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出國報告（出國類別：其他）

參加IPCC-28研討會發表研究論文出國報告

服務機關：核能研究所
姓名職稱：陳銘宏　副研發師
派赴國家：美國
出國期間：100 年 9 月 10 日~100 年 9 月 16 日
報告日期：100 年 10 月 18 日

摘 要

本次會議主題爲第二十八屆匹茲堡國際煤碳研討會。

基於目前政府積極推動之減碳相關政策，本次派員赴美國參加 28th International Pittsburgh Coal Conference (IPCC)，發表會議論文，除可瞭解世界各國目前於潔淨能源之發展現況，亦可與相關領域之專業人士交流相關知識。

IPCC 之議題包括捕碳/封存計畫近況、燃燒與氣化等重要議題，爲獲知目前減碳議題發展最新狀況之重要年度會議。

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一、目　的

核能研究所(以下稱本所)目前正積極進行能源相關計畫，包括「減碳政策評估與淨碳技術發展」、「淨碳系統模擬分析技術開發」與「潔淨燃料工廠虛擬整合工程模擬平台研發」等。爲瞭解目前國際於相關研究議題之發展現況，本次公差主要爲參加 28th International Pittsburgh Coal Conference (IPCC)，並發表研究論文。

第 28 屆年會於 2011 年 9 月 12 – 15 日於美國賓州匹茲堡市(Pittsburgh)舉行，會議主題包括捕碳/封存計畫近況、燃燒與氣化等重要議題，爲獲知目前減碳議題發展最新狀況之重要年度會議。

爲了在潔淨能源技術之研究議題上進行交流，有世界各先進研究團隊參與此會議，包括 NETL, DOE, Cogentrix, LTI, CAER, CONSOL Energy Inc., NICE, LLC, CAER 等。故本所派員參與此會議爲交流與驗證專業技術之良機。

二、過　程

(一) 公差行程

本次公差自民國 100 年 9 月 10 號至 9 月 16 號日止，共計 7 天(圖 II-1)。

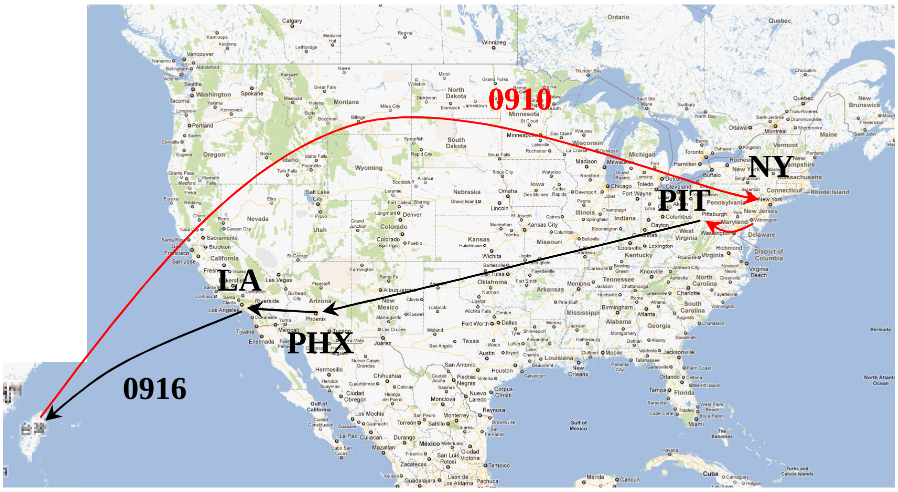

圖 II-1：公差行程示意圖

9 月 10 日(星期六)　自台灣桃園機場出發

9 月 10 日(星期六)　抵達美國紐約紐華克機場

9 月 11 日(星期日)　自紐約紐華克機場轉機至匹茲堡市

9 月 12 日(星期一)　~ 9 月 14 日(星期三)　註冊，出席第 28 屆 IPCC 會議，發表論文

9 月 15 日(星期四)　由匹茲堡出發，於鳳凰城轉機，再至洛杉磯轉機

9 月 16 日(星期五)　返抵台灣桃園機場

(二) 第 28 屆匹茲堡淨煤國際會議(International Pittsburgh Coal Conference, IPCC)

第 28 屆年會於 2011 年 9 月 12 – 15 日於美國賓州匹茲堡市(Pittsburgh)舉行(圖 II-2 ~ II-7)，會議主題包括捕碳/封存計畫近況、燃燒與氣化等重要議題，爲獲知目前減碳議題發展最新狀況之重要年度會議。

爲了在潔淨能源技術之研究議題上進行交流，有世界各先進研究團隊參與此會議，包括 NETL, DOE, Cogentrix, LTI, CAER, CONSOL Energy Inc., NICE, LLC, CAER 等約四百人參加此會議。

IPCC-28 之議程如表 II-1 所示。每天早上先進行全體會議(Plenary Session)，此全體會議各有三場 keynote 演講。接著是早上一段口頭論文發表，下午則是安排兩段口頭論文發表，每一段論文發表共有六個場次同時進行。海報論文發表安排在 9 月 14(星期四)晚上進行。

圖　II-2 舉辦會議之 Westin 飯店

圖　II-3 匹茲堡市區景象

圖　II-4 IPCC-28 會場外觀

圖　II-5　連接飯店與會場之天橋

圖 II-6 911 十週年紀念活動

圖 II-7 匹茲堡市夜景

表 II-1：IPCC-28 之議程

Preliminary Program Schedule

Monday, September 12, 2011						
11:00-16:00	Technical Tour - Cardinal Plant					
15:00-19:00	Registration – Room 306					
18:30-20:30	Reception – Rooftop Terrace					
Tuesday, September 13, 2011						
7:00-17:00	Registration – Room 306					
8:00-8:20	Opening Ceremony – Ballroom					
8:20-10:05	Plenary Session – Ballroom					
10:05-10:20	**Coffee Break**					
ROOM	**301**	**302**	**303**	**304**	**305**	**310/311**
	Session 1	Session 2	Session 3	Session 4	Session 5	Session 6
10:20-12:00	Major CCS Demo Projects: Financing of CCT and CCS Projects	Gasification: General Session – 1	Coal-Derived Products: General – 1	Carbon Management: CO_2 Capture - Sorbents – 1	Combustion: Emission Controls	Mining
12:00-13:30	**Conference Luncheon - Ballroom**					
	Session 7	Session 8	Session 9	Session 10	Session 11	Session 12
13:30-15:10	Major CCS Demo Projects: Financial Risk Management Stategies for CCT	Gasification: Economics	Coal-Derived Products: General – 2	Carbon Management: CO_2 Capture - Sorbents – 2	Combustion: Oxy-Combustion – 1	Coal Science: Beneficiation
15:10-15:25	**Coffee Break**					
	Session 13	Session 14	Session 15	Session 16	Session 17	Session 18
15:25-17:25	Major CCS Demo Projects: Insurance and Risk Management Strategies for	Gasification: Modeling – 1	Coal-Derived Products: General – 3	Carbon Management: CO_2 Capture - Sorbents – 3	Combustion: Oxy-Combustion – 2	Coal Science: Coal Geochemistry
18:00-21:00	**Gateway Clipper Dinner Cruise**					
Wednesday, September 14, 2011						
7:00-17:00	Registration – Room 306					
8:20-10:05	Plenary Session – Ballroom					
10:05-10:20	**Coffee Break**					
ROOM	**301**	**302**	**303**	**304**	**305**	**310/311**
	Session 19	Session 20	Session 21	Session 22	Session 23	Session 24
10:20-12:00	Major CCS Demonstration Projects: General – 1	Gasification: Low Rank coal	Coal-Derived Products: General – 4	Carbon Management: CCS and GHG Abatement – 1	Combustion: Combustion Studies – 1	Coal Science: Coal Geology
12:00-13:30	**Conference Luncheon - Ballroom**					
	Session 25	Session 26	Session 27	Session 28	Session 29	Session 30
13:30-15:10	Major CCS Demonstration Projects: General – 2	Gasification: Coal & Biomass	Coal-Derived Products: General – 5	Carbon Management: SECARB-ED CCS Training Session – 1	Combustion: Chemical Looping – 1	Coal Science: Coal Science – 1
15:10-15:25	**Coffee Break**					
	Session 31	Session 32	Session 33	Session 34	Session 35	Session 36
15:25-17:25	Major CCS Demonstration Projects: General – 3	Gasification: Modeling – 2	Coal-Derived Products: General – 6	Carbon Management: SECARB-ED CCS Training Session – 2	Combustion: Chemical Looping – 2	Coal Science: Coal Science – 2
18:00-21:00	**Poster Session - Room 319/320/321**					
Thursday, September 15, 2011						
7:00-17:00	Registration – Room 306					
8:20-10:05	Plenary Session – Ballroom					
10:05-10:20	**Coffee Break**					
ROOM	**301**	**302**	**303**	**304**	**305**	**310/311**
	Session 37	Session 38	Session 39	Session 40	Session 41	Session 42
10:20-12:00	Major CCS Demonstration Projects: General – 4	Gasification: Fundamentals	Gasification: General – 2	Carbon Management: CCS and GHG Abatement – 2	Combustion: Combustion Studies – 2	Sustainability and Environment: General – 1
12:00-13:30	**Awards Luncheon - Ballroom**					
	Session 43	Session 44	Session 45	Session 46	Session 47	Session 48
13:30-15:10	Major CCS Demonstration Projects: General – 5	Gasification: Gas Cleanup	Gasification: General – 3	Carbon Management: CCS and GHG Abatement – 3	Carbon Management: CO_2 Geologic Sequestration – Coal	Sustainability and Environment: General – 2
15:10-15:25	**Coffee Break**					
	Session 49	Session 50	Session 51	Session 52	Session 53	Session 54
15:25-17:25	Major CCS Demonstration Projects: General – 6	Gasification: Underground Coal Gasifcation	Gasification: General – 4	Carbon Management: CCS and GHG Abatement – 4	Carbon Management: CO_2 Capture – Solvents	Sustainability and Environment: General – 3
18:00-20:00	**Advisory Board Meeting**					

本次大會之議程共計分七項領域進行，各領域之主題摘要如下：

2011 Sessions and Topics

1. Combustion

Session Chair: John Wheeldon, EPRI and Evan Granite, U.S. DOE/NETL

- Industrial Applications, Economics, and Environmental Issues
- Advance Pulverized Coal Combustion Technologies (Supercritical, Fluidized Bed, Etc.)
- Novel Technologies (Oxyfuel, Chemical Looping, Etc)
- Flue Gas Clean Up
- Science And Modeling
- Materials, Instrumentation, and Controls
- Turbines (Steams)

2. Gasification

Session Chairs: Massood Ramezan, Leonardo Technologies, Inc. (LTI), and Jenny Tennant, U.S. DOE/NETL

- Industrial Applications, Economics, and Environmental Issues
- Underground Coal Gasification (UCG)
- Synthesis Gas Cleanup
- Gasification Science and Modeling
- Novel Gasification Technologies and Concepts
- Co-Gasification of Coal and Biomass

3. Sustainability and Environment

Session Chair: Jim Hower, University of Kentucky, CAER

- Energy Production and Water Use - Conservation and Recycle
- Life Cycle Analysis (LCA) of Energy Production Systems

- Energy Production Impact on the Environment
- Energy Sustainability - Efficiency and Conversion to Reduce GHG
- GHG: Inventory Protocol,   Legal and Regulatory Considerations, Credits

4. Carbon Management

Session Chairs: Richard Winschel, CONSOL Energy Inc. and

Steve Carpenter, Advanced Resources International, Inc.

- Pre-Combustion Capture
- Post-Combustion Capture
- CO2 Sequestration (Monitoring, Mitigation, and Verification; Storage: Depleted Oil/Gas Reservoirs, Aquifers, Basalt, Coal Bed Methane)
- Transportation Infrastructure and Issues
- Legal and Regulatory Issues
- Carbon Footprint Comparison: CTX (DCL/ICL), Petroleum

5. Coal-Derived Products

Session Chairs: Belma Demirel, Rentech, Inc., Ke Liu, National Institute of Clean & Low-carbon Energy (NICE), Rachid Oukaci, Energy Technology Partners, LLC, and Xin Xiao, Savannah River National Laboratory

- Coal-To-Liquids, CTL (Direct Liquefaction, Fischer-Tropsch, Methanol-To-Gasoline, Etc.)
- Substitute Natural Gas (SNG)
- Hydrogen Production
- Syngas Utilization (Gas Turbines, Fuel Cells)
- Chemicals/Materials
- Coal Utilization By-Products (Ash, Fertilizers, Etc.)
- Jet Fuel

6. Coal Science

Session Chair: Jim Hower, University of Kentucky, CAER, and Leslie "Jingle" Ruppert, US

Geological Survey

- Chemistry
- Geoscience/Coal Resources
- Trace Elements/Emission
- Processing
- Coal Preparation

7. Major CCS Demonstration Projects

Session Chairs: Gary Stiegel, U.S. DOE/NETL and Thomas Sarkus, U.S. DOE/NETL

- Updates on existing clean coal major demonstration projects (IGCC, SCPC, USC, Oxy-combustion, etc.)
- Status of current clean coal development projects with carbon capture and storage
- Industrial large-scale demonstrations of carbon capture and storage project

筆者於 9 月 15 日(星期四)搭機離開美國，於 9 月 16 日(星期五)返抵台灣桃園機場，結束本次公差行程。

會後亦公告下屆會議之時間，將於 101 年 10 月 15-18 日於相同地點舉行。

三、心　得

本次公差主要乃是參加第 28 屆 International Pittsburgh Coal Conference (IPCC-28)，發表研究論文。以下摘錄部份相關研究論文。

1. Plenary Sessions

會議進行方式首先進行全體會議(Plenary Session)，並安排各三場 keynote 演講，本屆應邀之講員如下：

PLENARY SPEAKERS

TUESDAY, SEPTEMBER 13, 2011

Energy Production/Policy Speakers

Charles McConnell

Chief Operating Officer, Fossil Energy

Department of Energy, USA

Thomas J. Bonner

President

Cogentrix Energy, LLC, USA

Steve Herman

Managing Director

Energy Capital Partners, USA

WEDNESDAY, SEPTEMBER 14, 2011

International Issues

Yuzhou Zhang

CEO

Shenhua Group, CHINA

Steve Orlins

President

National Committee on US-China Relations, USA

Sami Demirbilek

CEO

Ciner Group, TURKEY

<u>THURSDAY, SEPTEMBER 15, 2011</u>

Environmental Issues

Anthony Cugini

Director

Department of Energy, USA

Steven Winberg

Vice President, R & D

CONSOL Energy Inc., USA

Frank Princotta

Director, Air Pollution Prevention and Control

Division, USEPA, USA

(1) Energy Production/Policy

9 月 13 日早上之演講議題爲「能源產出/策略(Energy Production/Policy)」；講者分別來自政府單位，研究機構與產業界。首位演講者 **Charles McConnel**，爲美國化石能源部門(Fossil Energy Department of Energy)之首席運營長(Chief Operating Officer)(圖 III.1-1)，其講題爲“Fossil energy in a Carbon Constrained World” (圖 III.1-2)。演講重點摘錄如圖 III.1-3 ~ III.1-9 所示，其演講涵蓋以下議題：

- DOE Strategic Plan (圖 III. 1-3)
  - Transform our Energy Systems
  - Science and Engineering Enterprise
  - Secure our Nation
  - Management and Operational Excellence
- Fossil Energy Portfolio (圖 III. 1-4)
- Oil and Gas (圖 III. 1-5)
- CO_2-Enahnced Oil recovery (圖 III. 1-6)
- International Collaboration (圖 III. 1-7)
- Return of Investment (圖 III. 1-8)
- Conclusion (圖 III. 1-9)
  - Competition for Global Resources
  - Global Environmental Trends and Policies
  - Technology Demonstrations
  - Commercial Scale
  - Create a Compelling Choice for Fossil Energy That is Game-Changing and Sustainable

第二位演講者 **Thomas J. Bonner**，爲 Cogentrix Energy, LLC 之總裁，其演講之題目爲“Consideration of Coal, other Fuels, and Technology in Developing and Operating a U. S. Generation Portfolio”(圖 III.1-10)。Cogentrix 設立於 1983 年，自 1985 年起已建立 18 座電廠，裝置容量超過 5,000 MW。其中包括 9 座燃煤電廠。其報告中提及目前促使產業發展之動力爲燃氣成本與運煤成本之競爭，目前現存之電廠技術將會限制燃煤電廠修建之機會，另外，近況不佳之經濟情況將導致嚴重之電能短缺 (圖 III.1.11 ~ III.1.27)。其內容包括以下議題：

- Customer Objectives(圖 III.1.16)
  - Investor owned utilities, municipals and coops - build v. buy
  - Regulatory restrictions
  - Accounting and reporting
- Reserve Margins and Operating Environment(圖 III.1.17 ~ III.1.20)
- Regulation (圖 III.1.21 ~ III.1.24)
- Availability of Financing (圖 III.1.25)

- What's the Future for Coal in the Generation Mix in the U.S.? (圖 III.1.26)
  - Long term relationship between natural gas and coal pricing
  - Electric rate regulation and cost recovery
- Summarization (圖 III.1.27)

(2) International Issues

9 月 14 日早上之演講議題爲「國際議題(International Issue)」;講者爲大陸神華集團總裁 **Yuzhou Zhang**，講題爲：「The Clean Coal Conversion & Utilization Technologies in Shenhua and China」(圖 III.1-28)。神華公司設立於 1995 年，爲目前中國最大之產煤公司以及全球最大煤供應商。其整合多項業務包括礦業、動力、鐵路、港務以及煤轉換爲液態及化學原料等技術。並指出提升煤炭使用效率爲未來降低二氧化碳之有效方式。而將生質物混入煤炭中使用能夠更進一步降低二氧化碳排放(圖 III.1-29 ~ III.1-30)。其演講議題包括：

- CO_2 reduction (圖 III.1-31 ~ III.1-33)
- Clean coal conversion (圖 III.1-34)
- Technology Portfolio of Shenhua & NICE (圖 III.1-35)
- Major Clean Coal Conversion Demo Projects in China (圖 III.1-36 ~ III.1-41)
- Coal conversion process analysis (圖 III.1-42 ~ III.1-45)
- Concluding Remarks (圖 III.1-46)

2. Technical Paper Sessions

IPCC-28 之論文發表接在全體演講之後，早上一個時段，下午兩個時段，同時有六個場次之口頭論文發表進行，每場安排約 5~6 篇論文之發表。議題分爲七項：(1) Major CCS Demo Projects, (2) Gasification, (3) Coal-Derived Products, (4) Carbon Management, (5) Combustion, (6) Mining, (7) Coal Science。筆者參與主題與業務內容較相關之論文發表，摘錄部份論文如下。

論文 # 2-4 (圖 III.2-1 ~ III.2-12)

此篇論文由 NETL 之 **Stephen E. Zitney** 發表，演講主題爲 Advanced Virtual Energy Simulation Training and Research: IGCC with CO_2 Capture Power Plant。主要介紹其建立之 AVESTAR Center 之模擬技術及訓練課程及研究主題。其模擬器宣稱可模擬 IGCC 整廠之動態響應，且具有三維即時互動能力。訓練課程則包括 IGCC、氣化程序以及 Combined Cycle 操作等。

論文 # 14-1 (圖 III.2-13 ~ III.2-24)

此篇論文由 University of Utah 之 **Kevin J. Whitty** 發表，演講主題爲 Pressurized Entrained Flow

Coal Gasifier Performance: A Parametric Study。主要是針對加壓-吹氧式挾帶床氣化爐進行參數測試，測試之參數為氧氣壓降(停滯時間)、氧/煤比及壓力對於出口溫度、產氣成份之影響。該氣化爐為介於實驗室等級以及商轉等級之中等規格爐體，可在接近工業用條件進行測試，且易於取得結果進行分析。

論文 # 14-2 (圖 III.2-25 ~ III.2-33)

此篇論文由澳洲 CSIRO 之 **Daniel G. Roberts** 發表，演講主題為 Experimental and Modeling Studies of Pressurized Coal Gasification Behavior。CSIRO 之研究方向主要為澳洲煤之氣化行為與高溫 char-steam 之反應速率探討。模型主要用以確定氣化子模型當中部份化學成份之形成細部機制。採用之爐體為加壓式挾帶床氣化爐，在稀釋環境下進行測試，但保持適當之氧/碳比率。另外將 char-steam 反應獨立出來探討，實驗參數包括氧/碳比率與停滯時間對氣化結果之影響。

論文 # 14-3 (圖 III.2-34 ~ III.2-45)

此篇論文由 NETL 之 **Job S. Kasuel** 發表，演講主題為 Steady-State Modeling of a Single-Stage, Downward-Firing, Entrained-Flow Gasifier。主要是針對挾帶床氣化爐建立包括細部化學反應機制之穩態模型，並嘗試延伸至動態模型。其化學反應機制共包含 4 條異相反應與 6 條同相反應。另外，其模型亦包含一 heuristic recirculation 模型，用以評估迴流現象對於初始流場之影響。其爐體壁面熱傳模式採用熱對流模式進行計算，而非其它文獻中以假設之線性溫度分佈的方式。採用之求解器為 Aspen Customer Modeler (ACM)。其模型計算出之結果與文獻值、工業結果頗為一致。

論文 # 14-5 (圖 III.2-46 ~ III.2-54)

此篇論文由澳洲 CSIRO 之 **Daniel G. Roberts** 發表，演講主題為 Using Fundamental Data to Model Entrained Flow Gasification: Impacts of Coal Type on Gasifier Performance。主要是將其先前發展之 2 維軸對稱模型應用至實際氣化爐之構型與操作條件中。其子模型包括去揮發化模型、異相反應模型、揮發物與可燃氣之氧化反應、同相之水氣轉化反應、熱對流與熱輻射模型等。並選用四組不同之氧/碳比率進行測試。

論文 # 32-1 (圖 III.2-55 ~ III.2-59)

此篇論文由 West Virginia University 之 **Kiran Chaudhari** 發表，演講主題為 Development of Advanced Gasification Kinetics Models for CFD (and Process Simulation) Codes。主要是整合現有之各種化學反應機制子模型於其自行建立之模組當中。透過其自行建立之 GUI 介面，可將目前現在之各式化學反應機制導入其模組當中。在設定相關參數後，即可導入目前各式之商用軟體當中進行運算。

論文 # 32-2 (圖 III.3-1 ~ III.3-24)

此篇論文爲本所與 University of New Orleans 之王亭教授合作之成果，由王亭教授發表，演講主題爲 Numerical Analysis of Gasification Performance via Finite-Rate Model in a Cross-Type Two-Stage Gasifier。此研究主要乃是建立三維之 cross-type，兩級式氣化爐模型。分析之參數包括氧/煤比、水煤漿濃度、第一/第二級導入燃料分佈之影響。

論文 # 32-3 (圖 III.2-60 ~ III.2-72)

此篇論文由 University of New Orleans 之王亭教授發表，演講主題爲 Development of a Devolatilization Model in Multi-Phase Simulation of a Mild Gasifier with a Draft Tube。此研究主要乃是提出 IMGCC 之概念式系統設計，其中 M 表示 Mild 之 IGCC 系統，主要是在除硫系統中假設可在高溫情況下進行。此種 Mild gasifier 包含流體化之現象，故需採用 E-E 模型進行計算。初步結果顯示此概念設計是可行的，但細部設計需要再進一步修正。

3. Poster Sessions

IPCC-28 之 Poster session 場次安排在 9 月 14 日晚間舉行，主題同樣包含前述各領域，其論文篇數如下：

(1) Combustion：6 篇 (去年 17 篇)
(2) Gasification：19 篇 (去年 8 篇)
(3) Sustainability and Environment：9 篇(去年 11 篇)
(4) Carbon Management：10 篇 (去年 11 篇)
(5) Coal-Derived Products：6 篇 (去年 17 篇)
(6) Coal Science：19 篇 (去年 28 篇)

與前一年度比較，在 gasification 部份之論文篇數大幅增加，部份海報展示摘要如下(圖 III.4-1 ~ III.4-6)。

主要心得分述如下：

1. 原先於相關研究議題之瞭解只局限於研究文獻，藉由參加此國際會議可藉由演講提供大方向之瞭解，而參加論文發表會議則能夠獲知較細部之研究現況，對於往後進行相關研究能夠提出相關建議，對於核心業務之進行有相當大之助益。

2. 除了解歐美各國之發展現況外，本次公差亦獲知，目前大陸方面對於淨煤技術之發展現

況，且由於大陸當局為追求經濟成長，使其雖具有煤礦產出能力亦成為化石能源之輸入國；另外再加上金磚四國中之印度對於能源之需求，將進一步推升我國化石能源取得之困難度，故我國在潔淨能源與淨煤技術之研究為目前最重要之發展議題之一。另外，於神華集團主席 Yu Zhuo Zhang 之演講中提及，提高煤炭之使用效率為未來降低二氧化碳之最有效辦法，此觀點與目前本組進行之運轉參數測試以尋找提高煤炭氣化效能之目標一致；另外也提到生質燃料與煤炭混燒可進一步降低二氧化碳排放，此與本年度投稿於國際會議之探討項目相關。故本組目前進行之研究方向基本上與國際間認知之主要發展方向一致。

3. 本組所發表之論文場次中，與會人員曾提及是否曾驗證吾人提出之模型，然目前唯有 NETL 之報告內容可供成份比對，而溫度與爐內細部現象則無資料可供比對；因此在提出模型之結果前，須先以實驗數據驗證，再進行後續之參數分析。然目前於實驗結果獲得之困難度使得模型驗證只能以部份報告內容進行比對，往後若有機會能夠獲得較完整且細部之實驗結果，對於模型之發展將有重大之助益。

4. 在海報發表場次中，有學者建議吾人於關鍵組件分析時，亦同時須搭配完整之程序分析，方能避免見樹不見林之現象。故本組可與系統程序分析小組進行進一步交流互相了解目前最新發展現況。

5. 在本次公差之前，筆者主辦之委託案遇到無觸媒水氣轉化反應參數難以獲得之困境，而在此會議當中同樣有學者提出此議題，並表示約只有 5%之研究是符合需求之設定條件，因此找尋與氣化條件一致之反應參數，為改善模型可靠度之重點工作之一。

6. 本組進行關鍵組件分析時，為求模型之完整性，考慮約 8~10 條同相與異相之化學反應式，而此會議當中則有部份研究乃是僅考慮單一異相化學反應式之現象進行探討，例如煤焦-水蒸氣或二氧化碳之單一反應，此結果可納入目前建立之化學反應模型之反應參數

資料庫當中，藉由與其它文獻參數進行比較，並選取較適當之參數值用於模型之測試中。

7. 在氣化場次發表中部份作者無法出席，故筆者抽空前往參加 Major CCS Demonstration Projects 之發表。在聆聽該場次之發表中發現，報告人除說明目前技術層面之發展現況外，其計畫案都會建立一套 Revenue Model 以評估其商業價值。由於目前美國之經濟困境，故相關計畫推動所需之資金將由政府出資逐漸轉為民間資金。因此計畫之投資報酬率之重要性不亞於技術面之發展。本所在設計示範設施過程中，除技術層面之考量外，亦可將商業運轉之方向列入考慮，以提高其經濟價值。

8. 王亭教授提出之 IMGCC 之概念，若發展成功，將可提高目前燃煤電廠之可用率，唯其前提乃是高溫除硫技術需能配合。此研究預估需十年左右之研究時程，且比較偏重學術層面之研究。唯其建立之多相流、E-E 模式下之揮發模型與暫態分析能力為目前本組較不熟悉之部份，故往後可於此議題上與王教授交流，可提高本組於氣化爐分析能力之完整性。

四、建　議　事　項

本所目前正積極進行能源相關計畫，包括「減碳政策評估與淨碳技術發展」、「淨碳系統模擬分析技術開發」與「潔淨燃料工廠虛擬整合工程模擬平台研發」等。爲瞭解目前國際於相關研究議題之發展現況，本次公差主要爲參加 International Pittsburgh Coal Conference (IPCC)，發表研究論文。第 28 屆年會於美國賓州匹茲堡市(Pittsburgh)舉行，會議主題包括捕碳/封存計畫近況、燃燒與氣化等重要議題，爲獲知目前減碳議題發展最新狀況之重要年度會議。本次公差行程之建議事項如下：

(一)氣化爐內之反應機制仍充滿許多不確定性，尚需要進一步之基礎研究，除採用 CFD 模擬分析外，尚需搭配實驗結果以充份驗證反應機制，故實驗結果之取得爲後續在發展上之重要議題。

(二)在針對關鍵組件進行分析時，尚需搭配完整之程序分析，方能對氣化程序之整體概念有較完整之瞭解。

(三)目前氣化爐內之水氣轉化反應之數據主要是在有觸媒之情況下，而實際氣化過程則無觸媒參與其中，故找尋無觸媒情況下之反應參數，並導入目前建立之模型當中，爲進一步改善計算結果之重要工作之一。

(四)本次會議有數篇研究僅針對煤焦與水氣/二氧化碳之單一反應進行分析，此分析結果可用於調整目前所建立之異相化學反應機制。

(五)本次會議當中有許多論文將商業模型納入其設計參數之考量當中，並強調唯有將設計領往具有商業潛力之方向，才有進一步發展之價值，建議本所可投入在此議題上，以提高未來欲建立之氣化程序之商業價值。

(六)綜合考量目前國際上於氣化分析之現況，建議明年可採用 finite-rate，或 finite-rate/eddy-dissipation 之模型進行後續之操作參數分析工作。

(七)目前合作之紐奧良大學研究團隊已具有多相流與暫態行爲分析能力，建議明年度之傳輸式氣化爐/循環式流體化床氣化爐之研究可委託其進行。

五、附　錄

(一) 本屆大會議程

(二) Plenary Session 相關圖片

(三) Technical Paper Session 相關圖片

(四) 發表之論文投影片

(五) Poster Session 相關圖片

(一) 本屆大會議程

TWENTY - EIGHTH ANNUAL INTERNATIONAL

PITTSBURGH COAL CONFERENCE

PRELIMINARY PROGRAM

COAL - ENERGY, ENVIRONMENT AND SUSTAINABLE DEVELOPMENT

September 12 - 15, 2011
Pittsburgh, PA USA
The David L. Lawrence Convention Center

Sponsors

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北京低碳清洁能源研究所
NATIONAL INSTITUTE OF CLEAN-AND-LOW-CARBON ENERGY

Hosted By:
University of Pittsburgh
Swanson School of Engineering

General Information

2011 PCC

The University of Pittsburgh, along with the Advisory Board and Participating Organizations, invites you to attend the **Twenty-Eighth Annual International Pittsburgh Coal Conference**, September 12 - 15, 2011 at the David L. Lawrence Convention Center in Pittsburgh, PA. The opening ceremony will take place on Monday, September 12, 2011. Over 300 technical papers, including posters, will be presented throughout the conference. Technical topics cover a wide spectrum of energy and environmental issues and technologies related to coal and its by-products. For detailed information on technical sessions, papers, and speakers, turn to the Technical Program in this brochure.

TECHNICAL TOUR:

Cardinal Plant

Monday, September 12, 2011

11:00 - Bus Pickup from the Westin Hotel
12:15 - Arrive at plant
2:45 - Depart from plant
4:00 - Arrive at the Westin Hotel
Cost: $50 (Lunch included)

Cardinal Plant is located along the Ohio River south of Brilliant Ohio and represents the first ever alliance between an investor owned utility (AEP) and a member owned utility (Buckeye Power). Buckeye Power is an organization of 25 rural electric cooperatives.

Cardinal Units 1 and 2, put into service in 1967, utilize a double reheat supercritical cycle, are directly cooled from the Ohio River and have a net rating of 600 MW. Cardinal Unit 3, put into service in 1977, utilizes a single reheat supercritical cycle, employs a hyperbolic cooling tower and has a net rating of 630 MW. This unit is also the first and only coal-fired boiler in the U.S. that exhausts through the cooling tower.

All three Units burn high-sulfur eastern bituminous coal and consume about 4.5 Million tons per year. In the early 2000's, the three Units were retrofitted with Selective Catalytic Reduction systems and subsequently with wet FGD. The FGD systems on Units 1 and 2 are in service and that on Unit 3 is under construction.

The Pittsburgh Coal Conference tour will include a description of all 3 Units, and a tour of the Unit 3 facility. There will be an opportunity for questions and answers with the plant staff following the tour.

ACCOMMODATIONS

The Westin Hotel
1000 Penn Avenue
Pittsburgh, PA 15222

Recommended accomodations for the 2011 PCC are at the Westin Hotel in downtown Pittsburgh. The Westin Hotel is connected by a skywalk to the David L. Lawrence Convention Center. The conference rate is $165 per night in either a single or double room. There is an additional $10 charge per person for a room with more than two people.

Please note this group rate is available only until August 12, 2011 and is subject to availability.

To receive this discounted conference rate, please make your reservations directly with the hotel using the link provided on our website.

GATEWAY CLIPPER DINNER CRUISE

Tuesday, September 13, 2011

18:00 - 18:30 - Boarding at the dock
by the Convention Center
18:30 - 21:00 - Dinner and cruising
21:00 - Return to hotel

Please join us for a dinner cruise on Pittsburgh's three rivers! Back by popular demand, this cruise is complimentary for conference attendees, but there is a charge of $45 to bring a spouse or friend. However, you MUST RSVP to the PCC secretary to be included on the cruise. For more information and to RSVP, please visit our website.

PITT AWARD

The Pitt Award for Innovation in Coal was founded by the Chemical and Petroleum Engineering Department, University of Pittsburgh in 1983 through industrial support. Since 1992, it has been fully funded by CONSOL Energy Inc. The Pitt Award, as well as the best paper and poster awards, will be presented at the Awards Luncheon, Thursday, September 15 at 12:00.

CONFERENCE OVERVIEW

MONDAY, SEPTEMBER 12, 2011

Technical Tour	11:00 - 16:00
Registration	15:00 - 19:00
Reception	18:30 - 20:30

TUESDAY, SEPTEMBER 13, 2011

Registration	07:00 - 17:00
Opening Ceremony	08:00 - 08:20
Plenary Session – 1	08:20 - 10:05
Concurrent Tech. Sessions	10:20 - 12:00
Conference Luncheon	12:00 - 13:30
Concurrent Tech. Sessions	13:30 - 17:25
Gateway Clipper Dinner Cruise	18:00 - 21:00

WEDNESDAY, SEPTEMBER 14, 2011

Registration	07:00 - 17:00
Plenary Session – 2	08:20 - 10:05
Concurrent Tech. Sessions	10:20 - 12:00
Conference Luncheon	12:00 - 13:30
Concurrent Tech. Sessions	13:30 - 17:25
Poster Session	18:00 - 21:00

THURSDAY, SEPTEMBER 15, 2011

Registration	07:00 - 17:00
Plenary Session – 3	08:20 - 10:05
Concurrent Tech. Sessions	10:20 - 12:00
Awards Luncheon	12:00 - 13:30
Concurrent Tech. Sessions	13:30 - 17:25
Advisory Board Meeting	18:00 - 20:00

PLENARY SPEAKERS

TUESDAY, SEPTEMBER 13, 2011

Energy Production/Policy Speakers

Charles McConnell
Chief Operating Officer, Fossil Energy
Department of Energy, USA

Thomas J. Bonner
President
Cogentrix Energy, LLC, USA

Steve Herman
Managing Director
Energy Capital Partners, USA

WEDNESDAY, SEPTEMBER 14, 2011

International Issues

Yuzhou Zhang
CEO
Shenhua Group, CHINA

Steve Orlins
President
National Committee on US-China Relations, USA

Sami Demirbilek
CEO
Ciner Group, TURKEY

THURSDAY, SEPTEMBER 15, 2011

Environmental Issues

Anthony Cugini
Director
Department of Energy, USA

Steven Winberg
Vice President, R & D
CONSOL Energy Inc., USA

Frank Princotta
Director, Air Pollution Prevention and Control
Division, USEPA, USA

16:25 - **Extension of Reversible Carbon Dioxide Binding by Frustrated Lewis Pairs to New Phosphine and Amine Bases,** Robert L. Thompson, URS/DOE/NETL; Krishnan Damodaran, University of Pittsburgh,USA

16:45 - **First Principles and Classical Simulations of Ionic Liquids for Carbon Dioxide Capture,** Bo Zhang, J. Karl Johnson, University of Pittsburgh/DOE/NETL,USA

17:05 - **Using Novel Phase Change Solvents or High Molecular Weight Silicone Oil for the Pre-Combustion Capture of CO_2,** Matthew B. Miller, Robert M. Enick, University of Pittsburgh; David R. Luebke, DOE/NETL, USA

SESSION 54
SUSTAINABILITY AND ENVIRONMENT: GENERAL – 3

Jim Hower

15:25 - **The 3rd Assessment of Pennsylvania's ACT 54 – Protecting Structures, Land and Water Supplies from Underground Coal Mine Subsidence Damages, 2003 to 2008,** Anthony Iannacchione, Stephen J. Tonsor, William Harbert, University of Pittsburgh, USA

15:45 - **Projection of Australian Coal Production - Comparisons of Four Models,** Mikael Höök, Uppsala University, SWEDEN; Steve Mohr, Geoffrey Evans, The University of Newcastle; Gavid Mudd, University of New South Wales, AUSTRALIA

16:05 - **EPA Mandatory Reporting Rule and PSD BACT: Effects on Coal, ECBM and Lessons Learned from the First Year of Implementation,** Steven M. Carpenter, Advanced Resources International, Inc., USA

16:25 - **Minimizing Water Discharge and Maximizing Re-Use in Coal Combustion and Conversion Processes,** William A. Shaw, HPD, a Veolia Water Solutions & Technologies Company, USA

16:45 - **Quality and Quantity of Flowback Water in Marcellus Shale Gas Play,** Elise Barbot, Radisav Vidic, University of Pittsburgh, USA

17:05 - **The Activity of the Water Gas Shift Reaction over Copper Based Catalysts with Different Support,** Dong-Hyeok Choi, Joong Beom Lee, Tae Hyoung Eom, Jeom In Baek, Seong Jegarl, Seug-Ran Yang, Keun Woo Park, Chong Kul Ryu, KEPCO Research Institute, KOREA

POSTER SESSIONS
Wednesday, September 14, 2011
18:00 - 21:00

POSTER SESSION 1
COMBUSTION

P1-1 - **Attrition as a Key Parameter for Evaluation of Usefulness the Oxygen Carriers in Chemical Looping Process,** Ewelina Ksepko, Marek Sciazko, Olaf Piotrowski, Institute for Chemical Processing of Coal, POLAND

P1-2 - **Simultaneous NO_x/SO_2 Removal by Ammonia Gas Excited by Atmospheric Plasma,** Shinji Kambara, Yukio Hayakawa, Kazuhiro Kumabe, Hiroshi Moritomi, Gifu University; Megumi Masui, Actree Corporation, JAPAN

P1-3 - **Application of Sewage Sludge Ashes in Chemical Looping Combustion of Solid and Gaseous Fuels,** Ewelina Ksepko, Grzegorz Labojko, Marek Sciazko, Institute for Chemical Processing of Coal, POLAND

P1-4 - **W2 Wobble Plate Prime Mover - Sealed Unit,** Jerry Willis, Admiral Air, Inc., USA

P1-5 - **Morphologies and X-ray Parameters of Inertinite-rich and Vitrinite-rich South African Bituminous Coal Chars,** Enette Louw, Gareth D. Mitchell, Jonathan P. Mathews, The Pennsylvania State University, USA

P1-6 - **Fluidised Bed Combustion of Brown Coal with Different Ash Content,** Osipov Pavel, Ryzhkov Alexander, Remenuk Anastasia, Ural Federal University, RUSSIA; Chernyavskiy Nikolay, Dulienko Sergei, Coal Energy Technology Institute of NAS of Ukraine, UKRAINE

POSTER SESSION 2
GASFICATION

P2-1 - **The Design and Operational Behaviour of a Laboratory Scale Fixed-Bed Gasifier,** Frikkie Conradie, FB Waanders, North West University, SOUTH AFRICA

P2-2 - **Analyses of an Entrained-Bed Coal Gasifier Using a CFD Model Coupled with Chemical Reaction Kinetics,** Tsung Leo Jiang, Tai-Ping Wu, National Cheng Kung University; Ming-Hong Chen, Po-Chung Chen, Yau-Pin Chyou, Institute of Nuclear Energy Research Atomic Energy Council, TAIWAN

P2-3 - **Process Modeling of H_2S Removal from Brazilian Coal Gasification Syngas with MDEA,** Michael Crocetta, Thiago Fernandes de Aquino, Rui de Carvalho Junior, Brazilian Coal Mining Association/DOE/NETL; David Miller, Juan Morinelly, DOE/NETL, USA

P2-4 - **Comparison Study on CO_2-Gasification Reactivity of Different Chars,** Liwei Ren, Jianli Yang, Institute of Coal Chemistry, Chinese Academy of Sciences; Feng Gao, Taiyuan University of Technology, CHINA

P2-5 - **Model-Free Determination of Char-CO_2 Gasification Kinetics from Thermogravimetric Experiments,** Thinesh Vittee, University of the Witwatersrand, SOUTH AFRICA

P2-6 - **Progress of High Concentration Coal Water Slurry (CWS) Preparation Technology from Low Rank Coals and Lignite for CWS Gasification,** Baoqing Li, State Key Lab of Coal Conversion, Institute of Coal Chemistry, Chinese Academy of Sciences; Feng He, Yulin Western Coal Technology Research Center, CHINA

P2-7 - **Application of Brown Coal Pyrolysis Tars in Black Coal Flotation,** Peter Fecko, Eva Pertile, Monika Podesvova, Josip Isek, Konstantin Babic, Lukas Koval, Lukas Pjura, Tien Pham Duc, VŠB – TU Ostrava; Josef Vales, Jaroslav Kusy, Brown Coal Research Institute, CZECH REPUBLIC

P2-8 - **Investigation of Gasification Behavior of Turkish Lignite in a Fluidized Bubbling Bed Gasifier,** Ayşe Tarakçıoğlu, Selahattin Anaç, Ömer Sezgin, Mustafa Zıypak, Vedat Mıhladız, Zeki Olgun, Abdullah Akça, Turkish Coal Enterprises (TKI), TURKEY

P2-9 - **Design of an Atmospheric Bubbling Fluidized Bed for Co-Gasification of Coal and Paper Sludge,** Giovanna de Simone, Stefano Cordiner, Vincenzo Mulone, University of Rome "Tor Vergata", ITALY

P2-10 - **The Resource Utilization of Water Hyacinth by Co-Gasification with Coal,** Haifeng Liu, Qiang Zhang, Jianliang Xu, Xueli Chen, Xin Gong, East China University of Science and Technology, CHINA

P2-11 - **Effect of Bed Diffusion and Operating Parameters on Char Combustion in the Context of Underground Coal Gasification,** Ganesh A Samdani, Shauvik De, Sanjay Mahajani, Anuradda Ganesh, Indian Institute of Technology Bombay, Mumbai; Preeti Aghalayam, Indian Institute of Technology Madras, Chennai; Sapru R. K., Mathur D. K., UCG Group, IRS, ONGC, INDIA

P2-12 - **Kinetic Studies of CO_2 Gasification in the Context of Underground Coal Gasification,** Ramesh Naidu Mandapati, Sateesh Daggupati, Naresh Hanchate, Sanjay Mahajani, Anuradda Ganesh, Indian Institute of Technology Bombay, Mumbai; Preeti Aghalayam, Indian Institute of Technology Madras, Chennai; Sapru R. K., Pal A.K., UCG Group, IRS, ONGC, INDIA

P2 -13 - **Development and Application of Entrained-flow Coal Gasification Technology of ECUST,** Xin Gong, Jianliang Xu, Xueli Chen, Zhenhua Dai, Haifeng Liu, East China University of Science and Technology, CHINA

P2-14 - **Autothermal Reforming of Methane to Syngas Over Y_2O_3-Modified Ni/γ-Al_2O_3 Catalysts,** Yizhuo Han, Yisheng Tan, Qingde Zhang, State Key Laboratory of Coal Conversion, Institute of Coal Chemistry, Chinese Academy of Sciences; Laizhi Sun, Graduate University of Chinese Academy of Sciences, CHINA

P2-15 - **Methane Reforming with Carbon Dioxide Over Nanostructured CO-Ni Catalysts,** N.V. Shikina, Z.R. Ismagilov, S.A. Yashnik, V.V. Kuznetsov, I.Z.Ismagilov, Boreskov Institute of Catalysis SB RAS, RUSSIA; G.B. Aldashukurova, Z. A. Mansurov, Institute for Problems in Combustion of the Kazakh Committee of Science, KAZAKHSTAN

P2-16 - **Methane Reforming with Carbon Dioxide Over Nickel-Uranium Catalysts,** Z.R. Ismagilov, S.V. Lazareva, N.V. Shikina, V.V. Kuznetsov, M.A. Kerzhentsev, Boreskov Institute of Catalysis of the Siberian Branch of the RAS, RUSSIA

P2-17 - **New Technologies for Monitoring UCG,** R. J. Mellors, X. Yang, S. Hunter, J. Wagoner, W. Foxall, D. Camp, S. J. Friedmann, Lawrence Livermore National Laboratory, USA

P2-18 - **A Study on Mass Transfer Coefficients in Underground Coal Gasification Cavities,** Sateesh Daggupati, Ramesh N. Mandapati, Sanjay M. Mahajani, Preeti Aghalayam, Naresh D. Hanchate, Anuradda Ganesh, IIT Bombay; Mathur D.K., Sharma R.K., IRS, ONGC, INDIA

P2-19 - **Mitigating Environmental Risk of UCG Project by Detail Studies of its Geology & Hydrogeology,** Pankaj Bhuyan, D.K. Mathur, R.P. Singh, A. Kumar, M.M. Dwivedi, UCG group, IRS, Oil and Natural Gas Corporation Ltd. (ONGC), INDIA

POSTER SESSION 3
SUSTAINABILITY AND ENVIRONMENT

P3-1 - **Fotoelectrochemical Properties of Thick Films from in Natura Pyrite,** Michael Peterson, Márcio Antônio Fiori, Universidade do Extremo Sul Catarinense; Adilson Oliveira da Silva, Formula Indústria Química do Brasil, BRAZIL

P3-2 - **A CUBIC MILE OF OIL: Realities and Options for Averting the Looming Global Energy Crisis,** Ripudaman Malhotra, SRI International, USA

P3-3 - **Impact of Underground Exploitation in Romania to Civil Constructions,** Chirila Danut, University of Petrosani, ROMANIA

P3-4 - **Quartz in Thermal Coals of India: Its Measurement, Abundance and Impact in Power Plant and Environment,** Anup Kumar Bandopadhyay, Shobha Kumari, Rawesh Kumar, J K Pandey, Central Institute of Mining and Fuel Research, INDIA

P3-5 - **Integrated Solar Combined Cycle System to Achieve Near-Zero Emissions of Pollutants and**

16:15 - **The Medicine Bow Industrial Gasification and Liquefaction Project --- Project Update,** Robert Kelly, Jon Doyle, DKRW Advanced Fuels LLC, USA

16:40 - **Building a Cleantech USA "The New U.S. Synthetic Fuel Industry",** H. H. Graves, USA Synthetic Fuel Corporation, USA

SESSION 32
GASIFICATION:
MODELING – 2
Kristin Gerdes and Mehrdad Shahnam

15:25 - **Development of Advanced Gasification Kinetics Models for CFD (and Process Simulation) Codes,** Kiran Chaudhari, Richard Turton, West Virginia University; Chris Guenther, Mehrdad Shahnam, Ronald W. Breault, DOE/NETL; Aytekin Gel, ALPEMI Consulting, LLC; Philip Nicoletti, Tingwen Li, URS/DOE/NETL, USA

15:45 - **Numerical Analysis of Gasification Performance via Finite-Rate Model in a Cross-Type Two-Stage Gasifier,** Yau-Pin Chyou, Yan-Tsan Luan, Institute of Nuclear Research, Atomic Energy Council, TAIWAN; Ting Wang, University of New Orleans, USA

16:05 - **Development of a Devolatilization Model in Multi-Phase Simulation of a Mild Gasifier with a Draft Tube,** Jobaidur R. Khan, Ting Wang, University of New Orleans, USA

16:25 - **Numerical Simulation of coal Gasification in OMB Coal Gasifier,** Jianliang Xu, Xueli Chen, Zhenhua Dai, Haifeng Liu, Xin Gong, East China University of Science and Technology, CHINA

16:45 - **A Low-Dimensional Model for Detailed Simulation of Coal Gasification Systems**, James C. Sutherland, Naveen Punati, Babak Goshayeshi, University of Utah, USA

17:05 - **Studies on Spalling of Indian Coal in the Context of Underground Coal Gasification**, Sminu Bhaskaran, Sanjay Mahajani, Anuradda Ganesh, Indian Institute of Technology Bombay, Mumbai; Preeti Aghalayam, Indian Institute of Technology Madras, Chennai; Sapru R. K., Mathur D. K., UCG Group, IRS, ONGC, INDIA

SESSION 33
COAL-DERIVED PRODUCTS:
GENERAL – 6
Belma Demirel and Steve Xiao

15:25 - **The Effects of Catalytic Additives on the Reactivity of Metallurgical Coke under CO_2 Atmosphere,** J.H. Choi, E.J Kim, W.J. Lee, I.K. Suh, Raw Material Research Group of POSCO, KOREA

15:45 - **Studies on the Effect of High Temperature Carbonization Up to 2400°C on Coke Property from Tertiary Coal of North Eastern Region of India,** Ujjal Bhattacharjee, Atulya Bhattacharjya, Central Institute of Mining & Fuel Research, INDIA

16:05 - **Scavenging of Hazardous Organic Pollutants from Aqueous Waste Using Activated Carbon Prepared from Indian Coal,** Shripal Singh, Pragya Patil, Central Institute of Mining and Fuel Research, INDIA

16:25 - **The Possibility of Utilization of Carbon Black from Pyrolysis of Municipal Waste,** Dagmar Juchelková, Helena Raclavska, Adela Cízkova, Ondrej Zajonc, VSB-Technical University of Ostrava, CZECH REPUBLIC

16:45 - **Closure Turf: A New Approach to Coal Ash Closures**, Lindsey Agricola, Agru; Mike Ayers, Jose Urrutia, ClosureTurf, USA

17:05 - **Rapid Coal Pyrolysis to Acetylene in Multi-Stage Thermal Plasma Reactor,** Yi Cheng, Binhang Yan, Tsinghua University; Cliff Y. Guo, Xuan Li, Changning Wu, National Institute of Clean-and-low-carbon Energy, CHINA

SESSION 34
CARBON MANAGEMENT:
SECARB-ED CCS TRAINING SESSION – 2
Jack Pashin and Steve Carpenter

15:25 - **Water in Carbon Capture and Sequestration: Challenges and Opportunities,** James W. Castle, John H. Rodgers, Jr., John R. Wagner, Clemson University; Gerald R. Hill, Southern States Energy Board, USA

15:45 - **Clean Coal Technology Development and its Impact on the Energy Industry in the Southeastern United States,** Jack Pashin, Geological Survey of Alabama, USA

16:05 - **CO_2 Sequestration in Unmineable Coal with Enhanced Coal Bed Methane Recovery: The Marshall County Project,** James E. Locke, Richard A. Winschel, CONSOL Energy Inc.; Richard A. Bajura, Thomas H. Wilson, Hema J. Siriwardane, Henry Rauch, Douglas Patchen, Shahab D. Mohaghegh, West Virginia University; Arthur W. Wells, DOE/NETL, USA

16:25 - **China Coal and Carbon Capture and Storage (CCS)**, Timothy R Carr, West Virginia University, USA

16:45 - **Public Outreach and CCS: A Critical Analysis**, Brad Kelley, Nino S. Ripepi, Virginia Center for Coal and Energy Research at Virginia Tech, USA

SESSION 35
COMBUSTION:
CHEMICAL LOOPING – 2
John Wheeldon and Evan Granite

15:25 - **Alstom's Calcium Oxide Chemical Looping Prototype, Program Update**, Herbert E. Andrus, Jr., John H. Chiu, Paul R. Thibeault, Carl D. Edberg, Alstom Power Inc.; Bruce Lani, DOE/NETL, USA

15:45 - **Iron Based Chemical Looping Processes Developed at The Ohio State University,** Deepak Sridhar, Liang Zeng, Andrew Tong, Rae Kim, Zhenchao Sun, Siwei Luo, Liang-Shih Fan, The Ohio State University, USA

16:05 - **Comparative Investigation on Chemical Looping Combustion of Coal-Derived Synthesis Gas Containing H_2S Over Supported Bimetallic Fe_2O_3- MnO_2 and Fe_2O_3 - CuO Oxygen Carriers,** Ewelina Ksepko, Marek Sciazko, Institute for Chemical Processing of Coal, POLAND; Hanjing Tian, Thomas Simonyi, Parsons; Ranjani V. Siriwardane, DOE/NETL, USA

16:25 - **Chemical Looping with Oxygen Uncoupling: Exploring Opportunities by Process Modeling and Interpretation of Experimental Data**, JoAnn S. Lighty, Asad H. Sahir, Adel F. Sarofim, University of Utah, USA

16:45 - **Modeling, Simulation and Advanced Controls for Prototype Chemical Looping Process,** Abhinaya Joshi, Jie Luo, Xinsheng Lou, Carl Neuschaefer, Alstom Power Inc., USA

17:05 - **Study the Effects of Hydration on the CO_2 Adsorption Capacity of Calcium-Based Sorbents with Density Functional Theory Calculation**, Siwei Luo, Fuchen Yu, L.-S. Fan, The Ohio State University, USA

SESSION 36
COAL SCIENCE:
COAL SCIENCE – 2
Jim Hower and Leslie Ruppert

15:25 - **Influence of Discard Mineral Matter on Slag-Liquid Formation and Ash Melting Properties of Coal - A Factsage Simulation Study**, JC van Dyk, MJ Keyser, Sasol Technology R&D, SOUTH AFRICA

15:45 - **Coal It's Elementary My Dear Watson**, Jonathan P. Mathews, Vijayaragavan Krishnamoorthy, Enette Louw, Aime H. N. Tchapda, Fidel Castro-Marcano, Vamsi Karri, Dennis A. Alexis, Gareth D. Mitchell, The Pennsylvania State University, USA

16:05 - **Full-Scale Mercury Control Demonstrations: ICR Sampling with Mercury Control**, Jason Laumb, John Kay, Energy & Environmental Research Center, University of North Dakota; Mark Thoma, Otter Tail Power Company, USA

16:25 - **Mercury Speciation and Emission from Pilot-scale PC Furnaces under Air- and Oxy-fired Conditions**, Brydger Van Otten, Andrew Fry, Brad Adams, Reaction Engineering International; Larry Bool, Praxair Inc., USA

16:45 - **The US-China Clean Energy Research Center: Coal Developments**, Jerald J. Fletcher, US-China Energy Center at West Virginia University, USA

17:05 - **The Effect of the Boudouard-reaction on Reaction Rates of Coal Chars in CO_2/O_2- and N_2/O_2-Atmospheres at Oxygen Contents from 0% to 30%**, Dominik Christ, Malte Förster, Reinhold Kneer, RWTH Aachen University, GERMANY

ORAL SESSIONS
Thursday, September 15, 2011
10:20 - 17:25

SESSION 37
MAJOR CCS DEMONSTRATION PROJECTS:
GENERAL – 4
J. Hoffman and C. Miller

10:20 - **Status of the FutureGen 2.0 Oxy-Combustion Large Scale Test Project,** Mark H. Williford, David W. Burbridge, Ameren Energy Resources, USA

10:45 - **FutureGen 2.0 Oxy-Combustion Repowering at Meredosia,** Steve Moorman, Babcock & Wilcox, USA

11:10 - **Air Liquide's Global Roadmap Toward the Industrialization of Oxy-Combustion,** Roger Gilchrist, Mark Estopinal, Etienne Sturm, Jerry Oliver, Air Liquide Engineering & Construction, USA

11:35 - **FutureGen 2.0 CO_2 Transportation & Geologic Sequestration,** Steve Winberg, CONSOL Energy Inc.,USA

SESSION 38
GASIFICATION:
FUNDAMENTALS
Jenny Tennant and Pete Rozell

10:20 - **Mineralogical Analysis of Coal Chars Obtained by High Temperature Gasification of Gravity and Size Separated Fractions of a High Volatile Bituminous Coal,** Nari Soundarrajan, LaTosha M. Gibson, Nandakumar Krishnamurthy, Sarma V. Pisupati, Pennsylvania State University; Lawrence J. Shadle, DOE/NETL, USA

10:40 - **Particle Deposition Predictions by Critical Viscosity and Mechanistic Particle Deposition Models,** John M. Kuhlman, Weiguo Ai, West Virginia University, USA

11:00 - **Coal Ash Behavior in Reducing Environments (CABRE) III,** Joshua J. Stanislowski, Donald P. McCollor, Kevin C. Galbreath, Daniel H. Schwitalla, University of North Dakota, USA

(二) Plenary Session 相關圖片

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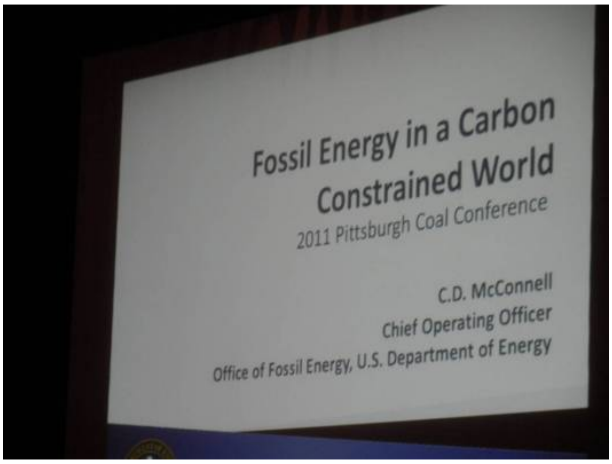

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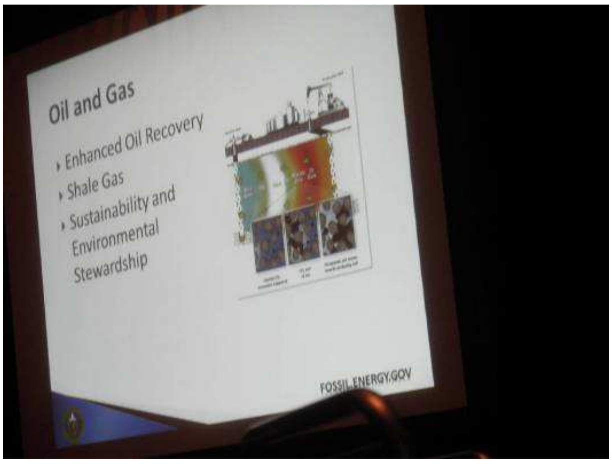

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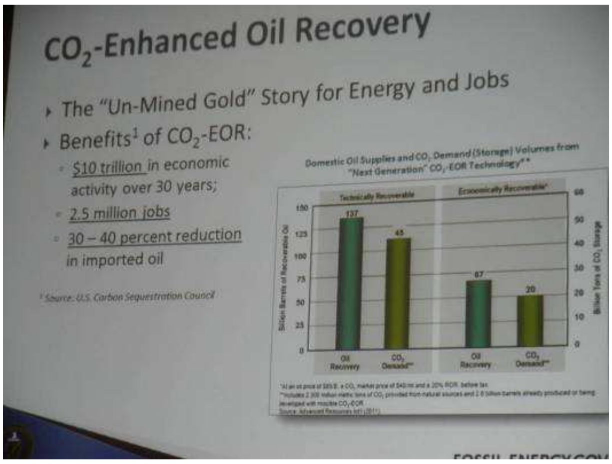

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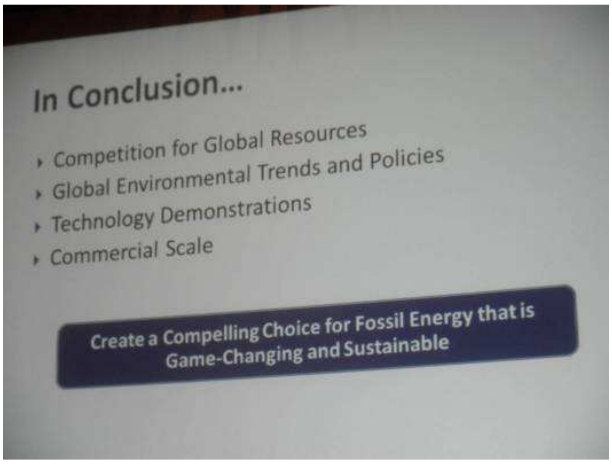

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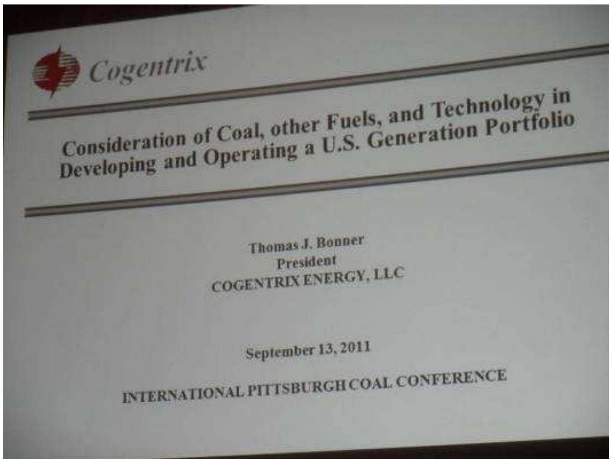

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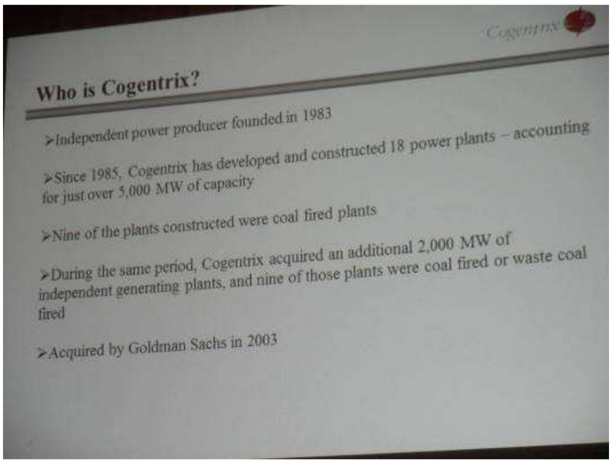

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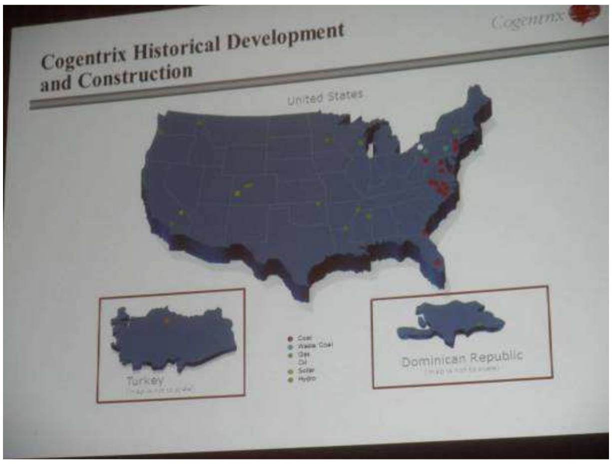

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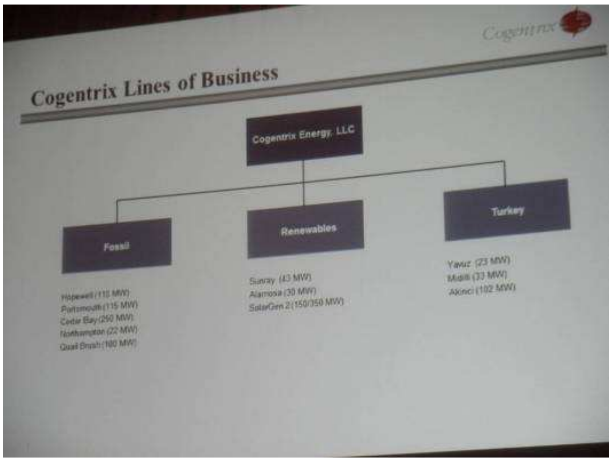

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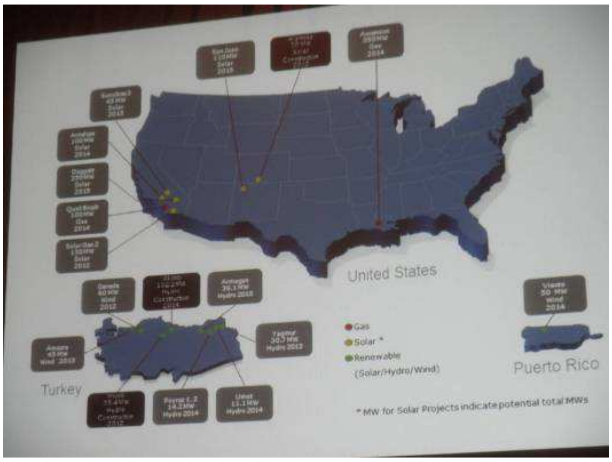

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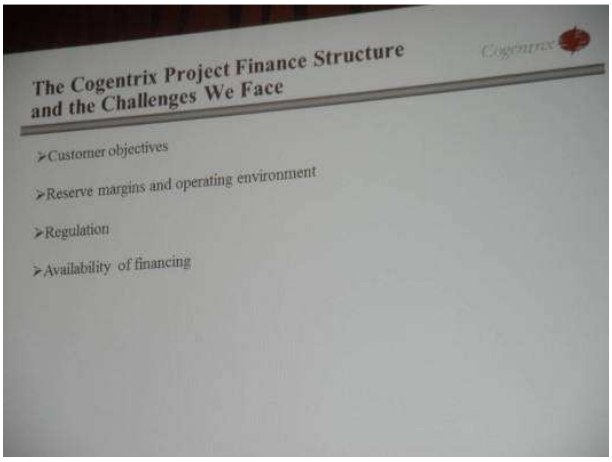

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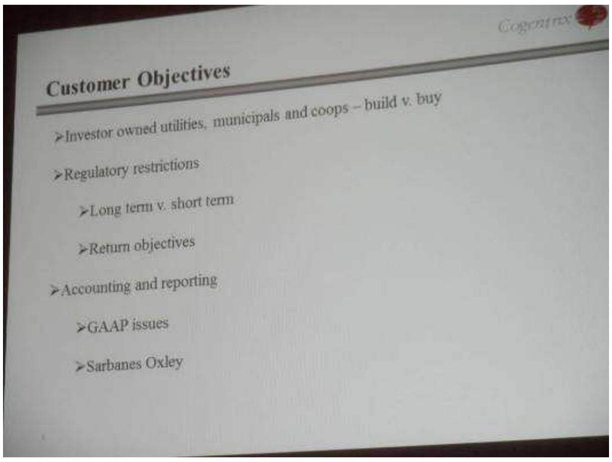

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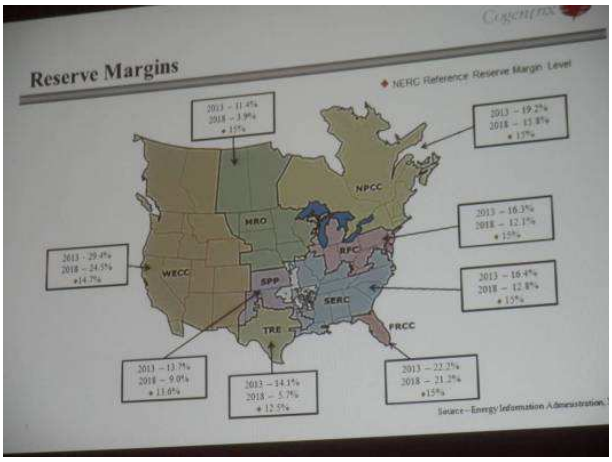

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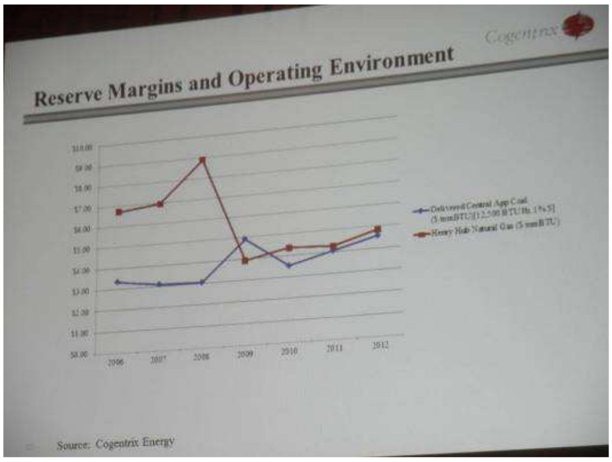

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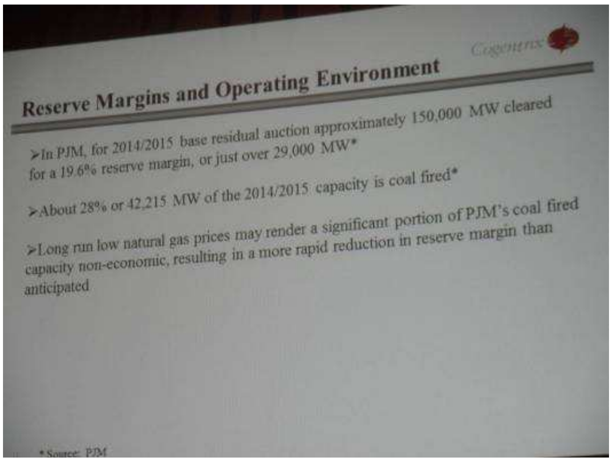

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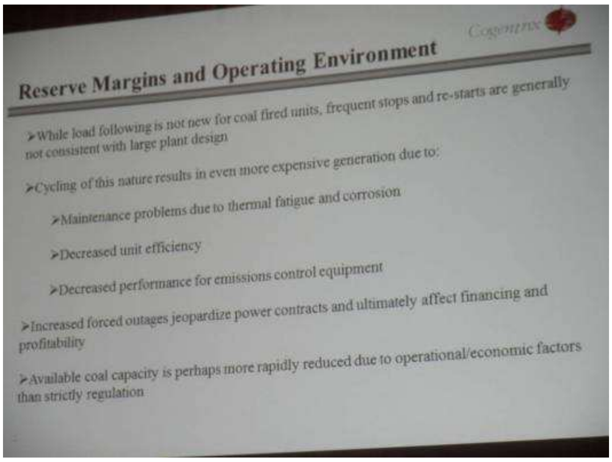

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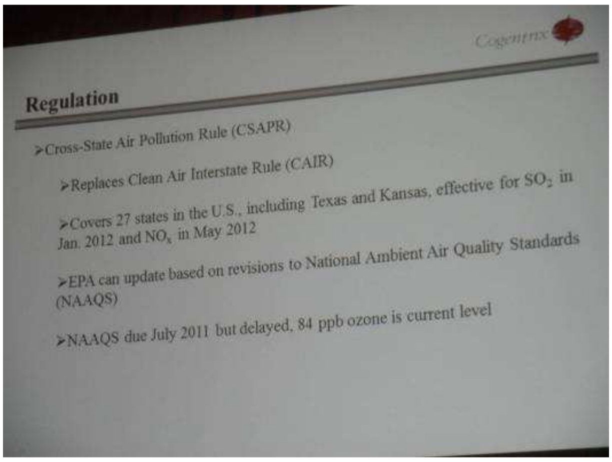

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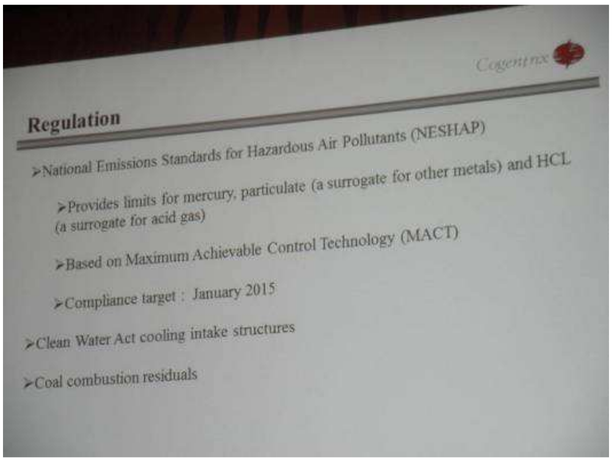

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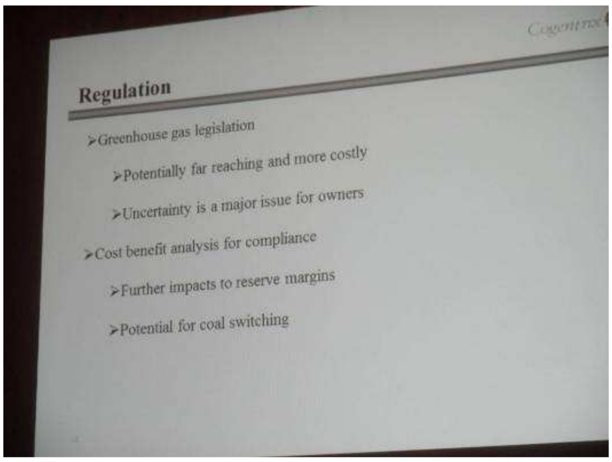

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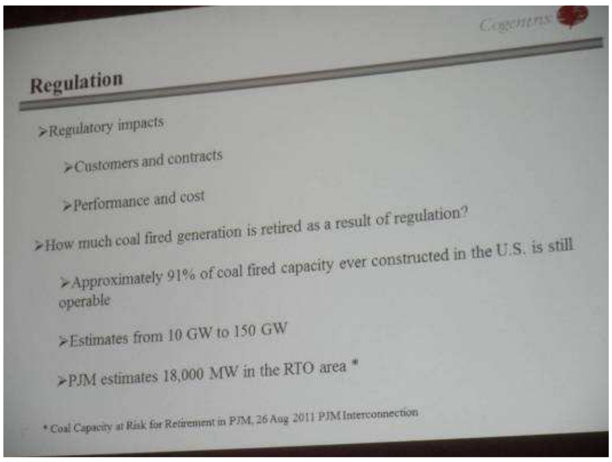

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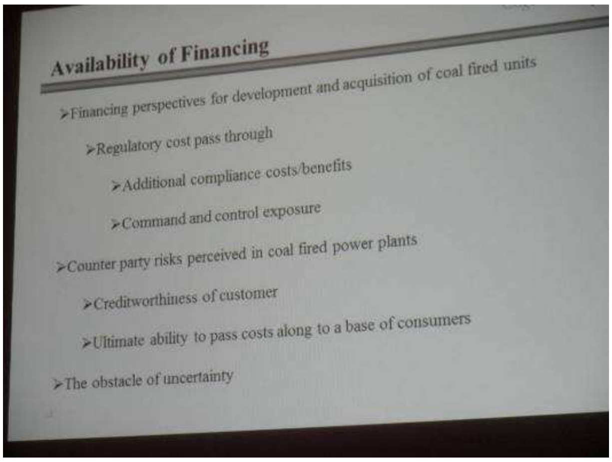

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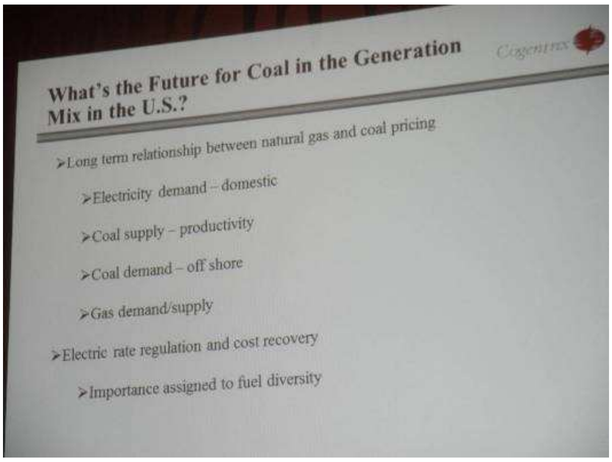

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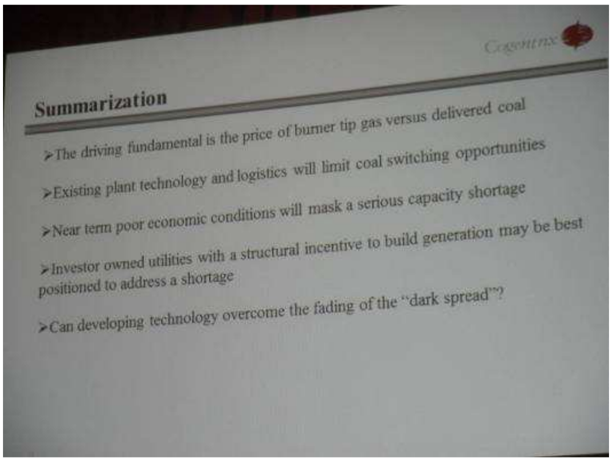

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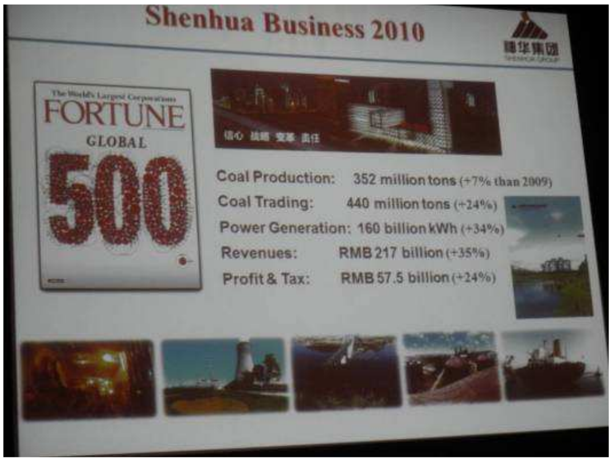

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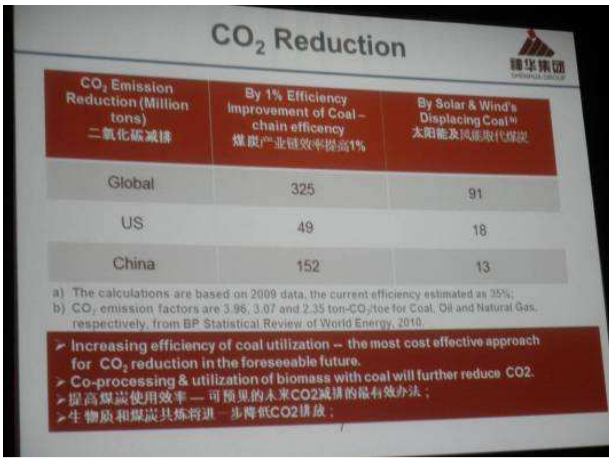

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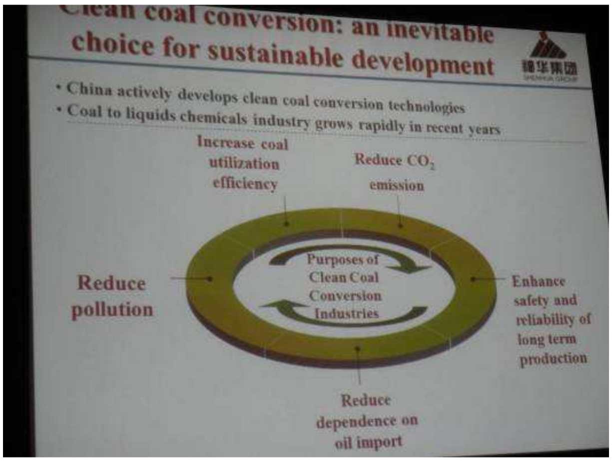

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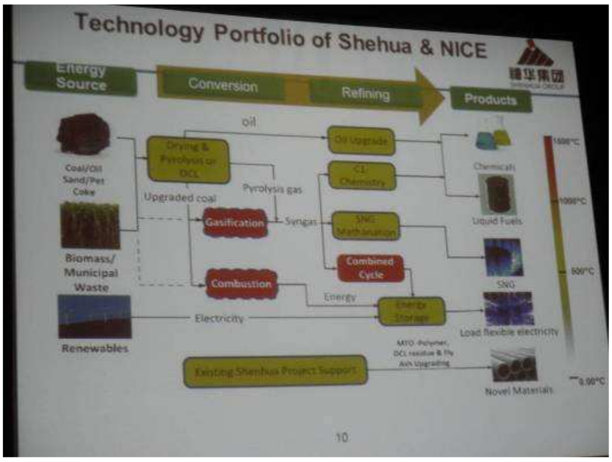

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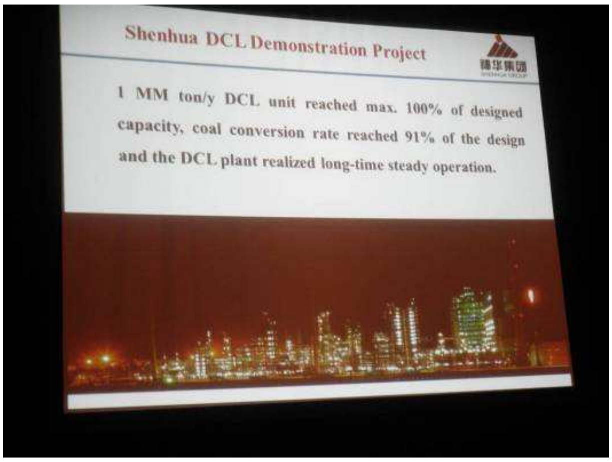

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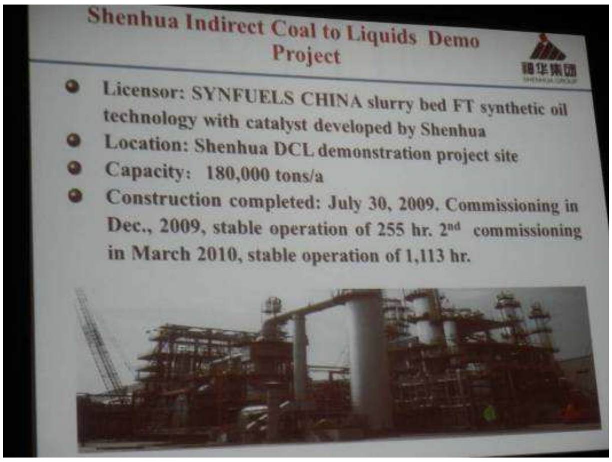

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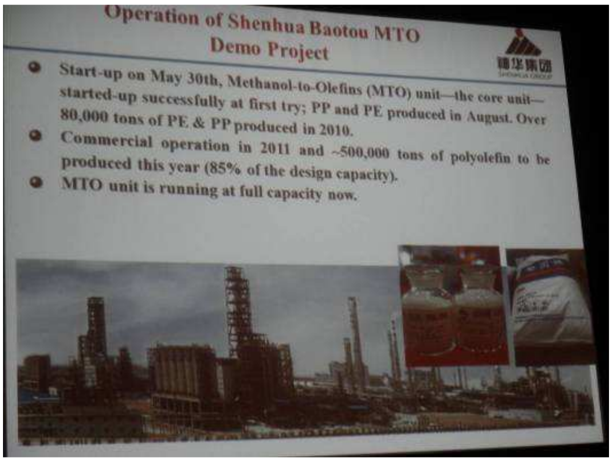

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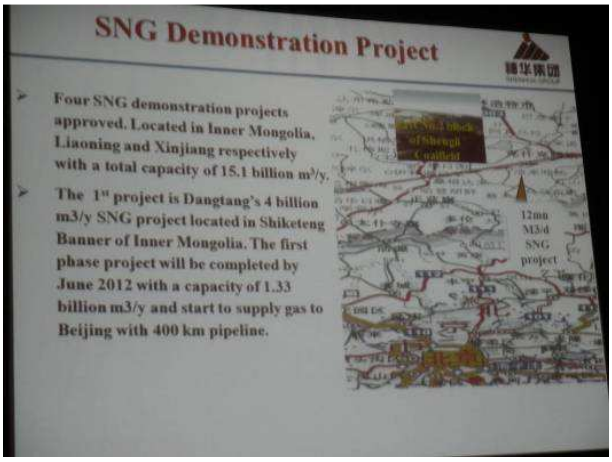

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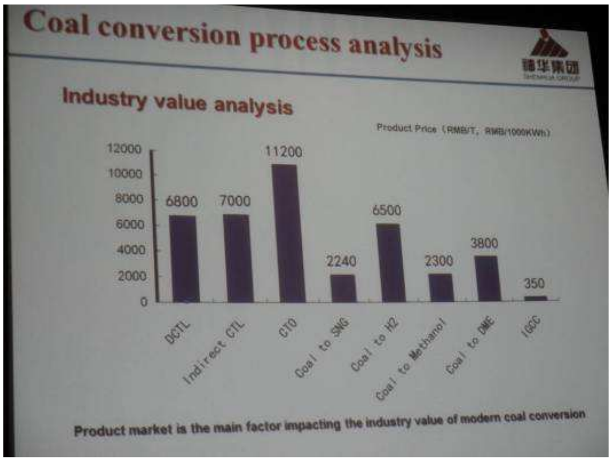

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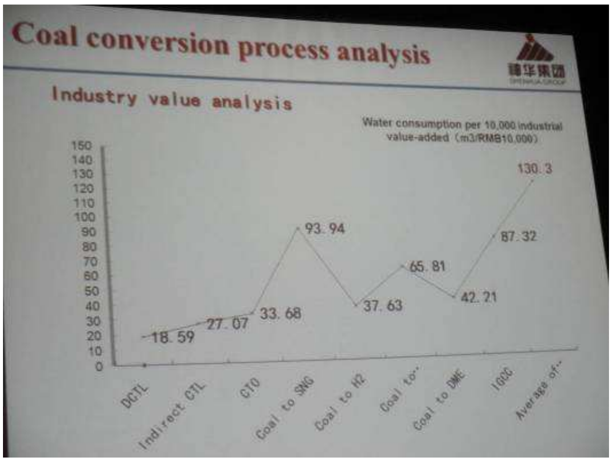

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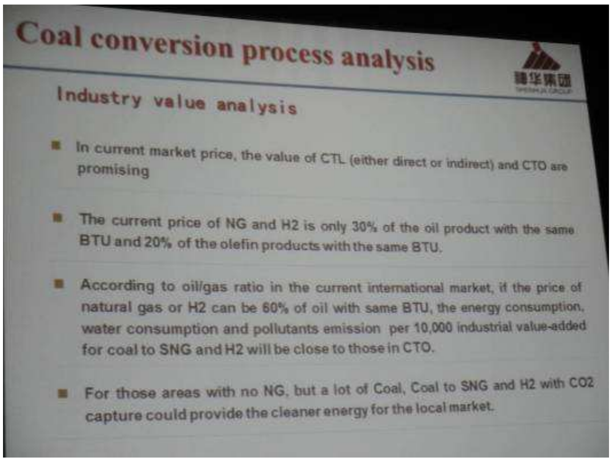

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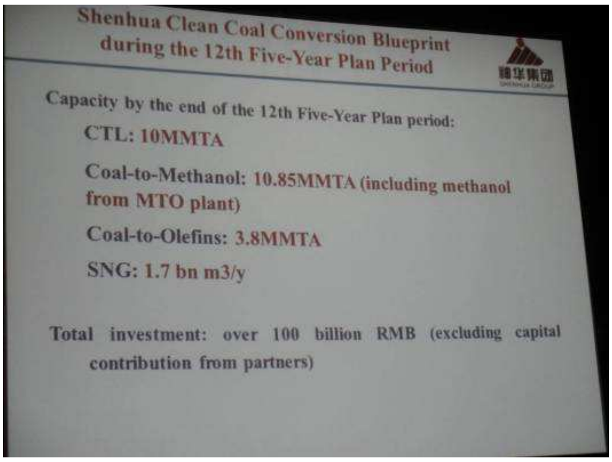

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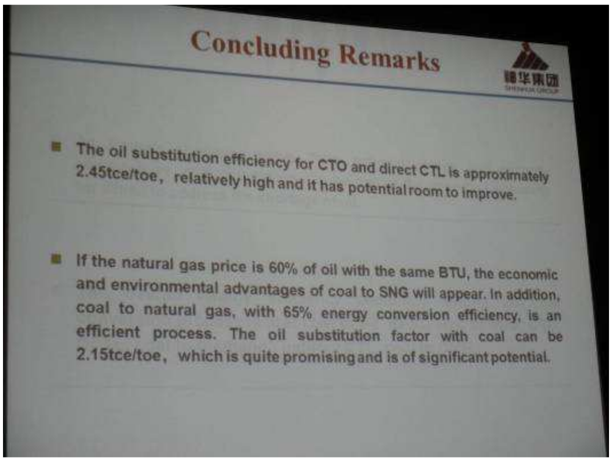

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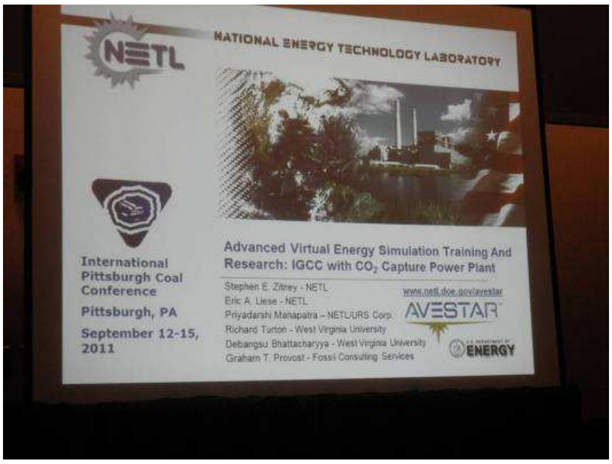
(三) Technical Paper Session 相關圖片



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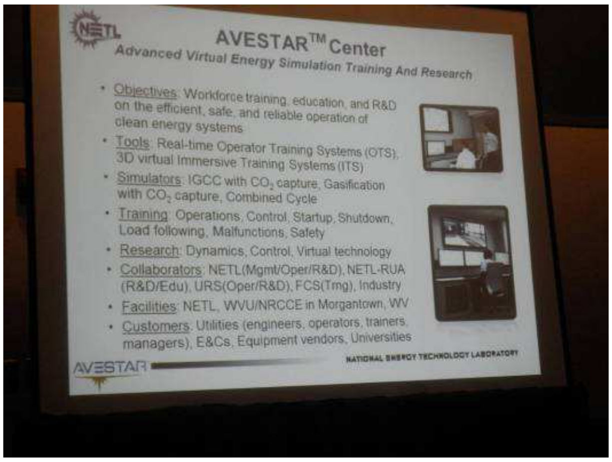

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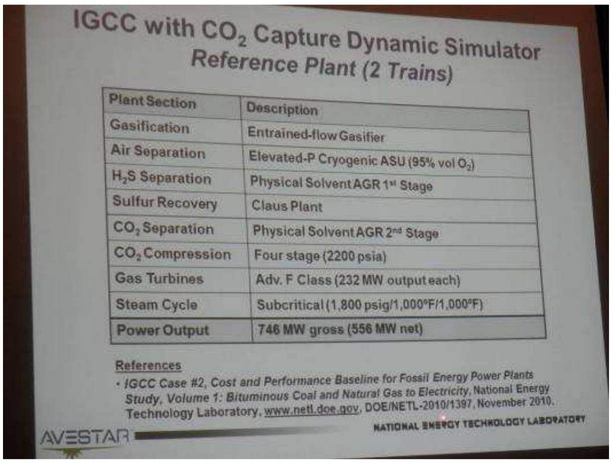

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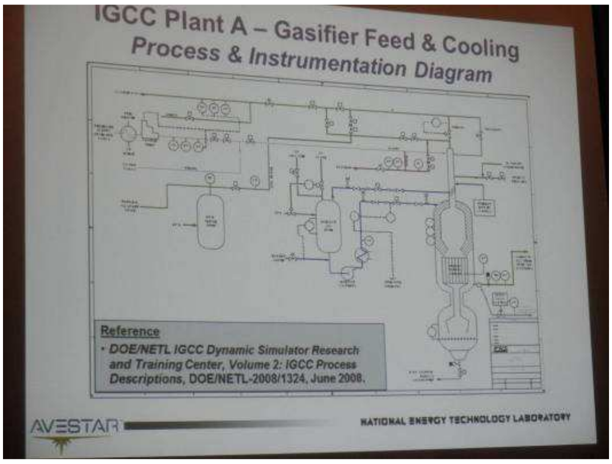

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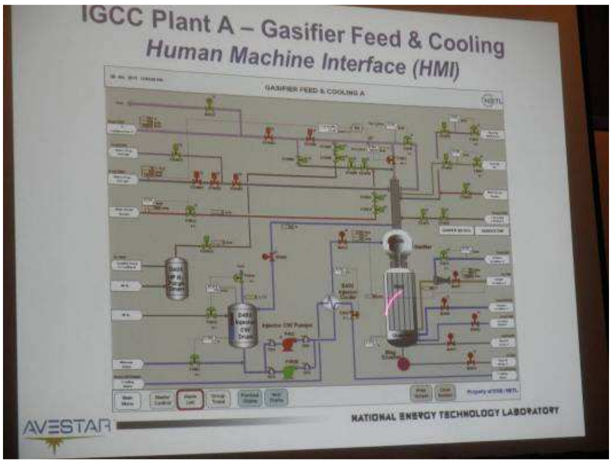

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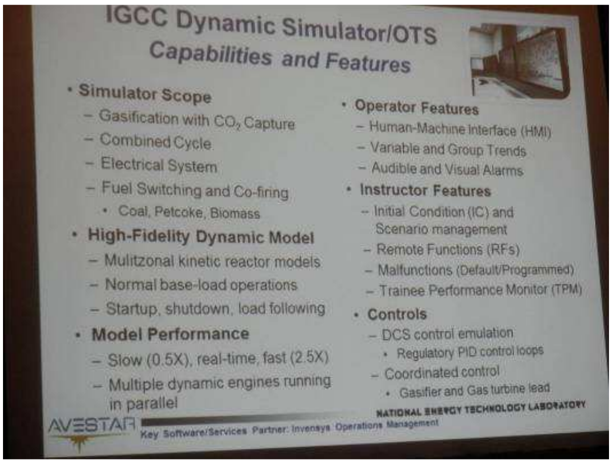

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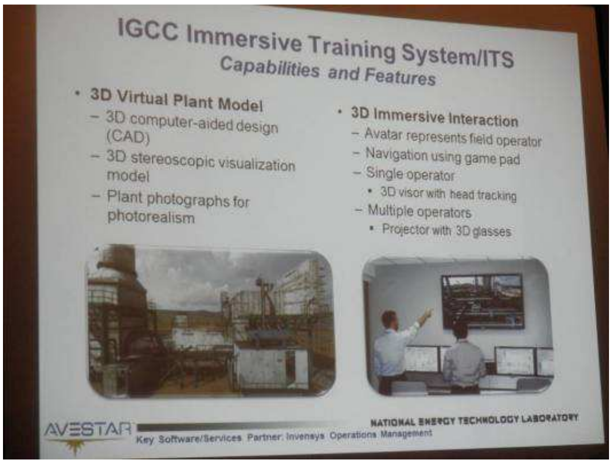

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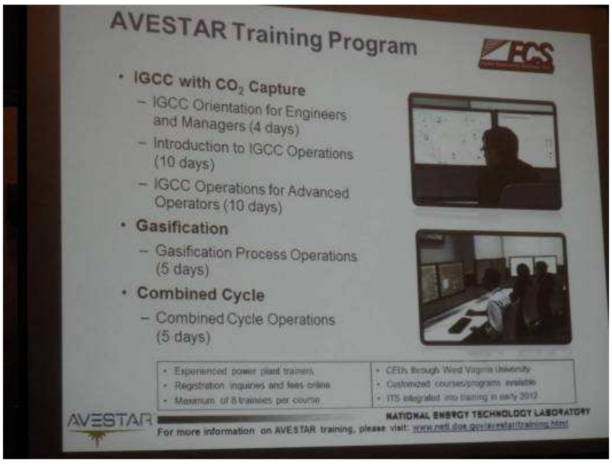

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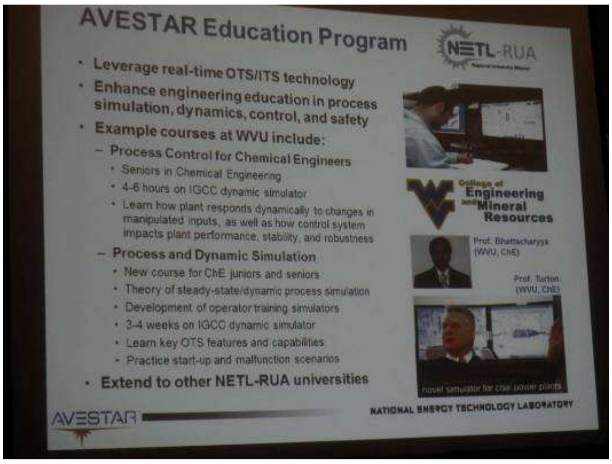

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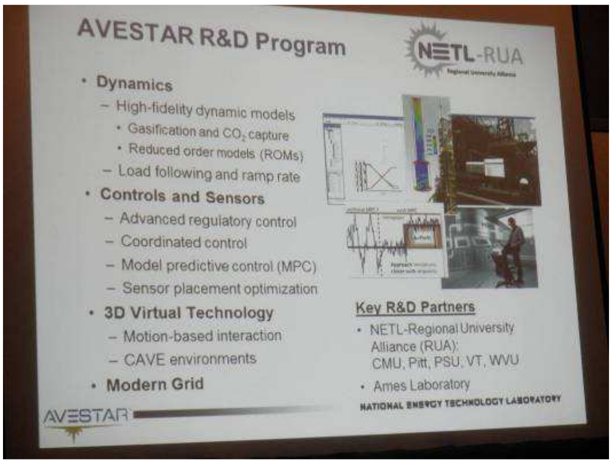

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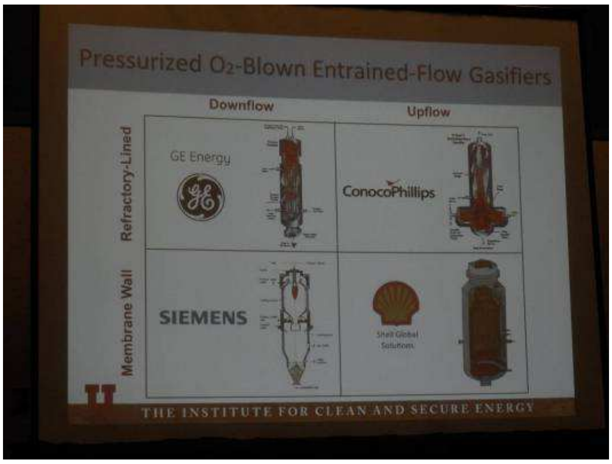

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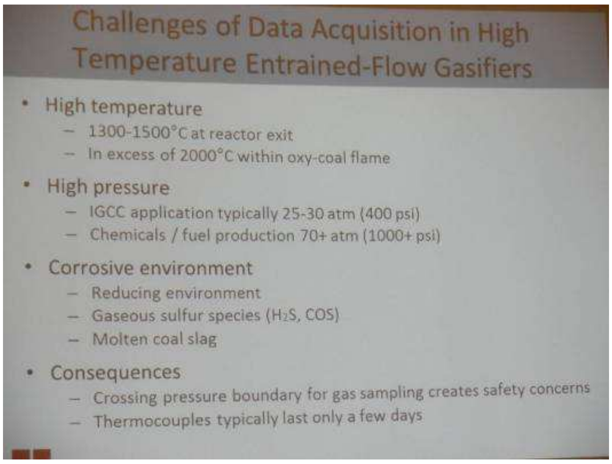

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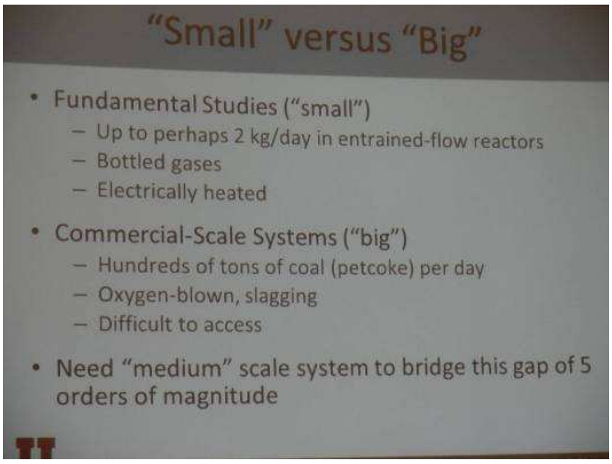

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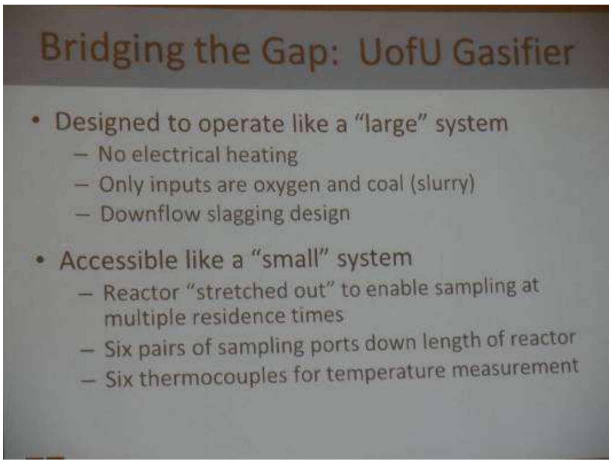

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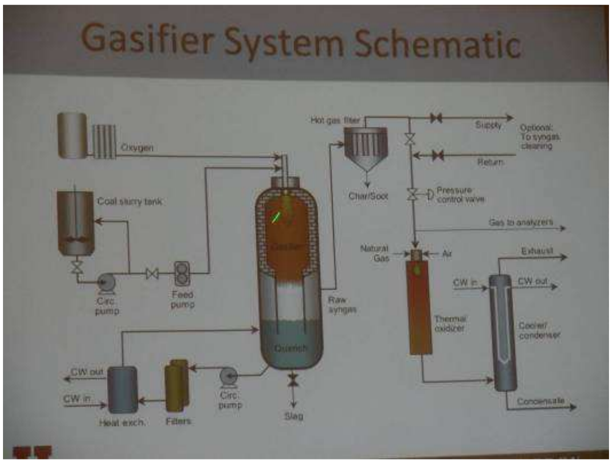

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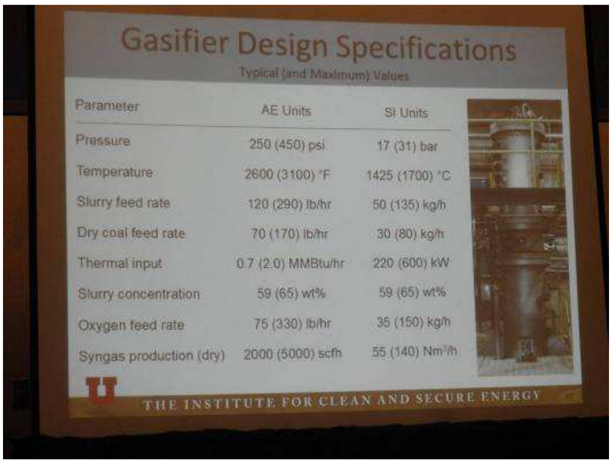

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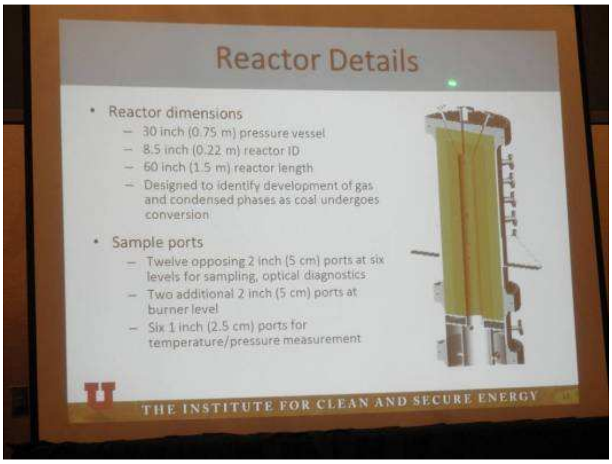

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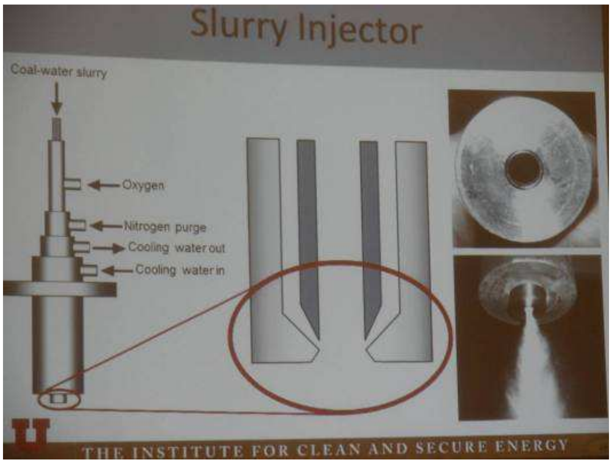

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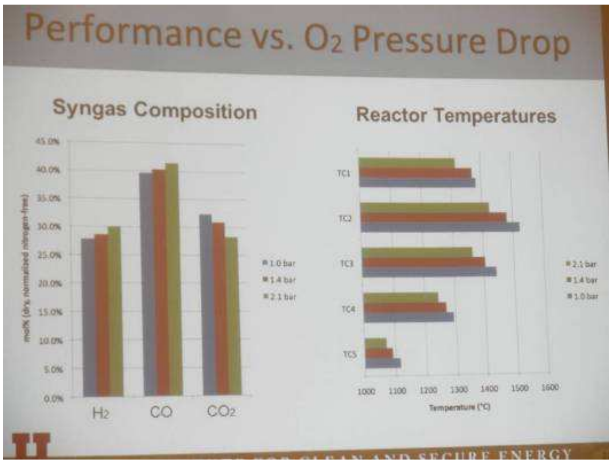

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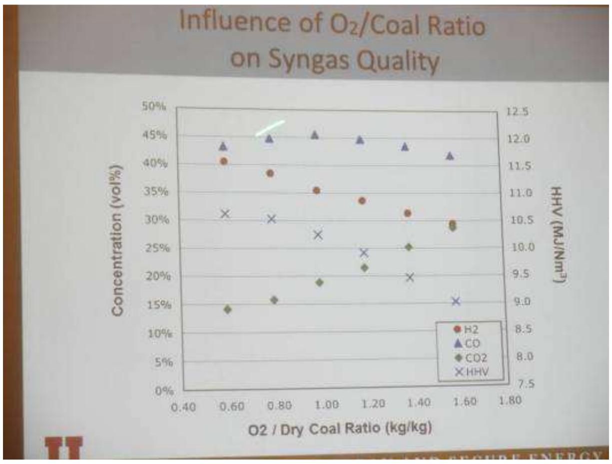

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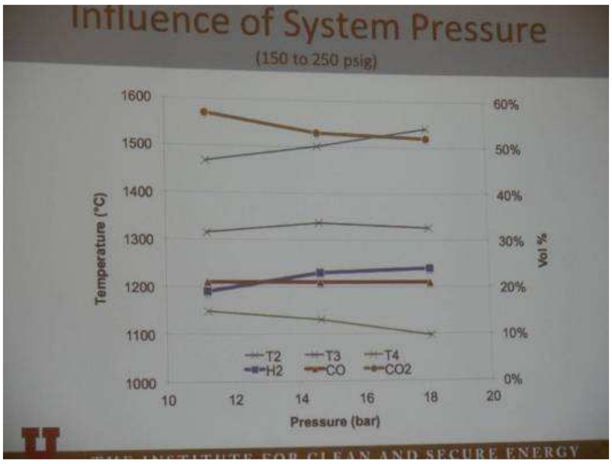

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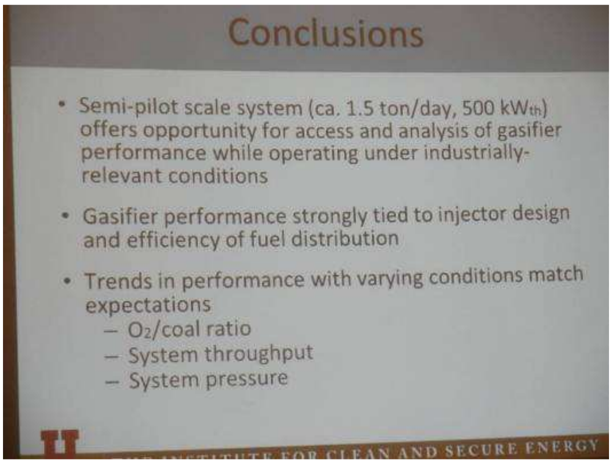

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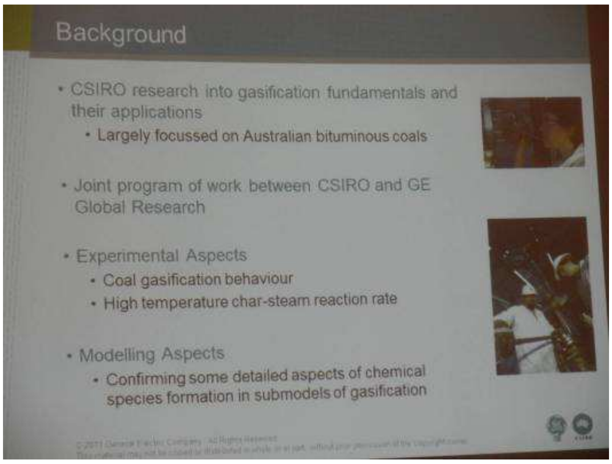

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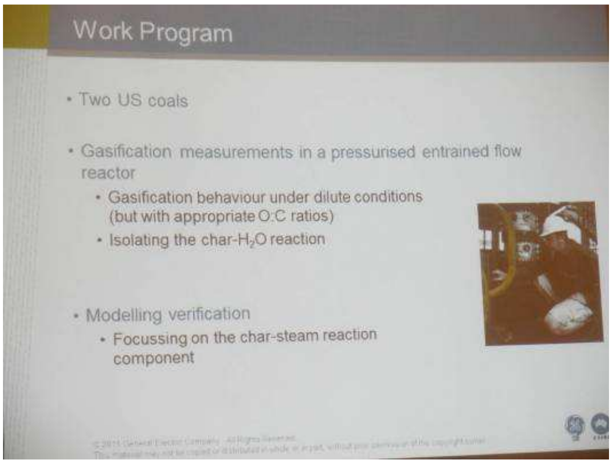

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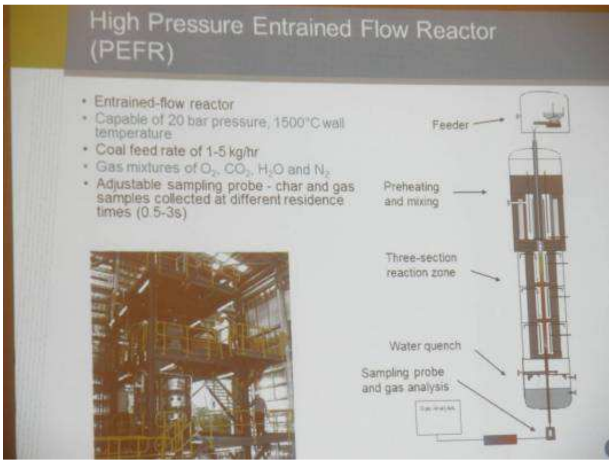

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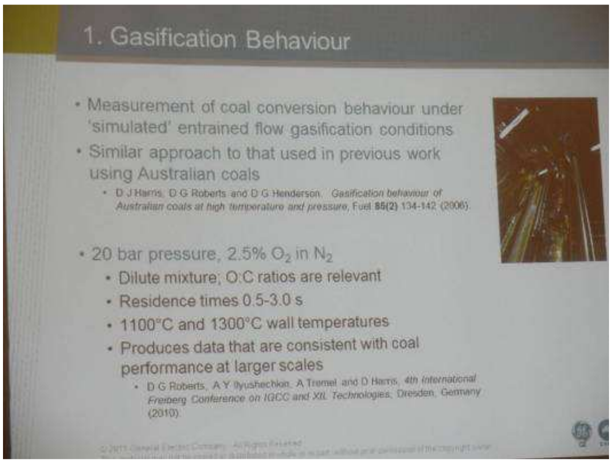

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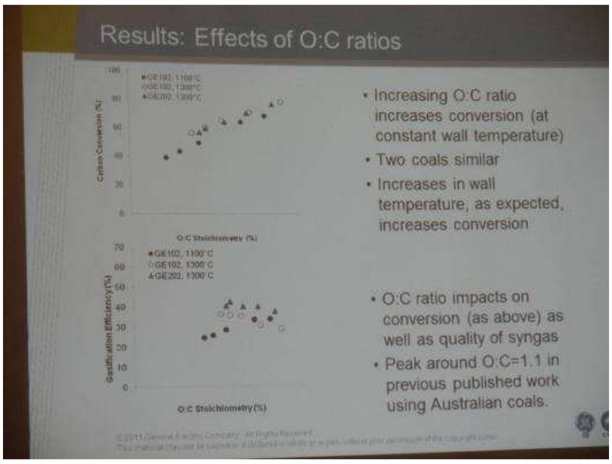

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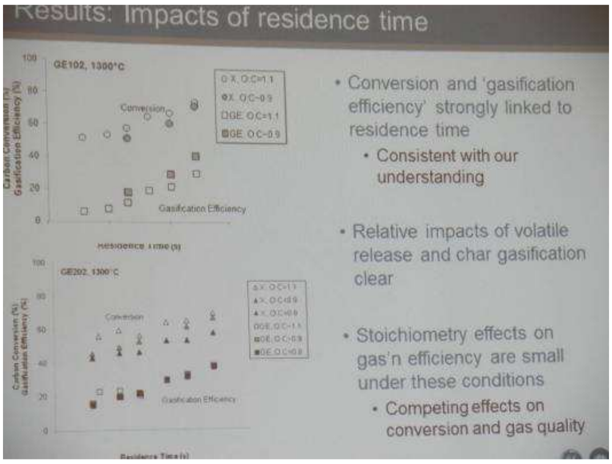

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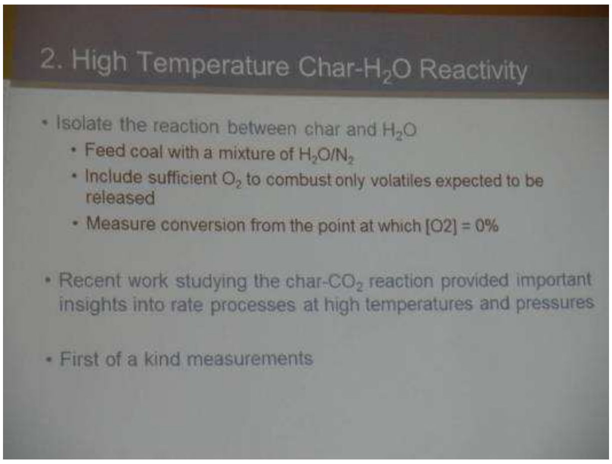

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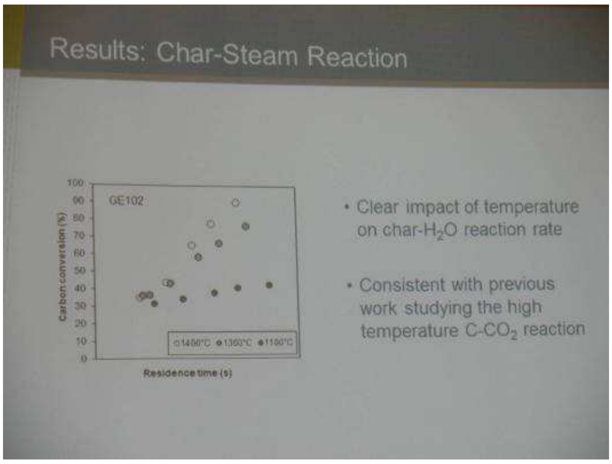

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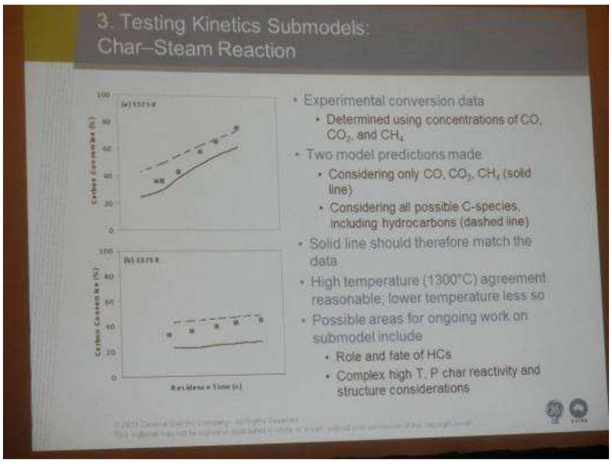

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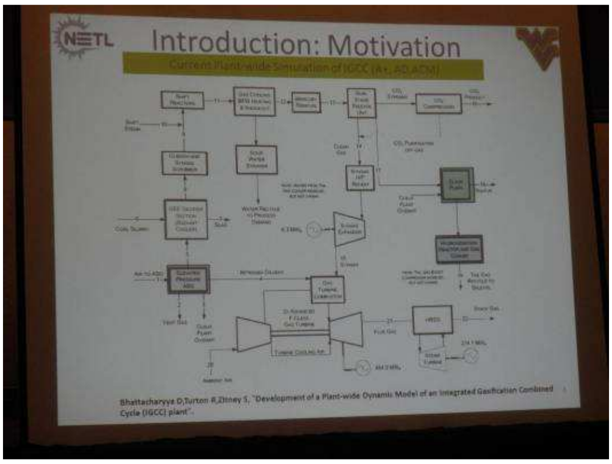

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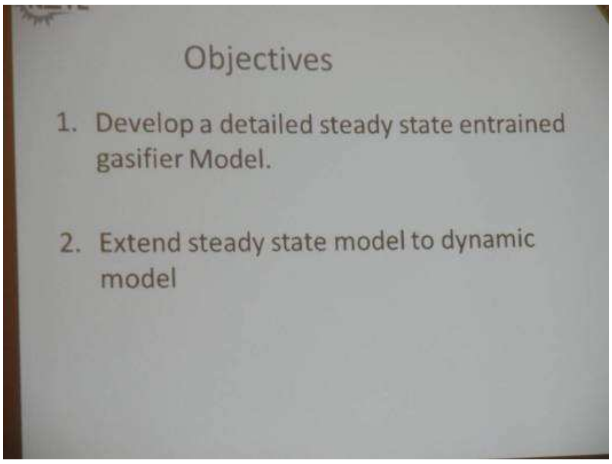

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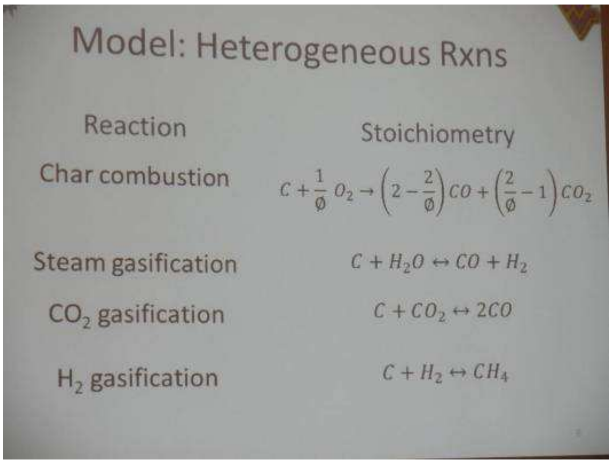

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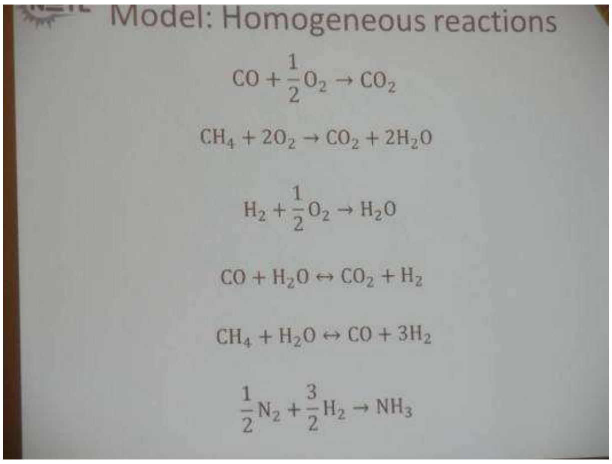

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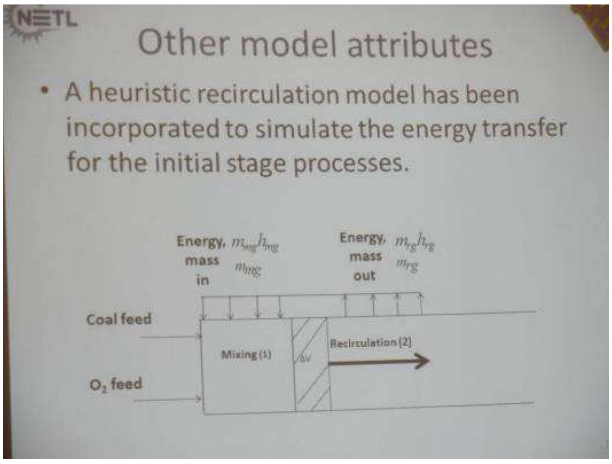

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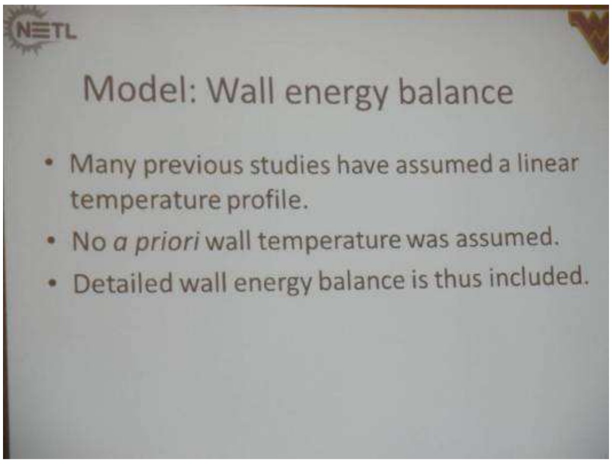

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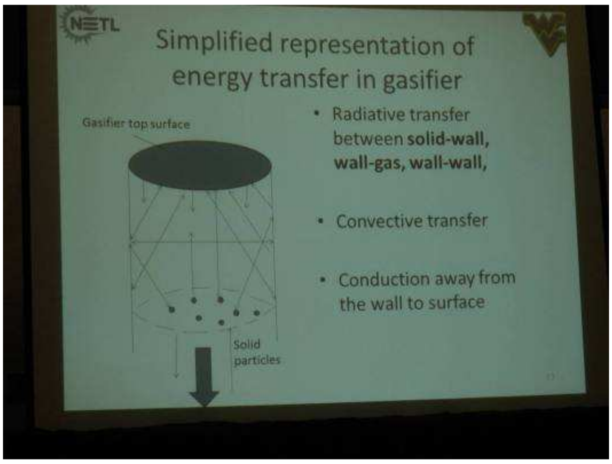

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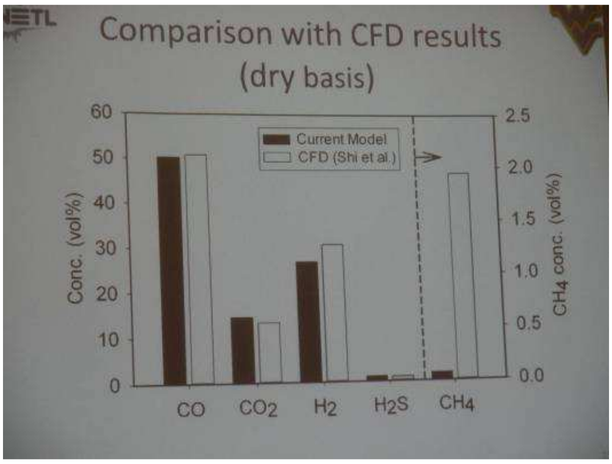

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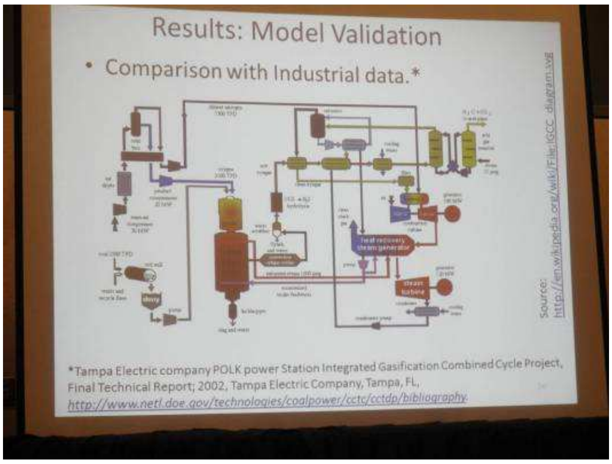

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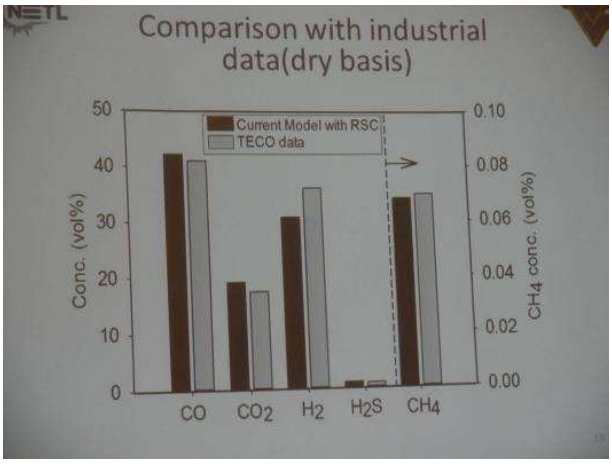

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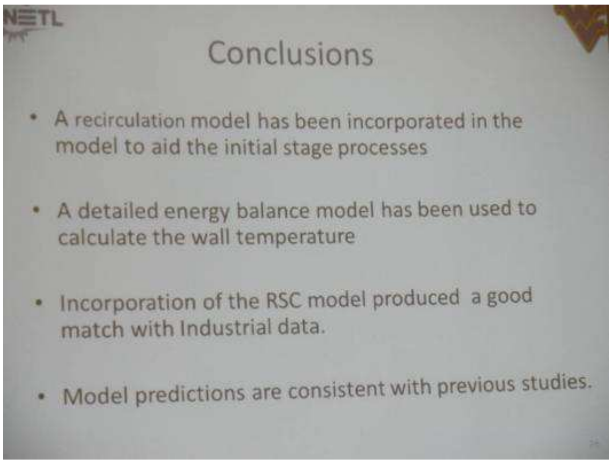

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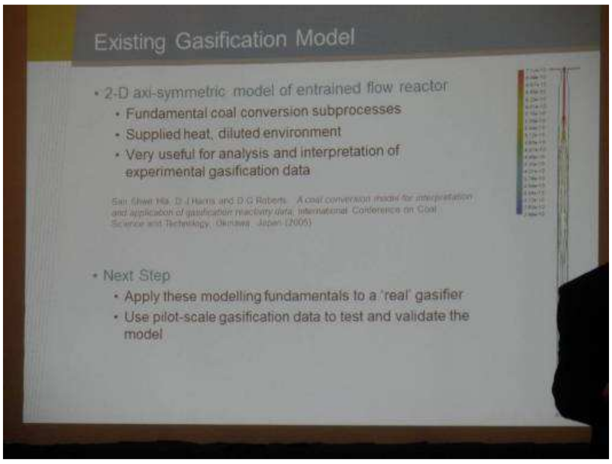

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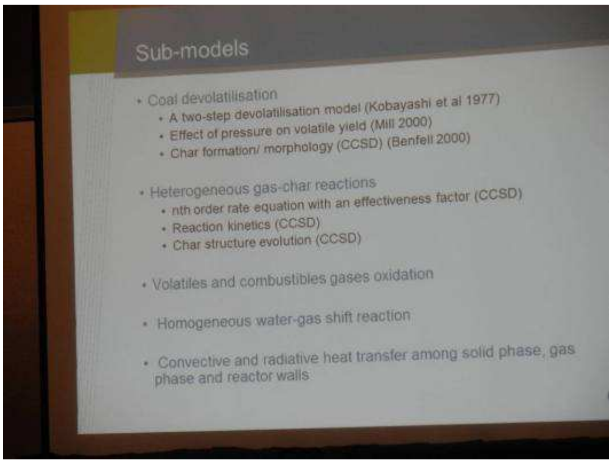

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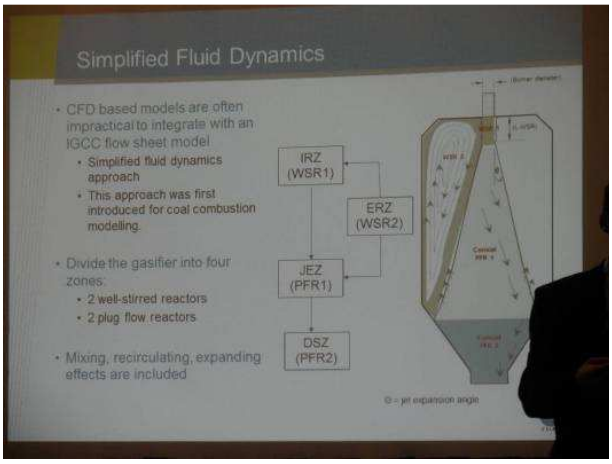

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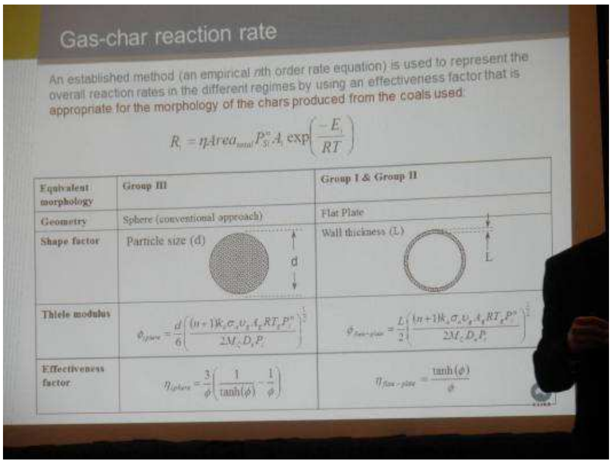

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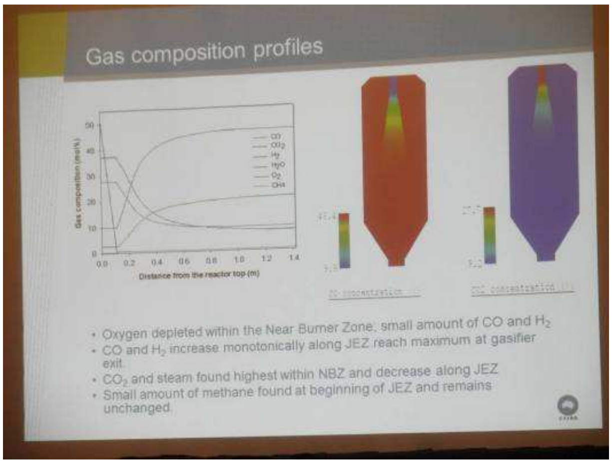

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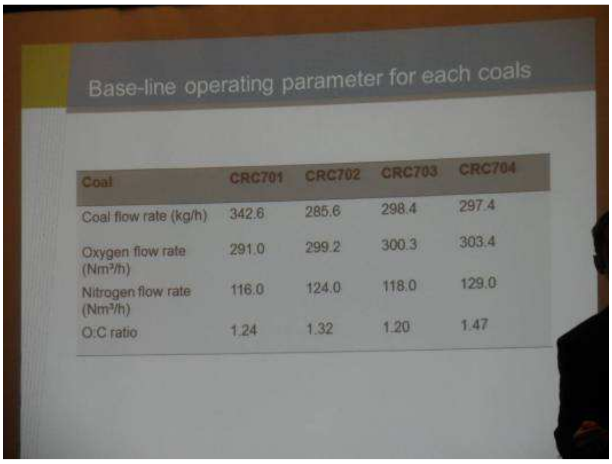

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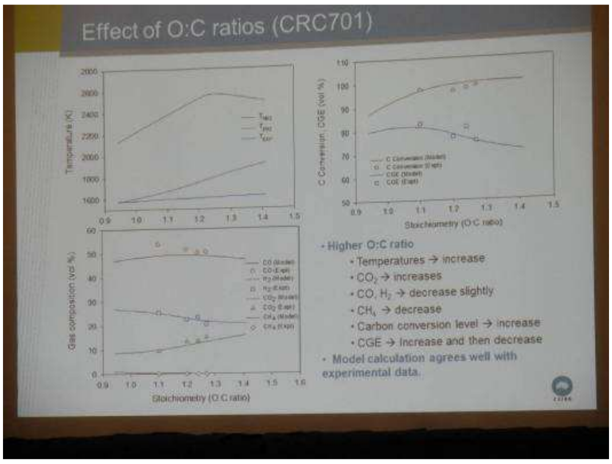

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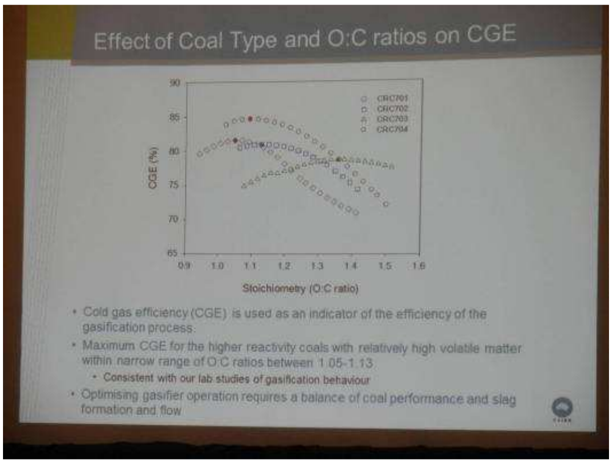

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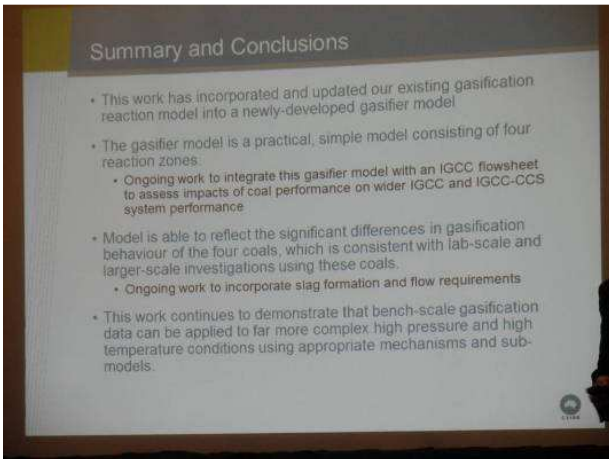

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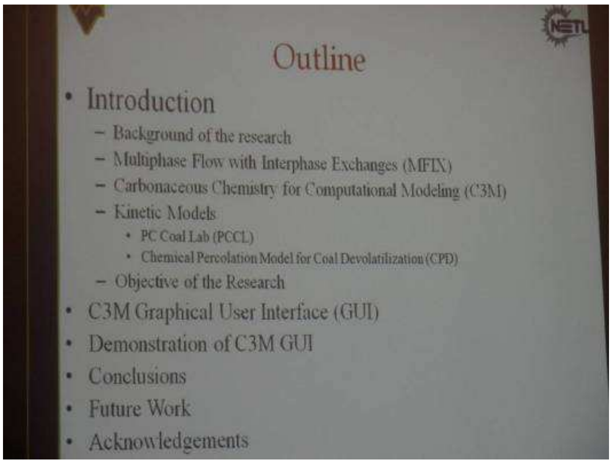

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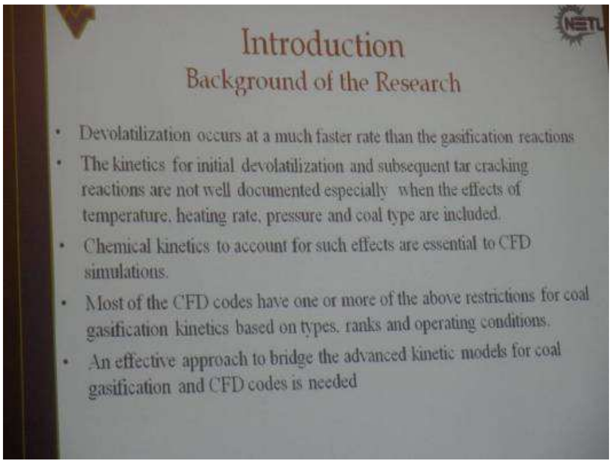

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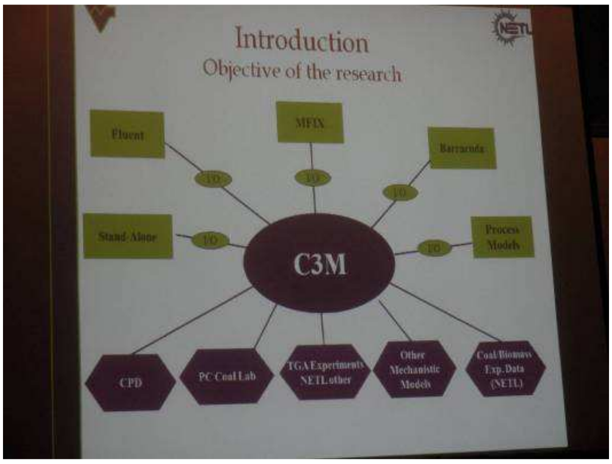

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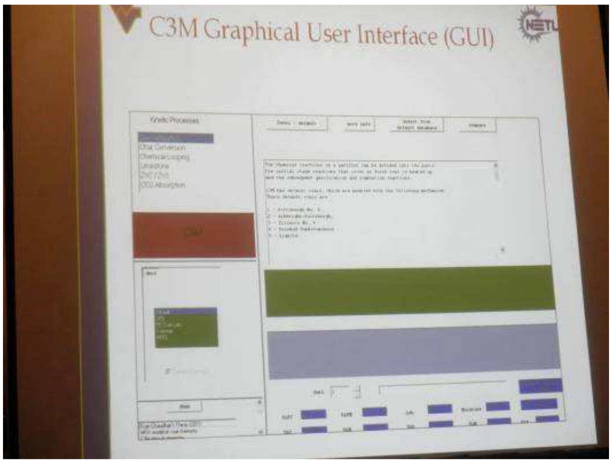

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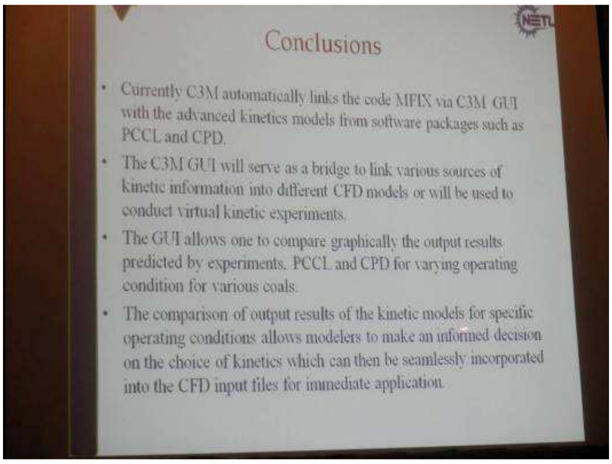

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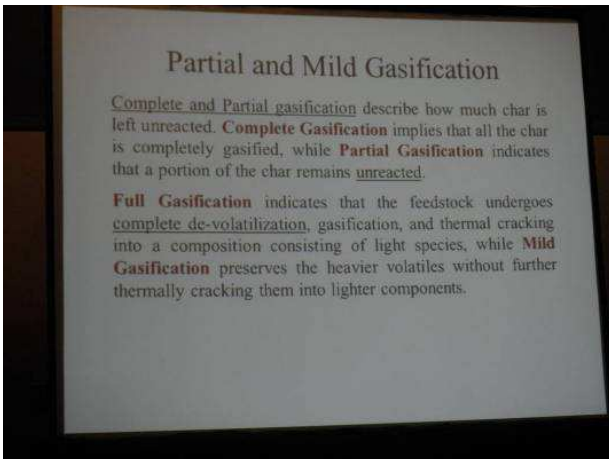

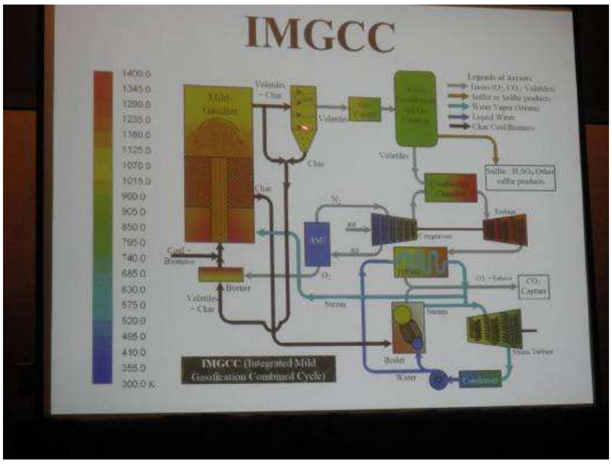

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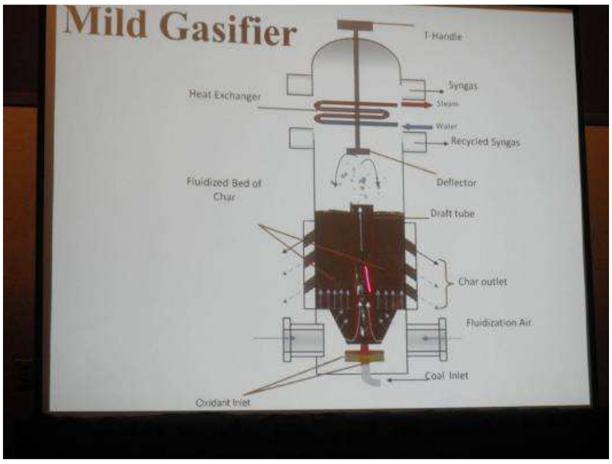

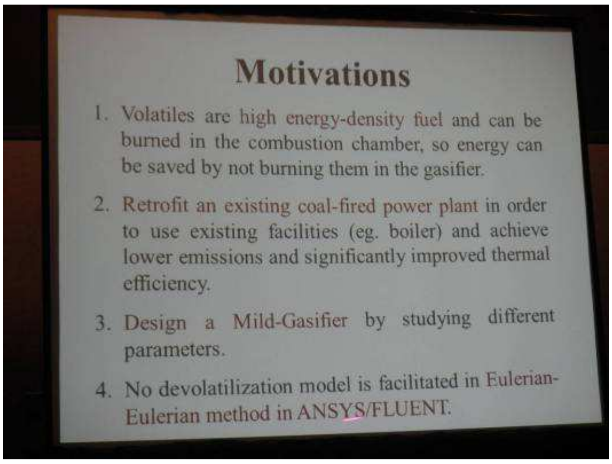

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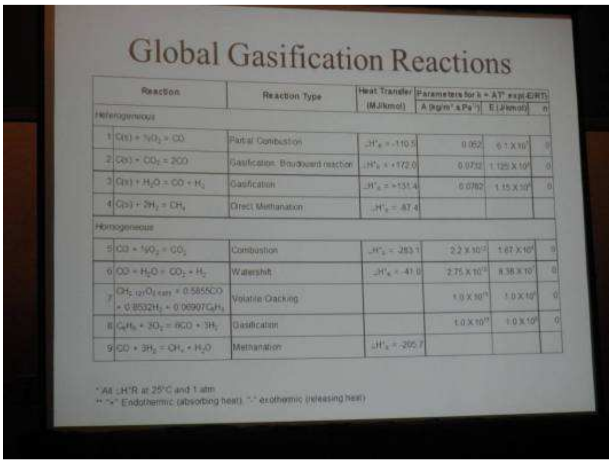

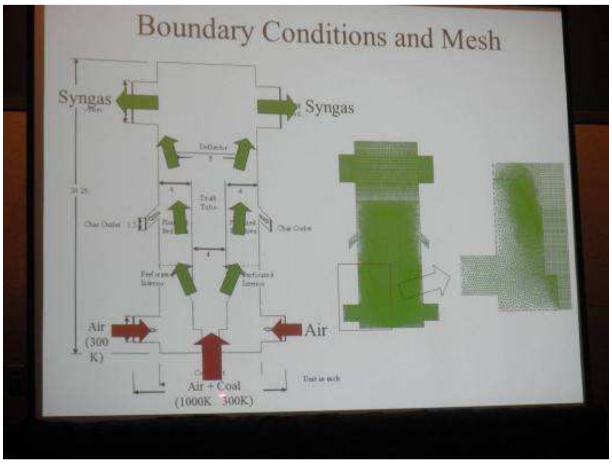

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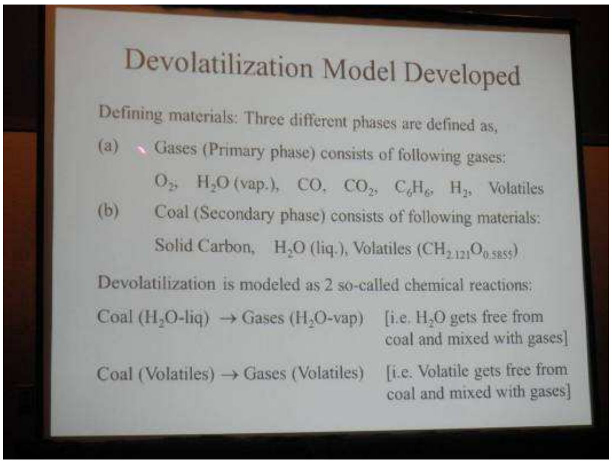
圖 III.2-66



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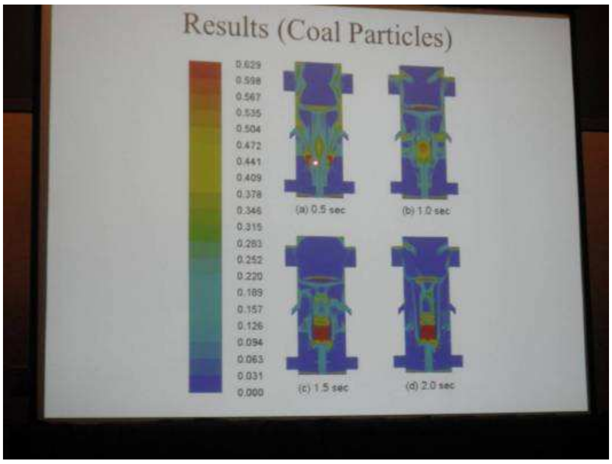

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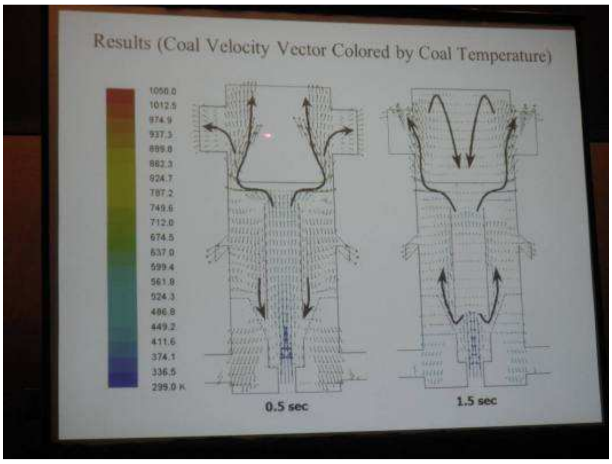

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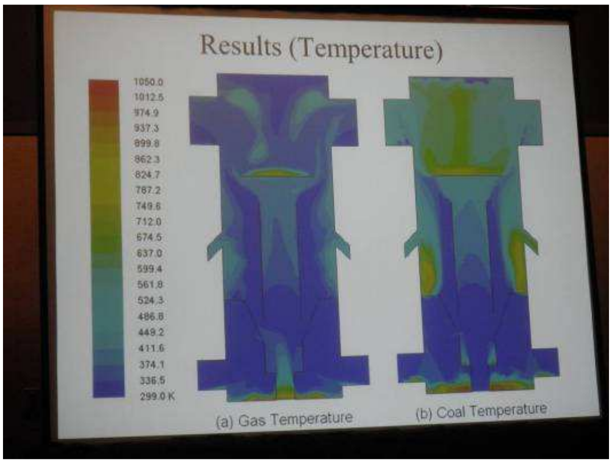

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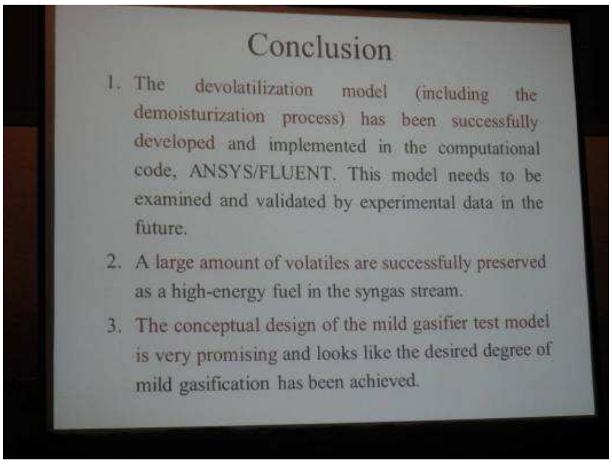

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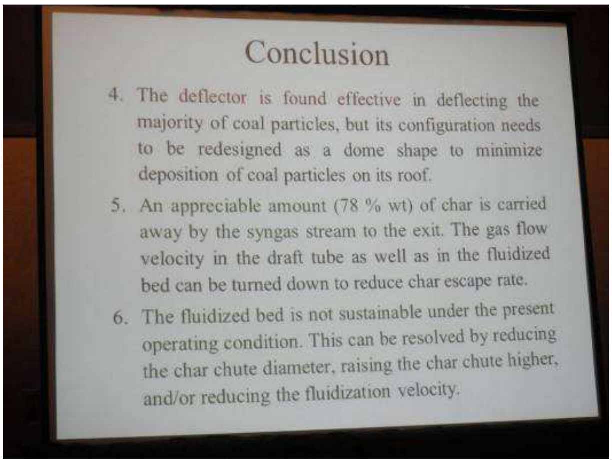

圖 III.2-72

(四) 發表之論文投影片

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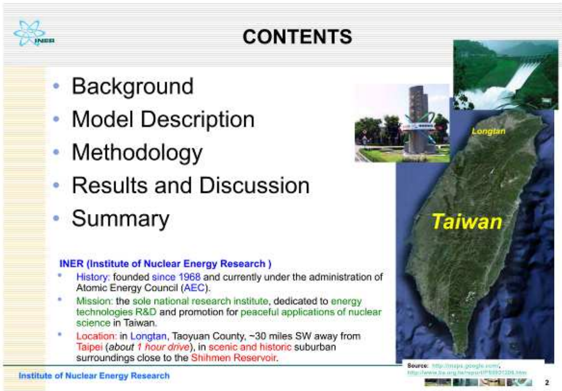

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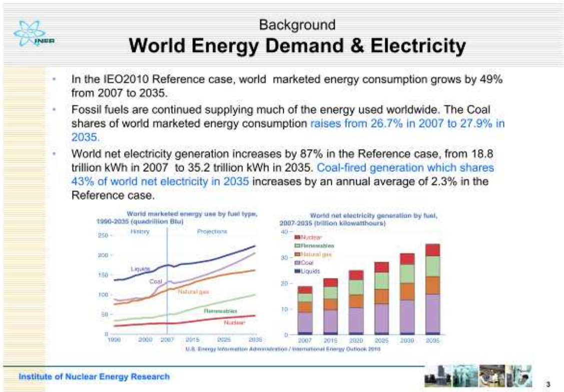

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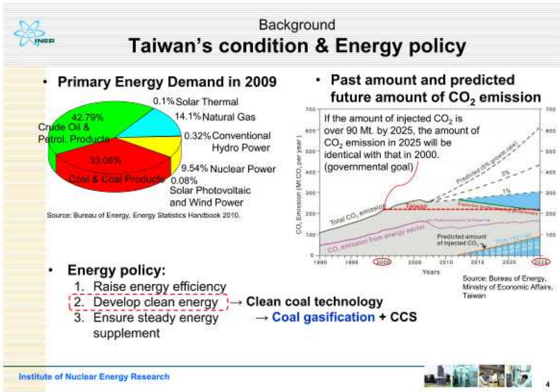

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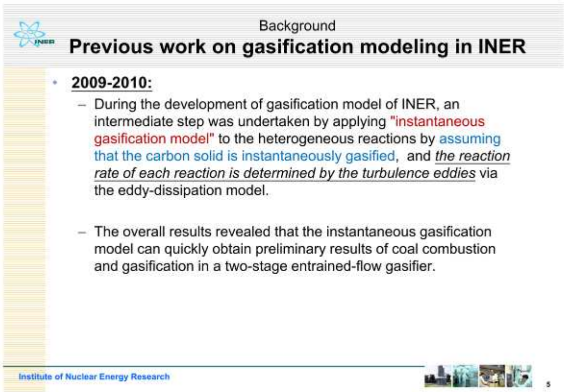

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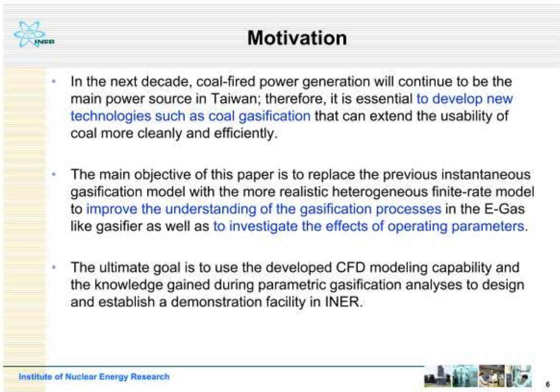

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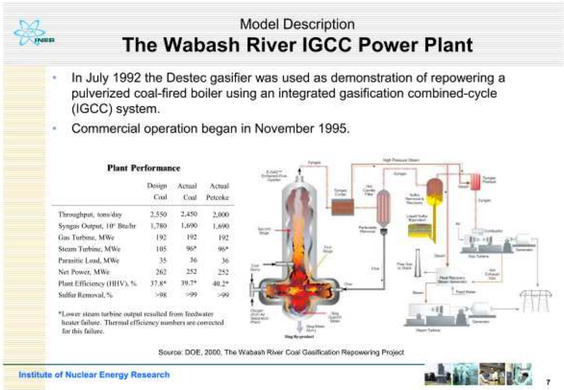

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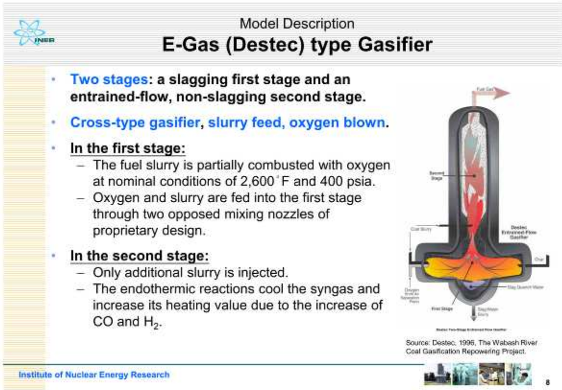

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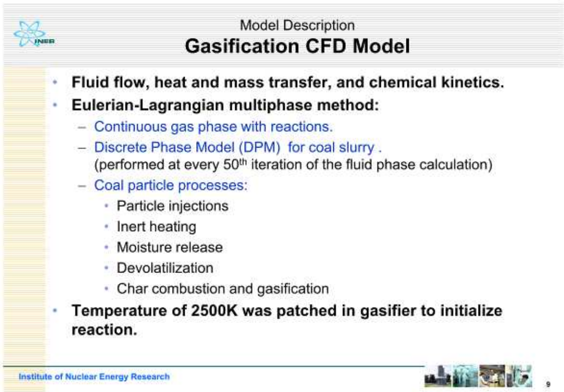

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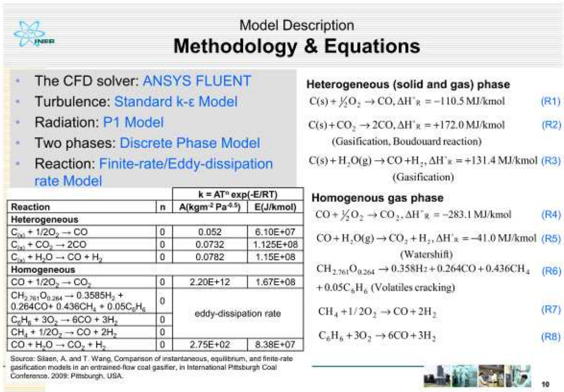

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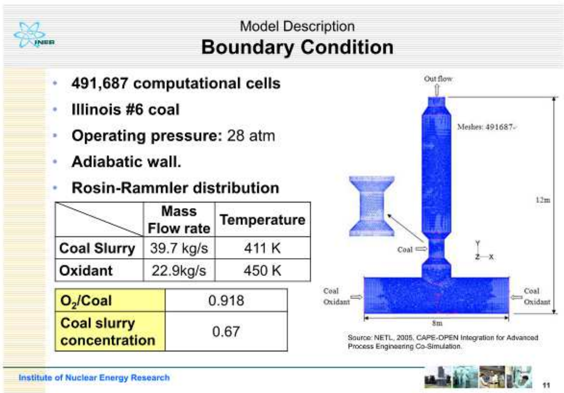

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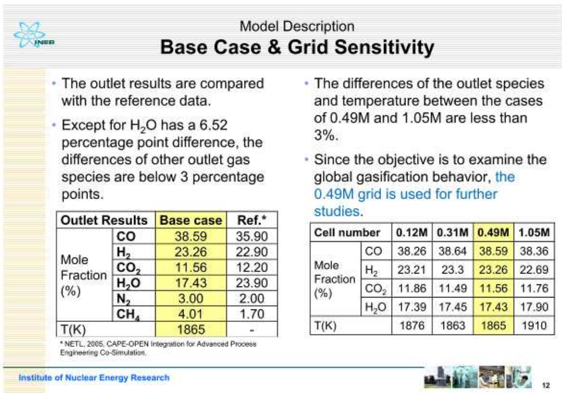

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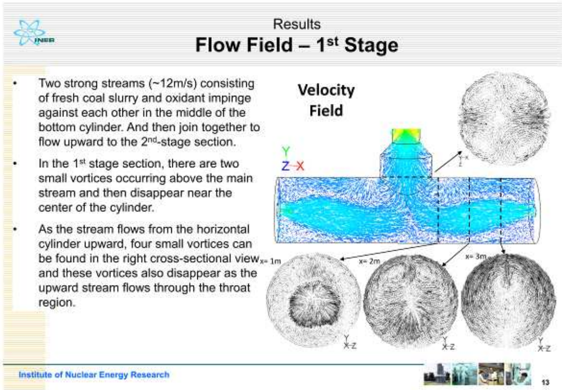

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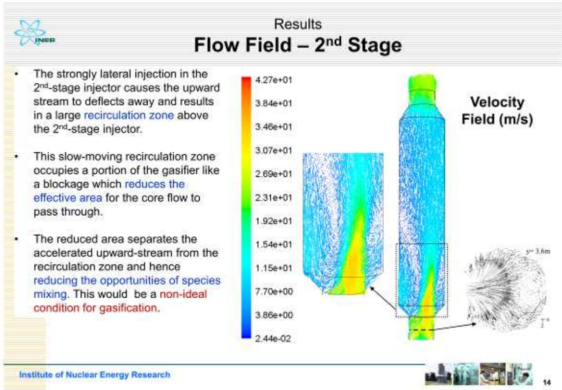

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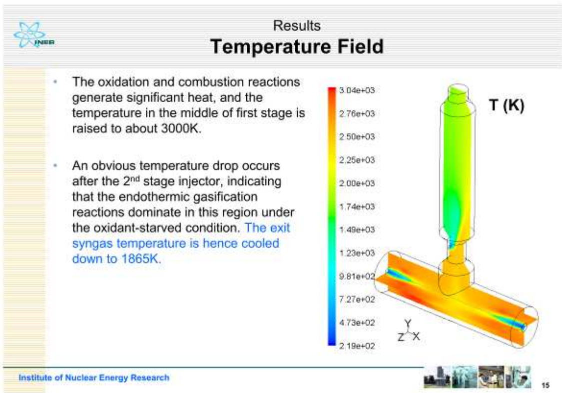

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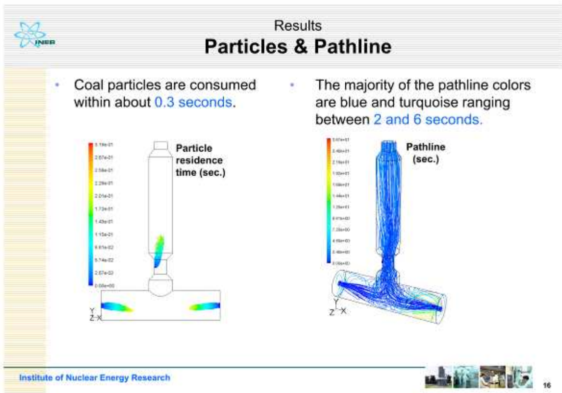

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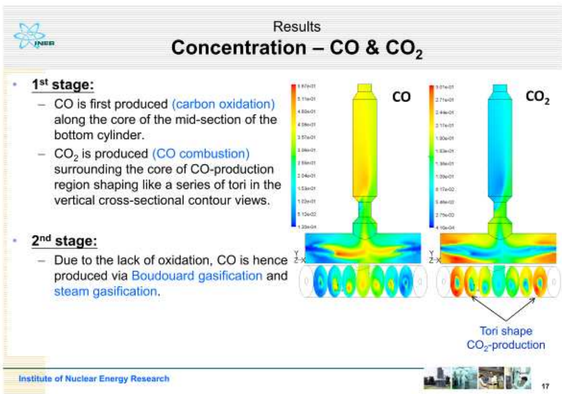

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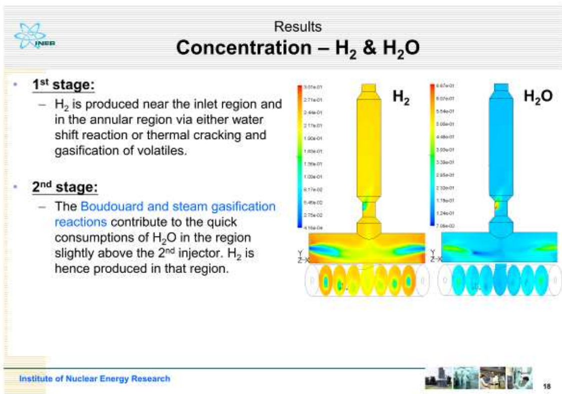

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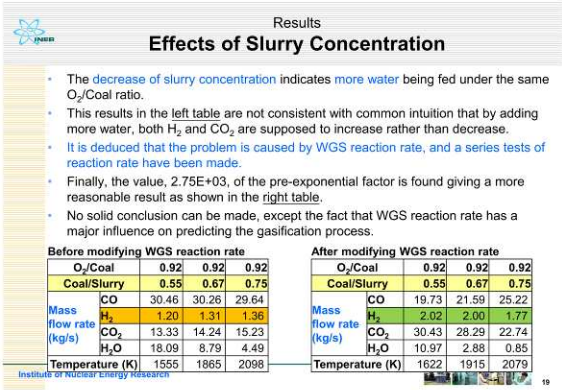

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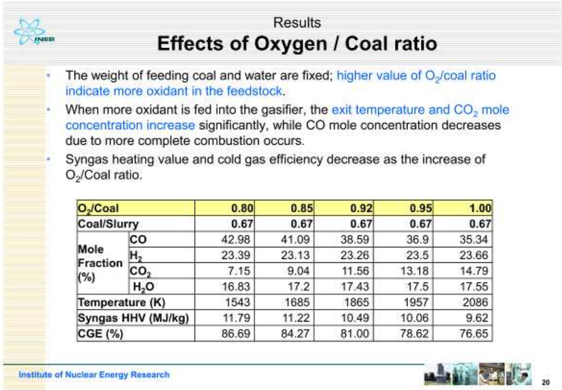

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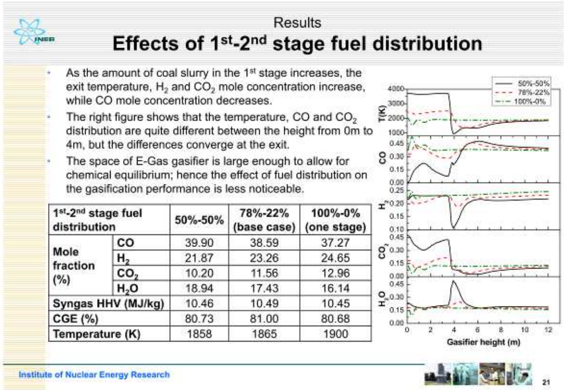

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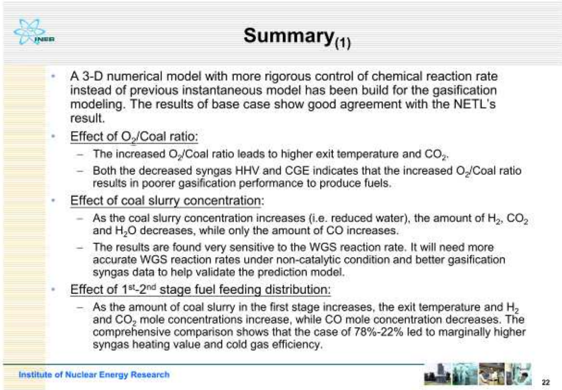

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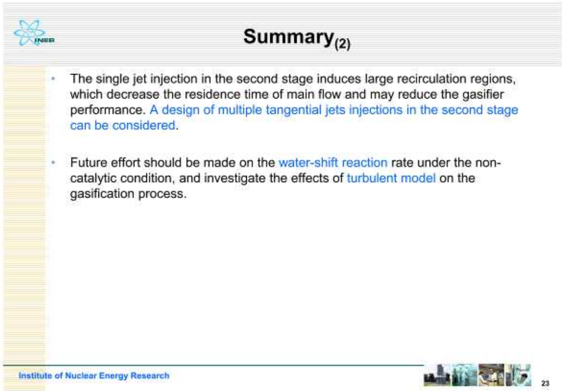

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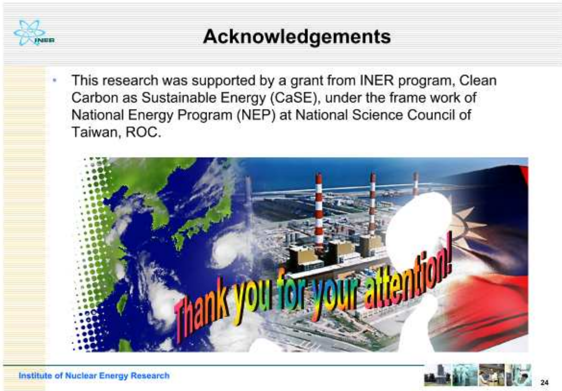

圖 III.3-24

(五) Poster Session 相關圖片

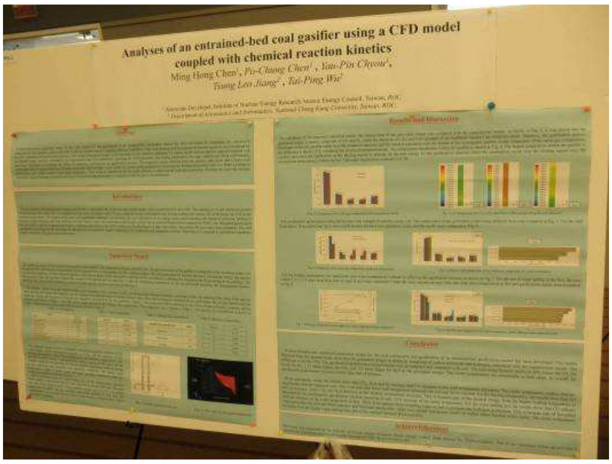

圖 III.4-1

圖 III.4-2

圖 III.4-3

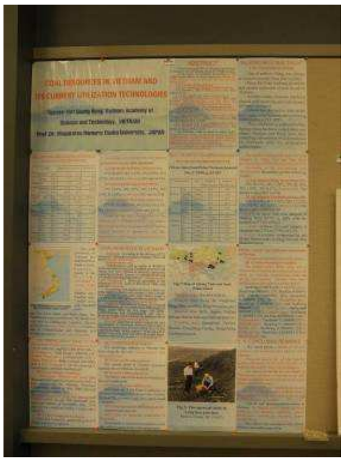

圖 III.4-4

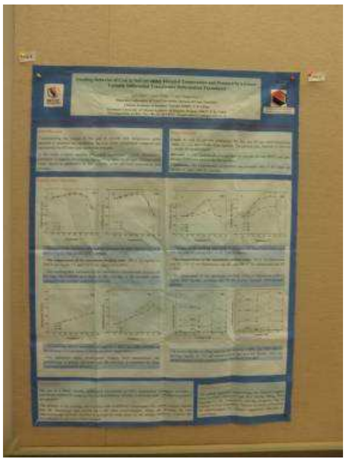

圖 III.4-5

圖 III.4-6