Energy Efficiency and Renewable Energy in Appalachia: Policy and Potential

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Appalachian Regional Commission

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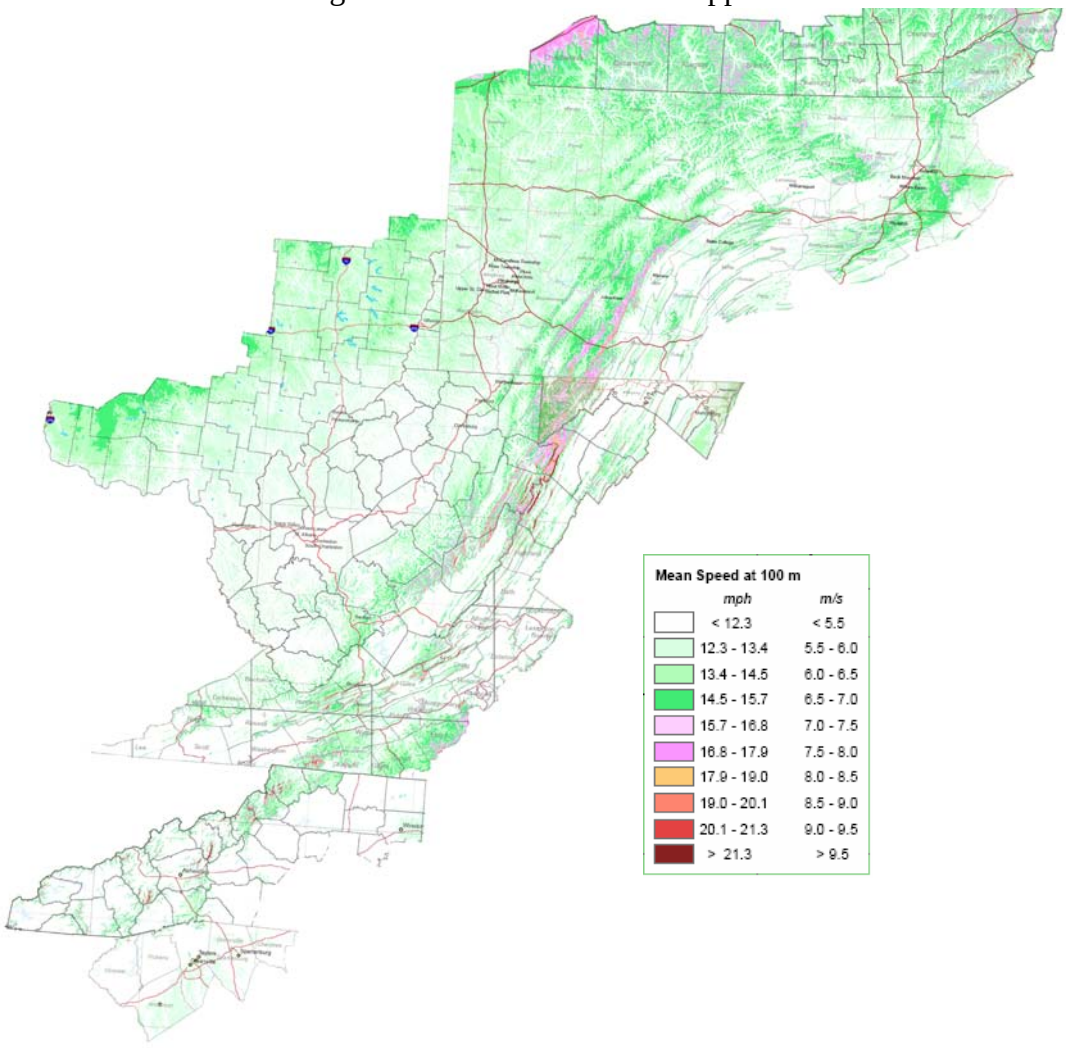
Chapter I. Resource Availability

1. Wind

The harnessing of the power of the wind to produce electricity is significantly undeveloped in the Appalachian region. Overall, this resource appears to be the greatest potential source of renewable power for the eastern U.S. The electricity production potential within the boundaries of the ARC region is difficult to isolate from the non-Appalachian areas of these states although for several states, notably Pennsylvania, West Virginia and Tennessee, the greatest wind potential is found in their mountain regions. For states with ocean borders the greatest potential lies offshore. The following figure shows maps of calculated wind speed for the ARC region at 100 meters above groundcover. Wind speeds of seven meters per second, corresponding with the pink to red areas of the map, are the wind Classes 4 through 7 most desired by developers.

Figure 1.1: Wind Potential in Appalachia[1]



[1] TrueWind Solutions, LLC

State by state estimates of wind potential have been calculated by various sources and are thus varied. For the states in the ARC area with the most wind potential, the following estimates of potential have been reported as shown in Table 1. Some estimates may not reflect higher production made possible by the larger turbines developed in the last couple years. It is important to note that generation potential for wind installations is typically only based on about 30 percent of installed capacity.

Table 1.1: Reported Potential Wind Capacity by ARC State

State	Capacity (MW)	Area
New York	5,000+	On land
Pennsylvania	5,120	State wide
Maryland	338	State wide
West Virginia	3,830	On private land
Virginia	1,380	On shore
North Carolina	835	State wide
Tennessee	186	State wide

Sources: American Wind Energy Association and TrueWind Solutions, LLC

2. Solar

The ability to fully utilize solar energy remains restricted by technology and cost. The Appalachian region has only moderate to low solar capability due to its geography and resulting cloud cover and cooler temperatures. Nonetheless, solar energy still has potential for both thermal use and electricity generation using photovoltaic (PV) panels.

Solar's best potential in the eastern U.S., including Appalachia, is likely to be for residential application, where subsidies are necessary to induce even modest adoption. A recent Department of Defense study determined that daylighting, transpired heat collectors (solar ventilation air preheating), hot water heaters and pool heating give the best paybacks as opportunities to use solar applications on military installations.[2]

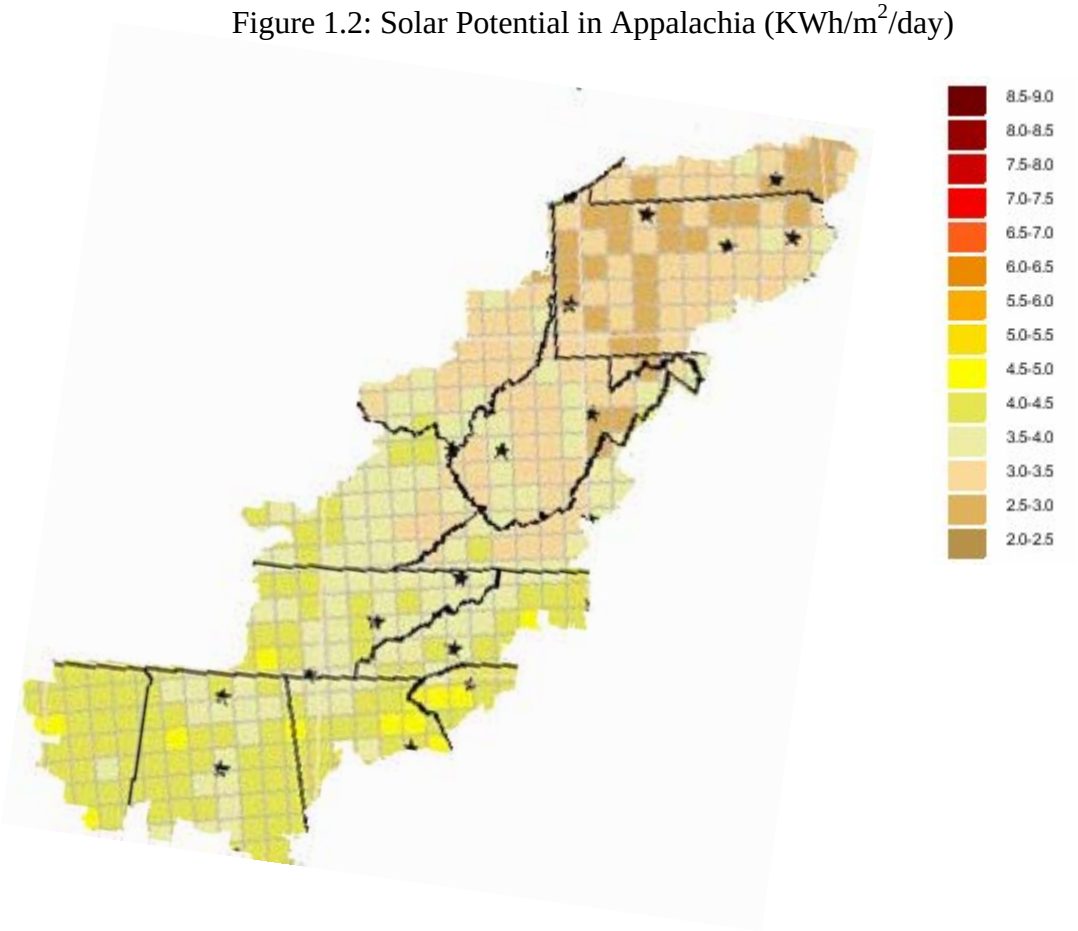
Estimated electricity generation capability allows comparison of solar capability in the ARC region. The grids in the following figure show ranges of KWh/m^2/day for a three kilowatt (KW) AC system. Grids in the Appalachian region could generate between 4200 KWh per year represented by a brown grid in Maryland or Pennsylvania, and 6900 KWh represented by a yellow grid in Georgia, depending on if the PV panels were fixed tilt or had two-axis tracking.

In relation to daily electricity consumption, this resource can not meet the average household demand in most ARC areas. Average demand ranges from about six KWh per day in New York to nearly 14 KWh per day in Tennessee (refer back to a 13 state comparison chart). In Georgia and South Carolina, where potential is best, this resource

[2] U.S. Department of Defense Renewable Energy Study, 2002.

could provide up to half of the average household demand. However, because solar capability is higher in summer than in winter its potential favorably coincides with the highest electricity loads of the year.

Figure 1.2: Solar Potential in Appalachia (KWh/m^2/day)



3. Geothermal

Within the Appalachian region there is very little variation in geothermal capability. Deep earth temperature varies little by geography in the region and the very high geothermal temperatures found in the western U.S. – above 100 degrees Celsius – that are conducive to electricity production are not found in Appalachia. For Appalachia, direct use of geothermal energy via recovery of heat from subterranean air and water is the best method of taking advantage of this resource. Electricity generation using geothermal energy is not physically feasible in the eastern U.S.

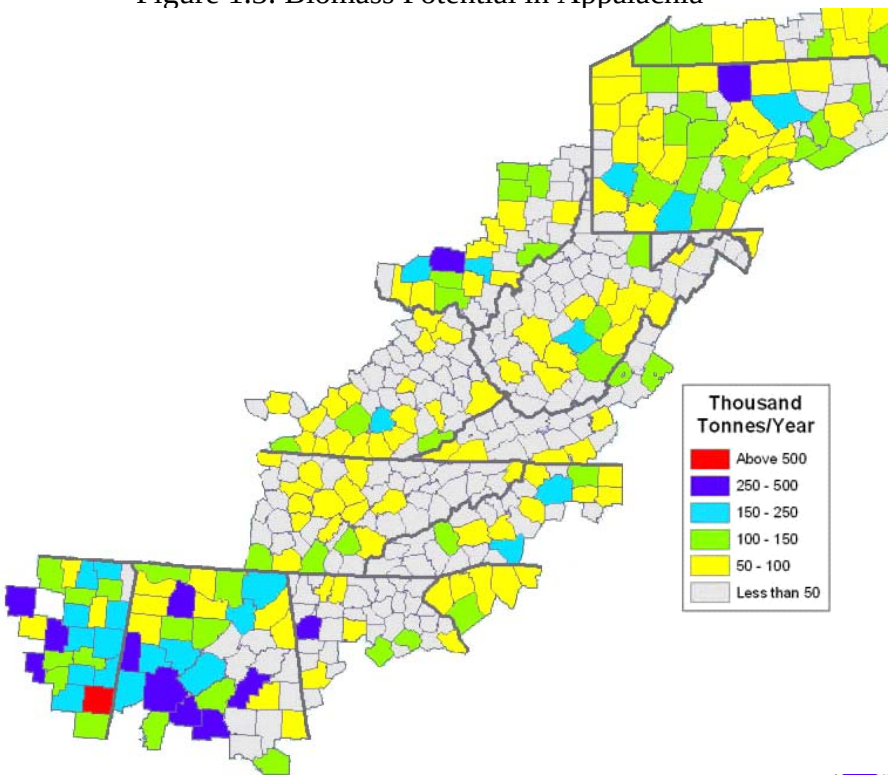
Direct use geothermal energy systems take advantage of the constant temperature of the earth to heat and cool buildings. In the summer, warm air is pumped into the cool subterranean areas where it is cooled and returned as air conditioning. In the winter, cold air is pumped into the relatively warm water – generally between 55 and 70 degrees Fahrenheit - and heated, then further heated via a heat pump as necessary and returned as heating. Geothermal systems are more efficient than gas furnaces and gas heat pumps,

because the air that must be heated or cooled is not as hot or cold as outdoor air temperatures. The higher the water temperature, the more efficient the geothermal resource is. While the groundwater temperature of the Appalachian region is relatively low, there is much of it and this leaves room for considerably more development of this resource.[3] There are already several geothermal systems installed in the ARC region. These systems are most cost-effective for residential and small commercial buildings.

4. Biomass

For this presentation, biomass includes the following feedstock categories: crop residues, methane emissions from manure management, methane emissions from landfills and wastewater treatment facilities, forest residues, primary and secondary mill residues, urban wood waste, and dedicated energy crops grown on Conservation Reserve Program and Abandoned Mine Lands property. The following figure shows the available tonnage of biomass by county in the ARC region. For this region, counties with higher availability generally contain a sawmill industry. Sawmills are the largest source of wood byproducts. Sawmills are most likely the source of the very high biomass availability in Mississippi and Alabama as well as the higher biomass counties in Pennsylvania and West Virginia. The highest biomass available county in Ohio contains a paper manufacturing facility.

Figure 1.3: Biomass Potential in Appalachia[4]



[3] Virginia Tech Regional Geophysics Laboratory (2003). http://www.geothermal.geos.vt.edu/. Some aquifers in the Appalachian region, particularly in New York, Pennsylvania, West Virginia and Virginia have temperatures up to 100 degrees C.

[4] National Renewable Energy Laboratory, 2005.

5. Small and Low Impact Hydroelectric

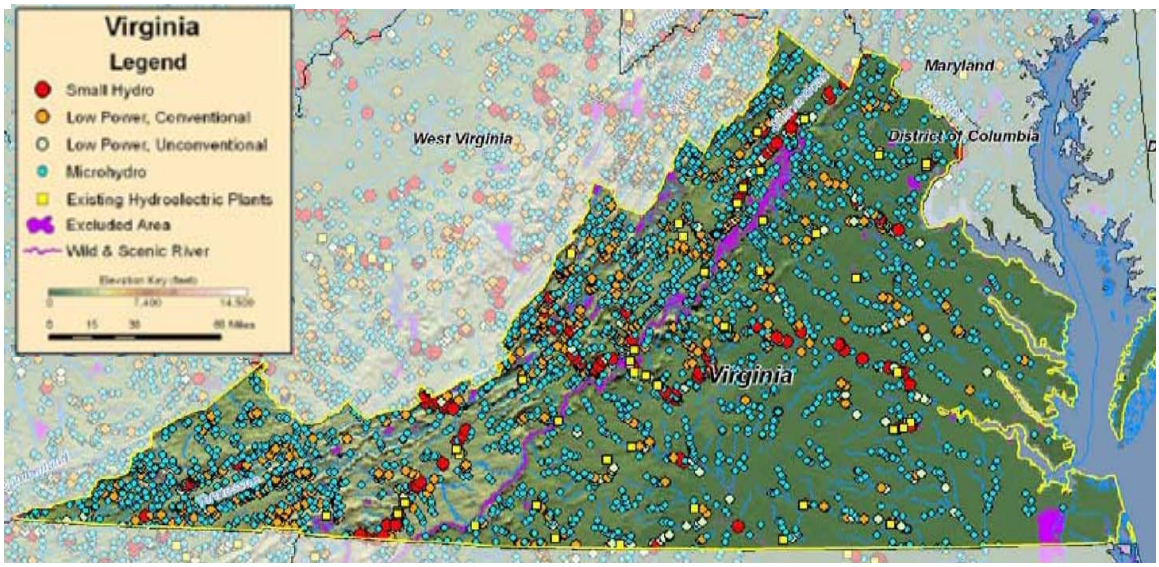
Small and low impact hydroelectric capability is another largely undeveloped energy resource in the ARC region. The region is traversed with several major rivers and watersheds that create numerous opportunities for small-scale and low-flow hydro installations. For this evaluation, small hydro is defined as having power less than one megawatt but having a hydraulic head of more than 30 feet. There are three categories of low head/low power that are often referred to as "run of river" installations:

1) Conventional Small Hydro - power > 100 KW and < 1 MW and hydraulic head >= 8 feet but < 30 feet
2) Unconventional Low Power Hydro - power >= 100 KW and < 1 MW and hydraulic head less than 8 feet
3) Microhydro - power less than 100 KW

The Idaho National Laboratory has estimated feasible hydropower potential for each state in each of these three categories. These estimates do not include streams excluded from development by federal statutes (national parks and monuments, wildlife management areas and designated wild and scenic rivers). The estimates are also based on feasibility as determined by proximity to population centers, industry, and existing infrastructure and location inside or outside non-Federal exclusion areas as well as environmental, legal and institutional constraints on development.

A sample of for the State of Virginia, with potential installations is shown in Figure 4 below. Small hydo is distinguished from the three categories of low power.

Figure 1.4: Small Hydropower Potential in Virginia[5]



[5] Idaho National Laboratory, January 2006. Hydropower Prospector. "Feasibility Assessment of the Water Energy Resources of the United States for New Low Power and Small Hydro Classes of Hydroelectric Plants."

Total feasible hydropower potential is shown in the following table for each of the states within the ARC region. The quantity MWa refers to the average megawatts estimated to be available for that hydropower class. The electricity generation capability is then calculated at 100 percent of this capacity. Tidal power is not included in these estimates.

Table 1.2: Estimated Small and Low Power Hydropower by ARC State[6]

			Low Hydro Power Potential		
State	**Total (MWa)**	**Small Hydro (MWa)**	**Conventional Turbines (MWa)**	**Unconventional Systems (MWa)**	**Microhydro (MWa)**
Alabama	462	311	40	48	62
Georgia	230	101	27	51	51
Kentucky	518	441	25	18	33
Maryland	91	57	20	2	12
Mississippi	298	194	9	59	36
New York	757	428	166	41	122
North Carolina	348	199	69	28	53
Ohio	319	197	39	38	45
Pennsylvania	953	659	140	47	108
South Carolina	211	153	11	25	22
Tennessee	655	481	64	49	61
Virginia	418	224	101	30	62
West Virginia	484	339	90	17	39

It is difficult to separate the non-ARC potential from that found within the region. However, due to the mountainous terrain found in Appalachia, it is expected that a large portion of this potential is found in the ARC region.

6. Biofuels

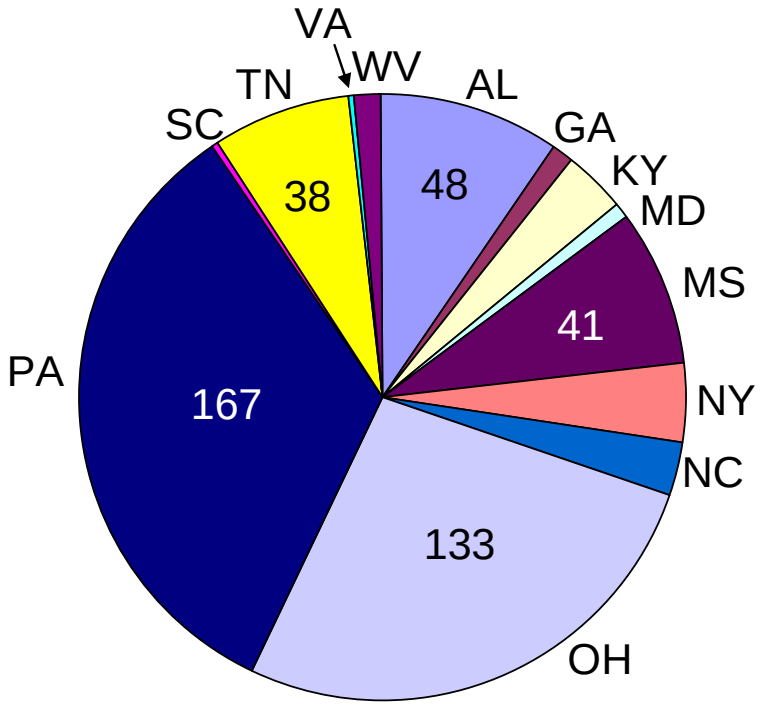
The conversion of agricultural products and byproducts to liquid fuel is an established manufacturing process that has not been widely developed due to its cost relative to production of petroleum-based fuels. Ethanol and biodiesel are the two primary types of biofuels. Ethanol is essentially distilled grain alcohol and can be produced from corn, as well as dedicated energy crops such as switchgrass and even wood. Biodiesel is made from vegetable or animal fat. Both fuels are available in limited quantity and are commonly blended with regular diesel fuel and gasoline. Ethanol is also used as a substitute for methyl tertiary-butyl ether (MTBE0 due to the Federal requirement to phase-out MTBE.

The following figure shows calculated biodiesel production from soybeans and ethanol from corn based on total 2005 production of those crops in ARC counties. Total production is approximately 500 million gallons per year, or 12 million barrels of oil

[6] Ibid.

equivalent. This amount is equal to 0.2 percent of annual U.S. petroleum consumption. Inclusion of animal fat waste and dedicated energy crops would increase these numbers, but would require much more complex calculations and additional data collection beyond the scope of this report.

Figure 1.5: Potential Annual Biofuels Production by State (millions of gallons)[7]



An alternative biofuel which is receiving increased attention in the southern ARC states is switchgrass[8]. Switchgrass being native to the region is highly productive (2-3 cuttings a year) and extremely resistant to disease. It grows well even in marginal soils. Unlike corn, switchgrass produces five times the energy used in its production. It is also environmentally neutral as the greenhouse gases produced when it burns are sequestered in the crops that are being grown[9].

Widespread use of biofuels can not occur with access to fueling stations. A potential partner is Wal-Mart, who is considering installing such stations at all its stores. Appendix A of this report discusses this possibility in more detail.

[7] U.S. Department of Agriculture, 2005 Census of Agriculture. National Agricultural Statistics Services.
[8] "Biofuels from Switchgrass: Greener Energy Pastures" Oakridge National Laboratory http://bioenergy.ornl.gov/papers/misc/switgrass.html
[9] Bransby, D. "Switchgrass Profile" Oakridge National Laboratory http//bioenergy.ornl/papers/misc/switchgrass-profile.html

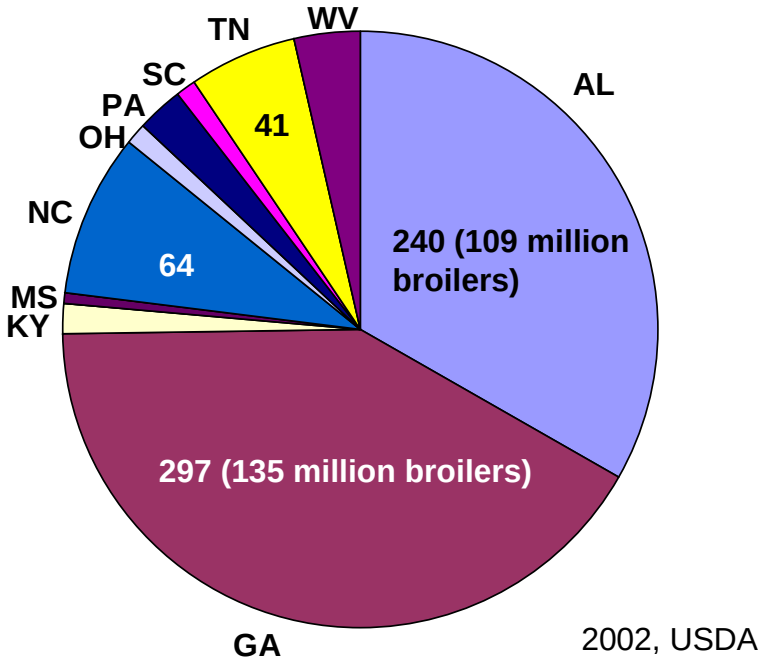
7. Chicken Litter

Chicken litter waste must be collected in very large quantities to make recovery of its energy content worthwhile. It is sometimes co-fired along with coal in conventional steam turbine power plants. Use of chicken litter for energy serves the dual purpose of preventing release of pathogens and pharmaceuticals into streams and rivers when untreated litter is land applied as fertilizer.

Chicken litter produced from broiler manufacturing in the Appalachian region would produce little electricity on its own. The combined litter of the approximately 327 million broilers produced in the region would generation only about 719 MWh - the equivalent annual electricity demand of about 70 homes in the region. Alternate uses of chicken litter include fertilizer production via anaerobic digestion, which also produces a modest amount of methane gas that can supplement the energy needs of a processing facility. Thermophilic anaerobic digestion of chicken litter, such as that demonstrated at the Bioplex Project at West Virginia State University, neutralizes up to 99 percent or more of certain pathogens found in the litter and produces a high nitrogen liquid and solid fertilizer that can replace commercial fertilizers.[10] Cow manure also contains recoverable methane and is also used in digester projects, including one at the University of Georgia.

The following figure shows calculated potential electricity production based on broiler production for ARC counties in 2002. As the figure shows, within the region broiler production is most concentrated in Georgia and Alabama.

Figure 1.6: Potential Annual Electricity Production From Broiler Litter (MWh)[11]



[10] http://bioplexproject.wvstateu.edu/index.html
[11] U.S. Department of Agriculture, 2002 Census of Agriculture. National Agricultural Statistics Services.

Chapter II. State Policies Promoting Use of Renewable Energy, Alternate Energy and Energy Efficiency in the ARC Region

There are a variety of policy measure adopted by the ARC states to promote the use of renewable energy, alternate energy, energy efficiency and conservation. This section provides an overview of these policies with highlights of developments in particular ARC states. In addition the activities of the Tennessee Valley Authority (TVA) are also covered as its programs cover all of Tennessee and impact significant portions of other states in the ARC region.

Recent years have seen the passage or proposal of comprehensive energy plans in many ARC states. Many of the specific provisions in those plans are detailed later in this chapter.

- In 2002 **New York** enacted *2002 State Energy Plan and Final Environmental Impact Statement (Energy Plan)* which provides for increased energy diversity through use of energy efficient technologies and alternative and renewable energy.
- **Georgia** has issued a draft *State Energy Strategy for Georgia* which is due for final release in September 2006. The draft plan stresses the production of ethanol and biodiesel and programs to increase the production of renewable energy.
- **Kentucky**'s Governor has presented *Kentucky's Energy Opportunities for Our Future: A Comprehensive Energy Strategy (2006)* for consideration by the legislature. One of the plans objectives is to maintain the low cost of energy in the state. It also emphasizes biofuels production and a promotion, but not mandate, the use of renewable resources in the sates electricity generation portfolio.
- The *North Carolina State Energy Plan (2005 revised)* sees biomass (including animal waste) resources as having the greatest potential among renewable fuels in **North Carolina.** It also calls for consideration of a Renewable Portfolio Standard to encourage alternate energy development.
- The 2006 **Virginia** legislature passed *The Commonwealth Energy Policy.* The policy places heavy emphasis on research. Clean coal, wind and solar are specifically mentioned for further development as is the increased use and production of biofuels.
- **West Virginia** passed the *West Virginia Energy Policy and Development Act* in the 2006 session establishing a Division of Energy within the Department of Commerce and continuing the Public Energy Authority. The division was charged with energy policy and economic development in coalfield communities. The Authority is to prepare an annual plan for energy diversification and efficiency.

1. Net Metering

State policies and individual utilities offer a dual-metering option to certain customers. Under these programs residences and business which are generating electricity using renewables such as solar, small scale hydro, wind or geothermal are able to either sell back to the grid the energy they generate or receive credit for it on their electric bills.

In most instances this is accomplished by dual-metering. The energy taken from the grid is metered as it is used while a second meter records the energy which is returned to the grid from the renewables. The customer is metered for all energy taken from the grid and either credited or paid for the energy supplied. Customers receive credit on next moth's bill for energy supplied to the utility. Some states use only a single meter which "runs both ways". The customer is only charged for the amount of electricity taken from the utility.

A major issue regarding net metering is the price to be paid for the electricity generated. When a single meter is used this is not an issue as the only bill received by the customer is what is supplied by the utility. When a dual meter system is employed the issue becomes will the generator receive credit or be paid at the retail tariff he is being charged or some other rate. In some states the price is set at the utility's "avoided cost" which is the lowest cost of power obtained from its own generation or purchased from another utility. Experience is some states with avoided cost has meant the return on installing small generation facilities can not be capitalized in a reasonable time period if at all.

There is an issue with safety and reliability. All net metering states require that the renewable installation meet certain standards such as those of Underwriters Laboratories, National Electrical Code or the Institute of Electrical and Electronics Engineers. While no state requires its utilities to pay for the renewable generator or its installation, there is variance as to who must pay for the cost of interconnection.

TVA and its related utilities have established net-metering for all residential and commercial customers through their Green Power Switch Program in **Tennessee, Georgia, Mississippi** and **North Carolina.** In addition TVA has a pilot Generation Partners Program. A two meter system is used with the TVA purchasing all the output at $0.15 for residential customers. For larger customers with units up to 50 kW the rate is $0.20. Larger units may be included with permission from TVA. For residential and small commercial both solar and wind systems are included, but larger commercial enterprises are limited to solar. For the ARC states there are only 22 of their distributors involved. With only 20 residential customers currently connected. Of the 158 distribution companies supplied by TVA, 98 offer the voluntary program.

In **Virginia** the program is limited to residential systems with less than 10 KW capacities while the limit on commercial systems is 500 kWh. Their program extends not only to renewables but to biomass, waste and sea motion. They use a single meter measuring flows in both directions.

Maryland's legislation allows net metering for systems with capacities up to 200 kWh without Public Service Commission approval and up to 500 kWh with approval. Solar wind and biomass systems are covered. A single bi-directional meter is used. The Maryland program is under revision to develop a credit system (other than based on kWh) which allows dollar for dollar offsets for electricity generated. There is a limit on allowable capacity equal to 0.2 percent of the state's peak load forecast.

The **Ohio** situation is similar to that in southern ARC states. All fuels including micro turbines and fuel cells are included. For power furnished to the grid the utility must pay their unbundled generate rate. New rules are under consideration by the Public Utilities Commission of Ohio (PUCO)

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Net metering is provided in **Kentucky** for both private and co-op utilities only for solar units of 15 kW or less. But the states two largest utilities Kentucky Power and Louisville Gas and Electric extend the program to wind and hydro customers. A single bi-directional meter is used. There is a limit of 0.1 percent of a utilities single-hour peak load that can be net-metered.

Net Metering rules in **New York** allow customers to sell the net excess generation from photovoltaic systems with a capacity of up to 10 kW, from farm-based biogas systems up to 400 kW, from residential wind turbine systems up to 25 kW and from farm-based wind turbine systems up to 125 kW. The net-metering program accept customers on a first-come, first-serve basis until the total net-metered solar-electric capacity equals to 0.1% of a utility's 1996 electric demand, the biogas system capacity equals to 0.4% of 1996 demand, and the wind system capacity equals to 0.2% of 2003 demand. Electricity from these systems will be purchased at the utility's avoided-cost rate except for the wind systems with a capacity higher than 10kW, which is credited at the state's avoided-cost rate.

Net Metering Rules in **Georgia** allow customers to sell all or part of the green power generated by their renewable-energy systems, include photovoltaic, fuel cells, and wind systems, up to 10kW for residential customers and 100kW for commercial customers. Utilities will purchase only up to the maximum capacity of 0.2% of the utility's annual peak demand during the previous year.

Evaluation

As a general statement net-metering has not become widespread even when it is available. Those contacted provided several reasons:

- In those state with low energy costs, net-metering does not represent a significant cost savings which would warrant the up-front capital and maintenance costs of installing renewable technologies.
- The uncertainty created in those states where there is no guaranteed purchase price, means few potential generators are willing to take the risk.
- Problems with interconnection are present in many states. These include who bears the costs or the interconnection and the requirements for interconnection.

Some states have required through their Distributed Generation Acts or other legislation that utilities provide interconnection at no cost to the customer.

- Voluntary programs are of limited success if a utility already has a sufficient generating capacity or purchase agreements with other generators to meet its current or anticipated needs.
- Caps on the amount of electricity that utilities are required to buy back under net metering when set at low levels may limit the usefulness of net metering.

2. Renewable Energy Portfolio Standards (REPS)

Renewable Portfolio Standards (RPS) require that a certain percentage of the power either consumed or generated in the state must come from renewable sources. In its most basic form an RPS requires a utility to either generate, build or buy renewable energy as part of the mix of fuels it uses. Only 19 states in the United States have currently adopted RPSs. In the ARC region Maryland, Pennsylvania and New York have adopted RPSs. But these standards are being actively considered in some of the other ARC states.

The amount of renewable electricity to be included varies widely across the nation from 1 percent to 25 percent. New York, which already makes extensive use of hydropower, has the nation's highest percentage at 25. Maryland will ultimately reach 7.5 percent and Pennsylvania 18 percent.

RPSs are viewed as a means of introducing new technologies and additional competition into electric markets. Since most utilities have little experience with renewables, the RPS provides a means by which they can adopt these technologies. Since most renewable fuels have little environmental drawbacks, their use contributes to reduction of problems associated with air pollution. Reduction of dependence on imported fuels will have significant economic and national security benefits as well.

RPS can be met in several different ways. The utility can build its own renewable facility. It can purchase renewable power from other generators. A more recent development is the use of Renewable Energy Credits (REC). Under this system a utility which uses renewables can meter the amount of energy it creates. It can then sell RECs which designates that the generator produced one megawatt hour of electricity from renewable sources. Utilities which neither produce nor buy renewable energy can use RECs to meet their RPS requirement. Maryland explicitly allows the use of RECs.

It is important to define what is included as renewables eligible for credit under a RPS. What is included in "renewables" vary considerably among the three ARC states which have adopted them. All included solar and wind. Hydro is usually included along with landfill gas. In a few cases waste from wood or coal, while not strictly renewable, are included. States such as Maryland and Pennsylvania divide their renewable fuels into two tiers. The RPS is to be met by employing a given percentage from each renewable source in each tier.

The greatest issue concerning RPS is the initial high capital cost of installation. Once the facility is in place the fuel costs are essential zero for wind, solar and small scale hydro. But the issue remains who is to bear these initial costs since they are often as much as three times those of the lowest cost natural gas fired power plant. This problem is particularly acute in states which have deregulated electric utilities and the company adopting renewable technologies may find itself at a competitive disadvantage. In states with traditional regulation, the question is will the regulators allow the higher capital costs to be part of the rate base. The National Council of State Legislators has estimated that the RPSs in the Pennsylvania and New York increase costs by only $3-$3.50 a year for the average residential customer.[12]

Other objections include utilities being forced to use technologies which are not fully technologically developed. Recent experience with renewable technology has demonstrated rapid deceases in costs and increases in efficiency. Forcing too early adoption under an RPS may be unwise until technologies are fully mature.

There is also concern that RPSs add complexity to an already heavily regulated industry. These standards, particularly when tiers are employed, require extensive monitoring and oversight. The more detailed an RPS is regarding types of fuel, size of generators, percentage tiers for use of specific fuels and interconnection standards reduce the ability of renewable markets to fully function as utilities are restricted from finding and using the least costly renewable alternatives.

Maryland's RPS requires utilities to generate a given percentage of their power from renewable sources. This is a two tier program. The state's electric companies must obtain 1 percent of their electricity from renewable sources: solar, wind, biomass, anaerobic decomposition methane, geothermal, ocean, fuel cells and small hydro (less than 30 mw). The second tier consists of hydro (large scale), waste to energy facilities and poultry litter. The electric suppliers must get 2.5 percent of their electricity from these sources. The Tier one standard increases in annual increments of 1 percent until reaching 7.5 percent in 2019 at which time the Tier 2 standard disappears. The program also includes renewable energy credits (REC) of 200 percent for solar 110 percent for wind and methane. A supplier not meeting the RPS standards must pay into the states Renewable Energy Fund 2 cents per kWh for Tier 1 and 1.5 cents for Tier 2 shortfalls.

New York's RPS stipulates an increase in the state's current 19 percent level of energy consumption from renewables to 25 percent. It is a two tier system with wholesale generators buying renewable credits from generators who use virtually any renewable or alternative fuel. Customers under the second tier are encouraged to install renewable generation capacity which can be sold into the grid for credit on their electric bills. The 25 percent target is divided into a mandatory 24 percent with 1 percent to be from voluntary generation under the state's Green Marketing Program.

[12] *National Conference of State Legislatures,* (June 2005) State Renewable Portfolio Standards: A Review and Analysis. Washington, DC. P.6.

Pennsylvania's Alternative Energy Portfolio requires that 18 percent of the electricity supplied come from alternative energy or renewables. The State uses the broadest definition of what fuels are included of any of the ARC states. In addition to the usual solar, wind, low-impact hydro, geothermal, biomass, methane and fuel cells, which constitute the Tier I sources, waste coal, distributed generation systems demand side management, municipal solid waste wood byproducts are included in Tier II sources. Starting in 2007 1.5 percent of supply is to come from Tier I and 4.2 percent from Tier 2. These percentages increase to 8 percent and 10 percent by 2020. Interconnection rules are currently under development by the State's PUC.

Evaluation

- RPSs have major benefits and deserve consideration in all ARC states. But the cost of requiring the use of renewable electricity in those ARC states with already below average electricity costs may pose difficulties particularly if the state uses its low energy costs as an inducement for economic development.
- States should not restrict the source of renewable power to generators within their boundaries. Political boundaries have little to do with the efficient allocation of electricity and will increase costs. Considering that all ARC states are interconnected to multi-state grids, such a requirement is not appropriate. None of the ARC states have such a limitation.
- Consideration should be given to using the broadest definition for renewable fuels. This will allow generators to seek the least costly source of renewable electricity. The advisability of tiers (and specific percentages within those tiers) and their impact on flexibility and costs should receive careful consideration.
- The regulatory environment as to how the initial costs are to be covered needs clear delineation. The policies in the ARC states now using RPS can serve as guidelines.

3. Public Benefits Funds

Public Benefit Funds go by different names in ARC states which have them. These are additional small charges to customers attached to their electric bills. The monies raised from these funds are used either for expansion of renewable energy, relief for low income households or promotion of energy efficiency.

The purpose of **New York's Systems Benefit Charge** is to collect a surcharge on the customers of the private utilities to support energy research, encourage energy efficiency and provide energy assistance to low income households. The charge may also be used to determine how to reduce the negative impacts of energy production and to increase competition in energy markets. During the five year period 2005-2010 the fund is estimated to receive $875 million. The program has demonstrated its effectiveness by reducing energy demand, saving utility consumers almost a quarter billion and generated almost $1.5 billion in energy investments. The fund traces significant reductions in air pollution and the creation of nearly 5,000 jobs to its projects.

Ohio's Energy Loan Fund (ELF) is financed by a surcharge collected from the state's four public utilities to provide low interest loans and loan guarantees for energy efficient upgrades at residential, governmental educational small commercial/industrial and agriculture facilities.

The five major private utilities in **Pennsylvania** have created **Sustainable Energy Funds (SEF)** which operate in their service areas. The specific programs supported by these funds are mentioned elsewhere in this report. The overall objectives are to promote renewable energy, advance clean energy technologies, encourage energy efficiency and support the clean energy business. Funds are collected from the customers by the utilities to support the programs.

4. Grant Programs

Grants as a means of encouraging the adoption of alternate or renewable technologies exist in many of the ARC states. A summary of sample state programs follows.

- **Alabama** has a **Renewable Fuels Program** to assist business in the installing of biomass energy system, this program offers participants technical assistance and subsidies up to $75,000 to cover the interest payment on loans to install approved biomass projects. But interest rate on the project should be no greater than 2% above the prime rate.
- **Kentucky** provides several grant programs focused on energy efficiency and alternate fuels. The **Energy Efficiency Education Grant** provided to the University of Kentucky gave $95,176 to promote energy efficiency education throughout the commonwealth. The **Kentucky Energy Efficiency Program for Schools Program** provided a $77,000 grant for the University of Louisville, which is aimed at managing the energy costs of schools in Kentucky. The program offers a complete package, including tools, curriculum, training, coaching and expertise to guide participating schools on how to reduce their energy costs and achieve energy efficiency. Further a $100,000 energy grant was awarded to the National Energy Education Development (NEED) Project for the design and delivery of an energy education program for teachers and students in grades K-12. **R&D Grants for Renewable Energy and Energy Efficiency** totaling $421,461for research and development grant renewable energy and energy efficiency initiatives, which include improved biomass conversion, advanced aluminum melting systems, improved biodiesel product and enzymes for the conversion of corn-fiber to biofuels.
- **Kentucky** has also a $70,000 grant awarded to Kentucky Clean Fuels Coalition to establish a network of Kentucky public school bus fleet interested in using biodiesel or biodiesel blends and to manage the **Kentucky's Clean Cities Program**. The grant provides $42,000 for schools to compensate for the additional cost of adding biodiesel to school bus fleets.
- Under its **Assisted Home Performance Grants, New York** offers grants, up to $5,000 for single-home owners and $10,000 per building for 2-4 family units, to low-income residences for energy efficient improvement. **New York** further offers grant to support companies in the development, testing and commercialization of renewable-energy technologies that will be manufactured

in New York. Funding varies by solicitation and is based in part on the likelihood that the technology will be competitive in the near future. Eligible technologies include solar thermal electric, photovoltaic, hydropower, alternative fuels, wind, landfill gas, and biomass.

- **Ohio** offers a **Fuel Cell Grant Program** which would use the $100 million budget to support fuel cells related research, project demonstration and job creation. The State offers **Dispersed Energy and Renewably Energy Grants** to commercial, institutional and industrial projects with a maximum capacity of 25 MW for up to $100,000 per grant. The program also provides grants to residential renewable-energy projects for up to $25,000 per grant and to non-residential projects for up to $150,000 per grant. A certain percentage of cost sharing is required for all grants. The. **Energy Loan Fund Grant for Energy Efficiency** provides funds to cover up to 25% of the total costs of projects that can improve energy efficiency by at least 15%. The maximum amount will be awarded is $50,000.
- **In Pennsylvania Metropolitan Edison Company SEF Grants** and **Penelec SEF of the Community Foundation for the Alleghenies Grant Program** established by First Energy, grant funds for the development and use of renewable energy and clean-energy technologies, energy conservation and efficiency, and projects that improve the environment. The grant amount varies according to project, but the maximum limit is $25,000. Also the **West Penn Power SEF Commercial Grant Program** provides funds to nonprofit companies and community-based organizations for the development and the use of renewable energy and clean energy. Grant amount varies by proposal.
- **Small Wind Incentives Program** offers funds to **Virginia** landowners for purchase and installation of small wind energy systems. The maximum award will be the lower of $10,000 or 33% of installed costs.

5. Loan Programs

ARC states also provide a variety of loans on very favorable terms for projects which use alternate or renewable energy or improve energy efficiency. Some of these are describes below.

- Under the **Solar Water Heater Loan Program** participating Eastern **Kentucky** counties are offering customers a 6-year payback term loan with 5% down payment and an interest rate of 3% to cover the total cost of a solar water heater for residential and commercial applications.
- **New York** provides three loan programs to its residents.
    - The **Home Performance with Energy Star Loan Program** offers up to $20,000 unsecured loan with a 5.99% APR to residential customers for the installations and developments of energy efficient and renewable resources measures. However, the measure has to meet the Energy Star qualifications to be eligible and the equipment must be installed by approved Building Performance Institute certified contractors.
    - The **Energy $mart Loan Fund** provides reduced-interest rate loans (4.0% below the lender rate for ten years; 6.5% below the lender rate for

borrowers in the Liberty Zone) for lenders to fund projects to improve a facility's energy efficiency or utilize renewable energy systems.
    - Moreover, all facilities can also apply for the **Green Building Improvement Loan**, up to $500,000, if the facility has been registered for the LEED certification with the United States Green Building Council. The maximum loans for residential is $20,000; for multifamily and all other non-residential is $1 million plus $500,000 for Green Building Improvement; and for existing multifamily is $2.5 million, plus an additional maximum of $2,500,000 for projects that include advanced meters.
- **Community Energy Loan Program (CELP)** in **Maryland** offers loans to eligible local governments and nonprofit organizations, including hospitals and schools, to finance energy saving projects. On average, about $600,000 is available per loan and the current interest rate is approximately 3.5%. Organizations have up to 7 years to pay off the loan. By September 2005, 49 organizations have utilized this program, generating an annual saving of 2.4 million in the state. Also the **State Agency Loan Program** provides loans with 0% interest and a 1% administration fee for state agencies to fund energy efficiency improvements in state facilities. This program offers about 1 million in new loans each year. A total of $1.5 million was awarded to state agencies in 2005, estimated to generate savings of about $267,114 annually.
- The **Energy Investment Loan Program** in **Mississippi** provides loans ranging from $15,000 to $300,000 at an interest rate 3% below the prime rate, with a maximum loan term of 7 years, for renewable energy and energy efficiency projects.
- There are three loan programs established in **Ohio.**
    - **Double Saving Loan** provides loans up to $10,000, with interest-rate reduced by up to 50% through a linked deposit, to qualified residential borrowers with projects that improve energy efficiency in one- to three-unit residential building.
    - **Renewable Energy Loans** offers loans to Ohio residents, range from $500 to $25,000 and businesses, range from $5,000 to $500,000, to implement energy-efficiency or renewable-energy projects. Also, this program will help applicants reduce interest rate by approximately half on standard bank loans.
    - **Business and Institutional Loans** are offered to businesses and institutions in Ohio. The loans will buy down the interest rate for energy efficiency projects, up to a maximum of $250,000 at a 50% reduced interest rate. Qualifying projects must reduce energy cost by at least 15% have an energy payback of 5 years or less and have an expected project life longer than the energy payback time.
- **Pennsylvania** has created four loan programs.
    - **Metropolitan Edison Company SEF Loans** is a fund established by FirstEnergy to promote development and use of renewable energy and clean-energy technologies, energy conservation and efficiency, projects

that improve the environment. The loan amount may vary according to project, but the maximum limit is $1 million.
    - **Penelec SEF of the Community Foundation for the Alleghenies Loan Program** also established by FirstEnergy, provides loans up to $500,000 to promote the development and use of renewable energy and clean-energy technologies, energy conservation and efficiency, projects that improve the environment. The loan amount varies according to project.
    - **SEF of Central Eastern Pennsylvania Loan Program** provides a limited number of grants and loans to organizations needing funds for projects on research and development of clean and renewable energy technologies.
    - **West Penn Power SEF Commercial Loan Program (PA)** – offers commercial loans to manufacturers, distributors, retailers and service companies involved in renewable and advanced clean energy technologies, as well as energy efficiency and conservation products and services to end-user companies and community-based programs. The amount of loans varies by proposal.
- The **ConserFund Loan Program** in **South Carolina** offers loans to fund energy efficiency improvements in state agencies, local governments, public colleges and universities, school districts and non-profit organizations. The loans can help organizations cover up to 100% of eligible projects costs, from $25,000 to $500,000.
- **Local Government Energy Loan Program** in **Tennessee** gives low interest loans to municipal and county governments for energy efficiency-related projects in courthouse, administration buildings, schools, maintenance facilities, and any other building owned by the city or county. Eligible projects can borrow up to $500,000 at an approximate 3% interest rate for up to 7 years. The **Small Business Energy Loan Program** creates low interest loans of up to $100,000 for a maximum of 7 years payback time to businesses with fewer than 300 employees or less than $3.5 million in annual gross sales or receipts for renewable energy and energy efficiency projects.

6. Tax Incentives

Tax incentives are a frequently used method by state governments to induce a desired activity. Listed below are examples of ARC state programs which provide either deductions or credits to various taxes for use of renewable or alternative fuels as well as promoting energy efficiency.

a. Personal and Corporate Income Taxes: Deductions and Credits

- **Wood-Burning Heating System Deduction: Alabama** allows individual taxpayers to take the total costs of the installation of a wood-burning heating system or the conversion from gas or electricity heating system to wood as a deduction on their taxes.

- **Tax Modernization Plan;** The **Kentucky** Governor's 2005 tax modernization plan includes a $1.5 million tax credit to bio-diesel producers and blenders.
- **Solar and Fuel Cell Tax Credit: New York** offers a personal income tax credit for expenditures on solar-electric, solar-thermal and fuel cells equipment used on residential property, excluding the solar-energy systems used for pool heating or other recreational applications. The credit will equal to, 25% of the total costs of solar-electric and solar-thermal systems (up to $3,750) and 20% for fuel cells systems (up to $1,500). To quality for the credit, the systems are limit to a maximum capacity of 25kW for the fuel cells and 10 kW for the solar-electric. Additionally, the fuel cells systems must also utilize the proton exchange membrane (PEM) technology. Further the state has a **Green Building Tax Credit Program (Corporate & Personal)** which provides owners and tenants of eligible buildings and tenant spaces, which meet certain "green" standards, with tax credits of up to $2 million per building. The credit can be used against corporate taxes, personal income taxes, insurance corporation taxes or banking corporation taxes.
- **Maryland's Income Tax Credit for Green Buildings (Personal & Corporate)** enacted in 2001, applies to only non-residential and residential multifamily buildings of at least 20,000 square feet. The credit encourages the use of alternate energy systems, such as PV, wind turbines and fuel cells. The tax credit amount differs depend on building type and renewable energy systems, for instances, 6-8% of the costs of construction or rehabilitation for green building, 20-25% for PV and wind systems and 30% for fuel cells systems. To be eligible, the buildings must meet specific environmental and energy requirement, but the renewable-energy system size is not specified.
- **Renewable Energy Tax Credit (Personal & Corporate)** provided in **North Carolina** offers a 35% tax credit for the cost of renewable energy property in North Carolina. The ceilings for the credit vary depending on the sector and the type of renewable-energy system. The maximum for different technology used in residential facilities are between $3,500 and $10,500 and in commercial and industrial facilities is $2.5 million.
- **West Virginia** has enacted a **Business and Occupation Tax Reduction** from 40 percent of generating capacity to five percent.

b. Sales Tax

- **Georgia** under its **3-Day Sales Tax Exemption** exempts the sales of any qualifying energy efficient residential appliances (under $1,500) that meets or exceeds the "Energy Star" program requirements, sold between August 03 and August 06, 2006, from the state sales and use taxes, but not local sales taxes. In addition the State provided a sales tax exemption on purchases for non-commercial, home and personal use energy efficient products, under the price of $1,500, purchased between

October 6 and October 9, 2005. Furthermore, Georgia mandates a sales tax exemption on energy purchases used for crop irrigation.

- **New York** has a **Solar Sales Tax Exemption** applied to sales and installation of residential solar-energy systems, which utilize solar energy to provide heating, cooling, hot water and/or electricity, from the state's sales and use taxes.
- There is in **Maryland** a **Wood Heating Fuel Exemption** from the sales tax on all purchase of wood or "refuse-derived" fuel, used for heating in residential buildings.
- A **Conversion Facilities Tax Exemption** exists in **Ohio** which exempts certain equipments used in energy conversion, such as thermal-efficiency improvements and the conversion of solid waste to energy, from property tax, the state's sales and use tax and the state's franchise tax where applicable.

c. Property Tax

- According to **New York's Solar, Wind & Biomass Energy System Exemption** solar, wind energy and farm-waste energy systems (limit to a maximum capacity of 400kW only), constructed in New York State prior to July 1, 1988 or between January 1, 1991 and January 1, 2006, and were eligible for a 15-year real property tax exemption. The amount of exemption will equal to the increase in assessed value attributable to the renewable energy system.
- A **Corporate Property Tax Credit** allowing counties in **Maryland** to provide tax credits to corporate or property tax when solar, geothermal and other qualifying alternate energy systems are used for heating or cooling. The tax credit amount and the length of the credit vary, because counties have the autonomy to decide on the amount of credit and length of time up to a maximum of 3 years. In addition the State permits solar heating and cooling systems to be assessed at no more than the value of a conventional system for property tax purpose and a full property tax exemption for solar energy equipment.
- The **North Carolina Active Solar Heating and Cooling Systems Exemption** program exempts active solar heating and cooling systems, placed on residential, commercial and industrial property, from being assessed at more than the value of a conventional system for property tax purposes.
- **Wind Energy Systems Exemption** in **Tennessee** was enacted in 2003, providing that wind energy systems operated by public utilities, businesses or industrial facilities shall not be taxed at more than one-third of their total installed cost.
- **Virginia** allows a **Local Option Property Tax Exemption for Solar** which any county, city or town may exempt or partially exempt solar energy equipment or recycling equipment, installed in residential, commercial or industrial property, from local property taxes.

- For the installation of wind farms **West Virginia** provides a **Property Tax Assessment Reduction** for utility wind turbines which lowered the property tax from 100 percent to five percent of assessed value.

7. Rebate Programs

Another way that ARC states promote alternative, renewable and efficient energy is by offering rebates under the programs outlines below.

- **Biomass Energy Interest Subsidy Program** in **Alabama provides** reimbursement of interest to property owners on loans for installing biomass energy system.
- The following rebate programs exist in **New York**
  - **Small Commercial Lighting Incentives Program** offers incentives, up to $30,000, for businesses to install effective and energy-efficient lighting in small commercial spaces. Under this program, lighting contractors, distributors, manufacturers, and designers are also eligible for various incentives associated with bringing energy-efficient lighting to small commercial spaces.
  - **Wind Incentive Program** develops a network of eligible installers who will install end-use wind energy turbines for facilities in all sectors, the incentive program offers up to $100,000 per installation to eligible installers. The incentives are paid based on a percentage of the installation cost (50% of costs for systems of 500W to 10kW; 15% for systems larger than 80kW and 70% for commercial customers).
  - Under the **$mart Equipment Choices Program** applicants are eligible for rebates up to $10,000 for installation and replacement of electric efficiency equipment and up to $25,000 for gas efficiency equipment in non-residential structures.
  - **Energy $mart New Construction Program** promotes the incorporation of energy efficiency and renewable energy resources in the design, construction, and operation of commercial, industrial, institutional and multifamily building, the NYSERDA has a 10 million budget for this program to provide incentives up to $375,000 per project for Whole Building Design projects and up to $120,000 for most other projects.
  - **PV Incentive Program** provides incentives of $4 to $4.5 per watt, based on direct-current (DC) module rating, to eligible installers for the installation of approved, grid-connected PV systems that has a maximum of 50kW capacity. The total budget available for this program has been raised to 12 million in 2005.
  - **LIPA Solar Pioneer Program** offers rebates for approximately 50% of the costs of a PV system with a maximum of 10kW capacity. As the overall price of PV system has been decreasing, the program has adjusted its rebate from $5 per watt for the 1000kW of PV installed to $3.75 per watt (DC) for the next 1,000kW block for residential and

commercial customers and $4.75 per watt (DC) for schools, nonprofits and government agencies.

- **Maryland's Solar Energy Grant Program** provides funding for homeowners, businesses, local governments and non-profit organizations to install solar water-heating and solar-electric (PV) systems. The reimbursement is 20% of the equipment cost (up to $3,000 for residential property, $5,000 for commercial property and $2,000 for solar water-heating equipment). Systems have to meet the minimum size requirement set by the U.S. Department of Energy to be eligible. The **Clean Energy Rewards Program** approved by the Montgomery county council offers residents and businesses incentives for buying clean energy. However, the reward levels and incentive rates have yet to be set.
- **Sustainable Development Fund Solar PV Grant Program** issues rebates to PECO customers for purchase of PV systems. The grant is paid based on system performance and customer type. For example, $4 per watt up to $20,000 is the buy-down incentive for the PV system owner; $1 per kWh in the first year up to $5,000 is the performance incentive for PV system owner; and $0.1 per kWh in the first year up to $250 is the performance incentive for the participating contractor.
- **Residential Solar Initiative for EarthCraft Homes Rebate** in **South Carolina** offers homebuilders a rebate for every home built with a solar hot water heating system. A maximum of $20,000 in total rebates has been allocated for this program, so a total of 20 rebates of $1,000 each will be awarded to builders for approved new installations.
- Under **Kentucky's Solar Water Heater Rebate Program** the Kentucky Solar Partnership is offering a $500 rebate for solar water heaters installed on residences. The budget is available for 25 installations in total.

8. Other Programs

The **TVA** has established a **Green Power Partners Program** in its service territory. Green power consists of electricity generated from renewable sources. Green Power is sold in 150 kWh blocks which is about 12 percent of an average households use. The cost is four dollars ($4) for each block. The green power used is from the TVA's 18 wind turbines, 16 solar facilities and one methane plant. No expansion is currently planned as there is a 30 percent surplus of unsold green power available.

Clean Energy Procurement programs require that public bodies obtain a certain percentage of their electric power from renewable sources. Maryland requires state owned facilities to acquire 6 percent and 11 cities and one county have established 5 percent requirements. New York's requirement is 10 percent. Several localities in ARC states also have renewable procurement standards.

Solar Easement Guidelines have been established in Georgia, Kentucky, Tennessee and Virginia. These allow owners of solar systems to obtain easements which insure access

to direct sunlight to operate their systems. These restrictions would limit new construction or other impediments to be constructed which block sunlight.

Chapter III. State of Technology and Manufacturing in Appalachia

1. Wind

Today's wind turbines are much larger and more efficient than those of the 1980s. Modern turbines are as large as 5 MW each while in early 1980s, during that wave of wind power development, a typical turbine was 25 to 100 KW. Today's turbines produce much more power and also require a larger physical footprint. Costs have declined by about 90 percent over the last 20 years, mostly from capital cost decreases and efficiency improvements.[13]

As rotor diameters have gotten longer, increasing from about 10 meters in early 1980s to over 80 meters today, capacity and energy production actually increased as a faster rate. This recent development of larger turbines has made Appalachian wind more attractive to commercial developers due to the greater quantity of electricity that can now be generated per turbine as well as improved availability. Turbines up to two MW in size, such as those installed at the Bear Creek Wind Farm in Pennsylvania, or the 2.5 MW turbines proposed for Clipper project in Garrett County, MD, are among the largest on-shore turbines in the world. Due largely to the State of Pennsylvania's active policy toward wind development, wind-energy company **Gamesa Corp.** of Spain selected an industrial park in Ebensburg, PA as the site for its U.S. blade manufacturing facility. The increased size and height of turbines has spurred debate over the issue of "viewshed" impacts from wind installations. Larger turbines have hub heights over 300 feet and are thus visible from further distances compared to older, smaller turbines that may have been only 30 to 40 feet tall.

Wind energy efficiency improvements have included use of advanced electronics to develop variable speed turbines and longer lived turbines. Systems integration improvements have induced system operators to give wind capacity credit on the electricity grid, increasing the viability of wind projects. New R&D on low-speed land-based turbines can help take advantage of lower speed winds, which have applicability throughout the Appalachian region.

Other wind-related manufacturing activity in the ARC region includes **General Electric**'s wind turbines R&D facility in Greenville, SC. That location does wind turbine fleet support engineering focused on the generator and other electrical components.

Magna Machine in Cincinnati, OH is a manufacturer of blade hubs. Its proximity on the border of the ARC region promises potential synergies with manufacturers in Appalachian.

[13] American Wind Energy Association, 2005.

2. Solar

The primary barrier to widespread installation of solar energy conversion systems is price. Photovoltaic (PV) systems are still expensive, up to 32 cents per KWh. These systems are also still fairly inefficient: thin-film cells are less than 10 percent efficient and crystalline-silicon cells are 12 to 14 percent efficient. Further improvements in efficiency would allow the less intense sun areas of the Appalachian region to get more from a PV cell. Other issues that continue to stymie expansion include low component manufacturing rates; the industry has a goal of creating a 200 MW factory by 2020. Silicon production is also expensive and a larger supply chain is needed. In spite of these issues, PV production costs have fallen by 100 times since the mid-1970s.[14]

Breakthroughs in system integration have improved the ease of maintaining solar systems which promotes usability. In addition, marketing of solar systems in nationwide stores such as Home Depot has also made the technology more accessible.

Other means of capturing solar power, such as concentrating solar power, where thermal solar energy is collected as heat and directed toward a conventional power generating system, have also made progress but are less applicable to the Appalachian region. Since the 1980s DOE R&D support has allowed the costs of this type of system to decline considerably while also improving efficiency.

Solar manufacturing and solar R&D activity in the Appalachian region is concentrated in Pittsburgh area. **Plextronics Inc.** conducts research to manufacture polymer cells that are thinner, lighter and more flexible than current PV cells. Polymer cells are made from regioregular polythiophenes, self-assembling nanoscale conducting polymers. This type of PV cells has the potential to be more cheaply produced (printed) than other PV cells. **Plextronics** was founded in 2002 as a spin-off from Carnegie Mellon University's McCullough Lab.

A firm by the name of **Solar Power Industries, Inc**. in Belle Vernon, PA makes crystalline cells, primarily for the gardening products.

AFG Industries' Blue Ridge Plant in Kingsport, TN is a flat glass manufacturer that supplies BP Solar, Shell Solar and GE Solar with photovoltaic glass.

There are several other solar manufacturers that are in ARC states but not in the ARC region, that are worthy of mention. These include **Atlantis Energy Systems, Inc.** in Exmore, VA that makes building integrated PV products including PV roofing slates and PV glass laminates and **BP Solar** in Frederick, MD, which is one of the larger PV panel manufacturers in the country.

[14] U.S. Department of Energy, Solar Energy Technologies Program.

3. Geothermal

Most recent geothermal technology improvements have been related to system design. Some increased efficiency has also been seen but most improvements are due to the way air and water is delivered from the ground to the building. Staging and zoning of delivery have become more sophisticated, which has reduced the costs of supplying geothermal heating and air conditioning to multiple zone buildings.

There are two geothermal system design companies in the ARC region. Both of these are in Pennsylvania: **Sunteq/Enviroteq** in State College, and **Hydro Delta Corp.** in Monroeville. Both companies design, build and install custom geothermal systems designed for specific applications. Enviroteq manufactures compressor units, with up to three stages of heating and cooling that interface with conventional air handlers. Hydro Delta manufactures a broad range of heating, cooling and water heating systems, including on-demand water heating equipment, and was the industry's first manufacturer to custom-insulate tube-in-tube heat exchangers to prevent condensate from forming on the outer surfaces.

4. Small and Low Impact Hydro

Modern hydroelectric technology has made progress in several areas. Overall, a major aspect of advancement has been in improved hydrologic assessment and project identification. Standardized design of turbines and generators also allows for greater ease of operation and maintenance.

Modern turbines also perform better regarding environmental impact. Newer turbines contribute less to fish mortality, with advanced turbine technology such as that supported by the DOE's Wind and Hydropower Technologies Program having the ability reduce fish mortality resulting from turbine passage to less than two percent, in comparison with turbine-passage mortalities of 5 to 10 percent for the best existing turbines and 30 percent or greater from other turbines. Newer turbines also have improved compliance with water quality standards in terms of maintaining required downstream dissolved oxygen levels.

The study team was not able to locate any regional firms that specialize in small-scale or low impact hydroelectric installations.

5. Biomass

Biomass energy recovery systems utilize mature technology. The primary barriers to its further development are policy and knowledge based. Landfill gas systems, for example, are comprised of common commercial piping and compressions systems and generators. Eight of the 13 ARC states currently have landfill gas projects within the region's counties that are used both for generating electricity and for direct methane use.

The States of West Virginia, Ohio, Maryland, Virginia and Mississippi do not have landfill gas projects.[15]

6. Biofuels

Cost if the primary barrier to widespread use of domestically produced biofuels. However, many states are providing financial incentives to overcome this barrier.

There are several biofuels production facilities in Appalachia and the development of biofuels is a large focus of many state energy plans in the region. Several states have operating biodiesel manufacturers. The manufacturers that were found for this report are summarized by state and should not be considered an exhaustive list of regional producers:

- The State of Kentucky is implementing a large-scale effort to power its school buses with biodiesel. Producers in the ARC region include:
    - **Green Earth Bio Fuels** is building a 3.2 million gallon biodiesel plant in Irvine, KY.
    - **Owensboro Grain** is building a 50 million gallon biodiesel plant in Owensburg, KY.
- The State of Georgia has at least two biofuels producers in the region. These are:
    - **U.S. Biofuels** uses chicken fat to produce three to five million gallons of biodiesel a year in Floyd County, GA.
    - **Peach State Labs** in Rome, GA produces soybean based biodiesel.
- The State of Alabama has at least one biodiesel producer in the region:
    - **Alabama Bio-Diesel** in Moundville, AL uses soybean oil to produces 24,000 gallons of biodiesel per year the Birmingham Airport Authority, with plans to triple production.
- The State of Pennsylvania has at least one biodiesel producer in the region:
    - **Capital Technologies International** in Pittsburg, PA has a 10 million gallon capacity plant that can use a combination of soybean, corn, and canola oils, as well as used cooking oil and animal fats.
- The State of Ohio already has several ethanol plants, although only one closed facility may be in the region:
    - **South Point Ethanol** in South Point, OH is now a fairly antiquated facility that closed in 1995.

[15] The Berkeley County Solid Waste Authority in West Virginia had a landfill gas to energy project from 1985 to 1996 that was a direct use line to a nearby Veterans' Administration hospital. The landfill was forced to close in 1992 following a lawsuit by a private landfill operator.

Chapter IV. Hydrogen R&D

Hydrogen research and development (R&D) is focused in several major categories: production, use, delivery and storage. In all areas, research includes some focus on basic science as well as practical application. Hydrogen production from natural gas and less commonly through electrolysis already occurs in a number of industrial settings, where it is quickly transformed into other products. Its production is costly and is not efficient enough to justify its use over direct use of the fossil feedstock. Hydrogen also cannot yet be practically stored in a way that makes distribution possible.

Hydrogen production R&D is being pursued in several parallel pathways. It has not yet been determined what method of production is the most efficient and sustainable. In the renewable arena several methods are under evaluation: reforming bio-gas, water electrolysis from electricity generated from renewable resources, biological production from algae, and several types of early-stage direct solar applications including photoelectrochemical and thermochemical production. Research on other methods of separating hydrogen from fossil fuels include natural gas reforming, coal gasification and nuclearchemical cycles as well as other basic materials research is also underway.

Production of hydrogen from renewable energy resources is most likely to come from electricity produced from those resources. Electrolysis, a process whereby electricity is used to separate hydrogen and oxygen in water, produces hydrogen with water as a by-product. Alkaline electrolysis systems are mature and commercial, although quite expensive and only used in niche processes. Proton exchange membrane systems are even more costly and need improved durability. Both types need greater efficiency. Other barriers are of course, the cost of renewable electricity itself and the intermittency of that power. Electrolysis also requires constant supply of clean power.

Hydrogen storage research is pursuing several potential storage mediums including high-pressure compressed storage, chemical storage and materials-based storage such as carbon, boron and metal hydrides. Storage, both for distribution and on-board vehicles, is a key component of a hydrogen-based economy.

Hydrogen use is likely to achieve the highest potential efficiency via fuel cells. Separate research on this energy conversion device is also underway, but is not discussed here. Fuel cells are also quite expensive to produce and do not yet have the durability and efficiency necessary for widespread use.

At least 15 hydrogen research projects are underway in the Appalachian region. The most concentrated research effort takes place at Oak Ridge National Laboratory in Tennessee. Research also takes place in several of the major universities in the region, with much of that work conducted at the Pennsylvania State University and the University of Alabama. A portion of this research is described below, with research on renewable hydrogen production discussed first.

1. Solar Hydrogen Production[16]

Several types of early stage research are underway on the potential production of hydrogen using solar heat to induce water electrolysis to separate hydrogen and oxygen. These include photoelectrochemical production, whereby water is split directly upon illumination using semiconductor materials and thermochemical production, whereby water is split as chemical or metal compounds such as sulfuric acid, metal sulfate, or metal oxides interact with water to produce hydrogen. Solar concentrating systems could provide heat for these processes. Another very early-stage research area is photobiological production, whereby hydrogen is produced from unicellular green algae or cyanobacteria that live on solar energy.

Hydrogen research in the Appalachian region based on production from renewable energy is concentrated in solar applications and includes:

- Pennsylvania State University –
  - observation of the efficiency of solar electrolysis by isolating single crystal silicon photovoltaic cells.
  - development of novel silicon and cadmium selenide nanowire for water splitting
  - development of "A Hybrid Biological/Organic Half-Cell for Generating Hydrogen"
- Virginia Polytechnic Institute and State University –
  - studies of trinuclear, rhodium-centered mixed-chemical complexes for water splitting.
- Oak Ridge National Laboratory –
  - Research to increase the rate of algal hydrogen production by designing a proton channel to stabilize proton activity during production, thus removing a physiological obstacle to efficient conversion of light energy.
- Marshall University (Huntington, WV) –
  - Adaption of photosynthesis to the production of hydrogen from algae.[17]

2. Non-Renewable Hydrogen Production R&D[18]

Much hydrogen research is also focused in production from fossil fuels.

- Oak Ridge National Laboratory –
  - Fossil Hydrogen Production: Use of microporous inorganic membranes to separate hydrogen from a synthesis gas (possibly coal derived) at certain pressures and temperatures.

[16] U.S. Department of Energy (2005). "Solar and Wind Technologies for Hydrogen Production," Report to Congress. http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/solar_wind_for_hydrogen_dec2005.pdf
[17] The lead researcher on this project, Dr. Sergei Markov, is no longer with Marshall University.
[18] http://www.hydrogen.energy.gov/annual_review06_delivery.html#electro

    - Nuclear Hydrogen Production: This method attempts to extract hydrogen from water at a low-temperature reaction – between 650C and 750C – through the use of a sulfur dioxide reaction and use of microporous membranes.
- Media and Process Technology, Inc. (Pittsburgh, PA) –
    - Use of a carbon molecular sieve membrane as reactor for water gas shift reaction. This method takes carbon monoxide and water through high temperatures into a ceramic membrane that facilitates the creation of carbon dioxide and hydrogen.
- Ohio University –
    - This project tries to tackle the problems of hydrogen sulfide in syngas derived from coal into the creation of solid oxide fuel cells through the use of specialized anodes.

3. Hydrogen Storage R&D[19]

- Pennsylvania State University's Carbon Center of Excellence –
    - Use of boron in metal loaded high porosity carbon materials for the reversible storage of hydrogen.
- University of Pittsburgh's Metal Hydride Center of Excellence –
    - Computational work on finding workable alloys in metal hydride systems.
- Oak Ridge National Laboratory –
    - Research on the use of carbon for the storage of hydrogen, including of carbon-based solutions and compounds.
- University of Alabama's Chemical Hydrogen Center of Excellence –
    - Evaluation of the chemical storage of hydrogen using carbenes and cyanocarbons, both types of electron deficient molecular compounds.
    - Evaluation of the use of boron in the storage of hydrogen.

[19] http://www.hydrogen.energy.gov/annual_review06_storage.html

Chapter V. Corporate Energy Efficiency and Renewable Energy

The following facilities in the ARC region are examples of the use of energy efficient processes and renewable energy in corporate settings. These cases highlight innovative implementation of waste reuse and energy saving system design. Some of these examples are Federal facilities that have reduced energy consumption through the Department of Energy's Federal Energy Management Program (FEMP). Others are partners in the DOE's Industrial Technologies Program.

1. Dublin, Virginia - Volvo Trucks

Volvo's New River Valley Plant is the largest Volvo Trucks manufacturing facility in the world and assembles all Volvo trucks sold in North America. This facility also makes electric cabs for Volvo's emerging line of fully electric cabs for long-haul trucks. In recent years, the New River Valley plant has made considerable changes in its industrial processes that have focused on reducing consumption of water, energy and materials, while increasing recycling and minimizing waste material. The facility utilized the Siemens Energy Management Program to reduce energy usage through the automation of lighting and building heating and cooling.

Photo: Volvo Trucks New River Valley Plant

Since 2003, the plant has reduced water consumption by half through recycling and reuse of water used for cab leak testing and in painting. A recycling program and increased sorting of refuse cut landfill waste in half since 2000; the plant currently recycles more

than 75% of the waste it generates. The amount of energy consumed for each truck produced has dropped by more than 60% since 2001, through a comprehensive energy management program. The facility was awarded the 2005 Governor's Environmental Excellence Award for its efforts to reduce emissions. These include replacing all paints and lacquers with lead and chromium-free products.

2. Radford, Virginia - Radford Army Ammunition Plant

Photo: Radford Army Ammunition Plant

This 4,080 acre manufacturing area supplies solvent and solventless propellant and explosives to the U.S. Armed Forces. The facility undertook an energy savings program that emphasized low cost energy conservation initiatives. Much of the savings were due to increased nitrocotton/ nitrocellulose production, which reduced the magnitude of steam line losses as a percentage of total plant steam. Other projects included installing an oxygen trim for powerhouse boilers, reducing reactive power charges from their utility, and varying steam turbine extraction pressures. The facility's energy saving projects allowed cost savings of more than $350,000 and 230 billion btu per year.

3. Hagerstown, Maryland – Statton Furniture

Statton Furniture is a manufacturer of quality, hand-crafted cherry furniture. The company has operated since 1926. Since 1973 the company has utilized over 40 percent of its wood waste by using this fuel source to operate a boiler within the company's plant facility. The wood waste used to run the boiler is transferred from the company's wood saws to storage where it is eventually fed to the boiler unit. The unit is currently used to heat the entire plant facility. The plant's utilization of wood waste enables the plant to obtain a 60 percent yield on lumber.[20]

4. Huntington, West Virginia - Steel of West Virginia

Steel of West Virginia is a supplier of structural beams, channels and special shape steel sections made of recycled steel. The company is one of three mills in the U.S. that uses a laser gauge to photograph steel bars for defects, allowing considerable time saving for that stage of production.

Over the past few years, Steel of West Virginia has spent more than $60 million to modernize its production process. Due to the energy-intensive nature of the operation, virtually every upgrade was related to energy consumption. Upgrades included a new high-speed reheat furnace, quick-change mill roll stands, installation of finger doors on furnaces and a reduction in the amount of time gas torches were on. As a result of these investments, productivity doubled and the facility has seen annual energy savings of $1.6 million or more. Current plans include more energy saving improvements, including the elimination of one of two scrap melting furnaces, without reducing capacity.

Photo: Steel of West Virginia

[20] Interview with Bill Whittington, plant manager, July 11, 2006.

5. Spartanburg, South Carolina - BMW Manufacturing

BMW manufactures its X5 Sports Activity Vehicle, Z4 Roadster, M Roadster, Z4 Coupe and M Coupe at its Spartanburg facility. The facility gets 53 percent of its energy needs from methane gas from a nearby landfill. A 9.5 mile pipeline from the landfill feeds the gas directly to the facility, where it is used to power BMW's generators and paint shop oven burners. The paint shop is the largest energy user within the BMW facility. The installation has saved BMW over $1 million in annual energy costs and reduces the company's exposure to volatile natural gas prices.

Photo: BMW Manufacturing

6. Tishimingo, Mississippi – Heil Environmental

Heil Environmental manufactures refuse truck bodies for the garbage collection industry. Following an energy assessment conducted by the Mississippi Development Authority and implementation of recommended upgrades, the company reported annual savings of $500,000. The savings were a major factor in the decision to keep the facility open and the resulting additional investments made in more efficient equipment and building upgrades.

7. Russell, Kentucky - AK Steel, Ashland Works

AK Steel's Ashland Works produces carbon and ultra-low carbon steel slabs, along with hot dip galvanized and galvannealed coated steels. AK Steel recently installed a new briquetting process to recycle and reclaim up to 250,000 tons per year of iron and carbon units, reducing the amount of raw materials that must be purchased. The facility also implemented several conservation and efficiency measures that reduced natural gas consumption per ton by approximately three percent since 2003. These cost savings have helped the facility to remain a player in an increasingly competitive international steel market.

Photo: AK Steel's Ashland Works

8. Uhrichsville, Ohio – Commonwealth Aluminum/Aleris Rolled Products

Commonwealth Aluminum manufactures alloy aluminum sheet from recycled aluminum and aluminum and nonmetallic wiring products. The company's Uhrichsville plant is a continuous-casting mini-mill. Commonwealth Aluminum is a partner with the State of Ohio and the U.S. Department of Energy's Industrial Technologies Program.

Results of the energy assessment identified several upgrades that could save the facility more than $1 million per year. These included upgrading the melter/holder furnaces, improving the melt stirring process, implementation of best practices for melting and use of infrared imaging technology for process diagnostics. Several of these upgrades would have an immediate payback, while upgrading of the melter was estimated to give a five year payback.

9. Ragland, Alabama - Ragland Clay Company

Ragland Clay Company is a manufacturer of brick and brick paver products. The company has been making extensive modifications and improvements to their plant since 1996. One of the most recent changes is the use of a biomass gasification unit that uses wood chips as fuel. The gasification unit was installed in order to reduce energy costs and to reduce moisture in the bricks themselves leading to a higher quality product. The gasification unit has been in use for less than three months making exact energy savings difficult to measure. However, it is estimated that the new unit will result in an energy savings that will range from $400 to $600 per day.

10. Freeland, Pennsylvania – Hazelton St. Joseph Medical Center

This 6,500 sq ft facility is heated and cooled with a geothermal air conditioning system. The system is comprised of two five-ton and one 7.5 ton water-to-air heat pumps. Six 220-foot vertical boreholes deliver constant temperature air via circulating groundwater loops all year round.[21] This system has caused the center's energy costs to be lower than comparably used smaller sized buildings.

Photo: Hazelton St. Joseph Medical Center

11. Vestal, New York – Kopernik Space Education Center

Installation of a geothermal HVAC system in this 8,000 sq ft building allowed the Roberson Museum and Science Center to expand its astronomical observatory and improve its energy efficiency without having to build a natural gas pipeline to the relatively remote hilltop where the observatory is located. The system includes eight

[21] http://www.geoexchange.org/pdf/cs-021.pdf

circulating tubes drilled 250 deep into granite bedrock. The payback on the system relative in terms of energy savings over a conventional system was about six years.[22] This investment was made possible through a grant from the State of New York.

Photo: Kopernik Space Education Center

12. Burnsville, North Carolina – EnergyXchange Renewable Energy Center

This demonstration facility uses landfill gas to fuel a pottery kiln, glass furnace and a regional forestry and horticulture center. The complex also includes a micro-turbine demonstration of electricity generation in partnership with Carolina Power and Light. The project is an example of a combined Federal, State and private partnership.

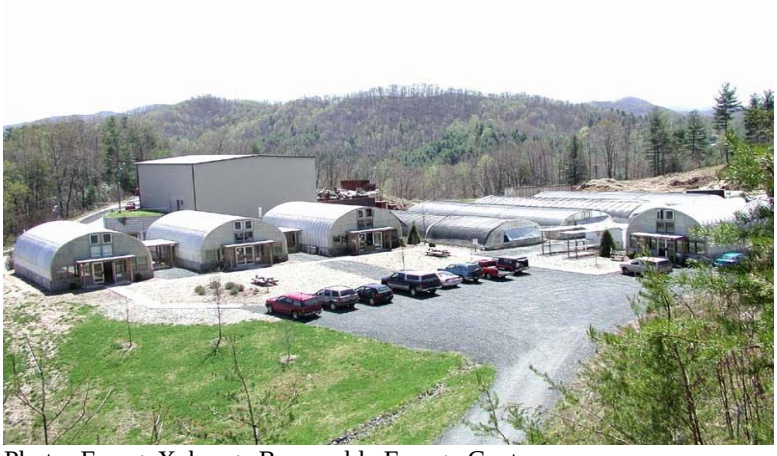


Photo: EnergyXchange Renewable Energy Center

[22] http://www.geoexchange.org/pdf/cs-066.pdf

13. Knoxville, Tennessee – Rohm and Haas Company

Rohm and Hass is a specialty chemical manufacturer that provides products to a number of industries including paints, electronics, adhesives and plastics manufacturers. The company is a partner with the U.S. Department of Energy's Office of Industrial Technology energy assessment program. Rohm and Hass's energy assessment identified potential energy savings in steam and electricity use equivalent to $1.5 million in cost savings. Energy savings implementation as of 2003 included 20 billion btu per year in fuel savings and 1,600 MWh per year in electricity savings. Specific identified energy projects included: optimization of steam system maintenance, recovery of preheated water, optimization of refrigerated water use and flow, and use of a consolidated compressed air management system.[23]

Photo: Rohm and Haas' Knoxville, TN plant

14. Rome, Georgia - U.S. Biofuels

U.S. Biofuels makes biodiesel from poultry grease. The company was started in 2003 as a spin-off from the owners' chemical business. The company is in the process of expanding its operations to increase production from 300,000 gallons a month to 800,000 gallons.[24]

[23] http://www.nrel.gov/docs/fy04osti/34705.pdf

[24] 6/20/2006, The Atlanta Journal-Constitution, "Biodiesel, Ethanol Hold Big Promise."

Chapter VI. Energy Intensity in Appalachia

Understanding energy use patterns at the local level is a critical part of evaluating policy innovations directed at altering energy use among individuals and firms. Unfortunately, local energy use patterns must be estimated from more aggregated state level data. To do so, the study team estimated several measures of state level energy use in a series of models which account for the dominant determinants of energy use.

Two of the most common measures of energy intensity are total energy consumption per capita and per unit of personal income. The study team estimated per capita energy use as a function of personal income, average electricity prices, manufacturing's share of employment income, average annual temperature spreads and the proportion of a county living in urban areas. We also employed a statistical technique that permitted the capture of unobserved variables to be accounted for in our model. We tested this model on a panel of the lower 48 U.S. states from 2000 to 2004.

National and state-level energy intensity is shown in Table 6.1 below. Five of the Appalachian states have lower than average state-wide energy use per capita. These states are more urban than the other eight states and energy use is undoubtedly weighted toward the urban areas which are not in the Appalachian region. Eight of the states have above-average energy use per capita.

Table 6.1: State and National Energy Intensity

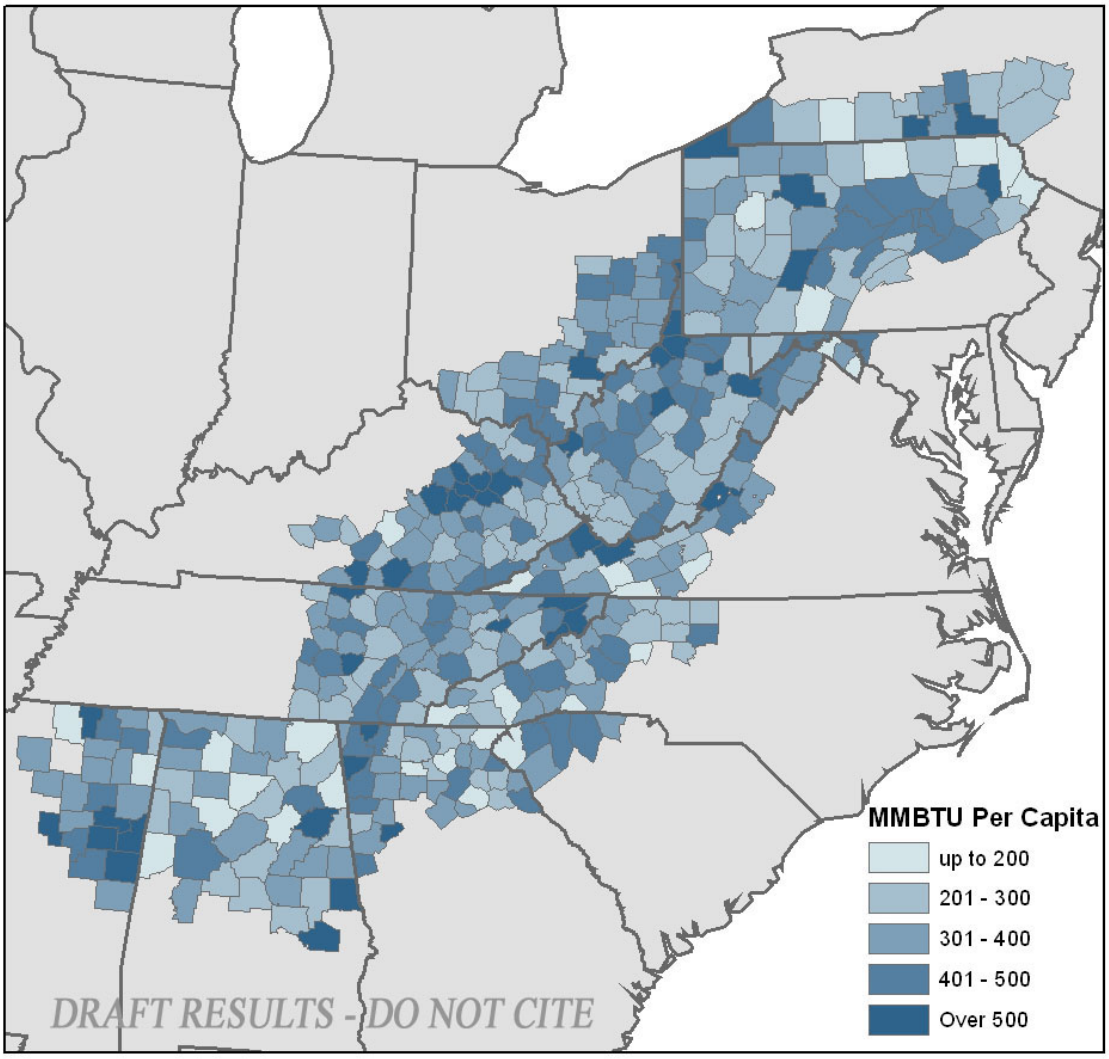
STATE	MMbtu/Capita	Mmbtu/$1000 Personal Income
New York	218	5.6
Maryland	268	6.4
Pennsylvania	319	9.5
North Carolina	322	10.3
Virginia	327	8.6
Ohio	351	11.2
Georgia	352	10.8
Tennessee	386	12.5
South Carolina	386	13.6
Mississippi	412	16.5
West Virginia	421	16.3
Alabama	437	15.5
Kentucky	465	16.6
United States	**338**	**11.0**

1. Energy Consumption Per Capita

State-wide statistical results were applied to county-specific data within the Appalachian region to estimate county-level energy intensity. Figure 6.1 presents estimated per capita energy consumption. These results show broad dispersion in per capita energy use, with manufacturing and population density having important effects. The overall region is very close to the national average per capita energy use. However, this is dominated by energy use trends in the heavily urban states of New York and Maryland. As shown above, most states have above-average consumption rates. This is likely due to high rates of electrification in some states, which may increase overall energy use, and a somewhat elevated share of manufacturing; the ARC counties account for about 26 percent of manufacturing income in the ARC states, but only 24.5 percent of the population.

At the county level, estimates of energy use per capita can are strongly influenced by the relative proportion of energy-intensive manufacturing to population. A sparsely populated county with a heavy industry present will have high per capita energy consumption. Conversely, urban counties with modest manufacturing presence may have low to average rates of energy consumption due to the more efficient residential use of energy in densely populated areas.

Figure 6.1: Estimated Per Capita Energy Intensity in Appalachia (MMBtu per Capita)

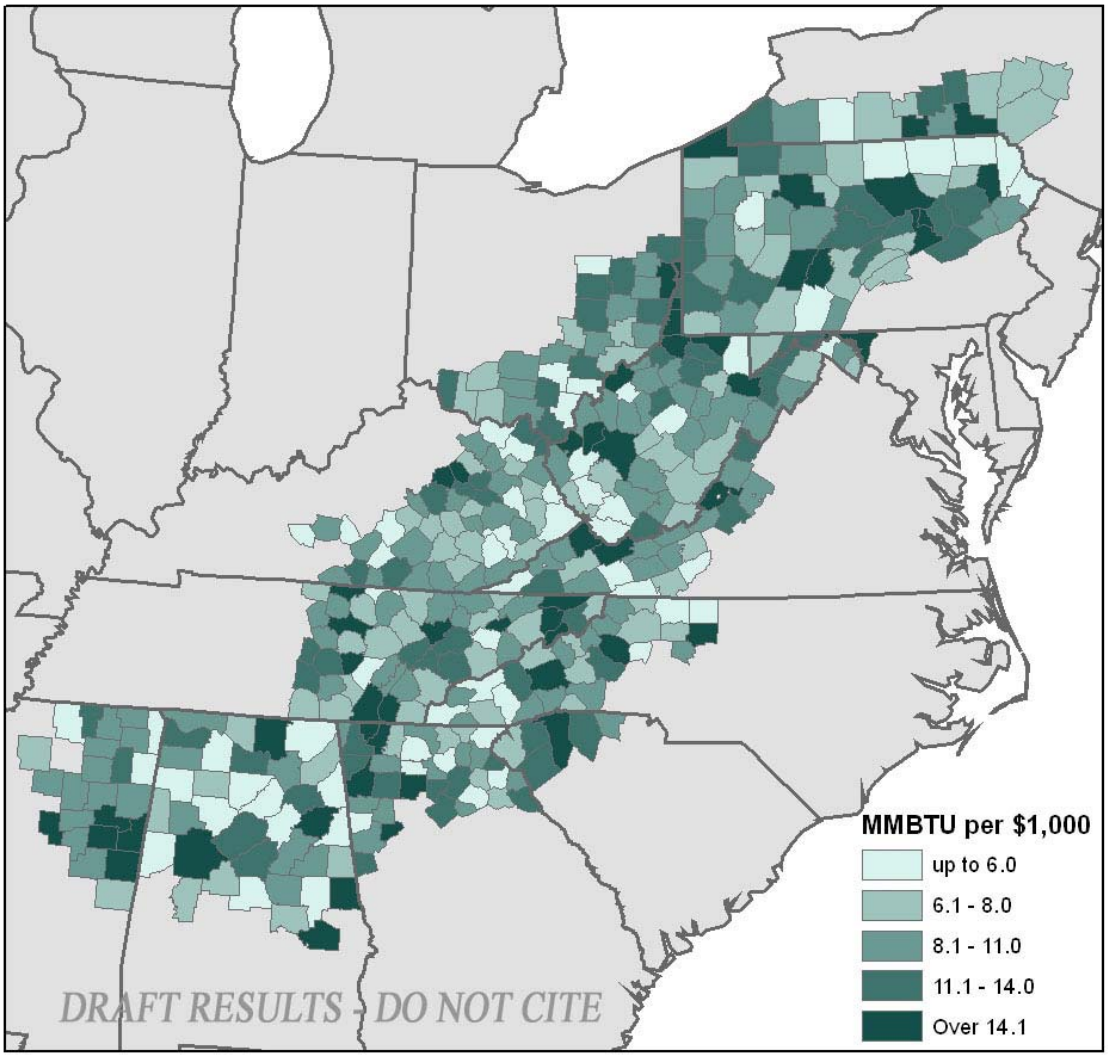


2. Energy Consumption Per Unit of Personal Income

Estimates of total energy use per dollar of personal income are shown in Figure 6.2. This is a county level measure of the energy intensity per dollar of economic activity. Again, the findings show that total energy use per dollar of personal income is heavily affected by industrial use and population density.

This measure of energy intensity also varies considerably by county. Economically distressed and at-risk counties with low personal income and little manufacturing will show below average consumption per unit of income, while those same counties with a single heavy manufacturing facility may be above-average consumers due to the dominance of that facility and the sparse population.

Figure 6.2: Estimated Economic Energy Intensity in Appalachia
(MMBtu per $1000 personal income)



3. Energy Demand Price Response

The responsiveness of residents and businesses to energy prices in another important policy consideration. In an effort to understand how policy innovations may alter use of energy, the price elasticity of demand for electricity for residential, commercial and industrial consumers in the Appalachian states was estimated by comparing price and demand trends from 2000 through 2004. The price elasticity of demand is formally the percentage change in quantity demanded when there is a one percent change in the price. These types of estimates are the stock in trade of economic analysis for more than a century. The results shown in Table 6.2 show that consumers of electricity are not very price responsive.

Table 6.2: Price Elasticity of Demand for Electricity in Appalachia

Residential Users	-0.15
Commercial Users	-0.17
Industrial Users	-0.55

The results of this estimate reaffirm a familiar belief among economists regarding price responsiveness of firms and consumers towards electricity use. In the short run electricity users are fairly price insensitive, and that this is especially true for residential and commercial users. These users are not likely to trade in appliances just because energy prices have increased. This is intuitively appealing since residential users tend to spend a small proportion of their total incomes on electricity, thus price fluctuations tend not to cause large changes in consumption. Further, since prices are dependent on factors that are local, both input costs and public utility pricing policies, they tend to change infrequently. This same argument is also true for commercial users, whose electricity costs are a relatively small share of their total production costs. In these cases, the capital costs of adopting new technologies may not be covered by the energy savings until the very long run.

Industrial users, who may bear very high energy costs, tend to be more price responsive than commercial users, and this may influence firm location decisions. This is especially true since industrial users are somewhat more flexible in their location decisions, as their sales are less tied to proximal population centers.

The policy insight garnered from this evidence is useful. For example, fiscal efforts to alter the effective price of electricity will have far more modest impacts on residential users than on industrial users. Policies to encourage installation of energy efficient or new technologies will not have very positive effects unless accompanied by heavy subsidization and education. On the other hand, energy audits which demonstrate how energy can be saved in industrial processes have positive results, as indicated elsewhere in the report.

4. Summary

Appalachian energy intensity is somewhat higher than in other areas of the country. Price, temperature variation, manufacturing share of employment and the degree of urban residences all matter in formulating both energy intensity and overall use. Appalachian residents and businesses are, like their counterparts in other regions, relatively unresponsive to electricity price changes in the short run. This thus provides some evidence of the magnitude of policy changes needed to alter short run use of energy.

Appendix A: Wal-Mart and Alternative Fueled Vehicles – The Role of the Private Sector

Public sector efforts to spur alternative fuel use will necessarily be limited to the fiscal and regulatory instruments wielded by governments. Ultimately, these efforts will lead to changes in the private sector that are consistent with profit maximizing efforts by firms. One clear example is in the evolution of alternative fueled vehicle (AFV) adoption by consumers.

In 2005, the Center for Business and Economic Research evaluated the economic alternatives related to location of a FutureGen facility in which AFVs were examined. This study performed a detailed analysis of the role incomes, population concentration, gasoline and alternative fuel prices, state and federal gasoline taxes and state tax incentives played on adoption rates of AFVs. Among the policy relevant findings were that state and federal gasoline tax rates and state tax incentives for AFVs played an important role in the adoption of the new technology. However, even with extensive tax incentives, per capita rates of AFV usage are quite low. For example, while the study found that extending or strengthening these incentives would, in some instances, double the AFV usage rates, this translated into perhaps a few hundred to at most a few thousand additional vehicles in most states.

The authors attribute this disappointing result to the widespread absence of refueling facilities, both in Appalachia and nationwide. Thus the absence of an AFV fueling network may well then dampen the effectiveness of public policy. Happily, a recent announcement by Wal-Mart, that it is considering locating AFV fueling stations at many of its stores potentially changes dramatically the network availability of AFV fueling stations. To illustrate this, compare the two accompanying figures.

Figure A.1 employs data from the Energy Information Administration showing AFV fueling stations currently located in Appalachia. The relative paucity of stations and their clustering in urban areas clearly presents the problem. Figure A.2 illustrates the Wal-Mart and Super Center locations in Appalachia. The introduction of AFV fueling facilities in even 50 percent of these locations would dramatically extend the network of AFV fuel. This extension would, at the very least, better enable public policy efforts to promote alternative fuel use in the region.

Figure A.1: Location of Current Alternative Fuel Stations in Appalachia

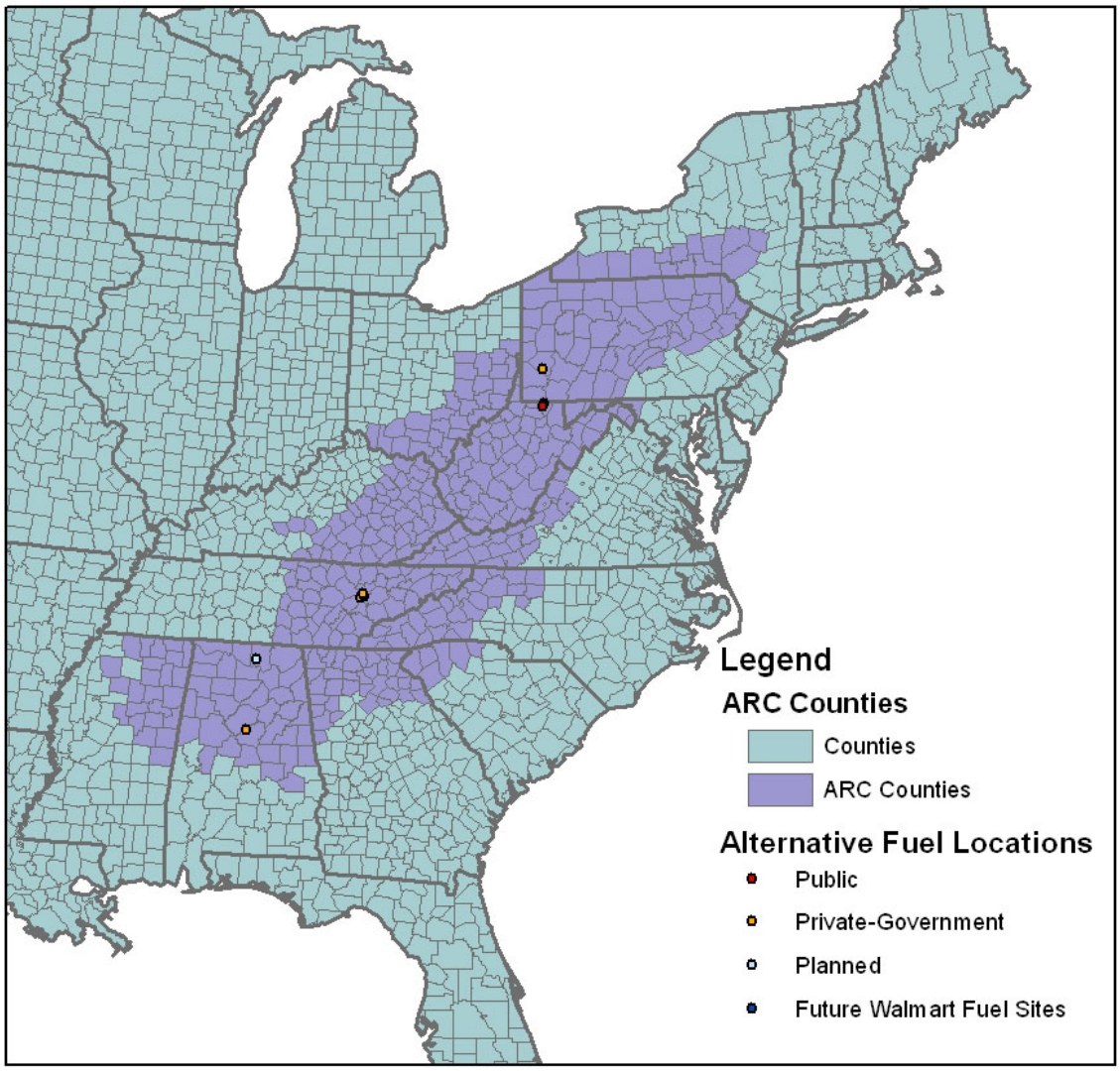


Figure A.2: Location of Potential Wal-Mart Alternative Fuel Stations in Appalachia