INER-F0832 **INER-F0832**

出國報告（出國類別：其他）

參加「2014 International Energy Workshop」國際研討會暨參訪上海復旦大學交流出國報告

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派赴國家：大陸
出國期間：103 年 6 月 1 日~103 年 6 月 11 日
報告日期：103 年 7 月 21 日

摘要

本次出國任務為參加「2014 International Energy Workshop(IEW)國際研討會」，以了解國際能源模型發展現況趨勢。會議於中國北京西郊賓館舉行，由中國礦業大學與國家發展與改革委員會能源研究所共同舉行，涵蓋主題甚廣，主要包含能源系統評估、能源與氣候模型建置與模擬、再生能源與電力市場、碳價與碳稅訂立、區域分析、氣候變遷政策與協議等。

核能研究所目前正積極執行「能源國家型科技計畫－我國能源科技及產業政策評估能力建置」與「能源國家型科技計畫－我國能源配比整合研究探討」兩項研究計畫，本次派遣孫廷瑞助理研發師、鄧謦瀚助理研發師參加 2014 IEW，發表會議論文「Estimation of price elasticities for MARKAL-ED model-Evidence from Taiwan」與「Analysis of Taiwan Power Planning Based on Zero Growth in Electricity Demand」兩篇，並與國外能源經濟研究專家討論交流，分享核研所近期研究成果，藉以掌握相關能源經濟與政策最新資訊，作為執行政策研究計畫之參考。同時，本次公差亦前往上海復旦大學進行學研交流，除拜會復旦大學能源經濟與戰略研究中心，亦拜訪復旦大學經濟學院張中祥特聘教授共同討論能源與環境經濟與政策最新國際趨勢，以拓展本所能源經濟及策略研究中心之國際關係。

關鍵字：國際能源研討會、能源技術系統分析計畫、復旦大學

Abstract

The 2014 International Energy Workshop (IEW) was hosted in Beijing Xijiao Hotel by the Energy Research Institute (ERI) and China University of Mining and Technology. Participating in the 2014 International Energy Workshop, it is important to understand the development of energy modelling around the world. The topics discussed in the workshop were extensive, including energy system evaluation, energy/climate modelling, renewable energy / electricity market, carbon tax, regional system analysis, and climate change policy/agreement.

There are two major national energy projects implemented in Institute of Nuclear Energy Research (INER)this year. Under the support of these two projects, Ting-Rui Sun and Ching-Han Deng were able to present 『Estimation of price elasticities for MARKAL-ED model-Evidence from Taiwan』 and 『Analysis of Taiwan Power Planning Based on Zero Growth in Electricity Demand』 in the 2014 IEW. It is beneficial to share our researches and exchange the experiences with the experts around the world. During the communication, the latest trends of energy economic and energy policy development can be caught. In addition, we also had meetings with Professor Li-Bo Wu (Deputy Director of Center for BRICS Studies) and Professor Zhong-Xiang Zhang (Distinguished Professor & Chairman of Department of Public Economics) in the Fudan University. We shared our views on global energy economic and environmental issues in the meetings. In summary, it is worthy to attend the 2014 International Energy Workshop, and the reputation of Center of Energy Economics and Strategy Research, INER has also been promoted internationally.

Keywords: International Energy Workshop, Energy Technology Systems Analysis Program, Fu-dan University

目錄

一、目的

能源技術系統分析研究計畫(Energy Technology Systems Analysis Program, ETSAP)係由國際能源總署(Internatioanl Energy Agency, IEA)自 1976 年以來建立之執行計畫協議，該計畫主要功能係促進 IEA 會員國與其邀請團隊共同合作建立、維持與擴展一致性的多國的 4E(能源 energy/經濟 economy/環境 environment/工程 engineering)分析能力，係由近 70 個國家研究團隊共同參與，致力於研發共同(common)、可比較(comparable)與可連結(combinable)之研究方法，以進行單國、多國或全球之長期能源與環境情境分析。

基於 ESTAP 成立目的，ETSAP 固定每半年舉辦一次 ETSAP meeting，共同交換近期研究成果，並討論如何提升能源政策評估工具能力，今年(2014)6 月召開「65th Semi-annual ETSAP meeting」，訂於 6 月 2 日~6 月 3 日在大陸北京西郊賓館舉行，共同討論國際能源模型最新發展現況與趨勢。

ETSAP 每年亦固定協辦 IEW 國際研討會，且每年輪流由不同國家能源研究機構主辦，今年(2014)於 6 月 4 日至 6 月 6 日在大陸北京西郊賓館召開，下圖 1 為 65th Semi-annual ETSAP meeting 官方網站文宣，今年度由中國礦業大學與國

IEA-ETSAP meetings

Back to back with IEW 2014, the IEA-ETSAP meetings will be held in Beijing as follows: from Wednesday to Friday, May 28th - 30th, the TIMES training course; on Monday June 2nd, the regular ETSAP workshop; on Tuesday morning June 3rd, the ETSAP-TIAM model meeting; on Tuesday afternoon June 3rd, the Executive Committee meeting.

More details are available at www.iea-etsap.org.

A separate registration to the IEA-ETSAP events will be possible via the web page given above.

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圖 1. 2014 IEA-ETSAP meeting 網站文宣

家發展與改革委員會能源研究所共同主辦，涵蓋主題甚廣，主要包含能源系統評估、能源與氣候模型建置與模擬、再生能源與電力市場、碳價與碳稅訂立、區域分析、氣候變遷政策與協議等。

核能研究所目前正積極執行「能源國家型科技計畫－我國能源科技及產業政策評估能力建置」與「能源國家型科技計畫－我國能源配比整合研究探討」兩項政策研究計畫，本次派遣孫廷瑞助理研發師、鄧聲瀚助理研發師除參加「65th Semi-annual ETSAP meeting」了解國際能源模型最新發展趨勢，亦於「2014 IEW國際研討會」發表會議論文「Estimation of price elasticities for MARKAL-ED model-Evidence from Taiwan」與「Analysis of Taiwan Power Planning Based on Zero Growth in Electricity Demand」兩篇，並與國外能源經濟研究專家討論交流，分享核研所近期研究成果，藉以掌握相關能源經濟與政策最新資訊，可作為執行政策研究計畫之參考。

另一方面，本次出國另一目的則是拜訪上海復旦大學能源經濟與戰略研究中心進行交流。復旦大學能源經濟與戰略研究中心自 2008 年成立至今，已有六年時間，目前中心主要負責人主要是復旦大學經濟學院世界經濟系吳力波教授擔任，研究團隊主要以吳副主任為首，其餘大部分之研究人員由吳副主任的博士生與碩士生組成，預計今年中開始招收博士後研究員，中心的主要以能源經濟相關議題為主，主要建置與維護 CGE 能源經濟模型與 TIMES 能源工程模型兩類，吳副主任每年固定指導研究生以 CGE(**C**omputable **G**eneral **E**quilibrium)模型為題進行研究，而 TIMES 模型主要請 IEA 能源技術政策組的研究員 Dr. Uwe 協助建置。另外亦有能源策略評析團隊針對大陸不同能源市場(包含煤、油、氣、電)進行研究。藉由本次交流會議之機會，共同討論「能源安全之指標與政策」、「再生能源發展現況與政策」、「核能、能源政策與社會溝通」等議題進行雙方意見交流，對於後續進行研究計畫亦有所助益。

同時，藉由造訪上海復旦大學之機會，亦拜會上海復旦大學經濟學院張中

祥特聘教授。張教授今年當選為亞太政策研究會(Asia and the Pacific Policy Society，APPS)會士，並擔任 International Journal of Public Policy (IJPP) 和 International Journal of Global Energy Issues (IJGEI)等知名國際期刊共同編輯，致力於能源、環境、氣候變遷經濟與政策領域，且去年八月亦造訪核能研究所進行參訪交流，提供許多寶貴政策研究建議。本次拜訪張教授，主要討論國際能源、環境等經濟政策趨勢，並建立本所能源經濟及策略研究中心與張教授交流聯繫之管道。

二、過程

本次出國行程共計 11 日，於 6 月 1 日從台北前往大陸北京，6 月 2 日~6 月 3 日主要參加「65th Semi-annual ETSAP meeting」，了解國際能源模型最新發展趨勢；6 月 4 日~6 月 6 日則參加 2014IEW 國際研討會，並發表兩篇論文，並於會中與國際能源經濟專家討論，獲得許多寶貴建議；6 月 8 日則前往上海，並於 6 月 9 日參訪上海復旦大學能源經濟與戰略研究中心，除分享本次於 2014IEW 發表研究成果，亦針對「能源安全之指標與政策」、「再生能源發展現況與政策」、「核能、能源政策與社會溝通」進行學研交流會議；6 月 10 日則拜訪拜訪上海復旦大學經濟學院張中祥特聘教授，討論國際能源、環境等經濟政策趨勢，建立本所能源經濟及策略研究中心與張教授交流聯繫之管道。6 月 11 日則從上海返回台北，結束這次出國公差行程，茲將出國公差行程表整理如下表 1。

表 1 本次出國公差行程表

日期	行程	工作重點
6 月 01 日(日)	台北-北京	去程
6 月 02 日(一)	北京	「65th Semi-annual ETSAP meeting」
6 月 03 日(二)	北京	「65th Semi-annual ETSAP meeting」
6 月 04 日(三)	北京	「2014International Energy Workshop」國際研討會
6 月 05 日(四)	北京	「2014International Energy Workshop」國際研討會
6 月 06 日(五)	北京	「2014International Energy Workshop」國際研討會
6 月 07 日(六)	北京	會議資料整理與參訪資料準備
6 月 08 日(日)	北京-上海	前往上海
6 月 09 日(一)	上海	參訪上海復旦大學能源經濟與戰略研究中心
6 月 10 日(二)	上海	拜訪上海復旦大學經濟學院張中祥 特聘教授
6 月 11 日(三)	上海-台北	回程

註：
(1)「65th Semi-annual ETSAP meeting」會議資訊：
http://www.iea-etsap.org/web/Beijing_Jun2014.asp
(2) 2014International Energy Workshop 研討會資訊
http://iew2014.ipac-model.org/iew2014/index.htm：
(3) 上海復旦大學能源經濟與戰略研究中心網站：
http://www.econ1.fudan.edu.cn/intro.do?opr=nengyuan

三、心得

(一)65th Semi-annual ETSAP meeting 與會心得

能源技術系統分析研究計畫(Energy Technology Systems Analysis Program, ETSAP)係由國際能源總署自 1976 年以來建立之執行計畫協議，該計畫主要功能促進 IEA 會員及其團隊共同合作建立、維持與擴展一致性的多國的 4E(能源 energy/經濟 economy/環境 environment/工程 engineering)分析能力，係由近 70 個國家研究團隊所共同參與，致力於研發共同、可比較與可連結之研究方法，以進行單國、多國或全球之長期能源與環境情境分析。基於 ETSAP 成立目的，ETSAP 固定每年兩次舉辦 ETSAP meeting，共同交換近期研究成果，並討論如何提升能源政策評估工具能力，本次 ETSAP 半年會議於舉辦於北京，討論近期能源模型最新發展趨勢，下圖 2 為 ETSAP meeting 會議現場實況。

圖 2 IEA-ETSAP meeting 與會實況 specific

核能研究所自 2005 年起建立 MARKAL (**MAR**ket **AL**location)能源工程模型，至今已邁向第 9 個年度，並積極努力精進 TIMES(**T**he **I**ntegrated **M**ARKAL-**E**FOM[1] System)能源工程模型，與國際趨勢接軌。透過本次參加 ETSAP 會議瞭解各國 MARKAL/TIMES 模型之建置經驗，作為核研所精進 TIMES 模型之基礎。經本次參加會議可了解，能源模型研究方面，最新國際趨勢主要有二點：(1)朝向評估多國、多區域之整合模型，即模型評估範圍的擴張，如國際知名之 TIAM 模型(**T**imes **I**ntegrated **A**ssessment **M**odel)即是為一成功案例；(2)整合評估能力不同之模型，如將產業發展評估模型與能源技術系統模型整合，以增強研究的全面性。由於能源工程模型對於總體經濟與產業間的互動效果評估能力較為缺乏，因此許多國家仍朝向能源工程模型(如 TIMES 模型)與能源經濟模型(如 CGE 模型)之整合，如日本富士研究所經濟研究中心、義大利 Fondazione Eni Enrico Mattei(FEEM)等。透過建立兩模型之間參數連結，充分發揮兩模型之評估能力。然而，由於兩類模型的相關基本假設差異甚大，因此在整合評估上有其限制，但仍是目前能源模型研究之國際趨勢。核研所今年(民 103 年)年初成立能源經濟及策略研究中心，建置與維護 3E 整合評估模型，並提出完整且務實之方案與逐期推動之能源策略，除本身長期建置與維護之 MARKAL/TIMES 能源工程模型外，亦積極與中原大學合作開發 GEMEET 能源經濟模型(**G**eneral **E**quilibrium **M**odel for **E**nergy, **E**nvironment, and **T**echnology analysis)。本次與會瞭解各國模型整合經驗，將有助於核研所未來整合模型之建置參考。此外，由於能源經濟涉及議題甚廣，且隨著全球化、國際化發展趨勢下，跨境能資源之流動將更為密切，因此有必要建立跨區域之能源經濟模型，評估各種國際重大事件對台灣或其他國家之影響，作為瞭解國際能源情勢、掌握台灣能源安全之基礎，因此建議核研所未來可透過與國際研究組織之合作，引進跨區域之多國模型，有利於與國際趨勢接軌。

ETSAP 會議中，各國研究團隊皆已使用 TIMES 模型進行研究，由於 TIMES

[1] EFOM 全名為 Energy Flow Optimization Model

模型在時間區間及參數資料輸入方面較具彈性，因此研究主題較為廣泛。核研所能源經濟及策略研究中心已著手由 MARKAL 模型轉換至 TIMES 模型，然因中心負責業務項目較為繁雜，且人力有限，造成建置 TIMES 模型時程略為落後，而後將儘速完成與精進 TIMES 模型，除有助於後續對外之溝通，也可增進能源系統研究的細緻化。另一方面，在模型結果呈現的繪圖方式，目前各國皆是採用直條圖描繪模型產出年度之數據結果，取代原本使用的區域堆疊圖，因此後續核研所同仁可參考使用直條圖呈現模型產出之結果。會議過程中，核研所同仁亦與眾多國際組織的專家進行交流，簡要列舉如下：

- **Choi Dong Gu, Korea Institute of Energy Research**：

Dr. Gu 於會議中報告韓國未來再生能源發展組合的量化探討，使用 TIMES 模型模擬電力部門不同再生能源推廣情形下的成本變化。Korea Institute of Energy Research 於 2011 年完成由 MARKAL 模型移轉至 TIMES 模型。後續核研所可與 Dr. Gu 聯繫，針對台灣、韓國的 TIMES 模型經驗進行交流。

- **Maurizio Gargiulo, E4SMA**：

Maurizio (E4SMA President)擔任 E4SMA 公司總裁，目前亦為核研所能源經濟及策略研究中心的模型教育訓練講師，本次會議中 Maurizio 報告將 macro-economic 影響整合入 TIMES 模型的成果。Maurizio 指出 TIMES 模型的發展，期望朝向能源工程與總體經濟結合的階段。

- **Steve Pye, UCL Energy Institute**：

Steve Pye 目前任職於英國倫敦大學(UCL)的能源研究所，曾擔任曾任核研所 MARKAL 模型教育訓練講師，提供模型技術支援。StevePye 建議核研所儘快轉換至 TIMES 模型，以較具彈性的模型工具，有助於進一步研析能源系統相關議題。

- **Uwe Remme, Energy Modeller, Energy Technology Policy, IEA**：

Dr. Uwe 目前任職 IEA 能源模型研究團隊，同時 Dr. Uwe 亦參與 Energy Technology Perspectives 報告製作，藉由本次會議與 Dr. Uwe 建立良好關係，有益於後續議題諮詢，亦可作為所內模型技術教育訓練之講師人選。

- **Asami Miketa, IRENA Innovation and Technology Centre, IRENA：**

Asami 目前任職於 IRENA 創新技術中心計畫主管,於本次會議報告 IRENA 與各國能源研究組織合作建置能源模型之成果，透過本次會議交流，未來將可做為國際再生能源市場現況與趨勢諮詢之聯絡窗口。

- **馬丁，能源環境經濟研究院，北京清華大學**

馬丁目前於北京清華大學攻讀博士，預計明年畢業，主要負責清華 TIMES 模型建置與維護工作，藉此會議機會，能夠與北京清華大學 TIMES 模型團隊建立聯絡窗口，未來將有機會進一步針對兩岸之 TIMES 的建置經驗進行交流。

- **Takuya Hara(原 卓也), Society, Industry, and Transportation Group, TOYOTA Central R&D LABS.,INC**

Dr. HARA 目前於豐田中央研究所社會產業運輸研究中心擔任研究人員，在會議結束後請教有關台灣各縣市運輸部門能源需求問題。Dr. HARA 對亞洲地區運輸能源需求現況與趨勢研究熟悉，若未來對於亞洲地區運輸部門相關議題，可向其諮詢討論。

- **Hiroshi Hamasaki(濱崎 博), Economic Research Centre, Fujitsu Research Institute(FRI)**

Dr. Hamasaki 目前為富士研究所經濟研究中心主任研究員，其建置 CGE 模型已有 15 年經驗，而建置 TIMES 模型已有 8 年經驗，對於能源經濟模型與能源工程模型整合具有豐富經驗，本此會議亦提出分享近期利用 CGE 模型之替代彈性作為兩類模型連結之基礎，未來可透過於日本參加會議之機會，藉此前往

該單位進行能源模型建置經驗交流。

以下針對 ETSAP 會議兩篇值得參考之發表論文，簡述其研究成果與心得：

①The importance of including short-term dynamics in planning models for electricity systems with high shares of intermittent renewables
(Kris Poncelet, EnergyVille/KU Leuven 荷語天主教魯汶大學)

Dr. Poncelet 發表的這篇文章，主要是利用比利時的 TIMES 模型，著重模型中電力系統部分，透過導入高比例的再生能源，檢視短期再生能源發電不穩定性對整體電力系統的影響。此外，再利用混合整數線性市場模型(Mixed Integer Linear Programming Market Model)，重新規劃發電技術的使用以滿足負載曲線。首先，作者說明電力系統若使用大量再生能源(如風力、太陽光電等)，將因再生能源發電的不穩定性，需仰賴傳統電廠(如火力)配合調度。此時，各時間區間電力系統發電量規劃甚為重要，以避免出現電力供應短缺的情形。此篇研究使用的比利時 TIMES 模型，電力系統為一單區域、無進出口的島國型態，且未於模型中建置電網部分。其他重要條件包括：5%的容量餘裕、導入碳稅等。在研究中，為清楚呈現再生能源在模型不同時間區間(TimeSlice)切割情況下，對系統規劃的影響，作者將 TIMES 模型時間區間做以下之劃分：

表 2 時間區間劃分

	TS 1	TS 1b	TS 2	TS 3
SEASON	4 Seasons	4 Seasons	4 Seasons	52 weeks
WEEKLY	-	Day, Night, Peak	WD, Sat, Sun	7 days/week
DAYNITE	Day, Night, Peak	High Wind, Med Wind, Low Wind	24 h/day	24 h/day
#TS	12	36	288	8736

資料來源：Poncelet (2014)，本研究整理。

模型結果顯示，當時間區間劃分越細緻，即 TimeSlice 數目較多時，需要建置較多的傳統發電技術(如核能、複循環燃氣渦輪機等))裝置容量，以利在再生

能源發電量較少的時間區間內，補足其不足之供電量，維持系統之平衡。作者接續將 TIMES 模型產出的裝置容量作為混合整數線性市場模型的輸入參數，同時加入電廠運作限制，如 ramping rates, minimal generation level, minimal up and down time 等，在不考量電網的情況下求解。當在 MILP 市場模型加入電廠運作限制後，將提高系統總成本，並在大量再生能源佔比的情況下，Residual Load Duration Curve (RLDC)將出現閒置的裝置容量，反應出真實運作情形。總結而言，作者認為：(1)傳統將時間區間依季節、每日等方式切割，無法顯現再生能源發電的不穩定性，有失其真實性。(2)電廠操作限制的設定，對整體電力系統規劃具關鍵影響。由於本所仍持續積極精進 TIMES 模型，從 Dr. Poncelet 的研究結果可知，TimeSlice 的劃分方式是高再生能源佔比系統重要影響因子，若要使模型的再生能源運作更貼近實際情形，應以較細緻的 TimeSlice 來切割，但前提是必須有足夠的技術資訊，這也是 Dr. Poncelet 在提及的重要考量因素。後續建議本所的 TIMES 模型，應在可取得資料的時間區間範圍內，盡可能細緻化 TimeSlice 的切割，以利後續再生能源相關研究。此外，Dr. Poncelet 的研究尚未將電網的部分，建置入模型中，這部分也是未來本所 TIMES 模型精進的重點目標。

②Hybrid Model Approach Using TIMES-based JMRT model
(Hiroshi Hamasaki, Fujitsu Research Institute)

Dr. Hamasaki 目前擔任日本富士研究所經濟研究中心主任研究員，本次發表主題為「Hybrid Model Approach Using TIMES-based JMRT model(整合模型方法-以 TIMES 模型為基礎之 JMRT(Japan Multi-Regional Transmission)模型之應用)」。鑒於由上而下(Top-down)與由下而上(Bottom-Up)之兩種模型分析取向，各別擁有各自模型之特色，Top-down 模型(如 CGE 模型)較能夠反映個體經濟與總體經濟之真實性與完整性，但卻無法代表描繪不同技術間之替代機制(一般皆主觀給定一替代彈性值作為代表)，而 Bottom-Up 模型(如 TIMES 模型)雖可清楚描

述個不同技術之間的替代機制(以發電成本之高低做為替代機制之準則)，但卻無法反映能源供需對個體經濟與總體經濟之影響與衝擊。有鑑於此，該篇研究提出一整合模型之思考方向，透過 TIMES 模型(Bottom-Up 模型)推估 CGE 模型發電巢式結構(nested structure)中之替代彈性，彈性推估方程式如下：

$$r_i = (qo_j - qf_{i,j})/(pf_{i,j} - p_{sj})$$

其中 r_i 為第 i 種發電技術之替代彈性，qo_j 為在第 j 項情境中之系統總發電量，$qf_{i,j}$ 為第 i 種發電技術在第 j 項情境中之發電量，$pf_{i,j}$ 為第 i 種發電技術在第 j 項情境中之發電成本，p_{sj} 為在第 j 項情境中之電價。透過發電量(用電量)、電價之假設，模擬不同發電成本變動對該項技術發電量之影響，在透過發電成本與發電量間變動關係推估替代彈性。此外，同時加入電網擴張(Grid Expansion)、CCS 技術導入、儲能設施(Electricity Storage)、核能(Nuclear)等發電系統情境，模擬不同發電技術在不同發電系統情境下之替代彈性(如下圖 2)。如此以來，CGE 模型可透過應用不同情境下所推估之替代彈性，反映不同技術之發電特性與發電系統變化之影響於模型中，可彌補 CGE 模型無法清楚描述技術間之替代機制與發電系統改變對整體電力供應之影響。Dr. Hamasaki 所提出之模型整合方法將可作為本所後續整合模型工作之借鏡與參考。

圖 3 不同情境下各種再生能源技術之替代彈性

		Technology				
		Biomass	Hydro	Solar	Offshore	Onshore
Condition	Reference		1.36**	1.24***	4.27***	1.65***
	Cheap Biomass	17.39*				1.96***
	Storage		2.22	3.59***	7.57*	5.76***
	GE		1.39**	1.23***	3.95***	3.54 ***
	CCS		1.25	2.37**	0.09	2.83 ***
	With Nuke		3.09	1.97	2.77*	2.48***

資料來源：Hiroshi and Amit (2013)

(二)2014 IEW 國際研討會與會心得

IEW 為 1981 年成立之國際知名能源模型研究組織，定期舉辦研討會，增進國際能源模型研究交流機會。「2014IEW」國際研討會由北京中國礦業大學與北京國家發展與改革委員會能源研究所共同舉辦，主要由三場專題演講，及六場平行場次之論文發表，本次發表論文約 120 篇，涵蓋主題甚廣，主要包含能源系統評估、能源與氣候模型建置與模擬、再生能源與電力市場、碳價與碳稅訂立、區域分析、氣候變遷政策與協議等，下圖 4 為 2014 IEW 官方網站文宣。

圖 4. 2014 International Energy Workshop 國際研討會文宣

核研所本次會議亦發表兩篇近期研究成果，獲與會專家提供實質建議，可供未來研究主題之擴展。下圖 5、圖 6 本所同仁於會場發表文章之實況。

針對「Estimation of price elasticities for MARKAL-ED model-Evidence from Taiwan」一文，與會專家提出，不同所得族群之價格彈性應有所差異，因此未來建議可嘗試推估不同所得族群的價格彈性，以確切反映價格政策對需求面之減碳貢獻；此外亦說明未來可採用進階計量經濟方法，考量價格彈性會隨時間而變化，推估不同時間區間之價格彈性(如 2020、2030、2040 與 2050)，將有助於提升 MARKAL/TIMES 能源工程模型之評估能力。針對「Analysis of Taiwan Power Planning Based on Zero Growth in Electricity Demand」一文，與會專家指出，由於模型情境設定使用大量液化天然氣，建議應呈現液化天然氣之價格推估方式與價格趨勢，亦建議需說明電力需求零成長的模型設定方式，以便讀者了解研究邏輯。

圖 5 鄧員於 2014 International Energy Workshop 會場簡報實況

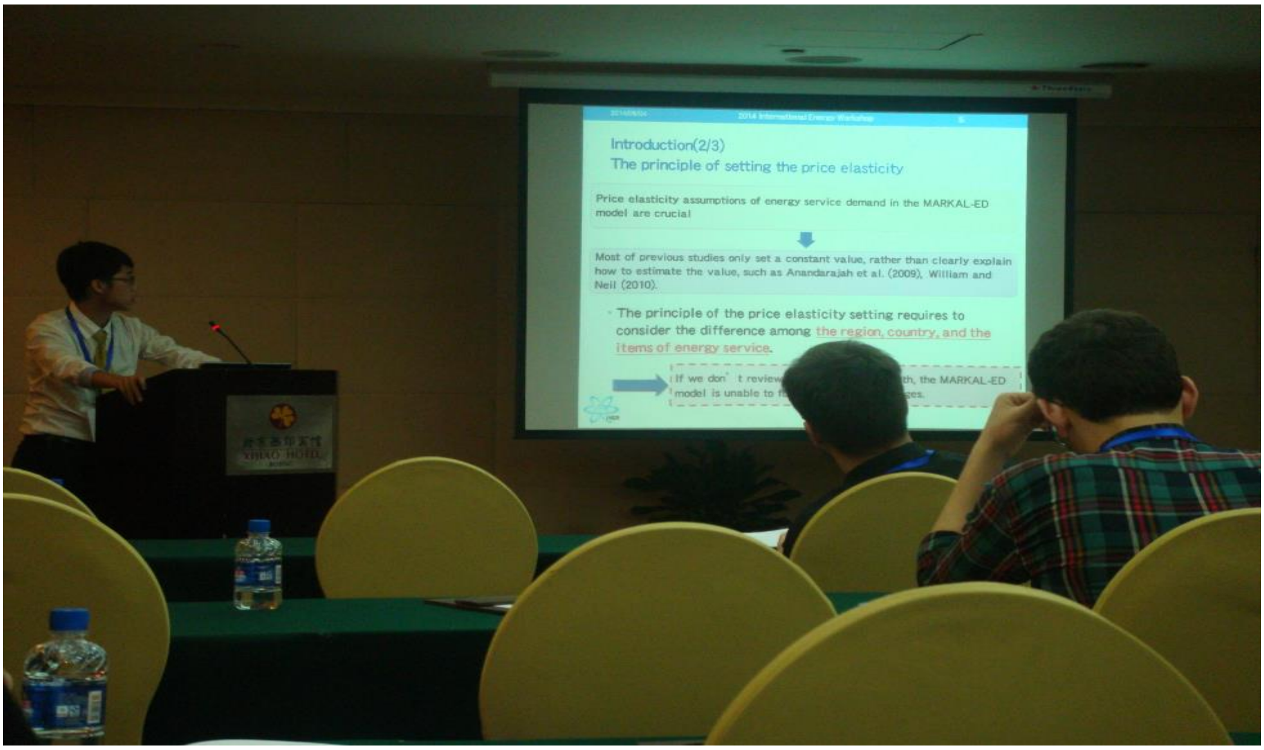

圖 6 孫員於 2014 International Energy Workshop 會場簡報實況

此外，國內研究單位－工研院綠能所亦派 2 名同仁參加本次研討會，研究主題為「Applying the Taiwan TIMES Model to Assess Effectiveness of Energy Efficiency Managements」，主要內容為研析台灣住宅與服務業部門耗能設備技術發展與市場轉化趨勢，同時運用 TIMES 模型評估台灣住宅與服務業耗能設備推行最低容許耗用能源標準、節能標章及能源效率分級標示等能效管理制度之節能成效，有助於本所 TIMES 模型住宅與服務業部門技術建置的參考。利用本次參加研討會之機會，一方面可瞭解各國能源研究組織之近期研究重點與成果，做為核研所後續研究主題之規劃；另一方面，透過與各國能源研究組織與會人員交流，建立核研所與各國能源研究組織聯繫管道，如 IEA、IRENA、WEC、EIA 等，此將有助於提升核研所於能源經濟領域之知名度，以及拓展核研所能源經濟及策略研究中心之國際關係。

(三)與復旦大學能源經濟與戰略研究中心交流心得

復旦大學能源經濟與戰略研究中心(下圖 7) 自 2008 年成立至今，已有六年

左右，目前中心主要負責人主要是復旦大學經濟學院世界經濟系吳力波教授擔任副主任，研究團隊主要以吳副主任為首，其餘研究人員由吳副主任的博士生與碩士生組成，預計今年中開始招收博士後研究員。圖 8 為本所孫廷瑞、鄧聲瀚與吳力波副主任之合影。中心的主要以能源經濟相關議題為主，主要操作、維護 CGE 能源經濟模型與 TIMES 能源工程模型兩類，另外亦有能源策略評析團隊針對大陸不同能源市場(包含煤、油、氣、電)進行研究。

圖 7 復旦大學能源經濟與戰略研究中心

圖 8 與復旦大學能源經濟與戰略研究中心副主任吳力波 教授合影

本次交流會議首先由本所孫廷瑞、鄧謦瀚報告核研所能源經濟及策略研究中心之簡介，並簡述本次於 2014 IEW 報告之議題，而後再以「能源安全之指標與政策」、「再生能源發展現況與政策」、「核能、能源政策與社會溝通」等議題進行雙方意見交流。下圖 9 為雙方意見交流實況。會議過程中，吳力波教授指出，目前大陸雖有揭露能源進口依存度、石油依存度等能源安全指標，但在其十二五能源發展規劃中，並無將其納入於政策目標中，而大陸目前官方是有一套能源安全風險評估系統，主要是著重在短中期之能源供應風險評估，但礙於涉及國家安全，因此並無公開。核能政策方面，由於大陸地廣人稀，且由於政治體制不同，核安相關資訊受到嚴格之管控，加上背後有強而有力的核能利益團體支持(如核能產業業者)，因此目前核能爭議在大陸不像台灣如此嚴重。另外，吳教授之研究助理－常瑜 小姐亦分享許多大陸電力與再生能源現況與政策，大陸自 2000 年開始進行廠網分離的改革後，目前主要由國家電網與南方電網兩大公司負責整體大陸的輸、變、配、電力調度等業務，而發電端則由五大發電集團負責運行(大唐、中電投、國電、華電、華能)。

圖 9 孫員於復旦大學能源經濟與戰略研究中心簡報實況

目前大陸再生能源推廣政策仍以固定費率補貼(Feed-in Tariff)政策為主，大陸稱其為「上網電價」補貼，主要以陸域風力及太陽光電為主要補貼項目，並根據不同地區訂立不同費率，鼓勵用戶積極設置，然由於許多太陽光電與風力發電設置點遠離負載中心(如大陸內陸地區)，使得需額外增加輸配電之相關投資，增加國家電網之財政負擔，此亦為目前大陸遇到的困境之一，將可能影響其再生能源目標之達成；而離岸風力方面目前仍根據十二五規劃於 2015 年建置 100GW 裝置容量，然由於目前離岸風機將影響近海漁業發展，故此政策仍存在不確定性。透過本次交流會議可瞭解到目前大陸之能源政策現況，對於大陸之能源政策環境更有進一步認識，而復旦大學能源經濟與戰略中心仍有許多能源模型建置經驗，仍值得核研所後續持續交流，將有助於核能所建置與維護能源模型。

(四)拜會復旦大學經濟學院張中祥 特聘教授心得

張中祥 特聘教授今年當選為亞太政策研究會(Asia and the Pacific Policy Society，APPS)會士，並擔任 International Journal of Public Policy (IJPP) 和 International Journal of Global Energy Issues (IJGEI)等知名國際期刊共同編輯，致力於能源、環境、氣候變遷經濟與政策領域，本次拜訪張教授，主要討論國際能源、環境等經濟政策趨勢，並建立本所能源經濟及策略研究中心與張教授交流聯繫之管道，圖 10 為本所孫廷瑞、鄧聲瀚與張中祥教授之合影。在與會過程中，張教授分享許多過去研究經驗與成果，他指出能源安全指標須先了解其背後之實質意涵，再行進行能源安全指標分析，而能源供應安全政策仍應以分散能源使用種類、分散進口能源國家、分散運送路徑等方式分散能源供應風險。其次，針對台灣屬於高度仰賴能源進口的地區，因此可透過與日本、南韓組成策略聯盟，整合進口能源買方力量(如 LNG、原油)，提升能源價格買方的議價能力，才是長久之計。另外，張教授亦指出，國際能源市場上，商業契約之效力仍超越政治力的約束，因此掌握中長期能源購買合約將有助於穩定台灣能源供應安全。最後，張教授提及由於能源議題涉及層面甚廣，且國際重大事件對台灣地區之能源供需皆有密切的影響，因此建議核研所能源經濟及策略研究中心除台灣地區能源研究議題為主外，應加強亞洲地區、歐美地區之能源市場研究議題，瞭解國際能源供需趨勢，對於確保台灣地區能源供應穩定、能源安全提升仍有極大益處，亦可作為政府能源政策研擬之基礎。

圖 10 與復旦大學經濟學院張中祥 教授合影

四、建議事項

經本次與會經驗可發現，能源模型建置與維護對於能源政策評估尤其重要，國際能源組織（如 IRENA）亦積極協助各國研究智庫建置與維護能源模型，詳情可至各國際組織之官方網站（如 http://www.irena.org/）參考。而參加這次會議與許多能源模型與政策評估經驗豐富之學者、研究人員交流，對於提升核研所能源政策評估與規劃能力具有莫大幫助，在此提出幾點未來核研所可持續努力精進的建議方向：

(一)TIMES 模型為未來發展趨勢

由於 TIMES 模型已逐漸發展成熟，大部分國際能源模型研究團隊已逐漸使用 TIMES 模型作為能源供需評估工具，取代 MARKAL 模型。因此建議核研所應努力精進 TIMES 模型，以較具彈性的模型工具，有助於進一步研析能源系統相關議題，並與國際趨勢接軌。

(二)總體能源經濟模型評估能力需盡早建立

各國在使用能源政策評估工具上，除能源工程模型(如 MARKAL、TIMES)外，CGE 模型為各國常見使用之模型，且可彌補能源工程模型對於總體經濟評估方面之限制。目前核研所與中原大學合作建立之 GEMEET 模型即為 CGE 模型之一種，然目前仍以中原大學研究團隊進行主要模型運跑，建議及早將 GEMEET 模型移轉至核研所，將有助於提升核研所自主能源政策評估能力。

(三)建議加強對亞洲、歐美國際能源市場研究議題

與復旦大學經濟學院張中祥特聘教授訪談當中提及，由於能源議題涉及層面甚廣，且國際重大事件對台灣地區之能源供需皆有密切的影響，因此建議核研所除台灣地區能源研究議題外，未來可更加強亞洲、歐美地區國際能源市場

議題之研究。建議可安排 2~3 位研究員人定期追蹤瞭解國際能源供需，對於台灣地區能源供需穩定、能源安全提升具有莫大助益，此亦可作為政府能源政策研擬之基礎。

(四)建議定期派人參加 International Energy Workshop(IEW)國際研討會

International Energy Workshop(IEW)為少數以能源經濟與政策為主題之世界型國際研討會，且參與人員多元(近半數來自歐美先進國家)，研究議題多與政策研究相關，而非單以純學術研究為主，且近 50%以上研究皆與能源模型建置、維護與政策評估相關，與核研所能源經濟即策略研究中心之研究重點吻合，建議核研所可將其視為國際研究交流平台，定期派人參加並發表近期研究成果，提升核研所於能源經濟與政策領域之研究能量與國際知名度。

(五)建議與大陸能源經濟研究單位定期進行學研交流

經本次參與會議經驗，與大陸能源經濟研究單位同仁交流(如北京清華大學能源環境經濟研究院陳文穎教授、中國科學院能源與環境政策研究中心范英主任等)，分享許多能源模型建置、維護與政策評估經驗。建議核研所未來可前往大陸能源經濟研究單位進行交流，亦或邀請其研究單位之研究人員發表研究成果，此不僅可實際了解大陸目前能源供需現況與趨勢，亦可分享雙方研究經驗，促進核研所於能源經濟與政策領域之研究素養。

五、附錄

附件一、會議論文摘要與簡報投影片(鄧聲瀚)

附件二、會議論文摘要與簡報投影片(孫廷瑞)

附件三、研討會手冊與議程

Analysis of Taiwan Power Planning Based on Zero Growth in Electricity Demand

Ching-Han Deng[1], Jyh-Jun Chen, Wei-Chen Liao, Chia-Hao Liu, Fu-Kuang Ko

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Abstract

For the most part, the CO_2 emissions were produced by the energy sector in Taiwan. From the aspects of power supply and demand, feasible carbon reduction measures include the reduction of electricity demand, the development of renewable energy, and the adjustment of power generation mix. This research applied the MARKAL-ED (MARKet ALlocate – Elastic Demand) model to evaluate the cost of electricity generation and CO_2 emissions of different scenarios based on excluding CCS power plants and zero growth in electricity demand in Taiwan. The results indicate that the government might consider adjusting the CO_2 reduction target. Otherwise, to reach the ambitious target, it is necessary for the government to further enlarge renewable policy objectives, to develop CCS power plants or more nuclear plants, or to reduce total electricity demand further.

1. Introduction

Mitigating the environmental impacts caused by human activities such as global warming has become a critical issue in the post-industrial era. In response to the CO_2 emissions reduction trends around the world, Taiwan government has set ambitious CO_2 reduction target: back to 2000 levels by 2025 and back to 50% of 2000 levels by 2050. The CO_2 emissions in Taiwan were 248.7 Mt (Million Tons) in 2012. The electricity sector which accounted for 55% of the emissions should actively develop mitigation measures (Chen and Ko, 2013). According to the IEA's Energy Technology Perspectives 2012, the application of renewables will contribute about 29% of CO_2 reduction in 2050, second to end-use fuel and electricity efficiency (31%) as shown in Figure 1 (IEA, 2012a). IEA also predicted that the greater usage of renewables will let the CO_2 emissions decrease by 10% in 2035 (Figure 2) (IEA, 2012b).Additionally, the local renewables can also improve national energy security by reducing fuel import (Md. Alam et al., 2012). Realizing the benefits of renewables, Taiwan government has promoted the installation and application of renewables through subsidy policies aggressively. In Taiwan, the total installed capacities of renewables have risen from 3,214MW to 3,615MW during 2010 to 2012. Conventional hydropower and waste

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Analysis of Taiwan Power Planning Based on Zero Growth in Electricity Demand

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2014.06.04
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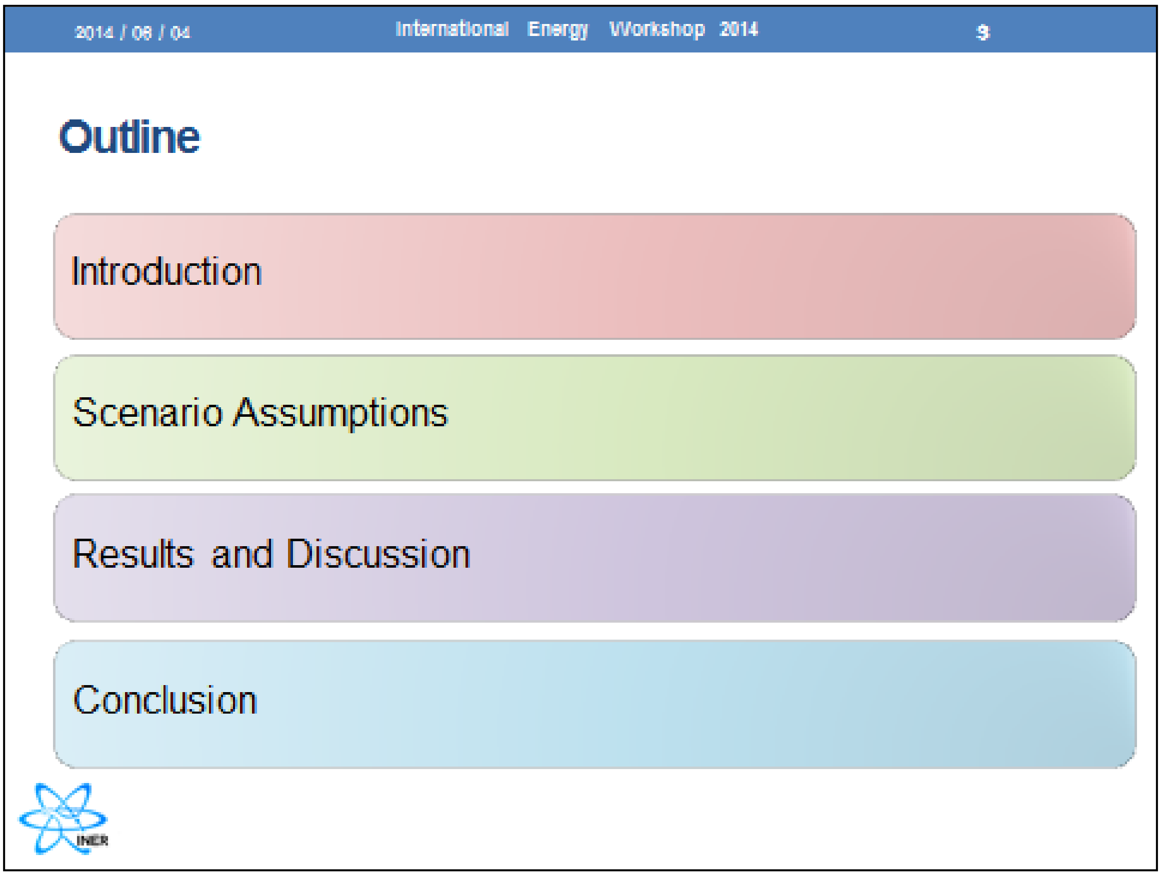
Summary

- This research applied the INER MARKAL-ED model to evaluate electricity generation costs and CO_2 emissions during **2010 to 2050** based on excluding CCS power plants and zero growth in electricity demand in Taiwan.

- The results indicate that the government might consider adjusting the emission targets. Otherwise, to reach the ambitious emissions targets, it is necessary for the government to further enlarge renewable policy objectives, or more CCS plants or nuclear plants would be required.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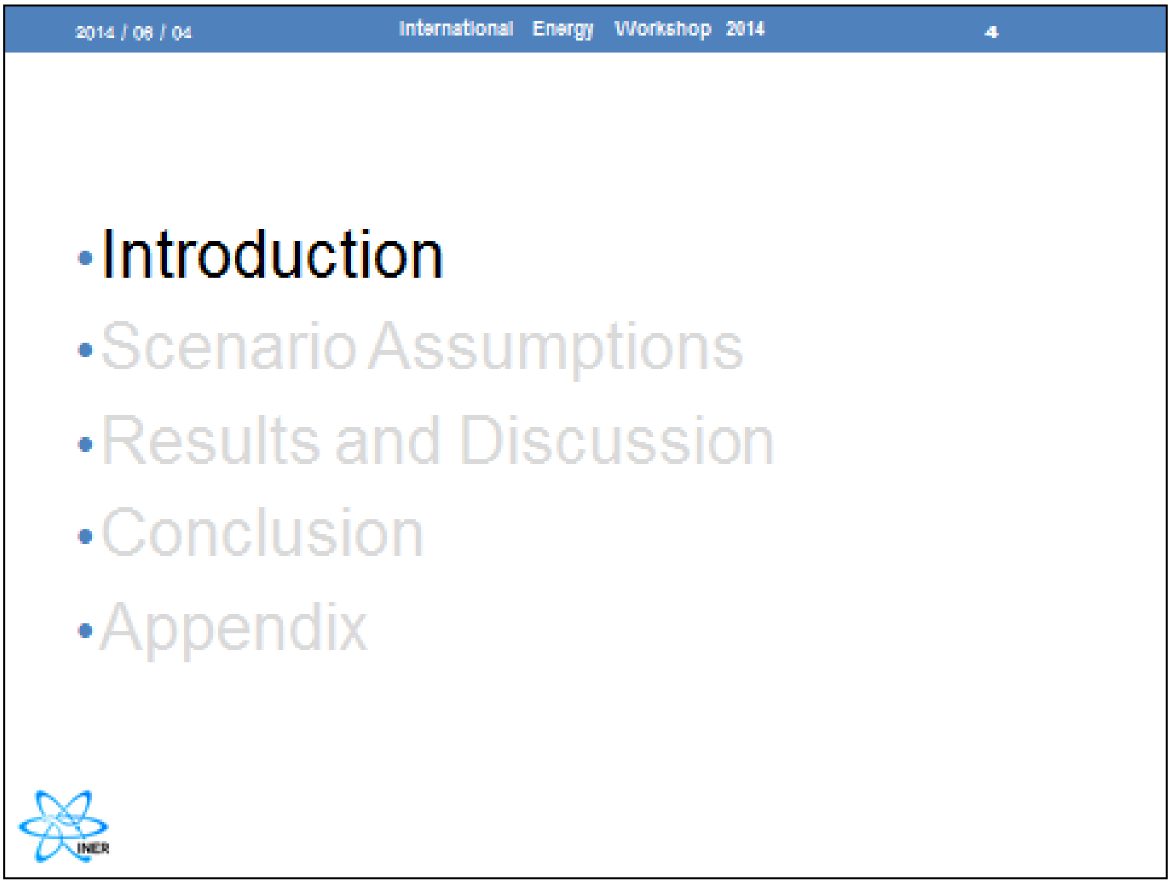
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- Taiwan has set ambitious CO_2 Reduction targets：
  - Emissions in 2025 → back to 2000 levels
  - Emissions in 2050 → back to 50% of 2000 levels
- CO_2 emissions in Taiwan：
  - 2012 → 248.7 Mt (55% from electricity sector)
- World Energy Outlook 2013：
  - Renewables help to abate world energy-related CO_2 emissions by 21% in 2020 and 25% in 2035.
- This research analyzed the electricity generation costs and CO_2 emissions in Taiwan during **2010 to 2050** by the MARKAL-ED model with different scenarios. The outcome can be provided to policy makers as references for renewable energy and carbon reduction planning.

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Policy Objectives of Renewables in Taiwan

2013 / 05 / 07

unit：MW	2012	2015	2020	2025	2030	2040	2050
Hydro Power	2,081	2,089	2,138	2,502	2,502	2,750	**3,000**
On-shore Wind	571	871	1,200	1,200	1,200	1,200	1,200
Off-shore Wind	0	15	600	1,800	3,000	5,200	**6,200**
Waste	803	848	925	1,369	1,369	1,560	1,766
Biogas	19	29	29	31	31	65	100
PV	222	747	1,622	3,052	3,100	4,000	**5,000**
Ocean Energy	0	1	30	200	600	1,800	**3,000**
Geothermal	0	4	66	150	200	420	650
H_2 and Fuel cells	0	7	60	200	500	750	1,000
Total	3,696	4,611	6,670	10,504	12,502	17,745	21,916

REF：Executive Yuan (2013)、Taiwan Power Company (2012)

BAU： 25.3% of total capacity
Zero Growth： 34.4%~39.9% of total capacity

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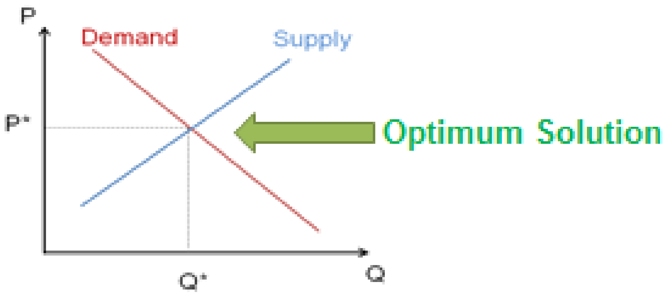
MARKAL-ED Model

- MARKet ALlocation - Elastic Demand : It is a linear programming tool supported by IEA-ETSAP (Energy Technology Systems Analysis Program).
- MARKAL provides a technology-rich basis for estimating energy dynamics over a period.
- The model will arrange appropriate technologies to satisfy the endogenous energy service demands under minimizing total cost (or maximizing net total surplus).



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Scenario Assumptions

- This research proposed six scenarios and simulated the electricity generation costs and CO_2 emissions of each scenario under **zero growth in electricity demand** and **non-CCS**.
- Electricity Demand Growth :
  - Before 2025: electricity demand less than 1.15 times of the 2010 level.
  - Electricity demand back to 2010 level between 2025 and 2050.
- Nuclear Power :
  - No life extension of existing plants & Nuke4 will not operate. **(N_0)**
  - No life extension of existing plants & Nuke4 will operate as scheduled. **(N_1)**
  - Life extension of existing plants & Nuke4 will operate as scheduled. **(N_2)**
- Renewables and other fuels :
  - Renewable capacities meet policy objectives & give priority to nuclear and gas-fired plants & the annual amount of LNG imports is limited. (R_1)
  - Renewable capacities keep in 2010 levels & new coal-fired plants is prohibited & the annual amount of LNG imports is unlimited. (R_2)

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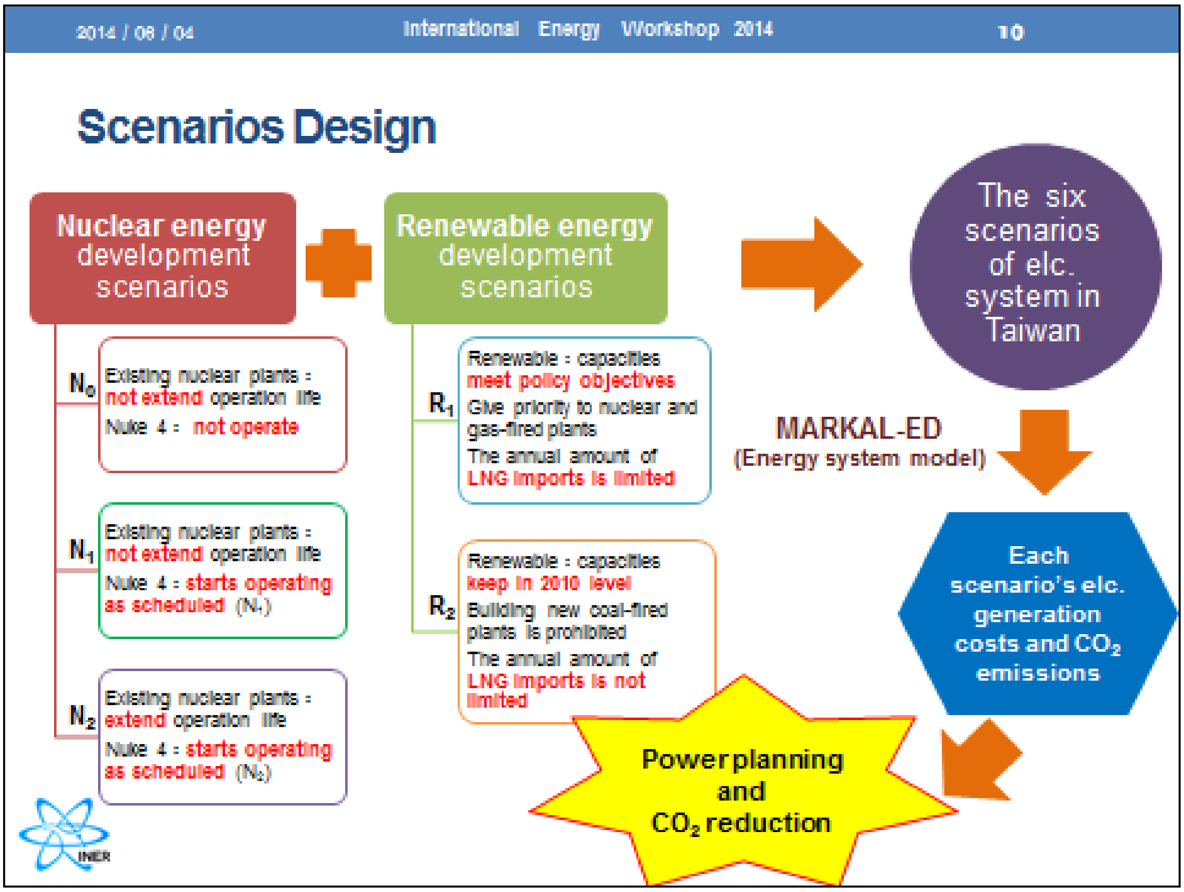

- Introduction
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  - Capacities of renewables meet policy objectives
  - Capacities of renewables maintained in 2010 levels
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- The 2010 historic data in Taiwan ：

Year 2010	
Net electricity generation (TWh)	233.4
Electricity generation cost (2010 NTD/kWh)	2.15
CO_2 emissions of electricity sector (Mt)	141

- CO_2 target：
  - CO_2 emissions in 2025 → back to 2000 levels.
    → 105 Mt (electricity sector)
  - CO_2 emissions in 2050 → back to 50% of 2000 levels.
    → 52.5 Mt (electricity sector)

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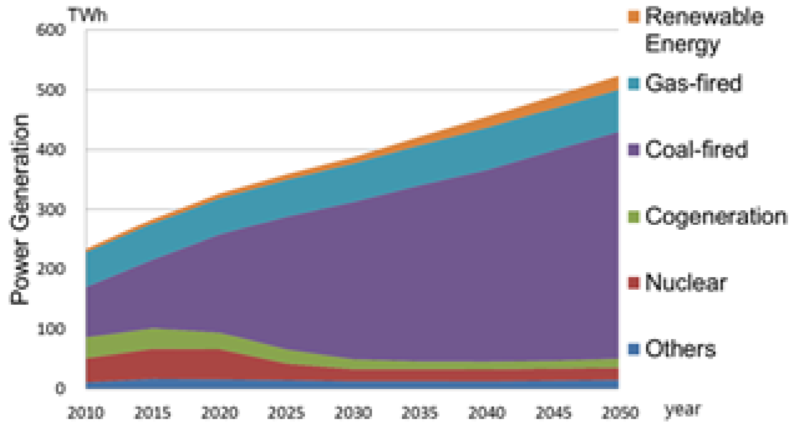
- Power generation mix of **BAU (business as usual)** :
  - 234 TWh (2010) to 525 TWh (2050)
  - Coal-fired power becomes the major source of electricity supply due to its lower cost.
  - Total CO_2 emissions : 157 Mt (2010) to 374 Mt (2050)



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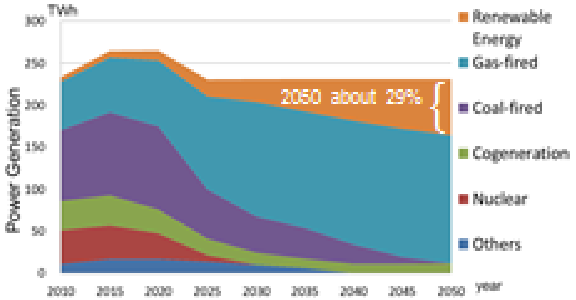
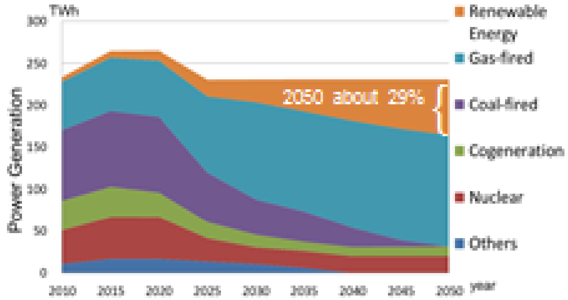
• Power generation mix ：



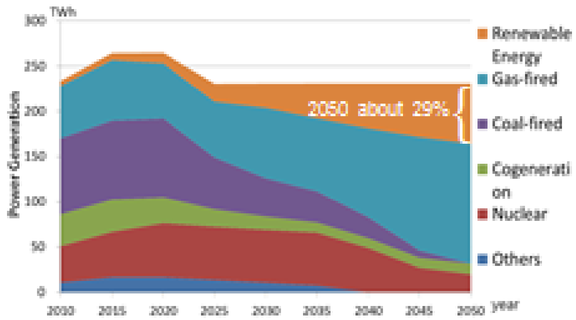
Scenario_N_0R_1



Scenario_N_1R_1

Scenario assumption：

1) Renewable capacities meet policy objectives.
2) Give priority to nuclear and gas-fired plants.
3) The annual amount of LNG imports is limited.



Scenario_N_2R_1

• Costs and emissions of different scenarios

(R_1) Renewables Capacities Meet Policy Objectives		Simulation results compared with 2010 historic data		Emissions reduction gap compared with targets	
		2025	2050	2025target (105Mt)	2050target (52.5Mt)
(N_0) No life extension of existing plants & Nuke4 will not operate	Costs	+41.9%	+76.3%	28	13.5
	Emissions	-5.5%	-52.3%		
(N_1) No life extension of existing plants & Nuke4 will operate as scheduled	Costs	+30.7%	+60.0%	22	8.5
	Emissions	-9.8%	-56.5%		
(N_2) Life extension of existing plants & Nuke4 will operate as scheduled	Costs	+14.0%	+59.0%	12	8.5
	Emissions	-16.8%	-56.7%		

Life extension and Nuke4 operation can reduce 28% of electricity generation cost and reduce 11% emissions in 2025.

There are still 8.5 to 28 Mt **emissions gap** even we maximize the exploitation of renewable energy and gas-fired plants.

- Although the renewables are beneficial to energy security, they are intermittent and unstable. The smart grid or storage facilities must be taken into account before raising the share of renewables in the system.

- Insights :
  - **mid-term (2025):**
    1) Electricity generation cost ↑ (renewables)
    2) Nuclear plants for transition to high share renewables
  - **Long-term (2050):**
    1) Further enlarging the renewable policy objectives
    2) Developing more CCS power plants or nuclear plants
    3) Reducing total electricity demand

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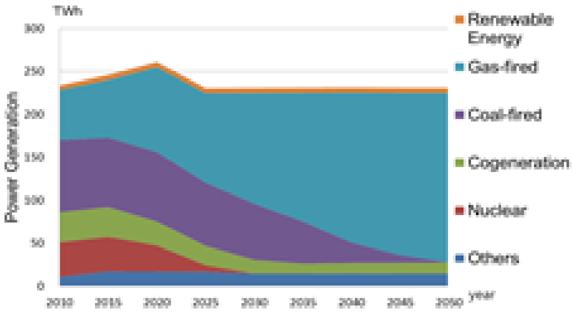
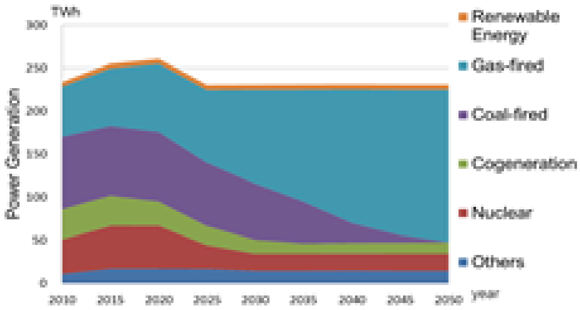
• Power generation mix ：



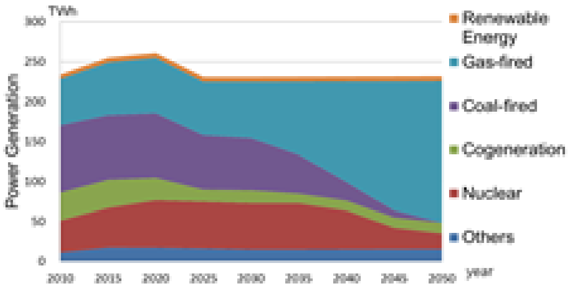
Scenario_N_0R_2



Scenario_N_1R_2

Scenario assumption：

1) Renewable capacities keep in 2010 levels.
2) New coal-fired plants is prohibited.
3) The annual amount of LNG imports is unlimited.



Scenario_N_2R_2

• Costs and emissions of different scenarios ：

(R_2) Development of Renewable Energy less than expected, the capacities maintained as in 2010		Simulation results compared with 2010 historic data		Emissions reduction gap compared with targets	
		2025	2050	2025target(105Mt)	2050target(52.5Mt)
(N_0) No life extension of existing plants & Nuke4 will not operate	Generation Costs	+20.9%	+74.4%	49	43.5
	Emissions	+9.2%	-31.9%		
(N_1) No extension of existing plants & Nuke4 will operate as scheduled	Generation Costs	+11.6%	+62.8%	41	36.5
	Emission	+3.5%	-36.9%		
(N_2) Extension of existing plants & Nuke4 will operate as scheduled	Generation Costs	+0%	+62.3%	21	36.5
	Emissions	-10.6%	-36.9%		
Annual LNG import amount (Mt/year)		15	**25**	-	-

YEAR	2012	2018	2030
Planning of LNG Import amount (Mt/yr)	13.5	14.75	20

REF：CPC Corporation Taiwan

R_2N_2 is the only scenario which can reduce emissions

Even extend the usage of LNG, the target cannot be achieved (21- 49 Mt gaps exist)

- Renewable energy is one of the indispensable options of reducing CO_2 emissions in power system.
- Excessive usage of nature gas will face some problems, such as limitation of national reserves, high electricity generation cost, and deteriorating energy security etc.
- Both energy supply security and electricity cost must be considered when developing a low-carbon energy system.

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- Generation costs and CO_2 emissions of all scenarios :

	2025		2050	
	Generation Cost (2010 NTD/kWh)	Emissions compared with 2010 historic data (%)	Generation Cost (2010 NTD/kwh)	Emission level compared with 2010 levels (%)
N_0R_1	3.05	-5.5	3.79	-52.3
N_1R_1	2.81	-9.8	3.44	-56.5
N_2R_1	2.45	-16.8	3.42	-56.7
N_0R_2	2.60	+9.2	3.75	-31.9
N_1R_2	2.40	+3.5	3.50	-36.9
N_2R_2	2.15	-10.6	3.49	-36.9

[Mid-term] Generation cost will increase **14%** due to the high cost of renewable energy, but emissions could only be reduced by **6.2%. Cost-effectiveness of emissions reduction is not obvious.**

[Long-term] Generation costs of renewables is approximate to those of fossil fuels. The extensive usage of renewables could reduce emissions by 20%. **Cost-effectiveness of emissions reduction is obvious.**

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- The emissions reduction gap would still exist although the electricity system in Taiwan satisfies the assumptions including：
  - Zero growth in electricity demand
  - Life extension of existing nuclear power plants and operating Nuke4 as scheduled
  - Maximizing the exploitation of renewable energy and gas-fired plants
- For the pursuit of economic and GDP growth, reducing energy use requires increasing the added-value of industries or adjusting industry structure.
  - Industry upgrading has a ceiling.
  - If the industry structure transits from manufacturing-based to service-based, it will be limited by the size of the domestic market in Taiwan.

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- The challenges of renewable energy：
  - Cost
  - Potential
  - Infrastructure (smart grid, storage facilities…etc.)
- The challenges of other low-carbon technologies：
  - Nuclear → safety and waste disposal
  - Nature Gas → high import cost and energy security
  - CCS → policy uncertainty and social acceptance

- The ambitious CO_2 targets could hardly be achieved based on the scenario assumptions such as zero growth in electricity demand. On the other hand, ambitious targets might cause unaffordable economic impact. The government might consider adjusting the targets. Otherwise, to reach the ambitious targets, more CCS or nuclear plants would be required.

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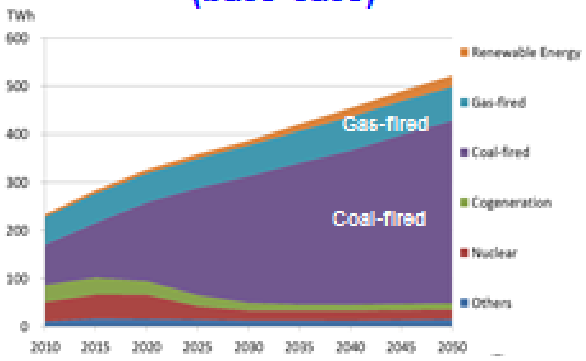
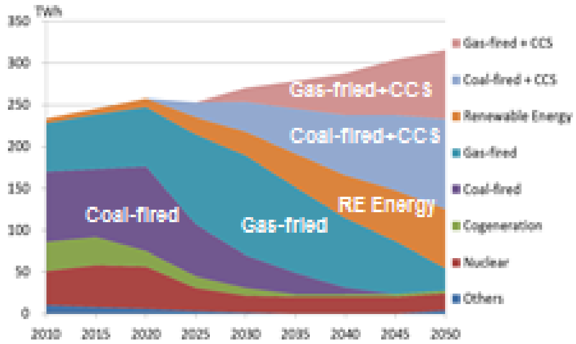
CCS Scenario Analysis of Electricity Supply in Taiwan

- **Base Case**：In order to satisfy the electricity consumption growth and minimum total cost of energy system, the proportion of coal-fired plants with lower investment cost would be highly increased.
- **CCS Case**：In order to **meet CO_2 emissions target**, the ratio of fossil fuel power plants would be decreased, and the low-carbon technologies such as CCS and Renewable energy would be promoted in the future.

Electricity Generation in 2010-2050 (base case)



Electricity Generation in 2010-2050 (CCS case)



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Acknowledgement

- We appreciate Dr. Yao-Jen Chang and Mr. Wei-Hsiang Teng for preparing the briefing materials in this research.

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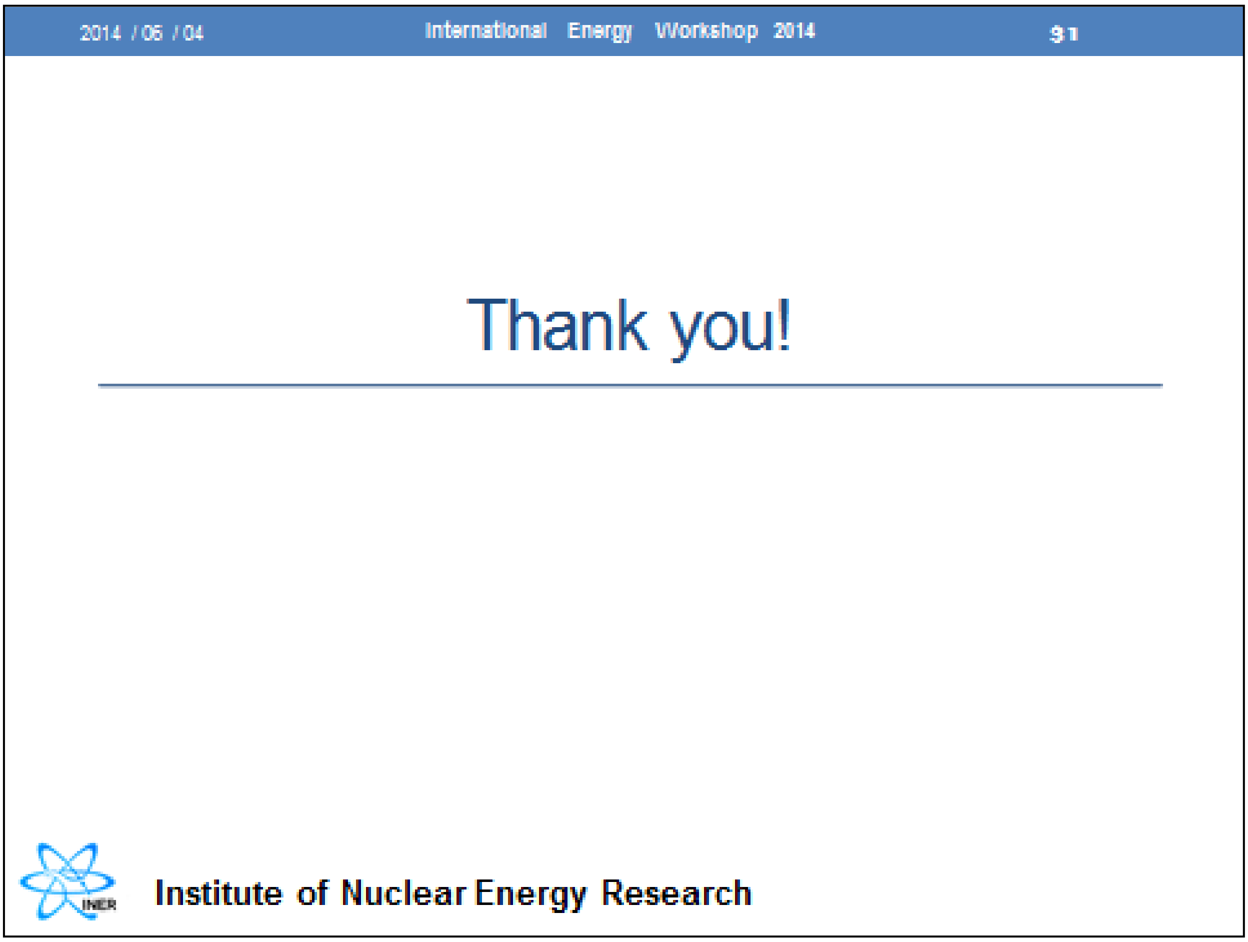
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附件二、會議論文摘要與簡告投影片(孫廷瑞)

Estimation of price elasticities for MARKAL-ED model-Evidence from Taiwan

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Abstract

Price elasticity assumptions of energy service demand in the MARKAL-ED model are crucial. However, the researches in the past only revealed the setting of elasticities, and didn't explain the source of elasticities and how to estimate. In the absence of a consistent method, this study introduces an econometric approach to obtain the price elasticity of energy service demand based on the statistic data of energy consumption. The reasonable parameters are helpful for the localization of MARKAL-ED model; furthermore, it makes the policy evaluation more realistic.

Keywords: price elasticity, energy service demand, energy consumption, time-series model.

1. Introduction

MARKAL (MARKet ALlocation) model is an energy system optimization model, it calculates the least cost set of technologies over time to satisfy the specified demands, subject to various user-defined constraints. However, energy service demands are exogenous constant in Standard MARKAL model, so the price of energy service demand does not influence the energy service demand. The demand curve of energy service is vertical in Standard MARKAL model.(see figure 1.1). Therefore, when the price of energy service changes due to the energy supply variation, the equilibrium quantities are still changeless. In MARKAL-ED (Elastic Demand) Model, the different energy service demand can set the different price elasticities, so it can appropriately reflect the change of energy service demand in response to its price. But in most of previous studies, they only set a constant value, rather than clearly explain how to estimate the value, such as Anandarajah et al. (2009), William and Neil (2010).

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INER Institute of Nuclear Energy Research

Summary

- Price elasticity assumptions of energy service demand in the MARKAL-ED model are crucial.
- The researches in the past only revealed the setting of elasticities without explaining the source of elasticities and how to estimate.
- Purpose：This study introduces an econometric approach to obtain the price elasticity of energy service demand based on the local statistic data of energy consumption.
- Result：The reasonable parameters are helpful for the localization of MARKAL-ED model; furthermore, it makes the policy evaluation more realistic.

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Outline

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- The Property of MARKAL-ED model
- The principle of setting the price elasticity
- Purpose and Contribution

Method and Data

- Method of estimating elasticity
- How to define the demand and price of energy service?
- Empirical Variable

Empirical Results and Discussion

- residential and service (building) sector
- transport sector
- industry and other sector
- The local price elasticities analysis of MARKAL-ED model

Conclusion

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Introduction(1/3)
The Property of MARKAL-ED model

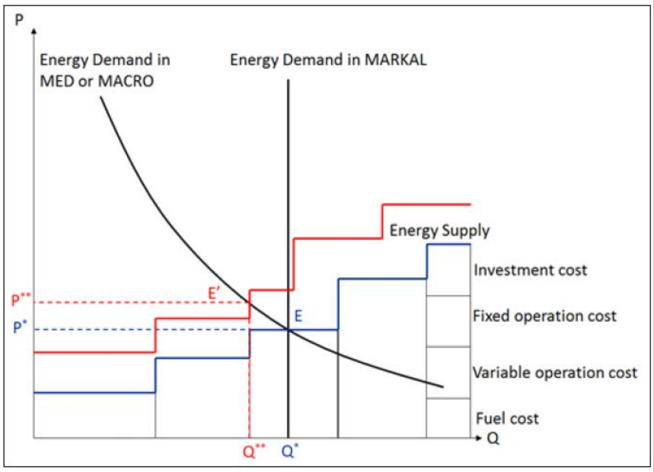
- MARKAL (MARKet ALlocation) model is an energy system optimization model, it calculates the least cost set of technologies over time to satisfy the specified demands, subject to various user-defined constraints.

Standard MARKAL Model

energy service demands are exogenous constant

MARKAL-ED Model

set the different price elasticities to appropriately reflect the changes of demand



Source：Chen et al., 2012

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Introduction(2/3)
The principle of setting the price elasticity

Price elasticity assumptions of energy service demand in the MARKAL-ED model are crucial

↓

Most of previous studies only set a constant value, rather than clearly explain how to estimate the value, such as Anandarajah et al. (2009), William and Neil (2010).

- The principle of the price elasticity setting requires to consider the difference among the region, country, and the items of energy service.

→ If we don't review the parameters in depth, the MARKAL-ED model is unable to fully utilize its advantages.

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Introduction(3/3)
Purpose and Contribution

local statistic data → econometric approach → Taiwan's Price elasticity

Purpose

- Try to collect the related data of energy service demand
- apply econometrics method to estimate the price elasticities of various energy service demands in Taiwan

Contribution

- The local price elasticities of energy service demand reflect the price effect of sectors for MARKAL-ED model
- The methods used in this study can be applied to other countries as well.

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Method and Data(1/4)
Method of estimating elasticity

- This research applies four econometric models to estimate the price elasticits (see Model A to D)

① $Q_t = c + a_0Y_t + b_0P_t$ (Model A)

② $Q_t = c + a_0Y_t + b_0P_t + F(Z_t)$ (Model B)

③ $Q_t = c + a_0Y_t + b_0P_t + F(Z_t) + \lambda Q_{t-1}$ (Model C)

④ $Q_t = c + a_0Y_t + b_0P_t + F(Z_t) + \Sigma a_iY_{t-l} + \Sigma\, b_jP_{t-j}$ (Model D)

We use AIC as a means for model selections, where c, a_0, b_0, a_i, b_j, λ are the estimated coefficient. After all the variable taking the natural logarithm to estimate, the estimated coefficients can explain to elasticities.

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Method and Data(2/4)
How to define the demand and price of energy service?

The demand of energy service

- Applying to definition of Haas et al.(2008), regarded as "indirect energy service demand" , and find a representative product.
- If there is not any representative product, we use the production index.
- If there are neither a representative product nor production index, we only use the end-use energy consumption.

The price of energy service

- Cost structure of industry
- In the absence of cost data, we regard energy price as the price of energy service demand ,and we consider the largest amount of energy.

◆ The elasticity based on energy consumption includes two type of energy saving effects (1) reduction from end-user ; (2) technical progress(facilities update) :

① Deducting the effect of technical progress from long-term price elasticity of energy consumption.

② short-term price elasticity (without technology improvement)

Method and Data(3/4)
Empirical Variable

Sector	Demand/industry	Quantity (Q)	Price (P)	Control variable(Y,Z)
Residential	Combined Residential	Per Capita Electricity Consumption	Average electricity price for Light	Real Disposable Income, CDD
Services	Combined Services	Per Capita Electricity Consumption	Average electricity price for Light	Real Disposable Income, CDD
Transport	Car	Passenger-Kms	Price of Unleaded Gasoline #95	N/A
	Bus	Passenger-Kms	Price of Premium Diesel	Real Disposable Income, population
	HGV	Ton-Kms	Price of Premium Diesel	N/A
	LGV	Ton-Kms	Price of Premium Diesel	N/A
	Rail	Passenger-Kms	Average electricity price for industry	Real Disposable Income, population
	2-wheeler	Passenger-Kms	Price of Unleaded Gasoline #95	Real Disposable Income, population, Car Passenger-Kms
	Air	Passenger-Kms	Price of Jet Fuel	Real Disposable Income, population, Rail Passenger-Kms
	Marine/shipping	Ton-Kms	Price of Premium Diesel Oil	Real Disposable Income

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Method and Data(4/4)
Empirical Variable (continues)

Sector	Demand/industry	Quantity (Q)	Price (P)	Control variable(Y,Z)
Industry	Iron and steel	Production of Steel Bloom and Billet	Price of imported coal (Coking Coal)	Real GDP for Iron and steel, Trend
	Non-Ferrous metals/Cement	Production of Cement	Price of imported coal (Steam Coal)	Real GDP for Non-Ferrous metals
	Pulp-paper	Production of Paper and Paper Board	Price of imported coal (Steam Coal)	Real GDP for Pulp-paper, Trend
	Chemical/ Chemical-material	Production of Ethylene	Price of imported Crude Oil	Real GDP for Chemical, Trend
	Electronics and Electrics(E&E)	Production index of E&E	Average electricity price for industry	Real GDP for Electronics and Electrics, Trend
	Other industry for electricity	Electricity consumption for other industry	Average electricity price for industry	Real GDP for others industry technical efficiency
	Other industry for heating	Heating consumption for other industry	Price of imported Crude Oil	Real GDP for others industry technical efficiency
Others	Non-energy sector	Energy consumption for Non-energy	Price of imported Crude Oil	Real GDP for industry、technical efficiency
	Combined agriculture	Production index of agriculture	O&M cost	Real GDP for agriculture

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Empirical Results and Discussion(1/5)
Residential and Service (building) sector

- **Results for Combined Residential and Service sector：**

① Based on electricity consumption. (electricity is major source of energy-use)

② Residential Sector：Short-term -0.324；Long-term -0.777

③ Service Sector：Short-term -0.417；Long-term -1.05

- **Challenges：**

① How to estimate the price elasticity of energy service demand based on the price elasticity of energy consumption demand?

② How to estimate the price elasticity of energy service demand by item of demand based on the combined price elasticity of energy service demand ?

◆ Short-run elasticity can be regarded as the price elasticity of energy service demand (without technology improvement)

◆ Assumption of elasticity for sub-item of energy service demand can refer to the literatures of technology economic optimal models, including UK MARKAL and Global TIMES models.

Empirical Results and Discussion(2/5)
Residential and Service (building) sector

- For residential sector, price elasticities for energy services suggested in this study are ranged from -0.28 to -0.39 based on both empirical finding and literature survey, which is close to the result in Lin's (2012) residential survey report for Taiwan.

- For commercial sector, price elasticities are little larger than that in the UK MARKAL model, which range from -0.38 to -0.42. Our findings is consistent with the logic of Kesicki and Anandarajah's (2011) study, they suggest larger elasticities for less developed countries.

Sector	Demand/Industry	Our study		UCL (2010)	UKERC (2009)	Suggestion values
		Short-run	Long-run			
Residential	Lighting	-0.33	-0.51	-0.31	-0.31	-0.33
	Space cooling(Heating)	-0.39	-0.71	-0.31	-0.31	-0.39
	Refrigeration	-0.30	-0.53	-0.31	-0.31	-0.30
	Cooking	-0.28	-0.45	-0.33	N/A	-0.28
	Water heating	-0.39	-0.53	-0.34	-0.34	-0.39
	Others	-0.12	-0.12	-0.31	-0.31	-0.12
Service	Space cooling(Heating)	-0.38	-0.38	-0.32	-0.32	-0.38
	Lighting	-0.42	-0.55	-0.32	-0.32	-0.42
	Others	-0.42	-0.65	-0.32	-0.32	-0.42

Empirical Results and Discussion(3/5)

Transport sector

- Most elasticities estimated in our study are smaller than the setting value of UK MARKAL.
- The estimated elasticity for motorcycle is 0.09, it reflects the unique fact that the residents in Taiwan are heavy reliance on motorcycle in their daily life.
- The estimated elasticities of cars, HGV and LGV are smaller in Taiwan, due to the lack of transport alternatives and inherent habits.

Sector	Demand/Industry	Our study		UCL (2010)	UKERC (2009)	Suggestion values
		Short-run	Long-run			
transport	Car	-0.01	-0.34	-0.54	-0.54	-0.34
	Bus	-0.0.5	-0.18	-0.38	-0.38	-0.18
	HGV	-0.31	-0.52	-0.61	-0.61	-0.52
	LGV	-0.19	-0.32	-0.61	-0.61	-0.32
	Rail	-0.04	-0.45	-0.24	-0.24	-0.45
	2-wheeler	-0.04	0.09	-0.41	-0.41	0.09
	Air	0.51	-0.36	-0.38	-0.38	-0.36
	Marine/shipping	-0.42	-1.29	-0.18	-0.18	-0.42

Empirical Results and Discussion(4/5)

Industry and Other sector

- Due to the price elasticities of industry and other sectors are inelastic (between -0.14~-0.38), we can explain that the role of energy service in industry and other sectors is quite significance.

U.K. (Domestic-demand oriented economic)
→ Export value ratio of GDP is 32% in 2011
→ Replace domestic demand by importing.(higher elast.)

Taiwan (Export-orinented economic)
→ Export value ratio of GDP is 74.5% in 2011
→ Consider the transport cost and profit.(lower elas.)

Sector	Demand/Industry	Our study		UCL (2010)	UKERC (2009)	Suggestion values
		Short-run	Long-run			
Industry	Iron and Steel	0	-0.14	-0.35	-0.44	-0.14
	Non-Ferrous metals/cement	-0.11	-0.15	-0.35	-0.44	-0.15
	Chemical-material	-0.20	-0.38	-0.50	-0.49	-0.38
	Pulp-paper	-0.21	-0.22	-0.15	-0.37	-0.22
	Electronics and Electrics	0	-0.14			-0.14
	Other industry for electricity	0	-0.15	-0.15	-0.32	-0.15
	Other industry for heating	-0.19	-0.24			-0.24
Others	Non-energy sector	-0.25	-0.25	-0.15	N/A	-0.25
	Combined agriculture	-0.12	-0.62	-0.32	-0.32	-0.12

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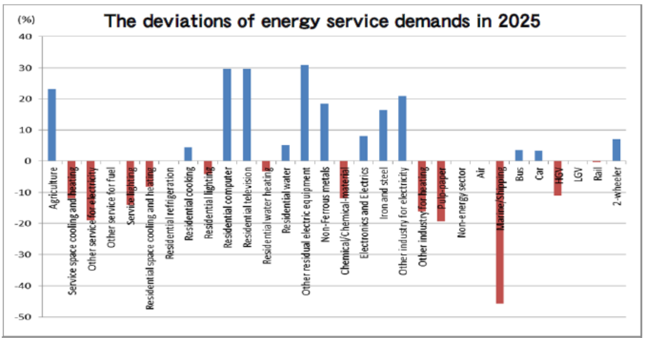
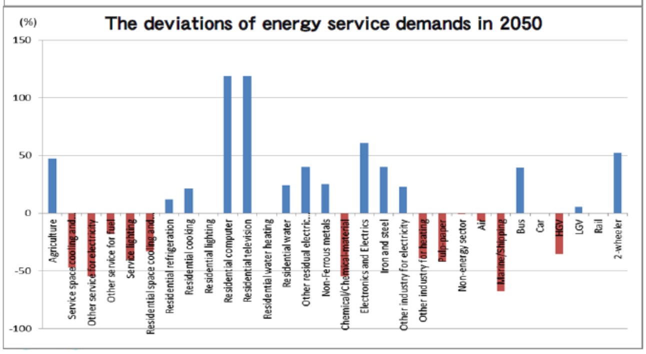
Empirical Results and Discussion(5/5)

The local price elasticities analysis of MARKAL-ED model





- ◆ The local price elasticities of energy service demands are applied in MARKAL-ED model, and compare the reference elasticity.
  - ① Reference elasticity : the price elasticity of energy service all set -0.3.
  - ② Local elasticity : the price elasticity of energy service is based on this research.

- ◆ Results of local price elasticities analysis : (parts)
  - ① The elasticity for other appliances of residential sector (-0.12), Iron and steel(-0.14), Non-Ferrous metals(-0.15), are **smaller** than reference elasticity.
  - ② The elasticity for all of the service sector (-0.38~-0.42) are **bigger** than reference elasticity.

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Conclusion

- The price elasticity of energy service demand is a set of critical parameters in MARKAL-ED model.
- Due to variations of national geographic, socio-economic backgrounds, the principle of the price elasticity setting requires to consider the difference between the region, countries, and the items of various energy service demands.

If the price elasticity was overvalued (higher than reality)

- It may overestimate the effect of government price policies (eg. energy tax policy), and it would be too optimistic to look the reduction from the demand side.

if the price elasticity was undervalued (lower than reality)

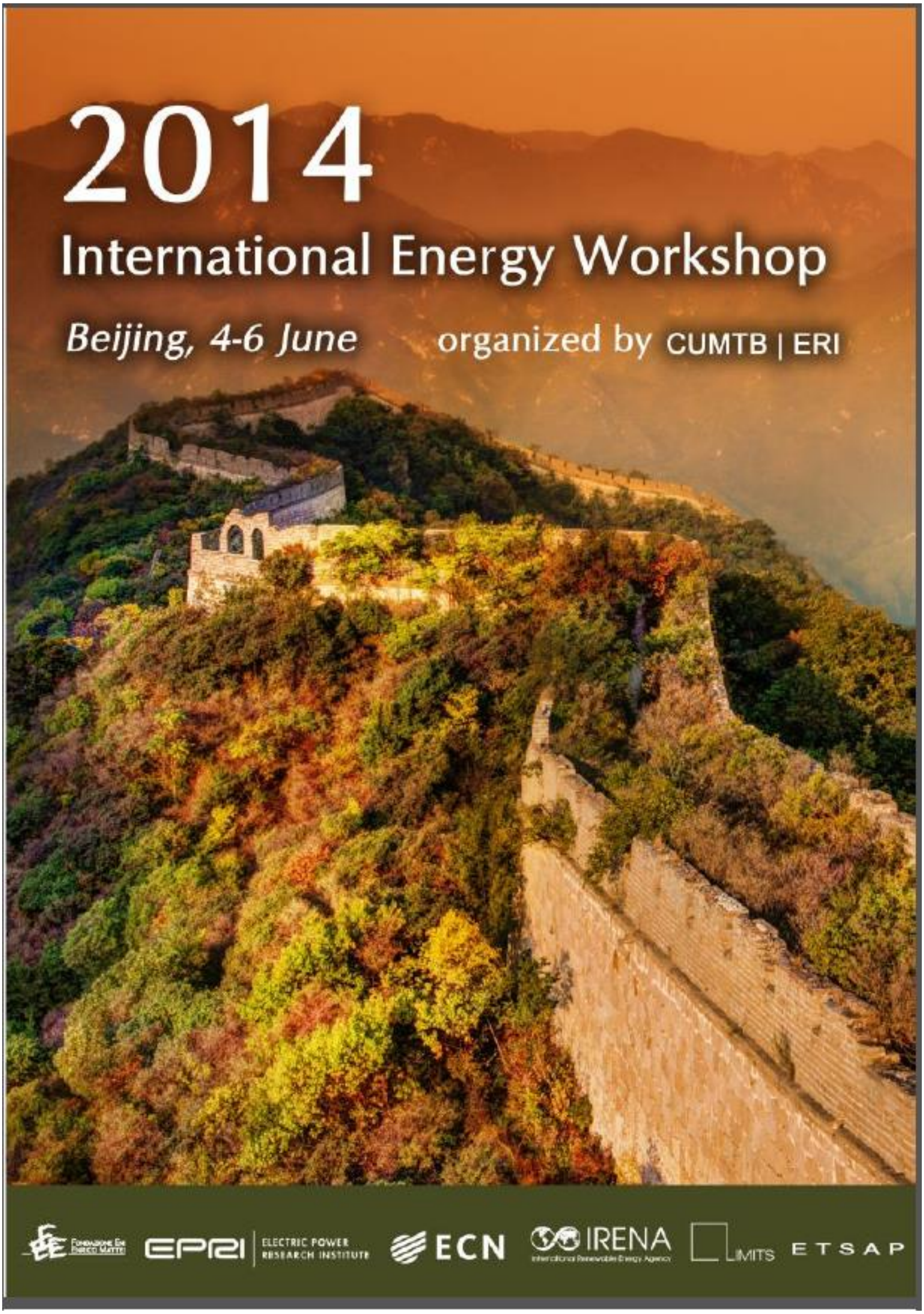
- It may underestimate the energy saving contribution of energy demand side, and energy policy will be oriented toward supply-side, such as CCS, renewables.

This paper applies the **local energy statistic data** to estimate the price elasticities of energy service demand for different sectors in Taiwan. The reasonable parameters are helpful for the localization of MARKAL-ED model; furthermore, it makes the policy evaluation more realistic.

Thank you for your attention!

Institute of Nuclear Energy Research

附件三、研討會手冊與議程



Photograph: Trey Ratcliff

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Welcome Letter

Dear colleagues,

I am so happy that the International Energy Workshop (IEW) 2014 comes to Beijing, it is the first time for IEW to visit China. It is a great pleasure to welcome you to the IEW 2014 held in the wonderful city of Beijing. IEW is an outstanding place for academic knowledge sharing, I believe we will learn a lot from this IEW2014. But please also remember to see Beijing, to get some idea for a rapid developing city. This is also a good opportunity to get to know about China, even though many people say Beijing is not typical China's city. Rapid change here in China really big challenge for energy and climate change modeling for China.

For this IEW 2014, the selected papers are of outstanding quality, which allowed us to put together an attractive programme including five parallel sessions and three plenary sessions with excellent keynote speakers. The parallel and plenary sessions cover a wide range of topics, including the challenges related to a low-carbon transition, the growing energy needs in emerging economies and understanding current and future game changers in the energy sector. In addition, one side event and one special session are part of the IEW 2014: the OSeMOSYS workshop (during lunch on 5 June) and the IRENA workshop (evening of 5 June).

On Wednesday evening, I kindly invite you to participate in the welcome dinner in the hotel.

This event would not have been possible without our sponsors: the Electric Power Research Institute (EPRI), the International Renewable Energy Association (IRENA), the Energy Technology Systems Analysis Programme of the IEA (ETSAP) and the LIMITS project, China University of Mining Technology, Beijing, and Energy Research Institute. I would like to thank all of them for their contribution.

Thanks also go to the organising committee and the co-directors for their support during the organisation of the event.

Finally, I wish you a pleasant stay in Beijing and enriching days at the International Energy Workshop 2014. It is your participation that is essential for the quality and relevance of this event.

General Information

Registration and Information Desk

The Registration and Information Desk will be open in the check in place of the Xijiao Hotel.

Wednesday, June 4 8:30am – 5:00pm
Thursday, June 5 8:30am – 5:00pm
Friday, June 6 8:30am – 5:00pm

If you have any questions, please feel free to visit the Registration and Information Desk

Participant Identification

All participants are required to wear the IEW 2014 representative cards at all times. Attendees with the card will have access to all plenary sessions, parallel sessions, Welcome Dinner on Wednesday night as well as the coffee breaks and lunches.

Internet Access

Xijiao Hotel provides wireless Internet connection. This service is available for all registered participants during the IEW 2014. The name of wireless and the access code are given as following:

The Ginkgo hall and the Zhongbei hall: HYZBT zb123456
The Jinyuan hall: jinyuanting no password
The Huiyuan hall: Huiyuan no password
The NO.3 meeting room:HY03 03123456
The NO.5 meeting room:HY05 05123456
The NO.6 meeting room:HY06 06123456
The NO.8 meeting room and the NO.9 meeting room:HY08 08123456

However, no computer for public use will be available at the conference premises.

Lunches and Coffee Breaks

Lunch will be served at the restaurant "Shang Yuan", on the Second floor of Building No.5 of the Xijiao Hotel. Please see the venue plan on the inside of the back cover for the restaurant location. Coffee will be served on the door of conference room. Please, see the venue plan on the inside of the back cover for the exact location. There will be two coffee breaks in a day; one during the plenary session, the other between the parallel sessions.

Welcome Dinner

The reception dinner will be held at the restaurant "Xiyuan Seafood Restaurant", on the **third** floor on Wednesday, June 4, from 7:00 pm to 9:00 pm.

Important Websites and TelephoneNumbers

Xijiao Hotel: (8610)-62322288
SOS Medicines: 120
Police: 110
About IEW2014
http://www.ipac-model.org/
About Logistic Info.
http://www.ipac-model.org/iew2014/E_Practicalinformation.htm

General Information

IEA-ETSAP

Back to back with IEW 2014, the next ETSAP meeting will be held in Beijing, from Monday 2nd June to Tuesday 3rd June 2014. The regular ETSAP workshop will be held on Monday 2nd June, the ETSP-TIAM meeting on Tuesday morning 3rd June, and the Executive Committee meeting on Tuesday afternoon 3rd June Register here. The agenda will be available in due time.

- Wednesday to Friday, 28- 30 May, the TIMES trainings
- Monday, 2 June, the regular ETSAP workshop
- Tuesday morning, 3 June, the ETSAP-TIAM model meeting
- Tuesday afternoon, 3 June, the Executive Committee meeting

More details are at www.iea-etsap.org.

OSeMOSYS Workshop

The Open Source Energy Modelling System (OSeMOSYS) is a long-term system optimisation model developed as a collaborative effort. Since its inception a couple of years back, it has been featured in various publications and has become the backbone of some major energy modelling endeavors for leading entities such as the United Nations Department of Economic and Social Affairs (UNDESA) and the World Bank.

This side event will focus on the recent developments in the OSeMOSYS community during the year 2013-2014. Amongst others, it will showcase the newly developed open, freely available and adjustable interface "OSINDA". For further background, please refer to www.osemosys.org.

IRENA Workshop

Within IRENA's mandate to promote accelerated use of renewable energy for sustainable development, one of the 6 priority areas defined by IRENA's member states and thus reflected in IRENA's current work program is 'mainstreaming renewable energy options and strategies in energy plans'.

In order to achieve this goal, IRENA is tasked to work with countries and regions to help reflect the real potential of renewable energy technologies in long-term regional and national energy master plans. In particular, there is a strong request from IRENA member states to help them enhance the quality of power sector planning through the improved representation of renewables in existing planning tools, and by highlighting renewable energy integration challenges and opportunities. More and more experience is gained in the context of developed countries, while different types of planning challenges may be expected for developing countries, where the power system needs to expand possibly by a factor of 2-5 in the coming decades.

As a response, during the coming months IRENA will conduct a comprehensive assessment of current planning methodologies with respect to the variable renewable technologies in the context of mid-term (20-30 years) planning in developing countries. The objective of the assessment is to review the extent and the ways in which existing modelling methodologies address the short-term operational characteristics of VRE (constraints and possibly benefits), and the relevance/irrelevance of particular characteristics of VRE to the mid-term planning and policy making. Against this background, IRENA will establish an expert committee to help guide the assessment process.

2014 INTERNATIONAL ENERGY WORKSHOP
Program
the programme is still updating on the page of
http://www.ipac-model.org/iew2014/E_Programme.htm

June 4-6, 2014 Beijing

Opening Session: Transition toward low carbon future
9:30 am - 12:30 pm, Wednesday, June 4, 2014
Chair: Zwaan, Bob. van der
Logistic issues: Jiang Kejun
Open Remark: Jiang Yaodong, Vice President of CUMTB
Elmar Kriegler, IPCC finding and transition pathways
H-Holger Rogner, perspective on energy and climate challenges in Asia

Plenary Session 2 Energy and development
9:30 am - 11:30 am, Thursday, June 5, 2014
Chair: Massimo Tavoni
RAO Shilpa, IIASA, The Global CleanGlobal Clean Air Challenge: Integrating Approaches for Air Pollution Control
Chen Wenying, Tsinghua University, Integrated Energy Environment Modeling for future China

Panel discussion
11:30 – 12:30, Thursday, June 5, 2014
Chair: Massimo Tavoni
Zwaan, Bob. van der, Geoffrey Blanford, Jiang Kejun

Plenary Session 3: Assessing economies growing energy needs and CO2 emission: China and the World
9:30 am - 12:30 pm, Friday, June 6, 2014
Chair: Jiang Kejun
Aart de Zeeuw, Climate Tipping and Economic Growth: Precautionary Saving and the Social Cost of Carbon
Wang Zheng, Chinese Academy of Science, An climate change economical IAM based on the world economy
Cao Jing, Tsinghua University, Carbon Tax and Air Pollution Control in China

ParallelSession 1
1:45 pm - 3:30 pm, Wednesday

A1. Energy System, the Fifth Meeting Room
Chair: Xu Xiangyang

Lorenza Campagnolo, FondazioneEni Enrico Mattei – Feem, DISTRIBUTIONAL IMPACT OF REDUCING FOSSIL FUEL SUBSIDIES IN INDONESIA

Jan Steckel, PIK, MCC, TU Berlin, Evidence for a renaissance of coal

Hui-ChihChai, Associate Engineer, Nonlinear cointegration in Asia LNG market and its policy implications

Ting-Rui Sun. Institute of Nuclear Energy Research， Estimation of price elasticities for MARKAL-ED model-Evidence from Taiwan

B1. Emission Trading Scheme, the Sixth Meeting Room
Chair: Frank Jotzo

Hongbo Duan, University of Chinese Academy of Sciences, What's impact of the allocation of carbon permits on the cost-effectiveness of carbon trading market?

Claudia Kettner, Austrian Institute of Economic Research (WIFO), The EU Emission Trading

Scheme: Is there a need for price stabilisation?

Jie Wu, Institute of Policy and Management, Chinese Academy of Science, Economic Effects of Different Quota Allocation in Carbon Trading of China

C1. Energy and Climate Modelling 1, Huiyuan Hall
Chair: Johannes Emmerling

Nico Bauer, PIK, Climate change stabilization and the energy-land nexus

Paul Burke, Australian National University, China's coal demand is becoming more price elastic

Mischke Peggy, Department of Management Engineering, Energy Systems Analysis Division, Technical University of Denmark, Modelling tools to evaluate China's future energy system: a review of the Chinese perspective

Rao Shilpa, IIASA, A Multi-model Comparison Of The Co-benefits Of Climate Policies For Air Pollution

D1. Renewables and Electricity 1, Jinyuan Hall
Chair: Welsch Manuel

Geoffrey Blanford, Ifo Institute, Modeling Decreasing Returns to Renewable Energy

Leduc Sylvain, IIASA, BIOENERGY PRODUCTION AND ECOSYSTEM SERVICES CONSERVATION IN THE ALPS

P.R.Shukla, Indian insitute of Management, Ahmedabad, Modelling solar and bioenergy dynamics in low carbon scenarios in India

Johanna Cludius, University of New South Wales, Distributional Effects of the Australian Renewable Energy Target (RET) through Wholesale and Retail Electricity Price Impacts

E1 Economics of Renewable Energy Technologies, the Eighth and Ninth Meeting Room
Chair: Iain MacGill

Gregory Nemet University of Wisconsin, Characterizing the effects of policy instruments on the future costs of carbon capture

Bruno Merven, Energy Research Centre, University of Cape Town, Economy wide Implications of Policy and Uncertainty in the Power Sector of South Africa: A Linked Modeling Approach

Alvaro Calzadilla, Kiel Institute for the World Economy, Desert Power 2050: Regional and sectoral impacts of renewable electricity production in Europe, the Middle East and North Africa

Ahlgren Erik, Chalmers University of Technology, Future bioenergy scenarios under carbon constraints - A model analysis for Sweden

ParallelSession2
4:00 pm - 6:00 pm, Wednesday
A2. Uncertainty, the Fifth Meeting Room

Chair: Alvaro Calzadilla

Laurent Drouet, FondazioneEni Enrico Mattei, Carbon budgets for different decision making criteria under uncertainty

Giacomo Marangoni, Fondazione Eni Enrico Mattei / Politecnico di Milano / Centro Euro-Mediterraneo sui Cambiamenti Climatici, Optimal Clean Energy R&D Investments Under Uncertainty: an Approximate Dynamic Programming Approach

Steve Pye, University College London, The uncertain but critical role of demand reduction in meeting long-term energy decarbonisation targets

B2. Carbon Pricing/Carbon Tariff, the, the Sixth Meeting Room
Chair: Claudia Kettner

Frank Jotzo, Australian National University, Carbon pricing in China: catalyst for market reform in the energy sector?

Mark Wolfgang Sommer， WIFO，Long-term Climate Mitigation and Energy Use in Austria - The impacts of carbon and energy prices

Ina Meyer, Austrian Institute of Economic Research – WIFO, Long-term Climate Mitigation and Energy Use in Austria - The impacts of carbon and energy prices

Weiqi TANG, Centre for European Economic Research (ZEW), Mannheim, PINNING DOWN THE "HOT AIR" IN CHINA -- Simulation of the Effect of Domestic ETS Using an Endogenous Growth CGE model

C2. Energy and Climate Modelling 2, Huiyuan Hall
Chair: Nico Bauer

Jae Edmonds, Pacific Northwest National Laboratory, Global Climate, Energy, and Economic Implications of International Energy Offsets Programs

Johannes Emmerling, FondazioneEni Enrico Mattei (FEEM) and CMCC, Sharing of Climate Risks across Macro Regions

Paul Natsuo Kishimoto, Massachusetts Institute of Technology, Projecting provincial energy demand and CO2 emissions in China to 2025

Adriana Marcucci, ETH Zurich, Effect on global technology development of moderate policies and unilateral action: The case of EU and China

D2 Transport 1, Jinyuan Hall
Chair: David McCollum

Jing Dai, University of Kassel, Stated Preferences for Alternative Fuel Vehicles: Are Chinese Individuals Different?

Subash Dhar, UNEP Risoe Centre, DTU Management Engineering, Fuel Efficiency of Road Passenger Vehicles: Energy Security and Co-Benefits Analysis for India

Takuya Hara, Toyota Central R&D Labs., Inc., A variety of near-optimal solutions in the vehicle mix optimization model

Gouri Shankar Mishra, University of California Davis, Global Transportation Demand and Fuel Use Assessment in the New IPCC Shared Socioeconomic Pathways (SSPs)

E2 Energy and Emission Scenarios, the Eighth and Ninth Meeting Room
Chair: Paul Burke

AyakaJones, Energy Information Administration, U.S. Department of Energy, International Energy Outlook 2013 and the Modeling Approach

Elmar Kriegler, Will economic growth and fossil fuel scarcity help or hinder climate stabilization?

Kris Poncelet, KU Leuven/EnergyVille, Thethe Importance of Incorporating Short-term Dynamics in Long-term Energy Planning Models: an Evaluation

Evangelos Panos, Paul Scherrer Institute, CHOOSING A TEMPO TO POWER SUB-SAHARAN AFRICA IN 2050:

JAZZ AND SYMPHONY SCENARIOS OF THE WORLD ENERGY COUNCIL

Open Source Energy Modelling System (OSeMOSYS) - Side Event
12:40 - 13:35, Thursday, the Sixth Meeting Room (With lunch box provided)

ParallelSession3
1:45 pm - 3:30 pm, Thursday

A3. Challenges in Energy Modelling 1, the Fifth Meeting Room
Chair: Evasio Lavagno

Karen Fisher-Vanden, Pennsylvania State University, Does Outsourcing Reduce the Cost of Blackouts? Evidence Fromfrom Chinese Enterprises

Nadia Maizi, MINES ParisTech, WHAT COMMITMENTS FOR THE FUTURE CLIMATE REGIME: LONG-TERM DECODING USING TIAM-FR

Bertrand Rioux, KAPSARC, Lowering Saudi Arabia' s fuel consumption and energy system costs without increasing end consumer prices

Yingying Lu, Australian National University, Substitutability and the Cost of Climate Mitigation Policy

B3 .Buildings, the Sixth Meeting Room
Chair: Kenneth Karlsson

Chiara Delmastro, Politecnico di Torino, Effect of urbanization growth and policies on the energy pattern of the Chinese residential sector: scenarios up to 2030

Xinfang Wang, Tyndall Centre for Climate Change Research, University of Manchester, Exploration of High-emitting Households in the UK

Dieter Mayr, University of Natural Resources and Life Sciences, The curse of residential photovoltaic: potentialPotential negative impacts on public tax revenues in Cape Town, South Africa

Shengyuan ZHANG, School of Social Science, HKUST, The impact of building energy codes on urban residential energy consumption in China

C3 Renewables and Electricity 2, Huiyuan Hall
Chair: Ahlgren Erik

Martin Börjesson, Chalmers University of Technology, Future bioenergy scenarios under carbon constraints - A model analysis for Sweden

Welsch Manuel, KTH Royal Institute of Technology, Incorporating Flexibility Requirements into Long-term Models - A- A Case Study on High Levels of Renewable Electricity Penetration in Ireland

Swantje Sundt, Kiel Institute for the World Economy, Consumer's willingness to pay for green electricity: A meta-analysis of the literature

D3 Energy-Economy 1, Jinyuan Hall
Chair: Jan Steckel

Emanuele Campiglio, London School of Economics - Grantham Research Institute, The economics and management of climate-related international financial flows

James Carroll, Trinity College, Dublin, Increasing Efficient Appliance Purchases through Lifetime Monetary Consumption Information

Zsuzsanna Csereklyei, Vienna University of Economics and Business, Energy and Economic Growth: The Stylized Facts

Stéphanie Monjon, University Paris Dauphine, Would climate policy improve the European energy security?

E3 Electricity Market, the Eighth and Ninth Meeting Room
Chair: Zhou Sheng

Onur Cobanli, Humboldt University Berlin, Pipeline Power

Evangelos Panos, Paul Scherrer Institute, CHOOSING A TEMPO TO POWER SUB-SAHARAN AFRICA IN 2050: JAZZ AND SYMPHONY SCENARIOS OF THE WORLD ENERGY COUNCIL

Vincent Krakowski, Mines ParisTech, Towards sustainable low-carbon power systems

Chunbo Ma, School of Agricultural and Resource Economics, University of Western Australia, Electricity Market Restructuring and Technological Mandates: Plant-level Evidence for China's Changing Operational Efficiency from 1997 to 2010

ParallelSession4

4:00 pm - 5:40 pm, Thursday

A4 .Challenges in Energy Modelling 2, the Fifth Meeting Room
Chair: Stéphanie Monjon

Massimo Tavoni,FEEM-CMCC, Production of Knowledge in Energy Efficiency

Meriem Hamdi-cherif, CIRED (Centre International de Recherchesurl'Environnement et le Dveloppement), Economic Globalization, Global energy issues and Climate Change China in global perspective

Evasio Lavagno, DENERG - Politecnico di Torino, A GIS-Integrated Model for Advanced Local Energy Planning

Evangelos Panos，Paul Scherrer Institute, Orchestrating or Improving the Global Energy Transition: Scenario Modelling with the World Energy Council

B4 Policies in Electricity Generation, the Sixth Meeting Room
Chair: Vincent Krakowski (TBC)

Zsuzsanna Csereklyei, Vienna University of Economics and Business, Measuring the Impact of Nuclear Accidents on Energy Policy

Ching-Han Deng, Institute of Nuclear Energy Research, Analysis of Taiwan Power Planning Based on Zero Growth in Electricity Demand

Christoph Weissbart, Ifo Center for Climate, Energy and Exhaustible Resources, Ifo Institute, Munich, Current and future role of Renewable Energies in the Chinese Electricity System

C4. Energy Use and Technology Change, Huiyuan Hall
Chair: Mori Shunsuke

Kenneth Karlsson, Head of Energy System Analysis, System Analysis, DTU, Nordic Energy Technology Perspectives - Pathways to a Carbon Neutral Energy Future

David McCollum, International Institute for Applied Systems Analysis, Energy independence: Assessing energy system, cost and climate implications

Mariliis Lehtveer, Chalmers University of Technology, Will Nuclear Power Reduce Climate Mitigation Cost? - Critical Parameters and Sensitivity

D4. Energy-Economy 2, Jinyuan Hall
Chair: Meriem Hamdi-cherif

Uwe, Remme, IEA, Energy Technology Perspectives 2014: Harnessing electricity's potential

Gang He, Energy and Resources Group, University of California, Berkeley, China's ability to achieve national energy objectives depends on coordination of infrastructure and policy initiatives

Juergen Stich, TUM Create Limited, Cost Optimal Options for the Future Power Supply of Indonesia, Malaysia and Singapore

Rui zhang, Shanghai jiaotong university, Energy Wave Transition

E4 Regional analysis, the Eighth and Ninth Meeting Room
Chair: Lu Yingying

Brian Ó Gallachóir, University College Cork, Challenging EU Climate Energy Package Analysis - a Member State Case Study

Claudia Kettner, Austrian Institute of Economic Research (WIFO), Assessing regional energy transition in Austria: An economy-wide approach

Nawfal SaadiFailali, KTH division of Energy Systems Analysis, An open source approach to Sweden's future energy system

Jan Steckel, PIK, MCC, TU Berlin, Determinants of Access to Basic Infrastructure in Developing Countries

IRENA special session

5:45 pm - 7:15 pm, Thursday, the Sixth Meeting Room
Brain storming session on the modelling of renewables for policy making

Parallel Session5

1:45 pm - 3:30 pm, Friday

A5. Climate Policies/Climate Agreement 1, Zhongbei Hall
Chair: Govinda Timilsina

Bobvan der Zwaan, ECN, Technology Roll-Out for Climate Change Mitigation: A Multi-Model Study for Latin America

Lei Zhu, University of Science and Technology of China &Chinese Academy of Science, Financing and Disbursement of the Green Climate Fund in the Post-Kyoto Era

Ruben Lubowski, Environmental Defense Fund (EDF)-) - Columbia University, Balancing Risks from Climate Policy Uncertainties: The Role of Options and Reduced Emissions from Deforestation and Forest Degradation (REDD)

Sonia Yeh, University of California, Summary of California Climate Policy Modeling (CCPM) Project

B5 Key factors in the modeling, the Third Meeting Room
Chair: Gary Jefferson

Marian Leimbach, Potsdam Institute for Climate Impact Research, Future growth pattern of regions - divergence or convergence?

Takayuki Takeshita, Nagasaki University, Assessing the Competitiveness of Wave Energy

Technologies: A Regionally Detailed Analysis

Giacomo Schwarz, ETH Zurich, Household heterogeneity with non-homothetic preferences and the general equilibrium incidence of environmental taxes

Shu-Yi Ho Shuyi, Industrial Techonology Research Institute, Applying the Taiwan TIMES Model to Assess Effectiveness of Energy Efficiency Managements

C5 Green Paradox 1, Huiyuan Hall
Chair: Fan Ying

Jérôme Hilaire, Potsdam Institute for Climate Impact Research, A Green Growth paradox: Are rebound and leakage effects undermining the effectiveness of renewable support policies?

Evelina Trutnevyte, UCL Energy Institute, Does cost optimization approximate the real-world energy transition? Retrospective modelling and implications for modelling the future

Lara Aleluia Reis, FEEM, Fondazione Eni Enrico Mattei, Synergies and interactions between climate change policies and air pollution control strategies - Results of the WITCH integrated assessment model

XI YANG, Tsinghua University, Qualifying co-benefit for carbon mitigation based on China-MAPLE model

D5 Adaptation and Land Use, the Seventh Meeting Room
Chair: Jae Edmonds

Delavane Turner, Stanford University, Management Science and Engineering, The Roles of Mitigation and Adaptation for Coastal Impacts from Climate Change, Extreme Events, and Catastrophe

Shunsuke Mori, Tokyo University of Science, An Expansion of an Integrated Assessment Model for the Assessment of Adaptation Effects

Markus Blesl, IER- University Stuttgart, Price and demand effects for energy crops and biomass under the EU GHG reduction target: linkages between the energy and the agricultural sector in the EU until 2050

David Gernaat, Utrecht University, Understanding the contribution of non-CO2 gases in deep mitigation scenarios.

E5 Renewable Policies 1, the Eighth and Ninth Meeting Room
Chair: Karen Fisher-Vanden

Adrian Stone, Energy Research Centre, University of Cape Town, Exploring Pathways to a Hydrogen Fuel Cell Transition in the South African Road Transport Sector

Diran Soumonni, University of the Witwatersrand, An Adaptive Modeling Approach to Off-grid Electrification in West Africa

Samuel Carrara, FEEM - FondazioneEni Enrico Mattei and CMCC - Centro Euro-MediterraneosuiCambiamentiClimatici, Modeling the integration of Variable Renewable Energies (VRE) into the electrical grid in the WITCH model: techno-economic impacts of different approaches

Liu Yang. Ecole Polytechnique. Interaction of climate and energy policies between the EU and China

ParallelSession6

4:00 pm - 6:00 pm, Friday

A6. Climate Policies/Climate Agreement 2, Zhongbei Hall
Chair: Sonia Yeh(Yeh (TBC)

Ying Fan, Center for Energy and Environmental Policy Research, Institute of Policy and Management, Chinese Academy of Sciences, Assessment of the effect of the Chinese 'green credit' policy based on a financial CGE model

Govinda Timilsina, The World Bank, Will Global Convergence of Per Capita Emission Lead Meeting UNFCCC Goal?

Peng Pan, Chinese Academy of Sciences，A Research Focus on Abatement Activities by 3E China Model with RBC

Junling Liu, School of Environment and Natural Resources, Renmin University of China, Analysis of trends in carbon emissions embodied in China's trade and factors decomposition

B6 Low carbon technologies, the Third Meeting Room
Chair: Zsuzsanna Csereklyei

Ryoichi Komiyama, Thethe University of Tokyo, Optimal Integration of Variable Renewables with Flexible Power Resources into Japan's Long-term Power Generation Mix to 2050

Tom Kober, ECN, Uncertain CCS power plant parameters - Do they matter for CCS deployment in Europe?

Ogundiran Soumonni, Wits Business School, University of the Witwatersrand, An Adaptive Modeling Approach to Off-grid Electrification in West Africa

C6. Green Paradox 2, Huiyuan Hall
Chair: Evelina Trutnevyte(TBC)

Mike Toman, American University, CLIMATE CHANGE, INDUSTRIAL TRANSFORMATION, AND "AND "DEVELOPMENT TRAPS"

Gary Jefferson, Brandeis University, Factors influencing energy intensity in four Chinese industries

Xiangzhao Feng, PRCEE，The Co-benefit Study on CO2 and NOx emission reduction in China's Cement Industry

D6 Transport 2,
Chair: Subash Dhar

Claudia Aravena, Department of Economics - Trinity College Dublin, Attitudes and Preferences towards Electric Vehicles. - What characteristics and policies do people value most?

Miao-shan Tsai, Institute of Natural Resource Management, National Taipei University, Taiwan.,Taiwan. Implications of energy price rationalization policy for the transportation needs of the elderly population in Taiwan - A Case Study

Jimin Zhao, Hong Kong University of Science and Technology, Pathways to Low-Carbon Mobility in Chinese Cities: Case Study of Jinan

E6. Renewable Energy Policies 2, the Eighth and Ninth Meeting Room
Chair: Markus Blesl

Da Zhang, Institute of Energy, Environment and Economy,China'sEconomy, China's Wind Potential Revisited: An Analysis of Key Constraints and Sensitivities

Michele Peruzzi, Bruegel, When and how to support renewables? - Letting the data speak.

Iain MacGill, Centre for Energy and Environmental Markets, University of New South Wales, Does wind need â 'back-up' capacity? Modelling the system integration costs of 'back-up' capacity for variable generation

Open Source Energy Modelling System (OSeMOSYS) - Side Event

The Open Source Energy Modelling System (OSeMOSYS) is a long-term system optimisation model developed as a collaborative effort. Since its inception a couple of years back, it has been featured in various publications and has become the backbone of some major energy modelling endeavors for leading entities such as the United Nations Department of Economic and Social Affairs (UNDESA) and the World Bank.

This side event will focus on the recent developments in the OSeMOSYS community during the year 2013-2014. Amongst others, it will showcase the newly developed open, freely available and adjustable interface "OSINDA". For further background, please refer to www.osemosys.org.

AGENDA

5 June 2014, Thursday, 12:40 - 13:35, the Sixth Meeting Room

12:40– 12:50	Opening statement – H. Rogner
12:50 – 13:00	Selected OSeMOSYS applications – M. Welsch, N. Saadi: • Assessing the climate vulnerability of Africa (World Bank) • Investment Needs for Africa's Power Sector (African Development Bank) • Modelling electrical vehicles (University of Pavia/KTH) • Sharing operating reserve across regions (University of Pavia/KTH) • Swedish energy model and cascading hydropower (KTH)
13:00 – 13:05	OSeMOSYS as a teaching tool – M. Welsch
13:05 – 13:10	OSeMOSYS, LEAP and Ireland – B. Ó Gallachóir
13:10 – 13:30	OSINDA OSeMOSYS Interface and Database – N. Saadi
13:30 – 13:35	Discussion and Wrap-up – H. Rogner