



**GLOBAL** INSIGHT

THE POWER OF PERSPECTIVE

**Non-Renewable Energy Innovation:**  
*Research to Support the Appalachian Energy Initiative*

**BRIEF PREPARED FOR:**



**Appalachian Regional Commission**

**PREPARED BY:**

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## I. Summary of Non-Renewable Opportunity

All signposts point to fundamental changes in the energy market to a future characterized by a sustained higher level of oil and natural gas prices. Based on this expected market outlook, Appalachia may have significant non-renewable opportunities.

The larger opportunities appear to be coal-related, including clean-coal generation and coal conversion to liquids, gas, and chemicals. Appalachia has the ability to participate in each and every one of these future non-renewable opportunities. The Appalachian Regional Commission ("ARC") may be able to help the development of these non-renewable resources through regional commercial, policy, and research initiatives, as shown in the following table.

**Non-Renewable Opportunities and Possible ARC Initiatives**

Possible ARC Initiative	Smaller Opportunity	Larger Opportunity
<i>Commercial Initiatives</i>		<ul style="list-style-type: none"> <li>Clean-Coal Generation</li> <li>Coal Conversion: Liquids, Gas, Chemicals</li> </ul>
<i>Policy Initiatives</i>	<ul style="list-style-type: none"> <li>Natural Gas &amp; Oil</li> <li>Energy Infrastructure</li> <li>Nuclear Generation</li> </ul>	<ul style="list-style-type: none"> <li>Clean-Coal Generation</li> <li>Coal Production</li> </ul>
<i>Research Initiatives</i>	<ul style="list-style-type: none"> <li>Hydrogen</li> </ul>	<ul style="list-style-type: none"> <li>CO<sub>2</sub> Capture &amp; Sequestration</li> </ul>

## II. *Research Approach*

The purpose of the brief is to provide a market scan of non-renewable opportunities in Appalachia for use by ARC and ARC's Energy Plan Advisory Council in developing the *Energy Blueprint*.

Global Insight's approach to completing this scan of non-renewable energy innovation relied on three major sources of information:

- **Global Insight's current forecasts and analyses:** The basis for our research was our current worldwide energy and economic forecasts, scenarios, and analyses, including the *Global Petroleum Outlook*, *2005 U.S. Energy Outlook*, *2006 U.S. Energy Price Outlook*, *Natural Gas Monthly, U.S.*, *Coal Monthly*, the *Global Climate Change Forum*, our multi-client study *Bridging the Methane Gap: Resolving the Growing Gap between Natural Gas Supply & Demand*, and the preliminary assumptions underlying our *2006 U.S. Energy Outlook*.
- **Public information on non-renewables:** We reviewed a large body of public information on the non-renewables market and opportunities for Appalachia.
- **Outreach:** We discussed state initiatives and Appalachian opportunities with members of the ARC Energy Plan Advisory Council and selected industry participants.

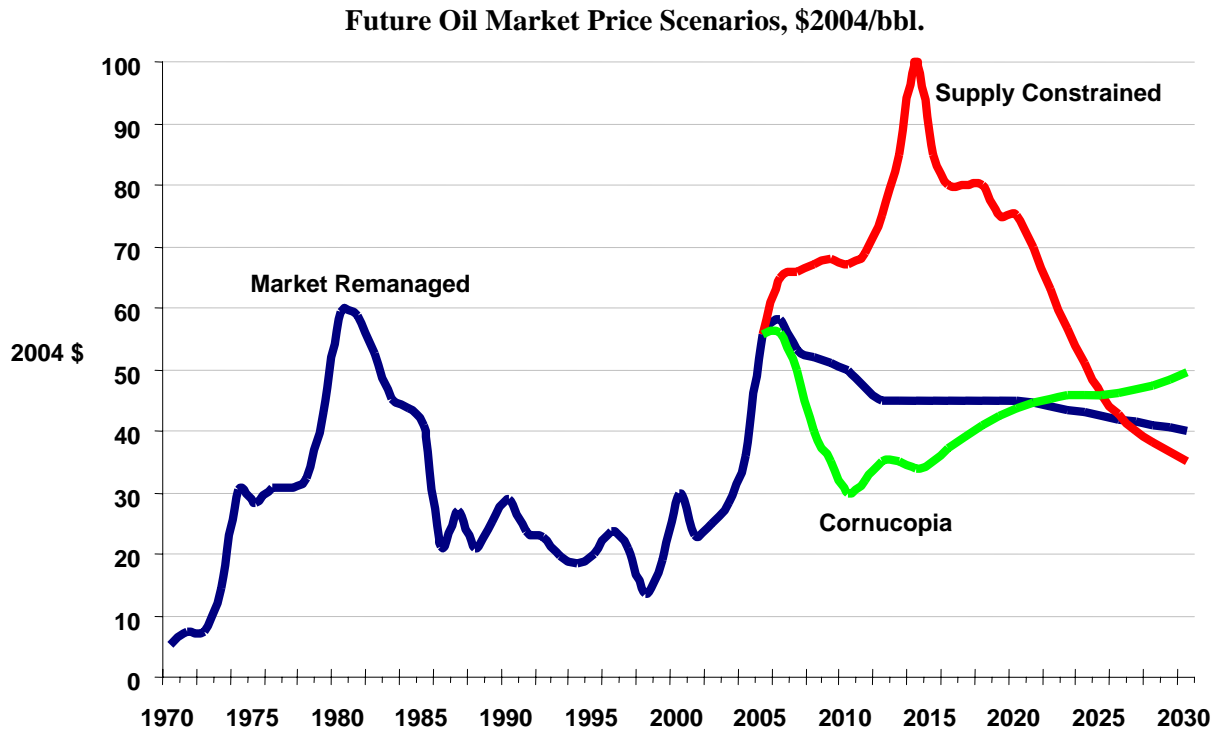
### III. Energy Markets Dynamics<sup>1</sup>

All signposts point to fundamental changes in the energy market to a future characterized by a sustained higher level of oil and natural gas prices.

Global Insight's analysis of the future oil market suggests three realistic going-forward scenarios.

- **Supply Constrained:** We enter a new oil market era. Tight supply conditions drive the market and price spikes to more than \$100 per barrel in today's dollars.
- **Market Remanaged:** Under this scenario, OPEC re-emerges as the oil market "governor." OPEC attempts to manage oil prices in the mid-\$40 per barrel range.
- **Cornucopia:** Higher prices result in a significant oil supply surplus and prices drop to the low to mid \$30 per barrel range, approximately at the level of marginal production costs.

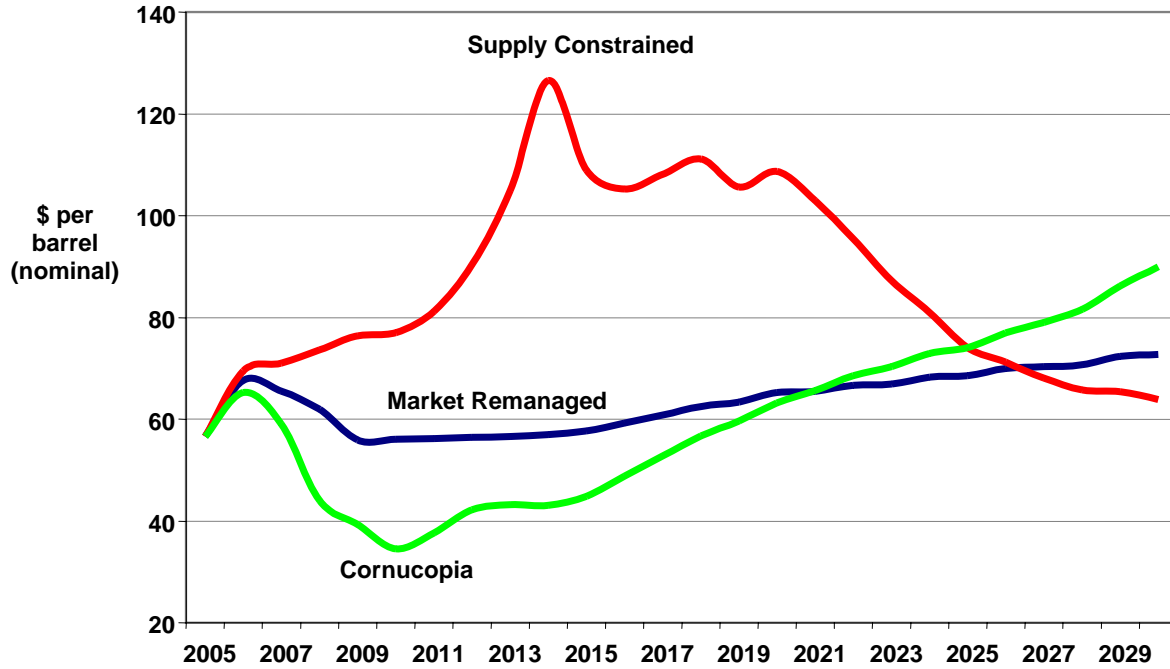
Based on our analysis of future oil supply and demand, Global Insight believes that the Supply Constrained and Market Remanaged scenarios are most likely to occur. Our analysis strongly suggests that we will not see significant growth in either OPEC or non-OPEC oil production, thus yielding sustained higher prices.



<sup>1</sup> The Energy Markets Dynamics section is based on Global Insight's ongoing energy market analysis. See our website, [www.globalinsight.com](http://www.globalinsight.com), for additional detail.

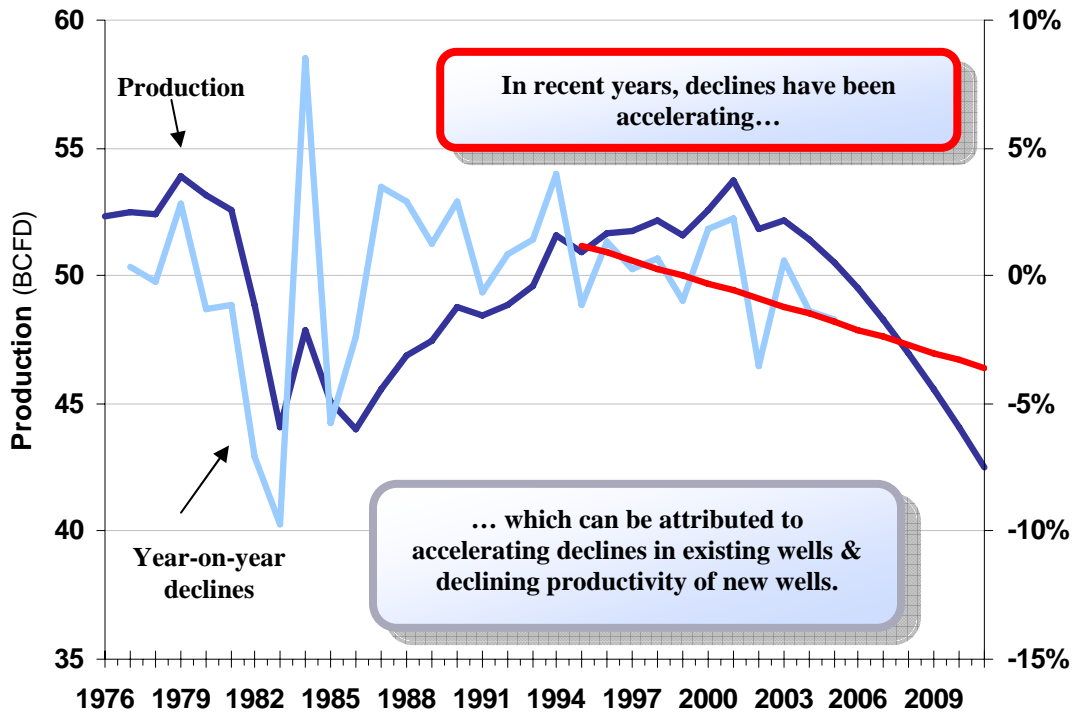
Analyzing the likely scenarios in inflation-adjusted dollars further highlights the expected oil market. For the most likely future scenarios, Supply Constrained and Market Remanaged, we expect that long-term, nominal oil prices would average well over \$60 per barrel.

**Future Oil Market Price Scenarios, \$Nominal/bbl.**



Conditions in the future North American natural gas markets may not be any better than the oil markets. Based on our basin-by-basin analysis of key natural gas producing regions, Global Insight believes that the U.S. faces the prospect of an accelerated decline in domestic natural gas production.

### Future U.S. Natural Gas Production



We also believe that imported liquefied natural gas ("LNG") will not be able to fill the supply gap caused by the accelerated decline in U.S. natural gas production. Despite Federal efforts, there are still significant issues in siting the increased number of LNG import terminals that would be required to fill this gap.

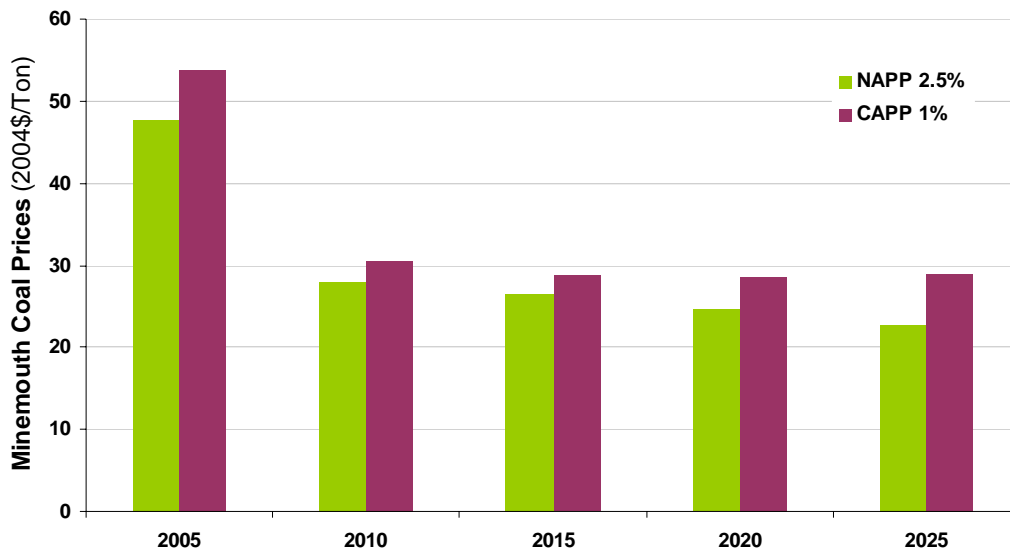
Furthermore, the LNG market is a global market with significant worldwide trade. Numerous liquefaction plants under construction to serve export markets like the U.S. are facing significant cost overruns and delays. The most likely LNG sources for providing incremental LNG supplies to the U.S. market are Russia, Qatar, and Nigeria. In each case, project development is slowing:

- Russia is holding-up several LNG projects
- Qatar has a moratorium in place for new projects
- Nigeria has internal political issues and civil strife

Finally, European customers are geographically much closer to future LNG supplies and appear ready to sign long-term supply contracts. In contrast, the unwillingness of U.S. customers to sign long-term contracts creates significant financing issues for liquefaction projects aimed at the U.S. market. Given this market outlook, we expect high, long-term natural gas prices, with real prices at or above \$7.50 per thousand cubic feet ("Mcf"), which equates to nominal prices in excess of \$10 per Mcf.

In contrast to oil and natural gas markets, we expect coal prices to be competitive in the long-term. Greater coal-on-coal competition resulting from increased mining capacity investment and scrubber installations will help bring coal prices down from their current highs. The near-term driver of this competition will come from the massive amount of power plant scrubbing that is underway, which will allow generators to pick coal supply from a variety of mining regions. Given higher oil and gas prices, we also expect coal companies to expand production capacity further enhancing coal-on-coal competition. Lastly, competition from renewable and possibly nuclear generation will also exert downward pressure on long-term coal prices.

Following these national trends, we expect Appalachian prices to be competitive and fall in real terms over the planning horizon, as shown in the following chart of representative Northern and Central Appalachian coal prices.



In the power segment, a steady 1% to 2% growth in electricity demand (net of demand reduction from energy efficiency initiatives) will require significant increases in U.S generation capacity. The U.S. will require between 400 and 500 gigawatts ("GWs") of new generating capacity by 2030 to meet electric demand growth. Given the expected tight supply and high price outlook for natural gas, natural gas-fired capacity faces difficult economics, especially for baseload or even intermediate generation. We expect significant additions of renewable and possibly nuclear capacity. There are significant opportunities for coal capacity additions, especially using clean-coal technology. We expect significant new coal capacity additions, the acceleration of construction for planned coal capacity additions, repowering of existing coal-capacity, and replacement of coal units that need to be retired.

New environmental initiatives will overlay these fuels and power market dynamics. There is a high likelihood that the U.S. will see a major global climate change initiative at the Federal level over the planning horizon. We expect this initiative to be comprehensive, broadly addressing the control of greenhouse cases and energy security, and include higher renewable standards, further policy enhancements to encourage clean-coal and nuclear generation, as well as the increased use of biofuels. Coal's challenge is to capitalize on the market opportunity by focusing on clean-coal technology and greenhouse gas capture and sequestration.



#### *IV. Opportunities for Appalachia*

Based on Global Insight's expected market forecasts, scenarios, and analyses, Appalachia may have significant non-renewable opportunities, including:

- Clean-coal generation
- Greenhouse gas capture and sequestration
- Coal-to-liquids
- Coal-to-gas and coal-to-chemicals
- Coal production and services
- Natural gas and oil
- Infrastructure for non-renewables: natural gas, rail, electric, and fuels
- Nuclear
- Hydrogen

Each of these opportunities is discussed individually in this section, addressing:

- Market overview
- Appalachian resources and initiatives
- Possible needs and initiatives for Appalachia and ARC to consider for its *Energy Blueprint*

## Clean-Coal Generation

### *Market Overview: Lots of Momentum*

Given expected North American power and fuel market conditions, significant incremental coal capacity is needed to meet future electric demand growth. Nationwide, generators and investors have announced plans to build more than 90 gigawatts ("GWs") of incremental coal-fired generation.<sup>2</sup> Global Insight expects that it is highly likely that new coal-fired generation will expand further if the signposts indicate a continuation of the accelerated decline in North American natural gas production. This accelerated decline will further deteriorate the economics and increase the risks of future investment in natural-gas fired generation.

There are a number of clean-technologies that are expected to provide resources to this growing market, including:

- Existing commercial technologies such as pulverized coal combustion ("PC") and circulating fluidized bed ("CFB") technologies, using subcritical or supercritical steam cycles
- Emerging technologies such as integrated gasification combined cycle ("IGCC") or ultrasupercritical ("USC") PC technologies
- Future technologies advancing PC, FCB, USC, or IGCC focused on further improving efficiencies, reducing environmental impacts, and facilitating the capture of CO<sub>2</sub>

We expect the generation industry to employ a portfolio of clean-coal technologies to meet future needs.

- There is growing industry and government support for IGCC technology. Current research suggests IGCC technology may have cost and environmental benefits over PC technologies, especially under the assumption that carbon sequestration may be required in the future. Major vendors, such as General Electric, Bechtel, Shell, and Conoco-Phillips, have begun to embrace IGCC technology, including offering comprehensive "guarantee wraps" for the entire IGCC system and process. As a result, both debt and equity financial investors and state regulators have become more comfortable with the use of IGCC technology going forward. The emerging benefits are the reason that American Electric Power ("AEP") specified IGCC technology for its new generation resource to be built in Kentucky, Ohio, or West Virginia.<sup>3</sup>
- However, companies will also specify PC and FCB technologies depending on the need. For example, Dominion Energy has proposed using FCB technology for its new facility planned for Wise County in southwest Virginia.<sup>4</sup>

There is substantial market support for clean-technology among equipment vendors, generators and utilities, the Federal government (e.g., the *FutureGen* initiative), and the states (e.g., the Ohio Coal Development Office, *FutureGen* proposals from Kentucky, Ohio, and West Virginia).

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<sup>2</sup> For example, see U.S. NETL's analysis, *Tracking New Coal-Fired Power Plants: Coal's Resurgence in Electric Power Generation*, March 20, 2006.

<sup>3</sup> See Claudia Banner's presentation to ARC, *Integrated Gas Combined Cycle Technology: AEP's Strategic Decision*, undated.

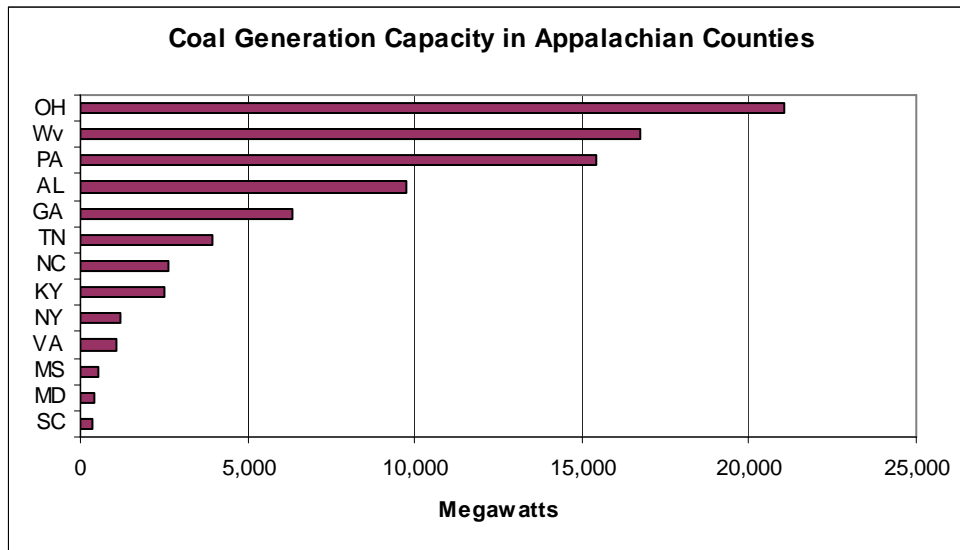
<sup>4</sup> See Dominion's presentation, *Southwest Virginia Power Station*, 2006.

Given expected market trends, generation from clean-coal technology would also be economic to support biofuels production processes. The production of ethanol or biodiesel requires significant amounts of electricity and heat for the production process.

*Appalachian Resources and Opportunities: Positioned to Participate*

The Appalachian region is well positioned to participate in the market for clean-coal generation. The Appalachian states and the surrounding market areas<sup>5</sup> will require from 100 to 200 GWs of incremental resources (e.g., new or replacement generation and energy efficiency) by 2030 to meet the expected 1 to 2% annual growth rate in electric demand. With its abundant coal resources and access to electric market areas (e.g., through the PJM Interconnection), Appalachia should be able to participate in this development.<sup>6</sup>

The region can build upon the almost 82,000 megawatts ("MWs") of coal-fired capacity that is currently operating, under construction, or planned in Appalachian counties as of 2006. Ohio, West Virginia, and Pennsylvania each have over 15,000 MWs of coal-fired generation capacity located in Appalachian counties.<sup>7</sup>



New coal-generation development is a multi-year, large scale effort. A new 600 megawatt ("MW") clean-coal plant is expected to cost from \$700 million to \$1.1 billion to construct (in today's dollars). This type of development could generate about 1,000 construction jobs (at peak) with 50 to 100 permanent plant jobs as well as 100 to 300 related permanent coal mining and support jobs depending on the individual project circumstances.<sup>8</sup>

<sup>5</sup> Including the Middle Atlantic, South Atlantic, East North Central, and East South Central U.S. Census Regions.

<sup>6</sup> Global Insight analysis based on our 2005 U.S. Energy Outlook.

<sup>7</sup> Global Insight analysis of U.S. DOE data.

<sup>8</sup> Global Insight analysis.

*Possible Needs and Initiatives for ARC to Consider for Its **Energy Blueprint**: Encourage Investment in Appalachia*

A number of initiatives might be taken to encourage the development of clean-coal generation in Appalachia including:

- Ensuring that state and regional policies enable and encourage investment in clean-coal technologies in Appalachia. For example, IGCC is still an emerging power generation technology. To encourage IGCC, policies should support the large investment required. Options could include pre-approving cost recovery for utilities, allowing long-term power purchase contracts, or streamlining siting or regulatory processes.
- Supporting Federal incentives for clean-coal technology and developing an appropriate mix of state incentives
- Coordinating an Appalachian region-wide approach to matching electric consuming and generation/mining areas

Given the initiatives occurring nation-wide with coal generation, there are numerous investors, including utilities, generating companies and developers, private equity firms and funds, and infrastructure developers, searching for clean-coal generation opportunities and locations. The trick is to lead this eager group of investors to Appalachia.

## Greenhouse Gas Capture and Sequestration

### *Market Overview: Critical Future Need to Keeping Coal in the Money*

Global Insight anticipates that major Federal initiatives to address greenhouse gases will be enacted and implemented over the planning horizon of ARC's *Energy Blueprint*. As a result, the expected growth in coal generation capacity will require that the industry address greenhouse gas capture and sequestration issues to meet expected future environmental laws and regulations.

Capture and sequestration of greenhouse gases may be costly. For example, for a 600 MW clean-coal generator, initial estimates suggest that capture and sequestration requirements may increase the construction costs by 35% to 70%, or \$200 million to \$800 million (today's dollars). The delivered cost per megawatt hour of electricity with capture and sequestration requirements might rise by 50%.<sup>9</sup>

Technologies and processes to capture and sequester greenhouse gases are still in very early stages of development. The Federal government has taken a leadership role by encouraging forums, establishing seven Regional Carbon Sequestration Partnerships ("RCSP"), funding core R&D programs, and launching the *FutureGen* initiative that will have a capture and sequestration component.

### *Appalachian Resources and Opportunities: Can and Will Participate*

The sequestration process involves capture of greenhouse gases such as CO<sub>2</sub> at the source, compression of the gases, transportation of the gases by pipeline, and injection and storage. The most promising technologies involve underground injection. Appalachia has a host of regional sequestration opportunities, including depleted oil and gas reservoirs, deep salt/saline geological formations, and unmineable coal seams.

In addition to geological sequestration, there is also the possibility of terrestrial sequestration. With this method, CO<sub>2</sub> uptake is enhanced by plants that grow on land or in freshwater and through carbon storage in soils.

The Appalachian states currently participate in capture and sequestration efforts through the Midwest RCSP (coordinated by Battelle) and the Southeast RCSP (coordinated by the Southern States Energy Board). The next phase of these efforts will focus on demonstration projects and further analysis (e.g., at AEP's Mountaineer Plant in West Virginia to study geological suitability for sequestration.)

### *Possible Needs and Initiatives for ARC to Consider for Its **Energy Blueprint**: Make Appalachia Part of the Game*

Appalachia could participate in this critical research effort by identifying and supporting gaps in the Midwest RCSP and Southeast RCSP agendas including:

- Identifying and promoting Appalachian opportunities (e.g., specific sequestration sites)
- Providing outreach in Appalachia on capture and sequestration issues

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<sup>9</sup> For example, see the Wisconsin Department of Natural Resources and the Public Service Commission of Wisconsin, *Integrated Gasification Combined-Cycle Draft Report*, June 2006.

## Coal-to-Liquids

### *Market Overview: Significant Interest Given Sustained High Oil Prices*

Despite the forecast for high and sustained oil prices, Global Insight expects significant worldwide demand growth for petroleum products. At the level of long-term oil and coal prices outlined in the scenarios in Section III, the economics of converting coal into liquids appears promising. There is worldwide interest in commercializing existing technology to produce diesel and related fuels from coal and to enhance energy security by producing more petroleum products domestically. The price and availability of petroleum products continues to have a significant economic and political impact in the U.S.

The current favored technology is indirect coal liquefaction. With this process, coal is first gasified with steam and oxygen into "synthesis or syngas" and then is catalytically converted to liquid hydrocarbons with pressure and temperature using the Fisher Tropsch ("FT") process. In the key step of the FT process, the syngas is bubbled through a catalyst/liquid mixture to produce the hydrocarbons.

Coal-to-liquids requires large scale development. Project developers plan for units that produce 10,000 to 40,000 barrels per day of liquids. The capital cost for such units ranges between \$75,000 to \$170,000 per daily barrel or \$1.7 billion to \$3.0 billion in today's dollars. There are also significant operating and reliability risks to be addressed. Current North American developers are focusing on early-stage units in the 5,000 to 10,000 barrel per day range with capital costs of \$500 million to \$1 billion (today's dollars).<sup>10</sup>

One of the economic challenges facing coal-to-liquids development is the required investment in comparison to simply expanding existing petroleum refining capacity. The cost of a new coal-to-liquids facility is multiple times that of expansion projects. The incremental cost of expanding an existing refinery ranges between \$5,000 and \$10,000 per daily barrel, or \$50 million to \$400 million for expansions ranging from 10,000 to 40,000 barrels per day.

The Federal government is providing both R&D and demonstration project funding (through the Department of Energy) and commercialization support (through the Department of Defense fuels purchasing initiative) to help develop the coal-to-liquids industry.

### *Appalachian Resources and Opportunities: States Beginning to Participate in Market Development*

The Appalachian region has ample coal reserves and possible sites to potentially participate in the development of the coal-to-liquids market. Several Appalachian states have begun supporting coal-to-liquids project development, including Pennsylvania (with WMPI in Gilberton, PA using waste coal), West Virginia (also with WMPI in Mingo County), and Mississippi (with Rentech at a site near Natchez).

Coal-to-liquids plants are capital intensive. This type of development could generate about 1,000 construction jobs (at peak) with 50 to 100 permanent plant jobs as well as 100 to 300 related permanent coal mining and support jobs depending on the individual project circumstances.<sup>11</sup>

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<sup>10</sup> Global Insight analysis.

<sup>11</sup> Global Insight analysis.

*Possible Needs and Initiatives for ARC to Consider for Its **Energy Blueprint**: Support Commercialization of Investment Opportunity*

The Appalachian region may be able to take a number of steps to enhance commercialization of the technology.

- Helping with feasibility studies
- Assisting with siting and permitting processes
- Providing leverageable funding
- Pooling together the fuel requirements of the States to provide long-term off-take commitments

## Coal-to-Gas and Coal-to-Chemicals

### *Market Overview: Developing*

With an expected accelerated decline in natural gas production and the expected long-term price differentials between gas and coal, converting coal into syngas begins to make economic sense. Numerous firms, including Conoco-Phillips, GE, M.W. Kellogg, and Shell offer gasification processes that are either commercially available now or under development. The basic technology has been around for more than a century. Furthermore, the coal gasification process also produces methanol, anhydrous ammonia, and hydrogen that can be used as feedstocks for fertilizer, industrial chemicals, and other basic chemicals.

The gasification process is flexible and can be tailored to individual site or market needs. It could include a number of processes including gas production, coal-to-liquids conversion, electricity generation, chemical manufacturing, and hydrogen production. The cost for these types of facilities may range from \$750 million to \$1 billion (today's dollars).<sup>12</sup>

The coal-to-gas market is not nearly as far along as IGCC or coal-to-liquids conversion. There is not a clear path to identify investor groups among natural gas producers, coal producers, or chemical companies that would likely participate. Many of these businesses view gasification as outside of their core business activity. Coal-to-liquids conversion is more attractive to consumer and political stakeholders.

### *Appalachian Resources and Opportunities: Some Activity*

Appalachia has abundant coal resources to support coal-to-gas or coal-to-chemicals initiatives. Some states (e.g., West Virginia) have begun investigating opportunities with project developers.

Eastman Chemical Company in Kingsport, Tennessee has operated a commercial gasification facility since 1983, with apparently strong operational, reliability, safety, and environmental performance. Eastman's process produces acetic anhydride, acetic acid, methanol, and methyl acetate, and provides chemical building blocks for tape, Tylenol, film, artificial sweeteners, and other common products.

Like coal-to-liquids plants, a single coal-to-gas/chemicals facility could generate about 1,000 construction jobs (at peak) with 50 to 100 permanent plant jobs as well as 100 to 300 related permanent coal mining and support jobs depending on the individual project circumstances.

### *Possible Needs and Initiatives for ARC to Consider for Its **Energy Blueprint**: Support Commercialization of Investment Opportunity*

As with coal-to-liquids, the Appalachian region may be able to take a number of steps to enhance commercialization of coal-to-gas and coal-to-chemicals technology.

- Bringing together interested investor groups
- Helping with feasibility studies
- Assisting with siting and permitting processes
- Providing leverageable funding
- Pooling together requirements of the States, and their utilities, to provide long-term off-take commitments (e.g., for gas)

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<sup>12</sup> Global Insight analysis.



## Coal Production and Services

*Market Overview: Thinking Big for the U.S. – "Yeah... Coal Can Do That"*

There is significant momentum to embrace coal, especially clean-coal generation and conversion technologies, to supply growth needs for electric capacity, transportation fuels, and related-energy products. If increased use of coal occurs, significant increases in coal production capacity will follow.<sup>13</sup>

Coal companies continue to focus on productivity and profitability in a relatively low growth industry.

*Appalachian Resources and Opportunities: Positioning to Compete*

Appalachia has recoverable reserves of over 52,000 million short tons and a demonstrated coal reserve base of over 100,000 million short tons, representing about 20% of U.S. totals. Direct employment in Appalachian region mines averaged 49,327 in 2004.<sup>14</sup>

### U.S. Coal Reserves and Production in the Appalachian Region (Million Short Tons)

State	2004 Estimated Recoverable Reserves	2004 Estimated Demonstrated Reserve Base	2005 Production
Alabama	2,806	4,242	22.6
Georgia	2	4	---
Kentucky-East	5,960	10,671	89.9
Maryland	366	652	5.5
Mississippi	NA	NA	3.7
North Carolina	5	11	---
Ohio	11,507	23,342	24.3
Pennsylvania	11,822	27,597	65.2
Tennessee	462	779	3.2
Virginia	1,022	1,740	28.3
West Virginia	18,104	33,220	151.0
<b>TOTAL</b>	<b>52,056</b>	<b>102,258</b>	<b>393.7</b>

<sup>13</sup> For example, see the National Coal Council's comprehensive report, *Coal: America's Energy Future*, March 2006.

<sup>14</sup> U.S. EIA, *Annual Coal Report: 2004*, November 2005.

A number of factors will shape the future competitive position of Appalachian coal.

- Investment and productivity improvements in Appalachian mines, which will be the most significant driver of future competitiveness
- The impact of scrubber investments in the electric power segment and the demand for high/low sulfur products
- Barge and rail transportation economics
- World-wide coal market dynamics

The Appalachian states place a significant focus on the coal workforce, safety, and environmental issues.

*Possible Needs and Initiatives for ARC to Consider for Its **Energy Blueprint**: Support Marketing and Productivity Growth*

A number of regional initiatives may help improve the competitiveness of Appalachian coal.

- Helping to identify niches (e.g., waste coal) or support marketing initiatives that the coal companies do not carry out themselves
- Supporting company-driven continuous improvement initiatives in the Appalachian region to encourage investment and productivity improvement

## Natural Gas and Oil

### *Market Overview: Supply Constrained*

Global Insight believes (1) an accelerated natural gas production decline in key U.S. basins is a distinct possibility, (2) imported LNG will not be able to fill this supply gap, and (3) sustained, high natural gas prices will result. Furthermore, we are also entering an environment of sustained, high world oil prices. As a result of these market conditions, opportunities exist to economically develop unconventional gas and oil resources.

### *Appalachian Resources and Opportunities: "Mature Region, Youthful Potential"<sup>15</sup>*

The Appalachian region contains between 50 and 70 Tcf of technically recoverable natural gas resources, primarily in Kentucky, New York, Ohio, Pennsylvania, Virginia, and West Virginia. These natural gas resources include proved and probable reserves as well as unconventional resources, including coalbed methane, tight gas sands, and gas shale. These resources represent about 5% of the technically recoverable natural gas resources in the U.S. In 2004, eight Appalachian states produced over 680 Bcf of natural gas or about 1.9 Bcf per day from the Appalachian Basin.

In addition, the Appalachian Basin contains 3 to 4 billion barrels of unconventional oil resources, primarily oil sands and oil shale in Kentucky. In 2004, oil production from the Appalachian Basin was over 38,000 barrels per day.

The oil and gas extraction industry employs almost 17,000 workers in the Appalachian Basin. Most of these workers are employed by small and independent oil and gas exploration and production companies and service firms.

A number of states have programs to help the industry: many are focused on oil and gas information exchange.

### *Possible Needs and Initiatives for ARC to Consider for Its **Energy Blueprint**: Help Promote Information Exchange*

There may be a need to undertake regional initiatives to support this small business community focused on oil and gas exploration and production.

- Sharing information and best practices on oil and gas exploration and production technology
- Helping provide access to resources for drilling, including addressing gas resource ownership issues
- Providing enhanced access to geological information for the Appalachian Basin

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<sup>15</sup> See Interstate Oil and Gas Compact Commission, *Mature Region, Youthful Potential: Oil and Gas Resources in the Appalachian and Illinois Basins*, September 2005.

## Infrastructure for Non-Renewables: Natural Gas, Rail, Electric, and Fuels

### *Market Overview: Participate or Perish*

Nationwide, there are a host of important policy issues where new rules, regulations and laws will be developed or enacted concerning energy infrastructure.

- Reliability and price of rail and barge transportation for coal shipments (e.g., to expand coal production from the Appalachian region)
- Access to and adequacy of the electric transmission system (e.g., for siting of new clean-coal generation)
- Natural gas pipeline and underground storage adequacy and access (e.g., for new coal-to-gas facilities or to expand production such as coalbed methane from the Appalachian Basin). For example, in a recent presentation to stock analysts, CONSOL Energy's touted the Appalachian production and reserve base of its natural gas affiliate, CNX Gas – the second largest producer in the Basin. CONSOL outlined the growth potential in connecting to a second pipeline in 2006 that will allow better access to northeastern and southeastern markets.<sup>16</sup>
- Petroleum product distribution system adequacy (e.g., for new coal-to-liquids facilities)

The outcomes of these proceedings have a profound impact on the competitiveness of energy resources from any one particular region.

### *Appalachian Resources and Opportunities: States Are Engaged*

Appalachia faces similar adequacy and cost issues concerning the energy infrastructure serving the region. The Appalachian states are active in assessing, monitoring, and participating in the various Federal, regional, and state and local proceedings on infrastructure issues.

### *Possible Needs and Initiatives for ARC to Consider for Its **Energy Blueprint**: Take the Regional Perspective*

There may be opportunities to analyze and address region-wide infrastructure issues and barriers to non-renewable growth in the various policy forums.

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<sup>16</sup> Presentation by CONSOL Energy to J.P. Morgan Basic Materials Conference, June 6, 2006.

## Nuclear

### *Market Overview: Building Acceptance*

The potential lack of future natural gas supply plus expected greenhouse gas initiatives suggest there may be a larger role for new nuclear generation. For example, Global Insight believes there may be the opportunity to develop 30 to 40 GWs of new nuclear capacity rather than the 6 GWs that may result from incentives in the Energy Policy Act of 2005.

There is significant Federal and industry effort to advance new nuclear generation, including initiatives to streamline processes for new nuclear plant design and certification, to obtain early site permits, and to issue a combined construction and operating license.

A key issue is the public's acceptance of new nuclear generation.

### *Appalachian Resources and Opportunities: Interest*

There are operating nuclear generation facilities in 11 of the Appalachian states. Six existing nuclear stations are located in Appalachian counties including Browns Ferry (AL), Beaver Valley (PA), Susquehanna (PA), Oconee (SC), Sequoyah (TN), and Watts Bar (TN).

Several companies and organizations (e.g., Southern Company; TVA) are moving forward with plans for new nuclear generation. The Southern States Energy Board has moved to support nuclear development as a way to meet future electricity capacity needs, diversify generation resources, preserve the environment, and reduce dependence on foreign energy sources.

### *Possible Needs and Initiatives for ARC to Consider for Its **Energy Blueprint**: Assess Regional Acceptance*

There may be a role to assess the Appalachian region's acceptance of new nuclear generation.

## Hydrogen

### *Market Overview: For the Future*

Longer-term research is being conducted on the potential for a hydrogen economy. There is continuing Federal support for R&D efforts. Any near-term hydrogen initiatives will most likely be tied to gasification initiatives, where hydrogen can be a product of the gasification process.

### *Appalachian Resources and Opportunities: Willing to Participate*

There are a number of demonstration initiatives in the region focused on transportation and fuel cells.

### *Possible Needs and Initiatives for ARC to Consider for Its **Energy Blueprint**: Educate*

There may be a role to educate and communicate the future possibilities for hydrogen within Appalachia.

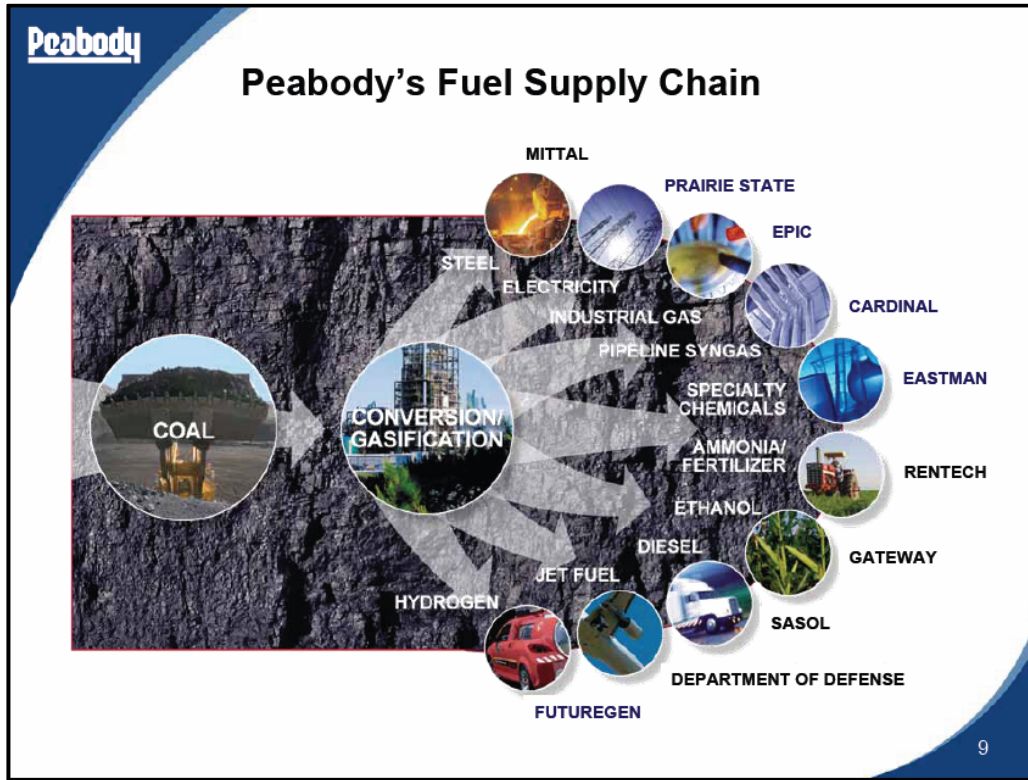
## V. Conclusions

The Appalachian region has significant opportunities with non-renewable resources. The larger opportunities appear to be coal-related, including clean-coal generation and coal conversion to liquids, gas, and chemicals. ARC may be able to help the development of these non-renewable resources through regional commercial, policy, and research initiatives, as shown in the following table.

**Non-Renewable Opportunities and Possible ARC Initiatives**

Possible ARC Initiative	Smaller Opportunity	Larger Opportunity
<i>Commercial Initiatives</i>		<ul style="list-style-type: none"> <li>• Clean-Coal Generation</li> <li>• Coal Conversion: Liquids, Gas, Chemicals</li> </ul>
<i>Policy Initiatives</i>	<ul style="list-style-type: none"> <li>• Natural Gas &amp; Oil</li> <li>• Energy Infrastructure</li> <li>• Nuclear Generation</li> </ul>	<ul style="list-style-type: none"> <li>• Clean-Coal Generation</li> <li>• Coal Production</li> </ul>
<i>Research Initiatives</i>	<ul style="list-style-type: none"> <li>• Hydrogen</li> </ul>	<ul style="list-style-type: none"> <li>• CO<sub>2</sub> Capture &amp; Sequestration</li> </ul>

The coal-related opportunities have attracted significant attention from coal market participants. For example, in recent presentations to stock analysts, Peabody Energy, the largest U.S. coal producer and a company with a stock market capitalization of \$13 billion, detailed significant non-renewable opportunities for its future, as shown below. These opportunities are based on coal conversion and gasification, and include electricity, industrial gas, syngas, specialty chemicals, ammonia/fertilizer, ethanol, diesel, jet fuel, and hydrogen.<sup>17</sup> Appalachia has the ability to participate in each and every one of these future non-renewable opportunities.



<sup>17</sup> Peabody Energy 2006 Investor Forum, May 25, 2006.