Stokes
ECONOMIC CONSULTING INC.

The Economic Impacts of Reducing Natural Gas and Electricity Use in Ontario

Prepared for

Blue Green Canada

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Executive Summary

Blue Green Canada hired Stokes Economic Consulting to conduct an independent study that would estimate the economic and employment impacts of reducing both natural gas and electricity use in Ontario by 25% over the period to 2025.

The approach adopted to estimate the economic impacts on Ontario of reducing the use of electricity and natural gas employs the Centre for Spatial Economics (C_4SE) macroeconomic model of the Ontario economy. The model is used to prepare two economic projections for the future performance of the economy. The first projection shows the performance of the Ontario economy without the reduction in the use of electricity and natural gas. The second one shows the performance of the economy when the usage of electricity and natural gas is reduced. The impacts on the economy are then estimated by comparing the results of the two projections for key economic variables such real Gross Domestic Product (GDP) and employment.

Key assumptions in the analysis include the financing of government energy reduction programs, how households and business finance purchases of capital, and how energy efficient capital is introduced into the economy. In the case of government programs it is assumed that any additional expenses made through energy reduction programs are offset by reductions in other expenditures. It is assumed that both households and firms substitute more energy efficient capital for both the new and replacement demand expenditures found in the base case projection. In addition, capital expenditures will increase somewhat as the energy efficient capital will represent a more valuable type of capital. The decision to purchase more energy efficient capital will take place as households and firms assume that the expenditures for the higher valued capital will be offset by future reduced expenditures on electricity and natural gas.

Key Findings

Reducing both natural gas and electricity use in Ontario by 25% over the period to 2025 has the impact of**:**

- Increasing Ontario real GDP by $3.7 billion and employment by over 25 thousand by 2025;
- Substantially reducing investment in the electric power generation industry;
- Improving Ontario's trade balance by significantly reducing imports of natural gas;
- A nearly $1 billion improvement in the federal budget balance by 2025 alongside a $982 million improvement in the Ontario government balance;
- Positive impacts on real GDP in the manufacturing industry that are most notable in the primary metals and paper and allied products industries;
- Positive impacts on real GDP in retail and wholesale trade, finance, insurance, and real estate, and accommodation and food services; and
- Reducing GHG emissions by 9% or 19 Mt of CO_2 by 2025.

Introduction

Blue Green Canada hired Stokes Economic Consulting to conduct an independent study that would estimate the economic and employment impacts of reducing both natural gas and electricity use by 25% over the period to 2025. The reductions are to be focused in the residential, commercial / institutional and industrial sectors of the Ontario economy. The study assumes that Conversation Demand Management programs will be successful in reducing natural gas and electricity usage in the province.

The current study examines the economic impacts of reduced energy use in the province by creating a projection for the future economic performance of the Ontario economy that contains a 25% reduction in the use of natural gas and electricity by 2025. The impact is determined by comparing the results of this scenario against a baseline projection that does not contain these reductions.

The next section provides background on secondary energy use in Ontario and a discussion of some of the Government of Canada's efficiency programs. The third section provides a description of the approach adopted by Stokes Economic Consulting to estimate the impacts of reducing the use of natural gas and electricity and the assumptions behind the approach. The fourth section discusses the expected impacts on the economy from a qualitative point of view. The final section presents the quantitative estimates of the economic impacts as well as impacts on greenhouse gas (GHG) emissions. A technical appendix at the end provides a general description of the C_4SE economic model[1] that was used in this study.

[1] This model is maintained by Stokes Economic Consulting.

Secondary Energy Use in Ontario

The study focuses on secondary energy users including the residential, commercial, institutional and industrial sectors of the Ontario economy. This section describes background on basic trends in energy use by these sectors. Other important secondary users of energy include the transportation and agriculture sectors however these are omitted from the study.

Residential Sector

In the residential sector energy is used for space heating and cooling; water heating; and the operation of appliances, electronic equipment and lights. In 2010 energy use by the residential sector was 492 petajoules (PJ) as shown in **Table 1** below. Electricity use was 120 PJ while natural gas use was considerably larger at 313 PJ. Over the last 10 years electricity use in the sector has fallen by 22% while natural gas use was unchanged.

Table 1: Total Energy Use - Residential Sector

	2006	2007	2008	2009	2010
Total Energy Use (PJ)	528	566	582	503	492
Energy Use by Energy Source (PJ)					
Electricity	154	151	163	112	120
Natural Gas	315	353	359	329	313
Heating Oil	32	31	27	30	30
Other	8	9	9	8	9
Wood	20	22	23	23	21

Source: Natural Resources Canada

Energy efficiency upgrades in this sector include improvements to the thermal envelope of dwellings including upgraded insulation and windows as well as more energy efficient appliances, furnaces and lighting. In 2010 energy use for the average household (energy intensity) was 99 GJ and was down by 19% compared to 2000.

Commercial and Institutional Sector

The commercial and institutional sector includes the wholesale and retail trade, finance, real estate, public administration, education and commercial services industries. This sector uses energy mainly for space and water heating, operation of auxiliary equipment as well as space cooling and lighting. In 2010 energy use by the commercial / institutional sector was 409 PJ as shown in **Table 2** below. Electricity use was 196 PJ and natural gas use was similar at 197 PJ. Over the last 10 years electricity use in the sector has increased by 11% while natural gas use was down by 11%.

In 2010 energy use by the commercial / institutional sector per unit of floor space (energy intensity) was 1.5 GJ and was down by down by 20% compared to 2000.

Table 2: Total Energy Use – Commercial / Institutional Sector

	2006	2007	2008	2009	2010
Total Energy Use (PJ)	407	442	470	416	410
Energy Use by Energy Source (PJ)					
Electricity	186	206	235	192	196
Natural Gas	200	213	215	207	197
Light Fuel Oil and Kerosene	7	9	6	3	3
Heavy Fuel Oil	3	2	1	1	1
Steam	0	1	0	0	0
Other	11	12	13	12	13

Source: Natural Resources Canada

Industrial Sector

The industrial sector includes manufacturing, mining and oil and gas extraction, forestry and construction industries however it excludes electric power generation. In the industrial sector, energy was consumed primarily in mining, pulp and paper production and the petroleum refining industries. In 2010 energy use by the industrial sector was 680 PJ as shown in **Table 3** below. Over the period from 2000 to 2010 energy use in the sector has fallen by 21%.

Table 3: Total Energy Use – Industrial Sector

	2006	2007	2008	2009	2010
Total Energy Use (PJ)	840	845	826	684	680
Energy Use by Industry (PJ)					
Construction	26	25	26	22	23
Pulp and Paper	127	120	110	91	82
Smelting and Refining	23	23	24	19	14
Petroleum Refining	92	99	102	96	77
Cement	41	38	33	31	30
Chemicals	57	57	56	49	60
Iron and Steel	214	208	206	152	172
Other Manufacturing	229	234	229	197	193
Forestry	6	7	8	2	2
Mining	25	32	33	24	28

Source: Natural Resources Canada

Energy efficiency improvements in the form of more efficient capital and management practices are important factors in managing energy use in the industrial sector. The energy intensity of the sector was down by 20% over the period from 2000 to 2010.

Energy Efficiency Initiatives

The Ontario government has invested about $1.7 billion in conservation programs since 2006. The government's Long Term Energy Plan lays out conservation targets of 7,100 MW of capacity and 28 TWh of generation by 2030. The Plan anticipates that the province's commercial sector will contribute 50 percent of the conservation target; residential sector will contribute 30 percent; and industrial sector 20 percent.

To achieve these targets a number of important government initiatives have helped create a culture of conservation in the province including: changes to the province's building code, Home Energy Savings Program, the OPA's Great Refrigerator Round Up, Ontario's Solar Thermal Heating Initiative and the use of Smart Meters and Time of Use billing. In addition to these measures the Ontario government will provide broad support for achieving these targets through policy initiatives such as bringing forward a proposed regulation to require the broader public sector (municipalities, universities, schools and hospitals) to develop energy conservation plans.

The federal government's ecoENERGY Efficiency program is investing $195 million between 2011 and 2016 to improve energy efficiency. The objectives of the program are: to make the housing, building and equipment stock more energy-efficient; energy performance more visible; and industry operations more energy efficient.

The ecoENERGY Efficiency program features the following components:

- ecoENERGY Efficiency for Buildings provides information and benchmarking tools to improve building energy performance of new and existing buildings
- ecoENERGY Efficiency for Housing[2] encourages the construction and retrofit of low-rise residential housing, making the stock more energy-efficient
- ecoENERGY Efficiency for Equipment Standards and Labelling introduces or raises energy efficiency standards for a wide range of products and promotes energy-efficient products through the ENERGY STAR initiative in Canada
- ecoENERGY Efficiency for Industry aids the adoption of an energy management standard and accelerates energy-saving investments and the exchange of best practices information within Canada's industrial sector

[2] This program has been cancelled

Study Approach

The approach adopted to estimate the economic impacts on Ontario of reducing the use of electricity and natural gas employs the C_4SE macroeconomic model of the Ontario economy.[3] This model is used to prepare two economic projections for the future performance of the economy. The first projection shows the performance of the Ontario economy without the reduction in the use of electricity and natural gas. The second one shows the performance of the economy when the usage of electricity and natural gas is reduced. The impacts on the economy are then estimated by comparing the results of the two projections for key economic and fiscal variables such real Gross Domestic Product (GDP), the Consumer Price Index (CPI), employment, population, and government budget balances.

The C_4SE macroeconomic model is a multi-sector (industry) model that assumes the existence of a gross output (total value of production) KLEM production technology for the different sectors – KLEM stands for the production inputs of capital, labour, energy, and materials. It incorporates variable input-output coefficients that respond to changes in relative prices for production inputs. For example, increases in the price of natural gas will lead to a reduction in natural gas's share of total inputs to gross output and an increase in the share for the other inputs. The model also incorporates a Green House Gas emissions component that estimates CO_2 equivalent emissions.

The projection that does not contain the reductions in electricity and natural gas is called the *base case* projection. It is created with the C_4SE model by making assumptions about the key drivers for the Ontario economy such as economic growth and inflation in Ontario's major trading partners, oil prices, natural gas prices, fiscal policy, and so on. The projection with the reductions in electricity and natural gas is created using the base case assumptions and then reducing the input shares of electricity and natural gas in gross output for the various industries along with the consumer expenditure shares of electricity and natural gas for households. This projection is called the *efficiency scenario*.

It should be noted that the reductions in electricity and natural gas use implemented through the model's input shares will not reduce electricity and natural gas use in the same proportion as the input shares. This difference is a result of changes in economic performance caused by the changes in the input shares. To the extent that the reduction in electricity and natural gas use increases or reduces overall production in the economy the latter change will lead to a corresponding impact on the demand for electricity and natural gas. If the reduction in electricity and natural gas, for example, increases overall production in the economy then the demand for electricity and natural gas will rise offsetting somewhat their use with the reduction in their input shares.

It is assumed that an increase in the share of capital and labour in gross output will occur with the reduction in the use of electricity and natural gas use in gross output as firms purchase new energy efficient technologies and hire associated workers. As a result, there will be an increase in the share of value-added (net output or GDP) in gross output in the economy. In the case of

[3] A technical appendix provides more details on the workings of the C_4SE model of the Ontario economy.

households, the reduction in the share of electricity and natural gas in consumer expenditures is replaced by an increase in the share of the other household expenditure categories.

Key assumptions in the analysis include the financing of government energy reduction programs, how households and business finance purchases of capital, and how energy efficient capital is introduced into the economy. In the case of government programs it is assumed that any additional expenses made through energy reduction programs are offset by reductions in other expenditures.

It is assumed that both households and firms substitute more energy efficient capital for both the new and replacement demand expenditures found in the base case projection. In addition, capital expenditures will increase somewhat as the energy efficient capital will represent a more valuable type of capital. The decision to purchase more energy efficient capital will take place as households and firms assume that the expenditures for the higher valued capital will be offset by future reduced expenditures on electricity and natural gas.

Expected Impacts

Before presenting the quantitative estimates of the impact of the reduction in electricity and natural gas use it is worthwhile to review the nature of impacts expected from a qualitative point of view – that is, directions of change rather than the estimated size of change.

The reduction in the use of electricity and natural gas is to be accomplished by replacing electricity and natural gas with more energy efficient capital equipment and associated labour services. This replacement is expected to allow firms to produce the same amount of goods and services they did when using electricity and natural gas as the more productive capital and associated labour services replaces the contribution of electricity and natural gas use in gross output thereby increasing GDP. In the case of households reduced expenditures on electricity and natural gas lead to a corresponding increase in expenditures on other goods and services.

It is expected that the reduced use of electric power and natural gas will lead to an increase in GDP for almost all industries if their gross output (total sales) does not fall significantly with such a reduction – as the share of GDP in gross output rises. Nevertheless, the changing structure of the economy will have an impact on gross output and GDP in many industries.

The electric power industry, for example, will see a significant reduction in production, employment, and investment as electric power use declines. Moreover, those industries that supply the electric power industry with goods and services will see a reduction in their sales to the industry. The reduction in the production of electric power, for example, will also reduce the use of natural gas by the electric power industry.

Because Ontario does not produce natural gas, the reduction in its use will not have a major negative impact on the economy. Nevertheless, firms in the natural gas distribution system and industries that supply these firms are likely to see some reduction in their sales, employment, and investment.

The reduction in natural gas use will be observed through a reduction in provincial imports, which will lead to an improvement in the trade balance (exports minus imports) over the long run – which increases overall GDP. During the period in which the less energy-efficient capital is being replaced, nevertheless, the reduction in natural gas imports will be offset by increased imports of machinery and equipment. The import share of the machinery that will be purchased to reduce electricity and natural gas use is high for the province.

Increases in investment expenditures in industries other than the electric power and natural gas-related industries in the economy are expected to be observed over the period relative to the base case projection when firms substitute more energy efficient capital for electricity and natural gas. In the electric power industry investment expenditures will decline in line with reduced production of electric power.

The purchase of new equipment and the construction of structures needed to achieve lower gas and electricity use will increase production and employment in industries throughout the economy. The increased employment and disposable income will lead to increases in consumer

and housing expenditures. These increases, in turn, will lead to additional production and employment, and so on.

The increased economic activity resulting from the reduction in gas use will also result in an improvement in the budget balances of the federal and provincial governments. This improvement comes from increases in revenues from both income taxes – personal and corporate – and indirect taxes such as the HST. Expenditures also rise as the increase in employment results in additional persons moving into the province, but this increase will be lower than the increase in revenues.

The reduction in the use of electricity and natural gas will lead to a reduction in CO_2 emissions. This reduction will be somewhat offset by increases in emissions resulting from a higher level of economic activity associated with replacing electricity and natural gas with more energy efficient capital and workers - the net impact will be a reduction in CO_2 emissions.

Estimated Impacts

Estimates of the impacts of reducing natural gas and electricity use in the province for key economic indicators are shown in **Table 4** below. The impacts for many indicators refer to the percentage differences and level differences from the base case projection values. The level differences for expenditure or income variables are measured in millions of 2013 dollars.

The results for real GDP show a 0.4 percentage point increase from the base case in 2025. This increase represents 3.7 billion measured in 2013 dollars. It should be noted that a small part of the increase in GDP and some of its components is a result of an increase in population caused by higher employment leading to additional migration to the province.

Consumer expenditures account for the largest amount of the increase in GDP in 2025 where the percentage difference in expenditures is 0.6. The increase in consumer expenditures is the result of an increase in personal income, which rises 0.8 percent by 2025.

The increase in personal income results from increases in employment and wages. The wage rate rises 0.8 percent above base case values while there is a 0.4 percent increase in employment in 2025. The increase in employment is over 25 thousand in 2025. Part of the increase in wages is due to the higher productivity that results from the increase in capital with the reduction in the use of natural gas and electricity.

Non-residential investment expenditures decrease reaching 0.6 percent below base case values in 2025. The additional investments in energy saving capital are being offset by reduced investment in the electric power generation and natural gas distribution industries. It should be remembered that the more energy efficient capital is replacing new and replacement demand for capital that is found in the base case so large increases in investment are not expected to take place.

There is also a 1.0 percent increase in residential investment by 2025 as the additional residential capital needed to reduce natural gas and electricity consumption is put in place. Some of the higher residential investment is accounted for by an increase in population associated with the higher employment attracting more people to the province.

Imports fall in the projection where natural gas and electricity use is reduced. While there are higher levels of both business fixed investment and consumer expenditures the increase is more than offset by lower imports of natural gas. The impact on exports is negligible and there is an improvement in Ontario's trade balance. Reduced costs are also responsible for the increase in corporate profits before taxes over the projection period.

The federal and provincial governments see an improvement in their budget balances with the increased economic activity. The federal budget balance is nearly 1 billion higher in 2025 while the Ontario government balance is about 982 million higher.

Table 4: Impact on Key Economic Indicators
($2013 Millions Unless Stated Otherwise)

	2014	2020	2025
Real GDP			
% Difference	0.0	0.2	0.4
Difference	74	1628	3748
GDP Deflator			
% Difference	0.0	0.3	0.5
Consumer Expenditures			
% Difference	0	0.3	0.6
Difference	37	1218	3147
Residential Investment			
% Difference	0.0	0.6	1.0
Difference	17	284	421
Non-Residential Investment			
% Difference	-0.2	-1.1	-0.6
Difference	-95	-657	-419
Exports			
% Difference	0.0	0.0	0.0
Difference	-7	-20	15
Imports			
% Difference	-0.1	-0.6	-0.7
Difference	-401	-2628	-3118
CPI			
% Difference	0	0.1	0.2
Hourly Wage Rate			
% Difference	0	0.3	0.8
Employment 000s			
% Difference	0	0.2	0.4
Difference	1.4	15.8	25.6
Productivity (GDP/Hour)			
% Difference	0.0	0.0	0.1
Personal Income			
% Difference	0.0	0.4	0.8
Difference	95	1916	4626
Net Operating Surplus Business			
% Difference	0.3	3.0	4.4
Difference	186	1871	2714
Federal Net Lending			
Difference	50	588	1013
Provincial Net Lending			
Difference	30	429	982

The Ontario industry impacts are shown in **Table 5** below. The impacts on the various industries reflect their relative intensities of natural gas and electricity use as well as their involvement in producing and installing capital goods.

Table 5: Industry Impacts – Real GDP
(Percentage Difference from Base Case)

	2014	2020	2025
Total Industry			
% Difference	0	0.2	0.4
Forestry			
% Difference	0.0	0.1	0.3
Mining			
% Difference	0.0	0.0	0.0
Utilities			
% Difference	-1.5	-9.7	-13.2
Construction			
% Difference	-0.1	-0.6	-0.4
Manufacturing			
% Difference	0.1	1.1	1.6
Wholesale & Retail Trade			
% Difference	0.1	0.5	1.0
Transportation And Warehousing			
% Difference	0.0	0.4	0.7
Finance, Insurance, and Real Estate			
% Difference	0.1	0.8	1.3
Professional, Scientific and Management			
% Difference	0.0	0.1	0.3
Accomodation & Food Services			
% Difference	0.1	0.9	1.5
Other private services			
% Difference	0.1	0.6	1.0
Education Services			
% Difference	0.0	0.1	0.1
Health & Social Services			
% Difference	0.0	0.0	0.1
Government Services			
% Difference	0.0	0.0	0.1

Table 6: Manufacturing Subsector Impacts – Real GDP
(Percentage Difference from Base Case)

	2014	2020	2025
Manufacturing			
% Difference	0.1	1.1	1.6
Food Products			
% Difference	0.1	1.3	2.1
Wood Products			
% Difference	0.1	1.2	1.9
Paper and Allied Product			
% Difference	0.5	3.7	5.3
Petroleum and Coal Products			
% Difference	0.0	0.0	0.2
Chemicals			
% Difference	0.5	3.4	4.7
Plastic Products			
% Difference	0.1	0.7	1.1
Non Metallic Minerals			
% Difference	0.2	1.5	2.2
Primary Metals			
% Difference	0.3	2.1	3
Fabricated Metals			
% Difference	0.1	0.6	1
Machinery			
% Difference	0.0	0.4	0.6
Computer and Electronic Products			
% Difference	0.0	0.2	0.4
Motor Vehicles			
% Difference	0.1	1	1.5
Motor Vehicle Parts			
% Difference	0.1	0.6	0.9
Other Transportation Equipment			
% Difference	0.0	0.3	0.5
Other Manufacturing			
% Difference	0.0	0.5	0.8

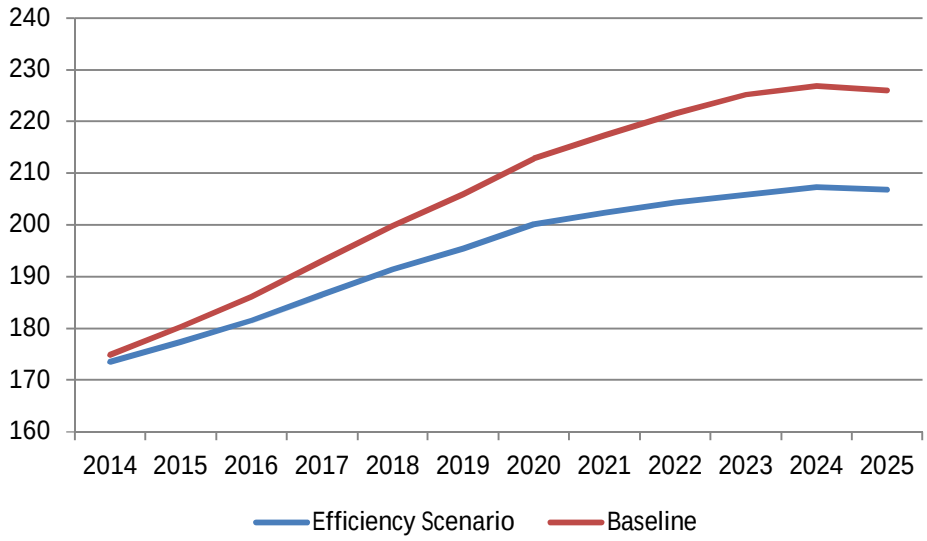
The construction industry registers a decrease because of the reduced need for capacity in the power generation industry. The manufacturing industry sees a relatively large increase in GDP because they use relatively large amounts of electricity and natural gas. **Table 6** shows the impacts on manufacturing sub-industries. Primary metals manufacturing and the pulp and paper industry show relatively large increases in GDP.

The impacts on the service industries reflect in part the higher population associated with the employment increase as well as a reduction in the use of electricity and natural gas. The retail and wholesale trade, finance, insurance, and real estate, and accommodation and food services show the largest increases in real GDP among private services.

A 25% reduction in electricity and natural gas use by the residential, commercial, institutional and industrial sectors will also have the effect of reducing GHG emissions in the Ontario

economy – see **Chart 1**. In 2014 the Ontario economy emits an estimated 175 Mt of CO_2 and this rises to 226 Mt in 2025 in the base case. In the efficiency scenario, CO_2 emissions rise to an estimated 207 Mt by 2025, representing a 9% reduction or 19 Mt of CO_2.

Chart 1: Greenhouse Gas Emissions (Mt of CO2)



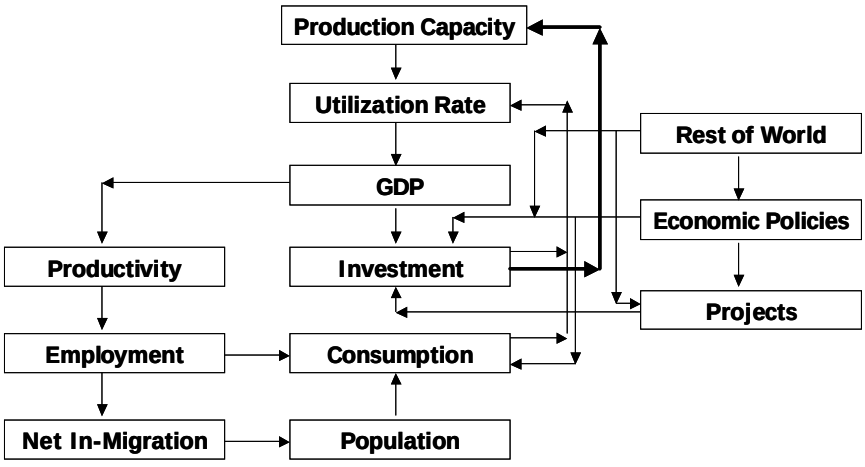
Technical Appendix

Stokes Economic Consulting maintains the C_4SE multi-sector provincial economic models. The purpose of these models is to produce medium to long-term economic projections and conduct impact studies.

The provincial models can be characterized as multi-sector (industry) general equilibrium models. They are KLEM models – capital (K), labour (L), energy (E), and materials (M) are combined to produce gross output in each industry sector. Materials are used in fixed proportion to output while substitution is allowed among capital, labour, and energy. Natural gas and electricity are energy inputs to production. Changes in the relative factor cost of capital, labour and energy bring about the substitution. The production function is Cobb-Douglas for each industry sector.

The main outside forces driving the economy are the influences of the rest of the world and economic policies. These two sets of influences shape the views of local decision makers including the decision to undertake major projects. Real GDP growth, inflation, and interest rates in the rest of the world drive local economic growth through their influence on exports, local inflation, and the cost of credit. Economic policies such as government tax rates and expenditures also impact local growth.

The basic workings can be seen from figure shown below.



Given the external forces and the production capacity of the various sectors in the economy, firms set capacity utilization rates based on expected sales thereby determining real output. Once real output for each industry is determined, employment for all industries is set through the productivity of labour. Employment combined with wages, other income, and consumer prices then determines private consumption. Employment when compared with labour force then drives net in-migration, which in turn sets population growth.

Population growth combined with personal income then determines private consumption. Population also impacts government consumption, as a change in population leads to a change in the demand for government services. Both government consumption and investment are affected.

The increase in real output combined with changes in consumption then changes private investment decisions. The changes in consumption and investment decisions, in turn, lead to changes in capacity utilization rates and output. This type of cycle continues until the one-year solution of the model is obtained.

In the long term, the key determinants of changes in overall economic activity in the model are growth in fixed investment expenditures and productivity growth. The rate of productivity growth is determined by changes in technology and modifications to the way in which business is conducted. Productivity is an exogenous variable – is set outside of the model.