Part One: Job Implications of a 21st Century National Energy Portfolio: Methods of Estimating Job Impacts of the Growth in Non Renewable and Renewable Energy Sources and the Importance of Carbon Sequestration

Methods Used to Estimate Job Impacts of the Expansion of the Alternative Energy Sector

Since 2001, several major studies have been commissioned to examine alternative energy futures and the economic development potential of the expansion of renewable energy sectors, including wind, various forms of biomass and solar. In these studies, two widely used methods are employed to calculate the job impacts of a change in the nation's energy budget: input-output analysis, which captures the direct, indirect and induced effects of investment in a sector, and analytical models that yield an estimate of the direct job generation from the expansion of a sector based on the implied labor time required to produce industry components. While the first method provides a comprehensive means of estimating total job impacts including potential job losses associated with shifts between sectors and increasing efficiencies provoked by changes within sectors, it is data and computationally intensive. In contrast, an analytical approach to estimation is a simple and transparent means of creating a rough estimate of job generation potential from the expansion of alternative energy industries. For this report, we use the simpler approach as a starting point and recommend that a more comprehensive assessment be considered that employs input-output analysis.

For our purposes we illustrate the range of possibilities for growth in the number of jobs in separate industry segments, and investigate the prospect of sectoral growth in states that are currently the locations of alternative energy industry activity. These studies use as a baseline different energy scenarios that calculate the job impacts of future energy

portfolios including higher and lower reliance on fossil fuels. From these differences in energy portfolios, economic impacts can be calculated and then translated first into material inputs, operations and process activities and ultimately into total job impacts. If we isolate different combinations of renewable energy sources for the generation of electrical energy we see that there are considerable differences across the different feed stock combinations. According to some estimates, biomass-related energy generation is predicted to create more long-term jobs compared with other renewable energy sources (Table 1).

Table 1: Comparison of Estimated Employment Associated with Alternative Scenarios in the Production of Energy in the US

Scenarios	Average employment associated with each scenario (jobs)		
	Construction, Manufacturing, Installation	O&M and Fuel Processing	Total Employment
20% Renewable Portfolio Standard (RPS) by 2020 (85% biomass, 14% wind, 1% solar PV)	52,533	188,317	240,850
20% Renewable Portfolio Standard (RPS) by 2020 (60% biomass, 37% wind, 3% solar PV)	85,008	91,436	176,444
20% Renewable Portfolio Standard (RPS) by 2020 (40% biomass, 55% wind, 5% solar PV)	111,879	76,139	185,018
Fossil Fuels as Usual to 2020 (50% Coal, 50% Natural Gas)	22,711	63,657	86,369
20% Gas intensive by 2020 (100% Natural Gas)	22,023	61,964	83,987

Comparison of estimated employment created by meeting the equivalent of 20% of current US Electricity demand vian and expansion of fossil or renewables-based electricity generation.

This section provides an overview of job potential in light of the expansion of energy sources non renewable and renewable, and then briefly examines job growth potential at the national level. A discussion of the importance of accounting for carbon sequestration follows.

Job Growth and Fossil Fuels

Appalachia's tremendous reserves of fossil fuels, particularly coal, will be an important component of the nation's future energy budget, but its exploitation presents significant environmental challenges. Recent data from the US Energy Information Administration (EIA) indicates that fossil fuels will continue to be a major component of the Nation's energy budget. US consumption of fossil fuels consists of a mix of natural gas, coal and oil. If the price of oil continues to climb, the demand for coal will increase. At the same time, according the EIA, western coal used for the production of electricity has significantly advantages over Appalachian coal due to differences in production cost and sulfur content. In its 2006 report and near term estimates, the EIA reports:

> "Appalachian coal production remains nearly flat in the reference case. Although producers in Central Appalachia are well situated geographically to supply coal to new generating capacity in the Southeast, the Appalachian basin has been mined extensively, and production costs have been increasing more rapidly than in other regions. The Eastern Interior coal basin (Illinois, Indiana, and western Kentucky), with extensive reserves of mid- and high-sulfur bituminous coals, does benefit from the new builds of coal-fired generating capacity in the Southeast. Nonetheless, in 2004, approximately 20 plants, many located east of the Mississippi River, used Powder River Basin coal for the first time. "
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> In terms of job growth, again the EIA reports,
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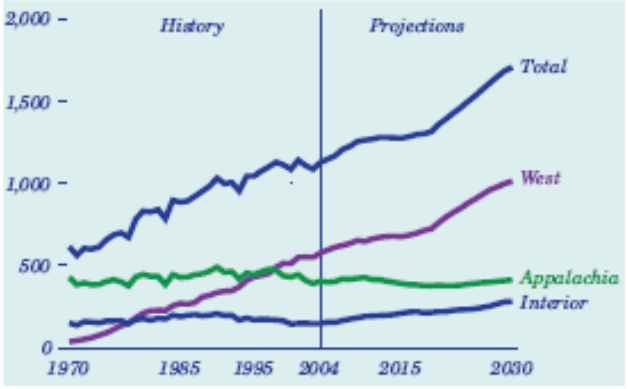
> "Most jobs in the U.S. coal industry remain east of the Mississippi River, mainly in the Appalachian region (67 percent in 2004). Most coal production, however, occurs west of the Mississippi River (56

percent in 2004), with the major share from the Powder River Basin. As coal demand increases, pressure to keep prices low will shift more production to mines with higher labor productivity. Large surface mines in the Powder River Basin take advantage of economies of scale, using large earth-moving equipment and combining adjacent mines to increase operating flexibility. Underground mines in the Northern Appalachia and Rocky Mountain supply regions use highly productive and increasingly automated longwall equipment to maximize production while reducing the number of miners required. Additionally, more costly Appalachian coal competes with lower cost imports from Latin America and Asia. http://www.eia.doe.gov/oiaf/aeo/coal.html"

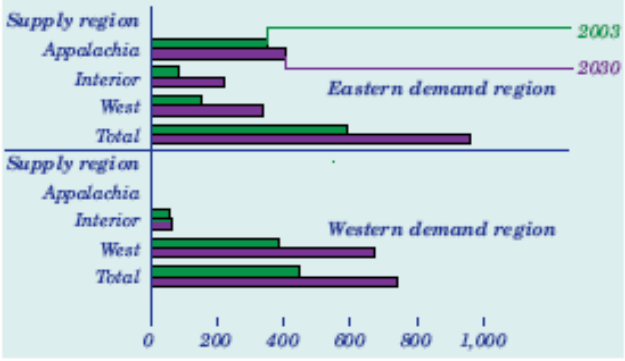
Market Share of Western Coal Continues To Increase

Figure 97. Coal production by region, 1970-2030 (million short tons)



More Eastern Power Plants Are Expected To Use Western Coal

Figure 98. Distribution of domestic coal by demand and supply region, 2003 and 2030 (million short tons)



Overall job growth in fossil fuels is projected to be static or to decline over the next ten years (Table 2). This pattern reflects increasing efficiencies in the production of fossil fuels combined with a reduction in yields from domestic oil, coal, and gas fields. Together these industries are not expected to generate significant job gains over the next 20 years.

Table 2. Net projected losses of jobs by fossil fuel and energy generation due to technological change and decreasing yield of natural resource deposits	
Sector	**Net Job Gain/Loss by 2020**
Overall for all sectors of the economy	+1,314,000
Coal Mining	-23,900
Oil and gas mining	-61,400
Oil refining	-6,300
Electric utilities	-35,100
Natural Gas utilities	-26,200

Net projected losses by sector of the economy in comparison to overall projected net gains. Source: Worldwide Fund for Nature.

While fossil fuels will be a major component of Appalachia's contribution to the nation's future energy budget, environmental consequences of continued fossil fuel dependence will continue to be significant and therefore will represent only one of many elements required to achieve national energy independence.

Job Growth and Renewable Energy

The picture of growth in employment from changes in renewable energy industries is decidedly different from that of fossil fuels. Growing evidence suggests considerable job development potential from the expansion of alternative energy sectors. Kammen et al. (2004) summarized recent reports about job potential from alternative energy industry expansion, highlighting the significant growth potential of wind, solar, and biomass industries (Table 3). Several of these studies suggest that renewable energy creates more jobs than other sources of energy.

Table 3. Renewable Energy Growth in the United States (MW)			
Technology	Installed Capacity (Latest Year with Data)	Previous Year Installed Capacity	% Growth from Previous Year
Solar including PV	365 (1998)	334	9%
Wind	3,804 (2001)	2,554	49%
Biomass	7,367 (1998)	7,676	-4%
Geothermal	2,917 (1998)	2,853	2%

Source: Wind data from correspondence with Kathy Belyee, American Wind Energy Association. All other data from US Energy Information Administration (EIA). *Renewable Energy Annual 1999.* Washington DC, March 2000. DOE/EIA-0603(99). Biomass data includes wood and wood waste, straw, digester gas, paper pallets, methane, waste alcohol, tires, fish oils, sludge waste and tall oil. It does not include municipal solid waste and landfill gas.

According to some estimates, given their early stage in the product cycle, renewable energy sources are estimated to generate four times as many new jobs per megawatt of installed capacity as natural gas and 40% more jobs per dollar invested than coal. Thus the job development opportunities are potentially substantial. In these reports, the authors consider three stages in the job generation process: manufacturing, construction, and operations. To the extent possible, we also follow this strategy in reporting job generation potential for the constituent elements of the energy sector under consideration. [1]

Carbon Sequestration

A discussion of job impacts associated with the expansion of energy production, must take into account the job impacts of the need to reduce CO_2 emissions and to capture and sequester that which is produced in

[1] Kammen et al. further report that alternative energy industry expansion generates more jobs per megawatt hour compared with conventional energy industry alternatives, due to increasing efficiencies in extractive industries combined with job losses associated with mergers and acquisitions

the consumption of fossil fuels and resulting outputs of other CO_2 emitting processes. While the development of the technology to capture and sequester CO_2 is still in it infancy, an ability to determine job impacts require that this by-product of energy production and consumption be taken into account alongside of alternative energy scenarios.

The US will continue to utilize fossil fuels for the foreseeable future. In the process of mining and utilizing fossil fuels, CO_2 is emitted. Like other countries the US is embarking on a path to reduce the nation's CO_2 output. To do so will require the development of new technologies and processes. The job impact of this development will be both positive and negative. Positive change will occur as new techniques and processes are implemented to capture and store CO_2 emissions. Negative change will occur as high CO_2 emitted processes and technologies are phased out in favor of low emission activities. At present, the majority of technologies being developed to help capture and sequester CO_2 are in the development stage. Some are at an advanced stage of development while others are many years off and will require significant investment in research and technology to reach commercial scale.

Sequestration is linked to the source point of the CO_2 emissions. Almost one third of US emissions are derived from power generation and power plants. Present costs of sequestration are estimated at $100-300/ ton, a sum that must be reduced to $10/ton to be economical.

Current research is focusing on identification of novel concepts to control emissions. These are expected to be cost effective taking into account total costs and impacts over the product cycle. This means production through disposal including social and environmental effects comparing local and global levels.

In the medium term, projects are testing carbon capture ad re-use alongside existing power plants. Examples in the Netherlands demonstrate the efficacy of such an approach. Plans for the US include carbon capture and injection into existing oil fields to extract otherwise

unrecoverable petroleum.

At present, plans and strategies for CO_2 capture are in their infancy and the payoff is five to seven years away. Thus, in contemplating the implementation of a new energy future, the costs of sequestration need to be taken into account in order to effectively estimate the job impact over time.

Summary, Part 1

A national energy portfolio that: a) reduces reliance on fossil fuels; b) maximizes the utilization of renewable sources; and c) reduces CO_2 emissions will yield a jobs profile significantly enhanced compared with current conditions. The contribution to job generation by different industries will depend on their level of maturity and their position in the product cycle. The fossil fuel industry is mature. Growth in demand is likely to lead to modest direct job generation, but is likely to precipitate process-innovation-related job generation over time. In contrast, widespread commercialization of renewable energy sources is in its infancy. Many renewable energy sources are just being developed and are thus at an early stage in the product cycle. Moderate levels of growth in demand will lead to the expansion of the existing supplier base and lead to the creation of complementary product lines. Significant new growth in demand will not only augment the existing base, but is likely to lead to the development of whole new products, an expansion of the supplier base attendant with this new productive capacity, and the growth of entirely new product-based innovations. Production bottlenecks and the search for efficiencies will further stimulate technological change leading to process innovations.

The impact of actions to pursue carbon sequestration will depend on a host of serious short, medium and long term challenges. In the short run, solutions to the problems of sequestration will have direct positive job impacts. Over time, net job impact will reflect gains in the form of new industrial practices set against losses due to retirement of existing capacity.