出國報告（出國類別：研究）

亞太能源研究中心之
國際能源共同議題研究報告

服務機關：台灣電力公司

姓名職稱：林永川 **(課長)**

派赴國家：日本

出國期間：**102.07.24~104.07.23**

報告日期：**104.08**

出國報告審核表

出國報告名稱：亞太能源研究中心之國際能源共同議題研究報告		
出國人姓名(2人以上，以1人為代表)	職稱	服務單位
林永川	課長	再生能源處
出國類別	□ 考察 □進修 ■研究 □實習 □ 其他_____（例如國際會議、國際比賽、業務接洽）	
出國期間：102 年 7 月 24 日至 104 年 7 月 23 日	報告繳交日期：104 年 8 月 25 日	

出國人員自我審核	計畫主辦機關審核	審 核 項 目
■	□	1.依限繳交出國報告
■	□	2.格式完整（本文必須具備「目地」、「過程」、「心得及建議事項」）
■	□	3.無抄襲相關資料
■	□	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：
□	□	（1）不符原核定出國計畫
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□	□	（4）抄襲相關資料之全部或部分內容
□	□	（5）引用相關資料未註明資料來源
□	□	（6）電子檔案未依格式辦理
□	□	（7）未於資訊網登錄提要資料及傳送出國報告電子檔
□	□	9..本報告除上傳至出國報告資訊網外，將採行之公開發表：
□	□	（1）辦理本機關出國報告座談會（說明會），與同仁進行知識分享。
□	□	（2）於本機關業務會報提出報告
□	□	（3）.其他
□	□	10.其他處理意見及方式：

單位　　主管處　　總 經 理

報告人 ：　　主管　：　　主　管　：　　副總經理　：

說明：

一、各機關可依需要自行增列審核項目內容，出國報告審核完畢本表請自行保存。

二、審核作業應於報告提出後二個月內完成，以不影響出國人員上傳出國報告至「公務報告資訊網為原則」。

行政院及所屬各機關出國報告提要

出國報告名稱：亞太能源研究中心之國際能源共同議題研究報告

頁數 60 含附件：■是□否

出國計畫主辦機關/聯絡人/電話：

台灣電力公司/陳德隆/(02)2366-7685

出國人員姓名/服務機關/單位/職稱/電話：

林永川/台灣電力公司/再生能源處規劃組/課長/(02)2366-7535

出國類別：□1 考察□2 進修■3 研究□4 實習□5 其他

出國期間：102.07.24~104.07.23　　出國地區：日本

報告日期：104.08

分類號/目

關鍵詞：亞太經濟合作組織、再生能源、低碳城市

內容摘要：

一、 本次赴日本亞太能源研究中心參與國際能源事務，除可與 APEC 各國之研究人員共同研究分析，提高國家能見度和促進國際能源資訊合作交流外，對亞太地區各經濟體在考量氣候變遷的因素，並致力於能源安全、能源效率、潔淨能源技術和再生能源之開發應用有更

深一層的了解，獲益良多。

二、 至 2040 年止，預估整個 APEC 區域最終能源需求，以能源別而言，石油需求將占第一位（2934 萬公噸油當量，40%），其次分別為電力（1760 萬公噸油當量，24%）、天然氣（1100 萬公噸油當量，15%）、煤炭（733 萬公噸油當量，10%）和再生能源（513 萬公噸油當量，7%）的能源消耗。此外，大陸的能源需求量將占 APEC 區域之第一位，其次分別為美國和俄羅斯的能源需求量。

三、 積極推動風力和太陽光電的設置是政府既定的政策，考量風力和太陽光電的出力受日夜和季節性氣候影響很大而造成間歇不穩定的出力，若過高比例的太陽光電和風力系統容量併聯至電力系統，一旦無法可靠地提供負載需求，將會對電力系統產生衝擊，造成電壓和頻率的變動，故為因應未來太陽光電和風力發電系統大規模設置，本公司應建立風力和太陽光電系統的發電量預測，將有助於提供電力系統安全調度的參考依據。

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

亞太能源研究中心之國際能源共同議題研究報告

目錄

圖目錄

壹、出國緣由

亞太能源研究中心（Asia-Pacific Energy Research Centre, APERC）為協助亞太經濟合作組織（Asia-Pacific Economic Cooperation, APEC）所屬 21 個會員經濟體了解未來能源供給與需求的趨勢，且進一步提升亞太地區的經濟成長、能源安全與環境保護等關切議題的貢獻度，並同時致力於亞太區域的能源永續發展，因此該中心的能源研究內容包括各會員經濟體能源資料分析、區域能源供需展望、再生能源擴大應用和低碳城市推動等項目，而該研究中心亦不定期視任務需要，徵求各會員經濟體派遣具有能源供需預測或能源政策規劃等相關領域的研究人員參與前述之專案業務。

近年來，積極參與亞太經合會議與配合辦理亞太能源研究中心推動的各項國際能源事務，一直是政府既定的政策和目標，而藉由本計畫之實施，可與 APEC 各國之研究人員共同研究分析，以瞭解各會員體之能源政策、規劃與發展方向，除可提升國家能見度和促進國際能源資訊合作交流外，並能提供未來公司和政府推廣再生能源政策與策略之參考。

本計畫係經由能源局推薦參與 2012 年日本亞太能源研究中心甄選案，獲該中心錄取為資深研究員赴日本東京參與能源經濟等相關議題的研究，而該中心在能源研究的項目主要是針對 APEC 面對許多能源安全的挑戰，包括過度依賴石油、煤和天然氣等化石能源，現存能源資產的過度利用以及新能源與替代

性能源的開發，並提出一些措施來面對能源安全的問題，例如，短期措施包含共同原油資訊倡議、海事安全、即時緊急資訊分享系統以及能源應變緊急措施（石油儲備機制）；長期措施包含天然氣交易、能源投資、能源效率、再生能源、潔淨化石能源、核能、氫能及燃料電池、甲烷水合物和石油基礎建設等研究項目。

本次出國案件係應用 102 年度出國計劃第 1021981 號，出國核定書為 EE102074 號，電人字第 1028063647 號函。

貳、出國行程

時　間	地　點	工　作　概　要
102 年 7 月 24 日	桃園中正機場、 成田機場	往程 (台北－東京)
102 年 7 月 25 日～ 104 年 7 月 22 日	日本東京 亞太能源研究中心	國際能源事務、 能源供需預測、 擴大低碳城市推動
104 年 7 月 23 日	羽田機場、 桃園中正機場	返程 (東京－台北)

參、研習心得

一、前言

本次計畫係由日本亞太能源研究中心主辦，進行為期二年的國際能源業務參與。赴日期間主要負責業務包含(1)常態性計畫：APEC Energy Overview 和 APEC Energy Demand and Supply Outlook；(2)所內研究計畫：APEC 地熱和頁岩氣計畫；(3)國際合作計畫：APEC Low Carbon Model Town Project Phase 3；(4)國際會議等 4 大項目，除了參與 APEC 各項國際能源事務活動外，並協助 APERC 完成相關研究計畫的報告。

二、亞太能源研究中心 (APERC)

亞太能源研究中心是依據 1995 年大阪亞太經合領袖會議之行動綱領，於 1996 年 7 月在日本東京成立，由日本政府同意主持，而主要的經費來源是由經濟產業省（Ministry of Economy, Trade and Industry, METI）編列預算，其組織結構關係如圖 1 所示。其成立主要功能和職掌是為與 APEC 各會員體合作以執行能源工作組（Energy Working Group, EWG）的能源政策倡議、促進了解各會員體間之能源政策、能源前景和能源市場的發展合作機會，以進行亞太地區的相關能源與經濟研究工作，所執行的國際合作計畫包括亞太地區能源需求和供應展望（APEC Energy Demand and Supply Outlook）、亞太地區能源效率的專家評審（APEC Peer Review on Energy Efficiency）、亞太地區的低碳能源供應專家評審（APEC Peer Review on Low Carbon Energy Supply）和低碳示範城市計畫（Low Carbon Model Town Project）等項目。

該中心位於東京都中央區勝閧（Kachidoki）車站附近，可搭乘都營大江戶地鐵線(Ohedo Line)於該站A4出口後，步行約5分鐘可抵達，辦公大樓緊鄰隅田川(Sumida River）畔，可遠眺東京鐵塔（Tokyo Tower）和天空樹（Sky Tree），風景非常優美，其位置概要如圖 2 和圖 3 所示。目前各會員體派駐 APERC 的研究人員共有 16 人，分別來自加拿大、印尼、菲律賓、祕魯、俄羅斯、墨西哥、紐西蘭、新加坡、大陸、澳洲、泰國、越南、馬來西亞、韓國、日本和台灣。

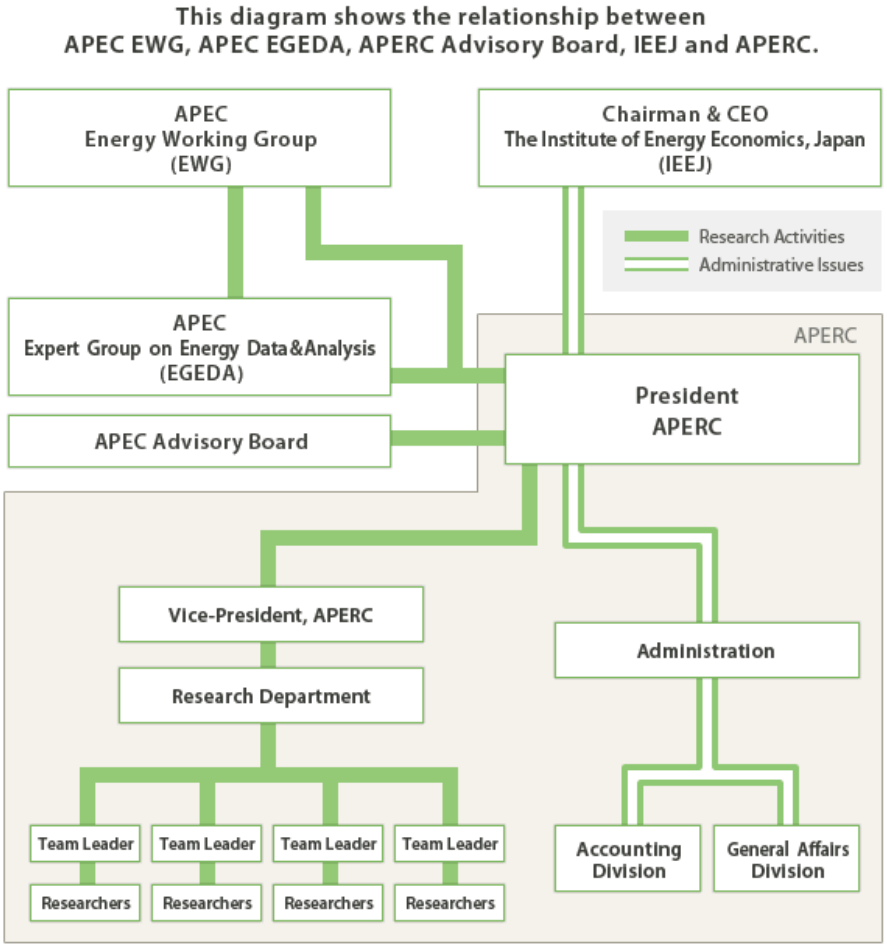

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圖 1 亞太能源研究中心組織結構圖

圖 2 亞太能源研究中心辦公大樓

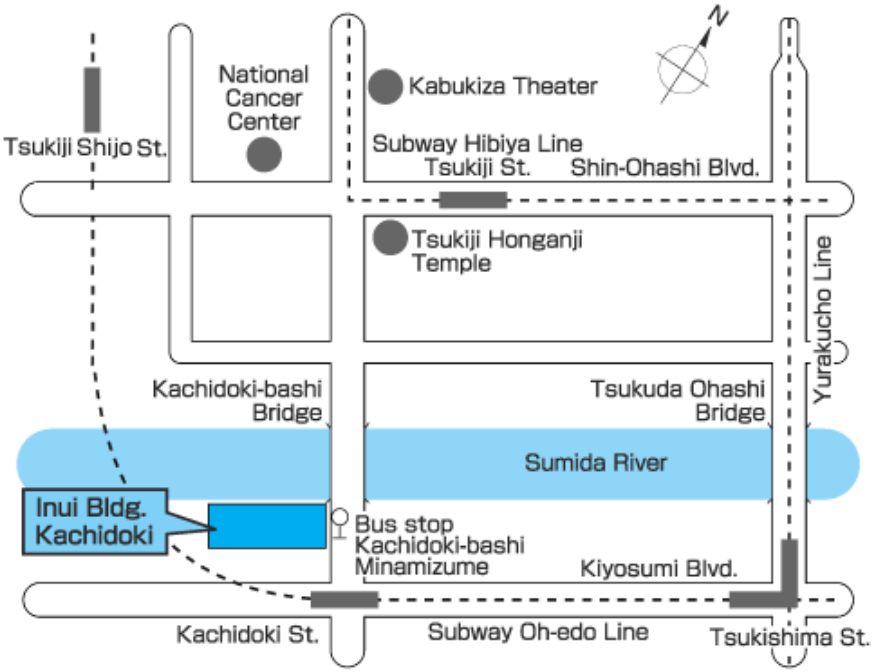


圖 3 APERC 相關位置概要圖

三、亞太經濟合作組織 (APEC)

APEC 是亞太地區最重要的多邊官方經濟合作論壇之一，其會員遍布東北亞、東亞、東南亞、大洋洲、北美及中南美地區，涵蓋地區的總人口數約 26 億人（占全世界的 40.5%），國內生產毛額占全球近 60%，貿易量約占全世界的 47%，因此 APEC 會議所達成的共識，對全球的經濟貿易有很大的影響力。目前 APEC 成員除我國外，尚有澳大利亞、汶萊、加拿大、智利、中國、香港、印尼、日本、韓國、馬來西亞、墨西哥、紐西蘭、巴布亞紐幾內亞、秘魯、菲律賓、俄羅斯、新加坡、泰國、美國及越南等共計 21 個會員體，詳如圖 4 所示。此外，各會員體均以「經濟體」(Economy) 身分參與，此為 APEC 之特殊設計。

圖 4 亞太經濟合作組織會員體分布圖

APEC 主要組織架構由上而下包含經濟領袖會議、部長級年會、企業諮詢委員會、資深官員會議、秘書處、次級論壇及工作組，詳如圖 5 所示並說明如下：

1. APEC 經濟領袖會議

APEC 經濟領袖會議是由美國前總統柯林頓於 1993 年倡議召開，並自該年起，APEC 會議主辦會員體皆在部長級年會之後召開經濟領袖會議，會中採納部長級年會通過的重大決議，經發布為領袖宣言的方式，揭示 APEC 未來發展的政策方向。

2. APEC 部長級年會及專業部長會議

部長級年會約於每年 9 月至 11 月間舉行，主要任務為決定 APEC 活動的政策方針，並討論區域內重要的經貿問題。

3. APEC 企業諮詢委員會（APEC Business Advisory Council, ABAC）

自 1995 年起，為能直接將民間部門的意見提交 APEC 領袖參考，以加強公私部門間之合作關係，APEC 開始設置企業諮詢委員會，由各會員體選派該國 3 名企業界代表組成，共計有 62 位代表成員。

4. APEC 秘書處

APEC 秘書處位於新加坡，係 APEC 主要行政支援機制，為各會員體提供技術性協助及諮詢服務，並負責資訊管理、通訊及公關等相關工作。APEC 各會員體均可指派人員駐於秘書處擔任計畫主任（Program Director），秘書處最高職務為執行長（Executive Director，ED）與副執行長（Deputy Executive Director，DED），分別由該年 APEC 主辦會員體及次年 APEC 主辦會員體指派大使級官員出任。

5. APEC 資深官員會議

資深官員會議為 APEC 運作的核心機制，出席該會議之代表為各會員體主管部會的次長級或司長級官員，主要任務除向領袖及部長們提出建議，並執行部長級會議的

決議外，亦指導及監督協調 APEC 各委員會、工作組及任務小組之工作。

依據 APEC 運作規則，各會員體的各項提案與年度工作事項首先應送交各委員會、工作組與次級論壇初步討論與研商，經由資深官員會議確認同意後，再由資深官員送交部長會議及領袖會議認可，並做為該年 APEC 成果。

此外，資深官員會議下設有 4 個委員會，包括貿易與投資委員會、預算與管理委員會、經濟委員會和資深官員會議經濟與技術合作指導委員會，其中資深官員會議經濟與技術合作指導委員會下又設有 5 個特別任務小組及 11 個工作組，特別任務小組分別為反貪污與透明化專家任務小組、反恐任務小組、性別聯絡人網路、礦務任務小組及緊急事件準備任務小組；工作組則有人力資源發展、能源、運輸、海洋資源保育、通訊與資訊、觀光、漁業、中小企業、衛生、工業科學與技術、農業技術合作。

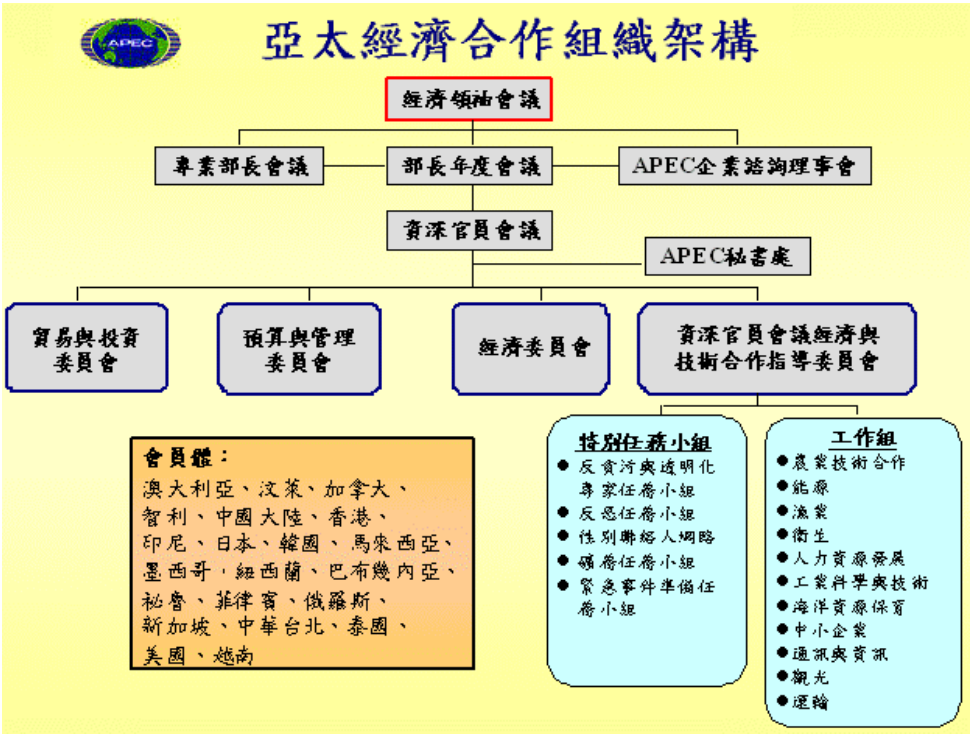


圖 5 APEC 組織結構圖

四、國際能源事務

1. 研究計畫

(1) 撰寫 2013 和 2014 台灣能源概況 (APEC Energy Overview 2013 and 2014 for Chinese Taipei)

本報告是 APERC 每年度出版的英文刊物，主要探討台灣當前的能源情勢，包括能源供應和需求、能源推動政策和顯著的節能策略和推廣應用，並提供有效的參考資料。英文報告可由網址 http://aperc.ieej.or.jp/file/2015/6/19/APEC_Energy_Overview_2014.pdf 下載，並摘述相關資料如下：

至 2012 年底，台灣的國內生產總值（GDP）為 7847 億美元，人均收入是 33656 美元 （USD 2010 at PPP），2000~2012 其國內生產總值的年平均增長率約為 3.7%。另由於過去數十年中經濟快速的發展已經大大改變了經濟結構，並從傳統重視工業生產逐漸移轉到服務部門的產值。例如 2012 年，服務業占 GDP 貢獻度約為 61.6%，其次是工業部門（37.0%）和農業部門（1.3%）。

此外，國內缺乏能源和礦產資源，致進口能源（煤、石油和天然氣）占其一次能源供應的 97.8%。依據能源局資料顯示，2012 年台灣一次能源供應總量為 107.5 百萬公噸油當量（Mtoe），按燃料分類，石油占第一位（38.8%），其次是煤炭（33.5%）和天然氣（15.3%）。而石油主要進口來源以中東的供應商為主，占整個原油需求的 80.8%；澳大利亞和印尼是煤炭主要供應商，占煤炭總進口總量的 81.6%，其中大多數煤炭（72.8%）用於發電；印尼、卡達和馬來西亞是天

然氣的主要供應商，占天然氣進口總量的 83.9%。針對 2012 年台灣終端能源消費量為 66023 ktoe，若以消費部門別，則工業部門使用消費量占總消費量的 33.7%，交通運輸行業占 17.9%，住宅及服務使用消耗量占 48.4%。若以燃料別分，則石油產品占終端能源消費總量的 56.4%，電力占 29.1%，煤炭占 10.5%，天然氣則占 4.0%。

(2) 參加越南峴港（Da Nang）低碳城市計畫(APEC Low Carbon Model Town Project Phase 3)專家評審小組並撰寫有關再生能源推動規劃和策略之建議報告

本計畫主要是協助越南政府致力建設峴港市成為一座環保城市，並將 2020 年規劃願景設定在不同的環境議題上，如減少空氣污染、廢棄物處理、資源回收利用、節能減碳和推廣再生能源。由於峴港市對抗氣候變遷和全球暖化所推動計畫是屬於新興的項目，目前減少二氧化碳排放的政策尚未正式授權頒布，因此現階段結合亞太地區低碳城鎮的合作研究具有重要作用和意義。峴港市針對未來低碳城鎮之發展提出多項低碳推動計畫，包括可充電型電動機車、低耗能(節能)建築物、再生能源發電技術(風力和太陽光電)、地下鐵路系統及快速捷運公車等。根據該市所制定的低碳城市建設目標，除減少二氧化碳排放量外，還需建設相關設施以有助於增加峴港的能見度和吸引力而成為一個旅遊城市，未來完成後將可以促進經濟發展，同時創造舒適的生活條件和環境。

有關本案再生能源建議撰寫的英文報告如附件 1 所示。

(3) 大陸地區頁岩氣（shale gas）發展現況

根據 2011 年 the US Energy Information Administration on World Shale Gas Resources 報告，顯示大陸地區頁岩氣可開採的蘊藏量約 36 兆立方公尺,占世界第一位，比第二位的美國(約 24 兆立方公尺)高出 50%。大陸地區為了促進頁岩氣的開發和利用，於 2012 年 3 月，由大陸的國家發展改革委員會、國土資源部、財政部和能源局等單位共同發布了【頁岩氣發展十二五規劃(2011 年~2015 年) 】，根據該規劃，預計在 2015 年達到年產量 65 億立方公尺，2020 年達到年產量 1000 億立方公尺。另為鼓勵企業投資與建立良好的投資開發環境，中國大陸亦於 2012 年公告頁岩氣開發補貼政策，其前三年(2012～2015 年)的補貼金額為 0.4 元人民幣/立方公尺。此外，頁岩氣在中國的探勘和開採也面臨著許多挑戰，包括地質困難、開發成本高、水資源短缺、缺乏輸氣管路的基礎設施及開採時會造成環境汙染等問題。

有關本案大陸頁岩氣發展現況撰寫的英文報告如附件 2 所示。

(4) 台灣地熱發展現況

由於台灣位於環太平洋地質斷層線之火山帶上，具有豐富的地熱資源。依據 1994 年以前探勘資料估算，顯示全台共有 6 處主要的地熱潛力地區，其發電潛能之總裝置容量約為 714MW，其中以大屯山地熱區約 514MW 佔第一位，其次分別為清水地熱區(61MW)和台東金崙地熱區(48MW)。地熱資源可分為火山和非火山型，惟因台灣的地熱資源屬火山型特性，其酸性成分太高或蒸汽含量較少，

且大都位於山區或偏遠地區，輸電線不易到達處，致發電成本高，較不具發電經濟效益。

為了能有效地利用台灣的地熱潛能並實現地熱開發目標，政府未來開發計畫的策略將從短期目標之發展傳統淺層地熱能技術，逐步採用先進的深層地熱發電技術(如加強型地熱系統，enhanced geothermal systems, EGS)之中期和長期目標，其設置目標規劃如下：

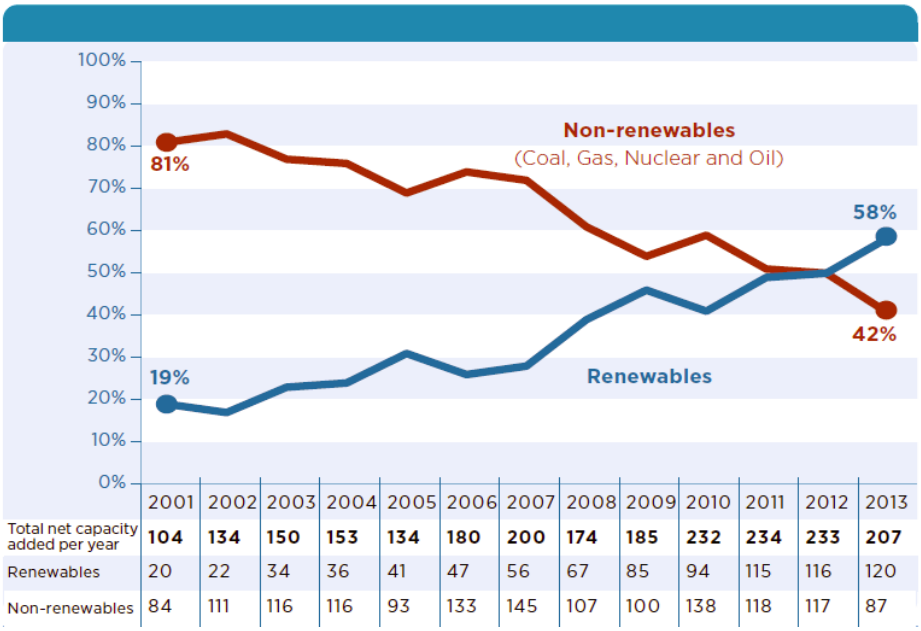
(a)短期(2010-2015 年)目標：推廣地熱發電總裝置容量為 4MW

(b)中期(2016-2025 年)目標：推廣地熱發電總裝置容量為 150 MW

(c)長期(2026-2030 年)目標：推廣地熱發電總裝置容量為 200 MW

(5) 探討 2012 年全世界再生能源發展現況

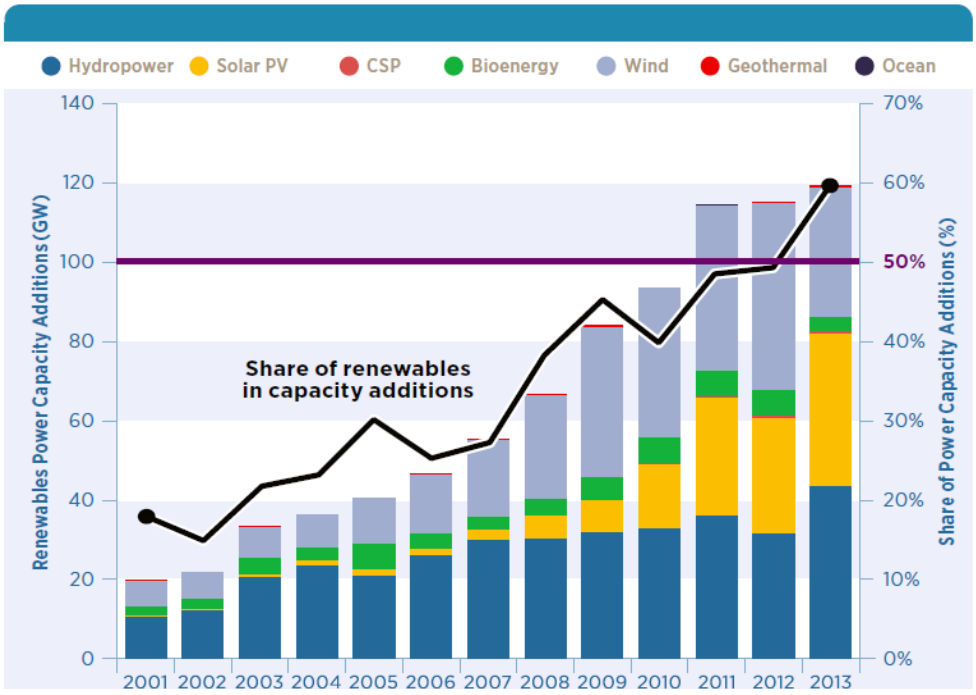
根據 IRENA 所出版【REthinking Energy 2014】的報告指出，自 2011 年起，全球每年新增加再生能源的裝置容量都超過 100GW，此增加量相當於巴西全國的發電總裝置容量，而逐年增加的結果，導致於 2013 年再生能源的年新增加量（120GW）首次超過煤、天然氣、核能和燃油發電機組的年增加量（87GW），其中太陽光電年增量將達 38GW、水力約 40GW 和風力 35.5GW，詳如圖 6 和圖 7 所示。



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Total net capacity added per year	**104**	**134**	**150**	**153**	**134**	**180**	**200**	**174**	**185**	**232**	**234**	**233**	**207**
Renewables	20	22	34	36	41	47	56	67	85	94	115	116	120
Non-renewables	84	111	116	116	93	133	145	107	100	138	118	117	87

資料來源: IRENA database

圖 6 全球再生能源年新增量



資料來源: IRENA database

圖 7 各種再生能源的年新增量

至 2013 年全球再生能源發電的總裝置容量達到 1700GW（約占 30％全球總發電裝置容量），而再生能源的發電量則超過 22%，其中水力為 16.4％、風力約 2.9％、生質能 1.8％，而太陽光電、聚光型太陽熱能發電、地熱發電和海洋能則為 1.1％。此外，近年來由於太陽光電價格不斷下跌，使得太陽光電裝置年成長率增加迅速，甚至在德國、義大利和西班牙等日照條件較佳的國家，其太陽光電的發電成本已達到與電價相同（grid parity）的成果，具有極大發展的潛力，並預估於 2020 年太陽光電系統裝置成本約為 1.92 美元/瓦，包括模組 0.53 美元/瓦、電力調節器 0.14 美元/瓦、系統周邊設備 0.53 美元/瓦、工程採購建造 0.49 美元/瓦和其他 0.23 美元/瓦。

(6) 撰寫 APEC Energy Demand and Supply Outlook 6th Edition — Residential, Commercial and Agriculture Final Energy Demand

針對第 6 版能源需求展望涉及住宅、商業和農業等部門 2012 年~2040 年的最終能源需求預測，APERC 採用「top-down approach」方法建立預測模型，其原理說明如圖 8 所示。在以燃料別為需求的基線情境（business-as-usual, BAU），主要受到人口、經濟增長、能源利用技術和及能源政策等因素的影響，因此可利用能源需求彈性（energy demand elasticity）和人均的國內生產總值（GDP PPP per capita）之相關性（圖 9 所示）以預測未來的能源需求量。本模型計算所需的能源消費歷史資料，來自國際能源總署（IEA）；國內生產總值歷史資料，來自世界銀行的資料庫；人口的歷史資料，來自聯合國的資料庫。

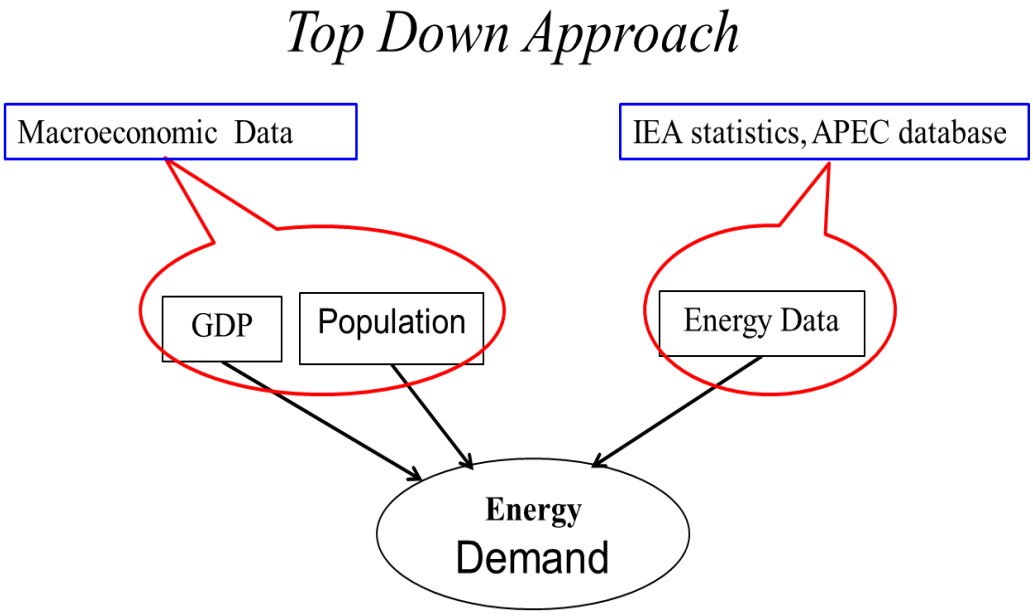


圖 8 Top-down approach 的原理說明

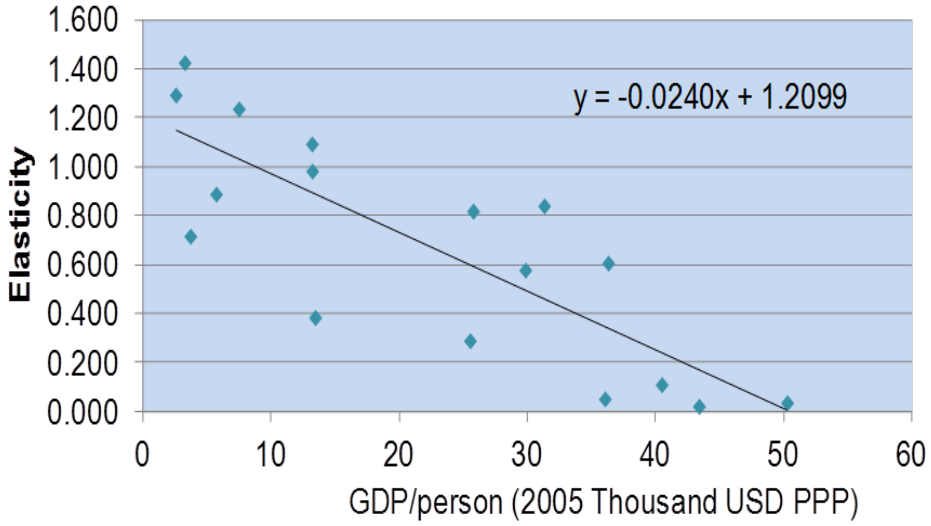


圖 9 能源需求彈性和人均的國內生產總值之相關性

依據模型分析結果如下：

（a） 根據國際能源總署的統計數據模擬分析，從 2012 年至 2040 年，針對整個 APEC 區域的住宅、商業和農業能源需求預測，其能源需求年平均成長率約為 1.31%，而能源消費量將從 2012 年的 1588 百萬公噸油當量（如圖

10 所示），增加至 2040 年的 2288 百萬公噸油當量（如圖 11 所示），其中住宅部門將占最大比例（超過 55%），而住宅和商業部門的能源需求量則超過 86%。

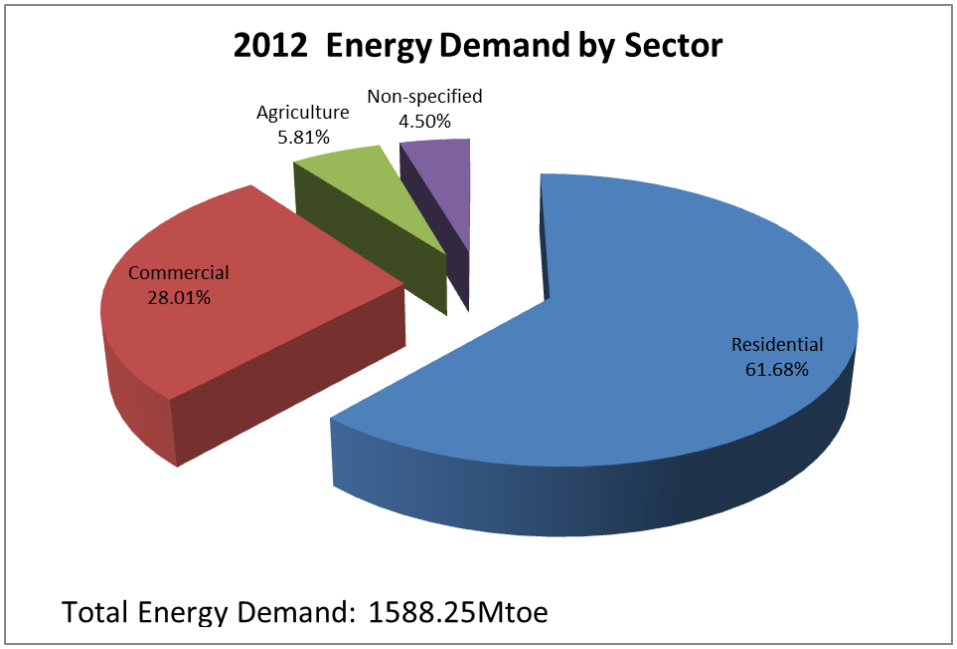


圖 10　2012 年 APEC 之住宅、商業和農業能源需求量

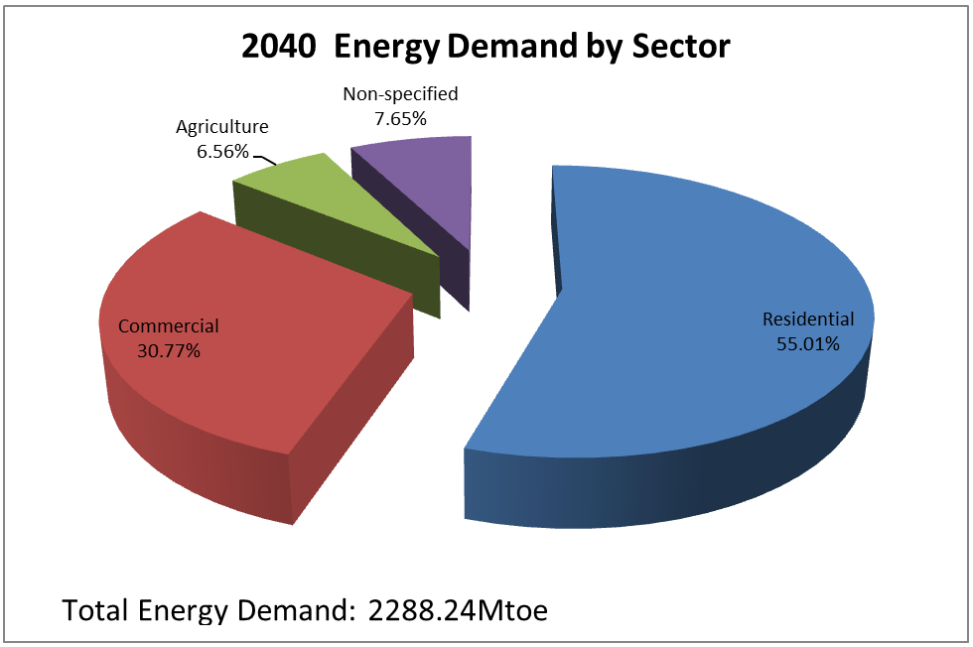


圖 11　2040 年 APEC 之住宅、商業和農業能源需求量

（b） 針對能源別，電力消費於 2012 年~2040 年仍將持續是最大的占比和年成長率最快，其電力需求年平均成長率為 2.06%，主要原因是民眾的所得收入增加和商業部門越來越多的生產和業務活動力，而這些因素將導致對空調、空間、熱水、照明和電器用品需求量的提高。此外，依據資料顯示，住宅耗能最大來源是中國大陸和東南亞國家，由於經濟的快速發展並實施農村電氣化使得空調和冷凍的需求迅速增加所致，預估大陸將占整個 APEC 區域消費需求量的 42.8%。

預測至 2040 年天然氣的需求量將占第二位，年平均年成長率為 0.92%。其增加的主因在於大陸對天然氣基礎設施持續的擴建開發以及天然氣替代傳統生質能在烹飪和熱能的使用。另預估大陸天然氣年平均成長率約 4.7%。

預估未來煤炭需求將是所有燃料中具有最低的年平均成長率，經模擬分析約為 0.78%，其主因是煤炭容易產生二氧化碳造成環境汙染，將逐漸受到電力、天然氣和液化石油氣取代。惟在 2040 年底，大陸仍將是最大的煤炭消費地區，其消費量約占整個亞太地區煤炭需求的 90%。

（c） 針對亞太地區的經濟體分析，至 2040 年，大陸預估仍將繼續維持為最大的能源消費體，預測在住宅、商業和農業能源需求量約為 1078 百萬公噸油當量（約 47%），其次是美國在 492 百萬公噸油當量（約 21.5%）。另該分析資料顯示，有關開發中的亞洲經濟體言，泰國具有最高年平均增長

率約為 3.45%，其次分別是汶萊的 3.01%、馬來西亞的 2.86%和大陸的 2.65%。

有關本案最終能源需求撰寫的英文報告如附件 3 所示。

2. 國際會議

(1) The 2nd LNG Producer-Consumer Conference, 10 September 2013, Tokyo, Japan

(2) APEC Workshop on Renewable Energy Promotion and Pricing Mechanism, 26-27 September 2013, Taipei, Chinese Taipei，並於會議中報告「The Development of Peer Review on Low-Carbon Energy Policy (PRLCE) in APEC」

(3) APEC New and Renewable Energy Technologies Expert Group (EGNRET) 41 Meeting, 14-19 September 2013, Beijing, China，並於會議中報告「Progress of Peer Review on Low-Carbon Energy Policies (PRLCE) in APEC（詳如附件 4）和「Progress of APEC Low-Carbon Model Town (LCMT) Task Force」

(4) APEC EWG 20/2012A Low Carbon Model Town (LCMT) Project Phase 3 Policy Review, 3 – 7 December 2013, Da Nang, Viet Nam

(5) The 2014 APERC Annual Conference and workshops, 25-28 March 2014, Tokyo, Japan，並於會議中報告「Brief Overview of Findings on Chinese Taipei Geothermal」

(6) APEC Conference on Future Energy Smart Communities Model, 16-17, October 2014, Taipei, Chinese Taipei，並參加圓桌討論會議 Roundtable Discussion on Industry: ESCO of Energy Conservation and Energy Efficiency

(7) the 43rd Meeting of Expert Group on New and Renewable Energy Technologies (EGNRET) and APEC Workshop on Smart DC Power Opportunity for Community, 10-14 November 2014, Chiang Mai, Thailand，並於會議中報告「Progress of APEC Low-Carbon Model Town (LCMT) Task Force」

(8) The 2015 APERC Annual Conference and workshops, 9-11 June 2014, Tokyo, Japan

肆、結論與建議

一、近年來，為因應金融危機與經濟成長停滯，APEC 能源事務的主軸，已從強調傳統油氣供應與能源貿易投資之能源安全，加入考量氣候變遷的因素，並著重在能源效率、潔淨能源技術、新能源及再生能源之開發應用，因此 APERC 的工作規劃策略將以加強能源安全、促進能源效率與能源永續發展、發展潔淨能源，和促進能源貿易與投資等四大項目，作為未來能源計畫的發展重點。

二、至 2040 年止，預估整個 APEC 區域最終能源需求將以運輸部門占第一位（2435Mtoe，33.2%），住宅、商業和農業部門（2288Mtoe，31.2%）占第二位，第三位則為工業部門（2270Mtoe，31%）的能源需求；以能源別而言，石油需求將占第一位（2934Mtoe，40%），其次分別為電力（1760Mtoe，24%）、天然氣（1100Mtoe，15%）、煤炭（733Mtoe，10%）和再生能源（513Mtoe，7%）的能源消耗。此外，大陸的能源需求量將占 APEC 區域之第一位，其次分別為美國和俄羅斯的能源需求量。

三、現階段再生能源應用在發電方面仍以風力、水力和太陽光電為主，根據 IRENA 資料顯示，至 2013 年底，全球再生能源發電的總裝置容量達到 1700GW（約占 30％全球總發電裝置容量），而再生能源的發電量則超過 22%，其中水力為 16.4％、風力約 2.9％、生質能 1.8％，而太陽光電、聚光型太陽熱能發電、地熱發電和海洋能則為 1.1％。此外，近年來由於太陽光電價格不斷下跌，使得太陽光電裝置年成長率增加迅速，甚至在德國、義大利和西班牙等日照條件較佳的國家，

其太陽光電的發電成本已達到與電價相同（grid parity）的成果，具有極大發展的潛力，並預估於 2020 年太陽光電系統裝置成本約為 1.92 美元/瓦，包括模組 0.53 美元/瓦、電力調節器 0.14 美元/瓦、系統周邊設備 0.53 美元/瓦、工程採購建造 0.49 美元/瓦和其他 0.23 美元/瓦。

四、積極推動風力和太陽光電的設置已是政府既定的政策（至 2030 年，風力發電和太陽光電國家目標值分別為 3000MW 和 6200MW），惟風力和太陽光電的出力受日夜和季節性氣候影響很大而造成間歇不穩定的出力，若過高比例（penetration）的太陽光電和風力系統容量併聯至電力系統，一旦無法可靠地提供負載需求，將會對電力系統產生衝擊，造成電壓和頻率的變動，故為因應未來太陽光電和風力發電系統大規模設置，本公司應建立風力和太陽光電系統的發電量預測(energy production forecasting)，將有助於提供電力系統安全調度的參考依據。

伍、附件

附件 1　Low Carbon Model Town (LCMT) Project

Renewable energy

Findings

The review team was very impressed to see the following achievements regarding renewable energy use and development in Da Nang city:

- To cope with the National Power Development Plan aiming the share of electricity produced from renewable energy resources increasing from 3.5% of total electricity production in 2010 to 4.5% in 2020 and 6.9% in 2030, the power generation development plan 2011~2015 has been conducted by Da Nang City Government. Currently an additional 49.2MW hydropower was installed to supply the electricity fed into the national grid system and a 2.8MW stand-alone photovoltaic (PV) system was installed to provide the electricity to the airport.
- The year average solar irradiation is 4.89kWh/m^2/day showing a good site for promoting the use of PV systems in Da Nang city.
- Renewable energy such as PV system and wind power is still under the demonstration and research stage.
- PV systems are used in some remote areas where are off-grid location.
- There is no buyback scheme for PV system and wind power.
- The generation cost of PV systems is high.

Recommendations

Based on the above observations and findings, the following suggestions and recommendations can be applied for further improvement of renewable energy.

- Facilitate the planning consent process for installation of renewable energy technologies.

  Da Nang has a tropical monsoon climate with two seasons including a dry season lasting from April through June and a wet season lasting from July through March. A lot of typhoons especially hit Da Nang city during the wet season. In order to make installation safe and effective for renewable energy equipment, relevant renewable energy producers shall submit documents consisting of facility planning and design and electricity supply to a competent authority established by the DNPC for work permit, and shall not commence construction until the permit has been granted.

- Promote the use of PV system.

  The 2013 European Photovoltaic Industry Association (EPIA) noted that the world's cumulative installed PV capacity surpassed the impressive 102GW by the end of 2012. This capacity is capable of producing as much annual electrical energy as 16 coal power plants or nuclear reactors of 1 GW each. Each year these PV installations save more than 53 million tons of CO_2. The photovoltaic system is now, after hydro power and wind power, the third most important renewable energy source in terms of globally installed capacity. In addition, Da Nang has an abundant solar energy resource. Promoting the use of PV system can fulfill the plan for Da Nang as an Environment City aiming at reductions of greenhouse gas emissions in energy activities by 20~30% from BAU emission in 2030 by implementing air pollution reduction, waste treatment and recycling, energy conservation, and renewable energy.

- Introduce building integrated photovoltaic (BIPV) system technology for the new green building.

  Building integrated photovoltaic systems are photovoltaic materials that are used to replace conventional building materials in parts of the building envelope such as the roof, skylights, or facades. They are increasingly being incorporated into the

construction of new green buildings as a principal or ancillary source of electrical power, although existing buildings may be retrofitted with similar technology. The advantage of integrated photovoltaic systems over more common non-integrated systems is that the initial cost can be offset by reducing the amount spent on building materials and labor that would normally be used to construct the part of the building that the BIPV modules replace. These advantages make BIPV one of the fastest growing segments of the photovoltaic industry. Building integrated photovoltaic modules are available in several forms including flat roofs, pitched roofs, facades and glazing.

- Evaluate the potential capacity and set up the long term target for photovoltaic systems.

  Photovoltaic system installations may be ground-mounted (and sometimes integrated with farming and grazing) or built into the roof or walls of a building (either BIPV or simply rooftop). In general, urban areas for photovoltaic systems are not excluded when considering rooftop applications. The land availability is constrained mostly by considering protected areas, and land occupation such as agricultural and forestry areas, grasslands, or any area assumed unsuitable due to socio-geographical reasons. Other parameters include the spacing between rows of PV systems to avoid shadowing of adjacent systems. Once the land availability has been established, it is possible to evaluate the technical installed capacity and energy output potential. The rating for PV systems, for example, applies to system output rating at a resource level of 1000 W/m^2. Thus, for an available area of 5000m^2 with the annual average solar radiation of 4.89 kWh/m^2/day and a PV system that operates at 12% conversion efficiency and performance ratio of 0.7 (figures quoted from feasibility study), the technical installed capacity and energy output can be calculated by the formulae expressed as follows:

(Technical installed capacity)$_{PV}$ = Area x system rating condition x conversion efficiency = 5000m^2 × 1kW/m^2 × 12% = 600kW

(Technical Energy Output Potential)$_{PV}$ = Technical Installed Capacity x annual solar radiation x performance ratio /system rating condition = 600kW × 4.89kWh/m^2/day × 365/year × 0.7 ÷ 1kW/m^2 = 749,637kWh/year

Thus, the technical installed capacity and energy output potential are 600kW and 749,637kWh/year respectively.

There is insufficient information available for review team to evaluate the potential capacity. However, in order to promote the utilization of photovoltaic system, the clear long term target in association with the National Power Development Plan for photovoltaic system deployment should be set up.

- Monitor and survey the performance of the existing photovoltaic system by collecting operation data.

  Monitoring data can provide actual performance relative to benchmarks of quality for existing photovoltaic systems under realistic operating conditions and photovoltaic system engineering. Many photovoltaic systems provide little feedback to users as to whether they operate correctly, so failures can go undetected for long periods of time. This can undermine support for further installations. Ideally, monitoring should provide information both on-site and to a central point where program managers can track performance of all systems. Therefore, evaluating performance of the existing 2.8MW grid-connected photovoltaic system is important for planners, owners, investors and manufacturers.

- Survey the total installed prices of photovoltaic system.

  Total installed prices are composed of the sum of module costs plus the expenses for the balance of system, including mounting structures, inverters, cabling and power management devices. Capital costs usually dominating installed prices of photovoltaic

systems act as a key barrier to photovoltaic deployment. The installed prices are still relatively high, although they are decreasing rapidly as a result of technology improvements and economies of volume and scale. According to the 2013 U.S. Department of Energy SunShot Initiative estimates, the installed photovoltaic system prices fell 6%~14% from 2011~2012. In the near future analysts expect installed prices of both distributed and utility-scale systems continue to fall. Distributed and utility-scale systems are expected to reach $2/W~$4.75/W and $1.5/W~$3.15/W by 2014 respectively. As time progresses, photovoltaic technologies generally get cheaper, while fossil fuels generally get more expensive. The less installation costs, the more favourably it compares to conventional power, and the more attractive it becomes to utilities and energy users around the globe.

- Consider use of small scale photovoltaic systems in remote areas.

  In remote areas such as mountainous areas, islands, or other places where a grid system is unavailable, a photovoltaic system can be used as a mature and mainstream source of electricity power supply because installed prices in recent years have been reduced dramatically. A small scale photovoltaic system is capable of providing enough electricity to power a single home. In addition, small photovoltaic systems also provide a cost-effective power supply in locations where it is expensive or impossible to send electricity through conventional power lines.

- Develop incentives to encourage use of grid-connected photovoltaic systems.

  The investment costs of PV systems are still relatively high and high investment costs represent the most important barrier to PV deployment today. For promoting the utilization of photovoltaic systems, the government of Viet Nam should develop a policy mechanism designed to accelerate investment in photovoltaic technologies. Financial incentives for photovoltaic systems such as feed-in tariffs (FIT) and renewable portfolio standards (RPS) are incentives offered to electricity consumers to

install and operate photovoltaic systems. The government can also offer incentives to encourage the photovoltaic industry to achieve the economies of scale needed to compete where the cost of photovoltaic generated electricity is above the cost from the existing grid. Such policies are implemented to promote national or territorial energy independence, high technology job creation and reduction of carbon dioxide emissions which cause global warming.

附件 2　China's Shale Gas Development

List of information to gather on China's shale gas development:

Shale gas production framework

- Regulatory organization

  To promote the development and utilization of shale gas, in March 2012, the National Development and Reform Commission (NDRC), the Ministry of Land and Resource (MLR), the Ministry of Finance (MOF) and the National Energy Administration (NEA) jointly issued the 12th Five Year Plan on shale gas development from 2011 to 2015 (Sun, 2013a).

  A 2013 report by Lee on "Shale gas in China: how far from dream to reality?" noted that

  "There are six key authorities at mineral level for the regulation of shale gas including the National Development and Reform Commission, Ministry of Land and Resources, Ministry of Finance, Ministry of Environmental Protection (MEP), Ministry of Science and Technology (MOST) and the State Administration of Taxation (SAT).
  The NDRC is responsible for shale gas industrial policies and planning, including targets, transportation, consumption and pricing. The MLR is in charge of public tenders of shale gas blocks and the thresholds for entry. The MOF and SAT works jointly on fiscal incentives, such as grants and preferential tax policies. The MOST runs a program for improving and inventing technologies that work in Chinese geological conditions. The MEP plays a significant role because of its responsibility for underground and surface water protection, wastewater treatment and recycling, air pollution and protection of species of animals and plants."

- Private/public participation

In order to retain control of essential shale gas blocks, the Chinese central government has restricted foreign participation in the exploration and development of shale gas sector. The sector has attracted interest from state-owned enterprises (SOEs), especially those in traditional oil and gas, the coal mining and power industries as well as private companies (CSIS 2012, Sun 2013b).

- Traditional oil and gas companies: China National Petroleum Corporation (CNPC), Sinopec, China National Offshore Oil Co. (CNOOC) and Shaanxi Yanchang Petroleum Group.
- Coal mining companies: China United Coalbed Methane Co. and Henan Coalbed Gas Co.
- Power companies: China Huadian Corporation.
- Private Companies: Huaying Shanxi Energy Investment, Beijing Taitan Gas Technology.

Although international energy companies with developed advanced technologies and extensive experience were not allowed to directly participate in the shale block bidding, they are encouraged to form joint ventures with Chinese companies and to provide technology/services in the exploration and production of shale gas (Sun, 2013a).

- Public agencies participating in shale gas development
  - ✓ In June 2011, the Ministry of Land and Resource held the first round auction of exploration rights for four shale gas blocks.
  - ✓ On December 31 2011, the Ministry of Land and Resource announced that the legal status of shale gas as the 172th independent mining resource. The result of such legal qualification is that shale gas is now exempted from the restrictive legal regime currently in effect for exploration and hydrocarbon production in China.

- ✓ In March 2012, the National Development and Reform Commission, the Ministry of Land and Resource, the Ministry of Finance and the National Energy Administration jointly issued the 12th Five-year Plan on shale gas development, and set the 6.5 billion cubic meters production goal for 2015.
- ✓ In October 2012, the Ministry of Land and Resource held the second round auction of exploration rights for four shale gas blocks.
- ✓ In November 2012, the Ministry of Finance announced a subsidy of RMB0.4 (0.065 USD) per cubic meter of shale gas production from 2012 to 2015 (Sun, 2013a).
- ✓ In March 2013, the first shale gas production sharing agreement (PSA) between Shell and CNPC was approved by the National Development and Reform Commission for drilling in the Fushun-Yongchuan block in the Sichuan Basin. Under the agreement, Shell will contribute its technology and operating expertise in an effort to reduce the drilling cost per well from $12 million to $4 million. This block is viewed as the first commercial shale gas project in China. Shell committed to contribute $1 billion at a minimum each year of the joint venture to fund exploration. An advantage of the PSA model is that Shell can exit easily without having to go through a complicated approval procedure (Lee, 2013).

- Government's production goals

Lee (2013) noted that

"According to a 2011 report by the US Energy Information Administration on World Shale Gas Resources: An Initial Assessment of 14 Regions Outside the United States, China has 107 trillion cubic feet (tcf) of proven natural gas reserves and is one of only five countries with proven natural gas reserves of more than 100 trillion cubic feet. The other four

countries are the United States, Australia, Algeria and Venezuela. The amount of technically-recoverable shale gas in China is 1,275 trillion cubic feet, 50% more than the 862 trillion cubic feet in the United States.

Chinese official figures differ from the US estimates. A paper by the CNPC Economics and Technology Research Institute in July 2012 estimates that the recoverable shale gas in China is 36.0825 trillion cubic meters (equivalent to 1,275 trillion cubic feet), around 20% of the world total proven reserves of 187 trillion cubic meters (equivalent to 6,607.77 trillion cubic feet). The figure quoted in this report is similar to the EIA estimate.

However, in March 2012, the Ministry of Land and Resources (MLR) said in a report that the recoverable shale gas in China is only 25.1 trillion cubic meters (equivalent to 886.93 trillion cubic feet). This conservative estimate is still more than the reserve of 862 trillion cubic feet in the United States. The shale gas development plan (2011-2015) issued by MLR in the same month repeats this estimate."

CSIS (2012) also noted that "The estimates on the amount of shale gas resource vary greatly shown as the table 1."

Table 1 Estimates on China shale gas resource

Institution	Shale Resource Estimate
U.S. Energy Information Administration	1274.85 tcf
International Energy Agency	918.18 tcf
China Ministry of Land and Resources	886 tcf
China National Petroleum Corporation	1084 tcf

Source : Center for Strategic & International Studies,"Prospects for Shale Gas development in Asia", August 2012.

Under the national shale gas development plan (2011-2015), the Chinese Government set the following targets by 2015: a complete national survey of shale gas reserves, selection

of 30 to 50 proven shale gas areas and 50 to 80 favourable target areas, and production by 2015 of 6.5 billion cubic meters (229.52 billion cubic feet).

The plan lists 19 shale gas areas for exploration: Changning, Weiyuan, Zhaotong, Fushun-Yongchuan, Er West and Yu East, Chuan West-Langzhong, Chuan North-East, Anshuan-Kaili, Jiyang, Yanan, Shenfu-Lingxing, Qinyuan, Shouyang, Wuhu, Hengshanbao, Nanchuan, Xieshan, Liao River North and Cengong-Songtao. The shale gas blocks for the coming third round public tender are expected to be mostly in those areas. The plan also commits to increase the investment in shale gas exploration in these areas during the period 2016 through 2020 if there has been a breakthrough in exploration technology. Shale gas production is expected to reach 60 to 100 billion cubic meters by 2020 (Lee 2013).

- International cooperation/mechanisms conducive to shale gas development

  Most Chinese shale gas deposits are buried deep underground at 1,500 to 4,000 meters (Lee, 2013). Although China claims to have technologies and equipment for shale gas development , there are no systematic technologies offering the full package for shale gas development as well as the experimental apparatus for measuring and testing the parameters obtained during exploring and developing. The technologies consisting of oilwell serving technique and equipment such as rotation-guided technologies, well drilling-measuring technology; fracturing separated components are lagging behind the international advanced standards. Two national oil companies participating in international cooperation are outlined as follows (Sun, 2013a):

  - CNPC: worked with US Newfield and Shell in Weiyuan block and Fushun-Yongchuan block; training agreement with US PRC Company.
  - Sinopec: jointly study shale gas development with ConocoPhilips in the onshore Qijiang block, Sichuan Basin pertaining to exploration, development and production.

In addition, Chinese companies seek any opportunity to acquire intellectual property from foreign partners. In 2012, three national oil companies completed major overseas acquisitions that were closely connected with shale gas. Sinopec acquired a 33.3% interest ($900 million) from Devon Energy in five shale oil and gas basins in U.S. CNOOC closed on a $15.1 billion takeover of Nexen, which holds shale gas assets in Canada. PetroChina acquired a 49.9% interest from Encana in the Duvernay shale gas project in Canada (Lee, 2013).

Shale gas production status

- Challenges reported (of any type)

  The exploration and production of the shale gas in China faces numerous challenges, including geological difficulties, high development costs, water shortage, a lack of pipeline infrastructure and environmental impacts.

  Sun (2013a) noted that

  "Complex geological environment: The shale gas deposits in China are generally located in mountainous, rocky desert and are buried deep underground. The transportation and installation of heavy equipment required for the operation of these deposits will be a complicated and expensive process."

  Due to geological differences, gas wells cost 10 times more to drill in China than in the US. The drilling cost per shale gas well in the United States is between $2.7 million and $3.7 million compared to $27 million to $37 million in China (Lee, 2013).

  "Infrastructure: Most shale gas reserves have to be connected to the existing network of pipelines. Although China has already increased the development of its pipeline network in recent years, the identification of new routes, the construction of new pipelines and their connection with the existing network will inevitably be a long-term

process. Such bottlenecks, coupled with high development costs, could also slow the development of shale gas.

Environment impacts: The process of hydraulic fracturing requires large volumes of water. However, many shale gas fields in China are located precisely in areas facing serious problems of water shortages. The large-scale development of shale gas in these regions will need to take into account the availability of accessible water supplies. Both the use of chemically treated water to extract the gas and the disposal of waste water after extraction requires primary attention." (Sun, 2013a)

Water consumption will be a challenge since China is a country badly lacking in water. According to a report by Accenture, a consultancy, drilling and fracking will consume around 19,000 tons of water per well. The vast amount of extraction of underground water will reduce the water table and could result in salt-water encroachment. Water pollution is another major concern. The water injected into shale gas wells is accompanied by around 700 kinds of additives and poisonous materials, such as lead. This could cause pollution of underground water (Lee, 2013).

- Rounds/bids already made or in progress

  The MLR has conducted two rounds of bidding for shale projects by the end of 2012. Except for two private companies, the successful bidders are state-owned enterprises in power generation or coal mining industries (Sun, 2013a).

  The first auction of shale gas was carried out in June 2011 by inviting six SOEs to bid. Sinopec Corp. and Henan Coal Seam Gas Development Group were awarded licenses. According to the MLR, Sinopec planned to invest RMB591 million (US$91 million) on exploration at the Nanchuan block, and Henan Coal Seam Gas Development Group planned to invest RMB248 million (US$38 million) at Xiushan block over the next three years. The area of each block is over 2,000 square kilometres (CSIS, 2012).

The second round of tender was held in October 2012. Results of the 2nd round for the 19 blocks were released on 7 December 2012 with two Chinese private firms and fourteen SOEs as successful bidders. Winners are entitled to 3 years (2013~2015) exploration rights with the obligation to invest over RMB12.8 billion (US$2 billion) by the end of 2015. The successful bidders are also required to spend at least RMB 30,000 (US$4600) per square kilometre of shale gas blocks annually and drill two wells per 500 km^2 (Sun, 2013b).

- Operational results by project

  China established 2 national-level demonstration areas for shale gas located in Sichuan Changning-Weiyuan and Yuannan Zhaotong. In Sichuan Changning-Weiyuan area, a total of 27 wells were drilled with 19 well-completions. The daily production from vertical wells has reached 2,000~33,000 m^3 and 10,000~160,000 m^3 from horizontal wells. Sichuan Basin is the most favourable area for shale gas exploration with major projects led by CNPC and Sinopec. Up till the end of February 2013, China has drilled 80 wells. Among which, CNPC drilled 30 wells, Sinopec drilled 26 wells and Yanchang drilled the rest 24 wells. The Chinese government approved the first production-sharing contract on shale gas between Shell and CNPC in March 2013 (Sun, 2013b). CNPC estimates that it will produce 1.5 billion cubic meters and Sinopec estimates 0.13 billion cubic meters. One local government, Chongqing, is planning to drill 150 to 200 shale gas wells by 2015 whose annual production will be 1.3 to 1.5 billion cubic meters. These plans could account for almost 50% of the national target of 6.5 billion cubic meters by 2015 (Lee, 2013).

- Players and production volumes involved

Two rounds of bidding for the development were held by the MLR in 2011 and 2012 respectively. Table 2 shows the successful bidders of the total 21 shale gas blocks.

Table 2 winners of two rounds of bidding for shale gas projects

No.	Winner	Block	Province	Area (km^2)	Ownership
1	Sinopec Corporation	Nanchuan	Chongqing	>2000	SOE
2	Henan Coal Seam Gas Development Group	Xiushan	Guizhou	>2000	SOE
3	Huadian Coal Industry Group Co.,Ltd	Suiyang	Guizhou	1204.53	SOE
4	China Coal Geology Engineering Co.	Fenggang-1	Guizhou	1053.37	SOE
5	Huaying Shanxi Energy Investment Co., Ltd.	Fenggang-2	Guizhou	1030.40	Private
6	Beijing Taitantongyuan Natural Gas Resources Technology Co.,Ltd.	Fenggang-3	Guizhou	1167.49	Private
7	Tongren City Energy Investment Co., Ltd.	Cengong	Guizhou	914.63	SOE
8	Chongqing Energy Investment Group	Qianjiang	Chongqing	1272.40	SOE
9	Chongqing Mining Resources Development Co., Ltd.	Youyangdong	Chongqing	1002.09	SOE
10	State Development & Investment Corp.	Chengkou	Chongqing	1020.95	SOE

11	Huan Huasheng Energy Investment Development Co.,Ltd.	Longshang	Hunan	878.00	SOE
12	China Shenhua Energy Company Limited	Baojing	Hunan	1189.72	SOE
13	China Huadian Engineering Co., Ltd	Huayuan	Hunan	400.43	SOE
14	China Coal Geology Engineering Co.	Sangzhi	Hunan	760.36	SOE
15	Hunan Shale Gas Development Development Co., Ltd.	Yongshun	Hunan	982.23	SOE
16	Hudian Hubei Power Generation Co., Ltd (Huadian Corp.)	Laifengxianfeng	Hubei	369.23	SOE
17	Hudian Hubei Power Generation Co., Ltd (Huadian Corp.)	Hefeng	Hubei	2306.71	SOE
18	Jiangxi Provincal Natural Gas Holdings Ltd.	Xiuwu basin	Jiangxi	598.28	SOE
19	Anhui Province Energy Group Co., Ltd	Lin’an	Zhejiang	580.09	SOE
20	Henan Yukuang Geology and Exploration Investment Co., Ltd	Wenxian	Henan	1377.91	SOE
21	Henan Yukuang Geology and Exploration Investment Co., Ltd	Zhongmou	Henan	1395.99	SOE

- Status of the current projects

Refer to aforementioned shale gas projects.

Reference:

National Development and Reform Commission (NDRC), http://www.sdpc.gov.cn/

Ministry of Land and Resource (MLR), http://www.mlr.gov.cn/

National Energy Administration (NEA), http://www.nea.gov.cn/

Ministry of Finance (MOF), http://www.mof.gov.cn/

Ministry of Environmental Protection (MEP), http://www.mep.gov.cn/

Ministry of Science and Technology (MOST), http://www.most.gov.cn/

State Administration of Taxation (SAT), http://www.chinatax.gov.cn/n6669073/

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附件 3　APEC Energy Demand and Supply Outlook 6th Edition

Other Sector (Residential/Commercial/Agriculture Sectors)

a. Assumptions and methodologies used in modelling business-as-usual（BAU）

The other sector encompasses residential, commercial, agriculture and non-specified sectors. A top-down approach was used to project energy demand in these four sectors. In the 'top-down' approach, APERC developed the energy demand model by fuel based on aggregated statistics for the economy. The assumptions for other sector energy demand by fuel in the business-as-usual (BAU) include energy data, macroeconomic data and energy policies. It is discussed in more detail in the Annex 1 on Key Assumptions and Methodologies.

Given the difficulties of obtaining good data for some economies, the simplest and most important variable should be selected. A study by Judson et al. illustrated (1999) that GDP per capita is the major driver of energy demand. In APERC's other sector energy demand model, residential and commercial energy demand is forecasted using useful energy demand elasticity with respect to GDP (PPP) per capita (Chen and Samuelson, 2012). Agriculture energy demand is forecasted based on energy intensity (i.e. energy intensity expressed in terms of energy use per agriculture value added) and non-specified energy demand is forecasted based on growth rate method due to the difficulties of finding the significant relationship between energy demand and macroeconomic index (Chen, 2012).

b. Final Energy Demand

According to IEA statistics (2014), in 2012, the total APEC energy consumption in the 'other' sector was 1588 million tonnes of oil equivalent (Mtoe) which accounted for about 31.73% of the total APEC final energy consumption. Figure 1 shows total APEC

'other' sector energy demand by sector. The residential sector had the largest share at 62% (980Mtoe), followed by commercial at 28% (445Mtoe), agriculture at 6% (92Mtoe), and non-specified at 4% (71Mtoe). In 2040, residential will account for more than 55% of other sector energy consumption, remaining the biggest share shown as Figure 2. The residential and commercial sectors will be responsible for about 86% of other sector energy demand. The energy sources and the amount of energy used in the 'other' sector vary greatly from economy to economy.

Figure 1 Total APEC other sector energy demand by sector in 2012

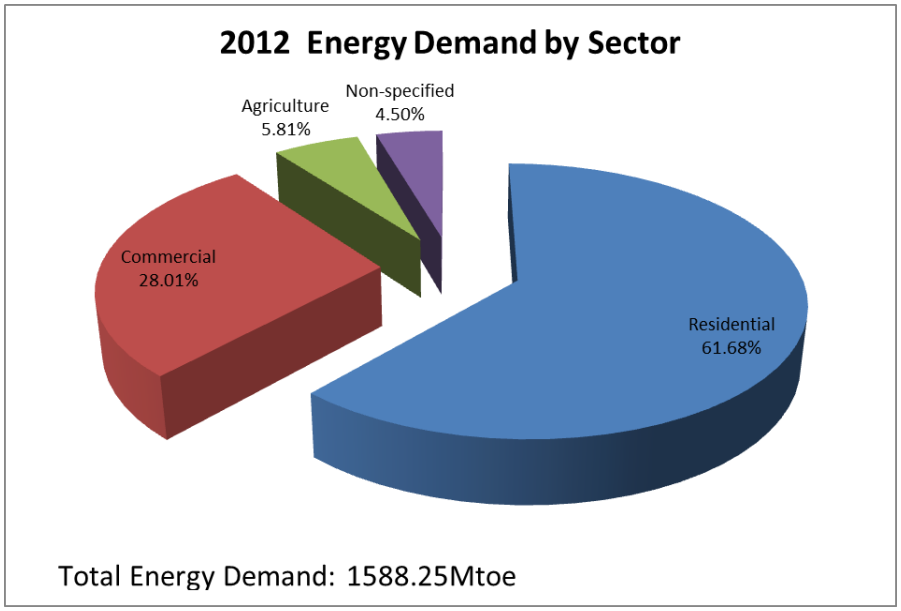
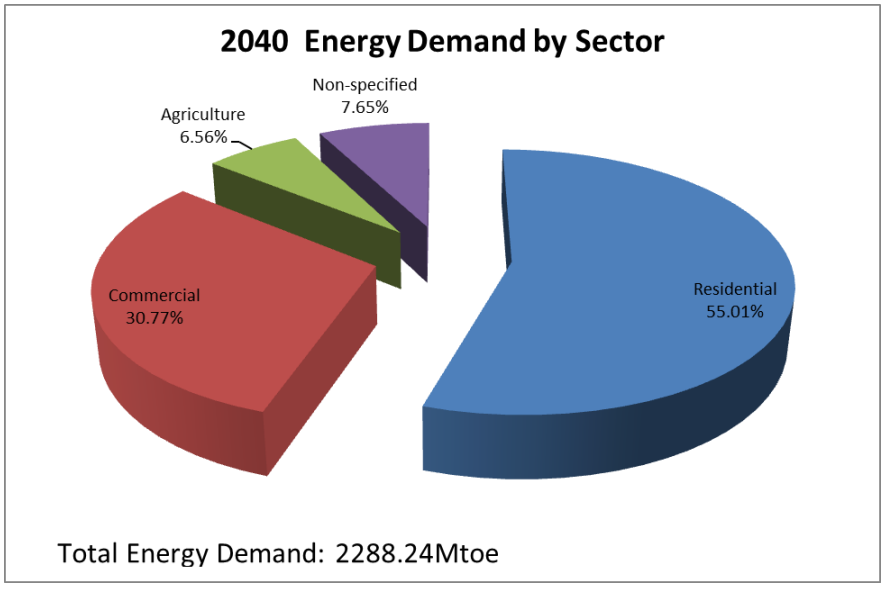


Figure 2 Total APEC other sector energy demand by sector in 2040



- Other sector energy demand and average annual growth rate by economy

Table 1 illustrates the projected other sector demand in each APEC economy, under business-as-usual. Over the outlook period between 2012 and 2040, other sector energy demand is projected to increase at an average annual increase of 1.31% from 1588 Mtoe in 2012 to 2288 Mtoe in 2040. By 2040, the 'other' sector will account for about 31.14% of the total APEC final energy demand. By 2040, China will become the largest energy consuming economy in the 'other' sector. This will account for 1078Mtoe or about 47% of the total APEC 'other' sector energy demand. The US will be second largest energy consumer, with 492Mtoe (about 21.5%). This table also shows that higher growth rates tend to be in the developing Asia economies. Thailand had the highest average annual growth rate of 3.45 percent from 2012 to 2040, followed by Brunei Darussalam at 3.01 percent, Malaysia at 2.86 percent and China at 2.65 percent.

Table 1 Project other sector energy demand by economy

Economy	Other Sector Energy Demand (Mtoe)			AAGR
	2012	2030	2040	2012~2040
Australia	19.70	25.26	28.10	1.28%
Brunei	0.30	0.50	0.68	3.01%
Canada	61.95	68.95	71.44	0.51%
Chile	7.68	11.28	12.54	1.76%
China	518.18	936.64	1078.48	2.65%
Chinese Taipei	11.54	13.02	12.91	0.40%
Hong Kong	4.18	5.33	5.85	1.21%
Indonesia	66.91	82.06	91.19	1.11%
Japan	114.51	110.84	104.04	-0.34%
Korea	45.40	61.01	64.41	1.26%
Malaysia	9.88	17.17	21.77	2.86%
Mexico	26.84	33.70	36.07	1.06%
New Zealand	3.42	4.09	4.45	0.95%
Peru	5.00	7.10	8.68	1.99%
Philippines	9.13	11.25	11.34	0.78%
Papua New Guinea	0.25	0.36	0.44	2.13%
Russia	156.98	158.14	145.12	-0.28%
Singapore	2.32	3.29	3.57	1.56%
Thailand	21.88	39.56	56.63	3.45%
United States	482.70	491.88	492.00	0.07%
Viet Nam	19.50	28.82	38.56	2.46%
APEC	1588.25	2110.25	2288.23	1.31%

- Other sector per capita energy demand by economy

Table 2 shows 'other' sector energy demand on a per capita basis. It can be seen that, in 2040, Canada will have the highest per capita in the other sector at 1.71 toe/capita, followed by Korea at 1.31 toe/capita and United States at 1.28 toe/capita. In addition, Papua New Guinea, Philippines and Peru will still be using less energy per capita ranging from 0.04 toe/capita to 0.23 toe/capita.

Table 2 projected other sector per capita energy demand by economy

Economy	Per Capita Energy Demand		
	2012	2030	2040
Australia	0.86	0.84	0.83
Brunei	0.72	0.96	1.20
Canada	1.79	1.73	1.71
Chile	0.44	0.58	0.62
China	0.38	0.67	0.79
Chinese Taipei	0.50	0.55	0.57
Hong Kong	0.58	0.63	0.65
Indonesia	0.27	0.29	0.31
Japan	0.91	0.92	0.91
Korea	0.93	1.21	1.31
Malaysia	0.34	0.46	0.53
Mexico	0.23	0.25	0.25
New Zealand	0.77	0.79	0.81
Peru	0.17	0.20	0.23
Philippines	0.09	0.09	0.08
Papua New Guinea	0.03	0.04	0.04
Russia	1.10	1.06	0.96
Singapore	0.44	0.55	0.58
Thailand	0.31	0.54	0.78
United States	1.53	1.36	1.28
Viet Nam	0.22	0.28	0.37
APEC	0.57	0.70	0.75

- APEC 'other' sector total energy demand by energy source

Figure 3 shows the total APEC 'other' sector energy demand by energy source. Among these sources, electricity is projected to be consistently the largest between 2012 and 2040. Electricity demand will grow at an average annual rate of 2.06% over

the outlook period, driven by increasing income levels and growing activity in the commercial sector. These factors will result in an increasing requirement for air conditioning, space and water heating, lighting, and home appliances. The expansion of rural electrification and the wider use of air conditioning and refrigerators in China and South-East Asia is a significant factor contributing to an increased demand for electricity in the residential sector. By 2040, China will account for 42% of the total APEC 'other' sector electricity demand, while the US will account for 27%.

Natural gas is projected to be the second largest energy source in the 'other' sector between 2012 and 2040. Gas demand will grow at an average annual rate of 0.92%. An increase in natural gas demand is expected as income levels expand and the extensive development of gas infrastructure continues. This will allow gas to replace non-commercial biomass for heating and cooking. Natural gas demand for China in the 'Other' sector in, in particular, is expected to grow at about 4.7% a year.

In 2040, the forecast of the demand for oil products, which is dominated in the 'other' sector by LPG (liquefied petroleum gas), will reach to 312 Mtoe at an average annual growth rate of 1.27%. The growth in demand for oil products will be held back by their relatively high prices and by the loss of some markets to natural gas, due to the expanded coverage of gas distribution networks.

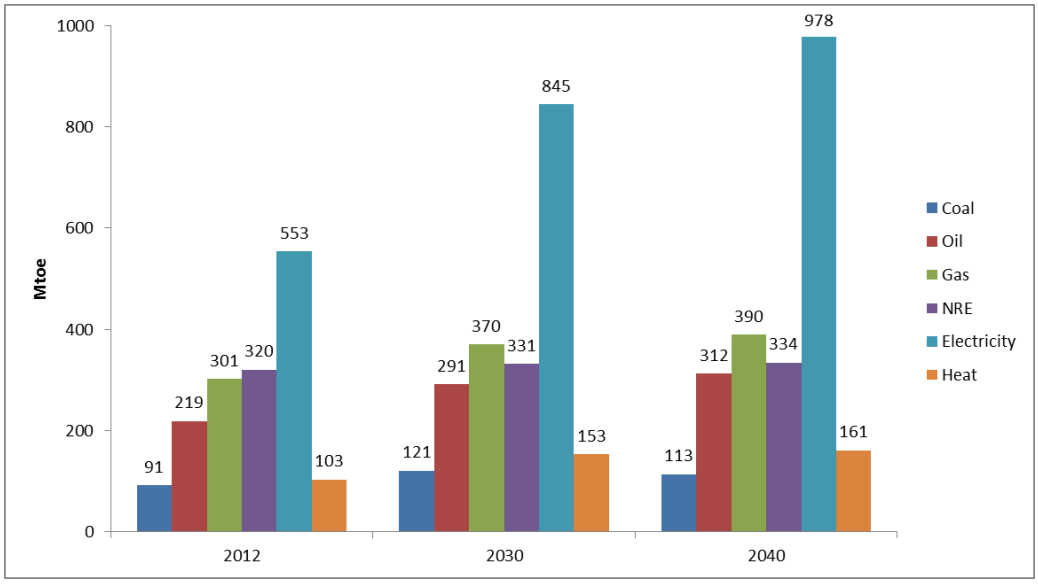
The demand for heat (mainly district heating systems) is projected to be the second growing of any form of 'other' sector energy, at 1.59% a year. District heating is potentially a very efficient energy source, since relatively low-temperature heat from power plants and industrial facilities that would otherwise be wasted can be used for space and water heating in nearby buildings. China and Russia, which already have extensive district heating systems, are projected to represent about 96% of the total APEC 'other' sector heat demand in 2040.

Coal demand is expected to have the lowest growth among the commercial fuels in

the ‘other’ sector, at 0.78% annually. Coal will be increasingly replaced by electricity, natural gas and LPG. In 2040, China will remain the largest ‘other’ sector coal consumer in the APEC region, consuming about 90% of the total ‘other’ sector coal demand.

Commercial fuels will increasingly replace biomass in the ‘other’ sector. However, while the biomass share of ‘other’ sector energy demand will decline overall, its use is expected to persist in rural areas, especially in China and South-East Asia, as a fuel for cooking and water heating. In regard to other NRE sources, there will also be some growth in the demand for solar water heating in the ‘other’ sector; however, it is not expected to be large compared to biomass. The net result will be a more or less stable demand for NRE in the ‘other’ sector over the outlook period.

Figure 3 APEC ‘other’ sector energy demand by energy source



	Coal	Oil	Gas	NRE	Electricity	Heat
AAGR(2012~2040)	0.78%	1.27%	0.92%	0.15%	2.06%	1.59%

c. Conclusions

1. Over the outlook period, other sector energy demand will increase at average annual growth rate of 1.31% form 1588 Mtoe in 2012 to 2288 Mtoe in 2040. By 2040, residential and commercial sectors will be responsible for about 86% of other sector energy demand.
2. Electricity, the largest energy source, will expand its share of other sector energy consumption from 34.85% in 2012 to 42.75% in 2040, with heat's share widening from 6.51% to 7.03%, while the share will fall from 18.97% to 17.03% for gas, from 5.74% to 4.95% for coal and from 20.15% to 14.6% for NRE. The share for oil will remain flat at 14% between 2012 and 2040.
3. By 2040, China is expected to remain the largest energy consuming economy in the other sector which accounts for 1078Mtoe, followed by the US at 492Mtoe.

d. Reference:

Chen, Lei and Ralph D. Samuelson (2012), Residential Energy Demand Modeling Based on Multi-Economy Data, presentation to the 3rd International Association for Energy Economics Conference, Kyoto, Japan, http://eneken.ieej.or.jp/3rd_IAEE_Asia/pdf/paper/057p.pdf

Chen (2012), A Manual of Processing Procedure on APERC's Other Sector Energy Demand Model, February 2012.

Judson, Ruth A., Richard Schmalensee and Thomas M. Stoker (1999), "Economic Development and the Structure of Demand for Commercial Energy", Energy Journal, Vol 20 No 2, 1999.

附件 4　Progress of Peer Review on Low-Carbon Energy Policies (PRLCE) in APEC

APEC New and Renewable Energy Technologies
Expert Group (EGNRET) 41 Meeting
16-17 October 2013, Beijing, China

The Progress of Peer Review on Low-Carbon Energy Policy (PRLCE) in APEC

Dr. Yeong-Chuan Lin
Asia Pacific Energy Research Centre (APERC)

Asia-Pacific
Economic Cooperation

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APERC's Cooperative Activities

- APERC's Cooperative Activities can be defined as "APERC's activities to directly cooperate with the APEC member economies in solving their energy problems or improving their energy situation".

- The major methods of APERC's Cooperative Activities are **peer reviews** and **workshops**.
  - **Peer reviews**: Experts, mainly from the APEC region, visit a host economy to review its energy situation and policies, and make recommendations for the host economy.
  - **Workshops**: Experts from both within and outside of the APEC region work with host economy to share information necessary for policy planning.

Declaration of PRLCE

APEC Energy Ministers' 2010 Fukui Declaration:

"We commend the **Peer Review on Energy Efficiency (PREE)** which has been successfully carried out for four APEC economies and urge additional economies to participate".

"We instruct the EWG to explore ***mechanisms*** to encourage economies to set **individual goals** and **action plans** for introducing ***low-emission power sources*** - renewable, nuclear and fossil fuels with carbon capture and storage (CCS) - to make our energy supply cleaner. We will create ***low-carbon communities*** in the region".

Contents

- Introduction
- **Mechanism for Peer Review of Low Carbon Energy Supply (PRLCE)**
- Progress of PRLCE Phase 1
- Work Plan on PRLCE Phase 2
- Option for future PRLCE
- Conclusion

Objectives of PRLCE

- Assist volunteer APEC economies to promote **low-emission power sources** by providing recommendations from APEC peer review experts.
- Share experiences and knowledge on best practices for efficient and effective policies to promote **low emission supplies** (such as renewable energies) in developing APEC economies, and to determine how to adapt policies and measures which have been successful elsewhere to the unique conditions of each economy;
- Encourage developing APEC economies to **set individual goals** on energy supply from low emission sources (such as renewable energies), and to formulate action plans to achieve the goals

Process of PRLCE

Stage	Activity	Responsibility
1	EWG endorses the host economy volunteering for Peer Review	EWG
2	Economy prepares for and submits to APERC pre-briefing information within one month	Economy
3	APERC PRLCE Manager and economy representative plan Peer Review using Peer Review guidelines	Economy and APERC
4	Peer Review team proposed and contacted	Economy and APERC
5	Peer Review team confirmed	Economy and APERC
6	Economy plans visit in discussion with APERC	Economy and APERC
7	Economy and APERC confirm review team and visit program. APERC with Review team may submit specific questions / data requirement to host economies. APERC request for briefing information	Economy and APERC Review Team
8	Economy provides the answers for the specific questions and information to review team	Economy
9	Review visit to economy	Review Team, Economy and APERC
10	Draft Review Report finalized	Review Team and Economy
11	Final draft report signed off by economy	Economy
12	Economy provides Draft Peer Review Report to EWG	Economy
13	Economy and EWG Secretariat tables the final draft review report at EWG for its discussion and approval	Economy and EWG Secretariat

Main Roles and Responsibilities of Stakeholders

Host Economy

- Plan review process
- Prepare Documents for Review
- Arrange logistic needs
- Assess the preliminary and the draft final report

APERC

- Coordinate the review team formation with the host economy
- Coordinate the draft final report preparation with Host Economy
- Prepare the guidelines for PRLCE

Review Team

- Conduct the review
- Present findings and recommendations in the preliminary report
- Prepare the draft final report

EWG

- Discuss and Endorse the draft final report
- Report to APEC Senior Officials

cf. "Guideline on APEC Peer Review on Low-Carbon Energy Supply (PRLCE)"

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Summary of PRLCE Activities

PRLCE-1 in Thailand (Outline)

- Thailand hosted the first PRLCE-1 on 21~25 May 2012 with the focus on Alternative Energy Development Plan (2008-2022) (AEDP) for Solar, Wind , Biomass, Biogas and other renewable energy.
- The review team consisted of 7 experts (from China, Japan, Malaysia, Chinese Taipei, USA, Viet Nam, IRENA) and 3 APERC Researchers.
- The review team experts have provided 45 *policy recommendations*.

PRLCE in APEC- 11/30

PRLCE-1 in Thailand (Framework of AEDP)

Department of Alternative Energy Development and Efficiency
MINISTRY OF ENERGY

Alternative Energy Development Plan (2008 – 2022) (AEDP)

New Energy Type (Wave, Geothermal) 3MW

Biofuel
Oil Substitution 44%

Alternative Energy Consumption : 25% by 2021

Solar Wind 3,200MW

Hydro 1,608MW

Bio Energy 4,390MW

PRLCE in APEC- 12/30

Alternative Energy Development Plan (2012~2021)

Department of Alternative Energy Development and Efficiency
MINISTRY OF ENERGY

Thailand's Renewable Energy Development

To substitute energy imported,
increase energy security, commit low carbon society

Government Funding On R & D Activities

Alternative Energy Development Plan (AEDP : 2012-2021)

Encouraging Private-Led Investment

Target 25 % of RE in Total Energy Consumption By 2021

Solar	Wind	Small + Mini Hydro	Bio Energy			Biofuels&CBG	Others
			Biomass	Biogas	MSW		
3,000 MW*	1,800 MW*	324 MW*	4,800 MW	600 MW 3,000 MW* (Napier grass)	400 MW	• Ethanol 9 Million l/d • Biodiesel 7.2 Million l/d* • Advance biofuel replace diesel 3 Million l/d* •Compress biogas replace NGV 1,200 ton/d*	• Tidal wave 2 MW • Geothermal 1 MW
100 ktoe (Heat)			8,500 ktoe (Heat)	1,000 ktoe (Heat)	200 ktoe (Heat)		

*Last revised July 2013

Source: Ministry of Energy, APEC Workshop on Renewable Energy Promotion and Pricing Mechanism, 26-27 September,Taipei,Chinese,Taipei.

PRLCE-2 in the Philippines (Outline)

- The Philippines hosted the second PRLCE-2 on 19~23 November 2012 with the focus on National Renewable Energy Program (2011-2030) (including the Feed-in Tariff system for renewable energy).
- The review team consisted of 6 experts (from China, Japan, Malaysia, New Zealand, Thailand, IRENA) and 3 APERC Researchers. The review team experts have drafted policy recommendations.
- The first draft of Review Report for the 2nd PRLCE in the Philippines was compiled and then reviewed by the Philippines Government.
- The final draft will be tabled for the endorsement of EWG46 at Da Nang, Viet Nam in November.

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- Introduction
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- **Work Plan on PRLCE Phase 2**
- Option for future PRLCE
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PRLCE Phase 2

- Indonesia hosted the first PRLCE-3 on 13~27 May 2013 with the focus on Renewable Energy.
- The review team consisted of 5 experts (from China, Japan, Malaysia, Thailand, USA) and 3 APERC Researchers.
- The first draft of Review Report for the PRLCE-3 in Indonesia was compiled and is now under review by the Indonesia Government.
- The Review Report was presented at a High Level Meeting on Renewable Energy at Bali, Indonesia in October, and EWG endorsement will be sought in their November, 2013 meeting.
- One more economy (Malaysia) has volunteered to host PRLCE-4.

Areas covered in the Review

PRLCE

- Institutional Context
- Renewable Energy Goals, Targets and Strategy
- Regulation and Infrastructure
- Biofuels and Biomass Energy
- Geothermal, Solar and Wind Energy
- Hydro Power Energy
- Power Supply System-FIT, Smart Grid & Private Participation)
- Green House Gas Management

PRLCE in APEC- 17/30

Areas covered in the Review

Institutional Context

The National Energy Council (DEN)

- Review the role of DEN related to RE
- Review the decision made by DEN related to RE

The Directorate General of New Renewable Energy & Energy Conservation (DGNREEC)

- Review the role of DGNREEC related to RE
- Review the procedure for RE development

Stakeholders : review their participation related to RE development

Recommendations

Areas covered in the Review

Renewable Energy Goals, Targets & Strategy

The 2006 National Energy Policy and the Draft National Energy Policy

- Review the targets related to RE
- Review the plans related to RE
- Review the programs related to RE

Recommendations

PRLCE in APEC- 19/30

Areas covered in the Review

Regulation and Infrastructure

Regulation

- Review existing laws & regulations and planned

Infrastructure

- Review electricity infrastructure
- Review infrastructure funding

Recommendations

PRLCE in APEC- 20/30

Areas covered in the Review

Bio-Fuels & Biomass Energy

Geothermal, Solar and Wind

Hydropower Energy

- Review potential resources and installed capacity
- Review the existing regulations and planned
- Review the plans and program
- Review the barriers

Recommendations

PRLCE in APEC- 21/30

Areas covered in the Review

Power Supply System

- Review implementation FIT related to RE
- Review the plans and program of smart grid
- Review the private participation in RE development and the barriers for them to participate it

Recommendations

PRLCE in APEC- 22/30

Areas covered in the Review

Green House Gas Management

- Review existing regulation and planned
- Review the targets, plans and program

Recommendations

PRLCE in APEC- 23/30

Possible Option for future PRLCE

- Compared with PREE (for all economies), given the resource constraints of APERC and recognizing the smaller number of potential host economies (only developing economies), it may be necessary to reduce the number of PRLCE peer reviews per year.

Example:

Two PRLCEs in 2012 and 2013

↓

One PRLCE after 2014

PRLCE in APEC- 26/30

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- Introduction
- Mechanism for Peer Review of Low Carbon Energy Supply (PRLCE)
- Progress of PRLCE Phase 1
- Progress of PRLCE Phase 2
- Future option of PRLCE
- **Conclusion**

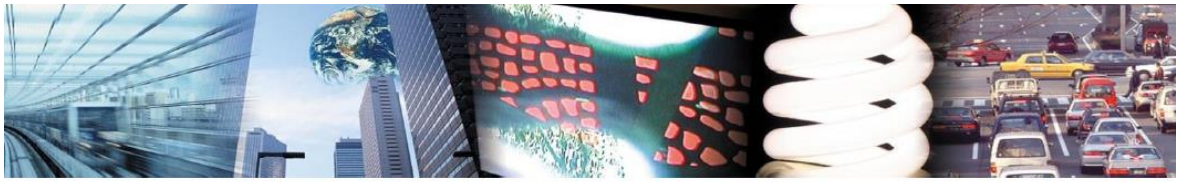
Conclusion (1/2)

- Increase in energy consumption and fast economic growth in the APEC region needs a more aggressive approach and efforts for the development and application of low carbon energy.

- Host economy and other APEC economies can share experiences and knowledge on best practices for efficient and effective policies to promote low carbon power supplies (such as renewable energy), including how to adapt policies and measures/technologies which have been successful elsewhere to the unique conditions of each economy.

Conclusion (2/2)

- Valuable recommendations on how to improve low carbon energy policies can be gained for host economy.
- APERC will act as the coordinator to promote the sustainable development of the APEC Region in cooperation with each economy in the region.



Thank you for your kind attention

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