Coal and Renewable Energy: History, Impacts, and Future in Alabama

by

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Abstract

Coal and renewable energy have differential impacts on human society. Coal is the most abundant, cheap, and yet environmentally detrimental source of energy. Renewable sources are environmentally benign but constrained by economic, logistical, and technical factors. As the United States moves towards a renewable energy generation policy the challenges and opportunities for the state of Alabama are vast. To understand the possibilities and benefits associated with renewable energy it is essential to note the factors which have aided the rise of coal-based energy in the state as well as the future possibilities associated with renewable energy. Hence this research primarily aimed at describing historical growth of coal-based energy, the contemporary debate of renewable energy policy, and the prospects of generating energy from the most abundant renewable resource in the state, biomass.

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List of Abbreviations

ADIR	Alabama Department of Industrial Relations
ADECA	Alabama Department of Economic and Community Affairs
ACCCE	American Coalition for Clean Coal Electricity
ACEEE	American Council for Energy Efficient Economy
ANGA	America's Natural Gas Alliance
APC	Alabama Power Company
ARRA	American Recovery and Reinvestment Act
ASTM	ASTM International
ATDSR	Agency for Toxic Substances and Disease Registry
BCAP	biomass crop incentive program
CBO	U.S. Congressional Budget Office
CEED	Center for Energy and Economic Development
CHP	Combined heat and power
CRP	Conservation Reserve Program
DOE	U.S. Department of Energy
EIA	Energy Information Administration
EPA	U.S. Environmental Protection Agency
EPRI	Electric Power Research Institute
GAO	U.S. Government and Accountability Office

HAPs	hazardous air pollutants
HQ	Hazard Quotient
ICGCC	Integrated Coal-Gasification Combined Cycle
IPCC	Inter Governmental Panel on Climate Change
IRS	Internal Revenue Service
IURE	Inhalation Unit Risk Estimate
MEI	Maximally Exposed Individual
MIR	Maximum Individual Risk
MSW	municipal solid waste
NAICS	North American Industry Classification System Codes
NIOSH	National Institute of Occupational Safety and Health
NMA	National Mining Association
NMRDI	Natural Resources Management Development Institute
PACE	Partnership for Affordable Clean Energy
PURPA	Public Utilities Regulatory Policies Act
RfCs	reference concentrations
RfDs	reference doses
TEP	toxic equivalency potential
TRI	Toxic Release Inventory
TVA	Tennessee Valley Authority
UCSA	Union of Concerned Scientists of America
USDA	U.S. Department of Agriculture
UMWA	United Mine Workers Association

WRI	World Resources Institute

I. INTRODUCTION

Background and Objectives

The United States is poised to take the first major step to reduce dependence on polluting sources of energy generation with the introduction of renewable energy standards. Yet the impacts of energy generation are not limited to the environment. Fossil and nuclear fuels led by coal have concentrated the modes of power generation in the American society. Renewable energy can bring a societal transformation by redistribution of resources within and among the various regions of the country, as well as contribute to the goals of improving environmental quality and energy independence.

As a mandated national renewable energy policy looks a certainty, the merits and demerits of coal and other sources of power generation are been intensely debated. Coal is conceived to be cheap and abundant, and in states like Alabama is the major source of inexpensive electricity production. However, coal has very detrimental impacts on the natural environment and human health. Any analysis of the potential of renewable energy resources, for the purposes of comparison to current technologies should focus on the costs of coal based energy generation in terms of the impacts on human health.

If the opposition to renewable energy is driven by the concerns over socio-economic impacts of a renewable energy policy, then the policy debate maybe insightful for revealing the possibilities associated with various generation sources. In regard to new energy policy, the news media has emerged as important source of public debate, to highlight the various possibilities of renewable energy generation and their relative advantages and disadvantages for the Southeast. These debates are helpful in understanding the future potentials of renewable energy resources. If a long-term and workable solution for promoting renewable energy is desirable, then an understanding of the factors contributing to potentials and constraints of specific sources need understanding. In the Southeast and Alabama, biomass is the most abundant renewable source of energy (Bailey, Dyer, and Teeter n.d.). Hence this thesis will primarily focus on the potentials and constraints of generating electricity from biomass in the state. Documenting the developments of coal-based energy generation and responses to a renewable energy policy augment the analysis of potential impacts of renewable energy.

Hence the specific objectives of the study are the following:

1. To briefly document the origin and growth of coal as the major source of power generation in Alabama from the 18th century to the present, and describe the associated impacts on human health.
2. To document the contemporary media based renewable policy discourse and its potential impact on energy policies in Alabama.
3. To understand factors which promote and constrain the generation of bioenergy in Alabama and understand the associated social impacts for the community.

Justification of the Study

Historical Growth and Public Health Impacts of Coal Production and Consumption

The premise of this study is based on an acknowledgment of continued U.S. dependence on coal for energy generation. In addition to the use of coal in the industrial sector, domestic consumption of coal has also grown in the last few years, primarily for home heating. With the growing rise of coal use, its impact on public health has been detached from the environmental policy on energy production. Public health is an important policy issue. In poorer regions of the nation, it is of significance because local governments may not have the means, resources, or inclination to evaluate or mitigate the associated threats. The threats are sustained when communities and regions become increasingly dependent on such polluting industries for economic growth. In the United States dependence on coal is extensive. However, some regions, including the Southeast, are more dependent on coal because of a combination of economic and political factors, which may be accounted for by the historical development of coal production and consumption. The knowledge of historical development then becomes crucial for understanding why and how the region is dependent for coal and how these developments may affect the adoption of renewable energy. These developments are important because they also conceal the broader societal causes for impacts on public health. Directed studies on public health often tend to overlook the social factors behind the sources of threat to public health. Such insights help us to understand the problem of public health in its entirety through the understanding related to both historical and social dimensions.

There are other strong motivations for policy changes related to the public health impacts of coal. Currently carbon emissions, which lead to global warming, are the most important cause of policy action against coal-based electricity generation. As a result accounts of coal production and combustion are becoming detached from the realities and concerns of local communities, and underestimating genuine concerns of public health. Along with an understanding of global concerns on emission of greenhouse gases and climate change, an evaluation of the local impacts of energy generation is necessary.

Due to the vast production and combustion of coal in the United States, and the extensive impacts of coal, it is impossible to cover all the public health effects related to coal in a single endeavor. Region specific analyses are required for a meaningful insight into the issues. Apart from extensive use of coal in electricity generation the state of Alabama also has an active mining history of more than 200 years. Hence the possibility of extensive impacts of coal mining and production on human health in the region is high.

Of the several affects of coal production, occupational hazards of coal mining have been the more fatal effects of coal-based energy (Goodell 2007). The two major occupational risks associated with coal production include mining related fatalities and black lung disease. If the entire scope of impacts of coal on public health is to be considered, the concern of miners should be a priority because their contribution to availability of coal is most crucial.

Similarly risk posed by power plants is an important public health issue as well. Power plants are a significant source of toxic air pollutants, also known as hazardous air pollutants (HAPs). HAPs may cause cancer or other serious health effects, including reproductive defects and may retard natural development. The U.S. Environmental Protection Agency (EPA) identifies 188 toxic pollutants released by both mobile and stationary sources, including power plants (2008a). However EPA data on releases from coal-fired plants are aggregated by pollutants. Risks for specific communities need a finer degree of analysis that cannot be understood by aggregate emissions because different toxins have different potencies.

Based on these public health concerns, first objective of this study is established follows:

I. To briefly document the origin and growth of coal as the major source of power generation in Alabama from the 18th century to the present, and describe the associated impacts on human health.

News Media Based Policy Debates on Renewable Energy

Though coal-based energy generation may have several detrimental impacts on human health, the sphere of energy policy is dominated by concern over anthropogenic carbon emissions. Concerns about energy independence and diversification of the base for energy production are also contributing in the promotion of renewable energy. Carbon emissions and their impacts on the climate are a very complex issue. Since the discovery of global warming, the phenomenon has dominated the attention of scientists, politicians, industries, media, and the general public in an unprecedented manner. The most authoritative arguments by the Inter Governmental Panel on Climate Change (IPCC) clear doubts on two focal aspects of global warming (2007). Firstly, global warming is indeed happening and secondly anthropogenic sources of greenhouse gases are primarily responsible. Despite the IPCC (2007) report, the administration of former President George W. Bush did not initiate any carbon reduction legislation. Possibilities of international agreements on carbon reduction and a change in administration have shifted the momentum of U.S. environmental policy to mitigate the threats of climate change, and to protect U.S interests in the global carbon economy. Though the actual design and content of mandates to increase renewable energy and reduce carbon emissions are still under deliberation, the response to climate change policy has been distinct from previous responses on energy policy.

Due to differential resource and industrial bases a uniform national energy policy will have a varied impact on various regions of the United Sates. Since the economy of the United States is based on fossil fuels for energy supply, any measures which restrict their use will have multiple political dimensions. The news media has emerged as an important source of public thought and provided an opportunity for a debate on the policy. Hence news media based articles are a useful tool for an analysis of the policy discourse. To reach to the public and explain their stance on energy policy, policy-makers, industries, and environmentalists extensively use the news media. Hence this discourse on renewable energy may also reveal their positions on coal-based energy and provide insights into the impacts of energy policies. Though it is unclear if the shape and content of the debate has any substantial impact on the policies adopted by the governments and utilities in the South, it may indicate the direction, sources, and extent of support for or opposition to different forms of energy. The social and political support for energy generation sources may decide the allocation of economic support for different types of generation sources and technologies in the future. An analysis of the concurrent discourse of energy policy will also be helpful in understanding some of the challenges faced by the region in reducing its dependence on coal, effectiveness of policy design, and the challenges in adoption of higher levels of renewable energy.

Hence the second objective of this study is the following:

II. To document the contemporary media based renewable policy discourse and its potential impact on energy policies in Alabama.

Biomass-based Electricity: Constraints and Potentials

Though renewable energy has found greater political support due to the climate change threat, it is still a long way from gaining any measure of prominence in the United States. Multiple challenges exist in the path of renewable energy, where policy is necessary but not sufficient. It is crucial to understand all the challenges or the potentials for renewable energy deployment in a region. Since Alabama has abundant and well identified sources of biomass, understanding factors which may constrain or promote the adoption of biomass for power generation is essential. If some of the constraining and encouraging factors are identified it can be helpful to shape policies to promote the growth of biomass-based power generation. It is expected that the findings of this research will help policy makers to concentrate on areas of concern, researchers to move ahead on harnessing various possibilities of bioenergy, and communities to understand the possibilities associated with bioenergy generation, and contribute to the growth of the sector.

The third objective of the research is as follows:

III. To understand factors which promote and constrain the generation of bioenergy in Alabama and understand the associated social impacts for the community.

Theoretical Framework

Understanding the transformation associated with societal replacement of polluting technologies to environmentally benign techniques has been addressed by the theory of ecological modernization. Mol and Sonnenfeld (2000), summarize the scholarly focus of the theory as follows:

1. Science and technology should solve environmental problems rather than create them.
2. The market has a role in promotion of “green technologies.”
3. Decentralized and flexible regulations of the nation-state are needed.
4. Modification in the position and role of the environmental movements is needed.
5. New discourses and ideologies which reject contradictions between environmental and economic interests are needed.

In advanced capitalist countries, industrial transformations have been scrutinized on the following eco-modernist parameters:

1. Technologies need to remove the fundamental cause of pollution rather than aim for “end of the pipe” control.

2. Introduction of new technologies should lead to reorientation of production structure for greater social and community benefits.
3. The firm has to bear all the costs of the polluting the environment
4. Introduction of new technologies can economically benefit the firm

The energy generation sector or more specifically the renewable energy satisfies almost all the tenets of the theory. By replacing coal and other fossil sources of energy bioenergy plugs polluting techniques at the base. Since biomass resources are widely distributed their utilization can benefit the local community, more so rural areas. At the organizational level biomass based power can benefit the firm by reducing risks of stringent pollution control techniques, changing environmental law, and improving public image.

This research aims at understand the changing nature of energy generation to determine if and how eco-modernization based practices are adopted or resisted by the energy sector in Alabama. The history of coal production and its rise in energy generation reveals the factors behind the rise of a polluting technology and its spatial domination of energy sector at the cost of human and environmental health. State responses suggest a shifting toward new environmental policies. Both the historical legacy and ecological modernization is reflected in the contemporary discourse on energy policy. The response to new environmental polices not only signifies technological changes with the society but also testifies about the organizational change need to accompany the introduction of new technologies. The possibilities that are foreseen from new forms of renewable energy generation systems, both in terms of environmental benefits and the associated potential for economic growth from such technologies, will also be studied.

II. HISTORICAL GROWTH AND PUBLIC HEALTH IMPACTS OF COAL PRODUCTION AND CONSUMPTION

History of Coal Production and Consumption

The abundance of coal and its extensive production and consumption in the United States has drawn a lot of scholarly attention. Though there is substantive literature on historical development of coal and the accompanying growth of energy industry in the United States from the early seventeenth to the twentieth century (Freese 2003, Miller 2005, Goodell 2007), a similar analysis for Alabama is absent. Accounts of the coal industry in Alabama are limited to the pre World War II era.

Sources of Documentation

Documentation of the historical growth of coal production and consumption of electricity generation has been collected from the Energy Information Administration (EIA) - the statistical agency of the U.S. Department of Energy (DOE) and the U.S. Geological Survey (USGS). The U.S. Census Bureau (Census Bureau) and the Alabama Department of Industrial Relations (ADIR) provided data on mining employment. Qualitative accounts were collected from the EIA and have been augmented by historical and social accounts of coal production and mining in academic literature. Information was also collected from media articles, obtained from an archive search of *The New York Times* and other national publications for the period 1860-2007, and through the archives of Alabama-based news publications. The accounts for historical developments in the United States and Alabama are presented separately to compare and contrast the trajectories of developments

History of Growth of Coal Production and Consumption in the United States

The rise of coal production in the United States is a history of more than two hundred years. In the last two centuries coal production has witnessed fluctuations, but is now the most widely used energy source of generation in the country. In 2006, the United States ranked second worldwide in production of the mineral (British Geological Survey 2009).The nation also has the largest known reserves of coal in the world (British Petroleum 2008), far exceeding the reserves of its nearest competitor Russia and almost twice the individual reserves of India and China.

Coal was reportedly used by the Indians of the Southwest before the arrival of the foreign explorers (Miller 2005). The earliest discovery of coal in the United States is credited to French explorer Louis Joliet in the late seventeenth century (EIA1995). This discovery was followed by the mapping of coal by other explorers and geologists in the next century. Commercial production of coal in the United States began near Richmond, Virginia, in 1748 (EIA 1995). Coal production existed in measurable quantities in Pennsylvania and Ohio by the start of nineteenth century and spread to most states by the end of the century (EIA 1995). Milici's (1997) compilation reveals that the production of coal in Alabama began in 1840 but according to Armes (1972), the earliest record of coal mined in Alabama goes back to the Warrior Coal field in 1827.

The earliest users of coal in the United States were blacksmiths and local farmers, but the origin of the industrial development of the coal industry is tied to the growth of iron and steel industry. Industrial Revolution in Britain and the discovery that coal was a better alternative than charcoal to smelt iron became the first major landmark for the industrial use of coal. The use of coal for making coke was an important impetus for the nascent American coal industry. In its infancy, the industry struggled to convert coal into coke due to the high sulfur content of the mined coal (Freese 2003). Anthracite, the form of coal with the highest heating value, emerged as the solution to this problem. The use of anthracite to smelt iron established the earliest coal mining industries in the United States. A large anthracite industry was established in Pennsylvania, which has the most significant anthracite resources in the nation. In order to expand their markets, most coal mining companies began improving navigation and transport systems. An extensive canal network was built on the Lehigh River and coal mining companies multiplied in the region.

James Watt's model of the steam engine provided another impetus in the growth of coal production. Coal producers needed new markets for expansion and railroads were to emerge as the most important source of transportation of coal across the nation. The first railroad to transport coal was installed in the Panther Creek Valley in Pennsylvania in 1829 (Armes 1972). The partnership of coal and railroads has lasted for almost two centuries. In 2004 more than 60 percent of domestic supplies of coal in the United Sates depended on railroads (EIA 2007).

A number of other uses were found for coal, including domestic heating and running steam boats (Miller 2005). However the sustained expansion of the coal industry has occurred due to the electric power industry. During the process of coking, it was discovered that resulting gas could be burned. In1816, Maryland became the first city in the United States to light streets with coal gas (Miller 2005). The foundation of coal combustion to generate and distribute electric power was laid with Thomas Edison's inauguration of an electric light system in New York in 1882 (Atkins 2006). Edison, his secretary Samuel Insull, and legendary investor J.P. Morgan, combined to establish the modern electric utility industry system of large, vertically-integrated, monopolized, and regulated utilities (Goodell 2007). This model persists extensively, though some states are trying to switch to more competitive markets. According to Goodell (2007), this system of regulated monopolies has played an important role in expanding and sustaining the use of coal for power generation.

With the emergence of coal-fired plants for power generation in the 1880's, coal became the most important source of energy in the United States ahead of wood (Miller 2005). A rapid expansion of road networks following World War II led to an increase in demand for petroleum, which displaced coal as the leading source of energy. Railroads, the major carriers of coal, switched to diesel for efficiency (Miller 2005). Some coal-fired electric plants were also converted to oil-based plants. Natural gas replaced coal as the energy source for domestic consumption. Alternative technologies, including hydroelectric power and nuclear power appeared around 1890 and 1957, respectively (Miller 2005). However a combination of factors including industrial growth, rapid electrification of U.S. households, the Arab Oil Embargo of 1973, and deregulation of both railroads and oil and gas prices helped coal to make a comeback as the leading source of power generation. A few other important inventions which occurred in the early twentieth century, and may contribute to coal's future include the process of direct coal high pressure hydrogenation by Friedrich Bergius and the Fischer-Tropsch process.

Origins and Growth of Coal Production and Consumption in Alabama

The earliest growth of the coal industry occurred in the Northeast and this was a primary source of the South's disadvantage in the Civil War. Freese (2003) mentions that the Union had an overwhelming advantage in both industrial and coal production, with a coal output nearly 38 times greater than the Confederate states. In the antebellum South, only Virginia and Tennessee produced significant quantities of coal. One of the earlier ventures for coal trade in Alabama was made by David Hanby who transported coal on the Warrior River to Mobile (Armes 1972). The people of Mobile were not very receptive of his product. He then hired African-Americans to show the town folks to use and burn coal and achieved some success with his venture, sending as many as 75 boat loads a year, most of which was sold to a city gas company (Armes 1972). Water transportation was risky, and Hanby lost several loads in the process. Mirroring the developments of the anthracite coal region in Pennsylvania, the growth of coal in Alabama was intricately linked to the railroads, and the iron and steel industry of the state.

The prospects of coal production in the state increased significantly as surveyors looked for deposits of coal and iron. Encouraged by the findings of independents surveys on coal reserves, the Alabama Legislature assigned the responsibility of exploring the state's mineral wealth to Micheal Tuomey, a professor at the University of Alabama (Armes 1972). Following Tuomey's reports increased activity was seen in the commercial mining and investors showed interest in the promising industry of the state. However the growth of the coal industry, in the pre Civil War period, like the development of iron furnaces, was slow. An important outcome of the increased interest in the coal and iron industry was the plan to develop an extensive railroad system in the coal abundant regions of Alabama, credited to pursuits of John T. Milner, a railroad engineer. Before the Civil War began, the Alabama legislature had made appropriations to develop an extensive railroad system (the North and South Railroad) in the mineral abundant regions of Alabama. The construction of the railroad was halted by the war. The war acted as both a boon and bane for the coal industry in the region. When the region went to war, the Confederate forces took a stock of their resources and found that they lacked adequate arsenal or combat resources, and set about building foundries, arsenals, and other stockpiles (Armes 1972). The war not only stimulated the demand for coal in Alabama but several other Southern states.

After the war, it was a challenge to rebuild Alabama's industries. The advent of Louisville and Nashville Railroad Company into Alabama in 1872 played an important role in establishment of Birmingham as the center of the iron and steel industry. Several new iron furnaces and foundries were established in the state due to increasing interest in coal production. An important event in the history of Alabama coal production was initiation of operations by the Tennessee Coal, Iron and Railroad Company. It became the most influential coal producer of the state until J.P. Morgan took over the company and merged it with the U.S. Steel Corporation in 1907. Apart from supplying local and domestic furnaces, coal produced during this era was also exported to Mexico, West Indies, and England. Coal production rose from 8 million short tons at the turn of the nineteenth century to 21 million tons in 1926 (U.S Department of Energy1994). However demand plunged during the Great Depression until World War II rekindled the demand for coal in the region. One of the largest coal-mining companies in the state, Drummond Coal, was founded in 1935 (Drummond Coal 2009a).

The start of the twentieth century also witnessed the establishment and growth of the Alabama Power Company (APC), which became one of the largest consumers of coal in the post World War II era. Pulp and paper mills, which relocated to the region after the World War II, and iron and steel companies, are the other important industrial users of coal. Ironically both the two major power generators within the state, APC and the Tennessee Valley Authority (TVA), began with the development of the hydroelectric potential of the state. APC began its first coal-fired plant Gadsden in 1914 as a backup to its hydroelectric generation (Atkins 2006). Rising demand and projection for wartime exigencies resulted in construction of another plant at Black Warrior River (Plant Gorgas). Electric generation by coal witnessed a sharp expansion after the Second World War when several plants with high generation capacity were constructed (table 1).

Currently there are 9 coal-fired electricity plants in Alabama (table 1). New forms of consumer use including home heating and air-conditioning contributed to a rapid increase in electricity consumption after the war. An aggressive recruitment policy by the state contributed to a significant increase in the industrial demand of electricity. Since then, power generators of the state have preferred to operate coal-fired plants to generate electricity at cheaper rates.

The coal mines of Alabama and the Southeast once enjoyed the advantage of saving on transportation costs in supplying coal to many Southern utilities (Lyles 2000). However the competitive advantage was lost due to advanced techniques of surface mining and large and cheap reserves of coal in the West. Coal seams are generally thicker in the West, which substantially reduces mining costs. State-based power generators, the major consumers of coal, changed to low-sulfur and cheaper domestic and international coal. Tracing the development of the coal mining industry, it appears that new environmental regulations under the Clean Air Act of 1990 were not the major factor in determining the fate of Alabama coal industries. In their study on the increased use of Western Coal in power generation, Gerking and Hamilton (2008) find that market power exerted by railroad companies played the pivotal role and environmental policy played a secondary role. Electric utilities of the state have found it cheaper to purchase coal from Western mines, despite transportation costs. The fact that Western coal has lower sulfur content has augmented its use for power generation nationwide. APC now imports 70 percent of its coal, from destinations in the West and countries as far as Columbia.

If demand related factors are excluded, the staggered coal production since the late twentieth century is due the economics of coal production. Most of the profitably mineable coal in Alabama has already been extracted. With falling reserves, mining companies reduced their production. The largest producer, Drummond Coal, withdrew from Alabama and expanded its operation in Columbia, claiming to ship more than 20 million tons in 2007 (2009b), equivalent to the total annual coal production in Alabama (table 2). Though reserves of coal in Alabama may not be comparable to some other regions, the state has a good reserve of high energy content coal, with a heating value in range of 11000-15000 Btus (EIA 1994). The high heating value makes it attractive for metallurgical uses. Global markets, especially manufacturing industries like steel and cement, where metallurgical coal is a necessity, is reviving interests in the coal-fields of Alabama (Lyles 2000).

In the last decade the net output of coal has been relatively stable (table 2). According to the Alabama Department of Industrial Relations (ADIR), coal production was reported from 12 counties (2009). Alabama has also lost a number of coal mining employees in the last decade (table 3). Labor journalist David Bacon notes that Drummond Company alone removed almost 1,700 jobs in Alabama between 1994 and 2001 (2001). Net fluctuations in production have ranged between 1 million to 3 million tons (table 2), and for an industry with a low productive base this is very substantial. The coal industry in Alabama still employs more than 3000 workers, and underground mines in Alabama employ almost twice the number of miners as surface mines (ADIR 2009). Alabama mines are also some of the deepest in the nation with a high content of methane (Lyles 2000). Underground mines also present greater degree of risks than surface mining. In the following section we look at the occupational risks associated with coal mines in Alabama.

Public Health Impacts of Coal Production and Consumption

Scope of Public Health Risks

If attention is turned to public health impacts from coal mining or combustion in Alabama, there is very limited literature in social sciences. The sole contemporary account of social impacts of coal-production in Alabama is Glynn's study of resentment of local communities in Walker County against new mining initiatives (2009). The study reveals that public health was not the main concern among residents of the community, though they were aware that coal-mining was not in their welfare. This demonstrates there is an inadequate public knowledge of the health impacts from coal-mining. In contrast, public recognition of coal use as a contributor to global warming is widespread.

The dangers of coal-mining have not been completely ignored by social scientists. The most tragic of these is the coal-mining waste spill in Buffalo Creek, West Virginia (Erikson 1972; Stern 1977). Erikson's account of the tragedy revealed negligence on the part of the mining-company and acute losses for the Buffalo Creek community, plunging it in sense of hopelessness (1972). A coal-mining fire in Centralia, Pennsylvania which led to relocation of the townspeople also destroyed community spirit, already at its low ebb (Kroll-Smith and Crouch 1990). Regulatory response before and after crisis was perceived to be inadequate after the Buffalo Creek disaster (Erikson 1972), even though a massive civil suit resulted in unexpectedly high compensation by the mining company (Stern 1977). In other cases the community was not so fortunate, even economically. Little media and regulatory attention or financial aid followed the 300 million gallon coal-waste spill in Martin County, Kentucky, which endangered the lives of the entire community (McSpirit, Hardest, and Welch 2002). A common finding of studies on coal-mining threats and disaster is the apathetic response by coal industries and regulators (Erikson 1972; McSpirit et al. 2002; Glynn 2009).

The growth of the coal industry is intricately linked to the role, welfare and health of miners. Reflecting on the plight of miners in the pre-World I War era, Armes (1972) noted of both riches and tragedies from coal-mining industry. Regulatory response is crucial for occupation hazards of coal mining. Goodell (2007) covers the history of mining accidents in West Virginia and Pennsylvania, and writes about the Jim Walters disaster in Alabama, and the insufficient political will to control mining accidents. Other accounts of coal mining history (Armes 1972, Lewis 1987) do not elaborate on mining accidents in the modern era.

The other major source of coal mining fatalities, black lung disease has witnessed attention from scholarly literature (see Smith 1987; Derickson 1998), though of late attention on the problem has been limited. The disease is very critical from the perspective of public health because it is directly related to underground mining and has resulted in thousands of deaths in the last century. As underground coal mining shows no signs of abatement, the risks are likely to be prolonged. In the future these two occupational risks need close monitoring for assessment of societal benefits from coal-based energy generation.

Occupational Health Risks of Coal Mining

Sources of Documentation

Data on the incidence of black lung and mining fatalities has been collected from cited sources. The aim is to present the incidence of the two occupational risks within the United States and the associated policy issues. Comments of federal agencies and scholars on the two diseases have been incorporated for an insight into the regulatory issues involving the two occupational risks.

Mining Safety

The Federal Coal Mine Health and Safety Act of 1969, amended in 1977, states that the first priority and concern of all in the coal industry must be the health and safety of the miners. Yet miners have been exposed to significant perils at their work place. Mining related disasters have resulted in the deaths of thousands of miners. Since the late nineteenth century the National

Institute of Occupational Safety and Health (NIOSH) has reported almost 622 disasters where fatalities of five or greater were recorded (2009). A list of the major coal mining accidents in Alabama is presented as table 4. Data on fatalities from 1998 to 2007 is presented in table 5.

In the infant coal industries mining safety was not a concern. Hence records of mining safety and health in the early twentieth century are very poor. The worst disaster in the history of coal mining occurred in Monogah, Pennsylvania when 386 miners were killed following a series of explosions in 1908. Its Alabama equivalent occurred on April 8, 1911, when 128 miners, mostly convicts, were killed at Banner Mine of the Pratt Consolidated Coal Company (Yates 2006). Noting the causes of mining disasters, it is obvious that most deaths have occurred due to explosions. In 1910, a study by the Bureau of Mines concluded that most explosions were erroneously attributed to “fire damp” or the combination of inflammable gases, when coal dust was the real trigger of mining explosions. Coal dust suspended in air may explode spontaneously. Once an explosion is initiated it may lead to a chain of reactions due to the presence of inflammable gases. However this was a more technical explanation, the social cause lay somewhere else. Writing about the Banner Mine disaster, Yates notes that the mining company’s desire for greater profits led to deeper mining and pushed the convicts into a virtual death-trap (2006).

Even after the realization that deep underground mines produced more coal dust and methane, mining accidents did not stop. Regulatory infrastructure to control or monitor mining accidents before the Second World War was weak, leaving miners at the mercy of mine operators and chance. Alabama had a series of mining accidents prior to the Second World War. Inspection was insufficient and sporadic. Yates comments, “Alabama’s industrial mining engineers overlooked technological solutions to human injury and environmental degradation, however, they found innovative ways to meet specific environmental challenges that stood in the way of production demands" (2006:106).

Until safety equipment such as methane detectors and roof top support were introduced in underground mines, miners used animals such as rats and canaries to detect threats. Improvements in mining techniques, increased mechanization of mining jobs, and a decrease in net employment has significantly reduced the number of mining fatalities (Levine 2008). Federal regulation on mining safety began with the Federal Coal Mine Safety Act of 1969. However it did little to improve mining safety, and was filled with loopholes (Goodell 2007). Almost 50 mining accidents have been recorded since the law was enacted (NIOSH 2009). After a terrible mining disaster at a West Virginia mine, which was home to two previous disasters, the laws was expanded in scope (Goodell 2007). The expanded law made a series of bindings on operators and expanded the rights of miners to request federal inspection and report mining safety violations. However the law has not been followed in letter. Most mines continue to operate after being cited for safety violations. In 2001, thirteen miners in Alabama died following an underground mine explosion in Brookwood. The tragedy received negligible media coverage in the aftermath of September 11 terrorist attacks, even though most of the deceased miners had bravely entered the site to save their co-workers. An inquiry by the United Mine Workers Association (UMWA) reported that a combination of mining safety violations, inadequate enforcement of Mine Safety and Health Administration (MSHA) provisions, and insufficient emergency response resulted in the fatalities (2003). The UMWA report also noted that in 2000, the mine was cited 110 times for violating inflammable coal dust standards which had been allowed to accumulate despite regulatory supervision (2003). Interestingly Jim Walters Resources, owner of the fateful mines shifted head-quarters to Alabama this year.

Though the Jim Walters disaster did not receive extensive media coverage two subsequent disasters made national news. In the first, miners at Quecreek, Pennsylvania, escaped unharmed. Their counterparts in Sago, West Virginia were not so fortunate. Twelve miners died after a series of mine explosions. Refuting the mine operators charge that natural lighting was the cause of explosions at the mine, the UMWA charged both the mine operators and the MSHA for serious negligence of safety measures (2007). Exploring federal responses to mining safety an investigative report found that the Bush administration had relaxed mining safety regulations, ignored safety violations citations by the MSHA, and appointed coal industry officials at top positions in the MSHA (Ward Jr. 2007).

Without active sanction mine operators find it easy to shift blame to the miners. Akin to the response of Pratt Coal Company's president G. B. McCormack, who denied responsibility for the deadly mine explosion in 1911, Jim Walters Resources attributed its Brookwood mine explosion to individual error from the miners (Yates 2006).

Black Lung

The risk associated with coal mining dust is not limited to explosion or accidents. Coal dust is also the cause of black lung disease or coal workers' pneumoconiosis. Occupational fatalities related to black lung have been the highest in the coal mining industry killing almost 100,000 workers in the last century (Goodell 2007), with 10,000 deaths occurring in the last decade (table 6). Though media coverage has kept mining safety within public attention, black lung has faded from public imagination. The scope of black lung disease is noteworthy not only for its direct impact on the health of miners. The disease is strongly tied to the political economy of coal production and has a very complicated history.

After reports of permanent disabilities and deaths of miners from the disease, the Black Lung Benefits Program was launched in 1969. The complex design of the program distributed the liability of benefit payments between the federal government, state governments, and mine operators according to the date of file of claims and other conditions. Effectively the responsibility of paying the claims fell upon federal government and the coal operators. In 1977 the Congress reformed the Act and created a Black Lung Benefits Trust Fund to meet the administrative expenditure of claim settlements, and payment of new claims. The new amendments by design shifted the financial responsibility for all unresolved claims filed after 1969, new claims filed after 1973, and all the administrative expenditures for running the trust fund to the coal-mine operators. The law also levied an excise-tax on coal for meeting the administrative expenditure of running the fund. Less than 12 percent of black lung claims were approved in 2004 and in Alabama the existing number of compensations are less than 0.4 percent of all claims since 1973 (Office of Workers' Compensation Program 2008) suggesting that benefits have been very hard to obtain.

The simple reason for the low number of claims has been the inability of the miners to prove their claims in courts (U.S. Government Accountability Office 2009). After all the responsibility and tax burden was shifted to them, mine operators faced a huge number of claims and adopted a defensive stand in approving the claims. A large number of claims went to court. A great mismatch between the resources of mine operators and miners results in the denial of claims (U.S. Government Accountability Office 2009). Mine operators have also managed to reduce the scope of their liabilities in other forms. In 1981 the federal government removed the liability of paying benefits to totally disabled miners from coal operators. Mine operators were also relieved from paying benefits granted under the new and liberalized standards for claims. Instead the liability for these benefits was transferred to the fund.

Scholarly opinions have termed the Black Lung Program as a public health disaster (Derickson 1998). Instead of a showing a humane face to the tragedies of permanent disability and deaths, the coal industry and the government forced miners and their dependents to legally prove that their diseases were linked to the occupation. Not only have operators fought individual claimants they have managed to reduce their obligations to the Black Lung Trust Fund through court rulings. In 1988, on the basis of moisture content of coal and again in 1998, for exported coal. The second ruling also rendered coal excise taxes unconstitutional because no tax could be imposed on any export from a U.S. state. The Internal Revenue Service (IRS) did not challenge the judgment and allowed excise tax on exported coal to lapse. Despite a ruling by the U.S. Supreme Court that the IRS has no obligation to refund taxes if refund claims were not filed within three years of paying the tax, the Energy Policy Act of 2005 granted a full refund for all the excise tax (with interest) paid on exported coal between 1990 and 2005 (Lunder 2008). According to another report, the total potential excess repayment under the new law could exceed $1 billion (Lazzari 2004). Meanwhile the Fund has been in chronic debt since its inception (U.S. Government Accountability Office 2009).

If the fiscal responsibility and management of claims, and bringing operators to task for adequate liability has been a challenge, so too has been an improvement in the safety standards for coal dust. The current maximum permissible exposure limit for coal dust is 2.0 mgs per cubic meter (NIOSH 1995). The NIOSH recommends a lower limit of 1.0 mg per cubic meter of dust (1995). However NIOSH has no regulatory power and the MSHA has resisted the implementation of such recommendations. To add to the inherent dangers of coal dust, there are frequent reports of mine operators tampering with samples to mislead regulators (Goodell 2007). Consequently the perils of black lung exist and maybe on the rise. Recently the NIOSH published a report stating that incidences of Black Lung are on the rise, indentifying advanced cases for miners less than 50 years of age (2008).

Following the Sago Mine disaster, the S-MINER Act of 2008, mandating stricter safety enforcements and reduction in dust limits, was introduced. Unfortunately the after passing in the House, the bill could not pass the Senate and is now virtually dead. In fact former President Bush had announced his clear intent of not signing the Bill even if it passed the Senate. As mining companies delve deeper to dig coal, and the United States looks ahead to coal as its energy future, regulations may be the only hope to save miners from the risks of occupational deaths.

Assessment of Public Health Risks from Coal-fired Plants in Alabama

Existing Studies and Concerns

Existing studies of risks from toxic exposure in Alabama has ignored coal-powered electricity generation, though studies at regional and national levels have raised concerns. Recently the increasing focus on greenhouse emissions has led to an expansion in the literature concentrating on emissions from power plants. A study by the Conservation Alabama Foundation (2008), found that concentrations of 15 HAPs (including 13 carcinogens) in 31 counties of Alabama were substantially higher than the levels mandated by the EPA. The report also indicates that monitoring and regulatory efforts of the Alabama Department of Environmental Management (ADEM) are insufficient to control the release of these pollutants. Inadequate regulatory control of HAPs from coal-plants is not a new concern, nor is limited to Alabama. In response to the report, the ADEM claimed that it adopted the insights of and federal standards enforced by the EPA. Regulatory concern needs to consider that children and ethnic minorities are at particular risks from coal-fired pollution (Clean Air Task Force 2002), apart from the risks posed to adjacent communities. Federal response to the toxic air emissions from coal-fired plants has been a contentious issue and will be discussed later.

There has been some scholarly work on industrial emissions of HAPs. In Alabama, previous studies on industrial toxic releases have covered the pulp and paper mills and their impacts on human health, revealing significant risks for adjacent communities (Bailey and Newland 2000; Bailey, Newland, and Thomas 2001). These findings revealed that the industry posed the greatest aggregate risk from all industrial sources (Bailey and Newland 2000; Bailey et al. 2001), and subsequent changes in regulatory standards helped in mitigation of those threats (Bailey, Newland, and Carter-North 2004). Since regulatory controls helped mitigate the threats posed by the pulp and paper mills, and concerns are raised over adequate regulatory coverage, the first priority should be an understanding of the regulatory structure for HAP releases from coal-fired plants.

Regulatory Issues

Legislation to control air pollutants of any kind was effected with the first amendment to the Clean Air Act in 1970. However emission standards for the first seven classified HAPs-asbestos, beryllium, mercury, vinyl chloride, benzene, radionuclides, and arsenic-did not specifically target coal-fired electric plants (Miller 2005). It was not until 20 years later, when mounting scientific evidence, worsening ambient air quality, and slow regulatory progress resulted in the amendment of Clean Air Act and the extension of the list of HAPs to 187, along with their sources of emissions. The Congress required the EPA to conduct a study to identify the risks posed by coal-fired plants. According to 1990 amendments, sources of HAPS were to be regulated under the section 112 (c) (1) of the Act. The amended and original list consisted of

167 “major sources” and 7 “area” sources. All sources regulated under this section had to adopt the Maximum Achievable Control Technology (MACT), as prescribed by the EPA.

According to the Clean Air Act Amendments of 1990, the term “major source” refers to any stationary source or combined group of stationary sources that emits or has the potential to emit 10 tons per year or more of any hazardous air pollutant, or 25 tons per year or more of a combination of hazardous air pollutants. “Area” sources are those sources that emit less than 10 tons annually of a single hazardous air pollutant or less than 25 tons annually of a combination of hazardous air pollutants. As per the directions of the Congress, the EPA (1998a) conducted a detailed study on the risks of HAP emissions from electric plants (including coal-fired plants).

After completing the study in 1998, the EPA announced its decision to regulate coal - fired power plants under section 112 concluding that emissions from coal-fired plants present significant hazards to the public health and the environment (Meltz and McCarthy 2008). However in 2005, the EPA reversed its decision, and decided to remove coal-fired plants from the list with a new plan to regulate mercury emissions by a cap and trade rule. In 2008 a Washington D.C. Circuit Court, vacated both the EPA rules (Meltz and McCarthy 2008). The court observed that EPA has not followed the word of law before deciding to remove power plants as source of risk to human health and welfare (Meltz and McCarthy 2008).

Goodell writes that mercury reductions standards proposed under the EPA’s revised legislation were not based on scientific knowledge and were criticized by the U.S. Government and Accountability Office (GAO) as well (2007). There is great deal of uncertainty over regulation of HAPs. It is evident that the EPA has not added coal-fired plants to the list of major sources of toxic air pollutants. From the above history it is also clear that the EPA (1998a) study holds some important information and it is essential to review the report.

Summary of the EPA Study on Public Health Impacts from Coal-fired Plants (1998a)

The EPA method was elaborate and complex. It was centrally based on estimated and projected emissions of HAPs, and on various types of risk assessment methods defined by the EPA. For cancer risks, a risk estimate known as the Inhalation Unit Risk Estimate (IURE) was used. The EPA (2008b) defines IURE by this example : if unit risk = 2×10^{-6} per µg (microgram)/m^3 (cubic metre), a maximum of 2 excess cancer cases are expected to develop per a population of 1 million people exposed daily for a lifetime to 1 µg of the chemical per m^3 of air. Emissions of HAPs were recorded by the Electric Power Research Institute (EPRI) and the DOE at various coal, gas and oil-fired power plants. The EPRI was advised to select generating units by a filtering process based on identification of combustion mechanisms and fuel type to ensure maximum representativeness of the utility industry. Using the data, projections for years 1990, 1994, and 2010 were made.

The EPA also screened risk for compounds based on the reference doses (RfDs) or reference concentrations (RfCs) to assess effects from exposure to toxic substances for both cancer and non-cancer health (1998a). In this analysis the EPA used the Human Exposure Model (HEM). The HEM uses the concentration of toxins in the ambient air to assess cancer and non-cancer risk risks based on the thresholds of IURE and RfC (EPA 2007a). The maximum concentration of pollutants was projected by a modeling system. The model covered two types of exposure risks, Maximum Individual Risk (MIR) and Maximally Exposed Individual (MEI). MIR represents the highest estimated risk to an exposed individual in inhabited areas whereas MEI represents the highest estimated risk to an exposed individual, regardless of whether people occupy the area or not (EPA 1998a). In one form of analysis, risk within a radius of 50 km from the emission source was analyzed. In the second form of analysis, risks beyond 50 km. to the borders of United States were analyzed. Based on the probabilistic modeling technique the study concluded the following on the possibilities of human health risks from coal-fired plants (EPA 1998a):

1. The vast majority of coal-fired plants (424 of the 426 plants) were estimated to pose lifetime cancer risks (MIR) (i.e., increased probability of an exposed person getting cancer during a lifetime) of less than one in a million due to inhalation exposure. Only two of the 426 plants were estimated to potentially pose inhalation risks greater than 1 in a million.
2. The increased lifetime cancer maximum individual risk (MIR) due to inhalation exposure to coal-fired utility HAP emissions, based on the local analysis, was estimated to be not greater than three in a million. The increased lifetime cancer risk for the combined effects for all types of exposure (both local and long –range) was estimated to be not greater than four in a million.
3. In the EPA analysis, arsenic, chromium, cadmium, and nickel were the HAPs contributing most to the cancer inhalation risks. Out of these, only arsenic and chromium posed a risk of greater than one in a million.
4. The highest MEI risk from carcinogenic exposure to coal-fired plants was found to be four in a million.
5. The probability of carcinogenic risk was the same for both MIR and MEI, with only arsenic and chromium posing risks greater than one in a million.
6. The Hazard Quotient (HQ) or the ratio of exposure concentration to RfC was greater than 0.1 for only hydrogen chloride (hydrochloric acid). HQ value at or less than one implies that exposures are at or below the RfC and are not likely to cause adverse effects.

7. Due to its bioaccumulative nature, mercury deposition in water bodies and fish was a concern and was a possible area of research along with the specification of cancerous forms of chromium and nickel.

More than a decade has passed since the EPA conducted this study. Based on available data, it is evident that utility plants emitted millions of pounds of HAPs in the ambient air in the last decade (table 7). This necessitates a reassessment of risks from coal-fired plants

Methodology

The EPA study had considered 1990 as the base year and was submitted in 1998. To place the EPA study in proper perspective aggregated data from the most recent years (1998-2007) has been used to estimate the public health risks. The EPA maintains a database of toxic releases from facilities known as the Toxic Release Inventory (TRI) Explorer (http://www.epa.gov/triexplorer/). This interactive web resource was used to obtain data by geographical and industrial profile. The code used for various industries is based on system known as North American Industry Classification System Codes (NAICS), where electric utilities have been given a code number of 2211. Using the search functions of the TRI Explorer, TRI data for state, by industry, and by facility can be obtained.

The selection of TRI data by itself has several advantages in screening of public health risks from coal fired plants:

1. The EPA (1998a) study was based on projected data whereas the presented TRI-based analysis is based on actual data.
2. TRI data is self-reported by the facilities and hence there could no room for any kind of contentions.

3. Selection of all the coal-fired plants in Alabama and aggregation of actual level of emissions for each pollutant should eliminate any uncertainty arising due to variances in combustion technologies, type of coal feedstock, generation output, and performance of controls. There is a high probability of change in those factors since 1994.

There are some merits in analyzing the risks from coal-fired plants on the concept of toxic equivalency potential (TEP).

1. TEPs indicate the relative risk associated with a release of one pound of a chemical for human health, compared to the risk posed equivalent release of a reference chemical. The values of TEP were obtained from a web resource known as Scorecard available at (http://www.scorecard.org/env-releases/def/tep_gen.html).
2. Depending on the release in air or water the HAPs can vary in their potencies. TEP values of commonly released chemicals in Alabama are displayed on (table 8), indicating a wide disparity. Hence TEP values are a better indicator of the potential health risk posed by environmental releases than mere aggregate releases of chemicals, because they take into account large differences in toxicity and exposure potential across chemicals (Scorecard 2005).
3. TEP values also help in clear demarcation of assessment of both cancer and non-cancer risks. HAPs maybe classified into two major categories, carcinogens or non-carcinogens. The two categories are not mutually exclusive. Some compounds may also be reproductive carcinogens or developmental toxins. In the selected TEP values, all releases of carcinogens are converted to pounds of benzene-equivalents; all releases of chemicals that cause non-cancer health effects are converted to pounds of toluene-equivalents (Scorecard 2005). According to the Agency for Toxic Substances and

Disease Registry (ATSDR) benzene is one of the most commonly occurring carcinogens, and is a substantial part of cigarette smoke (2007). Toluene has been established as very severe neurotoxin (Filley, Halliday, and Kleinschmidt-Demasters 2004).

Total releases of HAP over a period of 10 years (1998-2007) were obtained and aggregated for 9 major coal-fired plants in Alabama (tables 9-17). Data were obtained by simple multiplication of the total release of the compound by the TEP of the given compound. After aggregating the risks score (table 18), the cancer and the non-cancer risk scores per unit of generation capacity was found for all of the power plants (table 19). The generation capacity for the plants in Alabama (for 2008) was found at the U.S. EIA database (http://www.eia.doe.gov/fuelelectric.html). However it must be kept in mind that total amount of toxins emitted will depend on the actual amount of electricity produced, which is complex function of demand load, generation capacity and availability of electricity within and among grid systems. Generation capacity is a quantifiable and important variable which can be used to present the unit risks of public health impact of coal based power generation.

Limitations of the Analysis

It is also important to note some of the limitations of this analysis. The first set of limitations is related to TEPs. TEP are helpful in a preliminary screening of risks where lack of data or resources prevent a detailed and comprehensive risk assessment of a specific facility's toxin releases (Scorecard 2005). This limitation occurs because all the factors related to the toxicity, environmental fate, transport and exposure routes of a chemical cannot be covered by the TEP values (Scorecard 2005).

The second sets of limitations occur due to humans themselves. Humans vary by their health and resistance to toxic chemicals, which is also influenced by personal habits.

The complex interaction effect of several toxicants is difficult, if not impossible, to present quantitatively (Bailey and Newland 2001).

TEP values for some possible carcinogens and non-carcinogens are missing. It appears that the database of the website (Scorecard) has not been updated for some time. According to the Agency for Toxic Substances and Disease Registry (ATSDR) cobalt may be a carcinogen (2004), but no TEP value of cobalt is found in the Scorecard database. Sulfuric acid, corrosive by nature, is classified as a carcinogen by the New Jersey Department of Health and Senior Services (2008) but not by ATSDR (1999). No TEP values for carcinogenic or non-carcinogenic risks are available for the substance. In studies, sulfate ion has been used as a surrogate for sulfuric acid (see Ostro et al.1991), and hence TEP values of sulfate have been used to screen risks for sulfuric acid emissions.

The TRI inventory aggregates emissions release under the category of compound groups for each element. This leads to a few complications. TEP values of styrene have been used represent all form of styrene. No TEP values for any form of cancer risks are available for styrene, but styrene oxide has cancer TEP of 0.5 and 0.11 respectively for air and water releases respectively (Scorecard 2005). The non-cancer TEPs of styrene oxide is substantially higher than styrene. For all other elements, with the exception of mercury, compounds of the element have the same TEP score as element itself (Scorecard 2005). In this analysis TEP values for all types of mercury emissions are considered to be the same as the mercury. Hydrogen fluoride has been considered to be equivalent to hydrofluoric acid as recommended by both ASTDR and the EPA. In fact, gaseous or anhydrous form of the compound is potentially more hazardous than hydrogen fluoride in dilute water solutions (EPA 1998b).

The next under-estimation may occur due to missing data. It is not known whether the toxic release inventory was not reported by utilities or was not recorded by the EPA, but the raw data indicate that emissions for some HAPs maybe missing for a few years. For example, no air emissions for ammonia from Plant Miller have been recorded between 1998 and 2002. The missing data is not included in our analysis and no provisions have been made in this regard. Finally land disposal of carcinogens has been ignored because no TEP value of land releases is available.

Findings and Analysis

Tables 9-17 highlight the analysis of risks from coal-fired plants. There are a few direct observations which can be made. Firstly cancer risks posed by water releases are greater than risks for air release for all the power plants, except Lowman and Colbert. This is primarily because arsenic, which has high water TEP for cancer, is discharged in great amounts from all plants. This may indicate a phenomenon when air controls are operating at the expense of water controls.

Secondly Plant Miller has the lowest per unit air emissions and cancer risks among all the power plants. It is noteworthy that Plant Miller was penalized under the Clean Air Act regulations and had to install pollution control mechanisms, indicating that regulatory action can control toxic pollution. As a rule, annualized and unit cancer risks (tables 18-19) from both air and water emissions of toxins are high for all power plants, especially for Gorgas, Gaston, and Greene County plants, indicating insufficient control.

Non-cancer risks are especially high for all power plants primarily because mercury regulations are yet to put in control. Since all power plants except Gaston and Gorgas were built around the same era, it would be unfair to blame engineering specifications of boilers for variable risks.

III. MEDIA BASED DISCOURSES ON RENEWABLE ENERGY POLICY

Renewable energy policy is relatively a new idea for a country, which has traditionally relied on fossil based sources of power generation for almost a century. According to the Pew Center on Global Climate Change (2009), 36 U.S. states either have a renewable energy standard, alternative energy standards, or renewable energy goals. The states which did not have any renewable energy mandates were mostly states from the mid-West and the Southeast, including Alabama. Scientific opinions have claimed that a uniform national standard with clear guidelines would solve problems related to compliance and lead to an equitable impact on ratepayers (Sovacool and Cooper 2007).

Studies about renewable energy standards generally have been technical in nature or avoided examination of societal response to such policies. The first detailed scholarly analysis of renewable energy mandates appeared in 1996 (Rader and Norgaard). Since then, studies have evaluated the effectiveness of state level renewable energy mandates (Wiser, Porter and Grace 2005) and compared various policy tools to promote renewable energy (Menz 2005). Opinions about the effectiveness of renewable standards have been mixed (Wiser et al. 2005), but scholars note that renewable energy mandates may work well if they are supplemented with financial incentives (Menz 2005). One analysis of media based discourse on energy 20 years ago looked at the effect of mass media on public opinion about nuclear power and associated state policy (Gamson and Modigliani 1989).

As this thesis is being written, the United States is engaged in an important energy policy debate. The objective of this chapter is to understand how different actors have responded to the ongoing Congressional debates and how these responses reflect views which may influence policy. The attention is on Alabama, a state that does not have any preexisting renewable energy standards and a high dependence on coal-based energy. However, before we attempt to analyze the media based discourse on renewable energy, it is essential to have a basic understanding of the policy initiatives on renewable energy standards.

Legislative Initiatives

There are multiple legislative initiatives that hint at the future U.S. energy policy. Based on the Waxman-Markey bill (HR2454) which was introduced and passed in the U.S. House of Representatives, the important features of the policy can be understood. It appears that a climate change policy (in relation to the electric power sector) will aim at a two pronged strategy: increase renewable energy and reduce carbon emissions. However, these two policy approaches have witnessed a lot of comprises. Combined heat and power (CHP), and energy efficiency savings are likely to be incorporated in the renewable electricity mandates. According to the Waxman-Markey bill, electric utilities can meet targets of renewable energy generation by achieving energy efficiency or by incremental capturing of the waste heat in combined heat and power plants (CHP). Such savings can account for up to a third of total energy generation and may go higher under the provisions of the bill. The proposed legislation aims for a 20 percent renewable energy standard by 2029. However, amendments could reduce this figure to as low as 12 percent in a few states. Inclusion of large-scale hydropower, waste-based streams of power generation, biomass harvested from federal land, and use of carbon emission offsets, are other provisions which may make the legislation limited in scope, at least from the environmental perspective.

Methods of Data Collection and Analysis

The major sources used in this analysis were editorials and opinion columns appearing in both national and regional newspapers during the period of January 2009 to October 2009. There are some advantages in doing this. In the context of news media, editorials, opinion columns, or "letters to the editor" may be interpreted as solely opinions, and not facts (Fowler 1991). According to Fowler (1991) these articles employ both an authoritative as well as consensual tone in the discursive process (1991).

Yet the writers of these are not the same. Editorials are written by the editors and other staff of the newspaper. Opinion columns or letter to the editors can be written by anybody. The selection of opinion articles or editorial columns by itself has qualitative merits in understanding a policy discourse because studies reveal that newspapers editorials have some role in framing policies (see Ryan 2004). Though renewable energy policy is work in progress, the importance of editorials or opinion columns in framing the policy is worth investigating. Since the geographical focus is on Alabama, state- based news sources were given priority during selection. However to provide a broader and balanced perspective, related opinion columns and editorials in national and other regional media were also collected.

The sampling technique employed in selection of the news articles was purposive. Purposive sampling involves the use of expert judgment to select sources that are "typical" or "representative" of the population (Singleton Jr. and Straits 2005). The editorials/opinion columns were selected keeping the following objectives in mind:

1. The editorial/opinion column commented on renewable energy policy.

2. The editorial/opinion column discussed various policy options for carbon emissions/renewable energy.

3. The opinion column represented the views of officials and representatives from coal-mining industry, utility, policy-makers, and regulatory organizations. It was felt that a sampling technique to ensure diversity and balance in both the sources of editorials and opinions will be helpful in ensuring a comprehensive coverage of the policy debate.

For Alabama and Southeast based news media a keyword search using the words “coal” and “renewable energy” was conducted for the period of January 2009 to October 2009. A web resource known as *NewsBank* was used to collect the first set of articles. This database includes more than 1200 newspapers. The articles were screened to filter out editorials, opinion columns, or letter to the editors. Such materials were found in the following newspapers - *The Montgomery Advertiser, The Birmingham News, The Mobile Register, The Anniston Star, The Cleburne News, The Valley Times. The Athens Banner-Herald, The Atlanta Journal Constitution,* and *Knoxville News Sentinel*. The total number of opinion columns or editorials from Alabama and Southeast-based news media totaled 30.

For national editorials and opinion columns, archives searches of three influential newspapers, *The New York Times, The Washington Post,* and *The Wall Street Journal* were conducted by using the same words. This was followed by an internet based search using the Google search engine to find news articles from other regional news media. From this search editorials and opinion columns from *The Charleston Gazette* (West Virginia), *The Oregonian* (Oregon) and *The Richmond Times-Dispatch* (Virginia) were selected. The total number of opinions from national and other regional sources totaled 21.

A count of the fundamental positions (in favor or not in favor of renewable energy policy) of editorials and opinion columns revealed divergence between Southeast and national and other regional media. Eighteen out of the 30 editorials or opinion columns in the Southeast opposed a national renewable energy standard or a carbon cap policy, but only seven out of the 21 editorials or opinion articles in non-Southeast newspapers adopted the same position. One editorial in an Alabama based newspaper, *The Anniston Star*[1], was neutral and one opinion column (Rogers 2009) outside the Southeast news media did not take a particular stand. A list of the newspapers and number of editorials or opinion articles supporting or opposing Waxman - Markey Bill or its provisions is presented in table 20.

The articles selected for further analysis were organized by the main recurring themes, which were found to be the following:

1. Critiques of a national renewable energy policy
2. Support for cheap coal-based energy
3. Opposition to cheap coal-based energy.
4. Opinions about alternative sources of energy
5. Biomass and the South.

The views expressed in the newspaper editorials and opinion columns were evaluated in the light of peer reviewed literature. Issues such as climate change and environmental policy are under continual scrutiny. The effects of pollution and environmental change have become subtle and beyond the comprehension of empirical senses (Haajer 1995), and impact studies of policies have become increasingly reliant on modeling and simulation to predict the future. Hence a social analysis of energy policy related to environmental change cannot be considered complete by documenting only the comments expressed in public sphere.

[1] July 20, 2009. pp1.

Critiques of National Renewable Energy Policy

National

Some critiques in the national media were based on the social or economic concerns related to the energy mandates. Former governor of Alaska, stressed on the need to promote domestic energy sources raised concerns about job loss and the impacts on poor (Palin 2009), terming the cap-and trade policy as a tax and dead end. An editorial in *The Wall Street Journal*[1] noted that the bill defied the laws of economic and would impact the GDP of the nation adversely.

A few critiques were directed at the technical limitations of renewable energy. Two experts, including a former energy secretary, brought attention to the intermittent nature of solar and wind power, claiming that such technologies needed backup from fossil based sources (Schlesinger and Hirsch 2009). They also noted that with fossil backup such technologies will not be completely carbon-neutral. A Senator from Tennessee noted that renewable energy technologies such as solar or wind had a greater "sprawl" than conventional sources of generation like nuclear, coal, or hydropower (Alexander 2009). Hence they would occupy more land for generation than fossil or nuclear fuels (Alexander 2009). The Senator also noted that the increased generation of renewable energy would need the placement of solar panels or windmills in ecologically sensitive regions, calling it an "unprecedented assault on the American landscape"
(Alexander 2009). An energy policy analyst claimed that the promotion of "green jobs" will reduce jobs in the fossil-fuel producing sectors (Schulz 2009).

The following critiques were not related to fundamental intent of controlling carbon emissions but focused on the design of policy. An opinion column by Thomas Friedman and an

[1] June 26, 2009 (http://online.wsj.com/article/SB124588837560750781.html)

editorial in *The Washington Post*[1] stated that a carbon tax would have been a better policy (2009). Another editorial in *New York Times*[2] stated that the version of the Bill passed by the House is compromised and further comprises may be worse than no legislation. The editorial also stated that not including provisions to account for carbon emissions from corn based ethanol, and tariffs on imports from countries without similar legislations were two major flaws in the policy. Another editorial in the same newspaper (*New York Times*[3]) noted that the House version of the Bill does not set any carbon reduction standards on the older and more polluting coal-plants, warning that offsetting allowances may achieve little in the actual reduction of carbon emissions. Both the editorials stressed on a strong will to get the legislation passed in the U.S. Senate. An opinion column in *The Oregonian* noted that the grant of free allowances to polluters would defeat the purpose in achieving the desired reduction of carbon emissions (Blumm 2009). An opinion column in *The Washington Post* noted that since the bill does not address carbon emissions from transportation fuels it may ultimately increase U.S dependence on foreign energy because all the stationary generation sources use domestic energy (Parker 2009).

Southeast

As noted earlier, Southeast-based opposition to a national renewable energy policy was more apparent and strong, focusing on the economic and social impacts of the policy. The opposing opinions came from politicians, industry groups, and businessmen. A few clear strands of arguments emerged. Firstly, the high use of coal for energy generation would place consumers in the region at a disadvantage. Most of the opposing editorials or opinion columns called the new energy policy a tax on the customers in the region. Writing in *The Montgomery Advertiser*,

[1] June 26, 2009 (http://www.washingtonpost.com/wp-dyn/content/article/2009/06/25/AR2009062503469.html)
[2] July 1, 2009, pp. A32
[3] July 22, 2009, pp. A22

the leader of an Alabama-based lobbying firm, Partnership for Affordable Clean Energy (PACE), projected an annual cost of $380 million for the customers of Alabama (Brown 2009).

The argument of unbalanced costs for the customers in the region was based on the limitations of renewable resources in the region. In his editorial, “One Size Does Not Fit All,” Senator Richard Shelby argued that punishing the region for lacking natural resources was “unfair and economically unreasonable,” even under better economic circumstances (2009). All the editorials or opinion columns opposing a uniform renewable energy policy claimed that the region had limited wind and solar capacities and many questioned the exclusion of hydropower generation when capacities from other renewable generation sources were allowed to be calculated.

Some editorials offered a few other causes of challenges for the region. Alabama’s price for exporting electricity was noted by Robert S Weil II, a famous cotton entrepreneur, in an opinion column in *The Montgomery Advertiser* (2009). The entrepreneur claimed that the people of the state commute long distances by choice, increasing transportation emissions of carbon (Weil II 2009). The unique insight of the column was an alleged neglect of the contribution of Alabama’s abundant forest cover in carbon reduction, noting that other states had reduced forest cover for industrial growth in the past (Weil II).

Support for Renewable Energy

Support for renewable energy at both the national and regional news media converged on a few points. In the South, this support mostly came from members of environmental groups on arguments of a cleaner environment and the associated economic benefits of renewable energy.

One opinion column claimed that a healthy environment and healthy economy are mutually dependent (Dorgan 2009). A supportive editorial in *The Anniston Star*[1] noted that renewable energy generation in the region was limited to hydroelectricity and mandates were need to promote renewable energy. The program coordinator of the Alabama Environmental Council claimed that the United States, once the largest producer of wind mills and solar cells, had squandered its technological advantage (Dorgan 2009). The environmentalist warned that other countries will soon use U.S. innovations to compete in future global energy markets (Dorgan 2009). A similar view was expressed by the chairman of General Electric, who wrote that few of the leading manufacturers of renewable technologies in the world were American (Doerr and Immelt 2009). The column by the industrialist claimed that the proposed legislations would send strong signals for adoption and promotion of renewable energy technologies (Doerr and Immelt 2009). The strongest economic argument in favor of renewable energy mandates was made by a member of the Union of Concerned Scientists of America (UCSA) who claimed that Alabama residents could save actually hundreds of million dollars due to the policy (Deyette 2009).

At the federal level support for a renewable energy policy took a more balanced perspective of costs and opportunities. Citing reports by federal institutions, Energy Secretary Chu wrote in *The Richmond Times-Dispatch* noted that the mandates maybe achieved at low costs ranging from 22 cents to 48 cents a day (2009). His opinion was based on the report of the U.S. Congressional Budget Office (CBO) report that estimates an increase of $175 in the average household bill by 2039 due to the mandates. A joint column by a Republican and a Democratic Senator urged that energy bill should be passed because it strengthens the U.S. position in global

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[1] May 8, 2009.

negotiations on climate change and with suitable provisions impacts on domestic industries and consumers can be addressed (Kerry and Graham 2009).

Energy efficiency also found support from supporters of the mandates at the regional and national level. The U.S. Energy Secretary referred to energy efficiency as the "lowest-hanging fruit" (Chu 2009). However, opponents of the renewable energy policy did not pay any attention to the energy efficiency mandates. Under the present generation and consumption profile, the state of Alabama would be challenged to save energy thorough efficiency. A Washington based research group gave the state a rank of 48 among all the states for energy efficiency programs (ACEEE 2009), indicating little progress on the front. The EIA notes that a long summer and use of electricity for home heating during the winter months increases per capita energy consumption (2009a). More than the residential demand, controlling industrial demand would be challenging. Alabama has one of the largest industrial demands for electricity in the United States (EIA 2009a) and the industrial recruitment strategy of the state has been based on cheap and abundant electricity (Atkins 2006).

Support for Cheap Coal-based Energy

Most opponents of the national renewable energy policy in the Southeast did not elaborate on the high dependence for coal-based power generation in the region. Instead they chose to highlight the negative economic consequences of a uniform energy policy due to geographical disparities in renewable energy resources. Many referred to the energy mandates as a tax. An opinion column by the Tallapoosa River Electric Cooperative thanked all Alabama representatives for cutting along party lines and voting against the bill (2009). Another opinion column, by the president of Alabama's leading industry lobbying group (Manufacture Alabama) noted that only an affordable energy future is possible (Clark and Burkhalter 2009) .At the national level, an editorial in *The Wall Street Journal*[1] claimed that coal-reliant states will be severely impacted by the new bill and too many assumptions in the CBO report make it useless (2009).

A few opinion columns by the supporters of the bill, including important policy makers also supported emerging coal-based technologies. These technologies are scientifically called Integrated Coal-Gasification Combined Cycle (ICGCC) and popularly known as “clean-coal.” The combination of ICGCC with carbon capture and sequestration offers the possibility of controlling carbon emissions from coal-fired plants.

The support for clean coal was manifested in many forms within the editorials and opinion columns. Energy Secretary Chu voiced his optimism about the clean-coal technology (2009). The president of NRG Energy wrote that clean coal should be a “national project” but claimed that the adoption of the technology would be a challenge in the Southeast because the soil of the region was not suited for the sequestering carbon. Senator Lamar Alexander (member of Senate Environment and Public Works Committee) noted that coal has a lesser energy sprawl than renewable resources. Two other senators urged that the United States should aim to become “the Saudi Arabia of clean coal” (Kerry and Graham 2009).

Representatives of the coal industry and mine workers took a strong view on the proposed legislations. The president of UMWA was silent on renewable energy mandates but strongly favored giving more carbon allowances to coal-dependent utilities (Roberts 2009b). The UMWA president claimed that funding to ensure the “future of coal” was a positive but the Bill in its present form would not be endorsed by the UMWA (Roberts 2009b). The most critical comment against the bill came from the CEO of Murray Energy (the largest privately owned coal

[1] June 26, 2009 (http://online.wsj.com/article/SB124588837560750781.html)

company in the United States), who claimed that the Waxman-Markey Bill was the "most destructive legislation" in the history of the United States (2009).

The support for clean-coal marks an increasing turnaround within the realm of energy generation. However, opinions expressed in the newspaper editorials about "clean coal" differed from those written for a more knowledgeable audience. In an editorial in peer-reviewed journal, Secretary Chu noted that commercial deployment of ICGCC would take 8 to10 years by the most aggressive efforts (2009). In a testimony before the U.S. Senate, a representative of the National Coal Council said that clean coal technologies could only be realized by aggressive federal funding and support (Hollinden 2007). A report prepared by the Massachusetts Institute of Technology (MIT) compared various studies to present that electricity costs would increase by a minimum of 60 percent if clean-coal technologies were employed (2007). Apart from the costs, an EPRI official identified at least 10 technical and/or policy issues that need to be addressed before carbon capture can be commercialized (Phillips 2007).

The challenges associated with its commercialization or its feasibility notwithstanding, the possibility that IGCC will allow coal to dominate the realm of "renewable energy" is now a distinct possibility. The Alabama Legislature granted tax credits to "alternative" energy sources including clean-coal, but offered no support for solar, wind or biomass based power generation. Conventionally "renewable" or clean energy is defined by its source, which can be replenished and its environmental impact, which is minimal both for the natural environment and the human environment. However the emergence of new technologies and new policies seems to have redefined energy generation by "technology" marking a complete shift in environmental policies.

Opposition to Cheap Coal-Based Energy

In an opinion column, a member of Alabama environmental group called clean-coal business as usual (Dorgan 2009).An editorial in *The Anniston Star*[1] stated that West Virginia introduced laws that define waste coal and tires as renewable sources, urging Alabama not to adopt similar rules. Another editorial in *The Anniston Star*[2] noted that fossil based technologies will not remain cheap forever, and demanded that utilities in the South must clarify their position on renewable energy Discussion on the socio-economic impacts of coal- mining, or the public health impacts of coal production and consumption were very limited. Only one opinion column noted about public health impacts of coal (Lowry 2009).

In contrast to media-based opinions, contribution of coal to the welfare of mining dependent regions or communities is under scrutiny from scholars. Goodell (2007) notes that many coal-rich states have created an economic dependency for coal mining by not diversifying their industries and allowing political domination by the coal industry. However the exact contribution of the coal industry to the welfare of their dependent regions is slowly coming under scrutiny. This year, a lawsuit was filed against one of the leading coal companies in Alabama, Drummond Coal for supporting paramilitary groups responsible for killing several union leaders in Columbia. Columbia has become a very important centre for Drummond. Coal in Columbia is far cheaper to mine and wages to workers are usually 80 percent lower than the wages paid to an Alabama mine worker (Bacon 2001). Any mention of the coal mining industry in Alabama was conspicuous by its absence.

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[1] July 20, 2009, pp.6

[2] May 8, 2009.

Discourse and Power

. An opinion column noted that politicians and lobbyists have unified against the bill (Lowry 2009). Increasingly public thought is influenced by actors who have superior economic and political resources and the ability to uses communication and mobilization resources more effectively (Korten 2003). There is no better example of this than lobbying. Policies related to climate change, energy and environment have resulted in an unprecedentedly large number of lobbyists. A report claims that 140 businesses and organizations hired nearly 770 lobbyists for the climate change policy (Marianne 2009). Unfortunately, the dialogues between lobbyists and policy-makers are beyond the scope of any academic inquiry. Korten claims that the domination of public thought by corporations is contrary to the spirit of the U.S. Bill of Rights that places all the subjects of the United States on equal terms (2003). This is primarily because corporate organizations have their own vested interest and may concentrate more on protecting the rights of their investors. The Center of Responsive Politics (2009), noted that oil and natural gas companies, electric utilities, railroads, and mining companies spent far more on lobbying than renewable energy based industries and environmental organizations.

Even if it is theoretically assumed that publically available discursive resources are equal, power is not. Unequal power distribution may not produce an equal discourse. Since economically and politically powerful actors own the modes of production (in this case electricity generation), their opinions are more likely to be sought and appreciated. Ever since new scientific findings on climate change emerged the industry has used discursive resources in greater measure to neutralize their impact on public opinion (Freese 2003).

The importance of lobbying or discourse in energy policy can be understood by examining the efforts of the coal-utility industry to act as early as 1992 with the formation of

Center for Energy and Economic Development (EconomyWatch N.d.). A decade ago the industry created an advocacy group known as the America for Balanced Energy Choices to focus on general public opinion. These two groups were subsequently merged under the new name of the American Coalition for Clean Coal Electricity (ACCEE) which was again renamed as the America's Power this year (ACCEE 2009). The new name "America's Power" also suggests that its sponsors want to project the inevitability of coal as the major source of energy generation in the region. The organization is backed the major coal and electricity companies of the United States (ACCEE N.d.). The website of the new organization notes " the change in our name more accurately reflects who we are and our belief that technology will help ensure that coal remains a fuel of the future when it comes to meeting America's growing energy needs" (ACCEE 2009). The genealogy of the organization's development suggests that the coal-based interest have grown increasingly defensive as mandates for renewable energy became a distinct possibility.

The influence of the electric power industry against a national energy policy was noted by two Southeast based opinion column (Deyette 2009, Dorgan 2009) and one editorial in *The Anniston Star*[1]. Highlighting the economic positives of a national renewable policy for Alabama, a member of the UCSA noted that utilities in Southeast have resisted national renewable standards (Deyette 2009). Once renewable technologies are promoted and become more cost competitive with a larger and proven generation base, fossil based fuel technologies will be challenged to maintain their competitive advantage (Deyette 2009). The UCSA member claimed that Alabama spent almost $1.3 billion on imported coal (Deyette 2009). An opinion column by the member of Alabama Environmental Council (AEC) criticized the opposition of local businesses led to the new energy policy, claiming that a "healthy economy "and "healthy

[1] May 8, 2009.

environment" are mutually dependent (Dorgan 2009). An editorial in *The Anniston Star*[1] claimed that utilities were wary that increasing generation of renewable energy would reduce the worth of their existing fossil-based generation sources and break their monopoly in the energy market.

Alternative Sources of Energy

The debate also brought attention to the importance of other sources of energy. Two other important sources of power generation, natural gas and nuclear, found divergent degrees of support. Natural gas did not find any great measure of support and only one of the opinion columns spoke about the impacts the resource may have in the future. However an editorial in *The New York Times*[2] noted that natural gas produced almost half the carbon emissions as coal. Natural gas also has some direct advantages. Natural gas plants are more efficient than coal-plants, reportedly have lower emissions of toxins than coal-fired plants (EPA 1998a), and consume less water than coal and nuclear plants (World Resources Institute 2009). The disadvantage for natural gas is the volatile price structure of the industry. Natural gas can be put to variety of uses including home heating and transportation. The creation of a new alliance by natural gas producers (America's Natural Gas Alliance), and increased lobbying by the industry (Center for Responsive Politics 2009) suggests that the industry is likely to be more vocal in the future years.

Nuclear power was also supported by important policy-makers at the national level. Energy Secretary Steven Chu (2009), and senators across the political spectrum (Alexander 2009; Kerry and Graham 2009) advocated for an increased generation of nuclear energy. Most of the opinion columns against renewable energy mandates in the Southeast also supported nuclear

[1] May 8, 2009.
[2] July 22, 2009, pp. A22.

power. This included politicians (Shelby 2009; Rogers 2009), a member of the Georgia Public Service Commission (Wise 2009), and the Chief Operating Officer of the TVA (McCollum 2009) and the CEO of Duke Energy (Rogers 2009). The president of NRG energy claimed that that nuclear could become the "renewable of the South." However the challenges associated with nuclear power was not noted by their supporters. Nuclear generation has a very contentious history and many nuclear reactors were abandoned after projected costs were exceeded, leaving ratepayers to bear the stranded costs (Cooper 2007). Most financial institutions are unwilling to extend any credit to build large scale nuclear power, unless they are backed by federal guarantees (Cooper 2007). However, the GAO noted that extending loan guarantees to nuclear power plants should be done with caution (2008). Nuclear technology has traditionally been excluded from the definition of renewable sources of energy. However it may benefit from carbon emission laws. Since nuclear power generation is almost carbon neutral, their operators can save the maximum allowances in the long run, provided they are allocated those credits.

However the editorials supporting nuclear energy did not speak about the high costs of generation, and supported it as a source of clean and reliable power. Apart from cost barriers, nuclear power faces other risks in terms of proliferation of weapons, terrorist threats, and lack of competent and technical staff (MIT 2003). The biggest challenge to nuclear power is disposal of nuclear waste and currently there are no regulated sites to store nuclear waste. Also consumers may be forced to pay higher costs before new nuclear plants are operational. The state of Georgia passed a bill this year which allows Georgia Power to recover almost $2 billion from residential consumers before the completion of a nuclear plant (Williams 2009).

Biomass and the South

The only form of renewable resource which found a mention from the opponents of national renewable energy policy in the Southeast was biomass. However, two opinions (Brown 2009; Benefield 2009), claimed that increasing use of biomass resources for power generation would adversely affect preexisting forest products based industries, particularly the pulp and paper industry. There was also one strong opposition for increasing biomass based generation at the national level. An editorial in *The Washington Post* [1] claimed that clear cutting of forest land to grow biomass for energy generation would defeat the purpose of the mandates.

Better prospects for biomass based power offered by a member of the UCSA (Dyette 2009) and a member of Southern Environmental Law Center (Smith 2009). They claimed that biomass resources were plentiful in the region and their use in energy generation could be beneficial. An Alabama Senator, though opposing the mandates, wrote that greater promotion of biomass based energy is needed (Rogers 2009).

Conclusion

The discourse on renewable energy policy indicated some dichotomy and convergence between national and regional priorities. Local newspapers are in ambiguous position, needing to provide a voice to different views but also directly interested in economic growth to maintain and grow circulation and advertising revenue. The opposing views in Alabama newspapers levels were more centered on the short-term socio-economic impacts of renewable energy policy, whereas national opinions concentrated more on technological aspects. It was interesting to note that politicians, lobbyists, and industry groups from Alabama were unanimously opposed to the new energy mandates. Their choice of words directly aimed at influencing public opinion.

[1] June 17, 2009 (http://www.washingtonpost.com/wp-dyn/content/article/2009/06/16/AR2009061602796.html)

Carbon reduction policy was referred to as a “tax”. Audiences at the regional level were warned of the rising costs and the bias of policy towards the regions of the Northeast, whereas the wider societal audience was reminded of the technological limitations of the renewable energy. However the support for large-scale technologies including “clean-coal” and “nuclear” from policy makers and industries suggests that a discursive-coalition has been formed which aims to perpetuate the concentration of the modes of power generation. Lack of opinions about the impacts of coal-mining on occupational safety and dependent communities, and on public health indicates that energy policy is getting detached from local and important environmental, and social concerns. This may work to the benefit of large scale generation techniques and to the disadvantage of renewable energy sources.

IV. BIOMASS-BASED ELECTRICITY: CHALLENGES AND OPPORTUNITIES

Existing Developments and Studies

The Public Utilities Regulatory Policies Act (PURPA) promotes biomass based power generation in the United States. As a part of the National Energy Act of 1978, it was meant to encourage greater production of renewable energy. This law created a market for independent power producers, mandating electric utilities to buy power from these producers at their "avoided costs", or the cost the utility would incur if it were to generate renewable power itself. PURPA was a very limited success in the United States. Since electricity markets are mainly regulated by state laws, enforcement or promotion of the act was left to individual states. The earliest growth in biomass based electricity generation occurred in California where a biomass based capacity of 1000 MW was established by 1994 (Morris 20003). Deregulation dealt a blow to the industry in the state. Elsewhere in the nation, generation capacity was very limited. It may come as surprise that Alabama leads the nation in renewable energy from wood biomass (EIA 2009b). However, Most of this generation is limited to pulp and paper mills or forest products industries which use their residuals for generating power. Concern about greenhouse emissions from coal-fired plants, successful experiences in some European countries (Sweden, Finland), high initial estimates of biomass feedstock (Haq 2002, Perlack et al. 2005), and the possibilities of rural development by bioenergy markets have raised hopes that electricity generation from biomass would soon become a widespread technology.

One of the earliest stimuli of biomass based power generation was the possibilities associated for cogeneration of electricity from coal with biomass. Several studies looked at the technical challenges of commercialization of co-combustion of coal with biomass (Tillman 2000, Baxter 2005) and the associated policy issues (Hughes 2000). Studies have also concentrated on finer analyses of biomass conversion technologies (Sondreal et al. 2001), life-cycle carbon emissions from biomass based power generation (Mann and Spath 2001) and review of the biomass based electricity generation sector (Bain et al. 2003). However, no study conducted a comprehensive examination of the possibilities or challenges of biomass based electricity in specific regions. This analysis aims to describe the key possibilities for biomass based electricity generation in Alabama.

Since the bioenergy sector is far from showing any positive growth in most regions, studies on social impacts have been very limited. The sole effort that looked into the possibilities of developing biomass based power in Alabama explored the possibilities of co-firing coal and biomass (U.S. Department of Agriculture 2005). The study concluded that enough biomass was available to replace 5 percent of coal-based energy, and the associated market potential of the feedstock itself was put at $105 million. However policy changes and emergence of new industries within the bioenergy sector have necessitated a reevaluation of the possibilities associated with using biomass to generate energy.

There has been a rapid rise and fall of commercial interests in cellulosic biofuels within the state. Interest the cellulosic ethanol industry emerged in response to high prices of gasoline and critiques of using food grains for ethanol production. The federal government also mandated the Renewable Fuel Standards for biofuels with increasing goals for the cellulosic variety. The opportunity was aptly used by some for understanding the prospective growth of the transportation fuels sector in the Southeast. In their analysis of the prospects of the emerging biofuel industry Bailey et al. (N.d) find that the biofuels mandates may add 2,661 jobs and nearly $450 million to the economy of Alabama. However in order to maximize the benefits the emphasis should be on the distributed location and ownership of generation facilities (Bailey et al. N.d). Elsewhere in the nation an evaluation of social impacts through stake-holder's perception of the Chariton Valley Biomass Project in Iowa revealed diverging opinions about the future prospects of the industry (Meyer and Hinrichs 2007). Though refiners and bioenergy experts expressed hope, farmers were uncertain about the economic prospects of the industry (Meyer and Hinrichs 2007).

Predicting the associated impacts of growth of any emerging industry is a challenge, more so for the energy sector. Unlike other industries which have more specialized inputs, the energy sector is more likely to draws its resources from a variety of industries. Since the base of any emerging bioenergy related industry in Alabama is likely to be the timberland of the state (Dyer, Bailey, and Teeter 2009), the constraints and potentials of the industry are likely to affect stakeholders involved in forest industries, including loggers and landowners. Existing research suggests that these stakeholders have not been benefitted by the existing forest products industry. Diversity of ownership, and unpredictability about structural changes in the pulp and paper industry, has created capital constraints for small loggers in Alabama (Bliss and Flick 1994). Owners of small timberland and their produce are increasingly being left out of commercial markets due to capital intensive harvesting techniques and structural changes within the market (Bailey et al. 2004).

Studies on the impacts of other forest-based industries, such as pulp and paper industry, have been not been very positive about the accompanying social impacts. Joshi et al. (2001) note that tax breaks granted to the industry caused significant underinvestment in human capital. In another study, Bliss and Bailey find that forest dependent communities in Alabama were poorer than other regions (2005). The documentation of the potential impacts of biomass based electricity generation on the community will be useful to understand the opportunities for community development, and avoiding the constraints that may have be associated with other forest-based industries in the state.

Methods of Research

A review of the scientific literature was conducted to identify the existing opinions about the prospects and challenges of biomass based energy generation in the United States and Alabama. General and technical challenges are well highlighted by existing scientific evaluation (Hughes 2000, Baxter 2005). Based on the scientific review, semi-structured interview schedules were prepared for variety of experts related to bioenergy development. This methodology is based on approach adopted by Dyer et al. (2009) in their study on the emerging cellulosic ethanol sector in Alabama.

Interviewed experts were knowledgeable about biomass harvesting, feedstock processing, conversion technologies, energy crop production, economics and the logistics of the forest products industry, extension services, and environmental issues. Face to face interviews were conducted for all the experts. In order to get the most comprehensive insight, officials of regulatory agencies for electric utilities including Alabama Public Service Commission (PSC), and the ADEM, were also approached. To understand the potentials and constraints of commercialization of biomass based electricity generation, opinions were sought from the largest electric generator in the state, APC. Unfortunately interviews with APC or the PSC officials could not be scheduled in person so responses were obtained in the written format. Telephonic interview was conducted with ADEM representatives.

There was a limited possibility for using any sampling technique for interviews with representatives of ADEM, PSC, or APC. Officials from these organizations were selected by representatives of the respective organizations and their identification of the most suitable source of information. It is suspected that the politicized nature of the emerging renewable energy policy may have influenced the response of a few individuals. However an attempt has been made to present their views as objectively as possible.

Snowball sampling technique was used in selection of bioenergy experts. In snowball sampling, when members of the target population are located they are asked to provide information about other members of the population, who are then contacted for information, and the similar process is repeated (Singleton and Straits Jr. 2004). The first few experts were selected from the publicity about the Natural Resources Management Development Institute (NMRDI) at Auburn University. NMRDI is one of the premier research institutes on bioenergy generation in the Southeast, and has a wide variety of experts in its rank. The first interviewed researchers were asked to identify other researchers who could provide relevant information, and so on. All but one interview with the experts were recorded using a voice recorder. The interviews were stopped when there was a saturation of information from the experts. The total number of interviews with experts totaled 23. Two follow up interviews, one with a PSC representative, and another with a policy maker on bioenergy was done by electronic mail. The number of interviews by various methods totaled 28.

Valuable insights were also gained from attendance at professional and academic seminars.

Findings and Analysis

Available Technologies

The analysis begins with a review of available technologies. Most of the research on bioenergy development is centered on technology and hence it is essential to understand the available technologies and their scope. According to the EPA (2007b), technologies to convert biomass to energy may be classified according to decomposition method or platform (thermochemical, biochemical), by process specifications (combustion, gasification), and by engineering design specifications (updraft gasifier, downdraft gasifier, fluidized bed gasifier). Since the analysis focuses on the challenges of bioenergy in its entirety, discussion of technology is limited to three main generation systems. The term bioenergy is used here in reference to generation of electricity. Technologies being developed to generate biofuels are beyond the scope of inquiry. According to four experts, the market is waiting for the "winning technology" or the most cost effective technology in nominal terms, though one forest industry and biomass logistics expert was confident that transportation fuels would be the dominant products in the future.

There are currently three available types of biomass based electricity generation systems:

1. Modular Systems - The National Renewable Energy Laboratory (NREL) defines modular systems to consist of a fuel processor and an electric generator with a net capacity ranging between 5 kW to 5 MW (2002). This kind of system also provides an opportunity for establishing a CHP system to capture waste heat for greater energy output. Using simple conversion technologies modular systems can be used for onsite power generation at industrial facilities, and on farms where there is a cost associated with disposal of waste biomass.

2. Cogeneration systems - The popular nomenclature denotes cogeneration as CHP systems. However the term cogeneration as it is used here is for systems where coal is used in combination with various forms of biomass to generate electric power. Cogeneration systems are applied to replace energy output supplied by coal at existing coal-fired power plants, where the proportion of energy generation by biomass is renewable. Scientific opinions claim that a 15 percent replacement of energy generation of coal by biomass is technically possible (Baxter 2005), but the market adoption of the technique has been very slow.
3. Biopower systems – Larger capacity power plants where electricity is generated from biomass fuels alone are called biopower systems.

Technical challenges with the three biomass generation systems are not mutually exclusive. As a general reference Baxter (2005) identifies the following challenges with regard to cogeneration:

1. Feedstock preparation, storage, and delivery.
2. Ash deposition on boilers.
3. Fuel conversion (or processing).
4. Pollutant formation by chemical interaction during biomass and coal combustion.
5. Corrosion of boiler by chemical reactions during biomass coal combustion
6. Coal-biomass combustion ash utilization.
7. Impacts on resulting emissions on selective catalytic reduction systems (SCR) that control emissions of nitrogen oxides.
8. Formation of striated flows (or unequal mixing of resulting gases from combusting coal and biomass)

The first three are common to all types of biomass feedstock. Speaking about the challenge of bioenergy generation, two experts working on conversion technologies and a third expert on processing technology raised similar concerns. The high bulk density of biomass, high ash content, and the unstable nature of biomass ash at higher temperatures were some of the concerns raised by the experts. Low bulk density increases the transportation costs. The maximum feasible transportation distance for biomass feedstock is recommended at 50 miles (Wiltsee 2000). If bulk densities are to be increased, then additional energy inputs are needed, raising overall prices of biomass. High ash content causes slag to form in boilers because biomass ash may melt at lower temperatures than coal ash. The range of biomass ash content as identified by scientific literature varies from 0.1 to 15 percent and agricultural residues typically have higher ash content (Biomass Technology Group 2005). Speaking about the experiences with a mobile gasifier at Auburn University, an extension engineer and a gasification expert concluded that various feedstocks including agricultural residues were being tested for gasification. Most of agricultural residues were amenable to gasification, but chicken litter and human waste were presenting challenges. Ash content and obnoxious vapor from human waste were the main concerns from the two sources, respectively.

The last five concerns identified by Baxter (2005) are more technical in nature, and need to be resolved at the plant level. A report by Southern Company (2008) outlines a few boiler related technical challenges at demonstrational co-firing tests conducted in 2007. Two experts (one on energy crops and another on biomass harvesting and processing) who have been closely involved with demonstrational cogeneration tests of APC at Plant Gadsden confirmed the results of the report.

The expert associated with switch grass co-firing concluded that there were technical concerns, but they could be addressed. The major concern was the low bulk density of switch grass and hence the fuel occupied considerable space in the boiler. According to him, roughly, for cogeneration to produce 10 percent energy, switchgrass would occupy 50 roughly percent of the boiler. A solution could be densification of the fuel but that would require additional inputs. Storage and handling was another big challenge. Coal-fired plants are equipped to handle and store coal but not biomass. Switch grass and its "friable" nature made movement of the feedstock on the conveyor unpredictable. Switch grass also contains silica and potassium which may cause deposits on the boilers. A gasification expert had also noted that the presence of heavy metals in both coal and biomass and their interactions in the boiler was a relatively unexplored area. The expert with experience on switchgrass cofiring suggested that gasification was the best technology to generate energy from the crop.

The second expert with experience on trials for cogeneration noted that wood chips of size ¼ inch had emerged as the best choice for cogeneration by a process known as "co-milling" where biomass and coal are fed separately into the boiler. However the expert was uncertain if the APC would adopt the technology adding that the power company was reluctant to get into feedstock processing. Wood, like switch grass, would also require greater boiler volume for effective cogeneration. A test suggested that wood may require almost 35 percent more volume than coal with an equivalent weight (Southern Company 2008). The second expert also noted that success at Plant Gadsden did not automatically translate into replication of cogeneration at all the other coal-fired plants of APC. Different plants operated by the company had subtle operational and technical differences. APC's written response to the interview questions suggested that the utility may be considering all types of possibilities, including building new plants, “repowering” or changing some of its plants to operate on biomass alone, and cogeneration. Since the utility did not specify any single technology it would be very difficult to concentrate this study on a single technology and present its merit or demerits. Cogeneration would require a capital investment for boiler modifications and fuel handling. Cost estimates ranges from about $119 to $273 per kWh of the biomass capacity, depending on the type and size of the boiler (EIA 2009c).

An important factor affecting all technologies is related to efficiency or energy output to input ratio. Commenting on combustion-based technologies, a biomass gasification expert and a mechanical engineer agreed that coal-fired plants will have better efficiency than cogeneration or stand-alone biomass power plants. Efficiency is a crucial aspect for all forms of electricity generation and is a major contributor to market adoption of any technology. Scientific opinion supports the view that cogeneration would result in minor or negligible loss of efficiency (Tillman 2000, Hughes 2000). However, at a seminar in 2008, an electric industry official stated that cogeneration tests had resulted in some efficiency loss. Reports by the utility suggest that boiler efficiency was unaffected if 15 percent of coal by weight was replaced with wood (Southern Company 2008). A bioenergy logistic expert associated with the cogeneration tests also noted that efficiency loss was a concern because existing coal-fired plants of the utility met the base-load demand. However the report on cogeneration evaluation by the utility did not report any boiler efficiency loss at the 15 percent level (Southern Company 2008).

Written responses of APC representatives state that the utility is looking at variety of possibilities including cogeneration and converting its power plants to run biomass on alone. Studies of APC also include research on utilization of biomass-coal ash for cement manufacturing and impact of cogeneration on SCR (nitrogen oxide control) systems. Preliminary tests suggest that coal-biomass ash is identical in physical properties to coal ash and the problems associated with meeting ASTM International (ASTM) standards could be resolved by management (Baxter 2005). Since coal-ash is extensively used for cement manufacture until the issue of ASTM standard is resolved, it will be a significant challenge for cogeneration. Impact of cogeneration on SCR systems is another challenge because utilities would not want to violate air pollution control laws.

In their review of the biopower industry Bain et al. (2003) note that modular systems and gasification based systems would be future of biomass technologies and existing standalone direct combustion biomass plants were constrained by low capacities and poor efficiencies. However Georgia Power, the leading electric utility of Georgia, is converting one its power plant to biomass. A utility expert working on the conversion stated that the technology was not new and was being used by pulp and paper mills. The following were the main technological changes as noted by him:

1. Installation of a wood grater at the base of boiler.
2. Installation of a wood handler (conveyor belt) to lead the wood into the boiler.

A press release by the utility suggested that there is abundant biomass within the close proximity of the plant (claimed at 12 million tons surplus), which may require almost 1 million tons of feedstock (Georgia Power 2009). This suggests that there are no technological obstacles to convert coal plants to biomass plants. However the plant would lose efficiency from 120MW to 96 MW. It appears that “repowering” or retro-fitting has now become an important corporate policy. However, detailed costs of converting facility are not available for this technology. A press release by First Energy, an Ohio based utility, announced a plant conversion of 312MW coal-based capacity to biomass at a cost of $200 million (2009). If these numbers can be used as a reference, "repowering" may cost more than $600 per kWh under present market values.

Moving towards modular systems is another important direction in energy policy. Three experts were hopeful that agricultural waste could be used for modular or "distributed generation." Researchers at NMRDI are working towards promoting a mobile gasifier of 25kW, which could be used for onsite power generation. According to one extension engineer, the product has created enthusiasm among farmers for its novelty and its ability to display biomass based power generation techniques. It is mostly used for extension and educational purposes and capital costs are prohibitive. The gasifier costs around $200,000 and has yet to be marketed for retail sale. The life expectancy of the gasifier cannot be predicted but maintenance costs were expected to be low. Costs for collecting feedstock and operating the gasifier also need to be considered. According to an extension engineer, the gasifier may generate electricity at a cost of 30 cents per kWh (for input cost of biomass at $35 per ton) when retail prices for electricity in Alabama were between 6-11 cents.

These constraints notwithstanding, there are some benefits which make modular systems attractive in the future. Average efficiencies of modular systems are reported to exceed 60 percent (Biomass Technology Group 2005), and they offer the prospect of capturing waste heat. The extension engineer concluded that the mobile gasifier can work on sites where there is a cost associated with the disposal of the residue. He hoped that if famers are able to sell the electricity back to the grid they may be more receptive to the technique. The version of the new energy bill passed by the House (Waxman-Markey) will provide 3 renewable credits for distributed generation from renewable sources. Any facility with a capacity less than 2MW (not using combustion processes), and all types of units with a maximum possible capacity 4 MW can qualify as a distributed unit. The gasifier can use most types of agricultural residues but poultry litter has produced challenges because of high ash content. Tests with human waste have been a failure, more so because of unpleasant and obnoxious odor.

Some of the other constraints are more related to policy. Distributions of the costs to construct gridlines to remote areas and maintain those lines have to be considered. Experiences in California suggest that regulated utilities have been very protective of their investments in transmission and distribution infrastructure and have been reluctant to share such benefits without a recovery of their “stranded costs” or investments. Nonetheless the premium set for distributed generation needs to be explored in its fullest.

An expert working on gasification technologies concluded that as long as coal-fired or biomass-fired plants are based on internal combustion engine, thermodynamic limitations of the system will affect efficiency. Another mechanical engineer expressed skepticism at industry reports that new gasification based coal plants will improve efficiency. Hence modular systems hold an advantage over large generation systems due to their high efficiency. However long-term prospects may also lie in technologies which have not been commercialized, including gasification plants. High capacity technologies are also affected by their rising costs. Costs for bioenergy plants based on existing technologies have increased to beyond $3000 per kWh (EIA 2009c).

Research is being done to improve energy content of biomass fuels which could substantially improve the energy content of feedstock and hence generation systems in the future. Torrefaction is a process which pelletizes and increases the energy content of biofuels. Experts at NMRDI were not doing any research on torrefaction. However an expert on conversion technology pointed to a company in South Carolina which was using an innovative technology to torrefy biomass at costs of $45 a ton.

Research at NMRDI are working on alternative processes like "fractionalization" where wood or other sources of biomass are separated into their three major chemical components, cellulose, hemi-cellulose, and lignin. The possibilities of bringing new fuels into the generation systems are also being explored. Hence pecan halls, corn stover, peanut shells, and municipal solid waste (MSW) have caught the attention of researchers. A biosytems engineer suggested a future with uniform feedstock in pelletized, form which could be purchased like petrol and gasoline, or traded at commodity exchanges.

A review of the opinion of technical experts suggests that the future of biomass generation technologies may lie in gasification and most of the research on conversion technologies is headed in that direction. In the gasifying process, biomass feedstock is chemically decomposed into various compounds to a form synthesis gas (primarily hydrogen, carbon monoxide, and oxygen) (Demirbas 2004). Biomass gasification is also promising because the synthesis gas or "syngas" produced from conversion of the feedstock can put to a lot of variable uses including heat and power, transportation fuels, and commercial chemicals. From the opinions of researchers and experts on conversion technologies at NMRDI it appears that the future focus of research will be on the clean-up of synthesis gas and analyses of its composition. Several pollutants and impurities in the syngas need to be removed before gasification technologies could be ready for commercial deployment. The analysis of synthesis gas from different feedstock, particularly agricultural waste to find their energy capacities was an issue identified by a graduate researcher.

Policy

Policy initiatives which limit or constrain the growth of biomass are very important because policy is an important driver of environmentally beneficial technologies. Since most of the established electricity generation technique in Alabama is based on fossil and nuclear power it was evident that policy initiates are needed to promote bioenergy generation. Due to rising concerns of climate change and emission of greenhouse gases most states have established renewable energy mandates. However, Alabama has no policy to promote renewable energy generation. Most of the generation capacity in the state is owned by a single utility, APC. Due to the existing model of regulated and investor-owned utilities in Alabama, both state and utility policies need to be understood. The analysis here is not limited on the mandates and their implications for electric operators but their role in the future increase of biomass based power generation is important .

As this thesis is being written, federal energy policy is being debated in the U.S. Congress. The discussion which follows is based on the Waxman-Markey Bill which was passed in the House of Representatives. By definition in Waxman-Markey Bill, operators who sell 4,000,000 megawatt hours of electric energy to electric consumers for retail purposes need to meet renewable energy mandates. One megawatt hour of renewable energy generation will count as one renewable energy credit. At the end of year, utilities must have renewable credits equivalent to the mandated levels of generation. Only two generators in the state, APC and the TVA, are required to meet the mandates according to the definition in the Waxman-Markey Bill.

The law also designs flexibility of compliance, as noted in the previous chapter. If operators cannot meet the targets on their own they can purchase renewable energy credits from certified operators and the federal government. However there is a distinction between purchase of credits from federal government and other operators. If credits are purchased from the federal government the money would come to back to the state for investments in energy efficiency measure. If credits are purchased from other operators, the money may go out of the state. The Waxman -Markey bill also designates an important authority to state regulatory institutions. PURPA has been amended to authorize the state legislature or the equivalent electric regulatory authority to set rates for sale of electricity by independent and distributed generators to commercial utilities in a state. This raises hope that in the future independent power producers and modular systems with distributed generation can sell electricity to large scale operators.

The Alabama PSC has authority only over APC. The Commission did not directly answer the question of making rules for independent power producers or on policies for promotion of renewable energy. However the responses of the PSC suggest that APC will have to obtain the PSC's permission to retrofit it coal-fired plants to use biomass. According to PSC representative "prudently" incurred expenditure may be considered for reimbursement. Hence the utility has the option of shifting capital costs to the rate-payers. The utility did not directly respond to the question of possibilities of increasing its generation profile, or the projected increase in renewable energy. All possible forms of renewable generation were listed as part of the utility's plans. The TVA, the other major operator in the state, has announced more concrete plans, to increase its renewable energy portfolio to 2000 MW by 2011 and to 50 percent of its net generation capacity by 2050 (2009). It remains to be seen how much of this energy would come from Alabama based sources. Little effort has gone to harnessing solar power in Alabama and no independent bioenergy projects have been announced in the state. If these targets are met, it is likely that most of the energy supplied to the federal utility would come from sources located outside Alabama. From a media release of APC, it appears that the utility is to looking to purchase renewable energy credits and carbon allowances, indicating that it is preparing for a failure to meet the energy generation standards on its own (2009). In such an eventuality the federal renewable energy credits would come at a cost of 2.5 cents per kWh, though credits from the open market may be more expensive.

Another set of regulatory and policy obligations relate to environmental controls. The Alabama Department of Environmental Management (ADEM) responded by stating that all new plants would have to undergo some permitting process, though the ADEM as such does not have any specified standards for air emissions from power plants. ADEM administers rules for air quality and pollutants irrespective of their sources. According to an ADEM administrator on air quality, the rule that applies to existing power plants, and will apply to new plants, is the Prevention of Significant Deterioration (PSD) rule. This rule applies to new sources or major modifications at the existing sources when the sources are located in areas where the National Ambient Air Quality Standards (NAAQS) are not applicable (EPA 2009). Since most existing coal-fired power plants in Alabama are exempt from meeting the most stringent provisions of the Clean Air Act and the New Source Review (NSR) rules have been significantly relaxed, environmental permits and rules may not be a huge concern for biomass operators. However, the ADEM administrator concluded that opacity standards (used as surrogate for particulate emissions) have been a contentious issue. Since six minute averages are used to calculate the opacity standards power plants have been found to be in violation of such standards. Biomass combustion can increase fine particulate emissions, and hence meeting opacity standards could be a challenge for their operators. In the past the ADEM has requested the EPA to relax the opacity standards without success. Expert opinions claim that particulate emissions from wood may be controlled through standard emission control systems (Bergman and Zerbe 2008), but it is unclear if existing technologies can meet the standards by EPA. Recently, at a seminar, an environmental officer of Southern Company stated that the EPA is expected to establish MACT standards for industrial boilers in 2010. He noted that these standards will have a significant impact on environmental controls for power generation

One of the long standing barriers identified in increasing biomass based power generation has been economics (Hughes 2000). Since biomass has lower energy content than fossil fuels, it is not possible to produce equivalent amount of energy from the two sources. However one forest policy expert and bioenergy logistic expert were both hopeful that with rising costs of coal, wood may become more cost competitive with coal in the future. A lot also depends on how the federal or state financial incentives for biomass based power generation would be provided. Most experts did not pinpoint to any particular incentive. Financial incentives to operators would help make biomass based power projects economically attractive and help operators stabilize their operating costs and attract credits. Construction costs for new power plants have increased at an extraordinary rate over the past several years and capital costs for standalone bioenergy plants are projected to be in excess of $3,000 per kW, greater than those for "clean-coal" plants (EIA 2009c). It must be noted, that though "clean-coal" is still an unproven technology, bioenergy plants have reached a stage of commercial deployment (National Academy of Sciences 2009), provided they have the adequate resources.

There are no reasons to believe that building new bioenergy plans in the state would have any less multiplier effects than nuclear or coal-fired plants. However financial incentives for biomass based generation have been very limited. The Alabama Legislature granted potential tax credits worth billions of dollars to large hydropower, coal and nuclear power plants under the Alternative and Renewable Energy Act of 2008. Biorefineries producing transportation biofuels for all possible range of feedstock have also been awarded tax credits. Financial incentives for biomass power plants by the state government are conspicuous by their absence. A forest-policy expert noted that entrenched coal interests in the state may limit the possibilities and incentives for energy generation from biomass. In the neighboring state of Georgia, as many as three biomass power plants have been announced in 2009 but not a single project was announced in Alabama, though the states have similar energy markets and resource bases. An expert on logistics of bioenergy plants explained these differential developments by claiming that Georgia foresees excess demand in the coming years and hopes to add to the demand by renewable sources. In Alabama energy producers are already overcapacity and export electricity to other states. Hence, the construction of new energy plants will not be market driven, but policy driven. In this capital constrained economy new bioenergy ventures are struggling to get financing from credit institutions. Credit institutions were more reluctant to provide prospective bioenergy ventures without long-term purchase agreements for feedstock.

An expert on switch-grass noted that biofuels ventures in the state have been a failure so far. Several biorefineries went out of business before commercial generation and recently the lone wood pellet producer of the state (located in Selma) filed for bankruptcy. A new program announced by the DOE under the American Recovery and Reinvestment Act (ARRA) provides loan guarantees worth $8.5 billion to fund new renewable energy and efficiency projects. However technical requirements are stringent and the emphasis would be on “new technologies” that have not been commercially deployed. Biomass has been included as a renewable source and gasification technologies may be the best bet to qualify under the scheme.

Other federal incentives for renewable energy also pale in comparison to credits for transportation fuels. Presently closed loop biomass generation facilities can qualify for 2.1 cents credit and open- loop biomass generation can qualify for 1.1 cent credit subject to operational dates. It is interesting to note that technological requirements have not been set for cellulosic biofuels where credits are multiple and higher. Cellulosic ethanol is promoted by a $1.01 blenders' credit and according to a biomass logistic expert could gain from the trading of renewable identification numbers (RINS). Established under the RFS, RINS are a unique set of numbers which indentify the production, transfer, or sale of transportation biofuels. When the benefits are stacked up, transportation fuels enjoy an overwhelming financial advantage.

The dichotomy between classification of "open" and "closed-loop" generation has been a long standing conundrum for biomass generation. A closed-loop process is defined as a process in which power is generated using feedstock that is grown specifically for the purpose of energy production. Open-loop process defines a process where all types of biomass may be used for generation. According to scientific opinions the reasons federal policy has placed a premium on naturally grown forests are contentious (Baxter 2005). Since plants absorb biomass during growth the carbon balance is unchanged. The primary concern should be sustainability of forests, though one expert pointed at sustainability having variable definitions. If sustainable meant the number of trees, most forest and harvesting related experts were convinced that it was not an issue in the short run, at least in Alabama.

One major unresolved issue of policy is the potential environmental benefits of the two industries within the region. It appears that the national focus has shifted more towards transportation biofuels. The most recent report by the National Academies of Sciences notes that DOE has abandoned its focus of bioenergy in favor of liquid fuels (2009). Scientists have greatly debated the energy inputs and the life cycle balance energy balance of various generating sources. Like all model based studies, these appear highly sensitive to definition and accounting of inputs and outputs. An agronomist noted that energy balance for fossil fuels is greater than biofuels. However, there may different types of biofuels, whose energy balance will differ. According to an expert on conversion technologies, cellulosic ethanol can have range of energy output to input ratio depending on the feedstock and technology, ranging from 2 to 20 times the energy input. According to Pimentel and Patzek (2005), ethanol production from all types of feedstock, cellulosic or starch, results in negative energy balance. However another study refuted such findings, claiming ethanol in general has positive energy balance and cellulosic ethanol is more promising than corn-based ethanol for net reduction in greenhouse gases (Farell et al. 2006). Comparisons have also been made about the energy efficiency among bioenergy products and recent a recent study revealed that production of electricity from biomass leads to greater carbon offsets and efficiency than transportation fuels (Campbell, Lobell and Field 2009).

Resource Potential

From most of the interviews conducted it was evident that the existing resource base of the state would be stretched to meet the demands of renewable energy mandates. Alabama has good stock of timberland, which can be an important feedstock for bioenergy generation. However, wood availability for biomass generation is limited by proprietary issues and existing market structure. Due to the abundance of wood, water, cheap labor, and aggressive economic incentives by the state, Alabama has a well established but a struggling wood products industry. Alabama has at least three major industries which may compete with bioenergy industries. The first industry is the solid wood products industry which uses large diameter timber for housing and construction purposes. The next major industry is the pulp and paper industry, which uses small-diameter greenwood timber for manufacturing pulp, and is also looking at possibilities of using internal as well external residues for generating bioenergy. Finally the state also has a set of mills that make pulpwood and oriented strand board for construction.

In Alabama the potential for production wood based biomass is very high. Since most experts concluded that wood will be the most important renewable resource, a major focus has been on the resource potential of wood. Alabama has a forest cover of almost 22.7 million acres (Alabama Forestry Commission 2009). The timberland inventory within the Southeast has remained very stable. Low market demand and fragmentation of land ownership has affected the rates of timber exploitation in the region (Bailey et al. 2009). According to the most recent estimates, the worth of energy content of Alabama timberland is second only to Georgia (Southeast Agriculture and Forestry Energy Resources Alliance 2009). However, the measure of the resource potential for bioenergy generation cannot be provided by a simple examination of timberland stocks. The unanimous opinion of forest-related experts concluded that all types of harvested wood or wood residues in Alabama have some existing market, but there is some unutilized potential due to falling demand within the last few years.

Most experts were reluctant to provide any figures on unutilized resource potential. The nearest estimate provided by a logistic an expert is as follows. Almost 40 million tons of wood is harvested annually in Alabama. Surplus could be 20 percent or 8 million green tons. Assuming that a 100 MW generation capacity plant would require 1 million tons of wood a year, the potential is to generate almost 800 MW of electric power without factoring the constraints of collection, harvesting or processing. According to the most recent estimates of the Alabama

Forestry Commission, 8.5 million tons of harvesting residuals were produced in 2008 (2009). However, these residuals may be demanded by the entire bioenergy sector (including transportation fuels) indicating stiff competition in the future. Other forms of residues, including those from sawmills and pulp and paper mills, would be difficult to obtain. In 2005 less than 1 percent of mill residues remained unutilized (Bentley, Cartwright, and Hendricks 2008). Competing for those residues in the open-market may not be easy. For example, prices of sawdust rose to as high as $50 a ton last year. Collecting forest residuals is a big challenge and would be dealt in the following section. A USDA forest expert noted that resource analysis needs to be more spatially defined. Apart from the timberland cover, there is a need is to identify all the existing sources of biomass utilization as well the existing infrastructure within a more specified region. Hence, the conventional restriction of a 50 mile radius maybe inadequate to define a resource base for a new power plant planning to use wood as feedstock. Supporting infrastructure including roads was not identified as a concern.

Experts also responded to questions about challenge of growing more wood in the future. All forest related experts were hopeful about the potential for growing more wood to meet the emerging demand though time horizons varied. While a biotech industry representative thought increased harvests of timber for was possible with genetically modified eucalyptus within 6 to 8 years, a forest industry expert concluded that 10 years was a more practical duration for. Two other forest related experts concluded that some increase could come with better management practices and increased plantation, but a bioenergy expert concluded that genetic engineering would be required in the longer run. However a lot would depend on the motivations of landowners. There is no obligation for landowners to replant harvested trees or improve timberland management. Harvesting of timber, especially from small tracts owned by private landowners is low, though two harvesting experts noted that owners themselves have been unwilling to be part of the timber market. Hence owners have no positive signals to increase plantation or output. On a concluding note, one agricultural engineer pointed out that Alabama's forests had sustained two dynamic and growing industries, the pulp and paper industry, and the solid products industry, for almost three decades and hence there was a potential for other biomass based industries to operate.

It appears that switchgrass, the "model" energy crop (Wright 2007), has recently lost its favor. An expert on switch grass concluded that in the short-run wood will realize the demand for bioenergy in the region. Apart from the technical challenges in using the feedstock in cogeneration, switch grass is not easy to establish as crop, and may take almost three years for full harvesting. It can be harvested only once a year and is difficult store. So far there is only one major farming venture for switchgrass, at the federally-supported Charlton Valley Biomass Project in Iowa. It appears that switchgrass will not have any impact on the biomass resource in the region in the near future. Switch grass also suffers from lack of market potential and higher production costs. According to an agricultural expert, a ton of switch grass may cost anything from $70 to $100 per ton to produce. The more expensive timber sells for around $50 a ton. Wood products have multiple markets but switchgrass, being a dedicated energy crop will require demand from a full-scale bioenergy industry and sought for demand to generate enthusiasm for cultivation. At a seminar Southern Company executive noted that switchgrass yields need to be improved if the product is to become a bioenergy feedstock. Another electric utility officer claimed that utility has not given up on switchgrass as feedstock because it offers some potential for future use. However the reasons were not specified. In the scientific literature yields of switchgrass have been placed as high as 19 tons per acre but significant variations were noted for changing input and weather conditions (McLaughin and Kszos 2006). The expert on switchgrass also noted that little is known of farmers' perception on the crop, and suggested this as an area of future research. However some literature does exist on this issue. An existing study on farmers' perception about in Tennessee notes that the majority of the respondents had not even heard about the crop and almost half were not sure about growing it (Jensen et al. 2007)

The potential of biomass feedstock also needs to be understood from the perspective of its energy content. The more energy stored in a biofuel, higher is its potential in terms of bioenergy development. The expert on gasification technology concluded that most wood-based biofuels will have uniform energy content though pinewood and hardwood may have some advantage. However one forest engineer noted that for residual forest biomass, the energy content needs to be analyzed closely, and impurities, especially dirt, could impact the energy content.

The resource potential of agricultural residues is subject to harvest yields. And most experts concluded that they could not be used for commercial generation of electricity. As a matter of reference Alabama has high production of peanuts, pecans and poultry. Production of corn is not the high when compared to average of other states (Dyer et al. 2009). However, one researcher concluded that corn-based residues could have the maximum potential in terms of availability and energy content.

Other forms of residues, including municipal solid waste (MSW) are being considered for bioenergy generation. It is not clear if such systems could be used for commercial generation. An expert working on a project to utilize yard waste for bioenergy generation in the city of Fultondale hoped that project would be economically feasible after accounting for the avoided costs of collecting and disposing the waste. His research involved a projection of the annual supply of yard waste and analyzing its energy content. However he noted that these types of initiatives are more likely to work in cities and are highly dependent on the landscape of the region. Homeowners would also have to be motivated or mandated to collect yard waste separately from other waste, or else toxic streams of wastes could end up in the yard waste creating emission problems. A switch-grass expert noted of a technology where the non-toxic waste from MSW could be separated and used for bioenergy generation. He concluded that the significant advantage of MSW is its free availability and hence the associated possibilities could be endless. However the environmental officer of an electric company claimed that the chemical composition of MSW was a big challenge in its use for bioenergy generation.

An important policy initiative that may affect actual resource availability, the biomass crop incentive program (BCAP) the program has generated mixed responses from experts. One bioenergy expert felt that the program would help growers of niche feedstock such as switch-grass, to gain entry to the biomass market. Two forestry experts also concluded that the program would motivate non-industrial landowners to the sell their timber because they will receive incentive payments. However, another extension expert noted that landowners hold on to land for emotional, aesthetic and recreational reasons and hence they may not prefer to harvest their land. Additionally, fragmentation of land ownership will make present significant administrative costs and challenges for BCAP implementation. One expert was also skeptical of the actual benefits reaching landowners. According to USDA more than 400,000 acres of land is enrolled in Conservation Reserve Program (2009). The 2008 Farm Bill also increased the opportunities for enrolling in Conservation Reserve Program (CRP) acreage. If landowners increase enrollment in CRP, resource availability may decrease in the future. A forest policy expert noted that most industries in the region, especially pulp and paper mills, were obtaining permits to qualify for administering the program. It indicates that that the industry realizes the program will have a major impact on the market.

Developments within existing industries in the future will have a bearing on resource availability in the future. The solid products industry is expected to make a quick comeback with the revived interest in the housing market but the pulp and paper industry is expected to witness a challenging future for its primary products. Pulp and paper mills are exploring opportunities to convert themselves into second generation biorefineries, and most already use their residuals and waste to generate electricity. It is expected that such industries will compete for the remaining resources. The energy bill (Waxman- Markey) will allow pulp and paper mill residue to qualify as biomass. However, a chemical engineer noted that the most valuable product from pulpwood was pulp and paper and hence there is great merit in not utilizing pulpwood for energy generation. But some experts were skeptical about the industry regaining previous levels of demand. Pulp and paper demand is correlated to per capita population and economic growth. Neither is expected to change drastically in the near future. International competition, especially from South America, is likely to intensify, limiting the opportunities for industry expansion in the future.

Noting an overwhelming financial advantage for production of transportation fuels due to financial incentives, one expert was argued that industry could end up dominant within the next 10-12 years. More importantly, if pulp and paper mills are able to get refiners' credits for transportation biofuels, they have a head start over other operators. They already have well established infrastructures for supply and processing. Most mills are preparing for such a possibility by enrolling to administer the BCAP program. However a researcher working on the modeling of logistics of biofuels production from pulp and paper mills concluded that profitability of biorefineries would be sensitive to the price of fossil fuels. He claimed that modeling shows that minor changes in prices of gasoline or diesel may severely affect the economic prospects of these refineries. Several limitations exist in the retail selling and distribution of transportation biofuels.

The electric power sector will be pressed by the urgency to meet the renewable energy mandates when they are passed. One USDA expert noted that if the electric industry acted swiftly it may have an advantage in obtaining the feedstock and excluding competition. Unlike competitive pricing in transportation industry, regulated utilities have both flexibility and constraints in passing increased costs to consumers. Unfortunately both the APC and the Alabama PSC did not directly answer the query about the impact of energy mandates on retail electric costs. The existing pricing arrangement and past experiences suggest that APC may be able to pass some costs to its consumers. The utility, however noted that it has very limited time to respond to the proposed mandates which begin in 2012. In 2007 APC had a nameplate generation capacity of 12,216 megawatts. By a simple calculation, to meet a modest 10 percent renewable energy target it must install more than 1200 MW of renewable capacity by 2029. Assuming that all this capacity is met by biomass (with 1 million ton annual requirement for a 100 MW plant capacity) it may require more than 12 million tons of biomass by the oversimplified estimates. Since different biomass plants are located in different regions, local scale analysis needs to be done.

Past experiences suggest dedicated biomass power plants need to be very concerned about supply and flexibility in feedstock and full-time emphasis procurement is suggested (Wiltsee 2000). However there may be a difference between resource constraints among different technologies. Modular systems are unlikely to run on purchased fuel. For such systems careful estimates about residues supply and their energy content maybe necessary. Supply constraints maybe lower for cogeneration plants because the primary fuel (coal) should be readily available (Demirbas 2003), hence the plants could solely operate on coal under extreme constraints. The biggest resource challenge would be for plants that run solely on biomass. Accurate and long-term projections, and supply structure needs, must be place, before operations commence.

A relatively unexplored phenomenon has been the linkage between water resources and electric generation. According to the World Resources Institute (WRI) almost 4 out of every 5 gallons of freshwater withdrawals in Alabama is used by power plants for cooling needs (2009). Hence about 2 gallons of water are consumed for every 3 kWh of electricity produced in the state. The sole non-governmental expert interviewed claimed that water will be a huge challenge for the energy sector in the future. One expert of water quality concluded that differential policies on water quality and water withdrawal complicated the issue of water management in Alabama. Water quality is administered by ADEM whereas water withdrawal was monitored by Alabama Department of Economic and Community Affairs (ADECA). The non-governmental expert noted that facilities could withdraw was much as 100,000 gallons by simply informing ADECA. Among all sources of energy generation, nuclear consumes the most, and natural gas consumes the least water. Biomass and coal plants withdraw significant amounts of water and a lot of this water is lost by evaporation. The non-governmental representative noted that Alabama does not have any water use or management policy. Unfortunately at present technological levels, policy options are very limited, apart from energy efficiency to reduce energy consumption itself.

Harvesting and Collection of Biomass

A significant amount of effort in the region is being devoted to the prospects of collecting feedstock material not readily available, and reducing the costs of harvesting. As previously noted most of the harvested wood in Alabama has a market. The material most likely to remain is wood thinnings and forestry residues, which is uneconomical and practically useless to collect under the present market structure. However, an expert noted that of late pulp and paper mills may be collecting some of the forest residuals as they look to combust it for energy generation for internal purposes. It is debatable whether all the forestry residuals could be collected. Forestry experts conclude that some material must be left in the forests for environmental reasons, including preventing soil erosion. As a rule of thumb, it is suggested that 10 percent of residuals from forest harvesting should be left in the woods (Herrick et al. 2009).

Economics and adaptation of harvesting logistics is a concern as is logging capacity. There were divergent views in this regards. Most experts with the exception of one, concluded that there was excess capacity in logging. Only one expert concluded that harvesting capacities may have been lost. An expert on harvesting and transportation noted that loggers have to be concerned about delivering the wood to the mills, and hence the entire management of wood delivery becomes a challenge for them. Several issues, including insurance for trucks, quality and age of trucks, errant drivers, and differences in load specifications across state borders were identified by the expert. He also stressed improving transportation efficiencies, a long concern for existing forest products industry. After truckers deliver feedstock to the mills, they come back empty, leading to almost 50 percent unproductive mileage. With regard to reducing collection costs, most experts thought that some form of joint or cooperative marketing could help, but they could not provide any further insight into the idea.

Greater concern has been the structural transformation of the markets. The current market structure has made logging a less attractive business. In market dictated by the mills, most loggers in the business make only a reasonable income to survive. The existing systems are optimized to harvest wood, but not to convert them into small wood-chips, the most preferred size of feedstock for the industry. Mitchell and Gallagher (2007), provide operational and transportation costs of approximately $16 a ton for harvesting wood for fuelchips, noting the system to be cost competitive to other types of harvesting operations. However the returns to landowner will depend on the market price of feedstock. A harvesting expert hoped that if price of fuel chips exceed $30 per ton, logging for feedstock could become profitable for all the stake-holders. However biomass harvesting and collection costs may be sensitive to energy costs (Pan et al. 2008), not considered by most experts. If prices of fossil fuels increased collection and transportation costs would go up. The energy potential of wood based biomass that is directly combusted can be significantly affected by natural events such as rainfall, and studies show that costs could be sensitive to other transportation-related factors which include the nature and types of roads (Pan et al. 2008). Suggestions have been made that reducing off-highway hauling should receive more attention than reduction in on-highway mileage in harvest planning and collection (Pan et al. 2008).

A harvesting and logistics also noted that U.S. based companies were not investing much into forest harvesting and chipping equipment. A company in Canada was working on the idea and was close to making it commercially viable. However investments in harvesting equipment for residuals and chippers may cost up to $1 million. An extension engineer noted that U.S. companies were soliciting inputs on chip sizes. However he claimed that it is not possible to suggest uniform input sizes for biomass feedstock. An USDA expert flatly pointed that new investment in harvesting equipment for bioenergy feedstock would be a very difficult choice for loggers in a non-existent market without any guarantees of reasonable returns. Obtaining credit would also be a challenge. However, most experts were hopeful that stable demand and long-term supply contracts of 5 to10 years would motivate loggers to enter the bioenergy feedstock market.

Impacts on the Community

Since the direction and growth on the industry cannot be predicated with certainty it is a challenge to predict any localized impacts of growth of the industry. As a general rule creation of a new market for bioenergy products would bring some benefits for local communities and landowners, a vision shared by most forest experts. An expert on forest economics felt that the primary impact would be on the logging sector, noting that forest products industries have high multiplier values. However if pulp and paper mills lose markets or become less competitive a potentially negative impact could occur in terms of employment and tax revenues. According to APC almost 70 percent of its coal comes from regions outside the state. There is some potential in reducing the value of imported fuels and promoting local industries. Additionally, a reduction in coal will help bring down some of the costs of timberland.

Alabama has a low property tax on timberland. Hence non-industrial landowners may not have any inherent motive to put their land to commercial use. However, the emerging bioenergy sector could create some incentives for landowners. A most recent study estimated that more than half of landowners (representing almost 80 percent of the land) were willing to supply both timber and wood residues for a prospective wood-based bioenergy industry in Lee County (Paula 2009). The “right price” was the most important factor in the motivation to the supply wood. However, it has to be understood that not all benefits of increased wood demand may stay in the region. Several counties, especially in the “black belt” region of the state, are characterized by high levels of absentee ownership. Additionally the tax on timber harvests is not very high. If timber land in Alabama is taxed on its use value, it may be assessed as low as $1 per acre. Transforming their land to timberland is a motivation for landowners to defray higher property taxes.

V. CONCLUSION

The history of coal production in Alabama is long and eventful. The industry faced challenges, but has been sustained due to the superior heating value of coal. The EIA estimates of coal in the state exceed almost 4,000 million short tons (2009d), and at current rates of production, coal in Alabama could be mined for centuries. The high market value of Alabama coal, and the increase in commercial interests for its mining, is suggestive of an active mining industry in the future. Hence the limited inquiries on communities impacted by coal mining in the state is a scholarly gap that should be addressed for understanding the specific social, economic, and environmental impacts of the industry in the state. Since Alabama mines are increasing underground production, occupational risks for miners may continue in the near future, if policy on occupational safety is not tightened.

The preliminary analysis of toxin releases from coal-fired plants indicates that they may be sources of great risks to human health. The risks have been sustained by an inadequate regulatory framework and weak enforcement. Instead of a comprehensive oversight, the regulatory response has been muddled and weak. More site specific analyses of the impacts of toxic releases from coal-fired plants would be helpful in policy deliberations. A screening of risks from all major industrial facilities and their relative impacts at the state level could be the first step in that direction. The example of Plant Miller, where APC was forced to implement pollution abatement measures leading to reduced risk suggests that further public health improvements are possible.

The discourse of renewable energy suggests that coal and nuclear generation sources will find favor in the near future. The tone of public discourse also indicates limited political and economic support for renewable energy in the region. Instead of using the opportunity of national renewable energy mandates to assess and harness the social and environmental benefits of renewable energy, opposition from policy makers and local industry is contributing to a lack of political will to promote renewable energy within the region.

At this juncture, the exact design of national energy policy is unclear. Multiple legislative initiatives and increased lobbying suggests that policy makers are being influenced by coal based commercial interests. Various discursive opinions suggest that the focus on carbon emissions has sidelined equally important, localized impacts of coal-based energy. These considerations may be helpful in improving the case for renewable energy. However, there may be some merit in the concerns of unfavorable impacts for rate-payers. If the mandates are implemented, the immediate challenge would be to develop strategies which negate the economic impacts of short-term increases in energy prices, and create a long-term infrastructure for renewable energy systems. An understanding of public perceptions regarding renewable energy policy will help in a wide societal adoption and support for renewable energy.

Analysis of the potentials and constraints of bioenergy generation reveals some positives for the cause of renewable energy. Technical issues related to combustion based generation systems appear to have been overcome, but technology on advanced biomass-based generation systems is still commercially. Technological concerns notwithstanding, policy objectives must be clear within the region and provide an equal opportunity for all forms of biomass based energy, whether transportation fuels or electric power

Constraints of resource due to existing industries and emerging competition are another challenge for biomass based power generation. Expert opinions suggest that current market structures and harvesting technologies limit the possibility of use of biomass residuals of any kind, and indicates that the timberland inventory of the state will come to greater use if bioenergy generation increases in the future. Effort should go into more specified spatial analyses of the resource base of the state, especially when more than one wood-dependent industry is located in close proximity. The resource base will also be tied to the motivation of non-industrial landowners, who own more than 75 percent of timberland in the state. Their willingness to supply biomass feedstock and access to local markets may be important in establishing the future feedstock market for the entire bioenergy sector.

Promotion of any industry should be based on the possibilities offered for social and community development. Since all forms of bioenergy are in part driven by their potential environmental benefits more specified and local impacts of energy generation are important. The possibilities offered for direct and secondary economic benefits from new bioenergy facilities and their contribution to public infrastructure is another suggested area of research.

The analyses of bioenergy potential in Alabama reveal that the industry can be an important driver of eco-modernist ideas in capitalist societies. In regions where old and polluting technologies are strongly embedded, resistance to new technologies can resist call for change. Dichotomous environmental policies at different organizational levels of the state, and functional differences between regulatory agencies of the state, also complicate the adoption of structural changes need to promote environmentally benign sources of generation.

Even if they are developed in response to environmental concerns, not all technological changes are for the net benefit of society. In regard to energy generation, coal-based technologies have resisted changing environmental priories for almost half a century. This is well highlighted by the discourse on energy policy where “clean coal” technologies find favor at both the national and regional levels. Controlling pollution without replacing coal as a generation source is representative of incremental pollution control, and the current centralized and capitalist mode of energy generation.

Bioenergy related ecological modernization in the energy generation sector may only occur when knowledge regarding costs of current systems are widespread and when a combination of technological and policy innovations open the door to investments in alternative forms of energy.

Table 1. Details of Existing Coal-fired Electric Plants in Alabama, United States, 2009

Plant	Operator	Total Nameplate[4] Capacity (in MW)	In-service Year
Barry[1]	Alabama Power Company	1770.7	1954[1]
Miller [1]	Alabama Power Company	2822	1978[1]
Gaston[1]	Alabama Power Company	2012.8	1960[1]
Gorgas[1]	Alabama Power Company	1416.7	1917[1]
Greene Co.[1]	Alabama Power Company	568.4	1965[1]
Gadsden[1]	Alabama Power Company	138	1913[1]
Lowman[2]	Power South	538	1969[2]
Colbert[3]	Tennessee Valley Authority	1350	1965[3]
Widows Creek[3]	Tennessee Valley Authority	1968.6	1965[3]

1. Source: Atkins (2006).
2. Source: Power South (N.d.).Retrieved October 9, 2009 (http://www.powersouth.com/about_power.aspx)
3. Source: Tennessee Valley Authority. Retrieved October 9, 2009 (http://www.tva.com/power/fossil.htm).
4. Energy Information Administration (2008) (http://www.eia.doe.gov/fuelelectric.html)

Table 2. Coal production in United States and Alabama, 1998-2007

Year	Production (in million short tons) United Sates	Alabama
1998	1,117,535	23,013
1999	1,100,431	19,504
2000	1,073,612	19,324
2001	1,125,935	19,364
2002	1,093,295	18,931
2003	1,070,655	20,118
2004	1,111,109	22,271
2005	1,130,802	21,339
2006	1,161,997	18,830
2007	1,145,480	19,327

Source: U.S. Department of Energy
Compiled from Annual Coal Review (1997-2008)

Table 3. Employment at Coal-Mines, United States, 1998-2007

	Employment	
Year	United Sates	Alabama
2007	79,848	3,882
2006	77,939	4,032
2005	74,260	3,738
2004	69,855	3,128
2003	68,685	3,264
2002	74,915	3,173
2001	70,999	3,102
2000	70,666	3,139
1999	76,381	4,088
1998	81,272	4,894

Source: U.S. Census Bureau (2009)
Retrieved October 02, 2009 (http://censtats.census.gov/cgi-bin/cbpnaic/cbpsect.pl)

Table 4. Chronology of Mining Disasters in Alabama, 1900-2001, United States

Date	Mine	Location	Deaths	Cause
2/20/1905	Virginia City	Virginia City	112	Explosion
2/27/1906	Little Cahaba	Piper	12	Explosion
12/16/1907	Yolande	Yolande	57	Explosion
11/16/1908	Pratt No. 3	Ensley	8	Fire
2/2/1909	Short Creek	Short Creek	18	Explosion
4/20/1910	Mulga	Mulga	40	Explosion
5/5/1910	Palos No. 3	Palos	84	Explosion
11/3/1910	Yolande No. 1	Yolande	5	Explosion
4/8/1911	Banner	Littleton	128	Explosion
8/13/1912	Abernant	Abernant	18	Explosion
11/18/1913	Acton No. 2	Acton	24	Explosion
1/10/1914	Rock Castle	Rock Castle	12	Explosion
10/5/1914	Mulga	Mulga	16	Explosion
10/22/1916	Roden	Marvel	18	Explosion
11/4/1916	Bessie	Palos	30	Explosion
6/13/1917	Banner	Banner	6	Explosion
4/29/1919	Majestic	Majestic	22	Explosion
11/23/1920	Parrish	Parrish	12	Explosion
2/2/1922	Belle Ellen No. 2	Belle Ellen	9	Explosion
5/25/1922	Acmar No. 3	Acmar	11	Explosion
11/22/1922	Dolomite No. 3	Dolomite	90	Explosion
1/10/1923	Dolomite No. 1	Dolomite	5	Explosion
5/31/1925	No. 2	Piper	6	Explosion
12/10/1925	Overton No. 2	Irondale	53	Explosion
1/29/1926	Mossboro No. 1	Helena	27	Explosion
7/21/1926	Dixie	Moffat	9	Explosion
5/27/1929	Connellsville	Yolande	10	Explosion
1/13/1930	Peerless	Straven	7	Explosion
12/28/1931	Overton No. 1	Irondale	5	Explosion
10/15/1937	Mulga	Mulga	34	Explosion
7/1/1938	Praco No. 7	Praco	6	Roof Fall/Bump
6/4/1941	Docena	Adamsville	5	Explosion
7/10/1941	Acmar No. 6	Acmar	11	Explosion
5/11/1943	Praco No. 10	Praco	12	Explosion
8/28/1943	Sayreton, No. 2	Sayreton	28	Explosion
7/30/1948	Edgewater	Birmingham	11	Explosion
9/23/2001	No. 5 Mine	Brookwood	13	Explosion

Source: National institute of Occupational and Safety Health (2009).
Retrieved September 27, 2009 (http://www.cdc.gov/niosh/mining/statistics/discoal.htm)

Table 5. Fatalities from Coal-Mining Accidents, United States, 1999-2008

Year	United States	Alabama
1999	35	2
2000	38	0
2001	42	14
2002	27	1
2003	30	1
2004	28	2
2005	22	4
2006	47	2
2007	34	3
2008	30	2

Source: U.S. Department of Labor, Mine Safety and Health Administration (MSHA), (2009) Retrieved October 2, 2009 (http://www.msha.gov/stats/charts/coalbystate.asp)

Table 6. Number of Deaths from Black Lung Disease, United States and Alabama, 2006

	No. of Deaths	
Year	United States	Alabama
1996	1,417	14
1997	1,297	15
1998	1,103	13
199	1,003	8
2000	950	6
2001	889	8
2,002	858	7
2003	773	11
2004	703	9
2005	653	6
Total	9,646	97

Source: National Institute for Occupational Safety and Health (2008). Retrieved September 27, 2009 (http://www2a.cdc.gov/drds/worldreportdata/FigureTableDetails.asp?FigureTableID=509&GroupRefNumber=F02-01)

Table 7: Total Release of Toxic Air Pollutants, United Sates and Alabama

Year	United States (in billion lbs)	Alabama (in million lbs)
2007	1.01	36.9
2006	1.02	37.6
2005	1.08	37.7
2004	1.04	34.7
2003	1.07	37.9
2002	1.07	46.0
2001	1.06	50.1
2000	1.15	51.7
1999	1.14	49.1
1998	1.18	45.8

Source: U.S. Environmental Protection Agency (2009)
Retrieved October 2, 2009 (http://www.epa.gov/triexplorer/)

Table 8. TEP values of Chemicals Released by Coal-Fired Plants in Alabama, 2009

TOXIN	cancer tep (air)	cancer tep (water)	non-cancer tep (air)	non-cancer (water)
1-2-4 trimethyl benzene	NA	NA	11	300
ammonia	NA	NA	3.8	0.01
antimony	NA	NA	8100	1500
arsenic	16000	4000	84000	20000
barium	NA	NA	370	48
beryllium	1200	0	24000	540
chromium	130	0	2400	260
cobalt	NA	NA	31000	65
copper	NA	NA	13000	12000
hydrochloric acid	NA	NA	12	110
hydrofluoric acid	NA	NA	3.6	NA
lead	28	2	580000	42000
manganese	NA	NA	780	3.5
mercury	NA	NA	14000000	13000000
nickel	2.8	0	3200	26
selenium	NA	NA	2400	1600
styrene	NA	NA	0.08	0.34
sulfates (1)	NA	NA	5	NA
thallium	NA	NA	12000000	2700000
vanadium	NA	NA	1200	710
zinc	NA	NA	190	14

Source: Scorecard (2005)
Retrieved August 09, 2009 (http://www.scorecard.org/env-releases/def/tep_gen.html)

Table 9. Public Health Risk Assessments for Plant Barry, Alabama

toxin	air release[1]	water release [1]	cancer risk [2] (air)	cancer risk [2] (water)	non-cancer risk [2] (air)	non-cancer risk[2] (water)
1-2-4 Trimethyl Benzene	NA	NA	NA	NA	NA	NA
ammonia	673822	1840	NA	NA	2560523.6	18.4
antimony	NA	NA	NA	NA	NA	NA
arsenic	6100	63535	97600000	254140000	512400000	1270700000
barium	49770	42121	NA	NA	18414900	2021808
beryllium	138	0	165600	0	3312000	0
chromium	8048	625	1046240	0	19315200	162500
cobalt	2334	0	NA	NA	72354000	0
copper	5473	0	NA	NA	71149000	0
hydrochloric acid	21788887	0	NA	NA	261466644	0
hydrogen fluoride	5988215	0	NA	NA	21557574	0
lead	4280.9	1022.3	119865.2	2044.6	2482922000	42936600
manganese	11863	6623	NA	NA	9253140	23180.5
mercury	4959.2	0	NA	NA	69428800000	0
nickel	8221	4275	23018.8	0	26307200	111150
selenium	155969	2907	NA	NA	374325600	4651200
styrene	0	0	NA	NA	0	0
sulfuric acid	5664408	0	NA	NA	28322040	0
thallium	NA	NA	NA	NA	NA	NA
vanadium	8141	11	NA	NA	9769200	7810
zinc	23576	0	NA	NA	4479440	0
Total	34404205.1	122959.3	98954724	254142044.6	73346708462	1320614267
Unit per MW[3]	19429.7	69.44	55884.5	143526.3	41422437	745814.8

1. Releases are from an aggregate from 1998 to 2007.
2. Total risks are for chemical are obtained by the product of the total release and the relevant TEP value for the respective medium of release.
3. Unit per MW release or risk is obtained by division of total releases/risks by generation capacity.

Table 10. Public Health Risk Assessments for Plant Miller, Alabama

toxin	air release[1]	water release[1]	cancer risk[2] (air)	cancer risk[2] (water)	non-cancer risk[2](air)	non-cancer risk[2] (water)
ammonia	196452	626	NA	NA	746517.6	6.26
antimony	0	0	NA	NA	0	0
arsenic	1368	8546	21888000	34184000	114912000	170920000
barium	126339	59742	NA	NA	46745430	2867616
beryllium	83	5	99600	0	1992000	2700
chromium	5690	769	739700	0	13656000	199940
cobalt	1827	274	NA	NA	56637000	17810
copper	7494	545	NA	NA	97422000	6540000
hydrochloric acid	5261986	0	NA	NA	63143832	0
hydrogen fluoride	6917894	0	NA	NA	24904418.4	NA
lead	2809.3	90.4	78660.4	180.8	1629394000	3796800
manganese	9920	3698	NA	NA	7737600	12943
mercury	11253.2	0	NA	NA	1.57545E+11	0
nickel	6882	190	19269.6	0	22022400	4940
selenium	540	0	NA	NA	1296000	0
styrene	4560	0	NA	NA	364.8	0
sulfuric acid	2376901	0	NA	NA	11884505	NA
thallium	5026	30	NA	NA	60312000000	81000000
vanadium	5026	30	NA	NA	6031200	21300
zinc	24301	3978	NA	NA	4617190	55692
Total	14966351.5	78523.4	22825230	34184180.8	219959942457.80	265439747.3
Unit per MW[3]	5303.4	27.8	8088.3	12113.5	77944699.7	94060.9

1. Releases are an aggregate from 1998 to 2007.
2. Total risks are for chemical are obtained by the product of the total release and the relevant TEP value for the respective medium of release.
3. Unit per MW release or risk is obtained by division of total releases/risks by generation capacity.

Table 11. Public Health Risk Assessments for Plant Gaston, Alabama

toxin	air release[1]	water release[1]	cancer risk[2] (air)	cancer risk[2] (water)	non-cancer risk[2] (air)	non-cancer risk[2] (water)
1-2-4 Trimethyl Benzene	NA	NA	NA	NA	NA	NA
ammonia	9932	125	NA	NA	37741.6	1.25
antimony	0	0	NA	NA	65610000	2250000
arsenic	13216	67825	211456000	271300000	1110144000	1356500000
barium	66166	105275	NA	NA	24481420	5053200
beryllium	541	0	649200	0	12984000	0
chromium	11124	4028	1446120	0	26697600	1047280
cobalt	3444	507	NA	NA	106764000	32955
copper	8690	56399	NA	NA	112970000	676788000
hydrochloric acid	27463740	0	NA	NA	329564880	0
hydrogen fluoride	8549798	0	NA	NA	30779272.8	0
lead	6936.2	4915.8	194213.6	9831.6	4022996000	206463600
manganese	14188	2754	NA	NA	11066640	9639
mercury	7919.6	0	NA	NA	110874000000.00	0
nickel	10223	NA	28624.4	0	32713600	0
selenium	60145	1612	NA	NA	144348000	2579200
styrene			NA	NA	0	0
sulfuric acid	9710824	0	NA	NA	48554120	0
thallium	NA	NA	NA	NA	0	0
vanadium	12568	0	NA	NA	15081600	0
zinc	25269	7783	NA	NA	4801110	108962
Total	45974723.8	251223.8	213774158	271309831.6	116973593984.4	2250832837
Unit per MW[3]	22841.2	124.8	106207.4	134792.2	58114861.9	1118259.5

1. Releases are an aggregate from 1998 to 2007.
2. Total risks are for chemical are obtained by the product of the total release and the relevant TEP value for the respective medium of release.
3. Unit per MW release or risk is obtained by division of total releases/risks by generation capacity.

Table 12. Public Health Risk Assessments for Plant Gorgas, Alabama

toxin	air release[1]	water release[1]	cancer risk[2] (air)	cancer risk[2] (water)	non-cancer risk[2](air)	non-cancer risk[2] (water)
1-2-4 Trimethyl Benzene	NA	NA	NA	NA	NA	NA
ammonia	12509	1044	NA	NA	47534.2	10.44
antimony	NA	NA	NA	NA	0	0
arsenic	8989	80832	143824000	323328000	755076000	1616640000
barium	40749	62518	NA	NA	15077130	3000864
beryllium	299	0	358800	0	7176000	0
chromium	7448	8203	968240	0	17875200	2132780
cobalt	2342	792	NA	NA	72602000	51480
copper	5037	19494	NA	NA	65481000	233928000
hydrochloric acid	22322001	0	NA	NA	267864012	0
hydrogen fluoride	5483833	0	NA	NA	19741798.8	0
lead	4073.8	0	114066.4	0	2362804000	0
manganese	9790	2971	NA	NA	7636200	10398.5
mercury	5293.4	0	NA	NA	74107600000	0
nickel	6578	9475	18418.4	0	21049600	246350
selenium	0	0	NA	NA	0	0
styrene	45011	0	NA	NA	3600.88	0
sulfuric acid	7380097	0	NA	NA	36900485	0
thallium	0	0	NA	NA	0	0
vanadium	7136	0	NA	NA	8563200	0
zinc	15803	0	NA	NA	3002570	0
total	35356989.2	185329	145283524.8	323328000	77768500331	1856009883
Unit per MW[3]	24957.3	130.8	102550.6	228226.2	54894120.4	1310093.8

1. Releases are an aggregate from 1998 to 2007.
2. Total risks are for chemical are obtained by the product of the total release and the relevant TEP value for the respective medium of release.
3. Unit per MW release or risk is obtained by division of total releases/risks by generation capacity.

Table 13. Public Health Risk Assessments for Plant Greene, Alabama

toxin	air release[1]	water release[1]	cancer risk[2] (air)	cancer risk [2] (water)	non-cancer risk[2](air)	non-cancer risk[2] (water)
ammonia	0	0	NA	NA	0	0
antimony	0	0	NA	NA	0	0
arsenic	6516	8343	104256000	133488000	547344000	166860000
barium	16470	9453	NA	NA	6093900	453744
beryllium	21	1	25200	0	504000	540
chromium	3705	415	481650	0	8892000	107900
cobalt	1107	18	NA	NA	34317000	1170
copper	9435	19438	NA	NA	122655000	233256000
hydrochloric acid	39861577	0	NA	NA	478338924	0
hydrogen fluoride	2066681	0	NA	NA	7440051.6	0
lead	6305.2	121.7	176545.6	243.4	3657016000	5111400
manganese	9011	10370	NA	NA	7028580	36295
mercury	3182	0	NA	NA	44548000000	0
nickel	0	4539	0	0	0	118014
selenium	0	0	NA	NA	0	0
styrene	0	0	NA	NA	0	0
sulfuric acid	4605717	0	NA	NA	23028585	0
thallium	457	8141	NA	NA	5484000000	21980700000
vanadium	4214	0	NA	NA	5056800	0
zinc	10620	0	NA	NA	2017800	0
Total	46605018.2	60839.7	104939395.6	133488243.4	54931732641	22386645063
Unit per MW[3]	81993.3	107.0	184622.4	234849.1	96642738.6	39385371.3

1. Releases are an aggregate from 1998 to 2007.
2. Total risks are for chemical are obtained by the product of the total release and the relevant TEP value for the respective medium of release.
3. Unit per MW release or risk is obtained by division of total releases/risks by generation capacity.

Table 14. Public Health Risk Assessments for Plant Gadsden, Alabama

toxin	air release[1]	water release[1]	cancer risk[2] (air)	cancer risk[2] (water)	non-cancer risk[2](air)	non-cancer risk[2] (water)
1-2-4 Trimethyl Benzene	NA	NA	NA	NA	NA	NA
ammonia	NA	NA	NA	NA	NA	NA
antimony	NA	NA	NA	NA	NA	NA
arsenic	627	5406	10032000	21624000	52668000	108120000
barium	4229	23236	NA	NA	1564730	1115328
beryllium	NA	NA	NA	NA	NA	NA
chromium	NA	NA	NA	NA	NA	NA
cobalt	NA	NA	NA	NA	NA	NA
copper	NA	NA	NA	NA	NA	NA
hydrochloric acid	NA	NA	NA	NA	NA	NA
hydrogen fluoride	NA	NA	NA	NA	NA	NA
lead	266.1	NA	7450.8	NA	154338000	NA
manganese	372	81	NA	NA	290160	283.5
mercury	805.9	NA	NA	NA	11282600000	NA
nickel	NA	NA	NA	NA	NA	NA
selenium	NA	NA	NA	NA	NA	NA
styrene	NA	NA	NA	NA	NA	NA
sulfuric acid	592550	NA	NA	NA	2962750	NA
thallium	NA	NA	NA	NA	NA	NA
vanadium	591	NA	NA	NA	709200	NA
zinc	NA	NA	NA	NA	NA	NA
total	599441	28723	10039450.8	21624000	11495132840	109235611.5
Unit per MW[3]	4343.7	208.1	72749.6	156695.6	83298064.1	791562.4

1. Releases are an aggregate from 1998 to 2007.
2. Total risks are for chemical are obtained by the product of the total release and the relevant TEP value for the respective medium of release.
3. Unit per MW release or risk is obtained by division of total releases/risks by generation capacity.

Table 15. Public Health Risk Assessment for Plant Lowman, Alabama

toxin	air release[1]	water release[1]	cancer risk[2] (air)	cancer risk[2] (water)	non-cancer risk[2](air)	non-cancer risk[2] (water)
1-2-4 Trimethyl Benzene	NA	NA	NA	NA	NA	NA
ammonia	502	0	NA	NA	1907.6	0
antimony	0	0	NA	NA	0	0
arsenic	1467	1567	23472000	6268000	123228000	31340000
barium	5262	2123	NA	NA	1946940	101904
beryllium	0	0	0	0	0	0
chromium	3073.5	171.27	399555	0	7376400	44530.2
cobalt	0	0	NA	NA	0	0
copper	1972	4777.1	NA	NA	25636000	57325200
hydrochloric acid	7496000	0	NA	NA	89952000	0
hydrogen fluoride	595300	0	NA	NA	2143080	0
lead	1643.9	7071.37	46029.2	14142.74	953462000	296997540
manganese	2870	9723.26	NA	NA	2238600	34031.41
mercury	1583	18.82	NA	NA	22162000000	244660000
nickel	2188.9	1393	6128.92	0	7004480	36218
selenium	0	0	NA	NA	0	0
styrene	0	0	NA	NA	0	0
sulfuric acid	2092800	0	NA	NA	10464000	0
thallium	1570	118	NA	NA	18840000000	318600000
vanadium	2226	343	NA	NA	2671200	243530
zinc	11024	693.9	NA	NA	2094560	9714.6
total	10219482.3	27999.7	23923713.12	6282142.74	42230219168	949392668.2
Unit per MW[3]	33839.3	92.7	79217.6	20801.8	139835162.8	3143684.3

1. Releases are an aggregate from 1998 to 2007.
2. Total risks are for chemical are obtained by the product of the total release and the relevant TEP value for the respective medium of release.
3. Unit per MW release or risk is obtained by division of total releases/risks by generation capacity.

Table 16. Public Health Risk Assessment for Plant Widow Creek

toxin	air release	water release	cancer risk (air)	cancer risk (water)	non-cancer risk(air)	non-cancer risk (water)
1-2-4 Trimethyl Benzene	500	NA	NA	NA	27500	750000
ammonia	16005	1970	NA	NA	60819	19.7
antimony	0	0	NA	NA	0	0
arsenic	7195	46300	115120000	185200000	604380000	926000000
barium	24685	120600	NA	NA	9133450	5788800
beryllium	2250	780	2700000	0	54000000	421200
chromium	7290	11505	947700	0	17496000	2991300
cobalt	2545	2505	NA	NA	78895000	162825
copper	5045	45055	NA	NA	65585000	540660000
hydrochloric acid	18960040	0	NA	NA	227520480	0
hydrogen fluoride	2500040	0	NA	NA	9000144	0
lead	7587.38	962.1	212446.64	1924.2	4400680400	40408200
manganese	11655	240000	NA	NA	9090900	840000
mercury	2500.5	48.1	NA	NA	35007000000	625300000
nickel	0	0	0	0	0	0
selenium	14000	10800	NA	NA	33600000	17280000
styrene	0	0	NA	NA	0	0
sulfuric acid	2092800	0	NA	NA	10464000	0
thallium	1570	118	NA	NA	18840000000	318600000
vanadium	2226	343	NA	NA	2671200	243530
zinc	11024	693.9	NA	NA	2094560	9714.6
Total	23668957.88	481680.1	118980146.6	185201924.2	59371699453	2479455589
unit per MW	12023.2	244.7	60439.0	94078.0	30159351.6	1259502.0

1. Releases are an aggregate from 1998 to 2007.
2. Total risks are for chemical are obtained by the product of the total release and the relevant TEP value for the respective medium of release.
3. Unit per MW release or risk is obtained by division of total releases/risks by generation capacity.

Table 17. Public Health Risk Assessments for Plant Colbert, Alabama

toxin	air release[1]	water release[1]	cancer risk[2] (air)	cancer risk[2] (water)	non-cancer risk[2](air)	non-cancer risk[2] (water)
1-2-4 Trimethyl Benzene	500	NA	NA	NA	27500	750000
ammonia	82300	1000	NA	NA	312740	10
antimony	0	0	NA	NA	0	0
arsenic	3260	2000	52160000	8000000	273840000	40000000
barium	49100	55300	NA	NA	18167000	2654400
beryllium	NA	NA	NA	NA	NA	NA
chromium	6000	2530	780000	0	14400000	657800
cobalt	1265	1015	NA	NA	39215000	65975
copper	5500	30795	NA	NA	71500000	369540000
hydrochloric acid	18960040	0	NA	NA	227520480	0
hydrogen fluoride	3220040	0	NA	NA	11592144	0
lead	4274	971.5	119672	1943	2478920000	40803000
manganese	12200	16215	NA	NA	9516000	56752.5
mercury	3401.5	0	NA	NA	47621000000	0
nickel	6000	1285	16800	0	19200000	33410
selenium	NA	NA	NA	NA	NA	NA
styrene	NA	NA	NA	NA	0	0
sulfuric acid	2930040	0	NA	NA	14650200	0
thallium	0	0	NA	NA	0	0
vanadium	6200	0	NA	NA	7440000	0
zinc	14050	0	NA	NA	2669500	0
Total	25304170.5	111111.5	53076472	8001943	50809970564	454561347.5
Unit per MW[3]	12853.8	56.4	26961.5	4064.8	25810205.5	230905.9

1. Releases are an aggregate from 1998 to 2007.
2. Total risks are for chemical are obtained by the product of the total release and the relevant TEP value for the respective medium of release.
3. Unit per MW release or risk is obtained by division of total releases/risks by generation capacity.

Table 18. Average Annual Public Health Risk Posed by Coal-fired Plants in Alabama. 1998- 2007

Plant	cancer risk[1] (air)	cancer risk[1] (water)	non-cancer risk[1](air)	non-cancer risk[1](water)
Barry	9895472	25414204	7334670846	132061427
Miller	2282523	3418418	21995994246	26543975
Gaston	21377416	27130983	11697359398	225083284
Gorgas	14528352	32332800	7776850033	185600988
Greene	10493940	13348824	5493173264	2238664506
Gadsden	1003945	2162400	1149513284	10923561
Lowman	2392371	628214	4223021917	94939267
Widows Creek	11898015	18520192	5937169945	247945559
Colbert	5307647	800194	5080997056	45456135

1. Risks are the average of the total risks for the period of 10 years.

Table 19. Average Annual Unit Public Health Risk Posed by Coal-fired Plants in Alabama, 1998-2007

Plant	Generation capacity[2]	cancer [1] risk (air)	cancer risk[1] (water)	non-cancer risk [1] (air)	non-cancer risk[1] (water)
Barry	1770.7	4931	12665	3655091	65810
Miller	2822	809	1211	7794470	9406
Gaston	2013	10621	13479	5811486	111826
Gorgas	1417	10255	22823	5489412	131009
Gadsden	138	7275	15670	8329806	79156
Greene	568	18462	23485	9664274	3938537
Lowman	538	7922	2080	13983516	314368
Widows creek	1969	6044	9408	3015935	125950
Colbert	1350	2696	406	2581021	23091

1. Unit risk is total annual risk per unit generation capacity.
2. Generation capacity is nameplate or installed capacity

Table 20: Papers and Positions Taken In Editorials and Opinion Columns Supporting or Critical Of National Renewable Energy Portfolio/Carbon Cap Standards of the Waxman-Markey Bill

Papers	**Supportive**		**Critical**	
	editorials	**opinions**	**editorials**	**opinions**
National				
The New York Times	2	4	0	0
The Wall Street Journal	0	0	1	2
The Washington Post	0	3	0	2
Selected Other Papers				
The Oregonian (OR)	0	2	0	0
The Charleston Gazette (WV)	0	1	0	2
The Richmond Times-Dispatch(VA)	0	1	0	0
Papers from the Southeast				
The Atlanta Journal-Constitution	0	1	0	1
Knoxville News Sentinel	0	1	0	0
The Athens Banner-Herald	0	0	0	1
Alabama Papers				
The Montgomery Advertiser	0	3	0	3
The Birmingham News	0	1	0	2
The Mobile Press Register	0	0	0	4
The Anniston Star	3	2	1	1
The Cleburne News	0	0	0	1
The Valley Times	0	0	0	2
The Jacksonville News	0	0	0	2

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