REPORT BRIEFS

Publications of the Energy Division
Oak Ridge National Laboratory

1999

CATEGORIES:
Decision Support Systems / Electric Energy Systems / Energy Efficiency / Transportation

Prepared by the
Energy Division
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831
managed by
Lockheed Martin Energy Research Corp.
for the
U.S. Department of Energy
under contract DE-AC05-96OR22464

ENERGY DIVISION

ornl

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: DECISION SUPPORT SYSTEMS

OAK RIDGE NATIONAL LABORATORY ENERGY DIVISION

REPORT NUMBER ORNL/M-6701

AUTHORS B. E. Tonn and F. Conrad (Bureau of Labor Statistics)

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

Method for Developing Descriptions of Hard-to-Price Products: Results of the Telecommunications Products Study

This report presents the results of a study to test a new method for developing descriptions of hard-to-price products.

BACKGROUND

The Bureau of Labor Statistics (BLS) is responsible for collecting data to estimate price indices such as the Consumer Price Index (CPI). BLS accomplishes this task by sending field staff to places of business to price actual products. The field staff are given product checklists to help them determine whether the products found are comparable to products priced the previous month. Prices for noncomparable products are not included in the current month's price index calculations. A serious problem facing BLS is developing product checklists for dynamic product areas, new industries, and the service sector. It is difficult to keep checklists up to date and quite often simply to develop checklists for service industry products. Some people estimate that more than 50% of U.S. economic activity is not accounted for in the CPI.

OBJECTIVE

To provide the results of tests on a method for helping BLS staff build new product checklists quickly and efficiently.

APPROACH

The domain chosen for studying the method was the telecommunications industry. The method developed by ORNL is based on behavioral science and knowledge-engineering principles. The method has ten steps, which include developing a sample of domain experts, asking experts to list products in the domain, culling the list of products to a manageable number, asking experts to group the remaining products, identifying product clusters using multidimensional scaling and cluster analysis, asking experts to compare pairs of products within clusters, and, finally, developing checklists with the comparison data.

RESULTS

The method performed as expected. Several prototype checklists for products in the telecommunications domain were developed, including checklists for paging services, digital cell phones, web browsers, routers, and LAN modems. It was particularly difficult, however, to find experts to participate in the project. Attending a professional meeting and contacting experts from the conference's mailing list proved to be the best approach for this domain.

CONCLUSIONS

The method has performed well in two domains: the telecommunications industry, as demonstrated in this project, and the PC software industry, as demonstrated in a previous project. It is recommended that the method be further tested in additional service industries, such as the nursing home industry. In addition, further attention needs to be devoted to developing procedures for the method to improve its cost and time efficiency. For example, if automated methods were used to collect information from the experts and if the experts could be assembled at one time, it could be possible to create prototype checklists in one day.

ORNL/M-6701, May 1999, 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. 4500N, MS 6207, Oak Ridge, TN 37831-6207; telephone 865-574-4041; facsimile 423-574-3895; e-mail, tonnbe@ornl.gov.

REPORT BRIEF

CATEGORY: DECISION SUPPORT SYSTEMS

OAK RIDGE NATIONAL LABORATORY ENERGY DIVISION

REPORT NUMBER ORNL/NCEDR-9

AUTHORS B. E. Tonn and R. S. Turner (ORNL); J. Mechling, T. Fletcher, and S. Barg (Harvard University)

SPONSOR Research sponsored by the National Science Foundation

Environmental Decision Making and Information Technology: Issues Assessment

This report presents a summary of the Information Technology and Environmental Decision Making Workshop held at Harvard University on October 1–3, 1998.

BACKGROUND

Information technology is transforming the practice of environmental protection, much as it is transforming virtually every other aspect of American life. The Internet and advanced database systems provide users access to environmental data anytime from anywhere. The Internet facilitates communication about environmental issues at many scales, such as within communities and regions and across the nation and the globe. Sophisticated decision support and visualization systems assist decision makers in structuring and evaluating environmental decisions. Enterprise systems are helping environmental protection organizations redesign their processes from static linear systems to more flexible, nonlinear systems. The challenges for information technology to improve environmental decision making are extreme because environmental decision making is a particularly demanding endeavor.

OBJECTIVE

To summarize the discussions of the October 1998 Information Technology and Environmental Decision Making Workshop.

APPROACH

The workshop was hosted by the Strategic Computing and Telecommunications in the Public Sector Program of Harvard's Kennedy School of Government and supported by the National Center for Environmental Decision-Making Research. The purposes of the workshop were to assess the current practice of using information technology to support environmental decision making — what works and what does not work — and to explore future considerations of information technology development, information policies, and data quality issues. The workshop drew over 60 attendees from across the United States, representing state and local government, the federal government, the research community, and vendors and consultants.

RESULTS

Current practice is focusing on geographic information systems and visualization tools, Internet applications, and data warehousing. In addition, numerous organizations are developing environmental enterprise systems to integrate environmental information resources. Plaguing these efforts are issues of data quality (and public trust), system design, and organizational change.

CONCLUSIONS

In the future, there needs to be a focus on building community-based environmental decision-making systems and processes, which will be a challenge given that exactly what needs to be developed is largely unknown and that environmental decision making in this arena has been characterized by a high level of conflict. Experimentation and evaluation are needed to contribute to efficient and effective learning about how best to use information technology to improve environmental decision making.

ORNL/NCEDR-9, May 1999, 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 6207, Oak Ridge, TN 37831-6207; telephone 865-574-4041; facsimile 865-574-3895; e-mail, tonnbe@ornl.gov.

REPORT BRIEF

CATEGORY: ELECTRIC ENERGY SYSTEMS

OAK RIDGE NATIONAL LABORATORY ENERGY DIVISION

REPORT NUMBER ORNL/CON-472

AUTHORS E. Hirst and S. Hadley

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

Maintaining Generation Adequacy in a Restructuring U.S. Electricity Industry

This report analyzes alternative ways of ensuring that sufficient new generating capacity is constructed to meet the needs of U.S. electricity consumers.

BACKGROUND

Historically, decisions on the amounts, locations, types, and timing of investments in new electricity generation have been made by vertically integrated utilities with approval from state public utility commissions. As the U.S. electricity industry is restructured, these decisions are being fragmented and dispersed among a variety of organizations.

OBJECTIVE

To examine and analyze the two primary approaches to ensuring that enough generating capacity is available so that customers will not be involuntarily disconnected from the grid.

APPROACH

There are two primary approaches to ensuring adequate generating capacity. One approach stresses reliability and calls for continuation of required minimum planning reserve margins. The other focuses on economic efficiency and the use of competitive markets to balance demand and supply.

This report provides background on the concept and definition of adequacy and presents historical data and projections on generation investments and capacity. We present the findings from our literature review and our discussions with several industry experts. We explain the workings of the Oak Ridge Competitive Electricity Dispatch (ORCED) model and use the model to assess the effects on consumer and producer costs of letting markets decide on the appropriate level of generation capacity vs having central planners specify a minimum planning reserve margin. Finally, we present our conclusions.

RESULTS

- Generation-capacity margins have been declining for at least a decade, and utility plans show continued declines.
- Whether these declines in generation adequacy reflect increased productivity or shortfalls in reliability is unclear. It is clear, however, that the transitional state of the U.S. electricity industry (half competitive and half regulated) leads to tremendous

uncertainty, which may limit investments in long-lived assets, such as generating units.

- Independent power producers plan to build large amounts of new generation capacity throughout the country during the next few years.
- Generation adequacy could be maintained in competitive electricity markets in one of two ways: (1) by sole reliance on markets acting through time-varying spot prices or (2) by continuation of the historical practice of setting minimum requirements on installed capacity that must be met by all load-serving entities.
- Market-based methods for generation expansion seem, both to us and to most of the people we talked with, the preferred long-term approach.
- Only a very small fraction of loads needs to respond to real-time prices for this approach to work well in maintaining generation adequacy.

CONCLUSIONS

During the lengthy, awkward, and difficult transition from a highly regulated, retail-monopoly-franchise structure to a competitive and deintegrated structure, maintaining appropriate levels of installed generating capacity may be difficult. Perhaps the key generation-adequacy problem is the absence of a demand-side response to real-time pricing. Economic theory suggests that consumers and suppliers, in response to real-time prices, will take appropriate steps to ensure generation adequacy. But if most retail consumers continue to face traditional tariff prices that have little or no temporal variation, this approach will be short-circuited. In addition, customers must have the technical ability (including metering, communications, and computing systems), as well as the economic incentive, to respond quickly to changes in energy prices. Real-time pricing should stimulate the use of distributed supply resources as well as customer modification of loads. Until real-time pricing is available to at least some retail customers, traditional approaches to maintaining generation adequacy may be needed.

A second critical factor is creation of efficient, competitive spot markets for energy. These markets need to be integrated with those for ancillary services and transmission. And they need to accurately reflect the intrahour costs of energy (including startup, ramping, and shutdown costs) when system conditions are changing rapidly from minute to minute.

ORNL/CON-472, October 1999, 53 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, 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: ENERGY EFFICIENCY

OAK RIDGE NATIONAL LABORATORY ENERGY DIVISION

REPORT NUMBER ORNL/CON-467

AUTHORS M. Schweitzer and L. G. Berry

SPONSOR Research sponsored by the U.S. Department of Energy (DOE)

Metaevaluation of National Weatherization Assistance Program Based on State Studies, 1996–1998

This report documents the findings of a recent metaevaluation of DOE's Weatherization Assistance Program.

BACKGROUND

The national Weatherization Assistance Program, sponsored by DOE and implemented by state and local agencies throughout the United States, weatherizes homes of low-income residents in order to increase the energy efficiency of the houses and lower residents' utility bills. Staff at Oak Ridge National Laboratory (ORNL) performed a metaevaluation of this program, which involved synthesizing the results from ten individual studies of state weatherization efforts completed between April 1996 and September 1998. This effort represents a follow-up to a previous ORNL metaevaluation of the Weatherization Assistance Program, which looked at 19 state studies completed between 1990 and early 1996. That study, in turn, was done as an update to a national evaluation of the Weatherization Assistance Program that examined a representative national sample of structures weatherized in 1989.

OBJECTIVES

To document the energy savings resulting from DOE's Weatherization Assistance Program in recent years and to compare this with the savings achieved in the past.

APPROACH

The results of ten recent state-level evaluations were obtained from staff in seven states and the District of Columbia. Nine of the studies examined gas-heated houses, three studied electrically heated dwellings, and four looked at structures that used electricity for nonheating purposes. Each of these sets of studies was analyzed separately. Energy savings were calculated by taking the arithmetic mean of the average savings reported by the individual evaluations. The key variables associated with energy savings were identified by running a regression analysis using energy savings as the dependent variable and a number of potentially related factors as independent variables. The regression analysis was performed only for gas-heated homes because gas was the only fuel for which there were enough state studies to allow a reasonably accurate analysis. The results of this regression analysis were used to estimate average household energy savings that could be expected to be achieved nationwide.

RESULTS

For gas-heated residences, mean household energy savings for the nine relevant studies amounted to 32.7 million BTUs annually, or 21.0% of pre-weatherization consumption for all end uses. There was a strong positive relationship between pre-weatherization energy use and weatherization-induced energy savings, with the former explaining nearly two-thirds of the variance in the latter. Nationwide, it is estimated that the average weatherized house saves 26.1 million BTUs annually, which is 19.6% of average pre-weatherization consumption for all end uses and 27.6% of pre-weatherization space-heating energy use.

CONCLUSIONS

There were no significant differences between the savings identified in this metaevaluation and the savings reported in the previous ORNL metaevaluation. The savings reported in both metaevaluations, however, were substantially greater than those found in the earlier national evaluation of the Weatherization Assistance Program. The increase in savings since 1989 could be accounted for by the fact that, since that time, advanced audits have become widely used, the use of blower doors as a diagnostic tool has become commonplace, and cooling efficiency measures have become allowable thanks to changes in DOE regulations.

ORNL/CON-467, May 1999, 48 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 865-576-2726; facsimile 423-576-6661; e-mail, schweitzerm@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: ENERGY EFFICIENCY

OAK RIDGE NATIONAL LABORATORY — ENERGY DIVISION

REPORT NUMBER ORNL/CON-477

AUTHORS S. K. Fischer and S. D. Labinov

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

Not-in-Kind Technologies for Residential and Commercial Unitary Equipment

This report compares 27 heat pump technologies in terms of energy use and operating costs under consistent operating conditions and consistent assumptions about component efficiencies.

BACKGROUND

This project was initiated by the U.S. Department of Energy in response to a request from the heating, ventilating, and air-conditioning (HVAC) industry for consolidated information about alternative heating and cooling cycles and for objective comparisons of those cycles in space conditioning applications.

OBJECTIVE

To provide a concise summary of the underlying principles of each technology, its advantages and disadvantages, the obstacles to commercial development, and the economic feasibility of each of the technologies compared.

APPROACH

Twenty-seven different heat pumping technologies were compared on energy use and operating costs using consistent operating conditions and consistent assumptions about component efficiencies. Both positive and negative results are reported.

RESULTS

Many of the technologies being promoted as alternatives to electrically driven vapor compression heat pumps using fluorocarbon refrigerants are in fact not necessarily more cost- or energy-efficient. Although reverse Rankine cycle heat pumps using hydrocarbons have an energy use similar to that of conventional electric-driven heat pumps, there are no significant energy savings because of the minor differences in estimated steady-state performance; higher costs would be required to accommodate the use of a flammable refrigerant. Magnetic and compressor-driven metal hydride heat pumps may be able to achieve efficiencies comparable to reverse Rankine cycle heat pumps, but they are likely to have much higher life cycle costs because of high costs for materials and peripheral equipment. Both thermoacoustic and thermionic heat pumps could have lower life cycle costs than conventional electric heat pumps because of reduced equipment and maintenance costs, but their energy use would be higher.

There are strong opportunities for gas-fired heat pumps to reduce both energy use and operating costs outside of the high cooling climates in the Southeast, South Central states, and the Southwest. Diesel and IC (Otto) engine-driven heat pumps are commercially available and should be able to increase their market share relative to gas furnaces *on a life cycle cost basis;* the cost premiums associated with these products, however, make it difficult to achieve 3- to 5-year paybacks, and these initial costs adversely affect their use in the United States. Stirling engine-driven and duplex Stirling heat pumps have been investigated in the past as potential gas-fired appliances that would have longer lives and lower maintenance costs than diesel and IC engine-driven heat pumps at slightly lower efficiencies. These potential advantages have not been demonstrated, and there has been little interest in Stirling engine-driven heat pumps since the late 1980s. GAX absorption heat pumps have high heating efficiencies relative to conventional gas furnaces and are viable alternatives to furnace/air conditioner combinations in all parts of the country outside of the Southeast, the South Central states, and the desert Southwest. Adsorption heat pumps may be competitive with the GAX absorption system at a higher degree of mechanical complexity; insufficient information is available to be more precise in that assessment.

CONCLUSIONS

Many of the technologies being promoted as alternatives to electrically driven vapor-compression heat pumps using fluorocarbon refrigerants are in fact not necessarily more cost- or energy-efficient. Others, such as gas-fired heat pumps and GAX absorption heat pumps, may indeed be more efficient on a life cycle cost basis when used in specific climate regions. Finally, the efficiency advantages of some alternative technologies either has not been proven or cannot be adjudged because of insufficient information.

The unattractiveness of many of these cycles for space conditioning avoids any additional investment of time or resources in evaluating them for this application. In other cases, negative results in terms of the cost of materials or in cycle efficiencies identify where significant progress needs to be made in order for a cycle to become commercially attractive.

ORNL/CON-477, December 1999, 188 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 865-574-2017; facsimile 865-574-9338; e-mail, fischersk@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: ENERGY EFFICIENCY

OAK RIDGE NATIONAL LABORATORY ENERGY DIVISION

REPORT NUMBER ORNL/M-6633

AUTHORS C. W. Bayer (Georgia Tech Research Institute), S. A. Crow (Georgia State University), and J. Fischer (SEMCO, Inc.)

SPONSOR Research sponsored by the U.S. Department of Energy, Office of Building Technology, State and Community Programs

Causes of Indoor Air Quality Problems in Schools: Summary of Scientific Research

This report summarizes the findings of objective research reports on the causes and solutions for indoor air quality (IAQ) problems encountered in schools.

BACKGROUND

Much credible scientific research has been conducted on causes of IAQ problems in schools. These results needed to be collected and correlated to provide a basis for identifying or developing solutions. Given that the U.S. government's General Accounting Office (GAO) has concluded that one in five schools has IAQ problems and that thousands of schools are slated to be constructed or renovated in the next 5 years, the need for effective, energy-efficient solutions is obvious and significant.

OBJECTIVES

To provide guidance on improved heating, cooling, and ventilation practices and systems and to provide direction for future microbial ecology and health-related IAQ research.

APPROACH

The authors conducted a comprehensive survey of IAQ research reports, with a primary focus on schools, to identify the causes of IAQ problems and the key controllable factors associated with heating, ventilating, and air-conditioning (HVAC) systems. These reports, taken from a range of sources, were abstracted, correlated by similarities, and summarized to provide a basis for an hypothesis on the positive IAQ effects of improved filtration, humidity control, and continuous ventilation, as well as to provide recommendations for further research.

RESULTS

Research summarized in this report indicates that compromising the continuous supply of fresh air to school buildings seriously diminishes the IAQ in classrooms. Packaged air-conditioning systems that provide outdoor ventilation air only when the thermostat calls for cooling or heating allow indoor air contaminants to build to unacceptable levels between cycles. The same equipment, when operated with the supply fan running continuously and with an outdoor air damper adjusted to provide the required quantity of outdoor air, loses humidity control, especially under part load conditions. The research conducted to date confirms that both proper outdoor air ventilation and humidity control are necessary to assure adequate IAQ in schools. The report discusses the use of desiccant-based energy recovery, dehumidification, and air pretreatment technologies as important contributors to improved indoor air quality.

CONCLUSIONS

On the basis of the research work cited in this report and an evaluation of related HVAC system approaches, the authors conclude as an hypothesis that most IAQ problems can be avoided or resolved by

- providing an adequate amount of outdoor air on a continuous basis,
- controlling humidity in the space so that it is usually between 30 and 60% relative humidity, and
- providing a level of particulate filtration efficiency for outdoor air adequate to prohibit most mold spores and fungi from entering the HVAC system.

The authors recommend a field study in actual school facilities to verify this hypothesis.

ORNL/M-6633, January 1999, 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. Available online at www.ornl.gov/ORNL/BTC/desiccant.html.

Laboratory Contact: James R. Sand, Oak Ridge National Laboratory, P.O. Box 2008, Bldg. 3147, MS 6070, Oak Ridge, TN 37831-6070; telephone 865-574-5819; facsimile 865-574-9338; e-mail, sandjr@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: ENERGY EFFICIENCY

OAK RIDGE NATIONAL LABORATORY ENERGY DIVISION

REPORT NUMBER ORNL/Sub/94-SV044/2

AUTHOR J. Fischer (SEMCO Inc.)

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

Active Desiccant–Based Preconditioning Market Analysis and Product Development

This report identifies and documents the compelling market-driven reasons for heating, ventilating, and air-conditioning (HVAC) equipment manufacturers to integrate desiccant-based air-conditioning options into current product lines.

BACKGROUND

Many benefits would be realized by building occupants, the U.S. economy, and the environment if the major HVAC manufacturers embraced desiccant-based comfort conditioning as a viable alternative to conventional cooling and air conditioning. With desiccant air-conditioning equipment, the moisture (latent load) in outdoor ventilation air is removed by a desiccant material in a dehumidifier, and then the temperature (sensible load) of the dried process air is reduced to desired comfort conditions by sensible heat exchangers combined with conventional air-conditioning approaches such as direct expansion refrigeration or chilled water cooling coils. The latent and sensible loads are handled separately and more efficiently in this approach.

Desiccant cooling and dehumidification is currently being used in niche markets like supermarket and skating rink applications but has not achieved widespread acceptance for comfort conditioning within the broader buildings market. Before major manufacturers will invest resources in any new technology, the potential markets must be well-defined, those markets must be broad enough to add significant sales volume, and the technology must truly satisfy a need that cannot be served by existing products.

OBJECTIVE

To document the compelling market-driven reasons for HVAC equipment manufacturers to integrate desiccant-based air-conditioning options into current product lines.

APPROACH

Identifying and clearly establishing the market drivers for regenerated desiccant products in mainstream HVAC applications requires significant market research, modeling, systems analysis, and cost evaluation. Benefits provided by desiccant systems — improved humidity control, dry cooling coils, removal of airborne pollutants, downsized conventional equipment, reduced demand charges, and improved comfort and indoor air quality — have to be quantified. Two key economic questions have to be answered: (1) How much more will the customer pay for these benefits? (2) Are the benefits valuable enough so that customers will support a significant market for these products?

RESULTS

The starting point for this report was a comprehensive field survey and market analysis comparing various specialized outdoor air ventilation handling units. The survey concluded that several markets do promise a significant sales opportunity for an active desiccant product based on a modular Trane Climate Changer® system format. This initial market analysis was used to determine the most promising active desiccant system configurations. The report includes a thorough investigation of the most promising markets for active desiccant systems identified in the initial survey and estimates of the annual sales potential for a cost-effective product line of active desiccant systems built from Climate Changer modules.

A product development strategy section describes the active desiccant system configurations chosen to best fit the needs of the marketplace and lists key design objectives based on market research for those systems. Corresponding performance goals for the desiccant dehumidification wheel required to meet the overall system design objectives are also specified. A performance modeling section describes the strategy used by SEMCO to design the dehumidification wheels integrated into prototype systems. Actual performance data from wheel testing was used to revise the system performance and energy analysis modeling results presented in the initial market survey. This section also includes a payback analysis comparing the selected active desiccant systems with other, more conventional specialized outdoor air ventilation handling units.

CONCLUSIONS

In a comparison of the most promising active desiccant systems with a conventional cooling approach based on latent capacity, both the first cost and operating efficiency are found to be similar, with the active desiccant systems having an advantage of lower operating cost due to the use of gas versus electricity. This and other performance advantages make the active desiccant approach an attractive design alternative in targeted markets.

ORNL/Sub/94-SV044/2, June 1999, 64 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: J. R. Sand, Oak Ridge National Laboratory, P.O. Box 2008, Bldg. 3147, MS 6070, Oak Ridge, TN 37831-6070; telephone 865-574-5819; facsimile 865-574-9338; e-mail, sandjr@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. Neither the U.S. government nor any person acting on behalf of the U.S. government assumes any liability resulting from the use of the information contained in this document or warrants that such use will be free from privately owned rights.

REPORT BRIEF
CATEGORY: TRANSPORTATION

OAK RIDGE NATIONAL LABORATORY ENERGY DIVISION

REPORT NUMBER ORNL-6950

AUTHORS D. L. Greene, J. R. Kahn, and R. Gibson

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

An Econometric Analysis of the Elasticity of Vehicle Travel with Respect to Fuel Cost per Mile Using RTEC Survey Data

This report presents an econometric analysis of the “rebound” effect for household vehicles — the tendency for fuel economy improvements to result in increased travel, thereby “taking back” some of the potential reduction in motor fuel use.

BACKGROUND

U.S. energy policy for transportation has focused on technological solutions, from automotive fuel economy standards to the Partnership for a New Generation of Vehicles. Such strategies tend to increase the fuel economy of vehicles without increasing the price of fuel, resulting in a lower fuel cost per mile of travel. Energy economists have long recognized that reducing the cost of energy to produce a service will result in increased consumption of that service. The important question is, “By how much?” If such rebound effects are large, then technology-based energy efficiency improvements may not actually reduce energy consumption significantly. If rebound effects are small, technological solutions can be very effective in reducing energy use and associated greenhouse gas emissions.

Recent econometric estimates of the rebound effect based on aggregate national or state-level data appear to have converged on the conclusion that motor vehicle rebound effects are small: about 20% of the potential savings due to fuel economy improvements are “taken back” in the form of increased travel. Recent estimates based on household survey data, however, are less consistent.

OBJECTIVE

To use the most comprehensive database on household vehicle travel and fuel economy to determine whether these data confirmed or refuted the inferences of small rebound effects suggested by aggregate fuel consumption data.

APPROACH

A unique feature of this study is its use of the entire series of Residential Transportation Energy Consumption (RTEC) surveys conducted by DOE’s Energy Information Administration from 1979 to 1994. Fifteen years’ worth of information were combined into five databases, according to the level of vehicle ownership (1 to 5 vehicles). Three-stage least squares regression was used to infer the parameters of systems of simultaneous equations for vehicle use, fuel economy, and fuel cost. The use of simultaneous equation estimation methods was necessary to recognize the existence of important unobserved factors affecting a particular household's choice of travel, fuel economy, and fuel/service combination. Each database was randomly divided into two parts: one for exploring alternative model formulations and one for hypothesis testing.

RESULTS

The results confirmed that the overall rebound effect for household vehicle travel is approximately 20%. This can generally be interpreted as a long-run response, with certain caveats. Furthermore, tests showed that the hypothesis that household vehicle use will respond symmetrically to changes in fuel economy or fuel price could not be rejected.

CONCLUSIONS

These results broadly confirm that the rebound effect for household vehicle travel is relatively small, even over a long period of time. Thus, technology-based strategies for reducing transportation energy consumption via fuel economy improvement can be effective.

ORNL-6950, May 1999, 72 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 greendl2@ornl.gov.

REPORT BRIEF

CATEGORY: TRANSPORTATION

OAK RIDGE NATIONAL LABORATORY ENERGY DIVISION

REPORT NUMBER ORNL-6958

AUTHOR S. C. Davis

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

Transportation Energy Data Book: Edition 19

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 19.

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 19th 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 25% from 1987 to 1998, the amount of crude oil imported rose 60% in that time period to meet the domestic demand. Net imports of crude oil and petroleum products in 1998 accounted for 51% of U.S. petroleum consumption. Most of the petroleum consumed in the United States was in the transportation sector (66%). This accounted for 28% of total energy use in 1998.

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 1997, 76% was consumed by the highway mode, while the nonhighway transportation modes (which include water, air, pipeline, and rail transportation) accounted for 21%. The remaining 3% of transportation energy use was consumed by the off-highway mode.

CONCLUSIONS

Edition 19 of the *Transportation Energy Data Book* includes over 200 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-6958, September 1999, 250 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-AC05-96OR22464. Neither the U.S. government nor any person acting on behalf of the U.S. government assumes any liability resulting from the use of the information contained in this document or warrants that such use will be free from privately owned rights.

REPORT BRIEF
CATEGORY: TRANSPORTATION

OAK RIDGE NATIONAL LABORATORY ENERGY DIVISION

REPORT NUMBER ORNL/TM-13731

AUTHORS S. Das, T. R. Curlee, D. W. Jones, P. E. Leiby, J. Rubin (University of Maine, Bangor), S. M. Schexnayder (University of Tennessee), D. P. Vogt, and A. K. Wolfe

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

Supporting Infrastructure and Acceptability Issues for Materials Used in New Generation Vehicles

This report identifies infrastructure and acceptability issues associated with the transition to new-generation vehicles that are three times more fuel efficient (3X vehicles), being developed under the Partnership for a New Generation of Vehicles (PNGV) program.

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. The targeted fuel consumption will be achieved by substituting lightweight materials to reduce weight and by changes in vehicle design. Adopting these materials and designs will 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 components of the life cycle analysis conducted by Oak Ridge National Laboratory (ORNL) in 1996 and 1997.

OBJECTIVE

To identify potential barriers — direct and indirect economic barriers as well as infrastructure and public acceptance barriers — to the materials substitution anticipated for 3X vehicles being developed under the PNGV program.

APPROACH

This study employed a rigorous methodology, with each analysis of economic barriers relying upon a specific model to assess the potential for transitional barriers to the adoption of 3X vehicles. Of the three models implemented, the first identifies infrastructure and cost barriers; the second — an input-output model — addresses changes to the macro-economy and primary and secondary industries involved in producing 3X vehicle materials; and the last addresses the effects that new materials will have on the existing automotive recycling industry. A more qualitative methodology was used to examine barriers related to market acceptability of 3X vehicles. Only aluminum and glass-reinforced polymer composites material substitution scenarios were considered, in the absence of a PNGV design from which to do a formal cost estimation or market analysis.

RESULTS

With technology learning ("learning-by-doing"), accurate foresight, and no risk premium, the new materials can quickly gain share with PNGV production experience. The input-output model demonstrates that no major difficulties are likely to arise during the transition to either composites- or aluminum-intensive 3X vehicles. However, the transition would slightly increase labor requirements (especially in the case of the labor-intensive composite vehicle) and require a <1% increase in intermediate materials, resulting in an expansionary boost to the economy. The recycling of aluminum-intensive vehicles will probably have a positive effect on the recycling industry if some changes occur. On the other hand, the cost of automobile shredder residue (ASR) disposal and its effect on the industry's profitability is the primary threat resulting from composite-intensive vehicles. The PNGV's 80% recycling goal cannot be met without the development of technologies and the necessary infrastructure. The most significant barrier to market acceptance, both in the short term and in the long term, is public concern about safety — based either on extrapolated experience with other lightweight cars or on anecdotal evidence, which has the potential for widespread, rapid dissemination through the internet and mass media. Other, less significant issues include the availability of fuel and qualified service personnel, which could affect adoption in the short term.

CONCLUSIONS

In their consideration of a broad range of issues and technological and market factors, the authors found no single issue that is likely to prevent market penetration of 3X vehicles, particularly given their anticipated gradual penetration into the market. However, hypothetical materials composition and market penetration scenarios indicate that some notable economic changes may occur, that critical industries need to expand, and that new technologies need to be developed and adopted to accommodate the transition to 3X vehicles.

ORNL/TM-13731, April 1999, 88 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 423-574-5182; facsimile 423-574-8884; e-mail, dass@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-1999/100

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

SPONSOR Research sponsored by the U.S. Department of Transportation, Federal Highway Administration, Office of Highway Information Management

Fuel Used for Off-Road Recreation: A Reassessment of the Fuel Use Model

This report reevaluates the off-road recreational fuel use model previously designed by ORNL in light of more accurate, recent data and documents the results of the analysis.

BACKGROUND

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) required that certain tax revenues generated from the sale of motor fuel used for off-road recreation be transferred from the Highway Trust Fund to the Trails Trust Fund for recreational trail and facility improvements. In order to apportion the Trails Trust Fund to individual states equitably, the Federal Highway Administration (FHWA) asked Oak Ridge National Laboratory (ORNL) in 1993 to estimate the amount of motor fuel used for off-road recreation at the state level by different vehicle types. A modification of the methodology developed by ORNL has been used to apportion funds to the states since that time. The recent surface transportation reauthorization act, the Transportation Equity Act for the 21st Century (TEA-21), extends the funding for the Recreational Trails Program for 6 years (from 1998 to 2003) with significant increases. To ensure that the current method benefits from recent data more accurate than those available in 1993–1994 and to investigate the concern that recreational fuel usage by light trucks is overestimated, the model previously designed by ORNL was reevaluated.

OBJECTIVE

To document the results of an analysis and update of a fuel use model for estimating off-road recreational fuel use.

APPROACH

On the basis of the previous study and any new data sources available, a method for estimating fuel use was determined for each vehicle type used for off-road recreation. Fuel use estimates rely on the population of vehicles within a state and an estimate of the average annual fuel used per vehicle. Every effort was made to include registered and unregistered vehicles. The amount of time a vehicle is used for recreational pursuits as opposed to nonrecreational off-road travel was also taken into consideration. Once the estimate of total off-road recreational fuel use was determined, the state shares were adjusted by a factor determined by the amount of rural land in the state. The adjustment was deemed necessary because vehicle registration data can be misleading for estimating fuel use by state if a vehicle travels in a different state than that in which it is registered.

RESULTS

Outdoor recreational activities are becoming more and more popular every year. Participants are active in maintaining trails and protecting the environment. This report indicates that the enthusiasm for off-road vehicle recreation requires a substantial quantity of fuel each year — almost 2 billion gallons, based on currently available data. This fuel usage represents a 27% increase over the fuel use estimated in 1992. Although there are differences among the off-road vehicles considered in this study (e.g., the snowmobile riding season is not equal to the motorcycle riding season), every vehicle type saw an increase in the total amount of annual fuel use.

CONCLUSIONS

ORNL examined various information sources, analyzed the available data, and then calculated a fair and equitable distribution of off-road recreational fuel use that is based on the vehicles within each state, the fuel economy of each type of vehicle, and the opportunity for usage within each state.

ORNL/TM-1999/100, June 1999, 72 pages

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 423-574-5957; facsimile 865-574-3851; e-mail davissc.

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-1999/258

AUTHOR D. L. Greene

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

An Assessment of Energy and Environmental Issues Related to Increased Use of Gas-to-Liquid Fuels in Transportation

This report describes the status of current gas-to-liquid (GTL) fuels in terms of technology, economics, market development, availability, and possible impacts on U.S. energy security, air pollution, and greenhouse gas (GHG) emissions.

BACKGROUND

Recent technological advances in processes for converting methane into liquid hydrocarbons, combined with a growing need for cleaner, low-sulfur distillate fuel to mitigate the impacts of diesel engines on air pollution, have raised the prospects for a significant, global GTL industry.

OBJECTIVE

To describe the status of current GTL fuels vis-à-vis technology, economics, and market development, to provide an overview of resource availability, to analyze the potential impacts of a significant GTL industry on U.S. energy security, and to review what is presently known about impacts on air pollution and GHG emissions.

APPROACH

Most of the information was derived from reviewing the extant literature, both scholarly and trade publications. A simple simulation model of the world liquid fuels market, together with an exploration of the economic theory of partially monopolistic cartels, is used to explore the energy security implications of increased GTL production and use.

RESULTS

Sufficient unused methane resources exist for a globally significant GTL industry based on low-cost methane from remote, flared, or vented natural gas. Economical production of GTLs at oil prices in the vicinity of $20 per barrel has yet to be demonstrated at commercial scales, but a few key projects now under way or planned may help resolve the issue. GTLs provide meaningful reductions in diesel engine pollutant emissions, suggesting that stringent requirements for reformulated diesel fuel could create the added value that GTLs are likely to need to be commercially viable in large-scale production. GHG effects are a substantial question mark. If GTLs are produced from gas that would otherwise be vented or flared, GHG benefits will be substantial. Otherwise, for a positive or neutral GHG impact, production of GTLs will have to produce electric power from excess steam or sequester CO_2 produced in fuel conversion. A GTL industry of even one or more million barrels per day is likely to yield energy security benefits to the United States, even if OPEC states produce a dominant share of the GTL output. This probable outcome is due to a combination of increased competition from non-OPEC producers and the lower profit margin available from GTLs in comparison to oil.

CONCLUSIONS

GTLs offer benefits in terms of reducing air pollution and diversifying and expanding the resource base for world liquid fuels supplies. GTLs may or may not be the most economical means for achieving these goals, but information will soon be available from a variety of projects that will help clarify the economics of GTL production. In addition, the role of GTLs as blending stocks for reformulated diesel fuel should be studied in conjunction with other refining strategies. Whether GTLs are a positive or negative for GHG emissions is highly dependent on context. Opportunities for synergistic sequestration of CO_2 in conjunction with GTL conversion deserve further study. Although GTLs appear to benefit U.S. energy security under a wide variety of circumstances, the topic is important and the analysis here was highly simplified, so that more detailed analysis is warranted.

ORNL/TM-1999/258, October 1999, 65 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.

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.

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-2000/95