行政院及所屬各機關出國報告

（出國類別：考察）

出席亞太經合會再生能源研討會暨考察美國煤炭氣化發電技術

服務機關：台灣電力公司

出國人職稱：副處長

姓名：楊勳得

出國地區：美國

出國期間：民國 90 年 3 月 25 日至 90 年 4 月 5 日

報告日期：民國 90 年 6 月 4 日

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出 國 報 告

目　　錄

壹、前言

我國基於地球村的一份子以及受到全球氣候變化綱要公約的壓力，在民國八十七年全國能源會議結論中，研訂我國因應溫室氣體排放減量策略為：積極推動新能源及淨潔能源，大幅提高再生能源及其他淨潔能源容量，其中推廣再生能源利用，至 2020 年佔能源需求比率以 3%為目標。近年來全球再生能源蓬勃發展，欣欣向榮，尤以風力及太陽能之開發更為迅速，值得我國借鏡。

又從控制溫室氣體排放量而言，排放量低或完全不排放的能源均為淨潔能源，煤炭氣化發電所產生氣體及固體廢棄物之排放量遠低於傳統燃煤機組，從技術成熟度、能源使用效率及環保優越性而言，煤炭氣化發電技術，勢必成為未來燃煤發電的主流。

本公司為積極推動再生能源及淨潔能源之開發，爰指派職赴美參加 APEC 21 世紀再生能源論壇暨考察印第安那州 Wabash River 及佛羅里達州 polk 煤炭氣化電廠，俾作為本公司規劃設計之參考。

貳、出國行程

日　　期	地　　點	工　作　內　容
90年3月25日	Taipei→portland	往　　程
90年3月26,27日	portland	出席APEC再生能源研討會
90年3月28日	portland→Indianapolis	路　　程
90年3月29,30日	Indianapolis	赴Wabash River電廠考察
90年3月31日	Indianapolis→Tampa	路　　程
90年4月1日	Tampa	撰寫報告
90年4月2日	Tampa	赴Tampa電廠考察
90年4月3日	Tampa→Los Angeles	路　　程
90年4月4、5日	Los Angeles→Taipei	返　　程

參、APEC 21 世紀再生能源論壇

本論壇係由美國發起，並經去(2000)年 5 月亞太經合會部長級會議決議通過，交由亞太經合會再生能源技術工作小組負責推動。本次論壇由美國及我國共同主辦，且有亞太經合會永續發展組織及 10 家廠商贊助，於 3 月 26 及 27 日在美國俄勒岡州波特蘭市舉行，約有 100 人參加，行政院環保署為代表我國之主辦單位，應邀在會中致詞，展現我國推動再生能源之決心，我國其他出席單位尚有行政院國科會、工研究能資所、台灣經濟研究院、茂迪公司、光華開發科技公司、美國俄勒岡州貿易資訊辦事處及台電公司等。

本論壇之宗旨為建立私人廠商與政府間之溝通管道，加速再生能源之開發，俾早日實現亞太地區再生能源合作開發計畫，該合作計畫以應用為主，包括再生能源與電力系統並聯，混合式發電或再生能源獨立發電系統，或推廣再生能源應用於偏遠地區之衛生所、學校、農村以及提供資金、法規、教育訓練、設計規範等資訊。

本次論壇具有下列實質意義：(1)促進亞太地區各會員體彼此相互瞭解再生能源之開發情形，(2)促進亞太地區各會員體再生能源技術交流及提供貿易機會，(3)建立政府與民間企業相互溝通之管道，(4)促進亞太地區再生能源之開發。本次論壇之議程表詳如附錄。

謹將本次論壇，APEC 各會員體所發表之論述摘要如下：

澳大利亞

報告人：Frank Reid, Managing Director, Australia Cooperative Research Centre for Renewable

內容摘要：

澳洲政府已宣示未來十年將積極推展開發再生能源，預估其發電量將達 950 萬度，投資金額達 25 億美元。澳洲再生能源研究中心致力於再生能源推廣教育，尤其培訓出許多 APEC 會員體之技術人員。

APEC 在推廣再生能源應扮演之角色：

(1) 鼓勵 APEC 各會員體開放電力市場

(2) 促進 APEC 各會員體建立再生能源技術交流之管道

(3) 促進 APEC 各會員體間有關再生能源之合作

(4) 加強 APEC 各會員體間之合作俾進軍國際市場

APEC 各會員體可能合作之措施：

(1) 舉辦電業自由化對再生能源開發之衝擊研討會

APEC 某些會員體因電力自由化而對再生能源之開發產生一些微妙的影響，APEC EWG 可提供資訊給 APEC 各會員體參考，俾激發開發再生能源之意願。

(2) APEC EWG 應加強推動 APEC 各會員體偏遠地區使用再生能源，包括提供財源、教育訓練，扶植中小型再生能源企業等。

(3)協助 APEC 會員體取得再生能源國際交易認證

再生能源之交易制度已在歐洲先進國家萌芽，APEC 會員體如能取得國際認證，將有助於再生能源之開發。

(4)建立全球氣候變化綱要公約京都議定書所載清潔發展機制之策略聯盟，以促進亞太地區再生能源之開發。

(5)建立亞太地區再生能源器材之統一規格及認證制度，俾使各項再生能源器材得以相互流通。

加拿大

報告人：Bill Eggertson, Executive Director, Canadian Association for Renewable Energies

內容摘要：

(1)APEC 應提供資金或財務擔保，俾促進亞太地區再生能源之開發。

(2)APEC 應蒐集 APEC 各會員體有關再生能源之資訊，並協助 APEC 各會員體訂定開發再生能源之目標。

中國大陸

報告人：Miao Hong, Financial Planning Specialist/ Coordinator, GEF/World Bank China Renewable Energy Development Project, State Economic and Trade Commission

內容摘要：

中國大陸截至 1999 年止，併入電力系統之風力發電總裝置容量為 34.4 萬瓩，分散式小型風力發電機共 17 萬座，太陽光能發電裝置容量為 1.5 萬瓩，住宅用沼氣槽 6.6 百萬座，大型沼氣槽 740 座。預估至 2015 年太陽能發電容量將達 32 萬瓩，併入電力網風力發電容量 700 萬瓩，分散式小型風力發電裝置容量 10.5 萬瓩，地熱發電容量 11 萬瓩，工業廢棄物沼氣利用 40 億立方公尺，農業廢棄物沼氣利用 4.5 億立方公尺，植物莖桿利用 20 億立方公尺。

印尼

報告人：Chayun Budiono, PT Gerbang Multindo Nusantara

內容摘要：

(1) APEC 應舉辦促進亞太地區再生能源產業之活動，俾使中小型再生能源企業獲得商機。

(2) APEC 應促成太陽能發電併聯系統合作計畫。

(3) APEC 應設立太陽能研究中心，以促進各會員體之技術交流。

(4) APEC 會員體應在生質能氣化技術進行合作，使達到技術性、經濟性及環境接受性均為可行。

(5) APEC 會員體亦可就小水力發電及地熱發電進行技術交流。

日本

報告人：Haruo Nogami, Manager, Team Ⅱ/Engineering of Combustion Technology, Energy & Environmental Development Department

內容摘要：

野上先生介紹該公司所研發之循環流體化床(Circulating Fluidized Bed)鍋爐，以玉米莖桿或蔗渣為燃料，每年可處理 9 千噸，年發電量約 1 千 6 百萬度。該項設備已銷售 600 座至東南亞國家。渠認為再生能源之開發應因地制宜，考量當地之天然條件，而 APEC 應設立再生能源研究開發基金，來推動制定適合於各會員體之再生能源開發策略。

菲律賓

報告人：Angelito Angeles, NRE (Engineer, Technology Development Extension Group, Inc.

內容摘要：

菲律賓進口能源佔 58%，自產能源佔 42%，其中有 28%係來自於再生能源(不包括大水力及地熱)，16%係燃燒木材，12%為燃燒稻殼，椰殼及蔗渣，預估 2009 年再生能源比例約佔 21%，其中燃燒木材、稻殼、椰殼、蔗渣佔 20%，太陽能、風力及小水力約僅佔 1%。菲律賓之風力潛能有 76GW，但已開發

者僅100KW及368座風力抽水機，生質能發電之潛能約150MW，小水力潛能約28MW，菲律賓預估至2009年開發再生能源之投資費用將達10億美元，其中大約有57%之資金需仰賴外資，其餘則為國內資金。菲律賓推動再生能源所遭遇到困難有(1)再生能源之開發未受到獎勵，(2)再生能源資訊缺乏，(3)決策者、政府官員及一般民眾普遍缺乏對於再生能源的認知，(4)缺乏開發再生能源資金融資之管道。

俄羅斯

報告人：Raphael Vartanov, Business Developer, International Applied Engineering

內容摘要：

在美國派遣生質能專家之協助之下，俄羅斯自1997年以來致力於開發偏遠地區之生質能發電技術。渠對於開發再生能源之建議有(1) APEC應提供開發再生能源之資訊及商機，(2)美國及俄羅斯政府共同提供開發再生能源資金，(3)將再生能源列入高峰會議之議題，(4)請美國廠家提供開發再生能源之案例，(5)建立亞太地區再生能源資料庫，(6)提供再生能源相關技術及培訓計畫。

中華民國

報告人：Simon Tsuo, Solar Electricity Division, Motach Industries, Inc., Shek Chung Gau, Sinonar Corp

內容摘要：

茂迪太陽光電公司左總經理報告該公司單晶太陽電池年生產量為 4MW，今年年底可擴充生產設備至 10MW。光華開發科技公司高副總經理報告該公司非晶薄膜太陽電池年生產量為 12MW。

有關推動再生能源之建議事項為(1)在台灣舉辦亞太地區再生能源展示會，(2)教育大眾及政府官員如何推廣再生能源，(3)促請 APEC 各會員體制定推廣再生能源法案，(4)促請 APEC 各會員體設立再生能源電腦網路，俾便各廠商得以作資訊及技術交流。

泰國

報告人：Wattanapong Rakwichian, Director of SERT, Naresuan University

內容摘要：

泰國能源政策局為推廣利用太陽能，於 Nare Suan 大學太陽能研究中心內，設立太陽能公園，即將於今年年底完工。公園內有太陽能商業中心、試驗館及訓練館，太陽能產品之

廠商與顧客可在太陽能商業中心進行交易及交換資訊，各取所需，試驗館內展示太陽能發電試驗器材及太陽能冷氣機，訓練館為提供太陽能產品銷售及安裝等之訓練場所。公園內之設施有太陽光電系統 3KW 一組，太陽光電、風力、柴油機、蓄電池併聯系統一組，太陽能路燈、太陽能及風能觀測站、太陽能熱水器、太陽能冷氣機、太陽能乾燥機。

公園內亦有一太陽能示範村，有 9 戶住家，以太陽能發電系統供電，參觀者可實際體驗太陽能獨立電力系統之運轉情形。村內設置太陽能發電 75W、150W 及太陽能抽水機。

泰國開發再生能源所遭遇之困難有(1)再生能源發電成本昂貴，(2)一般人普遍缺乏再生能源之知識，(3)缺乏再生能源產品之行銷策略。

對於推廣再生能源之建議為(1)獎勵設立再生能源公司，(2)加強太陽光電與系統併聯技術之研發，(3)加強太陽能冷氣機之研發。

越南

報告人：Vu Mank Ha, Clean Energy Company, Ltd.

內容摘要：

越南境內煤蘊藏量約 35 億噸，石油蘊藏量 35 億立方公尺，技術可行水力蘊藏量約 510 億度。越南電力系統裝置容量約 5559MW，其中水力佔 55%，年總發電量 260 億度。

對於推廣再生能源之建議為(1)請 APEC 協助越南發展風力、太陽能、地熱、波浪發電、沼氣發電、生質能等再生能源利用，(2)請 APEC 在越南舉辦再生能源研討會，俾激發政府重視再生能源之開發，(3)請 APEC 協助越南政府設立再生能源展示館，(4)請 APEC 協助越南政府在離島及偏遠地區開發再生能源。

肆、Wabash River 電廠

一、概　述

Wabash River 電廠位於美國印第安那州 West Terre Haute，該計畫係在舊有燃煤電廠旁新設氣化廠（屬 Global Energy 所有）及氣渦輪機組容量 192MW，與經整修後舊有燃煤機組容量 104MW。在示範運轉期間曾試燃用煤、石油焦及焦炭和煤之混合燃料，該電廠於 1993 年 7 月開工，1995 年 11 月完工，2000 年 1 月完成示範運轉，總工程費 4.38 億美元，美國能源部補助一半 2.19 億美元。（詳如圖一）

二、電廠主要設施（詳如圖二）

1. 氣化爐

E-GAS 煤炭氣化爐為二段式，加壓噴流式氣化爐，煤漿（煤水比例為 60:40）與純度 95%之氧氣一起飼入下段燃燒爐中，燃燒溫度約 2500°F，壓力為 400 psig，實際操作溫度要視煤質而定，煤炭部份燃燒產生合成氣，往上貫入上段燃燒爐，再注入煤漿與高熱合成氣接觸後，經過熱解及液化作用，產生粗合成氣，在上段燃燒爐中注入煤漿，除了增加合成氣的熱值外，並使合成氣溫度稍微降低至 1900°F，

因此，可省略體積龐大而且昂貴之輻射式熱交換器。粗合成氣離開氣化爐後送入熱管鍋爐產生高壓飽和蒸氣(1600psia)，煤灰熔融自爐底流出落入驟冷水槽，凝結成難溶解之玻璃狀煤渣，可供作建材用。本計畫裝設二整套氣化爐，平時僅運轉其中一座，日燃煤量約 2544 噸。

2. 合成氣淨化系統

粗合成氣中所含有煤灰及懸浮微粒，經金屬過濾器處理後，回收至上段燃燒爐中再利用，經過濾後之合成氣中含有 H_2，CO_2，CO，H_2O，N_2，CH_4，COS，H_2S 及 NH_3 等，由於 COS 無法直接移除必須藉觸媒轉化成 H_2S，而在移除 H_2S 之前需先經過熱交換器將合成氣溫度降低至 100°F，此時合成氣所含水份將會凝結，此凝結水中含有氨氣，二氧化碳和硫化氫，送至水處理廠處理，經過冷卻之合成氣即進行酸氣吸收移除系統，藉由 MEDA 溶劑移除 H_2S 後，成為乾淨之合成氣，即可供氣渦輪機使用。

3. 硫磺回收

合成氣中之 H_2S 經觸煤之催化作用回收成硫磺，一部份 H_2S 經燃燒後生成再 SO_2 與 H_2S 起化學反應生成硫及水，而殘留之 H_2S 經壓縮後回收至氣化爐中，

煤炭中所含有之硫成份有 97%均被回收成硫磺。

4. 空氣分離廠

空氣分離廠生產純度 95%之氧氣供氣化爐使用。

5. 水處理系統

在水處理系統中先 CO_2 和 H_2S 移除，再移除 NH_3。

6. 發電機組

氣渦輪機組採用 GE MS 7001FA 可兼燃合成氣及 2 號輕油，以輕油啟動並噴蒸氣控制氮氧化物之排放量，額定出力為 192MW，HRSG 為單注水鼓設計，可耐過熱高壓蒸氣 754,000 lb/hr，1010F，燃用合成氣之廢熱蒸氣為 600,820 lb/hr，1010F，汽輪機於 1953 年開始運轉，原額定出力為 90MW，經整修後額定出力之提升為 104MW，扣除廠內用電為 34MW，淨出力為 262MW，廢煙氣自 225 呎高之煙囪排放。

三、運轉實績及問題探討

1. Wabash River 電廠氣化爐之利用率至 2000 年已可提高至 75%，淨出力原設計值為 262MW 而無論燃用煤炭或石油焦，其淨出力均可達到 261MW，綜合熱效率(HHV)原設計值為 37.8，經實際運轉結果燃煤為 39.7，燃石油焦為 40.2 均高於原設計值（詳如表一及圖三）。

表一　Wabash River 電廠運轉實績

燃料別	原設計煤	實際使用燃料	
		煤	石油焦
輸入量(tons/day)	2250	2450	2000
合成氣產量(million Btu/hr)	1780	1690	1690
氣渦輪機出力(MW)	192	192	192
汽輪機出力(MW)	105	96	96
廠用電(MW)	35	36	36
淨出力(MW)	262	261	261
綜合效率(HHV,%)	37.8	39.7	40.2

2. 雖然煤炭和石油焦之成份不同，但所產出合成氣之成份卻幾乎相同。(詳如表二、三)。

表二　煤及石油焦成份

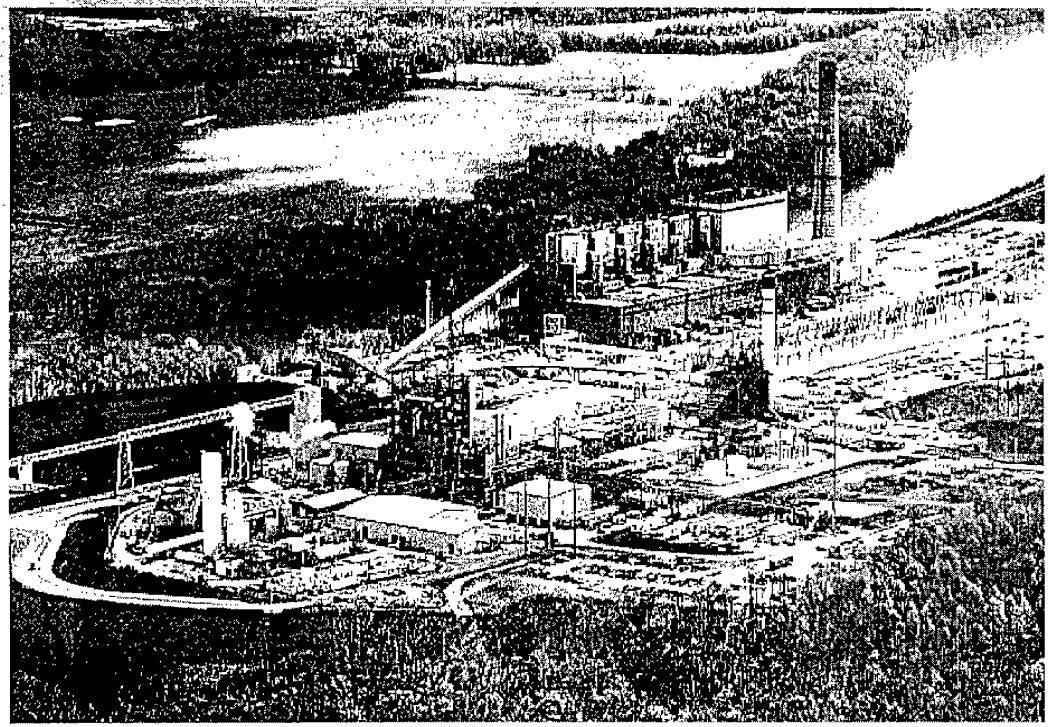
燃料別	原設計煤	石油焦
水份，%	15.2	7.0
灰份，%	12.0	0.3
揮發份，%	32.8	12.4
碳份，%	39.9	80.4
硫份，%	1.9	5.2
熱值(HHV, Btu/lb)	10,536	14,282

表三　合成氣成份

燃　料　別	原設計煤	石油焦
氮，Vol %	1.9	1.9
氬，Vol %	0.6	0.6
二氧化碳，Vol %	15.8	15.4
一氧化碳，Vol %	45.3	48.6
氫，Vol %	34.4	33.2
甲烷，Vol %	1.9	0.5
硫，ppmv	68	69
熱值，Btu/SCF	277	268

3. 一般而言，硫氣化物之排放量為 0.1 lb/MMBtu，僅為排放標準之十分之一，亦曾有低於 0.03 lb/MMBtu 之記錄，氮氧化物之排放量可低於 10ppm，可符合 2003 年之排放標準，而懸浮微粒之排放量幾乎為零。(詳如圖四、五)
4. 煤渣中之含碳量較預期為高，約達 10%，經改良攪拌器及更換新燃燒器後，煤渣之含碳量降低至 5%。
5. 電廠運轉初期冷凝器，懸浮微粒移除系統，COS 催化系統，合成氣過濾系統及氣渦輪機均曾發生過故障，經改善後漸入佳境。
6. Wabash River 電廠宣稱其煤炭氣化複循機組之建設成本較其他廠便宜。(詳如圖六、七)

圖一 WABASH RIVER ENERGY LTD.



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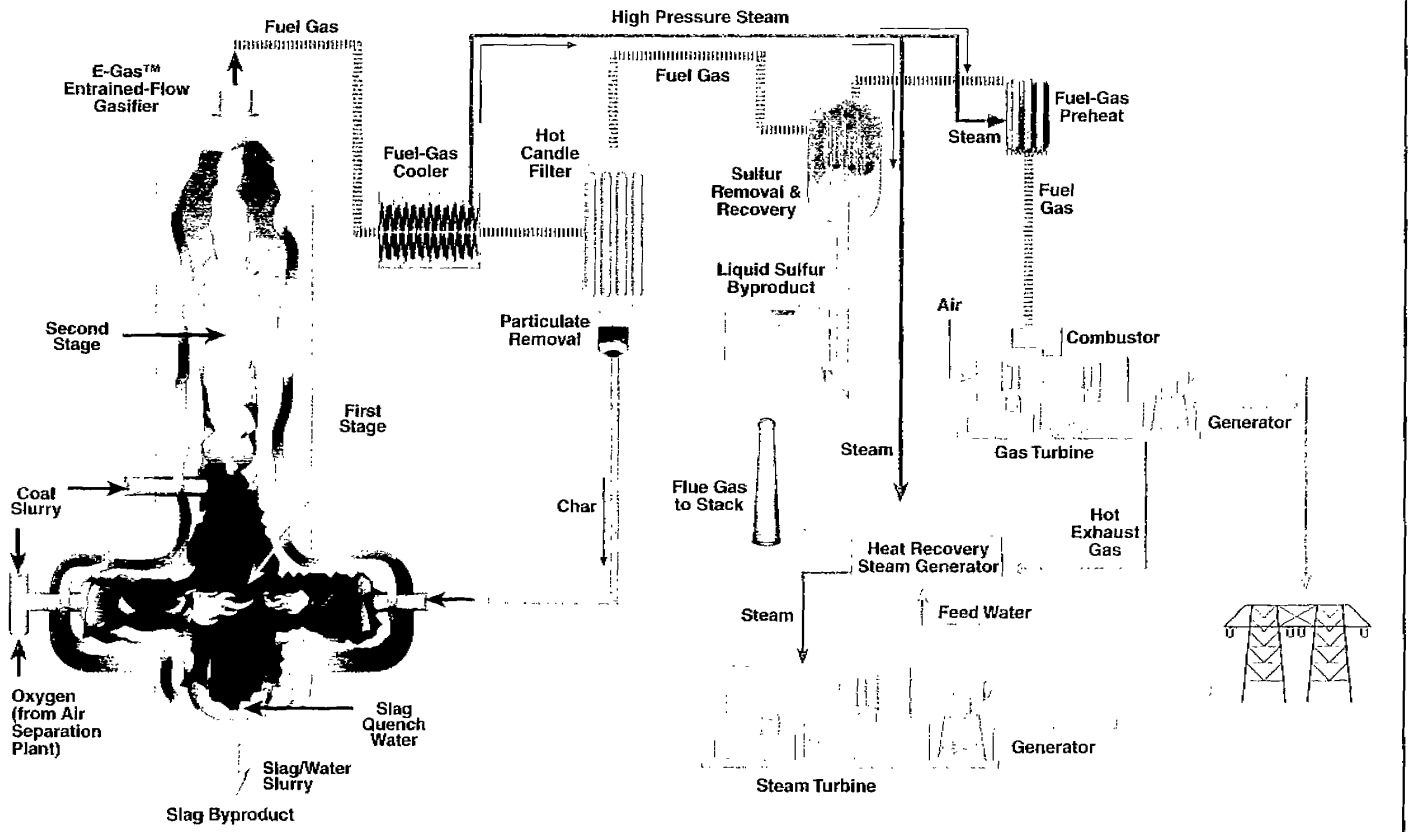
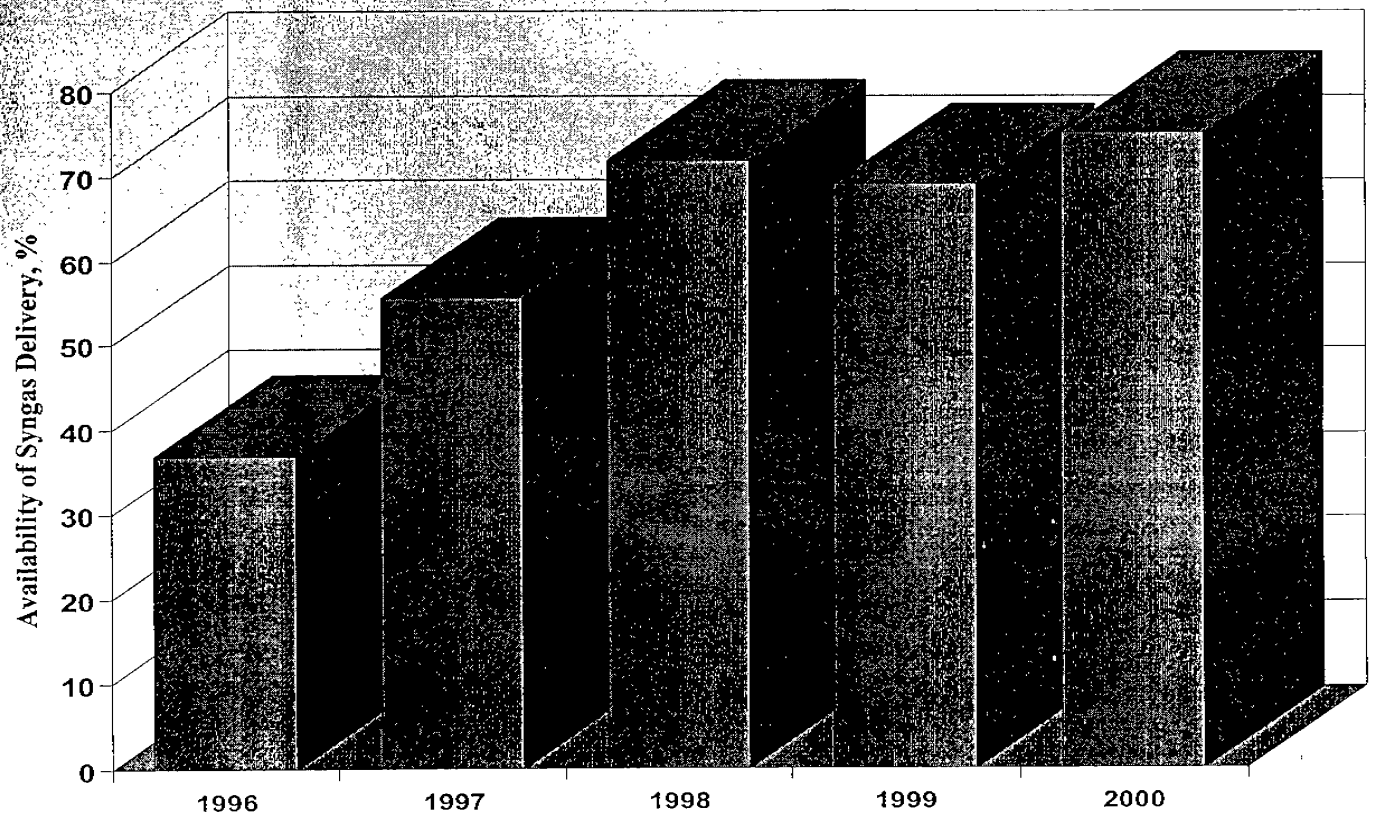
圖二　Process Flow Diagram



Process Flow Diagram

圖三 *Syngas Availability*



GLOBAL ENERGY

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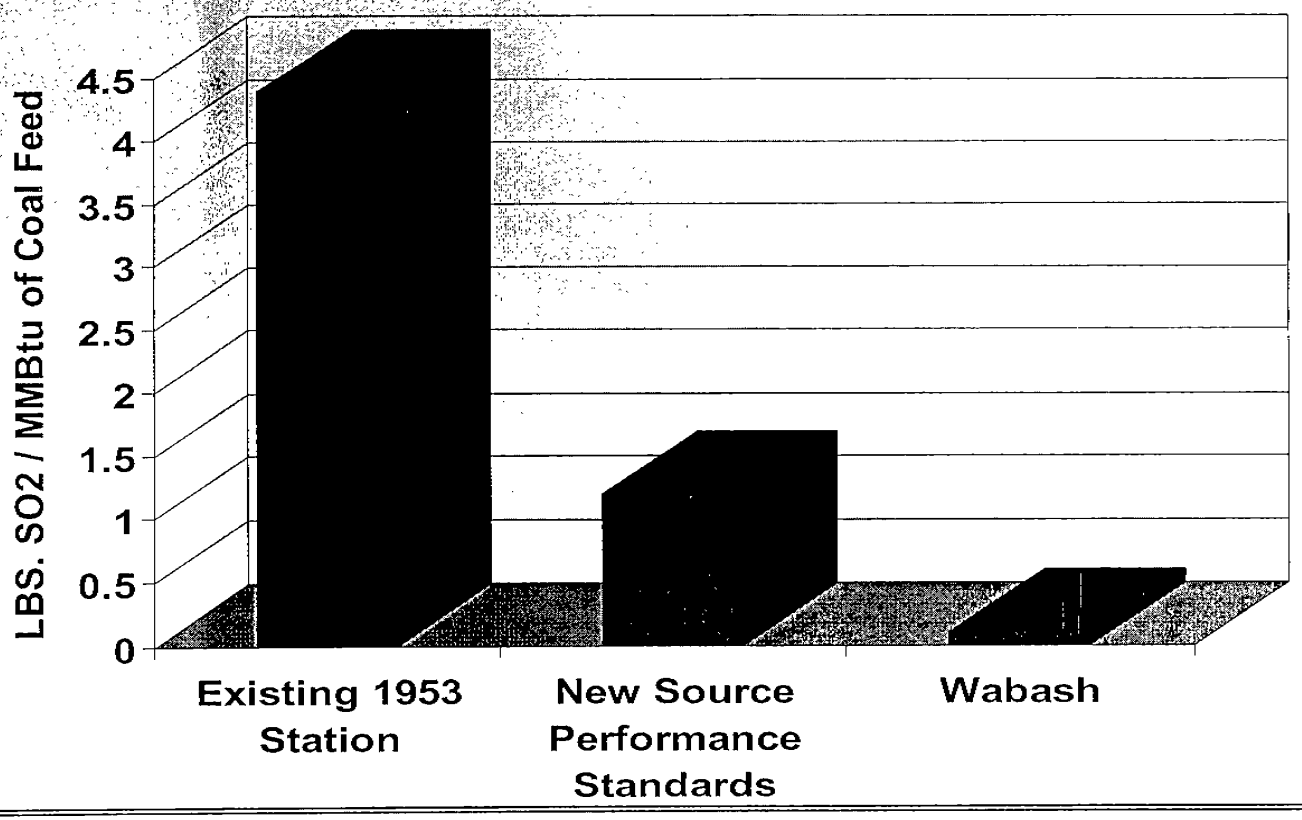
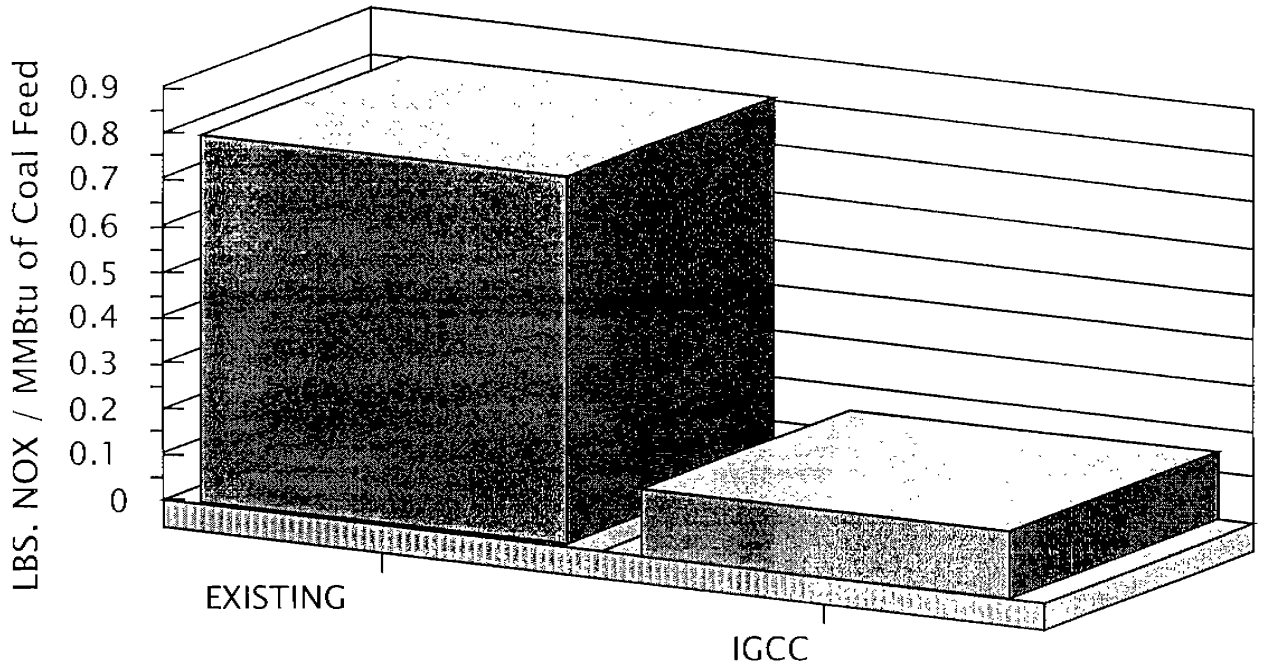
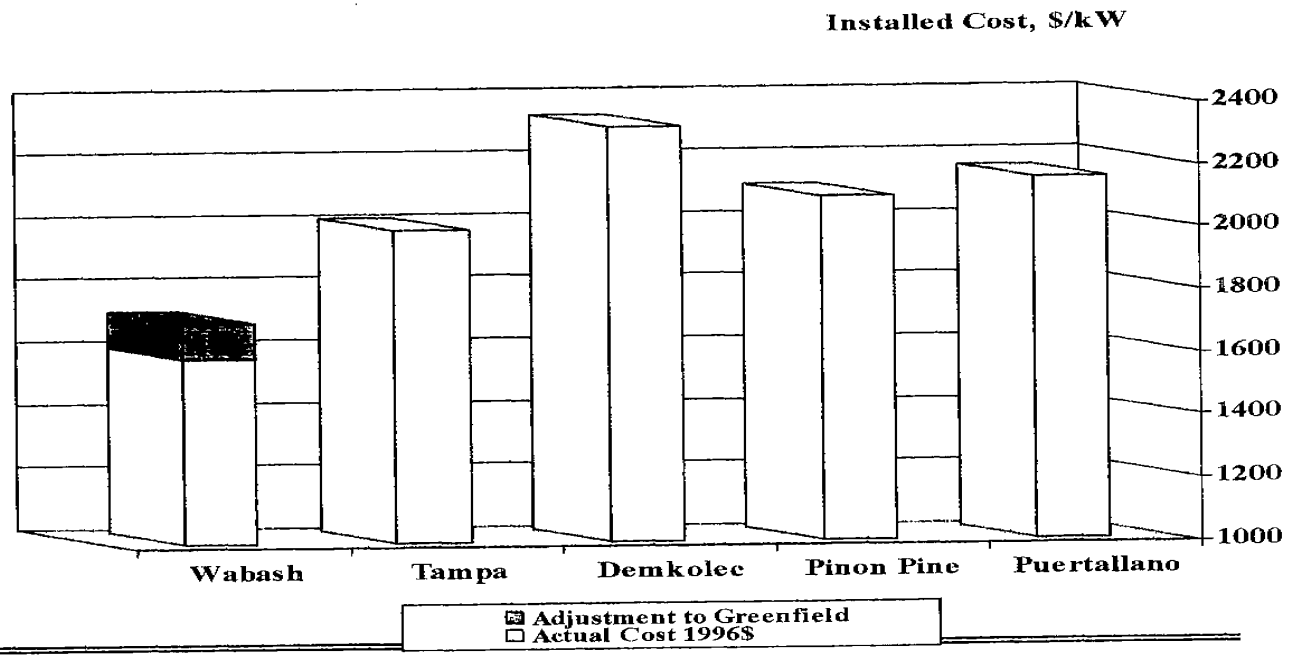
圖四 SO_2 EMISSIONS



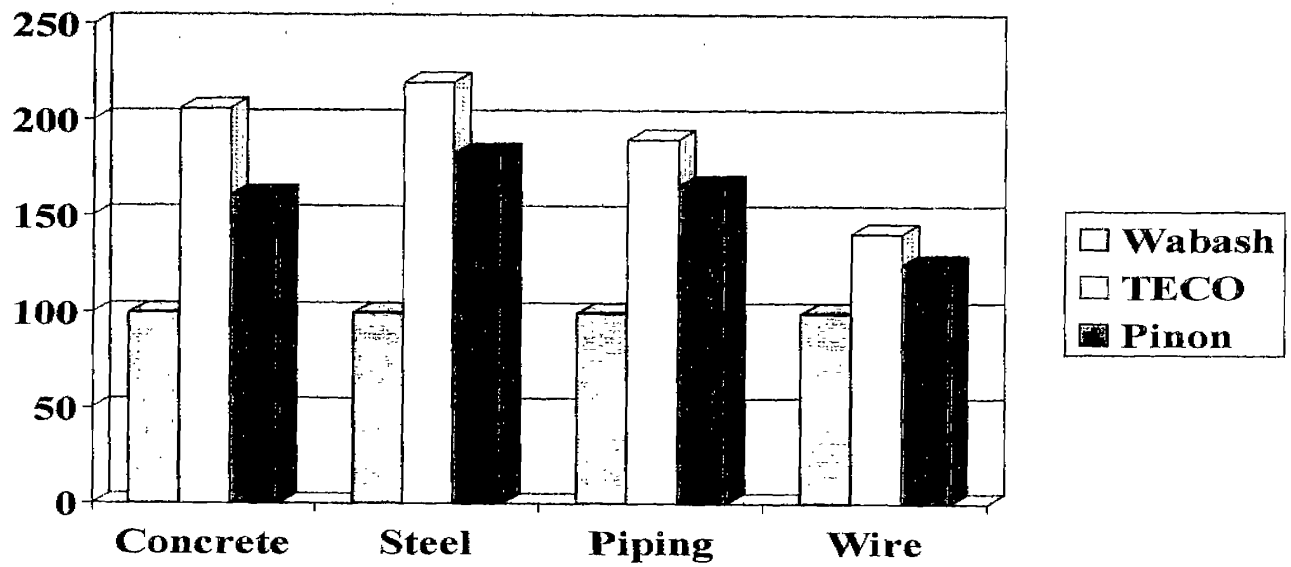
圖五 NOX EMISSIONS



圖六 INSTALLED COSTS OF FIRST GENERATION COAL FIRED IGCC



圖七 Installed Quantities per MW Compared to Wabash



伍、Polk煤炭氣化電廠

一、概　述

Polk電廠位於美國Florida州Polk郡，佔地600公頃，其中343公頃為冷卻水池，採用Texaco煤炭氣化技術，GE氣渦輪機組容量192MW，汽輪機容量121MW，扣除廠內用電63MW，淨出力為250MW，電廠綜合效率約40%，該電廠之特色為將空氣分離廠所得氮氣注入氣渦輪機內，可增加出力及減少氮氧化物之排放量。並試用高溫氣體淨潔系統及多種不同煤質之燃料，蒐集試驗資料，作為日後改進之參考，Polk電廠於1994年11月動工，1996年10月商轉，總工程費5.06億美元，美國能源部提供1.42億美元，電廠照片如圖八。

二、電廠主要設施（詳如附圖九）

1. Texaco氣化爐

Texaco煤炭氣化爐係單段噴流式向下點火煤炭氣化設備，將煤炭含量約60至70%之煤水漿和純度95%之氧氣同時飼入溫度高達1482℃之氣化爐內，煤與氧氣反應產生合成氣，當高熱合成氣流經直徑17呎，高100呎，重達900噸之輻射冷卻器而產生高壓蒸氣後，合成氣即流出氣化爐，煤渣落入爐底水

中，煤渣水經處理後循環使用。每天燃用匹茲堡 8 號煤 2300 噸，其含硫量約 2.5～3.5%。

2. 空氣分離廠

空氣分離廠生產純度 95%之氧氣，供應氣化爐及硫酸廠，並提供熱壓縮氮氣至氣渦輪機，除可增加出力外，亦可抑低氮氧化物之排放量，每天生產 2100 噸氧氣及 6300 噸氮氣。

3. 合成氣淨化系統

低溫淨潔系統可之設計容量為可淨化全部粗合成氣但為測試高溫淨潔系統之功效，乃將百分九十之粗合成氣送入低溫淨潔處理系統，先經水洗移除懸浮微粒，作為填方材料，水則作為煤漿水再利用。合成氣去除懸浮微粒後，加入氨將合成氣中之硫化氫和二氧化碳製成硫酸，氨水則再循環使用。百分之十之高溫粗合成氣送入高溫淨潔處理系統，先以一次旋風機(primary cyclone)移除合成氣中之懸浮微粒，作為填方材料，再注入碳酸氫鈉後，送入二次旋風機(secondary cyclone)將氯及氟用化學方法吸收，以減少氣渦輪機之腐蝕作用。合成氣中之 H_2S 及 COS 進入吸收器底部與反方向流動之吸收劑接觸，硫與金屬氧化物反應成金屬硫化物，此時，合

成氣中之 H_2S 及 COS 的濃度降低至 30ppm。

在高溫氣體淨潔過程中，硫化物可還原成氧化物，在氧化還原過程中，溫度控制為非常重要因素，溫度不能太高以避免破壞吸收劑之組成，最後一個步驟係用氮氣冷卻吸收劑及清除二氧化硫，才不致於產生硫酸鹽，吸收劑之再利用可以降低很多耗用成本。經過淨化後之合成氣可去除 99.5%之煙塵。

3. 硫酸廠

從合成氣淨潔處理系統取得之二氧化硫與空氣分離廠供應之氧氣，轉化成 SO_3，再製成純度 98%，每月產量約 200 噸，出售給肥料廠使用，殘留微量之二氧化硫，直接從 200 呎高之煙囪排放。

4. 發電機組

氣渦輪機係採用 GE MS700F，具有可燃用合成氣或低硫輕油，以及氮氧化物排放量低之優點，以輕油啟動，額定出力為 192MW，注入氮氣稀釋合成氣，除了增加氣渦輪機之出力外，並可減少氮氧化物之排放量，使用輕油時需噴水以降低氮氧化物排放量。汽輪機進氣壓力為 1450 psig，1000°F，額定出力為 121MW。

三、運轉實績及問題探討

1. polk 電廠原設計使用煤炭為匹茲堡 8 號煤，電廠自開始運轉後之前 10 個月均使用這種煤炭，自 1997 年5月起開始試用其他燃料，迄今共試用10種煤炭，並就煤漿拌合度(Slurryability)，碳化率(Reactivity)，煤渣活性(Slag Aggression)，煤渣特性(Slag characteristics)及 SGC 結垢(SGC Fouling)等，進行測試研究，俾選用綜合發電成本最低之煤炭，各種不同煤質如表四。

表四　polk 電廠試用之煤質

煤炭別	匹茲堡 8 號煤#1 (原設計煤)	匹茲堡 8 號煤 #2	匹茲堡 8 號煤 #3	肯塔基 11 號煤	伊利諾 6 號煤 #1	伊利諾 6 號煤 #2
運轉天數	183	15	25	160	25	5
灰融點(°F)	2400	2200	2230	2250	2240	2325
硫份(%)	2.5	2.8	2.0	3.2	3.4	2.8
灰份(%)	9.0	11.3	9.6	7.0	11.0	9.1
熱值(Btu/lb)	13,500	13,350	13,500	13,500	12,700	12,700
氯份	0.1	0.08	0.1	0.11	0.1	0.19

2. 經過四年多運轉實績得知，氣化爐因運轉經驗之累積以及不斷改進，利用率逐年提高，至 2000 年達

80%，而氣渦輪機如含使用輕油之利用率亦曾達 91%（詳如圖十）。

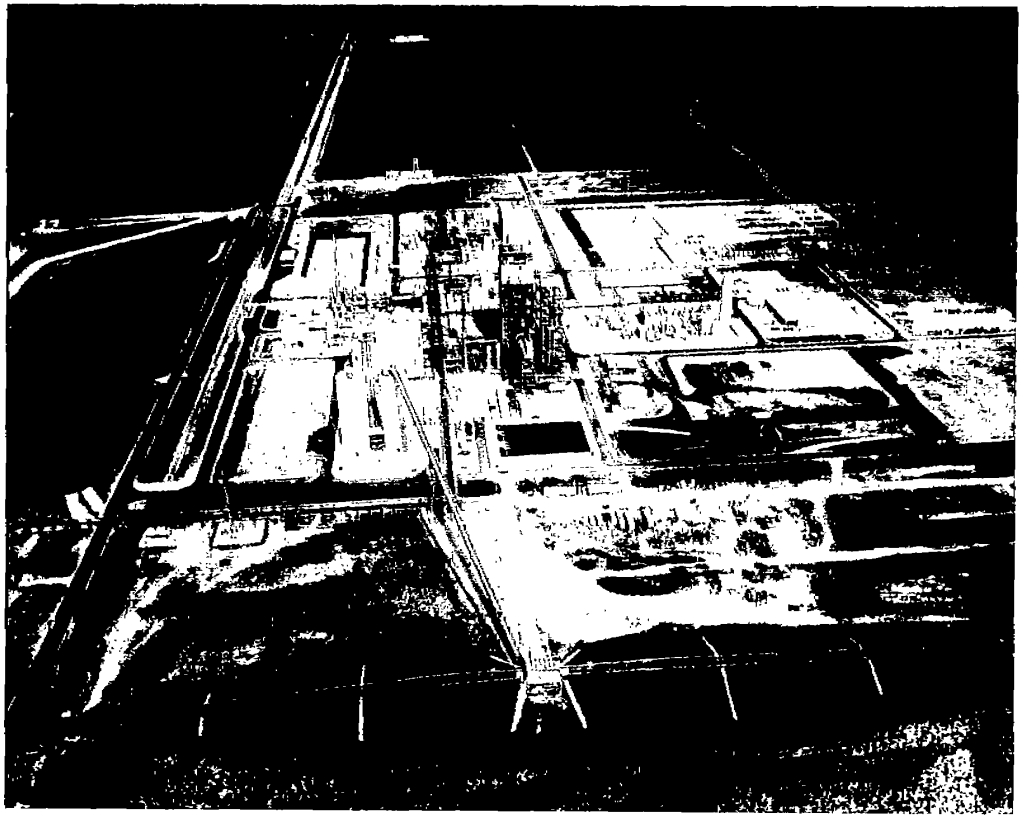
3. 煤漿中必須要有足夠之含煤量，和充分的氧氣量在氣化爐中燃燒，才能產生優質之合成氣，俾使氣渦輪機達到滿載運轉，如果煤漿之含煤量不足，則需加添加劑來改善，如此則會增加運維費用，polk 電廠煤漿含煤量之設計值為 61 至 62%。
4. 氣化爐之燃燒溫度必須適中，溫度太高會縮短耐火襯之使用壽命，溫度太低則煤炭燃燒之碳化率不足，增加燃料使用量，並影響煤渣之流動性。一般而言，氣化爐的燃燒溫度愈高，碳化率愈高，而耐火襯之壽命則相對縮短。polk 電廠煤漿氣化過程之碳化率原設計值為 97.5%，但實際運轉實績卻僅達 95%，因此，煤渣量為原設計值之二倍，導致運轉初期常因煤渣堵塞而停機，經增設煤渣處理系統及旋轉真空過濾器後，煤渣堵塞問題業已排除，惟碳化率迄今仍未獲得改善。
5. 煤渣活性(Slag Aggression)強之煤料，會損及耐火襯之壽命，因而增加運維成本。
6. 經過試用多種煤炭後，可將煤渣依含碳量之多寡大致可分為三類：(1)含碳量低於 2%者，用途很廣極

易出售，(2)含碳量介於 15%至 30%之間者，用途極少必須儘量減少產生這種煤渣，(3)含碳量大於 50%者，其熱值介於 5,000 至 10,000 BTU/Lb，可回收至氣化爐再利用或出售供作燃料用。

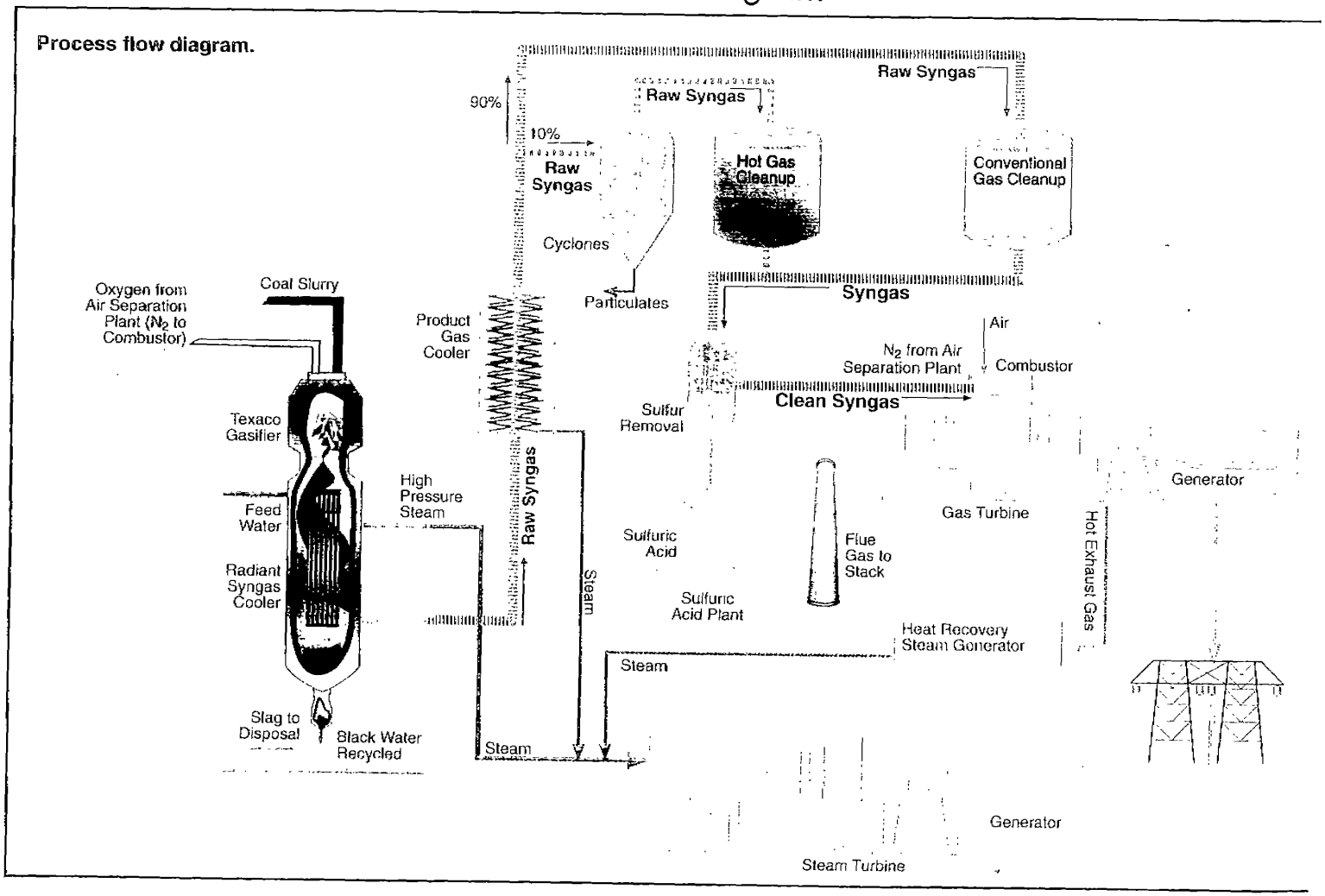
7. 輻射式冷凝器因結垢較預期為少，而原先為清除煙垢之吹灰器形同贅物，必須予以折除。但是，對流式冷凝器之管路容易結垢，每隔一、二個月就得花三天時間進行清洗工作，經改善後結垢可減少 50%。
8. 在煤碴水、合成氣及煤漿等輸送管路之轉彎接頭、分歧管接頭及控制閥處，共發生 21 次意外故障，經以超音波作定期檢查及變更設計等方式處理後，故障情形已大幅獲得改善，1998 年發生二次，1999 年僅發生一次。煤渣水中含有細顆粒煤渣，易造成管路磨損，尤其常發生在控制閥下游側之管路中，雖在磨損段塗敷一層耐磨材料，仍未見效，最後在控制閥處變更設計才獲得改善。煤漿輸送管之彎管處亦曾發生磨損變薄之情形，經以耐磨管材抽換來改善。
9. polk 電廠產生 COS 和 H_2S 之量約為預估值之兩倍，而除硫系統之效率又低於設計值，最後以加裝催化器使 COS 轉化成 CO_2 和 H_2S 而加以改善。

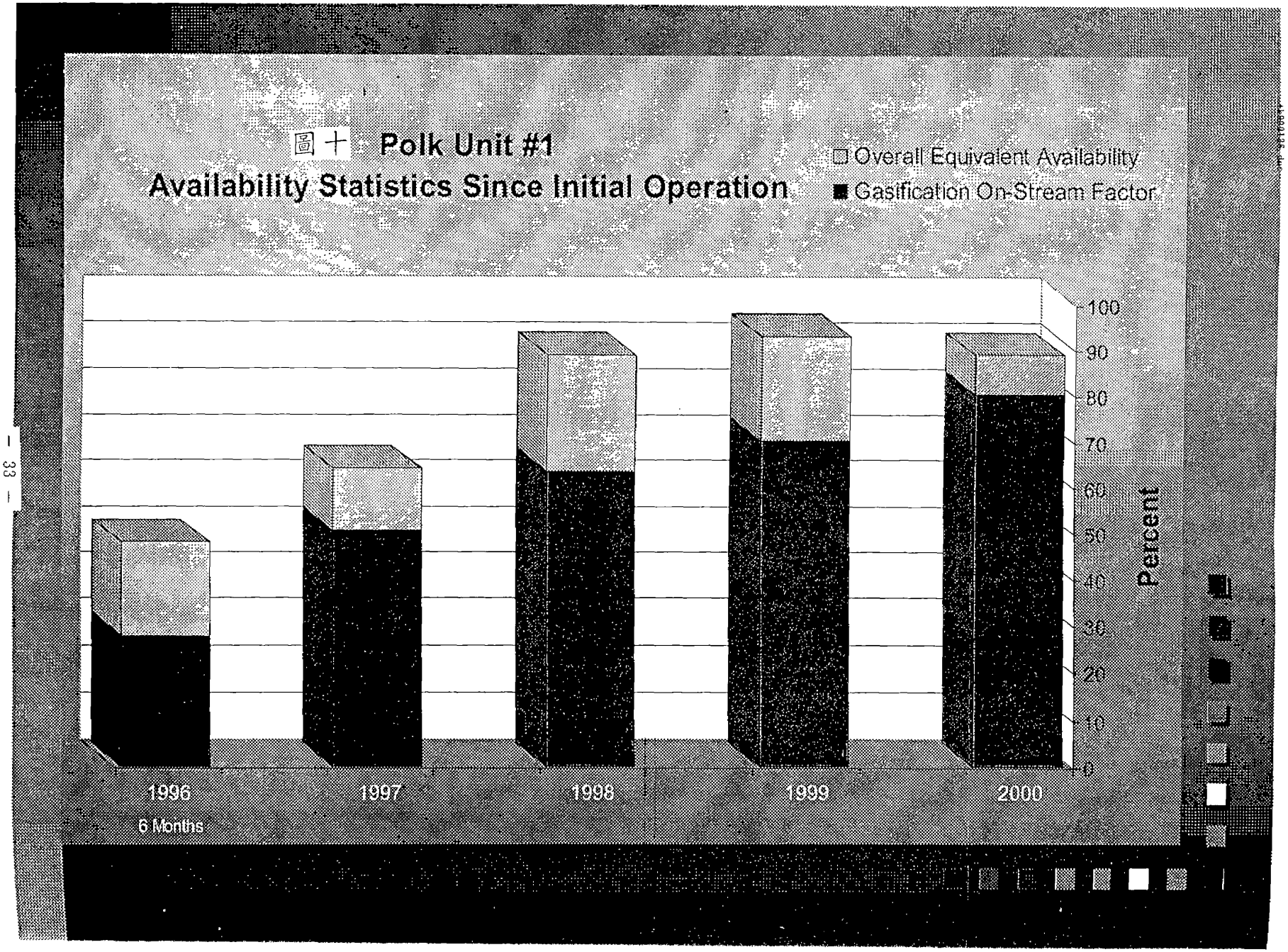
10. 煤炭氣化之過程與煤質有極密切之關係，如含硫量、灰份、熱值、灰熔點、含氯量等，polk 電廠除硫設備含硫量之設計值最高可達 3.5%，由運轉經驗得知，含硫量愈高，運維費愈高。灰份含量設計值為 12%，高灰份煤會影響熱值。如果煤之熱值較設計值低，會影響汽輪機之出力。氣化爐之燃燒溫度必須高於煤之灰熔點，俾使煤炭中之礦物質得以熔解，順利排出。polk 電廠煤炭含氯量之設計值為 0.15%，但伊利諾 6 號煤之含氯量高達 0.19%，使得若干製程及材料必須變更。

圖八　Polk IGCC Power Plant



圖九　Process Flow Diagram




圖十 Polk Unit #1
Availability Statistics Since Initial Operation
Overall Equivalent Availability
Gasification On-Stream Factor
100
90
80
70
60
50
40
30
20
10
0
Percent
1996
6 Months
1997
1998
1999
2000

陸、結論與建議

一、煤炭氣化複循環發電之優點有(1)氣體及固體廢棄物排放量低，(2)綜合發電效率高，(3)用水量少，(4)電廠用地面積小，(5)可生產化學製品或運轉用油等副產品，(6)燃料使用彈性大，可燃用高硫份煤或石油焦等廉價燃料，故未來發展潛力相當大。

二、目前全球運轉中及規劃中之氣化廠有 160 座，合成氣產能達 60,000MWth，相當於電廠裝置容量 30,000MW，預估氣化廠之年平均成長率約 7%，亦即每年增加 3,000MWth。

三、根據美國能源部推估 2000 年煤炭氣化複循環機組之單位建設成本約為每瓩 1250 美元，綜合發電效率約 42%，至 2008 年單位建設成本約可降為每瓩 1000 美元，綜合發電效率約 52%，至 2015 年單位建設成本約可降為每瓩 850 美元，綜合發電效率約可達 60%以上。

四、煤炭氣化電廠之發電成本與煤質有非常密切的關係，煤質與碳化率、煤漿拌合度，耐火襯壽命，合成氣品質，煤渣量，煤渣流動性息息相關，煤炭在氣化爐中之化學反應非常複雜，唯有經過實際運轉，累積經驗，才能挑選出，最經濟最合適之煤炭。

五、至目前為止 250MW 級煤炭氣化複循環機組，雖謂已達

商業化階段，但是氣化廠利用率最高約達 80%左右，顯示技術上並非完全成熟，本公司彰濱煤炭氣化複循環機組，以選擇與現有運轉中相同容量為宜。

六、煤炭在氣化爐內之燃燒機制相當複雜，必須藉由實際操作，累積經驗才能順利運轉，本公司宜邀集規劃、設計、施工及運轉等相關單位，早日成立推動小組，積極研究及培訓人才。

附錄

PRIVATE SECTOR FORUM

APEC 21ST CENTURY RENEWABLE ENERGY DEVELOPMENT INITIATIVE

MARCH 26-27, 2001

EMBASSY SUITES HOTEL
PORTLAND, OREGON USA

PROGRAM

The Asia-Pacific Economic Cooperation — APEC Private Sector Renewable Energy Forum is sponsored by the United State Department of Energy with assistance from the National Renewable Energy Laboratory and hosted by the APEC Sustainable Development Network. The purpose of the Forum is to engage the private sector in partnership with the APEC economies to identify new opportunities and implement renewable energy "collaboratives" (joint projects) throughout the Asia-Pacific region.

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HOSTED BY THE APEC SUSTAINABLE DEVELOPMENT NETWORK

INTRODUCTION

The *Private Sector Forum* on March 26-27, 2001 is the inaugural opportunity for business and industry associations to help set the direction and target collaborative opportunities for the *Asia-Pacific Economic Cooperation (APEC) 21st Century Renewable Energy Development Initiative.*

The Forum is designed to engage private business and industry associations in the future work of the Initiative and, through increased cooperation and interaction with APEC officials and government representatives, identify barriers and opportunities to accelerate the use of renewable energy throughout the Asia Pacific region. A priority for the Forum is to propose collaborative projects for implementation in the APEC region.

Projects will be considered that are application-driven in the areas of on-grid, hybrid or stand-alone systems such as the use of renewable energy for rural health care, rural education, or rural economic development; utilization of wind technologies for grid-connected power; and the use of distributed power in rural electrification. Projects may also be program-based, in such areas as renewable-energy financing, regulations, training and standards.

The Private Sector Forum is designed to benefit companies and industry groups by:

- Developing a better understanding of regional renewable energy issues and opportunities in the economies of APEC;
- Increasing trade and investment in renewable energy technologies, facilities and projects throughout the Asia Pacific;
- Establishing a framework for future public-private cooperation that focuses on projects and demonstrated results; and
- Creating a win-win situation where new and renewable energy can meet an increasing share of the Asia-Pacific's development needs – harnessing new technologies, developing human capital, strengthening economic infrastructure and promoting sustainable development throughout the region.

The *APEC 21st Century Renewable Energy Development Initiative* was proposed by the United States at the 4th APEC Energy Ministers meeting in San Diego in May 2000, where it was endorsed by all the Energy Ministers. At the Minister's direction, the APEC Energy Working Group asked the Expert Group on New and Renewable Energy Technologies to lead the development of this multi-year Initiative to accelerate the use of renewable energy throughout the Asia Pacific region. The Expert Group is completing a baseline survey of APEC economies and renewable energy, which will be presented at the March Forum.

APEC was formed in 1989 to promote trade liberalization, trade facilitation and technical assistance among the major economic partners in the Asia Pacific region. Today, twenty-one "economies" are members: Australia, Brunei Darussalam, Canada, Chile, China, Hong Kong China, Indonesia, Japan, Korea, Malaysia, Mexico, New Zealand, Papua New Guinea, Peru, Philippines, Russia, Singapore, Chinese Taipei, Thailand, the United States and Vietnam. Together, APEC members represent almost 50 percent of the world's total merchandise trade.

AGENDA

MONDAY, MARCH 26

Plenary Session – Colonel Lindbergh Room, Mezzanine Level

7:30-8:30 Check-In and Registration

8:30-8:45 Introduction to the Forum
- Cary Bloyd, Ph.D., Executive Director of the APEC Sustainable Development Network and Secretariat for the APEC Expert Group on New and Renewable Energy Technologies

8:45-9:00 Welcoming Remarks
- Rick Schulberg, International Sustainable Development Foundation

9:00-9:15 APEC and the 21st Century Renewable Energy Development Initiative
- Andre van Rest, Chairman of the *Expert Group on New and Renewable Energy Technology*

9:15-9:45 Report on the findings from the "Survey of APEC Member Economies' Renewable Energy Based Priority Needs and Issues Relating to Sustainable Development"
- David Renne, Ph.D., *National Renewable Energy Laboratory*

Coffee Break — 9:45-10:00

10:00-10:15 21st Century Sponsor – United States-Asia Environmental Partnership
- Judith Barry, Ph.D.

10:15-10:30 21st Century Sponsor – Chinese Taipei Environmental Protection Administration
- Chin-Jen Yang, Ph.D. and Hone-Ling Sun

10:30-11:20 Opportunity for Renewable Energy Development in the APEC region (1)
- Frank Reid, Ph.D., *Australian CRC for Renewable Energy Ltd.*—Australia
- Bill Eggertson, *Canadian Association for Renewable Energies*—Canada
- Miao Hong, *GEF/World Bank China Renewable Energy Development Project, State Economic and Trade Division*—China
- Alan Chan, *Hopewell Holdings Limited*—Hong Kong China

11:20-11:30 Sponsor Presentation – The Climate Trust
- Michael Burnett

11:30-12:20 Opportunity for Renewable Energy Development in the APEC region (2)
- Chayun Budiono, *Pt Gerbang Multindo Nusantara (Gmn)*—Indonesia
- Haruo Nogami, *Takuma Co., Ltd.*—Japan
- Man Geun Lee, Ph.D., *Soleitec*—Korea
- Salim Bin Sairan, Ph.D., *Tenaga SPL*—Malaysia

AGENDA

12:20-12:30 Sponsor Presentation – Bonneville Power Administration
- Terry V. Oliver

Lunch — 12:30-2:00 Queen Marie Ballroom, Mezzanine Level

Sponsor Presentation – Trexler and Associates, Inc.
- Mark C. Trexler, Ph.D.

Plenary Session – Colonel Lindbergh Room, Mezzanine Level

2:00-2:10 Presentation – Renewable Energy in the Americas Program
- Sasha B. Gottlieb, *Organization of American States*

2:10-3:00 Opportunity for Renewable Energy Development in the APEC region (3)
- Eng. Carlos Gottfried Joy, Ph.D., *Fuerza Eolica S.A. de C.V.*—Mexico
- Iain Sanders, Ph.D., *Industrial Research Limited*—New Zealand
- Jose Sallas S., *Servicios de Alternodores y Turbinas SA*—Peru
- Angelito Angeles, Ph.D., *Technology Development Extension Group, Inc.*—Philippines

3:00-3:10 Sponsor Presentation – Sea Solar Power International
- Robert J. Nicholson III

3:10-3:50 Opportunity for Renewable Energy Development in the APEC region (4)
- Raphael Vartanov, Ph.D., *International Applied Engineering*—Russia
- Simon Tsuo, Ph.D., *Motech Industries, Inc.*
  Shek Chung Gau, Ph.D., *Sinonar Corporation*—Chinese Taipei
- Wattanapong Rakwichian, *Solar Energy Research Institute*—Thailand

Coffee Break — 3:50-4:10

4:10-4:20 Sponsor Presentation – Portland General Electric Green Building Services
- Nathan Good

4:20-5:00 Opportunity for Renewable Energy Development in the APEC region (5)
- Peter Lowenthal, *Solar Energy Industries Association*—USA
- Vu Manh Ha, *Clean Energy Company*—Vietnam
- Bruce Clay, *Clay Engineering*—South Pacific Forum

5:00-5:30 Summary of Day One and Agenda for Day Two
- Cary Bloyd, Ph.D.

Welcome Reception and Banquet – Queen Marie Ballroom, Mezzanine Level

6:00-7:00 Reception

7:00-8:30 Dinner
Welcome — Greg Wolf, Senior Advisor to Oregon Governor Kitzhaber
Speaker — Thomas Kiser, President of Professional Supply, Inc.

AGENDA

TUESDAY, MARCH 27

Breakout Groups – The Conference Center, Lobby Level

8:30-10:00 Breakout Groups will discuss and design "collaboratives" (implementation projects).

Breakout Group (1)
Chair: David Renne, Ph.D. – National Renewable Energy Laboratory
Facilitator: Susan Anderson – City of Portland, Office of Sustainable Development
Recorder: Daniel Budihardjo – APEC Sustainable Development Network

Breakout Group (2)
Chair: Michael Royce – Green Empowerment
Facilitator: Joseph Richards – Green Empowerment
Recorder: Ryan Marquardt – Zero Waste Alliance

Breakout Group (3)
Chair: Jerome Weingart – Alternative Energy Development, Inc.
Facilitator: Christopher Dymond – Oregon Office of Energy
Recorder: Andrew Mayer – APEC Sustainable Development Network

Breakout Group (4)
Chair: Gerald Elliott – International Applied Engineering, Inc.
Facilitator: Mark Kendall – Oregon Office of Energy
Recorder: Aquila Velonis – APEC Sustainable Development Network

Coffee Break — 10:00-10:15

10:15-12:30 Breakout Groups (Continued)

Lunch — 12:30-2:00 Queen Marie Ballroom, Mezzanine Level

Sponsor Presentation – US Export Assistance Center
- Jennifer Alston

Speaker – Ralph Overend, Ph.D., Fellow of National Renewable Energy Laboratory, "Pathways to Sustainable Rural Development".

AGENDA

Plenary Session – Colonel Lindbergh Room , Mezzanine Level

2:00-3:30 Reports from the Breakout Groups — identification of collaborative opportunities.

Breakout Group (1)
David Renne, Ph.D. – National Renewable Energy Laboratory

Breakout Group (2)
Michael Royce – Green Empowerment

Breakout Group (3)
Jerome Weingart – Alternative Energy Development, Inc.

Breakout Group (4)
Gerald Elliott – International Applied Engineering, Inc.

Coffee Break — 3:30-3:45

3:45-5:00 Charting a Course for Success — dialogue led by Andre van Rest, Chairman of the Expert Group on New and Renewable Energy Technologies

- Refine "collaboratives"
- Engage potential partners
- Identify next steps
- Establish communication system for moving forward

Definition of "Collaborative": A Collaborative is a multi-economy, multi-disciplinary team to implement a renewable energy project or activity in the APEC region. A Collaborative consists of at least three different APEC economies and should be composed of a cross section of representatives from the private sector, APEC economies (public sector), non-governmental organizations, utilities and financing organizations. Collaboratives can be designed to address a range of needs and issues. They may be application-driven such as in the areas of on-grid, hybrid or stand-alone applications (e.g., the use of renewable energy for rural health care, rural education, or rural economic development; utilization of wind technologies for grid-connected power; the use of distributed power in rural electrification) or program-based (e.g., renewable-energy financing, regulations, training, standards, etc.).

21ST CENTURY SPONSOR

On behalf of the Environmental Protection Administration, Chinese Taipei, I would like to first express my best thanks to the US Department of Energy for hosting this important event. My appreciation also extends to the meeting organizers, the National Renewable Energy Laboratory (NREL) and the APEC Sustainable Development Network in Portland for their hard work. The Chinese Taipei EPA has the honor to be the co-sponsor of this meeting and would like to express our support of this environmental friendly initiative -- APEC 21ST CENTURY RENEWABLE ENERGY DEVELOPMENT INITIATIVE.

Since the Industrial Revolution in the 18th Century, economic growth and modern societies have been critically dependent on energy supply. How energy is produced, supplied and consumed will determine how the environment will be affected by human activities. The consumption of fossil fuels has produced large amounts of emissions that lead to air pollution, acid rain and global warming. Chinese Taipei EPA did not become the co-sponsor of the meeting by accident. With a sense of responsibility and being a caring member of the global village, Chinese Taipei has already invested tens of millions of dollars to reduce air pollution and contain greenhouse gas emissions. Over the years, our approach to reducing air pollutants has gone through an evolution. In the past, we simply enforced environmental laws to meet our mandate of air quality protection. But now Chinese Taipei adopts a more friendly and efficient approach, including offering technical assistance and adopting various administrative measures and economic incentives so that our manufacturers and business enterprises can meet our environmental standards. We now provide subsidies for solar energy, wind power and landfill gas power generation. We are also working on electricity market's deregulation, which will provide more opportunities for renewable energy. Moreover, we are in the process of amending the Electricity Industry Law to require the electricity companies to set a premium price for renewable energy. We have noticed that new and renewable technologies have the potential to make a significant contribution to reducing CO_2 emissions and combating global warming.

Going into the 21st Century, APEC member economies are facing increasingly higher economic and environmental costs dealing retrospectively with accumulated pollution and natural resource management problems. Indeed, we are creating new opportunities from building public-private partnership in the Private Forum, which is seen as a driving force to help APEC to achieve its goals of sustainable economic growth, stable energy supply and environmental protection. The private sector's expertise and resources are a key constituency for APEC, both regionally and in individual member economies, to fulfill the APEC 21st Century Renewable Energy Development Initiative. I trust the input from the distinguished participants of the Private Forum and the results of the meeting will directly benefit future tasks of the Initiative, and look forward to the recommendations from this meeting which may pave our way to a sustainable future. I wish you a most successful meeting, as well as good health and happiness.

LUNG-BIN HAU, PH.D.
Administrator
Environmental Protection Administration, Chinese Taipei

21ST CENTURY SPONSOR

US-AEP
United States-Asia Environmental Partnership

The U.S.-Asia Environmental Partnership (US-AEP) is a public-private and interagency partnership of the U.S. Agency for International Development (USAID) with the Department of Commerce, the U.S. Environmental Protection Agency, other U.S. government and state agencies and the private sector. Created in 1992 by a Presidential initiative, US-AEP promotes the adoption of clean, efficient technologies, policies and practices by Asian industries, cities and governing entities.

The context of US-AEP's engagement is economic as well as environmental, harnessing the broad-based desire in Asia for accelerated but cleaner economic growth to drive a "clean revolution" of sustainable development. US-AEP's approach is to pursue sustainable change in the way Asia proceeds with its industrial and urban growth through a development assistance approach founded in two basic premises:

(1) To form a nexus between sustainable development and trade, particularly with the United States, to the mutual benefit of each; and

(2) To create and promote lasting partnerships, locally, regionally and internationally, that will carry on beyond the reach and longevity of development agencies.

US-AEP's approach to fostering a transformation to clean growth is to engage key decision makers in the public and private sectors, and harness those forces which serve as incentives for change: market, political, corporate, regulatory and public advocacy. Ultimately, the future of the environment in Asia will be determined by these key Asian decision makers, including individuals, institutions and the general public.

US-AEP targets four main areas related to the interdependent goals of environmental quality and economic growth:

- public policy and environmental regulation;
- urban environmental management;
- corporate governance and environmental management; and
- the transfer of U.S. environmental technology, expertise and practices through trade and investment.

Woven throughout these four areas is an emphasis on energy and resource efficiency and other measures which reduce greenhouse gas emissions and thereby mitigate the impact of developing Asia on global climate change.

In order to leverage resources from outside the U.S. government and to create self-sustaining partnerships that will outlive development assistance, US-AEP enlists the expertise and commitment of U.S. and Asian stakeholders: professional associations, large multinational corporations, small-to medium-sized U.S. private sector firms, U.S. states, and Asian and American municipalities and non-governmental organizations. Through the partnership of USAID and the Department of Commerce, Asia's environmental quality and economic growth are mutually advanced by connecting Asia's decision makers with the best in American environmental technology and expertise.

US-AEP's engagement with a wide variety of partners serves another key component of the US-AEP vision: supporting U.S. foreign policy interests and fostering improved international relations in many sectors of American society. By facilitating the active participation of the business community and public sector at state and municipal levels, US-AEP makes development assistance relevant to Americans not directly connected with international relations.

SUPPORTING SPONSORS

The Bonneville Power Administration is an agency of the U.S. Department of Energy. It wholesales electric power produced at 29 federal dams located in the Columbia-Snake River Basin in the northwestern U.S., as well as the power from one non-federal nuclear plant. BPA is a federal utility, specifically one of five power marketing agencies (PMAs). The others are the Southeast, Southwest, Western Area and Alaska power administrations. For more information, please visit their web site at http://www.bpa.gov.

Trexler and Associates, Inc. (TAA) is an internationally recognized leader in climate change mitigation services. Since 1991, TAA has worked with clients to find innovative policy solutions to the questions posed by climate change policy; manage the corporate risks and rewards associated with developing climate change policy; deploy technologies and mitigation projects that will advance emissions reduction objectives; and provide access to the nascent and still confusing greenhouse gas market. TAA is one of the very few companies worldwide that specializes in climate change mitigation. For more information, please visit their web site at http://www.climateservices.com.

The International Division of the Oregon Economic and Community Development Department provides Oregon firms with export assistance through a staff of international trade managers who are global marketing specialists with many years of experience in specific regions of the world. The International Division also provides Oregon firms with export opportunities through the State of Oregon's trade offices in Tokyo, Seoul and Taipei. The Oregon Economic and Community Development Department is a cabinet-level agency, reporting directly to the governor. For more information, please visit their web site at http://www.econ.state.or.us.

Sea Solar Power International is an innovative company investigating the ocean as an alternative energy source for power and fresh water to meet the growing demands of population growth and the increase in wealth of equatorial regions. Sea Solar Power's technology takes advantage of the temperature difference between the solar heated surface water and the deep cold bottom water, using the warm surface water as the heat source and the cold bottom water as the heat sink. For more information, please visit their web site at http://www.seasolarpower.com.

PGE's Green Building Services understands that the best commercial and industrial buildings must deliver more than striking lines and appealing interiors. They need to reduce environmental impacts, increase energy efficiency, minimize construction resource use and exhibit healthier, more productive environments. As a leader in this trend, Green Building Services provides consultation services that can save money, time and trouble on projects, helping to meet expectations for sustainable design and position firms as leaders in the sustainable building market. PGE is the electric utility for the Portland metropolitan area, home to a rapidly expanding high-tech industry and one of the fastest growing economies in the country. For more information, please visit their web site at http://www.greenbuildingservices.com.

SUPPORTING SPONSORS

PSI
504 Liberty Street
Fremont, Ohio 43420

PSI was founded by Thomas E. Kiser, an aeronautical engineer, who has successfully implemented radically new Heating, Ventilating and Air Conditioning techniques known as Kiser Concepts. These concepts have been integrated into many industrial applications in various American industries and will soon be applied in Asian countries. For more information, please visit their web site at http://www.professionalsupplyinc.com.

OREGON OFFICE OF ENERGY

The purpose of the Oregon Office of Energy is to ensure that Oregon's energy future is built on a least-cost mix of conservation, renewable and conventional energy resources and to clean up nuclear waste. The Office aims to ensure that Oregon develops a mix of resources that not only minimizes environmental harm, but also provides electricity that is affordable, reliable, adequate and safe. Beyond the work to accelerate conservation, the Office sites new facilities and promotes the development of renewable resources. For more information, please visit their web site at http://www.energy.state.or.us.

US EXPORT ASSISTANCE CENTER

The Portland US Export Assistance Center is part of a vast network of domestic and international offices, staffed by the US and Foreign Commercial Service, a division of the International Trade Administration of the US Department of Commerce. The Commercial Service assists U.S. firms in exporting by providing expert counseling and advice, information on markets abroad, international contacts and advocacy services. The Portland Office combines these resources of the Commercial Service with the financial expertise of the Small Business Administration. The Portland office can provide information on all Federal programs designed to support international trade. For more information, please visit their web site at http://www.usatrade.gov.

The Climate Trust

The Climate Trust's mission is to initiate, encourage, and fund projects and educational activities to reduce the greenhouse gas emissions that will result in the damaging effects of climate change on future generations. The Trust will hold rights to any carbon dioxide or other greenhouse gas reduction credits resulting from projects it funds or implements in trust for the citizens of Oregon. The Trust's priorities are to effectively implement power plant carbon dioxide offset projects in Oregon, undertake projects to prevent or mitigate the emission of greenhouse gases from sources other than the construction of new energy facilities in Oregon and increase Oregonians' understanding of climate change and their opportunities for preventive action. For more information, please visit their web site at http://www.climatetrust.org.

NW Natural

NW Natural and its predecessors have been providing gas service to the Pacific Northwest since 1859. NW Natural provides reliable, cost-effective natural gas to more than 500,000 residential and business customers throughout Oregon and Vancouver, Washington. The company advocates the direct use of natural gas versus electricity for heating, cooking, clothes drying and a multitude of commercial and industrial uses because the company believes natural gas provides a markedly more efficient use of energy. NW Natural is committed to enhancing the quality of life in its service area through environmental protection. For more information, Please visit their web site at http://www.nwnatural.com.

APEC Sustainable Development Network

The Asia Pacific Economic Cooperation (APEC) Sustainable Development Network -- *APEC Network* is a gateway for cooperation, capacity building and the application of sustainable development practices among the twenty-one members of the Asia Pacific Economic Cooperation forum. The *APEC Network* has strategic relationships with the APEC Energy Working Group (EWG), the Human Resources Development Working Group (HRD) and the APEC Study Centers.

The *APEC Network* works closely with the Expert Group on Energy Efficiency and Conservation, the Expert Group on New and Renewable Energy Technologies, the APEC 21st Century Renewable Energy Development Initiative, the Energy for Sustainable Communities Program and the Energy-Industry Project on Sustainable Energy Services. The central goal of these initiatives is to develop partnerships among national and local governments, and the private sector in APEC member economies to generate and use energy in a manner that supports both development and environmental goals. The *APEC Network* is also a clearinghouse to draw upon the expertise in sustainable technologies at national laboratories and research centers.

The *APEC Network* hosts the APEC Sustainable Development Training and Information Network. This program is operated on behalf of APEC's Human Resources Development Working Group and supports capacity building to advance sustainable practices in the public and private sectors among the twenty-one member economies of APEC.

For more information, please consult the *APEC Network* web site at http://www.apecnetwork.org.

Notes

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