Tracing the Economic Ripple of Commercial Building Retrofits Through Input-Output Modeling

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ABSTRACT

Investments in energy efficiency retrofits reduce energy use and costs. What is not apparent is how these investments stimulate broader economic activity. This study uses an input-output (IO) modeling framework to estimate how spending on commercial retrofits influences local economies and extends to surrounding counties and states.

An IO model traces how dollars spent in one sector such as remodeling or retrofitting, circulate through the economy by mapping inter-industry linkages. It captures three layers of impact: direct spending on labor and materials, indirect effects on suppliers, and induced effects from household re-spending of income. Using region-specific multipliers, the analysis quantifies resulting changes in employment, labor income and output, and value-add (contribution to the gross domestic product).

Results show that $2.5 billion investments in commercial retrofits generate approximately $6.9 billion in total economic output, supporting more than 30,000 jobs and producing measurable gains in labor income and public revenues. Indirect and induced effects account for a large share of total impacts, reflecting the role of supply chains and household spending in amplifying initial investments. The findings highlight how retrofit programs extend beyond energy savings to generate broader economic activity across regions.

Keywords: Commercial building retrofits, energy efficiency investment, input-output model, economic impact analysis, economic multipliers.

Introduction

Building retrofits are used to improve the performance of existing buildings and reduce energy use. In commercial buildings, common measures include insulation upgrades, air sealing, window replacement, and improvements to heating, ventilation, and air conditioning systems. These measures reduce energy consumption and operating costs. They can also improve indoor environmental quality and comfort. The current literature examines the performance of retrofit measures and their energy savings (Clinch and Healy 2001; Olatunde et al. 2024; Papadakis and Katsaprakakis 2023), leaving a gap in understanding how such investments ripples through the economy, which this study seeks to address.

Most studies focus on technical outcomes including changes in energy use, building system performance, and equipment efficiency. Reviews of retrofit interventions often discuss building envelope improvements and efficient HVAC technologies as common strategies for improving building performance (Olatunde et al. 2024; Papadakis et al. 2023). Some studies also examine the cost-benefit analysis of domestic energy efficiency measures (Clinch and Healy 2001). Federal and state programs have supported large-scale retrofit investments in the United States and have published the program impact (Tonn et al. 2014; U.S. Department of Energy 2024). Most prior studies have focused on building-level outcomes such as energy savings and energy cost savings. For example, comprehensive retrofits of commercial buildings can reduce energy use by up to 15-40% (Srivastava and Mah 2022). The cost of electricity saved through commercial and industrial utility efficiency programs has been estimated at approximately \$0.025/kWh, compared with \$0.021/kWh for residential programs (Goldman et al.2020). Despite these benefits, commercial retrofit activity remains limited, with only about 0.95% of small commercial buildings retrofitted annually (Sherman et al. 2021) and approximately 2.2% of total commercial building floor area undergoing renovation each year (Kwatra and Essig 2014).

However, these efforts provide limited insight into the broader economic activity generated by such investments across industries and regions. In contrast, this study examines the economy-wide impacts of commercial building retrofit expenditures. The results represent macroeconomic activity supported by retrofit investments and should not be interpreted as building-level energy savings, utility bill reductions, or project-level benefit-cost ratios.

In the United States, investments in commercial energy efficiency improvements from federal programs, utilities, and state initiatives together approach roughly \$2.5 billion annually in 2022 (CEE 2023). Retrofit projects require spending on labor, equipment, materials, and professional services. Spending in one sector leads to activity in supplier industries and through household consumption. Therefore, retrofit expenditures create demand across multiple industries as contractors purchase materials and equipment from suppliers and workers spend their wages, generating additional economic activity beyond the initial investment (Garrett-Peltier 2017).

This scale of \$2.5 billion investment in commercial building retrofits calls for examining the economic ripple effects generated across the broader economy. This study examines economy-wide effects using an IO modeling framework. IO models describe how industries are connected through production and purchasing relationships. This study uses the IMPLAN system to estimate the economic outcomes of commercial retrofit investments in the United States[1]. The analysis models a one-time \$2.5 billion annual investment in 2022 in commercial retrofits. The investment is allocated across industries related to installation services, equipment manufacturing, building materials production, professional services, and distribution activities. The model estimates the resulting impacts on jobs, labor income, economic output, and GDP.

2. Methodology

2.1 IO modeling framework

This study uses an IO modeling framework to estimate economic activity associated with commercial retrofit investments. IO models describe how industries are connected through

[1] The IO model and IO data information detail can be accessed here- https://implan.com/economic-impact-analysis/

production and purchasing relationships. Each industry purchases goods and services from other industries to produce its output. These relationships are represented in a transactions table that shows how industries supply inputs to one another (Leontief 1936, Miller and Blair 2009).

The basic structure of an IO model can be written as

$$x_i = \sum_{j=1}^{n} z_{ij} + f_i$$

where x_i represents the total output of industry i, z_{ij} represents intermediate purchases from industry i by industry j, and f_i represents final demand for the output of industry i.

These intermediate transactions can be converted into technical coefficients that represent the amount of input required from one industry to produce a unit of output in another industry:

$$a_{ij} = \frac{z_{ij}}{x_j}$$

Using these coefficients, the production relationships in the economy can be written in matrix form as

$$x = Ax + f$$

Solving this system gives

$$x = (I - A)^{-1} f$$

where I is the identity matrix and $(I-A)^{-1}$ is the Leontief inverse.

The Leontief inverse captures both the direct production required to satisfy final demand and the additional production generated through inter-industry linkages. A change in final demand in one sector leads to a sequence of transactions throughout the economy as industries purchase input from suppliers and suppliers purchase input from other suppliers. The magnitude of these interdependencies is reflected in the elements of the Leontief inverse matrix, which quantify the total production required across all industries to support a given level of final demand. In the context of commercial retrofit investments, the framework allows the estimation of how spending on construction activities, equipment, materials, and professional services propagates through supply chains and generates broader economic activity beyond the initial investment.

IO models are widely used to evaluate the economic effects of investments and policy programs. The model traces how spending flows through supplier industries and through household consumption (Miller and Blair 2009; Garrett-Peltier 2017). Figure 1 illustrates the relationships among key economic impact metrics, showing how labor income, value added, and output are constructed from their underlying components.

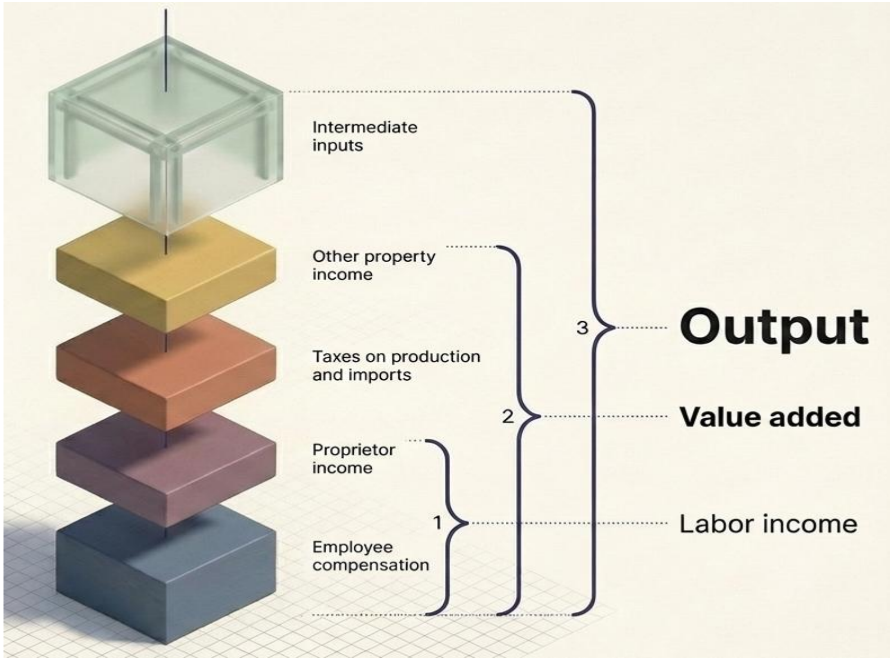

Figure 1. A unified view of how the elements of economic impact sequentially stack and nest to form aggregate macroeconomic metrics.

The analysis in this study uses the IMPLAN tool (implan.com) to examine investment in retrofits in commercial buildings in the US using the IO model[2]. IMPLAN traces how spending moves through the economy and estimates the cumulative effects of that spending across industries. The IO model is based on input-output tables developed by the Bureau of Economic Analysis, which describe production relationships among industries and commodities (Horowitz and Planting 2009). These tables provide the foundation for estimating how spending in one sector leads to activity in other sectors.

2.2 Economic impact categories and model selection

Economic impacts estimated with an IO model are usually grouped into three categories.

- Direct effects represent the economic activity generated by the initial investment.
- Indirect effects represent activity generated when industries purchase goods and services from suppliers.
- Induced effects represent activity created when workers spend their wages in the economy.

Together these effects show how spending moves through supply chains and household consumption. As described in section 2.1, this study uses the IMPLAN tool to implement the IO model using the economic input framework for the commercial retrofit investment scenario.

[2] For more information on the IMPLAN modeling process, visit IMPLAN.com

The Leontief inverse provides the basis for estimating economic multipliers. Multipliers summarize the total economy-wide response to an initial expenditure and reflect the interconnectedness of industries through production and purchasing relationships. For a given economic indicator, the multiplier can be calculated as,

$$\mathrm{M} = \frac{(\text{Direct} + \text{Indirect} + \text{Induced})}{\text{Direct Impact}}$$

where 'M' represents the corresponding output, employment, labor income, or value-added multiplier. Multipliers greater than one indicate that the initial investment generates additional economic activity beyond the directly affected industries through supply-chain transactions and household spending.

The IO framework is selected because it aligns with the objective of estimating the short-run economic effects of a defined investment scenario in commercial retrofits. The analysis focuses on how a fixed level of spending propagates through supplier industries and household consumption using observed industry relationships. The IO approach is well suited for this purpose because it uses nationally consistent data and requires relatively few assumptions about behavioral responses. In contrast, computable general equilibrium models allow prices, wages, and production patterns to adjust, but require detailed parameterization and additional assumptions that are not necessary for a scenario-based analysis of a single investment shock. However, the scale of the modeled $2.5 billion investment is small relative to the overall U.S. economy (which was $25.46 trillion in 2022) and hence unlikely to alter production relationships or prices. Therefore, IO modeling is appropriate approach for this analysis, avoiding additional model complexity that is unlikely to materially affect the estimated impacts.

Under the linear structure of the IO model, an increase in investment by a given percentage leads to a proportional increase in estimated output, employment, and income. As such, IO models have limitations. The model assumes that industries use inputs in fixed proportions. Similarly, it does not capture changes in technology or substitution among inputs when prices change. The framework also assumes that industries can meet additional demand without capacity constraints. Because of these assumptions, the results represent estimates of economic activity associated with a short-term investment rather than long-term economic adjustments (Miller and Blair 2009).

2.3 Commercial retrofit investment scenario

To examine the economic effects of commercial retrofit spending, the analysis models an investment of $2.5 billion in the year 2022 in commercial building energy-efficiency improvements spent in 2022. This value is based on commercial-sector energy efficiency programs' expenditures reported from 2010-2022 by the Consortium for Energy Efficiency (CEE 2023). The reported expenditure level is used as a reference investment scenario for the economic impact analysis [3]. This investment level reflects the approximate scale of combined

[3] CEE's estimates of utility demand-side management expenditures are based on data reported by utilities to the U.S. Energy Information Administration (EIA). Data source: Figure 2 in (CEE 2023) accessed from https://cee1.org/program-insights/annual-industry-reports/ for 2023.

annual spending from over 1700 electricity utilities and power marketers that support commercial electric efficiency programs across the U.S. (EIA-861)[4]. The reference annual investment considered for this study does not include 179D tax deduction, loans, rebates and other financial assistance presented in detail in Doughty (2023).[5].

Commercial retrofit projects typically involve several types of expenditure. These include contractor labor, equipment purchases, building materials, professional services, and distribution activities within supply chains. The investment scenario therefore allocates spending across industries that correspond to these components.

- The largest share of spending is assigned to the maintenance and repair construction of the non-residential structures sector. This sector represents on site installation activities such as air sealing, insulation installation, duct sealing, window replacement, and HVAC installation.
- Equipment manufacturing is represented through the air conditioning, refrigeration, and warm air heating equipment manufacturing sector. This sector captures the production of HVAC systems commonly installed during retrofit projects.
- Building envelope upgrades are represented through the metal window and door manufacturing sector. Replacement windows and exterior doors are frequently installed during retrofit projects.
- Technical services are represented through architectural, engineering, and related services. These services include building audits, retrofit design, and other professional activities related to project planning.
- Material inputs such as insulation products and sealing materials are represented through other plastics product manufacturing. Distribution activities within supply chains are represented through retail building material stores and wholesale appliance distribution sectors.

2.4 Sector allocation and economic indicators

The $2.5 billion retrofit investment is allocated across seven industries that represent typical components of commercial retrofit projects. These sectors include installation services, equipment manufacturing, building materials production, professional services, and supply chain distribution. Table 1 presents the industries included in the model and the share of total investment assigned to each sector. The allocation reflects bounded expert judgement based upon sparse and widely varied data related to the typical structure of retrofit/renovation expenditures in commercial buildings in North America.

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[4] Annual electric power industry report from the form EIA-861 for 2022 collected information on electric efficiency improvement program available at https://www.eia.gov/electricity/data/eia861/ compiled by CEE, 2023.

[5] Although information on tax credits, rebates, and other financial incentives can be obtained from multiple sources, no comprehensive dataset currently consolidates annual spending across these programs. Therefore, these expenditures are not incorporated in this analysis. However, IO model outcomes typically vary linearly with the level of investment, indicating that the results may be approximately proportional.

Because no comprehensive national dataset reports the distribution of commercial retrofit expenditures across economic sectors, the allocation is developed using bounded expert judgement, engineering experience of a typical composition of retrofits projects in the US. Within research around building renovation/retrofit even the % cost split between simple “labor” and “materials” varies considerably between projects. Based on these considerations, this study assumes a cost split of 53% labor (45% direct, 8% indirect) and 47% materials (35% production, 12% distribution). These shares are intended to provide a representative investment scenario for the economic impact analysis and not project-specific cost estimates.

Table 1. Modeled industry allocation of the $2.5 billion commercial retrofit investment scenario

Sr.	Sector Name	Retrofit activities represented	% share	Investment ($)
1	Maintenance and repair construction of non-residential structures	Contractor labor for retrofit installation, air sealing, insulation installation, duct sealing, equipment installation, minor building repairs	45%	$1125M
2	Air conditioning, refrigeration, and warm air heating equipment manufacturing	Manufacturing heat pumps, furnaces, air conditioners, ventilation equipment	15%	$375M
3	Metal window and door manufacturing	Production of replacement windows, exterior doors, framing components used in retrofit projects	12%	$300M
4	Architectural, engineering, and related services	Energy audits, retrofit design, building performance assessment, engineering services	8%	$200M
5	Other plastics product manufacturing	Foam insulation products, plastic building components, sealing materials, fiberglass, mineral wool etc.	8%	$200M
6	Retail – Building material and supply stores	Distribution of building materials, insulation products, sealing materials, hardware	7%	$175M
7	Wholesale – Household appliances and electrical and electronic goods	Distribution of HVAC equipment and appliances through contractor supply chains	5%	$125M
		Total	%	$2500 M

The analysis uses the national IMPLAN dataset to estimate the economic activity associated with this investment scenario. The model traces how the initial spending generates additional economic activity through supplier purchases and household spending.

The results are reported using four economic indicators. Employment represents the number of job-years supported by investment reported as jobs created. Labor income includes wages and salaries earned by workers. Output represents the total value of production generated in the economy. Value added represents the contribution to gross domestic product generated by the investment.

The analysis models a one-time $2.5 billion commercial energy-efficiency retrofit investment using the 2022 national input-output framework. The investment amount is allocated across relevant industry sectors according to the spending shares shown in Table 1. The 2022 IMPLAN dataset was used because it was the most recent complete national input-output dataset available at the time of analysis. All investment values are expressed in 2026 dollars to facilitate interpretation of the results in current dollar terms. Employment impacts are not equal to full-time equivalents[6]. Therefore, the estimated employment impacts represent average jobs supported during the year in which the modeled investment occurs and should not be interpreted as permanent ongoing positions.

3. Results

This section presents the economic impacts of a $2.5 billion investment in commercial retrofit activities in the United States. The analysis uses the IMPLAN model and includes direct, indirect, and induced effects. The model is based on 2022 data, and all results are reported in 2026-dollar values. The analysis covers all states in the United States. The results are reported in terms of output, employment, labor income, value added, and tax revenue as shown in the schematic diagram in Figure 2[7].

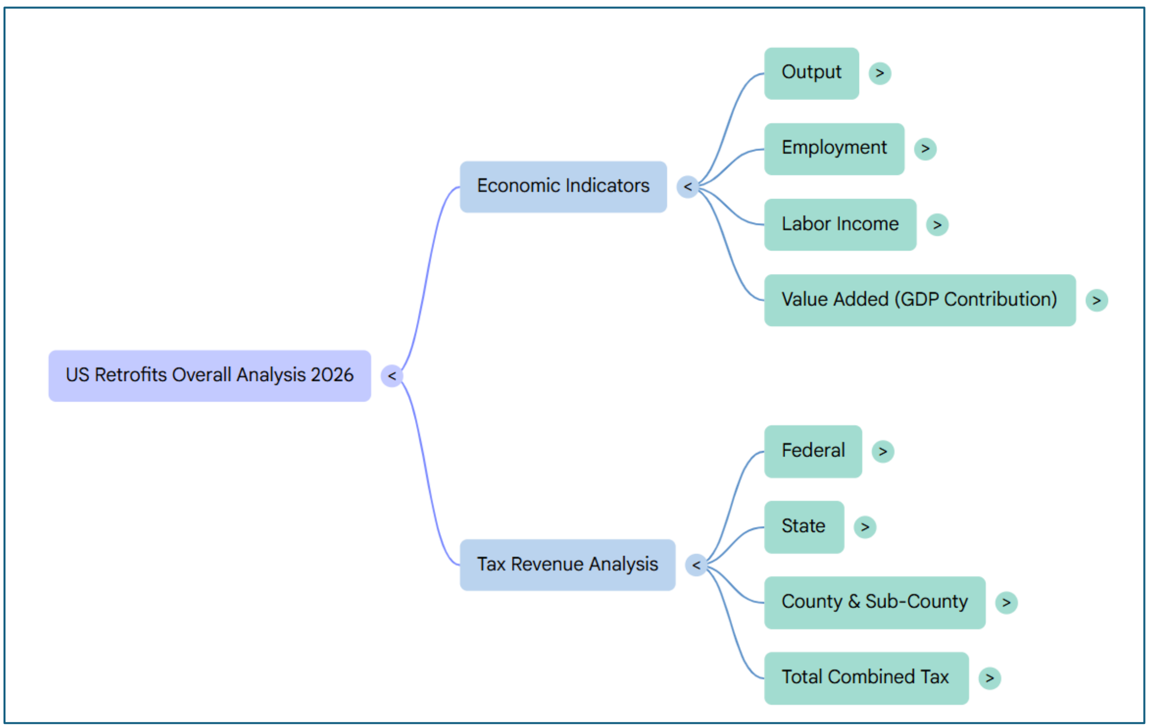

Figure 2. Schematic diagram of metrics of economic impact analysis.

[6] Jobs are an industry-specific mix of full-time, part-time and seasonal employment. 'Jobs' here has the same definition used by the Bureau of Labor Statistics (BLS). https://support.implan.com/hc/en-us/articles/115009668628-Jobs

[7] The results tables from the economic analysis are recreated for clarity using NotebookLM from Google Workspace.

3.1 Total economic impacts

The total economic impact of the investment is summarized in figure 3. The analysis shows that a $2.5 billion investment in commercial retrofit activities generates an estimated $6.9 billion in total economic output. This corresponds to an output multiplier of about 2.75, meaning that each dollar investment generates about $2.75 in total economic output across the economy, including direct, indirect, and induced effects (IMPLAN 2022 data). The investment supports 30,880 jobs and generates $2.348 billion in labor income. The total contribution to gross domestic product is estimated at $3.49 billion. The analysis also shows that the investment generates $920 million in tax revenue across federal, state, and local levels.[8].

Figure 3. Estimated overall economic outcome of $2.5 billion investment in commercial retrofit activities in the US. *Source:* IMPLAN 2022 data for model region US (all states)

Employment represents the total number of jobs supported by the investment and should not be interpreted as permanent ongoing positions. Labor income includes wages, salaries, and income earned by workers and self-employed individuals. Value added represents the contribution to gross domestic product and includes labor income, business income, and taxes on production. Output represents the total value of goods and services produced in the economy including the intermediate goods. These results show that retrofit investments generate economic activity beyond the initial spending.

3.2 Economic impacts by type

This section examines how the total economic impact is distributed across direct, indirect, and induced effects. Figure 4 presents the overall economic impact by type of effect. Direct effects represent the initial spending on commercial buildings retrofit activities. This includes contractor services, equipment installation, and material use. Indirect effects represent economic activity generated through supply chains. These occur when contractors and firms purchase

[8] Intermediate inputs (see Figure 1) are not explicitly analyzed in this paper. Therefore, labor income, contribution to GDP, and tax revenue do not sum to total output.

materials, equipment, and services from other industries. Induced effects represent economic activity generated from household spending. Workers involved in retrofit projects spend their income on goods and services in the economy.

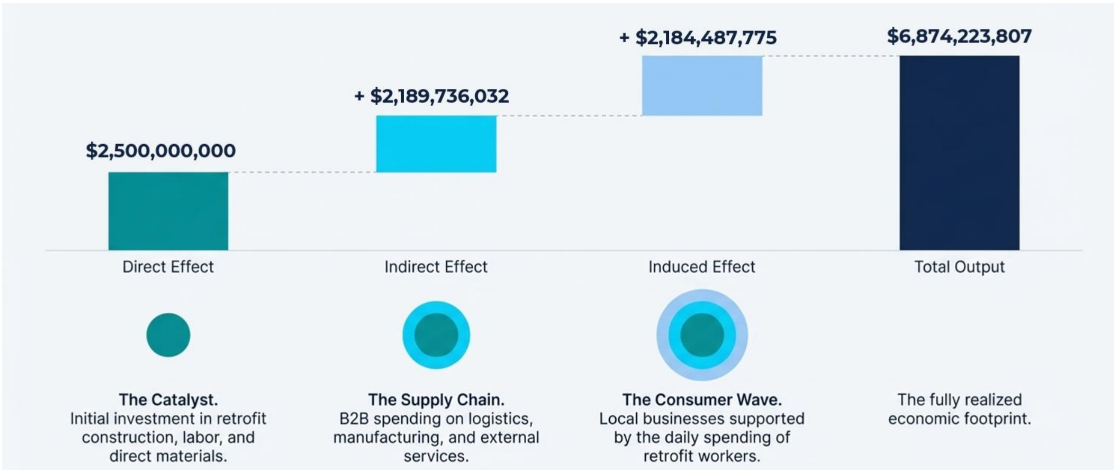

Figure 4. Breakdown of total economic output from a $2.5 billion commercial building retrofit investment into direct, indirect, and induced effects. *Source*: IMPLAN 2022 data for model region US (all states)

In addition to the estimated output shown in Figure 4, Figure 5 presents the breakdown of employment and labor income across the three economic effects showing how economic activity from retrofit investments is generated through project implementation, supply chain linkages, and household spending.

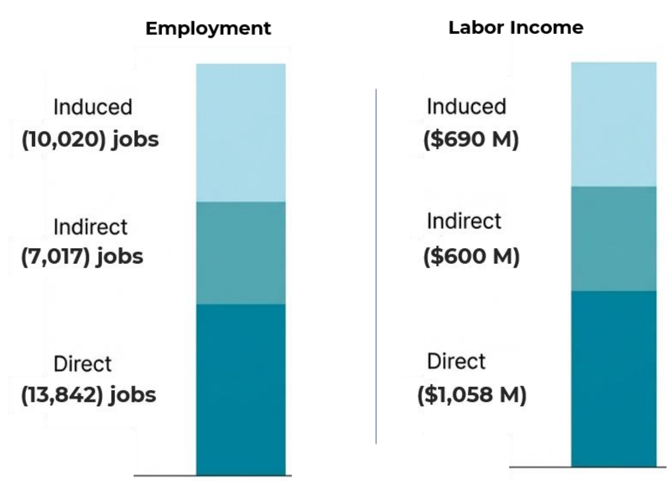

Figure 5. Breakdown of employment and labor income across direct, indirect, and induced effects. *Source*: IMPLAN 2022 data for model region US (all states).

The results show that a large share of total impacts comes from indirect and induced effects and further contributes meaningfully to total impacts across all economic indicators. Figure 5 further illustrates that the distribution of labor income differs from the distribution of employment across impact types, reflecting differences in wage and compensation levels among industries involved in retrofit activities.

3.3 Tax impacts

The potential tax impacts associated with investment are presented in Figure 6. The analysis shows that commercial buildings retrofit investment of $2.5 billion generates an estimated $920 million in total tax revenue. Federal taxes account for the largest share, followed by state and local tax revenues. These estimates are based on national average relationships from the IMPLAN dataset and therefore reflect aggregate outcomes for the U.S. economy. Actual tax impacts may vary depending on the regional allocation of investment, local tax structures, and industry composition. These results show that retrofit investments contribute to public revenues across multiple levels of government.

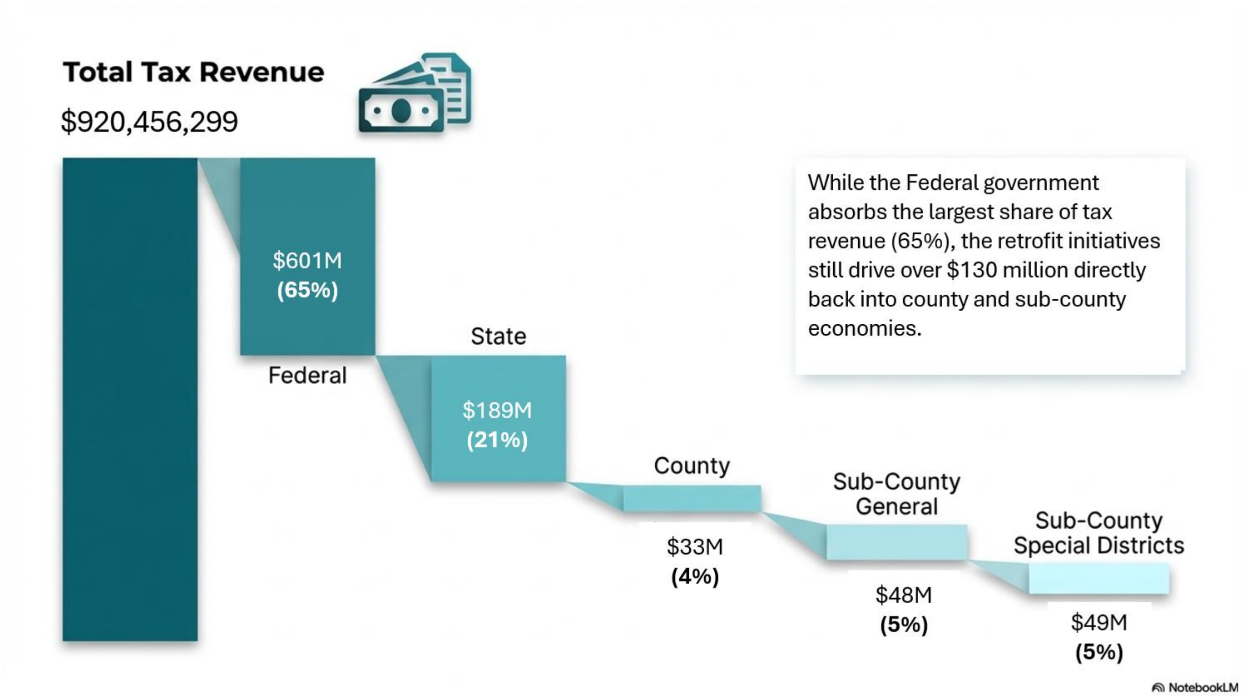

Figure 6. Breakdown of total tax revenue generated from commercial buildings retrofit investments across federal, state, county, and sub-county jurisdictions, illustrating how economic activity translates into public revenues at multiple levels of government. *Source:* IMPLAN 2022 data for model region US (all states).

3.4 Distribution of economic impacts across retrofits activities

Figures 7 and 8 present the distribution of economic impacts across retrofit activities and the structure of tax generation across levels of government. These results are based on a $2.5billion reference investment that generates about $6.88 billion in total output and supports about 30,880 jobs.

Figure 7 shows how impacts are distributed across retrofit activities. Maintenance and repair construction drive the volume and mass employment and accounts for the largest share of output. This reflects the role of installation activities in retrofit projects. HVAC systems, windows and doors, and insulation related activities contribute to output through equipment and material production. These activities are linked to supply chains and production processes.

Specialized fields like architectural and engineering services account for a smaller share of employment but yield highly concentrated labor income through professional services. Retail and wholesale activities support the movement of materials and equipment across sectors. These activities connect production with final use in retrofit projects.

Values rounded to nearest million

Sector	Total Output	Total Jobs	Labor Income	Tax Revenue
Maintenance and Repairs	$3,300	17,856	$1,300	$479
HVAC Retrofits	$1,000	3,179	$261	$107
Windows and Doors	$840	2,861	$223	$88
Arch & Eng. Services	$504	2,409	$213	$75
Insulation and Plastics	$586	1,830	$145	$60
Building Materials	$325	1,724	$104	$71
Household Appliances	$308	1,021	$84	$38

Figure 7. Economic impact by sector of the industry modeled in the analysis.
Note: Cell shading represents the relative magnitude of impacts within each column. Darker shades indicate higher values, while lighter shades indicate lower values. *Source:* IMPLAN 2022 data for model region US (all states).

Using the multiplier framework introduced in Section 2.2, the Maintenance and Repair Construction sector has an output multiplier of 2.93 ($3.30 billion ÷ $1.125 billion) and an employment multiplier of 1.91 (17,856 ÷ 9,338). Across the retrofit categories examined, output multipliers range from approximately 2.4 to 2.9, except for Building Materials, which has an output multiplier of approximately 1.85. These values summarize the ratio of total economic activity to the initial investment within each modeled sector.

The results also indicate that economic outcomes are not distributed uniformly across retrofit activities. Sectors associated with on-site installation and construction tend to support a larger share of employment, whereas manufacturing and professional service activities contribute proportionally more to output and labor income relative to their investment shares. This variation reflects differences in labor requirements, wage levels, and production structures across sectors and suggests that the economic composition of retrofit programs can influence the mix of outcomes generated by a given level of investment.

In Figure 8, the table shows the distribution of tax revenues across levels of government and impact types. Total tax revenue is about $920 million. Federal taxes account for the largest share, followed by state and local taxes. The potential induced tax revenue generated at subcounty, county and state level are more than the estimated tax generated by direct and indirect impact.

Values rounded to nearest million

Effect Type	Sub County General	Sub County Special Districts	County	State	Federal	Total
1 - Direct	$12	$12	$8	$56	$252	$340
2 - Indirect	$16	$16	$11	$59	$162	$264
3 - Induced	$21	$21	$14	$74	$186	$316
Totals	$49	$48	$33	$189	$601	**$920**

Figure 8. Estimated tax outcomes from the economic analysis using IO model.
Note: Color shading highlights the relative magnitude of tax revenues within each column, with darker shades representing larger contributions and lighter shades representing smaller contributions. Distribution of tax revenues by jurisdiction and economic effect shows that the Federal tax revenues account for the largest share of total tax impacts, particularly from direct economic activity. At the local level, induced effects generate the highest tax revenues for sub-county and county governments, indicating that household spending supported by retrofit-related income contributes to the local public revenues.
Source: IMPLAN 2022 data for model region US (all states).

The results show how different retrofit activities contribute to different levels of economic outcomes using IO model with standard assumptions. The spillover effects of the retrofit investment ripples through the local economy.

4. Limitations of the study

This study uses an IO modeling framework to estimate the economic impacts of commercial buildings retrofit investments that offers representation of supply chain relationships. However, it is based on assumptions that affect the outcome of the analysis (IMPLAN 2023) .

- The results are sensitive to the allocation of investment across industries. The sector shares used in this study are based on a modeled distribution of retrofit activities. A higher share of spending in labor intensive sectors would increase employment estimates. Therefore, program specific or project specific investment shares would render more accurate estimates.

- The IO model assumes constant return to scale (fixed relationships between inputs and outputs). As a result, the model may overstate the level of intermediate demand and total output when industries adjust their production processes in practice.
- The model is linear. This assumption does not capture changes in productivity, economies of scale, or supply constraints at higher levels of investment.
- The model does not include resource constraints. It assumes that labor, materials, and production capacity are available to meet increased demand. In practice, shortages in skilled labor or materials can limit the scale of activity.
- The model is static and does not capture feedback effects over time from price changes, wage adjustments, or changes in consumption patterns, and capture long term effects such as technology adoption. As a result, the model reflects short run economic activity rather than long term economic outcomes.
- The model does not represent vendor specific or project specific conditions. The results reflect average industry relationships in the national economy.
- The model captures limited temporal effects. The results represent a single period of economic activity and do not account for the timing of investments or the duration of impacts. This may lead to differences between modeled results and realized impacts over multiple years.

To address these limitations, hybrid IO frameworks can be used to capture dynamic effects. These approaches combine IO structure with changes in consumption, investment, and income. Multi-regional input-output (MRIO) models can improve the representation of regional supply chains and spillover effects across states.

Future analysis can use alternative modeling approaches. Computable general equilibrium (CGE) models allow prices, wages, and production patterns to adjust across sectors (Carbone and Rivers 2017). These models can account for resource constraints and substitution between inputs. They are useful for examining economy-wide adjustments over time.

5. Conclusion

Investments in commercial building retrofits are often evaluated based on technical outcomes such as energy savings and improvements in building performance. Less attention is given to how these investments affect the broader economy. This study attempts to address this gap by examining how retrofit spending circulates through industries and generates economic activity beyond the initial project. The analysis uses an IO modeling framework to estimate the economy-wide effects of a $2.5 billion investment in commercial retrofit activities across the United States, reflecting the approximate scale of current annual investment in commercial retrofit programs.

The model allocates investment across installation services, manufacturing, professional services, and distribution activities. The IO model assumes fixed input relationships and constant returns to scale, and it represents economic activity in a single period without price or resource constraints. Within this framework, the results show that a $2.5 billion investment in commercial building retrofits in the U.S. potentially generates approximately $6.88 billion in output. This implies an output multiplier of 2.75, meaning that each dollar investment generates approximately $2.75 in total economic output, using the estimated industry share in the model.

These results should be interpreted as estimates of short run economic activity under the structure of the IO model. The assumptions of industry share, fixed production relationships and the absence of supply constraints can influence the magnitude of estimated impacts.

Extending this framework to residential building retrofits would require additional data on residential building systems, scale of investments, and regional variation in supply chains to construct accurate expenditure profiles. Future work can build on this approach by integrating these data with alternative modeling frameworks, such as CGE models, to capture dynamic adjustments and examine longer-term economy-wide adjustments associated with commercial retrofit investments.

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