**IEAGHG Information Paper 2017-IP65; US Study on Approaches for International Collaboration and Financing of CCUS Pilot Projects**

## *Background*

The Coal Utilisation Research Council (CURC)[1] began an effort to identify strategies to fund large pilot scale testing of advanced fossil energy and CCS technologies in the R&D pipeline in 2014. Once proven effective, these technologies will reduce the cost of fossil power with CCS and thereby improve the prospects for world-wide deployment. From a funding perspective, large pilots present a challenging set of facts:

1. They are a necessary interim development step prior to commercial demonstration;
2. They may cost $100 – $500 Million which is beyond balance sheet financing for most technology developers; and,
3. They are unlikely to generate enough revenue to support typical project based financing.

The same year, CURC convened a Technical Workshop with support from Alstom, American Electric Power, Arch Coal, Cloud Peak Energy, Consol Energy, Duke Energy, Peabody Energy, Southern Company, Tri-State Generation and Transmission Association, and the United States Department of Energy. A report of the workshop can be found via the following link: http://media.wix.com/ugd/80262f_0e0ffae694454287ad5a14998327d3f2.pdf

The report outlined steps that could be taken to address barriers to the development and deployment of advanced fossil fuel-based power generation technologies at pilot plant-scale. The major conclusions drawn from the workshop include:

1. Large-pilot projects are in fact a necessary step in technology development since transition from bench scale to commercial demonstration involves unacceptable technical and economic risk.
2. Pilots in the range of 10-50 MWe are appropriate; however, certain advanced technology components may be tested at a smaller size.
3. A number of advanced fossil-based power and CCS technologies have been proven at small scale and are ready for larger scale testing. Transformational technologies were of particular interest.
4. Large-scale pilots present a financing challenge. They may cost $100 – $500 million, which is beyond balance sheet financing for most technology developers. And, they are unlikely to generate sufficient revenue to support typical project-based financing given that they are usually sub-commercial in scale.
5. Due to risk and business case concerns, the private sector may be able to share 10-20 percent of large-pilot project costs. Substantial financial support must come from governments. 6. Innovative financing mechanisms should be explored including international collaboration.

The follow up to the workshop are the Phase I and Phase II studies commissioned by Japan's New Energy and Industrial Technology Development Organization (NEDO) and DOE that further evaluated the major conclusions from the workshop.

[1] The Carbon Utilization Research Council (CURC) is an industry coalition focused on technology solutions for the responsible use of our fossil energy resources in a balanced portfolio to support our nation's need for reliable and affordable energy. Created in 1998, CURC serves as an industry voice and advocate by identifying technology pathways that enable the nation to enjoy the benefits of abundant and low cost fossil fuels in a manner compatible with societal energy needs and goals. For more details see: http://www.curc.net/about-curc

***Phase I***

CURC and NEDO released a study titled "Analysis of Options for Funding Large Pilot Scale Testing of Advanced Fossil-Based Power Generation Technologies with Carbon Capture", or the Global CCS White Paper. The Phase 1 study supports the hypothesis that innovative approaches are needed to fund large scale pilots. The Study also identified multinational collaboration as a potentially important component of large-pilot financing. The premise is that governments with overlapping R&D missions can find value in leveraging financial resources to support the various promising technologies in the pipeline. Resources can be pooled, redundancies eliminated, and ultimately more large-scale projects may reach successful completion.

The Executive Summary of the 2016 Global CCS White Paper can be found via the following link:
http://media.wix.com/ugd/80262f_2949eafbd03847619b8c02754de116fe.pdf

***Phase II***

The Phase II study is a follow-on effort to investigate options to overcome barriers to financing large-pilot projects (10-50 MWe) for fossil fuel-based power plants with CCS as well as barriers to multinational collaboration as a funding approach for such projects.

Working with the Department of Energy and NEDO, CURC produced a report in July 2017 entitled ***"Analysis of Options to Overcome Barriers to Unilateral and Multilateral Large-Pilot Projects for Fossil Fuel Based Power Plants Equipped with CCS".*** The report can be found via the following link:
http://64.106.168.122/webfiles/CURC/Final%20Report%20-%20Analysis%20of%20Options%20for%20Financing%20CCUS%20Projects.pdf

The report was split into Tasks 2 and 3. Key findings from each task are included below:

**Task 2 Key Findings**

1. Large-pilot scale fossil fuelled electric power technology projects with CCS are an essential part of the CCS technology development chain. Such projects are typically 10-50 MWe in capacity and cost $100-500 million (U.S. $).
2. These large-pilot projects face significant barriers, including a perception of a limited near term market for the commercialized technology, their relatively high cost, difficulties securing financing, and inadequate or counter-productive government policies.
3. A portfolio of policies and incentives will be necessary to advance large-pilot scale CCS projects.
4. Measures to address market barriers would endorse the need for a diversified generating portfolio that included fossil fuel-based generation with CCS to meet social goals related to climate change
5. Financial barriers could be overcome by a mix of financial incentives that recognize the range of differences in pilot projects. For example, "tear-down" projects and projects that only demonstrate capture ("catch and release") would benefit primarily from capital cost-related incentives, whereas projects continuing operation after completion of pilot testing and permanently storing CO2 are also amenable to incentives based on operation such as CO2 storage credits. The incentive mix could include tax credits, grants, and loan assistance. Sources for funds could vary by country and include general tax revenues, climate programs, and fees levied on electricity users and fossil producers. Incentives should be viable across the full range of electric generation business structures. Policymakers should seek financial participation from non-traditional supporters of new technologies such as environmentally purposed foundations, export credit agencies, and purpose-based public finance institutions.

6. Measures to reduce the cost of CCS technologies would reduce financial barriers to pilot projects. These measures could include increased bench-scale R&D, pursuit of modular technologies, and reusable large-pilot scale test platforms.
7. Needed policy initiatives centre on a genuine commitment by governments to the development of CCS-based technologies? Specific measures that might demonstrate such a commitment include providing financial incentives for large-pilot scale projects, enacting regulatory incentives such as "bonus allowances" or using allowance sales by "cap and trade" jurisdictions to fund large pilot projects, levying fees to support dedicated funds for large-pilot projects, and exercising regulatory flexibility for environmentally beneficial pilot projects and commercial demonstration projects. A government program to store CO2 captured at initial pilot and demonstration projects would overcome barriers to CO2 storage for those units.

**Task 3 Key Findings**

1. Governmental collaboration on fossil-based power and CCS technology development is widespread, ranging from laboratory research to demonstration scale across the power generation and CCS value chain.
2. Large-pilot projects present unique financing risks and challenges that could be mitigated by multilateral financial collaboration.
3. National interests must be considered in framework development. The need for substantial domestic involvement in return for a country's contribution to large pilot projects may be compelling, can complicate framework development, and will impact project structure.
4. Countries and regions have different viewpoints on fossil-based power and CCS technology development and deployment. A singular collaborative approach may not work. Targeted collaboration and framework development by countries with like-minded viewpoints may be preferred.
5. Development of a collaborative framework is a complex undertaking, requiring time, human resources, and cross-disciplinary skills. Completion may take several or more years. Compromises between the perfect and the achievable must be considered
6. For collaboration to be successful, sustained and consistent political support is necessary.
7. Concurrent award of government support and flexibility in managing use of government funds for project expenditures will facilitate project development and implementation.
8. Intellectual property rights are perceived as a potential barrier to collaboration. Early resolution of intergovernmental issues along with early agreement among project team members on intellectual property rights would facilitate collaborative projects

For members' reference, the General Manager participated in both the Phase II activity and contributed/inputted to both Tasks 2&3.

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