ENERGY EFFICIENCY IN APPALACHIA

HOW MUCH MORE IS AVAILABLE, AT WHAT COST, AND BY WHEN?

Prepared by:

APPALACHIAN REGIONAL COMMISSION

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EXECUTIVE SUMMARY

In 2006, the Appalachian Regional Commission (ARC) prepared a report – *Energizing Appalachia: A Regional Blueprint for Economic and Energy Development* – that articulates the ARC energy goal: "Develop the Appalachian Region's energy potential to increase the supply of locally produced, clean, affordable energy, and to create and regain jobs" (ARC, 2006). The report identified three strategic objectives that support this goal, one of which involved developing energy efficiency within the Region.

To more fully articulate this strategic objective, ARC commissioned an assessment of "the potential long-term energy efficiency gains for the Appalachian Region over current baseline projections from introducing a range of advanced efficiency standards for each energy end-use sector, and to detail the economic and environmental impacts from the technologies and investment required to attain these objectives." *Energy Efficiency in Appalachia* presents the results of this assessment. It addresses several essential questions:

- How big are the energy-efficiency resources in Appalachia?
- How quickly can these energy-efficiency resources be realized?
- What policies and programs can most effectively translate these resources into energy savings?
- What impact will such policies and programs have on jobs and wages in Appalachia?

The Energy Challenges Facing Appalachia

The Appalachian Region faces daunting energy challenges and opportunities. As an historic center of coal production in the United States, Appalachia and energy have long been intertwined. With 7.95 percent of the U.S. population, Appalachia produces 35 percent of the nation's coal output, employs two-thirds of the nation's coal miners, and generates approximately 15 percent of the total U.S. electrical output. The Region's annual consumption of 7.98 quadrillion Btu (quads) in 2006 produces a per capita energy intensity that slightly surpasses the national average, reflecting the historically cheap price of energy in the Region. The Energy Information Administration (EIA) forecasts that this comparative energy price advantage will continue through 2030.

Compared with the rest of the nation, Appalachia spends slightly more of its energy on residential and commercial uses, reflecting both its high reliance on electricity for heating and cooling, and its relatively inefficient building stock. The Region's energy consumption is expected to grow to 10.1 quads by 2030, a growth of 28 percent over 2006 levels, which is considerably higher than the 19 percent growth forecast for the United States. As is the case nationwide, the EIA projects that coal will increase its share of energy use in the Region as part of the major expansion of coal use that is anticipated in the 2015-2030 timeframe, if restrictions on CO_2 emissions are not legislated.

Prior research suggests that residential and commercial consumers in this Region are fairly insensitive to short-term to increases in the price of electricity. One study concluded that residential and commercial users in Appalachia would need to experience a doubling of electricity prices in order to produce a 15 to 17 percent reduction in electricity consumption. This lack of responsiveness to electricity price changes, which is similar to behavior in other regions of the country and for other fuels, suggests that strong policy interventions will be needed to promote energy-efficient purchases

and practices. Fortunately, smart policies can transform markets for energy products and services, and it is this perspective that is explored in this report.

Policy Portfolio

To assess the magnitude of cost-effective and achievable energy-efficiency improvements in Appalachia, we assume that a set of transformative energy policies are adopted in the Region beginning in the year 2010. These policies build upon the progressive steps Appalachia has already taken in the area of clean energy through an array of state and local programs, regional planning activities, and utility initiatives.

The policy portfolio modeled in this report includes a combination of vigorous deployment initiatives that increase the achievable potential for energy efficiency, and expanded research, development, and demonstration (RD&D) funding that accelerates the advancement of energy-efficient technologies. These policy bundles were defined and then modified iteratively as the result of discussions with the project‘s Advisory Committee and Stakeholder Group (Table ES.1).

Table ES.1 Energy-Efficiency Policy Portfolio

Residential Buildings	Commercial Buildings	Industry	Transportation
Improved Building Energy Code with Third Party Verification and Compliance Incentive	*Commercial Building Energy Codes with Third Party Verification and Compliance Incentives*	*Expanded Industrial Assessment Centers*	*Pay-as-You-Drive Insurance*
Expanded Weatherization Assistance Programs	*Support for Commissioning of Existing Commercial Buildings*	*Increasing Energy Savings Assessments*	*Clean Car Standards*
Residential Retrofit Incentive with Resale Energy Labeling and Incremental Cost Incentives	*Efficient Commercial HVAC and Lighting Retrofit Incentive*	*Supporting Combined Heat and Power (CHP) with Incentive*	*SmartWay Heavy Truck Efficiency Loan Program*
Super-Efficient Appliance Deployment	*Tightened Office Equipment Standards with Efficient Use Incentives*		*Speed Limit Enforcement*
Illustrative RD&D Initiative			
Air-Source Integrated Heat Pump	*Solid State Lighting*	*Industrial Super Boiler*	

In addition to overlaying this energy-efficiency policy portfolio onto an otherwise ―business-as-usual” forecast, the project‘s analytic team undertook a systematic assessment of alternative possible futures for the Appalachian Region. Because it seems likely that some form of national climate or carbon policy will be announced early during the study‘s 25-year time horizon, we conduct a sensitivity analysis of a **carbon constrained scenario** where there is a ―price adder” of $25 to $100 per metric ton of carbon dioxide beginning in 2011. In the **region-at-risk scenario**, a national climate policy is assumed to be promulgated early in the time frame (perhaps in 2011), initiating a

shift in the way energy is produced and used. However, in this scenario the shift takes place without the aid of fundamentally different technologies. With a premium on the price of fossil fuels, energy-efficient technologies are highly cost-effective; however, the difficult economic conditions dampen investments. In the **high-tech investment boost scenario**, the country produces significant material, technology, and process advances in the performance and cost competitiveness of clean-energy supply technologies, most notably clean coal. As a result of the successful investment climate that results, energy efficiency is also able to play an enhanced role in the Region. These last two scenarios are not modeled.

Methodology

For the purposes of this study, *energy efficiency* refers to the long-term reduction in energy consumption resulting from the increased deployment and improved performance of energy-efficient equipment and practices. *Program potential* is the cost-effective energy-efficiency improvements that would occur in response to specific policies such as subsidies and information dissemination. We do not examine the impact of energy-efficiency investments on demand reductions, which is critical to electric power planners. Nor do we examine the role of demand-response or load-management programs aimed strictly at shifting on-peak consumption to off-peak hours.

This project uses a variety of sources of data, models, and energy-engineering analyses to estimate Appalachia's energy-efficiency program potential. Results of past energy-efficiency program evaluations is the basis of estimating the administrative and implementation costs of each energy-efficiency policy bundle. Our analysis of potential in each sector uses a common baseline forecast, common energy price projections, identical discount rates for calculating cost-effectiveness, and the same economic tests of cost-effectiveness (the participants cost test and the total resource cost test). The specific data sources and methodologies are summarized in each of the sector chapters and are described in greater detail in Appendices B through G. The results of these policy analyses are then input into a dynamic input-output model to evaluate the macro-economic impacts of proposed policies. In addition, the project team created an Advisory Committee and Stakeholder group to review and guide the research.

The following two examples illustrate how the policies are modeled and preview some of the results:

- **Residential Building Codes**: All Appalachian states are assumed to adopt the 2006 International Energy Conservation Code (IECC) by 2009 and more efficient codes every three years thereafter. Codes are assumed to become effective the year following adoption. Third-party verification of measures occurs, and an incentive to builders is provided for the period 2010-2020. This results in an 80 percent compliance rate. To illustrate, the 419,000 single and multi-family homes projected to be built from 2013 to 2015 in Appalachia are assumed to conform to the 2009 IECC code and therefore use 18 percent less energy for space heating, space cooling, and water heating than they would have if built to 2005 current practice. Homes built from 2016 to 2019 are assumed to use 30 percent less energy. With $281.5 million in program spending and an additional $2.1 billion in customer investments over the 2010-2030 period, the Appalachian Region could see net cumulative savings of 1.0 quads of energy and $16.3 billion in energy bills by 2030.
- **Increased Energy Savings Assessments and Training**: Large industrial facilities receive expanded training and assistance on how to pinpoint energy-efficiency improvements in systems throughout their complex. Each assessment takes three days and involves plant

personnel to achieve acceptance and training to enable future in-house assessments. It is assumed that over 60 percent of available assessments are completed by 2030, and all recommendations are executed. On average each assessment results in reducing overall site consumption by roughly nine percent. With $23 million in program spending and an additional $8 billion in customer investments over the 2010-2030 period, the Appalachian Region could see net cumulative savings of 18.7 quads of energy and $43.3 billion in energy bills by 2030.

Magnitude of the Energy-Efficiency Resource in Appalachia

The engineering-economic modeling conducted in this study indicates that an ambitious package of energy-efficiency policies implemented throughout Appalachia in 2010 could result in significant energy savings. According to the latest EIA ―business-as-usual" forecast, Appalachia will require 9.2 quads of energy in 2020 and 10.1 quads in 2030. In contrast, a bold energy-efficiency initiative could cut that consumption by between 9 and 12 percent to approximately 8 quads in 2020 and by between 23 and 28 percent to less than 8 quads in 2030. (The upper bound includes savings from commercial building commissioning, while the lower bound does not.) Such a bold and aggressive initiative could shrink the energy budget required by the Region in 2030 to less than the Region consumed in 2006 – more than offsetting the forecast growth in energy use (Figure ES.1).

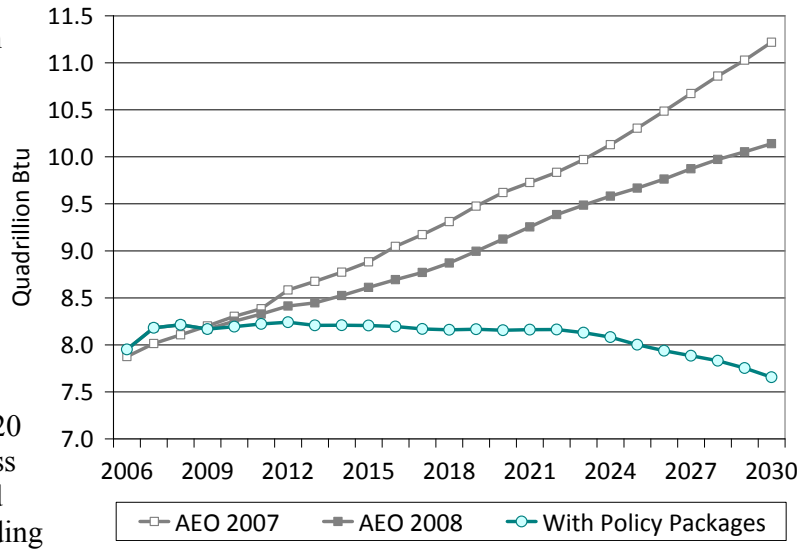

Figure ES.1 Potential Displacement of Appalachian Energy Consumption by Cost-Effective Efficiency Resources

Table ES.2 shows that the most significant savings are in electricity overall, representing a reduction of between 11 and 15 percent in 2020 rising to between 27 and 33 percent in 2030. Motor gasoline consumption is reduced by almost as much: 11 percent in 2020 and 33 percent in 2030. Natural gas savings are next in order of magnitude, saving between 5 and 7 percent of the forecast consumption in 2020, and between 14 and 20 percent of the forecast consumption in 2030.

Table ES.2 Cost-Effective Efficiency Resources as a Percent of Projected Primary Energy Consumption in the Appalachian Region in 2020 and 2030[a]

	2020	2030
Electricity	10.5 – 15.4	27.2 – 33.1
Natural Gas	4.7 – 6.8	14.2 – 19.5
Gasoline	10.7	33.1
All Fuels	8.8 – 11.9	23.4 – 27.8

[a] The upper bound includes savings from commercial building commissioning, while the lower bound does not.

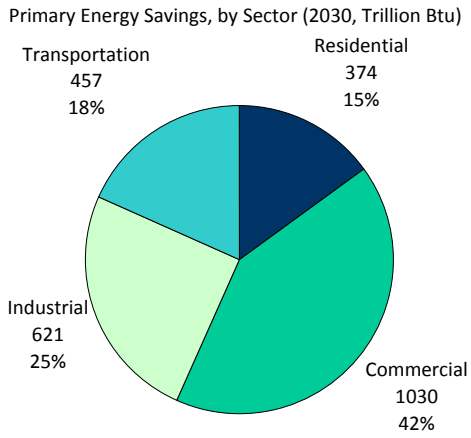

Figure ES.2 Share of Cost-Effective Efficiency Resources by Sector
(Primary Energy in trillion Btu, 2030)

Dividing the cost-effective energy-efficiency resources by sector helps explain the prominent potential for reduced electricity consumption, since the vast majority of electricity produced in the U.S. is consumed in residential and commercial buildings, which are prominently featured in Fig. ES.2. Taking into account the energy lost in the generation and transmission of electricity as well as losses from ―end-use" equipment such as motors, lighting, and air conditioning, 68 percent of the energy-efficiency potential in Appalachia resides in the electricity system. The next largest wedge of energy savings potential comes from motor gasoline consumption by vehicles (17 percent), followed by natural gas savings potential in the commercial, residential, and industrial sectors (12 percent).

As Figure ES.3 illustrates, energy savings expand at a slightly increasing pace over the 20-year period. In contrast, public investments (including incentives plus program administrative costs) drop from approximately $700 million per year during the first decade to slightly less than $500 million in the second decade, reflecting the sun-setting of several program subsidies and incentives in the year 2020.

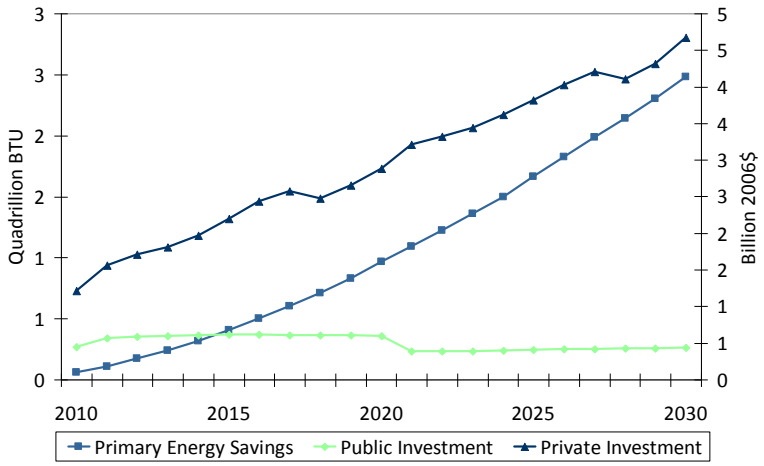

Figure ES.3 Annual Investment and Energy Savings: 2010-2030

Economic and Job Impacts

In Appalachia, the electric utility and the natural gas sectors directly and indirectly employ about 5.3 and 3.7 jobs, respectively, for every $1 million of spending. But, sectors vital to energy-efficiency improvements, like construction and manufacturing, utilize 13.3 and 8.3 jobs per $1 million of spending. Once job gains and losses are netted out in each year, the analysis suggests that, by diverting expenditures away from non-labor intensive energy sectors, the cost-effective energy policies can positively impact the larger Appalachia economy – even in the early years, but especially in the later years of the analysis as the energy savings continue to mount. An early program stimulus that drives a higher level of efficiency investments can create more than 15,000 net new jobs each year in the first five years of the study, rising to an estimated average of 60,000 net new jobs over the last decade of the analysis.

The annual energy bill savings begins with a modest first year benefit of almost $800 million. As the policy portfolio spurs further investment in energy efficiency, the annual consumer energy bill savings rise to more than $27 billion by 2030. These savings directly benefit the consumers who make these investments, but they also help to moderate energy prices for all consumers because they reduce overall demand growth. These investments also increase both wages and Gross Regional Product (GRP) throughout Appalachia.

Table ES.3 Financial and Economic Impact of Energy-Efficiency Investment in Appalachia

Macroeconomic Impacts	2010	2013	2020	2030
Annual Consumer Outlays (millions $2006)	1,083	2,734	4,564	6,165
Annual Energy Savings (millions $2006)	788	2,577	9,944	27,567
Annual Net Consumer Savings (millions $2006)	(295)	(157)	5,380	21,402
Jobs (Actual)	16,231	15,466	37,268	77,378
Wages (million $2006)	517	450	1,169	3,018
GRP (million $2006)	763	444	1,197	3,056

	Residential	Commercial	Industrial	Transportation	Total
△ 50% Lower than Energy Prices	0.97	3.40	1.04	1.66	1.65
○ 25% Lower than Energy Prices	1.46	5.10	1.56	2.49	2.48
▪ Retail Energy Prices	1.94	6.80	2.08	3.33	3.31
◆ Energy Prices with $25/MtC Tax	2.15	6.59	2.67	3.41	3.45
□ Energy Prices with $50/MtC Tax	2.35	7.42	3.26	3.49	3.58
● Energy Prices with $100/MtC Tax	2.75	9.09	4.45	3.65	3.84

Figure ES.4 Sensitivity Analysis of Benefit/Cost Ratios for the Total Resource Cost Test With Carbon "Adders"

The principal estimate used in this project to monetize the avoided costs of potential energy savings is the retail price of energy. Figure ES.4 shows what would happen to the cost-effectiveness tests of the energy-efficiency policy portfolio if the value of the avoided costs were inflated as the result of a national climate policy that imposed a cost of $25 to $100 per metric ton of carbon dioxide emissions. Such a policy would significantly raise the benefit/cost ratios of the policy packages in three sectors: commercial, residential, and industrial. Because of the lower carbon content of gasoline and diesel, there is a much smaller impact on the cost-effectiveness of the transportation sector's energy savings potential. Across all of the sectors, the carbon-inflated avoided costs make investments in energy efficiency more cost-effective compared with the business-as-usual scenario. Figure ES.4 also shows that even if retail energy prices are 50 percent higher than the cost to the wholesaler or distributor, the combined sector policy packages remain cost-effective.

The Value of Exploiting Appalachia's Energy-Efficiency Potential

Policy action aimed at exploiting the energy-efficiency potential described in this report would set Appalachia on a course toward a sustainable and prosperous energy future. The Region's energy-efficiency resources could go a long way toward meeting its future energy needs while ensuring its continued economic and environmental health.

The problem is that energy-efficiency upgrades require consumer and business investment and they take time away from other priorities. With so many demands on financial and human capital, energy-efficiency improvements tend to be given a low priority. Through a combination of information dissemination and education, financial assistance, regulations, and capacity building, consumers, businesses, and industry can be encouraged to take advantage of energy-efficiency opportunities. In addition, expanded RD&D is needed to innovate and deploy transformational technologies that expand the efficiency potential.

By exploiting the Region's substantial energy-efficiency resources, Appalachia can cut the energy bills of its households, businesses and industries, create ―green" jobs, and grow its economy. The ability to convert this vision into a reality will depend on the willingness of business and government leaders to implement and champion the kinds of policies modeled here.
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