出國報告（出國類別：開會）

# 參加 Asia-Pacific Forum on Renewable Energy 2012 國際研討會

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派赴國家：韓國
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行政院及所屬各機關出國報告提要

出國報告名稱：參加 Asia-Pacific Forum on Renewable Energy 2012 國際研討會

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出國期間：自 101 年 11 月 25 日至 101 年 11 月 30 日　出國地區：韓國

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分類號/目

關鍵詞：再生能源、低碳技術、生質能源

內容摘要：（二百至三百字）

因應當前全球氣候變遷的發展趨勢，「節能減碳」成為全球矚目焦點，世界各主要國家莫不大力推動以高能效、低排放為核心的「低碳經濟」，積極發展「低碳技術」，並對產業、能源、技術、貿易等政策進行重大調整，以爭取先機，發展綠色產業。本公司配合國家政策，在電廠營運上未來可引入先進之再生能源及相關低碳發電技術以達能源、環境、經濟 3 者之均衡發展。

Asia-Pacific Forum on Renewable Energy 2012 國際研討會於2012

年12月26-29日舉辦，內容主題包括太陽光電、風力發電、生質能源、地熱能源、氫能暨燃料電池及低碳技術等議題，參加此次會議，不但蒐集了質能及低碳發電技術等再生能源發展相關資料，也更進一步了解目前國際上的研發現況，有利於本公司後續相關研究計劃的規劃與推展。

本文電子檔已傳至出國報告資訊網（http：//report.nat.gov.tw/reportwork）

# 目次

# 壹、目的

本次出國之緣由及目的如下:

1. 經濟部能源局之2012年能源產業技術白皮書緒論:當前全球氣候變遷的發展趨勢，「節能減碳」成為全球矚目焦點，世界各主要國家莫不大力推動以高能效、低排放為核心的「低碳經濟」，積極發展「低碳技術」，並對產業、能源、技術、貿易等政策進行重大調整，以爭取先機，發展綠色產業。本公司配合國家政策，在電廠營運上未來可引入先進之再生能源及相關低碳發電技術以達能源、環境、經濟3者之均衡發展。
2. 依據國際能源總署統計，全球再生能源發電自 1990 年以來平均每年增長 2.7%，低於整體總發電量的 3%成長率。因此，到 2050 年實現減少一半全球能源相關的二氧化碳排放量，需要在 2020 年前較目前規模再增加一倍的再生能源發電。
3. Asia-Pacific Forum on Renewable Energy 2012 國際研討會( 如附件一)於 2012 年 11 月 26-29 日舉辦，內容主題包括太陽光電、風力發電、生質能源、地熱能源、氫能暨燃料電池及低碳技術等議題，參加此次會議，有助於生質能及低碳發電技術等研發工作的推展。

# 貳、過程

本次出國開會之行程及工作概要如表 2-1 所示。

表 2-1、實習行程概要表

| 日期 | 行程及工作概要 |
|---|---|
| 101/11/25 | 往程（台北→濟州島） |
| 101/11/26-29 | 參加 Asia-Pacific Forum on Renewable Energy 2012 國際研討會 |
| 101/11/30 | 返程（濟州島→台北） |

# 參、與本公司相關主要研討內容

1.以熱化學轉化生質物中間物製成燃料或化學品

A.作者:Yong Wang

B.內容摘要:

隨著全球暖化與石化原料耗盡的憂慮日增，越來越多的研究致力於可再生能源來源的轉化和利用，例如生質物。經由生物或熱化學的途徑可以將生質物轉化成燃料或化學品。然而生物途徑充滿限制，生產的醇類類型有限，利用非糧食料源的效率也不高。換句話說，熱化學轉化途徑不限特定料源，而且提供一個高空間—時間—產率的產品。熱化學轉化途徑包括直接及間接製程。經過氣化進行合成氣轉化的間接製程已用於商業，所以主要的挑戰是在較小的產能上，特別是生質物轉化，實現較大的規模經濟。直接製程例如熱裂解雖是一個較為簡單的製程，但是中間物的提升，例如熱解油的催化仍是重大的挑戰。這篇文章將會提出最近在熱化學轉化生質物的中間物方面，例如乙醇、合成氣、醣及熱解油的突破。

C.心得

氣化進行合成氣轉化成甲烷氣是目前重要之發展方向，因可直接與天然氣複循環機組整合。

2.含油微藻的選擇在燃煤煙氣上的應用

A.作者:You-Kwan OH

B.內容摘要:

作為替代石化柴油的生質柴油之料源，微藻展現了相當大的潛力。從微藻產製生質柴油，各單元的程序發展包括：藻種選擇、細胞培養、收成、除水、油轉換等等。在這篇研究裡，我們篩選微藻從燃煤煙氣生產生質油。將收集到的藻種置於燒瓶中，並以空氣、10%二氧化碳的二氧化碳與空氣的混合氣，以及燃煤煙氣(~15%二氧化碳)進行氣泡柱式的培養測試。其中幾種顯示了較高的生質物生產力(>0.2 克細胞數/公升/天)，它們的油脂生產力也較近期發表的超出兩倍。主要的脂肪酸有棕櫚酸(C16:0)、硬脂酸(C18:0)、油酸(C18:1)、亞油酸(C18:2)、亞麻酸(C18:3)。這篇研究報告了一些有潛力以燃煤煙氣生產生質柴油的料源藻株。

C.心得: 微藻製油後之殘渣可再用熱化學法(例如氣化)將熱量回收。

3. 透過 SCENEDESMUS OBLIQUUS HM103382 及 MICRACTINIUM REISSERI JN169781 來利用都市廢水生產生物質及生質柴油

A.作者:Reda A.I. ABOU-SHANAB

B.內容摘要:

都市廢水富含營養鹽，容易致使週遭水體優養化而影響健康及環境，所以都市廢水的排放就成了一個重要的問題。由於微藻可以利用廢水中的氮、磷，使得微藻產製生質柴油具有成本效益，以及永續

性的潛力。因此，將微藻 Scenedesmus obliquus HM103382 及 Micractinium reisseri JN169781 養在經過預處理及輔以 15%二氧化碳的生活污水中，從而達成同時去除營養鹽並產生油脂。不論是生質物或油脂的產量，都是以經過高壓滅菌或過濾滅菌的汙水，較經過紫外光照射或未處理的汙水多。M. resseri 和 S. obliquus 在高壓滅菌入流水中均有最高的生質物產量(0.41±0.01 及 0.26±0.03 dwt/L)與油脂含量(22%及 19%)。其中，以高壓滅菌過的汙水培養 M. resseri 得到的氮、磷與無機碳最高去除率則分別為 97%、98%與 77%。而以過濾滅菌與高壓滅菌培養 M. resseri 得到的飽和脂肪酸分別佔總脂肪酸的 66%及 60%，適合產製生質柴油。

C.心得:利用生活污水養藻可降低成本及碳排放量。

4.熱裂解反應條件對廢棄生質物建材生產生質油的影響

A.作者: Jeong Wook KIM1

B.內容摘要:

科學家已經開始研究廢棄木建材的熱裂解特性，透過熱重分析估算廢棄木建材的活化能，以測試其熱裂解的動力學。除此之外，也比較了批次式與流體化床反應器的產品特性。當纖維素和半纖維素完全分解時，活化能隨著溫度逐漸升高，從 149.41 千焦/摩爾～590.22 千焦/摩爾，只剩木質素仍在緩慢分解。經熱裂解實驗得知在攝氏 400 度至 550 度之間，在攝氏 500 度時有最大的油產量。流體化床式與批

次式反應器相比，產量較高與溫度的關聯性較低，而且更適合用以熱裂解生產生質油。相較於批次式反應器，從流體化床反應器產生酸的含量較少，以及酚的含量較多，可知其能更有效的分解木質素。

C.心得:利用生質廢棄物轉化成能源，可減碳並降低環境污染。

5.以銅鋁催化水煤氣變換反應產氫

A.作者:Rasika B. Manel

B.內容摘要:

由於碳中性能源日益受到關注,使得質子交換膜燃料電池所需的潔淨、高效產氫技術得以發展。重組富氫燃料產氫有兩個問題，一是一氧化碳對環境有害；二是燃料電池中的鉑電極有毒。本研究著重於開發高效催化劑，以提高合成氣產氫，減少水煤氣變換反應中的一氧化碳。水煤氣變換為溫和放熱反應，意味著銅基催化劑在較低的溫度下有著較高的熱力學效率。雖然銅-鋁、銅-鐵及銅-錳催化劑尖晶石相，被發現在水煤氣轉換反應中具有高活性，仍能開發新一代的銅催化劑以提高穩定性與持續性。在此，我們報告了一個同時以不同銅-鋁成分共沉澱及消化技術製備的新型、不含鉻的銅鋁催化劑。並於大氣壓力條件下，在固定床式微管狀石英反應器中，評估這些催化劑在攝氏200至400度下的水煤氣變換反應。

C.心得: 一氧化碳加水轉換成二氧化碳及氫氣，二氧化碳可先行分離。

6.太陽能燃料的光電發展

A.作者: Hyunwoong PARK

B.內容摘要:

隨著碳足跡燃料成本與大氣中二氧化碳濃度的持續增加，以太陽能燃料作為替代的清潔能源載體，正受到越來越多的關注。這些燃料包括從水分子產生的氫與過氧化氫，以及與二氧化碳轉換而成的碳氫化合物。對高效太陽能燃料生產來說，不僅是光的吸收劑（氧化物半導體、矽、無機複合物等）要具有高的吸光效能，也要能夠有效的分離及傳輸電荷。考慮到這一點，本篇將介紹太陽能燃料的生產以及人工光合作用的基本原理，然後詳細討論光電催化分解水及轉化二氧化碳。

C.心得: 太陽能產生燃料也是一種儲能方式。

7. 中國風能產業介紹

A.作者: Shen Dechang

B.內容摘要:

在 2011 年，中國風能產業相較美國和歐洲，仍非常快速的在發展，新的風力發電機組裝機容量接近 17.3GW。至 2011 年底的總累積裝機容量則已接近 63 GW。約 30 個風力發電機組製造商位於中國，可以將合格的產品推向市場。最低的風力發電機組價格(不包含塔柱和地基)降至 572 美元/kW，2011 年底。推測中國風能產業將會穩定

的發展到 2020 年。3MW 的雙饋風力發電機組已被用於離岸風力發電廠，以及 2.5MW 的直驅風力發電機組已被用於潮間帶風力電廠。一些 5、6MW 的風力發電機組已經開發完成，不久的將來將會應用在離岸風力發電廠，而風力發電機組變大，企業國際化已是必然的趨勢。據估中國的風力發電機組的累積裝機容量將會在 2020 年底達到 200GW。對中國的風力發電機組製造商而言，尋找海外市場將是一項艱鉅的任務。根據中國風能產業的實際狀況，本文客觀分析了中國大尺寸風力發電機製造產業的發展前景。

C.心得:強而有力的製造產業方可支撐再生能源工業。

8.燃燒煙氣中汞的排放行為

A. 作者: Sung Hoon SHIM1, Sang Hyun JEONG1

B.內容摘要:

燃料的性質及燃燒的特性會影響煙氣中汞的形態。實驗室規模的沉降爐被設計來研究汞在燒燃煙氣中的行為。將四種煤炭樣品分別放入沉降爐中燃燒；在出口端以衝擊瓶採集汞元素及氧化汞，以分析它們的濃度；再以一個氣體分析儀來記錄出口端的氧氣、一氧化碳及二氧化碳的濃度，及監測燃燒的程度。過程中不僅發現濃度與燃燒時間一致，而且各煤樣的燃燒效率皆大於 80%。這些結果展示了各樣品的汞排放和氧化量程度，進而發現汞排放的程度與煤炭中的汞含量有

關。然而，汞的種類及比例受到許多因素的影響，例如氯和硫的含量、汞的保留百分比及燃燒程度。

C.心得：煙氣中汞的形態會影響汞的去除方法。

# 肆、心得及建議

## 4-1 心得

1. 再生能源工業之研發方向可從增加效率及降低成本方向著手，降低成本則需與系統製造業結合，在研發方向上宜參考國外技術但與本土之基礎工業結合，以期再生能源利用與經濟發展並進。
2. 全世界人口激增，地球資源有限，再生能源發展應同時考量糧食供應、水資源、環境污染及碳足跡，以維持地球永續發展。
3. 人口老化及煤炭大量使用使得汞的問題日益嚴重，發電業應及早建立經濟有效之汞處理技術。
4. 微藻具捕捉電廠二氧化碳、作為生物燃料及生產高價產品等多重功能，發展微藻生物能源技術並低成本大規模養殖生產，則為影響此產業發展的關鍵因素之一。利用廢水之營養源及水資源是一個可開發之方向，其他如養藻模組化及自動化都是降低成本的有效方法。

## 4-2 建議

1. 煤炭及生質物之氣化合成氣長期發展應與燃料電池整合成高效率之IGFC 發電系統；中期可研究氣化合成氣轉化成甲烷氣，直接與天然氣複循環機組整合發電，加速氣化合成氣之利用及達節能減碳之目標。
2. 低熱值褐煤全球蘊藏量豐富，價格相對便宜，研發有效率(低碳)褐煤改質技術提昇熱值，可望降低燃煤電廠之購煤成本。

# 伍、本會議發表之文章名稱

| 文章名稱 | 作者 |
|---|---|
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| Impact of Zn1-xMgxO:Al transparent electrode for Buffer-less Cu(In,Ga)Se2 solar cells | Yoshihiro Kuwahata* , Takashi Minemoto, Ritsumeikan University Noji-Higashi, Kusatsu, Shiga. |
| DEVELOPMENT OF PHOTOELECTRODES FOR SOLAR FUELS | Hyunwoong PARK, |
| LONG-TERM STABILITY AND CHARGE TRANSPORTATION IN DYESENSITIZED SOLAR CELLS | Jongchul Lim, Young Soo Kwon, Sung-Hae Park, Taiho Park |
| ENHANCED PERFORMANCE OF DYE SENSITIZED SOLAR CELLS USING PEDOT ELECTRODEPOSIT COUNTER ELECTRODE | Kyung Hee Park, Hyung Jin Kim, and Chang Kook Hong |
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| Recent Research on Hybrid Bulk Hetero-junction Solar Cells | Chinho Park* and Nguyen Tam Nguyen Truong |
| HIGHLY EFFICIENCY INORGANIC/ORGANIC HYBRID TANDEM SOLAR CELLS | Jae-Wook KANG, Chang Su KIM |
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| Energy yield of different PV module technologies and influencing factors | SooBong Lim TUV Rheinland |

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| PHTOTOVPLTAIC SYSTEMS IN UNIVERSITY OF MIYAZAKI | Kenji Yoshino,,Kensuke Nishioka Atsuhiko Fukuyama Hidetoshii Suzuki |
| Development of the Ultra-Thin Concentrator for a CPV module using the TIR Fresnel lens | Sungbin Kim, Sangkyoung Oh Jangkyun Kim, Chankyu Park,Jaehak Jung Yujin Jung and Byungwook Kim |
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