The pivotal role of carbon capture, utilisation and storage

CCUS promises a unique bridging solution for developing countries, offering affordable and attainable clean energy that will enable development. Large-scale commercial demonstrations are now needed

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The next 35 years will bring many complex challenges, especially to developing countries. The UN projects global population to increase by two billion people by 2050, mostly in the developing countries of Africa and Asia. During this period, the imperative that will drive developing country governments will be poverty alleviation and the transition to sustainable economic growth. The pressures of resource scarcity, combined with limited supplies of hard currency, will push many developing countries toward mounting reliance on domestic fossil fuels, especially coal.

Historical emissions and continuing release of greenhouse gases by industrialised countries, combined with increasing fossil fuel-related emissions from developing countries, will push atmospheric concentrations of carbon dioxide (CO_2) and other greenhouse gases to record levels.

The International Energy Agency's (IEA) World Energy Outlook 2014 concludes that policy choices and market developments as outlined in their central scenario bring the share of fossil fuels in primary energy consumption just below 75% in 2040, and are not enough to stem the rise in energy-related CO_2 emissions, which will increase 20% by 2040.[1]

Transformational clean energy technologies needed to ensure the 2ºC scenario

Fortunately, a new set of cleaner fossil energy technologies has emerged to act as a bridge from conventional fossil fuels to abundant clean and sustainable forms of energy. The commercial introduction of carbon capture, utilisation and storage (CCUS) technologies in countries such as China, India, Indonesia, Mexico and South Africa will allow conversion of conventional coal to a much cleaner resource.

In fact, the Fifth Assessment Report of the Intergovernmental Panel on Climate Change concludes that most climate mitigation scenarios aimed at limiting temperature change to 2ºC rely on the availability and widespread deployment of carbon capture and storage (CCS) technologies in the power and industrial sectors.

Furthermore, the IEA finds that if CCS is removed from the list options in the energy sector, the capital investment needed to meet the same CO_2 emissions constraint increases by 40%.[2] According to the IEA, 70% of all CCS in 2050 will need to be in non-OECD countries, where energy demand is growing and fossil fuels remain the principal energy resource.

One CCUS strategy, in particular, seems likely to create near-term, win-win opportunities that are highly relevant in developing countries. Jupiter Oxygen Corporation's practical application of high flame temperature oxy-combustion (i.e., the burning of fossil fuels in a boiler with nearly pure oxygen) involves fitting the technology to existing and new power plants. Oxy-combustion technology generates highly concentrated CO_2 in the flue gas and enables cost–effective capture of CO_2. Co-benefits from applying oxy-combustion based, carbon capture and utilisation technologies include air pollutant control, process water recycling and making CO_2 available as a salable product.

Key to sustainable development: clean energy technology solutions

Who will buy the CO_2?

The captured CO_2 from oxy-combustion can be injected into partially-depleted oil wells, driving out previously untapped quantities of crude petroleum. This process, called enhanced oil recovery (EOR), has been employed for decades, using a variety of injectable gases, including CO_2, allowing resource owners to squeeze more economic value from existing oil deposits than is possible with conventional oil production techniques alone. When 'anthropogenic CO_2' injection is used, this process simultaneously sequesters carbon emissions that would have otherwise been emitted to the atmosphere.

Alternatively, depending on local geologic conditions, the captured CO_2 can be mixed with nitrogen (N_2, available from the air separation unit that is part of the oxy-combustion technology application) and injected into deep, unmineable coal seams.

The injection of compressed gases produces additional methane. This process is referred to as enhanced coal-bed methane (ECBM) recovery. The additional methane produced by ECBM in a developing country could be substituted for coal in electricity production or for natural gas that would otherwise need to be imported at high cost.

A combined injection of the proper ratios of CO_2 and N_2, with both gases produced close to the ECBM injection site, can possibly improve ECBM recovery rates and economics, as demonstrated in several initial R&D projects in the US and Canada. Moreover, commercially profitable ECBM can be done in this way at sites with favourable reservoir and geological conditions.

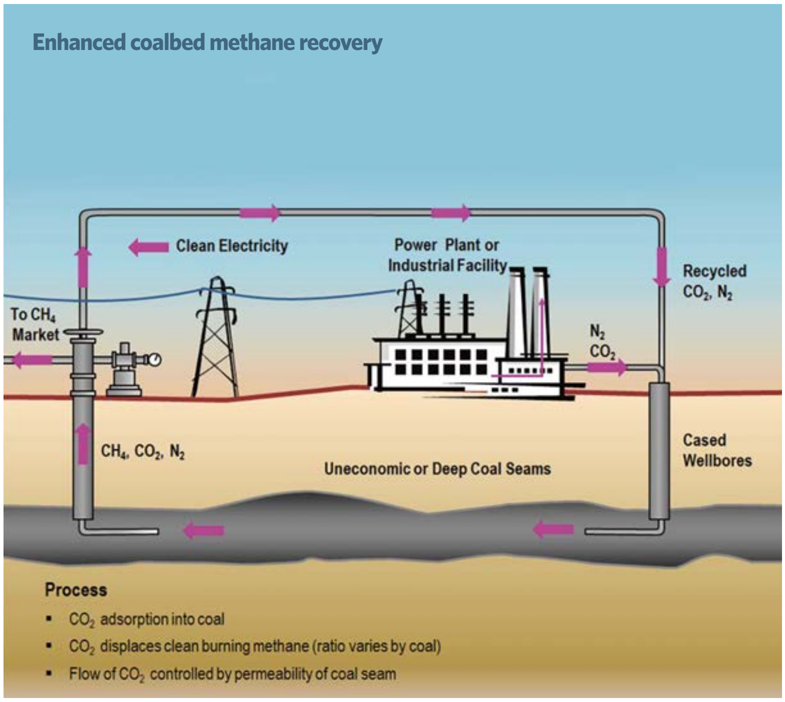
CO_2 utilisation: economic benefits and mitigation potential

The cost of EOR depends on the details of local economic and geologic conditions. The value of EOR depends on the internationally traded crude oil price. To implement EOR, a country needs to have oil fields close to an industrial facility or a power plant able to generate a steady stream of concentrated CO_2. Alternatively, a long-distance CO_2 pipeline infrastructure could also support this industry.

Projections developed by Advanced Resources International (ARI) for the National Energy Technology Laboratory indicate that 19 billion metric tons of CO_2 will need to be purchased by CO_2-EOR operators to recover 66 billion barrels of economically recoverable oil in the US. Research done by ARI for the IEA's Greenhouse Gas Programme indicate that as much as 43 billion barrels of oil can be technically recoverable from the application of CO_2-EOR in China's large oil basins, and would sequester at least 12 billion metric tons of CO_2.

Similarly, with ECBM recovery, the cost is very sensitive to both the geology of the local coal seam and the distance between the unmineable seam and the CO_2 'source' facility. The benefits of creating a new resource of clean-burning natural gas from previously unexploitable coal deposits can be quite significant. For example, ARI estimates there are 70 to 90 trillion cubic feet (TCF) of coal-bed methane (CBM) in place in India, of which 20 TCF are recoverable with 'conventional' CBM, and another 15-18 TCF are potentially recoverable with 'enhanced' CBM, while storing billions of tons of CO_2 safely underground, and simultaneously generating significant additional revenue.

CCUS technologies, in the context of EOR or ECBM recovery, can thus reduce the fiscal burden of clean energy development and enhance energy security by replacing imports and expanding the use of untapped domestic resources.



Industrialised countries are moving to underwrite the incremental costs for first-of-a-kind larger scale commercial demonstrations of CCUS technologies, and emerging economies are considering being 'host' sites for these demonstrations. The Green Climate Fund can be instrumental to CCUS technology implementation in emerging economies. Wider CCUS technology deployment will reduce overall cost of carbon capture technologies and will thus achieve better public acceptance of CCUS/CCS-based clean energy strategies. CCUS technologies can provide win-win options for developing countries, fuelling economic growth and other national development priorities while enhancing energy security, engaging these countries proactively in protecting their local environment while ensuring the stability of our shared global atmosphere. ■

Footnotes:

1 International Energy Agency - World Energy Outlook 2014, Executive Summary.

2 International Energy Agency - Energy Technology Perspectives 2012, Executive Summary.

About Jupiter Oxygen Corporation

Jupiter Oxygen Corporation (JOC) has developed technologies for industrial energy efficiency and cost effective carbon capture from fossil fuel power plants. Jupiter Oxygen has worked for a decade with experts from the National Energy Technology Laboratory (NETL) of the US Department of Energy to develop clean fossil energy solutions, with a focus on retrofitting existing coal fired power plants. JOC's high flame temperature oxy-combustion technology, combined with the NETL's Integrated Pollutant Removal™ system, enables the capture of 95% -100% of CO_2, and the elimination of key pollutants (NOx, SOx, PM, mercury). JOC holds and maintains patent rights to this joint clean technology development. JOC's unique technologies can be a critical part of strategic alliances for the financing and management of successful carbon capture and utilisation projects. Jupiter Oxygen is engaged in demonstration project activities in the US, China, India and Mexico.

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