West Virginia Energy Opportunities

A Blueprint for the Future

Resources for Economic Growth and Energy Security

WEST VIRGINIANS ARE FREE…
BUT NOT OF FOREIGN OIL.

WE ARE PLANNING TO BE FREE OF FOREIGN ENERGY IMPORTS BY 2030
West Virginia currently imports 1.3 billion barrels of oil a year. We believe that if we are to enjoy energy security and economic freedom, we must reverse that trend.

We will develop an Energy Policy and Plan for the State that seeks to achieve energy independence by 2030, and whenever possible, will seek to implement it through all of our state agencies with the Public Energy Authority taking the lead.

Our policy will include all forms of feasible energy technologies, from clean coal, to coal liquefaction, natural gas, biomass, hydrogen, hydro, wind and solar power.
We can't say at this time what the appropriate mix might be but we are committed to achieving a comprehensive energy policy and plan that is technically feasible, environmentally responsible & financially sound…

FOR THE BENEFIT OF ALL WEST VIRGINIANS.

I. Overview

The State of West Virginia has always played an important role in supplying energy for our nation's homes and factories. Today as a nation we are faced with a new challenge to demonstrate a resolve to become more reliant on domestic energy sources. West Virginia can and should be a leader in advancing its extensive portfolio of energy resources to meet national energy needs. It is important that each state conduct similar exercises to identify resources and commit to the timely development of these resources for our nation's benefit.

Since the mid-1970s we as a nation have been confronted with the reality that the cost of imported oil is driven in part by international politics rather than purely supply/demand factors. As a nation we have been less than fully committed to resolving this problem. Past federal government efforts have stalled when oil prices have fallen.

Oil exporting nations realize that there are or can be alternatives to their oil. It is not in their interest for oil consuming nations to adopt alternatives. Past dramatic movements in the price of oil are reflective of the ebb and flow of international tensions and a resource pricing to eliminate competition.

Dependence on imported petroleum also creates security threats to our nation. Within our recent past, oil exporting countries have curtailed the supply of oil products to the United States for political purposes. Given that the United States has energy options to displace imported oil, it is incumbent on us to develop these opportunities.

Debate continues regarding the adequacy of our world oil resources to meet future world demand. With new demand for oil coming from emerging economies such as China and India, the world demand for oil is anticipated to increase dramatically. Oil producers are optimistic that higher prices will, through enhanced exploration and production, stimulate new oil finds. A contrary view is that our current world oil demand of 84 million barrels a day cannot be sustained let alone accommodate future growth. Should additional resources be found, they would necessarily come from remote or marginal reserves at costs higher than established oil fields.

As a nation, we now import 60% of our oil needs. The supply and price of oil in the future are unpredictable. Developed nations are highly dependent on oil. Short-term interruptions or price spikes can be catastrophic to local economies. In West Virginia, the high price of natural gas, which is to a significant degree driven by the price of oil, has caused plant closings, substantial job losses and communities and lives changed forever. When the price of gasoline exceeds $3 per gallon, it causes serious hardship on all West Virginia families.

West Virginia played a pivotal role in the early oil economy. Whether oil was first produced at Petroleum in Wood County or by Colonel Drake in Pennsylvania is subject to debate. When homes in the United States began using kerosene for lighting, that refined oil product came from the Appalachian basin. Today our state's energy economy is dominated by coal, electric and natural gas production. A long-term perspective on our economy recognizes our past leadership role in oil as well. It is that long-term perspective that will help West Virginia capitalize on the variety of energy resources within our borders.

On Oct. 19, 2006, Marshall University and the West Virginia Development Office sponsored a conference titled "Innovative Energy Resources." That conference featured businesses that are developing our coal waste, coal bed methane, wind, oil and biomass resources. The presenters made the case that unconventional energy sources can in many instances compete with conventional fuels. While the conference was a validation of the many energy resource opportunities yet to be tapped, it emphasized the criticality of market prices as the stimulus for the development of these resources.

New technologies applied to our conventional energy resources will be an even more significant factor in our energy future than nontraditional resources. Specifically, advanced coal technologies represent the most viable option for our nation to transition away from imported oil. Coal, via advanced coal technologies, can be gasified and liquefied. While our conventional oil and gas reserves could be materially depleted in decades, our nation's coal reserves are plentiful. West Virginia's high BTU coal is ideally suited to advanced coal technologies such as those to be employed by integrated gasification combined cycle plants. Coal can be a substitute for liquid

transportation fuels and pipeline natural gas. Advanced coal technologies provide the same level of environmental beneficiation as pulverized coal plants with SOx, NOx and mercury control technologies applied. Advanced coal plants would also be able to capture and sequester CO2. While CO2 sequestration technology is still in the experimental/demonstration stage and has not been proven to be financially and technically viable yet for existing plants, there is guarded optimism that current studies and experiments will refine and prove sequestration technology to be technically feasible, financially sound and environmentally safe.

As is the case with unconventional resources, advanced coal technologies will need to be competitive with conventional energy sources. A 20,000-barrel-a-day coal-to-liquids (CTL) plant would cost more than $2 billion to construct. It has been assumed that with a certain oil price level (e.g. $55 per barrel) it would become economically attractive to construct a CTL plant. Commercially proven technologies and oil price stability are necessary to attract private-sector investments in CTL plants. Many would argue that our current energy situation would warrant a significant federal role in ushering in a coal-based economy. National consensus has not been reached on that issue.

The vision of using hydrogen as a fuel also offers a distinct alternative to petroleum based transportation fuels. Hydrogen can be produced from coal, natural gas, biomass or water. Hydrogen burns cleanly.

Hydrogen is viewed by the U.S. Department of Energy as an important future fuel and DOE has made significant investments in technology development and pre-commercial demonstrations in the last ten years. The promise of hydrogen is to provide fuel at a stable cost over a long period of time. Today's rising costs of imported oil and natural gas causes severe economic stress and increases the nation's interest in alternatives.

A new hydrogen energy industry will create jobs and tax revenue for the states that attract this emerging "knowledge economy" driver. The DOE's National Energy Technology Laboratory in Morgantown is an important center of innovation for hydrogen energy. NETL is collaborating with the state in exploring how the state of West Virginia can adapt hydrogen energy in support of its economic, environmental and energy positioning for the future. NETL's focus on coal to hydrogen fits West Virginia's abundant coal resources. NETL is positioned to support West Virginia as it positions itself for a future of greater control over its energy utilization and retention of energy based wealth.

II. Approach

A long-term solution to our energy needs will involve a combination of all three energy opportunity areas: (1) enhanced production of fossil energy sources including advanced coal technologies; (2) renewable energy development; and (3) energy efficiency. What follows is a discussion of opportunities available to West Virginia in each of these three categories that could be deployed for the benefit of economic development and energy security. It is prefaced with a discussion on the

current oil use in West Virginia. It is followed by a chart depicting a BTU accounting of the contribution that each opportunity could add to our energy portfolio.

Our overall goal is to displace 1.3 billion gallons of oil by 2030. That figure represents 60% of our state oil use, our nation's current level of oil imports. Our savings are reflected in oil use reductions as well as enhanced resource development. Our BTU chart identifies the oil equivalent contribution of these opportunities to our goal.

The largest contributor to our goal could be CTL plants. Additional oil reduction options addressed are expanded use of ethanol, biodiesel and hybrid vehicles. State fleets are the target of efficiency measures.

We believe that higher energy prices are providing and will continue to provide market opportunities for coal waste, coal fines and coal bed methane. Issues relevant to these resources, such as gas pipeline constraints and West Virginia's electric transmission infrastructure, are included within the opportunity discussions.

Wind is the most significant renewable energy opportunity at this time. This could be overshadowed by the development of new biomass technologies that would allow wood to be converted into ethanol. We are proposing that wood-to-chemicals research become a priority of West Virginia University. With the recent adoption of net metering policies by the Public Service Commission, residential solar applications have become a more viable renewable energy option in West Virginia.

West Virginia is becoming more energy efficient. Our new building code is a strong reflection of that. Overall, we believe we can become 30% more energy efficient in all sectors by 2030. Specific opportunities are outlined that would lead to enhanced efficiency in buildings, at home and in our industry. Efficiency reduces the costs of consuming energy as well as improves the overall environmental performance of our economy.

Energy and environmental policies are uniquely intertwined. The opportunities identified in this document are consistent with an appreciation that preserving the quality of our environment is fundamental to our health and well-being. We firmly believe that enhanced energy development can be accomplished consistent with environmental stewardship.

III. West Virginia's Petroleum Demand

According to the Energy Information Administration, which provides official energy statistics from the U.S. government, West Virginia's total petroleum consumption in 2004 was 5.9 million gallons per day, which places the state 35th in the U.S. in total petroleum consumption. West Virginia ranks 9th per capita in total energy consumption at 431 million Btus (2002) and 34th in gross energy consumption at 0.8 quadrillion Btu (2002).

That figure includes:
Gasoline consumption of 2.3 million gallons per day (state ranked 38th).
Distillate fuel consumption of 1.6 million gallons per day (state ranked 39th).
Liquefied petroleum gas consumption of 0.2 million gallons per day (state ranked 39th).
Jet fuel consumption of 0.03 million gallons per day (state ranked 48th).

The state ranks 25th (including Federal Offshore areas) in crude oil production with volumes totaling 4,000 barrels per day. About one-half of West Virginia's crude oil production is derived from stripper wells (wells that produce less than 10 barrels per day).

For 2005, U.S. net imports of petroleum represented 59.8 percent of petroleum consumption. Applying that percentage to West Virginia yields an imported petroleum figure of 1.3 billion gallons a year. This West Virginia Energy Opportunities document provides options for reducing and/or eliminating West Virginia's share of the nation's total dependency.

IV. Opportunities

A. ADVANCED COAL TECHNOLOGIES

Overview: Rising direct and indirect cost of transportation fuels and the depletion of conventional oil reserves will lead to the introduction of new liquid fuels. Coal is uniquely positioned to be a cornerstone of a transition away from petroleum-based fuels. West Virginia, with substantial quality coal reserves, abundant water, an established energy infrastructure and trained workforce, is in a position to capitalize economically on advanced coal technologies.

Requirements: A 20,000 barrel per day plant would require roughly 4 million tons of coal a year. Coal conversion (gasification or liquification) requires adding hydrogen to coal. Water is the source of hydrogen. The consumption and cooling requirements of a coal conversion facility would be at least 6 million gallons a day. Long-term coal contracts, minimal coal shipping and railroad or barge access is important to provide a competitive product.

In addition to coal-to-liquids, coal gasification could supply pipeline-quality gas or transportation fuel in the form of hydrogen. An additional advanced coal opportunity

is the production of ammonia nitrate from coal, as well as nitrates for fertilizer. The cost of these products is heavily dependent on the price of natural gas. Coal gasification and ammonia nitrate production facilities would have similar input requirements as a coal-to-liquids facility.

Displacement: A 20,000 barrel a day plant would annually produce roughly 300 million gallons of diesel product. West Virginia's goal of displacing 1.3 billion gallons of oil annually by 2030 could be met with 5 coal-to-liquids plants. Providing the coal to support these plants would lead to a 15% increase in annual coal production. Coal production in 2006 was 148,483,816 tons.

Short term goals:

1. Partner with industry to establish a polygeneration plant (liquids, gases and electricity) by 2010.
2. Work with the West Virginia Geological and Economic Survey to identify potential locations for advanced coal plants.
3. Work with the West Virginia Geological and Economic Survey to identify carbon sequestration opportunities.

Medium term goals:

1. West Virginia Public Service Commission to establish a policy that facilitates the production and sale of pipeline gas or transportation fuels produced from coal.
2. West Virginia Department of Environmental Protection to establish state carbon sequestration procedures and guidelines.

Long term goal:

1. Ensure state-of-the-art pollution abatement/management technology is component of coal-based energy projects.

Lead Agency/Institution: West Virginia Division of Energy; West Virginia Development Office; West Virginia Department of Environmental Protection; West Virginia Geological and Economic Survey; West Virginia Public Service Commission; West Virginia University; Marshall University; WVU Institute of Technology.

Action Items:

1. Identify siting requirements for coal conversion plants.
2. Develop environmental compliance thresholds that coal conversion facilities would need to meet.
3. Establish siting teams at West Virginia Geological & Economic Survey.

B. ELECTRIC TRANSMISSION INFRASTRUCTURE

Overview: Interstate sales of electricity – produced primarily from coal-fired power plants – are an important component of West Virginia's economy. Because the nation's demand for electricity continues to increase, the state and national economy will continue to rely on such exports.

Environmental concerns about the effects of burning coal require that increased production will necessarily require advanced technologies such as gasification, carbon sequestration and the use of renewables. It is clear that each method has its place in the nation's energy future. West Virginia's electric utilities are exploring cleaner methods to make electricity from coal.

The necessary increases in electricity generation in West Virginia are coupled with concerns about the existing – and aging – national transmission grid. Improvements in the grid will enhance system reliability.

Methods: Transmission infrastructure improvements, reductions in emissions from production facilities

Optimum results: Increased reliable export of West Virginia-produced electricity with reduced environmental impacts.

Short term goals:

1. Study impacts of and needs for increased electricity production, infrastructure improvement and modernization of generation methods

Medium term goals:

1. Assess and monitor transmission and generation upgrades

Long term goals:

1. Increase cleaner electricity production in West Virginia

Lead Agency/Institution:

W.Va. DEP, W.Va. GES, W.Va. Division of Energy

Action items:

1. Develop study parameters for analyzing impacts of and needs for increased electric production and enhanced electric infrastructure in West Virginia
2. Review retail renewable energy purchase opportunities

C. COALBED METHANE

Overview: Coalbed methane (CBM), a greenhouse gas, occurs naturally in coal seams.

Methods: Mines are vented before and during mining for safety purposes.

Effectiveness: CBM recovery prior to mining enhances safety, provides a pipeline-quality gas and reduces emissions.

Cost: CBM wells are typically shallow and less productive per square foot than conventional natural gas wells.

Optimum results: The West Virginia Geological and Economic Survey estimates that West Virginia's CBM resource could provide 4 bcf in annual production by 2030.

Short term goals:
1. Use the West Virginia Geological and Economic Survey to quantify locally available resources.
2. Work with industry, the West Virginia Public Service Commission and West Virginia Geological and Economic Survey to identify pipeline constraints.

Medium term goals:
1. Become a state ENERGY STAR Partner in the methane component of the program.
2. Analyze legal ownership issues of gas recovery.

Long term goal:
1. Work with WVU and West Virginia Geological and Economic Survey to explore technological opportunities for recovery of low gas concentrations.

Lead Agency/Institution: West Virginia Division of Energy; West Virginia Department of Environmental Protection; West Virginia Geological and Economic Survey.

Action Items:
1. Identify quantity of economically available coal bed methane resources.
2. Initiate study on pipeline constraints with input from West Virginia Public Service Commission, West Virginia Independent Oil and Gas Association and West Virginia Oil and Natural Gas Association. Study to be supported through the W.Va. Division of Energy. This study will also be relevant to the expansion of conventional natural gas production in West Virginia.

D. COAL WASTE

Overview: Coal waste is coal gob, a coal preparation waste, and coal fines, a byproduct of coal cleaning. The energy value and usability of gob varies considerably from site to site and must be sampled extensively to identify the volume and quality of the product. This is a necessary step for reclamation or sale of this material. It is believed that recovery of coal waste could be increased by 4 million tons annually divided between waste coal (gob) and fines. There are 360 abandoned sites that have yet to be reclaimed.

Methods: While the location of coal waste sites is documented, no information is available on the amount or quality of coal waste available.

Effectiveness: Coal waste has a btu content range of 4,000-8,000 BTUs per pound. Currently, 1 million tons a year of coal waste is used in three West Virginia power plants.

Optimum results: Coal waste is both an environmental hazard and energy resource.

Recommendation: Prioritize recovery sites.

Short term goals:
1. Use the West Virginia Geological and Economic Survey to provide a general assessment of coal waste availability.
2. Promote use of coal gob as an electrical generation fuel.

Medium term goals:
1. West Virginia Division of Energy and WVU to sponsor state conference on coal separation technologies.
2. Interact with industry to promote separation technologies that negate the need for coal fine impoundments.
3. Identify low BTU gob opportunities.

Long term goal:
1. Remediation of all waste coal sites in West Virginia.

Lead Agency/Institution: West Virginia Division of Energy; West Virginia Department of Environmental Protection; Marshall University/Center for Business and Economic Research.

Action Items:
1. Secure funding through the West Virginia Legislature to determine the quantity and quality of targeted refuse piles.
2. Identify coal waste sites for electrical generation stations.
3. Participate in Center for Advancing Separation Technologies (CAST) forums.

E. ENHANCED OIL RECOVERY

Overview: West Virginia oil production in 2004 was 1,510,004 barrels. State oil production in 2005 was 1,563,000 barrels. This increase can be attributed to enhanced oil recovery (water flooding) projects. The West Virginia Geological and Economic Survey estimate of original oil in place in West Virginia is 2,387,019,380 barrels. The estimate of cumulative production to date is 307,918,000 barrels. This remaining

reserve totals 2,079,101,380 barrels (this is a significant departure from the EIA estimate of 11 million barrels). Assuming Enhanced Oil Recovery (EOR) could yield a sustained 10% increase over 2005 production levels, this yields an annual increase in oil production of about 160,000 barrels through 2030.

Amount displaced: A 10 percent increase in production through EOR yields an increase of 160,000 barrels annually.

Observation: EOR is a long-term oil supply initiative that could be hindered by short-term oil price fluctuations.

Short term goals:

1. Through the West Virginia Geological and Economic Survey, provide technical assistance as needed to support EOR efforts.
2. Use the West Virginia Geological and Economic Survey to identify future EOR opportunities.

Medium term goal:

1. Use EOR as a carbon sequestration opportunity in conjunction with advanced coal technologies.

Long term goal:

1. Advance tertiary recovery opportunities.

Lead Agency/Institution: West Virginia Division of Energy; West Virginia Department of Environmental Protection; West Virginia Geological and Economic Survey; Marshall University/Center for Business and Economic Research.

Action Items:

1. Use Geological and Economic Survey to identify oil resources that could be produced through enhanced oil recovery.

F. TRANSPORTATION

1. Alternative Fuels

A transition to domestically produced vehicular fuels can be a significant boost to West Virginia's economy. Coal-based transportation fuels including coal-to-liquid diesel, coal-to-hydrogen gas, cellulosic ethanol from wood or grasses such as switchgrass, electric vehicles, and biofuels represent fuels that could originate in West Virginia and use West Virginia resources. Currently, new markets are evolving for E-85, hydrogen and biodiesel. Other than as an oxygenate, ethanol has not attracted a strong interest from major oil companies. Similarly, biodiesel is not marketed by the majors. The recent announcement by General Motors of their new vehicle, the "Volt", provides

hope that plug-in electric vehicles will soon become a reality. Electric vehicles are a good complement to West Virginia's infrastructure and our exportation of electric energy. Additionally, electric vehicles provide substantial consumer's savings when used as a commuter vehicle.

In addition to alternate fuels, vehicles are also going through a technology revolution which will significantly enhance their efficiency. The most prominent example is hybrid vehicles. With the federal government revisiting the corporate average fuel economy standards, gasoline powered vehicles of the future could become significantly more energy efficient.

Individuals and fleet owners will have a wide array of opportunities to purchase domestically produced transportation fuels. The price that these alternatives can be brought to market will be critical in predicting their success. These fuels must first be able to compete with the price of imported oil.

Hybrids:
Overview: The petroleum industry predicts that 50 percent of all vehicles will be hybrid models by the year 2030. There were 1,300,906 registered passenger vehicles in West Virginia in 2004, including state fleet vehicles. If 50 percent of West Virginia vehicles were hybrids, the state could save 206,910,158 gallons of oil or 230,270,928 gallons of gasoline.

Biodiesel:
Overview: As of January 2007, 16 West Virginia school systems were using some blend of biodiesel to fuel their bus fleets: Marion, Wood, Monongalia, Jefferson, Berkeley, Barbour, Ohio, Randolph, Upshur, Brooke, Hancock, Kanawha, Ritchie, Roane, Clay and Wirt. Marion (2002) and Monongalia (2003) counties were the first in the state to adopt the use of the fuel. The Public School Support Program (PSSP), a plan of financial support for West Virginia public schools operated by the West Virginia Department of Education, allows a 10 percent additional reimbursement for transportation fuels for that portion of a district's bus fleet that uses alternative fuels. The state school bus fleet consumed 5,884,920 gallons of diesel in 2004-5; a 20 percent reduction through the use of B20 (a blend of 20 percent biodiesel and 80 percent diesel) would save 1,176,984 gallons of diesel, equivalent to 1,316,361 gallons of gasoline.

Flex Fuel Vehicles:
Overview: Flex fuel vehicles can operate on E-85 (85% ethanol – 15% gasoline) or gasoline. Limited E-85 fueling stations and available flex fuel models limit this option. As new cellulosic ethanol technologies develop, both retail outlets and the number of flex fuel models should increase.

Diesel Vehicles:

Overview: Clean diesel technologies are being applied to passenger vehicles. This is an opportunity for liquids from coal to fuel both cars and trucks. By 2030, market penetration could be substantial.

Electric Vehicles

Overview: Electric vehicles could have significant cost and environmental benefits over gasoline vehicles, especially in commuter applications. Plug-in electric vehicles have the ability to charge in the evening when there is less demand on the electric infrastructure. Electric vehicles also represent new market opportunities for West Virginia electricity.

Hydrogen Vehicles:

Overview: Hydrogen can be a byproduct of the coal gasification process. Transportation vehicles that use hydrogen exist or can be modified from existing internal combustion vehicle technologies.

Recommendations:

West Virginia should promote and adopt more efficient vehicles. Efficiency could be realized in improvements in miles per gallon (e.g., hybrids) or in vehicles that use domestic resources.

Short term goals:

1. Reduce use of transportation fuels in state government by 15 percent.
2. Develop Internet-based promotional campaign for the use of hybrid vehicles and high mileage gasoline and diesel vehicles.
3. Promote the use of biodiesel in county school systems.

Medium term goal:

1. Support demonstration of plug-in electric vehicles.

Long term goal:

1. Promote market penetration of coal-based transportation fuels including diesel and hydrogen and cellulosic ethanol as transportation fuels.

Lead Agency/Institution:

West Virginia Department of Administration; West Virginia Department of Environmental Protection; West Virginia Division of Highways (Department of Transportation); West Virginia Department of Education; West Virginia Division of Energy; County Boards of Education.

Action Items:

1. Advance high mileage, hybrid vehicles and trip reduction strategies in state government fleets.

2. Use West Virginia Clean State partners to advance alternate fuel use in West Virginia.
3. Promote biodiesel use by county school systems.

2. Public Transportation:

Overview: Increasing West Virginians' use of public transportation can save petroleum. More transit system riders mean fewer single-occupancy vehicles; alternative fuels in the state's transit fleets means less petroleum-based fuels. The American Public Transportation Association reports that if Americans used public transportation for roughly 10 percent of daily travel needs, the United States would reduce its dependence on imported oil from the Persian Gulf by more than 40 percent.

In West Virginia, 18 public transit programs report 9,984,749 miles driven in 2005-2006 and 5,158,512 passengers. As buses average 4 miles per gallon, the systems used approximately 2.5 million gallons of diesel in 2005-6.

According to a 2006 report from the West Virginia Department of Transportation Division of Public Transit, "West Virginia has 181 organizations that provide transportation services in all 55 counties (including) public transit systems, taxis, head start providers, non-emergency Medicaid transportation providers and social service agencies, such as councils on aging, health centers and community action programs. … Approximately 1,385 vehicles are in the combined specialized transportation and transit fleets. … Transit systems operate in 30 of the state's 55 counties. … Taxi service is available in 33 of the state's 55 counties."

Public transit bus systems are located in Charleston, Huntington, Martinsburg, Morgantown, Parkersburg, Weirton and Wheeling. Rural and small urban bus systems are in Bluefield, Clarksburg, Fairmont, Grantsville, Kingwood, Petersburg, Philippi, Summersville, Wayne and West Hamlin.

The American Public Transportation Association reports that "by using public transportation to commute to work, a person can save between $300 and $3,000 in fuel costs per year. … By getting rid of a car, and using transit instead to commute to work, a person would save between $3,300 and $11,100 annually. … Transit use saves more than 855 million gallons of gasoline every year."

Amount displaced:
Using a blend of 20 percent biodiesel, converting all of the state's public transportation fleet to B20 could save 500,000 gallons of diesel a year.

Recommendations:
Recognize that increasing ridership in the state's public transit systems and the use of alternative fuels in those fleets can significantly reduce West Virginia's dependence on imported oil.

Short term goal:
1. Support media campaign to encourage the use of West Virginia's public transit systems
2. Promote the use of biodiesel (B-20) in state's public transit systems

Medium term goal
1. Increase ridership by 20 percent.
2. Increase use of biodiesel to 50 percent of transit fleets
3. Promote hybrid-diesel vehicles

Long term goal:
1. Increase ridership to capacity of system
2. Increase use of biodiesel blends to 100 percent of transit fleets

Lead agency/Institution:
Department of Transportation Division of Public Transit, West Virginia Division of Energy

Action Items:
1. Survey of state's transit system fleets to determine interest in biodiesel.
2. Communications Division of the Department of Commerce to design a media "Ride the Bus" campaign focusing on possible energy/dollar savings.

3. Idling Reduction Initiative

Overview: Commercial truck drivers and locomotive operators idle their diesel engines while parked for a variety of reasons. These include cab heating or cooling, to avoid start-up problems, or to operate electrical equipment. It is estimated that more than 7 million gallons of diesel fuel is used annually for this purpose in West Virginia. This measure examines the savings possible if auxiliary electrical power units were utilized for idling reduction by 20% in these transportation sectors. West Virginia state fleet diesel vehicles would not have the same use profile as long-haul trucks and are not impacted by this.

Amount displaced: 1,500,000 gallons of gasoline could be saved.

Recommendations: Promote installation and use of idling reduction equipment and strategies by trucking industry and railroads.

Short term goal: 10 percent by 2010.

Medium term goal: 15 percent by 2020.

Long term goal: 20 percent by 2030.

Lead Agency/Institution: West Virginia Department of Environmental Protection; West Virginia Division of Energy; Marshall University/Center for Business and Economic Research.

Action Items:
1. Promote truck stop electrification technology at all West Virginia truck stops.
2. Provide information on Small Business Administration loans for auxiliary power units.

G. BUILDINGS

1. Building codes:

Overview: The West Virginia Legislature adopted the 2003 ICC building codes in 2006 with voluntary adoption by jurisdiction. By the spring of 2007, five counties and 56 municipalities adopted the code. Homes built in compliance with the energy component of the code could save the equivalent of 12 MCF of natural gas or 12,000,000 BTUs.

Based upon the number of houses authorized by building permits in 2004, that is equivalent to a savings of 553,161 gallons of gasoline per year.

Methods: Building code adoption to reduce energy consumption in buildings.

Cost: $500 incremental costs for compliance to the 2003 International Energy Conservation Code.

Percentage reduction: Up to 17% annual energy use.

Optimum results: Costs recouped through savings in three years.

Recommendation: Recognize building codes as an affordable energy tool.

Short term goals:
1. West Virginia Division of Energy to provide code training workshops.
2. For eligibility of state infrastructure grants, consider requiring local code adoption for successful award.

Medium term goal:

1. State Fire Commission adoption of updates of national code when issued without amendments.

Long term goal:

1. State adoption of ENERGY STAR criteria for new construction.

Lead Agency/Institution: State Fire Commission; West Virginia Division of Energy; city and local jurisdictions.

Action Items:

1. Building code training to be provided for builders, architects and code officials in 2007.
2. Provide incentives to communities for the adoption of codes.

H. K-12 SCHOOL BUILDING ENERGY PROGRAM

Overview: During the 2005-2006 school year, West Virginia county school systems spent $38,605,525 for heating and cooling in K-12 education facilities. In appreciation of an energy efficiency opportunity in schools, WVDO, in cooperation with the West Virginia Department of Education, has established a Center for Building Energy Use at campuses of West Virginia University Institute of Technology (WVUIT) and West Virginia University College of Engineering and Mineral Resources (CEMR). Supporting this program is EEP's Lighting Program. This program provides a lighting audit service for schools. Participation in the U.S. EPA ENERGY STAR Program is encouraged.

Methods: The School Building Energy Program provides technical assistance to county school systems. Included are energy benchmarking of selected county individual school buildings and training for county school system personnel in the ENERGY STAR portfolio manager assessments. WVUIT and WVU CEMR student teams are being trained as part of their senior class project to conduct building energy assessments. This will establish at WVUIT and WVU a network of trained building energy specialists.

Effectiveness: The goal of the School Building Energy Program is $5,790,828 annually based on a reduction in energy costs of 15% for all county school systems.

Approach: School Building Energy Program: Funds annually contracted to WVUIT and WVU CEMR.

Percentage reduction: School Building Energy Program short term goal is a 5 percent reduction in the energy used by county school systems; 25 percent target, long term.

Optimum results: All 55 county school programs participating in the program.

Recommendation: Continue WVUIT and WVU support and establish recognition programs for county school programs meeting voluntary energy reduction goals. Encourage participation in the ENERGY STAR Program.

Short term goals:

1. Establish at campuses of WVU Institute of Technology and WVU CEMR a Center for Building Energy Use.
2. Require county and state facility managers to attend energy management training.
3. Determine baseline energy use for county schools and state facilities.
4. Reduction in state school energy use achieved through operation and maintenance measures, lighting upgrades and low-cost measures.
5. Develop as a model for other schools the case histories of existing West Virginia schools that have achieved energy conservation by installation of geothermal HVAC systems and those who have benefited from AEP's Solar Schools program.

Medium term goals:

1. Advance energy efficiency opportunities in county school systems.
2. Develop energy-service company master contract agreements for use by state and county facilities.

Long term goals:

1. Identify funding/financing opportunities for efficiency retrofits.
2. Mandate that state-supported construction meet ENERGY STAR building certification standards for new schools.

Lead Agency/Institution: West Virginia Division of Energy; West Virginia Department of Education; WVU Institute of Technology and WVU College of Engineering and Mineral Use.

Action Items:

1. Energy management curriculum to be developed by WVU Institute of Technology and WVU CEMR.
2. Develop and promote training requirements for state and local building energy managers.
3. All schools to be benchmarked by 2010.

I. ENERGY STAR Compliance

Overview: The ENERGY STAR Program is responsible for setting and certifying voluntary energy efficiency standards for home energy appliances and equipment. This includes HVAC equipment, water heaters, kitchen appliances, washer/dryers and entertainment/computer equipment. ENERGY STAR states that using certified equipment can reduce home energy costs by an average of 31 percent.

Methods: Promotion of Energy Star by West Virginia Department of Environmental Protection and West Virginia Division of Energy to contractors and homeowners.

Savings: $672 in average annual homeowner energy savings. It is estimated up to 75% of all 732,911 single-family dwellings (2006) could be impacted.

Percentage reduction: Up to 31% annual energy use.

Optimum results: Costs recouped through savings in three years.

Recommendation: Promote ENERGY STAR Program as a residential energy reduction tool.

Short term goals:

1. Reduce energy use in state-owned buildings
2. West Virginia Division of Energy to conduct ENERGY STAR media campaign to promote ENERGY STAR to homeowners and builders through media and workshops.
3. Educate the public on the benefits of energy saving measures and how to implement them.
4. Continue to monitor Leadership in Energy and Environmental Design (LEED) requirements and applicability to public and private buildings.
5. Evaluate incentives program for adoption of LEED standards.
6. Explore energy performance contracts for state buildings

Medium term goal:

1. Adoption of ENERGY STAR product standards by state purchasing units and local jurisdictions.

Long term goal

1. Promote products consistent with the ENERGY STAR Guidelines for Energy Management and National Performance Energy Rating System.

Lead Agency/Institution: West Virginia Department of Environmental Protection; West Virginia Division of Energy; Department of Administration and Office of Technology.

Action Items:

1. Support ENERGY STAR campaign.
2. Consider adoption of ENERGY STAR guidelines for all new state government buildings.
3. Benchmark state-owned buildings.
4. Tax holiday for purchase of ENERGY STAR products.

J. INDUSTRY

Overview: Through the Industries of the Future-West Virginia program, the state of West Virginia is partnering with energy-intensive industries to help them reduce energy costs. IOF-WV has two principle focus areas: to provide technical assistance on how energy use can be reduced and to secure support, through federal funding, for cost-shared projects that demonstrate new industrial technologies. These technologies and the technical assistance are helping West Virginia industries remain competitive. IOF-WV's core technical assistance activities include:

- Industrial assessment: Energy audits performed through the College of Industrial and Management Systems Engineering
- Student Energy Intern Program: Using senior level engineering students from WVU and WVUIT colleges of engineering to provide energy-related technical assistance. Included in these programs are the Glass Industry Assistance Program and Wood Industries Assistance Program.
- Natural Gas Utilization Center: Provides assistance to natural gas-using industries on efficiency and resource substitution initiatives

Methods: Technical assistance and demonstration projects, industry partnerships.

Effectiveness: International competition, high energy costs and environmental constraints provide incentives to adapt new technologies. IOF-WV activities are the catalyst for modernization investments.

Optimum results: Through the delivery of training and research activities, the energy and environmental performance of West Virginia's heavy industries is improved.

Efficiency Opportunities: An oil equivalent savings of approximately 20 million gallons a year (primarily in natural gas savings) can be realized through industrial energy efforts. These programs are helping save millions of dollars a year in natural gas costs. Significant additional savings through IOF-WV are possible.

Recommendation: Maintain a strong interaction with industry on energy efficiency opportunities.

Short term goals:

1. Provide and coordinate IOF-WV services.

2. Support Industrial Gas Utilization Center
3. Continue support for IOF-WV technical assistance activities
4. Provide recognition for industrial energy efficiency accomplishments
5. Provide training for industrial energy managers
6. West Virginia Development Office will market West Virginia as the model location for industrial energy use applications.

Medium term goals:

1. Broaden IOF-WV industry sector collaboratives to include automotive parts manufacturers.
2. Advance state-of-the-art energy systems for use by West Virginia industries through technology-specific workshops.

Long term goal:

1. Advance state-based network for alternative energy solutions to support industry needs.

Lead Agency/Institution: West Virginia Division of Energy; WVU/National Research Center for Coal and Energy; WVU/College of Engineering and Mineral Resources; WVU Institute of Technology.

Action Items:

1. Maintain services provided through Industries of the Future – West Virginia.
2. Identify and recognize unique energy efficiency achievements of West Virginia industry.
3. Establish a technical training curriculum for industrial energy managers

K. WIND ENERGY

Overview: West Virginia has an estimated wind energy resource of 3,800 mw on private lands according to a study by Truewind Solutions for the West Virginia Development Office. Class 5 and 6 wind areas are identified as wind resources. The only operating wind turbine operation is rated at 66 mw.

Methods: Work with developers, property owners and local interests to advance wind development opportunities, including recovered surface mine areas.

Cost: Currently commercial wind projects costs between $1-1.5 million per mw.

Short term goal:

1. Advance wind energy as a small scale energy source
2. Catalog suitable surface mine areas for commercial wind operations and advance these locations for renewable energy applications.

Medium term goals:

1. Promote small scale wind opportunities by educating the public on net metering.
2. Acquaint local Economic Development Authorities with wind opportunities.

Long term goal:

1. Advance hybrid energy systems using wind and fossil energy to provide 24-hour-per-day generation capability.

Lead Agency/Institution: West Virginia Division of Energy; West Virginia Public Service Commission; WVU/College of Business and Economics.

Action Items:

1. Identify areas in the state where wind farming is technologically feasible and economically prudent.
2. Consider impact of wind farms on economic development.
3. Use Wind Working Group to stay abreast of pending wind developments.
4. Support reliability of West Virginia's electric transmission infrastructure.
5. Study impact of net metering on the cost effectiveness of wind technologies

L. BIOFUELS

Overview: Wood residues and agricultural resources will be used in the future to produce chemicals, including cellulosic ethanol. West Virginia currently generates 4.78 million tons of under-utilized wood residues annually and has the potential to produce approximately 41,000 tons of crop residue. Commercial cellulosic ethanol technologies will lead to increased demand for wood residue and small diameter trees as well as a new chemical industry focus in West Virginia.

Effectiveness: Development/implementation of a cost-competitive source of ethanol from wood/wood residues.

Opportunity: Wood residue, at $25 per ton, to be converted to ethanol.

Optimum results: Establish corn with wood as an ethanol feedstock.

Time line: Long-term initiative dependent on technology developments.

Recommendation: Promote chemical opportunities for wood.

Short term goals:

1. Conduct state-wide educational meeting on biomass technology.
2. Establish a biomass-to-chemical Center of Excellence at WVU.

Medium term goal:
1. Secure financial support for biomass-to-chemicals demonstration project.

Long term goal:
1. Usher in a new chemical-based industry in West Virginia.

Lead Agency/Institution: West Virginia Division of Energy; West Virginia Division of Forestry; WVU/Division of Forestry and Natural Resources; Fairmont State University.

Action Items:
1. Identify resources needed to establish biomass to chemical program at WVU.
2. Work with WVU to secure funding.
3. Advance renewable energy applications on surface mine locations.

M. CHICKEN LITTER

Overview: The poultry industry generates 190,000 tons of chicken litter in West Virginia annually. The material could be considered an energy resource.

Methods: Poultry growers could adopt technologies that convert chicken litter to energy.

Effectiveness: This technology reduces the environmental impacts of litter and can provide a heating fuel.

Opportunity: Litter has an energy value of $5 per ton. Projects need to be justified on an environmental and economic basis.

Optimum results: Provide an alternative to the winter use of propane in broiler houses.

Time line: Industry adaptation of litter to energy technologies will be slow.

Recommendation: Encourage larger poultry farmers to install gasification units or methane generators.

Short term goal:
1. Provide technical assistance in support of the USDA-funded Hardy County chicken litter gasification demonstration project.

Medium term goal:
1. Promote technologies to growers.

Long term goal:

1. Enhance the profitability of growing poultry in West Virginia through the utilization of poultry litter for energy.

Lead Agency/Institution: West Virginia Division of Energy; West Virginia Department of Environmental Protection; West Virginia Department of Agriculture; WVU/Davis College of Agriculture, Forestry & Consumer Sciences.

Action Items:

1. Work with USDA, Department of Agriculture, WVU and the poultry industry to support the gasification project in Hardy County.
2. Identify litter volumes available for this technology application.

N. LANDFILL GAS

Overview: Landfills produce a low BTU gas as a result of the decomposition of solid waste.

Methods: While several landfills have been identified as candidates for landfill gas (LFG) recovery systems, there are currently none in operation in West Virginia.

Opportunity: Landfill gas could be an alternative to pipeline gas in some applications. It is believed that West Virginia's potential from landfill gas is 4 billion cubic feet.

Optimum results: Reduce air emissions for West Virginia landfills by providing local uses for the landfill methane.

Recommendation: Make use of landfill gas as an energy source.

Short term goal:

1. Market landfill gas in partnership with landfill operators to local gas users.

Medium term goal:

1. Consider landfill gas as an incentive for locating new industries.
2. Establish database of landfill locations/gas users

Long term goal:

1. Require LFG recovery.

Lead Agency/Institution: West Virginia Department of Environmental Protection; West Virginia Division of Energy; County Solid Waste Authorities.

Action Items:

1. Establish a database of landfill locations in relation to commercial/industrial gas users.
2. Interact with county solid waste authorities, local development authorities and industrial businesses on landfill gas opportunities.

O. SOLAR TECHNOLOGIES

Overview: Solar energy represents conceivably the single largest source of energy. Solar energy opportunity has been estimated at 1.5 million barrels of oil of energy per year for every square kilometer.

Available solar energy is comparable in West Virginia to our neighboring states. Following from the NREL data bank * are some samples of available kilowatt hours for comparable cities:

- Akron OH: 4.1
- Columbus OH: 4.2
- Cleveland OH: 4.1
- New York City NY: 4.6
- Rochester NY: 4.1
- Charleston WV: 4.4

(* Data is for non-tracking flat panels set at the latitude of the site)

These numbers indicate that it is feasible to harness solar opportunities in West Virginia. As solar equipment becomes more cost competitive, more West Virginians will be exploring this option.

Solar energy, both thermal and photovoltaic, can be used on industrial, commercial and residential buildings that have available south facing areas:

A. Thermal Solar

1. Domestic hot water can be competitive with gas fired or electric hot water heating.
2. Concentrating solar power (CSP) plants use the concentrated rays of the sun to heat a fluid to steam generating temperatures, thereby driving a steam turbine electric generator.

B. Photovoltaic Solar Cells

A dramatic growth globally is occurring in the manufacture, sale and installation of PV's. Now that West Virginia has adopted net metering, homeowners and building owners alike can partner with the electric utilities and bring energy diversity to West Virginia.

Methods: Technical assistance, conferences, training

Results: Be able to effectively respond to public inquiries and consider solar options.

Recommendations: Enhance solar technology skill sets.

Short term goal:

1. Enhanced web site on solar technologies.
2. Solar conference on PV and hot water systems.
3. Identify training resources/curriculum to support a state network of solar contractors.
4. Review incentives adopted by other states for residential and light commercial applications of thermal and photovoltaic solar energy systems.
5. Promote net metering opportunities for West Virginians using solar technologies

Medium term goal:

1. Review commercial solar applications.
2. Promote solar for off-grid electrical production.
3. Assume 100 customers install 25 kw PV systems

Long term goal:

1. Increase opportunities for more retail customers to install 25 PV systems by 2030.

Action Items:

1. Support consumer education on solar energy applications – consider additional solar conference at Shepherd University.
2. Work with Solar America Initiative to develop enhanced web page on solar technologies.
3. Promote solar related business/industries.
4. Study impact of net metering on the cost effectiveness of solar technologies
5. Study concentrated solar power on surface mine properties.
6. Support reliability of West Virginia's electric transmission infrastructure.

P. HYDRO ELECTRIC POWER

Overview: Hydro power is the oldest form of renewable energy in service to generate electricity. West Virginia already has eleven hydro-electric dams in service and more are planned. There is currently 213 MW of hydro power in service in West Virginia.

Short term goals:

1. The Public Energy Authority, the West Virginia Division of Energy, Department of Environmental Protection and Division of Natural Resources,

with the cooperation of all interested parties, shall develop a specific subset of this Energy Plan to examine and tap into the hydro plant resource potential.

Medium term goals:

1. With an abundant inventory of rivers, the state will investigate how the new high efficiency turbines could be applied to existing hydro plants, dormant older hydro plants and sites for new potential plants at existing flood control dams.

Action Items:

1. Catalog status of all hydro facilities (dams with pen-stocks) in West Virginia.
2. Work with private sector in advancing hydro opportunities on the Ohio River.

Estimated Comparative Availability, Energy Market Value and Oil/Gasoline Equivalent by Resource

Energy Resource	Increase Production/ Enhanced Efficiency	Unit	BTU per Unit	Value per Unit	Estimated Annual Value	Oil Equivalent (BBLS)	Oil Equivalent (gallons)	Gasoline Equivalent (gallons)	Estimated First Year Value	First Year Oil Equivalent (gallons)	First Year Gasoline Equivalent (gallons)	First Year Energy Value (MMBTU)
Coal-to-Liquids	36,500,000	bbl	5,800,000	$50	$1,825,000,000	36,500,000	1,533,000,000	1,703,986,202	$365,000,000	306,600,000	340,797,240	42,340,000
Coal-Bed Methane	4,000,000	mcf	990,000	$8	$32,000,000	682,759	28,675,862	31,874,281	$6,400,000	5,735,172	6,374,856	792,000
Wood Residues	4,780,000	tons	10,600,000	$25	$119,500,000	8,735,862	366,906,207	407,829,820	$23,900,000	73,381,241	81,565,964	10,133,600
Waste Coal CFB	2,400,000	tons	3,412,000	$36	$86,400,000	1,411,862	59,298,207	65,912,150	$17,280,000	11,859,641	13,182,430	1,637,760
Coal Fines	1,600,000	tons	18,000,000	$20	$32,000,000	4,965,517	208,551,724	231,812,955	$6,400,000	41,710,345	46,362,591	5,760,000
Enhanced Oil Recovery	160,000	bbl	5,800,000	$50	$8,000,000	160,000	6,720,000	7,469,529	$1,600,000	1,344,000	1,493,906	185,600
Wind (includes wind from surface mine areas and small wind operations; 50 MW total)	122,640	mwh	3,412,000	$36	$4,415,040	72,146	3,030,138	3,368,111	$883,008	606,028	673,622	83,690
Landfill Gas	4,000,000	mcf	500,000	$4	$16,000,000	344,828	14,482,759	16,098,122	$3,200,000	2,896,552	3,219,624	400,000
Chicken Litter	1,800,000	mcf	650,000	$5	$9,454,545	201,724	8,472,414	9,417,401	$1,890,909	1,694,483	1,883,480	234,000
				TOTAL ENERGY RESOURCE SAVINGS	**$2,132,769,585**	**53,074,698**	**2,229,137,311**	**2,477,768,571**	**$426,553,917**	**445,827,462**	**495,553,714**	**61,566,650**

Energy Efficiency Measures	Annual Potential BTU Savings	Unit	Estimated Price Gasoline per Gallon	Estimated Annual Value	Oil Equivalent (BBLS)	Oil Equivalent (gallons)	Gasoline Equivalent (gallons)	Estimated First Year Value	First Year Oil Equivalent (gallons)	First Year Gasoline Equivalent (gallons)	First Year Energy Value (MMBTU)
WVU Industrial Assessment Center	199,582,000,000	$/gallon	$2.30	$3,701,924	34,434	1,446,246	1,609,532	$740,385	289,249	321,906	39,916
IOF-WV Assessments	396,801,000,000	$/gallon	$2.30	$7,360,019	68,461	2,875,370	3,200,008	$1,472,004	575,074	640,002	79,360
Wood assessments	36,768,000,000	$/gallon	$2.30	$681,987	6,344	266,435	296,516	$136,397	53,287	59,303	7,354
Projects with Industry	10,000,000,000	$/gallon	$2.30	$185,484	1,725	72,464	80,645	$37,097	14,493	16,129	2,000
Glass Industry Assistance Program	3,000,000,000	$/gallon	$2.30	$55,645	518	21,739	24,194	$11,129	4,348	4,839	600
IOF-WV BestPractices Workshops	493,735,000,000	$/gallon	$2.30	$9,157,988	85,185	3,577,790	3,981,734	$1,831,598	715,558	796,347	98,747
IOF-WV R&D Projects	1,000,000,000,000	$/gallon	$2.30	$18,548,387	172,533	7,246,377	8,064,516	$3,709,677	1,449,275	1,612,903	200,000
Transition to Hybrid Vehicles (1,300,966 vehicles registered in 2004. 650,483 vehicles targeted. Savings equals 354 gallons per car)	43,896,000 BTUs	$/gallon	$2.30	$529,623,259	4,926,432	206,910,158	230,270,982	$105,924,652	41,382,032	46,054,196	5,710,720
15% Reduction in K-12 schools through EEP Building Energy and Lighting Grant Programs	$38,605,525 (2005 school expenditures) 15% average savings realized per audit.	varies		$5,790,829	115,817	4,864,296	5,413,491	$1,910,973	1,605,218	1,786,452	221,520
Residential Energy Savings if75% of all West Virginia homes 762,911 single family dwellings in 2006) utilized ENERGY STAR certified HVAC, water heating and appliances	20,826,897,753,459 BTUs (572,183 total single family units)	btus	$.063 average residential electric price	$384,552,919	3,593,323	150,919,549	167,958,853	$76,910,584	30,183,910	33,591,771	4,165,380
Savings if 2003 International Energy Conservation Code were used statewide	5716 housing permits (2004)	btu/home	$.063 average residential electric price	$1,266,499	11,834	497,043	553,161	$253,300	99,409	110,632	13,718
B20 use in State school fleet (20% fuel savings)	1,191,342	gallons	$2.30	$2,740,088	675	28,365	31,568	$548,018	5,673	6,314	783
			TOTAL ENERGY EFFICIENCY SAVINGS	**$963,665,027**	**9,017,282**	**378,725,832**	**421,485,200**	**193,485,813**	**76,377,525**	**85,000,794**	**10,540,098**
			TOTAL ENERGY EFFICIENCY AND POTENTIAL RESOURCE SAVINGS	**$3,096,434,613**	**62,091,980**	**2,607,863,143**	**2,899,253,771**	**620,039,730**	**522,204,987**	**580,554,508**	**72,106,748**