Measuring the Economic Impact of Improved Electricity Distribution in Connecticut

Final Report

Prepared by Regional Economic Models, Inc.

For

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Executive Summary

This study shows the economic impact of proposed improvements to the electricity distribution system in Connecticut. Connecticut Light and Power Company (CL&P), a wholly owned subsidiary of Northeast Utilities, retained Regional Economic Models, Inc. (REMI) to conduct the analysis. We evaluated the impacts of direct capital expenditures, electricity price increases, and business benefits due to improved reliability and quality of electricity using the REMI Policy Insight® model for the State of Connecticut. Despite finding negative economic consequences due to rate increases, this study shows overall net economic benefits due to the positive effect of construction expenditures and improved business competitiveness.

CL&P has requested a rate increase in its service territory in order to fund improvements in the reliability of the electrical distribution system. While electricity rate increases reduce business competitiveness and raise consumer prices, the investments also stimulate business activity. The revenue collected from this rate increase will enable CL&P to finance its direct capital expenditures in infrastructure, which leads to local benefits for employees and firms that are engaged in construction, as well as intermediate suppliers and service providers. The overriding purpose of the investments, improved electricity reliability, increases economic activity through enhanced business competitiveness. The improved competitiveness of affected firms provides a further stimulus to the economy through higher wage disbursements to their employees and increased business with their suppliers and customers. The net impact is more economic growth, jobs, and income for residents and higher tax revenues for the state.

The REMI Policy Insight 70-sector model of Connecticut is a complete representation of the macroeconomic structure of the state. Thus, by entering direct changes to business costs, expenditures, and rates, we used the model to predict the total impact on economic activity.

Power failures represent a significant cost to many businesses. And if electric reliability continues to remain a problem, corporations in Southwestern Connecticut could easily migrate to Westchester County, New York or New Jersey. Thus, the proposed improvements in the distribution system will provide broad improvements to the current and future business climate in Connecticut.

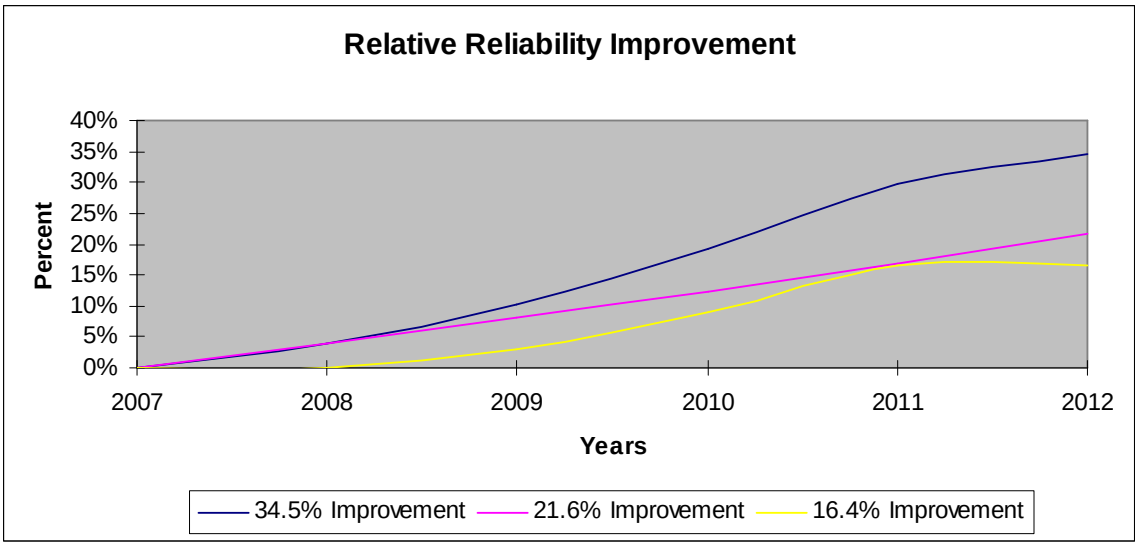
For this analysis, CL&P provided REMI with data for direct capital expenditures, electricity rate increases by customer type, and three SAIDI (System Average Interruption Duration Index) reliability minutes forecasts given various system conditions. The SAIDI is the recognized reliability standard for quantifying the effects of power disruptions. Table 1 and Figure 1 provide more detail on the CL&P SAIDI reliability forecasts.

Table 1: Reliability Data--SAIDI Minutes (2007-2012)

Reliability	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
No Preservation	134.0	140.7	147.7	155.1	162.9	171.0
Preservation	134.0	134.0	134.0	134.0	134.0	134.0
Improvement	134.0	134.0	130.0	122.0	112.0	112.0

Source: CL&P (2007)

Figure 1: Percent Change in Reliability for Three Scenarios, (2007-2012)



Source: CL&P (2007)
Note: Percent Improvement is based off of relative 2012 values from Table 1.

Data was also obtained from the REMI Policy Insight control forecast and a third party study[1]. More recent alternative studies that provide estimates of the costs of power disturbances are available, but tend to lack the level of depth and transparency made available in the cited reference material.

[1] "The Cost of Power Disturbances to Industrial & Digital Economy Companies", Prepared for EPRI by Primen, 2001.

Major Findings

The analysis period for this project is 2007-2017. By providing an outlook to 2017 we can assess both short-term construction impacts and long-term industry and household impacts. Throughout the analysis period the cost of doing business and the cost of living in Connecticut are directly affected and the ensuing results allow us to understand how businesses and households respond to the CL&P rate case and distribution system improvements. Table 2 summarizes the economic growth in the State of Connecticut due to CL&P investments, proposed rate increase, and business benefits. It should be noted that the employment and disposable personal income gains flow to the residents of Connecticut

Table 2: Average Annual Economic Impact (2007-2017), State of Connecticut, 2000 $s

SAIDI Reliability Improvement (% Change)	**Employment (Jobs)**	**Gross State Product ($M)**	**Disposable Personal Income ($M)**	**Disposable Personal Income Per Capita ($)**
34.5%	2,761	324	174	28
21.6%	1,711	194	89	14
16.4%	1,079	108	24	5

Investments made in the CL&P distribution system will stimulate net positive economic growth throughout Connecticut. In designing two of the three simulations the approach taken is that if investments are not made then reliability will continue to worsen. From this no-preservation perspective, that is, if system deterioration is left unchecked, the following two alternative forecasts are produced.

Scenario Description

The first alternative forecast captures a distribution system that provides 34.5% improved electricity reliability to Connecticut industries. This scenario describes a situation in which the system reliability improvement benefits are determined with respect to the no-preservation forecast relative to the improvement forecast (see Table 1). Due to the direct investments and improved reliability it is estimated that on average 2,761 net new jobs will be created annually in Connecticut, primarily in the construction, retail, food services, manufacturing, finance and insurance industries. By 2017, the cumulative change to Gross State Product (GSP) in Connecticut will be $3.566 billion, and after-tax disposable personal income will grow by $1.917 billion.

The second alternative forecast captures a distribution system that provides 21.6% improved electricity reliability to Connecticut industries. This scenario describes a situation in which the system reliability improvement benefits are determined with respect to the no-preservation forecast relative to the preservation forecast (see Table 1). Due to the direct investments and improved reliability it is estimated that on average

1,711 net new jobs will be created annually in Connecticut, primarily in the construction, retail, food services, manufacturing, finance and insurance industries. By 2017, the cumulative change to Gross State Product (GSP) in Connecticut will be $2.138 billion, and after-tax disposable personal income will grow by $984 million.

For our third alternative forecast we designed a simulation that captures a distribution system that provides 16.4% improved electricity reliability. Rather than measuring the reliability difference from the perspective of no-preservation, we considered savings to be realized from the perspective of the preservation forecast relative to the improvement forecast (see Table 1). Due to the direct investments and improved reliability it is estimated that on average 1,079 net new jobs will be created annually in Connecticut, primarily in the construction, retail, food services, manufacturing, finance and insurance industries. By 2017, the cumulative change to Gross State Product (GSP) in Connecticut will be $1.190 billion, and after-tax disposable personal income will grow by $263 million.

The majority of the economy will experience strong growth throughout the analysis period. The exception is in the repair and maintenance sector, which sees a large decrease in demand for equipment repair. This finding is not surprising since the need to repair equipment is reduced as damaging power outages are reduced. Overall, the strong growth in employment results from the reliability improvements, allowing for increased production and reduced equipment repair costs. To assist in understanding the net economic impacts of CL&P investment, our analysis can be observed in a multi-phase perspective. Table 3 reveals the different employment impacts of the CL&P investment detailed by project phase and scenario run.

Table 3: Average Annual Employment Impacts by Phase, State of Connecticut

SAIDI Reliability Improvement (% Change)	**Direct Capital Investment Phase (2007-2012)**	**Electricity Rate Increase Phase (2008-2017)**	**Business Benefits Phase (2008-2017)**	**NET (2007-2017)**
34.5%	1,882	-1,486	3,430	2,761
21.6%	1,717	-1,292	2,175	1,711
16.4%	1,882	-1,486	1,754*	1,079

Note: *Business benefits begin in 2009. In both the 34.5% improvement and the 16.4% improvement the level of direct capital investment and the electricity rate increase are the same, thus the employment impacts are the same. The 21.6% improvement run requires $25M less direct capital investment annually, and the cumulative electricity rate increase is $25M less.

By providing the businesses in Connecticut improved power quality and reduced outage events, CL&P enables these firms to produce and sell more goods and services. As the market shares of the positively impacted sectors expand, so does demand for additional employment. In addition, the average annual compensation for most sectors increase, thus an increase in disposable personal income leads to additional consumption in the Connecticut economy. It is difficult to discern the economic value of improved electric reliability to the operation of Connecticut households, yet it is clear that residents do benefit by having improved employment opportunities and slightly higher incomes.

1. Approach & Data Inputs

In designing these simulations, both benefits and costs of CL&P proposed investment and associated electricity rate increases were incorporated. By doing so, REMI is able to deliver complete results, capturing the net economic impact of this project. Also, for transparency purposes, the assumptions and modeling steps are detailed in the section below. It should be noted that different assumptions will produce different findings. However, different assumptions will not change the fact that there is an economic cost to power failures that is greater than the cost of improved system reliability.

1-1 Assumptions

Contained below is a description of the modeling assumptions developed for this study.

- Direct capital expenditures made to CL&P distribution system are modeled as an increase in construction employment and an increase in demand for equipment.
- Electricity rate increases occur in the industrial, commercial, household, and other customer categories.
- Industrial and commercial rate increases were modeled as an increase in the electricity fuel costs.
- Residential rate increase was modeled as an increase in consumer price for the household operations category.
- Improved reliability (reduced outages, improved power quality) relative to not investing in the system creates long-term benefits for the Connecticut economy.
- Benefits were distributed across 66 private sector NAICS industries according to each industry's share of Connecticut output and electricity use.
- Total benefits were distributed as decreased production costs by sector and as increased labor productivity by sector.
- Reliability improvement reduces the need for equipment repair and was modeled as reduced demand in the repair, maintenance sector.
- Benefits to the state are modeled at 75% weight due to the configuration of the CL&P service area in Connecticut.
- Initial savings estimated for the real estate sector were redistributed to Connecticut industries that buy services from real estate.

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1-2 Simulation Variables

For this study a number of economic policy variables were directly affected. Within the REMI Policy Insight model, the user has various policy 'levers' that can be directly changed in either a positive or negative direction. For more information on the structure of the REMI Policy Insight model please reference the model description

in the Appendix. Listed below is a description for each of the policy variables used in the various simulations.

Industry Employment (Construction Workers)

REMI Policy Insight is a complex economic forecasting tool that allows the user to enter situation specific variable changes. REMI modeled significant increases in employment in the construction sector through the Industry Employment variable. The application of the Industry Employment variable for activity associated with the CL&P investment allows for an increase in employment without displacing current regional market activity. The decision to model without local competition for labor and market shares was made because the type of investment made is highly specialized.

Producer's Durable Equipment (Non-Labor Capital Expenditures)

CL&P plans to make a substantial investment in its electric distribution system. For these non-labor expenditures, we applied the Producer's Durable Equipment to capture such investments.

Electricity Fuel Cost (Commercial, Industrial)

The proposed rate case will have the effect of increasing the per unit (kilowatt/hr) cost of electricity for CL&P commercial and industrial clients. This change is modeled as a constant change above the regional economic control forecast, to account for the long-term impact.

Consumer Price (Household Operations)

The proposed rate case also includes an increase in the price of electricity for residential customers. The consumer price (household operations) variable captures this price increase and effectively increases the cost of living in Connecticut.

Production Cost (All Impacted Industries)

With CL&P providing improved electricity reliability, the frequency of power outages is reduced and quality is improved. The production cost variable is applied to reflect the fact that damage to equipment is reduced and this savings effectively reduces the marginal cost for each unit produced.

Exogenous Final Demand (Repair, Maintenance)

The Connecticut economy experiences a reduction in demand for equipment repair and maintenance services post-CL&P investment. In using the exogenous final demand variable, the assumption is that there is a known change in demand for equipment repair and maintenance without a known source of supply. REMI Policy Insight includes a 3,000 by 3,000 county-level trade flow dataset that captures the level of demand satisfied

by local supply, commonly called the Regional Purchase Coefficient (RPC), along with imports and exports. These two data sets are applied when the exogenous final demand variable is employed. We know that some of the reduced sales will be felt in the local industry, and the rest will be lost sales from around the US and the world. This variable is used when modeling the reduced demand for equipment repair and maintenance in the absence of established contracts.

Labor Productivity (All Impacted Industries)

The labor productivity variable is applied to reflect the reduction of idled labor stemming from power quality improvements. This variable accounts for the increased production per worker realized if the distribution system is improved.

1-3 Model Inputs

Summarized in Tables 4 and 5 are the inputs to the REMI Policy Insight model for the direct capital expenditures, electricity rate increase, and business benefits. Please note that the Labor and Labor Cost figures in Table 4 are the jobs and direct pay held by Connecticut residents.

Direct Capital Expenditures

Table 4: CL&P capital expenditures (2007-2012)

	2007	**2008**	**2009**	**2010**	**2011**	**2012**
Labor (Jobs)	828	883	889	887	906	904
Labor Cost ($M)*	91.8	98.0	98.6	98.4	100.5	100.2
Equipment ($M)	178.2	190.1	191.4	191.1	195.1	194.6
Total Costs($M)	270.0	288.1	290.0	289.5	295.6	294.8

Note: * Labor costs were not directly modeled, rather direct increases in construction employment was the proxy model input. Both internal labor and outside contractors were included as increased construction sector employment. 21.6% SAIDI Reliability Improvement Run requires $25M less capital investment each year.

Electricity Rate Increase

Table 5: CL&P proposed rate increase, All Customer Types (2008-2012)

	2008	**2009**	**2010**	**2011**	**2012**
Residential ($M)	82	92	104	116	129
Commercial ($M)	81	91	104	116	129
Industrial ($M)	23	26	29	31	34
Other($M)	2	2	3	3	3
Total Increase($M)	189	211	239	267	296

Note: Table Values are rounded to the nearest million. 21.6% SAIDI Reliability Improvement Run requires roughly $25M less rate increase, cumulative.

Business Benefits

It is estimated that power disruption and outages cost Connecticut business roughly $1.9 billion dollars a year[2]. This estimate is derived from a large, multi-industry, state-by-state study conducted by the Electric Power Research Institute, Inc. (EPRI). The survey focused on industries involved in the digital economy, continuous process manufacturing, fabrication and essential services. Surveyed businesses were asked to generate a list of costs associated with power outages. By detailing costs associated with idled and additional labor, damage or spoilage to materials or finished products, inventory, operation restart , overhead, equipment damages, backup generators, and other costs the total cost of power outages was estimated. Conceivably, a 100 percent improvement in reliability can be viewed as a relative $1.9 billion dollar decrease in costs for the businesses in Connecticut. Therefore, our working assumption is that for each SAIDI minute of reliability improvement, there is a corresponding reduction in business operating costs. Though 100 percent improvement is nearly impossible given the size of CL&P's service territory, the logic of translating SAIDI reliability minute improvements as business savings is carried forward in the three scenarios. Table 6 shows the direct savings modeled in each of the three scenario runs.

Table 6: Annual SAIDI Percent Improvement and Business Savings

Scenario	**2008**	**2009**	**2010**	**2011**	**2012…**
16.4% SAIDI Improvement	*0.0%*	*3.0%*	*9.0%*	*16.4%*	*16.4%*
Business Savings (M)	---	42.6	127.8	234.4	234.4
21.6% SAIDI Improvement	*3.9%*	*8.0%*	*12.4%*	*16.9%*	*21.6%*
Business Savings (M)	55.9	114.7	176.3	241.1	309.0
34.5% SAIDI Improvement	*3.9%*	*10.4%*	*19.4%*	*29.7%*	*34.5%*
Business Savings (M)	55.9	148.0	276.5	424.7	492.7

[2] EPRI Study. Average of high and low estimate. Measured in Fixed 2000 $s

When modeling the long-term impact of the distribution system improvement, we assigned the total benefits as reduced production cost and increased labor productivity in Connecticut industries. Our approach calculates total benefits based upon the share of each industry's output relative to total state output, and its reliance on electricity as an input to the production cycle. Total benefits were modeled as 1) improved labor productivity rates (due to reduced idled labor hours), and 2) reduced production cost (due to other non-labor cost reductions such as equipment repair, spoilage, etc…). Table 7 lists the distribution of total benefits by industry as a share of the total change in Connecticut due to the investments made by CL&P.[3]

Table 7: Total Business Benefits Distribution by Industry

Industry	Benefits
Retail trade	9.71%
Chemical mfg	8.39%
Management of companies, enterprises	8.00%
Food services, drinking places	5.26%
Wholesale trade	4.67%
Fabricated metal prod mfg	4.06%
Securities, commodity contracts, inv	3.31%
Prof, tech services	3.21%
Transportation equip mfg. exc. motor vehicles	3.17%
Hospitals	2.73%
Paper mfg	2.61%
Nursing, residential care facilities	2.56%
Educational services	2.48%
Computer, electronic prod mfg	2.32%
Monetary authorities, et al.	2.26%
Amusement, gambling, recreation	2.19%
Personal, laundry services	2.11%
Machinery mfg	1.80%
Plastics, rubber prod mfg	1.78%
Primary metal mfg	1.70%
Ambulatory health care services	1.69%
Membership assoc, organ	1.59%
Construction	1.41%
Broadcasting, excluding Internet; Telecomm	1.35%
Food mfg	1.32%
Warehousing, storage	1.24%
Administrative, support services	1.22%
Social assistance	1.20%
Repair, maintenance	1.19%
Waste management, remediation services	1.15%
Electrical equip, appliance mfg	1.05%
All Other	11.28%
Total	100.00%

[3] An off-setting adjustment was made to include the reduced demand for equipment repair.

2. Results

2-1 Employment

For this study employment can be defined as a measure of jobs held in the Connecticut economy. The REMI model uses the Bureau of Economic Analysis (BEA) concept of employment, which accounts for full-time, part-time, and self-employed workers. Simulation results capture the direct, indirect, and induced employment impact of the project.

Figure 2: Net Employment Impact (2007-2017), State of Connecticut

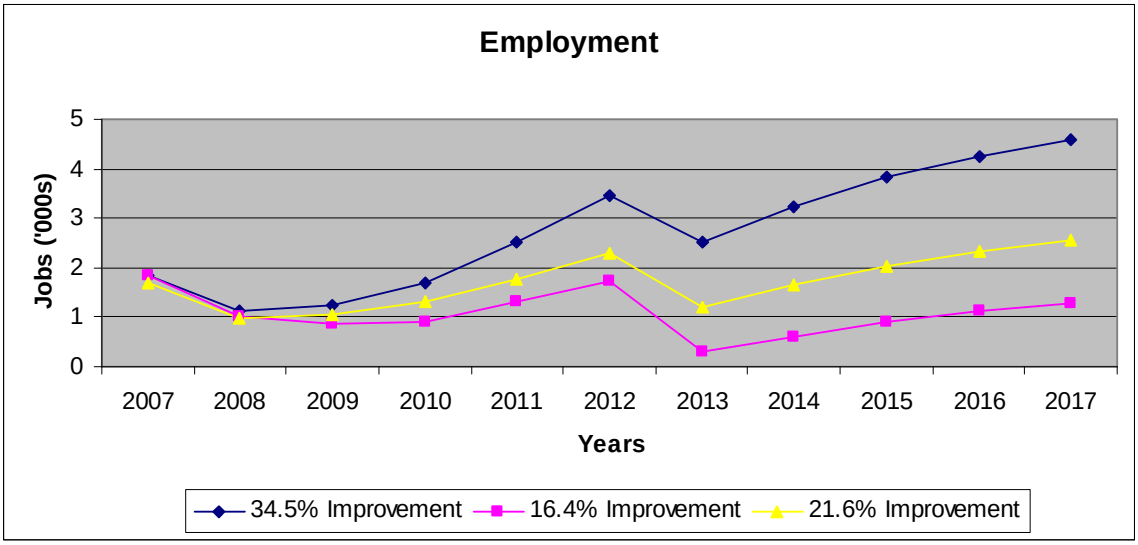


Figure 2 represents the net incremental change to employment in Connecticut if CL&P invests in its electric distribution system. Employment change attributable to reliability enhancements tend to be slowly realized over time as local and out-of-state markets adjust to reduced intermediate and final good prices available from Connecticut firms. For all three simulations, an employment jog downward is seen in the transition between 2012 and 2013 as the direct capital expenditures end in 2012. Long-term impacts for the three simulations are positive and primarily driven by the reduced cost of operating in the State. All simulations include the increased cost of electricity and reduced demand for equipment repair.

Table 8 provides details on the year-by-year change for the three scenarios. It is important to note that the three scenarios track closely with one another in the initial years. This is primarily due to the similar levels of direct capital investment and electricity rate changes used as model inputs for each simulation. Over time, the lagged market response to product price change shifts employment opportunities to the Connecticut economy and it is this responsive behavior that creates a divergence between the three simulations. In 2017, the last year of our analysis, potential net new employment increases range between 6,865, 3,812, and 2,341 (34.5%, 21.6%, and 16.4% reliability improvement, respectively).

Table 8: Annual Employment Change (2007-2017), State of Connecticut

Employment	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
34.5% Reliability Improvement	1,855	1,130	1,258	1,691	2,524	3,444
21.6% Reliability Improvement	1,682	970	1,058	1,302	1,755	2,299
16.4% Reliability Improvement	1,855	1,012	865	920	1,315	1,714

Employment	**2013**	**2014**	**2015**	**2016**	**2017**	**Average**
34.5% Reliability Improvement	2,529	3,251	3,823	4,264	4,600	2,761
21.6% Reliability Improvement	1,199	1,659	2,030	2,320	2,547	1,711
16.4% Reliability Improvement	284	612	886	1,111	1,293	1,079

Note: Units are number of jobs. The values are year specific and should not be mistaken as a cumulative or additive concept. The 21.6% improvement run requires $25M less direct capital investment per year, and the cumulative electricity rate increase is $25M less.

Benefits that accrue from the CL&P investment vary across the Connecticut industries. During the physical investment period (2007-2012) a large share of the employment gains can be found in the construction sector. Though significant, this benefit is not sustainable, and Table 9 details each major sector's share of long-term (2013-2017) employment benefits. These benefits can be thought of as the future drivers of employment growth in Connecticut due to improved electricity distribution.

Table 9: Average Long-Term Employment Impact by Sector (2013-2017)

Sector	**% of Employment Impact**
Accommodations, Food Services	15.0%
Retail Trade	13.1%
Manufacturing	13.6%
Health Care, Social Assistance	11.3%
Construction	7.0%
Professional, Technical Services	7.0%
Finance, Insurance	6.3%
Educational Services	5.5%
Arts, Enter, Recreation	5.0%
Admin, Waste Services	5.3%
Wholesale Trade	3.0%
Real Estate, Rental, Leasing	2.7%
Information	1.8%
Management of Co, Enter	1.6%
Transportation, Warehousing	1.5%
Forestry, Fishing, Other	0.2%
Mining	0.1%
Total	**100%**

The largest percent gain in employment can be found in industries that supply services (accommodations, food services and retail trade). These employment gains are more of a second-order effect of the reduced operating costs for businesses that export, namely manufacturing, finance and insurance. As export based industries sell more to out-of-state buyers, the employment and disposable income increases, thereby placing demands on Connecticut's service sectors. This impact is classified as an induced employment impact (an impact that is derived from increased consumption). Section 2-2 details the connection between employment, demand, and production in more detail.

2-2 Gross Regional Product (GRP)

Gross regional product (GRP) is an economic accounting method that measures economic activity as a value-added or final demand concept. The value-added concept equals the output of the region, excluding intermediate inputs, and represents the compensation and profits within the regional economy. The final demand concept is equal to regional consumption + investment + government + (exports-imports). GRP is affected by changes in demand. When CL&P makes an investment in the distribution system, demand for construction labor and distribution materials/equipment increases. The long-term effect of reduced operating costs in Connecticut is that the in-state industries are more attractive to buyers, and an increase in demand for Connecticut goods and services boosts GRP. For this study GRP is analogous to Connecticut's gross state product (GSP).

Figure 3: Annual Gross Regional Product Change, (2007-2017), State of Connecticut

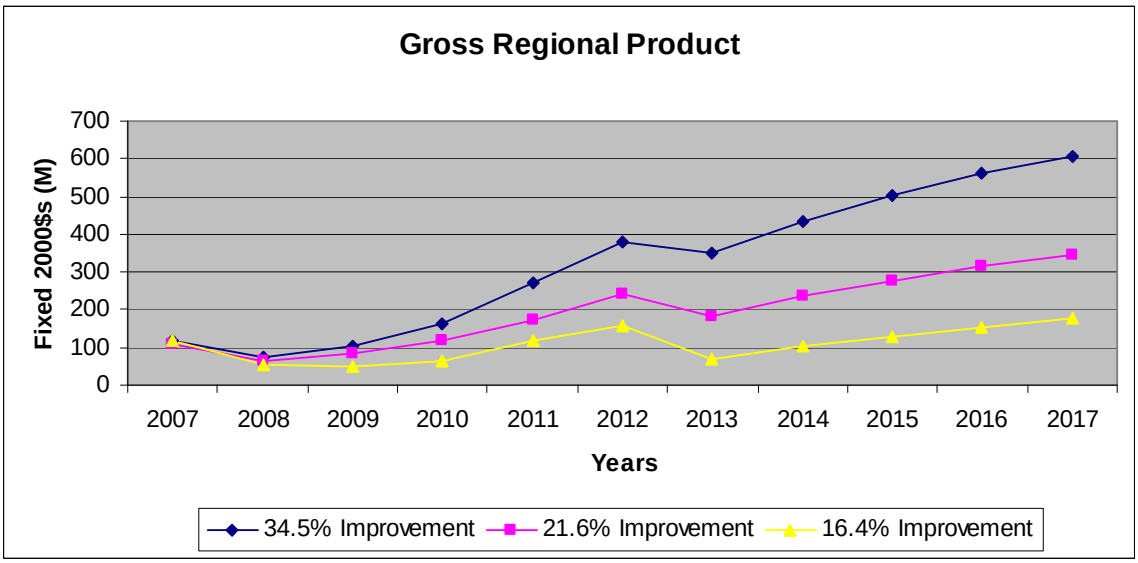


Figure 3 and Table 10 present the pattern of gross regional product development in an annual format. As the CL&P project passes through three phases, different amounts of demand are placed on the Connecticut economy and GRP is developed. The development of GRP is directly linked to the development of employment in Connecticut, as workers are needed to produce products and goods to meet new demands.

Table 10: Annual Gross Regional Product Change (2007-2017), Fixed 2000$s (M)

Gross Regional Product	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
34.5% Reliability Improvement	117.7	87.1	124.4	213.3	360.6	513.4
21.6% Reliability Improvement	106.8	85.3	109.1	155.3	226.6	314.9
16.4% Reliability Improvement	117.7	60.4	51.9	80.7	156.5	217.2

Gross Regional Product	**2013**	**2014**	**2015**	**2016**	**2017**	**Total**	**Average**
34.5% Reliability Improvement	519.6	632.7	726.0	803.6	868.0	3,566	324.2
21.6% Reliability Improvement	277.8	345.8	402.6	450.1	490.0	2,137	194.3
16.4% Reliability Improvement	145.5	193.0	233.4	267.7	296.7	1,190	108.2

Table 11 reports average percent changes to GRP-Value Added by major industry sector. It is important to note that employment and GRP are linked, but the percent change in one category is not always equivalent in the other category. For instance, Table 11 shows that the manufacturing sector receives nearly 25% of the benefits as measured by GRP-value added, while its employment impact is just 13.6% of total employment (see Table 9).

This distinction calls our attention to how each sector of the economy has different output per worker rates (commonly called labor productivity rates). Highly productive sectors, such as the manufacturing, finance and insurance industries, require fewer units of labor to produce a dollar equivalent amount of product versus a lower productivity sector. It is this connection between output and labor that determines total employment needs. Conversely, the accommodation and food services industry receives only 4.1% of the GRP-value added but receives the highest share (15%) of employment gains. The reason for this can be traced to the lower productivity rates within the industry and induced employment gains due to consumer spending.

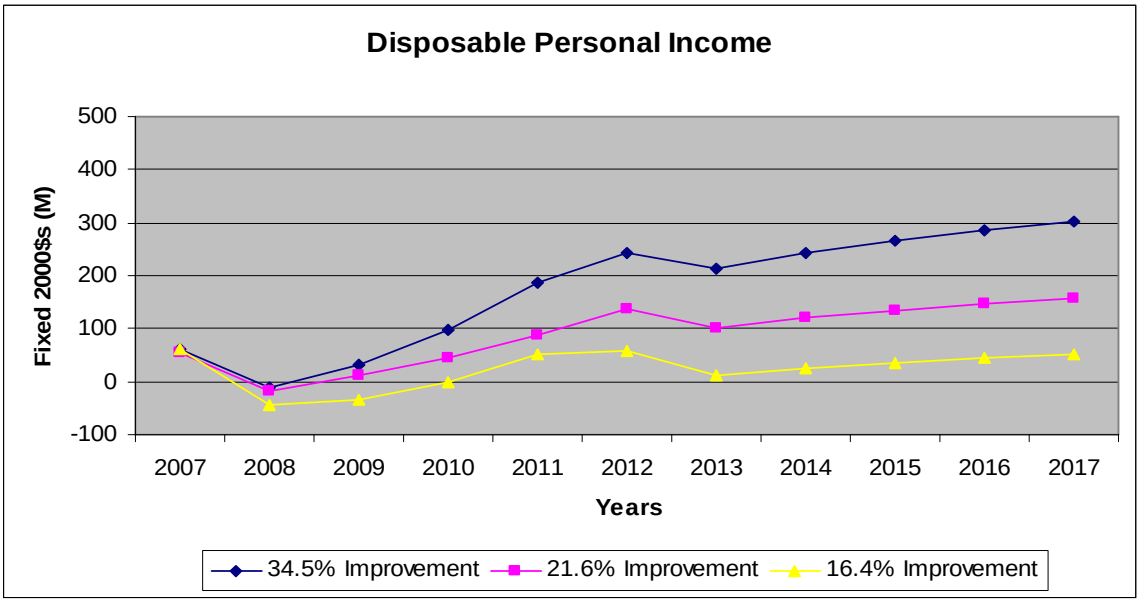
Table 11: Average Long-Term GRP-Value Added Impact by Sector (2013-2017)

Sector	**% of GRP by Value Added Impact**
Manufacturing	24.9%
Finance, Insurance	16.0%
Retail Trade	9.7%
Wholesale Trade	7.5%
Profess, Tech Services	6.8%
Real Estate, Rental, Leasing	6.4%
Management of Co, Enter	5.9%
Health Care, Social Asst	5.0%
Accommodation, Food Services	4.1%
Construction	3.2%
Information	3.2%
Admin, Waste Services	2.3%
Educational Services	1.8%
Arts, Enter, Recreation	1.8%
Transportation, Warehousing	1.3%
Mining	0.1%
Forestry, Fishing, Other	0.0%
Total	**100%**

2-3 Disposable Personal Income

Disposable Personal Income is a measurement of after-tax income to be spent in the regional economy. This concept can be loosely interpreted as "take home" pay. Personal Income is primarily derived from wage and salary disbursements (paychecks), transfer payments from government to individuals, dividends, interest, rents, and proprietors' income. Contributions to social insurance programs and income taxes are subtracted from personal income with the end product being disposable personal income. Figure 4 provides information on the annual change of disposable personal income in Connecticut due to CL&P investments and power distribution reliability improvements.

Figure 4: Annual Disposable Personal Income Change (2007-2017), State of Connecticut



Disposable Personal Income drives regional consumption, and as the economy reacts to improved electricity reliability and increased demand for labor, employment increases in most sectors, as does the average annual compensation rates (wage & salary plus benefits). The combined effect of increased employment and a higher compensation rate provides Connecticut residents more discretionary income.

Often total disposable personal income changes are reported in per capita units since this format allows for easier interpretation of macroeconomic changes by the reader. Table 12 provides information on average annual per capita disposable income increases.

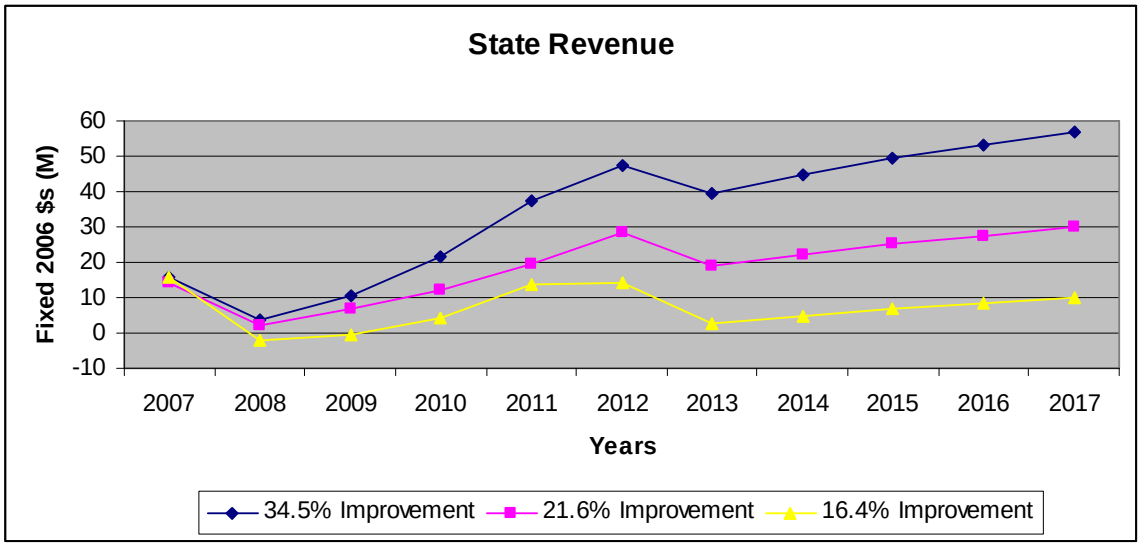
Table 12: Average Annual Per Capita Disposable Income Change (2007-2017), Fixed 2000 $s

Scenario Modeled	**Per Capita Change**
34.5% Reliability Improvement	28
21.6% Reliability Improvement	14
16.4% Reliability Improvement	5

2-4 State Revenue

As the State of Connecticut's economy expands due to CL&P's direct capital expenditures into the system and the long-run increase in business competitiveness, additional tax revenues are collected. The sources of the collections include increases in sales transactions, income, profits, licenses, and other fees. It is estimated that the annual average impact on State tax revenue could vary from $7.1 to $34.5 million (16.4% and 34.5% runs respective, see Table 13). Figure 5 reports the flow of state revenues that develop during the analysis period.

Figure 5: Annual State Revenue Change (2007-2017), State of Connecticut



In total and regardless of scenario, it is estimated, that the State of Connecticut will realize millions of additional tax collections. Table 13 reports the annual average and net accumulation of state tax collections as observed in the three scenarios.

Table 13: Cumulative and Annual Average Change to State Revenues (2007-2017), Fixed 2006 $s (M)

Scenario Modeled	**Average Annual Change (M)**	**Cumulative Change (M)**
34.5% Reliability Improvement	34.5	380
21.6% Reliability Improvement	18.8	207
16.4% Reliability Improvement	7.1	78

3. Conclusion

Maintaining and enhancing the quality and reliability of electricity is paramount in developing the Connecticut economy. This analysis proves that long-term economic benefits accrue in the majority of industries if CL&P makes investments in its electricity distribution system. By providing a balanced analysis, accounting for direct costs and benefits, an intelligible argument can be made which favors an electricity rate increase if system reliability is improved. Even in the most conservative case- 16.4% reliability improvement- the overall benefits of making such an investment far outweigh the negative impacts of increased electricity prices and the risk associated with not maintaining the distribution system.

Infrastructure is the support mechanism for economic growth, and by addressing potential future reliability and quality issues, CL&P is taking a pro-active approach that will boost the Connecticut economy. Often, fee or price increases are considered inherently negative, but this perspective leads to presumptuous criticism of any policy change. By applying a dynamic impact model, short and long-term effects are quantified, and a complete analysis allows us to conclude that, with all factors considered, the CL&P request for a rate increase is sensible and will improve the business climate in Connecticut.

Appendix

A-1 REMI Policy Insight

REMI Policy Insight is a structural economic forecasting and policy analysis model. It integrates input-output, computable general equilibrium, econometric, and economic geography methodologies. The model is dynamic, with forecasts and simulations generated on an annual basis and behavioral responses to wage, price, and other economic factors.

The REMI model consists of thousands of simultaneous equations with a structure that is relatively straightforward. The exact number of equations used varies depending on the extent of industry, demographic, demand, and other detail in the model. The overall structure of the model can be summarized in five major blocks: (1) Output and Demand, (2) Labor and Capital Demand, (3) Population and Labor force, (4) Wages, Prices and Costs, and (5) Market Shares. The blocks and their key interactions are shown in Figures A-1 and A-2.

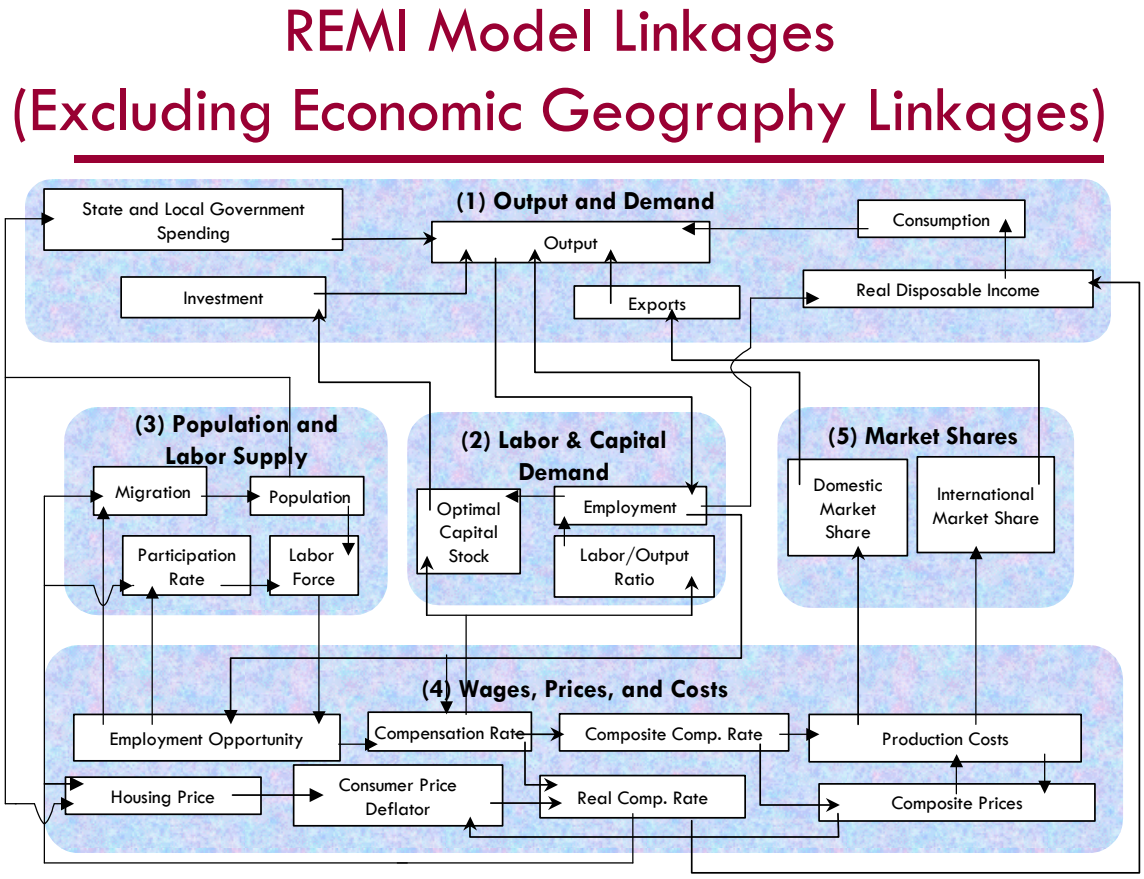


Figure A-1

Block 1. Output and Demand

This block includes output, demand, consumption, investment, government spending, import, product access, and export concepts. Output for each industry in Connecticut is determined by industry demand in the Connecticut and its trade with the rest of the US and International markets.

For each industry, demand is determined by the amount of output, consumption, investment and capital demand on that industry. Consumption depends on real disposable income per capita, relative prices, differential income elasticities and population. Input productivity depends on access to inputs because the larger the choice set of inputs, the more likely that the input with the specific characteristics required for the job will be formed. In the capital stock adjustment process, investment occurs to fill the difference between optimal and actual capital stock for residential, non-residential, and equipment investment. Government spending changes are determined by changes in the population.

Block 2. Labor and Capital Demand

The labor and capital demand block includes the determination of labor productivity, labor intensity and the optimal capital stocks. Industry-specific labor productivity depends on the availability of workers with differentiated skills for the occupations used in each industry. The occupational labor supply and commuting costs determine firms' access to a specialized labor force.

Labor intensity is determined by the cost of labor relative to the other factor inputs, capital and fuel. Demand for capital is driven by the optimal capital stock equation for both non-residential capital and equipment. Optimal capital stock for each industry depends on the relative cost of labor and capital, and the employment weighted by capital use for each industry. Employment in private industries is determined by the value added and employment per unit of value added in each industry.

Block 3. Population and Labor Force

The population and labor force block includes detailed demographic information about the region. Population data is given for age and gender, with birth and survival rates for each group. The size and labor force participation rate of each group determines the labor supply. These participation rates respond to changes in employment relative to the potential labor force and to changes in the real after tax compensation rate. Migration includes retirement, military, international and economic migration. Economic migration is determined by the relative real after tax compensation rate, relative employment opportunity and consumer access to variety.

Block 4. Wages, Prices and Costs

This block includes delivered prices, production costs, equipment cost, the consumption deflator, consumer prices, the price of housing, and the wage equation. Economic geography concepts account for the productivity and price effects of access to specialized labor, goods and services.

These prices measure the price of the industry output, taking into account the access to production locations. This access is important due to the specialization of production that takes place within each industry, and because transportation and transaction costs differ due to distance. Composite prices for each industry are then calculated based on the production costs of supplying regions, the effective distance to these regions, and the index of access to the variety of output in the industry relative to the access by other uses of the product.

The cost of production for each industry is determined by cost of labor, capital, fuel and intermediate inputs. Labor costs reflect a productivity adjustment to account for access to specialized labor, as well as underlying compensation rates. Capital costs include costs of non-residential structures and equipment, while fuel costs incorporate electricity, natural gas and residual fuels.

The consumption deflator converts industry prices to prices for consumption commodities. For potential migrants, the consumer price is additionally calculated to include housing prices. Housing price changes from their initial level depend on changes in income and population density.

Compensation changes are due to changes in labor demand and supply conditions and changes in the national compensation rate. Changes in employment opportunities relative to the labor force and occupational demand change determine compensation rates by industry.

Block 5. Market Shares

The market shares equations measure the proportion of local and export markets that are captured by each industry. These depend on relative production costs, the estimated price elasticity of demand, and effective distance between the home region and each of the other regions. The change in share of a specific area in any region depends on changes in its delivered price and the quantity it produces compared with the same factors for competitors in that market. The share of local and external markets then drives the exports from and imports to the home economy.

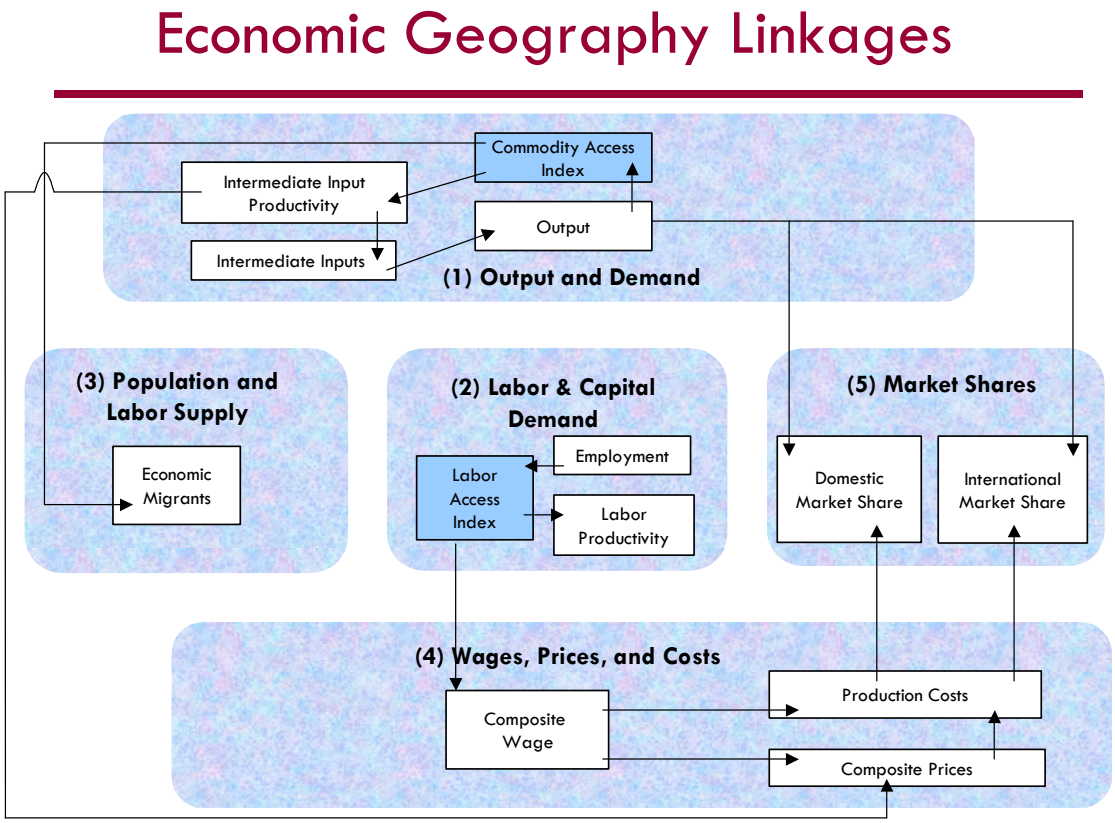


Figure A-2

As shown in Figure A-1 and A-2, the Labor and Capital demand block includes labor intensity and productivity as well as demand for labor and capital. Labor force participation rate and migration equations are in the Population and Labor Force block. The Wages, Prices and Costs block includes composite prices, determinants of production costs, the consumption price deflator, housing prices, and the wage equations. The proportion of local, inter-regional and export markets captured by each region is included in the Market Shares block.

Figure A-3 shows the policy simulation process for a scenario called Policy X. The effects of a scenario are determined by comparing the baseline REMI forecast with an alternative forecast that incorporates the assumptions for the scenario. The baseline REMI forecast uses recent data and thousands of equations to generate projected economic activity for a particular region. The policy variables in the model are set equal to their baseline value (typically zero for additive variables and one for multiplicative variables) when solving for the baseline forecast. To show the effects of a given scenario, these policy variables are given values that represent the direct effects of the scenario. The alternative forecast is generated using these policy variable inputs.

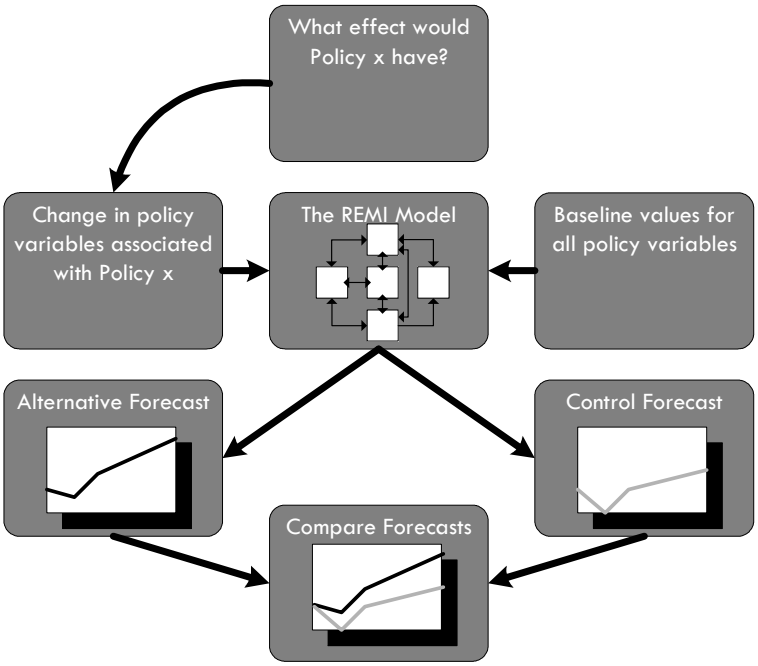


Figure A-3 Policy X scenario

Please note that the REMI Policy Insight model is not a cyclical short-run planning tool, but an economic impact tool.