Table 4-1

Summary of Renewable Fuel Options

The most promising renewable transportation fuel alternatives meet four criteria: (1) they can be produced from ample domestic feedstocks; (2) they have low or near-zero carbon emissions during production and use; (3) they work in existing vehicles and with existing infrastructure; and (4) they have the potential to become cost-competitive with petroleum fuels given sufficient time and resources dedicated to technology development.

	Hydrogen	Corn Ethanol	Cellulosic Ethanol	Bio-Diesel	Electricity
Ample, Domestic Resource	**Yes** Hydrogen can be produced from water through electrolysis or by separating hydrogen from fossil fuels. The U.S. has plentiful coal deposits and abundant water supplies to generate sufficient hydrogen to fuel the domestic transportation system.	**No** In 2003, roughly 7% of the U.S. corn crop was used to make ethanol. Corn ethanol production will continue to grow, but even use of 100% of the current crop would displace only 25% of current gasoline use on an energy-equivalent basis.	**Yes** Greater diversity of biomass and waste feed stocks means cellulosic ethanol is likely to be less limited by competing land uses for food and forest products. NCEP analysis suggests potential for substantial production w/o constraining food supply.	**Yes** Bio-diesel can potentially be made from a wide variety of organic materials, including animal and crop waste, vegetable oils, used grease, etc. Waste quantities generated in the U.S. could support significant production if new technologies for making bio-diesel prove cost-competitive and widely applicable.	**Yes** The diversity of fuels and technologies used to provide electricity is now much greater than the diversity of fuels used in the transportation sector. Moreover, nearly all electricity used in the U.S. is produced using domestic resources.
Low-Carbon	**It depends . . .** Three times more carbon intensive per mile than gasoline if produced using electri-city from existing pow-er plants. Use of natural gas, renewable, nuclear, or coal power with sequestration would make hydrogen low-carbon, but these technologies will provide greater benefits by directly displacing fossil-based electricity than by in-directly displacing gasoline.	**Yes** Corn ethanol is roughly 20% lower in greenhouse gas emissions than gasoline. Most emissions result from upstream energy inputs required for the cultivation, harvest, and processing of corn. CO_2 reductions from corn ethanol are modest compared to cellulosic ethanol.	**Yes** Unlike corn ethanol, has potential to achieve near-zero net carbon emissions. Cultivation of cellulosic feedstocks requires very low energy inputs and, if sustainably managed, the carbon released during fuel combustion is re-absorbed by the growth of new feedstocks.	**It Depends . . .** Provided it is produced from agricultural crops or wastes, bio-diesel would have very low carbon emissions (similar to cellulosic ethanol).	**It Depends . . .** Depends on the manner in which the electricity used was generated. The carbon intensity of future electricity production could be greatly reduced by more reliance on renewables and development of next-generation nuclear and fossil technologies with carbon sequestration.
Compatible with Existing Infrastructure	**No** As a gas, would require a new national distribution infrastructure estimated to cost hundreds of billions of dollars.	**It Depends . . .** Can be blended with gasoline at varying levels, but cannot now be transported by pipeline and must be moved by barge or truck.	**It Depends . . .** Infrastructure and vehicle compatibility issues are the same as for corn ethanol.	**Yes** New synthetic, waste-derived bio-diesels are compatible with existing diesel engines and infrastructure. Some existing vegetable oil bio-diesel can cause problems in older engines at blends greater than 20%.	**Yes** Assuming plug-in hybrids with short all-electric range, recharging could be done using the existing grid.
Potentially Competitive with Gasoline by 2020	**No** Substantial technological breakthroughs and dramatic cost reductions are required. National Academy of Sciences estimates 50-year time horizon to full development.	**No** Technology is mature, but still costs more than twice as much to produce as gasoline (~$1.40/gal). Current market for corn ethanol is supported by large public subsidies.	**Yes** Significant progress still needed, but costs have already declined by a factor of three since 1980. NCEP analysis suggests production cost below $0.80/gal. is attainable.	**It Depends . . .** Economics of early deployment depend heavily on feedstock costs. In the case of waste-derived fuels, avoided cost of waste disposal can in some instances help to make bio-diesel cost-competitive.	**It Depends . . .** Battery technology, not electricity itself, is main cost hurdle. Plug-in hybrids are more promising than all-electric vehicles.

Data Sources: National Academy of Sciences, 2004; Romm, 2004 (I); Lynd, Lave, and Greene, 2004; Lynd, Greene, and Sheehan, 2004; International Energy Agency, 2004; Energy Information Administration, 2004; Romm, 2004 (II).