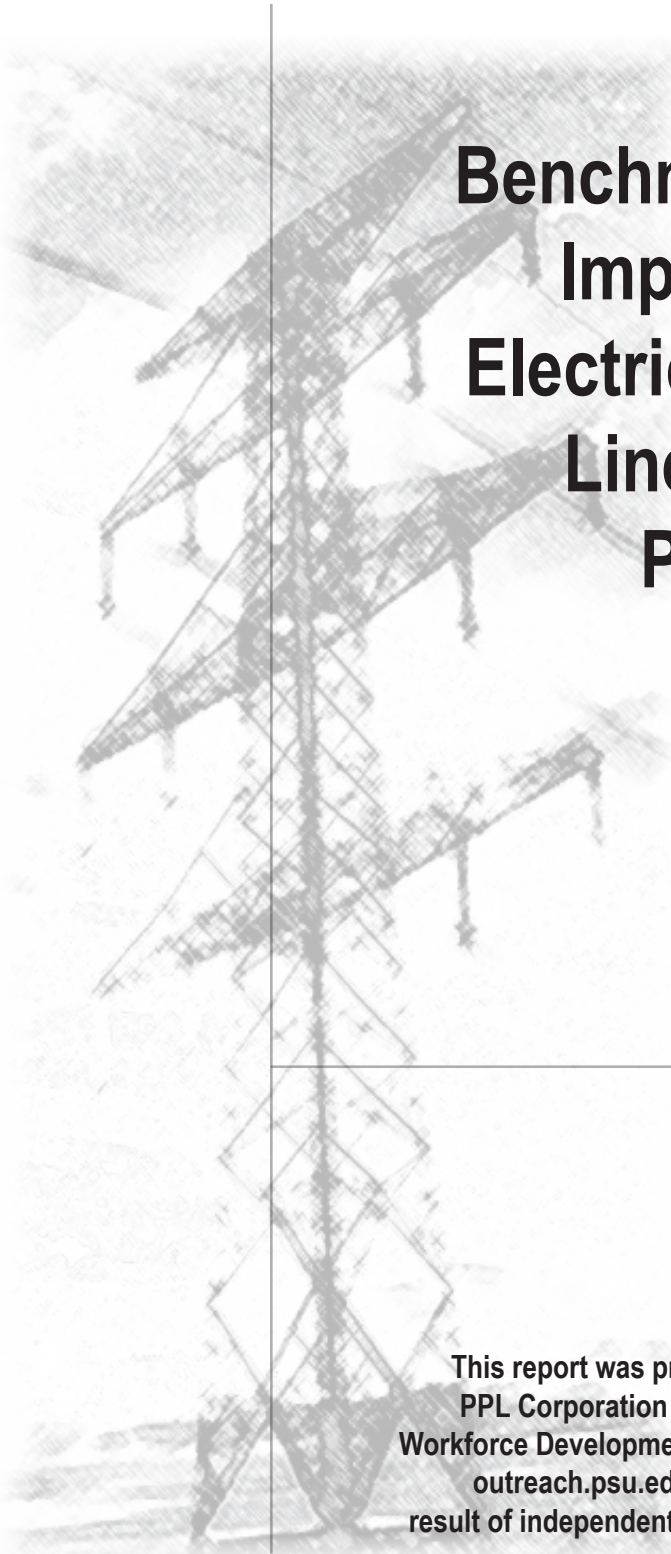




PENN STATE WORKFORCE EDUCATION AND DEVELOPMENT INITIATIVE

A large, faint, grayscale image of a power transmission tower is visible in the background, extending from the middle of the page down to the bottom. The tower is a lattice structure with multiple cross-arms.

Benchmarking the Economic Impact of Construction of Electric Power Transmission Lines in Selected Eastern Pennsylvania Counties

**Rose M. Baker
Matthew C. Loiacono
David L. Passmore**

January 2008

This report was prepared through a memorandum of agreement between PPL Corporation (<http://www.pplweb.com>) and the Office of Economic & Workforce Development (<http://oewd.psu.edu>) in Penn State Outreach (<http://outreach.psu.edu>). The economic impact described in this report is the result of independent and objective research conducted by the staff of Penn State's Workforce Education & Development Initiative.



Contents

Need for Assessment of Potential Economic Impact	1
Methods Employed to Assess Potential Economic Impact	1
Potential Economic Impacts of the Construction Project	2
Jobs, Income, and Economic Output.....	2
Table 1. Benchmark Annual Potential Impact of 100 Construction Jobs on Total Jobs, Labor Income, and Value-Added in Lackawanna, Luzerne, Monroe, Pike, and Wayne Counties, Separately and Together, in Eastern Pennsylvania	
Tax Revenues.....	4
Table 2. Benchmark Annual Potential Impact of 100 Construction Jobs on Federal, State, and Local Tax Revenues in Lackawanna, Luzerne, Monroe, Pike, and Wayne Counties, Separately and Together, in Eastern Pennsylvania (thous 2006\$)	
Additional Assessment Information Is Available	5
About This Report	5
Penn State Workforce Education and Development Initiative.....	5
Authors.....	6
Input-Output Model Applied in this Analysis.....	6
Basic Input-Output Accounting.....	6
Direct, Indirect, and Induced Requirements.....	7
Multipliers.....	7



Need for Assessment of Potential Economic Impact

The flap of a butterfly's wings in Brazil can set off a tornado in Texas.

~ Edward Norton Lorenze, meteorologist,
mathematician, and early pioneer of chaos theory.

Regional economies are complex. Industries, households, and governments within regional economies are highly interdependent. As a result, economic activity, such as construction, can have broad, sometimes unexpected, effects on the economy of a region. For instance, economic activity in one industrial sector can affect all industries in a region, even in those industries that do not, at first glance, seem to be connected directly to the sector in which the activity occurs. Increasing a personal income tax rate to raise revenue for a local government might affect, in turn, employment in local retail outlets by reducing consumers' spendable incomes. Increasing electricity prices might shift family expenditures away from discretionary items, and, as a consequence, reduce employment in local firms that make or sell the discretionary items. In these ways, a single economic activity in a region can ripple throughout a region's economy to affect the well-being of virtually every industry, household, and government service in the region.

Construction of an electric power transmission line is under consideration in eastern Pennsylvania. The line could cross Lackawanna, Luzerne, Monroe, Pike, and Wayne counties. Provided in the remainder of this report is information about the total potential economic impact of the transmission line construction on jobs, income, economic output, and tax revenues in the counties.

Methods Employed to Assess Potential Economic Impact

To assess the potential economic impact of an electric power transmission line construction project in Lackawanna, Luzerne, Monroe, Pike, and Wayne counties in Pennsylvania, staff of the Penn State Workforce Education and Development (WED) Initiative constructed macroeconomic models of each of the five counties separately and of all five counties taken together to represent a single economic region. Then, economic multipliers were calculated to benchmark the total potential economic impact of every 100 construction jobs on each county separately and together. When actual construction job figures become available, the multipliers presented in this report can be applied to calculate the actual effect of the line transmission construction project.

A multiplier is a number that describes the "ripple effect" of economic activity in a region. In a nutshell, three types of multiplier effects are tabulated in this report:

- ❑ *Direct effect.* Economic activity within an industry has a direct economic effect by itself. For instance, 100 jobs at a construction site are the construction project's direct job effect.
- ❑ *Indirect effect.* Economic activity in an industry stimulates additional economic activity in many other industries that supply it. This is described as an "indirect effect" of economic activity. For example, a construction site purchases supplies from other regional industries.



A site might purchase, among other things, fuel, concrete, accounting services, tools, and lubricants from local industries. In this way, jobs are created indirectly in these other industries due to the need to supply the construction site.

- *Induced effect.* In addition, workers within the industry and the industries that supply it spend their income in the region on consumer items, which generates additional employment throughout the region. For example, construction workers and the workers in industries who supply the construction site spend their pay on such goods and services as automobiles, groceries, tickets to ball games, medical diagnosis and treatment, refrigerators, gasoline, and a myriad of other consumer items. Jobs are created in stores, hospitals, and other local establishments because of this spending. The economic spin-off from this spending is called an “induced effect.”

Multipliers were calculated by the WED Initiative team for jobs, labor income, value-added, and selected tax revenues using IMPLAN, a regional economic database and input-output analysis system that is applied extensively through the United States for estimation of economic impact. Detailed information about the WED Initiative and input-output analysis is described in a section, “About This Report,” at the end of this document. IMPLAN is documented completely at <http://www.implan.com>. Technical definitions of jobs, labor income, value-added, and selected tax revenues are provided in footnotes to the two tables included in the subsequent section of this report, “Potential Economic Impacts of Construction Project.”

Potential Economic Impacts of the Construction Project

Jobs, Income, and Economic Output

Benchmarked in Table 1 are potential impacts of 100 jobs in construction on total jobs, income, and economic output in the five counties separately and taken together as one economic region. Impacts displayed in Table 1 are parsed into direct, indirect, and induced components. The sum of direct, indirect, and induced components is the estimated total effect of every 100 construction jobs necessary to build the electric power transmission line.

Several examples might help with interpretation of information in Table 1. In Lackawanna County, for instance, every 100 construction jobs creates other County jobs indirectly. Due to the need to supply the construction industry, other industries in Lackawanna County could employ an additional 23 workers. Other jobs are induced by spending of income earned in construction and its supplying industries. Spending of income earned by construction employees in Lackawanna County and by workers in Lackawanna industries that supply the construction industry on such items as housing, food, health care, and other retail goods and services could generate an additional 42 jobs in the County. In short, every 100 jobs in the Lackawanna construction industry are associated with 165 total jobs in the County (100 direct + 23 indirect + 42 induced).

For another example, reference is, again, made to Table 1. Every 100 construction workers in Pike County, earn a total of \$4.22 million. This total is the income earned by workers at all occupational levels in the construction industry in Pike County. For every 100 Pike County



construction workers employed, workers in Pike County industries that supply the County’s construction industry earn \$580,000. When Pike County construction workers—and the workers in industries that supply the construction industry—spend the income they earned, an additional \$520,000 is earned by Pike County workers. In sum, the construction industry in Pike County adds \$5.32 million in total labor income to Pike County.

Staffing requirements for the actual construction of electric power transmission lines might yield greater or fewer than 100 construction jobs in the counties. In that case, merely re-scale multipliers shown in Table 1 to estimate the effects of the project. For instance, if the project involved 200 jobs in the five counties, multiply the figures in the last column of Table 1 (“Five Counties Analyzed as One Region”) by a factor of 2. Fifty jobs? Divide the figures by 2. In this way, estimates of potential impact presented in this report are benchmarks for judging the impacts of projects of any scale. Refer technical questions about re-scaling multipliers to Rose M. Baker (rmb194@psu.edu; 814.865.9919) or David L. Passmore (dlp@psu.edu; 814.863.2583).

Table 1. Benchmark Annual Potential Impact of 100 Construction Jobs on Total Jobs, Labor Income, and Value-Added in Lackawanna, Luzerne, Monroe, Pike, and Wayne Counties, Separately and Together, in Eastern Pennsylvania

Impact	Lackawanna	Luzerne	Monroe	Pike	Wayne	Five Counties Analyzed as One Region
Jobs^a						
Direct	100	100	100	100	100	100
Indirect	23	22	19	14	12	23
Induced	42	40	31	19	26	42
<i>Total</i>	165	162	150	133	138	165
Labor Income^b (mill 2006\$)						
Direct	\$4.72	\$4.67	\$4.57	\$4.22	\$4.60	\$4.63
Indirect	\$1.02	\$0.87	\$0.73	\$0.58	\$0.49	\$0.96
Induced	\$1.37	\$1.28	\$0.97	\$0.52	\$0.74	\$1.39
<i>Total</i>	\$7.11	\$6.82	\$6.27	\$5.32	\$5.83	\$6.98
Value-Added^c (mill 2006\$)						
Direct	\$5.28	\$5.22	\$5.12	\$4.72	\$5.14	\$5.18
Indirect	\$1.28	\$1.16	\$0.98	\$0.78	\$0.66	\$1.28
Induced	\$2.47	\$2.39	\$1.94	\$1.21	\$1.52	\$2.60
<i>Total</i>	\$9.03	\$8.77	\$8.04	\$6.71	\$7.32	\$9.06

Source: Calculated for North American Industrial Classification System code 23 (see <http://naics.notlong.com>) using IMPLAN (see <http://www.implan.com>), a macroeconomic model applied by Penn State’s WED Initiative team to identify the impact of economic activity on Pennsylvania and its counties.

Caution: Figures for all five counties analyzed as one region are not the simple sum of the five county figures. Moreover, it is not valid to add any subset of county figures together to obtain totals for multiple counties. Each column in this table stands on its own as an independent estimate of impact.

^aJobs include full- and part-time jobs, including self-employment. Jobs refer to positions, not workers. One worker could be a multiple jobholder.

^bLabor income = Employee compensation + proprietor’s income. Employee compensation is the sum of employee wages and salaries and supplements to wages and salaries. Wages and salaries are measured on an accrual, or “when earned” basis, which may be different from the measure of wages and salaries measured on a disbursement, or “when paid” basis. Supplements to wages and salaries include employer contributions for employee pension and insurance funds and of employer contributions for government social insurance. Proprietor’s income is current-production income (including income in-kind) of sole proprietorships and partnerships and of tax-exempt cooperatives. Fees of corporate directors are included in income of proprietors, but the imputed net rental income of owner-occupants of all dwellings is included in rental income of persons. Proprietor’s income excludes dividends and monetary interest received by nonfinancial business and rental incomes received by persons not primarily engaged in the real estate business. These incomes are included in dividends, net interest, and rental income of persons, respectively.

^cValue-added is the dollar value added to the cost of intermediate goods and services in the production sector of the economy.



Dollar values provided in Table 1 are stated as millions of 2006 dollars. That is, each dollar has the purchasing power for the types and amounts of goods and services that a dollar could buy in 2006. Since 2006, modest inflation has degraded the purchasing power of the dollar. As a result, for example, \$6.82 million in labor income in 2006 dollars earned in Luzerne County would purchase fewer of the same bundle of goods and services in 2008 than in 2006.

Addition of row values in Table 1 across counties is not a valid use of these potential economic impact data. Each column of Table 1 represents the worth of every 100 construction jobs *only* within each county. The last column of Table 1 is an analysis of the potential impact of every 100 construction jobs for the entire five-county region, which is not the simple sum of rows of Table 1.

Tax Revenues

Contained in Table 2 are benchmark estimates of the impact of every 100 construction jobs on regional tax revenues expressed as thousands of 2006 dollars. Tax revenue impacts in Table 2 are displayed as totals and are not segmented into direct, indirect, and induced components.

Table 2. Benchmark Annual Potential Impact of 100 Construction Jobs on Federal, State, and Local Tax Revenues in Lackawanna, Luzerne, Monroe, Pike, and Wayne Counties, Separately and Together, in Eastern Pennsylvania (thous 2006\$)

Tax Revenue Source	Lackawanna	Luzerne	Monroe	Pike	Wayne	Five Counties Analyzed as One Region
Corporate Profits ^a	\$172.22	\$175.85	\$158.44	\$105.88	\$122.12	\$186.50
Indirect Business ^b	\$373.13	\$376.24	\$331.95	\$232.16	\$270.05	\$398.61
Personal Income	\$728.86	\$685.28	\$727.48	\$613.18	\$567.88	\$733.11
Other ^c	\$41.25	\$38.96	\$37.82	\$32.41	\$33.05	\$41.72
Employer Contributions to Social Insurance ^d	\$800.85	\$785.35	\$647.20	\$517.87	\$687.77	\$778.60
<i>Total</i>	\$2,111.31	\$2,061.68	\$1,902.89	\$1,501.20	\$1,680.87	\$2,138.54

Source: Calculated for North American Industrial Classification System code 23 (see <http://naics.notlong.com>) using IMPLAN (see <http://www.implan.com>), a macroeconomic model applied by Penn State's WED Initiative team to identify the impact of economic activity on Pennsylvania and its counties.

Caution: Figures for all five counties analyzed as one region are not the simple sum of the five county figures. Moreover, it is not valid to add any subset of county figures together to obtain totals for multiple counties. Each column in this table stands on its own as an independent estimate of impact.

^aCorporate profits taxes are levied on the accounting profits of corporations. This tax is only levied on corporations, and excludes businesses that are proprietorships or partnerships.

^bIndirect business taxes are sales, excise, and other taxes paid during normal operation of industry. These payments do not include taxes paid based on net income. Indirect business taxes is the official term used in the National Income and Product Accounts for sales taxes. They are termed *indirect* sales taxes because the business sector has the *direct* responsibility of paying these taxes to the government sector, but the business sector really acts as the "collection agency" for the government, collecting the taxes from the household sector. In this way, these taxes are paid indirectly by the household sector. The business sector collects the taxes from the household sector for the government sector. The household sector is considered the ultimate payer of the taxes. Other taxes paid by the business sector to the government sector are considered direct business taxes. These include corporate profits taxes, property taxes, and franchise taxes.

^cOther personal income taxes include federal and state estate and gift taxes, fines, motor vehicle and other license fees, and property taxes.

^dEmployer contributions to social insurance include employer payments (including payments-in-kind) to private pension and profit-sharing plans, publicly administered government employee retirement plans, private group health and life insurance plans, privately administered workers' compensation plans, and supplemental unemployment benefit plans.



Total tax revenue in Table 2 is summed over revenue sources for each county, although, as with Table 1, summing tax impacts across rows of Table 2 is not a valid use of this potential economic impact information.

Tax revenue estimates contained in Table 2 are best viewed as simple and provisional. Tax revenues are highly responsive to changes in economic activity. An increase in some types of economic activity actually might depress tax revenues in ways that are not necessarily intuitive. Also, revenues accumulated for Table 2 are based on revenue flows tabulated in regional income and product accounts in categories that might not match specific tax definitions applied by tax authorities to categorize their revenue collections.

Additional Assessment Information Is Available

Information provided in this report is a rough estimate of the economic impact of the construction of electric power transmission lines in eastern Pennsylvania. When more detailed economic and geographic dimensions of this construction project are available, more precise information about economic impact is possible.

The Penn State WED Initiative possesses additional data, models, and tools that could produce more detailed estimates of the impact of the construction of electric power transmission lines. These same data, models, and tools can help understand the economic impact of the implementation of the electric power transmission line. The line represents an asset to regional economic development by improving the region's capacity for reliable, scalable electric power service for residential, commercial, and industrial customer classes. Analysis of the new capacity offered by this asset could help identify economic and workforce development opportunities and bottlenecks. Information about data, models, and tools of the Penn State WED Initiative is available at <http://WED-Data.notlong.com>.

About This Report

Penn State Workforce Education and Development Initiative

This report was prepared using the resources and expertise of the Penn State WED Initiative, which is an alliance between Penn State's College of Education and Penn State Outreach. The mission of the WED Initiative is to support the development of the workforce in Pennsylvania primarily through the application of Penn State resources to conduct economic and workforce analyses for employers, industry partnerships, nonprofit organizations, and government entities. For additional information about the WED Initiative, see <http://PSU-WEDI-Guide.notlong.com>.



Authors

Rose M. Baker (see <http://RoseBaker.notlong.com>; 814.865.9919; rmb194@psu.edu) is Program Manager of Penn State's Workforce Assessment Center, a unit within the Office of Economic and Workforce Development in Penn State Outreach since November 2006. She also is Assistant Professor of Education associated with the Workforce Education and Development program and a Professional Associate of Penn State Management Development Programs and Services.

Matthew Loiacono (see <http://MatthewLoiacono.notlong.com>) serves as a graduate assistant for the 2007–2008 academic year for the Penn State WED Initiative and is assigned to the Institute for Research in Training and Development. He mainly works on document layout and on economic, demographic, and labor force analysis.

David L. Passmore (see <http://DavidPassmore.notlong.com>; 814.863.2583; dlp@psu.edu) is Professor of Education in the Workforce Education and Development Program at The Pennsylvania State University. He also is Professor of Operations Research in the dual degree, intercollege Operations Research Program, Director of the Institute for Research in Training and Development, and a Professional Associate in Management Development Programs and Services. He is an Adjoint Graduate Faculty Member in Human Resource Development and Technology for the College of Business and Technology at The University of Texas at Tyler.

Baker and Passmore are the primary contacts for any questions and comments about this report.

Input–Output Model Applied in this Analysis

Benchmark estimates of the potential economic impact of construction of electric power transmission lines was conducted using input–output modeling. Impacts are expressed as job, income, value-added, and tax multipliers. Documented in the three sections that follow are: basic input–output accounting; concepts of direct, indirect, and induced economic requirements; and calculation of multipliers that summarize the direct, indirect, and induced activity required to deliver an additional unit of economic output from an industry.

Basic Input–Output Accounting

Consider an economy with I producing industries and J purchasing industries, where $I = J$. Let \mathbf{X} stand for a matrix of interindustry transactions, with elements x_{ij} containing the dollar value of goods and services sold by producing industry i to purchasing industry j . Further, let \mathbf{y} indicate an I –length vector whose elements display the dollar value of goods and services delivered by producing industry i to fulfill the final demand of the economy for personal consumption, government purchases, fixed investments and net exports.

The production sector of the economy is described by \mathbf{X} , and \mathbf{y} is the consumption sector. The sum of column vector, \mathbf{y} , is the gross product of the economy (gross national or domestic product for countries; gross regional product for states and other regions). The total output of the economy, accumulated in an I –length vector \mathbf{x} , is equal to the sum of production plus consumption, or



$$\mathbf{x} = \mathbf{X} + \mathbf{y}. \quad (1)$$

Direct, Indirect, and Induced Requirements

Next, define \mathbf{A} , a *direct requirements matrix* with elements $a_{ij} = x_{ij} / x_p$, showing the proportion of industry i total output that is purchased by industry j . Equation (1) now becomes:

$$\mathbf{x} = \mathbf{A}\mathbf{x} + \mathbf{y} \quad (2)$$

Introducing an I -by- J identity matrix, \mathbf{I} , and rearranging terms in Equation (2),

$$\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{y},$$

where the term, $(\mathbf{I} - \mathbf{A})^{-1}$, is labeled in the regional science and economic development literature as a Leontief Inverse after input-output pioneer, Wassily Leontief. Elements of the Leontief Inverse, also called the *total requirements matrix*, show the additional dollar value of total output from industry i is required directly or indirectly to deliver one dollar's worth of output from industry j to meet final demand in the economy. Taking the difference between the total requirements matrix and the direct requirements matrix yields an *indirect requirements matrix*. Indirect requirements are generated from the long trail of transactions among industries representing the intermediate production that must occur to create a final product for consumption. For example, a loaf of bread sold to a consumer at a retail store is the result of the buying and selling of, among many other items, energy, wheat, transportation, plastics, paper, accounting services, and quality control services.

The addition of households as a row and a column in \mathbf{X} allows the inclusion of household production and purchasing in the input-output model. The addition of this row and column augments the total requirements matrix to include not only direct and indirect requirements, but also to show induced effects of household spending that stimulates purchases of additional good and services. The difference between the total requirements matrix including household spending—net of the indirect requirements matrix—yields an *induced requirements matrix*.

Multipliers

Indirect and induced requirements matrices demonstrate how each dollar spent on goods and services delivered to consumers multiplies itself throughout the economy. Ratios between $[(\text{direct requirements} + \text{indirect requirements}) / \text{direct requirements}]$ as well as ratios between $[(\text{direct requirements} + \text{indirect requirements} + \text{induced requirements}) / \text{direct requirements}]$ are called *Type I* and *Type II* multipliers, respectively, in the regional science and economic development literature (Type II multipliers are shown in tables of this report). Pre-multiplying the direct, indirect, and induced requirements matrices by, say, counts of total employment parses the impact of delivery of final demand to consumers into direct, indirect, and induced employment components.

Multipliers provide a way of quantifying the ripple of business activity that must occur to deliver a final good or service to a consumer. A single purchase by a consumer sets in motion a wave of other transactions by the final producer, who must, in turn, purchase goods and services from other producers—and they, again, from still other producers. It is not difficult to imagine each consumer purchase back-linked through the entire world economy. Perhaps



that one loaf of bread sold to a consumer at a retail store stimulates business transactions throughout the world and creates jobs for workers in seemingly unrelated activities such as, for example, oil fields, hospitals, steel plants, government social service agencies, and fertilizer outlets.