Integrated Assessment of Technology Options

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Sponsor: Global Climate and Energy Project

Objective: The purpose of this project is to design and develop tools that assist in the analysis of the consequences of various technology development possibilities. The goal is the development and use of a comprehensive analysis system, including mathematical models, which (a) could be used on a continuing basis for assessments of the probable significance of technological options, and (b) would serve as a basis for assessments of options designed to speed up diffusion of technologies once developed.

Analyses will include 1) estimations of greenhouse emission (carbon dioxide, other significant greenhouse gases, plus aerosols) baseline projections from various significant sources, 2) ranges of uncertainty, and 3) evaluations of reductions in emissions that could reasonably be expected from the various technological options over time, if successful. The analysis will be conducted through both micro-level technology costs and impacts, and then macro-scale estimates for the possible evolution of the entire energy system.

Background:
Micro-Level Cost and Impacts Analysis: The micro-level analysis of technologies starts with mathematical models, which build up estimates of the unit costs that could be expected for the various technologies. These models incorporate estimates of the major components of cost, including the capital depreciation and amortization, feedstock costs, costs of electricity or other energy inputs, costs of separating carbon dioxide from the gas stream, costs of sequestering carbon dioxide, and operation and maintenance costs. Consistent assumptions about economic conditions, interest rates, electricity costs, and carbon prices (if any) are used across the various technology estimates.

Macro-Level Analysis for Assessing the Value of New Energy Technologies: Given estimates developed from the micro-level analysis or other sources, regarding the characteristics of the new energy technologies resulting from R&D, macro-level assessments of the value of that new technology depend on 1) what other new technologies have been developed, 2) how fast existing technologies are improved, and 3) conditions in energy markets. Energy prices, which reflect market conditions, are influenced by many factors including population levels, economic output, the structures of the world's economies, resource availabilities, energy producer (and especially oil exporter) behavior, the set of available technologies for producing, transforming and consuming energy, and government energy, economic, and environmental policies.

Approach: A set of integrated probabilistic scenarios will be generated, rather than working with all the uncertainties independently. These scenarios will represent a wide range of future situations and be mutually exclusive and collectively exhaustive so that probabilities can be assigned to them. This will enable the computation of a discounted present value for the new

technologies across a wide range of possible technological and socio-economic futures. Figure 1 below shows the key elements of the proposed energy technology evaluation system.

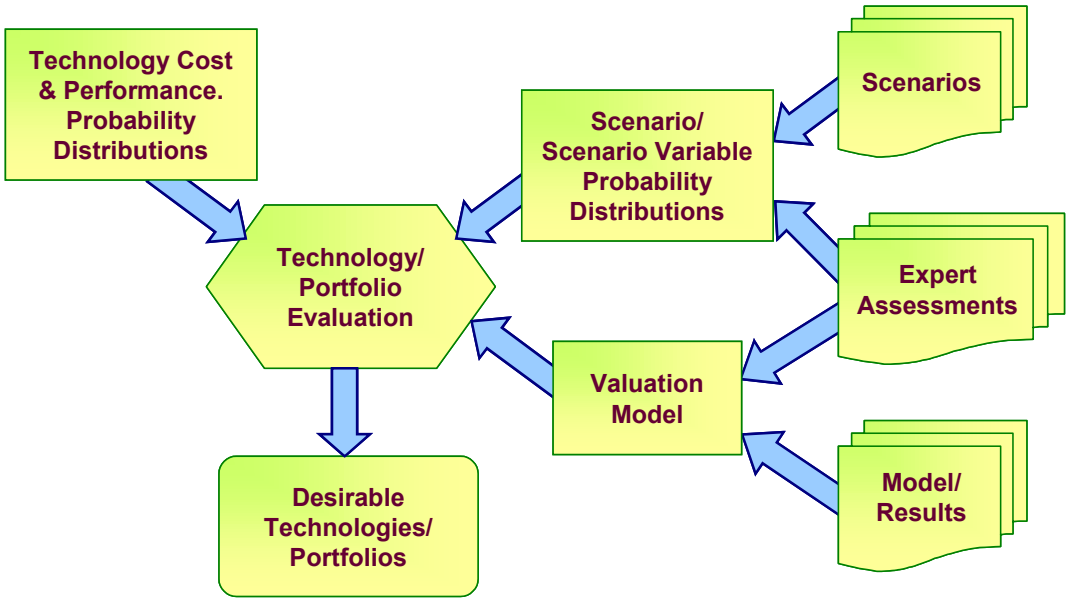

Figure 1: Schematic Diagram of Technology Evaluation Process

The scenario part of the system will be implemented in the following stages with refinements made at each stage: (1) a range of initial evaluation scenarios combining assumptions for a number of external scenario variables, (2) a probabilistic set of scenarios, and (3) a full probability treatment of all external scenario variables. The existing literature and expert opinion will be used to pick ranges of values for the key external scenario input variables. Uncertainty about the cost and performance of the technology being evaluated and those of other new technologies will be initially represented by sampling from the probability distributions for those characteristics. Over time, more sophisticated ways of incorporating the actual probability distributions into the analysis will be adopted, and the R&D effort will be broken down into stages reflecting the technical challenges that need to be met to bring the technology to fruition.

Finally the technologies will be evaluated in groups in order to find the most valuable portfolio(s) of technology options given the uncertainties about technology costs and performances, scenario variables, and valuation model parameters. Here we will consider using the whole portfolio as diversified protection against future uncertainties as well as using individual elements of the portfolio as hedges against lack of technical or economic success in the other elements of the portfolio.

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