



Cleaner Fossil Energy
Task Force
Action Plan

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Introduction

The six countries of the Asia-Pacific Partnership on Clean Development and Climate—Australia, China, India, Japan, the Republic of Korea, and the United States of America—are cooperating to meet both their increased energy needs and associated challenges, including those related to air pollution, energy security, and greenhouse gas intensities.

The Partnership has established public-private Task Forces in eight key sectors: (1) cleaner fossil energy; (2) renewable energy and distributed generation; (3) power generation and transmission; (4) steel; (5) aluminium; (6) cement; (7) coal mining; and (8) buildings and appliances. The Task Forces are designed to meet Partnership goals through international cooperation to facilitate the development, diffusion, deployment, and transfer of existing, emerging and longer term cost-effective, cleaner, more efficient technologies and practices among the Partners through concrete and substantial cooperation so as to achieve practical results.

As a product of its first stage of collaboration, each Task Force has created an Action Plan which has been endorsed by the Policy and Implementation Committee. The Action Plans contain an initial set of priority activities for implementation. Some projects contained within the Action Plans may need to be refined or elaborated. Financial resources are needed for the implementation of the Action Plans. Some initial funding from some government and industry sources has already been identified for the implementation of projects. Partner countries will continue to work to mobilize further funding from both public and private sectors in order to bring about full implementation of the practical projects identified in the Action Plans and will continually develop new projects and add them to this set of activities.

Sector Review

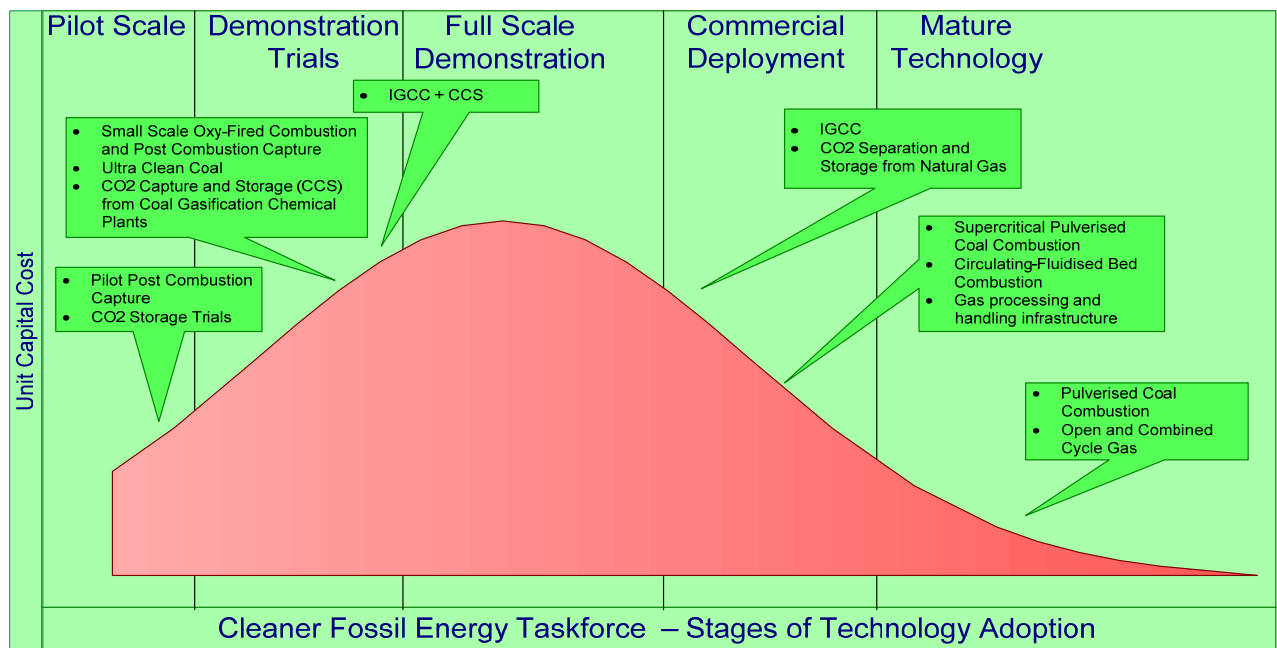
Coal, oil and gas will remain critical fuels for all six Partner countries. Against a background of increasing energy demand in the Asia-Pacific region, there is a need to improve the efficiency and environmental performance of fossil fuel use. Significant opportunities exist today to achieve efficiencies and performance improvements in the stationary use of coal, oil and gas. The development and deployment of lower emissions technologies will be a key in delivering clean development and climate outcomes associated with fossil fuel use.

There is a range of key advanced coal, oil and gas technologies identified with the potential to significantly reduce greenhouse gas emission levels, air-borne pollutants and other environmental impacts. The use of carbon dioxide (CO₂) capture and storage will be important in delivering significant greenhouse gas emission reductions from the use of fossil energy. These capture-enabling technologies include integrated coal gasification combined cycle (IGCC), oxy-fuel combustion, and post-combustion CO₂ capture. Other technologies, such as ultra-supercritical pulverized fuel, coal cleaning and treatment, gas hydrates and hydrogen technologies, coal bed methane, coal and gas liquefaction including poly-generation, co-gasification of coal/pet coke/residues/bio mass and liquefaction project with petroleum refinery products are also important elements that need to be considered in developing a cleaner fossil energy strategy. A summary of key technologies is contained in Appendix D.

These technologies are at different stages of development. Relatively new technologies, such as post-combustion capture of CO₂ and oxy-fuel combustion, need to be trialed in pilot plants or small-scale demonstration plants. Other technologies, such as IGCC, are being demonstrated commercially and are now being planned by several utilities on a commercial basis. Supercritical power generation is a mature technology and development and deployment efforts are now focused on ultra-supercritical boilers, which are capable of achieving even higher efficiencies. For gas-fired power generation and city gas uses, small incremental improvements in the technologies related to gas processing, handling and transportation are probably easy to achieve and may have significant benefit in reducing fugitive emissions.

Figure 1 provides a general overview of the current stage of development for some of the key cleaner fossil energy technologies. This figure also illustrates the relatively high cost of developing and deploying new technologies compared to the cost of mature technologies. The unit cost of new technologies generally declines with increased market penetration and operating experience. However, significant cost differentials exist between plants that do not capture and store CO₂ and those that do. This cost differential needs to be reduced. A major mission for the Task Force is to support collaboration that reduces cost barriers and facilitates the deployment of low emissions technologies. Technologies need to be developed and deployed so that they enhance energy access and security, taking into account mature and efficient processes, such as those used in supercritical power stations.

Figure 1 Technologies and Stages of Development/Diffusion



In addition to technology solutions, the Task Force will consider opportunities to support the greater uptake of natural gas in Partner countries through market mechanisms. This will include identifying and addressing potential barriers to the delivery of liquefied natural gas and cross-border pipeline gas, to help meet the rapidly growing need for high-quality, affordable and lower emission fuel for both stationary energy and transportation in Asia-Pacific Partnership countries.

The Task Force will develop a cleaner fossil energy work program that builds on and adds value to existing and prospective programs in each country. As can be seen from the

overview of most Partner countries' clean fossil energy policies and activities in Appendix C, each Partner country has its own technology development and energy market access strategies. The Task Force will draw on industry and government participation from each country to help ensure that its activities are responsive to the sustainable development needs and priorities of each Partner.

Objectives

The key objectives for the Task Force include:

- Accelerate demonstration, deployment and transfer of key technologies to improve environmental and economic performance of fossil fuel use.
- Build capacity, expertise and research base in Partner countries needed to support development and deployment of technologies.
- Develop an Asia-Pacific Partnership cleaner fossil energy technology roadmap that builds on the range of existing national (and other international) measures and initiatives that exist in Partner countries.
- Share best practices and eliminate market barriers to the deployment of these technologies, and increase the utilization and efficiency of cleaner fossil energy.
- Increase uptake of CO₂ capture and storage opportunities in Partner countries.
- Increase the utilization of gas and the efficiency of its use within the Asia-Pacific region.
- Identify and, where possible, reduce barriers to the uptake of cleaner fossil energy technology in Partner countries—including barriers, barriers, and other barriers, such as those related to planning, approvals and licensing, finance, public acceptance, lack of appropriate information, and market structures and incentives.

Partnership Actions

The responsibilities of the Cleaner Fossil Energy Task Force can be grouped under the five broad thematic areas contained in Table 1 below. Further detail on the strategies to progress the objectives of the Task Force in relation to each of these thematic areas is contained in Appendix B.

Table 1 Priority Thematic Areas for Task Force Actions

Themes	Possible Goals	Areas of Focus for Possible Projects and Activities
<p>1. CO₂ Capture and Storage: This covers enhanced oil recovery, natural gas CO₂ separation, and CO₂ capture from fossil fuel use. This theme is linked to technologies under themes 2 and 3 that enable the capture of CO₂ for storage.</p>	<ul style="list-style-type: none"> • To develop commercial storage sites by 2015. 	<ul style="list-style-type: none"> • Undertake measures including capacity building, general exchanges and information sharing, joint research to improve the development of CO₂ capture and storage technologies in Partner countries. • Pilot CO₂ storage projects in Partner countries, if needed.
<p>2. Post-Combustion Capture, Oxy-Fuel Combustion and Other Advanced Technologies: Development and commercial deployment of advanced combustion technologies, such as ultra clean coal and hyper coal, super/ultra-supercritical power stations with capture of CO₂ through oxy-fuel combustion or post-combustion CO₂ capture, and a range of advanced fluidized bed technologies that reduce emissions and support more efficient use of lower grade fuels.</p>	<ul style="list-style-type: none"> • Commercial deployment of large-scale oxy-fuel and post-combustion capture technologies by 2015. • Commercial deployment of advanced coal cleaning technologies by 2015. 	<ul style="list-style-type: none"> • Progress development of oxy-fuel combustion technology by facilitating and supporting medium- to large-scale demonstration projects. • Progress development of post-combustion CO₂ capture technology by supporting pilot demonstration trials covering a range of different power stations and flue gas combinations. • Support demonstration projects which progress the development of technologies (e.g. ultra clean coal, hyper coal) that allow the direct firing of coal in combined-cycle power stations. • Identify barriers to supercritical and combined cycle gas technologies being the minimum standard for future power stations. • Facilitate large-scale demonstrations of ultra supercritical, high performance turbines and fluidized beds.
<p>3. Coal Gasification and Liquefaction: This covers coal integrated gasification combined cycle, including with carbon capture and storage (CCS) and chemical plants with pure CO₂ for capture.</p>	<ul style="list-style-type: none"> • Commercial deployment of large-scale IGCC technology by 2015. • CO₂ capture from chemical plants by 2015. • Commence operation of large-scale demonstration of IGCC with CCS by 2015. 	<ul style="list-style-type: none"> • Capture existing CO₂ streams from existing coal gasification plant and link in with a possible pilot CO₂ storage project. • Facilitate deployment of IGCC power plants to improve the environmental performance of coal power. • Build on and add value to proposed zero emission coal gasification power stations (e.g. FutureGen, GreenGen, ZeroGen). • Facilitate trials of gasification of alternative fuels, like pet coke, residues from refineries
<p>4. Energy Market Access for Gas: This involves identifying and addressing potential barriers to LNG market efficiency and growth.</p>	<ul style="list-style-type: none"> • Improvements in environmental performance are achieved while reducing energy security concerns of member countries. 	<ul style="list-style-type: none"> • Gas/LNG market growth in Partner country economies. • LNG interchangeability • LNG public education
<p>5. Gas Handling Infrastructure Improvements: Energy efficiency gains and emissions reductions through application of gas processing, transport and utilization technology improvements.</p>	<ul style="list-style-type: none"> • Improvements in environmental performance are achieved while enhancing energy security of member countries. 	<ul style="list-style-type: none"> • Technology efficiency gains from gas processing and transportation. • Methane emissions from LNG facilities. • Increased efficiency of natural gas-fired combined cycle electricity generation.

The identified themes highlight initial areas of focus for the Task Force and indicate the strategic basis for selecting and developing projects. The projects identified in this Action Plan reflect the focus of the themes, the stage of development of specific technologies, and

the current capability to progress a project or activity. Additional projects will be identified and undertaken as the work of the Task Force progresses. The Task Force may establish working groups to provide guidance and advice and to support the implementation of activities and projects.

The Task Force recognizes the suite of international initiatives currently in place and the contribution Asia-Pacific Partnership countries are making to those efforts, including the Carbon Sequestration Leadership Forum and the Methane to Markets Partnership. In addition to these international activities, there are substantial domestic programs currently being progressed in member countries (see Appendix C). The activities and projects occurring under the auspices of this Task Force are intended to link, enhance and build on the substantial activities currently occurring through other international and domestic initiatives and programs.

In addition, there is considerable economic and technical work that cuts across the five areas which will use data from demonstration projects to add value to techno-economic evaluations of low emission technology, address gaps and add value to low emission technology R&D programs, and develop incentives to support demonstration and deployment of low emission technologies.

Appendix A contains project plan summaries proposed by Partner countries and endorsed by the Policy Implementation Committee in Korea on 11-13 October 2006.

Appendix A: Project Proposals

CFE-06-01	CO2 Capture and Storage Program	9
CFE-06-02	Ultra-Supercritical Pulverized Coal with Carbon Capture and Storage Near Zero Emissions Workshop and Design Guides for APP Countries	11
CFE-06-03	Ultra Clean Coal (UCC) Project	13
CFE-06-04	Oxy-fired Combustion Program	15
CFE-06-05	Callide A Oxy-fuel Demonstration Project	18
CFE-06-06	Assessing Post-Combustion Capture and Storage Technologies for Emissions From Coal-Fired Power Stations	20
CFE-06-07	Integrated Gasification Combined Cycle with Carbon Capture and Storage Workshop and Design Information for APP Country Coals Asia	22
CFE-06-08	Asia Pacific Gas Market Growth	25
CFE-06-09	Evaluating and Reducing Emissions in Producing, Processing and Transporting Natural Gas	27
CFE-06-10	Information Exchange on LNG Public Education Campaigns	30
CFE-06-11	Asia Pacific Gas Hydrate Cooperation	32
CFE 06-12	Costs and Diffusion Barriers to Deployment of Low Emission Technologies	35
CFE-06-13	APP Enhanced Coal Bed Methane (CSIRO-JCOAL –ECBM)	37

CFE-06-01: CO₂ Capture and Storage Program

Project

This project identifies a range of initiatives that Partner countries may wish to consider in advancing knowledge and understanding of carbon capture and storage technologies. Due to the varying level of development and technical advancement in different Partner countries, and the range of natural resource opportunities, the options and priorities that each Partner may consider pursuing will vary. A major focus of this program is to provide a greater understanding of the role and contribution that carbon capture and storage can make to reduce greenhouse gas emissions. The program will provide opportunities for researchers and senior officials from Partner countries to visit carbon capture storage projects in Australia to see first hand the work that is being done to monitor and verify the safe and secure long term capture and storage of CO₂. The project will support capacity building, knowledge transfer, education and training. This program will assist in the development of both a broad and more specific knowledge base for each Partner country, so that they may individually consider and develop their own appropriate strategies as relates to capture and storage technologies.

Project Structure

This program should be designed as a staged project with independent modules relating to CO₂ capture and storage. The various modules will be staged throughout the processes of selection, assessment and characterization, and would directly build upon findings and understandings emanating from within the program. The project should remain flexible to enable fast tracking, where considered appropriate, of early development opportunities if such situations are identified during members scoping, research and planning phases.

Capacity Building, Education and Training

Carbon capture and storage (CCS) technologies are within a rapidly developing technical and policy field with many known factors, but which still have high levels of uncertainties that need to be considered.

This capacity building within this project would be done by undertaking opportunities such as; study tours, staff transfers, workshops, and collaborative project specific activities. Such activities will include CCS topics such as; site selection, technical risk assessment, characterization, and monitoring, measurement and verification. The transfer of this knowledge will include training and education programs specific to CCS technologies as well as the more generic skill sets required to undertake the detailed activities.

Outcomes

A fundamental outcome will be to position countries to be capable of making their own independent assessment of how CCS technologies could be applied, if at all, within their region. The aim is to enable member countries to undertake such assessments with their own trained staff.

Participation

Geoscience Australia will manage the program under the auspices of the Australian government Department of Industry Tourism and Resources. University researchers and industry from other member countries have shown strong interest in collaboration that is aimed at increasing the capacity to assess and identify carbon capture and storage sites across different regions. Geoscience Australia will draw on its collaborative links with national geological survey officers in other Partner countries and a range of research institutions active in this area to transfer knowledge and provide training through general exchanges and initiate R&D efforts for geological assessments of CO₂ storage potential in Partner countries.

Objectives

This program has been developed in order for members of the Asia Pacific Partnership to gain a better understanding of what is involved in carbon capture and storage technologies, particularly in relation to safe and secure long term underground storage of CO₂ and of the economic viability of carbon capture and storage. The Task Force is undertaking a separate project that reviews the economics of CCS technologies. The capacity to assess geological storage potential and to evaluate storage sites is a key consideration in selecting and designing sites that are commercially viable, secure, reliable and safe.

This program aims to support the transfer of technology and expertise between Partner countries to undertake assessments of CO₂ capture and storage potential. It aims to present factual information to government and industry and to expand the capacity of researchers across member countries so that the potential contribution of carbon capture and storage can be fully evaluated and assessed.

Milestones

An initial product will be to provide information sharing workshops and site visits on CCS. Training programs will then be developed to provide support and guidance to researchers and geological assessment teams from Partner countries. This program can be expanded to respond to requests from Partners to support specific projects and workshops in their countries.

Location

The program will be based in Australia.

Resources

Australia will provide resources to establish and maintain the program.

CFE-06-02: Ultra-Supercritical Pulverized Coal and Carbon Capture and Storage (USC PC/CCS) Near Zero Emissions Workshop and Design Guides for APP Countries

Project

Plan and conduct a workshop, develop user-based plant design guidelines, and transfer information for Ultra-supercritical (USC) pulverized coal (PC) with near-zero pollutant emissions plus post-combustion CO₂ Capture and Storage (CCS) Technology applied to coals in Partner countries. The research and development needs and guidelines for Partner countries, as well as specialized technology transfer and training will be added into the ongoing CoalFleet for Tomorrow® USC/CCS Program.

New participants gain all current year deliverables plus special Partnership coal-based case study and guideline information. Participants in 2007 work will have access to CoalFleet for Tomorrow® combustion results, tech transfer, and expert advice when they join the ongoing international program on design guidelines, permitting, etc.

The content of the workshop to be held in an Partner country in early December 2006 will include but not be limited to 1) Highlighting the major demonstrations of USC PC and/or CCS being planned and the design progress in reducing energy and cost for post-combustion capture; 2) Exchanging other major demonstration and deployment experience and information on USC PC and of design studies for CCS; and 3) Refining needs for the development of plant design guidelines based on user input.

Follow-on activities would involve expanding ongoing CoalFleet for Tomorrow® work, which is creating user design guidelines for a number of USC PC configurations and will develop design guidelines for USC PC with Carbon Capture and Storage in 2007. This includes integration studies.

It is anticipated that this planned Partnership project will broaden the coal types and designs covered to include additional merchant and in-country coals (e.g. major coals traded in the Partnership region). Design guidelines have been developed for several U.S. coals and CoalFleet for Tomorrow® has developed information to consolidate worldwide USC PC lessons learned.

Participation

Management of workshops and organization of CoalFleet for Tomorrow® activities will be by the United States/Electric Power Research Institute. Cosponsors will be sought in Partner countries. CoalFleet is an ongoing international collaboration that has over 50 organizations involved including firms in United States, Australia, Japan, South Korea, but participation is open to all firms. Most participants are coal-based firms owning a total of over 200,000 MWe of coal-fired generation on five continents and four Partner countries. Supplier and engineering firms, coal companies and government entities are also participants.

This will expand deployment in Partner countries by providing international design information, lessons learned and guidelines for the technology, thereby reducing risk.

Objectives

Goals and outcomes sought from the Workshop—Design guidance and lessons learned on PC and CCS for a variety of coal types encountered in Partner countries. Additional designs

(including country specific) evaluated and reviewed to match appropriate technology with various coals and evaluate how designs can be integrated with CCS. Currently, many PC plant designs exist, but only selected international merchant coals are being included in design guidelines from both the CoalFleet for Tomorrow Program and “standard designs” by suppliers. But coals vary extremely widely within and between Partner countries. This will expand deployment in Partner countries by providing international design information, lessons learned and guidelines for the technology, thereby reducing risk.

Initial workshop will assure that all potential participants aware of coal differences and designs that are being developed and demonstrated worldwide and their applicability to Partner countries’ coals.

Partner exchange will broaden the types of coals considered for USC PC with low emissions and options for CO₂ capture and design information for these coals.

This expands on leverage for funders as the additional participation and adds cases relevant to the country coals. It brings in user experience and expertise and provides training and updates on the world state of the art.

Special guidelines, case studies and economic studies to be developed under this program could serve to reduce technology uncertainty and risk in application to Partner countries’ coals.

Participation in CoalFleet for Tomorrow® is open to all via annual fees based on MWe coal capacity (with a minimum for non-generating entities).

Milestones

Identify contacts in each Partner country to form an advisory team and seek co-sponsors (working by e-mail and internet) to plan the workshop (July – August 2006 time period).

Refine the agenda, set the dates and venue, send out invitations, etc. (Sept.-October 2006).

Hold the USC PC workshop, where possible, in conjunction with other USC meetings.

Follow-on CoalFleet for Tomorrow plant design guidelines—separate milestone chart is available for CoalFleet for Tomorrow—all participants are eligible to attend five meetings per year plus specially crafted web conferences and Partnership meetings.

Location

The venue for the USC PC Workshop is yet to be decided, however, preliminary thinking would recommend a venue in the Asia Pacific region. Partner countries would be requested to nominate a venue.

Resources

EPRI and other co-sponsors would share the cost of the seminar/workshop. Follow-on via CoalFleet for Tomorrow® has been entirely voluntarily funded by participants to date and it would continue to be funded via set fees. 2006 resources are anticipated to be approximately \$10 million without expansion by Partner country participation. Fees are based on coal capacity equity (owned) MW with a minimum annual fee for government and industrial and other non-generating entities. Intellectual property is usable by the funders and not redistributed broadly, but all participants are welcome.

CFE-06-03: Ultra Clean Coal (UCC) Project

Project

This project supports and facilitates the further development, commercial deployment and technology transfer of ultra clean coal (UCC). UCC is a fuel product that is derived by removing nearly all the incombustible impurities from coal.

UCC can be fired directly in gas turbines which, when used in a combined cycle configuration, will improve thermal efficiency, reduce local environmental pollution, eliminate the need for power stations to handle ash and can achieve substantial reductions in greenhouse gas emissions.

Participation

UCC Energy Pty Limited an Australian company that has developed UCC in conjunction with CSIRO is working with Mitsubishi Heavy Industries (MHI) a turbine supplier from Japan on the further development of UCC for electricity generation.

Activities under this project will be developed between these industry participants and agencies from other Partner countries, including the Department of Industry Tourism and Resources from Australia, who elect to provide a supporting role.

Objectives

The aim of this project is to realize the economic, environmental and energy security benefits of developing UCC technology to a stage where it can be commercially deployed. Activities under this project could, for instance, support the further development, testing and trials of high efficiency turbines to run on UCC, facilitate the scaling up of a UCC fuel production plant and support the design of a full scale UCC power station.

UCC fired turbines will potentially deliver increased efficiency, substantially reducing the fuel required to generate electricity when compared with a conventional coal fired generator of the same capacity. There is the potential to reduce GHG emissions from the generator by 20% to 30%. UCC fired turbine retain the advantages of gas-fired turbine in that it can be quickly brought on and off line and is thus suitable for peaking generation.

The reduction in local environmental emissions, compact fuel handling areas and the elimination of ash means that power stations can also be located close to the end users. This reduces transmission losses and provides combined heat and power opportunities, while utilizing a safe low-cost and widely available fuel, coal.

Milestones

In early 2007 industry participants will develop a roadmap and program of activities that leads to the commercial deployment of UCC technology. This roadmap will identify specific activities and milestones that have the support of the industry participants. This roadmap will be referred to countries involved in the project to obtain their endorsement before further activities under this project are undertaken in their country.

Location

Further development of UCC could lead to the first full scale UCC power station at a location to be determined by Partner countries.

Resources

Australia will provide matching industry funding and in-kind support for activities under this project.

CFE-06-04 Oxy-Fuel Combustion Program and Working Group

Project

An Ad-Hoc Working Group will be established to facilitate, support and add value to oxy-fuel combustion demonstration projects that are accepted as Cleaner Fossil Energy Task Force projects. The Working Group will develop a work program that aims to support the development, demonstration and commercial deployment of oxy-fuel combustion by 2015.

The work program will initially focus on:

- Undertaking a broad review of the status of oxy-fuel combustion technology and proposed demonstration projects. This review should outline the contribution of each project to developing the technology and the players involved in developing, trialling and supplying component technology and equipment.
- Facilitating and supporting the implementation of oxy-fuel demonstration trials. This could include (but not be limited to) the development of strategies to facilitate access to international funding for Partnership oxy-fuel demonstration projects and work with project proponents (as required) to promote wider involvement and investment in these projects, especially by power generators.

As demonstration projects proceed, the Working Group will develop a work program that:

- Supports information sharing and capacity building, including through on-site workshops and training programs, and lessons learned in applying this technology to different combustion processes.
- Identifies and puts in place strategies for addressing technological and research gaps.
- Identifies and make recommendations to address barriers to the commercialization of oxy-fuel technology.

Participation

The Task Force will draw on expertise from member countries to establish an Oxy-fuel Technology Ad hoc Working Group. The Task Force will seek nominations from members to participate in this Working Group.

The Working Group will bring fossil fuel producers and power generators together who have a particular interest in developing oxy-fuel combustion technology. The power sector as a whole and fossil fuel producers rely on individual power generators to carry out demonstration projects. However, the additional costs and risks incurred by individual generators in demonstrating low emissions technology can outweigh direct or short term commercial benefits resulting from their involvement.

By bringing these parties together, the Working group should be positioned to develop strategies that are responsive to their needs and interests. There is also the potential to directly involve other generators in demonstration projects to overcome or reduce the cost-direct benefit gap incurred by individual generators.

The Working Group can also include participants involved in developing and commercializing CO₂ storage who are prepared to help fund and support the CO₂ storage components of oxy-fuel demonstration projects.

Participation by Partner countries not directly involved in demonstration projects will help to ensure capacity building and information-sharing activities are developed to meet their requirements.

Objectives

Oxy-fuel combustion is an enabling technology for the capture and storage of CO₂ from fossil fuel power stations. It involves feeding a power station boiler (retrofitted or new) with oxygen (rather than air) and a proportion of the recycled flue gases. This raises the concentration of CO₂ in the flue gases, making it easier to capture and store. This technology has been tested in various pilot plants (less than 2-3 MWth). Further development of oxy-fuel combustion requires operating experience from larger scale demonstration trials.

This includes projects such as the proposal to retrofit oxy-fuel combustion technology to an existing 30 MWe Callide-A power station in Australia.

The Working Group will support the Cleaner Fossil Energy Task Force's goal in this area—namely to accelerate the development and bring forward the availability of Oxy-fuel combustion with CO₂ capture and storage as a viable low emissions technology.

In order to support this goal, an immediate focus of the Working Group will be to support the implementation of demonstration projects supported by the Task Force by active communication and promotion to relevant stakeholder groups within participant Partner countries of the agreed oxy-fuel demonstration projects. Once demonstration trials have commenced, the Working Group will move into a second phase of operations. It will draw on demonstration projects in cooperation with project participants to:

- Use the operational and commercial experiences from trials to guide the development of research priorities for oxy-fuel combustion technology.
- Provide confidence in this technology including confidence in the application of CO₂ geological storage technology to the capture of CO₂ from power generation.
- Provide capacity building opportunities through information exchange and education programs including site inspections and workshops.
- Provide real world case studies on CO₂ capture and storage (CCS) and develop the methodologies required under the UN Framework Convention on Climate Change to assess the greenhouse abatement potential for plants using this technology.
- Engage Power Generators so they can incorporate this technology into their long-term greenhouse response strategies.

In addition, the Working Group will facilitate technology transfer by:

- Addressing financial and other barriers to demonstration projects proceeding.
- Supporting information exchange and interaction with agencies outside of the Partnership such as the IEA Greenhouse R&D Program—Oxy-fuel Network.

- Organizing specific oxy-fuel technology workshops and publication of the workshop outcomes.
- Facilitating exchange of technologists between participating counties as part of agreed technology transfer and education packages.
- Identifying research gaps and developing strategies to address research priorities arising from demonstration trials.
- Encouraging wider active participation and financial support for demonstration projects (particularly from power generators).

Milestones

2006 (Sept/Oct): Establish Working Group and hold initial meetings to develop and initiate its work plan.

June 2007: 1st Year report, including:

- Publication of a State of the Art review of oxy-fuel technologies and status review on oxy-fuel demonstration projects.
- Recommendations on strategies to facilitate and support demonstration projects and the contribution that it has made to ensure demonstration projects supported by the Task Force are progressed.
- Submission of a detailed oxy-fuel work plan that provides the framework for activities of the Working Group.

2008-2010: Implement strategies to support demonstration projects, develop/implement capacity building and information sharing programs, and develop research strategies to address research and technical requirements, report and recommendations on addressing barriers to the commercialization of oxy-fuel combustion technology.

Location

Not applicable.

Resources

Australian Task Force members will seek funding under the Australian Government's Asia Pacific Partnership Fund to supplement the in-kind contribution of Working Group members to support research, project facilitation, information sharing and capacity building activities of the Working Group.

CFE-06-05: Callide-A Oxy-Fuel Demonstration Project

Project

This project will provide a world-first, fully integrated demonstration of oxy-fuel pulverized coal technology at 30 MW (electrical) scale, and capture and storage of up to 30,000 tonnes CO₂ per year.

Participation

The project will be managed by the Incorporated Joint Venture (IJV) established for the special purpose to conduct the project.

There are two types of project participants: Callide Participants and Supporting Collaborators. Callide Participants are actively involved in contributing to and participating fully in the IJV and through it, to the Callide-A Project. The Callide Participants are CS Energy Ltd (CSE), Ishikawajima-Harima Heavy Industries Co., Ltd (IHI), IHI Engineering Australia (IHEA), Japan Coal Energy Centre (JCOAL), Electric Power Development Co., Ltd (JPower) and Schlumberger Oilfields Australia. Supporting Collaborators are organizations that may make a valuable contribution to supporting the Callide-A Project without participating in the IJV. The initial Supporting Collaborators are the Co-operative Research Centre for Coal in Sustainable Development (CCSD) and the Co-operative Research Centre for Greenhouse Gas Technologies (CO₂CRC).

Following the signing of a collaboration agreement in September 2004, an Australian-Japanese team consisting of many of the Callide-A Project collaborators has carried out a feasibility study to determine the technical and economic merits of oxy-firing coal. The feasibility study report is due for formal release in June 2006. In addition, to meet the requirements of the Low Emissions Technology Demonstration Fund (LETDF) guidelines by the closing date, all collaborators have agreed to make conditional commitments to the project, conditional on the successful completion of core tasks, by signing each other on a Memorandum of Understanding.

Objectives

The Callide-A Project has three broad goals, namely to:

- Demonstrate a complete and integrated process of oxy-fuel combustion of pulverized coal, incorporating oxygen production, oxy-fuel combustion, CO₂ processing and liquefaction, and CO₂ transport and geological storage.
- Obtain detailed engineering design and costing data and operational experience to underpin the commercial development and deployment of new and retrofit oxy-fuel boiler applications for electricity generation.
- Obtain detailed geotechnical design and costing data and operational experience to support the development of geological storage projects in excess of 1 million tonne of CO₂ per year.

The successful demonstration of oxy-fuel combustion technology leads to the possession of the near zero emissions electricity with minimal environmental footprint for Partner countries producing electricity from coal, the security associated with coal as a primary energy source for Partner countries having coal resources, and the acquisition of carbon credit by applying the technology to coal fired boilers in underdeveloped countries for Partner countries.

Milestones

Stage 1: Demonstration: Boiler retrofit & CO2 capture	
EPC Specifications and project agreements	Jul 06 – Jan 07
Contract Award	Feb 07 – Mar 07
Retrofit construction & commissioning	Apr 07 – Dec 08
Operations Yrs 1–3	Jan 09 – Dec 11
Operations Yrs 4–5	Jan 12 – Dec 13
Stage 2: Geosequestration	
Site selection	Apr 07 – Sep 07
Procure tenements	Oct 07 – Dec 07
Pilot Injection/Field design/EIS	Jan 08 – Mar 09
Project Agreements and Financial Close	Jan 09 – Jun 09
Contract award	Jul 09 – Sep 09
Construction & commissioning	Oct 09 – Sep 10
Injection (3 years)	Oct 10 – Sep 13
Monitoring (4 yrs)	Oct 10 – Jun 14
Stage 3: Project Conclusion	
Sequestration site rehabilitation, Callide-A handover, and implementation of commercialization plan	Jul 14 – Jun 15

Location

The Callide-A Project to be based at CS Energy’s Callide-A Power Plant facility located near Biloela in central Queensland. A geosequestration site will be selected in the project.

Resources

Estimated total project expenditure: approx AuD\$188M (excl. revenue offset) (i.e. Gross Eligible Expenditure).

Estimated project revenue: approx AuD\$18M.

Support via Low Emissions Technology Demonstration Fund (LETDF): approx AuD\$63M (requested).

Support by CSE: A\$25M.

Support by Japanese Consortium: AuD\$35M (requested).

Support by ACA via the COAL21 fund: Up to AuD\$55M.

On the other hand, Participants Labor costs during front end engineering and design (FEED) and financial investment decision (FID) will be ‘in-kind’ (approx AuD\$300,000).

CFE-06-06: Assessing Post-Combustion Capture Technologies for Emissions From Coal-Fired Power Stations

Project

This project will progress the development of post combustion capture (PCC) as a technology that can be retrofitted to existing coal power stations to achieve major improvements in environmental performance by capturing SO_x, NO_x and CO₂ emissions. It will establish a post combustion capture (PCC) pilot plant demonstration and laboratory research program in Australia. It will support technology transfer to other Partner countries.

The technical risk and cost of applying the PCC technology are key issues that need to be addressed to facilitate the introduction of this technology. The proposed program will address both issues through targeted research, which will feed into and benefit from the pilot scale plant that will be deployed at several power stations in Australia. This pilot scale testing is crucial, as only assessment under real flue gas conditions will ensure the development of realistic and cost effective emission control technologies. The project also includes laboratory research on developing new sorbents, technologies and processes to improve the economic and environmental performance.

Participation

CSIRO will lead the project and partner with research organizations in Australia and other member countries. CSIRO will also encourage direct participation from industry from both the Coal Producing and Electricity Generating Sectors.

Objectives

The overall objective of the PCC program is to support the adoption of PCC technology through research, development and demonstration. The program will aim to reduce the costs of deploying PCC technology by improving the science associated with the capture of CO₂ and also by increasing the engineering process experience in using PCC technology as it is applied to Australian power station conditions. Scientists from other member countries will share engineering process experience through their participation in field trials. This program will also provide direct benefits for power station in other Partner countries that do not have de-SO_x and de-NO_x emission control on their power stations.

Pilot and Research Program

- Operation of mobile 1000 tpa PCC pilot plant at several Australian power stations to obtain process data, solvent performance testing and practical experience. Scientists from other member countries will be invited to take an active role in the operation and evaluation of pilot plant research at Australian power stations.
- Assessment of different solvents including but not limited to, Amines, Amino Acids, Room Temperature Ionic Liquids and Aqueous Ammonia.
- Modeling, synthesis and development of improved Solvents based on laboratory research of representative flue gases and then assessment under pilot scale testing.

Future Developments

- Assuming a favorable outcome from the research program and pilot scale testing, development of the following process designs for ongoing staged demonstration and application of the technology:
 - A small demonstration; 50,000 tpa.

- A full demonstration PCC plant of 225,000 tpa capacity (with both capture and compression).
 - A concept design for a PCC plant of 3.3 Mtpa capacity.
- This project could be extended to other member countries, but only if there is approval by the host government. This could involve the supply of a mobile pilot PCC plant to be operated at various power stations in that country, training of field operatives and laboratory support.

Milestones

- 12/2006 Finalize establishment of CSIRO laboratory facilities.
- 02/ 2007 Installation of CSIRO PCC mobile pilot plant at the first power station to undertake field trials in Australia.
- 01/2008-12/2010: Operation and Testing on real flue gases to obtain performance data for a range of existing and developed solvents.
- 10/2007 Implement training and technology transfer program that will be open to participants from other member countries.
- Annual - Undertake program technical exchange workshops for all parties.

Location

The initial work will be undertaken in Australia. The pilot plant project demonstrations will be undertaken at several power stations in NSW and Queensland and the research component will also be conducted in Australia at a number of different research locations particularly Newcastle and Melbourne.

Resources

The project will be funded by Australia and supplemented as appropriate by other Partner countries.

CFE-06-07: Integrated Gasification Combined Cycle with Carbon Capture and Storage (IGCC/CCS) Workshop, and Design Information for APP Country Coals

Project

Plan and conduct a workshop, and prepare User Design Basis Guidelines on Integrated Gasification Combined Cycle (IGCC) plus CO₂ Capture and Storage (CCS) Technology Needs in Partner countries with Partner countries' coals. The research and development needs, including design guidelines and information for Partner country coals and 50-Hz machines, will then be delivered by expanding the ongoing CoalFleet for Tomorrow® IGCC/CCS Program. This has been combined with the Japanese proposal "Clean Coal Day in Japan" "Advanced Clean Coal Technology International Symposium 2006 and Expert Group Meeting for APP" CFE-06-09 based on discussion in Tokyo Task Force meeting in July 2006.

Initial information is exchanged in the September 4th meeting being held at the Capital Tokyu hotel. Follow-up Information would be delivered through additional 2007 reports, seminars, and regional meetings, training sessions and webcasts conducted in the CoalFleet for Tomorrow® program. Participants would also have access and gain "gearing" to all guidelines and material performed in the year(s) that they fund for the CoalFleet for Tomorrow ® program with its established technology transfer and report material.

The content of the workshop to be held in Japan September 4th will include but not be limited to 1) Highlight the major demos of IGCC/CCS being planned (e.g. FutureGen and GreenGen; 2) Exchange of other major demonstration and deployment experience and information on IGCC and of design studies for CCS; 3) Needs for development of design guides based on user input (CoalFleet for Tomorrow® has created guidelines for a number of IGCC configurations and will develop design guides for IGCC with Carbon Capture and Storage in 2006). Webcasts can be used following this event to coordinate efforts.

It is anticipated that this planned Partnership project will broaden the coal types and designs covered in ongoing multinational CoalFleet for Tomorrow® work to include additional merchant and in-country coals (e.g. major coals traded in Partnership region), and to add 50-Hz designs. Design guidelines have been developed for several U.S. coals and CoalFleet for Tomorrow has developed information to consolidate worldwide IGCC lessons learned.

Participation

Management of workshop will be jointly sponsored by JCOAL (Japan) and the Electric Power Research Institute (EPRI USA) and organization of CoalFleet activities will be coordinated by EPRI. Presentations have been arranged from China, India, Japan, United States; with coverage of United States' FutureGen Project, Japan's EAGLE Project, Australia's Stanwell Project, and China's GreenGen Project and other projects.

The workshop is open to all participating organizations and new work on guidelines is accessible to paid participants. Later work is proposed as an expansion on CoalFleet for Tomorrow® collaborative research project. CoalFleet has currently over 50 organizations are involved, including firms in United States, Australia, Japan, and Korea, but participation is open to all firms. Most participants are coal-based firms owning a total of over 200,000 MWe of coal-fired generation on five continents. Supplier and engineering firms, coal companies, and government entities are also participants

This will expand deployment in Partner countries by providing international design information, lessons learned and guidelines for the technology, thereby reducing risk. It will open opportunities for cross training, exchange, and participation in large projects.

Objectives

Goals or outcomes sought from the Workshop—Insights into the needs and differences unique to Partner countries’ coals and the integration issues of IGCC/CCS. Later guidelines would provide design guidance and lessons learned on IGCC and CCS for a variety of coal types encountered in Partner countries. Additional designs (including country specific) would be evaluated and reviewed to match appropriate technology with various coals and evaluate how designs could be integrated with CCS. Currently many IGCC designs exist, but only selected international merchant coals are being included in both design guidelines from the CoalFleet for Tomorrow® Program and “standard designs” by suppliers but coals vary extreme widely in Partner countries. Examples are: very high-ash Indian coal, high-moisture Australian lignite, export-quality Australian bituminous, and widely varying coals in the United States, China, etc.

This will expand deployment in Partner countries by providing international design information, lessons learned and guidelines for the technology, thereby reducing risk. Early IGCC design guidelines developed in CoalFleet for Tomorrow® are in use at several U.S. locations planning IGCC projects and these guidelines should be equally valuable to international collaborators.

Technology transfer and information will also be highlighted as they have been in CoalFleet for Tomorrow® and can include appropriate exchange arrangements, such as recorded web-based information sessions to overcome travel and other issues.

The initial workshop would assure that all potential participants are aware of coal differences and designs that are being developed and demonstrated worldwide and their applicability to Partner country coals.

Partnership exchange would broaden the types of coals considered for IGCC/CCS and design information for these coals.

This expands FutureGen, GreenGen, and CoalFleet for Tomorrow® understanding for additional firms.

Special guidelines, case studies and economics to be developed under this program could serve to reduce technology uncertainty and risk in application to Partner countries’ coals.

Participation in GreenGen, FutureGen, and CoalFleet for Tomorrow® would continue to be determined by sponsoring organizations. Participation in CoalFleet for Tomorrow® is via annual fees based on MWe coal capacity (with a minimum for non-generating entities).

Milestones

Identify the contacts in each of the Partner countries to form an advisory team to plan the workshop (July 2006 time period).

Organize speakers, facility, conference and co-sponsorship and invite participants– July-August 2006.

Hold the IGCC /CCS workshop in Japan in conjunction with Japan Clean Coal Day September 4th.

Participants in CoalFleet for Tomorrow® after the workshop would have access to all current-year deliverables when they are funding, to training information, web-based information. Please see CoalFleet schedule for details

Location

The venue for the IGCC CCS Workshop is in Tokyo at the Capital Tokyu hotel to take advantage of participation by a number of firms in the Japan Clean Coal Days sponsored by JCOAL.

Resources

JCOAL and EPRI are co-sponsoring the cost of the workshop September 4th. CoalFleet for Tomorrow® has been entirely voluntarily funded by participants to date and it would continue to be funded via set voluntary fees. 2006 resources are approximately \$10M without expansion by Partnership participation. Fees are based on coal capacity equity (owned) MW with a minimum annual fee for government and industrial and other non-generating entities. Intellectual property is usable by the funders and is not public or redistributed broadly but all participants are welcome to fund and have access.

CFE-06-08: Asia-Pacific Gas Market Growth

Project

Overall project objectives include promoting energy security, national air pollution reduction, and greenhouse gas emissions growth reduction in ways that promote sustainable economic growth and poverty reduction. The Partnership can add value in providing a focus on expanding investment and trade in gas in key Partner country (and potentially other) markets.

Specifically, this project's objective will be to achieve a gas market in Partner economies that is consistent with the (potentially expanded and amended) best practice principles—facilitating the development of LNG trade and market access in the APEC region and in doing so facilitate an increase in the share of Partner country energy consumption supplied by gas. Reductions would be commensurate with share in reducing greenhouse gas emissions from “business-as-usual” projections in the medium term. Each of these outcomes will be quantified as part of the project.

In essence, the increased utilization of gas within the Asia-Pacific Region would:

- Enhance energy security.
- Reduce air pollution.
- Reduce greenhouse gas emissions.
- Enhance economic growth.

Taking account of the environmental benefits of gas, the capacity for gas delivering against the Partnership's objectives particularly in the short to medium term and the regional desire to increase energy security, the project will help to ensure that the energy demand growth aspirations of the Asia-Pacific region are met.

Specifically, the project will focus on:

- Improving conditions for cross-border trade.
- Developing regulatory and policy “best practice.”
- Data and information needs.
- The magnitude of the investment required.
- Skills enhancement.

Participation

Lead: Australia (the Australian Government Department of Industry, Tourism and Resources and the Department of Environment and Heritage; the Australian Petroleum Production and Exploration Association; and, the Australian Energy Alliance) and the United States (primarily the U.S. government; US Energy Association and the American Petroleum Institute).

Participants: representatives from the public and private sectors from all Partner countries as well as financial institutions.

Objectives

As articulated in the project description above—market access focus, with identification of possible means in addressing barriers to free access and market operation in Partner countries.

Objectives include promoting energy security, national air pollution reduction, and climate change in ways that promote sustainable economic growth and poverty reduction. The Partnership can add value in providing a focus on expanding investment and trade in natural gas in key Partner country (and potentially other) markets.

This project's objective would be to increase the share of Partner country energy consumption supplied by gas and commensurate reductions in greenhouse gas emissions from business as usual projections in the medium-term. Each of these outcomes should be quantified as part of the project.

Milestones

Phase 1:

- Preliminary discussions held at APP Gas Forum August 2006 coinciding with APEC Gas Forum 2006 (APGAS '06). Event/discussions would result in;
- Scoping study finalized by early September 2006.
- Deliverables quantified and qualified against the Partner country gas access to markets in Partnership region by December 2006.
- Regional gas master plan, including financing, agreed by Partner countries by end of 2007.

Phase 2:

- Implementation phase, based on developed Project Plan resulting from Phase 1—commencing 2008.

Location

At the Second Meeting of APGAS '06 to held in Perth, Australia, from 31 August 2006 – 1 September 2006.

Next Meeting: To be determined.

Resources

Phase 1: \$A 500,000 for staffing, analysis, modeling, travel, report, meetings, and report production.

Phase 2: \$A 500,000—Dependent on outcomes of Phase 1.

CFE-06-09: Evaluating and Reducing Emissions in Producing, Processing and Transporting Natural Gas

This project incorporates two former proposals: CFE-06-12 and CFE-06-16.

Project

Goals: Consistent and comprehensive internationally accepted methodologies will be developed to estimate methane, carbon dioxide, and other greenhouse gas emissions from LNG facilities and other gas processing and associated infrastructure. Adoption of these methodologies will be promoted within Partner countries and other interested countries.

Ways to encourage cost-effective investment to significantly reduce natural gas losses inherent in existing production, processing, and transportation technologies and practices will be identified.

Minimizing gas wastage will reduce greenhouse gas emissions, improve energy efficiency and security, and maximize returns on investments by increasing the amount of gas delivered to market.

Participation

Lead: United States (American Petroleum Institute, U.S. Environmental Protection Agency, U.S. Department of Transportation, Office of Pipeline Safety; US Energy Association); supported by Australia (the Australian Government Department of Industry, Tourism and Resources; the Department of Environment and Heritage; the Australian Petroleum Production and Exploration Association; and the Australian Energy Alliance) and other Partner country participants (through relevant government departments and research institutions).

Participants: representatives from the public and private sectors from all Partner countries as well as research and financial institutions.

Objectives

As articulated in the project description above.

Objectives include promoting energy security, national air pollution reduction, and climate change in ways that promote sustainable economic growth and poverty reduction. The Partnership can add value in providing a focus on expanding investment in natural gas technologies in key Partnership jurisdictions while reducing emission concerns.

Specifically, this project's objective will be to achieve a decrease of up to 30% of the current level of methane leakage in Partner countries (up to 30 million metric tons per annum of carbon equivalent) and commensurate reductions in greenhouse gas emissions from business as usual projections in the medium-term. This will equate to 8Bcm/yr of methane savings at current rates of use, or added value of \$750 million/yr at a gas price of \$3/mmBtu.

Seek synergy with existing programs such as Methane to Markets, Natural Gas STAR, Global Gas Flaring Reduction, and other initiatives.

Develop an estimate of GHG emissions from LNG operations and identify cost effective best management practices and technologies to achieve reductions from medium-term business as-usual emission projections.

Promote cost-effective investments to achieve reductions in the current level of methane emissions from natural gas operations in target Partner countries. Current emissions are estimated at up to 47 million metric tons CO₂ equivalent per year. Reductions will be achieved through utilization of:

- The U.S. DOE's portfolio of natural gas delivery reliability research, focused on advanced leak detection technologies for meeting vital national energy, environmental, and security needs. The portfolio of DOE and DOE directed natural gas delivery reliability research project can be reviewed at <http://www.netl.doe.gov/technologies/oil-gas/projects.html>. The total value of the 5-year program (2001-2005) was over \$50 million dollars.
- Best management practices and methane emission reduction technologies identified through EPA's Natural Gas STAR Program (www.epa.gov/gasstar). Over 70 cost effective practices and technologies have reduced emissions in the United States by over 450 billion cubic feet (13 billion cubic meters).

The participating agencies and institutions believe that attainment of these goals requires joint pursuit of the following objectives:

- *Identify Safety & Integrity Issues*—Understand stakeholder perspectives on the issues that must be resolved to ensure integrity of current and future pipeline facilities to mitigate methane emissions.
- *Identify Opportunities to Resolve Issues*—Identify a broad spectrum of opportunities for resolving these issues through research, development, demonstration and standardization activities.
- *Identify Gaps Between Needs and Available Technologies*—Understand the gaps between existing technologies and those needed to resolve the methane reduction issues.
- *Solicit & Select Projects*—Collaborate in the identification of solicitation topics, selection and management of the projects needed to fill identified gaps.
- *Promote Continuity in Technology Development*—Confirm proof-of-concept and promote continuity of technology development from the concept stage through demonstration & validation.
- *Evaluate Project and Program Results*—Evaluate the results of program activities using jointly designed performance measures and jointly managed evaluation processes.
- *Increase Accessibility of R&D Results to Users (Promote Application)*—Support increased accessibility of R&D results to users.
- *Seek Promising Technologies from Outside Sources*—Collaborate with other agencies and stakeholder organizations in recognition, development and demonstration of promising new technologies.

Milestones

Technology Track

- Phase 1:

- Develop Scoping and Project Plan by May 2007.
- Concurrently seek buy-in from case study participants (existing owners of appropriate gas infrastructure) by May 2007.
- Deliverables quantified and qualified against the Partner countries gas goals by September 2007.
- Pilot study results by 1Q 2008.
- Regional gas technology master plan, including financing, agreed 1Q 2008.
- Phase 2:
 - Implementation phase—commence late 2007.

Emissions Methodology Track:

- Phase 1:
 - Establish working group of interested companies/countries and compile relevant literature (3 months).
 - Identify and undertake necessary technical work (6-12 months depending on data gaps).
 - Develop and test comprehensive emissions estimation methodology appropriate for LNG facilities. (6-10 months).
 - Publish emissions methodology and develop case studies quantifying emission reduction opportunities.
- Phase 2:
 - Identify other areas of natural gas production, processing, and transportation system.

Location

Support provided by key institutions in participating countries including EPA’s Natural Gas STAR Program, the API and other organizations will be determined. Locations of activities and projects supporting this proposal will be identified by program participants.

Resources

Technology Track:

Phase 1: Estimated cost at \$100,000 or less.

Phase 2: Dependent on outcomes of Phase 1.

Emissions Methodology Track:

Phase 1: Emissions track technical work estimated at \$100,000 or less depending on gaps in available data.

Phase 2: Dependent on outcomes of Phase 1.

Note: Some funding and staffing contributions from API; some U.S. EPA funding may be possible; combination of core contributions plus contributions-in-kind from participating stakeholders.

CFE-06-10: Information Exchange on LNG Public Education Campaigns

Project

Goal: A regional workshop on LNG (liquefied natural gas) public education will be held to exchange information among governments and private sector with the aim of reducing public opposition to new LNG shipping and receiving terminals. The project will help to increase LNG trade and investment in the Asia-Pacific Region to:

- Enhance energy security.
- Reduce air pollution.
- Reduce greenhouse gas emissions.
- Enhance economic growth.

Taking account of the environmental benefits of natural gas over other fossil fuels and the increase in energy security through fuel diversification, the project will help to ensure that new LNG facilities in the region are safely developed and operated with the consent of the informed general public. Public opposition to LNG shipping and receiving terminal can block or delay their development. Such problems can arise when project developers do not fully engage the local population, who may not be well educated or understand the actual history of successful operation of LNG terminals around the workshop, prior to start of construction or during operations, especially if a problem arises. The workshop will build from three successful regional LNG public education workshops organized by the Department of Energy in the United States in early 2006.

Participation

Lead: *United States*

Organizers: APEC Expert Group on Clean Fossil Energy.

Participants: representatives from the public and private sectors from all Partner countries as well as financial institutions.

Objectives

This workshop was developed in direct response for cooperative activities spelled out in the final declaration of the 6th Meeting of APEC Energy Ministers, held in Manila in June 2004:

“...strengthen economic infrastructure to eliminate bottlenecks to economic growth, especially in such areas as telecommunications, transportation, and energy, in order to further integrate members into the regional economy, and the region into the global economy. The project will expand the capacity of APEC members to absorb LNG technologies and promote a free flow of information on these technologies to the public, thereby enhancing public acceptance and encouraging natural gas trade and investment.”

The APEC Workshop is being organized to exchange information on public education campaigns related to LNG in APEC economies. The workshop will be expanded under the Partnership by inviting India's participation (after receiving APEC approval for inclusion of a non-member economy).

Milestones

Phase I:

Interface with the APEC Gas Forum (APGAS), which will hold its second meeting in Perth, Australia, from August 31-September 1, 2006.

APEC/APP LNG Public Education Workshop to be conducted in the February-April 2007 timeframe.

Coordinate with another APEC natural gas event entitled “Prospects for Natural Gas as Clean Energy Source in Developing APEC Economies” to be held in the same location.

Proceedings including conclusions and recommendations to be available by mid-2007.

Phase II:

Develop case studies of both successful and unsuccessful LNG public education campaigns to share lessons learned among APEC/APP member economies (pending approval of APEC proposal for implementation in 2007).

Location

The location of the 2-day LNG Public Education Workshop is still to be finalized in one of the Partner countries.

Resources

US\$120,000, including US\$100,000 from APEC to support event organization and invitational travel from APEC member economies.

CFE-06-11: Asia-Pacific Gas Hydrate Cooperation

Project

Goal: Several Partner countries are conducting significant R&D programs to develop gas hydrates as a clean energy source. The goal of this project is share information on Partner countries' national programs, which will help to better inform policy makers and researchers, and to conduct cost-shared joint projects that will allow gas hydrates to become a viable commercial energy source sooner.

Gas hydrates represent a huge potential resource—as much as 400 million trillion cubic feet (tcf), a staggering figure compared to the 5,500 tcf that make up the world's currently proven gas reserves. Natural gas is expected to take on a greater role in power generation, largely because of increasing pressure for clean fuels, and gas hydrates could provide a vast new supply of affordable gas for power generation for centuries. In addition, because hydrates occur adjacent to the coasts of most countries this resource, if developed, has the potential to change the world energy and energy security balance.

Goal: Accelerate the development of technologies to allow the production of methane from gas hydrates while protecting the environment to:

- Enhance energy security.
- Reduce air pollution.
- Reduce greenhouse gas emissions.
- Enhance economic growth.

Taking account of the environmental benefits of gas, the extensive gas hydrate research and development (R&D) being conducted by Partner countries, particularly the United States, Japan, India, and Australia, and the regional desire to increase energy security, the project will help to ensure that the energy demand growth aspirations of the Asia-Pacific region are met.

Specifically, the project will focus on:

- Exchanging information about gas hydrate R&D to better inform policy makers.
- Exchanging gas hydrate research data to better inform researchers.
- Developing a plan of cooperation for joint projects.
- Public education on the benefits and environmental implications of gas hydrates.
- Skills enhancement.

Production of methane from hydrate, although shown to be feasible, still requires significant research to validate detection technology and test and refine potential production technologies. Because of the diversity of hydrate deposits and possible extraction techniques, each country has a slightly different approach, but will benefit from information about others' efforts.

Participation

Lead: United States.

Participants: Representatives from the public and private sectors from United States, Japan, India and Australia.

Objectives

As articulated in the project description above.

Project will enhance all participants' understanding of the geologic and engineering complexities of gas hydrates by sharing each participant's unique experiences with their resource. Shared information will reduce risk and accelerate technology for commercial production of methane from hydrates.

U.S. Department of Energy has a \$12 million/year methane hydrate program dedicated to realizing hydrate's energy supply potential, while continuing to address important hydrate research questions such as sea floor stability, drilling safety, and environmental issues associated with naturally-occurring methane hydrate. The program aims to develop the knowledge and technology necessary to allow commercial production of methane from hydrates by 2015.

In order to inform policy makers in participating countries of cooperative efforts, the plan includes informal discussions between government agencies and a planning meeting involving government policy makers.

In order to increase data exchange to better inform the research community, DOE supports and invites others to support CODATA (International Council for Science: Committee for Data for Science for Science and Technology) Task Group for Data on Natural Gas Hydrates.

Milestones

Phase 1:

- Enlist involvement of government and industry of Japan, China, Korea and India.
- Informal discussions on cooperation during 2006-2007 at Partnership and other multi-national meetings.
- CODATA-Hydrates meeting tentatively scheduled October 21-22, 2006 in Beijing.
- Planning meeting mid-2007.
- Complete plan for cooperation and joint projects by end 2007.

Phase 2:

- Implementation phase—commencing 2008.
- Possibly including multinational production test in 2010-2012.
- Commercialization of methane production from hydrates expected by 2015.

Location

TBD

Resources

Phase 1: Funds for travel, report, meetings, report production etc will be required (e.g., \$80,000 for CODADA.).

Phase 2: Dependent on implementation plan.

CFE-06-12: Costs and Diffusion Barriers to Deployment of Low Emissions Technologies for APP

Project

Partner countries are endowed with different resources and energy systems and face different clean development challenges indicating that deployment of clean energy technologies will likely be non-uniform across the region. Additionally, cost estimates are changing for all technology options as new technologies enter the portfolio mix and operating conditions change. This project is designed to determine the current level of maturity of a broad portfolio of Low Emission Technologies (LETs) and to derive their relative cost profiles over time, translated to specific Partner country energy markets incorporating design and regional issues. This information is critical for both policy makers and technology investors. The majority of LETs are characterized as either being immature, relatively costly and/or unintegrated. This project will enhance the understanding of LETs and explore the enabling infrastructure or systems required to deploy these technologies in the region. Identifying the costs and other barriers to the take up of different energy technologies is an important first step and the Partnership Work Plan, agreed at the Ministerial meeting in January 2006, identified this exercise as a priority Task Force consideration (referred to as “Stage 1 Road-mapping”).

Participation

Australia will manage the project with support from the United States.

An experienced high-profile technology and modeling organization will need to be contracted to undertake the project.

This project could be jointly undertaken with the Renewable Energy and Distributed Generation Task Force and cover both renewable and fossil fuel generation technologies including nuclear given its use by Partner countries and its inclusion in the Partnership Charter.

The project would also need to be coordinated with other ongoing studies being progressed through other fora (e.g., APEC, IEA etc) and incorporate learnings from other related Partnership projects (e.g., CFE 06-e8 Asia-Pacific Gas Market Growth).

Objectives

Like the energy markets themselves, generation costs in each Partner country vary greatly, primarily based on the availability of resources and technologies. While the costs of LETs have been estimated in many different situations, there is value in drawing this information together and determining where a specific technology is in the development and diffusion pathways and estimating/translating relative cost potential in specific Partner country energy markets. This study is intended to draw on and complement, rather than replicate, the suite of ongoing effort on this issue and will be focused on addressing the major gaps in the knowledge base.

The project’s objective is to determine the current level of maturity of a broad portfolio of Low emission Technologies and to derive their relative cost profiles over time within and between Partner country energy markets. The study will also identify the cost-effectiveness of these technologies in the context of the comparative environmental attributes—assessing the impact on energy costs of meeting clean development and climate objectives in an

integrated way (e.g., what are the additional costs of reducing greenhouse gas emissions if local air quality issues demand a change in generation technologies).

The relatively high cost of LETs is but one barrier to their deployment. An additional objective of the project is to identify and explore the enabling infrastructure or systems (e.g., intellectual property issues, enabling legislation/regulation, and integration of LETs into the electricity grid system) required to deploy these technologies within the Partnership region. These institutional and system barriers may occur at different stages through the commercialization pathway of a technology. As such it is essential to determine at what stages these factors impact on the deployment of specific LETs. This will provide for a better understanding of how and when to address impediments.

Milestones

Tender process	Fourth Quarter 2006 to First Quarter 2007
Workshop(s)—Seminar(s)	Second Quarter 2007
Draft report to Task Force	Third Quarter 2007
Task Force consideration of report and examination of implications for future actions	Third Quarter 2007

Location

N/A

Resources

The anticipated cost of this project is in the order of \$400,000 (AUD) with final costs to be refined following discussions with the contracted organization. Australia will consider contributing resources to this project, taking into account the contributions provided by other Partners, noting that additional support will allow for a more extensive and in-depth analysis. The US Department of Energy will consider the possibility of contributing to the project. EPRI has offered in-kind support through providing access to background information used in preparing the recently published “Generation Technologies in a Carbon Constrained World”, including access to any updates to this analysis. EPRI will also consider financial contributions closer to the commencement of the project.

CFE-06-13: CO₂ Enhanced Coal Bed Methane (CSIRO-JCOAL–ECBM)

Project

The project is to validate (and if appropriate to modify and improve) the use of CO₂ injection into coal seams to enhance methane recovery. It builds on the work of JCOAL in Japan. This validation will take place using both Japanese and Australian coal, and coal data.

Field trials will be undertaken in Australia in response to a proposal by China to support the transfer of ECBM technology to China. Later stages of this project will involve field trials in China and participation by Chinese industry and other agencies. The stages of the project will need to be authorized by the Chinese before proceeding.

JCOAL commenced a CO₂/ECBM field trial in Hokkaido in 2002 that covers reservoir characterization, micro pilot test, multi-well pilot testing and environmental monitoring. Now CSIRO is endeavoring to answer the remaining questions about the suitability of coal seams as a viable long-term storage option for CO₂ sequestration. The aim is to deliver tools that enable the interactions between CO₂ and coals to be characterized and to develop reservoir models that will use this data to predict the fate of the stored CO₂ while enhancing methane recovery.

The outcomes of this project could be used to guide larger projects for CO₂ sequestration. The project will draw on the JCOAL data, actual experience and the CSIRO models, and will develop:

- Validate and provide analysis of the JCOAL project at Hokkaido with cross testing of coal and methods.
- Impact on the methane recovery rates.
- Quantitative predictions of the maximum rate of injection and uptake of CO₂.
- Likely environmental impacts of the high CO₂ concentrations in the formation waters.
- Lifetime of the storage.

The interaction of supercritical CO₂ with coal, water and other gases within the seam environment.

The overall project plan is to use existing JCOAL and CSIRO knowledge and expertise in CO₂-Enhanced Coal Bed Methane (CO₂-ECBM) and to apply this technology and model in Australia. This existing technology will be analyzed and where appropriate modified and then applied in Australia and other Partner countries.

The project plan consists of three Stages:

- Stage 1: Laboratory work and verification.
- Stage 2: Pilot field test to validate existing JCOAL and CSIRO experimental data especially that obtained from the JCOAL test site at Hokkaido. This test will be conducted in Australia to ensure control of the test conditions and ideally use a source of CO₂ from a fossil fuel-powered power station.

- Stage 3: When the pilot field test in Australia has been completed successfully the collaborators will be confident as to the applicability of this sequestration technology to other coal and coal gas reservoirs. The participants will work with authorities in China to develop field trials in China to support the transfer of technology to China.

Stage 1 of the project is to validate the methodology of enhancement of methane recovery by injecting CO₂ in coal seams that has been developed in Japan by JCOAL. This validation will take place using Japanese and Australian coals, and coal data.

JCOAL commenced a CO₂-ECBM field trial in Hokkaido in 2002 that covers reservoir characterization, micro pilot test, multi-well pilot testing and environmental monitoring. Now CSIRO is endeavoring to answer the remaining questions about CO₂-ECBM. The aim is to deliver tools that enable the interactions between CO₂ and coals to be characterized and to develop reservoir models that will use this data to predict the fate of the stored CO₂ and quantify the enhancement of methane recovery.

The outcomes of this project could be used to guide larger projects for ECBM that are planned for Stage 2 and Stage 3 of this project.

The project will utilize the JCOAL and CSIRO field and laboratory experimental data and findings to validate and develop the experimental and analytical tools for CO₂-ECBM operation.

It is anticipated that this will require additional experimental work either in the laboratory or at the JCOAL test site in Hokkaido to answer specific questions that arise during this paper based analysis.

Stage 2 of the project will select a site with Japanese and Australian interests and a source of CO₂ such as that at Callide in Australia with the JCOAL 'oxy-firing' project. It may use CO₂ sourced from a power station.

The location of this project will depend upon the suitability of the site location relative to sourcing CO₂ and favorable geological conditions.

The suggested work program of Stage 2 will be as follows:

- Detailed analysis of data on some coal gas reservoirs at the potential sequestration sites.
- CO₂-ECBM pilot test will be performed at the selected site.
- Stage 3 of the project will be similar to Stage 2 and would seek China's collaboration, subject to China's agreement to enable the involvement of Chinese industry and researchers.

JCOAL and CSIRO have a strong history of collaboration and this project would follow on from our other projects on mine safety and coal seam methane drainage.

Participation

Management of this project will be JCOAL and CSIRO. These two participants will complete Stage 1 and then seek other collaborators for subsequent stages. These other collaborators might include:

- The IHI oxy-firing project managed by JCOAL.
- Companies involved in the CO₂-ECBM project in Hokkaido, for example Mitsubishi Materials.
- Companies developing an LETDF (Low emission Technology Development Fund) project in Australia, such as PCC Ltd.
- Power companies, coal companies and Government agencies.

Objectives

To develop and apply JCOAL/CSIRO CO₂-ECBM technology to other coal seam reservoirs in Australia and to other Partner countries.

To achieve the objective of the project the following main tasks should be undertaken:

- Understand the interaction between coal and supercritical CO₂.
- Investigation of the geological and geochemical interactions of CO₂ and the host minerals/coals and other materials.
- Investigation of reservoir engineering for CO₂ storage in coal seams and understanding of the likely fate of injected CO₂ in a well constrained geological setting from a study of natural analogues.
- Design and conduct of pilot field trial in Australia and China.

Milestones

12/2006	Set up protocol to identify the common areas of experimentation between CSIRO and JCOAL.
6/2007	Complete experiments to analyze and recommend trial design for Stage 2 and commence negotiations to collaborate with Australian project that will produce a source of CO ₂ .
2008/9	Commence ECBM trial in Australia.
2009/10	Commence ECBM trial, for example, in China, subject to agreement by the Chinese Government and upon securing Chinese private sector participation.

Location

Stages 1 and 2 will be conducted in Japan and Australia and Stage 3 in the agreed location.

Resources

JCOAL and CSIRO have allocated funding for their existing research into CO₂-ECBM for Stage 1 of this project. The majority of additional expenditure for Stage 1 will be travel and accommodation to “compare notes” and the time of researchers. Additional funding would be required for the next stages of the project. For Stages 2 and 3 it is difficult to estimate the costs as there is little certainty (even the sites are unknown.) The funding requirements have not been budgeted by either JCOAL or CSIRO, but it is estimated that the costs of Stages 1, 2 and 3 of the project will be a total AuD\$10 million.

Appendix B: Thematic Areas

Theme 1 Carbon Dioxide (CO₂) Capture and Storage

This theme covers the development, demonstration and commercial application of geological storage of CO₂ captured from natural gas operations, chemical plants, and low or zero emission power plants. As such, there will be synergies with the work that is being done to develop technologies to enable the capture of CO₂ under the coal gasification theme and the advanced combustion theme.

The initial focus of the Task Force under this theme will be to take measures, including capacity building, joint research, general exchanges and information sharing, to improve the development of CO₂ capture and storage technologies in the Partner countries. This work will flow through to the trial storage projects in Partner countries, which in turn could be linked to pilot or demonstration trials of low emission technologies. The ultimate objective under this theme is to support the development and reduce the costs of relevant technologies that are needed to make low emission technology a viable option for addressing future greenhouse gas emissions.

All members of the Partnership are also members of the Carbon Sequestration Leadership Forum (CSLF), which has a similar CO₂ storage agenda. Activities developed under the Partnership will be designed to complement and draw on and apply the wider expertise that is available through the CSLF.

Theme 2 Post-Combustion Capture, Oxy-Fuel Combustion and Other Advanced Technologies

This theme covers the development and commercial deployment of advanced combustion technologies, which enable the capture of CO₂ through oxy-fuel combustion or post-combustion capture of CO₂ from gas or coal power generation.

The Task Force will focus on the following technologies for new power stations—noting that the Power Generation and Transmission Task Force will focus on technologies to improve the thermal efficiency and environmental performance of existing power stations:

- Advanced coal cleaning technologies, such as ultra clean coal or Hyper coal, that allow direct firing of coal in gas turbines as part of a combined-cycle power station. These technologies can achieve significant reductions in greenhouse and local environmental emissions, eliminate power station ash and provide an alternative to heavy fuel oils suspended in water.
- Supercritical and ultra-supercritical power stations and high-performance gas turbines.
- A range of advanced fluidized-bed combustion technologies that reduce local emissions and support the more efficient combustion of lower grade fuels.

To make an effective contribution to the development and deployment of technologies under this theme, the Task Force will support a range of projects that reflect the stage of development of each technology.

For instance, many of these technologies (e.g. supercritical pulverized coal systems) are commercially available. In these cases, the role of the Task Force and the projects that it

supports will be one of considering and addressing barriers to the further commercial deployment of these technologies in member countries.

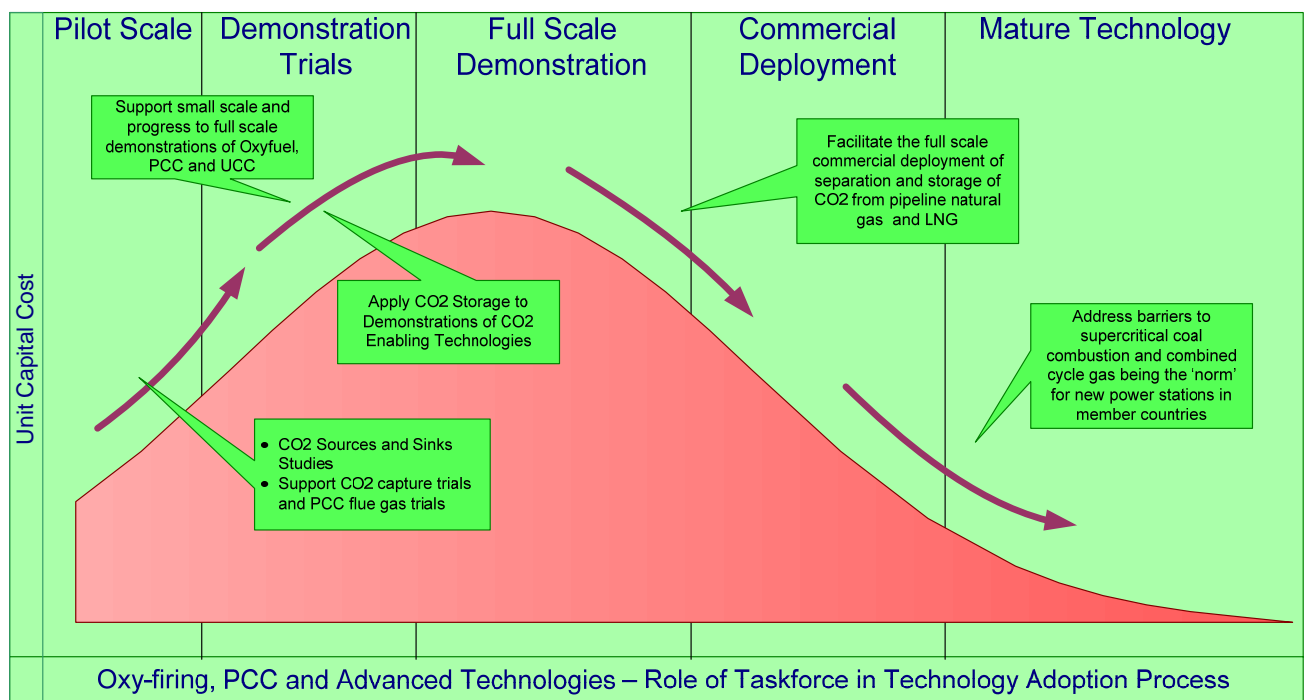
Other technologies are being further refined or need to be progressed to the demonstration stage (e.g. ultra clean coal, oxy-fuel combustion and post-combustion capture). The Task Force can add value by facilitating pilot trials and/or the commercial demonstration of these technologies.

In cases where demonstration projects are likely to proceed without further assistance (e.g. ultra-supercritical plants), the Task Force can add value by acting as an information clearinghouse, and focus its attention on the further development and deployment of high-priority technologies. In common with other technologies, this work may require coordinating the results of research programs, developing financial incentives, and building the skills and capacities needed to deploy these technologies.

The Task Force will consider establishing working groups to bring together experts and industry operators in these technology areas to provide guidance and to develop and implement programs and activities covering these technologies.

Figure 2 illustrates the technologies covered in these theme and their stages of development/diffusion.

Figure 2 Stages of Development/Diffusion—Oxy-Fuel Combustion, PCC, and Advanced Technologies



Theme 3 Coal Gasification

The Task Force will seek to enhance the further development and commercialization of coal gasification technologies and the potential contribution that these technologies can make to greenhouse gas emission abatement. There are three broad aspects of coal gasification that the Task Force will consider, namely:

1. Coal gasification-based chemical and liquid fuel plants.

2. IGCC-based power stations to improve the thermal efficiency and environmental performance of converting coal to electric power.
3. Coal gasification as an enabling technology for CO₂ capture and as one pathway to the hydrogen energy economy.
4. Facilitate trials of gasification with alternative fuels like pet coke, residues from petroleum refineries.

Demand for coal gasification technologies for the chemical industry is strong and expanding, for example in China, the United States and Japan, where gasified coal is used for fertilizer production. This application also has great potential in India. Demand is contributing to the further development and standardization of gasifier designs, which in turn should improve the economies of scale for the design and production of gasifiers. These benefits should in time flow through to gasifiers used in IGCC power stations.

The application of coal gasification to power generation through IGCC technologies has been under development for the past two to three decades. Within Partner countries, the United States and Japan have been actively developing and commercializing IGCC technology. IGCC power stations have been demonstrated on a commercial basis. Semi-commercial and commercial IGCC coal power stations are operating in Japan and the United States and orders have been placed in the United States for major new IGCC power plants. In Australia, a project involving production of hydrogen from coal to produce IGCC fuel is in the planning stage. However, diffusion and transfer to other markets, including other Partner countries, are still limited. This reflects the relatively high capital and operating costs and technological risks of IGCC—which in turn is a reflection that this technology is in an early stage of deployment.

The application of CO₂ separation and capture to coal gasification has become a major R&D focus over the last decade. The demonstration of coal gasification power plants with integrated CO₂ separation and capture is being progressed in Partner countries through FutureGen in the United States, extensions to the EAGLE project in Japan, GreenGen in China and ZeroGen in Australia.

The Task Force will develop a coal and oil gasification strategy and work program that will focus on:

- Adapting coal gasification chemical and liquid fuel plants to produce surplus electricity and/or to capture and store the CO₂ streams that these plants produce. This work could be progressed through possible pilot/demonstration storage projects.
- Facilitating the commercial deployment of IGCC technology, including by addressing research gaps; facilitating demonstration projects in Partner countries; adapting incentive schemes, such as international carbon financing to support investments in IGCC plants; and by addressing new skill sets needed to operate these plants effectively.
- Facilitating the development of proposed CO₂ capture and storage associated with IGCC plants (e.g. FutureGen and GreenGen), using these projects to target research priorities across member countries, progressing capacity building, conducting joint research, facilitating information exchange, and developing appropriate incentive mechanisms.

- Facilitating research, trials and development of gasification technology with alternative fuels like pet coke, residues or gas for commercial deployment and associated CO₂ capture and storage. Project proposal to be developed by USA, Australia and India.

This strategic approach is outlined in Figure 3, while Figure 4 illustrates the stages of development/diffusion.

Figure 3 Coal Gasification— Strategic Directions

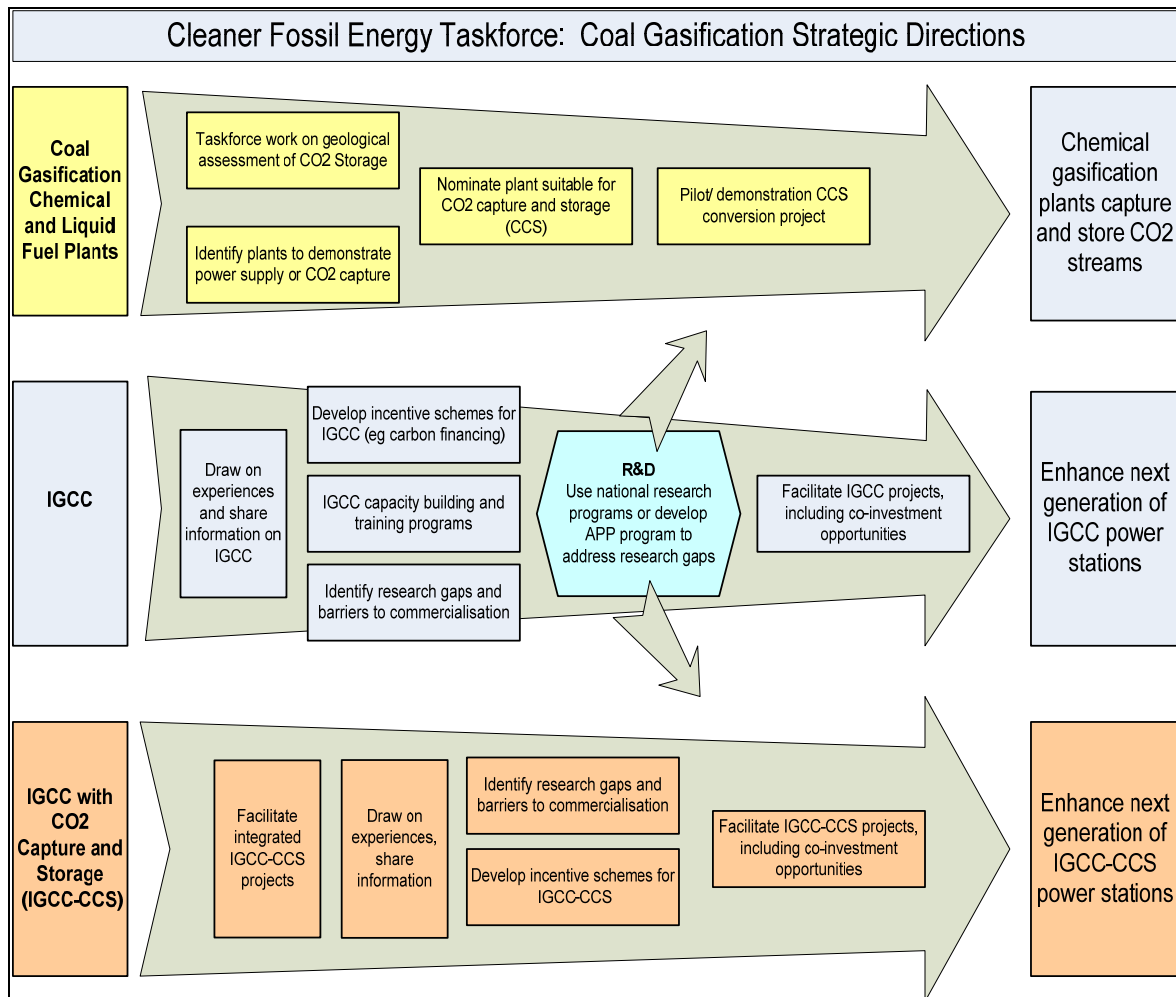
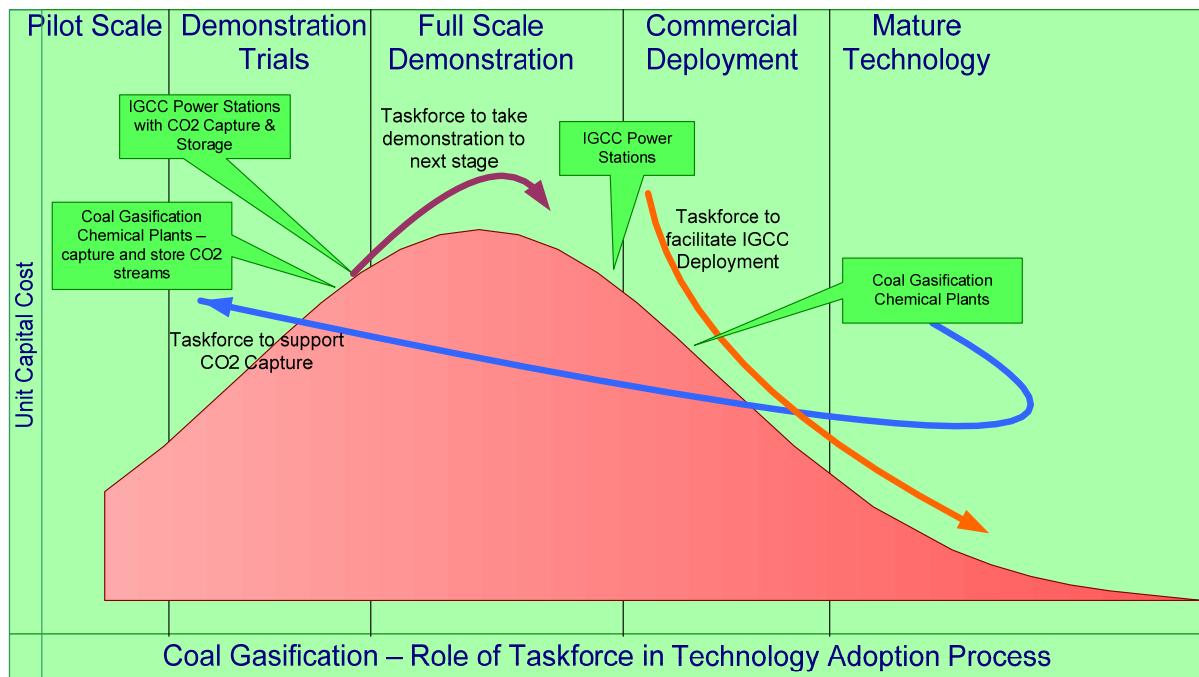


Figure 4 Coal Gasification - Stages of Development and Diffusion



Theme 4 Energy Market Access for Gas

Gas is becoming increasingly important in the global energy mix. Natural gas is the least carbon intensive of the fossil fuels and its greater use can help offset some of the growth in greenhouse emissions from expanding energy use. As well as greenhouse benefits, greater penetration of natural gas into Partner countries will help to improve air quality, and enhance fuel diversity and energy security.

Currently, the natural gas share of electricity generation in member countries varies from 0.3% (China) to 24% (Japan). There is a similar range in the use of natural gas as a heating/cooling and cooking fuel. Increasing the share of gas in all uses will help Partner countries in the transition from their current high emission fossil fuel technologies to the new low emission technologies that will emerge over the next few decades.

The focus of this theme will be on facilitating increased uptake of gas in Partners' economies by implementing best practice in market design, increasing the supply of pipeline gas and natural gas sourced from coal seams, and increased trade of liquefied natural gas (LNG) within Partner countries to meet growing energy demand. This will also meet the environmental objective of reducing greenhouse gas emissions, the social objective of access to reasonably priced energy for all citizens, and the geopolitical objective of supply security.

The Task Force will seek to:

- Identify actual potential cross-border impediments, such as regulatory and market impediments, and promotion of good practice regulatory models to ensure a consistent Partnership framework for natural gas.
- Encourage uptake of CO₂ capture and storage in the oil and gas industries of the Partner countries to support other Partnership initiatives.

- Develop an understanding of coal seam gas opportunities in the Asia-Pacific region, and other ways of growing the use of gas as an exportable fuel, e.g. compressed natural gas (CNG) or the use of gas as a feedstock for low-CO₂ liquid petroleum products, e.g., gas to liquids (GTL).

Theme 5 Gas Handling Infrastructure Improvements

The use of natural gas in all member economies is strongly dependent on pipeline distribution systems, ships, large-scale storage and re-gasification processes and high system pressures and/or low system temperatures. Gas losses along the oil and gas value chain occur as a result of normal operations, maintenance, outdated technology, management shortcomings and system disruptions. Although natural gas is a clean source of energy, fugitive emissions during production, processing, storage and transportation account for 15% of total global atmospheric methane emissions. Their reduction will not only help the climate change effort by lowering emissions, but also increase the amount of gas available for sale, enhance supply security and increase revenues. Because the emissions are predominantly methane (with some, usually minor, mix of CO₂) the greenhouse effects are extremely significant.

Even small incremental reductions in gas wastage and loss can be expected to have a very large benefit on the overall greenhouse emissions of Partner countries. Current methane emissions in the six Partner countries probably amount to at least 23 billion cubic meters of CH₄, or 90 million metric tons of carbon equivalent.

Emissions can be reduced in a cost-effective way in countries with significant gas infrastructure already in place by retrofitting upgraded technologies and equipment, and by improving operations and management practices. In countries with rapidly developing new gas infrastructure, learning, technology and prudent practices can be applied in such a way that an early engineering and management focus on minimizing gas losses can be successfully built in.

The global average efficiency of gas-fired power plants increased from 35% in 1992 to 42% in 2003, but regional variations are large. The Partnership represents an opportunity to raise the regional efficiency of gas-fired power generation by collaborating on the development of improved combined-cycle technology and by sharing knowledge and information on operations and management practices.

The Task Force will seek to:

- Quantify the current methane losses from Partner countries' gas infrastructure.
- Quantify the overall greenhouse effect and the value loss to member economies.
- Develop a recognition that leak prevention and mitigation should be a core business activity and policy focus, through a case study approach.
- Encourage access to, and application of, capital towards leakage reduction technologies and projects.
- Research ways to make investments in leak reduction viable in areas where gas prices are artificially low.

- Develop ways and means for Partner countries to share information on best practices for leakage reduction from infrastructure, and to facilitate the application of emission reduction technologies and practices.
- Engage the oil and gas industry to improve awareness of emission reduction opportunities.

All members of the Partnership are also members to the Methane to Markets Partnership, which has very similar goals to those described under Theme 5. Activities under the Partnership will be designed in coordination with the Methane to Markets Partnership, so that both Partnerships can complement each other and draw on and apply their combined expertise.

Appendix C: Country Sector Reviews of Partner Countries

Australia

Government Clean Fossil Energy Policy

The policy framework for clean fossil energy in Australia is reflected in the Energy White Paper, *Securing Australia's Energy Future*. Priority is given to the development of technological solutions that address environmental, greenhouse and energy policy objectives. This framework recognizes Australia's global responsibilities as a major supplier of coal and LNG, Australia's reliance on technology developed offshore and the contribution that Australia can make domestically and internationally to the development of low emissions technologies. Australia actively supports practical bilateral and international cooperation on greenhouse.

Government-industry partnerships, such as the COAL21 Partnership, the LNG Action-Agenda and Cooperative Research Centres, have developed strategies and technology roadmaps for developing carbon capture and storage, a national clean coal strategy, industry development strategies for LNG and national low emissions technology R, D&D strategies and programs. A cooperative government-industry approach is built into technology development and deployment programs, such as the \$500 million Low Emissions Technology Demonstration Fund, the Greenhouse Challenge Plus, the Greenhouse Gas Abatement Programme and Generator Efficiency Standards. Australian coal producers have also established the \$300 million COAL21 Fund to support the demonstration of low emissions technology in Australia.

Research and Development Activities

The IEA Clean Coal Centre has reported favorably on the comprehensiveness, coordination and information sharing of clean coal technology R&D in Australia. Much of this research is being progressed through the Commonwealth Scientific and Industrial Research Organization (CSIRO) and its Energy Transformed Flagship Initiative, and through Cooperative Research Centres covering the utilization of black and brown coal and CO₂ capture and storage (CCS). Australia has undertaken, for example, world leading research into mapping CO₂ storage potential, the gasification performance of different coals, gas separation, brown coal gasification, advance coal cleaning and supporting research for technologies that enable CO₂ capture.

Industry Demonstration Activities

Projects demonstrating low emissions technology currently under consideration in Australia include:

- Pilot trials of CO₂ storage.
- The Callide-A oxy-fired combustion projects.
- Post-combustion capture pilot and demonstration projects.
- Ultra clean coal demonstration power station.
- Stanwell ZeroGen coal gasification with carbon capture and storage (CCS).

- Brown coal gasification and coal gas to liquids with CCS.
- Brown coal drying including integrating drying gasification combined cycle.
- Large-scale CO₂ storage, such as from the proposed Gorgon LNG project and proposed Monash coal gas-to-liquids projects.

India

Government Clean Fossil Energy Policy

Share of fossil energy will remain more than 90 % of primary commercial energy sources in India. While coal constitutes about 50 % of the energy mix, oil and gas account for about 45%. The future projections given in the Vision 2020 document shows almost same ratio of coal and oil & gas in the energy mix. Out of total quantum of oil & gas, the share of gas will further go up with corresponding reduction in oil. Coal shall remain India's most important energy source till 2030 and possibly beyond until substantial gas replaces power generation.

Government policy is to pursue technologies that will maximize energy efficiency, demand side management and energy conservation to ensure energy security and reliability. The emphasis is reduced consumption of fossil fuels through substitution with improved fuels and efficient technologies while CDM projects to ensure minimum GHG emissions.

Research & Development activities

The National Mission for long term energy security and environment concern emphasize research and development of clean coal combustion technologies, new coal extraction methodology/technology, in-situ coal gasification, IGCC technology, coal to liquid (CTL) gas to liquid (GTL), carbon capture & storage (CCS), hydrogen technology and gas hydrates etc.

Industry demonstration activities

Preliminary development activities in coal cleaning, combustion control & efficiency improvement, IGCC technology has been initiated by the Power & Coal sector. Hydrocarbon sector to take up various clean energy options through GTL/CTL, SO_x/NO_x emission reduction, gas hydrates and hydrogen technology development.

Japan

Government Clean Fossil Energy Policy

Since the position of Clean Fossil Energy, especially coal, in the energy resources policy is to be determined on the basis of its relative advantages and the relative disadvantages as compared with other energy sources, it would be important to preserve and intensify such advantages and to make efforts to overcome such disadvantages.

Although coal has the advantage of superior supply stability at present, reducing its higher emission quantity of CO₂ per unit calorific value is the largest task faced; however, coal has remained one of the alternatives in the pursuit of a well-balanced energy supply structure to cope with various issues.

In the future, with advances in the development of innovative, environmentally friendly coal utilization technology (clean coal technology (CCT)), such as high-efficiency energy conversion technologies through coal gasification, CO₂ Capture and Storage (CCS)

technologies, and other technologies anticipated towards 2030, coal is expected to become a promising alternative as a CO₂-free energy source in the pursuit of a well-balanced energy supply structure.

Research and Development Activity

Implementation of research and development of integrated coal gasification fuel cells combined-cycle (IGFC), for example, the EAGLE project is progressing to establish its technologies with coal feed 150t/day pilot plant.

Implementation of research and development of coal flush partial hydro-pyrolysis technology, for example; ECOPRO project using a 20t/day pilot plant has been started to establish the process technologies for commercialization.

Implementation of research and development of CO₂ Capture and Storage (CCS) technologies (Aquifer/coal bed sequestration), for example, a CO₂ injection demonstration experiment, which is the injection rate of 40 t-CO₂/day, is processing in NAGAOKA project.

Industry Demonstration Activities

- Implementation of demonstration test of integrated coal gasification combined-cycle (IGCC), for example, the demonstration plant of IGCC with an air-brown type that is capacity of 250MW will progress to operation stage in 2007.
- Implementation of demonstration test of Callide-A Oxy-fuel Demonstration project.
- The contents of Clean Coal Day-related business.

Korea

Government Clean Fossil Energy Policy

The 2nd Fundamental Energy Plan (2003) is the basis of the governmental policy on fossil energy in Korea. The main direction of the policy on the fossil energy sector is to establish the market-oriented environment. To encourage energy industries to operate cleaner, the Plan also includes government-driven research and development activities for more efficient and cleaner uses of fossil energy. The future portfolio of power generation is forecasted in the 2nd Power Supply and Demand Plan. New power plants are built according to the Plan. New and Renewable Energy Deployment Enhancement Plan and the Fundamental Plan on the Rational Use of Energy are the detailed plans for energy R&D. We also have a Master Plan on the Hydrogen Economy, which spans 2005 to 2040.

Research and Development Activities

Most of fossil energy R&D in Korea is sponsored by the Ministry of Commerce, Industry and Energy (MOCIE). Korea Energy Management Corporation (KEMCO) manages energy R&D programs including New and Renewable Energy R&D Program and Cleaner Energy Use R&D Program. By Korean law, energy obtained from coal gasification is regarded as New Energy. Under those two programs, IGCC, ultrasupercritical PC boilers, poly-generation, coal bed methane, hydrogen production and coal cleaning researches are in progress.

The Ministry of Science and Technology (MOST) also carries out CO₂-related research through Carbon Dioxide Reduction and Sequestration Centre (CDRS). Oxy-fuel combustion and post-combustion CO₂ capture technologies are being developed through CDRS.

Industry Demonstration Activities

CFE Projects being demonstrated by Korean industries include:

- Ultrasupercritical PC boilers.
- 300 MW class IGCC plant (planning stage).

The United States

General U.S. Government Cleaner Fossil Energy Technology Policy

U.S. goals for clean fossil energy are articulated through federal and state legislation, such as the Energy Policy Act of 2005; through government agencies, such as the Department of Energy and Environmental Protection Agency; and through other organizations, such as the National Academy of Sciences. A number of drivers are currently shaping fossil energy policy, including:

- Environmental protection—Acquisition, transport, and use of fossil energy must be accomplished in a manner that minimizes impacts on the environment.
- Efficiency—Higher efficiency reduces the energy needed required for a given output, yielding lower emissions (including CO₂), conserving domestic resources, and reducing energy imports.
- Economic development—Development and utilization of domestic fossil energy resources helps sustaining economic growth by creating jobs and reducing energy imports.
- Reliable and predictable energy supply—The supply of energy, in its various forms, should be reliable and predictable to support economic growth and minimize price fluctuations.
- National and energy security—Energy systems need to be resistant to natural disasters and deliberate attacks, and energy trade should not result in negative geopolitical situations.

Major R&D Activities

Coal and Power

- *FutureGen*—A US\$1-billion industry/government partnership to build a coal gasification-based, nearly emission-free, integrated electricity and hydrogen production plant with carbon capture and storage.
- *Clean Coal Power Initiative*—A government/industry partnership to conduct full-scale demonstrations of new technologies to cut pollutants from coal-fired generation by nearly 70% by 2018.
- *Gasification*—By 2010, complete R&D to develop advanced power systems capable of 45-50% electrical efficiency at a capital cost of \$1000/kW or less.
- *Innovations for Existing Plants*—Develop technologies ready for demonstration by 2007 that can reduce emissions of mercury by 50-70% at 50-75% of today's cost; NO_x to less than 0.15 pounds per million BTUs at 50-75% of selective catalytic reduction cost; and particulate matter by 99.99%. By 2010, develop technologies to reduce mercury by 90%,

increase by product utilization by 66%, and reduce water use in power plant cooling systems.

- *Advanced Combustion*—By 2010, develop "hybrid" coal power systems integrating gasification with advanced combustion to achieve thermal efficiencies above 50% at a capital cost of \$1000/kW or less; by 2015, develop an advanced "hybrid" as a candidate core technology for the Vision 21 power plant.
- *Fuel Cells*—R&D includes developing (1) solid-state fuel cell modules at less than \$400/kW, (2) tubular solid oxide fuel cells, (3) molten carbonate fuel cells, (4) phosphoric acid fuel cells, and (5) fuel cell/turbine hybrids.
- *Turbines*—By 2010, develop turbine technology that efficiently uses coal-derived gases, including hydrogen, to produce electricity in FutureGen plants.

Oil and Gas

- *National Methane Hydrates R&D Program*—Produce the knowledge and products necessary for commercial production of methane hydrates by 2015.
- *Deep Trek & Other Drilling R&D*—Develop technologies to help operators safely drill and complete deep wells (>15,000 feet) faster, cheaper, and cleaner.
- *Enhanced Oil/Natural Gas Recovery Using CO₂ Injection*—DOE's program focuses on evaluating candidate locations for future CO₂ injection to facilitate enhanced oil recovery, utilizing CO₂ from industrial sources, as well as geologic sources.
- *Petroleum Fuels*—Facilitate economically efficient transition of the U.S. oil and gas processing and fuels delivery system to ultra-clean processing/fuels.
- *Domestic Oil & Gas Conservation*—(1) micro-hole systems, (2) marginal & stripper well revitalization, (3) environmental protection, (4) diagnostics, imaging & fundamental R&D, (5) transmission, distribution & storage, (6) field projects, technical assistance & technology transfer, (7) LNG, and (8) natural gas regulation.
- *Oil Shale/Tar Sands/Other Unconventional Sources*—Examine the potential of these resources for liquid fuels, including (1) strategic value, (2) public benefits, (3) possible ramifications of failure to develop these resources, and, (4) related public policy issues.

Carbon Capture and Storage

To address potential climate change concerns and facilitate continued utilization of domestic fossil energy resources, the United States is pursuing demonstration of safe, cost-effective CO₂ capture, storage, and mitigation technologies at commercial-scale by 2012, leading to substantial deployment and market penetration beyond. Through the Carbon Sequestration Leadership Forum and seven regional government/industry partnerships, the United States is leveraging national and international initiatives to advance the understanding of carbon capture and storage and to accelerate technology development and deployment.

Industry-Led Technology Demonstration Activities

A number of industry-led activities complement and reinforce public efforts aimed at achieving U.S. cleaner fossil energy goals. These initiatives convey the private sector's commitment to sustained use of fossil energy in an efficient, secure, and environmental responsible manner.

- Solid State Energy Conversion Alliance seeks to accelerate development of solid oxide fuel cells and get them to the market as quickly as possible as an affordable power generation option. The Alliance comprises (1) Industry teams, which design the fuel cells, handling most hardware and market penetration issues; (2) Core Technology Program teams of universities, national laboratories, and companies, which look into research problems affecting the industry teams; and (3) the U.S. government, which facilitates interaction between the first two groups and manages the program.
- DeepStar is a joint industry project focused on technologies to increase deepwater hydrocarbon production and reserves. Nine multi-national oil companies lead the effort, with support from dozens of product and service companies.
- Recognizing the importance of global climate change in future energy scenarios, and acknowledging the significant role that coal and other hydrocarbon fuels will continue to play, a number of leading U.S. utilities, oil companies, and technology vendors are pursuing IGCC technology and carbon capture and storage. For example, American Electric Power, Duke/Cinergy, TXU Energy, and NRG Energy have all publicly committed to investments in IGCC technology. BP and GE Energy have also announced plans to collaborate on building ten to 15 hydrogen-fuelled power plants capable of separating and storing CO₂ underground.
- CoalFleet for Tomorrow® (CoalFleet) emphasizes deployment and has not only analyzed and shared lessons learnt but has analyzed the financial barriers to deployment and suggested incentives for various types of firms. CoalFleet has also developed design guidelines and economics for IGCC and will publish USC design guides in 2006 while improving these with each version (in 2006 CoalFleet worked on version 4 of the IGCC design guides). CoalFleet will have IGCC plus CCS guidelines in 2006 and USC plus CCS in 2007. CoalFleet has international collaboration and support from over 300 GW worth of coal generators, coal companies, oil and rail and most major suppliers of IGCC worldwide (GE, Shell, Siemens, Conoco Philips, Rocketdyne), and several combustion suppliers (Alstom, B&W). CoalFleet is proposing to build on this collaboration for two of the Partnership's CFE initiatives.

Appendix D: Glossary

Summary of Key Technologies Identified in the Sector Review

Integrated Gasification Combined Cycle (IGCC)	In the IGCC process, coal is not combusted, but reacted with oxygen and steam to produce a “syngas” composed mainly of hydrogen and carbon monoxide. The syngas is cleaned of impurities and then burned in a gas turbine to generate electricity and to produce steam for a steam power cycle. If carbon capture is required, the syngas is reacted with steam prior to combustion to produce hydrogen and CO ₂ . These gases are then separated. The hydrogen is burned as a clean emission free fuel in the gas turbine and the CO ₂ is compressed for geological storage.
Oxy-Fuel Combustion	In oxy-fuel combustion, the coal is burned in oxygen rather than air and the flue gas is recycled through the system. This eliminates nitrogen and increases CO ₂ concentrations in the resulting flue gas to facilitate capture.
Post-Combustion Capture	In post-combustion capture, conventional coal or gas power plants (including the possibility of retrofit to existing ones) are fitted with solvent absorption technology to selectively absorb CO ₂ in the flue gas. The loaded solvent is then heated and passes through a stripping column, where steam is used to regenerate the solvent and remove the CO ₂ for capture.
Ultrasupercritical Pulverized Fuel	Most of the new clean coal technologies under development have 10–20 per cent lower greenhouse gas emissions than conventional pulverized fuel (pf) coal-fired power plants. New clean coal technologies include supercritical and ultra supercritical steam, fluidized bed combustion and a range of coal gasification systems. These technologies significantly increase thermal efficiency. This means less coal is required to produce a given amount of energy. Advanced modern plants use specially developed alloys, which enable the use of supercritical and ultra supercritical steam to achieve efficiencies of 45 per cent and above. As the technology advances, efficiencies of 55 per cent and above should be achievable in the near future.

Coal Cleaning and Equipment	<p>Also known as <i>coal cleaning</i>, <i>coal preparation</i> and <i>coal beneficiation</i>. As-mined coal is of variable quality and contains impurities. Coal beneficiation is the process by which these impurities are removed to produce a cleaner product. Coal washing increases the heating value and the quality of the coal, by lowering the level of sulfur and mineral constituents. Coal washing can reduce the ash content of coal by over 50% and reduce sulfur dioxide (SO₂) emissions.</p> <p>The removal of ash reduces the amount of coal that is transported so that reduction in energy needed to transport coal, especially over large distances, will outweigh the additional energy used in washing coal.</p> <p>The major greenhouse benefit is in terms of providing coals that support optimum design parameters of power stations. Processes have also been developed, for example—ultra clean coal in Australia and Hyper coal in Japan—which remove almost all the impurities in coal. This product can be burned directly in gas turbines to achieve major improvements in thermal efficiencies.</p>
Poly Generation	<p>Gasification systems, such as coal gasification, use the syngas for power generation and to produce chemicals or liquid fuels. The additional revenue streams from poly generation can help offset the additional costs of coal gasification power.</p>
Reformation of Fossil Fuel	<p>There are several technology options for the production of hydrogen that use renewable energy in the reformation of fossil fuels, including methane from natural gas. The reformation of fossil fuels may become a more efficient process for generating and storing power from renewable energy.</p>
Hydrogen Production	<p>Gasification technologies will support the production of hydrogen that can be burned directly into advanced gas turbines or used in hydrogen fuel cells, which can be used in either stationery or transport applications.</p>
Enhanced Coal Bed Methane	<p>Enhanced Coal Bed Methane (ECBM) recovery is seen as a potential opportunity for sequestering CO₂ in unmineable coal seams and obtaining improved production of coal bed methane as a valuable by-product.</p>

Coal Mine Methane

At active underground mines, methane must be removed from underground operations for safety reasons. This is done with large-scale ventilation systems that move massive quantities of air through the mines. These ventilation systems keep mines safe but also release large amounts of methane at very low concentrations, often termed Ventilation Air Methane (VAM). At some active mines and abandoned mines, methane is also produced from degasification systems (also commonly referred to as gas drainage systems) that employ vertical and/or horizontal wells to recover methane. There are a variety of uses for drained CMM including natural gas pipeline injection, electric power production, co-firing in boilers, district heating, mine heating, coal drying, vehicle fuel, and manufacturing/industrial uses, such as feedstock for carbon black, methanol, and dimethyl ether production. For VAM, technological development has progressed to the point where low cost solutions are now commercially available.