MPUC Docket No. E-6472-/M-05-1993
OAH Docket No. 12-2500-17260-2

BEFORE THE
MINNESOTA OFFICE OF ADMINISTRATIVE HEARINGS
100 Washington Square, Suite 1700
Minneapolis, Minnesota 55401-2138

FOR THE
MINNESOTA PUBLIC UTILITIES COMMISSION
127 7th Place East, Suite 350
St. Paul, Minnesota 55101-2147

In the Matter of the Petition of Excelsior Energy Inc. and Its Wholly-Owned Subsidiary MEP-I, LLC For Approval of Terms and Conditions For The Sale of Power From Its Innovative Energy Project Using Clean Energy Technology Under Minn. Stat. § 216B.1694 and a Determination That the Clean Energy Technology Is Or Is Likely To Be a Least-Cost Alternative Under Minn. Stat. § 216B.1693

PREPARED REBUTTAL TESTIMONY AND EXHIBITS OF EXCELSIOR ENERGY INC.

James A. Skurla

OCTOBER 10, 2006

EXCELSIOR ENERGY, INC.

BEFORE THE MINNESOTA PUBLIC UTILITIES COMMISSION

PREPARED REBUTTAL TESTIMONY OF

JAMES A. SKURLA

Q Please state your name, current employment position and business address.

A My name is James A. Skurla. I am currently the Acting Director of the Bureau of Business and Economic Research of the University of Minnesota Duluth's Labovitz School of Business and Economics, School of Business and Economics, University of Minnesota Duluth, Duluth, Minnesota.

Q Please describe your educational and professional backgrounds.

A I received my Bachelor of Arts Degree in Economics from the University of Minnesota Duluth in 1975 and my Master of Arts in Economics, with a concentration in Econometrics (Statistics), from the University of Wisconsin Milwaukee in 1977. In May of 1992, I became a Certified Economic Development Finance Professional through the National Development Council. Since 1977, I have served at the University of Minnesota Duluth, initially as an Instructor in the Department of Economics, then from 1983 to 1986 as the Assistant Director of the Bureau of Business and Economic Research. From 1987 to 2004, I served as Business Development Specialist, Natural Resources Research Institute Business Group, at the Center for Economic Development of UMD. From 2003 to the present, I have held the position as Acting Director of the Bureau of Business and Economic Research in the Labovitz School. My resume is attached as Exhibit JAS-1 to my June 19, 2006 testimony filed in this proceeding.

Q On whose behalf are you testifying?

A I am testifying on behalf of MEP-I LLC and Excelsior Energy Inc. (collectively "Excelsior"), the developers of the Mesaba Energy Project (the "Project").

Scope and Summary

Q What is the scope of your testimony in this proceeding?

A As I promised in my testimony filed on June 19, 2006 in this proceeding, I am updating the Research Report that our Bureau of Business and Economic Research prepared at the request of Excelsior Energy entitled, *The Economic Impact of Constructing and Operating An Integrated Gasification Combined-Cycle Power-Generation Facility on the Iron Range* ("2005 Report"). Excelsior Energy engaged the Labovitz School Research Bureau to update its previous detailed economic modeling of the anticipated impacts of the Mesaba One project on job creation and economic stimulus, both on the seven-county Arrowhead Region, which comprises most of the Iron Range, and in the State of Minnesota generally. Excelsior Energy also engaged the Labovitz School Research Bureau to create an appendix listing the economic effects of Mesaba Two. I supervised these efforts, which culminated in the creation of a Research Report in October of 2006, entitled *The Economic Impact of Constructing and Operating An Integrated Gasification Combined-Cycle Power-Generation Facility on the Iron Range, UPDATE 2006: Mesaba One Impacts* ("2006 Update"). The 2006 Update is attached as Exhibit JAS-1 to my testimony.

As in the original 2005 Report, the 2006 Update employed the economic modeling system, IMPLAN (which was created by the Minnesota IMPLAN Group, Inc.), using as the original inputs for our modeling Excelsior Energy's updated estimates of the values of Excelsior's direct expenditures on construction and operation of the Mesaba One Project. As is reflected in our 2006 Update, our modeling yielded estimates of the numbers of jobs that Mesaba One would both directly and indirectly create on the Iron Range and statewide. In addition, our modeling yielded estimates of the dollar value of economic activity which Mesaba One would generate on the Iron Range and statewide. I am available to answer any questions related to the 2005 Report and the 2006 Update.

Results from the 2006 Update

Q Please briefly summarize the results of your study for Excelsior Energy.

A Based on IMPLAN modeling, our general conclusions are that Mesaba One will directly create a total of nearly 1,555 construction jobs on the Iron Range in the peak year of construction, and more than 100 jobs on the Iron Range in a typical year of the IGCC Plant's operation. In addition, Mesaba One will create jobs indirectly, by stimulating the commercial, government, service and residential industries to create an additional 2,633 jobs statewide related to the construction of the plant, and another 167 permanent jobs statewide related to the operation of the plant.

With respect to economic stimulus, IMPLAN modeling reflects that Mesaba One's construction and operations expenditures will both directly and indirectly generate spending on the Iron Range and throughout the state. Excelsior Energy provided us with estimates of $1.6 billion in direct spending on construction of the plant over a 45-month period. Based on those inputs, we anticipate that Mesaba One will also generate economic activity indirectly, by inducing secondary spending across the State of Minnesota of $2.2 billion related to expenditures on construction and another $535 million annually related to the plant's operations.

Q. Are there any parts of your Research Report that you would like to further supplement or clarify at this time?

A. Not at this time.

Q. Does this conclude your prepared supplemental testimony?

A. Yes.

EXHIBITS

EXHIBIT NO. ____ (JAS-1)

Labovitz School
OF BUSINESS AND ECONOMICS
Bureau of Business and
Economic Research

Research Report

The Economic Impact of Constructing and Operating an Integrated Gasification Combined-Cycle Power-Generation Facility on the Iron Range

UPDATE 2006: Mesaba One Impacts

Including Appendix A: Mesaba Two Impacts

For copies of this and other research from the Labovitz School research bureau, please see: www.d.umn.edu/sbe/departments/bber

September 2006

For

EXCELSIOR ENERGY

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Including Appendix A: Mesaba Two Impacts

Executive Summary

As noted in the Labovitz School's initial impact study completed in 2005, the construction and operation of the first unit of the Mesaba Energy Project ("Mesaba One") by Excelsior Energy Inc. ("Excelsior") will provide a substantial boost both to Minnesota's economically-depressed Iron Range and the larger State of Minnesota.

This 2006 impact report includes new modeling based on updated assumptions provided to the research bureau, and calculates that Excelsior's construction of Mesaba One will impact Minnesota's economy in the following ways:

- Excelsior provided inputs to the models as follows: $1.6 billion in direct spending on construction to build Mesaba One and $1.4 billion for construction to build Mesaba Two.

- Excelsior provided inputs to the models as follows: $440 million in revenue or output on Mesaba One operations during a typical plant-year, recurring for the life of the plant.

- An additional non-recurring $399 million in increased business and household spending on Mesaba Unit One across the Arrowhead region, which will ultimately result in a non-recurring $640 million in increased spending throughout the State, driven by spending on construction. These numbers are derived from the input-output model, IMPLAN used in this analysis.

- An additional recurring $95 million in increased spending across the Arrowhead region for Mesaba One, which will ultimately result in a recurring $130 million in increased spending throughout the State, generated by spending on operations. These numbers are also derived from IMPLAN.

This report estimates that Mesaba One will also provide an impact on Minnesota's Iron Range (Arrowhead Region) and the State by creating thousands of jobs.*

- Over the course of the Mesaba One construction period 2008–2011, full-time, part-time and temporary construction jobs peak at 1555.

- A total of over 107 full-time, part-time, and temporary jobs in Mesaba One operations.

- An additional 1,966 new full-time, part-time, and temporary jobs during the peak year in other sectors across the Arrowhead region, as a result of the creation of Mesaba One construction jobs.

- An additional 143 new full and part-time jobs in other sectors across the region, caused by the

creation of jobs in the typical year of operations of Mesaba One.

This report assesses the economic impact on the Region and the State by Mesaba One. Appendix A presents impacts for Mesaba Two, which Excelsior currently has plans to develop and construct on the same site.

*Note that IMPLAN is driven by data sources that do not distinguish between full-time and part-time employment.

About the Project:

Excelsior Energy Inc. is an independent energy development company based in Minnetonka, Minnesota, that proposes to build, own, and operate the first unit of the Mesaba Energy Project. Mesaba One will be a privately funded power-generation facility, and it will be a large-scale commercial application of Integrated Gasification Combined Cycle (IGCC) technology. Excelsior asserts that Mesaba's use of IGCC will put Minnesota at the vanguard of far-sighted states utilizing next-generation technology, and the U.S. Department of Energy agrees that the Mesaba One development will be "one of the cleanest coal-fired power plants in the world."[1]

Mesaba One was initially modeled in 2005 with preliminary assumptions for output and employment from Excelsior Energy. It is important to note the assumptions provided for the 2006 impacts have changed somewhat from those provided for the 2005 impacts and the two reports (2005 and 2006) are therefore not comparable. The assumptions provided for modeling the 2006 update include changes in estimated employment and output as well as use of model deflators to report impacts in terms of 2005 dollars. This 2006 report also includes modeling for Mesaba Two (or Unit 2) in Appendix A to this report. As with the 2005 impact study, construction and operations impacts are modeled for two study areas, the State of Minnesota and the Arrowhead Region.

Economic Impacts from Construction:

Construction is predicted to span 45 months: Excelsior is slated to begin construction of Mesaba One in 2008 and should finish in 2011.

Summary: Economic Impacts of Mesaba One's Construction Expenditures, State of Minnesota and Arrowhead Region, 2008–2011 (2005 Dollars)

Source: IMPLAN

	Arrowhead Region			Minnesota		
Years	***Value Added Totals $***	***Employment Totals***	***Output Totals $***	***Value Added Totals $***	***Employment Totals***	***Output Totals $***
2008	**$135,141,055**	**1746**	**$477,749,810**	**$170,310,659**	**2,118**	**$538,716,607**
2009	**$276,740,596**	**3521**	**$915,863,165**	**$341,358,521**	**4,188**	**$1,027,748,108**
2010	**$149,304,573**	**1873**	**$464,076,598**	**$180,646,455**	**2,188**	**$518,310,750**
2011	**$25,977,172**	**344**	**$102,039,831**	**$33,978,679**	**432**	**$115,924,391**
Total	**$587,163,396**	**N/A**	**$1,959,729,404**	**$726,294,314**	**N/A**	**$2,200,699,856**

[1] "Minnesota Company to Receive $36 Million to Construct Clean Coal Plant," at http://www.fossil.energy.gov/news/techlines/2004/tl_ccpi2_excelsior.html.

The Table above is a summary of the direct, indirect and induced impacts for Value Added, Employment and Output. The detailed break-down of these impacts are highlighted in the report. Over the 45 months, Excelsior is predicted to generate $1.96 billion (in 2005 Dollars) in economic activity in the Arrowhead Region based on direct expenditures of $1.6 billion for construction. After construction is complete, construction impacts will end; operations impacts will continue for the life of the plant.

Construction of the plant is expected to have immediate and beneficial impacts beyond simply creating jobs in the construction sector. Just as the expenditure of Mesaba One's capital for construction costs will result in increased consumer spending across the Arrowhead region, Mesaba One's creation of construction jobs is calculated to cause the creation of almost two thousand full-time, part-time, and temporary jobs in sectors other than construction.

Economic Impacts from Operations:

Operations should begin in 2011 when the plant will start functioning at approximately 10% capacity; the sharp increase in the amount of value-added in 2012 indicates the commencement of operation at full capacity. "Typical Year" values show value added, employment, and output from on-going full capacity operations, modeled as 2015. Value added represents wages, rents, interests and profits and Output is the total production of the industry. Employment includes the total number of jobs in that industry. Mesaba One is projected to generate $535 million in economic activity in the Arrowhead Region based on revenue or output of $440 million for operations. Output totals for the typical year show this $535 million, below.

Summary: Economic Impact of Mesaba One's Operations Expenditures, 2010, 2011, and Typical Year (2005 Dollars)

Source: IMPLAN

	Arrowhead Region			Minnesota		
Years	*Value Added Totals $*	*Employment Totals*	*Output Totals $*	*Value Added Totals $*	*Employment Totals*	*Output Totals $*
2011	**$84,749,275**	**65**	**$122,379,672**	**$89,463,990**	**72**	**$130,416,708**
2012	**$257,723,155**	**185**	**$372,157,528**	**$272,060,689**	**199**	**$396,598,203**
Typical	**$370,182,128**	**250**	**$534,550,504**	**$390,775,856**	**273**	**$569,656,026**

Mesaba Energy, Mesaba One, Employment Impacts from Operations, Arrowhead Region, Typical Year, by Industry Sector

Source: IMPLAN

IMPLAN Sector	Projected Employment			
	Direct	*Indirect*	*Induced*	*Total*
Power generation and supply	107	0	0	107
Food services and drinking places	0	4	15	19
Commercial machinery repair and maintenance	0	8	0	9
Hospitals	0	0	6	6
Offices of physicians- dentists- and other health	0	0	6	6
Nursing and residential care facilities	0	0	5	5
General merchandise stores	0	0	5	5
Food and beverage stores	0	0	4	4
Wholesale trade	0	1	3	4
Motor vehicle and parts dealers	0	0	3	3
Social assistance- except child day care services	0	0	3	3
Automotive repair and maintenance- except car wash	0	0	3	3
Securities- commodity contracts- investments	0	1	2	3
Private households	0	0	3	3
Nonstore retailers	0	0	3	3
Legal services	0	2	1	3
Miscellaneous store retailers	0	0	3	3
Other maintenance and repair construction	0	2	0	2
Monetary authorities and depository credit intermediation	0	1	2	2
Rail transportation	0	2	0	2
Building material and garden supply stores	0	0	2	2
	107	21	69	197

Mesaba One's capital expenditures for operations should also result in the creation of jobs in industries outside the utility industry. The IMPLAN model estimates that in a Typical Year, Mesaba One's capital expenditures will create more than 250 jobs in other industries across the Arrowhead region.

This economic analysis from the UMD Labovitz School's research bureau quantifies both the Mesaba One project's direct effects, and its secondary effects on increased spending in the greater economy of the Arrowhead Region and the State of Minnesota. The study applies an economic multiplier analysis and input/output model that was created in Minnesota by the Minnesota IMPLAN Group, Inc., and is used by other state governments and the USDA Forest Service, among others. An impact for Mesaba Two is included in Appendix A to this report.

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Mesaba One Energy Impact

I. Project Description

Mesaba One was initially modeled in 2005 with preliminary assumptions for output and employment from Excelsior Energy. It is important to note the assumptions provided for the 2006 impacts have changed somewhat from those provided for the 2005 impacts and the two reports (2005 and 2006) are therefore not comparable. The assumptions provided for modeling the 2006 update include changes in estimated employment and output as well as use of model deflators to report impacts in terms of 2005 dollars. The 2006 report also includes modeling for Mesaba Two (or Unit 2) in Appendix A to this report. As with the 2005 impact study, construction and operations impacts are modeled for two study areas, the State of Minnesota and the Arrowhead Region.

Excelsior Energy Inc. is an independent energy development company based in Minnetonka, Minnesota, that proposes to build, own, and operate the first unit of the Mesaba Energy Project. Mesaba One will be a privately funded power-generation facility, and it will be a large-scale commercial application of Integrated Gasification Combined Cycle (IGCC) technology. Excelsior asserts that Mesaba's use of IGCC promises to put Minnesota at the vanguard of far-sighted states utilizing next-generation technology, and the U.S. Department of Energy agrees that the Mesaba One development will be "one of the cleanest coal-fired power plants in the world."[2]

The UMD Labovitz School research bureau (Bureau of Business and Economic Research) worked with Excelsior to determine the key assumptions in the development of the economic impact model. Regional and State data for the impact model for Value Added, Employment, and Output is supplied by IMPLAN. From these data, Social Accounts, Production, Absorption, and Byproducts information are generated from the national level data and incorporated into the model.

This report assesses the economic impact on the Region and the State by the construction and operation of the Mesaba One plant. Appendix A presents impacts for Mesaba Two, which Excelsior currently has plans to develop and construct on an additional site.

Two Study Areas

This report measured the economic impact of Mesaba One on two levels: the region surrounding the proposed plant, and the State of Minnesota. **Study area 1:** Seven County Arrowhead Region, MN, including Aitkin, Carlton, Cook, Itasca, Koochiching Lake, and St. Louis counties;

[2] "Minnesota Company to Receive $36 Million to Construct Clean Coal Plant," at http://www.fossil.energy.gov/news/techlines/2004/tl_ccpi2_excelsior.html.

also referred to in this report as the “Iron Range.”

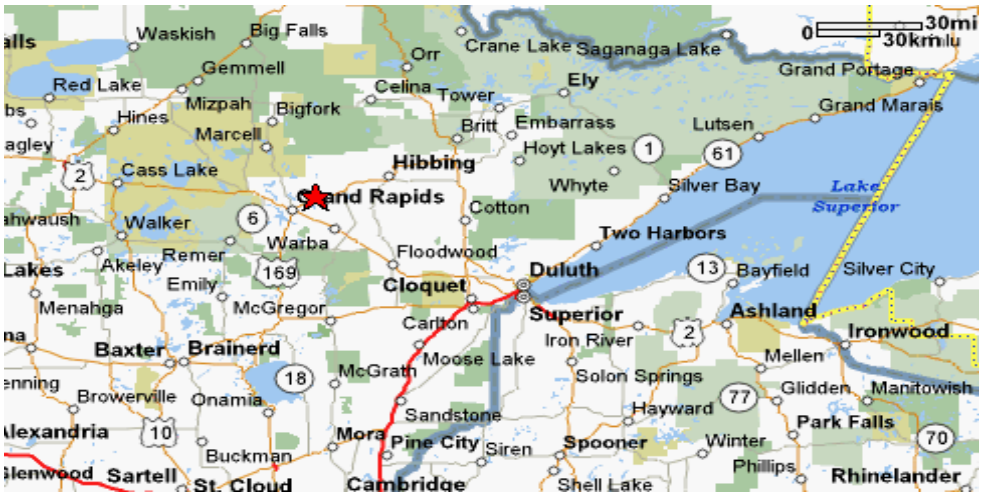

Figure 1. Area north of the city of Taconite in Itasca County has been suggested as the prime location. *Source: mapquest.com*

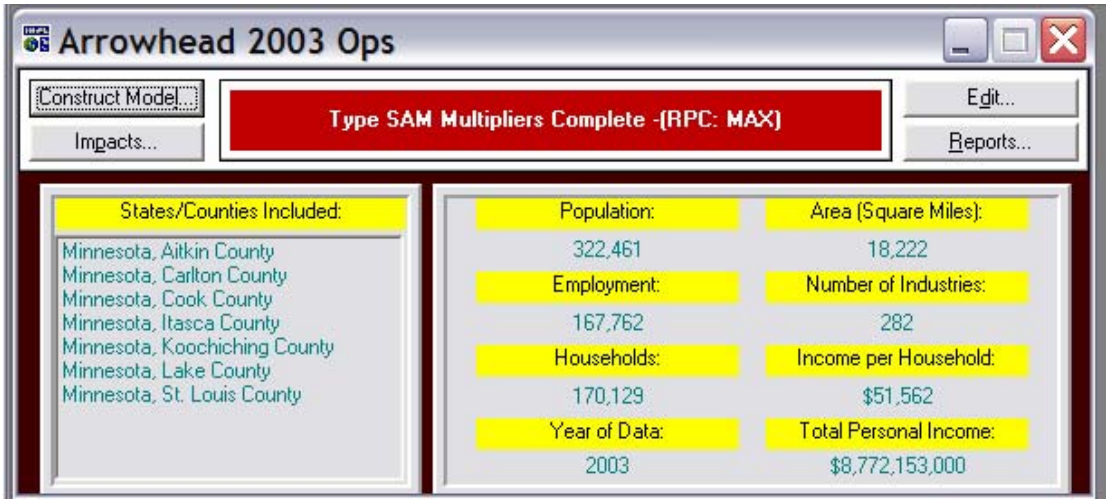

Figure 2. Minnesota Arrowhead Region IMPLAN model information.

Study area 2: State of Minnesota, including all counties.

Mesaba Two, in Appendix A, uses the two study areas as presented here.

II. Impact Procedures and Input Assumptions

IMPLAN Models

There are two components to the IMPLAN system, the software and databases. The databases provide all information to create regional IMPLAN models. The software performs the calculations and provides an interface for the user to make final demand changes.

Comprehensive and detailed data coverage of the IMPLAN study areas by county, and the ability to incorporate user-supplied data at each stage of the model building process, provides a high degree of flexibility both in terms of geographic coverage and model formulation, in this case definition of the State and seven-county Arrowhead Region study areas, and the definition of specific models for construction and operations, with adjusted production functions to reflect the proposed IGCC plant. Using the IMPLAN software and data, BBER identified Mesaba One's expenditures in terms of the sectoring scheme for the model, in producer prices, in historical dollars based on the year of the model, and applied those dollars spent within the two study area definitions given for the impact analysis.

Data

IMPLAN data files use federal government data sources including:

- US Bureau of Economic Analysis Benchmark I/O Accounts of the US
- US Bureau of Economic Analysis Output Estimates
- US Bureau of Economic Analysis REIS Program
- US Bureau of Labor Statistics County Employment and Wages (CEW) Program
- US Bureau of Labor Statistics Consumer Expenditure Survey
- US Census Bureau County Business Patterns
- US Census Bureau Decennial Census and Population Surveys
- US Census Bureau Economic Censuses and Surveys
- US Department of Agriculture Crop and Livestock Statistics

IMPLAN data files consist of the following components: employment, industry output, value added, institutional demands, national structural matrices and inter-institutional transfers.

Impacts for this model use the most recent IMPLAN data available which is for the year 2003. The impact is reported in 2005 dollars (given the data year of inputs supplied to BBER) and calculated with the built-in deflators of the modeling software.

Economic impacts are made up of direct, indirect, and induced impacts. The following cautions are suggested assumptions for accepting the impact model:

- IMPLAN input-output is a production based model
- Local or export based purchases that represent transfers from other potential local

purchases are not counted.
- The numbers (from U.S. Department of Commerce secondary data) treat both full and part time individuals as being employed.
- Assumptions need to be made concerning the nature of the local economy before impacts can be interpreted.
- The IMPLAN model was constructed for the year 2003 (most recent data available). 2005 dollars are estimated by the model.

Definitions used in this report:

Measures

- **Gross Output** represents the value of local production required to sustain activities.
- **Value Added** is a measure of the impacting industry's contribution to the local community; it includes wages, rents, interest and profits.
- **Employment** estimates are in terms of jobs, not in terms of full-time equivalent employees. Hence, these may be temporary, part-time or short-term jobs.

Effects

- **Direct** – Initial new spending in the study area resulting from the project
- **Indirect** – The additional inter-industry spending from the direct impact
- **Induced** – The impact of additional household expenditure resulting from the direct and indirect impact.

Inputs provided for modeling the impact of Mesaba One

Excelsior provided the BBER model estimated expenditures concerning specific processes for the proposed plant, including feed handling, slurry preparation, air separation, cooling water process, gasification, slag handling, wastewater collection and treatment, common mechanical, as well as other miscellaneous inputs.

Readers of the 2005 Mesaba One impact study may note this 2006 update includes assumptions by Excelsior of higher capital costs than the 2005 model. There are a number of factors leading such increased costs, including the larger plant size (603 MW vs. 531 MW) and significant increases in global commodity prices. The impact continues to show the higher cost of construction in Minnesota in terms of seasonality, and also shows an expected higher cost of building a plant which includes advanced technology, delivered at a higher percent of pre-fabricated and specialized components than that required for conventional coal fueled power plants. Most of the input assumptions for the 2006 update follow the detail provided for the 2005 impact study. All of the assumptions for the Mesaba Two modeling found in the Appendix A track the assumptions utilized for the Mesaba One 2006 update.

Other modeling challenges for both the 2005 and the 2006 update impacts include aligning the IGCC process with data from the industry sector. Conventional power plant employment will differ from the more technologized operations of the IGCC plant. This plant would still utilize much of the same labor skill sets associated with a conventional plant.

Construction

Materials: For the construction impact, Excelsior provided estimates for dollars, percent of the total cost for materials, and the percent Minnesota could supply of products and services for the project.

Labor: Excelsior provided estimates for loaded labor rate/hour and definition of specialized intermittent field labor costs including all typical overheads, insurance, etc.

Operations

For the operations impact, Excelsior provided estimates for such components as staffing and labor cost per year, including annual direct labor, overheads, employee expense, and contracted labor/equipment maintenance (estimated annual contract labor to support plant overhauls and routine equipment maintenance).

Industry sector adjustments

NAICS coded industry sectors supplying the proposed Mesaba One plant were adjusted to the requirements of the sector modeling in the IMPLAN model including such industry specific sectors as Power Boiler and Heat Exchanger Manufacturing; Turbine and Turbine Generator Set Units Manufacturing; Electric Power and Specialty Transformer manufacturing; Electric Power Generation; and Power and Communication Line and Related Structures Construction, among others.

Production functions addressed in the gross absorption tables for the industrial sectors of the input-output modeling were adjusted to reflect estimates for the Mesaba One plant construction and operations demand changes.

Benchmark (economic base) and impact (additional plant) models were constructed for the regional Arrowhead seven-county economy and the State of Minnesota economy.

Employment

Estimates for labor costs (escalated, with contractor profit and contingency) were provided by Excelsior. A cost estimate summary was reported to BBER from comparable plant construction and operation ratios, including labor cost for requirements such as feed handling, slurry preparation, air separation, cooling water, gasification, slag handling, sulfur recovery, power block, balance of plant, common E & I, water treatment, wastewater collection, common mechanic, and others.

IMPLAN measures of direct, indirect, and induced employment follow from assumptions in the model concerning the estimation of megawatts of energy produced, and the number of jobs created to deliver the production of energy to the economy. Individual plant efficiencies and individual plant allocations of permanent, temporary, and part-time employment can alter the model's job estimation.

Inflation

The most recent IMPLAN data available for modeling these impacts are for industry sectors in the year 2003. These 2003 impacts were then inflated to show 2005 dollars in the tables of this report, using the industry specific deflators from the IMPLAN model.

III. Mesaba One Impact Findings

All of the following tables (Tables 1 through 6) use the estimated values of Mesaba One's direct expenditures on the Iron Range Arrowhead Region as the original input for the model. Direct expenditures are listed in the column labeled, "Direct Effect." "Indirect Effect" measures the amount of increased spending between commercial, government and service industries, and "Induced Effect" measures the amount of increased spending by residential households. "Total Effect" is the sum of Direct, Indirect, and Induced Effects.

The "Value Added," "Employment," and "Output" totals in Tables 2a through c, and 4a through 4c show Mesaba One's economic impacts across the State of Minnesota. These totals incorporate the economic impacts that Mesaba One is likely to have on the Arrowhead Region, which are shown in the corresponding "Value Added," "Employment," and "Output" columns in Tables 1a through 1c, and 3a through 3c. (For instance, Table 1b shows that Mesaba One's construction expenditures are expected to have a "Total Effect" of $2.2 billion in spending across the State. This $2.2 billion incorporates, and is not in addition to, the $1.96 billion in "Total Effects" that Mesaba One is expected to generate in the Arrowhead Region, as shown in Table 2b.).

None of the tables that show Mesaba One's yearly employment impacts add the total number of jobs-created across all 45 months of construction. Although IMPLAN required that each calendar year of construction be modeled as a separate event, each job created by construction activity may carry through all calendar years as the same job, and could thus be counted more than once (For instance, the engineers, project managers, and installers that Mesaba One will employ for year 2008 might still be employed by Mesaba One in year 2011.)

Construction

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Table 1 Summary: Arrowhead Construction Impacts, Mesaba One, 2008–2011 (2005 Dollars)

Years	*Value Added Totals $*	*Employment Totals*	*Output Totals $*
2008	$135,141,055	1,746	$477,749,810
2009	$276,740,596	3,521	$915,863,165
2010	$149,304,573	1,873	$464,076,598
2011	$25,977,172	344	$102,039,831
Total	$587,163,396	N/A	$1,959,729,404

Table 1 summarizes the total effects of Mesaba One's direct construction expenditures, as detailed in Tables 1a through 1c. The column on the right (labeled "Output Totals") shows that Mesaba One's overall construction expenditure of $1.6 billion (direct effect) is calculated to create an additional $399 million (indirect and induced effects) in further spending—resulting in economic activity totaling $1.96 billion. The column on the left (labeled "Value Added Totals") measures the economic impact of the $369 million that Mesaba One is expected to use to pay for wages, rents, interest, and profits, and is estimated to result in an additional $218 million in commercial, government, services and consumer spending for a total of $587 million. The column in the center (labeled "Employment Totals") shows the total number of jobs that Mesaba One will create in the Arrowhead Region by directly employing construction workers. The column shows that in the peak calendar-year of construction, Mesaba One is expected to directly employ nearly 1,555 workers for project construction, which will result in the creation of nearly 3,521 jobs in the Region.

The Construction Impact findings in Tables 1a through 1c are detailed in separate tables by study area. Each table is further broken-down by year, and by effect.

Table 1a: Study Area 1: Arrowhead Region

Table 1a shows the impact of Mesaba One's construction expenditures on the seven-county Arrowhead Region over the 45 months of construction required to build Mesaba One. "Value Added" measures the economic impact of capital that Mesaba One specifically expects to spend on wages, rents, interest, and profits related to construction.

As Table 1a illustrates, Mesaba One expects to directly spend a total of $369 million on wages, rents, interest, and profits, which in turn will generate an additional $218 million in further spending (for a total of $587 million). Dividing total value added impact ($587 million) by direct expenditures ($369 million) results in a value added multiplier of 1.59. This means that for each dollar that Mesaba One expends on wages, rents, interest, and profits related to construction, the economy will spend another $0.59.

Table 1a: Mesaba Energy, Value Added Impacts from Construction, Arrowhead Region, Mesaba One, 2008–2011

Source: IMPLAN	Value Added in 2005 $			
Years	*Direct Effect*	*Indirect Effect*	*Induced Effect*	*Total Effect*
2008	$82,554,056	$29,671,423	$22,915,575	$135,141,055
2009	174,375,360	55,856,384	46,508,850	276,740,596
2010	96,690,584	27,729,635	24,884,357	149,304,573
2011	15,025,058	6,482,382	4,469,732	25,977,172
Total	368,645,058	119,739,824	98,778,514	587,163,396

Table 1b shows the economic impact of Mesaba One's total expenditures over four years of construction. Based on direct-expenditures of $1.6 million, Mesaba One is expected to create $399 million in further spending activity in the region. The ratio of Total Effect to Direct Effect ($1.96 billion to $1.56 billion) results in an output multiplier of 1.26 for the region.

Table 1b: Mesaba Energy, Output Impacts from Construction, Arrowhead Region, Mesaba One, 2008-2011

Source: IMPLAN	Output in 2005 $			
Years	*Direct Effect*	*Indirect Effect*	*Induced Effect*	*Total Effect*
2008	$381,471,424	$58,659,597	$37,618,792	$477,749,810
2009	729,280,832	110,232,616	76,349,717	915,863,165
2010	368,592,896	54,633,279	40,850,410	464,076,598
2011	81,850,384	12,851,745	7,337,702	102,039,831
Total	1,561,195,536	236,377,237	162,156,621	1,959,729,404

Table 1c shows Mesaba One's impact on employment in the seven-county Arrowhead Region over the 45 months of plant construction. This table shows that every job that Mesaba One creates during the construction-period will result in the creation of additional jobs. Table 1c shows that Mesaba One will create 1,555 full-time, part-time, and temporary jobs during the peak construction year, which in turn will cause the creation of almost 1,966 jobs throughout other sectors.

Table 1c: Mesaba Energy, Employment Impacts from Construction, Arrowhead Region, Mesaba One, 2008-2011

Source: IMPLAN	Employment			
Years	*Direct Effect*	*Indirect Effect*	*Induced Effect*	*Total Effect*
2008	736	559	451	1,746
2009	1,555	1,050	916	3,521
2010	862	520	490	1,873
2011	134	122	88	344

Note: Employment impacts from construction cannot be summed for a total over the four year construction period.

Study Area 2: State of Minnesota

Table 2 summarizes the total effects of Mesaba One's direct construction expenditures on the State, as illustrated in Tables 2a, through c. The column on the right (labeled "Output Totals") shows that Mesaba One's overall construction expenditure of $1.6 billion is calculated to create an additional $640 million in further spending—resulting in economic activity totaling $2.2 billion. The column on the left (labeled "Value Added Totals") measures the economic impact of the $369 million that Mesaba One is expected to use specifically to pay for wages, rents, interest, and profits, and is estimated to result in an additional $358 million in spending in the State. The column in the center (labeled "Employment Totals") shows the number of jobs that Mesaba One will create across the State by directly employing construction workers. The column shows that in the peak calendar-year of construction, Mesaba One is expected to directly employ nearly 1,555 workers in construction projects, which will result in the creation of over 4,188 jobs in Minnesota.

Table 2 Summary:
Minnesota Construction Impacts,
Mesaba One, 2008-2011 (2005 Dollars)

Years	Value Added Totals $	Employment Totals	Output Totals $
2008	**$170,310,659**	**2,118**	**$538,716,607**
2009	**$341,358,521**	**4,188**	**$1,027,748,108**
2010	**$180,646,455**	**2,188**	**$518,310,750**
2011	**$33,978,679**	**432**	**$115,924,391**
Total	**$726,294,314**	**N/A**	**$2,200,699,856**

Table 2a shows the detailed impact of Mesaba One's construction expenditures on the entire State over the 45 months of construction required to build Mesaba One. "Value Added" measures the economic impact of capital that Mesaba One specifically expects to spend on wages, rents, interest, and profits related to construction.

As Table 2a illustrates, Mesaba One expects to directly spend a total of $369 million on wages, rents, interest, and profits, which in turn will generate an additional $356 million in further spending (for a total of $726 million). Dividing total value added impact ($726 million) by direct expenditures ($356 million) results in a value added multiplier of 1.97. This means that for each dollar that Mesaba One expends on wages, rents, interest, and profits related to construction, the economy will spend another $0.94.

Table 2a: Mesaba Energy, Value Added Impacts from Construction, Minnesota, Mesaba One, 2008-2011

Source: IMPLAN	Value Added in 2005 $			
Years	*Direct Effect*	*Indirect Effect*	*Induced Effect*	*Total Effect*
2008	$82,550,416	$50,174,788	$37,585,453	$170,310,659
2009	174,388,832	92,497,581	74,472,103	341,358,521
2010	96,685,608	44,975,279	38,985,569	180,646,455
2011	15,024,376	11,316,541	7,637,762	33,978,679
Total	368,649,232	198,964,189	158,680,887	726,294,314

Table 2b shows the economic impact of Mesaba One's total expenditures over four years of construction. Based on direct-expenditures of more than $1.6 billion, Mesaba One is expected to create $638 million in further economic activity. The ratio of Total Effect to Direct Effect ($2.2 billion to $1.6 billion) results in an economic multiplier of 1.41 for the State.

Table 2b: Mesaba Energy, Output Impacts from Construction, Minnesota, Mesaba One, 2008-2011

Source: IMPLAN	Output in 2005 $			
Years	*Direct Effect*	*Indirect Effect*	*Induced Effect*	*Total Effect*
2008	$381,471,424	$94,603,475	$62,641,711	$538,716,607
2009	729,280,832	174,344,717	124,122,542	1,027,748,108
2010	368,592,896	84,738,980	64,978,869	518,310,750
2011	81,850,384	21,345,271	12,728,736	115,924,391
Total	1,561,195,536	375,032,443	264,471,858	2,200,699,856

Table 2c shows Mesaba One's impact on employment in the State, over the 45 months of plant construction. This table shows that every job that Mesaba One creates during the construction-period will result in the creation of additional jobs. Table 2c shows that Mesaba One will create 1,555 full-time, part-time, and temporary jobs during the peak construction year, which in turn will cause the creation of more than 2,633 jobs throughout other sectors of the State.

Table 2c: Mesaba Energy, Employment Impacts from Construction, Minnesota, Mesaba One, 2008-2011

Source: IMPLAN	Employment			
Years	*Direct Effect*	*Indirect Effect*	*Induced Effect*	*Total Effect*
2008	736	766	616	2,118
2009	1,555	1,412	1,221	4,188
2010	862	687	639	2,188
2011	134	173	125	432

Note: Employment impacts from construction cannot be summed for a total over the four year construction period.

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Operations

Tables 3 a through c show the economic effects that Mesaba One is expected to have on the Arrowhead Region during the calendar-year of start-up, the first year of operations, and a typical year of operations. It is important to note that unlike the effects of Mesaba One's construction expenditures, which are singular, this report assumes that the Arrowhead Region will reap the benefits of Mesaba One's typical-year operations expenditures annually for the life of the plant.

Study Area 1: Arrowhead Region

Table 3 summarizes Tables 3a through c, showing the total economic effects of Mesaba One's direct expenditures for operations on the Arrowhead Region. The right-most column (labeled "Output Totals") displays the economic effects that Mesaba One's total expenditures for operations are expected to have on the Region. In a typical year, Mesaba One is expected to directly produce $440 million in output, thereby generating a total of $535 million in economic activity across the Arrowhead Region. The left-most column (labeled "Value Added Totals") shows the economic impact of the money that Mesaba One expects to specifically use to pay for wages, rents, interest, and profits related to operations. During a typical year, it is predicted that Mesaba One will directly expend $316 million to meet these costs, which should result in total spending of $370 million. The center column (labeled "Employment Totals") measures the number of jobs that Mesaba One is likely to indirectly create by directly creating jobs in operations. Over a typical year, Mesaba One is likely to employ 107 workers in operations, which should result in the creation of nearly 250 jobs in total across the Region.

Table 3 Summary:Arrowhead Operations Impacts, Mesaba One, 2011, 2012 and Typical Year(2005 Dollars)

Years	Value Added Totals $	Employment Totals	Output Totals $
2011	$84,749,275	65	$122,379,672
2012	$257,723,155	185	$372,157,528
Typical	$370,182,128	250	$534,550,504

Table 3a shows the Value Added impacts that Mesaba One's specific spending on wages, rents, interest, and profits is expected to have on the seven-county Arrowhead Region. The Table shows that in a typical year, Mesaba One is expected to directly spend around $316 million to meet these expenditures, which should create a total of more than $370 million in spending throughout the rest of the Region. The economic multiplier is 1.17, the ratio of "Total Effect" to "Direct Effect" ($370 million to $316 million).

Table 3a: Mesaba Energy, Value Added Impacts from Operations, Arrowhead Region, Mesaba One, 2011, 2012, and Typical Year

Source: IMPLAN	Value Added in 2005 $			
Years	*Direct Effect*	*Indirect Effect*	*Induced Effect*	*Total Effect*
2011	$72,374,824	$3,324,928	$9,049,515	$84,749,275
2012	220,092,400	10,111,119	27,519,644	257,723,155
Typical	316,130,944	14,523,178	39,527,991	370,182,128

Table 3b shows the Output impacts on the seven-county Arrowhead Region of Mesaba One's expenditures for operations. As illustrated by Table 3b, Mesaba One is expected to produce $440 million in output in a typical year, which should result in a total of $535 million in spending region-wide. The economic multiplier is 1.22 ($535 million to $440 million).

Table 3b: Mesaba Energy, Output Impacts from Operations, Arrowhead Region, Mesaba One, 2011, 2012, and Typical Year

Source: IMPLAN	Output in 2005 $			
Years	*Direct Effect*	*Indirect Effect*	*Induced Effect*	*Total Effect*
2011	$100,687,976	$6,842,714	$14,848,982	$122,379,672
2012	306,192,928	20,808,727	45,155,868	372,157,528
Typical	439,801,888	29,888,751	64,859,878	534,550,504

Table 3c shows the impacts that Mesaba One's creation of permanent operations jobs is expected to have on the seven-county Arrowhead Region. In a typical year, Mesaba One is expected to employ 107 people in operations, which should result in the creation of 250 jobs total across the region.

Table 3c: Mesaba Energy, Employment Impacts from Operations, Arrowhead Region, Mesaba One, 2011, 2012, and Typical Year

Source: IMPLAN	Employment			
Years	*Direct Effect*	*Indirect Effect*	*Induced Effect*	*Total Effect*
2011	28	9	29	65
2012	79	25	81	185
Typical	107	34	109	250

Table 3d shows Employment impacts from Operations for the Arrowhead Region. Total jobs are ranked by industry sector for the Typical Year.

Table 3d: Mesaba Energy, Employment Impacts from Operations, Arrowhead Region, Mesaba One, Typical Year, by Industry Sector

Source: IMPLAN

IMPLAN Sector	Projected Employment			
	Direct	*Indirect*	*Induced*	*Total*
Power generation and supply	107	0	0	107
Food services and drinking places	0	4	15	19
Commercial machinery repair and maintenance	0	8	0	9
Hospitals	0	0	6	6
Offices of physicians- dentists- and other health	0	0	6	6
Nursing and residential care facilities	0	0	5	5
General merchandise stores	0	0	5	5
Food and beverage stores	0	0	4	4
Wholesale trade	0	1	3	4
Motor vehicle and parts dealers	0	0	3	3
Social assistance – except child day care services	0	0	3	3
Automotive repair and maintenance – except car wash	0	0	3	3
Securities- commodity contracts- investments	0	1	2	3
Private households	0	0	3	3
Nonstore retailers	0	0	3	3
Legal services	0	2	1	3
Miscellaneous store retailers	0	0	3	3
Other maintenance and repair construction	0	2	0	2
Monetary authorities and depository credit intermediation	0	1	2	2
Rail transportation	0	2	0	2
Building material and garden supply stores	0	0	2	2
	107	21	69	197

Study Area 2: State of Minnesota

Table 4 Summary: Minnesota Operation Impacts, Mesaba One, 2011, 2012 and Typical Year (2005 Dollars)

Years	Value Added Totals $	Employment Totals	Output Totals $
2011	$89,463,990	72	$130,416,708
2012	$272,060,689	199	$396,598,203
Typical	$390,775,856	273	$569,656,026

Table 4 encapsulates the information shown in Tables 4a through 4c, showing the total economic effects of Mesaba One's direct expenditures for operations on the State of Minnesota. The column on the right shows that the $440 million that Mesaba One expects to produce in output in a typical year is expected to result in total spending of $570 million across Minnesota. The column on the left estimates that in a typical year, Mesaba One will spend $316 million on wages, rents, interest, and profits related to operations, which should ultimately result in spending of $391 million across the State. The column in the center shows that the 107 new jobs that Mesaba will create in a typical year, which will cause the creation of a total of 273 jobs across the State.

Table 4a shows Value Added impacts that Mesaba One's specific spending on wages, rents, interest, and profits is expected to have on the State of Minnesota. The table shows that every dollar that Mesaba One spends on wages, rents, interest, and profits related to operations will result in a total of $0.24 spent across the State ($391 million over $316 million equals 1.24).

Table 4a: Mesaba Energy, Value Added Impacts from Operations, Minnesota, Mesaba One, 2011, 2012, and Typical Year

Source: IMPLAN	Value Added in 2005 $			
Years	*Direct Effect*	*Indirect Effect*	*Induced Effect*	*Total Effect*
2011	$72,374,136	$4,709,080	$12,380,769	$89,463,990
2012	220,090,320	14,320,354	37,650,012	272,060,689
Typical	316,127,936	20,569,108	54,078,804	390,775,856

Table 4b shows Output impacts of Mesaba One's operations expenditures on the State of Minnesota. Every dollar that Mesaba One spends for operations in general is expected to result in total spending of $1.30 (the ratio of $571 million To $440 million is 1.30).

Table 4b: Mesaba Energy, Output Impacts from Operations, Minnesota, Mesaba One, 2011, 2012, and Typical Year

Source: IMPLAN	Output in 2005 $			
Years	*Direct Effect*	*Indirect Effect*	*Induced Effect*	*Total Effect*
2011	$100,687,976	$9,090,586	$20,638,139	$130,416,708
2012	306,192,928	27,644,551	62,760,741	396,598,203
Typical	439,801,888	39,707,386	90,146,735	569,656,026

Table 4c shows the impacts of Mesaba One's creation of operations jobs on employment in Minnesota.

Table 4c: Mesaba Energy, Employment Impacts from Operations, Minnesota, Mesaba One, 2011, 2012, and Typical Year

Source: IMPLAN	Employment			
Years	*Direct Effect*	*Indirect Effect*	*Induced Effect*	*Total Effect*
2011	28	11	33	72
2012	78	30	91	199
Typical	107	42	125	273

Table 5: Mesaba Energy, State and Regional Review of Construction Impacts on the Arrowhead Region and Minnesota, Mesaba One, 2008-2011, Value Added, Output (2005 Dollars)

Source: IMPLAN		Value Added $				Output $			
		Direct	*Indirect*	*Induced*	*Total*	*Direct*	*Indirect*	*Induced*	*Total*
MN	2008	**$82,550,416**	**$50,174,788**	**$37,585,453**	**$170,310,659**	**$381,471,424**	**$94,603,475**	**$62,641,711**	**$538,716,607**
ARR		82,554,056	29,671,423	22,915,575	135,141,055	381,471,424	58,659,597	37,618,792	477,749,810
MN	2009	**174,388,832**	**92,497,581**	**74,472,103**	**341,358,521**	**729,280,832**	**174,344,717**	**124,122,542**	**1,027,748,108**
ARR		174,375,360	55,856,384	46,508,850	276,740,596	729,280,832	110,232,616	76,349,717	915,863,165
MN	2010	**96,685,608**	**44,975,279**	**38,985,569**	**180,646,455**	**368,592,896**	**84,738,980**	**64,978,869**	**518,310,750**
ARR		96,690,584	27,729,635	24,884,357	149,304,573	368,592,896	54,633,279	40,850,410	464,076,**598**
MN	2011	**15,024,376**	**11,316,541**	**7,637,762**	**33,978,679**	**81,850,384**	**21,345,271**	**12,728,736**	**115,924,391**
ARR		15,025,058	6,482,382	4,469,732	25,977,172	81,850,384	12,851,745	7,337,702	102,039,831
MN	Total	**368,649,232**	**198,964,189**	**158,680,887**	**726,294,314**	**1,561,195,536**	**375,032,443**	**264,471,858**	**2,200,699,856**
ARR		368,645,058	119,739,824	98,778,514	587,163,396	1,561,195,536	236,377,237	162,156,621	1,959,729,404

Table 6: Mesaba Energy, State and Regional Review of Operations Impacts on the Arrowhead Region and Minnesota, Mesaba One, 2010, 2011, and Typical Year, Value Added, Output (2005 Dollars)

Source: IMPLAN		Value Added $				Output $			
		Direct	*Indirect*	*Induced*	*Total*	*Direct*	*Indirect*	*Induced*	*Total*
MN	2010	**$72,374,136**	**4,709,080**	**12,380,769**	**89,463,990**	**$100,687,976**	**$9,090,586**	**$20,638,139**	**$130,416,708**
ARR		72,374,824	3,324,928	9,049,515	84,749,275	100,687,976	6,842,714	14,848,982	122,379,672
MN	2011	**220,090,320**	**14,320,354**	**37,650,012**	**272,060,689**	**306,192,928**	**27,644,551**	**62,760,741**	**396,598,203**
ARR		220,092,400	10,111,119	27,519,644	257,723,155	306,192,928	20,808,727	45,155,868	372,157,528
MN	Typical	**316,127,936**	**20,569,108**	**54,078,804**	**390,775,856**	**439,801,888**	**39,707,386**	**90,146,735**	**569,656,026**
ARR		316,130,944	14,523,178	39,527,991	370,182,128	439,801,888	29,888,751	64,859,878	534,550,504

IV. Conclusions

This study applies an economic multiplier analysis and input/output model that was created in Minnesota by the Minnesota IMPLAN Group, Inc., and is used by other state governments and the USDA Forest Service, among others.

This economic analysis from the UMD Labovitz School's research bureau reports the Mesaba Energy project's direct effects, plus the additional spending effects that it is expected to cause in the greater economy of the Arrowhead Region and the State of Minnesota.

With the completion of the construction phase for Unit One, it is estimated that the Mesaba Energy Project will have generated $2.2 billion in spending across the State of Minnesota (with $1.96 billion of that spending occurring in the Arrowhead Region) by directly expending approximately $1.6 billion on construction.

During the peak year of construction, Mesaba One will also have created 4,188 full-time, part-time, and temporary jobs (3,521 of those in the Arrowhead Region) by directly employing nearly 1,555 people.

When operations for the Mesaba Energy project reach "typical year" capacity, it is estimated to generate $570 million in spending across the State of Minnesota (with $535 million of that spending occurring in the Arrowhead Region) by directly producing $440 million in output.

During a typical year of operations, Mesaba One will create 273 full-time, part-time, and temporary jobs (with nearly 250 of those in the Arrowhead Region) by directly employing 107 people.

The Minnesota Legislature and Excelsior Energy, Inc. can be proud of the Mesaba Energy Project's positive impact on development and growth in the Arrowhead Region and the State.

Special considerations

Special considerations for interpreting these impact numbers: Regional indirect and induced effects are driven by assumptions in the model. One problem is that the assumptions can mask the true multiplier. This is especially true of the assumption of constant returns to scale: This assumption most affects induced effects and says that if I drink coffee, and my income increases, I will drink proportionally more than before. The amount of weight placed on the induced effects (the percentage of the total induced effect you would want to use) can be further analyzed with an in-depth impact study, involving much more specific data collection and more detailed analysis.

Construction costs may be larger due to commodity prices, banker's fees, and interest payments. Any differences would affect the estimates given here.

Readers are also encouraged to remember the BBER was asked to supply an economic impact analysis only. Any subsequent policy recommendations should be based on the "big picture" of total impact. A more detailed cost-benefit analysis would be needed to assess the total environmental, social, and governmental impacts.

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Appendix A: Mesaba Two Impacts

About the Project:

This 2006 update report also includes modeling for Mesaba Two (or Unit 2). As with the 2005 impact study, construction and operations impacts are modeled for two study areas, the State of Minnesota and the Arrowhead Region. This report assesses the economic impact on the Arrowhead Region and the State of Minnesota by the construction and operation of the Mesaba Two plant, which Excelsior currently has plans to develop and construct on the same or an additional site. Impacts include:

- An additional non-recurring $380 million in increased business and household spending on Mesaba Unit Two across the Arrowhead region, which will ultimately result in a non-recurring $608 million in increased spending throughout the State, driven by spending on construction.

- Over the course of the Mesaba Two construction period 2010–2013 full-time, part-time and temporary construction jobs peak at 1,483.

- An additional 1,845 new full-time, part-time, and temporary jobs during the peak year in other sectors across the Arrowhead Region, as a result of the creation of Mesaba Two construction jobs.

- An additional recurring $101 million in increased spending across the Arrowhead Region for Mesaba Two, which will ultimately result in a recurring $137 million in increased spending throughout the State, generated by spending on operations.

- $467 million in direct spending on Mesaba Two operations during a typical plant-year (modeled as year 2015), recurring for the life of the plant.

- A total of over 78 full-time, part-time, and temporary jobs in Mesaba Two operations, assuming it is located at the same site as Mesaba One.

- An additional 121 new full and part-time jobs in other sectors across the region, caused by the creation of jobs in the typical year of operations of Mesaba Two.

Summary Tables, Construction and Operations:

Table A-1: Summary: Economic Impacts of Mesaba Two's Construction Expenditures, State of Minnesota and Arrowhead Region, 2010-2013 (2005 Dollars)

Source: IMPLAN

	Arrowhead Region			Minnesota		
Years	*Value Added Totals $*	*Employment Totals*	*Output Totals $*	*Value Added Totals $*	*Employment Totals*	*Output Totals $*
2010	$77,790,922	1,446	$230,054,141	$105,165,061	1,731	$277,479,769
2011	179,250,497	3,328	515,993,466	239,166,505	3,944	619,738,963
2012	107,394,555	1,993	304,346,698	142,222,968	2,348	364,637,159
2013	22,616,519	422	73,666,308	32,136,934	525	90,182,823
Total	387,052,493	NA	1,124,060,613	518,691,468	NA	1,352,038,714

Table A-2: Mesaba Two, Top Employment Impacts from Construction, Arrowhead Region and Minnesota, Peak Construction Year 2009, by Industry Sector

Source: IMPLAN

Arrowhead	*Jobs*	MN	*Jobs*
Other new construction	1,526	Other new construction	1,527
Architectural and engineering services	244	Architectural and engineering services	297
Food services and drinking places	140	Employment services	159
Wholesale trade	75	Food services and drinking places	158
Employment services	64	Wholesale trade	122
Automotive repair and maintenance- except car wash	62	Food and beverage stores	64
General merchandise stores	58	Real estate	62
Food and beverage stores	57	Automotive repair and maintenance- except car wash	60
Hospitals	50	General merchandise stores	59
Services to buildings and dwellings	45	Services to buildings and dwellings	57
Offices of physicians- dentists- and other health practitioners	44	Hospitals	55
Motor vehicle and parts dealers	42	Offices of physicians- dentists- and other health practitioners	54
Securities- commodity contracts- investments	39	Motor vehicle and parts dealers	45
Nonstore retailers	37	Nursing and residential care facilities	41
Nursing and residential care facilities	37	Miscellaneous store retailers	35
Miscellaneous store retailers	34	Social assistance- except child day care services	34
Building material and garden supply stores	27	Nonstore retailers	33

*This total includes all construction activity from across the region and State.

Table A-3: Summary: Economic Impact of Mesaba Two's Operations Expenditures, 2013, 2014, and Typical Year (2005 Dollars)

Source: IMPLAN

	Arrowhead Region			Minnesota		
Years	*Value Added Totals $*	*Employment Totals*	*Output Totals $*	*Value Added Totals $*	*Employment Totals*	*Output Totals $*
2013	$63,283,345	35	$91,382,450	$66,803,896	38	$97,383,799
2014	319,679,967	147	461,624,419	337,464,263	161	491,940,662
Typical	392,733,837	182	567,115,661	414,582,151	199	604,359,788

Table A-4: Top Operations Employment Impacts by Industrial Sector, Ranked, Arrowhead Region and Minnesota, Typical Year

Source: IMPLAN

Arrowhead	*Jobs*	MN	*Jobs*
Power generation and supply	78.3	Power generation and supply	78
Food services and drinking places	13.8	Food services and drinking places	13
Commercial machinery repair and maintenance	6.2	Commercial machinery repair and maintenance	6
Hospitals	4.6	Wholesale trade	5
Offices of physicians- dentists- and other health practitioners	4.1	Hospitals	4
Nursing and residential care facilities	3.4	Offices of physicians- dentists- and other health	4
General merchandise stores	3.3	Real estate	4
Food and beverage stores	3.2	Food and beverage stores	3
Wholesale trade	2.8	Nursing and residential care facilities	3
Motor vehicle and parts dealers	2.4	General merchandise stores	3
Securities- commodity contracts- investments	2.3	Employment services	3
Social assistance- except child day care services	2.3	Social assistance- except child day care services	3
Automotive repair and maintenance- except car wash	2.3	Legal services	3
Private households	2.2	Motor vehicle and parts dealers	2
Nonstore retailers	2.1	Other maintenance and repair construction	2
Legal services	2.1	Automotive repair and maintenance- except car wash	2
Miscellaneous store retailers	1.9	Private households	2
Other maintenance and repair construction	1.6	Miscellaneous store retailers	2
Monetary authorities and depository credit intermediation	1.6	Non store retailers	2
Rail transportation	1.5	Colleges- universities- and junior colleges	2
Building material and garden supply stores	1.5		

Detailed Tables:

Construction

Table A-5 summarizes the total effects of Mesaba Two's direct construction expenditures, as detailed in Tables A-5a through c.

Table A-5: Summary: Arrowhead Construction Impacts, Mesaba Two, 2010-2013 (2005 Dollars)

Years	*Value Added Totals $*	*Employment Totals*	*Output Totals $*
2010	$77,790,922	1,446	$230,054,141
2011	179,250,497	3,328	515,993,466
2012	107,394,555	1,993	304,346,698
2013	22,616,519	422	73,666,308
Total	387,052,493	NA	1,124,060,613

Table A-5a: Study Area 1: Arrowhead Region

Table A-5a shows the impact of Mesaba Two's construction expenditures on the seven-county Arrowhead Region over the 45 months of construction required to build Mesaba Two. "Value Added" measures the economic impact of capital that Mesaba Two specifically expects to spend on wages, rents, interest, and profits related to construction.

Table A-5a: Mesaba Energy, Value Added Impacts from Construction, Arrowhead Region, Mesaba Two, 2010-2013

Source: IMPLAN

Years	Value Added in 2005 $			
	Direct Effect	*Indirect Effect*	*Induced Effect*	*Total Effect*
2010	$35,258,960	$23,476,498	$19,055,460	$77,790,922
2011	83,170,592	52,055,793	44,024,118	179,250,497
2012	50,491,456	30,487,632	26,415,466	107,394,555
2013	9,354,428	7,777,546	5,484,546	22,616,519
Total	178,275,436	113,797,469	94,979,590	387,052,493

Table A-5b: Mesaba Energy, Output Impacts from Construction, Arrowhead Region, Mesaba Two, 2010-2013

Source: IMPLAN

Years	Output in 2005 $			
	Direct Effect	*Indirect Effect*	*Induced Effect*	*Total Effect*
2010	$152,414,256	$46,358,066	$31,281,817	$230,054,141
2011	341,026,912	102,695,883	72,270,672	515,993,466
2012	200,869,216	60,113,510	43,363,975	304,346,698
2013	49,252,080	15,410,587	9,003,642	73,666,308
Total	743,562,464	224,578,046	155,920,106	1,124,060,613

Table A-5c: Mesaba Energy, Employment Impacts from Construction, Arrowhead Region, Mesaba Two, 2010-2013

Source: IMPLAN

Years	Employment			
	Direct Effect	*Indirect Effect*	*Induced Effect*	*Total Effect*
2010	629	442	375	1,446
2011	1,483	978	867	3,328
2012	900	573	520	1,993
2013	167	147	108	422

Note: Employment impacts from construction cannot be summed for a total over the four year construction period.

Study Area 2: State of Minnesota

Table A-6 summarizes the total effects of Mesaba Two's direct construction expenditures on the State, as illustrated in Tables A-8a, through c.

Table A-6: Summary: Minnesota Construction Impacts, Mesaba Two, 2010-2013 (2005 Dollars)

Years	Value Added Totals $	Employment Totals	Output Totals $
2010	$105,165,061	1,731	$277,479,769
2011	239,166,505	3,944	619,738,963
2012	142,222,968	2,348	364,637,159
2013	32,136,934	525	90,182,823
Total	518,691,468	NA	1,352,038,714

Table A-6a: Mesaba Energy, Value Added Impacts from Construction, Minnesota, Mesaba Two, 2010-2013

Source: IMPLAN

Years	Value Added in 2005 $			
	Direct Effect	*Indirect Effect*	*Induced Effect*	*Total Effect*
2010	$35,257,228	$39,154,761	$30,753,073	$105,165,061
2011	83,170,672	85,834,720	70,161,116	239,166,505
2012	50,489,544	49,934,699	41,798,722	142,222,968
2013	9,354,054	13,491,286	9,291,594	32,136,934
Total	$178,271,498	$188,415,466	$152,004,505	$518,691,468

Table A-6b: Mesaba Energy, Output Impacts from Construction, Minnesota, Mesaba Two, 2010-2013

Source: IMPLAN	Output in 2005 $			
Years	*Direct Effect*	*Indirect Effect*	*Induced Effect*	*Total Effect*
2010	$152,414,256	$73,809,906	$51,255,599	$277,479,769
2011	341,026,912	161,773,973	116,938,093	619,738,963
2012	200,869,216	94,101,083	69,666,858	364,637,159
2013	49,252,080	25,445,615	15,485,128	90,182,823
Total	$743,562,464	$355,130,577	$253,345,678	$1,352,038,714

Table A-6c: Mesaba Energy, Employment Impacts from Construction, Minnesota, Mesaba Two, 2010-2013

Source: IMPLAN	Employment			
Years	*Direct Effect*	*Indirect Effect*	*Induced Effect*	*Total Effect*
2010	629	598	504	1,731
2011	1,483	1,311	1,150	3,944
2012	900	763	685	2,348
2013	167	206	152	525

Note: Employment impacts from construction cannot be summed for a total over the four year construction period.

Operations

Tables A-7 a through c show the economic effects that Mesaba Two is expected to have on the Arrowhead Region during the calendar-year of start-up, the first year of operations, and a typical year of operations. It is important to note that unlike the effects of Mesaba Two's construction expenditures, which are singular, this report assumes that the Arrowhead Region will reap the benefits of Mesaba Two's typical-year operations expenditures annually for the life of the plant.

Study Area 1: Arrowhead Region

Table A-7 summarizes Tables A-7a through c, showing the total economic effects of Mesaba Two's direct expenditures for operations on the Arrowhead Region.

Table A-7: Summary: Arrowhead Operations Impacts, Mesaba Two, 2013, 2014 and Typical Year (2005 Dollars)

Years	***Value Added Totals $***	***Employment Totals***	***Output Totals $***
2013	$63,283,345	35	$91,382,450
2014	319,679,967	147	461,624,419
Typical	392,733,837	182	567,115,661

Table A-7a: Mesaba Energy, Value Added Impacts from Operations, Arrowhead Region, Mesaba Two, 2013, 2014, and Typical Year

Source: IMPLAN	Value Added in 2005 $			
Years	*Direct Effect*	*Indirect Effect*	*Induced Effect*	*Total Effect*
2013	$54,043,192	$2,482,767	$6,757,387	$63,283,345
2014	273,002,752	12,541,840	34,135,384	319,679,967
Typical	335,389,856	15,407,944	41,936,061	392,733,837

Table A-7b: Mesaba Energy, Output Impacts from Operations, Arrowhead Region, Mesaba Two, 2013, 2014, and Typical Year

Source: IMPLAN	Output in 2005 $			
Years	*Direct Effect*	*Indirect Effect*	*Induced Effect*	*Total Effect*
2013	$75,184,984	$5,109,542	$11,087,922	$91,382,450
2014	379,801,888	25,811,160	56,011,367	461,624,419
Typical	466,594,880	31,709,599	68,811,182	567,115,661

Table A-7c: Mesaba Energy, Employment Impacts from Operations, Arrowhead Region, Mesaba Two, 2013, 2014, and Typical Year

Source: IMPLAN	Employment			
Years	*Direct Effect*	*Indirect Effect*	*Induced Effect*	*Total Effect*
2013	15	5	15	35
2014	63	20	64	147
Typical	78	25	80	182

Table A-7d: Mesaba Energy, Employment Impacts from Operations, Arrowhead Region, Mesaba Two, Typical Year, by Industry Sector

Source: IMPLAN

IMPLAN Sector	Projected Employment			
	Direct	*Indirect*	*Induced*	*Total*
Power generation and supply	78	0	0.3	78.3
Food services and drinking places	0	2.6	11.2	13.8
Commercial machinery repair and maintenance	0	6.1	0.1	6.2
Hospitals	0	0	4.6	4.6
Offices of physicians- dentists- and other health practitioners	0	0	4.1	4.1
Nursing and residential care facilities	0	0	3.4	3.4
General merchandise stores	0	0.1	3.3	3.3
Food and beverage stores	0	0.1	3.2	3.2
Wholesale trade	0	0.8	2.1	2.8
Motor vehicle and parts dealers	0	0	2.3	2.4
Securities- commodity contracts- investments	0	0.5	1.8	2.3
Social assistance- except child day care services	0	0	2.3	2.3
Automotive repair and maintenance- except car wash	0	0.1	2.2	2.3
Private households	0	0	2.2	2.2
Nonstore retailers	0	0	2.1	2.1
Legal services	0	1.3	0.8	2.1
Miscellaneous store retailers	0	0	1.9	1.9
Other maintenance and repair construction	0	1.6	0.1	1.6
Monetary authorities and depository credit intermediation	0	0.5	1.1	1.6
Rail transportation	0	1.5	0	1.5
Building material and garden supply stores	0	0	1.5	1.5

Study Area 2: State of Minnesota

Table A-8 encapsulates the information shown in Tables A-8a through A-8c, showing the total economic effects of Mesaba Two's direct expenditures for operations on the State of Minnesota.

Table A-8: Summary: Minnesota Operation Impacts, Mesaba Two, 2013, 2014 and Typical Year (2005 Dollars)

Years	***Value Added Totals $***	***Employment Totals***	***Output Totals $***
2013	$66,803,896	38	$97,383,799
2014	337,464,263	161	491,940,662
Typical	414,582,151	199	604,359,788

Table A-8a: Mesaba Energy, Value Added Impacts from Operations, Minnesota, Mesaba Two, 2013, 2014, and Typical Year

Source: IMPLAN	Value Added in 2005 $			
Years	*Direct Effect*	*Indirect Effect*	*Induced Effect*	*Total Effect*
2013	$54,042,684	$3,516,331	$9,244,876	$66,803,896
2014	273,000,192	17,762,964	46,701,102	337,464,263
Typical	335,386,656	21,822,185	57,373,318	414,582,151

Table A-8b: Mesaba Energy, Output Impacts form Operations, Minnesota, Mesaba Two, 2013, 2014, and Typical Year

Source: IMPLAN	Output in 2005 $			
Years	*Direct Effect*	*Indirect Effect*	*Induced Effect*	*Total Effect*
2013	$75,184,984	$6,788,057	$15,410,759	$97,383,799
2014	379,801,888	34,290,300	77,848,464	491,940,662
Typical	466,594,880	42,126,376	95,638,530	604,359,788

Table A-8c: Mesaba Energy, Employment Impacts from Operations, Minnesota, Mesaba Two, 2013, 2014, and Typical Year

Source: IMPLAN	Employment			
Years	*Direct Effect*	*Indirect Effect*	*Induced Effect*	*Total Effect*
2013	15	6	18	38
2014	63	25	73	161
Typical	78	30	91	199

Table A-8d: Mesaba Energy, Employment Impacts from Operations, Minnesota, Typical Year, by Industry Sector

Source: IMPLAN

IMPLAN Sector	Projected Employment			
	Direct	*Indirect*	*Induced*	*Total*
Power generation and supply	78	0	0	78
Food services and drinking places	0	2	11	13
Commercial machinery repair and maintenance	0	6	0	6
Wholesale trade	0	1	3	5
Hospitals	0	0	4	4
Offices of physicians- dentists- and other health	0	0	4	4
Real estate	0	1	3	4
Food and beverage stores	0	0	3	3
Nursing and residential care facilities	0	0	3	3
General merchandise stores	0	0	3	3
Employment services	0	2	1	3
Social assistance- except child day care services	0	0	3	3
Legal services	0	2	1	3
Motor vehicle and parts dealers	0	0	2	2
Other maintenance and repair construction	0	2	0	2
Automotive repair and maintenance- except car wash	0	0	2	2
Private households	0	0	2	2
Miscellaneous store retailers	0	0	2	2
Nonstore retailers	0	0	2	2
Colleges- universities- and junior colleges	0	0	1	2

Table A-9 Mesaba Energy, State and Regional Review of Construction Impacts on the Arrowhead Region and Minnesota, Mesaba Two, 2010-2013, Value Added, Output (2005 Dollars)

Source: IMPLAN		Value Added $				Output $			
		*Direct**	*Indirect*	*Induced*	*Total*	*Direct*	*Indirect*	*Induced*	*Total*
MN	2010	**$35,257,228**	**$39,154,761**	**$30,753,073**	**$105,165,061**	**$152,414,256**	**$73,809,906**	**$51,255,599**	**$277,479,769**
ARR		35,258,960	23,476,498	19,055,460	77,790,922	152,414,256	46,358,066	31,281,817	230,054,141
MN	2011	**83,170,672**	**85,834,720**	**70,161,116**	**239,166,505**	**341,026,912**	**161,773,973**	**116,938,093**	**619,738,963**
ARR		83,170,592	52,055,793	44,024,118	179,250,497	341,026,912	102,695,883	72,270,672	515,993,466
MN	2012	**50,489,544**	**49,934,699**	**41,798,722**	**142,222,968**	**200,869,216**	**94,101,083**	**69,666,858**	**364,637,159**
ARR		50,491,456	30,487,632	26,415,466	107,394,555	200,869,216	60,113,510	43,363,975	304,346,698
MN	2013	**9,354,054**	**13,491,286**	**9,291,594**	**32,136,934**	**49,252,080**	**25,445,615**	**15,485,128**	**90,182,823**
ARR		9,354,428	7,777,546	5,484,546	22,616,519	49,252,080	15,410,587	9,003,642	73,666,308
MN	Total	**178,271,498**	**188,415,466**	**152,004,505**	**518,691,468**	**743,562,464**	**355,130,577**	**253,345,678**	**1,352,038,714**
ARR		$178,275,436	$113,797,469	$94,979,590	$387,052,493	$743,562,464	$224,578,046	$155,920,106	$1,124,060,613

*Value added direct values have been adjusted to reflect differences in the Minnesota and Arrowhead Region.

Table A-10: Mesaba Energy, State and Regional Review of Operations Impacts on the Arrowhead Region and Minnesota, Mesaba Two, 2013, 2014, and Typical Year, Value Added, Output (2005 Dollars)

Source: IMPLAN		Value Added $				Output $			
		*Direct**	*Indirect*	*Induced*	*Total*	*Direct*	*Indirect*	*Induced*	*Total*
MN	2013	**$54,042,684**	**$3,516,331**	**$9,244,876**	**$66,803,896**	**$75,184,984**	**$6,788,057**	**$15,410,759**	**$97,383,799**
ARR		54,043,192	2,482,767	6,757,387	63,283,345	75,184,984	5,109,542	11,087,922	91,382,450
MN	2014	**273,000,192**	**17,762,964**	**46,701,102**	**337,464,263**	**379,801,888**	**34,290,300**	**77,848,464**	**491,940,662**
ARR		273,002,752	12,541,840	34,135,384	319,679,967	379,801,888	25,811,160	56,011,367	461,624,419
MN	Typical	**335,386,656**	**21,822,185**	**57,373,318**	**414,582,151**	**466,594,880**	**42,126,376**	**95,638,530**	**604,359,788**
ARR		$335,389,856	$15,407,944	$41,936,061	$392,733,837	$466,594,880	$31,709,599	$68,811,182	$567,115,661

*Value added direct values have been adjusted to reflect differences in the Minnesota and Arrowhead Region.

Tables Summarizing the Combined Effects of Mesaba One and Mesaba Two in Typical Years

Table A-11: Summary:
Arrowhead Region Operation Impacts, Mesaba One and Two,
Typical Year (2005 Dollars)

Years	***Value Added Totals $***	***Employment Totals***	***Output Totals $***
Typical - MEP1	370,182,128	250	534,550,504
Typical - MEP2	392,733,837	182	567,115,661
Total	762,915,965	432	1,101,666,165

Table A-11a: Mesaba Energy, Value Added Impacts from Operations,
Arrowhead Region, Mesaba One and Two, Typical Year

Source:
IMPLAN

	Value Added in 2005 $			
Years	*Direct Effect*	*Indirect Effect*	*Induced Effect*	*Total Effect*
Typical - MEP1	316,130,944	14,523,178	39,527,991	370,182,128
Typical - MEP2	335,389,856	15,407,944	41,936,061	392,733,837
Total	651,520,800	29,931,122	81,464,052	762,915,965

Table A-11b: Mesaba Energy, Output Impacts from Operations,
Arrowhead Region, Mesaba One and Two, Typical Year

Source:
IMPLAN

	Output in 2005 $			
Years	*Direct Effect*	*Indirect Effect*	*Induced Effect*	*Total Effect*
Typical - MEP1	439,801,888	29,888,751	64,859,878	534,550,504
Typical - MEP2	466,594,880	31,709,599	68,811,182	567,115,661
Total	906,396,768	61,598,350	133,671,060	1,101,666,165

Table A-11c: Mesaba Energy, Employment Impacts from Operations,
Arrowhead Region, Mesaba One and Two, Typical Year

Source:
IMPLAN

	Employment			
Years	*Direct Effect*	*Indirect Effect*	*Induced Effect*	*Total Effect*
Typical MEP-1	107	34	109	250
Typical MEP-2	78	25	80	182
Total	185	59	189	432

Table A-12: Summary:
Minnesota Operation Impacts, Mesaba One and Two,
Typical Year (2005 Dollars)

Years	***Value Added Totals $***	***Employment Totals***	***Output Totals $***
Typical - MEP1	390,775,856	273	569,656,026
Typical - MEP2	414,582,151	199	604,359,788
Total	805,358,007	472	1,174,015,814

Table A-12a: Mesaba Energy, Value Added Impacts from Operations,
Minnesota, Mesaba One and Two, Typical Year

Source:
IMPLAN

	Value Added in 2005 $			
Years	*Direct Effect*	*Indirect Effect*	*Induced Effect*	*Total Effect*
Typical - MEP1	316,127,936	20,569,108	54,078,804	390,775,856
Typical - MEP2	335,386,656	21,822,185	57,373,318	414,582,151
Total	651,514,592	42,391,293	111,452,122	805,358,007

Table A-12b: Mesaba Energy, Output Impacts from Operations,
Minnesota, Mesaba One and Two, Typical Year

Source:
IMPLAN

	Output in 2005 $			
Years	*Direct Effect*	*Indirect Effect*	*Induced Effect*	*Total Effect*
Typical - MEP1	439,801,888	39,707,386	90,146,735	569,656,026
Typical - MEP2	466,594,880	42,126,376	95,638,530	604,359,788
Total	906,396,768	81,833,762	185,785,265	1,174,015,814

Table A-12c: Mesaba Energy, Employment Impacts from Operations,
Minnesota, Mesaba One and Two, Typical Year

Source:
IMPLAN

	Employment			
Years	*Direct Effect*	*Indirect Effect*	*Induced Effect*	*Total Effect*
Typical MEP-1	107	42	125	273
Typical MEP-2	78	30	91	199
Total	185	72	216	472

Appendix B: Input Output Background

Including:

- IMPLAN sectoring scheme for important expenditures
- Economic base data for study region, background to impact.
- General description of input/output analysis
- The mathematics of the model
- Press coverage of the proposed plant funding progress.

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IMPLAN Sectoring Scheme for Important Expenditures:

Some of the adjustments made to accommodate the IGCC technology were accomplished using a bridge to IMPLAN industrial sectors from the national BEA table and the NAICS industry descriptions, as follows:

IMPLAN	BEA 1997	Description	NAICs
30	221100	Power generation and supply	2211
41	230250	Other new construction	23*
238	332410	Power boiler and heat exchanger manufacturing	33241
285	333611	Turbine and turbine generator set units manufacturing	333611
333	335311	Electric power and specialty transformer manufacturing	335311

Economic Base Data for Study Region, Background to Impact:

For a description of the Region before the IGCC plant is added to the economy note the following base model for industrial sectors of the seven county Arrowhead Region, ranked descending by highest output.

Arrowhead Region, Ranked by Industry Output

Source: IMPLAN

IMPLAN Sector	Industry, most recent IMPLAN data year, 2003	Output in millions of $	Employment	Value Added in millions of $
125	Paper and paperboard mills	$1,299	2,542	$387
21	Iron ore mining	$817	3,660	$365
509	Owner-occupied dwellings	$788	0	$630
467	Hospitals	$770	8,133	$373
465	Offices of physicians, dentists, and other he	$706	6,495	$547
503	State & Local Education	$620	14,117	$620
30	Power generation and supply	$614	1,265	$442
504	State & Local Non-Education	$518	10,867	$518
481	Food services and drinking places	$487	12,269	$202
427	Insurance carriers	$439	1,769	$224
390	Wholesale trade	$417	3,667	$317
430	Monetary authorities and depository credit intermediation	$406	2,108	$286

Arrowhead Region, Ranked by Industry Output

Source: IMPLAN

IMPLAN Sector	Industry, most recent IMPLAN data year, 2003	Output in millions of $	Employment	Value Added in millions of $
114	Reconstituted wood product manufacturing	$316	954	$130
33	New residential 1-unit structures, non-farm	$294	1,864	$114
468	Nursing and residential care facilities	$265	7,016	$180
499	Other State and local government enterprises	$238	1,251	$78
38	Commercial and institutional buildings	$236	2,879	$120
14	Logging	$218	1,182	$88
171	Other miscellaneous chemical product manufacturing	$196	475	$62
422	Telecommunications	$192	882	$93
483	Automotive repair and maintenance, except car	$181	2,892	$86
401	Motor vehicle and parts dealers	$171	2,271	$134
426	Securities, commodity contracts, investments	$161	2,697	$65
392	Rail transportation	$158	672	$97
201	Mineral wool manufacturing	$156	552	$66
405	Food and beverage stores	$155	3,078	$105
393	Water transportation	$155	304	$40
410	General merchandise stores	$144	3,651	$122
394	Truck transportation	$134	1,369	$64
506	Federal Non-Military	$125	1,626	$125
431	Real estate	$125	821	$86
414	Periodical publishers	$124	737	$40
404	Building material and garden supply stores	$106	1,801	$82
451	Management of companies and enterprises	$102	759	$56
479	Hotels and motels, including casino hotels	$101	2,467	$71
407	Gasoline stations	$98	2,433	$74
437	Legal services	$98	1,198	$65
35	New residential additions and alterations, no	$97	972	$45
493	Civic, social, professional and similar organ	$95	1,706	$35
470	Social assistance, except child day care services	$89	2,818	$54
41	Other new construction	$85	780	$36
312	All other electronic component manufacturing	$84	479	$16
412	Non-store retailers	$80	2,064	$50
439	Architectural and engineering services	$78	897	$45
259	Construction machinery manufacturing	$75	175	$13
398	Postal service	$73	1,035	$48
460	Waste management and remediation services	$73	537	$33
428	Insurance agencies, brokerages, and related	$73	783	$68
60	Frozen food manufacturing	$69	242	$21
43	Maintenance and repair of nonresidential buildings	$68	719	$33
438	Accounting and bookkeeping services	$67	882	$37
420	Radio and television broadcasting	$67	453	$18
421	Cable networks and program distribution	$66	69	$17
39	Highway, street, bridge, and tunnel construct	$65	692	$31
351	Aircraft manufacturing	$65	154	$16
151	Other basic organic chemical manufacturing	$65	83	$9
411	Miscellaneous store retailers	$63	2,013	$44
406	Health and personal care stores	$62	1,026	$45
429	Funds, trusts, and other financial vehicles	$62	211	$8
455	Business support services	$62	1,288	$36

Arrowhead Region, Ranked by Industry Output

Source: IMPLAN

IMPLAN Sector	Industry, most recent IMPLAN data year, 2003	Output in millions of $	Employment	Value Added in millions of $
458	Services to buildings and dwellings	$56	1,261	$26
505	Federal Military	$54	1,371	$54
413	Newspaper publishers	$54	564	$26
485	Commercial machinery repair and maintenance	$53	475	$27
480	Other accommodations	$51	711	$19
478	Other amusement, gambling, and recreation industries	$50	1,038	$30
396	Pipeline transportation	$50	80	$6
447	Advertising and related services	$49	403	$27
492	Grantmaking and giving and social advocacy or	$49	607	$17
466	Other ambulatory health care services	$46	435	$15
408	Clothing and clothing accessories stores	$44	1,106	$30
498	State and local government electric utilities	$42	96	$16
391	Air transportation	$42	182	$22
37	Manufacturing and industrial buildings	$41	431	$20
441	Custom computer programming services	$41	571	$32
34	New multifamily housing structures, nonfarm	$40	392	$17
462	Colleges, universities, and junior colleges	$40	771	$21
435	General and consumer goods rental except vide	$38	415	$27
402	Furniture and home furnishings stores	$38	605	$28
221	Ferrous metal foundries	$37	234	$15
62	Fluid milk manufacturing	$36	66	$5
112	Sawmills	$35	165	$8
425	Non depository credit intermediation and related activities	$35	210	$28
399	Couriers and messengers	$34	472	$25
192	Ready-mix concrete manufacturing	$34	139	$11
487	Personal care services	$33	776	$18
491	Religious organizations	$32	816	$28
11	Cattle ranching and farming	$31	775	$3
349	Travel trailer and camper manufacturing	$31	184	$12
395	Transit and ground passenger transportation	$31	645	$19
463	Other educational services	$31	607	$12
486	Household goods repair and maintenance	$30	227	$10
243	Machine shops	$29	284	$13
260	Mining machinery and equipment manufacturing	$27	158	$9
203	Iron and steel mills	$26	61	$5
31	Natural gas distribution	$24	40	$6
40	Water, sewer, and pipeline construction	$24	304	$14
464	Home health care services	$23	744	$15
461	Elementary and secondary schools	$23	851	$16
42	Maintenance and repair of farm and nonfarm residence structures	$22	132	$9
409	Sporting goods, hobby, book and music stores	$22	867	$19
454	Employment services	$22	1,067	$21
469	Child day care services	$22	586	$13
123	Miscellaneous wood product manufacturing	$22	167	$10
403	Electronics and appliance stores	$21	475	$17
252	Fabricated pipe and pipe fitting manufacturing	$21	127	$10
107	Cut and sew apparel manufacturing	$20	188	$8

Arrowhead Region, Ranked by Industry Output

Source: IMPLAN

IMPLAN Sector	Industry, most recent IMPLAN data year, 2003	Output in millions of $	Employment	Value Added in millions of $
423	Information services	$19	104	$5
433	Video tape and disc rental	$19	312	$10
71	Seafood product preparation and packaging	$19	86	$3
350	Motor vehicle parts manufacturing	$18	68	$4
397	Scenic and sightseeing transportation and sup	$18	189	$15
450	All other miscellaneous professional and tech	$17	73	$7
25	Sand, gravel, clay, and refractory mining	$17	92	$12
168	Explosives manufacturing	$17	74	$8
418	Motion picture and video industries	$16	156	$2
444	Management consulting services	$16	123	$10
64	Cheese manufacturing	$16	25	$1
267	Food product machinery manufacturing	$16	87	$7
452	Office administrative services	$16	97	$7
446	Scientific research and development services	$15	196	$8
424	Data processing services	$15	108	$5
73	Bread and bakery product, except frozen, manufacturing	$15	178	$5
10	All other crop farming	$15	198	$10
139	Commercial printing	$15	256	$10
449	Veterinary services	$15	234	$7
44	Maintenance and repair of highways, streets,	$14	136	$6
489	Dry cleaning and laundry services	$14	325	$9
49	Rice milling	$14	30	$0
120	Wood container and pallet manufacturing	$14	132	$6
45	Other maintenance and repair construction	$14	191	$9
170	Photographic film and chemical manufacturing	$13	31	$6
445	Environmental and other technical consulting	$13	105	$7
459	Other support services	$13	157	$6
181	Other rubber product manufacturing	$13	76	$5
494	Private households	$12	1,826	$14
490	Other personal services	$12	127	$4
177	Plastics plumbing fixtures and all other plastic	$12	77	$5
293	Overhead cranes, hoists, and monorail systems	$12	58	$4
302	Electronic computer manufacturing	$11	18	$1
12	Poultry and egg production	$11	63	$5
261	Oil and gas field machinery and equipment	$11	50	$3
456	Travel arrangement and reservation services	$11	115	$3
322	Software reproducing	$11	32	$3
488	Death care services	$11	177	$7
321	Watch, clock, and other measuring and control	$11	56	$2
307	Broadcast and wireless communications equipment	$10	37	$3
143	Asphalt paving mixture and block manufacturing	$10	23	$1
36	New farm housing units and additions and alterations	$10	42	$3
475	Museums, historical sites, zoos, and parks	$10	160	$3
100	Curtain and linen mills	$10	63	$3
76	Dry pasta manufacturing	$10	37	$3
17	Hunting and trapping	$10	173	$1
482	Car washes	$10	389	$6
85	Soft drink and ice manufacturing	$10	19	$2

Arrowhead Region, Ranked by Industry Output

Source: IMPLAN

IMPLAN Sector	Industry, most recent IMPLAN data year, 2003	Output in millions of $	Employment	Value Added in millions of $
194	Concrete pipe manufacturing	$9	48	$3
497	State and local government passenger transit	$9	232	$1
15	Forest nurseries, forest products, and timber	$9	31	$3
113	Wood preservation	$9	40	$2
434	Machinery and equipment rental and leasing	$9	85	$6
381	Sporting and athletic goods manufacturing	$9	56	$2
273	Other commercial and service industry machine	$8	33	$2
476	Fitness and recreational sports centers	$8	293	$5
235	Metal window and door manufacturing	$8	47	$4
484	Electronic equipment repair and maintenance	$8	97	$2
443	Other computer related services, including facilities management	$8	58	$4
285	Turbine and turbine generator set units manufacturing	$8	9	$2
432	Automotive equipment rental and leasing	$8	39	$4
283	Cutting tool and machine tool accessory manufacturing	$7	72	$3
32	Water, sewage and other systems	$7	33	$6
362	Wood kitchen cabinet and countertop manufacturing	$7	60	$3
29	Support activities for other mining	$7	54	$1
6	Greenhouse and nursery production	$7	132	$7
334	Motor and generator manufacturing	$7	29	$3
118	Cut stock, resawing lumber, and planing	$7	50	$2
292	Conveyor and conveying equipment manufacturing	$7	30	$2
18	Agriculture and forestry support activities	$7	289	$6
111	Other leather product manufacturing	$7	54	$5
242	Spring and wire product manufacturing	$6	40	$2
448	Photographic services	$6	108	$3
457	Investigation and security services	$6	177	$4
224	Iron and steel forging	$6	39	$2
193	Concrete block and brick manufacturing	$5	27	$2
333	Electric power and specialty transformer manufacturing	$5	31	$1
160	Pharmaceutical and medicine manufacturing	$5	10	$2
233	Fabricated structural metal manufacturing	$5	29	$2
477	Bowling centers	$5	128	$3
274	Automatic vending, commercial laundry and dry	$5	28	$1
179	Tire manufacturing	$5	18	$2
119	Other millwork, including flooring	$5	29	$2
471	Performing arts companies	$5	329	$2
473	Independent artists, writers, and performers	$5	100	$1
301	Scales, balances, and miscellaneous general p	$5	22	$2
236	Sheet metal work manufacturing	$4	32	$2
496	Other Federal Government enterprises	$4	37	$3
103	Other miscellaneous textile product mills	$4	42	$1
400	Warehousing and storage	$4	75	$3
474	Promoters of performing arts and sports and a	$4	167	$2
13	Animal production, except cattle and poultry	$4	488	$1
371	Showcases, partitions, shelving, and lockers	$4	31	$2
47	Other animal food manufacturing	$4	7	$0
389	Buttons, pins, and all other miscellaneous ma	$4	36	$1

Arrowhead Region, Ranked by Industry Output

Source: IMPLAN

IMPLAN Sector	Industry, most recent IMPLAN data year, 2003	Output in millions of $	Employment	Value Added in millions of $
244	Turned product and screw, nut, and bolt manufacturing	$3	18	$2
68	Meat processed from carcasses	$3	10	$0
237	Ornamental and architectural metal work manufacturing	$3	27	$1
226	Custom roll forming	$3	12	$1
164	Polish and other sanitation good manufacturing	$3	9	$2
161	Paint and coating manufacturing	$3	6	$1
101	Textile bag and canvas mills	$3	31	$1
247	Electroplating, anodizing, and coloring metal	$3	20	$1
442	Computer systems design services	$3	55	$2
234	Plate work manufacturing	$3	14	$1
269	All other industrial machinery manufacturing	$3	17	$1
172	Plastics packaging materials, film and sheet	$2	9	$1
195	Other concrete product manufacturing	$2	19	$1
278	AC, refrigeration, and forced air heating	$2	10	$0
277	Heating equipment, except warm air furnaces	$2	10	$1
148	Industrial gas manufacturing	$2	5	$0
26	Other nonmetallic mineral mining	$2	29	$1
61	Fruit and vegetable canning and drying	$2	6	$1
116	Engineered wood member and truss manufacturing	$2	13	$1
345	Heavy duty truck manufacturing	$2	4	$0
294	Industrial truck, trailer, and stacker manufacturing	$2	11	$1
67	Animal, except poultry, slaughtering	$2	6	$0
5	Fruit farming	$2	43	$1
58	Confectionery manufacturing from purchased chocolate	$2	6	$1
384	Sign manufacturing	$2	20	$1
86	Breweries	$2	4	$1
358	Boat building	$2	10	$1
383	Office supplies, except paper, manufacturing	$2	11	$1
130	Coated and uncoated paper bag manufacturing	$1	7	$0
83	Spice and extract manufacturing	$1	3	$0
110	Footwear manufacturing	$1	12	$0
379	Dental laboratories	$1	23	$1
255	Miscellaneous fabricated metal product manufacturing	$1	7	$1
386	Musical instrument manufacturing	$1	12	$0
440	Specialized design services	$1	20	$0
316	Industrial process variable instruments	$1	6	$0
117	Wood windows and door manufacturing	$1	5	$1
3	Vegetable and melon farming	$1	24	$1
122	Prefabricated wood building manufacturing	$1	8	$0
378	Ophthalmic goods manufacturing	$1	7	$0
248	Metal valve manufacturing	$1	5	$0
380	Jewelry and silverware manufacturing	$1	6	$0
246	Metal coating and non precious engraving	$1	9	$0
288	Pump and pumping equipment manufacturing	$1	4	$0
329	Household cooking appliance manufacturing	$1	3	$0
318	Electricity and signal testing instruments	$1	6	$0
416	Database, directory, and other publishers	$1	4	$0
453	Facilities support services	$1	13	$0

Arrowhead Region, Ranked by Industry Output

Source: IMPLAN

IMPLAN Sector	Industry, most recent IMPLAN data year, 2003	Output in millions of $	Employment	Value Added in millions of $
364	Non upholstered wood household furniture manufacturing	$1	7	$0
178	Foam product manufacturing	$1	4	$0
2	Grain farming	$1	63	$0
232	Prefabricated metal buildings and components	$1	4	$0
80	Coffee and tea manufacturing	$1	2	$0
376	Surgical appliance and supplies manufacturing	$1	4	$0
106	Other apparel knitting mills	$1	5	$0
124	Pulp mills	$1	1	$0
220	Secondary processing of other nonferrous	$1	2	$0
347	Truck trailer manufacturing	$1	3	$0
419	Sound recording industries	$1	1	$0
169	Custom compounding of purchased resins	$1	2	$0
190	Glass and glass products, except glass containers	$1	4	$0
415	Book publishers	$1	2	$0
417	Software publishers	$1	3	$0
472	Spectator sports	$1	9	$0
135	All other converted paper product manufacturing	$1	3	$0
230	Saw blade and handsaw manufacturing	$1	4	$0
271	Optical instrument and lens manufacturing	$1	4	$0
1	Oilseed farming	$0	27	$0
223	Nonferrous foundries, except aluminum	$0	4	$0
369	Custom architectural woodwork and millwork	$0	4	$0
108	Accessories and other apparel manufacturing	$0	3	$0
280	Metal cutting machine tool manufacturing	$0	2	$0
186	Ceramic wall and floor tile manufacturing	$0	2	$0
115	Veneer and plywood manufacturing	$0	1	$0
202	Miscellaneous nonmetallic mineral products	$0	1	$0
199	Cut stone and stone product manufacturing	$0	1	$0
138	Blankbook and looseleaf binder manufacturing	$0	1	$0
141	Prepress services	$0	1	$0
508	Inventory valuation adjustment	-$11	0	-$11
	Totals	$16,508	167,762	$9,164

*Millions of dollars

General description of input/output analysis

1) See a general description of input/output analysis, "A Readymade Input-Output Model" in *Urban Regional Economics: Concepts, Tools, Applications*, by Wilbur R. Maki and Richard W. Lichty. February 2000. Publisher: Iowa State, Press, pp. 233-245, ISBN: 0813826799
2) The Mathematics of the Model

1) **A Readymade Input-Output Model**

The point of departure for this assessment is the suggestion that ". . . a truly flexible readymade model will enable the introduction of survey-based trade coefficients in some sectors while continuing to balance the rest of the sectors in a truly unbiased manner" (Brucker, Campbell, and Latham III, 1990, p.136). System effectiveness requires not only a truly flexible model but one that invites "coefficient fix-up" with superior information, coupled with ". . . software and/or handbooks that guide the user (professional or lay) through the intricacies of final demand determination" (p.137).

Forecasting Area Economic Impacts

Use of the IMPLAN regional modeling system as an impact prediction model starts with the existing database. The U.S. Department of Commerce Regional Economic Measurements Division Annual Regional Economic Information System (REIS) series covering industry employment, labor earnings, total population, and total personal income is a common starting place.[3] The historical (REIS) series include every county in the United States. They cover total employment and total labor earnings in a two-digit industry breakdown based on the 1987 Standard Industrial Classification Manual.

The U.S. IMPLAN database calibrates to the REIS series. The IMPLAN series also use the individual state ES-202 covered (by the cooperative federal-state unemployment insurance program) employment and payroll files, especially for the three- and four-digit industry groups that are not available in the REIS database. IMPLAN has a 528-sector industry breakdown for each of 3,120 counties in the United States.

The 1988 U.S. Department of Commerce Office of Business Economics Regional Series (OBERS) on industry employment, labor earnings, total population, and total personal income extend the corresponding 57-industry REIS series to 2040. The 1988 OBERS series calibrate to the 1988 U.S. Bureau of Labor Statistics (BLS moderate projection series. High and low projection series, which are derived for individual states, MSAS, and the Bureau of Economics economic areas in the auxiliary IMPLAN database, correspond to the U.S. BLS high and low projection series (Kutcher,

1991).

The IMPLAN database extends the OBERS series to equivalent measures of industry output and commodity production in a long-term forecast mode. It further allocates the commodity production to intermediate and final demand sectors in the United States and in each of the 50 states. The intermediate demand sectors include the two-digit industry groups in the OBERS sectors. Individual industries in the 528 sectors of the IMPLAN database aggregate to the three-and four-digit BLS sectors, the two-digit OBERS sectors, and many other combinations of two- and three-digit industry groups.

The final demand sectors in the IMPLAN database include (1) personal consumption expenditures, (2) gross private capital formation, (3) change in business inventory, (4) federal government purchases, (5*)* state and local government purchases, (6) exports, and (7) imports. Regional purchase coefficients (RPCs) that allocate imports to each local purchasing sector are calculated for each IMPLAN "model" (that is, a county or multi-county impact assessment). The uniquely estimated RPCs produce estimates of local exports and imports that are consistent with levels of industry output and commodity production in each IMPLAN impact assessment.

The IMPLAN-based regional forecast methodology presents a series of readily reproducible steps for converting BLS and OBERS projections to corresponding sets of county forecasts of industry employment, labor earnings, resident population, and personal income. The individual county series track their respective state projection series. Each state has a set of high, low, and moderate projections based on the 1988 OBERS projection series and the corresponding high, low, and moderate 1988 and 1990 BLS projections series for the United States. This method of approach to county-level forecasting thus extends the BLS and OBERS forecasting methods and results. It introduces the BLS county-level modeling capabilities and database for use in industry-specific assessments of local resource requirements and the effects of these requirements on local and state economies.

State, regional, and county projection series relate directly to corresponding data series from the IMPLAN models of one or more counties. Individual IMPLAN regional reports, for example, expand the number of variables that correlate with the two-digit employment and earnings projections, including commodity exports and commodity imports. They also provide a framework for assessing the differential rates of growth of individual counties and regions Each IMPLAN model takes given changes in final demands and derives the effects of these changes on the local economy and its institutions. Included with each IMPLAN model is a social accounting matrix (SAM) for tracking changes in local income distributions in the local economy.

The IMPLAN input-output model has been constructed using 528 industry sectors, although the model can be run for any level of aggregation of these sectors. The underlying coefficients in the model are derived from the U.S. input-output accounts. Flows of goods and services in the Minnesota model are derived from commodities produced and consumed in Minnesota as well as

those that are imported into the state and exported to areas outside of the state. The system is run for all regions together to ensure consistency with both U.S. and individual regional input-output accounts.

One very useful aspect of the IMPLAN model is the IMPACT module. It permits the user to evaluate the effects of changes or variations in economic activity. For example, the impact of the direct purchase of goods and services by the air transportation industry can be traced through the economy as a series of spending iterations among all sectors, including households. The long-term multiplier used in the model includes indirect effects (to which multipliers are normally limited) as well as induced effects related to employment and population change.

The U.S. Departments of Commerce, Labor, and Agriculture maintain the *reference data systems* for Micro-IMPLAN. The Department of Commerce houses the periodic censuses of population and employment, agricultural, manufacturing, wholesale, and retail trade, and selected business services, as well as the annual statistical series on personal income and industry employment and earnings of the employed industry workforce. State- and county-level data sources most critical for early fix-up and updating of the current database are the individual state reports on county business patterns, ES-202 files on covered industry employment and payroll, and the agriculture censuses.

A common problem in using each of these data sources is the occurrence of nondisclosures. Use of supplementary information in the bi-proportional adjustment procedures for filling in the missing data, for example, allow for closer correspondence of the remaining calculated values with values reported by the U.S. Department of Commerce.

Delays in the reporting cycles for reference data systems result in two- to three-year lags in the availability of each new update of the county-level Micro-IMPLAN database. Reducing lags in data availability is probably a less feasible alternative, however, than forecasting new control totals for the bi-proportionally adjusted U.S., state, and county input-output tables.

A hybrid approach that combines local surveys of critically important industries with the forecast approach facilitates the likelihood of attaining both greater timeliness and greater accuracy in regional impact assessments. Such an approach incorporates various measures of linkage between core and peripheral labor market areas, like survey-based estimates of the physical volume and market value of commodity shipments between the core area and periphery.

Delineation of the LMAs within an economic region introduces a spatial structure into the organization of the Micro-IMPLAN database. This helps address the twofold problem focus—system bias and specification error. Each of the problem sources, whether industry production functions, RPCs, marketing margins, or industry output, varies between center and periphery. Investment per worker is lower in the periphery, and rate of return on investment also is lower when discounted for perceived investment risk. However, high levels of commodity trade occur between center and periphery. This emanates from the unique competitive advantage of each of the two types

of export-producing systems, with the center specializing in high-order, high-profit services, and the periphery specializing in standardized commodity production.

The use of LMAs and the center-periphery structure of these areas apply especially well to the organization of transportation and local land use impact assessments. Commodity transportation originates from dispersed farms, mines, and factories. It concentrates in major shipping centers that also are the primary and secondary core LMAs of the U.S. trading regions. Air transportation concentrates even more than commodity transportation in the primary core areas.

This concentration of high-order economic services near the globally connected air nodes of core metropolitan areas apparently accounts for the higher productivity of both labor and capital in the core areas.

Modeling System Formulation

The first step in model reformation is to calculate *total regional commodity demand.* We multiply the regional absorption matrix by the regional industry output to obtain the intermediate input purchases of each industry. We add our estimate of gross final commodity demand to the estimate of intermediate demand to obtain total commodity demand. The U.S. estimates of industry purchases include both domestic production and foreign imports. Thus, the input profile for each industry includes all commodity inputs of that industry. In addition, each industry may produce more than one commodity. The estimates of gross domestic exports relate to both the commodity production and the regional demand for this production.

The next step relates to the calculation of *total regional commodity supply.* Again, the estimate of total regional industry output enters into the calculation, but in multiplication with the industry byproduct ratios from the U.S. byproduct matrix. The result is the regional matrix that shows the commodity production (columns) by each industry (rows). These estimates, together with the estimates of institutional commodity output (commodity sales by government and from inventory depletion), yield the total commodity output for the regional economy.

Finally, to estimate trade flows, the *RPC* is the key parameter.[5] The RPC value times the corresponding value in the regional gross use matrix yields the regional industry use of the locally supplied commodity. Similarly, the *import propensity* for a given commodity times the corresponding value in the regional gross use matrix yields the regional *industry domestic imports* of each commodity. This procedure applies also in estimating regional institutional use and regional institutional imports, that is, the commodity purchases for local final demand.

The calculation of *domestic commodity exports* results from subtracting regional commodity demand from regional gross commodity supply. The individual commodity imbalances in the U.S. estimates of foreign exports and imports carry through to the individual county or multi-county Micro-IMPLAN models. Domestic exports and imports theoretically balance for the domestic economy as a

whole, but not for individual counties or multi-county areas. However, the criteria for allocating the two sets of exports and imports differ greatly. Micro-IMPLAN allocates U.S. *foreign commodity exports* to regions according to their share of U.S. commodity production. It also allocates U.S. *foreign commodity imports* to regions according to the same rule. Estimates of a region's total imports and total exports thus derive from a variety of data sources and allocation criteria.

While local commodity production provides the basis for allocating foreign exports and imports, uniquely generated local RPCs provide the basis for estimating domestic exports and imports for each county or multi-county area. These estimates of gross domestic imports relate to both commercial production and the demand for this production in a given region. Model reformulation calls for similar criteria in allocating U.S. foreign imports to individual industries and regions.

Interregional trade is synonymous with commodity shipments. Most commodity shipments move from producing areas to export markets by truck, rail, and barge. However, an increasing volume of high-value manufactured products move by air transportation to and from the designated air transportation nodes. These shipments typically move by truck to the larger air transportation nodes, such as Chicago. Micro-IMPLAN currently fails to account for such multimodal shipments.

Technology transfer is an increasingly important form of interregional trade. It is also a singularly important factor in accounting for a region's competitive advantage in specialized production and its export to other regions. It is associated, in part, with the total value of technology-intensive manufactured products in a given region. Again, Micro-IMPLAN, when conjoined with an optimizing transportation network model, can simulate the local economic effects of technology transfer. This application may extend to the role of a state's research universities in the formation and strengthening of spatially separated, functionally integrated industry clusters. These clusters are viewed by at least one student of regional growth and change as the new industrial systems of the emerging information economy (Saxenian, 1994).

Refinements and Applications

Several types of refinements are available for the outcomes of the preceding steps (Alward et al., 1989). These include (1) changing regional supply, (2) modifying industry production function, (3) editing RPCs, and (4) controlling for induced effects once better information becomes available. Superior local knowledge warrants changing the readymade database values in each category. Superior local knowledge also warrants changing regional purchase coefficients, by institution, industry, or commodity. The RPC adjustments for an industry or institution result in the given change being applied to all commodities, by industry or institution. Overlooked, however, is the further regionalization of the final local sales accounts and the industry margins that convert industry output from producer prices to purchaser prices. This process requires detailed, regionally differentiated estimates of final product sales to households, governments, and businesses. Furthermore, input-output models generally are demand-driven with no supply constraints.

The lack of capacity limits for industry expansion and the assumption of full resource use or availability, including labor, result in overestimating industry production response to demand changes. Fixed-price multipliers add to this problem by overestimating multiplier effects and underestimating the substitution effects from exogenous changes (Koh, Schreiner, and Shin, 1993). Also, the current modeling system sidesteps the issue of commuting effects. These attributes of input-output models ultimately result in underestimating or overestimating factor income responses to market changes.

A Simple Input-Output Model

The model is triggered by changes in final demand; that is, demand for goods or services related to final uses. The components of final demand are exogenous to the model's structural characteristics in much the same way as final payments are, but the role of final demand as an initiator of impacts gives it a unique role in the input-output scheme.

The basic input-output model consists of a series of three separate tables. The first is called the transactions table. The transactions table lists all industrial sectors defined for the purposes of the analysis being conducted. It should be noted that these sectors have to be defined so as to account for every firm in the region. The individual sectors should be relatively homogeneous in terms of their input requirements and output distributions. They should generally be disaggregated enough to highlight the true structure of the region without being so disaggregated as to cause significant problems in data collection or in disclosure of the operations of any one firm in the region.

The transactions table also contains values for final demand, as discussed earlier, as well as the values for final payments. The grand totals of such a table contain the gross outputs for each industrial sector and the gross inputs required to produce those outputs.

Table 6-1A represents the structure of a hypothetical input-output table with three industrial sectors:

extractive, manufacturing, and services. Remember, the sectors should be defined so as to account for every firm in the region. The sectors should also, ideally, be as disaggregated as possible. For these reasons, this represents a very unrealistic example of the size of an actual table. Keeping the size of the model to just three industries, however, makes required computations much simpler. The structure and use of larger tables remains much the same.

One of the most important things to remember when reading an input-output table is that the rows of the table represent sales and the columns of the table represent purchases. Thus, the 700 that appears in the Extractive row and the Manufacturing column indicates that firms in the extractive industry sold $700 worth of goods and services to firms in the manufacturing sector.

TABLE 6-1A Commodity transactions of a regional economy

	Intermediate Demand					
Commodity	Extractive (mil.$)	Manufg (mil.$)	Services (mil.$)	Total (mil.$)	Final Demand (mil.$)	Gross Output (mil.$)
Extractive	100	700	0	800	4,625	5,425
Manufacturing	50	200	0	250	6,400	6,700
Services	75	300	75	450	4,905	5,355
Value added	5,000	5,500	230	10,730	1,800	28,730
Imports	200	0	5,000	5,200	0	5,200
Total inputs	5,425	6,700	5,355	17,480	17,730	33,930

Looked at the other way, we could say that the 700 also represents a $700 purchase by the firms in the manufacturing sector from firms in the extractive sector. The 50 in the Manufacturing row and the Extractive column represents a $50 transaction between manufacturing (the seller) and extractive (the buyer) and so on.

The same industrial sectors identified on the left-hand margin of the table appear along the top of the table. The sales and purchases between these sectors represent sales and purchases of “intermediate” goods and services. These are goods and services produced for the purpose of facilitating further production. Semi finished goods would be an obvious example of intermediate production but so would the services of lawyers, bankers, transportation agencies (in all cases not involving a final transportation use), and any other sector input or output oriented toward helping other industries with their own production.

The value added row of the table represents another form of sale—the sale of resources of production to each sector. In a theoretical sense, the resources of production include land, labor, capital, and enterprise. In a more practical sense, this row generally includes the income received by local households for whatever contribution they make to the production process.

These resource inputs are not generally considered to be intermediate even though the sale takes place so further production can occur. Rather, they represent final inputs that add to the income of households as opposed to industrial sectors.

Imports represent sales to local industries by industries and resource holders outside of the locality's defined boundaries. Although not shown above, in reality final demand accounts for a large, often a major, share of an area's imports; the smaller and less diversified the area, the larger the share. Remember, imports—and exports too, for that matter—are defined in terms of payments.

Finally, final demand consists of sales for final uses. The usual categories making up final demand include household consumption (by households located in the region), government purchases of goods and services, gross private domestic investment (including inventory changes), and exports (again, defined in terms of the payment made).

The gross output and input values are equal. This is due to the fact that the transactions table really represents a type of cost-accounting sheet for a regional economy—debits equal credits. The elements in the table that force this balance (which is a balance by definition) are profits or losses. This is because the final value of output is made up of all the costs that go into production, with profits and losses making up the difference.

In summary, the transactions table has three identifiable parts: the intermediate transactions component, representing sales and purchases between firms; the final payments plus imports component, representing resource inputs into the firm's production plus inputs from outside the region; and final demand, representing the sale of goods and services for final use. The table balances between inputs and outputs, with profit as the balancing mechanism.

The transactions table contains a great deal of useful information in its own right. The regional balance of trade (exports—imports) can be discerned from this table, as can gross regional product (the dollar value of all final goods and services produced with the economy minus imports). The level of interaction between local industries and between industries in the region and households can be seen in this table. Finally, the relation between local household income and production is depicted in the transactions matrix.

The principal use for this table is found in the construction of the other two tables of the input-output system. As mentioned, the transactions table alone represents a cost-accounting sheet for the region, nothing more or less. It is descriptive rather than analytical, and it does not allow for general equilibrium analysis of the type previously described without further modification. The next step uses the transactions table to construct a table of direct requirements, often called the technical coefficients matrix.

The question answered by the technical coefficients table is: if each local industrial sector sells to

other local industrial sectors some total value of intermediate goods and services so that the purchasing sectors can produce their own output, how much do the purchasing sectors require from the other local sectors per dollar of output? For example, Manufacturing purchased $300 worth of intermediate output from Services in order to facilitate its own production of $6,700 worth of intermediate and final outputs. How much did Manufacturing buy from Services per dollar of gross output? The answer is 300/6,700 = $0.45. The same computation can be made for each intermediate sale and purchase in the transactions table. The result of these divisions is shown in Table 6-2A.

TABLE 6-2A

Commodity	Extractive (mil.$)	Manufg (mil.$)	Services (mil.$)
Extractive	0.018	0.104	0.000
Manufacturing	0.009	0.030	0.000
Services	0.014	0.045	0.014
Subtotal	0.041	0.179	0.014
Value added	0.922	0.821	0.043
Imports	0.037	0.000	0.934
Total inputs	1.000	1.000	1.000

The rows are still read as sales and the columns as purchases. Only now the sales are in terms of cents per dollar, and the purchases have the special interpretation of “input requirements” per dollar of output. We call these input requirements because they represent requirements during the period of analysis in order for each sector to produce its own outputs, scaled down to a “dollar of output” basis.

The technical coefficient matrix represents a recipe for production. To produce one dollar’s worth of output, the extractive industry needed a pinch of its own intermediate output, a dash of the intermediate output of the manufacturing sector, and a smidgen of the intermediate products of the services industry. For Manufacturing to produce a dollar’s worth of output, it required a pinch from Extractive, a dash from Manufacturing, and a smidgen from Services. And so it goes through all the identified industries for the region.

One of the key assumptions of input-output analysis, as mentioned earlier, is that this recipe does not change, regardless of the level of output. Thus, if the extractive industry were to experience an increase in final sales equal to $10,000 it would require another $180 worth of intermediate products from its own firms, $90 from Manufacturing, and $140 from Services. It should be emphasized that this process starts with a change in the final sales of an industry, or from “exogenous” forces. The coefficients in the inter-industry section of the table represent the “endogenous” component of the table

It can be seen that this first computed table gives the analyst limited ability for impact analysis. He or she could go through the process of assuming any number of changes in the final sales of the identified industries, multiply these assumed changes by the direct requirements coefficients, and come up with estimates as to the direct effects from these changing final sales on each identified industry in the region. To make sure that this process is understood, one might ask: What is the direct effect on each regional industry from an increase in the exports from the manufacturing sector equal to $10 million? The answer is that Manufacturing would increase by $10 million plus a direct intermediate production effect of $300,000, for a total of $10.3 million, the extractive industry would find its intermediate production increasing by $1.4 million, and the services industry would see its intermediate production increase by $450,000.

But this is not the end of the story if each industry has to increase its output in order to service the increase in final sales of the manufacturing industry, then each must, in turn, increase its intermediate purchases and sales from and to one another to service this second round of expansion in activity. The second round must then be serviced by a third round of outputs.

TABLE 6-3A Round one of $10 million change in final sales

	Intermediate (mil.$)	Final (mil.$)
Extractive	0.300	0.000
Manufacturing	1.040	10.000
Services	0.450	0.000
Total	1.179	10.000

TABLE 6-4A Round two of $10 million change in final sales

Commodity	Extractive (thou.$)	Manufg. (thou.$)	Services (thou.$)	Total (thou.$)
Extractive	18.720	31.200	0.000	499.200
Manufacturing	9.360	9.000	4.050	106.650
Services	14.560	4.200	6.300	156.100
Total	42.640	325.200	10.350	761.950

Each round is smaller than the previous one due to leakages to imports and to local value added, until the process has completely played itself out. The first of three rounds of such a $10,000 increase in final sales is shown in Table 6-3A.

Note that the only exogenous change is the initial change in final demand assumed for the

manufacturing industry. The rest of the sales represent the direct first-round results from those sales on the intermediate output of all industries in the region, including Manufacturing. These are recipe requirements for Manufacturing to produce the hypothesized increased final sales.

Table 6-4A presents second-round totals. Note that Manufacturing requires still more intermediate inputs from its own firms, this time to service the additional $300,000 of output it had to produce to directly allow for the initial $10 million increase in final sales. Similarly, the services industry needs to buy from each of the other industries to enable it to produce the additional $450,000 directly required by Manufacturing. Finally, the extractive industry must have additional inputs to produce its additional $1,040,000 for Manufacturing. The rounds of production in Table 6-4A are *indirect* impacts.

Manufacturing has now increased its sales three times: the $10 million that was initially assumed, the $300,000 needed to directly service that increase in final sales, and the $22,410 to service the $300,000 in the first round. The extractive industry has increased its sales by $1,040,000 to service the final sales change for Manufacturing plus the $49,900 to service that first-round increase, for a total of $1,089,920 to this point and so it goes.

We will now run through a third round of increased production (Table 6-5A), this time to service the second round.

TABLE 6-5A Round three of $10 million change in final sales

Commodity	Extractive (thou.$)	Manufg. (thou.$)	Services (thou.$)	Total (thou.$)
Extractive	0.899	2.331	0.000	3.230
Manufacturing	0.449	0.672	0.225	1.346
Services	0.699	0.351	0.351	1.401
Total	2.047	3.354	0.576	5.977

Each additional round is computed in the manner shown above, and the totals are added to determine the total direct and indirect effects from the initial assumed change in the final sales of one of the regional industries. This process is obviously cumbersome. It would be even more difficult—impossible, probably— to work such an iterative scheme for a larger number of industries or for higher direct coefficient values. Fortunately, the system of simultaneous equations represented by an input-output system can be solved using high-speed computers in a matter of seconds, even for the largest of tables. The solution for the system in this example is given in Table 6-6A.

TABLE 6-6A Direct and indirect input requirements

Commodity	Extractive (Mil.$)	Manufg. (mil.$)	Services (mil.$)
Extractive	1.019	0.109	0.001
Manufacturing	0.010	1.032	0.010
Services	0.015	0.049	1.015
Total	1.044	1.190	.026

The diagonal of Table 6-6A shows "ones" plus some other number (for example, 1.032 in row 2, column 2.) These ones represent the dollar increase to final sales of the industry for which such an exogenous change is assumed. The numbers appearing after the decimal represent the direct (shown in Table 6-2A) plus indirect effects from each assumed change in final sales. Thus, the $10 million change for the example using Manufacturing turns into $10,320,000 total - increase in Manufacturing sales: $10 million to final sales, $300,000 in direct sales, and $20,000 in indirect sales. That $10 million in Manufacturing sales turns into an increase of $1,090,000 in sales by the extractive industry— $1,040,000 of that direct and $50,000 indirect. Finally, the $10 million assumed increase in manufacturing leads to an increase of $490,000 in the sales of services—$450,000 of that direct and $40,000 of that indirect.

The total impact on all of the industries in the region combined is $11.9 million (1.190 X 10 million). The 1.190 is called the demand multiplier for Manufacturing, or the total direct and indirect purchases this sector must make from itself and from the other regional industries in order to produce one dollar's final output. To conduct an impact study, simply multiply an assumed change in final demand for any of the industries by the demand multiplier for that same industry. This indicates the direct and indirect effects on the region resulting from the assumed change. The impacts stem from the fact that industries in a region interact with one another through their purchases from and sales to one another. The greater this level of interaction, the greater the industrial demand multiplier.

Thus, the input-output model represents a detailed accounting of the economic base of a region. It can be used to delineate the export structure of the regional economy and the multipliers that emerge from that structure. It also identifies, in final demand, the relationship between local activity, investment, and export activity in relation to the identified industrial structure. As in most models, its weakness is in its assumptions. But, at the least, the input output system can be used for simulations and sensitivity analyses for a regional economy.

Notes

1. According to *The American Heritage Dictionary*, 3d ed., version 3.6a, Houghton Mifflin Company, New York, 1993, *predict* means "to state or tell about, or make known in advance, especially on the basis of special knowledge." Somewhat along the same line, *project* means "to calculate, estimate, or predict (something in the future), based on present data or trends."

2. The Standard Industrial Classification (SIC) is the statistical classification underlying all establishment-based federal economic statistics classified by industry. This classification was established by the Office of Management and Budget and is used widely by states, industries, and analysts. The Major Group SIC 45 (Air Transportation) is a two digit classification (that is, the group number consists of two digits) and includes the following four-digit subcategories: Air Transportation, Scheduled (4512); Air Courier Services (4513); Air Transportation, Nonscheduled (4522); Airports, Flying Fields, and Airport Terminal Services (4581).

3. U.S. Department of Commerce, Regional Economic Measurements Division. *Regional Economic Information System*: Unpublished series, 1969—1990.

2) The Mathematics of the Model

The basic input-output model is production oriented and was developed by Wassily Leontief in the 1940's. It attempts to make operational the concept of general equilibrium, first discussed in detailed theoretical terms by Leon Walras.

The standard structural equation for an input-output model is as follows:

(1) $Yj = x1j + x2j + ... + Fj + Mj$

where: Yj is the gross dollar inputs of purchasing industry j,

xij is the intermediate dollar sales from selling industry i to purchasing industry j,
Fj is the final payments of purchasing sector j, primarily payments to value added components in the economy, and
Mj represents purchases from imports.

The same model from a sales, rather than purchases, point of view takes the following form:

(2) $Yi = xi1 + xi2 + ... + xij + Di$

where: Yi is the gross dollar output of selling industry i,
xij is as before, and
Ci is the sales of selling industry i to final uses (consumption, government, investment, and exports).

These equations make up the transactions table of an input-output system, dividing the economy into i = j sectors and tracing through the stages of production as a good or service moves toward the final sale.

The transactions table is descriptive rather than analytical. To make the model analytical, a direct coefficient must be computed as follows:

(3) $aij = xij/Yj$.

This is the percentage of gross output required by the purchasing industry in the form of intermediate outputs from the selling industries. Then:

(4) $Yi = aijYj + Di$.

Putting the model in vector/matrix form, there is a column vector of outputs, Y, a matrix, AY or X, of xij coefficients written in terms of the definition for technical coefficients,
(xij = aijYj) and a column vector of final demands, or:

(5) $Y = AY + D$.

If we assume the technical coefficients are constant, we can solve for this linear set of equations. The result will be industrial demand multipliers based on each industry's need to purchase intermediate outputs from the other industries in the region in order to produce a dollar's worth of output in the reference industry. The solution is as follows:

(6) $Y = AY + D$

(7) $(I - A)Y = D$

(8) $Y = (I - A)^{-1}D$

Where: I is the identity matrix,
Y is a column vector of gross outputs,
D is a column vector of final demands,
A is a matrix of technical coefficients, and
$(I - A)^{-1}$ is the Leontief inverse.

This inverse represents the direct and indirect input requirements of all industries in a region in order to produce a dollar's worth of output. It is out of this matrix that industrial demand multipliers are determined.

Thus, the most usual form of input-output analysis emphasizes the input structure of the economy. This is because most tables are constructed for relatively large areas where production relationships are deemed to be the most important. The emphasis on production would miss the point for small economies since little or no manufacturing activity takes place in such rural areas. For these economies, the emphasis should be on trade rather than production relationships.