫的緣起-高雄面臨的挑戰」 A Discussion on the Benefits of Environment Performance of the Promotion of Kaohsiung Green Building Specialties Policy.；2.「高雄市太陽光電政策的推行與效益分析」 Strategic Study on the benefit evaluation of solar photovoltaic promotion policy in Kaohsiung.，海報論文：1.「因應區域環境需求的能源效率設計研究-以高雄厝美濃菸樓為例」 Study on the energy efficiency of the climatic based passive design by Meinong Tobacco Barns in Kaohsiung.；2.「高雄綠色建築專業政策環境效益研究-高雄市集合住宅為例」 A Discussion on the Benefits of Environment Performance of the Promotion of Kaohsiung Green Building Specialties Policy -the Case Study on Residential Building in Kaohsiung City.，本年度「2017 全球永續建築環境國際會議」共計有 57 個國家、1800 多人參與，發表約 472 篇論文與創新成果，參與者包含了全球相關領域的學者、各地方政府的官員、產業界的專家及研究人員。

工務局趙建喬局長於 6 月 5 日下午在「高性能綠色建築政策」的群組中發表演說，分享高雄厝政策的推動緣由與具體成效，在因應各項氣候變遷的議題上，高雄市所做的努力與成果；趙局長在會議中表示，自高雄推動全台綠建築自治條例、建築物設置太陽光電設施辦法以來，已領先全國；階段成果已達成總減碳量 5,045 噸(約 1165 萬棵喬木固碳量)、設置 339,290m3 的雨水貯集設施(約 180 座國際標準泳池)、全齡通用化空間已有 17673 戶住宅採用通用化設計浴廁、立體綠化量合計 265,139 平方公尺(約 40 座國際標準足球場面積)；本次更藉由高雄厝創新政策的實踐，與全球各界共同分享與討論，也讓台

灣目前外交困境上，能夠藉由創新政策作為，在國際活動中受到矚目，更顯示台灣積極參與全球性議題上的成果。

針對高雄市政府推行多年的「太陽光電設置計畫」的政策與成果發表；工務局努力於未來達成 200MW（百萬瓦）光電系統設置量，並提出推廣多元化太陽光電的設置模式、整合國有及公有區域光電設置及推行太陽光電與立體綠化的整合，創造建築物的新形象。

今年參與 2017 全球永續建築環境國際研討會（WSBE 17）針對高雄市政府推行多年的「太陽光電設置計畫」的政策與成果發表，在此次國際會議中高雄市能夠藉由十大光電創新政策工具作為，提出 4 年百座世運光電計畫，目標 200MW（百萬瓦），於 6/6 在國際會議的發表受到各界矚目，更顯示台灣積極參與全球性綠色創能上的成果。

高雄市政府太陽光電的具體政策及成果，目前已達 3199 處的設置位址，設置容量約 223MW，約每年能夠減少 15 萬 349 噸的二氧化碳量，預估發電量 2 億 8475 萬 2195 度。現行光電推動具體政策包括「成立運作組織」：跨局處太陽光電推動委員會、結合專業團體與社區參與光電計畫、市府成立太陽光電專責窗口；「研擬不同類型政策工具」：創設太陽光電政策工具、太陽光電結合容積獎勵、透過審議手段強制設置光電；「建立推動標的」：深化公有建築屋頂設置太陽光電、建置太陽光電示範區、違建轉光電改造創新能建築、農漁業設施設置太陽光電等。

在未來永續環境政策的推行，工務局將持續在推廣多元化太陽光電的設置，包含垃圾掩埋場地面型光電設施、滯洪池及水庫漂浮光電等；並整合國有及公有區域光電設置容量，如加工出口區、岡山榮民之家與大專院校等；更希望未來逐步推行太陽光電與立體綠化的整合，提出具體實施計畫，朝向「創能、儲能、節能」成為高雄市建築物的未來趨勢。

圖 7 工務局趙建喬局長於會議中口頭發表

圖 8 WSBE 國際會議開幕現況

三、行程考察內容

1. 考察團成員及行程安排

2017 全球永續建築環境國際研討會（WSBE 17, World Sustainable Built Environment Conference 2017 Hong Kong）在香港於 6 月 5-9 日舉辦，今年共有 70 餘國，約 3000 多人參與，發表約 472 篇論文與創新成果，高雄今年提出成果共有四篇成果獲大會審核通過與發表；高雄市工務局以「高雄厝建築環境政策」進行發表，藉此國際會議交流場合，工務局趙建喬局長率隊參與，參與同仁如表 3 所示。

表 3 工務局參加 WSBE 17 國際會議的同仁名單

NO.	局處	姓名	職稱
1	高雄市政府工務局	趙建喬	局長
2		黃志明	總工程司
3	高雄市政府工務局建築管理處	謝志昌	課長
4		涂展晟	幫工程司

圖 9 工務局同仁暨與會專家學者於大會入口合影

表 4 工務局參加 WSBE 17 國際會議整體考察行程

日期	行　　程
Day 1 06/04(日)	**高雄-香港** ■ KA443 去程:高雄-香港 13:20-14:55
Day 2 06/05(一)	**香港** ■ 參加2017 WSBE國際研討會 09:00-18:00 ● 會議報到 08:00-09:00 ● 開幕儀式 09:00-10:00 ● 專題致詞 10:00-12:00 ● 主題論壇 13:30-18:00
Day 3 06/06(二)	**香港** ■ 參加2017 WSBE國際研討會 09:00-18:00 ● 會議報到 08:00-09:00 ● 專題演講(全球氣候變化與永續發展主題) 09:00-12:00 ● 主題論壇 13:30-18:00
Day 4 06/07(三)	**香港** ■ 參加2017 WSBE國際研討會 09:00-18:00 ● 會議報到 08:00-09:00 ● 專題演講 09:00-10:00 ● 主題論壇 10:30-16:40 ● 專題演講 16:50-17:20 ● 閉幕儀式 17:20-18:00
Day 5 06/08(四)	**香港** ■ 案例參訪與考察 09:00-18:00
Day 6 06/09(五)	**香港-高雄** ■ 市區考察 09:00-12:00 ■ 行李寄放 09:30-12:00 ■ KA454 回程:香港-高雄 16:55-1825

2. 考察行程

(1) 香港中文大學建築系(學術交流)

中大建築學系成立於 1991 年，學院現開辦五個本科及研究院課程，專研五個學術研究範疇，並設有三個研究單位，包括建築遺產研究中心、社區參與研究組，以及環境及可持續設計研究組，集中資源探索舊建築、永續環境設計及社區參與三大領域，為香港以至中國華南地區的城市規劃及永續建築提供重要指引。

參訪香港中文大學建築系可了解目前全球建築的最新發展趨勢的方向，並透過鄒經宇教授的導覽，中大建築系將永續建築的發展趨勢直接在建築系大樓直接呈現出來，除了永續建築的要求從原有的高性能提升至性能與健康性並重，評估建築物永續性的時間軸也從設計與施工延展至營運端的全生命週期。因此，新世代的永續建築，不再只是追求環境、社群以及經濟發展的三重底線均衡發展，而是需要更強調「人本健康、地球永續」的核心價值，一切以人的健康與舒適度作為設計、施工與營運的發展原點。

目前中大建築系，除了一般建築系應有的繪圖評圖教室等空間之外，並建 置因應數位化建築需要的四維 CNC 數位切割系統儀以及每個年級皆於工作室配有雷射切割與 3D 列印機，其設備完整度高於國內大專院校相關科系的設備；另一方面，中文大建築系與香港政府的有關建築與都市發展部門有相當密切的聯繫，不僅僅是將國際間的最新趨勢讓政府單位了解，更是香港政府重要的幕僚單位，鄒經宇教授表示，學術單位與政府機構的充分合作，不僅是讓學校學生對於產業界實務、新資訊的應用等相互的連結，並加強產業界與學術界之間的現有聯繫，中大與政府部門、產業界之間的合作已經越來越密切了，合作的模式也愈加豐富，贏得更多的信任與尊重，共同推進整體城市的合作與技術發展。


（1）建築系館前合影


（2）建築系館屋頂農園合影


（3）建築系圖書館合影


（4）學生畢業設計展


（5）於建築系室內合照


（6）與中大鄒教授交流互動


（7）黃總工程司致贈紀念品


（8）與中大鄒教授交流互動

圖 10 香港中文大學建築系交流考察

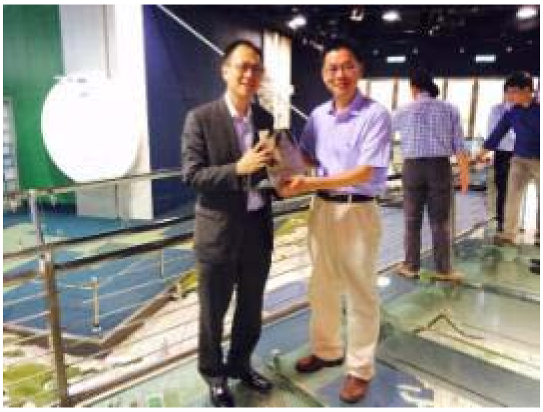
(2) 香港房屋署(城市發展)

房屋署是香港房屋委員會(房委會)的執行機關。房委會為法定機構,負責制定及推行公共房屋計劃,從而達至政府的公屋政策目標。房屋署同時為運輸及房屋局提供支援,處理有關房屋的政策和事務。

此次參訪香港房屋委員會展覽中心展示香港的公營房屋發展,以及多年來的工作和成果。展覽中心佔地 1000 平方米,設有內容豐富的展示說明、有趣的公宅樓房模型、懷舊的模擬單位,以及歷史發展照片和影片,為你呈現香港公共房屋的發展歷程。沿 着玻璃瞭望橋,你可俯瞰我們在各區的發展項目;你更可到互動角,透過有趣的遊戲建設理想的公共屋邨。

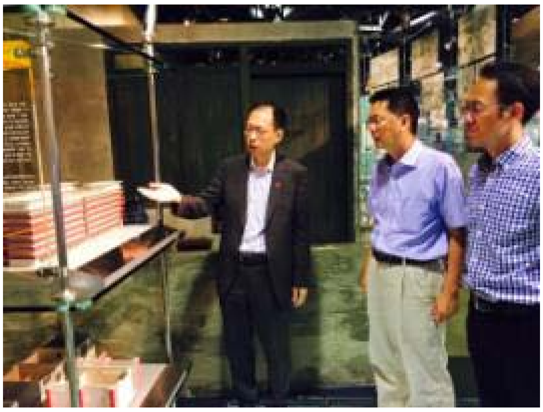
透過房屋署總建築師嚴汝洲先生的說明,在香港因應氣候變遷以及生活型態的改變下,香港公宅的發展歷程以及整個香港的都市規劃的演變;參觀開始,嚴總建築師先撥放一段短片,講述香港房屋委員會及房屋署的目標及變革、公共屋邸的發展歷程以及建造方式等,讓我們對展覽中心的展示項目有初步了解,隨後嚴總建築師介紹展覽中心的布局與設計,並逐一介紹公宅的建築結構、家具裝潢、通風採光策略等重要設計因素;展覽中心不僅是以平面式的海報說明,更透過全香港的縮尺模型來看城市發展,透過互動模型談公宅的採光導風設計策略;清楚說明,從一個城市發展的歷程中,一個城市的努力是可以用很具體的說明方式,讓參觀者明瞭城市的發展願景。

對於地方政府而言,建置一處城市發展示範展示空間,是一個很明確展示都市發展脈若的方式,不僅是讓城市居民了解城市的歷史、人文、地景等等地方文化,也是政府部門面對城市變遷與發展格局的清晰表述。



（1）感謝 嚴總建築師的講解

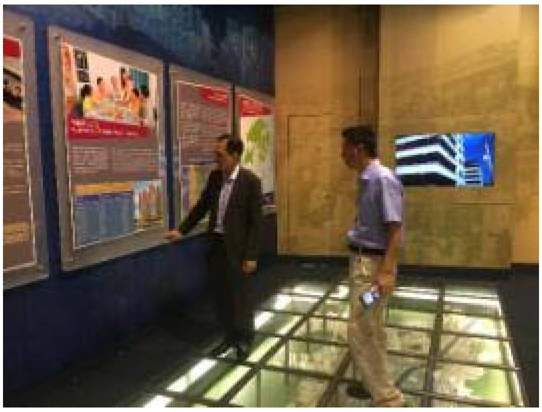
（2）於玻璃瞭望橋上合影



（3）公宅的演變

（4）公宅的演變

（5）都市規劃的進程



（6）都市環境評估系統

（7）房屋署前合影

（8）全香港城市模型一角

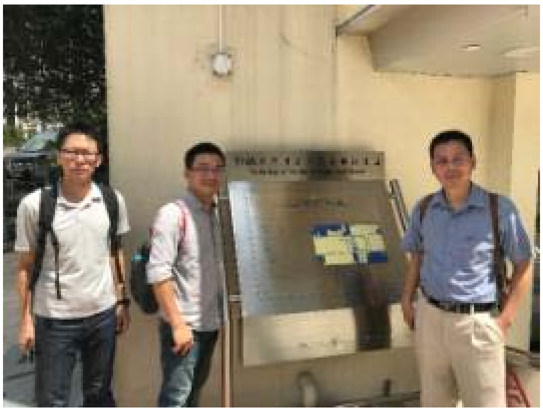
圖 11 香港房屋署都市發展展示場域參觀考察

(3) 美荷樓_青年旅舍(舊建築再利用)

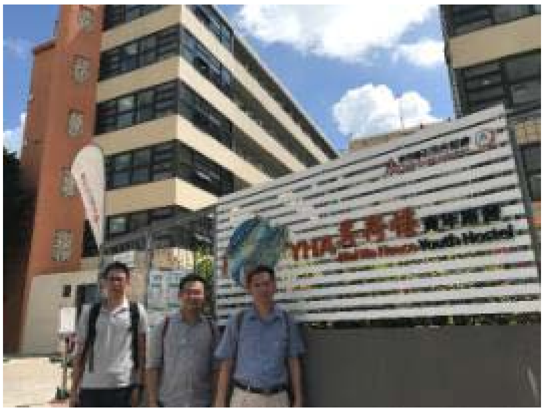
美荷樓_青年旅舍在香港的歷史建築級別:二級歷史建築,落成年份:1954 年,在香港,很多人都是「屋 邨仔」(在公共房屋長大的人)。現在,您也可以走進、甚至住進香港昔日的公共房屋,體驗這種道地的草根生活!美荷樓前身是安置災民的安置大廈,是目前香港僅存的 H 型大廈,位於第一代公共房屋石硤尾徒置區內。

經過活化後,美荷樓已變身成現代化的旅舍,地面和一樓的「美荷樓生活館」免費開放。館內有浴室、洗手間、雜貨店及居住單位等複製場景,以及超過 1,200 件藏品、40 多段口述歷史,讓您了解 1950 至 1970 年代香港公共屋邨居民的生活點滴。或住進由單位改建而成的房間,裡頭設有雙人房、家庭房和多人房等。

圖 12 香港美荷樓_青年旅舍相關解說暨活動文宣品



（1）美荷樓前合影



（2）美荷樓前合影

（3）生活館供校外教學活動

（4）歷史場景說明

（5）歷史場景重現

（6）歷史場景重現

（7）過去建築物模型(改造前)

（8）現況建築物模型(改造後)

圖 13 香港美荷樓_青年旅舍（舊建築再利用）參觀考察

(4) 中國建設銀行(立體綠化)

中國建設銀行此綜合用途大樓高 28 層，設有辦公樓、商場及停車場。委託方要求辦公樓層設計須體現高效的空間運用。"綠化"是大樓的設計主題，其外立面以綠化元素為設計特色，大樓低層部分的停車場樓層提供大量綠化。此區曾一度是製造業集中地，而大樓位於工業大廈林立的社區中，在設計上著重綠化效果，為鄰近地區帶來清新的綠意，也為大樓用戶和街上行人增添生活雅趣。

「綠色」是大樓的設計主題，最後的設計在大樓低層部分的停車場樓層佈滿了綠化元素，不但為鄰近地區增添綠化的視覺效果，而且種植範圍也有助過濾空氣和改善停車場的空氣質素。

綠色元素體現在整個大廈中，停車場層和辦公樓為垂直綠化牆。主要公共區域，如入口處大堂和電梯大堂，將伴隨景觀裝飾。獲得獎項：香港建築師學會 2011 年年獎評審特別獎、高空綠化大獎 2012 銀獎、International Property Awards Asia Pacific 2012－2013 的五星級香港最佳辦公室建築

圖 14 中國建設銀行(立體綠化)參觀考察

(5) 建造業議會_零碳天地（低碳設施）

零碳天地是香港首座零碳建築，位於九龍灣常悅道，由建造業議會與發展局合作發展，金門建築承辦興建，造價達 2.4 億港元，於 2012 年 6 月 26 日揭幕，零碳天地佔地 14,700 平方米，包括室內及戶外的展覽場地、會堂、綠色辦公室、綠色家居、公眾休憩綠化區及香港首個都市原生林，及透過光電板及生物柴油生 產可再生能源，達致零碳排放；建築物達到綠色建築環保評核體系 BEAM PLUS 認證的最高級別「白金級認證」。70％的電力將由廢食油或生物柴油產生，其餘 30%則由屋頂設有共 1,015 平方米的太陽能光電板發電系統，預料未來 50 年可以減少 8,250 噸的溫室氣體排放，比較傳統建築物減少能源消耗達 45％。透過安裝於天台、能夠 360 度吸收陽光的圓柱形太陽能光伏板、光導管及捕風塔等設施產生再生能源，估計每年可以產生 22.5 萬度電，使到建築物能夠自給自足，並且有剩餘電力供給予公共的電力網絡。

零碳建築的地盤面積達 147,000 平方英尺（13,700 平方公尺），其中約 75,000 平方英尺（7,000 平方公尺）為綠化區，佔整體面積逾半；建築物樓高兩層，設有 1 層地下室；整座建築物栽種了 135 棵原生樹木，及包括紅花荷、假蘋婆、木蓮及八角楓等逾 30 品種的灌木，希望為社區帶來生氣，對抗熱島效應，樹林成熟後樹冠層會緊密地相連，提供氧氣與涼蔭，公眾可以於都市中享受森林浴，接近大自然，夏季時更可以降溫攝氏 1 至 2 度，亦會減低附近建築物的溫度。樹林成熟後，每年可以吸收 3,100 公斤的二氧化碳，減低空氣污染問題。此外，此舉亦能夠構築樹林生態系統，為雀鳥和昆蟲提供食物和庇護。人工原生林模仿天然樹林環境，樹木高矮錯落，樹冠層互相滲透，而且樹木品種多樣化。

於室內，採用了高流量低轉速的吊扇，及能夠因應室內外溫度、濕度及光線而自動調節的智能管理系統等。

(1)全區配置

(2) 全區配置照片

(3) 零碳天地光電設施

(4) 回收木料景觀步道

(5) 零碳天地內的餐廳

(6) 零碳天地都市原生林

(7) 零碳天地外部景觀環景

圖 15 香港建造業議會_零碳天地(低碳設施)參觀考察

(6) 香港理工大學_創新樓（建築設計）

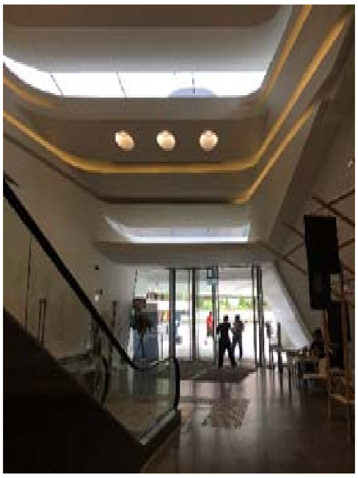
Zaha Hadid 在香港的第一座永久性建築：香港理工大學的「創新樓」。2013 年 3 月完成共耗時 6 年，顯現 Zaha Hadid 作品設計與施工上的不易。不過也因為如此，更反映出建築落成後，值得擁有數以萬計人的目光注視著。2013 年「創新樓」正式揭幕，「創新樓」有著 15000 平方公尺、15 層樓高的廣大面積。

主體大部分皆以白色作為主色，室內更大量使用白來呈現寬敞的視覺效果；而多處不規則的流線設計，更突顯出現代建築形式上的力與美。影響層面涵蓋多用途教室、實驗室、設計工作室、展覽區及公共休憩區等空間，透過曲線般的無縫環繞與連結，提昇集中力來鼓勵學生群聚學習和互動交流。此外，運用大量的大面積玻璃帷幕及不規則流動型通道，除了增加空間明亮度，也帶出適合設計學院的軟性氛圍。小至教室、大至會議廳的室內空間，經由無縫流線環繞式的結合，加上大片玻璃帷幕的運用，不僅造就無壓迫感的舒適環境，對於學生群體間的互動交流也相當有助益。

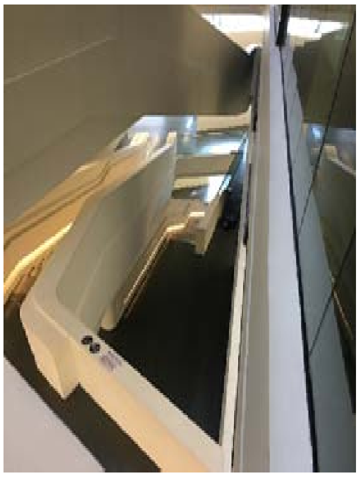
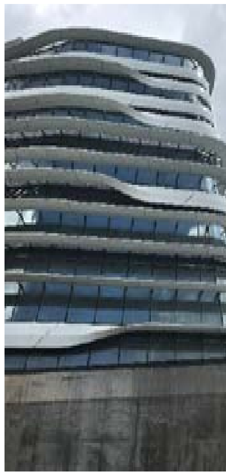
大樓的整體皆以白色為主要色調，也為室內提供更寬敞的視覺效果，流線型且無多餘稜角的設計形式，正是 Zaha Hadid 著名的設計特色。創新大廈中特別引人注意的是那些四通八達，穿梭在內部的通道，橫跨在大樓裡外的通道及露天的門廊，為大樓內部引入了更多光線。

然而 Zaha Hadid 認為更重要的是，藉由這座與船體相似的造型建築，讓紅磡當地環境增添上不一樣的色彩（創新樓周圍大多為幾十年以上的老建築），以期展現未來都市的活力，同時也代表著學校及設計學院源源不絕的「創新」能量。


(1) 建築物名　　建築物正向入口




(3)晝光引入　　(4)人工光　　(5) 側向挑空採光

(6)中庭挑空採光　　(7)垂直動線　　(8)建築物側向

圖 16 香港理工大學_創新樓（建築設計）參觀考察

四、心得

1. 參與 2017 全球永續建築環境國際會議(WSBE17 HK)

作為全球最重要的綠建築會議之一的 World Sustainable Built Environment Conference (WSBE)，今年 6 月 5 日－7 日在香港舉行，為期三天的研討會共有 1,800 人參與、涵蓋 57 個國家、100 多場平行會議，全球許多重量級的學者與政府代表齊聚香港，共同討論永續建築環境的現況與未來。主要目的是每三年集結所有專家檢討過去三年的成果並修正未來的方向，唯一的目標是人類與環境的永續發展。

本次高雄市政府工務局參與本國際性研討會，各項投稿論文受到審稿單位接受，得由本次會議中發表，不僅代表高雄創新政策作為，受到國際重視，更藉由本次機會，讓全球各界瞭解台灣面對永續環境劇變的議題上，台灣是從不缺席，並積極發揮全球公民的責任，主動提出減緩地球暖化政策，同時提供更適宜高雄在地性的永續建築策略，透過高雄厝執行效益經驗進行分享受到與會城市及專家學者高度讚賞。

本會議活動中各項研究發表成果，皆為各城市代表及永續建築領域人士努力研析的成果，不僅是相互交流的機會，更是一個極佳的國際行銷方式，如 WSBE17 這樣具有審查制度國際學術會議，更具有國際視野的推廣行銷效果，可持續將工務局各項專案計畫編列國際會議發表預算，並持續發展創新政策工具，擬定具在地特色的規範，讓高雄的努力不斷被國際發現。

下一屆 2020 年 WSBE 將由瑞典哥德堡(Gothenburg)主辦，建議延續高雄優良的努力成果，讓對氣候環境議題與新形態能源、具有高雄自明性的特色建築，透過市府與市議會推動具體的高雄厝行動，邀請各專業團體與市民提出建議，市府將其彙整分析，創立高雄市成功的市民參與案例，是值得努力的方向。

2. 考察行程

參訪香港中文大學建築系，可發現學術單位與政府機構的充分合作，不僅是讓學校學生對於產業界實務、新資訊的應用等相互的連結，並加強產業界與學術界之間的現有聯繫，讓政府部門、產業界之間的合作的模式也愈加豐富，讓政府機構贏得更多的信任與尊重，共同推進整體城市的合作與技術發展。

參訪香港房屋委員會展覽中心展示多年來的工作和成果。清楚說明，從一個城市發展的歷程中，一個城市的努力是可以用很具體的說明方式，讓參觀者明瞭城市的發展願景。對於地方政府而言，**建置一處城市發展示範展示空間，是一個很明確展示都市發展脈若的方式，不僅是讓城市居民了解城市的歷史、人文、地景等等地方文化，也是政府部門面對城市變遷與發展格局的清晰表述。**

美荷樓_青年旅舍在香港的歷史建築級別：二級歷史建築，經過活化後，美荷樓已變身成現代化的旅舍，地面和一樓的「美荷樓生活館」免費開放，提供民眾及遊客參訪；本次考察時更遇見當地小學生於此地的校外學習活動；**從而思考高雄市地區更多樣的歷史樣貌，更可參考活化歷史建築空間的展示空間型態。**

中國建設銀行"綠化"是大樓的設計主題，其外立面以綠化元素為設計特色，大樓低層部分的停車場樓層提供大量綠化。**不但為鄰近地區增添綠化的視覺效果，而且種植範圍也有助過濾空氣和改善停車場的空氣質素。**

參訪建造業議會_零碳天地，透過參觀在一個高度城市化的都市中建立的零碳建築，不僅做到電力需求為綠色創能，室內活動也做到被動式的節能與自動調節的智能管理系統；更透過 7,000 平方公尺的綠化區，栽種了 135 棵原生樹木，及 30 餘品種的灌木，**對抗熱島效應，樹林成熟後樹冠層會緊密地相連，提供氧氣與涼蔭，公眾可以於都市中享受森林浴；建構城市綠洲的新態樣。**

參訪香港理工大學_創新樓，藉由這座與船體相似的造型建築，讓紅磡當地環境增添上不一樣的色彩；期許高雄市在舊聚落的歷史街廓中，**可透過新形態的公有建築物設計，展現未來都市的活力，同時也代表著高雄市政府源源不絕的「創新」能量。**

五、建議事項

經由參加本次會議，我們知道未來到 2050 年全球永續建築環境目標是：減碳、 降溫、提升數位化及改進相關指標系統工具。而整體區域發展的趨勢議題，則是經由自然環境氣候條件等考慮因素後，採取「因地制宜」的在地化(localization)思考論點，取代過去長久以來的都市化(urbanization)發展的模式，從更貼近民眾需求去發展，由小區域性的微氣候環境，來營造符合居住的建築。故如何加強上述相關議題，以下提供幾點建議採行事項。

(1)「高雄厝」創新法令研議修法，讓法令與實務接軌，獲得專業團體及市民認同

高雄市政府為營造具地域特色之建築城鄉風貌，以及符合永續環境的條件，全國首創「高雄市高雄厝設計及鼓勵回饋辦法」，其內容為進一步提出節能減碳、永續環境、通用化設計及防災等鼓勵回饋規範，然法令創設之初，仍有許多疑義，因此如何進階能夠更貼近民眾需求，發揮創新法規之效益，並達到訂定之初衷，符合具在地化需求的條件，建議持續進行與專業團體及市民的政策說明，加強法令執行於實務接軌，藉由舉辦教育宣導及補助獎勵等活動計畫，獲得更多支持，更貼近民眾的需求。

(2)拓展與認同「高雄厝」，持續與建築專業團體或組織，辦理研析創新政策計畫與培訓課程

為將因地制宜的觀點轉化建築專業者，來達到更多的回響與回應，將擴大高雄厝學的認同，經由培訓課程的延伸，由學生、執業建築師等等，訂定不同方式的學程內容，將高雄厝學成為顯學，也將直接呼應培育在地人才的觀點，將因應高雄在地環境特色之觀點，經由課程講授，直接由多元多樣貌的設計，切入出更多元的在地特色設計，並

鼓勵民眾參與設計，發揮想像與創新，如此更能打造出不同的在地化論點，提出更多樣性的在地設計手法，來符合市民需求，並達到節能、永續的概念。

(3)持續關注永續建築發展趨勢，朝向創新政策與國際接軌，並實踐永續建築資訊平行學習願景

建議追蹤符合本府推動政策之各類型國際性會議，並持續辦理參訪與論文發表，讓本府推動創新豐碩成果，能夠與國際間專業人士交流，並持續與國際間各永續建築組織或相關技術團體簽署 MOU 協定，提昇雙方互助學習的機會，增加在永續建築議題上的互動，並藉由雙方學術、技術交流，來建立學習平台，實踐更多元性的國際接軌方式，進而提升高雄城市創新政策的國際視野。

經由實踐國際接軌的行動，讓更多國際性建築專業團體的關注，做為砥礪本府推動創新政策的動力，並持續精進與改進，來推動更符合市民需求以及能夠創造產業動能的政策工具。

附件、發表論文全文

World Sustainable Built Environment Conference 2017 Hong Kong
Track 2: Practices & Policies for High-Performance Buildings

A Discussion on the Benefits of Environment Performance of the Promotion of Kaohsiung Green Building Specialties Policy

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ABSTRACT

"Urban Heat Island" effect leads to high temperature in the urban climate, increased rainfall, reduced wind speed and air pollution as well as other effects. According to "International Association for the Evaluation of Educational Achievement," average carbon dioxide emission in Taiwan is 11.26 tons in 2008, while the building structures are the third source of carbon dioxide emissions. Taiwan' is ranked to have the 18th highest carbon dioxide emissions in the world. In view of this, for the new buildings, the Kaohsiung City Government actively promotes the transformation plan for "Green Building • Sustainable Environment", presenting the local culture, green architecture and the concept of public participation, and promotes Taiwan's first "green building autonomous regulations in Kaohsiung" , "the policy for design and encouragement reward for Kaohsiung building " and other innovative design policies. Kaohsiung implements existing buildings through "Improvement on Kaohsiung Buildings" action, prioritizing public buildings that are frequented by the people of Kaohsiung. Buildings will be elevated with the suitable solution based on integrated physical environment quality testing and data analysis (including sound, light, warmth, air).

Therefore, this study used the analysis of relevant policies of Kaohsiung city prompted by innovative green building. With the "Building (New) Sustainable Environment" of Kaohsiung City Government, practical benefits and the target completion of the policies will be discussed. From the point of view of environmental health diagnostic, existing buildings are examined for their achievement in actual practice. The aim of this study is to provide hope to enhance the quality of life in Kaohsiung, and to add to Taiwan's research reference.

Keywords: *Kaohsiung buildings, green buildings, innovative design policy*

1. INTRODUCTION

In 2015, Paris Climate Conference （COP21）performed protocols regarding the topic of restraining the global warming, which was aimed at reducing the emission of greenhouse gases and controlling the global temperature would not increase more two centigrade degree in 2100 with the global warming speed. The conference also advocated the concepts of think locally, act globally. To respond the changes of global climate and the trend of international energy conservation and carbon reduction, the central government promotes the policies of "Sponge City" and "Million Solar Roofs". Faced at the problems of high carbon emission, alternations of floods and droughts, the air pollution of PM 2.5 caused by urban island effect and difficult to diffuse, more than 120,000.00 unauthorized buildings and Aging Population with too Few Children and other problems, Kaohsiung City is in need of thinking about how to transform into the healthy and sustainable Southern Taiwan metropolitan district from the image of industrial city to develop the local architectural features and living cultures of Kaohsiung region.

2. TO PROMOTE STRATEGIES AND CREATIVE ACHIEVEMENTS

In order to solve the environmental studies of Kaohsiung and effectively plan and make reformation on sustainable construction environment of Kaohsiung, the countermeasures, "Kaohsiung House Plan" is created. To more properly adapt to the sustainable construction movement, the three cores of the plan are consist of global Environmental Sustainability, the Identity of Reflecting the Local in line with the local conditions of Kaohsiung, and Healthy Residence closed to the populaces' life, which conclude the following creative achievements:

2.3 Twelve creative policy tools

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Kaohsiung House Plan has constantly made twelve policy tools initiatively nationwide, and conducts the reformations on sustainable construction environment by away with a higher standard.

2.4 Vertical forests: roof greening and landscape balcony

The landscape balcony with the depth of three meter is initially built in line with the local conditions to create green landscape in metropolis, which seems as a 3-D vertical forest park, creating the unique architectural features and brand, and promoting the construction to the international construction with high quality.

2.5 The universalization of design space

The elderly population in Taiwan will reach to more than 20% in 2025. In response to the upcoming super-aged society, the universal design is further introduced by the laws so that the children, the elderly and disabled person, etc., can conveniently use all sorts of building environments.

2.6 The solar photovoltaic facilities set on buildings

By making full use of Kaohsiung's abundant sunshine to facilitate the renewable energy of solar photovoltaic to develop local characteristics, and to standardize the setting of the solar photovoltaic facilities in the roofs of buildings, the regulations of central government's laws and decrees are broken, and the restrictions on the height of the solar photovoltaic on the roofs are broaden so that those with the height fewer than 4.4 meters are excluded from the volume and height of the building.

2.7 The self-creation of financial resources-the sustainable operating fund of green buildings

The financial resource is self-created by handing in the giving back money of Kaohsiung adjacent. Apart from giving back to sustainable environmental construction, the operation of the innovation policy's mechanism can also be constantly rolled. The operating fund of sustainable green construction of this city is co-managed by experts of industry, government and science.

3. RELEVANT OUTCOMES

3.1 Motivate cities to study from typical example

"Kaohsiung house plan" has motivated more than 10 other cities in Taiwan to learn all sorts of innovation policies of Kaohsiung City, which has become the typical example of green and sustainable city and become the dialogue basis for diplomacies between international cities.

Figure 1: Vertical forests - landscape balcony and transformation of unauthorized buildings - green energy facilities

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3.2 Rainwater storage facilities

The disaster prevention of small flood detention: when the rainwater storage amount has reached to 223,920 cubic meters, equivalent to capacity of 119 swimming pools with international standard, then the delay time of the flood peak's arriving is set at about 30 minutes to reduce the disaster of heavy rain's impact.

The rainwater tank: the processed amount of recycled rainwater has reached to 2,761,365.24 liters/ day, which means 1,007,898 tons of water is saved per year, and 156,224 kg of carbon is reduced per year.

3.3 The set amount of solar photovoltaic

The set amount of solar photovoltaic in newly-built construction has reached to 54,446 KWP, equivalent to the amount the set amount of solar photovoltaic of 53 Kaohsiung World Games Main Stadium. It can create 700 million degrees of electricity consumption in one year, and the carbon reduction can reach to 430 million kg/ year.

3.4 The of lighting and energy saving

To standardize 97% of existing buildings in the city, the high-energy lamps and interior decorations shall not be used when applying for interior decoration for the buildings and changing the use of buildings. So far the energy-saving lamps applied in the case have reached to 2,861,768 watts, which can reduce the electricity consumption of 2,862/ hour. Calculated by using 16 hours one day, then, the reduced electricity consumption is 16,714,080 kWh/ year, and the reduced carbon amount is 10,228,188 kg / year.

3.5 The creation of universal space suit for All-Age

The universal design of the bathroom: the moving lines of the passageways are smooth and the net width of the door should reach 80 cm so that wheelchair users can be in and out smoothly and steadily, and the area has reached 12,406 square meters.

The universal design of social hall: Extending the traditional construct concept of "courtyard" space to create spaces of social hall for all-ages in the community, of which the area has reached 1,369 square meters.

3.6 To create the business opportunity for green building industry

By supporting green energy industry, increasing more than 2,500 job opportunities per year and newly- increasing 500 high-standard green buildings in four years to motivate the green business opportunity with about more than 700 billion of total industries, and to improve the job opportunity and wishes of returning the hometown to provide services for the people of Kaohsiung.

3.7 Verticals forest

The green area on the roof is 160,921 square meters.

The area of landscape balcony is 70,360 square meters, of which Green area 23,453 square meters. The balcony landscape with the depth of 3 meters, breaking the laws and decrees, is combined with more than 1/3 shrubs and arbors to afforest. By adjusting the micro environment, and creating a healthy rest space to promote the plane surface greening to become the vertical forest. By replacing the former frozen cement and iron sheet to transform the image of industrial city into Kaohsiung garden city.

The total green area has reached 184,374 square meters, equivalent to the areas of about 28 football fields, and the reduced carbon is 3,687,480 kg.

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Figure 2: The landscape balcony that can be used for sun shading and rest

3.8 The total amount of reduced carbon

The execution of the "Kaohsiung house plan," can reduced the annual carbon amount of 13,500 tons, equivalent to the carbon amount stored by 13.5 ten thousand arbours. So far the total reduced carbon amount has reached to 47,250 tons, equivalent to carbon amount stored by 4,725 ten thousand arbours.

3.9 Cross-border action and social participation

"Kaohsiung house plan" is a cross-domain construction action studied and participated by citizens and experts from industry, government and science. Now 100 green building awarding brands of Kaohsiung houses has been awarded certificates, 100 outstanding creative design works of Kaohsiung houses has been selected, 45 ACCD of Kaohsiung house has been cultivated, and more than 12,000 people have participated in the relevant activities. The plan emphasizes the public participation and empowerment of community, and is driven by the units of metropolis, economy, education, agriculture and marine division dividedly. Having launched the responses of 348 schools, and 95 agricultural and fishery facilities, the plan has got 144 buildings of construction license of Kaohsiung house, a total of 11,950 households.

4. THE FUTURE KAOHSIUNG GREEN BUILDING 3.0 VERSION DEVELOPMENT ASPECT

4.1 Orange construction planning

The most important element of orange technology is H2O, which stands for health, happiness and offering. Its correlative calculation is orange computing models are health model, happiness model and offering model. The details are as follow:

- Health Technology: senior medical care and old timers living technology are becoming increasingly important. Medical prevention of illness has become a crucial issue. To advance and develop senior living quality and green-orange health care is the challenging issue.
- Happiness Technology: in order to promote happiness indicator, engineering technology and social science and humanity can be used to advance public safety, anti-stress, pleasure, social relationship, education, energy, financial wellbeing.
- Offering Technology: other than establishing personal health and happiness, orange technology also promotes happiness in others. Offering technology uses technological innovation to better interpersonal relationship.

4.2 Intelligence: disaster prevention

Cloud technology can provide designers to directly on Web-GIS cloud system to design site development, install and control various water tanks in order to set and measure the precipitation.

4.3 Life box

Newly built residential households have to install a family emergency shelter. It is about 1.6~3.4 m² (determined by the surface area of the house). The door is made of steel board, and the four walls, ceiling and floor are made

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of concrete with steel foundation that are thickened to 200~300mm (determined by the height of the house). The inside has one or two vents and has electricity, internet and radio.

5. SUSTAINABLE DEVELOPMENT AND CONCLUSION

The city plan shown by Kaohsiung sustainable construction on its local culture, sustainable nature and friendly environment is: under the pluralistic development of the overall Kaohsiung city, not forgetting the traditional geographic landscape, architectural features and ethnic culture to show respects to different ethnics, cultures and regional characteristics by Kaohsiung house plan.

Figure 3: The field surveys on Kaohsiung house

Kaohsiung house case is integrated by project management, from which benefits of Kaohsiung house is studied and analysed. Inviting and getting the scholars and experts from industry and government to jointly study, analyse and discuss the case to formulate the basic standard of the sophisticated direction for Kaohsiung house plan's policy tools. Establishing the database of Kaohsiung house's newly-built cases to track application case progress of Kaohsiung houses which have got the licenses for the construction, and to build the databases of photos, decrees, construction methods, cost analysis on the basis of the weekly field surveys. Meanwhile the wind environment, ambient heat, light environment or user satisfaction will be studied and analysed by simulation software and questionnaires, and the benefits of industry, the economy and reduced carbon will be quantified.

To promote the sustainable environmental feedback mechanism, the financial resource should be self-created by paying agent money, fees for regulations and giving back money, besides which shall be executed by the management mechanism of sustainable green construction's operating funds. Apart from the direct giving back to sustainable environmental construction, the operation of the innovation policies' mechanism should be constantly scrolled.

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World Sustainable Built Environment Conference 2017 Hong Kong
Track 3: Advancing SBE Assessments

Session 3.5: Performance Review of Green Buildings (1)

Strategic Study on the Benefit Evaluation of Solar Photovoltaic Promotion Policy in Kaohsiung

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ABSTRACT

Kaohsiung City's urban landscape is adorned by its majestic mountain, streaming river, wavy ocean, and abundant sunshine. To further complement the city's vibrant atmosphere, the Kaohsiung City Government initiated a project to adjust its industrial structure to promote Kaohsiung as a green eco-city. The goal of the project is to provide a greener, safer, and most importantly, a more sustainable environment for Kaohsiung's citizens so as to create a truly happy and prosperous living environment.

To reach these goals, the Kaohsiung City Government took action with a series of policies to increase solar energy production. Firstly, it established an operating network by forming an inter-departmental task force to promote photovoltaic (PV) systems in the public and private sectors. It also linked professional organizations with local communities, and set up a dedicated hotline for consultation and inquiries. Secondly, it strengthened its photovoltaic infrastructure through formal statutes and regulations. This includes the announcement of a series of official solar photovoltaic policies, the promulgation of a floor area ratio incentive, and the enforcement of mandatory policies to increase photovoltaic implementation. Thirdly, it designated target sites to serve as examples of the project. This includes installing photovoltaic systems on public rooftops, building photovoltaic demonstration zones, transforming illegal structures into solar power providers, and assisting the fishing and agricultural sectors in building photovoltaic systems.

In total, Kaohsiung's 557 cases in 2015 oversaw an instalment capacity increase of 28,491 kW (or 28.491 MW), generated 37 million kWh of power annually, decreased carbon emissions by 23.3 thousand tons, and created a PV industry with a net worth of NTD 2,841.1 million. This study looks at the evidence of achievements the city has made promoting scientifically meaningful architectural aesthetics in its innovative green buildings and energy technology, as well as the success it has seen pushing the policies through a bottom-up structure. In conclusion, it can be said that, using a model based on a project developed by our institute, the Kaohsiung City Government has successfully made the renewable energy become an integral part of Kaohsiung's lifestyle, creating a threefold win for the government, the institute, and the people of Kaohsiung.

Keywords: solar photovoltaic, policy, suit locally, the city of green daylight, low carbon

1. INTRODUCTION

Despite having transformed itself from a wholly industrial city into a thriving metropolis, Kaohsiung City was still marked by its over-concentrated population, lack of green spaces, and excess of artificial heat sources. Kaohsiung is also much hotter compared to its neighbourhood areas, and its temperatures may well continue to rise while its humidity simultaneously lowers as Kaohsiung's population, commercial activities, and density in land use all continue to grow, leading the city to become what is commonly known as the urban heat island. As a result, increasing the city's green spaces has become a priority in its efforts to lower the rising temperatures.

Over the years, Kaohsiung City has gone through extensive measures to become its own city. Not only has it upgraded its hardware and software to create a healthy, sustainable, ecological, and cultural environment, it has also established itself as a diverse and sophisticated municipality, and rolled out innovative policies such as the Green Building Self-Governance Ordinance and the Regulations Governing the Establishment of Rooftop Solar Photovoltaic Systems so as to achieve its five core values of "ecology, economy, liveability, creativity, and internationality." Its strategies, which have been widely recognized, also include inserting an aesthetic sense of technology into the city's photovoltaic systems, promoting innovative green buildings and renewable energy technology, and using a bottom-up incentive to encourage owners of illegal structures to spontaneously come forward. Evidence of the city's efforts can be identified throughout the city as the government continues to build a greener, healthier, and more sustainable city.

2. OBJECTIVES

Working in coordination with Kaohsiung's climate, the Kaohsiung City Government set the goal to generate 150 MW worth of solar photovoltaic power within four years. It set up an interdepartmental task force to collectively promote the photovoltaic systems within the following five categories: general constructions, public buildings, schools, factories, and fishing and agricultural facilities.

The Kaohsiung City Government set the four-year goal as a mean to fulfil its global responsibilities against greenhouse effect as well as to take care of its citizens in the long run by implementing its core values of bringing "ecology, economy, liveability, creativity, safety, and internationality" into their daily lives.

3. POLICIES AND STRATEGIES

With global warming on the rise, the Kaohsiung City Government was ahead of its time when it initiated its photovoltaic project prior to the promulgation of Taiwan's Renewable Energy Development Act. While the city's geological climate rendered it a suitable candidate for solar energy, the reality on the ground was that current building regulations, the conditions of existing structures, and the price of setting up photovoltaic panels had made it hard to promote solar power on a city-wide scale. Having identified these obstacles, the government saw a need to relax existing laws while aggressively pushing, promoting, and subsidizing photovoltaic constructions. It also listed the photovoltaic project among its priority policies for better effect. Therefore, the Kaohsiung municipal government proposed the four year plan and the specific ten action plan. (Table 1)

Creating an Operating Network	Appointing an interdepartmental task force
	Giving local communities professional assistance
	Setting up a dedicated hotline
Utilizing Policy as Promotional Tools	Formulating statutes and regulations
	Providing floor-to-area ratio incentives
	Making photovoltaic systems mandatory
Push the subject	Installing photovoltaic systems on public rooftops
	Building photovoltaic demonstration zones
	Transforming illegal structures into solar power providers
	Building photovoltaic systems in the fishing and agricultural sectors

Table 1: Kaohsiung government put forward the specific ten action plan

3.1 Creating an operating network

Appointing an interdepartmental task force

The interdepartmental photovoltaic project task force was established with Kaohsiung deputy mayor as convener, deputy director general of the Secretariat as deputy convener, and the Public Works Bureau as chief managerial office. The task force is in charge of supervising the promotion of the photovoltaic project within the five categories of general constructions, public buildings, schools, factories, and fishing and agricultural facilities. The major and assisting offices in charge of the categories (as shown in Figure 1) work together to fulfil the city's innovative vision.

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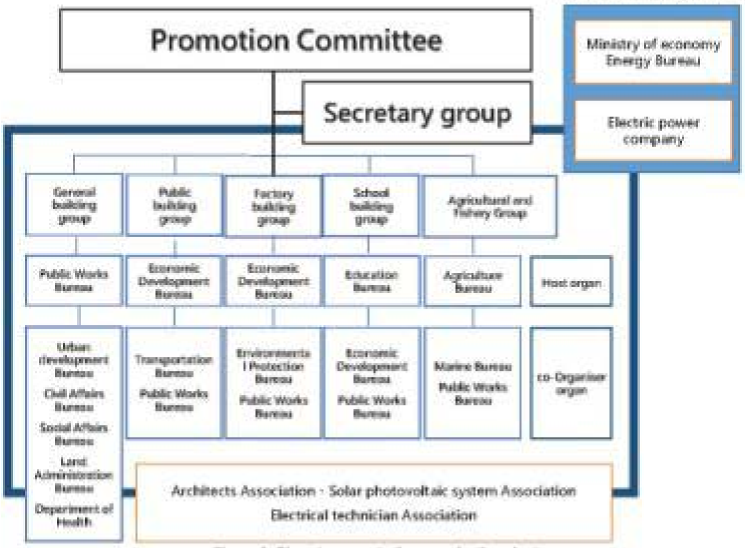

Figure 1: Plans to promote the organization chart

Giving local communities professional assistance

To promote widespread installation of photovoltaic systems across the city, the Kaohsiung City Government sought the assistance of professional associations (Figure 2). This includes the Kaohsiung Architects Association, the Kaohsiung Professional Civil Engineers Association, the Real Estate Development Association of Kaohsiung, the R.O.C. Solar Photovoltaic System Trades Association, the Taiwan Professional Electrical Engineers Association, the Taiwan Photovoltaic Industry Association, the Taiwan Electrical Contractors Association, and the Taiwan Solar Thermal Energy Association. In addition to signing official MOUs with the associations and hosting public briefing sessions to provide more information for the public, the government set up a platform to help pair citizens interested in installing photovoltaic systems with suitable vendors.

Figure 2: Combination of professional groups and community participation in the operation of the photovoltaic project.

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Setting up a dedicated hotline

A dedicated service hotline was set up so as to increase the efficiency and efficacy of installation requests. The service hotline not only takes inquiries and applications, but it is also in charge of collecting statistics and data.

3.2 Utilizing policy as promotional tools

Formulating statutes and regulations

The Kaohsiung City Government has since 2012 formulated four architectural laws governing the instalment of photovoltaic systems. The laws were created so as to promote the generation and utilization of the renewable solar energy.

In 2014, the laws were incorporated into a comprehensive project consisting of six laws, a platform pairing individuals with professional instalment vendors, and a subsidization program. Through the formulation, execution, as well as review and revision of these statutes and regulations, Kaohsiung's solar photovoltaic systems, intelligent energy management operations, and green building standards have been significantly improved. As the scale of income from promoting green buildings grows, the city is able to continue expanding solar power instalments and energy-saving buildings.

Providing floor-to-area ratio incentives

Another important promotional policy is the floor-to-area ratio (FAR) incentive. Areas with lower FARs will be granted a 30 percent FAR incentive with the instalment of photovoltaic systems. This allows areas consisting mostly of low-rise buildings become so-called "sunshine communities." Meanwhile, residential areas with an FAR of 180 percent must install a rainwater storage capacity that is at least 0.132 times the measurement of the area, build a green roof, or install photovoltaic panels that generate more than 2 kW power per building.

Making photovoltaic systems mandatory

The Kaohsiung City Government was able to make photovoltaic instalments mandatory in urban areas, open spaces, and the Kaohsiung LOHAS Housing Project by providing construction businesses with incentives during the initial reviewing stages in urban design projects and the licensing review of construction permits.

3.3 Designating exemplary demonstration sites

Installing photovoltaic systems on public rooftops

As action always speaks louder than words, the Kaohsiung City Government took the lead to install solar photovoltaic systems on the roofs of government buildings and public schools using a rental program. In having vendors set up the solar panels, the government is estimated to have saved around NTD 500-700 million in installation and maintenance fees. In addition to giving the city solar energy, the model also creates economic value for the local solar power industry, and at the same time serves as an example of the project's benefits, attracting public attention and recognition. In doing what's best for the environment, Kaohsiung increases its use of renewable energy, helps the solar photovoltaic related industries grow, and ultimately strengthens the city's economic structure and overall competitiveness.

Building photovoltaic demonstration zones

The Kaohsiung City Government has chosen the area surrounding the Pier-2 harbour, the Jhongdou redevelopment zone, and the area of the 2014 Kaohsiung gas explosions as the city's photovoltaic demonstration zones. The goal is to gradually have the installation of photovoltaic systems expand around the zones and ultimately link up to form a photovoltaic power city.

Transforming illegal structures into solar power providers

Kaohsiung City prides itself in its counselling rather than punishing attitude when it comes to illegal structures. It encourages owners of illegal structures to convert their illegal rooftop dwellings into photoelectric facilities (Figure 5). It also provides loans and subsidies as incentives to increase interest as well as lower installation thresholds.

The new structures, on the one hand, help solve the two most common problems seen in illegal rooftop dwellings, i.e. leaking and overheating, and on the other hand, can be legally built with an additional sunroom compartment. While the city is significantly beautified, the power generated can be sold to the Taipower Company for additional income. As a result, the original hot and stuffy city has the opportunity to be transformed into a pleasant and a steady provider of renewable energy.

Building photovoltaic systems in the fishing and agricultural sectors

Kaohsiung encourages its farmers' associations, traditional wholesales markets, animal protection units, agricultural facilities, and 95 livestock and poultry farms to install solar photovoltaic systems. It is also working with the various agricultural and fishery associations in encouraging the conversion of idle building rooftops into solar panel units.

4. RESULTS

Due to the nature of its development, Kaohsiung City's heavy-industry based economy has come with the price of serious air and environmental pollution. According to statistics, Kaohsiung's annual carbon emissions of 97 million tons make up 25 percent of the nation's total. What's more, each citizen's personal carbon emission is 2.67 times the nation's average. Nonetheless, the city's 2015 statistics show that the 557 photovoltaic application cases successfully created an instalment capacity of 28,491 kW (or 28.491 MW), generated 37 million kWh of power annually, decreased carbon emissions by 2.33 million tons, and created a PV industry with a value output of NTD 2,841.1 million.

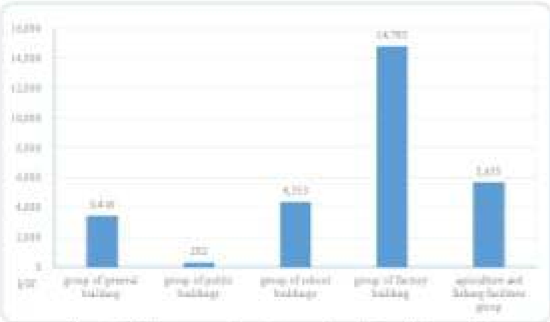

Figure 3: Various groups have been set up photovoltaic capacity

As indicated in Figure 5, factories have the largest photovoltaic power output at 14,785 kWp; fishing and agricultural facilities come in second at 5,655 kWp. It can be said that these traditionally high carbon emission industries are now fulfilling their social responsibilities in reducing greenhouse effect.

Shown in Figure 4, Kaohsiung City, the implementation of the solar photovoltaic policy has a number of specific implementation of the case, According to the situation of different groups, The presentation of the optoelectronic aesthetics of different buildings, Not only create a new state of the city state, Kaohsiung is also the specific contribution to the global energy conservation and carbon reduction.

(a) General constructions

(b) Factories and traffic facilities

(c) Public buildings

(d) Agricultural and fishery facilities

(e.) School buildings

Figure 4: Example of solar photovoltaic systems installed in various types of buildings

5. STAGE CONCLUSION

With the combined use of six laws, one subsidy plan, and one pairing platform, Kaohsiung City's solar photovoltaic project has been deemed a success. According to statistics, the city is estimated to see photovoltaic output of at least 30MW annually. The new regulations have also helped increase the overall number of green buildings in Kaohsiung. Kaohsiung's creative and diverse efforts to create a greener city have set an example of what could be achieved. It's achievements between 2000-2016 (as of May) are as follow:

- The total of 3,027 applications has a joint capacity of 152,615 kW (152.615 MW), generates 180,741 kWh annually, has reduced carbon emissions by 15,366 tons, and has created a NTD 15.26615 billion output value for the photovoltaic industry.
- With the talk of an international carbon tax of NTD 1,940 (EUR 50) per ton of emission likely to become a reality, Kaohsiung City's estimated 30 MW annual photovoltaic output may help lower carbon emissions by 24,276 tons per year. This would amount to saving NTD 47.1 million annually, and a cumulated NTD 924 million in 20 years.
- The cost saved from having to dismantle illegal rooftop structures, including paying personnel fees, dispatching vehicles, and processing construction waste, is estimated at NTD 135 million per year, which adds up to NTD 27 billion in 20 years.
- As the metal roofs of illegal rooftop structures are converted into solar panels, sunshine is absorbed and transformed into electricity, resulting in a drop in the city's scorching temperatures.
- The photovoltaic project's annual value output of NTD 20 billion helps increase employment opportunities.

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World Sustainable Built Environment Conference 2017 Hong Kong
Track 8: Innovative Processes and Methodologies to Transform SBE

Study on the Energy Efficiency of the Climatic Based Passive Design by Meinong Tobacco Barns in Kaohsiung

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ABSTRACT

There were lots of local buildings in rural area in Taiwan, which were over 40 years but still can afford the daily livings. These cultural and typical types of buildings in some cultural small town represent for the unique building styles, and to arise the issue for the revival of the cultural building for more sustainable attitude. This study is based on the requirement of this topic and following the policy of Kaohsiung City Government to renovate a traditional Tobacco Barns into more sustainable Kaohsiung LOHAS House.

The Tobacco Barns is a traditional house which combines the local industry of tobacco drying and a house living space, and this type of building is very popular and unique in Meinong district in Kaohsiung. This study conducted the processes from local climate data analysis, which is based on the local elementary school. The energy issue is the main target to verify the new possibility of the decisions to deal with the material and openings from eight orientations. The AutoDesk-Ecotect analysis was adopted to make the integrated analysis processes which will be in the same model and analysis methodology. The factors including heat load of transfer, indoor predicted temperature and daylighting situation were considered to make the comparison of the energy efficiency by the local common renovated material and opening styles. The suggestions were conducted by the methodology and for the further comparison of different design proposal with results of maintenance evaluation and energy saving fee to let the house owner do the decision making.

In this study, through the collection of relevant literature, data integration and analysis, the results showed the cross analysis with four material of wood, rammed earth wall, concrete and bricks structure, with different opening rate is 20%, 50%, 80%, and with horizontal shading monolayer bilayer depth by 0, 0.4, 0.6, 1.0, 1.8 ratio. The simulations of thermal environment and light environment were both verified to make the calculation of the estimated efficiency. The results can be used and references in this area for who wants to make the renovation.

Keywords: *opening rate, shading form, shade depth ratio, EUI energy dissipation value*

1. INTRODUCTION

For urban and rural renewal, old buildings can be revitalized through renovation. But when re-planning and redesigning buildings, reinforcing appearance-related structures, improving indoor spatial functions and outdoor landscape arrangement, we need to pay attention to evaluations and analyses of rebuilding costs and energy efficiency when examining whether the rebuilding process meets the concept of sustainable construction. The purpose of this study, thus, is to investigate the energy consumption efficiency of rebuilding and regeneration and material use strategy; the research subject case study is a tobacco building in the Meinong area. By contrasting the formation of traditional settlement type of tobacco building, the research scope is expanded to the whole area and region. The regeneration movement of the tobacco building has been examined for the purpose of conducting an architecture design study.

2. RESEARCH METHOD

Architecture theory is developed herein from the design of manual modules via a computer simulation analysis based on the comparison of heat transfer of various materials in the thermal environment, as well as the consideration of the indoor window opening conditions and the exterior architecture structure. The relationship between these factors is quite complicated. Thus, due to the limitations of conditional factors, previous studies have been taken into consideration to classify simulation factors for later analyses of the key ones. This section first explains the simulation case, the structure of simulation process, limitations and conditions.

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2.1 Establishment of simulation case

In principle, the site of architecture simulation was selected in Meinong, Kaohsiung City at latitude and longitude of λ= 190°54' and φ=22°90', respectively, and sea level of 543 meters (Figure 1) for this study. The architecture type is a four-ping tobacco leaf baking room located at the north orientation with an 85° angle of incidence; thus, the main chickened structure of the tobacco building is used as the basis for the main simulation test. Values in different orientations are then simulated for the purpose of comparison.

Figure 1: Site map/ aerial image

2.2 Analysis method

For the analysis of the experimental simulation, 132 sets of architecture types were set up; the simulation conditions were established by using the main structure of the tobacco building as the center. Different amounts of sunlight were acquired according to the different orientations of architecture. This study uses eight orientations: north (N), northeast (NE), east (E), southeast (SE), south (S), southwest (SW) and northwest (NW) for the simulation. The values acquired in the simulation include: the thermal environment of architecture materials, window opening ratio, shield format and shield depth. Through statistical analysis, the relationships among four different types of construction materials have been defined, as well as the changes in the thermal environment have been analyzed by using combinations of shield types (Figure 2).

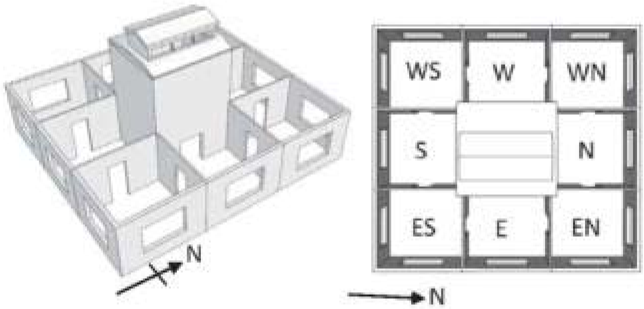

Figure. 2: Orientations of architecture in the simulation

2.3 Integrated evaluation and analysis method

This study focuses on the discussion of energy consumption in different spatial orientations; ECOTECT, a computer simulation, is adopted for the presentation. Unlike the single consideration of construction materials or window opening ratio, this study concerns the close relationships among architecture orientation, building envelope and energy consumption. For example, natural lighting, shield and depth are impacted by the changing conditions. Therefore, they all play an important role in energy-saving. We discuss the design application of architectural space via analysis of the amount of sunlight reflection, the thermal environment of various spatial orientations, window opening ratio, the use of responsive materials, and EUI (energy use intensity). Suggestions for improvement are also proposed according to the simulation results and analyses of the design of the architecture rebuilding.

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3. INTEGRATED COMPARISON AND ENERGY CONSUMPTION SIMULATION ANALYSIS

Via computer simulation, this study analyzes influential factors of architectural space, including the relationships among suitable construction materials, window opening ratio, shield format, depth ratio, amount of sunlight and thermal environment. The simulation of eight orientations helps us to ascertain the relationship between orientations and thermal environment, and to analyze the impact on the annual EUI of an indoor air conditioning system.

3.1 Total EUI comparison with an opening ratio of 20%

The results below are found after comparing and analyzing EUI in different orientations. (Table 1)

This study uses a fixed width and length ratio of window opening to discuss EUI in different orientations, and finds that EUI is reduced with the increased depth and that the decrease ratio is also reduced along with the increase of depth ratio. Wooden and rammed earth structures as construction materials are proven to provide the best energy saving effectiveness since these two have window opening ratios falling within the range of low energy consumption; concrete structures, due to higher heat capacity and difficulty of heat dissipation, have EUI of air conditioning systems within the middle range of energy consumption; and some spaces of bricked structure also reach the middle energy consumption range due to spatial orientations. (Figure 3)

Construction Materials/Shield Format		EUI %		
		Low	Middle	High
Wooden	Single Layer	100	--	--
	Double Layers	100	--	--
Rammed Earth	Single Layer	100	--	--
	Double Layers	100	--	--
Concrete	Single Layer	25.5	75.5	--
	Double Layers	25.5	75.5	--
Bricked	Single Layer	66.7	33.3	--
	Double Layers	62.5	37.5	--

Table 1: EUI comparison of an opening ratio of 20%

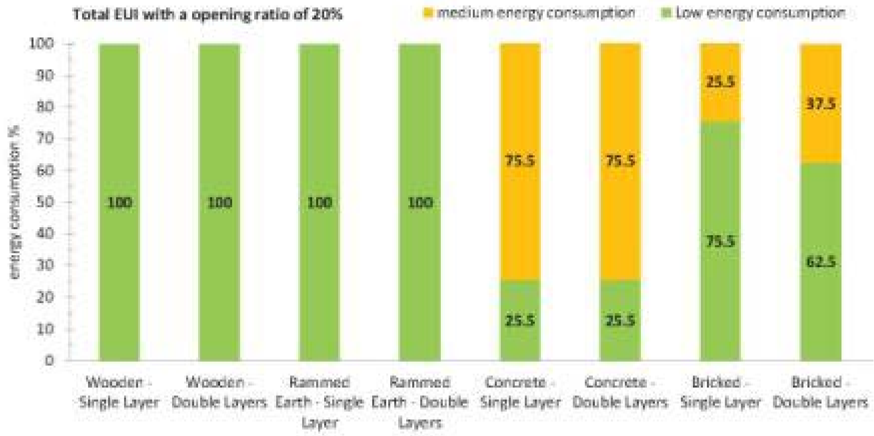

Figure 3: Total EUI comparison with an opening ratio of 20%

3.2 Comparison of total EUI with an opening ratio of 50%

The results below were garnered after comparing and analyzing EUI in different orientations. (Table 2)

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From Table 2, the EUI diagram at a window opening ratio of 50%, the structure with 50% more concrete belongs to the range of high energy consumption. Both single and double layered vertical shield structures have no impact on energy consumption. Wooden structures have the optimal EUI with significant impact of reduced EUI after the installation of double layered horizontal shield structure; rammed earth structures fall within the range of middle energy consumption with the same effectiveness after the installation of double layered horizontal shield structure; and bricked structural space falls within all ranges of energy consumption, from low to high. Therefore, other combined bamboo structures shall be considered for orientation selection to achieve the balance of spatial use and dynamic energy of an air conditioning system, as well as to form composite-structured architecture. (Figure 4)

Construction Materials/Shield Format		EUI %		
		Low	Middle	High
Wooden	Single Layer	62.5	37.5	--
	Double Layers	50	50	--
Rammed Earth	Single Layer	20.8	79.2	--
	Double Layers	22.9	77.1	--
Concrete	Single Layer	--	39.6	60.4
	Double Layers	--	41.7	58.3
Bricked	Single Layer	12.5	81.25	6.25
	Double Layers	12.5	83.4	4.1

Table 2: EUI comparison of an opening ratio of 20%

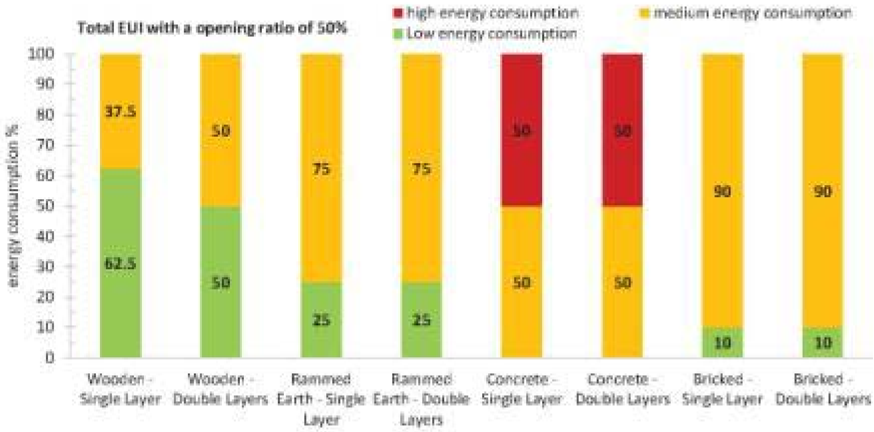

Figure 4: Total EUI comparison with an opening ratio of 50%

3.3 Total EUI comparison with an opening ratio of 80%

The results below were found after comparing and analyzing EUI in different orientations. (Table 3)

As shown in Table 3, with the EUI diagram at a window opening ratio of 80%, due to large window openings, structures with various construction materials exhibit high EUI to reach a high energy consumption range. Wooden structures, due to small heat capacity, maintain low energy consumption in some spaces, while rammed earth and wooden structures have the same coefficient of energy consumption ratio. Because of the slow speed of heat dissipation, concrete structures normally have higher EUI, with 75% falling within the range of high energy consumption. Although bricked structures have higher heat capability, they easily dissipate heat. Hence, EUI coefficient is relatively constant with the only impact of single window opening and double window openings being at the energy consumption ratio of 1:1. The design of large window opening with a ratio of 80% is shown in a bar diagram; even when a double-layered shield panel is installed on the exterior window opening, the energy consumption coefficient still remains constant. That proves that even with the use of large window aperture in architectural space, there is no need to use the design of double layered shield panels (Figure 5).

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Construction Materials/Shield Format		EUI %		
		Low	Middle	High
Wooden	Single Layer	10.4	37.5	52.1
	Double Layers	10.4	37.5	52.1
Rammed Earth	Single Layer	10.4	37.5	52.1
	Double Layers	10.4	37.5	52.1
Concrete	Single Layer	--	25	75
	Double Layers	--	25	75
Bricked	Single Layer	--	50	50
	Double Layers	--	50	50

Table 3: EUI comparison of a window opening ratio of 80%

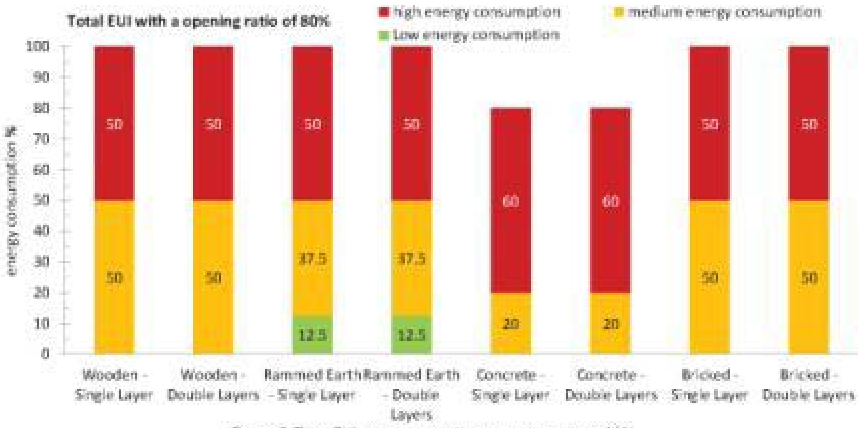

Figure 5: Total EUI comparison with an opening ratio of 80%

4. CONCLUSION

This study, after experimental simulation and analysis, examines the relationship of annual EUI of indoor spaces in different orientations corresponding to the motives and purposes of this study. Concrete conclusions and suggestions below are acquired for the reference of future studies on energy conservation of buildings.

The wooden spatial structure with a window opening ratio of 20% consumes less energy than the basis value of 30 kWh/m2.yr while at an opening ratio of 50%, energy consumption variance is determined by single or double openings. At a ratio of 80%, the increase of EUI also falls within the range of basis value and only Space N maintains lower energy consumption than the basis value.

The wooden and rammed earth structures at an opening rate of 20% consume lower than 30 kWh/m2.yr, and at a ratio of 50%, the EUI still falls within the basis range, while space in the N orientation has EUI lower than the basis value, indicating the significant variance of EUI due to the angle relationship in different orientations. At a ratio of 80%, EUI values in the ES and WS orientations both exceed the basis range. As a result, for spaces with double window openings, sunlight and west orientation should be considered in terms of design.

The concrete spatial structure at an opening ratio of 20% has EUI within the basis range, but at a ratio of 50%, the ES and WS orientations have EUI exceeding the basis range due to sunlight exposure and west orientation. At a ratio of 80%, a double-opening design significantly exceeds the basis value of 30 kWh/m2.yr. This indicates the impact of opening design of space on the EUI of an air conditioning system.

The bricked structure is found to exhibit a significant level of change for the EUI of an air conditioning system. At an opening ratio of 20%, single and double designs of opening have relative impacts on EUI; at a ratio of 50%, the

EUI is found to fall within the basis range, and only the N orientation falls below the range of 30 kWh/m2.yr. At a ratio of 80%, due to large window opening, single or double openings become an important factor related to EUI.

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World Sustainable Built Environment Conference 2017 Hong Kong
Track 2: Practices & Policies for High-Performance Buildings

A Discussion on the Benefits of Environment Performance of the Promotion of Kaohsiung Green Building Specialties Policy -the Case Study on Residential Building in Kaohsiung City

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ABSTRACT

"Water resource is the necessary natural resource for the development of a country's economy. According International Water Association, the total amount of annual precipitation in Taiwan is 2.6 times of the average amount of annual precipitation in all countries in the world. Thus, Taiwan should not suffer from water scarcity. However, Taiwan ranks as the 18th country with physical water scarcity.

Microclimate observation data is acquired from Central Weather Bureau of Taiwan in this research study. Other than analyzing and calculating the information from the database in order to identify the exterior microclimatic factors, the volume of the rainwater collection tanks in Kaohsiung will be calculated for its accuracy in correlation with rainwater overflow and tap water replenishment. Finally, the characteristics of Kaohsiung microclimatic factors collected in this research will be reflected with quantitative data on to the actual design for buildings in Kaohsiung. The main focuses of this research are the following:

- Analyze foundational microclimatic data in Kaohsiung
- The calculation of the volume of the rainwater collection tanks in Kaohsiung
- Provide method to incorporate and reconfigure rainwater collection tanks in accordance with Kaohsiung characteristics.

Keywords: *Kaohsiung buildings, water resource, innovative design policy.*

1. INTRODUCTION

According to a statistics generated from the United Nations-Water, "household water consumption" makes up 10% of global water withdrawal, indicating that disproportionate water consumption has become a common problem faced by several countries around the world. Taiwan Water Corporation reveals that in the past few years (2004~2015), domestic water consumption is maintained at a level between 257 and 265 liters per capita per day. In terms of industry types, "industrial water consumption" and "commercial water consumption" account for the largest proportion of total water consumption, while "household water consumption" closely followed next, implying that domestic Taiwan Kaohsiung local government must take action to promote guidance policies on water recycling. However, since rainwater collection can be affected by local water production, local water consumption, microclimate change at Kaohsiung Metropolitan District, and architectural volume, while considering about water circulation, considerations in the control parameters such as "overflow" and "shortage" related to water tank's spatial volume must be included, so as to increase benefit in water resource circulation. All this have become the major motivation for this study.

In this study, "Water Resource Sustainability Index" promoted by World Green Building Council is adopted as a solid foundation for analyzing long-term microclimate data of Kaohsiung Metropolitan District generated from Central Weather Bureau. Aside from performing statistical analysis on the big database to grasp outdoor microclimate influencing factors, total input and output volume is estimated for deciding water circulation balances in architectures located at Kaohsiung Metropolitan District. Based on the quantitative data, recommendations that suit local circumstances are proposed in response to rainwater collection analysis and global compliance rate for green buildings constructed in Kaohsiung Metropolitan District.

2. LITERATURE REVIEW

2.1. Specification related to architectural regulation in technicality in Taiwan

"Total daily water demand volume in a building" (Wt) must be calculated based on the standard given in Table 1. In other words, Wt must be calculated based on "daily water demand for individual building category" (Wf) and "floor area not including non-dwelling area" (Af) with spatial area such as parking lot, engine room and warehouse excluded. As to building categories not included in the Table (such as gymnasium and museum), Wt must be calculated based on water demand of the architectural design. However, since there is no prominent relationship between water consumption and floor area when it comes to residential building, Wt must be calculated based on the standard of "4 members per household", "250L of water consumption per person per day" and "total households in a residential building".

Construction Category	Scale Category	Water consumption per unit area Wf	Total Water Consumption of Whole buildings (liters / m² · day)
Offices	Exclusively Offices	7	Wt＝Wf×Af Wt＝Wf×Af among them： Af is the total floor area except the areas for the parking lot, the engine room, storage and elevators, stair cases and other services spaces (m²).
	Mixed Uses	9	
Malls and Department Stores	With Food Court	20	
	Without Food Court	10	
Lodging	City Business Hotels	15	
	Multipurpose Hotels	20	
	Medium and Large Recreational Hotels	25	
Medical Centers	Local clinics, Nursing Homes	15	
	General Hospitals	21	
	Academic Hospitals	24	
School Buildings	Administrative and Academic Buildings	10	
	other	References to Others	
Dormitory	----	10	
Residential	----	----	Wt = 250 liters / (person · day) × 4.0 (person / household) × Nf, where Nf is the total number of households in residence, hence water consumption is calculated uniformly as households of four.
other	----	----	Calculated according to the actual demand of water construction.

Table 1: Assessment and evaluation standards for water consumption in various building categories

Daily tap water substitution volume (Ws) must be decided based on the smaller value of either daily rainwater collection volume (Wr) or daily rainwater use volume (Wd). The main reason behind this principle is that once daily rainwater collection volume (Wr) is greater than daily rainwater use volume (Wd), excessive rainwater resource will be lost without adding any benefit to water conservation.

Since "request volume of rainwater storage tank" (Vs) can affect the usage rate of rain water collection volume, total value of "daily tap water substitution volume" (Ws) multiplied by "rational multiplier of the daily rainwater use volume" (Ns) is applied as the "minimum request volume of rainwater storage tank" (Vsm).

Since rainwater cannot be served as drinking water, tap water substitution rate (Rc) cannot be maintained at a level that surpasses 32% of the substitutable reclaimed water, with the exception of the introduction of high-end water quality processing techniques.

"Daily rainwater collection volume" (Wr) is calculated based on overall rainwater collection system and dynamic analysis on local precipitation frequency. This kind of evaluation will present a relatively negative result in rainwater collection volume and "tap water substitution rate" (Rc) of districts with lower precipitation frequency per day.

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EEWH Water Resource Indicator for Domestic Green Building

The Water Resource Indicator is one of the threshold indicators of EEWH-RS; indicator score RS8 must be greater than 1.5 to pass. WI is first calculated by tallying the points for the following water-saving sub-indicators and then converted to indicator score RS8. The calculations and scoring are as follows:

$$WI=a+b+c+d+e+f$$

Equation 1

Water Resource Indicator Calculation $RS8=2.50^{*}（WI-2.0）/2.0+1.5 \geq 1.5，0.0 \leq RS8 \geq 8.0$

Equation 2

Amongst them, RS8 stands for Water Resource Indicator Score; WI stands for water resource indicator (without unit); a stands for Toilet Score (without unit); b stands for Urinal Score (without unit); c stands for Tap for Public Use Score (without unit); e stands for Rainwater Equipment Score (without unit); while f stands for AC Water Conservation Score (without unit).

Residential Design and Encouragement Practices of Kaohsiung Metropolitan District

Article 10: Buildings under five stories with solar power facilities or greening facilities installed at roofs, roof protruding parts, or exposed platforms taking up more than 50% of legal building area can be installed with green power facilities that come with rainwater collection function.

Rainwater collection area generally refers to a part of the building such as roof and the wall. Rainwater storage system, on the other hand, is a part of the building that must be carefully considered for installation; with its volume not only affecting overall systematic benefit but also the building designs itself. In this research, "The Simulation and Evaluation of The Rainwater Utilization on Building Design (2000)" of Architecture and Building Research Institute (Ministry of the Interior) was adopted, with the rainwater utilization calculating software (given in Table 1) directly derived from water recycling calculation of "The Society of Heating, Air Conditioning and Sanitary Engineers of Japan".

2.2. Precipitation data analysis of Kaohsiung metropolitan districts

Based on different landscapes of plain area, hilly area, alpine area, and coastal area in Kaohsiung Metropolitan District, precipitation observatory data for over a decade is applied from Central Weather Bureau as a fundamental data in this research.

Kaohsiung Metropolitan District is located in the subtropical zone with warm temperature and sufficient sunlight throughout the year. Statistics from Central Weather Bureau has revealed that minimum temperature of the district is maintained at a range between 9.6 and 11.5 degree Celsius while maximum temperature of the district is maintained at a range between 36.4 and 36.9 degree Celsius, with average precipitation volume kept at 1,845 mm over the past ten years. Despite the abundant rainfall, precipitation period is generally concentrated in a short timespan that lasts from June to August, with a periodic precipitation volume of 1,199 mm that accounts for 65% of annual precipitation volume (as presented in Table 2). In terms of season, typhoon season usually lasts from May to October while drought season usually lasts from November to April of the next year, indicating a concentrated precipitation volume in the typhoon season. Compared to northern district, a ratio of "precipitation volume during typhoon season" to "precipitation volume during drought season" is merely 6.4, which is not at all beneficial for water utilization.

2.3. Citizen's water consumption from various building equipment

The term "water consumption per capita per day" can be referred to as "livelihood water consumption per capita per day". According to a calculation result, water consumption per capita per day in 2013 is 284 liters, which is 34 liters more than the international standard value of 250 liters. Due to a combine factors of raising living standard, subtropical climate, warm and humid weather, and higher demand for environmental sanitary and disease control, overall water consumption per capita per day is 250 liters.

Under "Water Consumption per Capita per Day of 250 Liters" proposed by the Ministry of Interior, recycled water can be applied to replace residential water used for toilet, cleaning and other purposes, which takes up 32% of total household water consumption. Tap water substitution rate can be evaluated through the following formula:

PCW = Qu / (Household Water Consumption x 0.32)

Usage / Water Amount	Parts that cannot be replaced by Recycled water 68%				Parts that can be replaced by Recycled water 32%			
	Bathe	Washing Food	Wash up	kitchen usage	Toilet	Cleaning	other	total
Daily average	50	60	20	40	60	10	10	250

Table 2: Water consumption per capita per day of 250 liters

3. CASE CALCULATION

In this research, rainwater utilization calculation software is taken as basic calculation approach, precipitation observation value over the past 10 years is applied as fundamental data, residential buildings in Kaohsiung Metropolitan District is considered as study subjects, and rainwater utilization rate or tap water substitution rate are utilized as referential indicators for rainwater storage tank. Base area: 3478.61 ㎡, basic Information

The above mentioned household water consumption is more difficult to be controlled by the engineering design of rainwater collection system. Under condition where rainwater collection area is kept constant, higher rainwater tank capacity and precipitation usually yield greater rainwater collection and utilization volume, which in turn increases tap water substitution rate. Please be noted that this article is written to discuss two indicators of rainwater storage design – rainwater utilization rate PRU (%) and substitution rate of tap water PCW (%), which are different from the tap water substitution rate Rc stated in the "Technical Regulations for Rainwater Storage Design on Buildings" proposed by Construction and Planning Agency (Ministry of Interior). The tap water substitution rate Rc stated in the regulations can be considered as tap water substitution volume / total building water consumption.

4. CALCULATION RESULTS

4.1. General climate

According to "Technical Regulations for Rainwater Storage Design on Buildings" proposed by Ministry of Interior, recycled water can be applied to replace water used for toilet, cleaning, and other purposes. Since water volume of this kind takes up approximately 32% of total household water consumption, under condition where rainwater can be applied to replace a maximum 32% of total household water consumption, tap water substitution rate can be evaluated through the following formula (Table 3):

Calculate the average rainwater collection volume CRW (m^3) per day per m^2.

(a) Alpine areas: 269 m^2x8.4mmx0.85 x 10^{-3}=2.25 m^3

(b) Coastal areas: 269 m^2x2.4mmx0.85 x 10^{-3}=0.54 m^3

(c) Hilly area: 269 m^2x5.6mmx0.85 x 10^{-3}=1.28 m^3

(d) Plains area: 269 m^2x4.2mmx0.85 x 10^{-3}=0.96 m^3

Calculate the average water overflow volume (m^3/day).

(a) Alpine areas：2.25 m^3+156 m^3-97 m^3=61.25m^3 (No water overflows)

(b) Coastal areas: 0.54 m^3+156 m^3-97 m^3=59.54 m^3 (No water overflows)

(c) Hilly area：1.28 m^3+156 m^3-97 m^3=60.28 m^3 (No water overflows)

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(d) Plains area：0.96 m^3+156 m^3-97 m^3=59.96 m^3 (No water overflows)

Calculate rainwater utilization rate PRU (%) and substitution rate of tap water PCW (%).

(a) Alpine areas：0.38% (Rainwater Utilization Rate)

(b) Coastal areas：1.5% (Rainwater Utilization Rate)

(c) Hilly area：0.6% (Rainwater Utilization Rate)

(d) Plains area：0.8% (Rainwater Utilization Rate)

4.2. Typhoon season

Calculate the average rainwater collection volume CRW (m^3) per day per m^2.

(a) Alpine areas：269 m^2x1487mmx0.85 x 10^{-3}=340 m^3

(b) Coastal areas：269 m^2x601mmx0.85 x 10^{-3}=137 m^3

(c) Hilly area：269 m^2x836mmx0.85 x 10^{-3}=191m^3

(d) Plains area：269 m^2x763mmx0.85 x 10^{-3}=174m^3

Calculate the average water overflow volume (m^3/day).

(a) Alpine areas：340m^3+156 m^3-97 m^3=399m^3(With water overflows 302 m^3)

(b) Coastal areas：137m^3+156 m^3-97 m^3=99 m^3(With water overflows 302 m^3)

(c) Hilly area：191m^3+156 m^3-97 m^3=250m^3 (With water overflows 153 m^3)

(d) Plains area：174m^3+156 m^3-97 m^3=233 m^3 (With water overflows 136 m^3)

Calculate rainwater utilization rate PRU (%) and substitution rate of tap water PCW.

(a) Alpine areas：10%(Rainwater Utilization Rate)

(b). Coastal areas：25%(Rainwater Utilization Rate)

(c) Hilly area：18%(Rainwater Utilization Rate)

(d) Plains area：20%(Rainwater Utilization Rate)

In this study, rain water utilization rate of 30%, 50%, and 70% in "Water Consumption Efficiency" under LEED and rainwater utilization rate of 30%~80% under SBTool are both applied as a grading and evaluation standard. Based on rainwater storage and utilization design in "Building Technical Regulation", new buildings with total floor areas more than 10,000m2 must have their rainwater storage and utilization system adequately installed.

5. CONCLUSION

The study takes into account the items specified by the LEED Green Building Evaluation of the United States which states the efficiency of rainwater usage as 30%, 50%, 70%, and the evaluation basis of rainwater recycle rate of SBTool of 30% to 80%, and is in accordance with the rainwater storage and recycling policy from "Specification Related to Architectural Regulation in Technicality in Taiwan" which emphasizes that new constructions with the total floor surface area greater than 10,000m^2 is required to install rainwater recycling system. Hence, the study focuses on the data gathered from collective housing as an example and establishes the rainwater recycling rate at 30%, 50%, and 70% to calculate the average mean of the data collected. The result of the rain water recycling rate is calculated as 1m³ per each of the studied region, and the results of each region's requirement for rainwater storage volume and the replacement rate of tab water are specified in Figures 4.

In other words, in order to satisfy the specification of "Silver Level Rainwater usage rate" of 30% declared by LEED association, the example of the collective housing in the hilly area examined in this study would only need 3m³ of rain water collection volume; for the "Gold Level of Rainwater usage rate" of 50%, the rainwater collection volume should be 25m³. In order to obtain the "Platinum Level of Rainwater usage rate" of 70%, the volume should be 35m³.

Regions in Kaohsiung and Rainwater Usage (%)		Mountainous Region	Coastal Region	Hilly Region	Plains Region	Tab Water Replacement Rate (%)
Suitable Goal for Rainwater Recycling Usage	30%	7.5(m³)	4.2(m³)	3(m³)	15(m³)	Increase 17.90%
	Annual Saving on Water Bill	2,664 NTD / household	2,892 NTD / household	2,988 NTD / household	1,620 NTD / household	
	50%	12.5(m³)	7.1(m³)	5(m³)	25(m³)	Increase 31.70%
	Annual Saving on Water Bill	1,896 NTD / household	2,640 NTD / household	2,820 NTD / household	540 NTD / household	
	70%	17.5(m³)	10(m³)	7(m³)	35(m³)	Increase 43.00%
	Annual Saving on Water Bill	1,356 NTD / household	2,400 NTD / household	2,652 NTD / household	The same amount	

Figure 3: Calculation for the amount of increase needed for the rainwater collection volume in each of the collective housing region in Taiwan

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