An ORNL State Partnerships Program Success Story

Assessment of the Potential to Reduce Emissions from Road Transportation, Notably NO_x, through the Use of Alternative Vehicles and Fuels in the Great Smoky Mountains Region

Air pollution is a serious problem in the Great Smoky Mountains region of North Carolina and Tennessee. The pollutants—nitrogen oxides (NO_x), sulfur dioxide (SO_2), carbon monoxide (CO), volatile organic compounds (VOCs), lead, and particulate matter—pose health hazards to residents and visitors, damage the natural environment, and limit visibility. The main contributors to this pollution are industry, transportation, and utilities.

Transportation—primarily motor vehicles—is a major source of NO_x emissions, contributing about 32% in the Southern Appalachian region and as much as 60% in some urban areas. Vehicles also contribute to SO_2 emissions; reducing the sulfur content of fuel would improve the effectiveness of catalysts used to reduce NO_x. Compounding this impact is the projection that in this region the number of vehicle miles traveled will more than double by 2040.

Reducing pollution from vehicles will be a complex undertaking, requiring the achievement of multiple objectives. Fortunately, there are a number of ways to decrease vehicle emissions, ranging from use of more fuel-efficient, less-polluting vehicles and fuels to use of mass transit systems and intelligent transportation systems. To study this issue the ORNL State Partnership Program (SPP) funded a study with four partners—the Electronic Transit Vehicle Institute (ETVI) of Chattanooga, the Knoxville Area Transit (KAT), the Joint Institute for Energy and Environment (JIEE) at the University of Tennessee, and the Tennessee Valley Authority (TVA)—to assess the true potential for reducing emissions through the use of alternative vehicles and fuels.

Transportation—mainly motor vehicles—contributes about 32% of NO_x pollution in the Southern Appalachian region. This impact will be increased as the number of vehicle miles traveled more than doubles by 2040.

Using information available from a variety of sources, the collaborators compiled a simplified list of emissions characteristics for the types of vehicles and fuels being discussed for the Smokies region. For the study, the collaborators made certain assumptions—for example, a 4.2% annual increase in vehicle miles per year offset by implementation of new EPA emission standards. The study compared normalized emissions data for vehicle types ranging from light-duty vehicles (passenger cars) to heavy trucks and buses and reported fuel efficiency for a variety of fuels. In comparisons of the different fuels, the study compared alternative fuels (compressed natural gas [CNG], ethanol, hydrogen, electricity) with gasoline in the near term and with reformulated gasoline in the long term (2010 and beyond).

A major consideration was the entire fuel life cycle, since large emissions over the total fuel cycle can make an otherwise attractive fuel unattractive if it is produced in the Southern Appalachian region. For instance, while electric-powered vehicles have the lowest emissions, if they are powered by electricity produced by a conventional coal-burning power plant, their complete fuel cycle emissions would be higher than the emissions produced by a conventional gasoline-powered vehicle.

Finally, the study looked at the benefits of replacing private vehicles with buses. How much—or whether—bus transportation would reduce emissions, as an alternative to private passenger vehicles, is dependent on a large number of variables, such as the number of passengers , the number of private vehicles "replaced" by bus transportation, the types of driving cycles (speed and number of stops) for each vehicle, and the emissions under those driving cycles. The data indicate that depending on the fuel efficiency of the bus used, the fuel type, the number of passengers and thus the number of cars taken off the road, the use of buses should reduce total emissions, reduce road congestion, and allow higher speed and reduced emissions for the passenger vehicles remaining on the road.

In addition to providing comparable data on achievable emissions reductions, the study provided policy makers with several conclusions (see box).

Conclusions for Policy Makers

- The entire fuel cycle must be considered in assessing the benefits or disadvantages of an alternative fuel option. If producing the fuel entails large emissions, the alternative fuel may not be an attractive option.
- Improvements to the energy efficiency of a vehicle/engine will also reduce emissions (e.g., by increasing engine efficiency, reducing vehicle weight, etc.).
- Reduction in vehicle emissions will necessitate the installation of an infrastructure to provide the improved fuels, support the maintenance of advanced vehicles, and provide emissions testing.
- While public transit with lower-emission vehicles can play an important role in reducing emissions per passenger mile, analysis is required for each situation.

The data from this study will be helpful in the planning and demonstration process for new transportation systems. It will also assist in presenting a persuasive and defensible case that the proposed changes will be beneficial to the environmental health of the region.

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