Investigators
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Objective
Technology assessments are performed to evaluate the status and prospects of various energy areas with respect to the project’s goal of enabling a low greenhouse gas future. Analysts make recommendations for topics and specific research programs that should be pursued to advance the state of the area. These assessments are conducted for two purposes:
1. to support the GCEP call for proposals in a specific technical area; and
2. to provide the energy community with an up-to-date analysis of the technology barriers, research opportunities, and potential options available for a specific energy technology.

Approach
Figure 1 describes the role of the assessment process in the larger GCEP process of identifying research opportunities and conducting research. Technical assessments of GCEP generally include performance of the following activities: review of existing analysis and research results in one or more technology areas of interest to the GCEP project; surveying already-in-place research programs for technical issues and directions; organizing of workshops at Stanford and elsewhere to assemble experts to discuss the relevant technologies and their prospects; and development of a fully referenced report that encapsulates GCEP understanding of the status and opportunities in the area.
Activities
The assessment efforts for 2004-2005 GCEP technical areas that are both currently funded or are being considered for funding. Major assessments already concluded or still in progress are discussed below.

Hydrogen Production and Storage
This assessment explores the notion of using hydrogen as an energy carrier to replace fossil fuels. Since hydrogen must be manufactured and a large-scale infrastructure does not exist, there persist fundamental issues in production, byproducts, transportation, distribution, storage, and utilization. Research efforts funded by GCEP began in 2003 and encompass a multidisciplinary scope of specialties including biological sciences, materials research, and advanced combustion. Assessments efforts will continue with a particular focus on carbon-free production and storage.

CO₂ Separation and Capture
Separation of a concentrated stream of CO₂ from the product gases of fossil fuel utilization facilitates subsurface geologic storage. Methods now used to separate CO₂ from other gases include solvent techniques and membrane separations. Both methods require significant energy input to recover CO₂ from the solvent. This assessment explores the current state of CO₂ capture technologies and identifies ongoing research on more efficient, lower-cost separation techniques that may improve the feasibility of CO₂ capture.

Wind Power
Using turbines to harness wind energy is a mature technology that is commercially applied on a large scale. With the aid of a government funded production tax credit, wind farms produce electricity at a cost that is competitive with traditional fossil fuel generation methods. Further technical research in the subject must innovate new turbine designs, boost efficiency, and lower costs. Areas of promise include wind resource assessment and forecasting, turbine development, offshore turbines, and grid interconnection.

Biomass
Biomass is a solar energy resource with potential to be a significant contributor to a renewable energy portfolio. It has a unique range of physical, chemical and biological parameters that sets it apart from fossil fuel analogs. There are several categories of research needs to address the barriers to deployment. These topics include combustion, gasification, fuel synthesis, biological processes, crop growth, anaerobic digestion, and alcohol fermentation.

Solar Energy
Solar energy is a crucial component of a renewable energy portfolio. New technologies with high conversion efficiencies and low production costs are required to enhance the deployment of solar energy. New photovoltaic concepts include the so-called “3rd generation PVs” that aim to achieve efficiencies approaching the thermodynamic limits for solar energy conversion, and organic-based thin films such as conjugated-polymer-based cells, that may substantially decrease the cost of photovoltaics. Other solar technologies are also considered, such as solar thermal and photoelectrochemical cycles.

Advanced Transportation
In this area are options explored for both increasing transportation efficiency and utilizing energy carriers that emit zero net CO₂. Higher efficiency could result from significant changes in vehicles or shifting mobility demand to alternate transportation systems. Besides hydrogen, which is the object of a separate assessment, alternative energy carriers under consideration are electricity and biofuels.

Energy Storage
Energy storage is a key issue to be addressed to allow intermittent energy sources, typically renewable sources, to match energy supply with demand. There are numerous storage technologies that are capable of storing energy in various forms including kinetic energy, chemical solutions, magnetic fields, or other novel approaches. Improvements in the density and safety of carbon-free energy carriers such as electricity or hydrogen could foster the use of renewable energies in mobile applications.