ORNL/TM-2000/344

REPORT BRIEFS

Publications of the Energy Division Oak Ridge National Laboratory

2000

CATEGORIES:
Analysis and Assessment / Electric Energy Systems / Energy Efficiency / Transportation

ENERGY DIVISION

ornl

ORNL/TM-2000/344

REPORT BRIEFS

Publications of the Energy Division Oak Ridge National Laboratory

2000

Prepared by the
Energy Division
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831
managed by
UT-Battelle, LLC
for the
U.S. Department of Energy
under contract DE-AC05-00OR22725

CONTENTS

ABOUT REPORT BRIEFS

This publication contains abstracts of current reports published by the Energy Division, one of 15 research divisions at Oak Ridge National Laboratory (ORNL). The division's work has four principal thrusts: (1) research and development (R&D) to improve the efficiency of building energy use and delivery technologies; (2) environmental, technological, regional, and policy analysis and assessments related to energy production and use; (3) research on improving the efficiency of transportation systems; and (4) applied R&D for emergency planning capabilities. More information on the division is available from our World Wide Web home page (*http://www.ornl.gov/ divisions/energy/energy.html*) or can be obtained by contacting the division (Kim Grubb, Energy Division, Oak Ridge National Laboratory, Bldg. 4500N, MS 6187, P.O. Box 2008, Oak Ridge, TN 37831-6187, USA; telephone 865-576-8176).

These reports are available to DOE, DOE contractors, and the public as noted on page ii of this publication. Please specify the report number in any inquiry. Questions on individual reports may be directed to the author address indicated at the end of each report brief.

REPORT BRIEF

CATEGORY: ANALYSIS AND ASSESSMENT

OAK RIDGE NATIONAL LABORATORY ENERGY DIVISION

REPORT NUMBER ORNL/TM-2000/5

AUTHORS H. T. McAdams, R.W. Crawford, and G. R. Hadder

SPONSOR Research sponsored by the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Office of Fossil Energy; and Office of Policy

A Vector Approach to Regression Analysis and Its Application to Heavy-Duty Diesel Emissions

This report offers a new approach to modeling the effects of transportation fuel characteristics on emissions.

BACKGROUND

Multiple regression analysis is one of the most widely used methodologies for expressing the dependence of a response variable on several predictor variables. In spite of its evident success in many applications, the regression approach can face serious difficulties when the predictor variables are to any appreciable extent covariant. This point was made quite evident in a recently published review, which found that efforts to evaluate the separate effects of fuel variables on the emissions from heavy-duty diesel engines were often frustrated by the close association of fuel properties.

Most research on heavy-duty diesel engines has been conducted with test fuels that have been "concocted" in the laboratory to vary selected fuel properties in isolation from each other. This approach can eliminate the confounding effect caused by naturally covarying fuel properties, but it departs markedly from the real world, where the reformulation of fuels to reduce emissions will naturally and inevitably lead to changes in a series of interrelated properties.

OBJECTIVE

To explain a new modeling approach that uses the natural covariance of fuel properties — a confounding factor for the original fuel properties—as a strength associated with realism and efficiency.

APPROACH

The approach presented here is based on the use of principal components analysis to describe fuels in terms of vector quantities called *eigenfuels*. Each eigenfuel represents a unique and mathematically independent characteristic of diesel fuel, and the most important eigenfuels can be related to the refinery and blending processes used in creating the fuels.

RESULTS

When applied as predictor variables for emissions in regression analysis, eigenfuels are found to have many advantages. These advantages are

- simplification of the analysis, because the mathematical independence of eigenfuels eliminates correlations among the variables and the complications introduced by multi-collinearity;
- economy of representation, because a small number of such vector variables may effectively replace a larger number of the original variables;
- greater understanding of the patterns of variation that are important to emissions, and of how these patterns relate to fuel blending and refinery processes;
- possible new insights into the optimal formulation of fuels to reduce emissions; and
- improved experiment design for the estimation of fuel effects.

An improved database is a prime requirement for the future development of a reliable diesel emissions model. The following are recommendations for future testing to correct the limitations of the existing data:

- More testing of oxygenated fuels will be required before a complete diesel emissions model can be developed. Few programs to date have evaluated oxygenated fuels, and the available data is too sparse to support an analysis.
- It may be important for new testing to report *a more detailed hydrocarbon speciation*. Existing information is frequently limited to monoaromatic and polyaromatic content, but it could well be important to know which hydrocarbon species were increased when, for example, aromatics content was reduced.
- An improved database should represent *a substantially larger number of engines and engine characteristics*. The existing database, while representing 280 individual engine tests, is based on only 11 individual engines and cannot support the assessment of engine-related effects.

CONCLUSIONS

The eigenfuel approach provides new ways to design test fuels that are far more likely to be representative of future fuels that will be produced in refineries, compared to fuels blended in an effort to vary selected properties independently. The eigenfuel approach can also be used to extract additional insights from the emissions data. Test fuels design could be implemented in at least two ways: (1) development of test fuels to capture the processing and blending variability likely in the production of low-sulfur fuels, and then procurement of the test fuels from several differently configured refineries; (2) use of the eigenfuel approach to guide blending of test fuels in the laboratory, so that the resulting test fuels closely replicate the signature characteristics expected for future low-sulfur diesel fuels. In either case, the test fuels will express the natural correlations among fuel properties. While these correlations would be confounding factors in conventional analysis, they can be exploited in eigenfuel analysis.

ORNL/TM-2000/5, November 2000, 175 pages

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831; for prices call 865-576-8401. Available to the public from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161; for prices, call 703-487-4650.

Author Address: Oak Ridge National Laboratory, P.O. Box 2008, Bldg. NTRC, MS-6472, Oak Ridge, TN 37831-6472; telephone 865-946-1311; facsimile 865-946-1314; e-mail haddergr@ornl.gov

REPORT BRIEF

CATEGORY: ANALYSIS AND ASSESSMENT

OAK RIDGE NATIONAL LABORATORY ENERGY DIVISION

REPORT NUMBER ORNL/TM-2000/67

AUTHORS R. D. Perlack, C. G. Rizy, C. A. Franchuk, and S. M. Cohn

SPONSOR Research sponsored by U.S. Department of Energy, Office of Technology Access

Commercial Progress and Impacts of Inventions and Innovations

This report presents the results of the 1997 inventions and innovations evaluation questionnaire.

BACKGROUND

For more than two decades, the U.S. Department of Energy (DOE), through its Office of Industrial Technologies, sponsored the Energy-Related Inventions and Innovations Program. This program provided financial assistance for the early development and proof-of-performance testing of innovative ideas and inventions with the potential for significant energy savings impact and future commercial market potential. In addition to financial assistance, the program offered technical and commercialization support. Inventions and innovations were screened for technological merit and commercialization potential before receiving program support. More than 500 inventions received financial support from DOE, with nearly 25% reaching the marketplace.

OBJECTIVE

To present the evaluation metrics of the 1997 inventions and innovations biennial survey.

APPROACH

For the 1997 survey, questionnaires were sent to 334 inventors considered to be actively pursuing their invention. Usable responses from 136 inventors form the basis of the evaluation.

RESULTS

In 1996, there were 67 inventions that currently have direct, licensed, or spinoff sales. The total number of inventions and innovations with current sales and past sales (i.e., now retired from the market) is 144. This represents a commercial success rate of more than 25%. For these grant-receiving inventions, the following performance metrics are significant:

- Total cumulative direct and licensed sales through 1996 were $700 million (1995 U.S.$). In addition, cumulative spinoff sales and royalties were $90 million and $20 million, respectively, through 1996.
- Employment sustained by direct and licensed sales was 1,189 full-time equivalents in 1996. Employment attributable to technologies with no sales was

90 full-time equivalents. The annual federal income taxes collected as a result of this employment were in excess of $6 million.

- Energy savings attributable to supported inventions and innovations were estimated at 78 trillion Btu in 1996 with a estimated value of nearly $190 million (1995 U.S.$). The associated reduction in carbon emissions was over 1.5 million metric tons.

- Among the respondents to the 1997 survey, 60% were actively pursuing their inventions. Nearly 50% of these inventions were in prototype development, pre-production prototype testing, and pre-production development stages.

CONCLUSIONS

The performance metrics summarized above demonstrate the success of the Inventions and Innovation Program.

ORNL/TM-2000/67, March 2000, 50 pages

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831; for prices call 423-576-8401. Available to the public from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161; for prices, call 703-487-4650.

Author Address: Oak Ridge National Laboratory, P.O. Box 2008, Bldg. 4500N, MS 6205, Oak Ridge, TN 37831-6205; telephone 865-574-5186; facsimile 865-574-8884; e-mail, perlackrd@ornl.gov.

Document prepared by the Energy Division, Oak Ridge National Laboratory, managed by Lockheed Martin Energy Research Corp. for the U.S. Department of Energy under contract DE-AC05-96OR22464.

REPORT BRIEF

CATEGORY: ANALYSIS AND ASSESSMENT

OAK RIDGE NATIONAL LABORATORY ENERGY DIVISION

REPORT NUMBER ORNL/TM-2000/299

AUTHORS K. S. Gant, K. L. Kline, R. B. Shelton, T. D. Ferguson, and M. V. Lapsa

SPONSOR Research sponsored by the U.S. Environmental Protection Agency

Energy and Environmental Issues in Eastern Europe and Central Asia: An Annotated Guide to Information Resources

This report provides short descriptions of more than 150 information resources related to energy, economics, and environmental issues in selected countries around the Black and Caspian Seas.

BACKGROUND

Telecommunications and the Internet have made vast quantities of data and numerous analyses and reports more accessible than ever, but wading through potential sources in search of relevant data is a formidable task. The rapid growth, complexity, and sheer number of data sets and sources can lead to information overload. To facilitate more successful data searches and retrieval of information related to energy and environmental issues in Eastern Europe and Central Asia, this report provides annotated references to Internet information resources, including over 20 search engines and data retrieval services.

OBJECTIVE

To make it easier to access information that can contribute to improving the environmental health and social welfare around the Caspian and Black Seas.

APPROACH

More than 800 documents and web sites were reviewed during September 2000. The information resources were located primarily by searching the Internet. The annotated sites included in this report were considered to have useful information related to environmental, economic, and energy issues in selected countries of Eastern Europe and Central Asia. Annotations also include a few recent journal articles and books as well as examples of search engines (free and fee-based) linked to commercial and governmental databases (such as the Energy Databases sponsored by DOE or Cambridge Scientific Abstracts).

RESULTS

The number of sites offering information related to development issues in this region grows and changes constantly. However, the content, size, timeliness, and utility of information encountered at different sites varies greatly. Some web sites offer powerful search engines capable of generating hundreds of links for a specific search request. Others offer tools permitting users to build custom tables with selected data sets. Over twenty search engine resources were annotated, including both free and fee-based sites. Other information resources were organized into chapters by geographic area: Armenia,

Azerbaijan, Bulgaria, Georgia, Kazakhstan, Romania, Russia, Turkey, Ukraine, Black Sea, and Caspian Sea.

CONCLUSIONS

The quantity of information on the World Wide Web is growing at exponential rates. Given the dynamic nature of data sets accessible via the Internet and the large number of possible sources, this report is not exhaustive. Rather, it provides a set of summaries for selected information sources organized by geographic area.

ORNL/TM-2000/299, September 2000, 154 pages

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831; for prices call 865-576-8401. Available to the public from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161; for prices, call 703-487-4650.

Author Address: Oak Ridge National Laboratory, P.O. Box 2008, Bldg. 4500N, MS 6200 Oak Ridge, TN 37831-6200; telephone 865-574-5816; facsimile 865-574-5788; e-mail, gantks@ornl.gov.

REPORT BRIEF

CATEGORY: ELECTRIC ENERGY SYSTEMS

OAK RIDGE NATIONAL LABORATORY ENERGY DIVISION

REPORT NUMBER ORNL/CON-474

AUTHORS B. J. Kirby and E. Hirst

SPONSOR Research sponsored by the U.S. Department of Energy

Customer-Specific Metrics for the Regulation and Load-Following Ancillary Services

This report presents analytical methods for customer-specific assignment of the costs of two key real-power ancillary services, regulation and load following.

SUMMARY This report discusses the economic efficiency and equity benefits of assessing charges on the basis of customer-specific costs (rather than the traditional billing determinants, megawatt-hours or megawatts), focusing on two key real-power ancillary services, regulation and load following. We determine the extent to which individual customers and groups of customers contribute to the system's generation requirements for these two services. In particular, we analyze load data to determine whether some customers account for shares of these two services that differ substantially from their shares of total electricity consumption.

BACKGROUND In competitive electricity markets, the costs for each ancillary service should be charged to those who cause the costs to be incurred, with charges based on the factors that contribute to these costs. For example, the amount of generating capacity assigned to the regulation service is a function of the short-term volatility of system load. Therefore, the charges for regulation should be related to the volatility of each load, not to its average demand.

APPROACH We defined and applied metrics for regulation and load following. For regulation, we chose the standard deviation (MW) of the thirty 2-minute values in each hour. For load following (MW), we chose the difference between the maximum and minimum values of the 30-minute rolling-average load during each hour. We also developed and applied methods to allocate these system-level metrics to individual customers and to groups of customers. The regulation allocation method uses a trigonometric relationship to correlate an individual customer's regulation burden with the total burden. The load-following allocation method calculates each customer's share of the total requirement on the basis of its coincident load-following requirement.

RESULTS Application of these allocation methods shows that charging customers for these ancillary services on the basis of average loads can be inequitable. For one control area, a few large industrial customers account for 34% of system load, compared with 93%

of the regulation and 58% of the load-following requirements. These customers disproportionately use these services but, in general, are not paying their fair share under typical utility tariffs.

ORNL/CON-474, January 2000, 40 pages

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831; for prices call 865-576-8401. Available to the public from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161; for prices, call 703-487-4650.

Author Address: Oak Ridge National Laboratory, P.O. Box 2008, Bldg. 4500N, MS 6206, Oak Ridge, TN 37831-6206; telephone 865-574-6304; facsimile 865-576-8745; e-mail, hirstea@ornl.gov.

REPORT BRIEF

CATEGORY: ENERGY EFFICIENCY

OAK RIDGE NATIONAL LABORATORY ENERGY DIVISION

REPORT NUMBER ORNL/TM-2000/26

AUTHOR D. L. Greene and J. DeCicco

SPONSOR Research sponsored by the U.S. Environmental Protection Agency, Office of Atmospheric Programs, and by the U.S. Department of Energy, Office of Policy

Engineering-Economic Analyses of Automotive Fuel Economy Potential in the United States

This report summarizes the state of knowledge concerning the potential of technology to increase automotive fuel economy and its cost, drawing from major U.S. studies of the last 25 years.

BACKGROUND U.S. passenger cars and light trucks account for 40% of U.S. petroleum consumption and 15–20% of carbon dioxide emissions. Over the past 25 years fuel economy improvements achieved via technological advances in automotive engineering have been the predominant means of restraining the growth of automotive energy use and greenhouse gas emissions.

OBJECTIVE To summarize the methodological and empirical state of knowledge regarding the potential to increase automotive fuel economy.

APPROACH This report provides a critical review of 20 major U.S. studies conducted over the past 25 years. The empirical findings of the six most recent studies are examined in greater detail, and their implications for the potential for technology to cost-effectively increase fuel economy are summarized.

RESULTS Early studies tend to confine their analysis of fuel economy potential to proven technologies (those already in use) over a relatively short (e.g., 10-year) planning horizon. Later studies consider longer time horizons and as yet unproven technologies. The findings of six recent studies are summarized in the form of fuel economy supply curves for passenger cars and light trucks.

CONCLUSIONS Nearly all studies are based on a variant of technology/cost analysis. While studies differ considerably in their conclusions about costs and fuel economy potential, even the most pessimistic assessments found some potential for cost-effective improvements. Recent studies indicated that a fuel economy of 32 to 41 mpg could be achieved at a cost of about $750 per car. Longer-term assessments indicate that a fuel economy of 38 to 52 mpg might be achieved for under $1,000 per car over a 15–20 year period.

ORNL/TM-2000/26, January 2000, 74 pages

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831; for prices call 865-576-8401. Available to the public from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161; for prices, call 703-487-4650.

Author Address: Oak Ridge National Laboratory, P.O. Box 2008, Bldg. 3156, MS 6073, Oak Ridge, TN 37831-6073; telephone 865-574-5963; facsimile 865-574-3851; e-mail, 9dg@ornl.gov.

REPORT BRIEF

CATEGORY: ENERGY EFFICIENCY

OAK RIDGE NATIONAL LABORATORY ENERGY DIVISION

REPORT NUMBER ORNL/TM-2000/41

AUTHORS B. J. Kirby and J. D. Kueck

SPONSOR Research sponsored by the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy

Review of the Structure of Bulk Power Markets

This report discusses the needs of a restructured electricity market and some of the market methods and systems that have developed to address those needs.

BACKGROUND

Historically, the bulk power market structure was dominated by vertically integrated utilities granted monopoly franchise service territories. Performance, both economic and reliability, was judged in a holistic fashion by regulators who approved tariffs that customers were obligated to pay. Restructuring seeks to introduce competition into electric power markets in order to improve economic efficiency.

Restructuring is not changing the physical needs of the power system. The functions previously performed by the vertically integrated utility must be accommodated by the new market structure. This report is part of an effort to examine the impacts of restructuring on the electric power industry.

OBJECTIVE

To examine how electricity marketers are changing as a result of electric industry restructuring.

APPROACH

The report first examines the historic framework of the electric industry. Then the basic objectives of restructuring are discussed. Next, alternative market structures are considered, and actual implementations are examined. Six restructured market systems are reviewed: California, the PJM market (Pennsylvania, New Jersey, Maryland), New England, the United Kingdom, Alberta, and Australia. Finally, special R&D needs are discussed.

RESULTS

Energy markets typically operate in hourly or half-hourly increments. This interval may shrink further as technology enables the market response to improve. Ancillary services, used for a variety of needs such as balancing load and generation on a shorter time frame than energy markets operate in and assuring system security, have typically been provided by generators under control of the system operator. Markets can be created for ancillary services as they are for basic generation. A range of possibilities exists for market-based ancillary service provision. The system operator can use markets to procure the services themselves through sequential or simultaneous markets, or can centrally optimize the provision of all ancillary services from a pool of resources whose

controllable capability is procured through a market mechanism. In either event, the specific services must be far better defined than they have been in the past.

Transmission presents a greater challenge still. The inability to control flows over individual elements makes the transmission system fundamentally a community resource. Transmission congestion can block low-priced generation from reaching high-priced markets. But it is difficult to entice private investment in resources that benefit both the investor and its competitors. Location-based pricing can allocate scarce transmission resources and illuminate transmission investment decisions, but it does not necessarily provide sufficient revenue to pay for transmission expansion. Investment decisions then become a community concern. The problem is made worse because of the heavy interaction of transmission and generation. Generation located in the correct spot can compensate for inadequate transmission. Similarly, generation inadequacy in one location can be eliminated through the addition of transmission. Conversely, generation that locates in a high-priced region and is doing well commercially can be driven out of business if new transmission links the region with a low-cost area. There is no clear institutional answer to this problem. It is clear that new planning tools are needed that accommodate private and public investment decisions.

CONCLUSIONS

There is a need for research on a number of fronts to ensure that the transition to an open market is made without jeopardy to system security or adequacy. The process of transition thus far, with the price spikes and rotating blackouts in the United States, and the wholesale restructuring of the new system in the United Kingdom, show us that the transition will be complicated, and that the potential for mistakes is real.

ORNL/TM-2000/41, April 2000, 76 pages

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831; for prices call 865-576-8401. Available to the public from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161; for prices, call 703-487-4650.

Author Address: Oak Ridge National Laboratory, P.O. Box 2008, Bldg. 3147, MS 6070, Oak Ridge, TN 37831-6070; telephone 865-576-1768; facsimile 865-574-5227; e-mail, kirbybj@ornl.gov.

Document prepared by the Energy Division, Oak Ridge National Laboratory, managed by UT-Battelle LLC for the U.S. Department of Energy under contract DE-AC05-00OR22725.

REPORT BRIEF

CATEGORY: ENERGY EFFICIENCY

OAK RIDGE NATIONAL LABORATORY ENERGY DIVISION

REPORT NUMBER ORNL/TM-2000/80

AUTHORS J. A. Shonder, M. A. Martin, and P. J. Hughes

SPONSOR Research sponsored by the U.S. Department of Energy, Energy Efficiency and Renewable Energy, Office of Power Technology—Geothermal Division

Geothermal Heat Pumps in K–12 Schools: A Case Study of the Lincoln, Nebraska, Schools

This report presents a comprehensive analysis of the life cycle costs and energy and maintenance performance of an institutional installation of geothermal heat pumps (GHPs) in four schools located in Lincoln, Nebraska, as compared to the same schools with conventional space-conditioning systems. The accuracy of borefield design software is also evaluated using data from these schools.

BACKGROUND

Geothermal heat pumps (GHPs) have been shown to have a number of benefits over other technologies used to heat and cool buildings and provide hot water, combining high levels of occupant comfort with low operating and maintenance costs. Public facilities represent an increasingly important market for GHPs, and schools are a particularly good application, given the large land area that normally surrounds them. Nevertheless, the perception that GHPs are more costly to install, and the lack of readily available published data on energy, maintenance, and life cycle costs for GHPs, remain barriers to the increased use of GHPs in institutional and commercial applications.

In 1998, Oak Ridge National Laboratory (ORNL) began a collaborative effort with the Lincoln, Nebraska, Public School District and Lincoln Electric Service to study four new, identical elementary schools built in the district that are served by GHPs. ORNL was provided with complete as-built construction plans for the schools and associated equipment, access to original design calculations and cost estimates, extensive equipment operating data, and access to the school district's complete maintenance record database, not only for the four GHP schools, but for all the other schools in the district.

OBJECTIVES

To determine the comparative costs of institutional GHP and conventional space conditioning systems and to evaluate the accuracy of borefield sizing programs.

APPROACH

We began by comparing the annual energy use of the GHP schools with that of the other schools in the district. We then used as-built construction plans and site-monitored data to develop a calibrated engineering models of one of the GHP schools, Maxey Elementary School, using both DOE-2 and TRNSYS. The calibrated TRNSYS model was used to benchmark four commercially available software programs for sizing

ground loop heat exchangers, to determine whether the models agreed with one another, and to determine whether their designs were consistent with the ground heat exchangers installed at the Lincoln schools. A detailed analysis of the district's maintenance database allowed us to determine per-square-foot planned and unplanned annual maintenance costs for the GHPs and for three other system types used in the district. Designs were developed for these three system types, as alternative space conditioning systems for the Maxey school. We developed new, independent estimates of the installation costs of these three systems and the GHPs, and the DOE-2 model was run to predict the annual energy consumption of each system type for providing heating and cooling for the school. Finally, all of this information—installed cost, annual energy use and annual maintenance cost—was used to determine the life cycle cost of each of the space conditioning options, assuming a 20-year system life

RESULTS

The findings of this study indicate that the four GHP schools are among the lowest energy consumers in the school district. On average, the GHP schools use 26% less source energy per square foot per year than the new non-GHP schools. Although 12% of the schools in the district use less energy per square foot, most of these cool less than 15% of their total floor space, compared to 100% for the GHP schools. In terms of maintenance costs, GHPs had the lowest annual repair, service, and corrective maintenance costs per square foot when compared to 16 other schools with conventional HVAC systems. When total annual maintenance costs were compared on the basis of total cooled floor space, GHP systems had the lowest total maintenance costs per square foot. Life cycle costs were estimated to be about 15% lower than the life cycle costs of the next most economical HVAC option.

On a one-year basis, there was a difference of ±16% between the designs from the four heat exchanger design programs and the benchmark design. Over 10 years, the four programs differed by only ±12%. There is therefore reasonable consistency between the available methods for designing vertical bore heat exchangers for GHP systems.

ORNL/TM-2000/80, April 2000, 100 pages

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831; for prices call 865-576-8401. Available to the public from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161; for prices, call 703-487-4650.

Author Address: Oak Ridge National Laboratory, P.O. Box 2008, Bldg. 3147, MS 6070, Oak Ridge, TN 37831-6070; telephone 865-574-2015; facsimile 865-574-9338; e-mail, shonderja@ornl.gov.

REPORT BRIEF

CATEGORY: ENERGY EFFICIENCY

OAK RIDGE NATIONAL LABORATORY ENERGY DIVISION

REPORT NUMBER ORNL/TM-2000/97

AUTHORS J. A. Shonder and J. V. Beck (Michigan State University)

SPONSOR Research sponsored by the U.S. Department of Energy, Energy Efficiency and Renewable Energy, Office of Power Technology—Geothermal Division

A New Method to Determine the Thermal Properties of Soil Formations from In Situ Field Tests

This report describes a new method for measuring the thermal properties of soil in short-term in situ tests, for use in designing vertical borehole heat exchangers for geothermal heat pump (GHP) installations, and introduces a public-domain software based on that method.

BACKGROUND

Design of a vertical borehole heat exchanger for a ground source heat pump requires, in addition to data such as the operating characteristics of the heat pumps and building loads, data on the thermal properties of the soil formation (thermal conductivity, thermal diffusivity, and undisturbed soil temperature). Two common methods for determining the soil formation's thermal properties—the line source and the cylinder source methods—rely on long-term approximate solutions to the classical heat conduction problem of an infinitely long heat source in an infinite homogeneous medium, and assume that power input to the water loop is constant

While these methods are attractive because of their simplicity, they also have some disadvantages. Because the approximations are inaccurate for early time behavior, some of the initial field test data must be discarded, affecting the property measurement. In addition, power line voltage can sag and swell during a field test, causing significant variations in power to the ground loop. Thus, there is a need for an analysis technique that does not rely on the assumption of constant power input.

OBJECTIVE

To describe an improved method for determining soil thermal properties and a software program using this method.

APPROACH

The new method for determining thermal properties is based on a parameter estimation technique. The model underlying the method is one-dimensional radial heat conduction in a composite medium; the conduction problem is discretized using finite difference techniques and solved using the Crank-Nicolson scheme. The method has been incorporated into a computer program, the Geothermal Properties Measurement (GPM) model, that allows users to determine thermal properties from short-term in situ field tests.

In a field test, water is heated at a measured rate and pumped through a U-tube heat exchanger. The measurement technique requires interval data on the heat input to the heat exchanger and the average temperature of the water in the heat exchanger. The field-measured heat input is used to drive the numerical heat-transfer model of the soil and grout. The temperature at the centerline of the numerical model is compared to the field-monitored average water temperature, and the thermal properties of the model (deep earth temperature, thermal conductivity and thermal diffusivity of both the soil and the grout, etc.) are varied until the model's predictions match the field-monitored average water temperatures in a least-squares sense. All of these calculations are carried out by the software, which then reports the thermal properties and an estimate of their accuracy given the accuracy of the data.

RESULTS

The parameter estimation method has been tested with a laboratory test rig at Oklahoma State University and in field tests at two elementary schools in Lincoln, Nebraska. These tests validated the GPM software's accuracy. The report describes both the numerical method and the software, providing a tutorial in the program's use.

CONCLUSIONS

Because it is based on numerical solutions to the heat conduction equation, the parameter estimation method is not affected by short-term variations in heat input. Also, since the model is accurate even for short times, there is no need to discard initial data. The parameter estimation technique used to determine the properties is based on statistical principles that provide quantitative estimates of measurement accuracy.

ORNL/TM-2000/97, April 2000, 42 pages

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831; for prices call 865-576-8401. Available to the public from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161; for prices, call 703-487-4650.

Author Address: Oak Ridge National Laboratory, P.O. Box 2008, Bldg. 3147, MS 6070, Oak Ridge, TN 37831-6070; telephone 865-574-2015; facsimile 865-574-9338; e-mail, shonderja@ornl.gov.

REPORT BRIEF
CATEGORY: TRANSPORTATION

OAK RIDGE NATIONAL LABORATORY ENERGY DIVISION

REPORT NUMBER ORNL-6959

AUTHOR S. C. Davis

SPONSOR Research sponsored by the U.S. Department of Energy, Office of Transportation Technologies

Transportation Energy Data Book: Edition 20

This report presents statistics that characterize transportation activities and data on other factors that affect transportation energy use.

BACKGROUND

In January 1976, the Transportation Energy Conservation (TEC) Division of the Energy Research and Development Administration contracted with Oak Ridge National Laboratory (ORNL) to prepare a data book on transportation energy conservation to be used by TEC staff in their evaluation of current and proposed conservation strategies. The major purposes of the data book were to draw together, under one cover, transportation data from diverse sources, to resolve data conflicts and inconsistencies, and to produce a comprehensive document. The first edition of the *Transportation Energy Conservation Data Book* was published in October 1976. With the passage of the Department of Energy (DOE) Organization Act, the work being conducted by the former Transportation Energy Conservation Division fell under the purview of DOE's Office of Transportation Programs (now the Office of Transportation Technologies). The Office of Transportation Technologies has supported the compilation of Editions 3 through 20.

OBJECTIVE

To prepare and publish a statistical compendium that brings together current and historical data that characterize transportation activity and energy use.

APPROACH

The twelve chapters of the 20th edition of the *Data Book* focus on various aspects of the transportation industry. Chapter 1 focuses on petroleum; Chapter 2, energy; Chapter 3, greenhouse gas emissions; Chapter 4, criteria pollutant emissions; Chapter 5, transportation and the economy; Chapter 6, highway vehicles; Chapter 7, light vehicles; Chapter 8, heavy vehicles; Chapter 9, alternative fuel vehicles; Chapter 10, fleet vehicles; Chapter 11, household vehicles; and Chapter 12, nonhighway modes. The sources used represent the latest available data.

RESULTS

The United States is responsible for more than one-quarter of the world's petroleum consumption. Domestic crude oil production is at the lowest level in the last 25 years. While domestic crude oil production declined 28% from 1987 to 1999, the amount of crude oil imported rose 87% in that time period to meet the domestic demand. Net imports of crude oil and petroleum products in 1999 accounted for 50% of U.S.

petroleum consumption. Most of the petroleum consumed in the United States was in the transportation sector (67%). This accounted for 28% of total energy use in 1999.

The fuels used in the transportation sector include gasoline, distillate fuel oil (diesel fuel), jet fuel, residual fuel oil, natural gas, electricity, and methanol. Gasoline, however, accounted for most of the transportation energy consumption in 1998. Of total transportation energy use in 1998, 77% was consumed by the highway mode, while the nonhighway transportation modes (which include water, air, pipeline, and rail transportation) accounted for 20%. The remaining 3% of transportation energy use was consumed by the off-highway mode.

CONCLUSIONS

Edition 20 of the *Transportation Energy Data Book* includes over 250 pages of tables and figures, presenting a comprehensive set of statistics on transportation energy use and the factors that affect it. Most of the data contained in the book are taken from published sources. In any attempt to compile a comprehensive set of statistics on transportation activity, numerous instances of inadequacies and inaccuracies in the basic data are encountered. Where such problems occur, estimates are developed by ORNL. To minimize the misuse of these statistics, an appendix is included to document the estimation procedures.

ORNL-6959, October 2000, 346 pages

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831; for prices call 865-576-8401. Available to the public from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161; for prices, call 703-487-4650.

Author Address: Oak Ridge National Laboratory, P.O. Box 2008, Bldg. 3156, MS 6073, Oak Ridge, TN 37831-6073; telephone 865-574-5957; facsimile 865-574-3851; e-mail, davissc@ornl.gov.

Document prepared by the Energy Division, Oak Ridge National Laboratory, managed by Lockheed Martin Energy Research Corp. for the U.S. Department of Energy under contract DE-AC05-00OR22725.

REPORT BRIEF

CATEGORY: TRANSPORTATION

OAK RIDGE NATIONAL LABORATORY ENERGY DIVISION

REPORT NUMBER ORNL-6963

AUTHORS P. S. Hu, D. W. Jones, T. R. Reuscher, R. S. Schmoyer, Jr., and L. F. Truett

SPONSOR Research sponsored by General Motors under a Cooperative Research and Development Agreement (CRADA)

Projecting Fatalities in Crashes Involving Older Drivers, 2000–2025

This report documents the research, explains the methodology, and provides tabular output for projections of older-driver fatalities through 2025.

BACKGROUND

The face of America is changing. In 2025, persons 65 and over will make up 18.5% of the total population in the United States. The number of persons aged 85 and over is increasing more rapidly than any other age group. More importantly, the elderly are taking more trips, driving farther, and continuing to drive much later in life. These conditions lead to concerns about traffic safety—from the viewpoint of the fragile, elderly traveler as well as from the viewpoint of other travelers who may feel endangered by the elderly driver. Because of these concerns, Oak Ridge National Laboratory (ORNL) was asked to develop a projection system to determine the impact of the elderly driver in the future.

OBJECTIVE

To develop a system of models for projecting national and regional fatalities, by age group and gender, in crashes involving older drivers for five-year increments from 2000 through 2025

APPROACH

Our goal was to provide estimates for several indicators:

- the number of older drivers in the future who will still be driving, by age group and gender;
- the average number of miles to be driven annually by an elderly driver, by age group and gender;
- the total number of elderly *driver* fatalities resulting from crashes in which older drivers are involved; and
- the total number of *all occupant and non-occupant fatalities* (all ages) resulting from crashes in which older drivers are involved.

Our approach to developing the model was as follows:

- review the literature to ascertain the current state of the research and to identify issues;

- examine data sources to determine compatibility between modeling issues and data;
- build a mathematical link between two national surveys so that the minimal information on health status could be included in the model;
- develop three empirical models based on historical data;
- formulate assumptions on the projections of independent variables in the empirical models for the years 2000–2025;
- adjust some empirically estimated parameter values in the models, primarily time trends;
- for the years 2000–2025, project the number of older drivers, the average vehicle miles traveled (VMT) per older driver, and crash rates, in order to generate projections of highway traffic fatalities by age group, gender, and Census region; and
- analyze the projections in terms of the extent to which various factors contribute to the increased fatalities.

RESULTS

Men and women have widely different fatality projections. Fatalities among male drivers continues to be greater than fatalities for females in overall numbers; however, the percentage of growth is projected to be less than that of female fatalities for most age groups. In 2025, for example, the ORNL model projects elderly-driver fatalities of 6696 males (291% higher than the number in 1995) and 4444 females (376% higher). The model also projects total occupant and non-occupant fatalities (all ages) in crashes involving older drivers.

CONCLUSIONS

The increases in the numbers of fatal traffic crashes among the elderly is likely to be large, but much of the growth will simply be a consequence of population growth. Much of the remaining increase will be a consequence of social changes, particularly the growing similarity in male and female social roles. The outlook would be worse if it were not for projections of substantial decreases in crash risks.

Additional research is recommended. Especially important research areas include the role of infrastructure and equipment, the asymptotic projection of VMT, additional and improved measures of health status, further comparisons of younger and older drivers' behavior, and the impact of alternative transportation options.

ORNL-6963, October 2000, 202 pages

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831; for prices call 865-576-8401. Available to the public from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161; for prices, call 703-487-4650.

Author Address: Oak Ridge National Laboratory, P.O. Box 2008, Bldg. 3156, MS 6073, Oak Ridge, TN 37831-6073; telephone 865-574-8267; facsimile 865-574-3851; e-mail, hups@ornl.gov.

REPORT BRIEF

CATEGORY: TRANSPORTATION

OAK RIDGE NATIONAL LABORATORY ENERGY DIVISION

REPORT NUMBER ORNL/TM-2000/91

AUTHORS S. Das, T. R. Curlee, S. W. Hadley, D. W. Jones, B. E. Tonn, and A. K. Wolfe (Oak Ridge National Laboratory [ORNL]); G. A. Davis, R. Dhingra, J. G. Overly, and S. M. Schexnayder (University of Tennessee)

SPONSOR Research sponsored by the U.S. Department of Energy, Office of Transportation Technologies, Office of Advanced Automotive Technologies

Supporting Infrastructure and Acceptability Issues Associated with Two New Generation Vehicles: P2000 and ESX2

This report identifies supporting infrastructure and acceptability issues associated with the transition to two new-generation concept vehicles that are three times more fuel-efficient (3XV) than current vehicles — the P2000 and the ESX2, being developed by Ford and DaimlerChrysler, respectively, under the Partnership for a New Generation of Vehicles program (PNGV).

BACKGROUND

The PNGV program is developing designs for new automobiles that will reduce fuel consumption by two-thirds while maintaining price, comfort, safety, and performance comparable to vehicles currently on the market. To achieve the targeted fuel consumption, automakers will have to reduce vehicle weights by substituting lightweight materials and make changes in vehicle design. Adopting these designs and materials would require the development of a supporting infrastructure to produce both the substitute materials and the components of the substitute materials, as well as the automotive parts constructed from the new materials. The analyses in this report build upon and refine some components of the life cycle analysis of hypothetical 3XV scenarios conducted by ORNL in 1996, 1997, and 1999.

OBJECTIVE

To identify infrastructure, acceptability, and life cycle issues associated with the transition to specific concept vehicles — the P2000 and the ESX2 — being developed under the PNGV program.

APPROACH

We used analytical approach wherever possible to explore the availability of materials and the adequacy of the materials-processing infrastructure to meet 3XV needs. The automobile recycling industry was modeled to determine how the new materials will affect automobile recyclability and the recyclers' profits. Infrastructure issues relating to the use of 3X vehicles were explored through primary sources, especially the expert opinions of industry experts. Emphasis was placed on automobile repair and insurance. The report explores issues that could affect consumer acceptance of 3XVs, relying on interviews with automobile sales staff and literature about acceptance of automotive

technologies. To determine "cradle-to-grave" impacts of the switch to lightweight materials, we conducted a life-cycle evaluation of the 3XV prototypes.

RESULTS

The raw materials and the production capacity required to produce lightweight materials for the vehicles are available for most alternative materials. In cases where production capacity must be increased, capital investment requirements appear manageable. However, the huge increase needed in lithium production is potentially problematic, as are prices for some lightweight materials (e.g., aluminum and titanium). There appear to be no major issues related to obtaining vehicle repair and automobile insurance — two significant infrastructures that support vehicles during their use. With high rates of vehicle recycling occurring currently, and even higher rates likely, 3XVs will affect the recycling industry. Each component of the industry stands to experience an increase in its profitability if a number of technical challenges, ranging from improving disassembly to recycling PET, are met.

Our examination of issues that could affect consumer acceptability of lightweight vehicles, and thus affect their ability to penetrate the market, found no certain showstoppers. Vehicle repair and insurance costs could be noticeably higher for consumers, especially in the early years of 3XV introduction. Consumers could have serious concerns about the safety of the vehicles, an issue that by itself or in tandem with several other less significant acceptability issues could affect consumers' willingness to venture into a new technological market. Future research could reduce the uncertainty in this area.

Over a vehicle lifetime the 3XV vehicles could have positive environmental effects, including significant reductions in global warming potential and energy consumption. However, the new materials and the diesel-fueled engines will contribute to notable increases in SF_6, particulate matter emissions, and NO_x if low-emission vehicle (LEV) and ultra-low-emission vehicle (ULEV) standards are not met. In addition, negative effects — i.e., an increased environmental burden — occur for most inputs and outputs in the extraction and materials-processing life-cycle stage.

CONCLUSIONS

Our analyses show no significant obstacles to the introduction and market penetration of the 3XV prototypes considered here if attention is given to a small number of potentially significant issues. The areas of planning, research, and technology development need the attention of the PNGV program to ensure easy transition to 3X vehicles.

ORNL/TM-2000/91, April 2000, 100 pages

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831; for prices call 865-576-8401. Available to the public from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161; for prices, call 703-487-4650.

Author Address: Oak Ridge National Laboratory, P.O. Box 2008, Bldg. 4500N, MS 6205, Oak Ridge, TN 37831-6205; telephone 865-574-5182; facsimile 865-574-8884; e-mail, dass@ornl.gov.

REPORT BRIEF

CATEGORY: TRANSPORTATION

OAK RIDGE NATIONAL LABORATORY ENERGY DIVISION

REPORT NUMBER ORNL/TM-2000/141

AUTHORS H. L. Hwang and J. P. Rollow

SPONSOR Research sponsored by the U.S. Department of Transportation, Bureau of Transportation

Data Processing Procedures and Methodology for Estimating Trip Distances for the 1995 American Travel Survey

This report presents the procedures and methodology used during the data quality improvements and mode-specific distance estimation activities for the 1995 American Travel Survey.

BACKGROUND

The 1995 American Travel Survey (ATS) collected information from approximately 80,000 U.S. households about their long-distance travel during 1995. It is the most comprehensive survey of where, why, and how U.S. residents travel since 1977. ATS is a joint effort by the U.S. Department of Transportation (DOT) Bureau of Transportation Statistics (BTS) and the U.S. Department of Commerce Bureau of Census; BTS provided the funding and supervision of the project, and the Census Bureau selected the samples, conducted interviews, and processed the data. Technical support for the ATS was provided by the Center for Transportation Analysis (CTA) at Oak Ridge National Laboratory (ORNL). Technical support included the estimation of trip distances as well as data quality editing and checking of variables required for the distance calculations.

OBJECTIVES

To document the detailed processing procedures for analyzing and using geographic information in survey data and to provide an account of the lessons learned and recommendations that would be beneficial to other surveys.

APPROACH

The ATS trip data was checked using mapping software, atlases, zip code databases, phone directories, the Internet, and geographic databases. In addition, the ORNL project team developed several specialized computer utility programs and databases to handle different types of data problems as they were encountered. The methodologies used to calculate mode-specific distances were based on those developed for the 1993 Commodity Flow Survey and were modified to accommodate passenger movements for the 1995 ATS project.

RESULTS

Approximately 20% of the person-trip records or 24% of the household trip records were modified by ORNL during the editing process. One or more fields in each of these records were edited. These changes or modifications were required in order to improve

data quality, perform distance calculations, or prevent elimination of data. Many of these editing and imputation results were stored in databases or integrated in utility programs and used for subsequent Wave-Cycle data sets. In addition, many of the procedures, utility programs, and databases developed by ORNL during the 1995 ATS processing were used during the processing of the 1997 Commodity Flow Survey data.

CONCLUSIONS

One of the several lessons learned from this project was that an add-on capability that enables the interviewer to catch inaccuracies or mistakes in location or mode information while the interview is ongoing would be highly beneficial to the survey instrument. This capability would significantly help to reduce errors and improve data quality. Time and costs associated with editing and fixing data errors would then be dramatically reduced. Overall, the ORNL team recovered about 30% of the 1995 ATS trip records that otherwise would have been unusable.

ORNL/TM-2000/141, May 2000, 85 pages

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831; for prices call 865-576-8401. Available to the public from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161; for prices, call 703-487-4650.

Author Address: Oak Ridge National Laboratory, P.O. Box 2008, Bldg. 3156, MS 6073, Oak Ridge, TN 37831-6073; telephone 865-576-6664; facsimile 865-574-3851; e-mail, hwang@ornl.gov.

REPORT BRIEF

CATEGORY: TRANSPORTATION

OAK RIDGE NATIONAL LABORATORY ENERGY DIVISION

REPORT NUMBER ORNL/TM-2000/147

AUTHORS S. C. Davis and L. F. Truett

SPONSOR Research sponsored by the U.S. Department of Energy, Office of Transportation Technologies

An Analysis of the Impact of Sports Utility Vehicles in the United States

This report analyzes the reasons for the popularity of sports utility vehicles (SUVs) and examines their impact on energy consumption, emission of pollutants, and highway safety.

BACKGROUND

During the 1990s, SUVs, especially those in the medium-size category, became the fastest growing segment of the auto industry. In 1999, SUV sales reached almost 19% of the total light vehicle market; and the mix of SUVs on the road, as measured by registration data, was about 8.7%. This immense popularity could be a passing fad—vehicle purchases based on the SUV "image." Additional possible explanations for SUV popularity include the general economic well-being in the United States, a perception of safety, and "utility."

OBJECTIVES

To analyze the world of the SUV to determine why this vehicle has seen such a rapid increase in popularity and to examine the impact of SUVs on energy consumption, emissions, and highway safety.

APPROACH

To analyze the popularity of the SUV, we compared historical market shares of SUVs and other light vehicles, examined general economic trends, and looked at increases in personal mobility in the United States. We also looked at buyer profiles and vehicle characteristics. To examine the impact of SUVs, we compared SUVs and other light vehicles in terms of fuel economies, emissions (in pounds of pollutant per year), and crash statistics.

RESULTS

Generally larger and heavier than the typical automobile, SUVs require more fuel per mile to operate and produce greater amounts of pollutants. They are also driven farther annually than are automobiles, a fact that exacerbates the fuel-use and emission problems.

Although buyers believe that SUVs are safer than automobiles, SUVs are actually more prone to rollovers than are automobiles. In addition, SUVs, with their higher bumpers

and greater weight, may be a threat to other vehicles on the highway, especially in side-impact crashes.

With sales projected to grow to over 3 million units per year beginning in 2001, SUVs show no sign of decreasing in popularity. These vehicles are used for general mobility, rather than off-road activities, and are driven more miles annually than are automobiles of the same vintage.

As the number of SUVs on the highways grows, the fatal crashes involving SUVs also increases, particularly for medium-sized SUVs, which are the best sellers. In 1998, Polk data indicated that 8.7% of light vehicles were SUVs. During this same year, 11.1% of all fatalities were in crashes that involved SUVs. The fatality rate for SUVs is higher than that of non-SUVs. Does this mean that SUVs are dangerous? No one can say for sure. Usually, larger, heavier vehicles protect their passengers in crashes better than smaller, lighter vehicles. Therefore, larger, heavier SUVs may have safety advantages (for their occupants) when compared to smaller, lighter vehicles. Smaller SUVs would not have the same advantage. And there are certainly concerns about SUV rollovers. Small SUVs are involved in more single-vehicle rollover fatalities than non-SUVs. Purchasing decisions, however, will most often be made on the basis of whether the buyer *feels* safe in the vehicle, rather than on the basis of hard facts and crash test data which are difficult to interpret. The perceived safety of these vehicles, therefore, may simply be in the eye of the beholder/buyer.

CONCLUSIONS

An emphasis on better fuel economy and improved emissions control could address environmental and oil dependency concerns. In addition, tests simulating crashes involving automobiles and SUVs could provide valuable data for identifying potential safety design issues. It is clear that automobiles and SUVs will be sharing the highways for years to come and that the SUV will continue to be useful as a station wagon/minivan/pickup truck/all-terrain vehicle rolled into one.

ORNL/TM-2000/147, June 2000, 44 pages

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831; for prices call 865-576-8401. Available to the public from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161; for prices, call 703-487-4650.

Author Address: Oak Ridge National Laboratory, P.O. Box 2008, Bldg. 3156, MS 6073, Oak Ridge, TN 37831-6073; telephone 865-574-5957; facsimile 865-574-3851; e-mail, davissc@ornl.gov.

Document prepared by the Energy Division, Oak Ridge National Laboratory, managed by UT-Battelle LLC for the U.S. Department of Energy under contract DE-AC05-00OR22725.

REPORT BRIEF

CATEGORY: TRANSPORTATION

OAK RIDGE NATIONAL LABORATORY ENERGY DIVISION

REPORT NUMBER ORNL/TM-2000/152

AUTHORS D. L. Greene and N. I. Tishchishyma (University of Tennessee)

SPONSOR Research sponsored by the U.S. Department of Energy, Office of Transportation Technologies

Costs of Oil Dependence: A 2000 Update

This report presents updated, revised estimates of the economic costs of oil dependence to the U.S. economy from 1970 to 1999.

BACKGROUND

Since the OPEC oil cartel first exercised monopoly power in world oil markets in 1973, price shocks and noncompetitive oil prices have been a significant economic and strategic concern for the United States. Measuring the magnitude of economic losses due to the U.S. economy's reliance on oil and the noncompetitive behavior of oil producers is critical to formulating effective policy responses.

OBJECTIVES

To update previous estimates of the costs of oil dependence by Greene and Leiby (1993), using an improved methodology, and to carry out a sensitivity analysis to place plausible bounds on the cost estimates.

APPROACH

Using historical data provided by the Energy Information Administration, the authors developed a spreadsheet model to estimate three cost components: (1) potential gross domestic product (GDP) loss (the shrinking of the economy's production capacity due to the higher cost of oil); (2) the transfer of wealth from oil consumers to producers; and (3) macroeconomic adjustment losses due to the effects of oil price shocks on the full employment of factors of production.

RESULTS

Since 1970, oil dependence has cost the U.S. economy about $7 trillion in present-value 1998 dollars. The three cost components—potential GDP, wealth transfer, and macroeconomic adjustment costs—are of similar magnitude. An analysis of sensitivity to key assumptions and parameters indicates that a plausible range of uncertainty is from as little as half that amount to as much as twice.

CONCLUSIONS

Oil dependence has been one of the most important issues facing the U.S. economy over the past three decades. The continued oil market dominance of an evolving OPEC suggests that oil dependence may continue to be a costly problem in the future. Improving and advancing the technologies of energy supply and energy use, especially in transportation, appears to be the best hope for a solution.

ORNL/TM-2000/152, May 2000, 45 pages

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831; for prices call 865-576-8401. Available to the public from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161; for prices, call 703-487-4650.

Author Address: Oak Ridge National Laboratory, P.O. Box 2008, Bldg. 3156, MS 6073, Oak Ridge, TN 37831-6073; telephone 865-574-5963; facsimile 865-574-5963; e-mail, dlgreene@ornl.gov.

REPORT BRIEF

CATEGORY: TRANSPORTATION

OAK RIDGE NATIONAL LABORATORY ENERGY DIVISION

REPORT NUMBER ORNL/TM-1999/157

AUTHORS S. W. Hadley, S. Das, and J. W. Miller

SPONSOR Research sponsored by the U.S. Department of Energy, Office of Advanced Automotive Technologies

Aluminum R&D for Automotive Uses and the Department of Energy's Role

This report describes the current market for aluminum in the automotive industry and the research programs under way to improve its penetration into that market.

BACKGROUND

The use of aluminum in automotive applications is expanding. Aluminum is a lower-weight alternative to steel, and thus, its use has the potential to increase the efficiency of vehicles. However, the application of aluminum has been only in selected areas of use, most notably (as cast aluminum) in the engine, transmission, and wheels. Other areas offer the potential for growth that could significantly expand the amount of aluminum used in vehicles.

OBJECTIVE

To analyze the current state of aluminum use in the automotive market and its prospects for expansion.

APPROACH

The study begins with a discussion of recent trends and the current market size of aluminum in the automotive industry, both in terms of types of aluminum components and forms of aluminum used. A review of various studies documents the current and past market for aluminum in vehicles. The costs of aluminum component manufacture, from initial ore through final assembly, are described. The report examines obstacles to further use in automobiles, describes R&D projects funded by the U.S. Department of Energy (DOE) to overcome those obstacles, and analyzes the potential for future increases. DOE's Office of Lightweight Materials funds 17 projects that could lower the cost or improve the quality of aluminum for use in vehicles.

RESULTS

This report finds that aluminum has successfully penetrated the automotive market, largely (>75%) in the form of castings. Aluminum sheet of the proper alloy is still too expensive to penetrate the market significantly except for components where lower weight has extra value (e.g., large hoods or deck lids). The cost of aluminum auto body sheet averages above $1.30/lb, 30% above what the auto industry has said is required for economic competitiveness. Further research is needed to either lower the cost of the alloys currently used for body sheet or develop methods for using less expensive alloys. Joining technologies need to be improved to lower their cost while improving quality.

Extruded aluminum components have potential but will make the most significant contribution if spaceframe designs are developed for high-volume automobile markets.

CONCLUSIONS

Aluminum has the potential to significantly reduce the weight of vehicles, improving fuel efficiency while maintaining other desirable attributes. Federally funded research contributes to this goal.

ORNL/TM-1999/157, March 2000, 36 pages

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831; for prices call 865-576-8401. Available to the public from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161; for prices, call 703-487-4650.

Author Address: Oak Ridge National Laboratory, P.O. Box 2008, Bldg. 4500N, MS 6205, Oak Ridge, TN 37831-6205; telephone 865-574-8018; facsimile 865-574-9338; e-mail, hadleysw@ornl.gov.

Document prepared by the Energy Division, Oak Ridge National Laboratory, managed by Lockheed Martin Energy Research Corp. for the U.S. Department of Energy under contract DE-AC05-96OR22464.

REPORT BRIEF

CATEGORY: TRANSPORTATION

OAK RIDGE NATIONAL LABORATORY ENERGY DIVISION

REPORT NUMBER ORNL/TM-2000/160

AUTHOR D. Xiong

SPONSOR Research sponsored by the U.S. Department of Transportation, Bureau of Transportation Statistics

Database Development of Land Use Characteristics along Major U.S. Highways

This report describes a method that can be used to develop data on land use characteristics along highways.

BACKGROUND

Information about land use by and adjacent to transportation systems is essential to understanding the environmental impacts of transportation systems. Nevertheless, such data are presently sparse and incomplete, especially at the national scale. To address the need for land use data, the Bureau of Transportation Statistics (BTS) and Oak Ridge National Laboratory (ORNL) undertook the development of land use data for major U.S. highways.

OBJECTIVES

To develop land use data for major U.S. highways; and to establish a procedure for integrating data, performing data interpolation and extrapolation, and generating land use measures in a cost-effective way.

APPROACH

The ultimate goal of this research is to establish a national land use database for U.S. transportation systems. The current work focuses on developing land use data for major U.S. highways. The database we intend to create will contain detailed information on land use characteristics along highways, such as land use type, highway length, and widths of pavement, median, and right-of-way for each major highway class.

To develop the land use database, we used data from three major sources: (1) the National Highway Planning Network (NHPN), (2) the Highway Performance Monitoring System (HPMS), and (3) the 1:250,000 and 1:100,000 scale Land Use and Land Cover (LULC) data from the U.S. Geological Survey. NHPN was used to establish the geographic location of highway networks and provide attribute data (e.g., highway name, functional type, state and county flags) to support data analysis. Overlays of LULC data and NHPN generated the mileage of different land use types along highways. Interpolation and extrapolation using HPMS sample data resulted in estimates of widths of pavement, median, and right-of-way for each highway link on the NHPN. Using the mileage of land use types and highway widths, we generated land use statistics, such as the mileage of different types of land use along highways and land areas occupied by highway infrastructure.

We used Geographic Information Systems (GIS) software to facilitate data integration, analysis, and visualization. Computational procedures such as sample interpolation and extrapolation were coupled with GIS to allow effective land use data estimation.

RESULTS

We estimate that the total land area or right-of-way given to highways in the continental United States, as represented in NHPN, is 7,634,872 acres. Of this total, pavement accounted for 2,173,052 acres; medians for 612,966 acres; and the rest of the right-of-way for 4,848,854 acres. Highway land use data are also established by the miles and areas and by land use types and highway functional classes, and can be aggregated or broken down into different geographic regions or administrative areas (e.g., counties or states).

CONCLUSIONS

The research provides a preliminary set of estimates for land use characteristics along major U.S. highways. Because there are currently no comprehensive data for transportation land use at the national level, the data developed in the research represent a significant first step toward a national database of highway land use characteristics. This research also establishes a procedure that can be used to obtain transportation land use data cost-effectively and can be extended to acquire land use data for complete highways and other modes of transportation.

Nevertheless, the data developed in this research are still considered preliminary and have some known problems—in particular, significant errors in overcounting of urban land that results from the use of the simple overlay of NHPN and USGS maps. Another major concern is the lack of currency of LULC maps, many of which were created with data collected about 20 years ago. Significant changes in land use have taken place since then. The report identifies some strategies to overcome these problems and recommends additional steps to be taken for improvement of both the method and the data.

ORNL/TM-2000/160, June 2000, 45 pages

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831; for prices call 865-576-8401. Available to the public from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161; for prices, call 703-487-4650.

Author Address: Oak Ridge National Laboratory, P.O. Box 2008, Bldg. 4500N, MS 6206, Oak Ridge, TN 37831-6206; telephone 865-574-2696; facsimile 865-574-3895; e-mail, xiongd@ornl.gov.

REPORT BRIEF

CATEGORY: TRANSPORTATION

OAK RIDGE NATIONAL LABORATORY ENERGY DIVISION

REPORT NUMBER ORNL/TM-2000/165

AUTHOR G. R. Hadder

SPONSOR Research sponsored by U.S. Department of Energy (DOE), Office of Fuels Development

Ethanol Demand in United States Production of Oxygenate-Limited Gasoline

This report presents the use of ORNL's refinery yield model (ORNL-RYM) to estimate ethanol demand in gasolines with restricted use of oxygenates.

BACKGROUND

The Energy Policy Act of 1992 outlined a national energy strategy that called for reducing the nation's dependency on petroleum imports. The act directed the Secretary of Energy to establish a program to promote and expand the use of renewable fuels. DOE's Office of Fuels Development (OFD) has evaluated a wide range of potential fuels and has concluded that cellulosic ethanol is one of the most promising near-term prospects. Ethanol is a clean fuel that helps reduce emissions of toxic air pollutants. Furthermore, cellulosic ethanol produces lower greenhouse gas emissions than does gasoline or any of the other alternative transportation fuels being considered by DOE.

Ethanol competes with methyl tert-butyl ether (MTBE) to satisfy oxygen, octane, and volume requirements of certain gasolines. However, MTBE has water quality problems that may create significant market opportunities for ethanol. In November 1998, the Administrator of the U.S. Environmental Protection Agency (EPA) appointed a Blue Ribbon Panel to investigate the air quality benefits and water quality concerns associated with oxygenates in gasoline. The panel generally agreed that less MTBE should be used in the reformulated gasoline program. Given the panel's recommendations, the EPA Administrator announced that "we must begin to significantly reduce the use of MTBE in gasoline as quickly as possible without sacrificing the gains we've made in achieving cleaner air."

OBJECTIVE

To provide the results of ORNL's estimate of ethanol demand in gasolines with restricted use of oxygenates.

APPROACH

ORNL-RYM was used to analyze ethanol demand for gasoline production in the U.S. East Coast, Midwest, and Gulf Coast. These regions account for about 80% of U.S. gasoline production.

RESULTS

Reduction in the use of MTBE would increase the costs of gasoline production and possibly reduce the gasoline output of U.S. refineries. The potential gasoline supply problems of an MTBE ban could be mitigated by allowing a modest 3 vol % MTBE in all gasoline. In the U.S. East and Gulf Coast gasoline-producing regions, the 3 vol % MTBE option results in costs that are 40% less than those for an MTBE ban. In the Midwest gasoline-producing region, which already has high use of ethanol, an MTBE ban has minimal effect on ethanol demand unless gasoline producers in other regions bid away the local supply of ethanol.

CONCLUSIONS

The ethanol/MTBE issue gained momentum in March 2000 when the Clinton Administration released a legislative framework to encourage immediate congressional action to reduce or eliminate MTBE and promote renewable fuels like ethanol. The framework sent to Congress included three recommendations: (1) Congress should amend the Clean Air Act to provide the authority to significantly reduce or eliminate the use of MTBE; (2) as MTBE use is reduced or eliminated, Congress should ensure that air quality gains are not diminished; and (3) Congress should replace the existing oxygenate requirement in the Clean Air Act with a renewable fuel standard for all gasoline. While the case studies described in ORNL/TM-2000/165 were performed prior to March 2000, the study premises are consistent with the Administration announcement, and the ethanol demand curve estimates of this report can be used to evaluate the impact of the Administration principles and related policy initiatives.

ORNL/TM-2000/165, August 2000, 86 pages

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831; for prices call 865-576-8401. Available to the public from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161; for prices, call 703-487-4650.

Author Address: Oak Ridge National Laboratory, P.O. Box 2008, Bldg. 3156, MS 6073, Oak Ridge, TN 37831-6073; telephone 865-574-4216; facsimile 865-574-3851; e-mail, haddergr@ornl.gov.

REPORT BRIEF
CATEGORY: TRANSPORTATION

OAK RIDGE NATIONAL LABORATORY ENERGY DIVISION

REPORT NUMBER ORNL/TM-2000/191

AUTHORS G. R. Hadder and B. D. McNutt (U.S. Department of Energy)

SPONSOR Research sponsored by the U.S. Department of Energy, Office of Policy

Ultra-clean Diesel Fuel: U.S. Production and Distribution Capability

This report examines the range of market possibilities for ultra-clean diesel fuel.

BACKGROUND

Diesel engines have potential for use in a large number of future vehicles in the United States. For this potential to be achieved, however, proponents of diesel engine technologies must solve diesel's pollution problems, including objectionable levels of emissions of particulates and oxides of nitrogen. Diesel fuel quality improvements could enable diesel engines with advanced after-treatment systems to achieve the necessary emissions performance. It is likely that diesel fuel would have to be reformulated to be as clean as low-sulfur gasoline. In May 2000, the U.S. Environmental Protection Agency (EPA) published a Notice of Proposed Rulemaking (NPRM) that included a proposal to reduce highway diesel fuel sulfur to 15 parts per million (ppm), a 97% reduction from the current maximum allowable sulfur content.

OBJECTIVES

To examine options for introducing ultra-clean diesel fuel into U.S. markets, ranging from small incremental volumes to total market coverage, and to examine the related production and distribution issues.

APPROACH

The report first presents an analysis that focuses on the small volume requirement of light-duty diesel fuel (LDDF). It then considers the U.S. refining system capability to produce more severely reformulated diesel fuel (RFD) for all diesel vehicles.

To produce low-sulfur LDDF for a smaller market refineries would probably change blendstock selection, making relatively small capital investments within existing refineries (e.g., segregated tankage and related piping). This report uses refinery industry survey data to estimate the potential of blendstock selection.

If sufficient volumes of RFD can be produced at a reasonable cost, then the full market potential for advanced light and heavy-duty diesel vehicles could be realized. The report evaluates the shifts in diesel fuel blendstocks and refinery investment, highlighting the types and costs of refinery changes required to make RFD. Results are based on a qualitative analysis drawn from published information.

RESULTS

If the LDDF sulfur specification is 10–15 ppm, the current U.S. refinery system could satisfy near- to mid-term premised requirements for the smaller LDDF market (5–10% of the highway diesel fuel market). However, hydroprocessing investments might be required to satisfy the long-term premised requirement for the LDDF market (20% of the highway diesel fuel market).

RFD for the total diesel fuel market could require process investments costing about a third of current refinery market value. With total projected investments of $11.8 billion (6–9 cents per gallon), financing, engineering, and construction and material availability are major issues that must be addressed for both refinery and gas-to-liquids (GTL) investments

---

CONCLUSIONS

Refinery and distribution systems could produce adequate low-sulfur blendstocks to satisfy the small markets for LDDF in the near term to mid-term and deliver LDDF to retail consumers with only modest changes. As volumes grow, the manufacturing cost may increase, depending upon on how hydrodesulfurization technologies develop, whether significantly greater volumes of the diesel pool have to be desulfurized for heavy-duty diesel vehicles, to what degree other properties like aromatic content have to be changed, and whether competitive fuel technologies like GTL plants become economic.

ORNL/TM–2000/191, July 2000, 33 pages

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831; for prices call 865-576-8401. Available to the public from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161; for prices, call 703-487-4650.

Author Address: Oak Ridge National Laboratory, P.O. Box 2008, Bldg. 3156, MS 6073, Oak Ridge, TN 37831-6073; telephone 865-574-4216; facsimile 865-574-3851; e-mail, haddergr@ornl.gov.

REPORT BRIEF
CATEGORY: TRANSPORTATION

OAK RIDGE NATIONAL LABORATORY ENERGY DIVISION

REPORT NUMBER ORNL/TM-2000/204

AUTHORS L. F. Truett, S. C. Davis, and P. S. Hu

SPONSOR Research sponsored by the U.S. Department of Transportation, Federal Motor Carrier Safety Administration

Revision of the MCSAP Allocation Formula: Summary Report

This report document's ORNL's involvement in the Motor Carrier Safety Assistance Program (MCSAP) formula.

BACKGROUND

In 1982, Congress authorized the Motor Carrier Safety Assistance Program (MCSAP), a federal grant-in-aid program to improve commercial motor carrier safety. MCSAP was reauthorized in 1986, 1991, and 1998. In June 1997, in anticipation of and preparation for reauthorization, a MCSAP Formula Workgroup convened to analyze requirements for a new allocation formula and to develop the formula. Because of provisions in the Transportation Equity Act for the 21st Century (TEA-21), a major change in approach was to consider including performance (i.e., safety improvements) in the formula.

Oak Ridge National Laboratory (ORNL) was tasked to facilitate the workgroup meetings, provide technical assistance in evaluating factors and conducting scenario analyses, prepare regulatory language for the *Federal Register* Notice of Proposed Rulemaking (NPRM), analyze NPRM comments and recommend responses to the comments, assist with preparation of the *Federal Register* Final Rule, and prepare an informational brochure on MCSAP for use by the states.

OBJECTIVE

To document the activities of the MCSAP Workgroup and the processes for obtaining final approval for a revised allocation formula for the MCSAP in order to provide guidance during the next reallocation process.

APPROACH

In 1997, researchers from ORNL teamed with staff members from the U.S. Department of Transportation, Federal Highway Administration (FHWA) Headquarters, and with federal representatives from each of the nine FHWA regions to form a workgroup. The mission of this workgroup was to examine and, if necessary, revise the formula that apportioned funds to the states and territories for improving highway safety with regard to motor carriers.[1]

[1] Territories eligible to apply for MCSAP funds are Puerto Rico, American Samoa, the Virgin Islands, Guam, and the Commonwealth of the Northern Marianas.

The primary objective of MCSAP is to promote safety. With safety improvements as the overriding consideration, the workgroup worked to develop a fair and equitable allocation formula that, to the extent possible, ensured relative continuity in funding distribution and had as little negative impact as possible on any state or territory. The charge to the workgroup was to advance a sound national program that served to promote commercial vehicle safety.

ORNL provided technical assistance to the workgroup by reviewing potential data sources for possible use as factors in the formula and by programming the Lotus 123 spreadsheet to test impacts of different formulas and scenarios. Seventeen potential factors were examined, and many different scenarios were run using various combinations of factors and weights, incorporating maximum and minimum limits, and imposing other conditions.

RESULTS

A distribution formula involving four equally weighted factors was recommended for apportioning basic MCSAP funds. This formula is described in the *Federal Register* 5, no. 55 (March 21, 2000). The MCSAP Final Rule also included a method for distributing incentive funds based on improved performance.

In summary, ORNL's involvement was as technical consultant and facilitator. ORNL was able to respond to every request for assistance and information in a timely manner. This report, which provides a summary of activities, will serve as a guideline for use during the next reconsideration of the MCSAP formula.

CONCLUSIONS

At the time of the next reauthorization, a total examination of factors, such as that conducted for this tasking, will not be necessary. Only new or improved data sources will need to be readdressed. These may include the Motor Carrier Management Information System (MCMIS) crash file, fatality data, the MCMIS carrier census file, the International Registration Plan (IRP), and the Commercial Drivers License Information System (CDLIS).

ORNL/TM-2000/204, July 2000, 28 pages

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831; for prices call 865-576-8401. Available to the public from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161; for prices, call 703-487-4650.

Author Address: Oak Ridge National Laboratory, P.O. Box 2008, Bldg. 4500N, MS 6207, Oak Ridge, TN 37831-6207; telephone 865-574-4225; facsimile 865-574-3895; e-mail, truettlf@ornl.gov.

REPORT BRIEF

CATEGORY: TRANSPORTATION

OAK RIDGE NATIONAL LABORATORY ENERGY DIVISION

REPORT NUMBER ORNL/TM-2000/283

AUTHOR S. Das

SPONSOR Research sponsored by the U.S. Department of Energy (DOE), Office of Transportation Technologies

The Cost of Automotive Polymer Composites: A Review and Assessment of DOE's Lightweight Materials Composites Research

This report assesses how R&D on automotive polymer composites supported by DOE's Office of Advanced Automotive Technologies, Lightweight Materials Program, is responding to the needs of the automotive industry, specifically from an economic viability perspective.

BACKGROUND

Polymer composite materials have been a part of the automotive industry for several decades but economic and technical barriers have constrained their use. To date, these materials have been used for applications with low production volumes because of their shortened lead times and lower investment costs relative to conventional steel fabrication. Although glass fiber–reinforced polymers dominate the composite materials used in automotive applications, other polymer composites, such as carbon fiber–reinforced polymer composites, show great promise. These alternatives are attractive because they offer a weight-reduction potential twice that of the conventional glass fiber–reinforced thermoset polymers used today. The economic viability of these materials is one of the major obstacles in their widespread use in automotive applications.

OBJECTIVE

To examine the economic issues currently posed by automotive polymer composites and determine how DOE's lightweight materials composites research is responding to the needs of the industry.

APPROACH

This assessment of the cost of automotive polymer composites is based entirely on a literature review. On the basis of studies done to date, the comparative costs of different automotive composite applications were analyzed to assess general, qualitative trends and to identify major barriers to the economic viability of composite technologies. Ongoing and five-year planned research activities by DOE's Lightweight Materials Program were reviewed to assess the programs's responsiveness to the current needs of the industry.

RESULTS

To date, most cost analyses of polymer composites are for body-in-white (BIW) applications because of the significant weight-reduction potential these offer. For the

most efficient composite monocoque design, the cost of glass fiber–reinforced thermosets and carbon fiber–reinforced thermoplastics are 62% and 76% higher, respectively, than the conventional steel unibody. Even on a life cycle basis, the cost of polymer composites is higher than steel unibodies. For composites to be cost-competitive on a part-by-part substitution, improvements are necessary in cycle times and material utilization, which currently contribute 60% and 21%, respectively, of the total cost of carbon fiber–reinforced thermoplastics. The material cost plays a key role in the economic viability of polymer composites, particularly at higher production volumes and for carbon fiber–reinforced thermoplastics composites. For the composites to be economically viable, there must be a cost reduction of 50% in carbon fiber and smaller cost reductions in other thermoplastic materials.

DOE in partnership with the USCAR's Automotive Composites Consortium is taking a comprehensive look at the research needs of the composites industry and has set priorities in certain areas, such as low-cost carbon fiber production, thermoplastic structural composites, and the development of new reinforcement technologies such as the nanocomposite technology. Its research portfolio is appropriately focused both on ongoing R&D and its five-year plan, which covers five major barrier areas — cost, manufacturability, design data and test methodologies, joining and inspection, and recycling and repair. Although cost reduction is a pervasive factor in all the composites R&D activities, it is appropriate to focus in the cost area on materials, primarily carbon fiber. To improve the manufacturability of polymer composites, DOE should continue to focus on development of high-volume production manufacturing processes as one of its research priorities.

CONCLUSIONS

For carbon fiber–reinforced polymer composites to be economically viable automotive materials and the material of choice for automakers, more research is needed. An aggressive R&D portfolio should be followed to achieve major breakthroughs that are necessary for several orders of cost reduction.

ORNL/TM-2000/283, October 2000, 45 pages

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831; for prices call 865-576-8401. Available to the public from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161; for prices, call 703-487-4650.

Author Address: Oak Ridge National Laboratory, P.O. Box 2008, Bldg. 4500N, MS 6205, Oak Ridge, TN 37831-6205; telephone 865-574-5182; facsimile 865-574-8884; e-mail, dass@ornl.gov.

REPORT BRIEF
CATEGORY: TRANSPORTATION

OAK RIDGE NATIONAL LABORATORY ENERGY DIVISION

REPORT NUMBER ORNL/TM-2000/336

AUTHORS S. C. Davis

SPONSOR Research sponsored by the U.S. Department of Energy, Energy Information Administration

Updating the Freight Truck Stock Adjustment Model: 1997 Vehicle Inventory and Use Survey Data

This report documents ORNL's role in updating the Freight Truck Stock Adjustment Model using data from the 1997 Vehicle Inventory and Use Survey.

BACKGROUND

The Energy Information Administration's (EIA's) National Energy Modeling System (NEMS) Freight Truck Stock Adjustment Model (FTSAM) was created in 1995. The model relies heavily on input data from the 1992 Economic Census, Truck Inventory and Use Survey (TIUS). FTSAM is part of the NEMS Transportation Sector Model, which provides baseline energy projections and analyzes the impacts of various technology scenarios on consumption, efficiency, and carbon emissions. The base data for FTSAM can be updated every five years as new Economic Census information is released.

Because of expertise in using the TIUS database, Oak Ridge National Laboratory (ORNL) was asked to assist EIA when the new Economic Census data were available. ORNL provided the necessary base data from the 1997 Vehicle Inventory and Use Survey (VIUS) and other sources to update FTSAM.[1]

OBJECTIVE

To explain ORNL's role in updating the Freight Truck Stock Adjustment Model using data from the 1997 Vehicle Inventory and Use Survey.

APPROACH

ORNL used SAS© to estimate and extract data from the Census Bureau's 1997 VIUS Microdata File to assist EIA in updating the FTSAM. The SAS output was imported into spreadsheet format, which was compatible with the current FTSAM.

RESULTS

A spreadsheet file containing 11 different multilevel cross-tabulations was delivered to EIA for inclusion in the FTSAM.

[1]The U.S. Census Bureau changed the name of the survey from *Truck* Inventory and Use Survey to *Vehicle* Inventory and Use Survey in 1997 in anticipation of including other vehicle types; however, the budget did not allow additional vehicle types to be included in the 1997 survey.

CONCLUSIONS

The next Economic Census will be in 2002. When the data from that census become available, EIA will again want to update FTSAM using VIUS. This report, which details the methodology of estimating and extracting data from the 1997 VIUS Microdata File, should be used as a guide for generating the data from the next VIUS so that the new data will be as compatible as possible with the data in the model.

ORNL/TM-2000/336, November 2000, 58 pages

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831; for prices call 865-576-8401. Available to the public from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161; for prices, call 703-487-4650.

Author Address: Oak Ridge National Laboratory, P.O. Box 2008, Bldg. 3156, MS 6073, Oak Ridge, TN 37831-6073; telephone 865-574-5957; facsimile 865-574-3851; e-mail, davissc@ornl.gov.

REPORT BRIEF
CATEGORY: TRANSPORTATION

OAK RIDGE NATIONAL LABORATORY ENERGY DIVISION

REPORT NUMBER ORNL/TM-2000/369

AUTHORS S. M. Chin, D. L. Greene, H. L. Hwang, B. E. Peterson, and F. Southworth (ORNL); A. A. Gibson (University of Tennessee)

SPONSOR Research sponsored by the U.S. Department of Transportation, Bureau of Transportation Statistics

Freight USA: Highlights from the 1997 Commodity Flow Survey and Other Sources

This report presents highlights from the 1997 Commodity Flow Survey (CFS), the most detailed national survey of freight shipments by all modes of transportation in the United States.

BACKGROUND

The CFS is the most detailed national survey covering freight shipments in the United States. It is undertaken through a partnership between the Bureau of Transportation Statistics (BTS) in the U.S. Department of Transportation (DOT) and the Bureau of the Census in the U.S. Department of Commerce. Conducted in 1993 and again in 1997, the survey provides a basis for comparing changes in U.S. freight shipments between these two years. Both surveys provide information on commodities shipped, their value, weight, and mode of transportation, as well as origin and destination.

The CFS data cover the majority of domestic shipments of commodities by value and weight, mode of transportation, and distance, but several key elements are missing. The principal freight movements out of the scope of the CFS are (1) shipments by out-of-scope establishments, such as governments, most retail and service industries, households, construction and utilities; (2) imports that may not have been received and reshipped by a within-scope establishment at the port of entry; (3) U.S. mail other than parcels; (4) first shipments of agricultural products off the farm; and (5) imports prior to reaching the port of entry and exports immediately after leaving the port of entry.

OBJECTIVES

To highlight recent trends in U.S. freight activity using data from the 1997 and 1993 CFS and to provide supplemental estimates drawn on data from other governmental sources to create a complete picture of total U.S. freight activity.

APPROACH

Because of the definitions and conventions of the CFS, a substantial amount of U.S. freight activity, and especially the export activities of modes such as water and air, are not covered. Using data from sources other than the CFS, ORNL prepared estimates of out-of-scope shipments to create a more complete picture of freight movement in the United States. The methodology used for estimating these supplemental estimates to the CFS is described in Appendix C of the report.

RESULTS

Total freight estimates show that in 1997, the U.S. transportation system handled $8.6 trillion dollars of cargo, weighing 14.8 billion pounds, and transported 3.85 trillion ton-miles of freight for the U.S. economy. While statistics such as value per ton, average shipment distance, and types of commodities carried reveal distinct patterns of modal specialization, intermodal transport continues to be a major technological and organization trend. By value, 11–19% of all freight shipments are intermodal. Trucks remain the single largest mode of freight transport, both in terms of value (62%) and in terms of tons (60%) of commodities moved. But rail and trucking produce a similar share of ton-miles (29% for truck and 28% for rail) due to the much longer distances covered by rail shipments (663 versus 126 miles, on average).

The fastest growing modes of freight transport—air and parcel-postal courier—also carry by far the highest-value products. Comparison of the 1997 and 1993 CFS results shows that shipments by air were up 51% by value, 43% by tonnage, and 56% by ton-miles. Parcel-postal-courier shipments were up 40% by value, 25% by tonnage, and 37% by ton-miles. At $29 and $18 per pound, the value/weight ratio of commodities carried by these modes far exceed those of any other mode.

CONCLUSIONS

Freight transportation is a key component of our growing economy. As the economy expands and changes in the information age, the American freight transportation system will continually face challenges in striving to serve the new economy flexibly and efficiently. This report merely scratches the surface of the information available in the CFS databases. Further details on the design, coverage, and limitations of the CFS can be obtained via the Internet at www.bts.gov.

ORNL/TM-2000/369, December 2000, 50 pages

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831; for prices call 865-576-8401. Available to the public from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161; for prices, call 703-487-4650.

Author Address: Oak Ridge National Laboratory, P.O. Box 2008, Bldg. 3156, MS 6073, Oak Ridge, TN 37831-6073; telephone 865-576-2718; facsimile 865-574-3851; e-mail, chins@ornl.gov.

For any additions, deletions, or changes to the mailing list for this report, please contact

Tracy Bodine
Oak Ridge National Laboratory
P.O. Box 2008, MS 6189
Oak Ridge, Tennessee 37831-6189.

ORNL/TM-2000/344