Economics at Oak Ridge National Laboratory

Oak Ridge National Laboratory (ORNL) has a long history of economics research and modeling to address key science and technology policy issues at the local, regional, national, and international levels. ORNL is known for its integration of economics with the social sciences (e.g., anthropology, sociology, geography) and with the environmental, health, engineering and computational sciences to provide comprehensive, real-world policy tools and analyses. Our science is targeted at informing policy makers about the social and economic dimensions of policies and programs designed and implemented to promote specific economic and social objectives.[1]

Emergency Management and Infrastructure Assurance –

For more than two decades ORNL has built economic models to assess the impacts and consequences of natural and man-made disasters. For example, ORNL built the National Infrastructure Information System (NIIS) for the Federal Emergency Management Agency (FEMA) to predict the regional, interregional, and national economic consequences of damages from natural and man-made events. This input/output approach, combined with models of vapor and radioactive plumes and other models of the physical impacts of events, allowed the prediction of the primary, secondary, and tertiary economic consequences of disasters. NIIS was used by FEMA in the nation's real-time response to Hurricane Hugo.

Reliable supply of electric power is crucial to a country's security, economic vitality, and social well being. Transmission congestion increases the vulnerability of our electric power systems, as well as the cost of providing reliable power. A recent ORNL report provides estimates of the severity of transmission congestion nationwide. The study found that there is significant congestion along some transmission corridors,

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such as from western New York State to the eastern part of the state, where congestion occurred on over 90% of the days during a 13 month period spanning September 2000 to September 2001. In the country as a whole, transmission congestion occurred on about 27% of all combinations of transmission paths and days. Also, transmission congestion, when it occurred, resulted in a median increase of 7% in the price of delivered electric power, and more than double the price in the worst case. As the U.S. Department of Energy (DOE) continually improves its performance-based management of its R&D programs, this type of analysis will help identify more cost-effective opportunities to enhance the efficiency and reliability of the nation's electric power system.

Regional Analysis –

Regional analysis involves the application of demographic and economic methods to help understand population and economic change in both temporal and spatial contexts. Models have been developed to predict change using a geographical information systems (GIS) framework. A large collection of regional economic and demographic information has been collected, which covers the entire United States, by state, county, and zip code. Tools have been developed for database management, statistical analysis, and geographical mapping, and these resources have been used in a wide variety of energy/economic impact assessments and

[1] For more information contact Dr. T. Randall Curlee (curleetr@ornl.gov) or visit http://www.esd.ornl.gov/research/ess.html

analyses. Regional decision support systems have been created for the Army, National Guard, the Department of Education, and the Army Corps of Engineers.

ORNL built the Maritime Input/Output Model (MIO) for the Army Corps of Engineers to estimate the regional and interregional impacts of improvements to the nation's inland waterway system. MIO is unique in that it integrates conventional input/output modeling with a sophisticated trade flow model built at ORNL. MIO can be used, for example, to examine the regional and interregional economic impacts of a natural or man-made event by (1) modeling the economic linkages between the regions and economic sectors, and (2) modeling how the economy would adjust in terms of altered physical flows of commodities. Most recently, ORNL is applying Computable General Equilibrium (CGE) Models to energy, environmental, and resource issues.

Global Change –

Global change research emphasizes impact assessment at a regional and local scale, vulnerability assessment, and assessments of potentials for coping and adaptation. This work is supported by DOE and other agencies participating in the U.S. Global Change Research Program, including central roles in the first U.S. National Assessment of Possible Consequences of Climate Variability and Change (1997-2000). A current effort seeks to develop improved tools for comparing the benefits and costs of climate change adaptation and mitigation pathways.

Other work addresses bankable permits for the control of stock and flow pollutants. This work integrates two themes in the intertemporal permit literature by constructing an intertemporal banking system for a pollutant that creates both stock and flow damages. Given a non-optimal negotiated emission path, ORNL economists have derived a permit banking system that has the potential to reduce net social costs by adjusting the intertemporal trading ratio taking into account the behavior of private agents.

Transportation Economics –

Economists at ORNL worked with engineers, environmental scientists, and computer scientists to build the Ohio River Navigation Investment

Model (ORNIM) for the Army Corps of Engineers. ORNIM, which continues to be enhanced, is a large scale model to assess the economic viability of public investments in the infrastructure of the Ohio River System. More specifically, ORNIN computes the benefits and costs of potential investments in new lock and dam construction, expenditures on major rehabilitations of existing lock and dam structures, and expenditures on routine maintenance to examine multiple investment options simultaneously, on a system-wide basis, and over a lengthy time period – as much as 70 years.

ORNL recently completed a major study for the Tennessee Department of Transportation (TDOT) to assess the benefits of public transit within the state of Tennessee. This assessment addresses both urban and rural transit programs. All direct and indirect benefits were included – e.g., mobility impacts, environmental impacts, safety and security impacts, societal and community benefits, and economic benefits from transit supply.

ORNL economists also do research related to transportation materials and new vehicle programs, such as Freedom CAR. FreedomCAR, a government-industry program for the advancement of high-efficiency vehicles, focuses on fuel cells and hydrogen produced from renewable energy sources. FreedomCAR's long-term goal is to develop technologies for hydrogen-powered fuel cell cars and trucks that will require no foreign oil and emit no harmful pollutants or greenhouse gases.

Energy Market Assessment –

Economists at ORNL are involved in the development of models and tools to assess energy markets. Models are currently being developed to better understand market transitions to alternative fuels, such as ethanol and natural gas.

ORNL economists built the Transitional Alternative Fuel Vehicles (TAFV) Model to (1) account for the effect of alternative-fuel vehicle (AFV) incentives/programs on vehicle supply behavior (vehicle diversity and price), (2) account for the effect of early AFV incentives/programs on fuel demand patterns and fuel distributor behavior (fuel availability and retail price), and (3) determine the combined effect of these changes on the time path of household alternative vehicle adoption. Similar modeling techniques are now being applied to potential transitions to a hydrogen-based economy.

Other work is targeted at assessing the optimal size, characteristics, and potential drawdown of the U.S. Strategic Petroleum Reserve (SPR). ORNL economists built, maintain, and enhance the DIS-Risk Model to assess alternative SPR sizes and drawdown capabilities.

ORNL also has developed models to assess the viability of biomass energy. Successful commercial development of bioenergy systems will require that these systems be economically competitive with alternative energy systems, and provide an income to farmers comparable to that which they could earn producing conventional crops on the same land. The cost of producing energy crops is an integral component in determining the economic competitiveness of bioenergy systems. ORNL's BIOCOST Model estimates the cost of producing hybrid poplars and switchgrass in seven regions of the U.S.

Environmental Economics –

ORNL economists specialize in the identification, valuation, and potential policy responses to environmental externalities and the existence of public goods. Externalities are costs or benefits that have not been internalized within the price at which goods and services are traded. This form of market failure can call for various forms of government intervention to either modify the market price or to otherwise effect changes upon suppliers and/or demanders in such a way as to modify their preferences and actions. ORNL led a major study of externalities associated with all major fuel cycles for the production of electricity. The concept of externalities and public goods also has been applied to water resources, waste management, transportation, and oil and other energy markets.

ORNL has also been instrumental in advancing the state of the art in environmental resource valuation methodologies following the Exxon-Valdez oil spill.

Economic Policy Analysis –

This area of economics specializes in topics dealing with the environment, natural resources, energy, and science policy. Its goal is to help public policy makers frame the issues they face and explore alternative solutions for problem solving. Research in this program addresses topics of real-world concern (e.g., bioremediation and genetic engineering) and is sensitive to the technical, institutional, and behavioral contexts that solutions must accommodate. To do this, the work draws upon the talents of economists, social and decision scientists, and legal analysis, as well as the science and technology base of ORNL. Specific applications include studying the acceptability of controversial technologies, examining intellectual property rights policies to promote more efficient use of the gene sequencing data, promoting new approaches to promote market penetration of energy saving technologies, and developing new approaches to regulate technologies emerging from recombinant DNA and nano-engineering technologies.

International Studies -

Economists at ORNL are involved in international studies to understand and promote the adoption of sustainable technologies in developed and developing countries. ORNL economists support the Asian-Pacific Economic Cooperation (APEC) Program in its examination and promotion of new energy and environmental technologies for the purpose of sustainable development in the countries of the Pacific Rim. ORNL also works with the Agency for International Development (AID). Subject areas of specialization include clean energy strategies,

environmental management, global change, institution-building, technology transfer, information systems, and program development and evaluation.

Information and Information Technology-

Technologically advanced censors, capable of gathering real time data regarding emissions, water, and energy use can have an impact on the operation of markets and the interaction between individuals and institutions. Information gathered from such devices can facilitate dynamic pricing and trading of emissions and resource use leading to a sustainable use and management of resources, and the incorporation of the social benefits of public goods into a market system.

ORNL economists also are doing research to examine the impact of internet use on the duration of search by consumers in selected markets, e.g. housing. This research has broad implications for how energy markets may react to information and information systems designed to provide more and more accurate information to consumers.

Water and Energy Security-

The energy security goals of the United States are inextricably linked with our nation's water resources. Greater energy security will require additional water resources, and the growing imbalance of domestic water supply and demand will require the more efficient use of energy in water and wastewater technologies. Conventional and unconventional domestic production of oil depend on water for extraction and refining. Revolutionary energy technologies, such as a hydrogen-based economy and Freedom CAR, will transform the domestic production, transport, and use of energy, with unknown water implications.

Economists at ORNL are addressing water constraints that may stand in the way of transitions to new fuels and energy technologies. Incentive structures to use energy and water most efficiently are also being considered. Incentive structures that are now being discussed, and in some cases implemented, to use our water more efficiently (while addressing equity concerns) have a direct link and similarity to the energy incentive structures that were put in place in the 1970s and 1980s to improve our nation's energy security.

About ORNL-

ORNL is a multiprogram science and technology laboratory managed for the U.S. Department of Energy by UT-Battelle, LLC. Scientists and engineers at ORNL conduct basic and applied research and development to create scientific knowledge and technological solutions that strengthen the nation's leadership in key areas of science; increase the availability of clean, abundant energy; restore and protect the environment; and contribute to national security. ORNL was established in 1943 to carry out a single, well-defined mission: the pilot-scale production and separation of plutonium for the World War II Manhattan Project. Today, ORNL pioneers the development of new energy sources, technologies, and materials and the advancement of knowledge in the biological, chemical, computational, engineering, environmental, physical, and social sciences.

Staff: 3800 total, 1500 scientists and engineers
Budget: $1.07 billion, 80% Department of Energy, 20% work for others
Replacement cost of buildings: $7 billion
Total land area: 58 square miles
Guest researchers: 3000 each year, about one-fourth from industry
Visitors: About 30,000 each year, plus 10,000 pre-college students

ORNL is located near Knoxville, Tennessee, the Great Smoky Mountain National Park, and numerous TVA lakes. Several ORNL economists serve as Adjunct Faculty Members at the University of Tennessee in Knoxville.