FORECASTING JOBS IN THE SUPPLY CHAIN FOR INVESTMENTS IN RESIDENTIAL ENERGY EFFICIENCY RETROFITS IN FLORIDA

By

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For my grandparents, Curtis and Lavon Fobair, who said I could do anything!

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This research presents a model for forecasting the numbers of jobs created in the energy efficiency retrofit (EER) supply chain resulting from an investment in upgrading residential buildings in Florida. This investigation examined material supply chains stretching from mining to project installation for three product types: insulation, windows/doors, and heating, ventilating, and air conditioning (HVAC) systems. Outputs from the model are provided for the project, sales, manufacturing, and mining level.

The model utilizes reverse-estimation to forecast the numbers of jobs that result from an investment. Reverse-estimation is a process that deconstructs a total investment into its constituent parts. In this research, an investment is deconstructed into profit, overhead, and hard costs for each level of the supply chain and over multiple iterations of inter-industry exchanges. The model processes an investment amount, the type of work and method of contracting into a prediction of the number of jobs created. The deconstruction process utilizes data from the U.S. Economic Census. At each supply chain level, the cost of labor is reconfigured into full-time equivalent (FTE) jobs (i.e. equivalent to 40 hours per week for 52 weeks) utilizing loaded labor rates and a typical employee mix. The model is sensitive to adjustable variables, such as

percentage of work performed per type of product, allocation of worker time per skill level, annual hours for FTE calculations, wage rate, and benefits.

This research provides several new insights into job creation. First, it provides definitions that can be used for future research on jobs in supply chains related to energy efficiency. Second, it provides a methodology for future investigators to calculate jobs in a supply chain resulting from an investment in energy efficiency upgrades to a building. The methodology used in this research is unique because it examines gross employment at the sub-industry level for specific commodities. Most research on employment examines the net employment change (job creation less job destruction) at levels for regions, industries, and the aggregate economy. Third, it provides a forecast of the numbers of jobs for an investment in energy efficiency over the entire supply chain for the selected industries and the job factors for major levels of the supply chain.

CHAPTER 1
INTRODUCTION

This research will present a model for forecasting the numbers of jobs created in the energy efficiency retrofit (EER) supply chain resulting from an investment in upgrading residential buildings in Florida. EER activities include installing or upgrading mineral wool insulation, glass doors/windows, and heating, ventilating, and air conditioning (HVAC) systems. This research will provide new job definitions, a method to calculate the numbers of jobs, and the job factors in the EER supply chain. The results of this research may be used to forecast the employment effect before an investment will have been made.

Problem Statement

There has been no study found with an established and transparent methodology to forecast job creation for investments in EER activities or other types of construction activities. Previous research had reported job creation in numbers that are unclear and incomparable, did not define jobs by FTEs or compensable hours worked, nor explained how jobs were categorized. Additionally, most had not explained the method utilized to calculate the results and none provided the factors of job creation.

Research Question

The research question is written: How many direct, indirect and induced jobs are created in the EER supply chain for an investment in residential structures in Florida? The scope of this question is clarified by the following objectives, assumptions and limitations.

Objectives

This research will have three objectives. First, define the job related terms specific to this research. Second, develop a methodology that will standardize how jobs in the EER supply chain are categorized and calculated. The methodology should convert dollars invested in residential EER activities into jobs. Third, create a working model that will demonstrate the methodology. The model should be flexible for various assumptions, allowing for changes in wage rates, benefits, number of annual compensable hours, and worker mix. The option of a contractor self-performing versus subcontracting the work should be available.

Assumptions

This research will make four assumptions. First, the investment can be public, private or a combination of both types of dollars. Second, a reasonably accurate representation of the EER supply chain can be modeled. Third, a reasonably accurate dollar breakdown of the costs can be made for materials consumed at each level of the supply chain. Fourth, energy efficiency activities are very similar to construction activities because the worker skills are identical.

Limitations

This research will have four limitations. First, the 2007 U.S. Economic Census data will be used. Second, the model will use data for three EER supply chains (i.e. mineral wool insulation, glass doors/windows, and HVAC systems). Third, the model will use state level (i.e. Florida) data for the project level of the supply chain. County level statistics exist; however, they are less complete than the state level statistics. Data for other states could be added. Fourth, the model will be designed for residential structures but can be modified to examine commercial construction.

Contributions

This research will contribute to the body of knowledge on EER activities in five ways. First, jobs in the EER supply chain will be defined. The new definitions will place the jobs into context and make distinctions between the categories of jobs that are necessary for performing the calculations. Second, a methodology will be developed that utilizes empirical data in a standardized fashion to forecast jobs in the EER supply chain for investments made in residential structures. The methodology will be unique because it examines gross employment at the sub-industry project and regional levels for specific categories of commodities. Most research on employment only examines the net employment change (job creation less job destruction) at levels for regions, industries, and/or the aggregate economy. Third, a working model of the methodology will be created. The model will provide estimates of the direct, indirect and induced jobs in the EER supply chain for a given level of investment. Contributions four and five will be the results of the model. Fourth, the numbers of jobs for each product category will be displayed in a variety of formats. Fifth, the factors of job creation for the four major levels of the supply chain (i.e. construction, sales, manufacturing and mining) will be provided.

Benefits

This research will have two major benefits. First, the numbers of jobs could be used in metrics for comparability and decision-making. For example, a $1 million investment could be compared to the number of jobs created in the EER supply chain. This investment-to-jobs comparison would be a form of cost-to-benefit analysis that could be used when comparing policy proposals. Second, the factors of job creation will provide a better understanding of the employment structure of EER supply chains and

could be used to calculate changes in employment on a regional level due to changes in magnitude of investment. For example, if the factors of jobs were based on a $1 million investment, then multiplying the manufacturing job factor by five would calculate the number of jobs at the same level for a $5 million investment. Knowing the numbers of jobs and the factors of job creation will be an important development in understanding the economic effects that policy oriented towards energy efficiency has on economic development. Furthermore, this new information will improve decision making when comparing and choosing between policy proposals.

Target Audience

The primary target audience for using this model will be state level government agencies that are attempting to quantify the economic development impact of energy efficiency policy focused on the built environment. The secondary target audience will be local economic development agencies that require a convenient method to compare and evaluate policy proposals when the metric of importance is number of jobs created.

Organization of the Research

This research will be arranged in chapters. Chapter 1 will be the introduction of the research, including the problem statement and research question. Chapter 2 will be the literature review. This review will present previous studies and research relevant to the topic of this research. Terminology specific to this research will be explained. Chapter 3 will be the methodology. The process of deconstructing an investment in EER activities will be explained and an Excel model to demonstrate the process will be developed. Chapter 4 will be the results. Sample outputs for each product category will be provided. Chapter 5 will be the analysis of the results. The sample outputs will be used to find the factors of job creation, employment multipliers, average wage rates,

and average hourly costs. The time relationship of jobs in the supply chain will be discussed, as well as the overall economic impact of a $1 million investment. Chapter 6 will be the summary and conclusion of the research. Chapter 7 will be recommendations for future research. The appendices will provide instructions for the working model, an example of a template used in the model, and a complete list of census data used for each supply chain.

Summary

This chapter has introduced research that will investigate the employment effect of investments in EER activities for residential use properties. The problem statement, research question, contributions, benefits, and target audience have been presented. The organization of the research has been outlined into chapters.

CHAPTER 2
LITERATURE REVIEW

This chapter will be divided into three sections: Background Information, Literature Analysis, and Recommendations. Background Information will present previous studies, research, and publications relevant to the topic of this research. Literature Analysis will analyze the previous literature for utility to this research and for shortcomings. Recommendations will present improvements for the shortcomings.

Background Information

Background Information will be divided into four categories: Related Studies and Research on Job Creation, Contextual Information, Definitions: Jobs and Energy Efficiency Retrofits, and Data Classification and Sets. 'Related Studies on Job Creation' will summarize the available studies and research that discuss the economic or employment effect of several types of investments. 'Contextual Information' will present literature that gives this research perspective. 'Definitions: Jobs and Energy Efficiency Retrofits' will review the terminology used to describe jobs and retrofits. 'Data Classification and Sets' will provide information on the methods of classifying data and the sources of data used in this research.

Related Studies and Research on Job Creation

The topic of job creation can be typically found in literature that discusses topics such as labor economics, employment, and economic development. Occasionally, job creation had been mentioned tangentially as an effect of some activity; however, the activity had been the focus of the research, not the job creation. The studies and research related to the topic of this research are presented below. When applicable and for ease of comparison, the job creation numbers were presented per $1 million.

Energy Dollars

The U.S. Department of Energy looked at the stimulus effect of energy dollars on a community (Laitner 1996). Assuming energy was generated outside a community, reducing energy consumption would cause fewer energy dollars to flow out of the local economy; hence, the energy dollars 'saved' remained in the community for use in other purchases. In general, each $1.00 used to purchase local consumer goods produced $1.90 of economic activity in the local economy because the store paid its employees who in turn purchased more goods using the same $1.00. The economic activity of $1.00 invested in energy efficiency was about $2.23. Energy dollars 'saved' by an energy conservation policy are a significant benefit to local economies, but they inherently lack the ability to be tracked and measured for comparison of results. Although jobs are certainly created from the additional spending, quantifying the jobs created would be impossible.

Non-Energy Benefits

Schweitzer and Tonn (2002) presented substantial energy and non-energy benefits from weatherization. Analyzing federal funding invested in weatherization, they predicted $1.83 worth of energy benefits and $1.88 worth of non-energy benefits. The non-energy benefits included societal benefits, such as job creation, but the number and type of jobs had not been quantified.

Non-Monetary Benefits

Tonn and Peretz (2007) discussed state-level energy efficiency programs. They identified numerous non-monetary benefits, including the creation of jobs and avoidance of job destruction. The results of model programs indicated energy efficiency initiatives create jobs; however, neither a methodology for calculating jobs nor the characteristics

of the jobs created (e.g. industry sector, skill level, full-time, or part-time) were given. Consequently, the number of jobs created per level of investment could not be determined throughout the supply chain.

Job Creation – Input-Output Models

Input-output models can analyze job creation through interdependencies between industry sectors and provide geographically based results. For example, Berry (1997) summarized an Iowa Study (The Statewide Low-Income Collaborative Evaluation (SLICE) of Iowa 1994; found in Berry 1997) that used input-output analysis to measure economic activity and job creation benefits. The SLICE investigators concluded $240,000 worth of additional economic activity was produced for each million dollars of program spending and determined 5.6 additional jobs were supported from the additional economic activity. This translates to about 23 jobs per $1 million invested. Specific dollar values were not assigned to the non-energy benefits; therefore, it was not possible to determine if the additional economic activity supporting the additional jobs was fully or only partially funding the jobs.

The SAVE Employment project (Jeeninga et al. 1999) addressed the employment impacts of energy conservation retrofits as a function of financing schemes (e.g., loans, subsidies, grants), based on case studies conducted in France, Germany, the Netherlands, Spain, the United Kingdom, and Finland. It used an input-output model as well, although it discussed only residential retrofits, and it measured the output in labor-years generated. However, the study noted that the positive effect on jobs due to energy efficiency programs was small compared to the large investment necessary.

The National Renewable Energy Laboratory (NREL) created the Job and Economic Development Impact Model (JEDI), a spreadsheet-based approach for

calculating employment and economic increases achieved by the construction of wind farms (Goldberg et al. 2004). The spreadsheet gathered data on the size and location of the wind farm and included regional considerations of spending patterns within local economies in order to determine the cost and employment benefits of wind farms and the strength of the multiplier effect. The multiplier effect is the economic effect from reinvestments back into the economy after an initial investment is made. For example, after an initial investment had been made to build a wind farm, the wages paid to employees of the farm will be spent in the local economy.

Regional Economic Models, Inc. (REMI) is well known commercially for creating policy models that utilize an input-output approach; however, REMI models integrate input-output techniques with other modeling approaches, including General Equilibrium (a balanced economy), Econometrics (estimating structural relationships with statistics), and New Economic Geography (spatial analysis of the economy) (REMI 2011). REMI models are powerful tools at the macro-econometric level of analysis, but their predictive power does not translate over to the micro level.

Job Creation – Louisiana Energy Fund

Kaiser et al. (2004) reviewed, among other things, the employment that had been created by The Louisiana Energy Fund, a public-private endeavor designed to provide publicly funded institutions with low cost, tax exempt financing to implement energy and water conservation projects in Louisiana. They stated that for a total investment of $13.7 million by the Fund in projects across seven parishes, the associated employment increase was 297 jobs, or about 22 jobs per $1 million invested. They also predicted the creation of 16.2 jobs for ongoing maintenance of the systems, costing approximately $490,000 annually, which approximates to 33 jobs per million dollars. The report did not

describe the methodology employed in this research and did not describe the types of energy conservation activities, types of jobs, nor how the job creation numbers had been determined.

Job Creation – Energy Saving Trust

Wiltshire et al. (1998) reported on the *Standards of Performance* program run by the United Kingdom Energy Saving Trust (EST). It was designed to stimulate the provision of cost-effective energy saving measures throughout all sectors of the electricity franchise market. The scheme was funded via a customer levy of up to £1 per year for each customer, amounting to a total of £25 million over a four year period (1994-1998). The Public Electricity Suppliers (PESs) were required to give priority to schemes likely to exert general downward pressure on the charge per kWh to consumers in order to encourage demand side management measures. The report calculated that the program had generated 394 full time jobs per year over the four years, of which approximately half were in installation and half are in project management and administration. This corresponds to approximately 10 direct and indirect jobs per $1 million invested. The report also calculated that a total 67 induced jobs have been generated, which is about 1.68 jobs per $1 million.

U.S. Weatherization Assistance Program

The U.S. Weatherization Assistance Program (WAP) is a Department of Energy venture that offers energy efficiency upgrades such as insulation and storm windows to low-income families. The WAP Technical Assistance Center (TAC) website reports that the weatherization programs create 52 direct jobs and 23 indirect jobs for every $1 million invested (WAPTAC 2009).

U.S. Bureau of Economic Analysis

Construction sector modeling from the U.S. Bureau of Economic Analysis (BEA) predicts 26.67 direct, indirect and induced jobs per $1 million of spending in the construction industry (EOSI 2009). Home remodeling and bridge construction have been included with general construction. The average wage rate in the BEA model is about $19.00, which includes employer benefits.

Development and Construction Contributions to the US Economy

Fuller (2007) examined the ripple effect of construction spending across the life cycle of development, from the initial idea creation of a development project, through construction, and forward during ongoing maintenance and operations. He concluded that $1 million in new construction spending supported 28.5 annual full-time jobs. He further stated the multiplier effect of a dollar invested in construction was 3.42.

Job Creation – National Association of Home Builders (NAHB)

Fei Liu and Emrath (2008) reported that the NAHB estimated 1.11 (FTE) jobs had been created per $100,000 spent on residential remodeling or 11.1 jobs per $1 million. Of the 11.1 jobs created per $1 million, construction jobs equaled 5.4, manufacturing jobs equaled 1.8, and other jobs equaled 3.9. This estimate was based on national averages of home values.

Jobs and Renewable Energy

Sterzinger (2006) reported on enhancements to the Renewable Energy Policy Project (REPP) Jobs Calculator model that included a jobs locator feature. The original REPP Jobs Calculator only calculated direct jobs resulting from renewable energy development. The new model expanded to include multiple renewable technologies and the capability to locate where new economic activity may occur related to each type

of renewable technology. The Jobs Calculator produced three results: 1) Potential skill gaps, 2) Jobs created per MW of installed capacity per technology, and 3) Type of jobs by manufacturing, installation, and operation and maintenance. Labor was calculated as a function of [potentially] installed capacity, where the actual installation depended upon the enactment of a Renewable Portfolio Standard or other legislation or program. The marginal labor quantities per level of capacity used to calculate the final output was based on a survey of current industry practices. The jobs locator was based on a four-step methodology that began with a review of the U.S. Census of Manufacturing data and utilized the six digit NAICS (North American Industrial Classification System) codes. After components of renewable energy equipment had been identified and linked with a NAICS code, cost was allocated by industry and allocated geographically by census data. Results of the calculator can be found in various REPP reports. For example, the substantial number of jobs for developing wind energy will result from manufacturing the equipment.

Sustainable Construction and Economic Development

Fobair (2009) discussed the increase in job opportunities related to sustainable building activities resulting from the 2008-09 federal stimulus funds. In response to sustainability becoming mainstream in the policy arena in the United States, Fobair recommended local planners critically examine economic development initiatives in search of sustainable job creation opportunities. He summarized the practice of urban planning has been criticized for its lack of identifying a definitive measurement procedure for sustainable policy. Furthermore, urban planning does not have a clear-cut method to calculate the number of jobs created by an economic development program focused on energy conservation in buildings.

Fobair believed investments in energy conservation for existing buildings was a good path to sustainable economic development. He proposed the measurement of project level jobs created due to energy conservation investments would be a good predictor of success for a sustainable economic development policy, and presented a calculator to measure the number of jobs that could be created by energy conservation investments in existing buildings. The calculator was flexible and could be applied to commercial and/or residential buildings; however, some inputs into the calculator required the opinion of experienced construction professionals.

Calculating Job Creation

Kibert, Fobair and Sullivan (2011) believed weatherization and construction worker skills are cross-functional and proposed calculating these jobs using a full-time equivalent (FTE) method. They presented a model for calculating jobs based on investments in energy conservation retrofits. The model was flexible. It considered multiple variables, provided three calculation methods based on user preferences, and forecast direct jobs at the project level and indirect jobs at the manufacturing level. Based on national cost averages, Methods 1 and 2 indicated approximately 10 direct jobs and 3-6 indirect jobs were created per $1 million. Method 3 indicated approximately 13 direct jobs and 3-5 indirect jobs were created per $1 million. The difference in results was due to Method 3 allowing user defined material and labor splits that were more accurate than the default 50%-50% split utilized in Methods 1 and 2.

The model used a reverse estimating technique to deconstruct an energy conservation investment. It began with backing out the contractor's profit and overhead and then the cost of materials. Next, the model allocated the labor portion of the investment based on loaded labor rates and typical crew make-up. The input variables

included worker skill level, allocation of worker time per skill level, regional effects on job creation, rate of pay, and worker benefits. The model did not consider taxes, administrative jobs embedded in overhead costs, or indirect jobs that could be created in other industry sectors from the profit markups. Additionally, jobs created in the supply chain before the project level up through and including the manufacturing level were calculated based on construction pricing schemes instead of retailer, wholesaler, and manufacturer pricing schemes.

Job Forecasting in Policy Making and Evaluations

Fobair and Kibert (2011) proposed calculating jobs from an investment in energy efficiency retrofits for the project level through mining. The retrofit work evaluated had been limited to energy efficient roofing systems/accessories (e.g. roof/ridge vents and radiant barriers); energy efficient doors and windows; window blinds and thermal shades; additional insulation; weatherization (e.g. air sealing, low flow devices, and hot water tank insulation); heating and air-conditioning system retrofits; and, upgrades to lighting systems.

A preliminary estimate of direct and indirect jobs from the project through mining was provided. This estimate was used to demonstrate two new calculations: the Savings-to-Jobs Ratio (SJR) and Jobs from Energy Efficiency Retrofit Savings (JEERS). The SJR was the estimated energy savings per year per job created from an investment in energy efficient retrofits. The JEERS was the estimated number of indirect jobs created in the first year from energy savings. An example using a standard 150 m^2 home as the basis of design demonstrated the calculations.

Contextual Information

Various studies and research questioned the accuracy of knowledge surrounding job creation from energy efficiency activities and in supply chains. Arguments have been made that past efforts were not performed systematically, fallacies existed in measurements, and research approaches were oversimplified. The following studies and research provide a setting for this research.

Non-Energy Benefits

Mills and Rosenfeld (1996) argued that non-energy benefits deserve more emphasis when assessing energy-efficiency technology and evaluating marketing and program activities for energy efficiency. The benefits accrued at the national, local and consumer levels; however, non-energy benefits created the most motivation to adopt energy-efficient technologies at the consumer level. The consumer motivation stemmed from the added value associated with non-energy benefits, which is contrasted to the common approach of emphasizing energy-efficient technologies that "provide equivalent services at lower costs" (Mills and Rosenfeld 1996, p. 708). They believed consumer decision making had reflected that non-energy costs have been typically emphasized over non-energy benefits. The authors had summarized past research on non-energy benefits, which focused on the societal level and included "enhanced energy security through reduced oil imports, job creation, local economic development induced by large-scale efficiency programs, enhanced international competitiveness and reduced pollution" (Mills and Rosenfeld 1996, p. 708). They found that other authors had concluded knowledge of consumer non-energy benefits was undeveloped, past efforts have not been performed systematically, and that data gaps exist in the literature on non-energy economic benefits in buildings.

Job Characteristics

Davis et al. (1996) performed insightful research on the manufacturing industry and specifically focused on the establishments that employ workers. They used the Longitudinal Research Database (LRD) to perform the research. The LRD had been populated with data from Census Bureau economic surveys, namely Census of Manufacturers and the Annual Survey of Manufacturers.

The Davis et al. (1996) research described the relationship between changes in employment and establishment characteristics such as size, industry, geographical location, level of wages, etc. It inferred restructuring and change in the economy are the rule and suggested large-scale employment change will be part of every sector of the U.S. economy. When employment change will be occurring, “job flows are large, persistent, and highly concentrated” (Davis et al. 1996, p. xviii). For example, job creation and destruction in manufacturing will typically be associated with the startup or closing of a large plant. In order to avoid long-term unemployment, the research advised workers to stay flexible in terms of location and skill requirements of jobs.

Davis et al. (1996) provided explanations of terms commonly used in employment analysis. Job reallocation and worker reallocation were not the same. Job reallocation was the job opportunity had been moved to a new location. Worker reallocation was a person entering or exiting the labor force or switching jobs. Although the concepts are distinct, overlap will exist between the two when calculating jobs. One-third to one-half of total worker reallocation will be due to job reallocation.

Davis et al. (1996) found jobs that require greater human capital command higher wages and tended to be more stable. Human capital referred to the capacity of the worker to produce valuable goods or services. Jobs characterized by higher wages and

greater human capital exhibited lower job reallocation. For example, jobs that paid more for better skills were less likely to go overseas.

Davis et al. (1996) shed light on the common belief that small business created most new jobs. In the manufacturing sector, this belief had been incorrectly promoted by statistical fallacies. Measurements of job creation have typically been performed by grouping companies that are similar in size. The fallacy of this method was that over time companies migrate between size categories. Based on SBA and government definitions of a small business, small employers created approximately twenty percent of all new manufacturing jobs; however, small businesses in nonmanufacturing industries accounted for a larger percentage of job creation and destruction. The in depth analysis concluded net job creation in the manufacturing sector "exhibits no strong or simple relationship to employer size" (Davis et al. 1996, p. 62).

Construction Supply Chains

London (2008) developed the concept of 'supply chain economics' to describe the "economic market structural characteristics and the firm and sector behavioral characteristics" of the construction industry (London 2008; p. 2). London summarized that construction supply chain research of the past decade has taken three paths: 1) transactions at the project level, 2) transactions at the industry level, and 3) performance at a market level. These approaches have had weaknesses. They failed to emphasize the importance of the complex and varied connections between the supply chain levels, actors, markets and commodities. Firm-firm procurement relationships have connected the project to many firms, industry markets, project markets and commodities. These relationships formed the "glue which ties these entities together" (London 2008; p. 7).

London (2008) believed project performance depended on firm-firm relationships throughout the chain of contracts. Firm-firm procurement relationships have been based on contracts which were embedded in a context that involves “historical relationships, demand, sourcing strategies, supplier response and current market competiveness” (London 2008; p. 7). Most research has been on clients, contractors and consultants, which on a given project represents “less than 5% of all contractual relationships between firms” (London 2008; p. 7). London (2008; p. 7) believed the remaining chain of firm-firm connections, also known as the supply chain, must be better studied to understand the “construction industry structure, firm conduct and associated industry performance.”

London (2008) discussed government economic models of performance, including input-output analysis and industrial organization economic theory, which has been specifically for “policy consideration and intervention related to firm conduct, market structure and market performance” but has not included information on “distinct chains of commodities and their markets” (London 2008; p. 8-9). Governments have played major roles in the construction industry: “as controller of the regulatory framework, as a major client, and as policymaker” (London 2008; p. 84). Their policies have affected the character of the industry (Cox and Townsend 1998) in three ways: 1) Encouraging competition or restricting practices (Warren 1993); 2) Allocating of budgets and capital works programs; and, 3) Altering procedural systems and practices of suppliers with purchasing power.

Supply chains will begin with the clients who originate the design and construction process. Different clients, for example the government, will impact suppliers differently.

The degree of impact will depend on leverage. A client with leverage will manage resources in a supply chain in a manner that will appropriate value to oneself. Managing supply chain resources has been difficult because the construction industry has a fragmented structure and fragmented processes. Fragmentation has lead to positive and negative benefits. For example, specialization of work has produced a better product, but multiple layers of contracts in a delivery process will compound markups resulting in higher cost. Due to this fragmentation, the author referenced work by Groak (1994) who suggested construction will be best represented by a multi-industry model made of several overlapping industries.

Firms in construction have provided commodities, whether it was a service, product, or product and service. Supply chain behavior in construction has been influenced by the way the industry operates as a project-based industry. It was unknown if the project based influence extended to the materials and manufacturer level, but it has influenced the subcontractor and supplier level.

Definitions: Jobs and Energy Efficiency Retrofits

Definitions is divided into two categories: Jobs and Energy Efficiency Retrofits. Jobs will present existing terms and definitions that define a job. Energy Efficiency Retrofits will present existing terms and definitions that describe an energy efficiency retrofit.

Defining Jobs

Defining a ‘job’ is not an easy task. In many instances, it was defined by the number of hours worked per week, such as full-time (40 hrs) or less than full-time. In other cases, the benefits associated with the job determined if it was ‘part-time’ or ‘less than full time’. Sometimes, the definition of a job depended on a person working a

certain day of the week or time period (USDOL 2009). For example, a job was counted if a person worked on the third Thursday of a month. The following terms provide a starting point for defining jobs in this research.

- *'Full-time workers'* described in the National Compensation Survey (USBLS 2011a) are classified as full-time, versus a part-time classification, based on how the employer defines the terms.
- *'Full-time workers'* described in the Current Population Survey (USCB 2006) and American Time Use Survey (USCB 2011) are persons who work 35 hours or more per week.
- *'Full-time equivalent'* is described as "the total number of regular straight-time hours (i.e., not including overtime or holiday hours) worked by employees divided by the number of compensable hours applicable to each fiscal year. Annual leave, sick leave, and compensatory time off and other approved leave categories are considered to be 'hours worked' for purposes of defining FTE employment (USGAO 2005, p. 57)."
- *'Job'* is "an employment position filled by a worker" (Davis et al. 1996, p.9).
- *'Green jobs'* are associated with energy efficiency and are measured either by the output or process approach (USBLS 2010). They preserve or restore the environment either by producing green goods and providing green services or by using environmentally friendly production processes.
- *'Direct Jobs'* are jobs created for a project by an investment (White House 2009a).
- *'Indirect Jobs'* are jobs created at the supplier who makes materials used in the project (White House 2009a).
- *'Induced Jobs'* are jobs created elsewhere in the economy when increased incomes from investment in the project lead to increased spending by workers and firms (White House 2009a).

Defining Energy Efficiency Retrofits

"Energy efficiency retrofit" did not have a universal definition. Possible synonyms for the phrase included: 'green retrofit', 'home energy retrofit', 'home retrofit', 'deep energy retrofit', 'home energy improvements', and 'home performance retrofit'. The following examples provide a few of the definitions.

Lovins (2004) of the Rocky Mountain Institute provided a taxonomic overview of the phrase 'energy efficiency'. It is defined as (Lovins 2004, p. 383): "Broadly, any ratio of function, service, or value provided to the energy converted to provide it. Herein,

energy efficiency and its components all use (a) physical rather than economic metrics and (b) engineering, not economic, definitions (this physical convention can, however, become awkward with multiple inputs or outputs). Energy efficiency may or may not count thermodynamic quality of energy (ability to do work); see the distinction between First Law and Second Law efficiency." Lovins (2004, p. 385) clarified that the term "retrofit" applied to technical improvements in energy efficiency installed in existing buildings.

An energy efficiency retrofit involved changes that reduce home energy use, typically by up to 40% (White House 2009b). A 'deep energy retrofit' was a 50% reduction in energy consumption in an existing home compared to a newly built efficient home (Scanla 2010).

The Environmental Energy Technologies Division of Lawrence Berkley National Laboratory preferred the phrase 'home energy improvements' over 'residential energy efficiency retrofits' or 'home performance retrofits' (Fuller et al. 2010). They reported consumers have reacted negatively to the term 'retrofit', which was often associated with the term 'audit'. Their phrase 'home energy improvements' was not explicitly defined; however, it implied the improvements were to reduce energy consumption.

Data Classification and Sets

Government surveys provide large population, highly standardized data sets free for download from the Internet. Data sets of this nature will be necessary when analyzing supply chains. The following data sets and classification system will be utilized in this research.

2007 Economic Census

The federal government performs an economic census every five years, and the most recent data available is for the year 2007. It is free for download and searchable using the U.S. Census Bureau's American FactFinder search engine. For example, contracting business data was available by geographic location, percentage of specialization in a type of construction (TOC), and kind-of-business activity (KOB) (USCB 2007a). As the largest and most comprehensive economic census performed in the United States, the data has been widely used to formulate public policy on economic development.

The 2007 Economic Census surveyed large and medium size firms using mailed report forms. Some small employers also received the mailed forms; however, gaps had been filled using administrative records of federal agencies. The collected data had been organized by North American Industry Classification System (NAICS) codes based on self-reporting by the business establishments, which effectively grouped the establishments into industries with similar production processes. Each data set had been itemized into defined categories. The categories represented a variety of statistics, including number of establishments, number of employees, payroll, sales, receipts, revenue, expenses, value of shipments and value of construction work done. The statistics provided are for within the U.S. borders; therefore, the work product and labor is American.

2007 Census of Governments

The Census of Governments, prepared by the U.S. Census Bureau (USCB 2007b), provides information on government employment and finances. Revenue,

expenditures, payroll, benefits and other data are routinely collected and reported every five years. This data is frequently used for public policy research.

2007 Census of Agriculture

The Census of Agriculture, prepared by the U.S. Department of Agriculture (USDA 2007), provides information on farms and ranches providing agricultural products. Revenue, expenditures, payroll, farm numbers, and other data are reported every five years. This is the only source of agricultural information for the entire nation. Data is arranged by North American Industry Classification System codes.

2009 Service Annual Survey

The 2009 Service Annual Survey, prepared by the U.S. Census Bureau (USCB 2009), includes data for 2007. Estimates of revenues and expenses, including payroll and benefits, are provided for select service sectors. Sectors are arranged by North American Industry Classification System codes.

Occupational Employment Statistics Survey

The Occupational Employment Statistics (OES) Survey provided employment and wage estimates for specific occupations. The mean annual wage was provided for occupations identified by Standard Occupational Classification (SOC) codes and by NAICS codes in the OES data sets (USBLS 2007).

National Compensation Survey

The National Compensation Survey (NCS) provided comprehensive data on occupational wages, benefits and employment cost trends. Part of the survey was the Employer Costs for Employee Compensation (ECEC) publication. The ECEC measured the average cost to employers for wages and salaries and benefits per employee hour worked. The percent of total compensation was provided by industry

and occupational group in the ECEC Historical Listing March 2004 – March 2011 (USBLS 2011b).

Davis-Bacon Weatherization Wage Rates

The Wage and Hour Division of the U.S. Department of Labor conducted a survey for the American Recovery and Reinvestment Act (ARRA) of 2009 to determine the prevailing wage rates for weatherization services (USDOL 2009). This survey was necessary for compliance with the Davis-Bacon Act that requires contractors and subcontractors performing work on federally funded or assisted contracts in excess of $2,000 to pay prevailing wages and fringe benefits equivalent to corresponding work on similar projects in the area. The survey was for all fifty states, and wages were reported for each county in each state. The data were reported in a tabular format comparing 'Weatherization Wage' rates to 'Existing Residential Wage' rates. 'Weatherization Wage' rates are provided for 'Weatherization Worker', 'Doors and Windows Replacement Worker', and 'HVAC, Furnace, Heating and Cooling Repair, Installation, Replacement Worker'. 'Existing Residential Wage' rates were provided for 'Carpenter', 'Electrician', and 'Plumber'.

NAICS Codes

The standard utilized by federal statistical agencies to classify business establishments by type of economic activity in the United States has been the North American Industry Classification System (NAICS) (OMB 2007). The NAICS is organized by a six-digit numbering system. Reading from left to right, the first two digits identify the business sector, the third digit identifies the subsector, the fourth digit identifies the industry group, the fifth digit identifies specific industries, and the sixth digit

identifies national industries. Appendix C has the complete list of NAICS codes for each product supply chain that will be used in this research.

Literature Analysis

The literature has been analyzed to find shortcomings in the current body of knowledge. Several have been identified, and the details will be provided below.

Few studies and research related to job creation in the EER supply chain exist. Of the sources that are related, the results on numbers of jobs created ranged from about five to fifty-two. See Figure 2-1 for a summary of the range of jobs reported in other literature for an equivalent $1 million dollar investment.

This wide range is unexplainable because most of the sources did not provide a methodology of how the jobs were calculated. Other deficiencies exist as well. Job definitions are ambiguous or not given, and the types of jobs counted are unclear. None of the studies addressed jobs throughout the entire supply chain.

The topic of this research merged three areas of knowledge together: job creation, energy efficiency retrofits, and supply chains. Authors (Mills and Rosenfeld 1996; Davis et al. 1996; London 2008) have written about these individual subjects using language similar to the following: undeveloped, not performed systematically, gaps exist, statistical fallacies, fail to emphasize, have weaknesses, and must be better studied. These individual subjects have been understudied, which partially explains the disconnect in not finding the topic of this research extensively written about in the literature while conducting this study.

Definitions depended on the usage and source. Several commonly used definitions for jobs and energy efficiency retrofits have been provided; however, some disconnects existed between these definitions and this research. The following

disconnects are “problems” that must be corrected in order to establish new definitions for this research.

1. The number of hours equaling a full year of work is not definitive.
2. The supply chain is not emphasized.
3. Green jobs addressing energy efficiency is a very broad subject.
4. Induced jobs from business-to-business exchanges outside of the supply chain and from utility savings reinvested in the economy are not addressed.
5. Energy efficiency retrofit does not have a universally agreed upon definition.

In summary, the literature that has been analyzed supports a conclusion more research will be needed on job creation, energy efficiency retrofits, and supply chains, each as individual subjects and in combination. Two primary shortcomings have been identified. First, the method of calculating jobs typically has not been provided. Second, definitions typically have not been provided, explained or universal.

Recommendations

Providing and explaining methodologies and definitions specific to job creation in EER supply chains would clarify which jobs will be counted and how. A new methodology will be presented in the next chapter that utilizes data in a similar fashion to Sterzinger (2006). Changes have to be made to the old definitions in order to make new definitions specific to this research. Specifically, terms need to be accurately defined with measurable inputs/outputs. The new definitions are provided below.

- *Direct Job*: A job installing or managing the installation of finished products at the project level. Direct jobs occur at the end of the supply chain.
- *Indirect Job*: A job caused by intra-supply chain industry exchanges (i.e. raw materials or parts for manufacturing work-in-process), which includes administrative office jobs at the project level.
- *Induced Job*: A job caused by one of three sources: 1) inter-industry exchanges outside of the product supply chain; 2) reinvestment of wages into the marketplace; and/or 3) reinvestment of utility savings into the marketplace.
- *Full-time Equivalent (FTE)*: The total number of regular straight-time hours (i.e., not including overtime or holiday hours) worked by employees divided by 2,080 hours per fiscal year. Annual leave, sick leave, and compensatory time off and other

approved leave categories are considered to be “hours worked” for purposes of defining FTE employment; however, approved leave categories shall reflect a minimum of at least ten paid holidays and two-weeks paid vacation pro-rated evenly on an annual basis over the time of employment.

- *Energy Efficiency Retrofit (EER) Job*: A full-time equivalent direct or indirect green job found in the supply chain of an investment to retrofit a building for energy efficiency. EER jobs can be classified as created, retained, or reallocated.
- *Energy Efficiency Retrofit (EER) Supported Job*: A full-time equivalent induced job found outside the supply chain of an investment to retrofit a building for energy efficiency. EER supported jobs benefit from the retrofit investment.
- *Energy Efficiency Retrofit (EER) [general]*: Changes made to an existing, functional, structure for reducing energy consumption.
- *Energy Efficiency Retrofit (EER) [specific]*: Changes made to an existing, functional, residential structure for reducing energy consumption. The term “existing” requires that the residential structure has previously received a certificate of occupancy from the local building department and/ or there is documented proof the structure has been inhabited. “Existing” also implies, but does not require, that the building is over 15 years in age. The term “functional” requires the building systems, generally speaking, are in working order and that the structure serves its intended purpose as a shelter for a household. The term “residential” includes single family, duplex, triplex, town homes, cottages, mother-in-law suites and multifamily of three story or less. “Residential” does not include lofts found in mixed use developments, condominiums or any other structure intended for residency that is over three stories or utilizes building systems designed for commercial applications.
- *Energy Efficiency Retrofit (EER) Supply Chain*: Enterprises connected by relationships that facilitate the flow of energy efficiency goods and services to an end.

This research proposes ten levels exist in an EER supply chain. The levels are listed in reverse order, meaning the first level is actually the end of the supply chain.

The ten levels are as follows:

1. Contractor
2. Subcontractor
3. Retailer
4. Wholesaler
5. Manufacturing – Finished Product
6. Manufacturing – Assembly Parts
7. Manufacturing – Intermediate Parts
8. Manufacturing – Beginning Parts
9. Mining – Raw Materials
10. Mining – Exploration and Development

Levels one and two, contractor and subcontractor respectively, are the project phase of the supply chain. At these levels, EER products are installed in the residence. Levels three and four, retailer and wholesaler respectively, are the sales levels. Levels one, two and three can purchase materials from level four. Levels five through eight are for manufacturing. Level five is the finished product, which is where the final assembly of a product takes place. Level six is the assembly parts. At this level, major sub-parts are made, such as motors and compressors. Level seven is the intermediate parts, where wire, fuses, nuts and bolts are made. Level eight is the beginning parts. Beginning parts is the final processing of raw materials into billets, blooms, rod, plate, etc. Level nine is the mining of raw materials, which includes the extraction of material from the earth. Level ten is the exploration and development of land for mining, which includes surveying and land clearing.

Summary

This chapter has summarized literature relevant to this research. First, background information has been provided on job creation, the context of this research, definitions, and data sets. Next, it has been analyzed to find shortcomings in the existing body of knowledge. Finally, recommendations to correct the definitional shortcomings have been made. Recommendations to correct the methodological shortcomings will be made in the next chapter.

Literature Source	Direct	Indirect	Induced	Total
Fei Liu and Emrath (2008)	5.40	1.80	3.90	11.10
Wiltshire et al. (1998)	5.00	5.00	1.68	11.68
Kibert et al. (2011)	10.00	5.00	0.00	15.00
Kaiser et al. (2004)	22.00	33.00	N/A	55.00
U.S.B.E.A. in EOSI (2009)	N/A	N/A	N/A	26.67
Fuller (2007)	N/A	N/A	N/A	28.50
U.S.W.A.P. (2009)	52.00	23.00	N/A	75.00

Figure 2-1. Range of jobs per $1 million investment

CHAPTER 3
METHODOLOGY

The chapter will be divided into two sections: Description of Methodology and Research Design. Description of Methodology will be the method of calculating job creation in the EER supply chain. Research Design will be the steps taken to conduct this research.

Description of Methodology

This methodology will utilize construction estimating and budgeting techniques to forecast jobs in the EER supply chain for a given level of investment in residential structures. Specifically, a reverse-estimation technique will be utilized to deconstruct an energy efficiency investment into profit, overhead and hard costs. Overhead and hard costs will be further broken down into the elemental pieces of an estimate, which are labor, materials, equipment, and other. The deconstructive process will be performed over the ten levels of the EER supply chain and repeated thirty-five times for the multiplier effect.

The methodology will be demonstrated in the form of an economic input-output model. The basic process of the model is shown in Figure 3-1. The primary user input will be the amount of the investment; however, other adjustable variables will include the wage rate, allocation by percent of worker time per skill level, mix by percent of self-performed versus subcontracted work (i.e. method of contracting), and type of supply chain (i.e. EER activity). The primary model outputs will be the numbers of jobs at each level of the EER supply chain.

Division of the investment will be based on percentages extrapolated from survey data primarily found in the U.S. Economic Census. The percentages are calculated

using a dollar breakdown template made for this research. The dollar breakdown template will distribute the survey data for each business establishment, identified by a NAICS code, into eight accounts (i.e. Profit, Overhead – Labor (OHL), Overhead – Material (OHM), Overhead – Equipment (OHE), Overhead – Other (OHO), Hard Cost – Labor (HCL), Hard Cost – Material (HCM), and Hard Cost – Equipment (HCE)) in order to find the percent of total for each account. The eight accounts will be explained later in Research Design, Phase IV: Data Analysis. The types of labor to be counted will include, but not be limited to, on-site installers, manufacturing assemblers, administrative management, and administrative assistants. The labor portion of the investment will be converted into full-time equivalent (FTE) jobs utilizing loaded labor rates (i.e. the hourly wage rate plus benefits) and a reasonable management/crew mix. The FTE jobs will be displayed as direct, indirect and induced jobs. The material portion will cascade down to the next supply chain level where the division process will be repeated. The profit, equipment and other portions will form new supply chains for materials or services not associated with EER activities. These supply chains will follow a similar deconstruction process. This dual process will continue for thirty-five iterations until the entire initial investment has been converted into labor.

Research Design

The design process for this research had seven steps. The steps are shown in Figure 3-2 and will be described below.

Step I: Literature Review

Chapter 2 discussed the literature review. Shortcomings in the existing body of knowledge have been identified, and new definitions have been provided for use in this research.

Step II: Develop a Methodology

Input-output models have been commonly used in the modeling of economic activity, such as the economic activity that occurs in a supply chain. For this research, the flow of goods through a supply chain has been based on transactions between many enterprises and a standard method of pricing the goods and services. The pricing method was to add a profit markup to the total cost. Profit markups typically were different for each industry, and costs included some arrangement of labor, materials, equipment, and overhead.

Each subsequent level downstream depended on the goods or services from the upstream level. Consequently, the inputs of each lower level would be the outputs of the upstream level. Complicating this chain structure was the number of enterprises at any given level. Multiple enterprises typically acted as feeder chains that flowed together to the next level.

The problem in modeling supply chains for this research has been deciding how to unbundle the dollars systematically over the multiple levels and iterations. These iterations consisted of passing material costs through a dollar breakdown to determine the distribution of profit, overhead and hard costs for each product and/or service. The goal has been to group monies into accounts that are similar across all levels of the supply chain and through all material pass-thru iterations. The accounts would become their own supply chains in subsequent iterations.

Step III: Data Collection

Data collection involved searching for existing data sets that would be applied to this research. Using the American FactFinder by the U.S. Census Bureau, data sets from the 2007 Economic Census were chosen. These data sets have been arranged by

North American Industry Classification System (NAICS) codes and provided detailed information on the costs and materials consumed. The benefits to using the government-collected data sets are larger populations and standardized data presentation.

Step IV: Data Analysis

For each of the three product categories (mineral wool insulation, glass doors/windows, and HVAC systems), files have been arranged in the ten levels of the EER supply chain. For each level, the appropriate data set had been downloaded from the 2007 Economic Census and saved in a separate file. Each data set has been organized into defined categories with the units expressed in dollars. A “dollar breakdown” template had been created in a format similar to an income sheet in order to standardize the format of the data for use in the model. A copy of this template has been saved in each file and linked to its data set. This template provides a breakdown of dollars that flow through each enterprise in the EER supply chain. For all data sets, the breakdown of dollars will be made into the following eight accounts:

1. Profit
2. Overhead Labor (OHL)
3. Overhead Material (OHM)
4. Overhead Equipment (OHE)
5. Overhead Other (OHO)
6. Hard Cost Labor (HCL)
7. Hard Cost Material (HCM)
8. Hard Cost Equipment (HCE)

These accounts comply with standard industry definitions and practices. Profit is the remaining money after all other costs have been covered. Overhead labor (OHL) is the administrative personnel performing day-to-day business activities, e.g. company officer, manager, secretary and receptionist. Overhead materials (OHM) are basic

office supplies required by administration. Overhead equipment (OHE) is basic equipment required by administration, e.g. copiers and computers. Overhead other (OHO) is a category for small miscellaneous company expenses, e.g. rent, communication services, data processing, insurance, professional/technical services, repair/maintenance, taxes/license fees, training, trash collection, utilities and travel. Hard cost labor (HCL) is the production personnel from foreman to labor and described as skilled, semi-skilled and unskilled. Hard cost material (HCM) is the products, materials and equipment incorporated into a more complete or finished product. Hard cost equipment (HCE) is the equipment utilized in the processing, transportation or installation of products or materials.

Step V: Develop a Prototype Model

The model is an Excel spreadsheet with over a thousand tabs. The first tab is an index with hyperlinks to other tabs. The next few tabs are for user defined inputs and model outputs (i.e. results). The inputs include the magnitude of investment, whether work will be self-performed or subcontracted, contractor mark-up on subcontracted work, number of compensable hours for FTE calculations, employee mix, and wage rates. Outputs include the number of jobs produced for a given investment. The job numbers will be displayed in a variety of ways, including an economic format (e.g. direct, indirect and induced) and a construction estimating/budget format (e.g. profit, overhead and hard cost, where overhead and hard cost will be subdivided into labor, materials, equipment and other). The remaining tabs are the working model. The procedure for using the model is fully described in Appendix A.

The model operates by a user entering an investment amount and selecting a path for the EER supply chains. Selecting a path requires choosing the product category

(i.e. mineral wool insulation, glass doors/windows, or HVAC systems) and who performed the installation (i.e. contractor self-performs or subcontracts). Other variables exist (e.g. wage rates and benefits), but it is recommended the user accept the default values.

After inputs have been made, the investment dollars initially cascade through the ten levels of the HCM supply chain. See Figure 3-3 for a diagram of the HCM supply chain.

The HCM balance at one level becomes the starting amount at the next level. At each level, the labor account will be reconfigured into full-time equivalent jobs utilizing loaded labor rates and a typical employee mix. The remaining accounts will be grouped in like-kind fashion to create two types of new supply chains. For example, one will be for OHM, OHE, HCM, and HCE supply chains, diagrammed in Figure 3-4. The other will be for profit and OHO supply chains, diagrammed in Figure 3-5. The diagram in Figure 3-6 illustrates how dollars flowed through these supply chains as part of the overall model.

This initial flow of investment dollars through the HCM account will create direct and indirect jobs. Employment from the newly created supply chains will make induced jobs, which result from the invested dollars turning over in the market from economic activity. The economic churn will be a repeating process; therefore, the dollars will 'pass-thru' the model in iterations converting the entire investment into labor.

Step VI: Test the Model

The model had been tested and checked for mistakes. After the mistakes had been corrected, tables and graphs have been made to display the output from the model. The tables display the information in various formats, including by category of

job (i.e. direct, indirect and induced), by level of the supply chain, and by iteration of the model. The graphs display the jobs created by level of the supply chain and by iteration of the model. A second iterative graph displays the cumulative number of jobs created over the supply chain.

Step VII: Develop the Final Model

One final change had been made to the model after testing it. The number of iterations for the economic churn had been increased to thirty-five from originally twenty. This change allows more induced jobs to be counted when the initial investment is a large dollar amount. Sample output from the model will be included in the next chapter.

Summary

This chapter has presented a new methodology to forecast jobs in the EER supply chain for residential structures in Florida. A working model demonstrating the methodology has been explained. The steps taken in the design of this research have been enumerated and discussed.

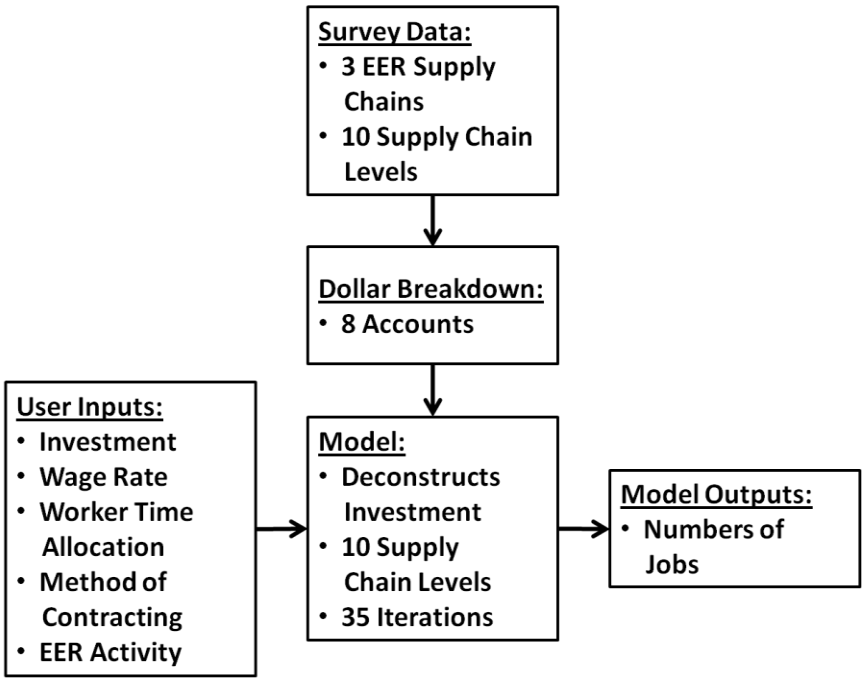

Figure 3-1. Model process

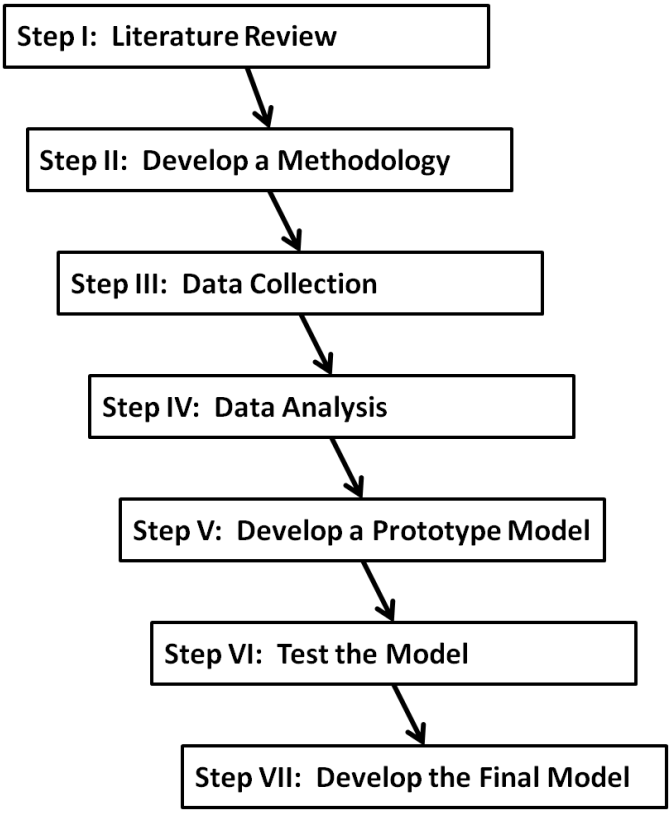

Figure 3-2. Research design

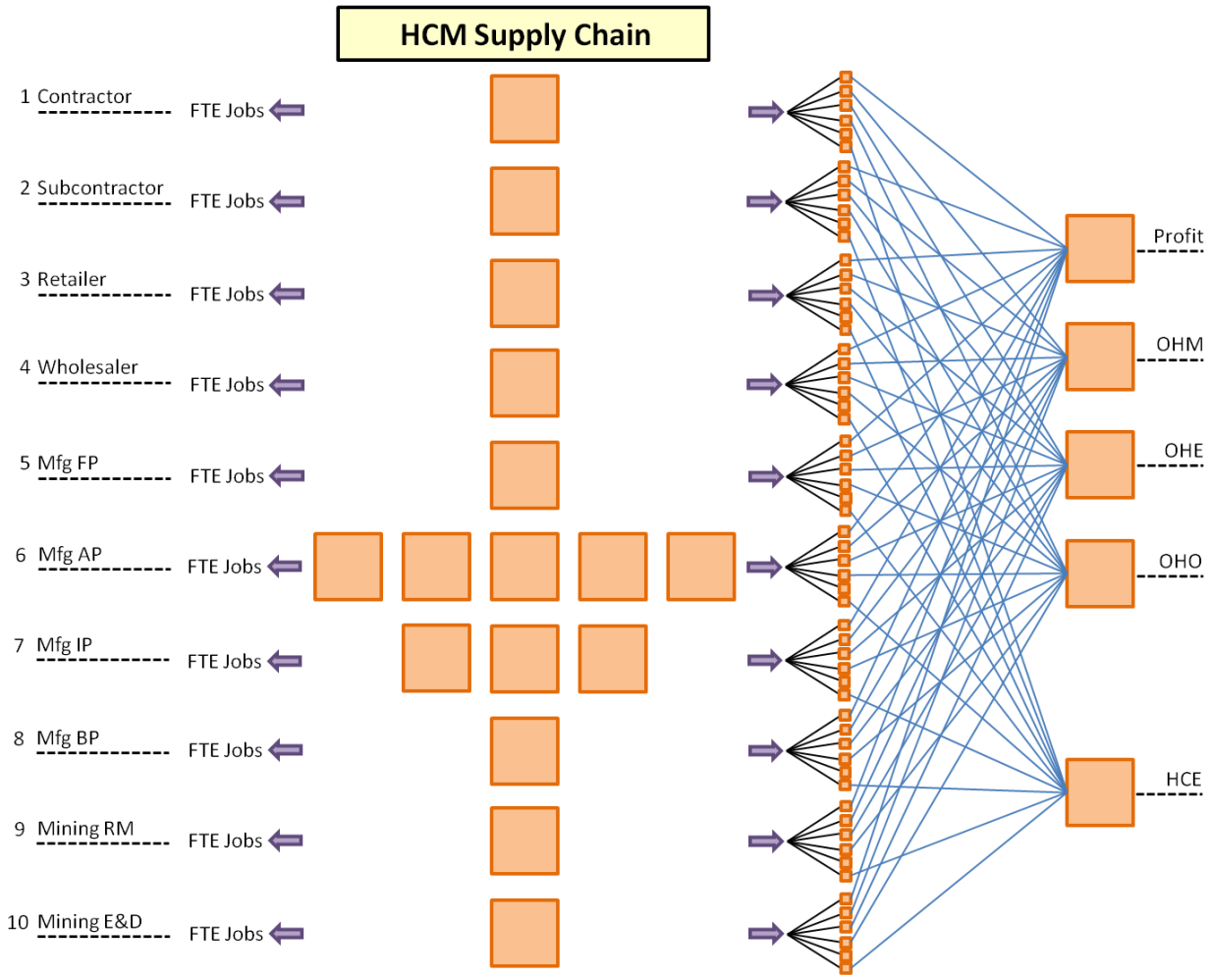

Figure 3-3. HCM supply chain

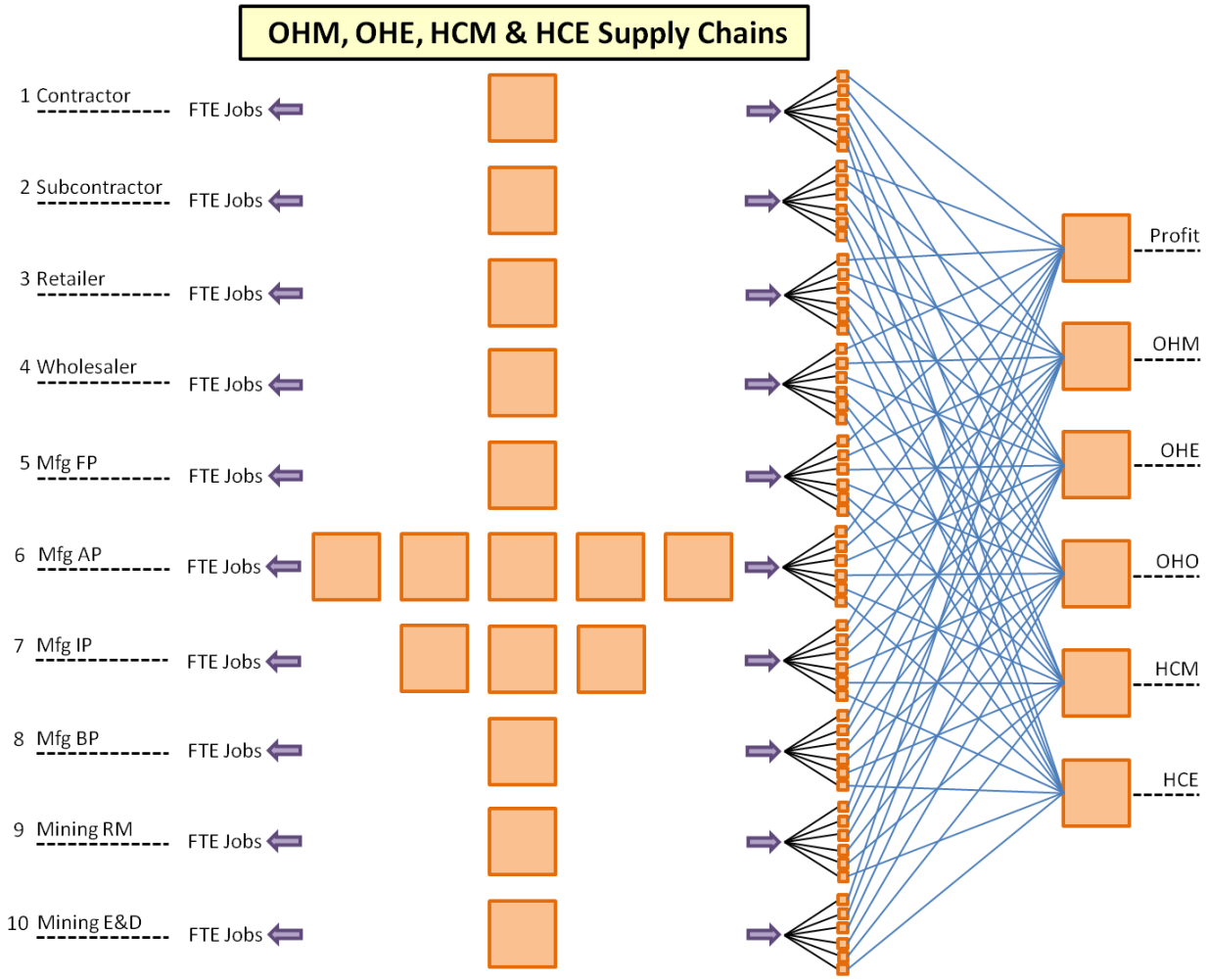

Figure 3-4. OHM, OHE, HCM and HCE supply chains

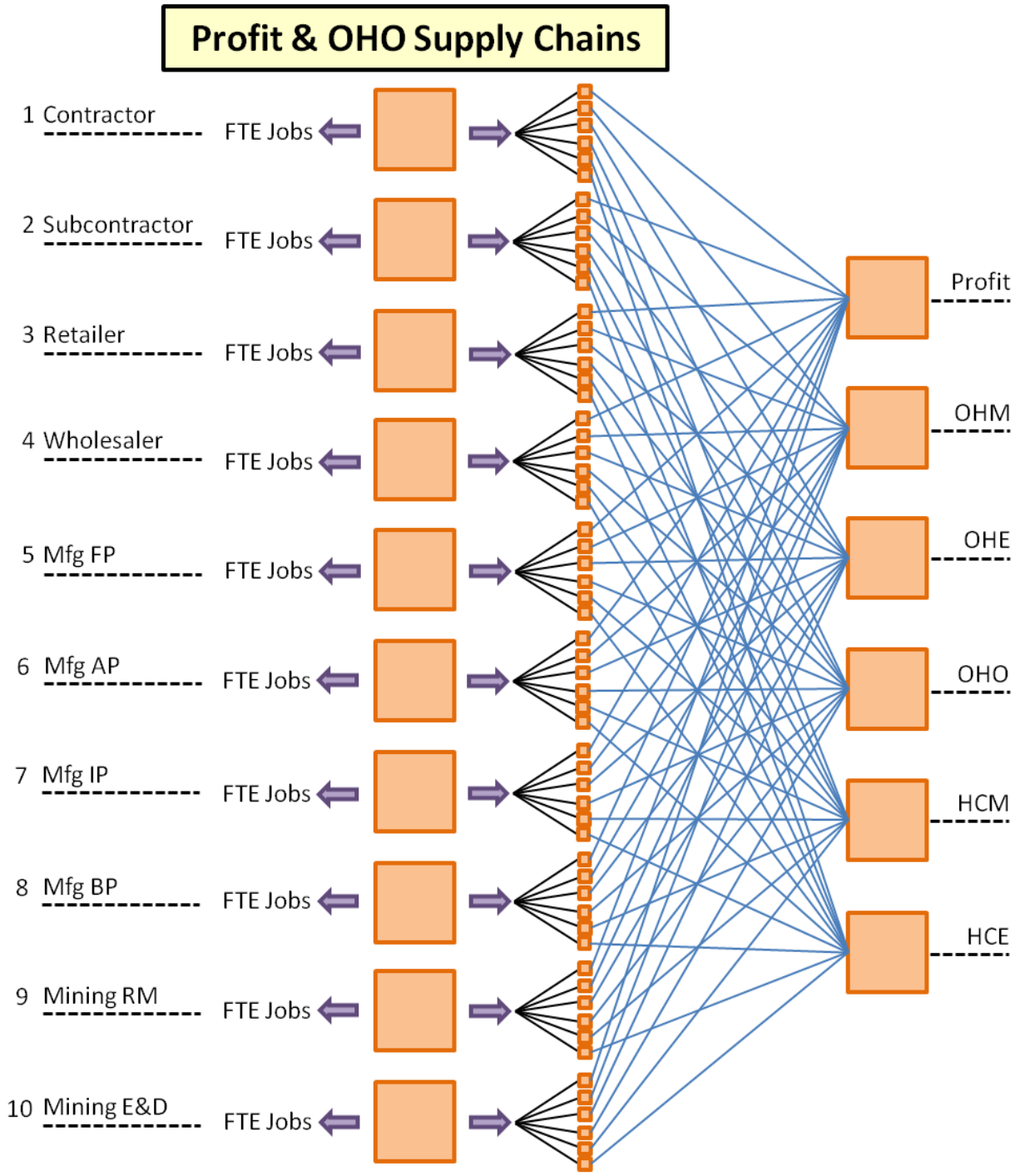

Figure 3-5. Profit and OHO supply chains

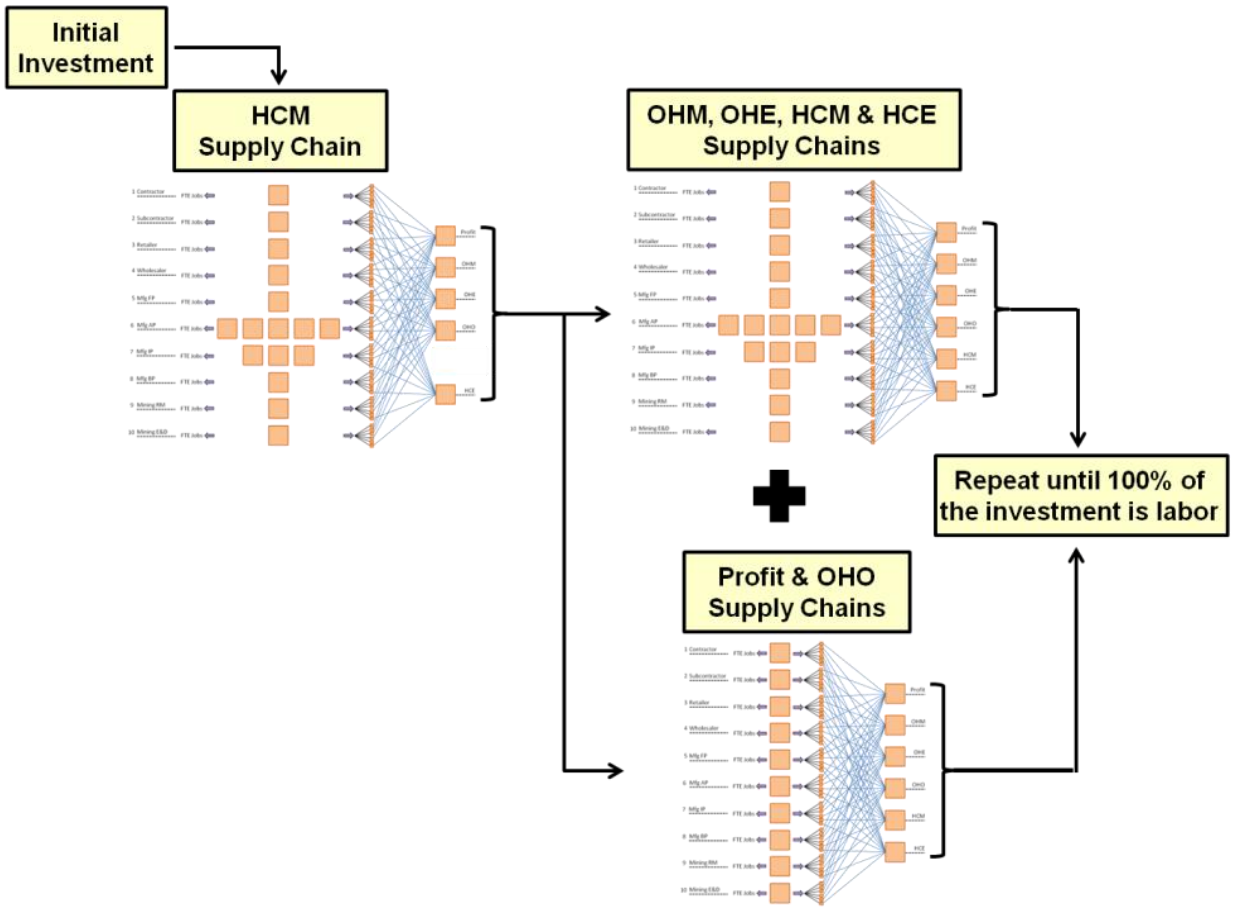

Figure 3-6. Model flowchart

CHAPTER 4
RESULTS

This chapter will present the results of the model. First, the user inputs will be summarized. Second, the model outputs will be provided for three energy efficiency product categories: mineral wool insulation, glass doors/windows (i.e. openings), and HVAC systems.

Model Inputs

The primary user input is investment dollars, which represented the magnitude of the work to be performed. Additional inputs included:

1. The division of the investment by percentage over the three products: insulation, openings, and HVAC systems;
2. The division of each product by percentage between the contractor and subcontractor levels of the supply chain (i.e. an indication by percentage of the amount of work self-performed by the contractor versus the amount of work subcontracted);
3. The team mix for “Administration and Project Management” and “Self-Performed and/or Sub-out Worker”, which is the assumed division of dollars by percentage across multiple worker categories;
4. The amount of “FTE Annual Hours”; and,
5. The Economic Census data sets relevant to the supply chain for the type of retrofit work to be performed.

Model Outputs

The primary outputs are the numbers of jobs as a function of the initial investment. Jobs are based on FTE calculations and have been organized by money source or sector. For the money source, a job has been counted in the level the money originated. For the sector, the job has been counted in the industrial sector where it occurred. Jobs have been calculated by the method of contracting, which could have been the contractor self-performing or subcontracting the work. Jobs have been arranged in two categories. The categories are type of job (i.e. direct, indirect or

induced) and cost category (i.e. overhead or hard cost). The numbers of jobs have been presented in four formats. The formats are the following:

1. Ten levels of the supply chain;
2. Four major levels of the supply chain (i.e. project, sales, manufacturing and mining);
3. Pass thru, which is dollars passing through the model in multiple iterations (i.e. economic turnover or multiplier effect); and,
4. Aggregate.

The following are sample outputs for mineral wool insulation, glass doors/windows (i.e. openings), and HVAC systems. For these outputs, the user input for EER investment had been set to $1 million. All other inputs had been set at the default levels discussed in Appendix A.

Insulation

The results for mineral wool insulation have been displayed in Figures 4-1 through 4-6. Figures 4-1, 4-2, and 4-3 display the results when the contractor is self-performing all of the installation work. Figures 4-4, 4-5, and 4-6 display the results when the contractor is providing only management and coordination because all of the installation work has been subcontracted.

Figure 4-1 displays the job results by the money source. Figure 4-2 displays the job results by the sector. For these formats, 29.60 total jobs are forecast per one million dollars. The numbers of direct, indirect and induced jobs are 6.52, 4.15 and 18.94, respectively. The numbers of hard cost and overhead jobs are 18.14 and 11.46, respectively. Jobs are also shown at each of the ten levels of the supply chain. Additionally, the ten levels have been grouped to indicate the subtotals of jobs at the project, sales, manufacturing, and mining levels. The results in Figure 4-1 for each of these four subtotals are 13.42, 9.50, 6.48 and 0.20, respectively. The results in Figure

4-2 for each of these four subtotals are 10.71, 12.84, 5.84 and 0.21, respectively. Figure 4-3 displays the job results by the number of times money passed through the ten levels of the supply chain. For this display, thirty-five iterations are shown, and each iteration is referred to as a 'pass thru'. The first 'pass thru' creates 12.65 jobs. Additionally, the job numbers have been arranged by direct, indirect, induced, hard cost and overhead.

Figure 4-4 displays the job results by the money source. Figure 4-5 displays the job results by the sector. For these formats, 30.78 total jobs are created per one million dollars. The numbers of direct, indirect and induced jobs are 9.34, 4.39 and 17.05, respectively. The numbers of hard cost and overhead jobs are 19.85 and 10.93, respectively. Jobs are also shown at each of the ten levels of the supply chain. Additionally, the ten levels have been grouped to indicate the subtotals of jobs at the project, sales, manufacturing, and mining levels. The results in Figure 4-4 for each of these four subtotals are 16.82, 8.30, 5.49 and 0.17, respectively. The results in Figure 4-5 for each of these four subtotals are 14.00, 11.47, 5.12 and 0.18, respectively. Figure 4-6 displays the job results by the number of times money passed through the ten levels of the supply chain. For this display, thirty-five iterations are shown, and each iteration has been referred to as a "pass thru". The first 'pass thru' created 15.56 jobs. Additionally, the job numbers have been arranged by direct, indirect, induced, hard cost and overhead.

Openings

The results for openings, which included windows and doors, have been displayed in Figures 4-7 through 4-12. Figures 4-7, 4-8, and 4-9 display the results when the contractor is self-performing all of the installation work. Figures 4-10, 4-11, and 4-12

display the results when the contractor is providing only management and coordination because all of the installation work has been subcontracted.

Figure 4-7 displays the job results by the money source. Figure 4-8 displays the job results by the sector. For these formats, 29.25 total jobs are forecast per one million dollars. The numbers of direct, indirect and induced jobs are 6.52, 4.66 and 18.08, respectively. The numbers of hard cost and overhead jobs are 17.94 and 11.31, respectively. Jobs are also shown at each of the ten levels of the supply chain. Additionally, the ten levels have been grouped to indicate the subtotals of jobs at the project, sales, manufacturing, and mining levels. The results in Figure 4-7 for each of these four subtotals are 13.46, 9.14, 6.36 and 0.30, respectively. The results in Figure 4-8 for each of these four subtotals are 10.73, 12.30, 5.96 and 0.26, respectively. Figure 4-9 displays the job results by the number of times money passes through the ten levels of the supply chain. For this display, thirty-five iterations are shown, and each iteration is referred to as a “pass thru”. The first ‘pass thru’ created 13.06 jobs. Additionally, the job numbers have been arranged by direct, indirect, induced, hard cost and overhead.

Figure 4-10 displays the job results by the money source. Figure 4-11 displays the job results by the sector. For these formats, 31.31 total jobs are forecast per one million dollars. The numbers of direct, indirect and induced jobs are 6.52, 4.80 and 19.99, respectively. The numbers of hard cost and overhead jobs are 19.06 and 12.25, respectively. Jobs are also shown at each of the ten levels of the supply chain. Additionally, the ten levels have been grouped to indicate the subtotals of jobs at the project, sales, manufacturing, and mining levels. The results in Figure 4-10 for each of

these four subtotals are 15.65, 9.31, 6.08 and 0.27, respectively. The results in Figure 4-11 for each of these four subtotals are 11.88, 13.16, 6.02 and 0.26, respectively. Figure 4-12 displays the job results by the number of times money passed through the ten levels of the supply chain. For this display, thirty-five iterations are shown, and each iteration is referred to as a "pass thru". The first 'pass thru' created 13.47 jobs. Additionally, the job numbers have been arranged by direct, indirect, induced, hard cost and overhead.

HVAC Systems

The results for HVAC Systems have been displayed in Figures 4-13 through 4-18. Figures 4-13, 4-14, and 4-15 display the results when the contractor is self-performing all of the installation work. Figures 4-16, 4-17, and 4-18 display the results when the contractor is providing only management and coordination because all of the installation work has been subcontracted.

Figure 4-13 displays the job results by the money source. Figure 4-14 displays the job results by the sector. For these formats, 29.06 total jobs are forecast per one million dollars. The numbers of direct, indirect and induced jobs are 6.52, 4.56 and 17.98, respectively. The numbers of hard cost and overhead jobs are 17.73 and 11.33, respectively. Jobs are also shown at each of the ten levels of the supply chain. Additionally, the ten levels have been grouped to indicate the subtotals of jobs at the project, sales, manufacturing, and mining levels. The results in Figure 4-13 for each of these four subtotals are 13.41, 9.48, 5.87 and 0.30, respectively. The results in Figure 4-14 for each of these four subtotals are 10.72, 12.51, 5.53 and 0.29, respectively. Figure 4-15 displays the job results by the number of times money passed through the ten levels of the supply chain. For this display, thirty-five iterations are shown, and each

iteration is referred to as a “pass thru”. The first ‘pass thru’ created 12.97 jobs. Additionally, the job numbers have been arranged by direct, indirect, induced, hard cost and overhead.

Figure 4-16 displays the job results by the money source. Figure 4-17 displays the job results by the sector. For these formats, 28.47 total jobs are forecast per one million dollars. The numbers of direct, indirect and induced jobs are 5.95, 5.39 and 17.13, respectively. The numbers of hard cost and overhead jobs are 16.67 and 11.80, respectively. Jobs are also shown at each of the ten levels of the supply chain. Additionally, the ten levels have been grouped to indicate the subtotals of jobs at the project, sales, manufacturing, and mining levels. The results in Figure 4-16 for each of these four subtotals are 11.87, 9.88, 6.39 and 0.33, respectively. The results in Figure 4-17 for each of these four subtotals are 10.12, 12.38, 5.67 and 0.30, respectively. Figure 4-18 displays the job results by the number of times money passed through the ten levels of the supply chain. For this display, thirty-five iterations are shown, and each iteration is referred to as a “pass thru”. The first ‘pass thru’ created 13.05 jobs. Additionally, the job numbers have been arranged by direct, indirect, induced, hard cost and overhead.

Summary

An input-output model had been developed to demonstrate the methodology in the previous chapter. The objective has been to forecast job creation in the supply chain for specific EER activities. First, the user inputs have been summarized. Then, sample output results have been provided for three investment scenarios, which include installing mineral wool insulation, glass doors/windows, and HVAC systems. Results have been provided for different contracting methods (i.e. self-perform vs.

subcontracting), types of jobs (i.e. direct, indirect and induced), and cost categories (i.e. hard costs vs. soft costs). In addition, the numbers of jobs have been provided at the four major levels of the supply chain (i.e. project, sales, manufacturing and mining).

Jobs by Money Source			Job Totals						Job Totals			Job Totals
			Direct		Indirect		Induced		Direct	Indirect	Induced	
Level			OH	HC	OH	HC	OH	HC	Combined (OH + HC)			
No.	Description	Description										
1	Contractor	SubTotal		6.52	1.81	0.00	2.39	2.70	6.52	1.81	5.10	13.42
2	Subcontractor	SubTotal		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	Retailer	SubTotal		0.00	0.86	0.00	2.34	2.98	0.00	0.86	5.31	6.17
4	Wholesaler	SubTotal		0.00	0.37	0.00	1.15	1.80	0.00	0.37	2.95	3.33
5	Mfg Finished Product	SubTotal		0.00	0.16	0.62	1.42	2.01	0.00	0.78	3.43	4.21
6	Mfg Assembly Parts	SubTotal		0.00	0.05	0.15	0.50	0.72	0.00	0.20	1.23	1.43
7	Mfg Intermediate Parts	SubTotal		0.00	0.02	0.04	0.20	0.30	0.00	0.06	0.50	0.56
8	Mfg Beginning Parts	SubTotal		0.00	0.01	0.03	0.10	0.14	0.00	0.04	0.24	0.28
9	Mining Raw Materials	SubTotal		0.00	0.01	0.01	0.07	0.07	0.00	0.02	0.14	0.16
10	Mining Explor. & Dev.	SubTotal		0.00	0.00	0.01	0.01	0.02	0.00	0.01	0.03	0.04
		Total		6.52	3.28	0.86	8.18	10.76	6.52	4.15	18.94	29.60
Level												
1-2	Project			6.52	1.81	0.00	2.39	2.70	6.52	1.81	5.10	13.42
3-4	Sales			0.00	1.23	0.00	3.48	4.78	0.00	1.23	8.26	9.50
5-8	Manufacturing			0.00	0.24	0.84	2.22	3.18	0.00	1.08	5.40	6.48
9-10	Mining			0.00	0.01	0.02	0.08	0.09	0.00	0.03	0.17	0.20
		Total		6.52	3.28	0.86	8.18	10.76	6.52	4.15	18.94	29.60

Figure 4-1. Insulation jobs by money source, contractor self-performs all work

Jobs by Sector			Job Totals						Job Totals			Job Totals
			Direct		Indirect		Induced		Direct	Indirect	Induced	
Level			OH	HC	OH	HC	OH	HC	Combined (OH + HC)			
No.	Description	Description										
1	Contractor	SubTotal		6.52	1.81	0.00	1.37	1.02	6.52	1.81	2.39	10.71
2	Subcontractor	SubTotal		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	Retailer	SubTotal		0.00	0.86	0.00	3.32	4.67	0.00	0.86	7.98	8.84
4	Wholesaler	SubTotal		0.00	0.37	0.00	1.54	2.08	0.00	0.37	3.62	3.99
5	Mfg Finished Product	SubTotal		0.00	0.16	0.62	1.13	1.64	0.00	0.78	2.77	3.54
6	Mfg Assembly Parts	SubTotal		0.00	0.05	0.15	0.46	0.78	0.00	0.20	1.24	1.44
7	Mfg Intermediate Parts	SubTotal		0.00	0.02	0.04	0.20	0.33	0.00	0.06	0.53	0.59
8	Mfg Beginning Parts	SubTotal		0.00	0.01	0.03	0.09	0.14	0.00	0.04	0.24	0.28
9	Mining Raw Materials	SubTotal		0.00	0.01	0.01	0.06	0.08	0.00	0.02	0.14	0.16
10	Mining Explor. & Dev.	SubTotal		0.00	0.00	0.01	0.01	0.03	0.00	0.01	0.04	0.05
		Total		6.52	3.28	0.86	8.18	10.76	6.52	4.15	18.94	29.60
Level												
1-2	Project			6.52	1.81	0.00	1.37	1.02	6.52	1.81	2.39	10.71
3-4	Sales			0.00	1.23	0.00	4.86	6.75	0.00	1.23	11.60	12.84
5-8	Manufacturing			0.00	0.24	0.84	1.87	2.89	0.00	1.08	4.76	5.84
9-10	Mining			0.00	0.01	0.02	0.08	0.10	0.00	0.03	0.18	0.21
		Total		6.52	3.28	0.86	8.18	10.76	6.52	4.15	18.94	29.60

Figure 4-2. Insulation jobs by sector, contractor self-performs all work

Pass Thru No.	Job Totals						Job Totals			Job Totals
	Direct		Indirect		Induced		Direct	Indirect	Induced	
	OH	HC	OH	HC	OH	HC	Combined (OH + HC)			
1		6.52	3.28	0.86	1.16	0.83	6.52	4.15	1.99	12.65
2					1.10	1.74	0.00	0.00	2.85	2.85
3					0.89	1.17	0.00	0.00	2.05	2.05
4					0.77	1.10	0.00	0.00	1.87	1.87
5					0.65	0.89	0.00	0.00	1.54	1.54
6					0.55	0.77	0.00	0.00	1.32	1.32
7					0.47	0.65	0.00	0.00	1.12	1.12
8					0.40	0.55	0.00	0.00	0.95	0.95
9					0.34	0.47	0.00	0.00	0.81	0.81
10					0.29	0.40	0.00	0.00	0.68	0.68
11					0.24	0.34	0.00	0.00	0.58	0.58
12					0.21	0.29	0.00	0.00	0.49	0.49
13					0.17	0.24	0.00	0.00	0.42	0.42
14					0.15	0.21	0.00	0.00	0.35	0.35
15					0.13	0.17	0.00	0.00	0.30	0.30
16					0.11	0.15	0.00	0.00	0.25	0.25
17					0.09	0.13	0.00	0.00	0.22	0.22
18					0.08	0.11	0.00	0.00	0.18	0.18
19					0.07	0.09	0.00	0.00	0.16	0.16
20					0.06	0.08	0.00	0.00	0.13	0.13
21					0.05	0.07	0.00	0.00	0.11	0.11
22					0.04	0.06	0.00	0.00	0.10	0.10
23					0.03	0.05	0.00	0.00	0.08	0.08
24					0.03	0.04	0.00	0.00	0.07	0.07
25					0.02	0.03	0.00	0.00	0.06	0.06
26					0.02	0.03	0.00	0.00	0.05	0.05
27					0.02	0.02	0.00	0.00	0.04	0.04
28					0.01	0.02	0.00	0.00	0.04	0.04
29					0.01	0.02	0.00	0.00	0.03	0.03
30					0.01	0.01	0.00	0.00	0.03	0.03
31					0.01	0.01	0.00	0.00	0.02	0.02
32					0.01	0.01	0.00	0.00	0.02	0.02
33					0.01	0.01	0.00	0.00	0.02	0.02
34					0.01	0.01	0.00	0.00	0.01	0.01
35					0.00	0.01	0.00	0.00	0.01	0.01
		6.52	3.28	0.86	8.18	10.76	6.52	4.15	18.94	29.60

Figure 4-3. Insulation jobs by pass thru, contractor self-performs all work

Jobs by Money Source			Job Totals						Job Totals			Job Totals
			Direct		Indirect		Induced		Direct	Indirect	Induced	
Level			OH	HC	OH	HC	OH	HC	Combined (OH + HC)			
No.	Description	Description										
1	Contractor	SubTotal		0.00	0.82	0.00	0.00	0.00	0.00	0.82	0.00	0.82
2	Subcontractor	SubTotal		9.34	1.60	0.00	2.19	2.86	9.34	1.60	5.05	16.00
3	Retailer	SubTotal		0.00	0.72	0.00	2.07	2.61	0.00	0.72	4.68	5.40
4	Wholesaler	SubTotal		0.00	0.31	0.00	1.01	1.57	0.00	0.31	2.58	2.90
5	Mfg Finished Product	SubTotal		0.00	0.13	0.52	1.22	1.68	0.00	0.65	2.89	3.55
6	Mfg Assembly Parts	SubTotal		0.00	0.04	0.13	0.44	0.62	0.00	0.17	1.06	1.23
7	Mfg Intermediate Parts	SubTotal		0.00	0.01	0.04	0.18	0.26	0.00	0.05	0.43	0.48
8	Mfg Beginning Parts	SubTotal		0.00	0.01	0.02	0.08	0.12	0.00	0.03	0.20	0.24
9	Mining Raw Materials	SubTotal		0.00	0.01	0.01	0.06	0.06	0.00	0.02	0.12	0.14
10	Mining Explor. & Dev.	SubTotal		0.00	0.00	0.01	0.01	0.02	0.00	0.01	0.03	0.04
		Total		9.34	3.67	0.72	7.26	9.79	9.34	4.39	17.05	30.78
Level												
1-2	Project			9.34	2.43	0.00	2.19	2.86	9.34	2.43	5.05	16.82
3-4	Sales			0.00	1.03	0.00	3.08	4.18	0.00	1.03	7.26	8.30
5-8	Manufacturing			0.00	0.20	0.71	1.91	2.67	0.00	0.90	4.59	5.49
9-10	Mining			0.00	0.01	0.02	0.07	0.08	0.00	0.02	0.15	0.17
		Total		9.34	3.67	0.72	7.26	9.79	9.34	4.39	17.05	30.78

Figure 4-4. Insulation jobs by money source, contractor subcontracts all work

Jobs by Sector			Job Totals						Job Totals			Job Totals
			Direct		Indirect		Induced		Direct	Indirect	Induced	
Level			OH	HC	OH	HC	OH	HC	Combined (OH + HC)			
No.	Description	Description										
1	Contractor	SubTotal		0.00	0.82	0.00	0.00	0.00	0.00	0.82	0.00	0.82
2	Subcontractor	SubTotal		9.34	1.60	0.00	1.18	1.06	9.34	1.60	2.24	13.18
3	Retailer	SubTotal		0.00	0.72	0.00	2.97	4.21	0.00	0.72	7.18	7.90
4	Wholesaler	SubTotal		0.00	0.31	0.00	1.38	1.87	0.00	0.31	3.25	3.57
5	Mfg Finished Product	SubTotal		0.00	0.13	0.52	0.99	1.45	0.00	0.65	2.44	3.09
6	Mfg Assembly Parts	SubTotal		0.00	0.04	0.13	0.41	0.70	0.00	0.17	1.10	1.27
7	Mfg Intermediate Parts	SubTotal		0.00	0.01	0.04	0.17	0.29	0.00	0.05	0.47	0.52
8	Mfg Beginning Parts	SubTotal		0.00	0.01	0.02	0.08	0.13	0.00	0.03	0.21	0.24
9	Mining Raw Materials	SubTotal		0.00	0.01	0.01	0.06	0.07	0.00	0.02	0.12	0.14
10	Mining Explor. & Dev.	SubTotal		0.00	0.00	0.01	0.01	0.02	0.00	0.01	0.03	0.04
		Total		9.34	3.67	0.72	7.26	9.79	9.34	4.39	17.05	30.78
Level												
1-2	Project			9.34	2.43	0.00	1.18	1.06	9.34	2.43	2.24	14.00
3-4	Sales			0.00	1.03	0.00	4.35	6.08	0.00	1.03	10.43	11.47
5-8	Manufacturing			0.00	0.20	0.71	1.65	2.57	0.00	0.90	4.22	5.12
9-10	Mining			0.00	0.01	0.02	0.07	0.09	0.00	0.02	0.16	0.18
		Total		9.34	3.67	0.72	7.26	9.79	9.34	4.39	17.05	30.78

Figure 4-5. Insulation jobs by sector, contractor subcontracts all work

Pass Thru No.	Job Totals						Job Totals			Job Totals
	Direct		Indirect		Induced		Direct	Indirect	Induced	
	OH	HC	OH	HC	OH	HC	Combined (OH + HC)			
1		9.34	3.67	0.72	0.98	0.84	9.34	4.39	1.83	15.56
2					0.98	1.63	0.00	0.00	2.61	2.61
3					0.79	1.03	0.00	0.00	1.82	1.82
4					0.69	0.99	0.00	0.00	1.68	1.68
5					0.58	0.80	0.00	0.00	1.38	1.38
6					0.49	0.69	0.00	0.00	1.18	1.18
7					0.42	0.58	0.00	0.00	1.00	1.00
8					0.35	0.49	0.00	0.00	0.85	0.85
9					0.30	0.42	0.00	0.00	0.72	0.72
10					0.26	0.36	0.00	0.00	0.61	0.61
11					0.22	0.30	0.00	0.00	0.52	0.52
12					0.18	0.26	0.00	0.00	0.44	0.44
13					0.16	0.22	0.00	0.00	0.37	0.37
14					0.13	0.18	0.00	0.00	0.32	0.32
15					0.11	0.16	0.00	0.00	0.27	0.27
16					0.10	0.13	0.00	0.00	0.23	0.23
17					0.08	0.11	0.00	0.00	0.19	0.19
18					0.07	0.10	0.00	0.00	0.16	0.16
19					0.06	0.08	0.00	0.00	0.14	0.14
20					0.05	0.07	0.00	0.00	0.12	0.12
21					0.04	0.06	0.00	0.00	0.10	0.10
22					0.04	0.05	0.00	0.00	0.09	0.09
23					0.03	0.04	0.00	0.00	0.07	0.07
24					0.03	0.04	0.00	0.00	0.06	0.06
25					0.02	0.03	0.00	0.00	0.05	0.05
26					0.02	0.03	0.00	0.00	0.04	0.04
27					0.02	0.02	0.00	0.00	0.04	0.04
28					0.01	0.02	0.00	0.00	0.03	0.03
29					0.01	0.02	0.00	0.00	0.03	0.03
30					0.01	0.01	0.00	0.00	0.02	0.02
31					0.01	0.01	0.00	0.00	0.02	0.02
32					0.01	0.01	0.00	0.00	0.02	0.02
33					0.01	0.01	0.00	0.00	0.01	0.01
34					0.00	0.01	0.00	0.00	0.01	0.01
35					0.00	0.01	0.00	0.00	0.01	0.01
		9.34	3.67	0.72	7.26	9.79	9.34	4.39	17.05	30.78

Figure 4-6. Insulation jobs by pass thru, contractor subcontracts all work

Jobs by Money Source			Job Totals						Job Totals			Job Totals
			Direct		Indirect		Induced		Direct	Indirect	Induced	
Level			OH	HC	OH	HC	OH	HC	Combined (OH + HC)			
No.	Description	Description										
1	Contractor	SubTotal		6.52	1.81	0.00	2.41	2.73	6.52	1.81	5.14	13.46
2	Subcontractor	SubTotal		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	Retailer	SubTotal		0.00	0.86	0.00	2.27	2.88	0.00	0.86	5.15	6.01
4	Wholesaler	SubTotal		0.00	0.38	0.00	1.03	1.72	0.00	0.38	2.75	3.13
5	Mfg Finished Product	SubTotal		0.00	0.30	0.80	1.00	1.43	0.00	1.09	2.44	3.53
6	Mfg Assembly Parts	SubTotal		0.00	0.08	0.20	0.55	0.79	0.00	0.28	1.33	1.61
7	Mfg Intermediate Parts	SubTotal		0.00	0.04	0.08	0.29	0.40	0.00	0.13	0.68	0.81
8	Mfg Beginning Parts	SubTotal		0.00	0.03	0.04	0.15	0.19	0.00	0.07	0.34	0.41
9	Mining Raw Materials	SubTotal		0.00	0.01	0.02	0.10	0.11	0.00	0.04	0.21	0.24
10	Mining Explor. & Dev.	SubTotal		0.00	0.00	0.01	0.02	0.02	0.00	0.01	0.04	0.05
		Total		6.52	3.50	1.16	7.81	10.27	6.52	4.66	18.08	29.25
Level												
1-2	Project			6.52	1.81	0.00	2.41	2.73	6.52	1.81	5.14	13.46
3-4	Sales			0.00	1.24	0.00	3.30	4.60	0.00	1.24	7.90	9.14
5-8	Manufacturing			0.00	0.44	1.12	1.98	2.81	0.00	1.56	4.79	6.36
9-10	Mining			0.00	0.02	0.03	0.11	0.13	0.00	0.05	0.25	0.30
		Total		6.52	3.50	1.16	7.81	10.27	6.52	4.66	18.08	29.25

Figure 4-7. Openings jobs by money source, contractor self-performs all work

Jobs by Sector			Job Totals						Job Totals			Job Totals
			Direct		Indirect		Induced		Direct	Indirect	Induced	
Level			OH	HC	OH	HC	OH	HC	Combined (OH + HC)			
No.	Description	Description										
1	Contractor	SubTotal		6.52	1.81	0.00	1.39	1.02	6.52	1.81	2.41	10.73
2	Subcontractor	SubTotal		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	Retailer	SubTotal		0.00	0.86	0.00	3.19	4.47	0.00	0.86	7.66	8.52
4	Wholesaler	SubTotal		0.00	0.38	0.00	1.42	1.98	0.00	0.38	3.40	3.78
5	Mfg Finished Product	SubTotal		0.00	0.30	0.80	0.88	1.39	0.00	1.09	2.27	3.36
6	Mfg Assembly Parts	SubTotal		0.00	0.08	0.20	0.47	0.78	0.00	0.28	1.25	1.53
7	Mfg Intermediate Parts	SubTotal		0.00	0.04	0.08	0.24	0.36	0.00	0.13	0.60	0.72
8	Mfg Beginning Parts	SubTotal		0.00	0.03	0.04	0.12	0.16	0.00	0.07	0.28	0.35
9	Mining Raw Materials	SubTotal		0.00	0.01	0.02	0.08	0.09	0.00	0.04	0.17	0.21
10	Mining Explor. & Dev.	SubTotal		0.00	0.00	0.01	0.01	0.03	0.00	0.01	0.04	0.05
		Total		6.52	3.50	1.16	7.81	10.27	6.52	4.66	18.08	29.25
Level												
1-2	Project			6.52	1.81	0.00	1.39	1.02	6.52	1.81	2.41	10.73
3-4	Sales			0.00	1.24	0.00	4.62	6.45	0.00	1.24	11.06	12.30
5-8	Manufacturing			0.00	0.44	1.12	1.71	2.69	0.00	1.56	4.40	5.96
9-10	Mining			0.00	0.02	0.03	0.09	0.11	0.00	0.05	0.21	0.26
		Total		6.52	3.50	1.16	7.81	10.27	6.52	4.66	18.08	29.25

Figure 4-8. Openings jobs by sector, contractor self-performs all work

Pass Thru No.	Job Totals						Job Totals			Job Totals
	Direct		Indirect		Induced		Direct	Indirect	Induced	
	OH	HC	OH	HC	OH	HC	Combined (OH + HC)			
1		6.52	3.50	1.16	1.11	0.78	6.52	4.66	1.89	13.06
2					1.05	1.67	0.00	0.00	2.72	2.72
3					0.85	1.11	0.00	0.00	1.96	1.96
4					0.73	1.05	0.00	0.00	1.78	1.78
5					0.62	0.85	0.00	0.00	1.47	1.47
6					0.53	0.74	0.00	0.00	1.26	1.26
7					0.45	0.62	0.00	0.00	1.07	1.07
8					0.38	0.53	0.00	0.00	0.91	0.91
9					0.32	0.45	0.00	0.00	0.77	0.77
10					0.27	0.38	0.00	0.00	0.65	0.65
11					0.23	0.32	0.00	0.00	0.55	0.55
12					0.20	0.27	0.00	0.00	0.47	0.47
13					0.17	0.23	0.00	0.00	0.40	0.40
14					0.14	0.20	0.00	0.00	0.34	0.34
15					0.12	0.17	0.00	0.00	0.29	0.29
16					0.10	0.14	0.00	0.00	0.24	0.24
17					0.09	0.12	0.00	0.00	0.21	0.21
18					0.07	0.10	0.00	0.00	0.18	0.18
19					0.06	0.09	0.00	0.00	0.15	0.15
20					0.05	0.07	0.00	0.00	0.13	0.13
21					0.04	0.06	0.00	0.00	0.11	0.11
22					0.04	0.05	0.00	0.00	0.09	0.09
23					0.03	0.04	0.00	0.00	0.08	0.08
24					0.03	0.04	0.00	0.00	0.07	0.07
25					0.02	0.03	0.00	0.00	0.06	0.06
26					0.02	0.03	0.00	0.00	0.05	0.05
27					0.02	0.02	0.00	0.00	0.04	0.04
28					0.01	0.02	0.00	0.00	0.03	0.03
29					0.01	0.02	0.00	0.00	0.03	0.03
30					0.01	0.01	0.00	0.00	0.02	0.02
31					0.01	0.01	0.00	0.00	0.02	0.02
32					0.01	0.01	0.00	0.00	0.02	0.02
33					0.01	0.01	0.00	0.00	0.01	0.01
34					0.01	0.01	0.00	0.00	0.01	0.01
35					0.00	0.01	0.00	0.00	0.01	0.01
		6.52	3.50	1.16	7.81	10.27	6.52	4.66	18.08	29.25

Figure 4-9. Openings jobs by pass thru, contractor self-performs all work

Jobs by Money Source			Job Totals						Job Totals			Job Totals
			Direct		Indirect		Induced		Direct	Indirect	Induced	
Level			OH	HC	OH	HC	OH	HC	Combined (OH + HC)			
No.	Description	Description										
1	Contractor	SubTotal		0.00	0.82	0.00	0.00	0.00	0.00	0.82	0.00	0.82
2	Subcontractor	SubTotal		6.52	1.42	0.00	3.01	3.88	6.52	1.42	6.89	14.83
3	Retailer	SubTotal		0.00	0.77	0.00	2.36	2.99	0.00	0.77	5.35	6.12
4	Wholesaler	SubTotal		0.00	0.34	0.00	1.07	1.78	0.00	0.34	2.85	3.19
5	Mfg Finished Product	SubTotal		0.00	0.27	0.71	0.99	1.41	0.00	0.98	2.41	3.39
6	Mfg Assembly Parts	SubTotal		0.00	0.07	0.18	0.54	0.77	0.00	0.25	1.30	1.55
7	Mfg Intermediate Parts	SubTotal		0.00	0.04	0.07	0.28	0.37	0.00	0.11	0.65	0.76
8	Mfg Beginning Parts	SubTotal		0.00	0.02	0.04	0.14	0.18	0.00	0.06	0.32	0.38
9	Mining Raw Materials	SubTotal		0.00	0.01	0.02	0.09	0.10	0.00	0.03	0.19	0.22
10	Mining Explor. & Dev.	SubTotal		0.00	0.00	0.01	0.02	0.02	0.00	0.01	0.04	0.05
		Total		6.52	3.76	1.04	8.49	11.50	6.52	4.80	19.99	31.31
Level												
1-2	Project			6.52	2.24	0.00	3.01	3.88	6.52	2.24	6.89	15.65
3-4	Sales			0.00	1.11	0.00	3.44	4.77	0.00	1.11	8.20	9.31
5-8	Manufacturing			0.00	0.39	1.01	1.94	2.73	0.00	1.40	4.68	6.08
9-10	Mining			0.00	0.02	0.03	0.11	0.12	0.00	0.04	0.23	0.27
		Total		6.52	3.76	1.04	8.49	11.50	6.52	4.80	19.99	31.31

Figure 4-10. Openings jobs by money source, contractor subcontracts all work

Jobs by Sector			Job Totals						Job Totals			Job Totals
			Direct		Indirect		Induced		Direct	Indirect	Induced	
Level			OH	HC	OH	HC	OH	HC	Combined (OH + HC)			
No.	Description	Description										
1	Contractor	SubTotal		0.00	0.82	0.00	0.00	0.00	0.00	0.82	0.00	0.82
2	Subcontractor	SubTotal		6.52	1.42	0.00	1.66	1.46	6.52	1.42	3.11	11.05
3	Retailer	SubTotal		0.00	0.77	0.00	3.44	4.91	0.00	0.77	8.35	9.12
4	Wholesaler	SubTotal		0.00	0.34	0.00	1.54	2.16	0.00	0.34	3.70	4.04
5	Mfg Finished Product	SubTotal		0.00	0.27	0.71	0.91	1.48	0.00	0.98	2.39	3.37
6	Mfg Assembly Parts	SubTotal		0.00	0.07	0.18	0.49	0.83	0.00	0.25	1.32	1.57
7	Mfg Intermediate Parts	SubTotal		0.00	0.04	0.07	0.25	0.37	0.00	0.11	0.62	0.73
8	Mfg Beginning Parts	SubTotal		0.00	0.02	0.04	0.12	0.17	0.00	0.06	0.29	0.35
9	Mining Raw Materials	SubTotal		0.00	0.01	0.02	0.08	0.09	0.00	0.03	0.17	0.20
10	Mining Explor. & Dev.	SubTotal		0.00	0.00	0.01	0.01	0.03	0.00	0.01	0.04	0.05
		Total		6.52	3.76	1.04	8.49	11.50	6.52	4.80	19.99	31.31
Level												
1-2	Project			6.52	2.24	0.00	1.66	1.46	6.52	2.24	3.11	11.88
3-4	Sales			0.00	1.11	0.00	4.98	7.07	0.00	1.11	12.05	13.16
5-8	Manufacturing			0.00	0.39	1.01	1.76	2.85	0.00	1.40	4.62	6.02
9-10	Mining			0.00	0.02	0.03	0.10	0.12	0.00	0.04	0.21	0.26
		Total		6.52	3.76	1.04	8.49	11.50	6.52	4.80	19.99	31.31

Figure 4-11. Openings jobs by sector, contractor subcontracts all work

Pass Thru No.	Job Totals						Job Totals			Job Totals
	Direct		Indirect		Induced		Direct	Indirect	Induced	
	OH	HC	OH	HC	OH	HC	Combined (OH + HC)			
1		6.52	3.76	1.04	1.14	1.01	6.52	4.80	2.15	13.47
2					1.15	1.91	0.00	0.00	3.07	3.07
3					0.93	1.21	0.00	0.00	2.14	2.14
4					0.81	1.16	0.00	0.00	1.96	1.96
5					0.68	0.94	0.00	0.00	1.61	1.61
6					0.58	0.81	0.00	0.00	1.39	1.39
7					0.49	0.68	0.00	0.00	1.17	1.17
8					0.42	0.58	0.00	0.00	1.00	1.00
9					0.35	0.49	0.00	0.00	0.84	0.84
10					0.30	0.42	0.00	0.00	0.72	0.72
11					0.25	0.35	0.00	0.00	0.61	0.61
12					0.22	0.30	0.00	0.00	0.52	0.52
13					0.18	0.25	0.00	0.00	0.44	0.44
14					0.16	0.22	0.00	0.00	0.37	0.37
15					0.13	0.18	0.00	0.00	0.32	0.32
16					0.11	0.16	0.00	0.00	0.27	0.27
17					0.09	0.13	0.00	0.00	0.23	0.23
18					0.08	0.11	0.00	0.00	0.19	0.19
19					0.07	0.10	0.00	0.00	0.16	0.16
20					0.06	0.08	0.00	0.00	0.14	0.14
21					0.05	0.07	0.00	0.00	0.12	0.12
22					0.04	0.06	0.00	0.00	0.10	0.10
23					0.04	0.05	0.00	0.00	0.08	0.08
24					0.03	0.04	0.00	0.00	0.07	0.07
25					0.03	0.04	0.00	0.00	0.06	0.06
26					0.02	0.03	0.00	0.00	0.05	0.05
27					0.02	0.03	0.00	0.00	0.04	0.04
28					0.02	0.02	0.00	0.00	0.04	0.04
29					0.01	0.02	0.00	0.00	0.03	0.03
30					0.01	0.02	0.00	0.00	0.03	0.03
31					0.01	0.01	0.00	0.00	0.02	0.02
32					0.01	0.01	0.00	0.00	0.02	0.02
33					0.01	0.01	0.00	0.00	0.02	0.02
34					0.01	0.01	0.00	0.00	0.01	0.01
35					0.00	0.01	0.00	0.00	0.01	0.01
		6.52	3.76	1.04	8.49	11.50	6.52	4.80	19.99	31.31

Figure 4-12. Openings jobs by pass thru, contractor subcontracts all work

Jobs by Money Source			Job Totals						Job Totals			Job Totals
			Direct		Indirect		Induced		Direct	Indirect	Induced	
Level			OH	HC	OH	HC	OH	HC	Combined (OH + HC)			
No.	Description	Description										
1	Contractor	SubTotal		6.52	1.81	0.00	2.40	2.69	6.52	1.81	5.08	13.41
2	Subcontractor	SubTotal		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	Retailer	SubTotal		0.00	0.86	0.00	2.26	2.85	0.00	0.86	5.11	5.97
4	Wholesaler	SubTotal		0.00	0.53	0.00	1.14	1.84	0.00	0.53	2.98	3.52
5	Mfg Finished Product	SubTotal		0.00	0.18	0.48	0.93	1.44	0.00	0.66	2.36	3.03
6	Mfg Assembly Parts	SubTotal		0.00	0.10	0.28	0.49	0.72	0.00	0.38	1.21	1.59
7	Mfg Intermediate Parts	SubTotal		0.00	0.04	0.11	0.28	0.39	0.00	0.16	0.67	0.83
8	Mfg Beginning Parts	SubTotal		0.00	0.03	0.06	0.14	0.20	0.00	0.08	0.34	0.42
9	Mining Raw Materials	SubTotal		0.00	0.03	0.04	0.10	0.08	0.00	0.07	0.18	0.25
10	Mining Explor. & Dev.	SubTotal		0.00	0.00	0.01	0.02	0.02	0.00	0.01	0.04	0.05
		Total		6.52	3.58	0.98	7.75	10.23	6.52	4.56	17.98	29.06
Level												
1-2	Project			6.52	1.81	0.00	2.40	2.69	6.52	1.81	5.08	13.41
3-4	Sales			0.00	1.39	0.00	3.40	4.70	0.00	1.39	8.09	9.48
5-8	Manufacturing			0.00	0.35	0.93	1.84	2.74	0.00	1.28	4.58	5.87
9-10	Mining			0.00	0.03	0.05	0.12	0.10	0.00	0.08	0.22	0.30
		Total		6.52	3.58	0.98	7.75	10.23	6.52	4.56	17.98	29.06

Figure 4-13. HVAC systems jobs by money source, contractor self-performs all work

Jobs by Sector			Job Totals						Job Totals			Job Totals
			Direct		Indirect		Induced		Direct	Indirect	Induced	
Level			OH	HC	OH	HC	OH	HC	Combined (OH + HC)			
No.	Description	Description										
1	Contractor	SubTotal		6.52	1.81	0.00	1.38	1.02	6.52	1.81	2.40	10.72
2	Subcontractor	SubTotal		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	Retailer	SubTotal		0.00	0.86	0.00	3.18	4.45	0.00	0.86	7.62	8.48
4	Wholesaler	SubTotal		0.00	0.53	0.00	1.48	2.02	0.00	0.53	3.50	4.03
5	Mfg Finished Product	SubTotal		0.00	0.18	0.48	0.82	1.38	0.00	0.66	2.20	2.86
6	Mfg Assembly Parts	SubTotal		0.00	0.10	0.28	0.44	0.75	0.00	0.38	1.19	1.57
7	Mfg Intermediate Parts	SubTotal		0.00	0.04	0.11	0.24	0.35	0.00	0.16	0.59	0.74
8	Mfg Beginning Parts	SubTotal		0.00	0.03	0.06	0.12	0.16	0.00	0.08	0.28	0.36
9	Mining Raw Materials	SubTotal		0.00	0.03	0.04	0.09	0.08	0.00	0.07	0.17	0.24
10	Mining Explor. & Dev.	SubTotal		0.00	0.00	0.01	0.01	0.03	0.00	0.01	0.04	0.05
		Total		6.52	3.58	0.98	7.75	10.23	6.52	4.56	17.98	29.06
Level												
1-2	Project			6.52	1.81	0.00	1.38	1.02	6.52	1.81	2.40	10.72
3-4	Sales			0.00	1.39	0.00	4.66	6.46	0.00	1.39	11.12	12.51
5-8	Manufacturing			0.00	0.35	0.93	1.61	2.64	0.00	1.28	4.25	5.53
9-10	Mining			0.00	0.03	0.05	0.10	0.11	0.00	0.08	0.21	0.29
		Total		6.52	3.58	0.98	7.75	10.23	6.52	4.56	17.98	29.06

Figure 4-14. HVAC systems jobs by sector, contractor self-performs all work

Pass Thru No.	Job Totals						Job Totals			Job Totals
	Direct		Indirect		Induced		Direct	Indirect	Induced	
	OH	HC	OH	HC	OH	HC	Combined (OH + HC)			
1		6.52	3.58	0.98	1.10	0.80	6.52	4.56	1.89	12.97
2					1.04	1.67	0.00	0.00	2.71	2.71
3					0.84	1.10	0.00	0.00	1.95	1.95
4					0.73	1.04	0.00	0.00	1.77	1.77
5					0.61	0.85	0.00	0.00	1.46	1.46
6					0.52	0.73	0.00	0.00	1.25	1.25
7					0.44	0.62	0.00	0.00	1.06	1.06
8					0.38	0.52	0.00	0.00	0.90	0.90
9					0.32	0.44	0.00	0.00	0.76	0.76
10					0.27	0.38	0.00	0.00	0.65	0.65
11					0.23	0.32	0.00	0.00	0.55	0.55
12					0.19	0.27	0.00	0.00	0.47	0.47
13					0.17	0.23	0.00	0.00	0.40	0.40
14					0.14	0.20	0.00	0.00	0.34	0.34
15					0.12	0.17	0.00	0.00	0.28	0.28
16					0.10	0.14	0.00	0.00	0.24	0.24
17					0.09	0.12	0.00	0.00	0.21	0.21
18					0.07	0.10	0.00	0.00	0.17	0.17
19					0.06	0.09	0.00	0.00	0.15	0.15
20					0.05	0.07	0.00	0.00	0.13	0.13
21					0.04	0.06	0.00	0.00	0.11	0.11
22					0.04	0.05	0.00	0.00	0.09	0.09
23					0.03	0.04	0.00	0.00	0.08	0.08
24					0.03	0.04	0.00	0.00	0.06	0.06
25					0.02	0.03	0.00	0.00	0.06	0.06
26					0.02	0.03	0.00	0.00	0.05	0.05
27					0.02	0.02	0.00	0.00	0.04	0.04
28					0.01	0.02	0.00	0.00	0.03	0.03
29					0.01	0.02	0.00	0.00	0.03	0.03
30					0.01	0.01	0.00	0.00	0.02	0.02
31					0.01	0.01	0.00	0.00	0.02	0.02
32					0.01	0.01	0.00	0.00	0.02	0.02
33					0.01	0.01	0.00	0.00	0.01	0.01
34					0.01	0.01	0.00	0.00	0.01	0.01
35					0.00	0.01	0.00	0.00	0.01	0.01
		6.52	3.58	0.98	7.75	10.23	6.52	4.56	17.98	29.06

Figure 4-15. HVAC systems jobs by pass thru, contractor self-performs all work

Jobs by Money Source			Job Totals						Job Totals			Job Totals
			Direct		Indirect		Induced		Direct	Indirect	Induced	
Level			OH	HC	OH	HC	OH	HC	Combined (OH + HC)			
No.	Description	Description										
1	Contractor	SubTotal		0.00	0.82	0.00	0.00	0.00	0.00	0.82	0.00	0.82
2	Subcontractor	SubTotal		5.95	1.62	0.00	1.83	1.65	5.95	1.62	3.49	11.05
3	Retailer	SubTotal		0.00	0.92	0.00	2.30	2.95	0.00	0.92	5.25	6.17
4	Wholesaler	SubTotal		0.00	0.57	0.00	1.19	1.94	0.00	0.57	3.13	3.70
5	Mfg Finished Product	SubTotal		0.00	0.20	0.52	1.00	1.58	0.00	0.71	2.58	3.29
6	Mfg Assembly Parts	SubTotal		0.00	0.11	0.30	0.53	0.78	0.00	0.41	1.30	1.72
7	Mfg Intermediate Parts	SubTotal		0.00	0.05	0.12	0.31	0.44	0.00	0.17	0.75	0.92
8	Mfg Beginning Parts	SubTotal		0.00	0.03	0.06	0.16	0.22	0.00	0.09	0.38	0.47
9	Mining Raw Materials	SubTotal		0.00	0.03	0.04	0.11	0.09	0.00	0.07	0.20	0.27
10	Mining Explor. & Dev.	SubTotal		0.00	0.00	0.01	0.02	0.02	0.00	0.01	0.04	0.06
		Total		5.95	4.35	1.05	7.45	9.68	5.95	5.39	17.13	28.47
Level												
1-2	Project			5.95	2.44	0.00	1.83	1.65	5.95	2.44	3.49	11.87
3-4	Sales			0.00	1.49	0.00	3.50	4.89	0.00	1.49	8.39	9.88
5-8	Manufacturing			0.00	0.38	1.00	2.00	3.02	0.00	1.38	5.01	6.39
9-10	Mining			0.00	0.04	0.05	0.13	0.12	0.00	0.09	0.24	0.33
		Total		5.95	4.35	1.05	7.45	9.68	5.95	5.39	17.13	28.47

Figure 4-16. HVAC systems jobs by money source, contractor subcontracts all work

Jobs by Sector			Job Totals						Job Totals			Job Totals
			Direct		Indirect		Induced		Direct	Indirect	Induced	
Level			OH	HC	OH	HC	OH	HC	Combined (OH + HC)			
No.	Description	Description										
1	Contractor	SubTotal		0.00	0.82	0.00	0.00	0.00	0.00	0.82	0.00	0.82
2	Subcontractor	SubTotal		5.95	1.62	0.00	1.09	0.65	5.95	1.62	1.73	9.30
3	Retailer	SubTotal		0.00	0.92	0.00	3.13	4.31	0.00	0.92	7.45	8.37
4	Wholesaler	SubTotal		0.00	0.57	0.00	1.47	1.97	0.00	0.57	3.44	4.01
5	Mfg Finished Product	SubTotal		0.00	0.20	0.52	0.84	1.37	0.00	0.71	2.21	2.92
6	Mfg Assembly Parts	SubTotal		0.00	0.11	0.30	0.45	0.75	0.00	0.41	1.20	1.61
7	Mfg Intermediate Parts	SubTotal		0.00	0.05	0.12	0.25	0.36	0.00	0.17	0.60	0.77
8	Mfg Beginning Parts	SubTotal		0.00	0.03	0.06	0.12	0.16	0.00	0.09	0.28	0.37
9	Mining Raw Materials	SubTotal		0.00	0.03	0.04	0.09	0.08	0.00	0.07	0.18	0.25
10	Mining Explor. & Dev.	SubTotal		0.00	0.00	0.01	0.01	0.03	0.00	0.01	0.04	0.05
		Total		5.95	4.35	1.05	7.45	9.68	5.95	5.39	17.13	28.47
Level												
1-2	Project			5.95	2.44	0.00	1.09	0.65	5.95	2.44	1.73	10.12
3-4	Sales			0.00	1.49	0.00	4.61	6.28	0.00	1.49	10.89	12.38
5-8	Manufacturing			0.00	0.38	1.00	1.65	2.64	0.00	1.38	4.30	5.67
9-10	Mining			0.00	0.04	0.05	0.11	0.11	0.00	0.09	0.22	0.30
		Total		5.95	4.35	1.05	7.45	9.68	5.95	5.39	17.13	28.47

Figure 4-17. HVAC systems jobs by sector, contractor subcontracts all work

Pass Thru No.	Job Totals						Job Totals			Job Totals
	Direct		Indirect		Induced		Direct	Indirect	Induced	
	OH	HC	OH	HC	OH	HC	Combined (OH + HC)			
1		5.95	4.35	1.05	1.07	0.64	5.95	5.39	1.71	13.05
2					1.00	1.60	0.00	0.00	2.60	2.60
3					0.81	1.06	0.00	0.00	1.86	1.86
4					0.70	1.00	0.00	0.00	1.70	1.70
5					0.59	0.81	0.00	0.00	1.40	1.40
6					0.50	0.70	0.00	0.00	1.20	1.20
7					0.42	0.59	0.00	0.00	1.02	1.02
8					0.36	0.50	0.00	0.00	0.86	0.86
9					0.31	0.43	0.00	0.00	0.73	0.73
10					0.26	0.36	0.00	0.00	0.62	0.62
11					0.22	0.31	0.00	0.00	0.53	0.53
12					0.19	0.26	0.00	0.00	0.45	0.45
13					0.16	0.22	0.00	0.00	0.38	0.38
14					0.13	0.19	0.00	0.00	0.32	0.32
15					0.11	0.16	0.00	0.00	0.27	0.27
16					0.10	0.13	0.00	0.00	0.23	0.23
17					0.08	0.11	0.00	0.00	0.20	0.20
18					0.07	0.10	0.00	0.00	0.17	0.17
19					0.06	0.08	0.00	0.00	0.14	0.14
20					0.05	0.07	0.00	0.00	0.12	0.12
21					0.04	0.06	0.00	0.00	0.10	0.10
22					0.04	0.05	0.00	0.00	0.09	0.09
23					0.03	0.04	0.00	0.00	0.07	0.07
24					0.03	0.04	0.00	0.00	0.06	0.06
25					0.02	0.03	0.00	0.00	0.05	0.05
26					0.02	0.03	0.00	0.00	0.04	0.04
27					0.02	0.02	0.00	0.00	0.04	0.04
28					0.01	0.02	0.00	0.00	0.03	0.03
29					0.01	0.02	0.00	0.00	0.03	0.03
30					0.01	0.01	0.00	0.00	0.02	0.02
31					0.01	0.01	0.00	0.00	0.02	0.02
32					0.01	0.01	0.00	0.00	0.02	0.02
33					0.01	0.01	0.00	0.00	0.01	0.01
34					0.01	0.01	0.00	0.00	0.01	0.01
35					0.00	0.01	0.00	0.00	0.01	0.01
		5.95	4.35	1.05	7.45	9.68	5.95	5.39	17.13	28.47

Figure 4-18. HVAC systems jobs by pass thru, contractor subcontracts all work

CHAPTER 5
ANALYSIS

This chapter will analyze the results of the model. First, the sample outputs will be analyzed. Second, the job factors for the major supply chain levels will be discussed. Third, the average wage rates for the supply chains will be calculated. Fourth, the time relationship between the investment and when jobs occur will be developed. Finally, the previous analyses will be brought together into an economic impact analysis.

Sample Outputs

In the previous chapter, sample outputs have been provided for three product categories: mineral wool insulation, glass doors/windows, and HVAC systems. The outputs are the numbers of jobs. The model has organized the jobs by money source or sector and has calculated by the method of contracting. Additionally, the jobs have been displayed in various formats and categories. The analysis considers all of these options.

Insulation

The analysis for mineral wool insulation includes Figures 5-1 through 5-10. Figures 5-1, 5-2, 5-3, 5-4, and 5-5 display the results when the contractor is self-performing all of the installation work. Figures 5-6, 5-7, 5-8, 5-9, and 5-10 display the results when the contractor is providing only management and coordination and subcontracting all of the installation work.

The job results displayed in Figure 5-1 are by the money source and in Figure 5-2 by the sector. Figure 5-3 combines Figures 5-1 and 5-2 into a single chart for easy comparison. More jobs occurred at level one by money source than by sector, 13.42 versus 10.71, respectively. The opposite happened at levels three and four. More jobs

occurred by sector than by money source. At level five the lead changed again. The explanation is based on how the jobs are organized. Jobs organized by money source attribute the jobs to the level spending the money, whereas the sector counts jobs at the level where the job is performed. Therefore, induced jobs are higher for the contractor and manufacturer of finished products because those levels provide more dollars being spent in the marketplace. Consequently, the sector jobs increased at the retailer and wholesaler levels due to the increased spending. Very little difference exists in the numbers of jobs from level six through ten. The chart indicates no jobs are created in level two of the supply chain because the contractor is self-performing all of the work.

The job results displayed in Figure 5-4 are by pass thru. Each pass thru represents an iteration of the economic turnover in the marketplace. Figure 5-5 presents the cumulative total as a percentage of the numbers of jobs being created for each pass thru. The figures show 12.65 jobs, which is 42.74%, are created in the first pass thru. Of the 12.65 jobs, the types of jobs (i.e. direct, indirect and induced) are about 51%, 33% and 16%, respectively. See Figure 4-3 in the previous chapter for details on the types of jobs. More than 90% of all jobs had been created by the twelfth pass thru, and over 95% of all jobs had been created by the sixteenth pass thru; however, all jobs created after the first pass thru are induced jobs. Direct and indirect jobs only occurred in the first pass thru, which is the EER supply chain. Induced jobs are EER supported.

The job results displayed in Figure 5-6 are by the money source and in Figure 5-7 by the sector. Figure 5-8 combines Figures 5-6 and 5-7 into a single chart for easy comparison. The chart indicates the same number of jobs, 0.82 for each method, have

been created in level one of the supply chain. These jobs represent the management provided by contractors to oversee the work performed by subcontractors. Level two had a sharp increase in the numbers of jobs because of subcontracting. More jobs occurred at level two by money source than by sector, 16.00 versus 13.18, respectively. The opposite happened at levels three and four. More jobs occurred by sector than by money source. At level five the lead changed again. The explanation is the same as before. The differences depend on how the jobs are organized. Jobs organized by money source attribute the jobs to the level spending the money, whereas the sector counts jobs at the level where the job is performed. Therefore, induced jobs are higher for the contractor and manufacturer of finished products because those levels provide more dollars being spent in the marketplace. Consequently, the sector jobs increase at the retailer and wholesaler levels due to the increased spending. Very little difference exists in the numbers of jobs from level six through ten.

The job results displayed in Figure 5-9 are by pass thru. Each pass thru represents an iteration of the economic turnover in the marketplace. Figure 5-10 presents the cumulative total as a percentage of the numbers of jobs being created for each pass thru. The figures show 15.56 jobs, which is 50.54%, are created in the first pass thru. Of the 15.56 jobs, the types of jobs (i.e. direct, indirect and induced) are about 60%, 28% and 12%, respectively. See Figure 4-6 in the previous chapter for details on the types of jobs. More than 90% of all jobs had been created by the eleventh pass thru, and over 95% of all jobs had been created by the fifteenth pass thru; however, all jobs created after the first pass thru are induced jobs. Direct and indirect

jobs only occurred in the first pass thru, which is the EER supply chain. Induced jobs are EER supported.

When the contractor has been self-performing or subcontracting the work, the numbers of jobs do not change regardless of the money source or sector. Of the total 29.60 jobs from the self-perform calculation method, the types of jobs (i.e. direct, indirect and induced) are about 22%, 14% and 64%, respectively, and the cost categories (i.e. overhead and hard cost) are about 39% and 61%, respectively. Of the total 30.78 jobs from the subcontracting calculation method, the types of jobs (i.e. direct, indirect and induced) are about 31%, 14% and 55%, respectively, and the cost categories (i.e. overhead and hard cost) are about 35% and 65%, respectively.

Openings

The analysis for glass doors/windows (i.e. openings) includes Figures 5-11 through 5-20. Figures 5-11, 5-12, 5-13, 5-14, and 5-15 display the results when the contractor is self-performing all of the installation work. Figures 5-16, 5-17, 5-18, 5-19, and 5-20 display the results when the contractor is providing only management and coordination and subcontracting all of the installation work.

The job results displayed in Figure 5-11 are by the money source and in Figure 5-12 by the sector. Figure 5-13 combines Figures 5-11 and 5-12 into a single chart for easy comparison. More jobs occurred at level one by money source than by sector, 13.46 versus 10.73, respectively. The opposite happened at levels three and four. More jobs occurred by sector than by money source. At level five the lead changed again. The explanation is based on how the jobs are organized. Jobs organized by money source attribute the jobs to the level spending the money, whereas the sector counts jobs at the level where the job is performed. Therefore, induced jobs are higher

for the contractor and manufacturer of finished products because those levels provided more dollars being spent in the marketplace. Consequently, the sector jobs increased at the retailer and wholesaler levels due to the increased spending. For levels six through nine, the money source indicated higher numbers than the sector. The explanation is based on the products being sold in those levels. Although much of the glass, aluminum extrusions and other products flow through the supply chain to become a door or window assembly, some of the assembly parts, intermediate parts, beginning parts and raw materials will be sold as parts or raw materials at the retailer and wholesaler level. At level ten, no difference exists in the numbers of jobs. The chart indicates no jobs are created in level two of the supply chain because the contractor is self-performing all of the work.

The job results displayed in Figure 5-14 are by pass thru. Each pass thru represents an iteration of the economic turnover in the marketplace. Figure 5-15 presents the cumulative total as a percentage of the numbers of jobs being created for each pass thru. The figures show 13.06 jobs, which is 44.66%, are created in the first pass thru. Of the 13.06 jobs, the types of jobs (i.e. direct, indirect and induced) are about 50%, 36% and 14%, respectively. See Figure 4-9 in the previous chapter for details on the types of jobs. More than 90% of all jobs had been created by the twelfth pass thru, and over 95% of all jobs had been created by the sixteenth pass thru; however, all jobs created after the first pass thru are induced jobs. Direct and indirect jobs only occurred in the first pass thru, which is the EER supply chain. Induced jobs are EER supported.

The job results displayed in Figure 5-16 are by the money source and in Figure 5-17 by the sector. Figure 5-18 combines Figures 5-16 and 5-17 into a single chart for easy comparison. The chart indicates the same number of jobs, 0.82 for each method, are created in level one of the supply chain. These jobs represent the management provided by contractors to oversee the work performed by subcontractors. Level two had a sharp increase in the numbers of jobs because of subcontracting. More jobs occurred at level two by money source than by sector, 14.83 versus 11.05, respectively. The opposite happened at levels three and four. More jobs occurred by sector than by money source. At level five the lead changed again. The explanation is the same as before. The difference depends on how the jobs are organized. Jobs organized by money source attribute the jobs to the level spending the money, whereas the sector counts jobs at the level where the job is performed. Therefore, induced jobs are higher for the contractor and manufacturer of finished products because those levels provide more dollars being spent in the marketplace. Consequently, the sector jobs increase at the retailer and wholesaler levels due to the increased spending. Level six had more jobs by sector than by money source. The explanation is the jobs by money source have been included in the sales levels. Levels seven through nine had higher numbers of jobs by money source than sector. The explanation is the spending in these levels support more jobs than exist in these levels. The jobs supported by spending in levels seven through nine on the money source chart have been included in the numbers for other levels on the sector chart. At level ten, no difference exists in the numbers of jobs.

The job results displayed in Figure 5-19 are by pass thru. Each pass thru represents an iteration of the economic turnover in the marketplace. Figure 5-20 presents the cumulative total as a percentage of the numbers of jobs being created for each pass thru. The Figures show 13.47 jobs, which is 43.01%, are created in the first pass thru. Of the 13.47 jobs, the types of jobs (i.e. direct, indirect and induced) are about 48%, 36% and 16%, respectively. See Figure 4-12 in the previous chapter for details on the types of jobs. More than 90% of all jobs had been created by the twelfth pass thru, and over 95% of all jobs had been created by the sixteenth pass thru; however, all jobs created after the first pass thru are induced jobs. Direct and indirect jobs only occurred in the first pass thru, which is the EER supply chain. Induced jobs are EER supported.

When the contractor has been self-performing or subcontracting the work, the numbers of jobs do not change regardless of the money source or sector. Of the total 29.25 jobs from the self-perform calculation method, the types of jobs (i.e. direct, indirect and induced) are about 22%, 16% and 62%, respectively, and the cost categories (i.e. overhead and hard cost) were about 39% and 61%, respectively. Of the total 31.31 jobs from the subcontracting calculation method, the types of jobs (i.e. direct, indirect and induced) are about 21%, 15% and 64%, respectively, and the cost categories (i.e. overhead and hard cost) are about 39% and 61%, respectively.

HVAC Systems

The analysis for HVAC Systems includes Figures 5-21 through 5-30. Figures 5-21, 5-22, 5-23, 5-24, and 5-25 display the results when the contractor is self-performing all of the installation work. Figures 5-26, 5-27, 5-28, 5-29, and 5-30 display the results

when the contractor is providing only management and coordination and subcontracting all of the installation work.

The job results displayed in Figure 5-21 are by the money source and in Figure 5-22 by the sector. Figure 5-23 combines Figures 5-21 and 5-22 into a single chart for easy comparison. More jobs occurred at level one by money source than by sector, 13.41 versus 10.72, respectively. The opposite happened at levels three and four. More jobs occurred by sector than by money source. At level five the lead changed again. The explanation is based on how the jobs are organized. Jobs organized by money source attribute the jobs to the level spending the money, whereas the sector counts jobs at the level where the job is performed. Therefore, induced jobs are higher for the contractor and manufacturer of finished products because those levels provide more dollars being spent in the marketplace. Consequently, the sector jobs increase at the retailer and wholesaler levels due to the increased spending. For levels six through nine, the money source indicated higher numbers than the sector. The explanation is based on the products being sold in those levels. Although much of the fittings, connectors and other products flow through the supply chain to become an HVAC system, some of the assembly parts, intermediate parts, beginning parts and raw materials will be sold as parts or raw materials at the retailer and wholesaler level. At level ten, no difference exists in the numbers of jobs. The chart indicates no jobs are created in level two of the supply chain because the contractor is self-performing all of the work.

The job results displayed in Figure 5-24 are by pass thru. Each pass thru represents an iteration of the economic turnover in the marketplace. Figure 5-25

presents the cumulative total as a percentage of the numbers of jobs being created for each pass thru. The figures show 12.97 jobs, which is 44.64%, are created in the first pass thru. Of the 12.97 jobs, the types of jobs (i.e. direct, indirect and induced) are about 50%, 35% and 15%, respectively. See Figure 4-15 in the previous chapter for details on the types of jobs. More than 90% of all jobs had been created by the twelfth pass thru, and over 95% of all jobs had been created by the sixteenth pass thru; however, all jobs created after the first pass thru are induced jobs. Direct and indirect jobs only occurred in the first pass thru, which is the EER supply chain. Induced jobs are EER supported.

The job results displayed in Figure 5-26 are by the money source and in Figure 5-27 by the sector. Figure 5-28 combines Figures 5-26 and 5-27 into a single chart for easy comparison. The chart indicates the same number of jobs, 0.82 for each method, are created in level one of the supply chain. These jobs represent the management provided by contractors to oversee the work performed by subcontractors. Level two had a sharp increase in the numbers of jobs because of subcontracting. More jobs occurred at level two by money source than by sector, 11.05 versus 9.30, respectively. The opposite happened at levels three and four. More jobs occurred by sector than by money source. At level five the lead changed again. The explanation is the same as before. The difference depends on how the jobs are organized. Jobs organized by money source attribute the jobs to the level spending the money, whereas the sector counts jobs at the level where the job is performed. Therefore, induced jobs are higher for the contractor and manufacturer of finished products because those levels provide more dollars being spent in the marketplace. Consequently, the sector jobs increase at

the retailer and wholesaler levels due to the increased spending. Levels six through nine had higher numbers of jobs by money source than sector. The explanation is the spending in these levels support more jobs than exist in these levels. The jobs supported by spending in levels six through nine on the money source chart have been included in the numbers for other levels on the sector chart. At level ten, no difference exists in the numbers of jobs.

The job results displayed in Figure 5-29 are by pass thru. Each pass thru represents an iteration of the economic turnover in the marketplace. Figure 5-30 presents the cumulative total as a percentage of the numbers of jobs being created for each pass thru. The figures show 13.05 jobs, which is 45.84%, are created in the first pass thru. Of the 13.05 jobs, the types of jobs (i.e. direct, indirect and induced) are about 46%, 41% and 13%, respectively. See Figure 4-18 in the previous chapter for details on the types of jobs. More than 90% of all jobs had been created by the twelfth pass thru, and over 95% of all jobs had been created by the sixteenth pass thru; however, all jobs created after the first pass thru are induced jobs. Direct and indirect jobs only occur in the first pass thru, which is the EER supply chain. Induced jobs are EER supported.

When the contractor has self-performing or subcontracting the work, the numbers of jobs do not change regardless of the money source or sector. Of the total 29.06 jobs from the self-perform calculation method, the types of jobs (i.e. direct, indirect and induced) are about 22%, 16% and 62%, respectively, and the cost categories (i.e. overhead and hard cost) are about 39% and 61%, respectively. Of the total 28.47 jobs from the subcontracting calculation method, the types of jobs (i.e. direct, indirect and

induced) are about 21%, 19% and 60%, respectively, and the cost categories (i.e. overhead and hard cost) are about 41% and 59%, respectively.

Summary of the Sample Outputs

The sample outputs have been analyzed for the various options offered by the model. Level one had the greatest number of jobs when work had been self-performed. Conversely, level two had the greatest number of jobs when work had been subcontracted. Comparing the jobs organized by money source to those by sector provides an insight into which level is supporting the jobs with economic activity. For example, the economic activity in levels one, two and five support the jobs at level three and four. Figure 5-31 summarizes the results for all three product categories and both methods of contracting. Figure 5-32 provides the percent of total for the results. The results are the same for money source and sector.

The numbers of direct jobs, 6.52 at 22%, is the same for all categories of products when the contractor has been self-performing the work. The explanation is the same data set had been used for the contractor regardless of the type of work performed. The numbers of direct jobs are different when the work has been subcontracted because a different subcontractor performed each category of work. Subcontracting created 9.34, 6.52 and 5.95 direct jobs for insulation, openings, and HVAC systems, respectively. Self-performing insulation installations created the least amount of indirect jobs (4.15). Subcontracting door/window installations (i.e. openings) created the greatest number of total jobs (31.31) and induced jobs (19.99). Subcontracting HVAC systems created the least number of total jobs (28.47) and direct jobs (5.95), but it created the greatest number of indirect jobs (5.39). Subcontracting insulation created the greatest number of direct jobs (9.34) and the least number of induced jobs (17.05).

The average total number of jobs for self-performing work was 29.30. The average percent of direct and indirect jobs for self-performing work was about 37%. The average total number of jobs for subcontracting work was 30.19. The average percent of direct and indirect jobs for subcontracting work was about 40%.

Figure 5-33 provides the percent of total for the hard cost and overhead cost categories. Hard costs accounted for 61% of the jobs when work was self-performed. For subcontracting, the percentage was about the same if the average is taken. Figure 5-34 summarizes the results and provides the percent of total for the first 'pass thru'. On average, in the first 'pass thru' subcontracting created more jobs than self-performing work. For all scenarios, the sixteenth 'pass thru' created 95% of jobs; however, subcontracting insulation made it by the fifteenth.

Job Factors

The EER supply chain has ten levels, which can be reduced to four by combining the levels based on commonality of industries. The four levels are project, sales, manufacturing and mining. The number of jobs at each of these four levels can be thought of as a factor. The project level factor is 1.0. When the number of project level jobs is known, it can be multiplied by the factor for any other level to find the number of jobs. Essentially, the factors represent a structure to the relationship of job creation in the EER supply chain. Figures 5-35, 5-36 and 5-37 provide the job creation factors by money source for each of the product categories. The money source indicates the level of supply chain spending the dollars that create economic activity and ultimately jobs.

The EER supply chain flows from the mining to project level; however, interpreting the results requires analyzing the supply chain in reverse order from the project to mining level. For the results organized by money source, the factors decreasing at a

greater rate translates to more jobs at the end of the supply chain. Subcontracting insulation had the greatest factor decay between the project and sales levels, making it the best option for maximizing project level jobs. Subcontracting openings was a close second. The manufacturing level created less than half as many jobs as the project level. The mining level created about two-hundredths of as many jobs as the project level. The average job factors of the three product categories for self-performing work was 1.00, 0.70, 0.46 and 0.02, respectively for project, sales, manufacturing, and mining. The average job factors of the three product categories for subcontracting work was 1.00, 0.64, 0.42 and 0.02, respectively for project, sales, manufacturing, and mining.

Figures 5-38, 5-39 and 5-40 provide the job creation factors by sector for each of the product categories. The results organized by sector indicate where the jobs actually occur. Sales level job factors were greater than 1.0 for all scenarios except for subcontracting insulation, which decreased to 0.82. The greatest sales level job factor was 1.22 for subcontracting HVAC systems. The manufacturing level created about half as many jobs as the project level except for subcontracting insulation, which made about one-third of the jobs. The mining level created about two-hundredths of as many jobs as the project level. The average job factors of the three product categories for self-performing work was 1.00, 1.17, 0.54 and 0.02, respectively for project, sales, manufacturing, and mining. The average job factors of the three product categories for subcontracting work was 1.00, 1.05, 0.48 and 0.02, respectively for project, sales, manufacturing, and mining.

Employment Multipliers

Employment multipliers measure how job creation or destruction in one or more industries results in employment changes throughout the broader economy. In this research, the employment multipliers indicate how many EER supported jobs, i.e. induced jobs, could be created from EER jobs, i.e. direct and indirect jobs. Figure 5-41 shows the EER employment multipliers based on sector results for the three EER supply chain categories. The results are for self-performed and subcontracted work

Self-performed insulation and subcontracted openings have the highest employment multiplier at 2.77. Subcontracted insulation has the lowest employment multiplier at 2.24. The average employment multiplier of the three product categories for self-performing work is 2.67. The average employment multiplier of the three product categories for subcontracting work is about 2.51.

Average Wage Rates

The average wage rate (AWR) per hour for jobs created in and supported by the EER supply chain can be easily calculated from the model by equating the inputs to outputs. See Figure 5-42 for the investment equation.

For this research, the primary input was a $1 million investment. The primary output was the numbers of jobs. Therefore, the AWR for jobs resulting from the EER supply chain can be calculated by dividing the total investment by the product of the number of jobs times the number of compensable hours per year. For this research, the default number of compensable hours per year was 2,080. The AWR equation is shown in Figure 5-43. Figure 5-44 shows the AWR for the three EER supply chain categories. The results are for self-performed and subcontracted work.

The AWR and the total number of jobs is inversely correlated. The highest AWR is $16.89 for subcontracting HVAC system work, which had the fewest number of jobs at 28.47. The lowest AWR is $15.36 for subcontracting openings, which had the greatest number of jobs at 31.31. The average of the self-perform AWR is $16.40. The average of the subcontract AWR is $15.96. When interpreting the AWR, remember the amount is the average for all types of workers (e.g. administrative officers, managers, secretaries, receptionists, skilled workers, semi-skilled workers and unskilled workers) over various types of industries (e.g. construction, retail, wholesale, manufacturing, and mining).

Calculating the AWR for the total number of jobs had a weakness worth mentioning. The total number of jobs represented all three types of jobs (i.e. direct, indirect and induced); thus, it included EER jobs and EER supported jobs. Consequently, the AWR calculated from the total number of jobs was low due to the heavy weighting of induced jobs (i.e. EER supported jobs).

Average Hourly Cost

In comparison to the AWR, a better measurement for EER jobs, i.e. direct and indirect jobs, would be the average hourly cost (AHC). The AHC is similar in concept to the cost of work-in-place or cost of goods sold. It demonstrates the cost of work that must be performed on an hourly basis to maintain a job. The AHC for EER jobs can be explained by equating inputs to outputs from the model as shown in Figure 5-45. Calculating the AHC is shown in Figure 5-46. Figure 5-47 shows the AHC for EER jobs for the three EER supply chain categories. The results are for self-performed and subcontracted work.

Similar to the AWR, the AHC and the total number of jobs is inversely correlated. The highest AHC is $45.06 for self-performing insulation work, which had the fewest number of jobs at 10.67. The lowest AHC is $35.02 for subcontracting insulation, which had the greatest number of jobs at 13.73. The average of the self-perform AHC is $43.82. The average of the subcontract AHC is $39.96. When interpreting the AHC, remember it is similar to the average cost of work-in-place, which can also be described as the average amount of spending, and expresses the hourly equivalent of activity required to create a FTE job. The difference between AWR and AHC is that AHC includes costs other than compensation costs. The other costs in AHC represent the spending that will create the EER supported jobs.

Time-Job Relationships

The time relationship of jobs to the investment is important. It must be understood before predicting when an economic impact will affect the four main levels of the supply chain or forecasting how long the effect will last. Figure 5-48 illustrates the general time-job relationship in the supply chain. The time of investment was considered time zero (t_0). Logically, some jobs occur before time zero and others after time zero.

The model in this research produced full-time equivalent (FTE) numbers of direct, indirect and induced jobs from an investment in EER activities. The EER jobs (i.e. direct and indirect jobs) can be analyzed on a time scale basis for each type of investment and scenario to determine a hypothetical schedule of work. For an example, Figure 5-49 is the monthly schedule of EER jobs for insulation installed by a subcontractor. It shows the number of FTE jobs in comparison to the possible number of actual jobs. Similar analyses could be performed for glass doors/windows and HVAC systems.

The analysis indicates that 13.73 direct and indirect FTE jobs in the insulation supply chain could make about 18.31 actual jobs. In the three months prior to investment (between t_{-3} and t_0), 0.16 jobs would be retained in mining and manufacturing; however, in the nine months after the investment (between t_0 and t_{+9}), 18.15 jobs would be created, retained or reallocated from activity in all four of the major supply chain levels.

Figure 5-50 is the graph of actual insulation jobs over a twelve-month period. The negative time jobs represent the small bump on the left-hand side of the graph. At time zero, a larger number of jobs will be immediately created. At the end of the investment period, jobs associated with the investment in the mining and manufacturing levels begin to taper off.

These hypothetical schedules facilitate performing calculations to determine the actual number of persons required to perform the direct and indirect work on a monthly basis. Because the FTE is a summation calculation of part-time jobs for a twelve-month period, the actual number of workers for any level of the supply chain would be greater if the period of employment for a specific level of the supply chain was less than twelve months.

The actual jobs represents a more accurate picture of the number of people employed over the course of a year due to an investment in EER activities; however, the employment for some of those people will be less than one-full year. This makes sense because some workers are part-time employees. It is also possible that part of the difference between the FTE and actual job numbers will be due to employees who work over-time to meet demand. Overtime hours would count towards the number of

hours required to perform the work. The model cannot predict this nuance; therefore, it cannot recognize overtime in its calculations.

Economic Impact Analysis

Economic impact is the effect a policy has on local and regional economies. Economic impact analysis can examine the effect by measuring different metrics, including levels of employment and worker income. The result of this research provides the numbers of jobs in the EER supply chain for a given level of investment. The analysis provides the average wage rate per hour of these jobs, the job factors per level of the supply chain for various scenarios, and explains the time-job relationship. Considering this newly available information, the economic impact of a proposed policy can be better understood before a decision to invest is made.

The following example demonstrates how to use this new information. If creating local jobs is a priority, then selecting to invest in insulation activities performed by subcontractors produces the greatest number of project level jobs (14.00). The AWR and AHC for this EER supply chain would be $15.62 and $35.02, respectively. The impact on the sales, manufacturing and mining levels of the supply chain could be forecast using the job factors 0.82, 0.37 and 0.01, respectively. Understanding the time-job relationship, the forecast of actual numbers of people employed full- or part-time would be 18.31.

Summary

This chapter has analyzed the sample output results of the model. The sample output results are forecasts of the numbers of jobs that occur in the supply chain from EER activities. First, the results for each product category have been analyzed by supply chain level and iteration for the various scenarios. Second, the job factors at the

four major levels of the supply chain have been discussed. Third, the EER employment multipliers have been determined. Fourth, the average wage rates per hour for the EER supply chain have been calculated. Fifth, the average hourly cost for the EER jobs have been calculated. Sixth, the time-job relationship to the EER investment has been explained. Finally, an example has been provided to demonstrate how this new knowledge can be used to perform an economic impact analysis.

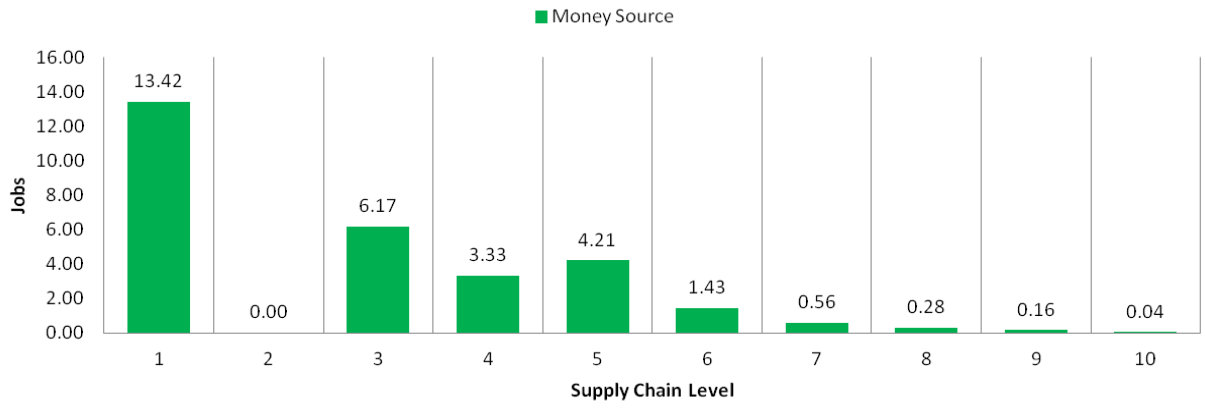

Figure 5-1. Insulation jobs by money source, contractor self-performs all work

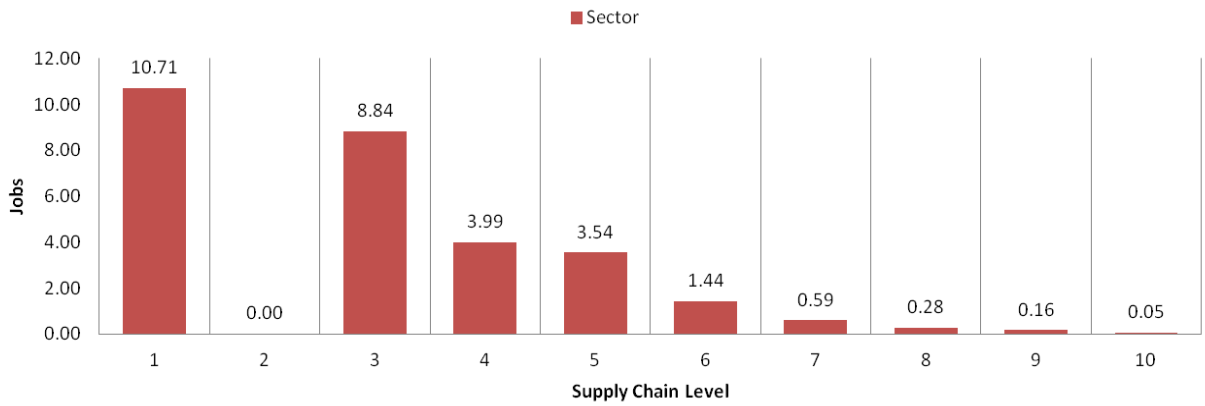

Figure 5-2. Insulation jobs by sector, contractor self-performs all work

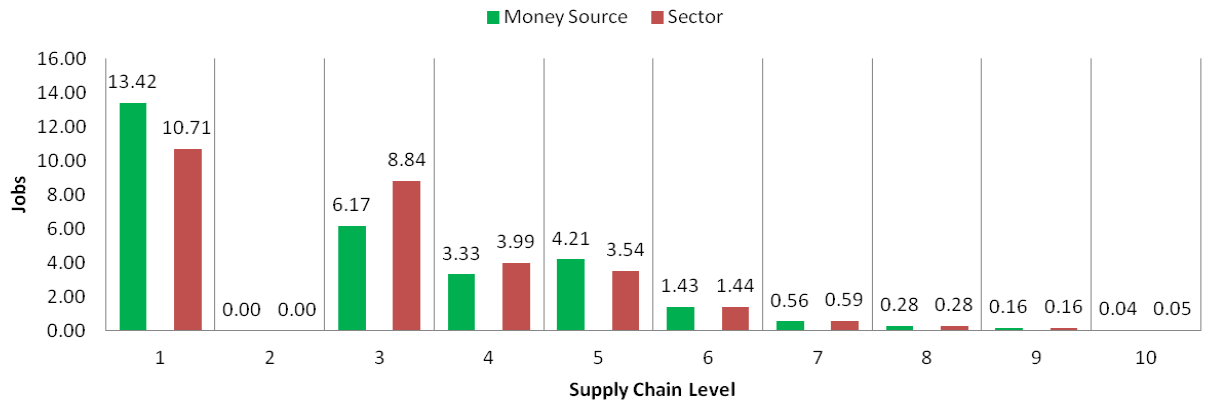

Figure 5-3. Insulation jobs comparison of money source vs. sector, contractor self-performs all work

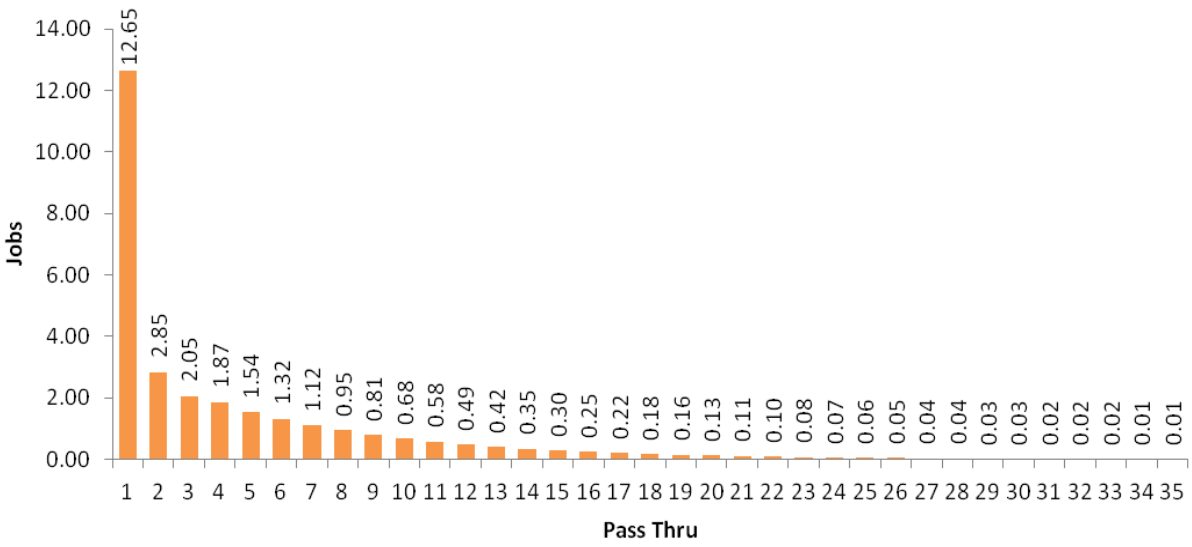

Figure 5-4. Insulation jobs by pass thru, contractor self-performs all work

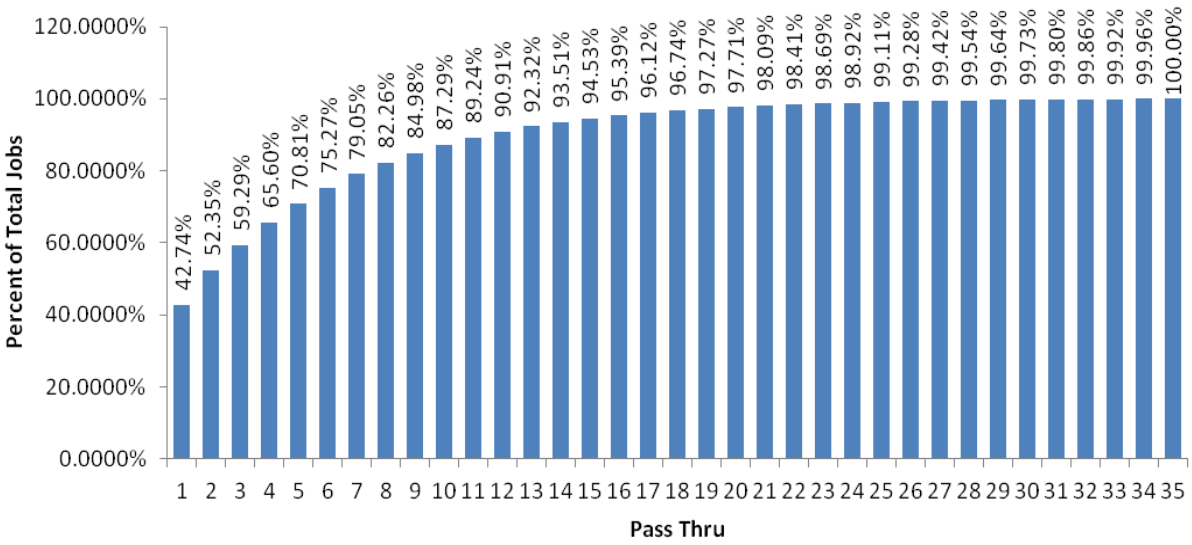

Figure 5-5. Percent of total insulation jobs by pass thru, contractor self-performs all work

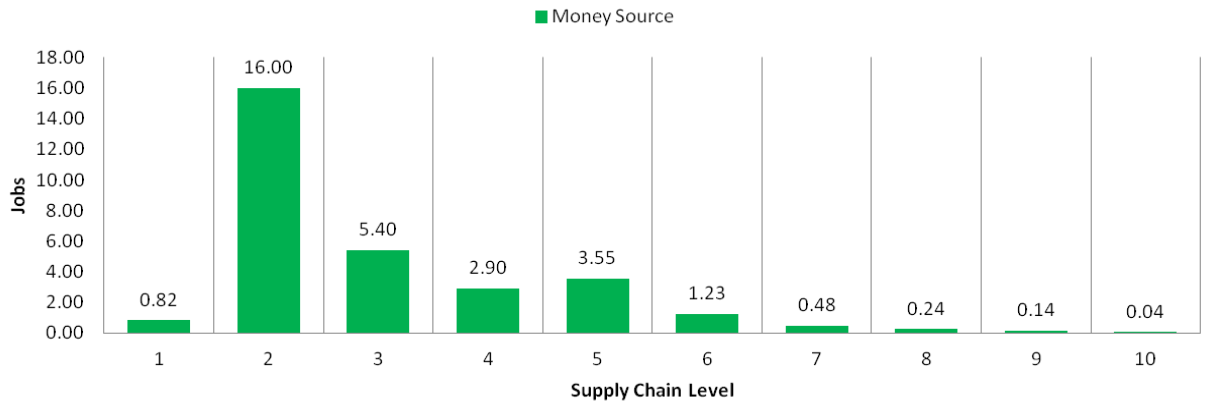

Figure 5-6. Insulation jobs by money source, contractor subcontracts all work

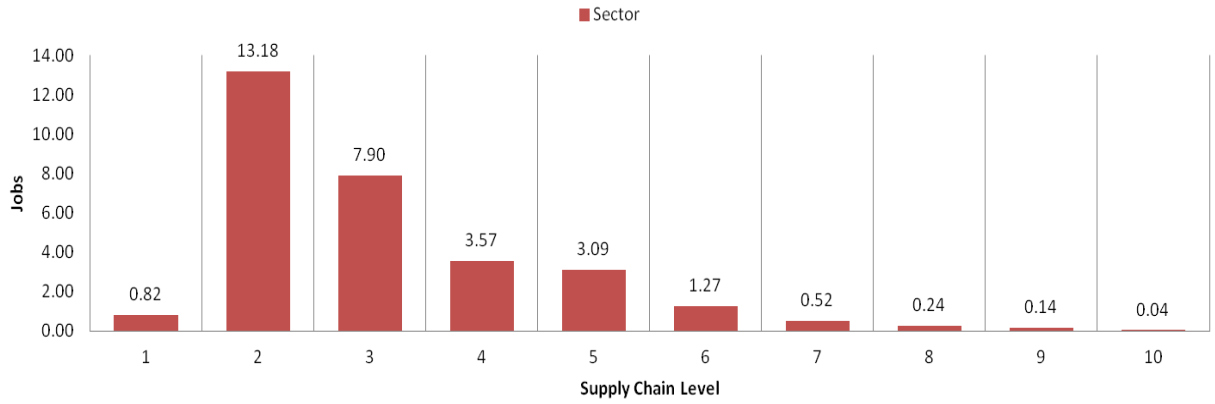

Figure 5-7. Insulation jobs by sector, contractor subcontracts all work

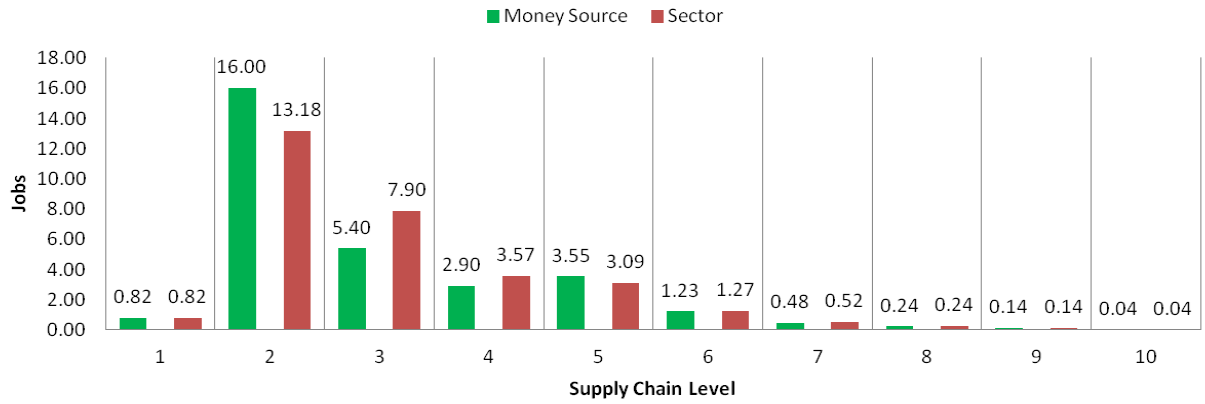

Figure 5-8. Insulation jobs comparison of money source vs. sector, contractor subcontracts all work

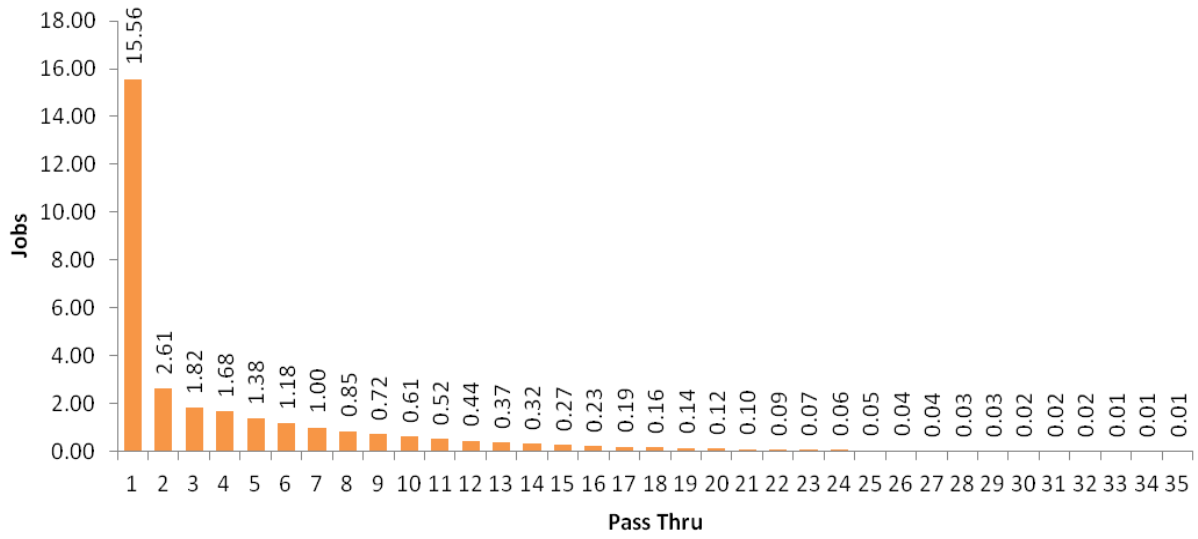

Figure 5-9. Insulation jobs by pass thru, contractor subcontracts all work

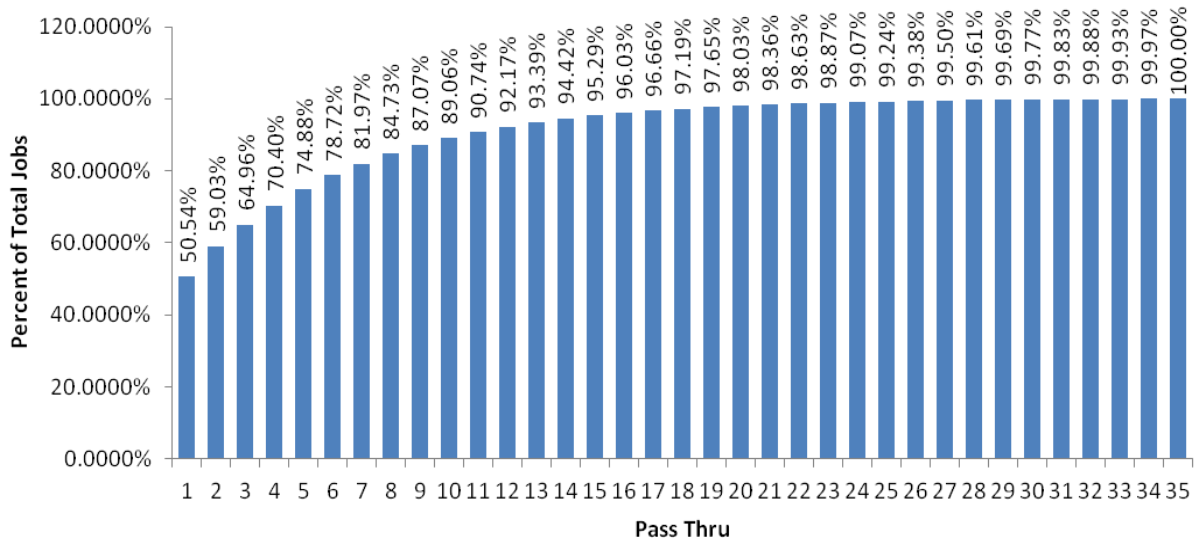

Figure 5-10. Percent of total insulation jobs by pass thru, contractor subcontracts all work

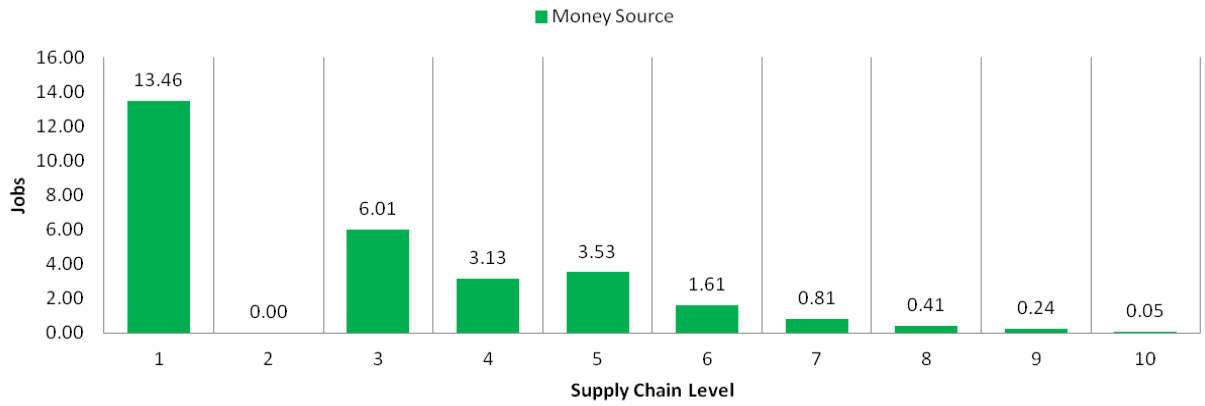

Figure 5-11. Openings jobs by money source, contractor self-performs all work

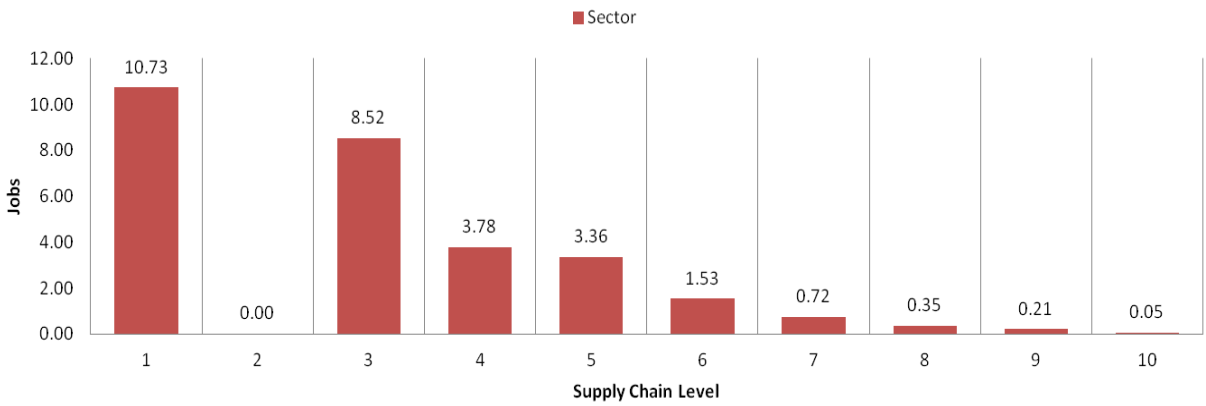

Figure 5-12. Openings jobs by sector, contractor self-performs all work

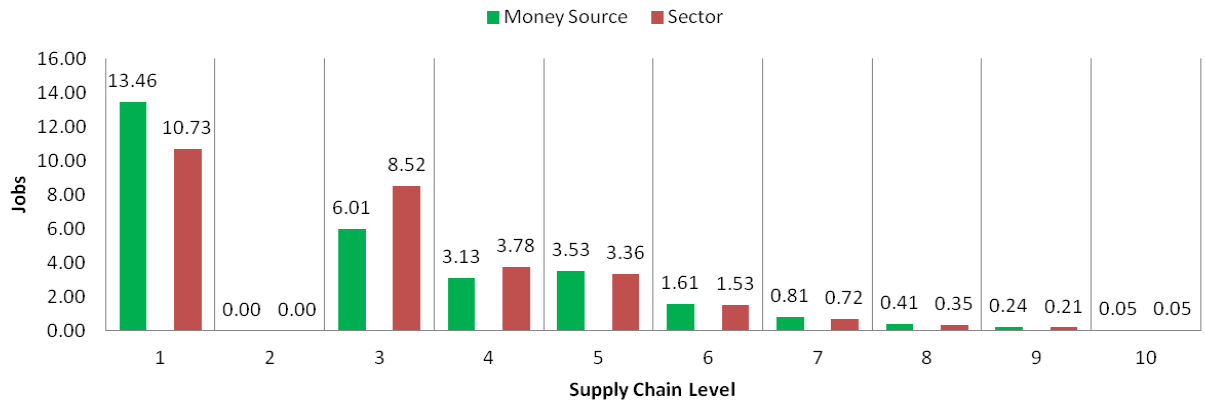

Figure 5-13. Openings jobs comparison of money source vs. sector, contractor self-performs all work

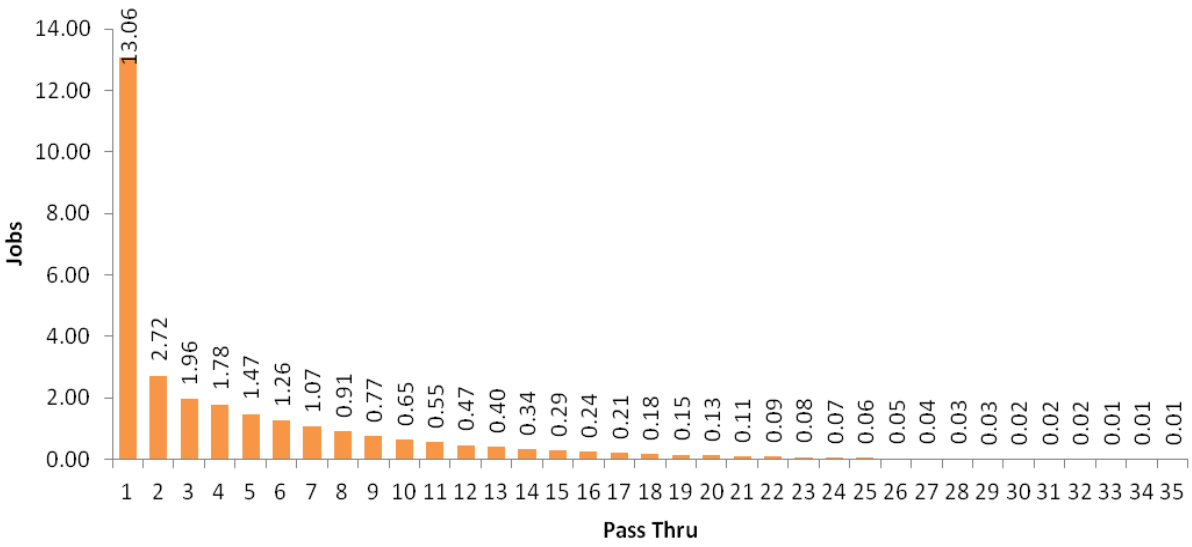

Figure 5-14. Openings jobs by pass thru, contractor self-performs all work

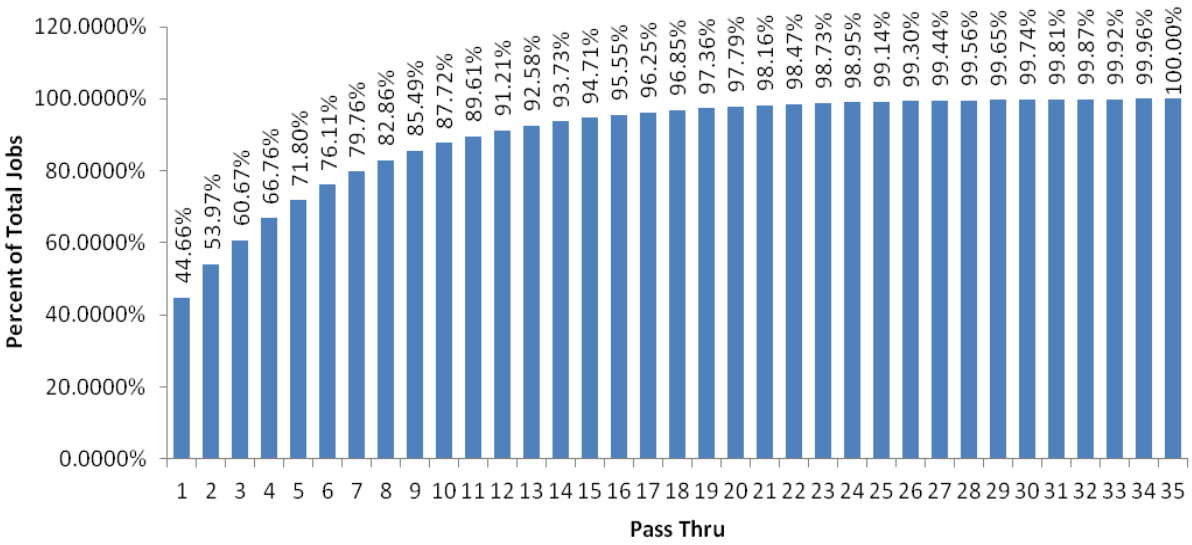

Figure 5-15. Percent of total openings jobs by pass thru, contractor self-performs all work

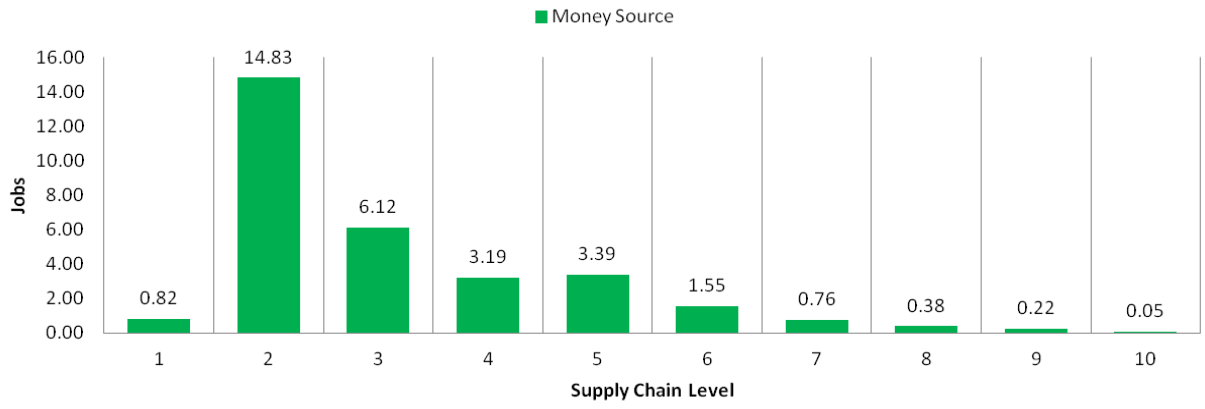

Figure 5-16. Openings jobs by money source, contractor subcontracts all work

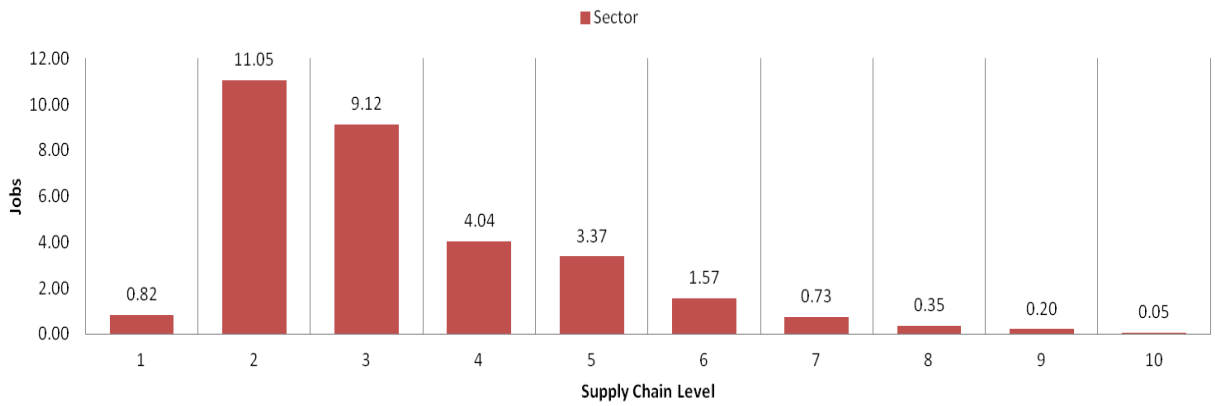

Figure 5-17. Openings jobs by sector, contractor subcontracts all work

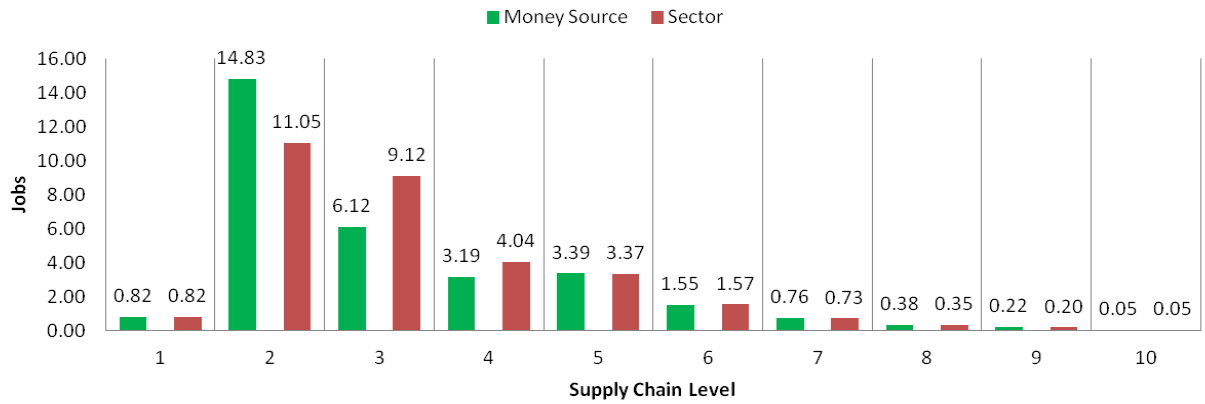

Figure 5-18. Openings jobs comparison of money source vs. sector, contractor subcontracts all work

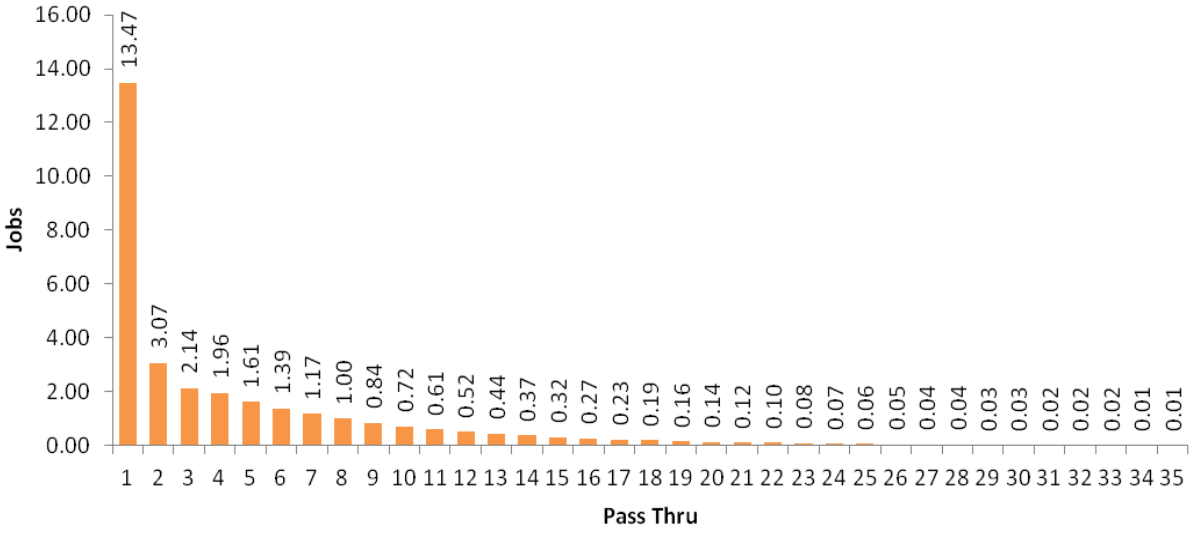

Figure 5-19. Openings jobs by pass thru, contractor subcontracts all work

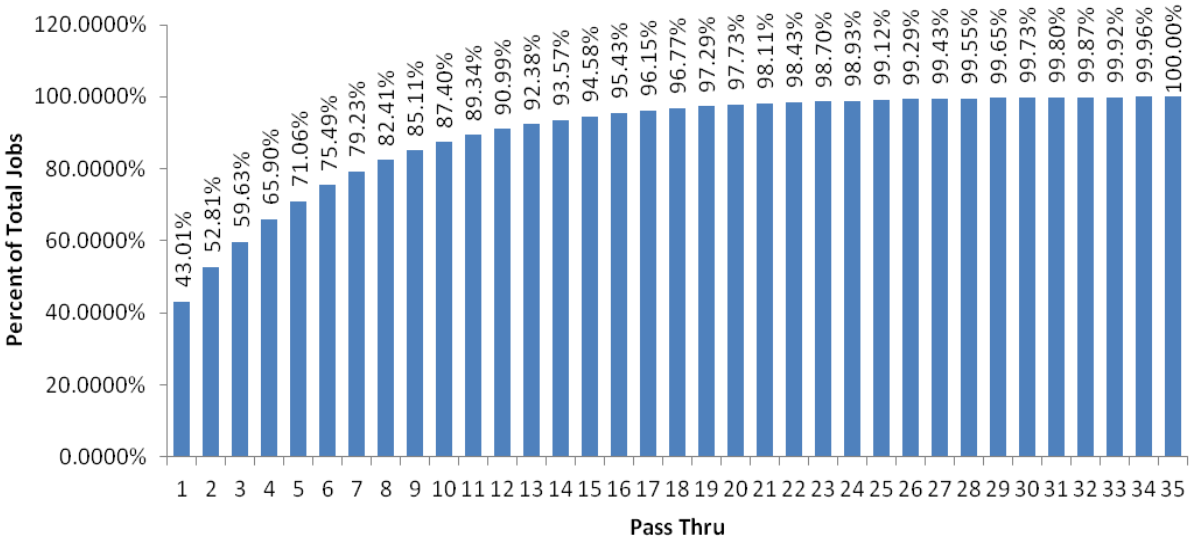

Figure 5-20. Percent of total openings jobs by pass thru, contractor subcontracts all work

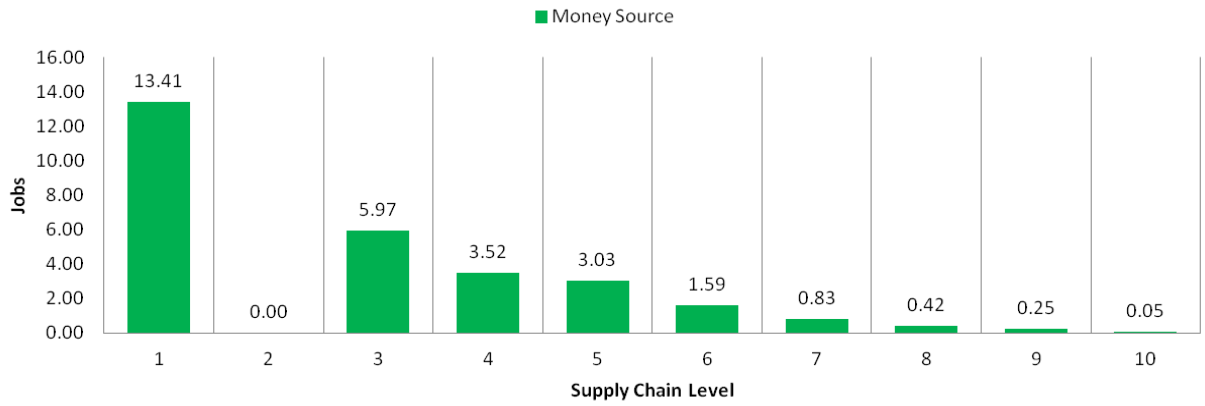

Figure 5-21. HVAC systems jobs by money source, contractor self-performs all work

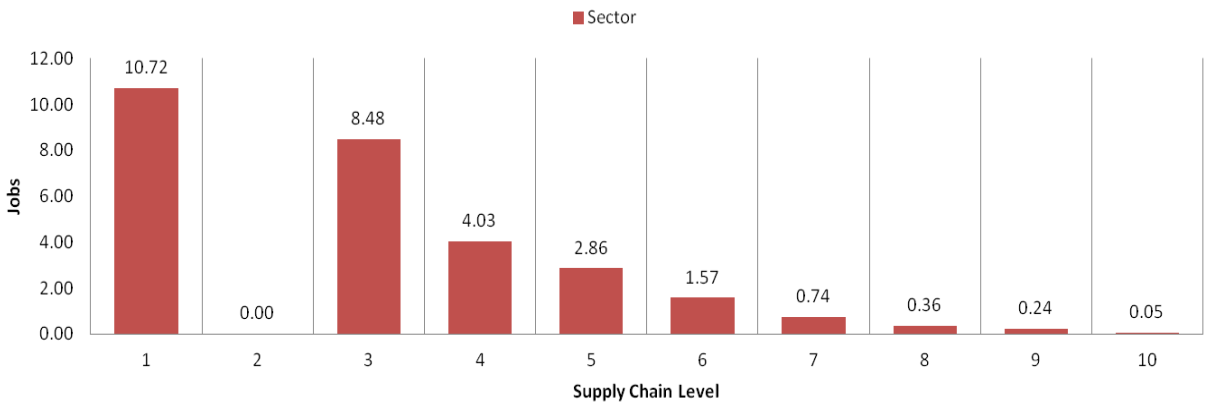

Figure 5-22. HVAC systems jobs by sector, contractor self-performs all work

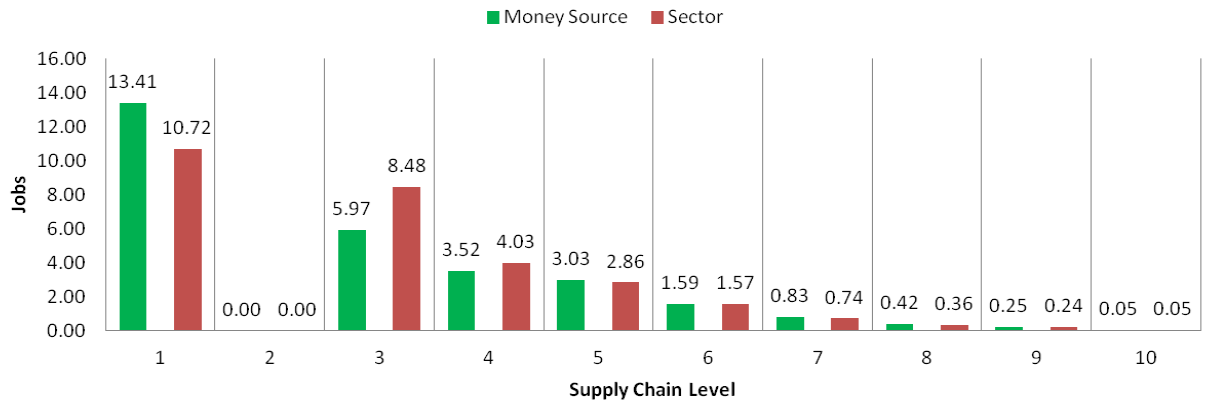

Figure 5-23. HVAC systems jobs comparison of money source vs. sector, contractor self-performs all work

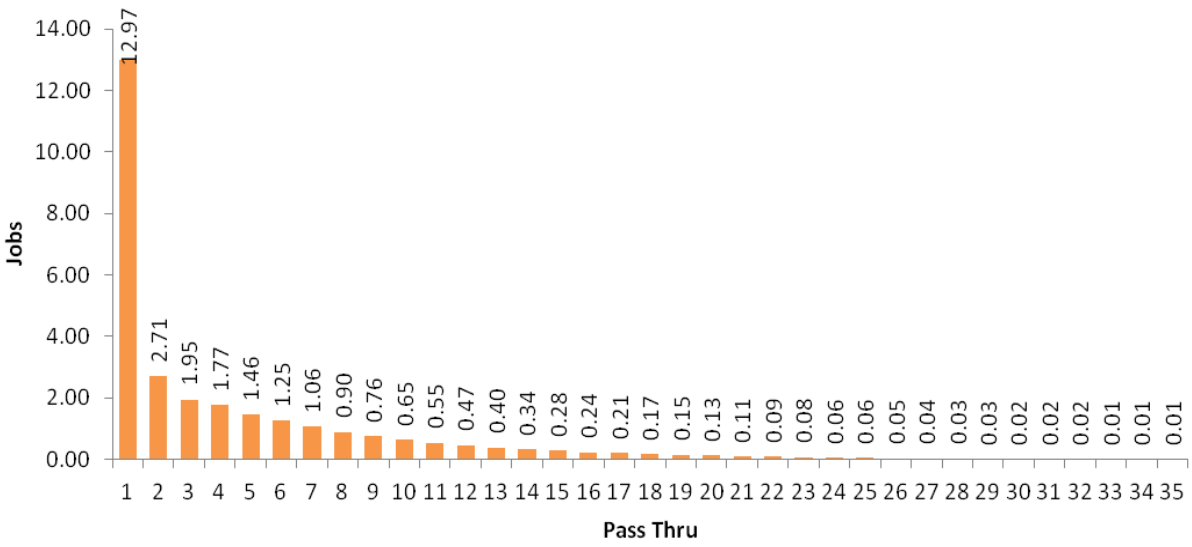

Figure 5-24. HVAC systems jobs by pass thru, contractor self-performs all work

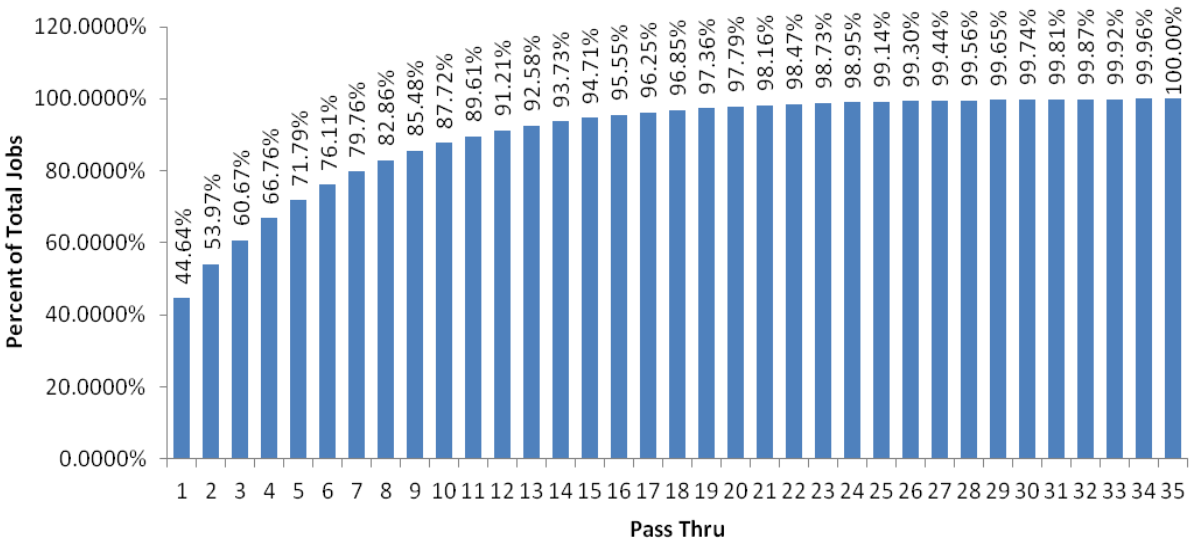

Figure 5-25. Percent of total HVAC systems jobs by pass thru, contractor self-performs all work

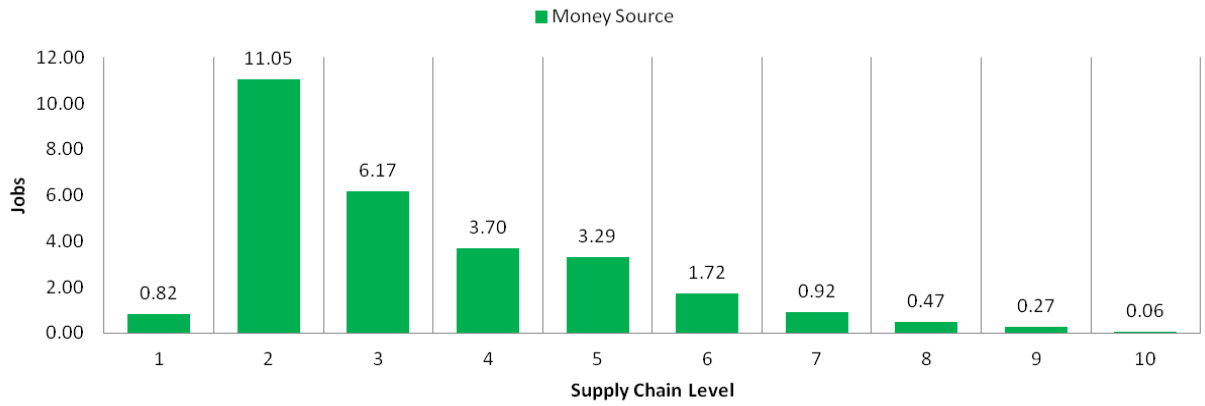

Figure 5-26. HVAC systems jobs by money source, contractor subcontracts all work

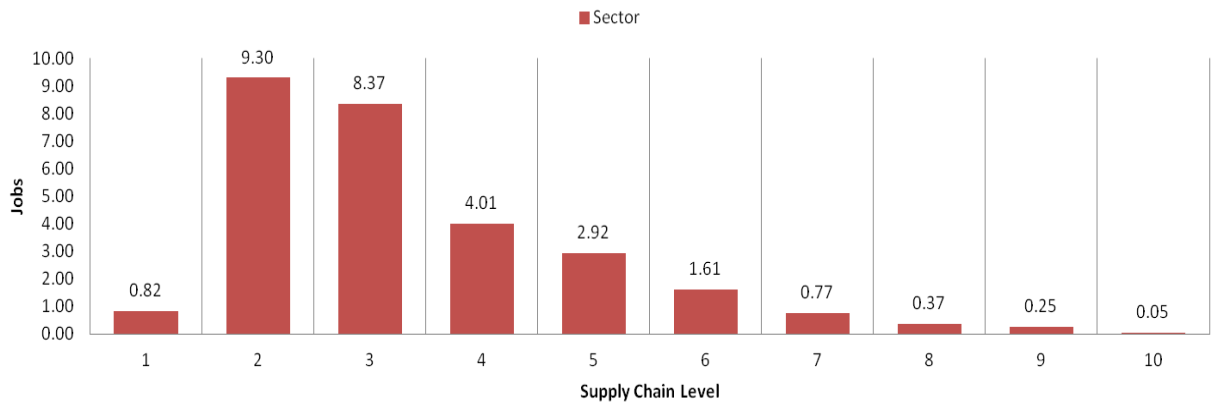

Figure 5-27. HVAC systems jobs by sector, contractor subcontracts all work

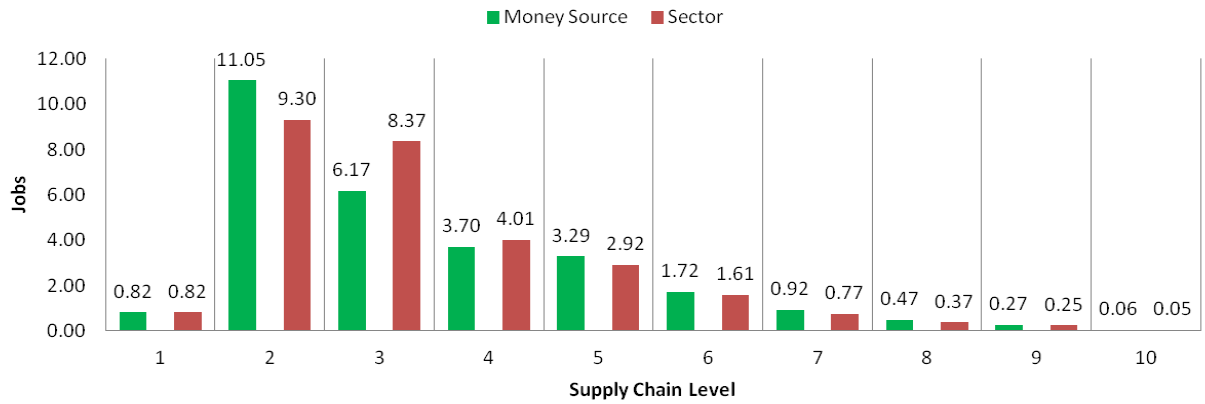

Figure 5-28. HVAC systems jobs comparison of money source vs. sector, contractor subcontracts all work

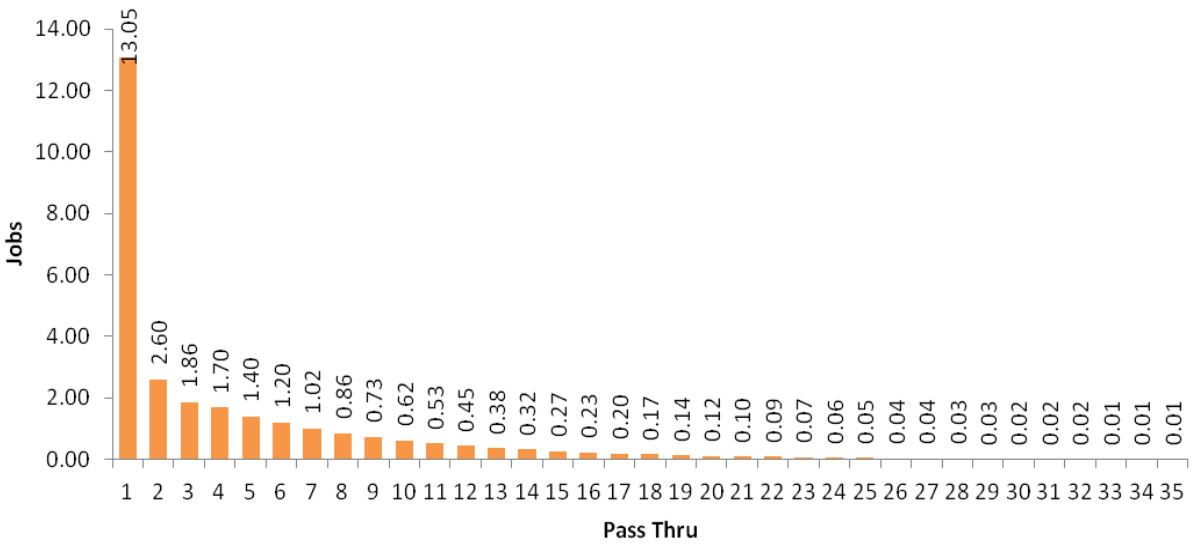

Figure 5-29. HVAC systems jobs by pass thru, contractor subcontracts all work

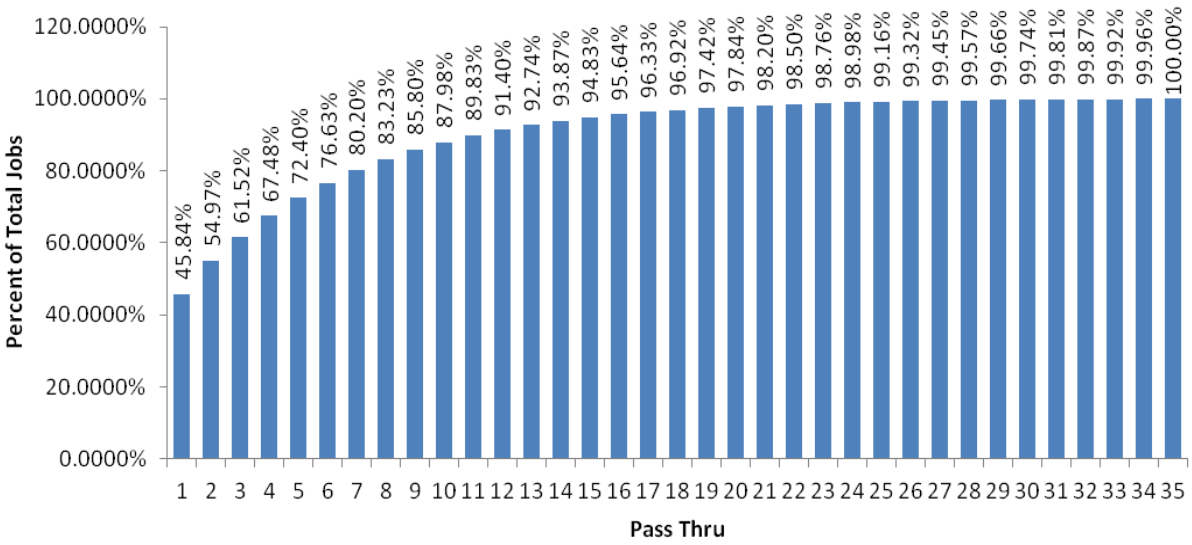

Figure 5-30. Percent of total HVAC systems jobs by pass thru, contractor subcontracts all work

	Self-Perform (Jobs)				Subcontract (Jobs)			
Description	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Insulation	6.52	4.15	18.94	29.60	9.34	4.39	17.05	30.78
Openings	6.52	4.66	18.08	29.25	6.52	4.80	19.99	31.31
HVAC Systems	6.52	4.56	17.98	29.06	5.95	5.39	17.13	28.47

Figure 5-31. Summary of the numbers of jobs created

	Self-Perform (Jobs)				Subcontract (Jobs)			
Description	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Insulation	22%	14%	64%	100%	30%	14%	55%	100%
Openings	22%	16%	62%	100%	21%	15%	64%	100%
HVAC Systems	22%	16%	62%	100%	21%	19%	60%	100%

Figure 5-32. Percent of total for the numbers of jobs created

	Self-Perform				Subcontract			
Description	HC	% of Total	OH	% of Total	HC	% of Total	OH	% of Total
Insulation	18.14	61%	11.46	39%	19.85	64%	10.93	36%
Openings	17.94	61%	11.31	39%	19.06	61%	12.25	39%
HVAC Systems	17.73	61%	11.33	39%	16.67	59%	11.80	41%

Figure 5-33. Percent of total for the hard cost and overhead cost categories

	Self-Perform		Subcontract	
Description	Jobs	% of Total	Jobs	% of Total
Insulation	12.65	43%	15.56	51%
Openings	13.06	45%	13.47	43%
HVAC Systems	12.97	45%	13.05	46%

Figure 5-34. Summary of the number of jobs created and percent of total for the first 'pass thru'

Insulation	Self-Perform		Subcontract	
	Jobs	Factor	Jobs	Factor
Project	13.43	1.00	16.82	1.00
Sales	9.49	0.71	8.30	0.49
Manufacturing	6.48	0.48	5.49	0.33
Mining	0.20	0.01	0.17	0.01
Total	29.60		30.78	

Figure 5-35. Job factors for insulation by money source

Openings	Self-Perform		Subcontract	
	Jobs	Factor	Jobs	Factor
Project	13.46	1.00	15.65	1.00
Sales	9.14	0.68	9.31	0.59
Manufacturing	6.36	0.47	6.08	0.39
Mining	0.30	0.02	0.27	0.02
Total	29.26		31.31	

Figure 5-36. Job factors for openings by money source

HVAC Systems	Self-Perform		Subcontract	
	Jobs	Factor	Jobs	Factor
Project	13.41	1.00	11.87	1.00
Sales	9.48	0.71	9.88	0.83
Manufacturing	5.87	0.44	6.39	0.54
Mining	0.30	0.02	0.33	0.03
Total	29.06		28.47	

Figure 5-37. Job factors for HVAC systems by money source

Insulation	Self-Perform		Subcontract	
	Jobs	Factor	Jobs	Factor
Project	10.71	1.00	14.00	1.00
Sales	12.84	1.20	11.47	0.82
Manufacturing	5.84	0.55	5.12	0.37
Mining	0.21	0.02	0.18	0.01
Total	29.60		30.78	

Figure 5-38. Job factors for insulation by sector

Openings	Self-Perform		Subcontract	
	Jobs	Factor	Jobs	Factor
Project	10.73	1.00	11.88	1.00
Sales	12.30	1.15	13.16	1.11
Manufacturing	5.96	0.56	6.02	0.51
Mining	0.26	0.02	0.26	0.02
Total	29.25		31.31	

Figure 5-39. Job factors for openings by sector

HVAC Systems	Self-Perform		Subcontract	
	Jobs	Factor	Jobs	Factor
Project	10.72	1.00	10.12	1.00
Sales	12.51	1.17	12.38	1.22
Manufacturing	5.53	0.52	5.67	0.56
Mining	0.29	0.03	0.30	0.03
Total	29.06		28.47	

Figure 5-40. Job factors for HVAC systems by sector

Description	Self-Perform	Subcontract
	EER Employment Multiplier	EER Employment Multiplier
Insulation	2.77	2.24
Openings	2.62	2.77
HVAC Systems	2.62	2.51

Figure 5-41. Energy efficiency retrofit (EER) employment multipliers

$$\text{(Investment)} = \text{(Average Wage Rate)} \times \text{(Jobs)} \times \text{(Hrs/Yr)}$$

Figure 5-42. Investment equation (AWR)

$$\text{(Average Wage Rate)} = \frac{\text{(Investment)}}{\text{(Jobs)} \times \text{(Hrs/Yr)}}$$

Figure 5-43. Average wage rate equation

Description	Self-Perform		Subcontract	
	Jobs	AWR	Jobs	AWR
Insulation	29.60	$ 16.24	30.78	$ 15.62
Openings	29.26	$ 16.43	31.31	$ 15.36
HVAC Systems	29.06	$ 16.54	28.47	$ 16.89

Figure 5-44. Average wage rate comparison for all jobs

$$\text{(Investment)} = \text{(Average Hourly Cost)} \times \text{(EER Jobs)} \times \text{(Hrs/Yr)}$$

Figure 5-45. Investment equation (AHC)

$$\text{(Average Hourly Cost)} = \frac{\text{(Investment)}}{\text{(EER Jobs) x (Hrs/Yr)}}$$

Figure 5-46. Average hourly cost equation

Description	Self-Perform		Subcontract	
	Direct and Indirect Jobs	AHC	Direct and Indirect Jobs	AHC
Insulation	10.67	$ 45.06	13.73	$ 35.02
Openings	11.18	$ 43.00	11.32	$ 42.47
HVAC Systems	11.08	$ 43.39	11.34	$ 42.40

Figure 5-47. Average hourly cost comparison for energy efficiency retrofit jobs

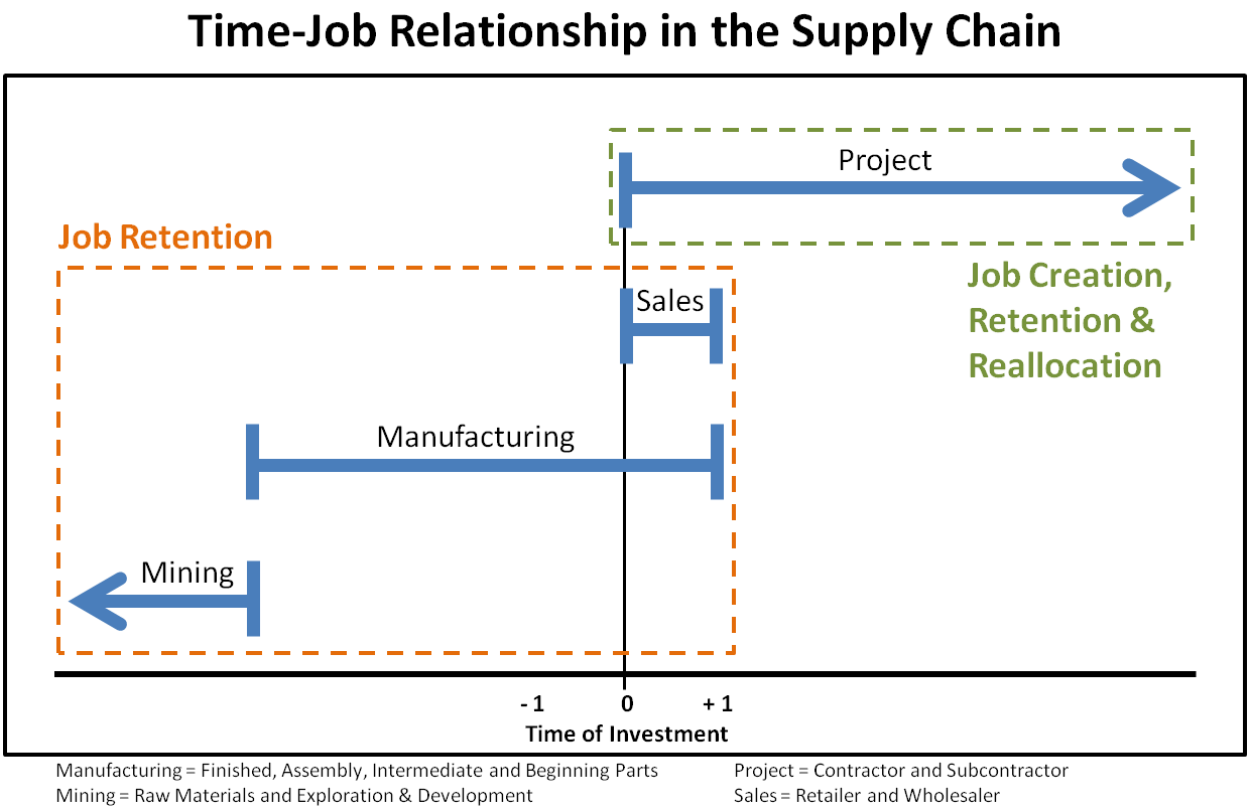

Figure 5-48. Time-job relationship in the supply chain

Contractor Subcontracts Insulation					Time Scale (Months)												
Level	Description	FTE Job Totals	Time (Months)	Jobs/ Time	-3	-2	-1	0	1	2	3	4	5	6	7	8	9
1	Contractor	0.82	9	1.10					0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.122
2	Subcontractor	10.94	9	14.59					1.621	1.621	1.621	1.621	1.621	1.621	1.621	1.621	1.621
3	Retailer	0.72	9	0.96					0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107
4	Wholesaler	0.31	9	0.42					0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047
5	Mfg Finished Product	0.65	9	0.87			0.097		0.097	0.097	0.097	0.097	0.097	0.097	0.097	0.097	
6	Mfg Assembly Parts	0.17	9	0.22			0.025		0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	
7	Mfg Intermediate Parts	0.05	9	0.07		0.008	0.008		0.008	0.008	0.008	0.008	0.008	0.008	0.008		
8	Mfg Beginning Parts	0.03	9	0.05		0.005	0.005		0.005	0.005	0.005	0.005	0.005	0.005	0.005		
9	Mining Raw Materials	0.02	9	0.02	0.003	0.003	0.003		0.003	0.003	0.003	0.003	0.003	0.003			
10	Mining Explor. & Dev.	0.01	9	0.01	0.001	0.001	0.001		0.001	0.001	0.001	0.001	0.001	0.001			
		13.73		18.31	0.004	0.016	0.138	0	2.034	2.034	2.034	2.034	2.034	2.034	2.030	2.018	1.896
Totals					0.16				18.15								
Percentages					0.86%				99.14%								

Figure 5-49. FTE vs. actual jobs, insulation subcontracted

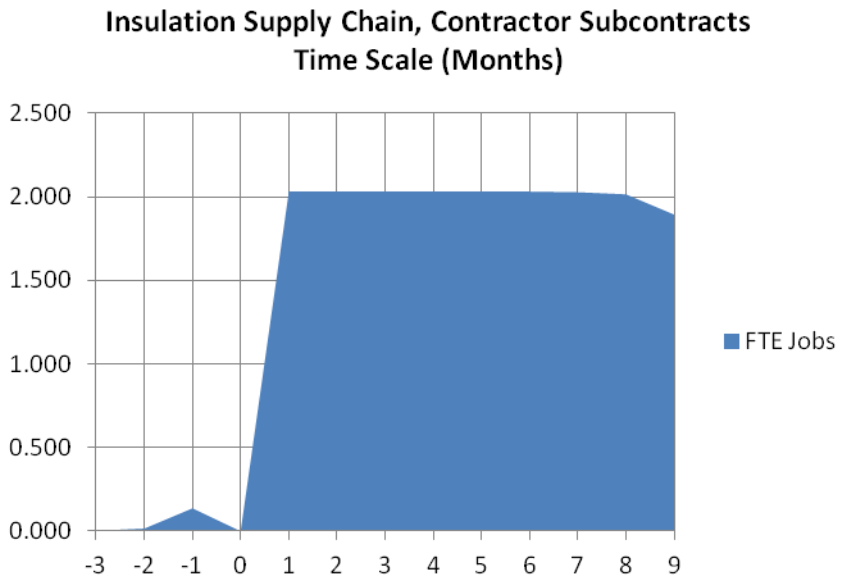

Figure 5-50. Graph of time-job occurrence

CHAPTER 6
SUMMARY AND CONCLUSIONS

This chapter will be a recap of the research and final word about the findings. First, the research effort will be summarized. Then, conclusions based on the research will be made.

Research Summary

This research has addressed job creation in the EER supply chain for investments in residential structures. A review had been made of existing literature addressing jobs created from investments to reduce energy consumption or raise levels of energy efficiency. Noticeable deficiencies were found in the existing literature. Terminology had been undefined and job calculations lacked uniformity. In response, terminology has been defined specifically for this research and a new methodology has been developed. A working model has been created and tested for a $1 million investment. The results are the numbers of jobs in the EER supply chain. Analyzing the results provides the average wage rate per hour of these jobs, the job factors per level of the supply chain for various scenarios, and explains the time-job relationship. This information can be used as metrics in economic impact analysis.

Conclusions

After concluding this research, the following new information has been discovered about a $1 million dollar investment in EER activities. Self-performed insulation produces 6.52 direct, 4.15 indirect, and 18.94 induced jobs for a total of 29.60. The numbers of hard cost and overhead jobs are 18.14 and 11.46, respectively. These results remained the same regardless of organization; however, the results grouped by project, sales, manufacturing, and mining levels are different. For these levels, money

source results are 13.42, 9.50, 6.48 and 0.20, respectively, and sector results are 10.71, 12.84, 5.84 and 0.21, respectively. The first ‘pass thru’ creates 12.65 jobs.

Subcontracting insulation produces 9.34 direct, 4.39 indirect, and 17.05 induced jobs for a total of 30.78. The numbers of hard cost and overhead jobs are 19.85 and 10.93, respectively. These results remained the same regardless of organization; however, the results grouped by project, sales, manufacturing, and mining levels are different. For these levels, money source results are 16.82, 8.30, 5.49 and 0.17, respectively, and sector results are 14.00, 11.47, 5.12 and 0.18, respectively. The first ‘pass thru’ creates 15.56 jobs.

Self-performing glass doors/windows (i.e. openings) produces 6.52 direct, 4.66 indirect, and 18.08 induced jobs for a total of 29.25. The numbers of hard cost and overhead jobs are 17.94 and 11.31, respectively. These results remained the same regardless of organization; however, the results grouped by project, sales, manufacturing, and mining levels are different. For these levels, money source results are 13.46, 9.14, 6.36 and 0.30, respectively, and sector results are 10.73, 12.30, 5.96 and 0.26, respectively. The first ‘pass thru’ creates 13.06 jobs.

Subcontracted glass doors/windows (i.e. openings) produce 6.52 direct, 4.80 indirect, and 19.99 induced jobs for a total of 31.31. The numbers of hard cost and overhead jobs are 19.06 and 12.25, respectively. These results remained the same regardless of organization; however, the results grouped by project, sales, manufacturing, and mining levels are different. For these levels, money source results are 15.65, 9.31, 6.08 and 0.27, respectively, and sector results are 11.88, 13.16, 6.02 and 0.26, respectively. The first ‘pass thru’ creates 13.47 jobs.

Self-performing HVAC systems produces 6.52 direct, 4.56 indirect, and 17.98 induced jobs for a total of 29.06. The numbers of hard cost and overhead jobs are 17.73 and 11.33, respectively. These results remained the same regardless of organization; however, the results grouped by project, sales, manufacturing, and mining levels are different. For these levels, money source results are 13.41, 9.48, 5.87 and 0.30, respectively, and sector results are 10.72, 12.51, 5.53 and 0.29, respectively. The first 'pass thru' creates 12.97 jobs.

Subcontracted HVAC systems produce 5.95 direct, 5.39 indirect, and 17.13 induced jobs for a total of 28.47. The numbers of hard cost and overhead jobs are 16.67 and 11.80, respectively. These results remained the same regardless of organization; however, the results grouped by project, sales, manufacturing, and mining levels are different. For these levels, money source results are 11.87, 9.88, 6.39 and 0.33, respectively, and sector results are 10.12, 12.38, 5.67 and 0.30, respectively. The first 'pass thru' creates 13.05 jobs.

For the sample outputs, level one or two had the greatest numbers of jobs depending on whether work had been self-performed or subcontracted. Comparing the jobs organized by money source to those by sector, the economic activity in levels one, two and five supported the jobs at level three and four. The numbers of direct jobs (6.52) were the same for all categories of products when the contractor was self-performing the work; however, they are different when the work is subcontracted. A different subcontractor performed each category of work; therefore, subcontracting created 9.34, 6.52 and 5.95 direct jobs for insulation, openings, and HVAC systems, respectively. Self-performing insulation installations created the least amount of indirect

jobs (4.15). Subcontracting door/window installations (i.e. openings) created the greatest number of total jobs (31.31) and induced jobs (19.99). Subcontracting HVAC systems created the least number of total jobs (28.47) and direct jobs (5.95), but it created the greatest number of indirect jobs (5.39). Subcontracting insulation created the greatest number of direct jobs (9.34) and the least number of induced jobs (17.05). The average total number of jobs for self-performing work was 29.30. The average percent of direct and indirect jobs for self-performing work was about 37%. The average total number of jobs for subcontracting work was 30.19. The average percent of direct and indirect jobs for subcontracting work was about 40%. Hard costs accounted for 61% of the jobs when work was self-performed. For subcontracting, the percentage was about the same if the average was taken. On average, in the first 'pass thru' subcontracting created more jobs than self-performing work. For all scenarios, the sixteenth 'pass thru' created 95% of jobs; however, subcontracting insulation made it by the fifteenth.

Job factors varied by the method of organization. The average job factors by money source of the three product categories for self-performing work were 1.00, 0.70, 0.46 and 0.02, respectively for project, sales, manufacturing, and mining. The average job factors by money source of the three product categories for subcontracting work were 1.00, 0.64, 0.42 and 0.02, respectively for project, sales, manufacturing, and mining. The average job factors by sector of the three product categories for self-performing work were 1.00, 1.17, 0.54 and 0.02, respectively for project, sales, manufacturing, and mining. The average job factors by sector of the three product

categories for subcontracting work were 1.00, 1.05, 0.48 and 0.02, respectively for project, sales, manufacturing, and mining.

The highest average wage rate (AWR) per hour for total jobs created in the EER supply chain was $16.89 for subcontracting HVAC system work, which had the fewest number of jobs at 28.47. The lowest AWR was $15.36 for subcontracting openings, which had the greatest number of jobs at 31.31. The average of the self-perform AWR was $16.40. The average of the subcontract AWR was $15.96. Using only direct and indirect jobs (i.e. EER jobs), the highest AHC was $45.06 for self-performing insulation work, which had the fewest number of jobs at 10.67. The lowest AHC was $35.02 for subcontracting insulation, which had the greatest number of jobs at 13.73. The average of the self-perform AHC was $43.82. The average of the subcontract AHC was $39.96.

The time-jobs relationship of an investment in subcontracted insulation indicated 13.73 direct and indirect FTE jobs in the supply chain could make about 18.31 actual jobs. In the three months prior to investment (between t_{-3} and t_0), 0.16 jobs were retained in mining and manufacturing; but, in the nine months after the investment (between t_0 and t_{+9}), 18.15 jobs were created, retained or reallocated from activity in all four of the major supply chain levels.

This research effort has lead to new metrics that can be used in economic impact analysis studies. Economic impact analysis examines the effect a policy has on an economy. For example, if creating local jobs is a priority, then the best policy option would be to invest $1 million in subcontracted insulation activities that produce 14.00 project level jobs. The average wage rate per hour for this EER supply chain would be $15.62. The average hourly cost for EER jobs would be $35.02. The impact on the

sales, manufacturing and mining levels of the supply chain could be forecast using the job factors 0.82, 0.37 and 0.01, respectively. Understanding the time-job relationship, the forecast of actual numbers of people employed full- or part-time would be about 18.31.

CHAPTER 7
RECOMMENDATIONS FOR FUTURE RESEARCH

Introduction

This chapter will make recommendations for future research. First, enhancements to the model will be suggested. Second, ways to merge the results with other existing research will be proposed. Finally, new places to take the research will be explored.

Enhancements

The working model could provide several new metrics with minor modifications. First, the profit in the EER supply chain for all thirty-five iterations could be calculated. This profit could be compared to jobs, or vice versa, to determine the relationships between profitability and the numbers of jobs created in a specific supply chain. Synergies may be found that maximize profit and the numbers of jobs. New light may be shed on the long-running profit maximizing versus profit satisficing debate. Perhaps corporations can promote social good without settling for less. Second, the numbers of jobs from reinvested wages could be calculated. Assumptions would be made that the reinvested wages equal the initial investment and are reinvested into the general economy for all iterations.

Mergers

The results of several existing studies could be merged with the results of this research to form comparisons and new metrics. First, carbon production in the EER supply chain could be calculated and compared to the jobs in the EER supply chain. The outcome would be carbon production per job for each $1 million investment. Additionally, the carbon production per job for non-EER supply chains of similar products could be calculated and compared to the EER supply chain results. Second, a

more complete forecast of induced jobs can be explored. There are three sources of induced jobs. The model in this research forecasts induced jobs from business-to-business spending. A recommendation was made to calculate induced jobs from reinvested wages. The final source is induced jobs from energy dollars. Energy dollars are the dollars saved by avoiding higher utility payments (because lower utility payments result from the installation of energy efficient products). Fobair and Kibert (2011) proposed a method to calculate the induced jobs from energy dollars. Their results could be combined with the results of this research to provide a more complete understanding of the induced jobs created from investments in EER activities. Once the induced jobs are fully known, results from the studies could be combined to provide a complete number of direct, indirect and induced jobs.

New Places

This model could have many applications. First, it can be expanded to other products, such as lighting and thermal shading. The progression would initially be to round-out the examination of commonly implemented retrofit options; however, other products of a non-retrofit nature could be examined. Second, the concept of the research could change to examine the job creation in supply chains for other forms of construction sustainability. For example, the model could be adapted to forecast the jobs resulting from deconstruction. The goal is to compare the jobs created from a building deconstruction to a building demolition. The comparison to be made is the number of jobs created versus the cost of the work. The assumption is when the cost of work is the same, deconstruction is more sustainable than demolition because more jobs are created and less waste is hauled to a landfill. Third, this research can be adapted for new sustainable buildings. Specifically, the research question would be:

How much do sustainable buildings contribute to job creation when viewed in terms of credits from a rating system? Does achieving certain LEED credits, or a combination of credits, result in a greater number of local jobs? If in fact buildings having a higher rating (by achieving more credits) or better performance in a design criteria (e.g. energy efficiency) produce more local jobs, then local governments and municipalities may choose to offer economic development incentives that promote certain credits for buildings pursuing higher performance ratings. The practical benefit would be more work for contractors that have experience building “sustainable” buildings and more jobs for employment.

Summary

This research has focused on calculating jobs for investments in three specific construction activities in Florida residences. Future research will make enhancements to the model, merge results with other studies, and take the concept into new places. Enhancements could have the model calculate profit and reinvested wages. Mergers could be with carbon production or induced jobs from energy dollars. New places could expand into new construction, deconstruction and waste management. For new construction, LEED credits could be examined for their job creation impact.

APPENDIX A
PROCEDURES FOR CREATING AND USING THE MODEL

The procedure for using the model in this research will be described in the following steps. The primary function of the model is to forecast the number of jobs that result from an investment in energy efficiency retrofit work on residential use buildings. The inputs and outputs shown in this Appendix are based on default settings.

Model Setup

1) The model is data intensive and requires the use of macros, data connections and links. Therefore, the file must be saved in a macro-enabled format and data connections and links should be checked and/or refreshed prior to use.
2) Data sets can be downloaded from the relevant government websites. See the "Methodology" chapter for the list of sources for the data sets utilized.
3) Data sets should be reorganized and placed into the "Dollar-Breakdown" templates. See Appendix B for an example of the template.
4) Data sets should be organized by supply chain and saved in a logical file order. File names should be unique for each data set and template.
5) The data sets for the model in this research are for mineral wool insulation, openings (wood, vinyl and metal doors or windows), and HVAC systems.

STEP 1 – User Inputs

1) Make the following selections on sheet "iii User Inputs":
    a. The model calculates jobs either for the material supply chain (direct, indirect and induced jobs) or for reinvested wages (induced jobs). Select "M" for the material supply chain. Select "W" for reinvested wages. The default setting is "M".
    b. Enter the "FTE Annual Hours". The default setting is "2,080".
    c. Enter the "Initial EER Investment". The default setting is "$1,000,000".
    d. Enter the "Materials (HC) Split". The material options are insulation, openings (windows and/or doors), or HVAC systems. The sum of percentages for all three materials should equal 100 percent. If the number of jobs for only one material is the desired answer, then 100 percent should be entered for one material. The default setting is "100%" for one material.
    e. Enter the "Materials (HC): Self-Performed by Contractor". A percentage must be entered for each material. The percentage range is from zero percent to 100 percent. Based on the percentage entered, the calculator divides the amount between work that is self-performed by the contractor and work that is subcontracted to others. Enter 100 percent to calculate the jobs created when the contractor self-performs all of the installation work. Enter zero percent to calculate the jobs created when the contractor

hires a subcontractor to perform the installation. The default setting is either zero percent or 100 percent depending on the desired answer.

f. Enter the “Materials (HC): Contractor Markup on Subcontracted Work”. A percentage must be entered for each material. The percentage range is from zero percent to 100 percent. Based on the percentage entered, the calculator allocates the amount to the contractor as compensation for the labor to oversee the work performed by a subcontractor. The default setting is 5 percent.
g. Enter the “Administration and Project Management Mix %”. The mix is assumed based on the following question: Of the payroll for administration and project management, how much is allocated to each category of worker? The worker options are officer, secretary, and manager. The sum of percentages for all three options should equal 100 percent. The default settings for officer, secretary, and manager are 10 percent, 30 percent, and 60 percent, respectively.
h. Enter the “Temporary Staff and Leased Employee Mix %”. The mix is assumed based on the following question: Of the payroll for temporary and leased employees, how much is allocated to each category of worker? The worker option is receptionist. The percentage must be 100 percent if temporary or leased employees are hired. The default setting is 100 percent.
i. Enter the “Self-Performed and/or Sub-Out Worker Mix %”. The mix is assumed based on the following question: Of the payroll for the contractor’s and/or subcontractor’s workers, how much is allocated to each category of worker? The worker options are skilled, semi-skilled, and unskilled. The sum of percentages for all three options should equal 100 percent. The default settings for skilled, semi-skilled and unskilled are 10 percent, 60 percent, and 30 percent, respectively.

2) Make the following selections on sheet “iv Wage Rates”:
   a. Enter the “Wage rate ($)”. The wage rate may be entered for any worker category in a material supply chain for any level of the supply chain. The table wage rate is always used unless a user defined wage rate is entered to override the default.
   b. Enter the “Benefits”. The benefits multiplier may be entered for any worker category in a material supply chain for any level of the supply chain. The table multiplier rate is always used unless a user defined multiplier rate is entered to override the default.

STEP 2 – Model Outputs

1) “v Output Results – By Money Source” provides the number of jobs calculated by where the money originates. Jobs are provided for each of the seven worker categories: officer, secretary, manager, receptionist, skilled, semi-skilled and unskilled. These jobs are divided into six categories: Materials (HC), Profit, Materials (OH), Equipment (OH), Other (OH), and Equipment (HC). Each

category is divided into three subcategories: Direct Jobs, Indirect Jobs, and Induced Jobs. Each subcategory is divided into three additional sub-subcategories: Profit, Overhead and Hard Cost. Jobs are reflected in the table at the sub-subcategory level. The table provides results for thirty-five iterations of money turn-over. In other words, the flow of money passing through the supply chain was calculated thirty-five times, where each subsequent "pass-thru" began with the supply chain remainder from the previous "pass-thru".

2) "vi Output Results – By Industrial Sector" provides the number of jobs calculated by where the job will occur in the ten levels of the supply chain. See the "Methodology" chapter for a description of the ten levels of the supply chain. Jobs are provided for each of the seven worker categories: officer, secretary, manager, receptionist, skilled, semi-skilled and unskilled. These jobs are divided into six categories: Materials (HC), Profit, Materials (OH), Equipment (OH), Other (OH), and Equipment (HC). Each category is divided into three subcategories: Direct Jobs, Indirect Jobs, and Induced Jobs. Each subcategory is divided into three additional sub-subcategories: Profit, Overhead and Hard Cost. Jobs are reflected in the table at the sub-subcategory level. The table provides results for thirty-five iterations of money turn-over. In other words, the flow of money passing through the supply chain was calculated thirty-five times, where each subsequent "pass-thru" began with the supply chain remainder from the previous "pass-thru".
3) "vii Output Summary – By Money Source" summarizes the results into an easy to read table for the ten levels of the supply chain. In addition, the results are summarized in a format that displays the jobs grouped by Project, Sales and Manufacturing, and Mining levels. This summary format can be described as the job factors between the three major levels of the supply chain.
4) "viii Output Summary – By Industrial Sector" summarizes the results into an easy to read table for the ten levels of the supply chain. In addition, the results are summarized in a format that displays the jobs grouped by Project, Sales and Manufacturing, and Mining levels. This summary format can be described as the job factors between the three major levels of the supply chain.
5) "ix By Money Source – Stacked" and "x By Industrial Sector – Stacked" summarize the results into an easy to read table for the thirty-five "pass-thru" iterations. In addition, the cumulative totals and the cumulative percent of totals are provided. The number of iterations necessary to achieve a certain percentage of the total number of jobs is found using these tables.
6) "xi Output Summary – Profit by Industrial Sector" provides the amount of total profit earned by all levels of the supply chain over all thirty-five "pass-thru" iterations. This sheet summarizes the results into an easy to read table for the ten levels of the supply chain. In addition, the results are summarized in a format that displays the profit grouped by Project, Sales and Manufacturing, and Mining levels. This summary format can be described as the profit factors between the three major levels of the supply chain.

APPENDIX B
DOLLAR-BREAKDOWN TEMPLATE

The dollar breakdown template demonstrates how dollars from the survey data have been categorized. Dollars could be placed in one of the following eight accounts: profit, overhead labor, overhead material, overhead equipment, overhead other, hard cost labor, hard cost material, and hard cost equipment. An example of the template has been provided in Figure B-1.

Description	Project Level								
Insulation	Contractor								
Residential Remodelers	Accounting Column	Profit	Overhead				Hard Costs (e.g. Production)		
NAICS #236118			L	M	E	Other	L	M	E
Sales									
Construction Work ***	2,764,248								
Other Revenues ***	16,226								
Total Sales	2,780,474								
Cost of Goods Sold (COGS)									
Labor:	906,134								
Construction Workers Payroll							254,660		
Fringe Benefits:									
Social Security, Medicare, FUTA, SUTA, Worker's Comp *							32,451		
Life/Medical Insurance, Pension, Welfare, Union Benefits *							15,042		
Work Subcontracted to Others ****							603,981		
Materials:	941,862								
Materials, Components and Supplies								941,862	
Equipment:	79,028								
Machinery Rental (75% Trucks and/or Construction Equipment) ******									6,107
Depreciation *****									36,665
Gasoline and Diesel Fuel									33,354
Other Fuels and Lubricants **									2,903
Total COGS	1,927,024								
Gross Margin	853,450								
Operating Expenses									
Sales Expenses:	45,181								
Computer Hrdwr & Equip					4,212				
Computer Software					3,529				
Data Processing & Comp Srv						1,383			
Communication Services						14,629			
Advertising and Promotional Services						21,428			
General Expenses:	210,653								
Utilities:									
Natural and Manufactured Gas **						4,294			
Purchased Electricity **						13,225			
Building Rental (25% Furniture, 75% Space)					4,379	13,138			
Machinery Rental (25% Office Equipment)					2,036				
Repair & Maintenance						5,207			
Refuse Removal						4,065			
Professional & Tech Srvcs						30,435			
Taxes & License Fees						15,884			
Other Expenses (25% Supplies; 75% Travel, Training, Transport, Insurance)				29,498		88,493			
Administrative Expenses:	305,551								
Administration and Project Managment Payroll			231,814						
Fringe Benefits:									
Social Security, Medicare, FUTA, SUTA, Worker's Comp *			29,540						
Life/Medical Insurance, Pension, Welfare, Union Benefits *			13,692						
Temp Staff and Leased Employees ****			30,505						
Total Operating Expenses	561,385								
Profit	292,065								
Total		292,065	305,551	29,498	14,156	212,181	906,134	941,862	79,028
Percent		10.5%	11.0%	1.1%	0.5%	7.6%	32.6%	33.9%	2.8%

Figure B-1. Dollar breakdown template

APPENDIX C
NAICS CODES FOR SUPPLY CHAINS

The following figures will show tables that provide the NAICS codes used in each supply chain. Figures C-1, C-2, and C-3 are for the hard cost materials used in insulation, doors /windows, and HVAC systems respectively. Figures C-4, C-5, C-6, C-7, and C-8 are for Hard Cost Equipment, Overhead Equipment, Overhead Material, Overhead Other, and Profit.

Supply Chain Level	2007 NAICS Code	Meaning of 2007 NAICS Code
1	236118	Residential Remodelers
2	238310	Drywall and Insulation Contractors
3	444100	Building Materials and Supplies Dealers
4	423330	Roofing, Siding and Insulation Material Merchant Wholesalers
5	327993	Mineral Wool Manufacturing
6	212311	Dimension Stone Mining and Quarrying
6	212312	Crushed and Broken Limestone Mining and Quarrying
6	212319	Other Crushed and Broken Stone Mining and Quarrying
6	212391	Potash, Soda and Borate Mineral Mining
6	212322	Industrial Sand Mining
6	212393	Other Chemical and Fertilizer Mineral Mining
6	322121	Paper (except newsprint) Mills
6	322211	Corrugated and Solid Fiber Box Manufacturing
6	322222	Coated and Laminated Paper Manufacturing
6	322224	Uncoated Paper and Multiwall Bag Manufacturing
6	322226	Surface-coated Paperboard Manufacturing
6	325131	Inorganic Dye and Pigment Manufacturing
6	325211	Plastics Material and Resin Manufacturing
6	325520	Adhesive Manufacturing
6	326111	Plastics Bag and Pouch Manufacturing
6	326113	Non-packaging Plastics Film and Sheet Manufacturing
6	327212	Other Pressed and Blown Glass and Glassware Manufacturing
6	327310	Cement Manufacturing
6	331111	Iron and Steel Mills
7	100	Agriculture (except livestock)
7	211	Oil and Gas Extraction

7	212	Mining (except oil and gas)
7	311	Food Manufacturing
7	313	Textile Mills
7	321	Wood Product Manufacturing
7	322	Paper Manufacturing
7	324	Petroleum and Coal Products Manufacturing
7	325	Chemical Manufacturing
7	326	Plastics and Rubber Products Manufacturing
7	327	Nonmetallic Mineral Product Manufacturing
7	331	Primary Metal Manufacturing
7	332	Fabricated Metal Product Manufacturing
7	333	Machinery Manufacturing
7	335	Electrical Equipment, Appliance and Component Manufacturing
8	10-11	Agriculture
8	21	Mining, Quarrying, and Oil and Gas Extraction (Including Support Activities of Exploration and Development)
8	31-33	Manufacturing
9	100	Agriculture (except livestock)
9	211	Oil and Gas Extraction
9	212	Mining (except oil and gas)
10	213	Support Activities for Mining

Figure C-1. Insulation

Supply Chain Level	2007 NAICS Code	Meaning of 2007 NAICS Code
1	236118	Residential Remodelers
2	238350	Finish Carpentry Contractors
3	444100	Building Materials and Supplies Dealers
4	423310	Lumber, Plywood, Millwork and Wood Panel Merchant Wholesalers
5	332321	Metal Window and Door Manufacturing
5	326199	All Other Plastics Product Manufacturing
5	321911	Wood Window and Door Manufacturing
6	313210	Broad-woven Fabric Mills
6	321113	Sawmills
6	321211	Hardwood Veneer and Plywood Manufacturing
6	321212	Softwood Veneer and Plywood Manufacturing
6	321219	Reconstituted Wood Product Manufacturing
6	321911	Wood Window and Door Manufacturing
6	321912	Cut Stock, Re-sawing Lumber and Planing

6	322110	Pulp Mills
6	322121	Paper (except newsprint) Mills
6	322130	Paperboard Mills
6	322211	Corrugated and Solid Fiber Box Manufacturing
6	322214	Fiber Can, Tube, Drum and Similar Products Manufacturing
6	325110	Petrochemical Manufacturing
6	325120	Industrial Gas Manufacturing
6	325131	Inorganic Dye and Pigment Manufacturing
6	325132	Synthetic Organic Dye and Pigment Manufacturing
6	325181	Alkalies and Chlorine Manufacturing
6	325188	All Other Basic Inorganic Chemical Manufacturing
6	325211	Plastics material and resin manufacturing
6	325212	Synthetic Rubber Manufacturing
6	325520	Adhesive Manufacturing
6	325991	Custom Compounding of Purchased Resins
6	326112	Plastics Packaging Film and Sheet Manufacturing
6	326121	Un-laminated Plastics Profile Shape Manufacturing
6	326199	All Other Plastics Product Manufacturing
6	327211	Flat Glass Manufacturing
6	327212	Other Pressed and Blown Glass and Glassware Manufacturing
6	331221	Rolled Steel Shape Manufacturing
6	331315	Aluminum Sheet, Plate and Foil Manufacturing
6	331316	Aluminum Extruded Product Manufacturing
6	331421	Copper Rolling, Drawing and Extruding
6	331511	Iron Foundries
6	331512	Steel Investment Foundries
6	331513	Steel Foundries (except investment)
6	331521	Aluminum Die-casting Foundries
6	331522	Nonferrous (except aluminum) Die-casting Foundries
6	331524	Aluminum Foundries (except die-casting)
6	331525	Copper Foundries (except die-casting)
6	331528	Other Nonferrous Foundries (except die-casting)
6	332111	Iron and Steel Forging
6	332112	Nonferrous Forging
6	332116	Metal Stamping
6	332510	Hardware Manufacturing
6	332722	Bolt, Nut, Screw, Rivet and Washer Manufacturing
6	332997	Industrial Pattern Manufacturing
6	332999	All Other Miscellaneous Fabricated Metal Product Manufacturing
6	333220	Plastics and Rubber Industry Machinery Manufacturing
6	333515	Cutting Tool and Machine Tool Accessory Manufacturing

6	334413	Semiconductor and Related Device Manufacturing
6	334417	Electronic Connector Manufacturing
6	334513	Industrial Process Variable Instruments
6	335314	Relay and Industrial Control Manufacturing
7	100	Agriculture (except livestock)
7	211	Oil and Gas Extraction
7	212	Mining (except oil and gas)
7	221	Utilities
7	311	Food Manufacturing
7	313	Textile Mills
7	321	Wood Product Manufacturing
7	322	Paper Manufacturing
7	324	Petroleum and Coal Products Manufacturing
7	325	Chemical Manufacturing
7	326	Plastics and Rubber Products Manufacturing
7	327	Nonmetallic Mineral Product Manufacturing
7	331	Primary Metal Manufacturing
7	332	Fabricated Metal Product Manufacturing
7	333	Machinery Manufacturing
7	334	Computer and Electronic Product Manufacturing
7	335	Electrical Equipment, Appliance and Component Manufacturing
8	10-11	Agriculture
8	21	Mining, Quarrying, and Oil and Gas Extraction (Including Support Activities of Exploration and Development)
8	22	Utilities
8	31-33	Manufacturing
9	100	Agriculture (except livestock)
9	211	Oil and Gas Extraction
9	212	Mining (except oil and gas)
10	213	Support Activities for Mining

Figure C-2. Doors/windows

Supply Chain Level	2007 NAICS Code	Meaning of 2007 NAICS Code
1	236118	Residential Remodelers
2	238220	Plumbing, Heating, and Air-conditioning Contractors
3	444100	Building Materials and Supplies Dealers
4	423730	HVAC Equipment Merchant Wholesalers
5	333415	AC, Refrigeration, and Forced Air Heating

6	322211	Corrugated and Solid Fiber Box Manufacturing
6	326100	Plastics Packaging Film/Sheet and Un-laminated Plastics Profile Shape Manufacturing
6	326199	All Other Plastics Product Manufacturing
6	326220	Rubber and Plastics Hoses and Belting Manufacturing
6	331221	Rolled Steel Shape Manufacturing
6	331315	Aluminum Sheet, Plate and Foil Manufacturing
6	331421	Copper Rolling, Drawing and Extruding
6	331510	Iron and Steel Foundries
6	331520	Aluminum, Copper and Non-ferrous Foundries, Including Aluminum and Non-ferrous Die-Casting
6	332000	Metal Stamping, Industrial Pattern, and Other Miscellaneous Fabricated Metal Product Manufacturing
6	332110	Iron, Steel, and Nonferrous Forging
6	332510	Hardware manufacturing
6	332722	Bolt, Nut, Screw, Rivet and Washer Manufacturing
6	332919	Other Metal Valve and Pipe Fitting Manufacturing
6	332991	Ball and Roller Bearing Manufacturing
6	334512	Automatic Environmental Control Manufacturing
6	335311	Power, Distribution and Specialty Transformer Manufacturing
6	335312	Motor and Generator Manufacturing
6	335931	Current-carrying Wiring Device Manufacturing
6	339991	Gasket, Packing and Sealing Device Manufacturing
7	100	Agriculture (except livestock)
7	212	Mining (except oil and gas)
7	313	Textile Mills
7	321	Wood Product Manufacturing
7	322	Paper Manufacturing
7	324	Petroleum and Coal Products Manufacturing
7	325	Chemical Manufacturing
7	326	Plastics and Rubber Products Manufacturing
7	327	Nonmetallic Mineral Product Manufacturing
7	331	Primary Metal Manufacturing
7	332	Fabricated Metal Product Manufacturing
7	333	Machinery Manufacturing
7	334	Computer and Electronic Product Manufacturing
7	335	Electrical Equipment, Appliance and Component Manufacturing
7	339	Miscellaneous Manufacturing
8	10-11	Agriculture
8	21	Mining, Quarrying, and Oil and Gas Extraction (Including Support Activities of Exploration and Development)

8	31-33	Manufacturing
9	100	Agriculture (except livestock)
9	212	Mining (except oil and gas)
10	213	Support Activities for Mining

Figure C-3. HVAC systems

Supply Chain Level	2007 NAICS Code	Meaning of 2007 NAICS Code
1	NA	NA
2	NA	NA
3	447000	Gasoline Stations
3	532000	Rental and Leasing Services
4	423800	Machinery, Equipment and Supplies Merchant Wholesalers
5	324110	Petroleum Refineries
5	324191	Petroleum Lubricating Oil and Grease Manufacturing
5	333120	Construction Machinery Manufacturing
5	333131	Mining Machinery and Equipment Manufacturing
5	333132	Oil and Gas Field Machinery and Equipment Manufacturing
5	333210	Sawmill and Woodworking Machinery Manufacturing
5	333220	Plastics and Rubber Industry Machinery Manufacturing
5	333295	Semiconductor Machinery Manufacturing
5	333511	Industrial Mold Manufacturing
5	333512	Machine Tool (metal cutting types) Manufacturing
5	333513	Machine Tool (metal forming types) Manufacturing
5	333514	Special Die and Tool, Die Set, Jig and Fixture Manufacturing
5	333515	Cutting Tool and Machine Tool Accessory Manufacturing
5	333516	Rolling Mill Machinery and Equipment Manufacturing
5	333518	Other Metalworking Machinery Manufacturing
5	333912	Air and Gas Compressor Manufacturing
5	333922	Conveyor and Conveying Equipment Manufacturing
5	333923	Overhead Cranes, Hoists and Monorail Systems
5	333924	Industrial Truck, Trailer and Stacker Manufacturing
5	333992	Welding and Soldering Equipment Manufacturing
5	333993	Packaging Machinery Manufacturing
5	333994	Industrial Process Furnace and Oven Manufacturing
6	211111	Crude Petroleum and Natural Gas Extraction
6	211112	Natural Gas Liquid Extraction
6	311222	Soybean Processing
6	311223	Other Oilseed Processing

6	311225	Fats and Oils Refining and Blending
6	322211	Corrugated and Solid Fiber Box Manufacturing
6	322212	Folding Paperboard Box Manufacturing
6	322213	Setup Paperboard Box Manufacturing
6	322214	Fiber Can, Tube, Drum and Similar Products Manufacturing
6	324110	Petroleum Refineries
6	324191	Petroleum Lubricating Oil and Grease Manufacturing
6	325110	Petrochemical Manufacturing
6	325120	Industrial Gas Manufacturing
6	325131	Inorganic Dye and Pigment Manufacturing
6	325132	Synthetic Organic Dye and Pigment Manufacturing
6	325181	Alkalies and Chlorine Manufacturing
6	325188	All Other Basic Inorganic Chemical Manufacturing
6	325211	Plastics Material and Resin Manufacturing
6	325212	Synthetic Rubber Manufacturing
6	325520	Adhesive Manufacturing
6	325991	Custom Compounding of Purchased Resins
6	325510	Paint and Coating Manufacturing
6	325998	Other Miscellaneous Chemical Product Manufacturing
6	326199	All Other Plastics Product Manufacturing
6	326211	Tire Manufacturing (except retreading)
6	326220	Rubber and Plastics Hoses and Belting Manufacturing
6	327999	Miscellaneous Nonmetallic Mineral Products
6	331221	Rolled Steel Shape Manufacturing
6	331311	Alumina Refining
6	331312	Primary Aluminum Production
6	331314	Secondary Smelting and Alloying of Aluminum
6	331315	Aluminum Sheet, Plate and Foil Manufacturing
6	331316	Aluminum Extruded Product Manufacturing
6	331319	Other Aluminum Rolling and Drawing
6	331421	Copper Rolling, Drawing and Extruding
6	331492	Secondary Processing of Other Nonferrous
6	331511	Iron Foundries
6	331512	Steel Investment Foundries
6	331513	Steel Foundries (except investment)
6	331521	Aluminum Die-casting Foundries
6	331522	Nonferrous (except aluminum) Die-casting Foundries
6	331524	Aluminum Foundries (except die-casting)
6	331525	Copper Foundries (except die-casting)
6	331528	Other Nonferrous Foundries (except die-casting)
6	332111	Iron and Steel Forging

6	332112	Nonferrous Forging
6	332116	Metal Stamping
6	332420	Metal Tank (heavy gauge) Manufacturing
6	332431	Metal Can Manufacturing
6	332439	Other Metal Container Manufacturing
6	332510	Hardware Manufacturing
6	332722	Bolt, Nut, Screw, Rivet and Washer Manufacturing
6	332911	Industrial Valve Manufacturing
6	332912	Fluid Power Valve and Hose Fitting Manufacturing
6	332919	Other Metal Valve and Pipe Fitting Manufacturing
6	332991	Ball and Roller Bearing Manufacturing
6	332997	Industrial Pattern Manufacturing
6	332999	All Other Miscellaneous Fabricated Metal Product Manufacturing
6	333515	Cutting Tool and Machine Tool Accessory Manufacturing
6	333612	Speed Changer, Drive, and Gear Manufacturing
6	333613	Mechanical Power Transmission Equipment Manufacturing
6	333618	Other Engine Equipment Manufacturing
6	333911	Pump and Pumping Equipment Manufacturing
6	333993	Packaging Machinery Manufacturing
6	333994	Industrial Process Furnace and Oven Manufacturing
6	333995	Fluid Power Cylinder and Actuator Manufacturing
6	333996	Fluid Power Pump and Motor Manufacturing
6	333999	All Other Miscellaneous General Purpose Machinery Manufacturing
6	334413	Semiconductor and Related Device Manufacturing
6	334418	Printed Circuit Assembly (electronic assembly) Manufacturing
6	335110	Electric Lamp Bulb and Part Manufacturing
6	335121	Residential Electric Lighting Fixture Manufacturing
6	335122	Nonresidential Electric Lighting Fixture Manufacturing
6	335129	Other Lighting Equipment Manufacturing
6	335222	Household Refrigerator and Home Freezer Manufacturing
6	335311	Power, Distribution and Specialty Transformer Manufacturing
6	335312	Motor and Generator Manufacturing
6	335313	Switchgear and Switchboard Apparatus Manufacturing
6	335314	Relay and Industrial Control Manufacturing
6	335911	Storage Battery Manufacturing
6	335912	Primary Battery Manufacturing
6	335921	Fiber Optic Cable Manufacturing
6	335929	Other Communication and Energy Wire Manufacturing
6	335931	Current-carrying Wiring Device Manufacturing
6	335932	Noncurrent-carrying Wiring Device Manufacturing
6	335991	Carbon and Graphite Product Manufacturing

6	335999	Miscellaneous Electrical Equipment Manufacturing
6	336111	Automobile Manufacturing
6	336322	Other Motor Vehicle Electric Equipment Manufacturing
6	336350	Motor Vehicle Transmission and Power Train Parts Manufacturing
6	339991	Gasket, Packing, and Sealing Device Manufacturing
7	100	Agriculture (except livestock)
7	211	Oil and Gas Extraction
7	212	Mining (except oil and gas)
7	221	Utilities
7	311	Food Manufacturing
7	313	Textile Mills
7	314	Textile Product Mills
7	321	Wood Product Manufacturing
7	322	Paper Manufacturing
7	324	Petroleum and Coal Products Manufacturing
7	325	Chemical Manufacturing
7	326	Plastics and Rubber Products Manufacturing
7	327	Nonmetallic Mineral Product Manufacturing
7	331	Primary Metal Manufacturing
7	332	Fabricated Metal Product Manufacturing
7	333	Machinery Manufacturing
7	334	Computer and Electronic Product Manufacturing
7	335	Electrical Equipment, Appliance and Component Manufacturing
7	336	Transportation Equipment Manufacturing
7	339	Miscellaneous Manufacturing
8	10-11	Agriculture
8	21	Mining, Quarrying, and Oil and Gas Extraction (Including Support Activities of Exploration and Development)
8	22	Utilities
8	31-33	Manufacturing
9	100	Agriculture (except livestock)
9	211	Oil and Gas Extraction
9	212	Mining (except oil and gas)
10	213	Support Activities for Mining

Figure C-4. Hard cost equipment

Supply Chain Level	2007 NAICS Code	Meaning of 2007 NAICS Code
1	NA	NA

2	NA	NA
3	447000	Gasoline Stations
3	453000	Miscellaneous Store Retailers
3	532000	Rental and Leasing Services
4	423200	Furniture and Home Furnishing Merchant Wholesalers
4	423400	Commercial Equipment Merchant Wholesalers
4	423800	Machinery, Equipment and Supplies Merchant Wholesalers
5	324110	Petroleum Refineries
5	324191	Petroleum Lubricating Oil and Grease Manufacturing
5	333120	Construction Machinery Manufacturing
5	333131	Mining Machinery and Equipment Manufacturing
5	333132	Oil and Gas Field Machinery and Equipment Manufacturing
5	333210	Sawmill and Woodworking Machinery Manufacturing
5	333220	Plastics and Rubber Industry Machinery Manufacturing
5	333295	Semiconductor Machinery Manufacturing
5	333511	Industrial Mold Manufacturing
5	333512	Machine Tool (metal cutting types) Manufacturing
5	333513	Machine Tool (metal forming types) Manufacturing
5	333514	Special Die and Tool, Die Set, Jig and Fixture Manufacturing
5	333515	Cutting Tool and Machine Tool Accessory Manufacturing
5	333516	Rolling Mill Machinery and Equipment Manufacturing
5	333518	Other Metalworking Machinery Manufacturing
5	333912	Air and Gas Compressor Manufacturing
5	333922	Conveyor and Conveying Equipment Manufacturing
5	333923	Overhead Cranes, Hoists and Monorail Systems
5	333924	Industrial Truck, Trailer and Stacker Manufacturing
5	333992	Welding and Soldering Equipment Manufacturing
5	333993	Packaging Machinery Manufacturing
5	333994	Industrial Process Furnace and Oven Manufacturing
5	334111	Electronic Computer Manufacturing
5	334112	Computer Storage Device Manufacturing
5	334113	Computer Terminal Manufacturing
5	334119	Other Computer Peripheral Equipment Manufacturing
5	334210	Telephone Apparatus Manufacturing
5	334220	Broadcast and Wireless Communications Equipment
5	334310	Audio and Video Equipment Manufacturing
5	337211	Wood Office Furniture Manufacturing
5	337214	Office Furniture (except wood) Manufacturing
5	337215	Showcase, Partition, Shelving and Locker Manufacturing
6	211111	Crude Petroleum and Natural Gas Extraction
6	211112	Natural Gas Liquid Extraction

6	311222	Soybean Processing
6	311223	Other Oilseed Processing
6	311225	Fats and Oils Refining and Blending
6	313210	Broad-woven Fabric Mills
6	313320	Fabric Coating Mills
6	314999	All Other Miscellaneous Textile Product Mills
6	321000	Aggregate of Sawmills, Hard/Soft Wood Veneer/Plywood, Reconstituted Wood Product, Wood Window/Door, Cut Stock, Re-sawing Lumber, and Planing Manufacturing
6	321211	Hardwood Veneer and Plywood Manufacturing
6	321219	Reconstituted Wood Product Manufacturing
6	321912	Cut Stock, Re-sawing Lumber, and Planing
6	321920	Wood Container and Pallet Manufacturing
6	322211	Corrugated and Solid Fiber Box Manufacturing
6	322212	Folding Paperboard Box Manufacturing
6	322213	Setup Paperboard Box Manufacturing
6	322214	Fiber Can, Tube, Drum and Similar Products Manufacturing
6	324110	Petroleum Refineries
6	324191	Petroleum Lubricating Oil and Grease Manufacturing
6	325110	Petrochemical Manufacturing
6	325120	Industrial Gas Manufacturing
6	325131	Inorganic Dye and Pigment Manufacturing
6	325132	Synthetic Organic Dye and Pigment Manufacturing
6	325181	Alkalies and Chlorine Manufacturing
6	325188	All Other Basic Inorganic Chemical Manufacturing
6	325211	Plastics Material and Resin Manufacturing
6	325212	Synthetic Rubber Manufacturing
6	325520	Adhesive Manufacturing
6	325991	Custom Compounding of Purchased Resins
6	325510	Paint and Coating Manufacturing
6	325520	Adhesive Manufacturing
6	325991	Custom Compounding of Purchased Resins
6	325998	Other Miscellaneous Chemical Product Manufacturing
6	326111	Plastics Bag and Pouch Manufacturing
6	326112	Plastics Packaging Film and Sheet Manufacturing
6	326113	Non-packaging Plastics Film and Sheet Manufacturing
6	326130	Laminated Plastics Plate, Sheet and Shapes
6	326150	Urethane and Other Foam Product Manufacturing
6	326199	All Other Plastics Product Manufacturing
6	326211	Tire Manufacturing (except retreading)
6	326220	Rubber and Plastics Hoses and Belting Manufacturing

6	327211	Flat Glass Manufacturing
6	327215	Glass Product Manufacturing Made of Purchased Glass
6	327999	Miscellaneous Nonmetallic Mineral Products
6	331221	Rolled Steel Shape Manufacturing
6	331311	Alumina Refining
6	331312	Primary Aluminum Production
6	331314	Secondary Smelting and Alloying of Aluminum
6	331315	Aluminum Sheet, Plate and Foil Manufacturing
6	331316	Aluminum Extruded Product Manufacturing
6	331319	Other Aluminum Rolling and Drawing
6	331421	Copper Rolling, Drawing and Extruding
6	331422	Copper Wire (except mechanical) Drawing
6	331492	Secondary Processing of Other Nonferrous
6	331511	Iron Foundries
6	331512	Steel Investment Foundries
6	331513	Steel Foundries (except investment)
6	331521	Aluminum Die-casting Foundries
6	331522	Nonferrous (except aluminum) Die-casting Foundries
6	331524	Aluminum Foundries (except die-casting)
6	331525	Copper Foundries (except die-casting)
6	331528	Other Nonferrous Foundries (except die-casting)
6	332111	Iron and Steel Forging
6	332112	Nonferrous Forging
6	332116	Metal Stamping
6	332117	Powder Metallurgy Part Manufacturing
6	332322	Sheet Metal Work Manufacturing
6	332420	Metal Tank (heavy gauge) Manufacturing
6	332431	Metal Can Manufacturing
6	332439	Other Metal Container Manufacturing
6	332510	Hardware Manufacturing
6	332722	Bolt, Nut, Screw, Rivet and Washer Manufacturing
6	332911	Industrial Valve Manufacturing
6	332912	Fluid Power Valve and Hose Fitting Manufacturing
6	332919	Other Metal Valve and Pipe Fitting Manufacturing
6	332991	Ball and Roller Bearing Manufacturing
6	332997	Industrial Pattern Manufacturing
6	332999	All Other Miscellaneous Fabricated Metal Product Manufacturing
6	333515	Cutting Tool and Machine Tool Accessory Manufacturing
6	333612	Speed Changer, Drive, and Gear Manufacturing
6	333613	Mechanical Power Transmission Equipment Manufacturing
6	333618	Other Engine Equipment Manufacturing

6	333911	Pump and Pumping Equipment Manufacturing
6	333993	Packaging Machinery Manufacturing
6	333994	Industrial Process Furnace and Oven Manufacturing
6	333995	Fluid Power Cylinder and Actuator Manufacturing
6	333996	Fluid Power Pump and Motor Manufacturing
6	333999	All Other Miscellaneous General Purpose Machinery Manufacturing
6	334111	Electronic Computer Manufacturing
6	334112	Computer Storage Device Manufacturing
6	334119	Other Computer Peripheral Equipment Manufacturing
6	334210	Telephone Apparatus Manufacturing
6	334220	Broadcast and Wireless Communications Equipment
6	334310	Audio and Video Equipment Manufacturing
6	334411	Electron Tube Manufacturing
6	334412	Bare Printed Circuit Board Manufacturing
6	334413	Semiconductor and Related Device Manufacturing
6	334414	Electronic Capacitor Manufacturing
6	334415	Electronic Resistor Manufacturing
6	334417	Electronic Connector Manufacturing
6	334418	Printed Circuit Assembly (electronic assembly) Manufacturing
6	334419	Other Electronic Component Manufacturing
6	334515	Electricity and Signal Testing Instruments
6	334611	Software Reproducing
6	335110	Electric Lamp Bulb and Part Manufacturing
6	335121	Residential Electric Lighting Fixture Manufacturing
6	335122	Nonresidential Electric Lighting Fixture Manufacturing
6	335129	Other Lighting Equipment Manufacturing
6	335222	Household Refrigerator and Home Freezer Manufacturing
6	335311	Power, Distribution and Specialty Transformer Manufacturing
6	335312	Motor and Generator Manufacturing
6	335313	Switchgear and Switchboard Apparatus Manufacturing
6	335314	Relay and Industrial Control Manufacturing
6	335911	Storage Battery Manufacturing
6	335912	Primary Battery Manufacturing
6	335921	Fiber Optic Cable Manufacturing
6	335929	Other Communication and Energy Wire Manufacturing
6	335931	Current-carrying Wiring Device Manufacturing
6	335932	Noncurrent-carrying Wiring Device Manufacturing
6	335991	Carbon and Graphite Product Manufacturing
6	335999	Miscellaneous Electrical Equipment Manufacturing
6	336111	Automobile Manufacturing
6	336322	Other Motor Vehicle Electric Equipment Manufacturing

6	336350	Motor Vehicle Transmission and Power Train Parts Manufacturing
6	337129	Wood Television, Radio, and Sewing Machine Cabinet Manufacturing
6	337215	Showcase, Partition, Shelving, and Locker Manufacturing
6	339991	Gasket, Packing, and Sealing Device Manufacturing
7	100	Agriculture (except livestock)
7	211	Oil and Gas Extraction
7	212	Mining (except oil and gas)
7	221	Utilities
7	311	Food Manufacturing
7	313	Textile Mills
7	314	Textile Product Mills
7	315	Apparel Manufacturing
7	321	Wood Product Manufacturing
7	322	Paper Manufacturing
7	324	Petroleum and Coal Products Manufacturing
7	325	Chemical Manufacturing
7	326	Plastics and Rubber Products Manufacturing
7	327	Nonmetallic Mineral Product Manufacturing
7	331	Primary Metal Manufacturing
7	332	Fabricated Metal Product Manufacturing
7	333	Machinery Manufacturing
7	334	Computer and Electronic Product Manufacturing
7	335	Electrical Equipment, Appliance and Component Manufacturing
7	336	Transportation Equipment Manufacturing
7	337	Furniture and Related Product Manufacturing
7	339	Miscellaneous Manufacturing
8	10-11	Agriculture
8	21	Mining, Quarrying, and Oil and Gas Extraction (Including Support Activities of Exploration and Development)
8	22	Utilities
8	31-33	Manufacturing
9	100	Agriculture (except livestock)
9	211	Oil and Gas Extraction
9	212	Mining (except oil and gas)
10	213	Support Activities for Mining

Figure C-5. Overhead equipment

Supply Chain Level	2007 NAICS Code	Meaning of 2007 NAICS Code
1	NA	NA
2	NA	NA
3	453000	Miscellaneous Store Retailers
4	424100	Paper and Paper Product Merchant Wholesalers
5	322231	Die-cut Paper and Paperboard Office Supplies Manufacturing
5	322232	Envelope Manufacturing
5	322233	Stationery, Tablet and Related Product Manufacturing
5	339941	Pen and Mechanical Pencil Manufacturing
5	339942	Lead Pencil and Art Good Manufacturing
5	339943	Marking Device Manufacturing
5	339944	Carbon Paper and Inked Ribbon Manufacturing
6	313210	Broad-woven Fabric Mills
6	313320	Fabric Coating Mills
6	314999	All Other Miscellaneous Textile Product Mills
6	321000	Aggregate of Sawmills, Hard/Soft Wood Veneer/Plywood, Reconstituted Wood Product, Wood Window/Door, Cut Stock, Re-sawing Lumber, and Planing Manufacturing
6	322100	Aggregate of Pulp Mills, Paper, and Paperboard Mills
6	322120	Aggregate of Paper and Newsprint Mills
6	322210	Aggregate of Corrugated/Solid Fiber Box and Fiber Can, Tube, Drum, and Similar Products Manufacturing
6	324100	Aggregate of Petroleum Refineries, Lubricating Oil/Grease, and All Other Petroleum/Coal Products Manufacturing
6	325000	Aggregate of Inorganic Dye and Pigment Manufacturing
6	325130	Aggregate of Inorganic and Synthetic Organic Dye and Pigment Manufacturing
6	325520	Adhesive Manufacturing
6	325910	Printing Ink Manufacturing
6	326100	Aggregate of Plastics Bag/Pouch and Non-packaging Plastics Film and Sheet Manufacturing
6	332000	Iron/Steel/Nonferrous Forging, Metal Stamping, Hardware, Bolt/Nut/Screw/Rivet/Washer, Industrial Pattern, and Other Miscellaneous Fabricated Metal Product Manufacturing
6	339941	Pen and Mechanical Pencil Manufacturing
7	100	Agriculture (except livestock)
7	211	Oil and Gas Extraction
7	212	Mining (except oil and gas)
7	311	Food Manufacturing
7	313	Textile Mills

7	321	Wood Product Manufacturing
7	322	Paper Manufacturing
7	324	Petroleum and Coal Products Manufacturing
7	325	Chemical Manufacturing
7	326	Plastics and Rubber Products Manufacturing
7	327	Nonmetallic Mineral Product Manufacturing
7	331	Primary Metal Manufacturing
7	332	Fabricated Metal Product Manufacturing
7	333	Machinery Manufacturing
7	335	Electrical Equipment, Appliance and Component Manufacturing
7	339	Miscellaneous Manufacturing
8	10-11	Agriculture
8	21	Mining, Quarrying, and Oil and Gas Extraction (Including Support Activities of Exploration and Development)
8	31-33	Manufacturing
9	100	Agriculture (except livestock)
9	211	Oil and Gas Extraction
9	212	Mining (except oil and gas)
10	213	Support Activities for Mining

Figure C-6. Overhead material

Supply Chain Level	2007 NAICS Code	Meaning of 2007 NAICS Code
ALL	22	Utilities (22)
ALL	48-49	Transportation and Warehousing (48 and 49)
ALL	517	Telecommunications (517)
ALL	518	Internet Service Providers, Web Search Portals, and Data Processing Services (518)
ALL	521	Monetary Authorities (e.g. Central Banks) (521)
ALL	522	Credit Intermediation and Related Activities (522)
ALL	524	Insurance Carriers and Related Activities (524)
ALL	531	Real Estate (i.e. Building Rentals) (531)
ALL	532	Rental and Leasing Services (e.g. Machinery Rentals) (532)
ALL	54	Professional, Scientific, and Technical Services (54)
ALL	561	Administrative and Support Services (e.g. Travel Agency) (561)
ALL	562	Waste Management and Remediation Services (562)
ALL	61	Educational Services (61)
ALL	81	Other Services (i.e. Repair and Maintenance) (81)

ALL	NA	Aggregate of Florida State and Local Governments (N/A)

Figure C-7. Overhead other

Supply Chain Level	2007 NAICS Code	Meaning of 2007 NAICS Code
ALL	10-11	Agriculture (crops and livestock)
ALL	21	Mining, Quarrying, and Oil and Gas Extraction (Including Support Activities of Exploration and Development)
ALL	22	Utilities
ALL	23	Construction
ALL	31-33	Manufacturing
ALL	42	Wholesale Trade
ALL	44	Retail Trade
ALL	48-49	Transportation and Warehousing
ALL	51	Information Services
ALL	52	Finance and Insurance
ALL	53	Real Estate and Rental Leasing Services
ALL	54	Professional, Scientific, and Technical Services
ALL	56	Administrative and Support and Waste Management and Remediation Services
ALL	61	Educational Services
ALL	62	Health Care and Social Assistance
ALL	71	Arts, Entertainment, and Recreation
ALL	72	Accommodation and Food Services
ALL	81	Other Services (i.e. Repair and Maintenance)

Figure C-8. Profit

LIST OF REFERENCES

Berry, L. (1997). *State-level Evaluations of the Weatherization Assistance Program in 1990-1994: A Metaevaluation that Estimates National Savings,* ORNL/CON-435, Oak Ridge National Laboratory, Department of Energy, Oak Ridge, Tenn.

Cox, A. and Townsend, M. (1998). *Strategic Procurement in Construction: Towards Better Practice in the Management of Construction Supply Chains*, Vol. 1, 1st ed., Thomas Telford Publishing, London. In: London, K. (2008). *Construction Supply Chain Economics,* Taylor and Francis Group, London and New York.

Davis, S., Haltiwanger, J., and Schub, S. (1996). *Job Creation and Destruction,* The MIT Press, Cambridge, Massachusetts, pp. xviii-62.

Economic Opportunity Studies, Inc. (2009). "How many workers does the weatherization assistance program employ now? What jobs will the Recovery Act offer?" < http://www.opportunitystudies.org/repository/File/weatherization/WAP_Workforce_Scenarios.pdf > (Jan. 20, 2011).

Fei Liu, H. and Emrath, P. (2008). *The Direct Impact of Home Building and Remodeling on the U.S.Economy,* National Association of Home Builders, Washington, D.C.

Fobair, R. (2009). *Job Creation Calculator: Assessing the Potential of Energy Conservation Investments,* M.S. Thesis, University of Florida, Gainesville, Fla.

Fobair, R. and Kibert, C. (2011). "Assessing Non-monetized Benefits of an Energy Efficiency Retrofit: A Job Forecasting Methodology for Use in Policy Making and Evaluations." Proc., SB11 Helsinki – World Sustainable Building Conference, Helsinki, Finland, October 17-21, 2011.

Fuller, S. (2007). *The Contribution of Office, Industrial and Retail Development and Construction on the U.S. Economy,* National Association of Industrial and Office Properties Research Foundation, Herndon, Va.

Fuller, M., Kunkel, C., Zimring, M., Hoffman, I., Soroye, K., and Goldman, C. (2010). *Driving Demand for Home Improvements: Motivating residential customers to invest in comprehensive upgrades that eliminate energy waste, avoid high bills, and spur the economy,* LBNL-3960E, Lawrence Berkeley National Laboratory, Environmental Energy Technologies Division. < http://eetd.lbl.gov/EAP/EMP/reports/lbnl-3960e-print.pdf > (Jan. 20, 2011).

Goldberg, M., Sinclair, K., and Milligan, M. (2004). *Job and Economic Development Impact Model (JEDI): A User-Friendly Tool to Calculate Economic Impacts from Wind Projects,* NREL/CP-500-35953, National Renewable Energy Laboratory, Golden, Co. <

http://www.eere.energy.gov/windandhydro/windpoweringamerica/pdfs/35953_jedi.pdf. > (Jan 20,2011).

Groak, S. (1994). “Is construction an industry? Notes towards a greater analytic emphasis on external linkages.” *Journal of Construction Management and Economics,* 12, 287-293. In: London, K. (2008). *Construction Supply Chain Economics,* Taylor and Francis Group, London and New York.

Jeeninga, H., et al. (1999). *Employment Impacts of Energy Conservation in the Residential Sector,* ECN-C—99-082, SAVE Employment Project for the Commission of the European Communities, Directorate-General for Energy, Netherlands.

Kaiser, M., Olatubi, W., and Pulsipher, A. (2004). *The Projected Impact of Energy Conservation Legislation*: *The Louisiana Fund*, Center for Energy Studies, Louisiana State University, Baton Rouge, La.

Kibert, C., Fobair, R., and Sullivan, J. (2011). “Assessing the Job Creation Potential of Energy Conservation Investments.” *Journal of Green Building*, 6(2), 156-169.

Laitner, S. (1996). *The Jobs Connection: Energy Use and Local Economic Development,* DOE/GO-10096-342, American Council for an Energy-Efficient Economy, National Renewable Energy Laboratory, Golden, Co.

London, K. (2008). *Construction Supply Chain Economics,* Taylor and Francis Group, London and New York.

Lovins, A. (2004). "Energy Efficiency, Taxonomic Overview", *Encyclopedia of Energy,* Vol. 2, San Diego and Oxford (UK), pp. 383-401. In: Rocky Mountain Institute, Publication #E04-02. < http://www.rmi.org/Knowledge-Center/Library/E04-02_EnergyEfficiencyTaxonomicOverview > (Jan 20, 2011).

Mills, E. and Rosenfeld, A. (1996). “Consumer Non-Energy Benefits as a Motivation for Making Energy-Efficiency Improvements.” *Energy-The International Journal,* 21, 7/8, 707-720.

Office of Management and Budget (OMB). (2007). *North American Industry Classification System (NAICS),* Executive Office of the President, Washington, D.C.

Regional Economic Models, Inc. (REMI). (2011). “The REMI Model.” < http://www.remi.com/index.php?page=model&hl=en_US > (Jan 17, 2011).

Scanla, V. (2010). “What is a deep energy retrofit? Experts at the NESEA Conference Respond.” *Energy Circle Pro,* March 11, 2010. < http://www.energycircle.com/blog/2010/03/11/what-deep-energy-retrofit-experts-nesea-conference-respond > (Jan 20, 2011).

Schweitzer, M. and Tonn, B. (2002). *Nonenergy Benefits from the Weatherization Assistance Program: A Summary of Findings from the Recent Literature,* ORNL/CON-484, Oak Ridge National Laboratory, Department of Energy, Oak Ridge, Tenn.

Sterzinger, G. (2006). *Jobs and Renewable Energy Project,* Renewable Energy Policy Project (REPP), Washington, D.C.

The Statewide Low-Income Collaborative Evaluation (SLICE) of Iowa. (1994). *An Evaluation of Iowa's Low-income Weatherization Efforts*, Wisconsin Energy Conservation Corporation. In: Berry, L. (1997). *State-level Evaluations of the Weatherization Assistance Program in 1990-1994: A Metaevaluation that Estimates National Savings,* ORNL/CON-435, Oak Ridge National Laboratory, Department of Energy, Oak Ridge, Tenn.

Tonn, B. and Peretz, J. (2007). "State-level benefits of energy efficiency." *Energy Policy,* 35, 3665-3674.

U.S. Bureau of Labor Statistics (USBLS). (2007). "May 2007 OES Estimates." < http://www.bls.gov/oes/oes_dl.htm > (June 24, 2011).

U.S. Bureau of Labor Statistics (USBLS). (2010). "Green Jobs." < http://www.bls.gov/green/ > (Dec. 29, 2011).

U.S. Bureau of Labor Statistics (USBLS). (2011a). "National Compensation Survey." < http://www.bls.gov/ncs/ncswage2010.htm > (Dec. 29, 2011).

U.S. Bureau of Labor Statistics (USBLS). (2011b). "National Compensation Survey, Employer Costs for Employee Compensation Historical Listing March 2004 – March 2011." Washington, D.C.

U.S. Census Bureau (USCB). (2006). *Current Population Survey, Design and Methodology,* Technical Paper 66, Washington, D.C. < http://www.census.gov/prod/2006pubs/tp-66.pdf > (Dec. 29, 2011).

U.S. Census Bureau (USCB). (2007a). *2007 Economic Census,* Washington, D.C. < http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=ECN&_tabId=ECN1&_submenuId=datasets_4&_lang=en&_ts=246366688395 > (Jan. 20, 2011).

U.S. Census Bureau (USCB). (2007b). *2007 Census of Governments*, Washington, D.C. < http://www.census.gov/govs/cog/ > (June 15, 2011).

U.S. Census Bureau (USCB). (2009). *2009 Service Annual Survey,* Washington, D.C. < http://www.census.gov/services/sas/historic_data.html > (June 21, 2011).

U.S. Census Bureau (USCB). (2011). *American Time Use Survey User's Guide*, Understanding ATUS 2003 to 2010, Washington, D.C. < http://www.bls.gov/tus/atususersguide.pdf > (Dec. 29, 2011).

U.S. Department of Agriculture (USDA). (2007). *2007 Census of Agriculture,* Washington, D.C. < http://www.agcensus.usda.gov/Publications/2007/Full_Report/index.asp > (June 21, 2011).

U.S. Department of Labor (USDOL). (2009). "WHD Information Related to the American Recovery and Reinvestment Act of 2009." Washington, D.C. < http://www.dol.gov/whd/recovery/#Survey > (Jan. 20, 2011).

U.S. Government Accountability Office (USGAO). (2005). "A Glossary of Terms Used in the Federal Budget Process." GAO-05-734SP, Washington, D.C. < http://www.gao.gov/new.items/d05734sp.pdf > (Dec. 29, 2011).

Warren, M. (1993). *Economics for the Built Environment*, Butterworth Heinnemann, Oxford, UK. In: London, K. (2008). *Construction Supply Chain Economics*, Taylor and Francis Group, London and New York.

Weatherization Assistance Program Technical Assistance Center (WAPTAC). (2009). "Weatherization Assistance Program Overview", Website updated: July 7, 2009. <http://www.waptac.org/sp.asp?mc=what_overview_program> (Oct. 11, 2009).

White House. (2009a). "Estimates of Job Creation from the American Recovery and Reinvestment Act of 2009." *Executive Office of the President Council of Economic Advisors*, Washington, D.C. < http://www.whitehouse.gov/administration/eop/cea/Estimate-of-Job-Creation/ > (Dec. 29, 2011).

White House. (2009b). "Recovery through Retrofit." Middle Class Task Force, Council on Environmental Quality, Washington, D.C. < http://www.whitehouse.gov/assets/documents/Recovery_Through_Retrofit_Final_Report.pdf > (Dec. 29, 2011).

Wiltshire, V., Jones, E., King, C., Jenkins, T., and Barry, R. (1998). *Green Job Creation in the UK,* London. In: "Awareness Campaign for Green Job Creation in the European Union", European Commission DGXI Unit A2, project no: 306/68/24.4.96, London.

BIOGRAPHICAL SKETCH

Richard Fobair II studied for his Doctor of Philosophy degree in the M.E. Rinker, Sr. School of Building Construction at the University of Florida. His committee included chairman Charles Kibert, Ph.D., P.E. and members James Sullivan, Ph.D., Paul Oppenheim, Ph.D., P.E., and Herbert Ingley, Ph.D., P.E. He has been published in the Journal of Green Building and presented his research at the SB-11 Helsinki World Sustainable Building Conference.

Richard's research interests include sustainable construction, sustainable material selection, building rating systems, effects of building rating systems on real estate valuation, and job creation throughout supply chains from investments in energy efficiency. He teaches at the University of Florida and Santa Fe College, where his courses include Construction Estimating I, Construction Mechanics, Structural Design, Construction Materials, and Building Codes and Regulations. Additionally, he has been a lecturer in the following courses: Leadership and Management, High Performance Building Systems, and Sustainable Construction. Richard holds a Master of Science in Building Construction, Master of Arts in Real Estate and Urban Analysis, and Bachelor of Arts in Political Science degree from the University of Florida. His concentrations were sustainable construction and urban planning.

Professional work experience includes eight years of commercial construction experience managing hospital, school, jail and courthouse projects, and two years of residential construction experience as the owner of a small contracting business. Currently, Richard teaches courses on green building and Leadership in Energy and Environmental Design (LEED) to building industry professionals throughout Florida.

Richard is a licensed certified general contractor and real estate sales person. Additionally, he is a U.S. Green Building Council (USGBC) LEED Accredited Professional (LEED – AP, BD&C).