Deriving an Economic Model to Identify Emissions Reduction Opportunities in the Carbon Energy Business*

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Abstract

Energy demand and growing pressure to impose limits on carbon emissions out of concern for postulated catastrophic climate change poses a serious problem in deriving lead time in developing a globally sustainable energy and economic system. The estimated carbon emissions potentials ranging from 1000 gigatonnes of carbon from conventional fossil fuels to over 5000 gigatonnes of carbon for the technically recoverable fossil resources in the 21st century, as a result of rising expectations for ultimate hydrocarbon recovery, will have major implications on energy and environmental policy approaches in the mid-century term, striving to limit cumulative anthropogenic carbon emissions in the form of CO_2 from 1991 to 2100 at 1000 gigatonnes, in order to stabilize atmospheric carbon concentrations at 550 ppmv. The paper is aimed at deriving an economic model for a sustainable carbon economy in 21st century, by identifying emissions reduction opportunities at the carbon energy business at large, that may result in formulating energy policy on long term carbon energy management through aligning the value chain of CDM credits in emissions trading mechanisms.

Emphatically, it will extend Lead Time for conversion of the Global Energy System to sustainable and carbon-free sources of power and hydrogen. An assessment of carbon dynamics and its accounting under emissions regulations aims to identify significant determinants contributing to evolve a Global Energy Policy and Economics in the 21st century. A quantitative assessment through econometric analysis of economic and environmental determinants of the carbon energy business, integrated with web-wide interactive simulation model leads to deriving a new set of parameters on carbon matrices to formulate sustainable energy portfolios under Kyoto and Clean Development Mechanisms as well as UNFCCC. The paper emphatically derives eligibility criteria for CDM projects on a long-term emissions signature by Establishing Trading Boundaries, Issuing Permits, Crediting and Carbon Accounting, Designing Energy Market Orientations, and Greenhouse Gas Abatement Programme (GGAP) and furthermore emissions sequestrations for improvements of market conditions, reduction in environmental risks, emergence of policy debate and formulations of energy scorecards and regulations. The Energy Industries' determination to develop a long term global greenhouse strategy for environmental sustainability of 21st century gas based carbon economy by incorporating elements of Global Climate Change and views of its stakeholders will have a significant bearing on design of future

scorecards of growing energy and gas market on the matrices of emissions trading, through Capacity-Building on low carbon-technology, and creating Carbon-Trust to support developers and investors in a low-carbon economy under efficient carbon regulation.
The paper objectively concludes in deriving roadmaps of sustainable energy portfolios under Kyoto and Clean Development Mechanisms to manage climate change and environmental risks for the whole gamut of the carbon energy business with integration of emerging regulations. Future orientations of energy market in terms of International Climate Negotiations will be determined by: lead time to optimize recoverable fossil fuels, development of hydrogen and renewable energy economy, policy approaches and regulations, global trade alignments on emerging energy, environment and economic orders, as well as on technological advances. The paper finally concludes in aligning determinants of value chain on long-term carbon energy management.

Introduction: Global Developments on Long Term Carbon Energy Management in CDM Context

Access to affordable energy is a key requirement for economic and social development. In its latest review, the International Energy Agency (IEA) states that world energy demands will increase steadily through 2030. Global primary energy demand is expected to increase by 1.7% per year from 2000 to 2030, reaching an annual level of 15.3 billion tones of oil equivalent. The increase will be equal to two thirds of current demand. Projections show that fossil fuels (gas, oil, and coal) will continue to be the primary economic supply choice to meet growing energy demands, and that the Earth's energy resources are adequate to meet this demand for at least three decades. These projections also raise concerns about long-term energy supply, investment in energy infrastructure, environmental issues associated with the resulting emissions from energy production and use, and unequal access of the world's population to modern energy. The world population is expected to increase from the current 6 billion to approximately 10 billion by 2050 and will create significant demands for additional energy from:

- Developing economies, as they industrialize and become more affluent. The evidence shows a direct correlation between energy consumption and economic prosperity. The observations of the World Energy Council are that health, water, food, education and many other key aspects of welfare cannot be improved unless modern energy becomes available to all,

- Industrialized countries, with continued economic growth. While the introduction of efficiencies and conservation efforts will have a mitigating impact, business-as-usual projections show an ever-increasing worldwide demand for energy.

For the Asian and Latin American regions the above translates to a CO_2 emissions increase from fossil fuel production from 423 Mt in 1973, to 877 Mt in 2000. In the future (*World Energy Outlook 2002*, International Energy Agency—EIA), total CO_2 emissions for Asia and Latin America will increase in the following manner:

Year	1972	2000	2010	2020	2030
CO_2 in Mt / yr	360	877	1185	1571	2104
% annual increase	-----	3.1	3.1	3.0	3.0

It is also recognized that in many countries in the region, forest clearing leads to greater CO_2 emissions than from fossil fuels, and agriculture adds to emissions of the greenhouse gases methane and nitrous oxide. The global situation, by comparison, is as follows:

Year	1972	2000	2010	2020	2030
CO_2 in Mt / yr	13,654	22,639	27,435	32,728	38,161
% annual increase	-------	1.8	1.9	1.9	1.8

With the vast potential for cleaner hydrocarbon energy, countries have the opportunity to turn the challenge of a carbon constrained world into sustainable and diversified economic growth. Since GHGs are derived from a variety of energy resources and processes, no single technology appears to be sufficient to stabilize increasing atmospheric GHG concentrations. Rather, a portfolio of technologies aimed at improving energy efficiency, and increasing the use of less GHG intensive fuels/processes will help reduce GHG emissions and other environmental impacts. Technology has already played a major role in helping to reduce GHG emissions and controlling costs and, as scientific and technical understanding grows, new technologies hold the promise of a more efficient and cleaner energy supply. The creation of value from hydrocarbon energy has always depended on the application of science and technology.

The hydrocarbon-energy industry has a strong record of introducing new technology and is a significant user of some of the most advanced manufacturing and information technologies available. Many of these technologies have either been developed by industry alone or with the support of governments. Incremental technology improvements will continue to enhance the financial performance of current operations. Achieving the major growth and diversification envisioned requires innovation, discovery, development and implementation of a range of new technologies. The challenges are substantial, and participation by governments, academia and the hydrocarbon industry will increase prospects for success in the timeframes that may be required for addressing climate change. Therefore, in terms of long-term carbon energy management:

- The technology challenges are significant,
- The solutions are anticipated to cut across traditional industry boundaries,
- The cost and skills required will be far beyond the resources of any one company, industry or government, and
- Market-based incentives will help to promote continued developments.

Eligibility Requirements for CDM Projects at Sustainable Carbon Energy Business

The Clean Development Mechanism (CDM) is a provision of Kyoto Protocol to the United Nations Framework Convention on Climate Change that offers a new pathway to encourage technology transfer, promote sustainable development in host countries, reduce greenhouse gas (GHG) emissions and assist Annex B countries (developed countries listed in Annex B of the Kyoto Protocol) to cost-effectively meet their commitments under the Kyoto Protocol. The success of the CDM will depend upon the rules governing its operation (e.g. clarity on eligibility requirements and baseline methodologies), on the development of appropriate projects, and on the emergence of national systems to support project development and review. CDM procedures and rules, and the institutional capacity required to manage the process of approving projects and assigning credits, still need to be established. A successful CDM will present practical opportunities to reduce greenhouse gas emissions. The three aims of the CDM, as specified in the Kyoto Protocol are to: 1) promote sustainable development in non-Annex B countries; 2) help achieve the ultimate objective of the Convention to stabilize atmospheric concentrations of GHGs; and 3) assist Annex B parties in cost-effectively meeting their obligations under the Protocol. For non-Annex B countries, the CDM promises to create a reduced-emission infrastructure, support national sustainable development objectives, promote technology transfer, build local capacity and attract foreign investment.

It has been surveyed that the international CDM market is currently dominated by a number of energy projects and initiatives across Asia and Latin America. It is further evident that E & P companies are applying risk management analysis to many of the projects in order to delineate the base business case and an understanding of other environmental co-benefits (e.g., improving air quality, better water quality). This will lead to a greater requirement for effective risk management tools and capacity building. Key points derived are as below:

- Total World Bank carbon finance in Asia, Latin America and Caribbean regions to date is USD 18.2 million; however, the World Bank anticipates its carbon finance portfolio in the regions will range between USD 50-100 million for 2004 and beyond,

- 28% of approved World Bank Prototype Carbon Fund projects are in Asia, Latin America and the Caribbean.

Specifically, the following types of CDM projects will be eligible for the simplified procedures:

- Renewable energy project activities with a maximum output capacity equivalent of up to 15 MW,

- Energy efficiency improvement project activities that reduce energy consumption on the supply and/or demand side by up to the equivalent of 15 giga-watt-hours per year,

- Other project activities that both reduce anthropogenic emissions by sources and that directly emit less than 15 kilo-tonnes of carbon dioxide annually.

It was recognized that the small-scale projects play an important role in developing the capacity and understanding of projects prior to initiating large-scale projects. At the same time, there was concern that the large-scale projects are receiving little attention at international or national levels. Large-scale projects could result in significant investments, technology transfers, and emission reductions. Meeting host country sustainable development criteria is an essential element in the approval process of CDM projects. Sustainable development requires making informed choices based upon the integration of economic, environmental and social considerations into the decision making process. In the context of developing CDM projects, the project developer, the DNA, and other stakeholders need to work together to develop a common understanding of the types of indicators of sustainable development appropriate for project review and approval. Developing adequate sustainable development indicators, with regard to the natural resources sector, will assist groups in reporting to stakeholders on sustainable development. The crediting of the emission reductions achieved through various project activities and technology development efforts will be vital to long term industry viability that will assist them in reaching their longer-term GHG emission reduction goals, possibly to expand into new markets, and will provide for international economic investment. The emission reduction targets and timetables set by the Kyoto Protocol run to 2012. It remains uncertain what kind of international framework may evolve after the first commitment period or what future obligations might be undertaken by developing countries.

Carbon Trading Mechanisms – Evolving Value Chain on CDM Credits at Hydrocarbon E & P Projects

The Emissions Trading Scheme for CO_2 is one of the major components of Climate Strategy reaching the Kyoto targets. Besides trading emissions allowances within the trading scheme, a linking between Clean Development Mechanism and Joint Implementation needs to be established. This allows Carbon Trading Mechanism to carry out emissions curbing projects in other Annex I countries (Joint Implementation) and non-Annex I countries (CDM) and to convert the credits earned into emissions allowances under the Trading Scheme. The Hydrocarbon E & P based projects Clean Development Mechanism (CDM) and Joint Implementation (JI), will also allow Annex I Parties of the Kyoto Protocol to use carbon credits from similar projects that reduce emissions in other Annex I countries (the JI Projects) and non-Annex I countries (the CDM Projects) to fulfill their Kyoto commitments. In the past few years, the global market for carbon credits from Hydrocarbon E & P Project-based mechanisms has been steadily growing. The future demand and especially the supply of CDM and JI credits are hard to estimate, not only since institutional issues constitute significant barriers to a more widespread use, but also since the role of CDM in the post-Kyoto period is not yet clear. Given these uncertainties, current evidence suggests that the minimum supply of CDM and JI credits at petroleum projects is around 200 Mt CO_2 p.a., and that it seems unlikely that it will be far above 600 Mt CO_2 per annum. CDM and JI projects help to reduce the cost of meeting Kyoto targets. While the use of CDM and JI drives down the allowance price in Carbon Trading Mechanisms, the supplementary condition of Kyoto Protocol requires the major part of the emissions reductions to be realized through production and consumption of fossil fuels and carbon energy. The best strategy to reduce the costs of the global climate strategies is to include more sectors, and gases and to allow for an unrestricted of CDM and JI at Hydrocarbon E & P projects. If this is not feasible, it is at least beneficial to reduce the burden for the non-Emissions Trading Scheme (ETS) sectors.

Interrelationships between Emerging Emissions Trading Systems under Kyoto and UNFCCC Framework

Estimates of marginal abatement costs for reducing carbon emissions derived from major economic-energy models vary widely. Policy differences are one source of variation. This variability in cost estimates undermines support for mandatory policies to curb carbon emissions, as policy makers are generally reluctant to adapt a major programme without understanding its true costs. Four principal factors can be identified that are likely to contribute to the estimated differences in estimates of carbon mitigation costs, roughly following IPCC and UNFCCC Framework:

1. Projections of base case emissions, which determine the quality of abatement required to meet Kyoto targets,
2. Structural characteristics of the models, including sectorial and technological details, the representation of substitution possibilities, international linkages, and optimization techniques,

3. The climate policy regime considered (especially the degree of flexibility allowed in meeting the emissions constraints), and

4. The consideration of averted climate damages or ancillary benefits from reductions in conventional pollutants associated with carbon mitigation.

The differences in policy regimes, e.g. emissions trading and revenue recycling have emerged as the key factors in most of the analyses, however with the harmonization of policy regimes and other relevant assumptions, the remaining variation in costs is solely attributable to differences in baseline assumptions and/or structural characteristics of the emissions trading systems. More refined characterization of technology, such as including capital stock turnover and limitations to the introduction of new technologies, does not help to explain the observed differentials in marginal abatement costs. Opportunities for interaction between emerging GHG Trading Systems incorporate Convertibility of Verified Emissions Reductions (VERs) into Certified Emissions Reductions (CERs) under Clean Development Mechanism (CDM) or Emissions Reductions Units (ERUs) under Joint Implementation (JI) arrangement.

Emissions Trading Behavior and Risk Management at Carbon Energy Business

Emissions trading leads to a shift in business' view of its emissions from a "compliance view" to a "market view". This market view includes the need to consider various market risks, and thus develop a "risk management policy". CDM projects will be attractive as a part of an overall GHG Risk Management Portfolio, if they provide a homogenous product with minimal transactions costs. Uncertainties under CDM Credits make risk management tools very important which allows analysis of relevant risks and determination of optimum emissions trading portfolios. In addition, a top-down energy-economy model can be derived that has three emissions reduction options under Emissions Trading Behavior and Risk Management at Carbon Energy Business, namely: energy savings, a transition towards less carbon-intensive or non-carbon energy resources, and the use of CO_2 capture and storage technology. Five policy instruments: carbon taxes, fossil fuel taxes, non-carbon (renewable) energy subsidies, a portfolio standard for the carbon intensity of energy production, and a portfolio standard for the use of non-carbon (renewable) resources are compared in terms of costs, efficiencies and their impact on the composition of the energy supply system. One of the main conclusions is that a carbon intensity portfolio standard, involving the recycling of carbon taxes to support renewable energy development and deployment, is the most cost effective way to address the issues of global climate change. A comprehensive introduction of the capture and storage of carbon dioxide would contribute to reducing the costs of climate change control, but would not obviate the large scale need for renewable.

Discussion: Future Developments on International Climate Negotiations in CDM Context

Future developments on International Climate Negotiations in CDM context address the timing of the use of biological carbon sequestration and its capacity to alleviate the carbon constraint on the Carbon Energy Sector. Researches confirm that biological sequestration options constitute a substantial margin of freedom for relaxing the carbon constraint on the energy sector.

There are broadly three policy types on International Climate Negotiations, through which the reductions of greenhouse gas emissions can be achieved to meet the Kyoto targets:

- Domestic CO_2 emissions reductions for the energy intensive installations in the Hydrocarbon E & P Industry, under the Emissions Trading Scheme (ETS),

- Domestic reductions of CO_2 emissions in the sector, not covered by the Emissions Trading Scheme and reductions of other greenhouse gases,

- Emissions reductions among nations mainly through CDM and JI, since it is not clear whether international emissions trading will take place within the 1st Kyoto commitment period from 2008-2012.

The third option can be used by nations, which have set domestic targets not sufficient to meet the emissions limits under the burden sharing agreement in the Kyoto Protocol. Even under an optimal allocation of allowances, there are distributional issues that need to be resolved. Basically, the decision of who is allowed to use the restricted amount of CDM and JI credits determines how the costs of meeting the Kyoto targets are distributed between the governments and thus tax payers on one side and industry on the other side.

Conclusion: Derived Roadmaps on Sustainable Energy Portfolios in CDM Context

Evolving a sustainable energy portfolio emphasizes the developmental framework with social equity and environmental equilibrium. The core of sustainable development represents the balance provided by political and economic stability, social equity and economic development in harmony with nature. Congruence between emissions mitigation projects and sustainable development goals is not only a sovereign right, but also a national obligation. Developing countries shall ensure that their criteria accurately reflect the country’s Sustainable Development goals and priorities. Clean Development Mechanisms (CDM), assist non- Annex Parties in achieving sustainable development and in contributing to the ultimate objective of the Convention, and it further assists parties included in Annex I in achieving compliance with their quantified emissions limitation and reduction commitments. Conclusively, the implementation of CDM shall fulfill the objectives of CDM, in terms of:

- Sustainable Development of the host country.

- Cost-effective emissions reductions that would not happened otherwise.

And furthermore it facilitates low-cost emissions reductions, encourages private sector involvement in global GHG reductions, and stimulates North to South technology transfer, investment flow and capacity building. Thus it provides a basis for equitable sharing of the cost burden of climate change between developed and developing countries.

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