ENERGY CHALLENGES FOR TRANSPORTATION IN THE 21ST CENTURY

Testimony to the
National Surface Transportation Policy and Revenue Study Commission

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Energy is fundamental to transportation. The laws of physics define work as applying force to move a mass over a distance, and energy *is* the ability to do work. There can be no transportation without energy.

In my opinion, transportation is approaching an energy crossroads. We face three crucial energy challenges:

1. reducing greenhouse gas emissions from transportation vehicles,
2. reducing dependence on petroleum in a world market dominated by OPEC,
3. achieving a transition to sustainable energy resources that will allow increasing global mobility.

These challenges are closely related but not identical. To solve them satisfactorily we will need the creative and dynamic power of markets, comprehensive and sustained public policies, and technological change.

Transportation is a major emitter of greenhouse gases (27.6% of the U.S. total) nearly all of which (95%) is carbon dioxide from the combustion of fossil fuels. More than four fifths of transportation's CO_2 emissions are from surface transportation vehicles. Our transportation system emits more carbon dioxide (1.9 trillion metric tons) than the entire economy of any other nation in the world, except China. Surface transportation produces 85% of transportation's carbon emissions (EPA, 2006, table 2-17). The Energy Information Administration predicts that under current policies, CO_2 emissions from U.S. transportation in 2030 will be 50% higher than in 2000 (EIA, 2006, table A18). In my opinion, we will decide to reduce the threat of dangerous climate change by mitigating greenhouse gas emissions, and surface transportation will have to make a serious and sustained effort to increase its energy efficiency and reduce the carbon intensity of its energy sources.

Today, petroleum supplies more than 95% of the energy required by the world's motorized transportation systems, and transportation accounts for most of the world's petroleum consumption. The U.S. is the world's largest consumer of petroleum. Our surface transportation system burns petroleum at an average rate of 5,500 gallons per second (Figure 1).

The world oil market is a truly global market in which the members of the Organization of Petroleum Exporting Countries (OPEC) play a special role as an imperfect monopolistic cartel owning 70% of the world's proven reserves and more than half of the world's estimated ultimate resources of conventional oil. Our surface transportation system's dependence on petroleum is the chief cause of our national dependence on petroleum, a dependence that has cost our economy trillions of dollars over the past three decades (Greene and Ahmad, 2005) and undermines our national security, as well (Council on Foreign Relations, 2006). It is possible for the United States to achieve oil independence, provided that we define it appropriately as freedom from the directing or controlling influence of oil suppliers and not as zero oil use or zero oil imports. By my estimates (Greene et al., 2007), meaningful oil independence could be achieve by 2030 by reducing our oil use by one third and increasing our domestic supply by one third over what they are projected to be. This could be achieved cost-effectively by a comprehensive and sustained strategy addressing all petroleum use throughout the economy.

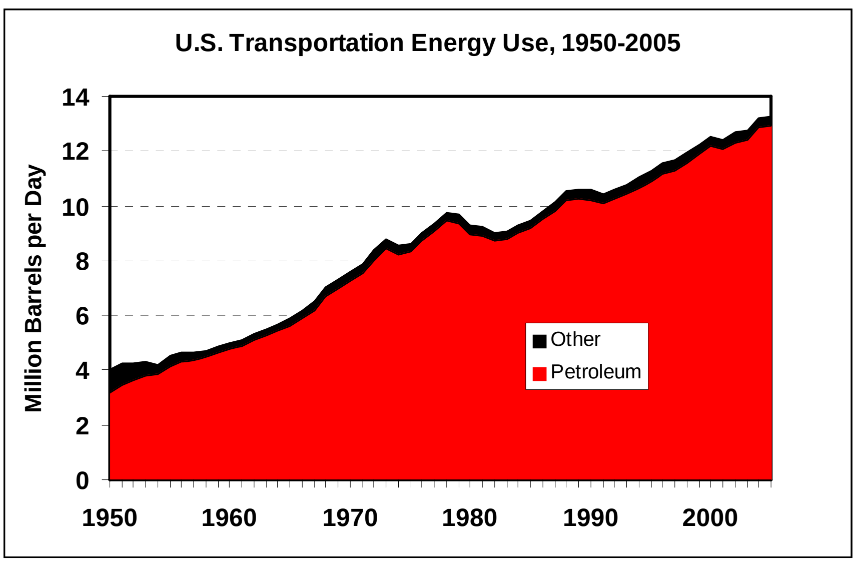

Figure 1. U.S. Transportation Energy Use and Oil Dependence, 1950-2005.
Source: Energy Information Administration, Annual Energy Review 2004, Monthly Energy Review, on line at www.eia.doe.gov .

Projections by ExxonMobil Corporation (Figure 2) and the International Energy Agency (IEA, 2006a) (Figure 3) indicate that conventional oil production in countries outside of OPEC will reach a maximum level by 2010 and be flat or declining thereafter. Continued growth in world demand for mobility fuels, combined with the peaking of non-OPEC supply will almost certainly magnify the cartel's market power. Unless OPEC greatly expands its oil production, which is considered highly unlikely (Gately, 2004), the peak or plateau in non-OPEC supply will result in a widening gap between the world's growing demand for mobility fuels and conventional oil supply. If world mobility is to continue to expand the gap will have to be filled by unconventional oil or alternative energy resources. To some extent, such developments are already underway in the production of Canadian oil sands and Venezuelan heavy oil.

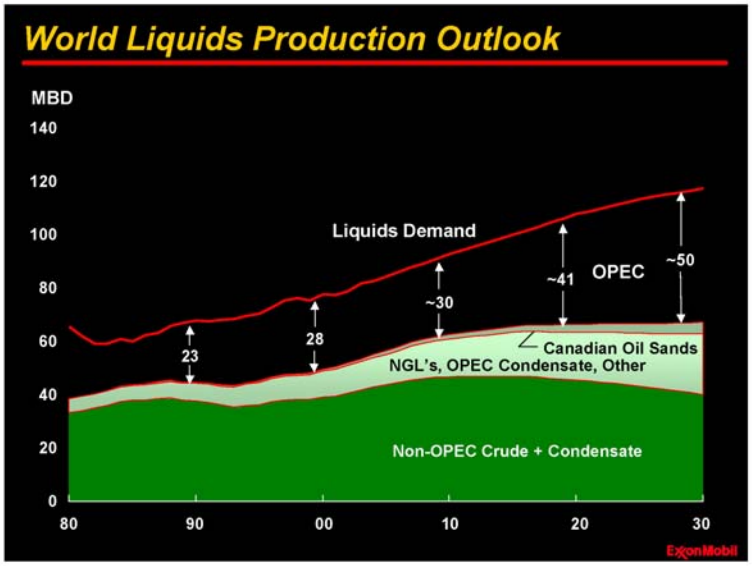

Figure 2. ExxonMobil's World Liquids Production Outlook.

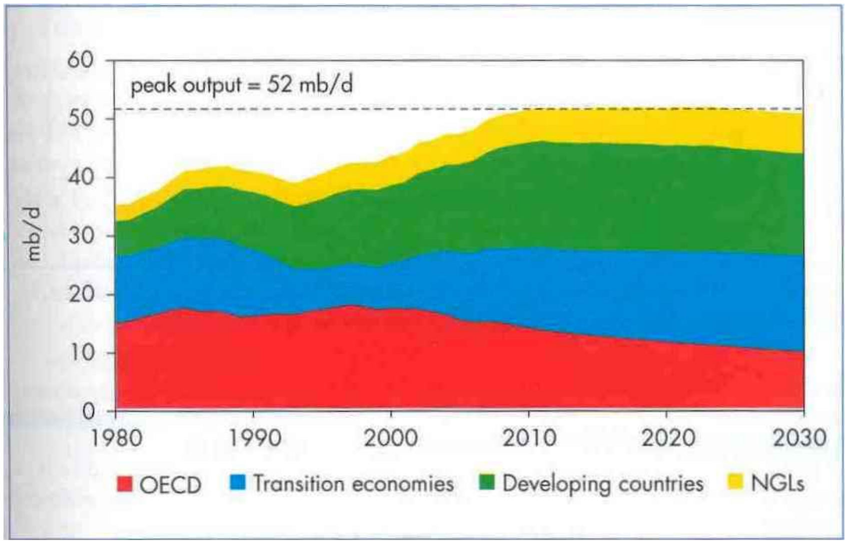

Figure 3. International Energy Agency's Non-OPEC Petroleum Supply Projection
Source: IEA, World Energy Outlook 2006.

The path of least resistance leads to filling the gap with more carbon intensive transportation fuels. Unconventional fossil hydrocarbon and carbon resources, in the form of oil sands, extra-heavy oil, coal and oil shale can be converted to conventional transportation fuels at costs comparable to oil prices seen over the past three years. These resources are more than adequate to supply the world's transportation energy needs through mid-century and beyond. Forecasts by the International Energy Agency and

Energy Information Administration (EIA) expect unconventional sources to provide between 5% and 20% of world petroleum fuel demand by 2030. Conventional transportation fuels made from unconventional fossil energy sources would be highly compatible with existing fuel distribution infrastructure, vehicle technologies, and emissions standards. However, unless upstream carbon emissions were captured and sequestered, converting unconventional fossil carbon resources to conventional fuels would increase well-to-wheel carbon emissions by from 10% (e.g., oil sands produced using natural gas) to 100% (coal-to-liquids without C sequestration). Even more importantly, reliance on unconventional fossil resources would greatly expand the quantity of fossil carbon that could be put into the atmosphere.

There are climate-friendly alternatives, but they all require significant technological advances to serve as major substitutes for petroleum fuels. Liquid fuels from biomass could make a significant contribution to supplying transportation energy (perhaps as much as 30% for the United States; Perlack et al., 2005) but biomass resources are inadequate to supply all of transportation's energy requirements. To produce as much as 30% of transportation's energy demands from biomass cost-effectively will require breakthroughs in the conversion of ligno-cellulosic biomass to liquid fuels. The current corn-to-ethanol system is not capable of producing either enough fuel or enough reduction in greenhouse gases to make it a useful long-term option. Other alternatives include hydrogen and/or electricity derived from renewable sources or from fossil fuels with carbon capture and sequestration. Significant use of electricity from the grid will require major advances in battery technology. Widespread use of hydrogen will require major breakthroughs in fuel cell systems and hydrogen storage (NRC, 2004). These technologies hold the promise of clean, abundant energy for transportation in the future but they are far from market-ready today.

Energy is essential for transportation. The energy challenges our surface transportation system faces are significant. They are already at hand or they are imminent. I believe we can and will address transportation's energy challenges without sacrificing the mobility that is so important to our economy and our way of life. But to solve them satisfactorily we will need to harness the innovative and dynamic power of markets, we will need to formulate and implement comprehensive and sustained public policies, and we must create technological change.

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