DURHAM COMMUNITY ENERGY PLAN

Baseline Energy Study for 2015

Final Report

May 2017

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Table of Contents

1.0 Introduction

1.1 Background

In June 2016, Durham Region and project partners initiated the Durham Community Energy Plan (DCEP) based on the Ministry of Energy's Municipal Energy Plan program.

The objectives of the DCEP are to:

- Set goals, objectives, targets and timelines for energy supply and demand management in Durham;
- Identify and assess opportunities to develop local sources of energy generation, co and tri-generation, district energy, energy storage and smart energy networks, factoring in local land use, transportation, climate, waste and water plans and strategies;
- Provide the data and market intelligence to enhance local Conservation and Demand Management (CDM) and Demand Side Management (DSM) programs for electricity, natural gas and transportation fuels in Durham and assist in the integration, promotion and implementation of these programs;
- Identify the business case and local economic impacts of these programs and projects and how they can contribute to the economic development of Durham;
- Identify appropriate next steps and mechanisms for the Region, local municipalities, utilities and others to implement the Durham Community Energy Plan.

The development of the DCEP consists of three stages:

- Stage 1: Stakeholder Engagement
- Stage 2: Baseline Energy Study
- Stage 3: Community Energy Plan Development

Durham Sustain Ability (DSA) has completed energy and greenhouse gas (GHG) emissions inventories for Durham Region for the years 2005, 2006, 2007, 2008 and 2011. Based on this work and expertise, DSA has been retained to develop the Stage 2 Baseline Energy Study for 2015.

1.2 Scope of Work

This Baseline Energy Study incorporates the following scope of work:

- Conduct energy data collection for the year 2015 within the Regional Municipality of Durham geographic boundaries for the supply, conversion and consumption of the following types of energy:
    - Electricity
    - Natural gas
    - Gasoline
    - Diesel fuel
    - Heating oil
    - Propane
    - Nuclear power
    - Solar
    - Wind
    - Bioenergy
    - Solid waste
    - Geothermal
    - Waste heat, if any
    - Hydrogen, if any
    - Electricity storage, if any

  Consumption of energy includes all energy consumed and/or purchased in Durham Region. The energy collection methodology, especially for transportation fuels, is different than past PCP community inventories and is not comparable.

  Supply of energy includes all energy generated in Durham Region (nuclear, other non-renewable energy facilities and renewable energy generation).

- Segregate and compile energy consumption data by the following sectors of the economy:
    - Residential
    - Apartment
    - Institutional

  - Commercial
  - Industrial
  - Agricultural
  - Transportation
- Calculate GHG emissions resulting from energy consumption in Durham region using the most recently published emissions coefficient data as provided in Table 2. GHG emissions from non-energy sources, such industrial process reactions and fugitive emissions are excluded as the focus is on energy only.

1.3 Methodology

Energy data was collected and compiled based on top down (major suppliers) and bottom up (local suppliers and local energy consumers) approaches including:

- Direct data requests to major energy providers including electricity and natural gas utilities, and major oil companies
- Direct data requests to local fuel distributors, local energy generators, and large industrial facilities
- Direct data requests to institutions including municipalities, school boards, post-secondary and hospitals

Gaps in data were filled by utilizing a fuel data survey organization and by provincial proxy data.

The following energy data was collected:

1) Electricity usage: Hydro One, Oshawa PUC, Veridian, Whitby Hydro
   a. Top level segregation by Residential (excluding apartments), Industrial, Commercial & Institutional (IC&I) customers < 50kW, IC&I customers > 50 kW, and street lighting all by municipality
   b. Electricity delivered prices by above sectors, which includes all charges paid by the customer including delivery, global adjustments, regulatory charges, debt retirement charge, and taxes and rebates.
   c. Sector segregation by Residential (dedicated metering), Apartment (single metering for multi-dwelling units), Commercial (including institutional) and Industrial

   d. Subsector segregation by North American Industry Classification System (NAICS) code or equivalent but for entire service area (provided by 3 of 4 utilities comprising 80% of electricity usage in Durham)

2) Electricity generation from photovoltaic (PV) solar and wind: Hydro One, Veridian and Whitby Hydro by municipality

3) Natural gas usage: Enbridge

   a. Segregation by Residential, Apartment, Commercial (including institutional) and Industrial by Forward Sortation Area (FSA) which are the first three digits of postal code

   b. Natural gas delivered prices by above sectors, which includes all charges paid by the customer. An average of multiple rates in the industrial sector was used.

4) Transportation fuels:

   a. Four of five major oil companies did not respond to multiple data requests (fuel data received by one major oil company was used to support use of provincial proxy data)

   b. Survey of retail gas stations in Durham provided by Kent Group for retail pump sales of gasoline (by grade and ethanol blend) and diesel by FSA

   c. Provincial proxy data used for commercial sales of gasoline and diesel

   d. Gasoline and diesel price data from the Ministry of Energy (MOE) for East Toronto

5) Other fuels:

   a. Only one local fuel distributor responded to multiple data requests

   b. Provincial proxy data used for propane, fuel oil and residential wood use

   c. Propane and fuel oil price data from StatCan & MOE for East Toronto

6) Industrial large emitters

   a. Seven facilities in Durham are included in the federal publication “Greenhouse Gas Emissions from Large Facilities” for 2015; received supplemental data from five of these organizations.

   b. Differentiated between GHG emissions from energy/fuels such as natural gas, petroleum coke and coal (included in this energy-focused study) and GHG emissions from process reactions and fugitive emissions (excluded from this study)

7) Institutional sector

   a. Public energy usage data for institutional facilities is provincially mandated, however the last published data is for 2014

   b. Received 2015 facility data (as well as street lighting and fleet vehicle data, as applicable) from municipalities, school boards, post-secondary and hospitals (22 of 23 institutions provided data for 2015; used 2014 data for one institution)

8) Agriculture sector
   a. Provincial proxy data based on prorating farm land area; only farm operations energy data is used for this sector

9) Energy generators
   a. Nuclear energy – provided by Ontario Power Generation (OPG) by site
   b. Renewable energy
      i. Solar and wind – electricity utilities based on Feed-In Tariff (FIT) and microFIT programs; off grid / non-FIT installations, except OPG's wind turbine, were not included due to lack of local data
      ii. Geothermal – multiple sources – province (residential), institutions, businesses
      iii. Biogas – Durham Region wastewater treatment biogas capture
      iv. Solid waste – Durham York Energy Centre (DYEC) facility - Durham Region and Covanta
      v. Wood waste – Index Energy's Ajax Cogen Facility – multiple sources including IESO, Town of Ajax and Doherty Engineering
      vi. Wood – provincial proxy data for residential use

   c. Non-Renewable Energy
      i. Cogen Facility – Whitby Cogen – GHG emissions, natural gas, electricity and steam data for 2015

The energy data was compiled and converted into energy units. Table 1 provides the energy conversion factors used to calculate energy use and production.

Table 1: Energy Conversion Factors

Energy Source	Base Unit	Energy Factor (Megajoules / base unit)
Electricity	kWh	3.60
Coal – bituminous	kilogram	26.33
Diesel	litres	38.30
Fuel Oil	litres	38.80
Gasoline	litres	35.00
Gasoline with 10% Ethanol	litres	33.86
Natural Gas	cubic metres	39.24
Petroleum Coke	kilogram	46.35
Propane	litres	25.31
Wood	kilogram	18.00

Source: Report on Energy Supply and Demand in Canada - 2015 Preliminary by Statistics Canada, March 2017

Energy consumption data was also converted into GHG emissions. The most recent published emission coefficients were used for each source of energy in order to calculate the resulting GHG emissions. Energy use and annual emissions are expressed in absolute terms and are not corrected for weather.

The electricity GHG emissions coefficient is based on the annual average amount of fossil fuel (natural gas, oil) used at Ontario's electricity power plants. Other sources such as hydropower, nuclear and renewable energy do not directly produce GHG emissions. As Ontario's generation mix changes from year to year so does the electricity coefficient.

Tables 2 provide the emission coefficients for the year 2015 used in the GHG emissions calculations.

Table 2: GHG Emission Coefficients

Energy Source	Base Unit	GHG Coefficient (tonnes eCO2 / base unit)
Electricity	kWh	0.000043
Coal – bituminous	kilogram	0.002153
Diesel	litres	0.002759
Fuel Oil	litres	0.002763
Gasoline	litres	0.002389
Gasoline with 10% Ethanol	litres	0.002150
Natural Gas	cubic metres	0.001900
Petroleum Coke	kilogram	0.003837
Propane	litres	0.001549
Wood	kilogram	0

Source: National Inventory Report 1990-2015 – Greenhouse Gas Sources and Sinks in Canada, Annex 6 by Environment and Climate Change Canada released April 13, 2017.

2.0 Baseline Energy Inventory for 2015

2.1 Durham Energy Consumption Summary

2.1.1 Consumption by Sector

Table 3 summarizes the energy consumption, energy cost and GHG emissions by sector along with a per capita total. The definition and detailed analysis of each sector will be provided in section 2.4.

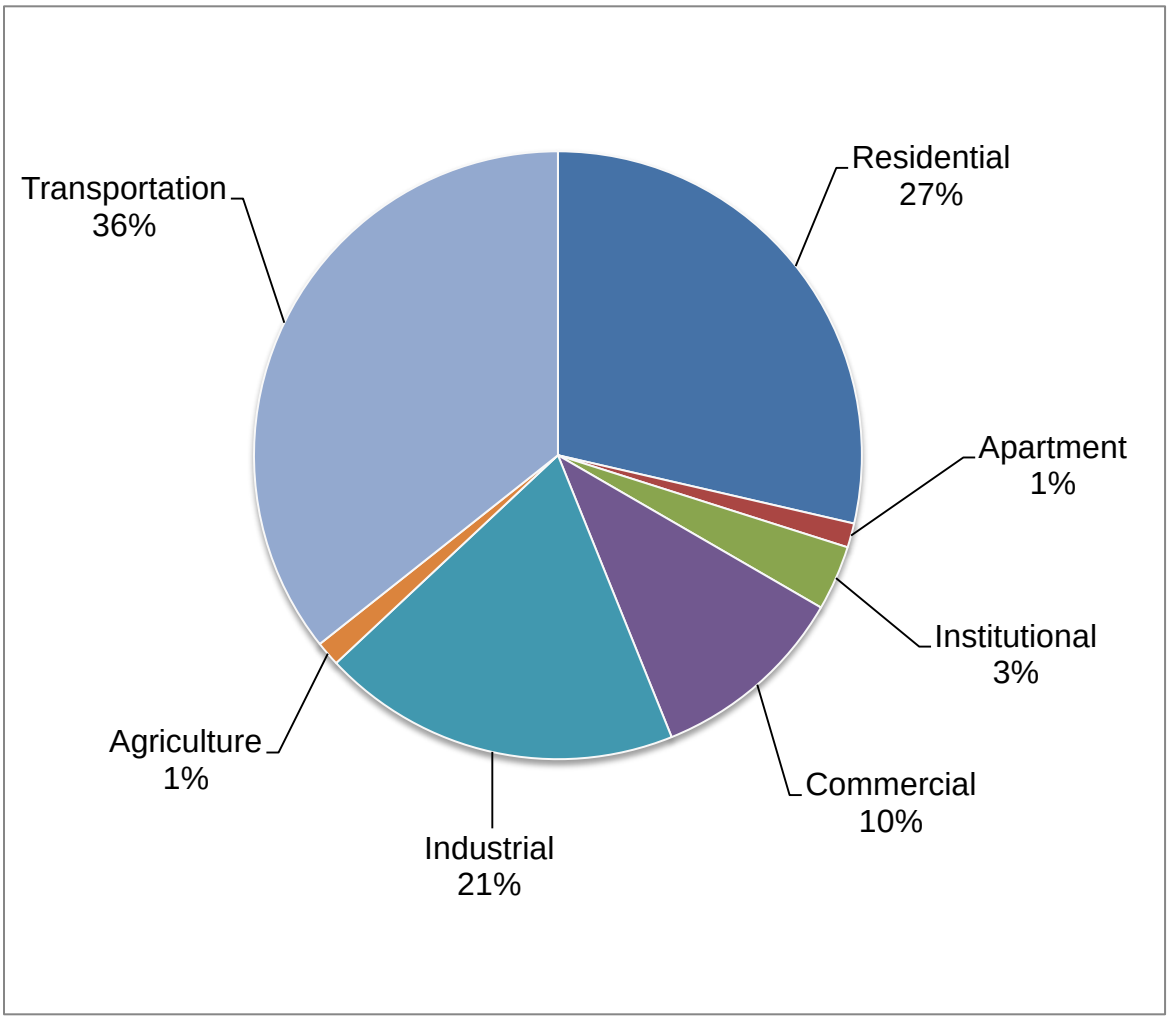
Table 3: 2015 Energy Consumption, Energy Cost and GHG Emissions by Sector

Sector	Energy Use in Gigajoules (GJ)	Energy Cost ($'000)	GHG Emissions from energy use (tonnes of eCO2)
Residential	26,393,849	551,011	959,145
Apartments	1,256,027	33,097	41,000
Institutional	3,344,939	101,539	101,396
Commercial	10,190,866	287,985	345,428
Industrial	20,455,801	195,524	1,103,481
Agriculture	1,196,346	28,241	70,085
Transportation	35,196,522	1,065,711	2,329,569
Total	**98,034,351**	**2,263,107**	**4,950,104**
Per Capita (per person)	**149**	**3.4**	**7.5**

The per capita figures are based on Durham Region's population estimate of 658,185 for 2015. The GHG emissions of close to 5 million tonnes (equivalent to 7.5 tonnes per person) are based on the consumption of just over 98 million GJ of energy from various sources as shown below in Table 4. The total energy cost of $2.26 billion is equivalent to a per capita expenditure of $3,400 per person.

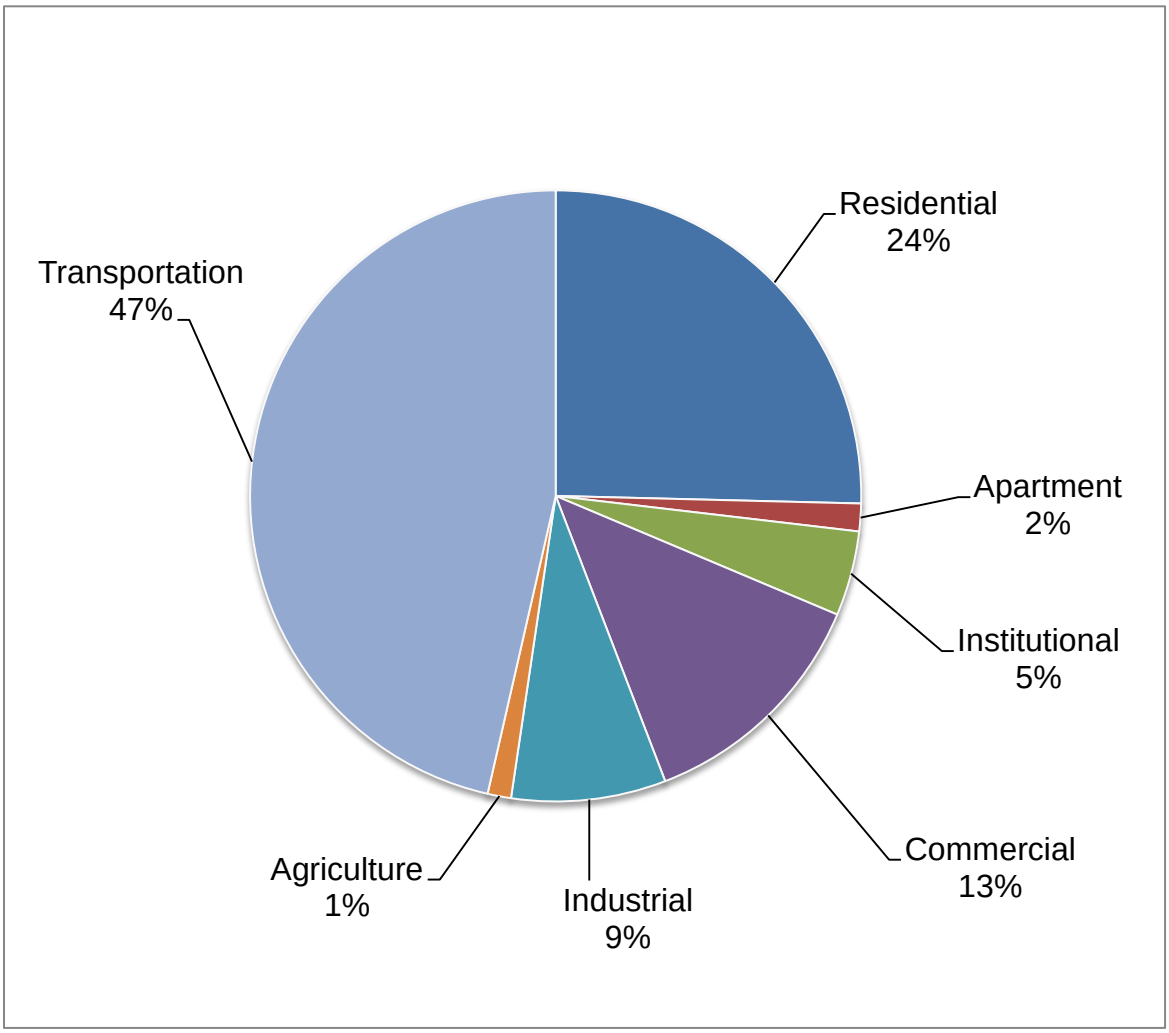
Figures 1, 2 and 3 below provide sector percentage breakdowns of the energy use, energy cost and GHG emissions, respectively.

Figure 1: Energy Consumption Breakdown by Sector



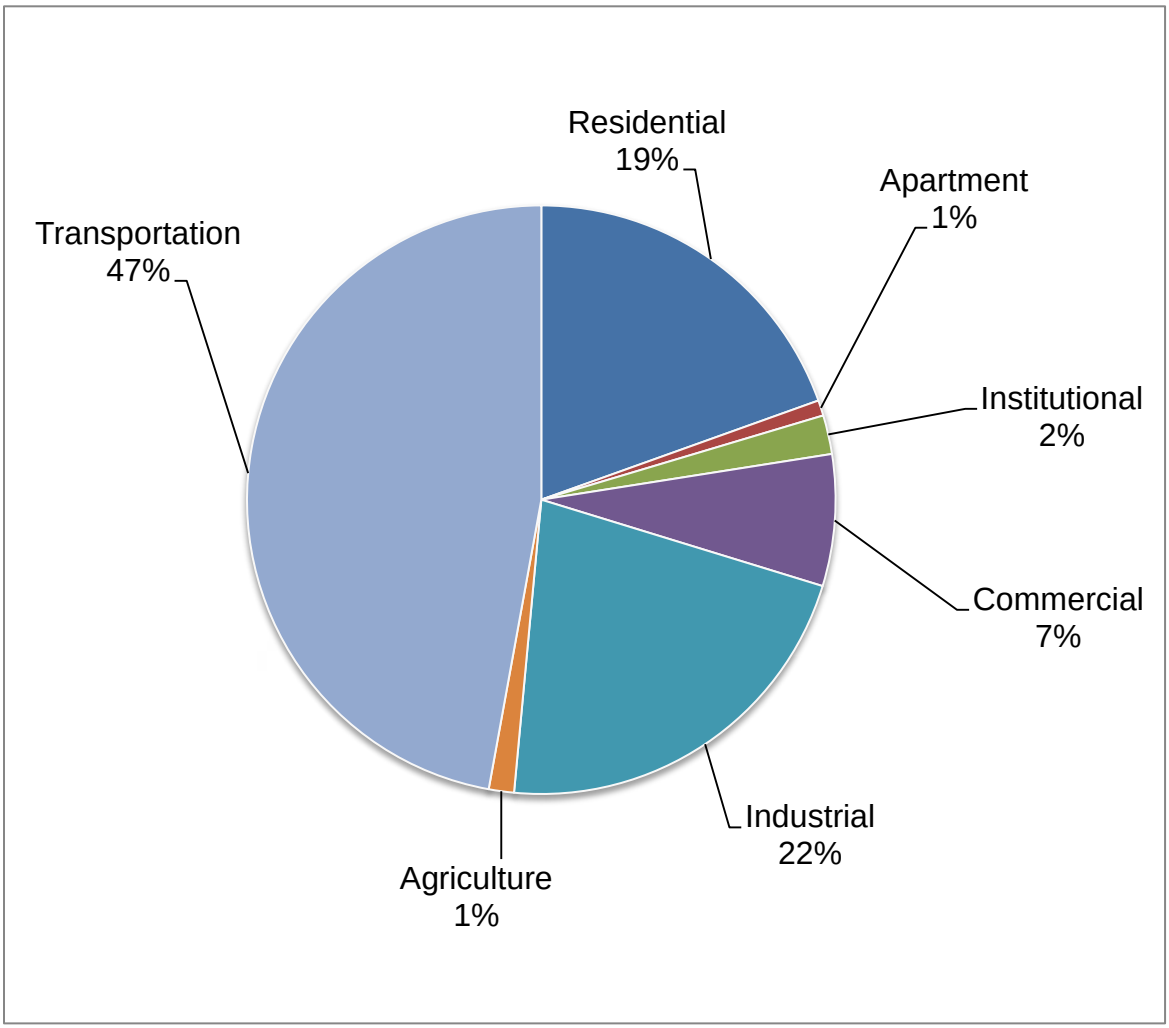
The transportation sector consumes the most energy at 36% of total energy use followed by the residential sector at 27%.

Figure 2: Energy Cost Breakdown by Sector



Most of the energy cost breakdown aligns with the energy use, except the industrial sector at 9% (versus 21% energy use) and the transportation sector at 47% (versus 36% energy use). The industrial sector tends to use proportionally lower cost fuels such as natural gas as well as very low costs sources of energy such as coal and petroleum coke. The prices of gasoline and diesel are relatively high for their energy content, which tends to make transportation more expensive.

Figure 3: GHG Emissions from Energy Use - Breakdown by Sector



The transportation sector is the largest emitter of GHG emissions at nearly half of all energy-related GHG emissions as gasoline and diesel have relatively high emissions intensities versus cleaner fuels such as natural gas. The industrial sector produces the second most emissions at 22% as lower cost fuels such as coal and petroleum coke are the most emission intensive fuels.

2.1.2 Consumption by Source

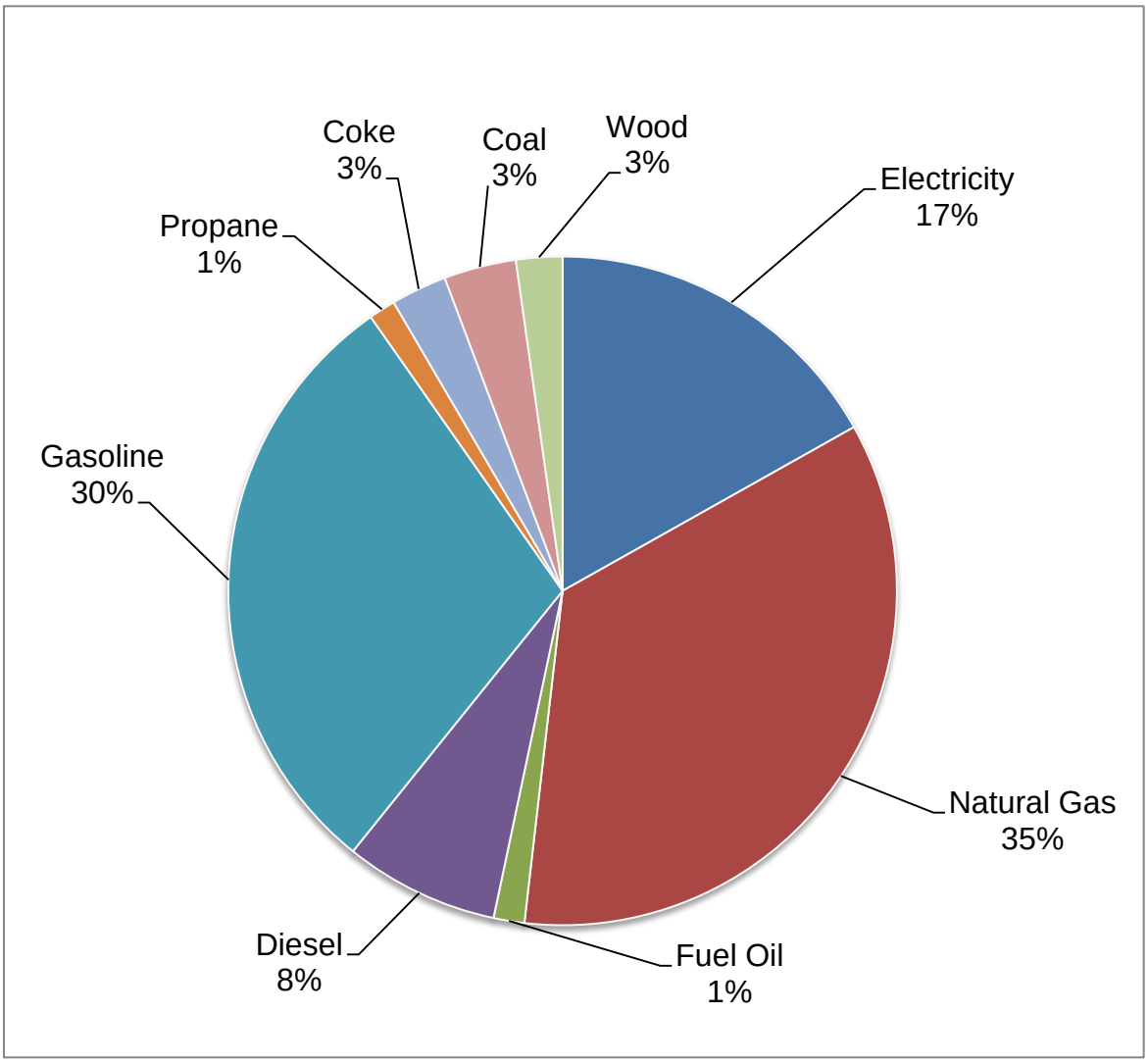
Table 4 summarizes the energy consumption, energy cost and GHG emissions by source.

Table 4: 2015 Energy Consumption, Energy Cost and GHG Emissions by Source

Energy Source	Energy Use (GJ)	Energy Cost ($'000)	GHG Emissions from energy use (tonnes of eCO2)
Electricity	16,365,146	873,534	195,473
Natural Gas	34,163,106	194,482	1,654,644
Fuel Oil	1,096,881	31,606	78,115
Diesel	7,941,688	224,151	581,782
Gasoline	28,875,079	889,155	1,879,263
Propane	1,082,988	18,570	66,282
Coke	2,621,185	5,067	216,986
Coal	3,394,832	17,244	277,559
Wood	2,493,445	9,298	0
Total	**98,034,351**	**2,263,107**	**4,950,104**

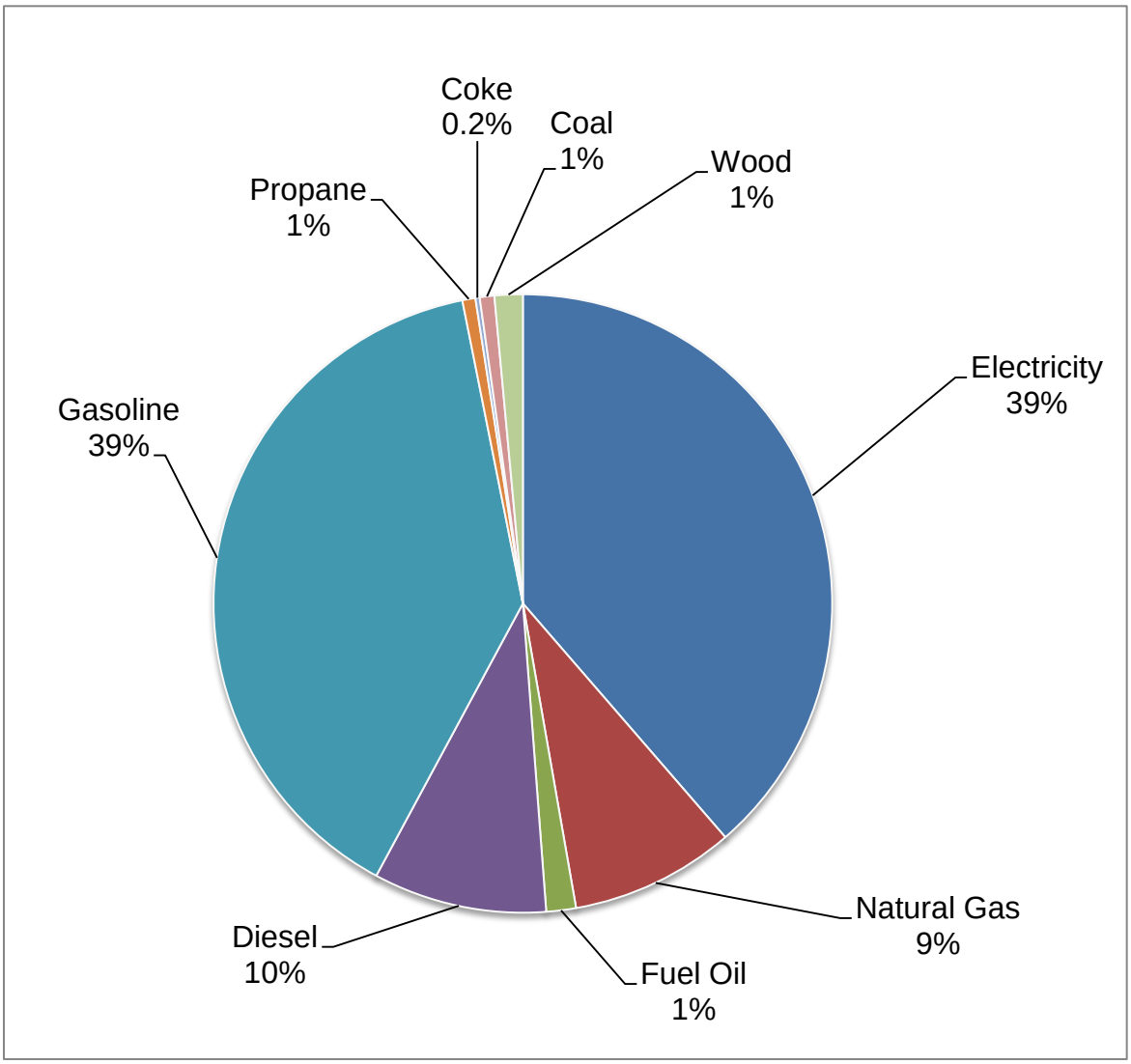
Figures 4, 5 and 6 below provide energy source percentage breakdowns of the energy use, energy cost and GHG emissions, respectively.

Figure 4: Energy Consumption Breakdown by Source



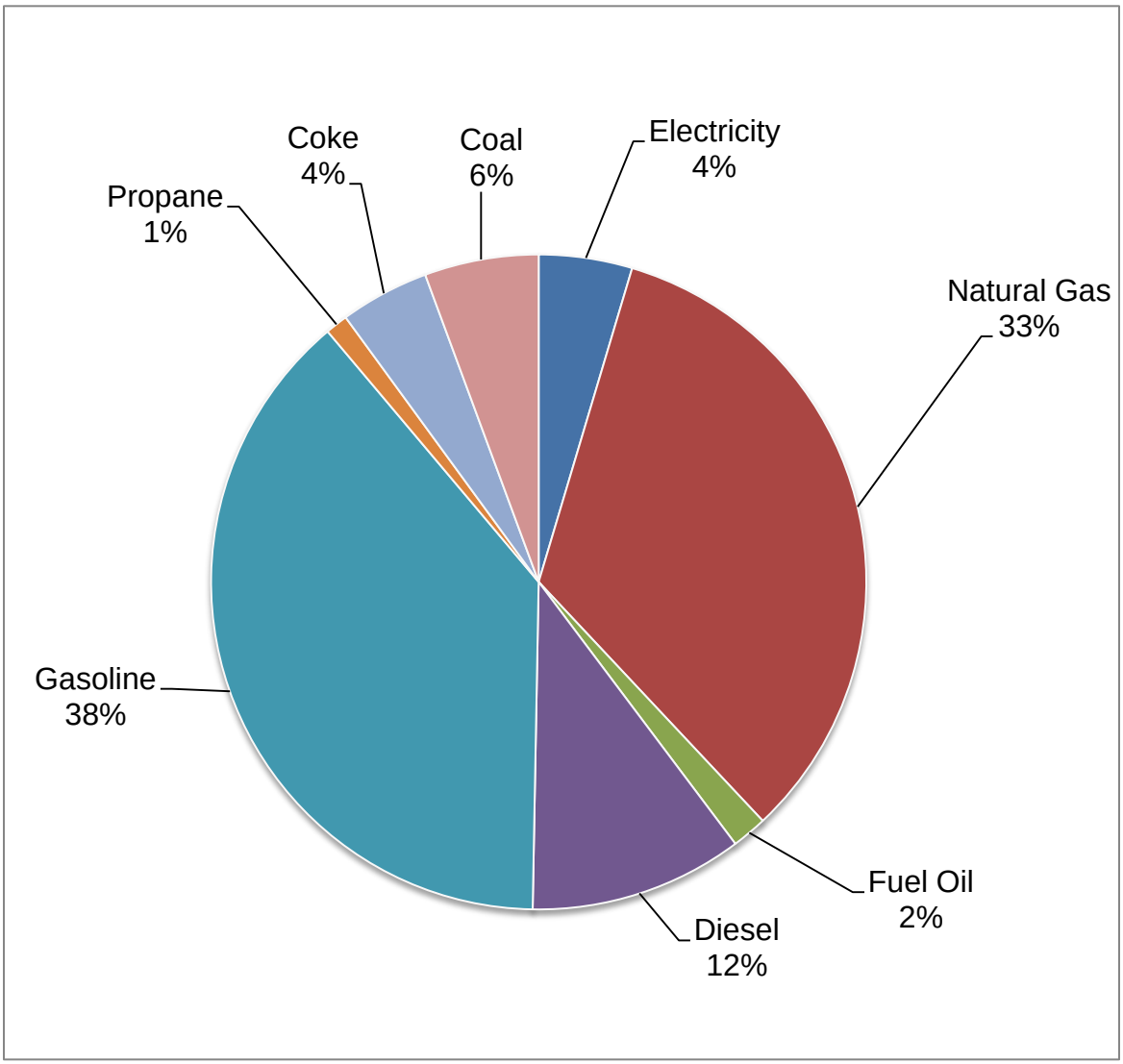
Gasoline and diesel comprise 38% of all energy use followed closely by natural gas at 35%. Electricity comprises only 17% of total consumption while the remaining fuels represent relatively minor contributions to total consumption.

Figure 5: Energy Cost Breakdown by Source



Although electricity represents 17% of energy use its share of energy costs is at 39% due to its high unit price. Gasoline and diesel comprise 49% of total energy costs versus 38% of energy use, which again shows that transportation fuels have a relatively high cost for their energy content. Natural gas has relatively good value for its energy content at 9% of energy costs versus 35% of energy use.

Figure 6: GHG Emissions from Energy Use - Breakdown by Source



Electricity produces only 4% of GHG emissions from 17% of the energy use. With the coal power plants closed, electricity from the provincial grid has a relatively low GHG emissions intensity. Transportation fuels, gasoline and diesel, produce 50% of the emissions from 38% of the energy use as these fuels have relatively high emission intensities. Natural gas generates 33% of emissions from 35% of energy use, which suggests that it's close to the average level of emissions intensity within this energy mix. Wood fuel is not shown on this graph as it has zero GHG emissions based on accepted protocol.

2.2 Energy Generation in Durham

In order to complete the energy picture for Durham Region, we need to quantify not only energy consumption, but also energy generation. Table 5 provides a summary of broad types of energy generation in Durham.

Table 5: Durham Energy Generation Summary

Type of Energy Generation	Energy Generation Equivalent Terawatt-hours (eTWh)	Energy Generation Gigajoules (GJ)
Nuclear Energy	44.50	160,200,000
Other Non-Renewable Energy	0.79	2,845,714
Renewable Energy	0.40	1,437,818
Total	**45.69**	**164,483,532**

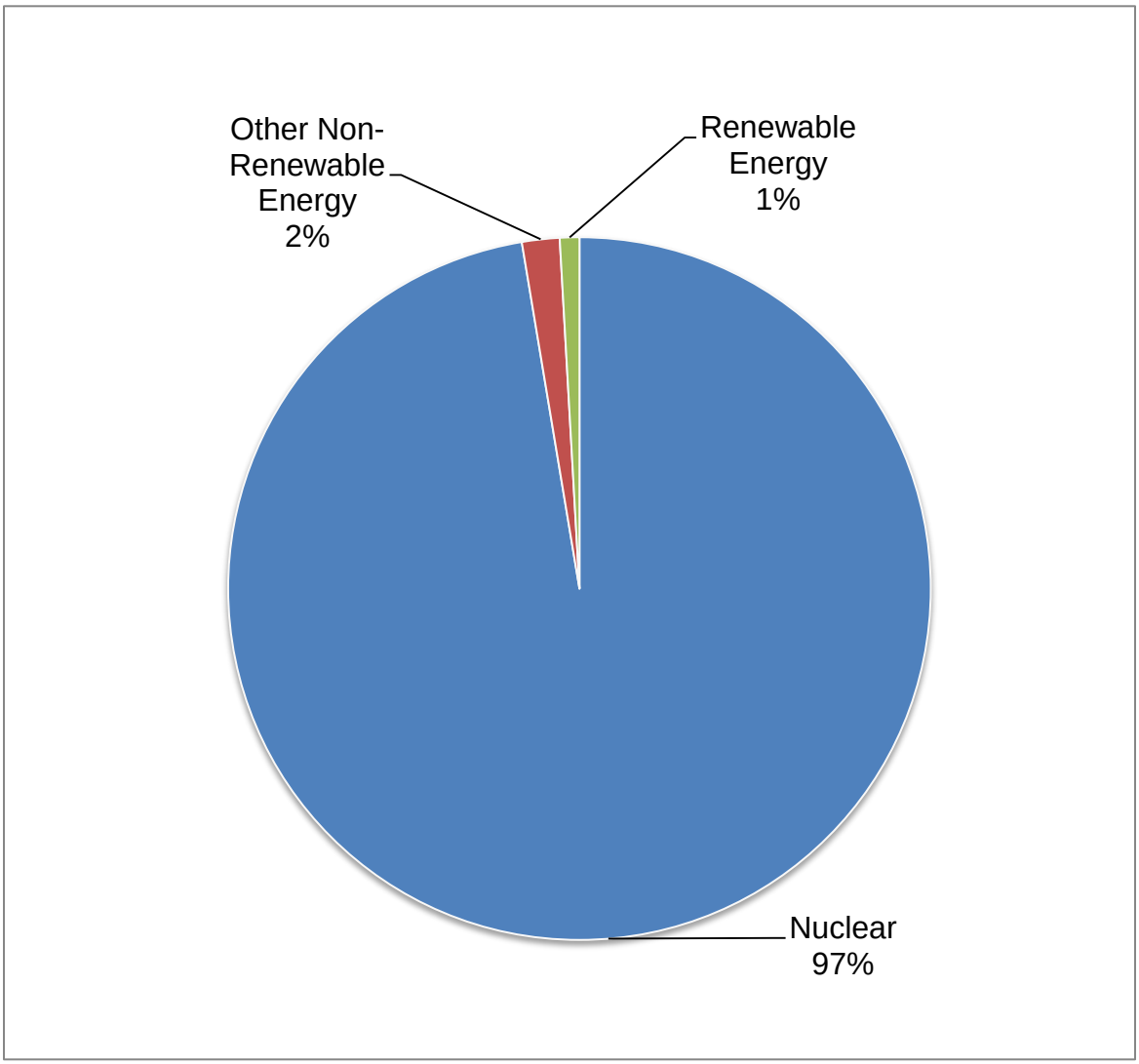
In 2015, the nuclear energy generation stations in Durham generated 21.6 TWh at Pickering Nuclear Generation Station, which operated at 79.4% capacity utilization, and 23.6 TWh at Darlington Nuclear Generation Station operating at 76.9% utilization. These two stations combined to produce 32.3% of the entire electricity demand in Ontario in 2015.

Renewable energy is broken down further in Table 6 and Figure 8 below.

The other non-renewable energy generation in Durham is produced by a natural gas fueled cogeneration facility (Whitby Cogen). In 2015, the facility consumed approximately 14% of the total natural gas usage in Durham to produce electricity to the grid equating to 9% of Durham's electricity demand as well as steam for a nearby industrial consumer.

Figure 7 provides the percentage breakdown of energy generation in Durham.

Figure 7: Breakdown of Energy Generation in Durham in 2015



Nuclear electricity generation accounts for a very large proportion (97%) of energy generation in Durham. Other non-renewable energy (2%) and renewable energy (1%) are much smaller in proportion to nuclear, however some types of renewable energy (especially solar PV) have grown significantly in recent years.

In Durham, renewable energy is generated by various means as shown in Table 6.

Table 6: Durham Renewable Energy Generation Breakdown by Type

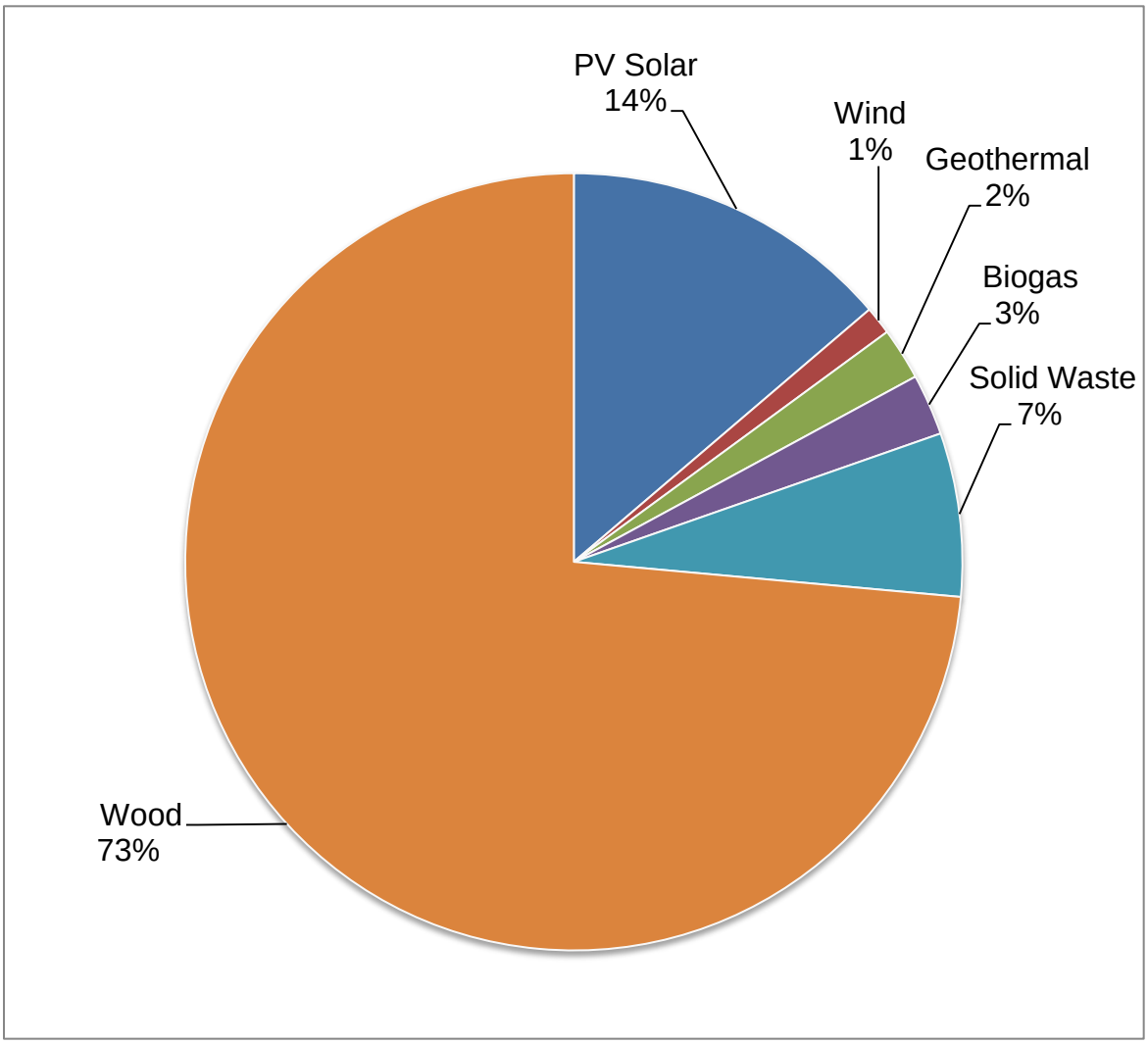
Type of Renewable Energy	Energy Generation (GJ)
PV Solar	203,076
Wind	17,285
Geothermal	27,800
Biogas	37,653
Solid Waste	100,415
Wood	1,051,249
Total Renewable Energy	**1,437,478**

Since the last survey of Durham renewable energy in 2011 energy generation from wind, geothermal, and biogas has remained relatively stable through to 2015 (although some additional wind turbines have been installed in 2016). Renewable energy from solid waste is new in 2015 with the start-up of the Durham York Energy Centre. A new cogeneration facility in Ajax owned by Index Energy also started-up in mid-2015. This facility consumes wood waste (mostly construction and demolition waste) to produce electricity to the grid and steam to a number of end-users in the area.

However, solar PV has grown at an astounding rate since 2011: electricity generation from solar installations has grown by over 20 fold (2130 %) in just four years.

Figure 8 provides the percentage breakdown of renewable energy in Durham.

Figure 8: Breakdown of Renewable Energy Generated in Durham in 2015



Wood biomass (firewood and wood pellets) consumed in the residential sector and wood waste consumed at the aforementioned Ajax cogeneration facility is the largest form of renewable energy generation in Durham at 73% of total renewables.

PV Solar installations in the residential, commercial and institutional sectors generated 14% of the renewable energy.

Electricity generated to the grid from solid waste incineration at the Durham York Energy Centre (DYEC) produced 7% of Durham's renewable energy production. The DYEC is not officially designated as a renewable energy facility by the province, however it is generally accepted that energy capture from solid waste is a renewable energy source. The DYEC was commissioned in 2015 so this

production represents a partial year of operation. Approximately 70% of the rated waste processing capacity was utilized in 2015.

Wind, geothermal and biogas (Durham Region wastewater treatment biogas captured as fuel) represented the small remainder of renewable energy generated in Durham.

2.3 Indices for Tracking Progress

Beyond measuring absolute and per capita changes in energy consumption and energy generation (including renewable energy generation), other meaningful measures of progress may be needed. The following provides some additional recommended indices created for this report to be included with other more standard measures.

2.3.1 Renewable Energy Index

The “Renewable Energy Index” is defined as the consumption of renewable energy as a percentage of total energy consumption. Table 7 provides a summary of total energy consumption in Durham and the corresponding renewable portion of each source of energy.

Table 7: Renewable Energy Portion of Durham’s Energy Consumption

Energy Type	Energy Consumption (GJ)	Renewable Portion	Renewable Energy (GJ)
Electricity	16,365,146	30.0%	4,903,601
Natural Gas	34,163,106	0.0%	
Fuel Oil	1,062,349	0%	
Diesel	7,894,103	0.0%	
Gasoline	28,866,160	4.6%	1,337,739
Propane	1,026,256	0.0%	
Coke	2,621,185	0.0%	
Coal	3,394,832	0.0%	
Wood Used Locally	2,493,445	89.9%	2,240,841
Other Renewables Used Locally	65,453	100.0%	65,453
Total	**97,952,035**	**8.7%**	**8,547,634**

The 30% renewable portion of 2015 electricity generation in the provincial grid is provided by IESO and includes electricity generated from hydro, wind, solar and biofuel.

The 4.6% renewal portion of gasoline is the ethanol content as provide by the Kent Group in their 2015 survey of gas stations in Durham. The average volume content of ethanol in gasoline is 6.9%, however on an energy basis it's only 4.6% as a result of the lower energy density of ethanol. There are no biodiesel pumps in Ontario, so the renewable portion of diesel is negligible in Durham.

Renewable energy generated in Durham that is consumed locally (that is not generated as electricity to the grid which is already counted) includes wood (except electricity generated at the Index Energy cogeneration plant), biogas and geothermal.

The renewable energy totals 8.5 million GJ and is 8.7% of the total energy consumed in Durham in 2015. The "Renewable Energy Index" of 8.7% in 2015 can be tracked in coming years to measure growth in renewable energy consumption.

2.3.2 Self-Sufficiency Index

The "Self-Sufficiency Index" is defined as the proportion of total energy consumption that is produced locally for each type of energy. Table 8 provides a summary of total energy consumption and the portion that is generated locally for each energy source.

Table 8: Local Energy Generation as a Portion of Durham's Energy Consumption

Energy Type	Energy Consumption (GJ)	Generated in Durham (%)	Energy Generated in Durham (GJ)
Electricity	16,365,146	100%	16,363,460
Natural Gas	34,163,106	0%	
Fuel Oil	1,062,349	0%	
Diesel	7,894,103	0%	
Gasoline	28,866,160	0%	
Propane	1,026,256	0%	
Coke	2,621,185	0%	
Coal	3,394,832	0%	
Wood Used Locally	2,493,445	89.9%	2,240,841
Other Renewables Used Locally	65,453	100%	65,453
Total	**97,952,035**	**19.1%**	**18,671,440**

Nuclear electricity generation in Durham is over 10 times local electricity use, so 100% of electricity consumption is supplied by local generation even though it feeds the provincial grid. Other energy produced and consumed in Durham in 2015 is wood fuel for residential use and steam generation at the Ajax Cogen Plant, biogas and geothermal energy.

In 2015, the locally generated energy that was consumed in Durham is 18.7 million GJ, which corresponds to 19.1% of the total energy consumption. The "Self-Sufficiency Index" of 19.1% in 2015 can be monitored in future years to measure growth in Durham's energy self-sufficiency.

2.3.3 Carbon Intensity Index for energy

The "Carbon Intensity Index" for energy is defined as the per capita GHG emissions emitted from consumption of energy. In 2015, the "Carbon Intensity Index" for energy is 7.5 tonnes of eCO2 per person in Durham as shown in Table 3, Section 2.1.1

2.4 Energy Consumption Analysis by Sector

2.4.1 Residential

2.4.1.1 Sector Definition

The residential sector is comprised of households with their own electricity meters and, if applicable, their own natural gas meters. Multi-unit residential buildings such as apartments and condominiums with metering for the entire building are segregated into the apartment sector (refer to section 2.4.2).

2.4.1.2 Residential Energy Data by Source

Table 9 provides residential sector energy consumption and cost by energy source.

Table 9: Residential Energy Use and Energy Cost by Source

Fuel Type	Energy Use (GJ)	Energy Cost ($'000)
Electricity	7,652,725	409,384
Natural Gas	16,779,051	111,903
Fuel Oil	551,691	15,697
Propane	264,155	4,530
Wood	1,146,227	9,298
Total	**26,393,849**	**551,011**

In 2015, the residential sector accounted for 27% of total energy consumption, the second largest energy-consuming sector after transportation. Residential electricity use at 7.7 million GJ (or 2.1 million MWh) represents 47% of total electricity consumption in Durham. Natural gas use in the residential sector at 16.8 million GJ (or 428 million m3) is 49% of all natural gas consumption.

In 2015, 224,815 households (includes residential and apartments) spent $584 million on home energy, which is about 26% of total energy costs in Durham. On a household basis, the average energy cost is approximately $2,600 in 2015.

Figures 9 and 10 show the percentage breakdown of the residential energy use and energy cost by source, respectively.

Figure 9: Residential Energy Use Breakdown by Source

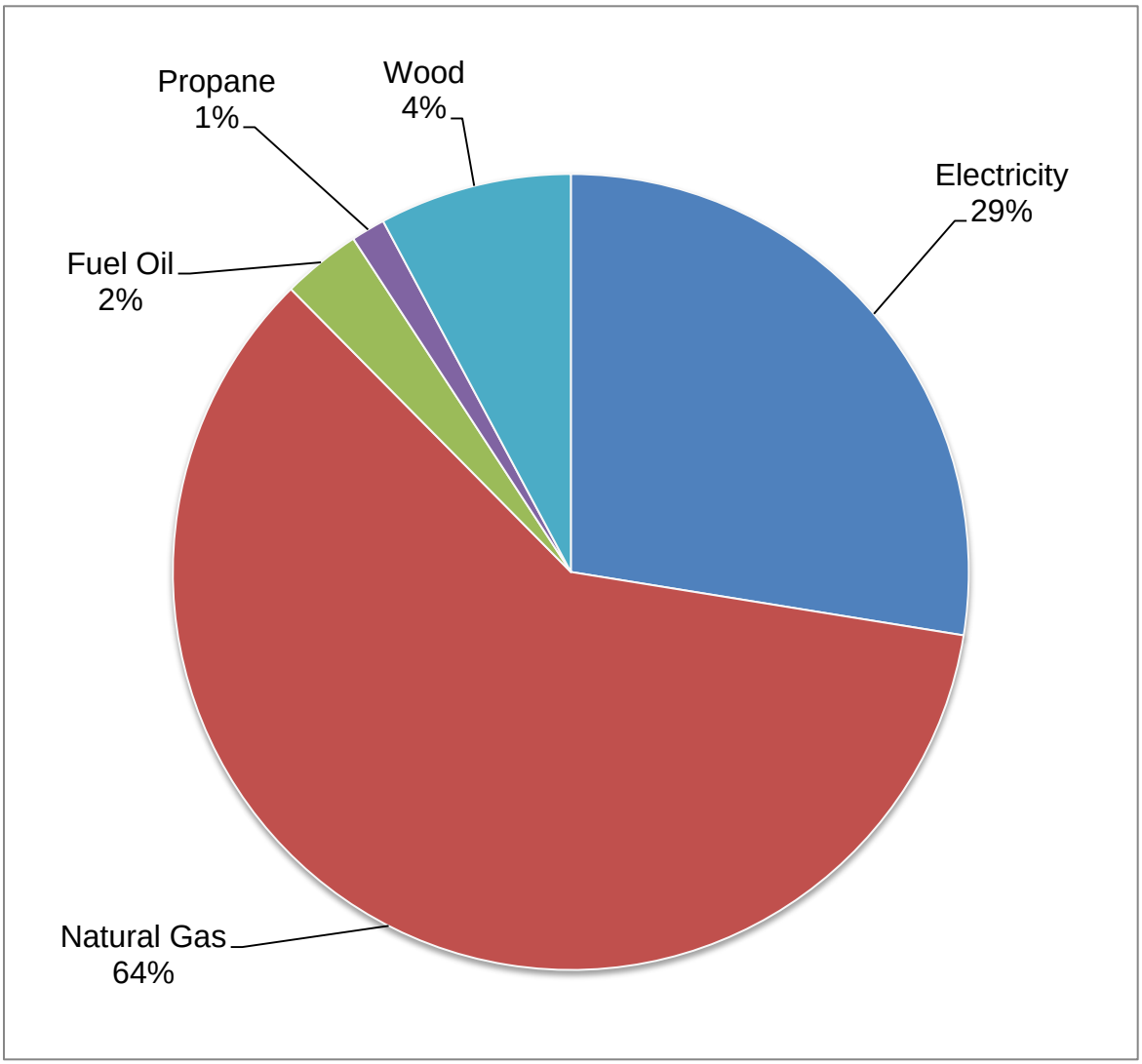
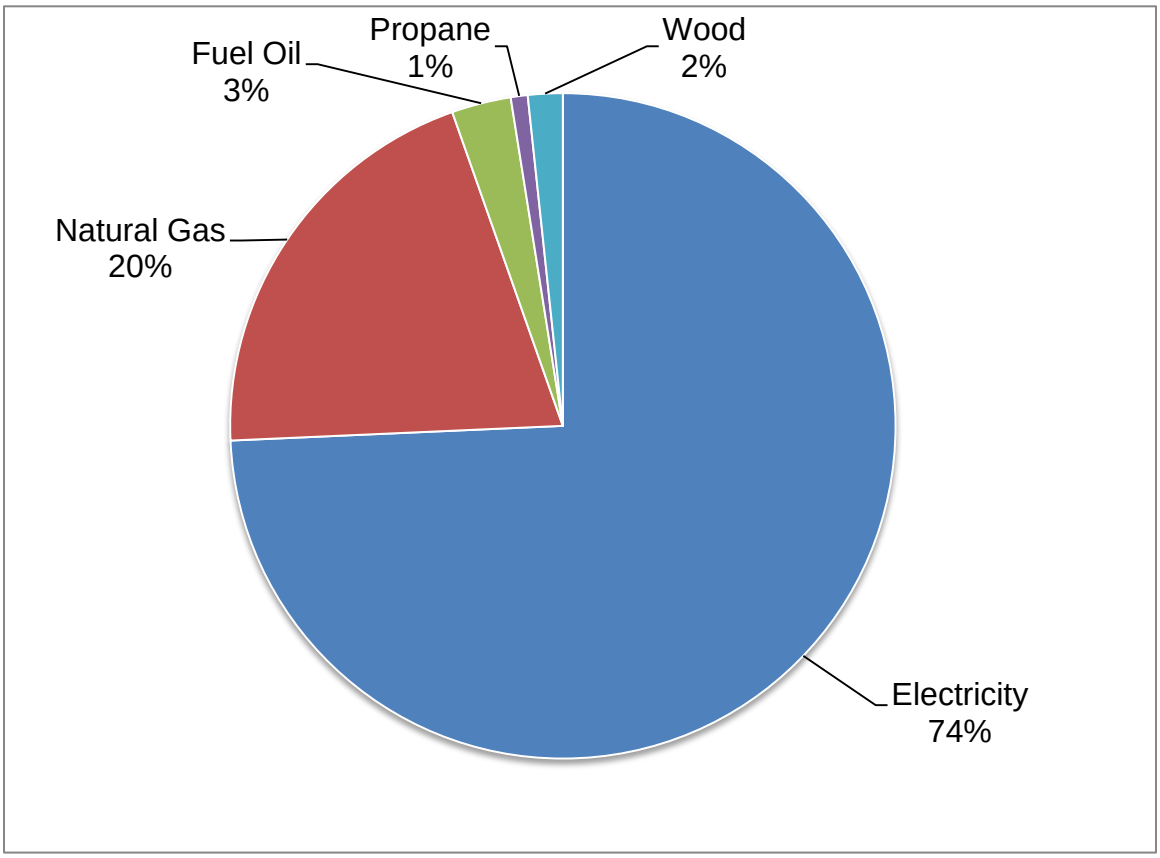


Figure 10: Residential Energy Cost Breakdown by Source



In the above figures, electricity and natural gas stand out the most. In 2015, electricity comprises 29% of household energy use and yet it costs residents on average 74% of the total household energy budget.

In 2015, natural gas is by far the largest source of energy at 64% while costing on average only 20% of the total household energy budget.

Wood and wood pellets, fuel oil and propane are predominantly used in rural areas where homes do not have access to natural gas. Approximately, 10% of households in Durham are classified as rural.

2.4.1.3 Potential Further Residential Energy Analysis

Residential Electricity Subsector Analysis

Three of the four electricity utilities have provided further residential segmentation for their service areas for the following subsectors: single and semi-detached, row house, multi-residential low rise, multi-residential high rise, and other residential (mobile homes). Hydro One did not provide this

segmentation as its service area throughout rural Ontario is so large that the data would not be meaningful for Durham.

The segmentation data from Veridian, Whitby Hydro and Oshawa PUC represents mainly the urban areas of Durham and accounts for 77% of the electricity use in the residential sector. This data could be used to develop priority targets beyond single dwellings that have their own metering, which can be differentiated from apartments with building meters.

Housing Stock Analysis

Durham Region can provide a summary level housing stock analysis by age of household. A study could be carried out to identify specific locations of older, potentially energy-inefficient homes.

2.4.2 Apartments

2.4.2.1 Sector Definition

The apartment sector is comprised of multi-dwelling residential buildings with electricity and natural gas metering for the entire building (i.e. no single household metering).

2.4.2.2 Apartment Energy Data by Source

Buildings in this sector are located in urban areas and have access to natural gas. As such, the two main sources of energy for these buildings are natural gas and electricity.

Table 10 provides apartment energy consumption and cost by energy source.

Table 10: Apartment Energy Use and Energy Cost by Source

Fuel Type	Energy Use (GJ)	Energy Cost ($'000)
Electricity	543,110	28,933
Natural Gas	712.918	4,164
Total	**1,256,027**	**33,097**

In 2015, the apartment sector accounted for 1.3% of total energy consumption in Durham. When combined with the residential sector, apartments represent 4.5% of total household energy consumption in Durham.

In 2015, energy cost for apartments was just over $33 million or 1.5% of the total energy cost in Durham.

Figures 11 and 12 show the percentage breakdown of apartment energy use and energy cost by source, respectively.

Figure 11: Apartment Energy Use Breakdown by Source

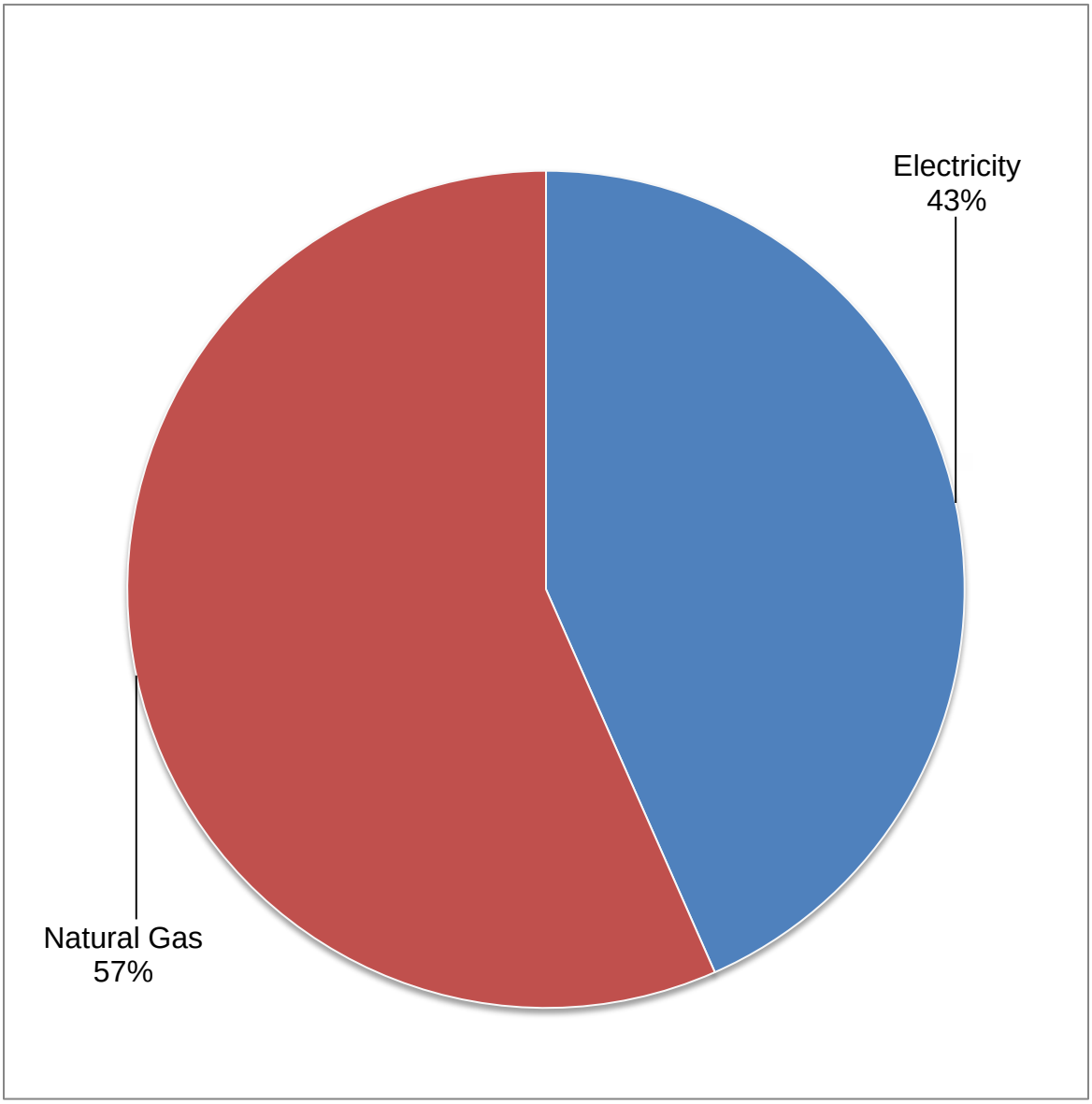
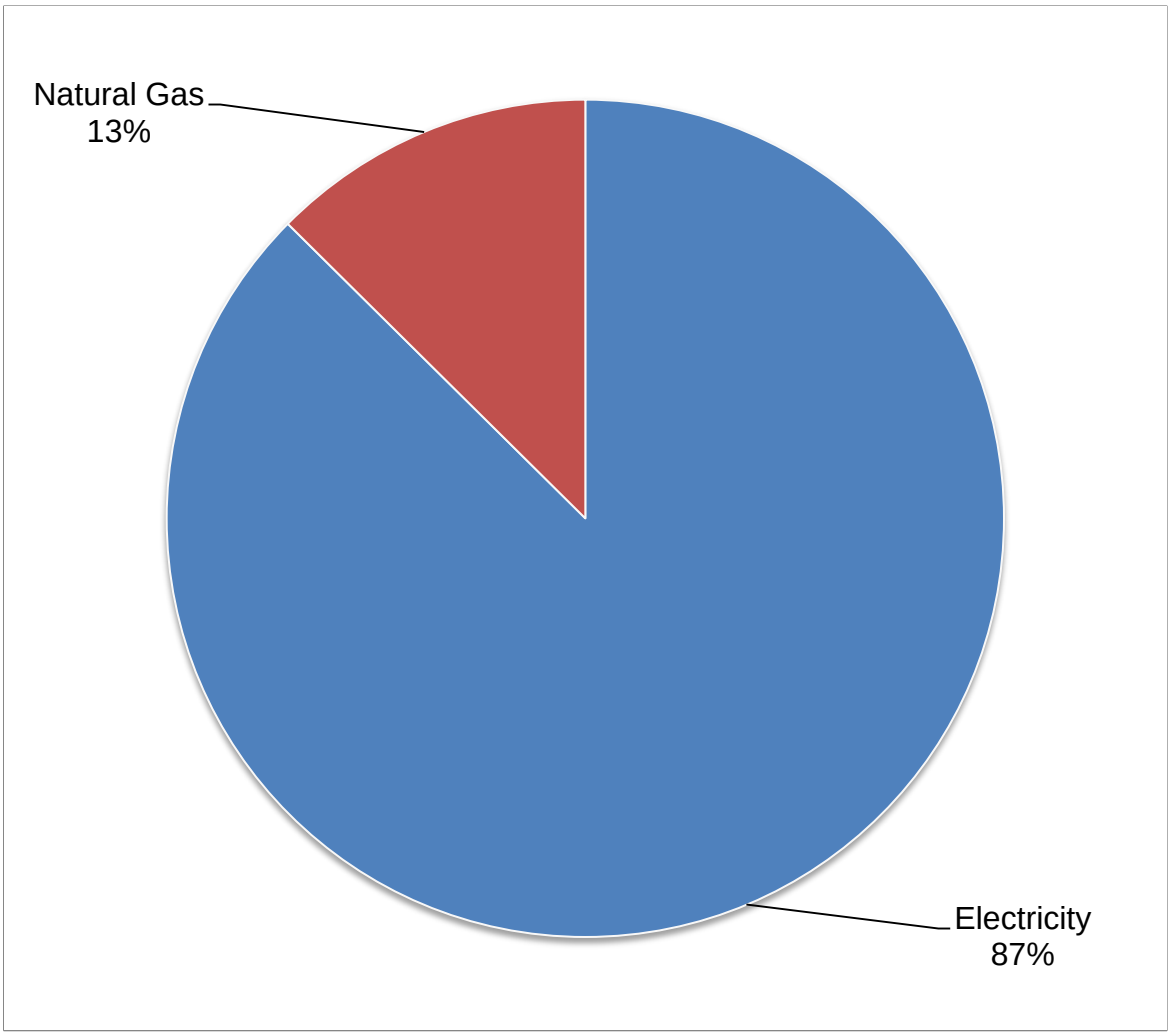


Figure 12: Apartment Energy Cost Breakdown by Source



Similar to the residential sector, there's a stark contrast between electricity usage at 43% and electricity cost at 87% and natural gas usage at 57% but only 13% of the cost. Energy conservation efforts are greatly enhanced economically by targeting electricity consumption.

2.4.2.3 Potential Further Apartment Energy Analysis

Apartment Segmentation and Location Analysis

Enbridge has provided consumption data by Forward Sorting Area (FSA) (first three digits of the postal code) for the 179 apartment buildings with single meters serviced by natural gas in this sector. Veridian, Whitby Hydro and Oshawa PUC have provided segregated electricity use data between multi-unit low rise and

high-rise buildings with separate household meters (part of residential sector) and multi-unit residential with building meters (apartment sector).

Further analysis of this data could provide targeted priorities regarding buildings with separate household metering and location of buildings with single meters.

Apartment Building Age Analysis

Durham Region can provide a summary level apartment building stock analysis by age. A study could be carried out to identify specific locations of older, potentially energy-inefficient apartment buildings.

2.4.3 Institutional

2.4.3.1 Sector Definition

The electricity and natural gas utilities provide sector segmentation that does not segregate the institutional sector from the commercial sector. As the institutional sector can exhibit different drivers regarding energy outlook and management than the commercial business sector, it is important to segregate this area for at least the main institutional subsectors.

For this study, the institutional sector is defined by the major subsectors of municipalities, schools, post-secondary, and hospitals.

There are other smaller-sized institutional subsectors such as places of worship, NGOs, and other levels of government with local facilities, however actual data on these institutions are difficult to compile accurately, so for purposes of this study they remain part of the commercial sector energy data.

2.4.3.2 Institutional Energy Data by Source

Table 11 provides a summary of energy use and cost data for the 23 institutions comprising the four aforementioned subsectors.

Table 11: Institutional Energy Use and Energy Cost by Source

Fuel Type	Energy Use (GJ)	Energy Cost ($'000)
Electricity	1,699,407	90,532
Natural Gas	1,582,793	9,245
Fuel Oil	53,251	1,534
Diesel	5,863	165
Propane	3,626	62
Total	**3,344,939**	**101,539**

The institutional sector consumes about 3.4% of all energy used in Durham.

The energy use is primarily for facilities plus municipal street, park, and traffic lights. Institutional fleet vehicle energy usage was also compiled, however that is part of the transportation sector.

The fuel oil is used primarily in rural facilities and the propane primarily for arena equipment. The diesel use is for stationary equipment such as power generators and is not part of fleet vehicle usage.

The institutional sector spends just over $100 million on energy, which represents 4.5% of total energy costs in Durham.

Figures 13 and 14 show the percentage breakdown of institutional energy use and energy cost by source, respectively.

Figure 13: Institutional Energy Use Breakdown by Source

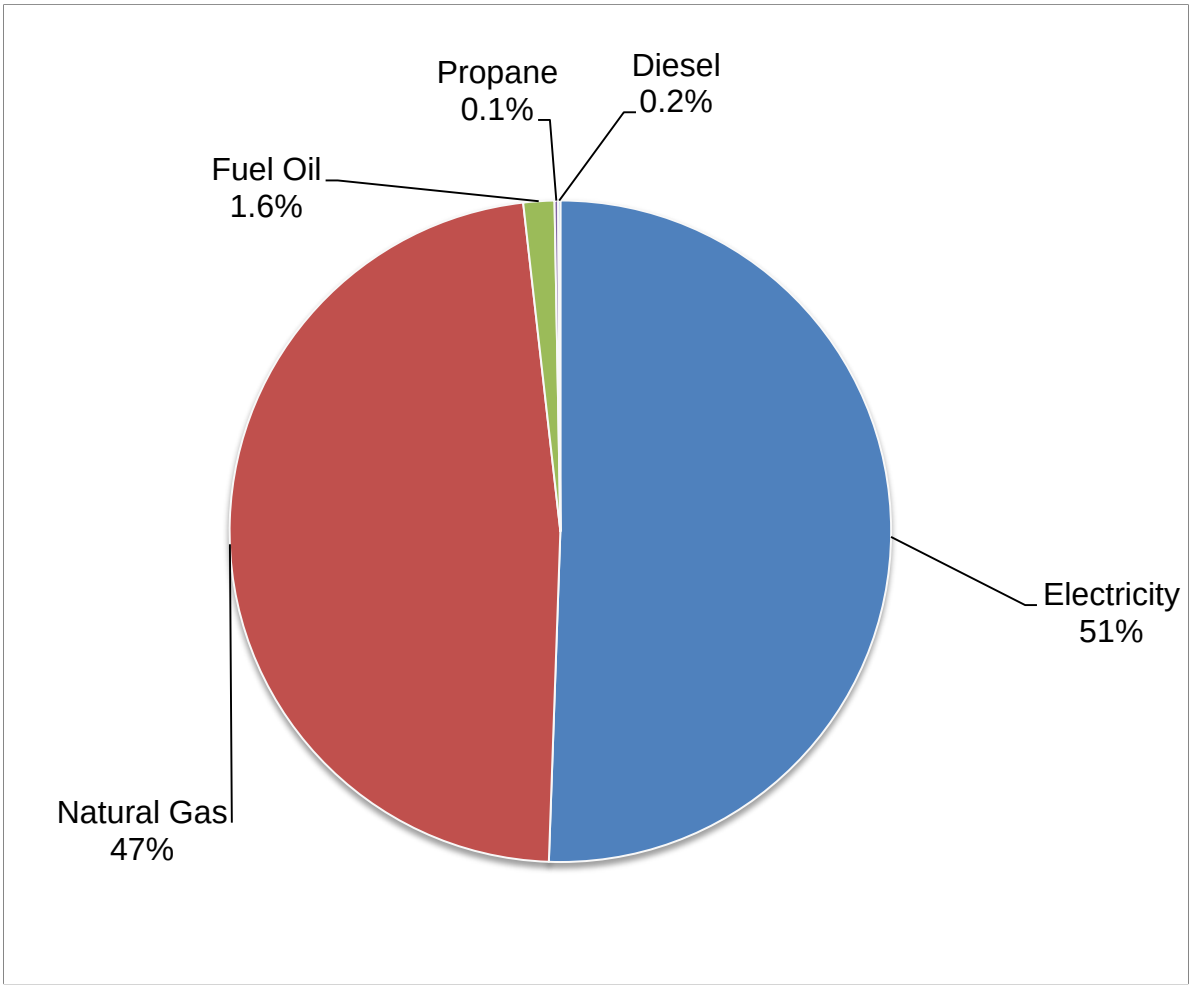
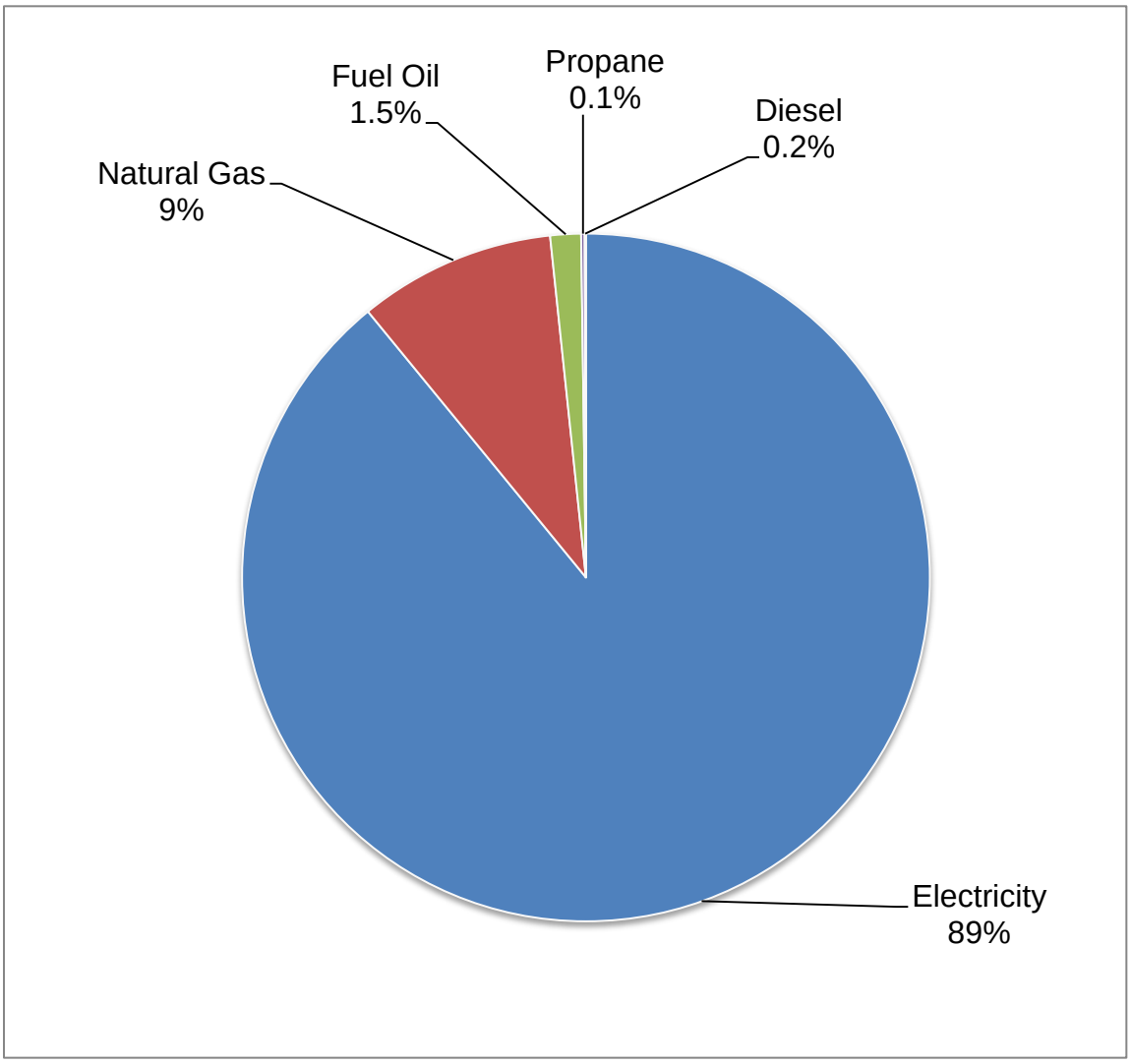


Figure 14: Institutional Energy Cost Breakdown by Source



In 2015, electricity usage at 51% cost 89% of institutional energy budgets. While natural gas energy usage at 47% is only 9% of the total energy cost.

2.4.3.3 Potential Further Institutional Energy Analysis

Building Energy Efficiency

Facility floor area is part of the public reporting required by the province. Table 12 provides a summary of the facility total energy use and energy use intensity per floor area for the four institutional subsectors.

Table 12: Facility Energy Use and Energy Use per Floor Area for each Subsector

Institutional Subsectors	Facilities Energy Use (GJ)	Facilities Floor Area (m2)	Facilities Energy Use / Floor Area (GJ/m2)
Durham Region & Municipalities	1,541,401	599,929	2.57
Schools	769,743	1,367,358	0.56
Post-Secondary	315,209	188,402	1.67
Hospitals	535,838	210,230	2.55
Total	**3,162,191**	**2,365,920**	**1.34**

Many of the buildings are specialized and can't be compared to one another, however, the energy use per floor area is a key benchmarking indicator for measuring future progress for similar types of buildings.

Renewable Energy Analysis

As part of the data request for this study, institutions provided data on renewable energy installations. This data has been used to augment other sources of data from the utilities to compile a renewable energy generation baseline as presented in section 2.2.

A renewable energy baseline can now be established for the institutional sector and used to measure future progress towards greater renewable energy generation. Some institutions can potentially lead by example in this area.

2.4.4 Commercial

2.4.4.1 Sector Definition

The commercial sector includes offices, retail facilities, restaurants, lodgings, nursing homes and a small portion of the institutional sector as defined above in section 2.4.3.

2.4.4.2 Commercial Energy Data by Source

Table 13 provides a summary of energy use and cost data by source within the commercial sector.

Table 13: Commercial Energy Use and Energy Cost by Source

Fuel Type	Energy Use (GJ)	Energy Cost ($'000)
Electricity	4,509,041	240,209
Natural Gas	4,907,791	28,666
Fuel Oil	133,474	3,846
Diesel	263,141	7,427
Gasoline	105,280	3,170
Propane	272,140	4,666
Total	**10,190,866**	**287,985**

In 2015, the commercial sector accounted for 10.4% of total energy consumption in Durham. Electricity use in the commercial sector at 4.5 million GJ (or 1.3 million MWh) represents 28% of total electricity consumption in the region. Natural gas use at 4.9 million GJ (or 125 million m3) is 14% of all natural gas consumption in Durham.

In 2015, the energy cost in the commercial sector at $288 million is 12.7% of total energy costs for the region.

Figures 15 and 16 show the percentage breakdown of commercial sector energy use and energy cost by source, respectively.

Figure 15: Commercial Sector Energy Use Breakdown by Source

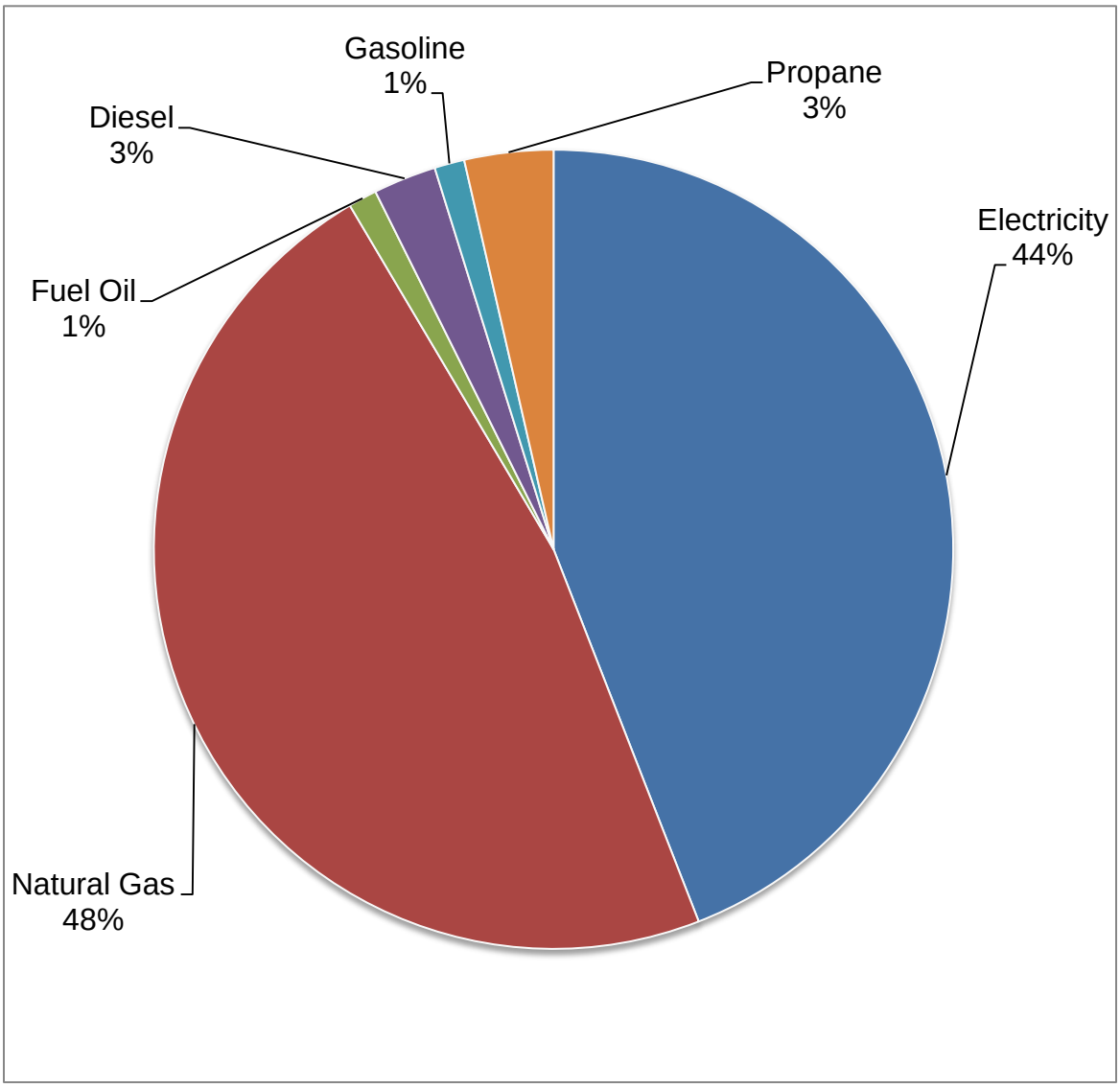
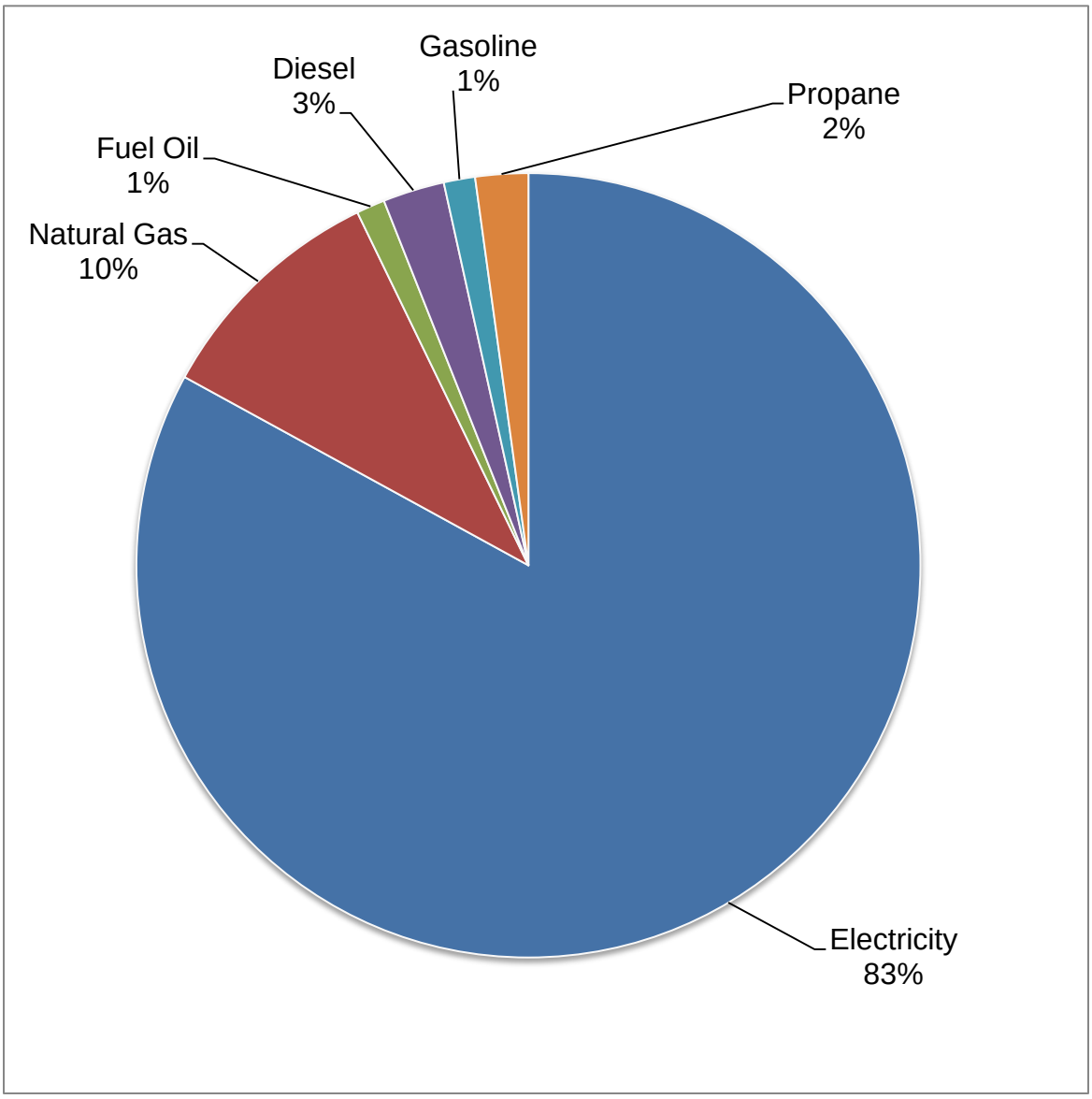


Figure 16: Commercial Sector Energy Cost Breakdown by Source



Electricity use at 44% cost 83% of total energy budgets. Natural gas consumption at 48% only cost 10% of the total. The other fuels are relatively minor in usage and cost.

2.4.4.3 Potential Further Commercial Sector Energy Analysis

Electricity Subsector Analysis

Veridian, Whitby Hydro and Oshawa PUC have provided subsector segmentation for the commercial sector in the urban areas of Durham, which comprises 76% of

total commercial electricity usage. Subsectors include large office buildings, small office buildings, non-food retail, food retail, restaurants, lodgings, nursing homes, warehouses, transportation/communication/utilities and other commercial buildings. Priorities could be established based on electricity use for each subsector and further analysis undertaken of businesses within each subsector.

Business Database Analysis

Durham Region has a business database of over 11,000 businesses in the region many of which include commercial floor space data. Enbridge has provided natural gas consumption by FSA/postal codes that include over 9,600 commercial customers. A business database analysis could potentially prioritize businesses within subsectors that have the largest potential for gains in energy efficiency and to establish energy/m2 floor area indicators.

2.4.5 Industrial

2.4.5.1 Sector Definition

The industrial sector includes manufacturing, mining and construction businesses but excludes agriculture (refer to section 2.4.6).

2.4.5.2 Industrial Energy Data by Source

Table 14 provides a summary of energy use and cost data by source within the industrial sector.

Table 14: Industrial Energy Use and Energy Cost by Source

Fuel Type	Energy Use (GJ)	Energy Cost ($'000)
Electricity	1,748,759	93,161
Natural Gas	9,796,977	38,499
Fuel Oil	302,338	8,712
Diesel	877,812	24,776
Gasoline	137,076	4,128
Propane	224,640	3,937
Petroleum Coke	2,621,185	5,067
Coal	3,394,832	17,244
Wood waste	1,347,218	
Total	**20,455,801**	**195,524**

The industrial sector consumes 20.5 million GJ of energy, 21% of all energy used in Durham. Electricity use at 1.7 million GJ (about 0.5 million MWh) represents

11% of electricity consumption in the region. Natural gas consumption at 9.8 million GJ (250 million m3) accounts for 29% of natural gas usage in Durham. All the coal and petroleum coke fuel is consumed within the industrial sector. Wood waste is consumed at the Ajax Cogen Plant to generate electricity and steam for local distribution to end-users.

The industrial sector spends $195 million on energy, which represents 8.6% of total energy costs in Durham. The cost of energy is significantly lower than energy consumption might indicate as high cost electricity is not a large portion of the energy use and low cost natural gas, coke, coal and wood waste are quite significant.

Figures 17 and 18 show the percentage breakdown of industrial energy use and energy cost by source, respectively.

Figure 17: Industrial Energy Use Breakdown by Source

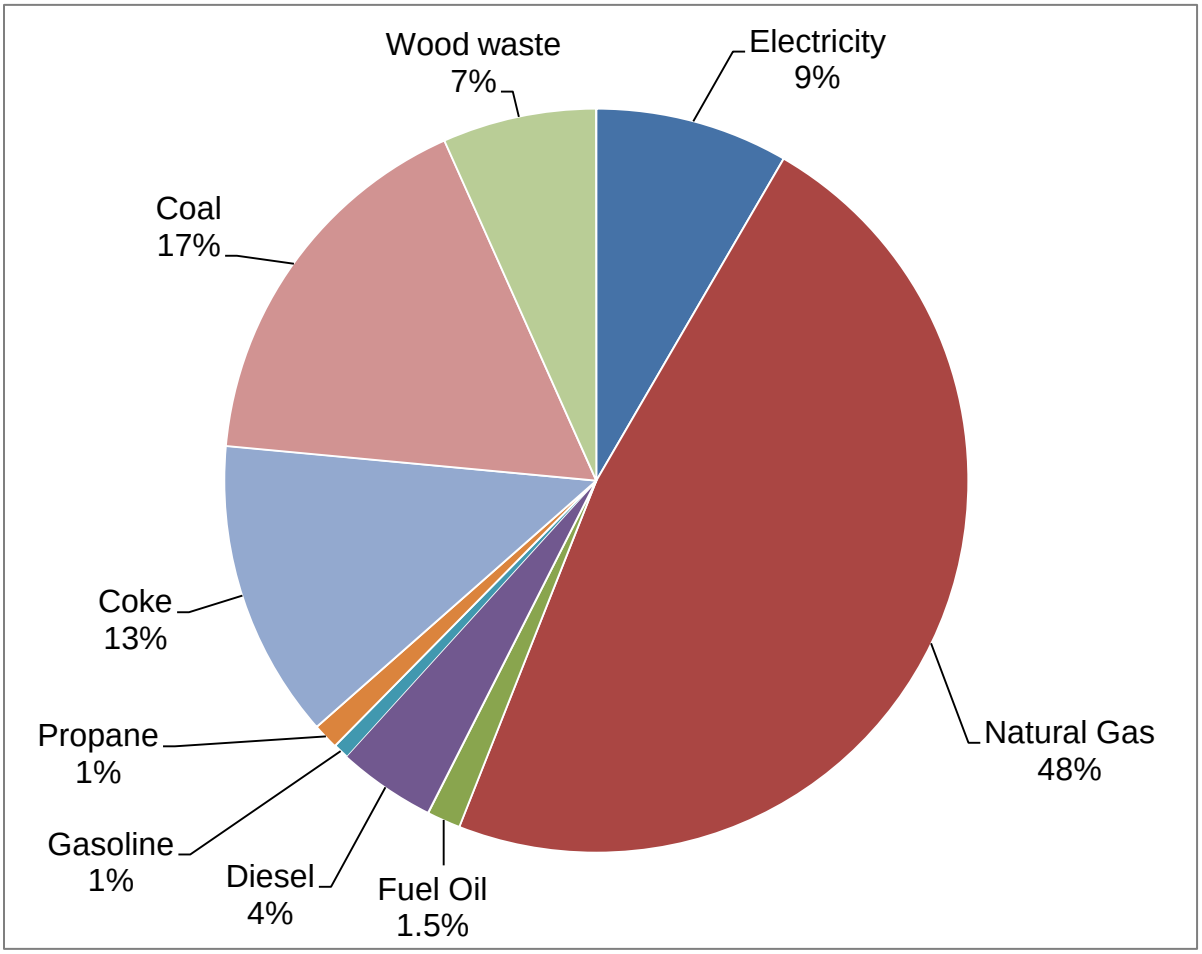
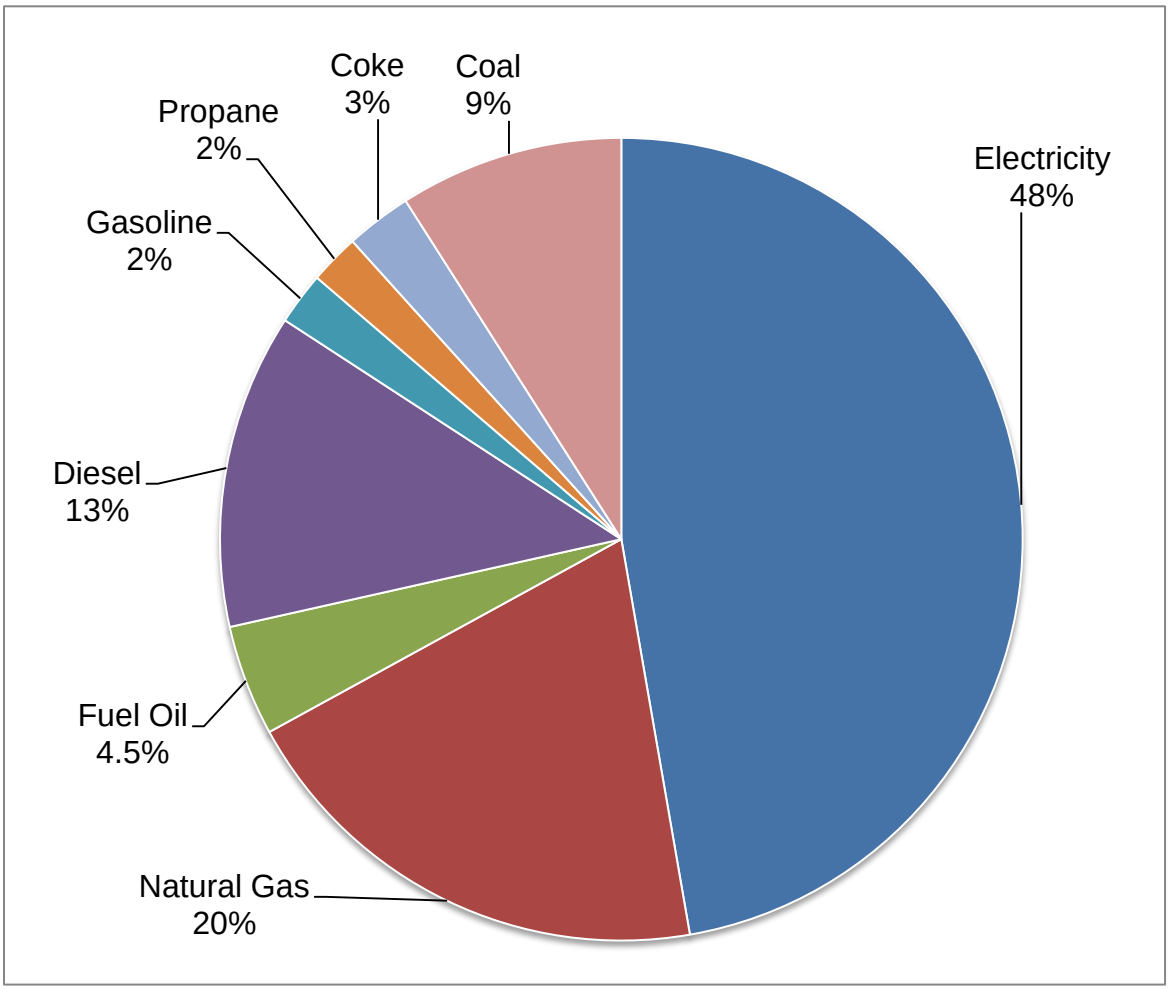


Figure 18: Industrial Energy Cost Breakdown by Source



Electricity use is only 9% of total energy and yet costs 48% of the energy budget. The industrial sector uses a significant portion of inexpensive natural gas (48% usage, 20% cost). Specific large industrial facilities can also purchase very low cost fuels such as coal (17% of the energy use, 9% of the cost) and petroleum coke (13% of the energy use, 3% of the cost).

2.4.5.3 Potential Further Industrial Energy Analysis

Electricity Subsector Analysis

Veridian, Whitby Hydro and Oshawa PUC have provided subsector segmentation for the industrial sector in the urban areas of Durham, which comprises 95% of total electricity usage. Subsectors include mining, manufacturing of primary metals, paper, auto parts, chemicals, plastics and rubber, food and beverages and miscellaneous industrial products. Priorities could be established based on electricity use for each subsector and further analysis of businesses within each subsector similar to the commercial sector.

Business Database Analysis

Like the commercial sector, business database analysis of Durham Region's business database of over 11,000 businesses in the region and Enbridge's natural gas consumption by FSA/postal codes for some 200 industrial customers could potentially prioritize businesses within industrial subsectors that have the largest potential for gains in energy efficiency and to establish energy/m2 floor area indicators.

2.4.6 Agricultural

2.4.6.1 Sector Definition

The agricultural sector includes working farms in Durham that involve crop production and/or animal production. The energy use is for motive and non-motive operations on the farm but excludes non-farm residential energy use and regular road transportation.

2.4.6.2 Agricultural Energy Data by Source

Table 15 provides a summary of agricultural energy use and cost data by source.

Table 15: Agricultural Energy Use and Energy Cost by Source

Fuel Type	Energy Use (GJ)	Energy Cost ($'000)
Electricity	140,005	7,458
Natural Gas	355,889	1,399
Gasoline	205,240	6,181
Diesel	366,216	10,336
Fuel Oil	56,128	1,617
Propane	72,868	1,249
Total	**1,196,346**	**28,241**

In 2015, the agricultural sector energy use of 1.2 million GJ accounted for 1.2% of total energy consumption in Durham. The energy cost at $28 million is 1.3% of the total energy cost in the region.

Figures 19 and 20 show the percentage breakdown of agricultural energy use and energy cost by source, respectively.

Figure 19: Agricultural Energy Use Breakdown by Source

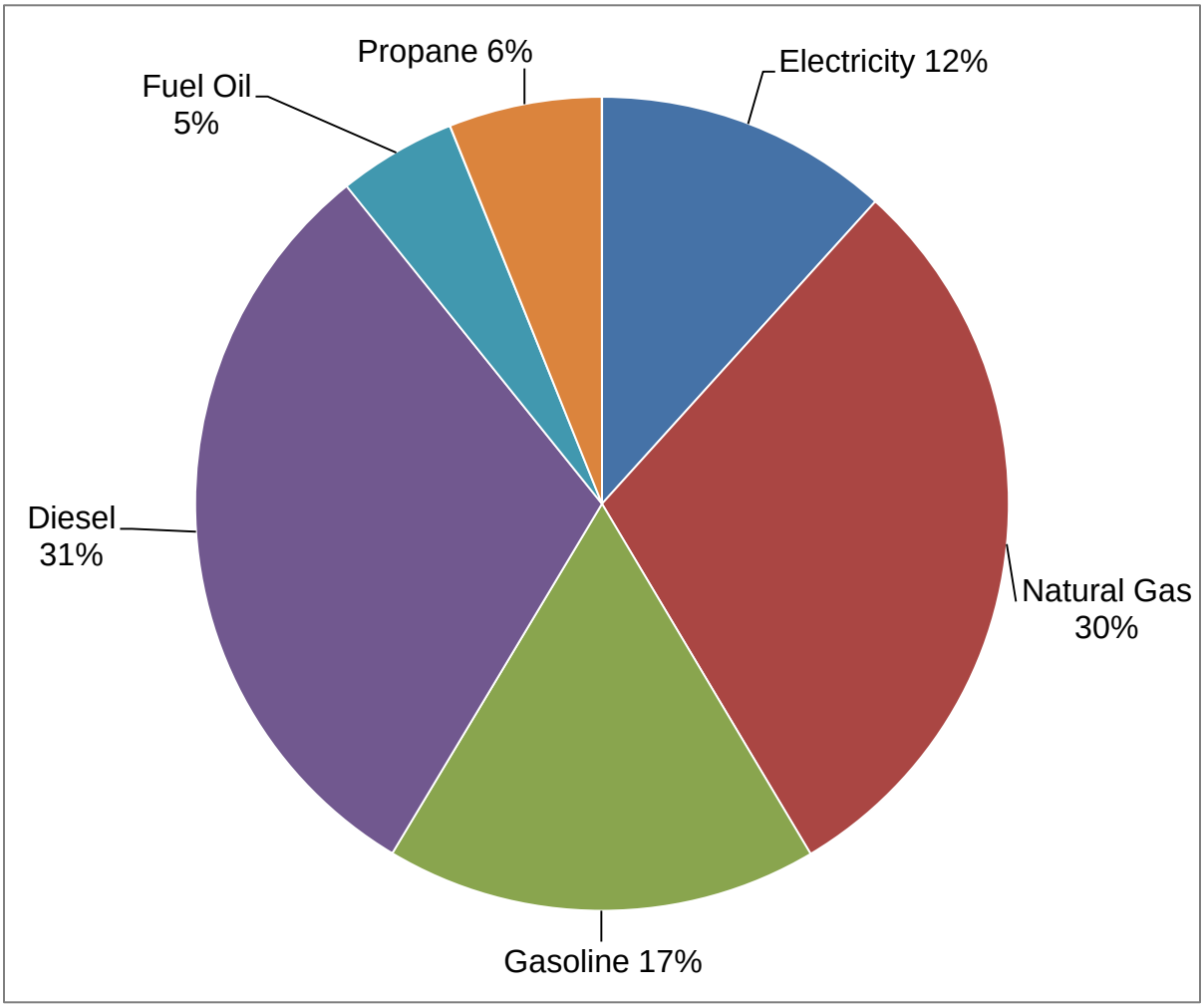
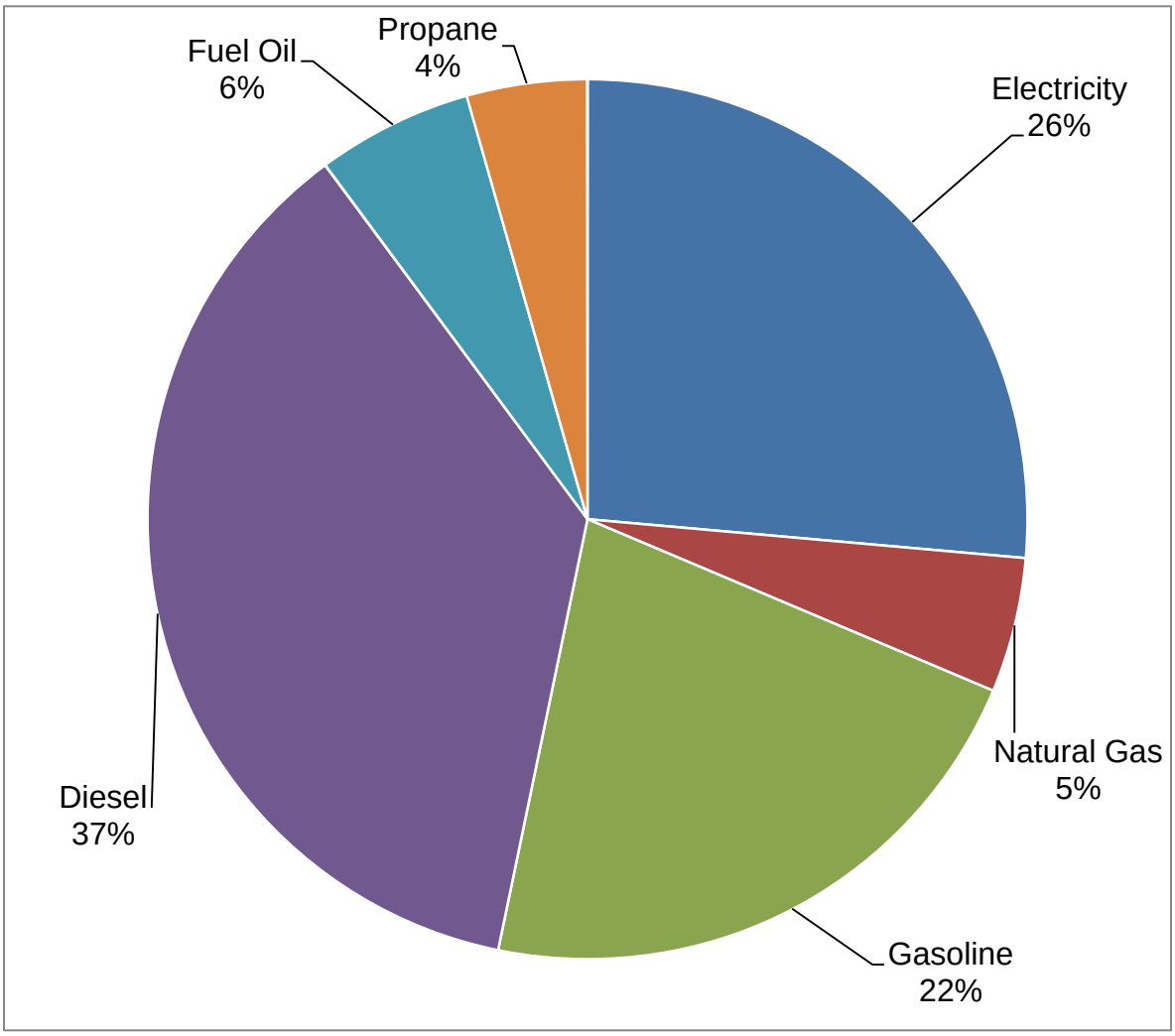


Figure 20: Agricultural Energy Cost Breakdown by Source



The diesel (31%) and gasoline (17%) are used primarily for motive operations. Natural gas (29%) is used for non-motive operations, mainly space heating of greenhouses and farm buildings and crop drying. According to the Ontario Federation of Agriculture, about 20% of farms have access to natural gas. Electricity (12%) is used for lighting, space heating and non-motive machinery including irrigation.

Cost of diesel (37%), gasoline (22%) and electricity (26%) lead the energy costs in the agricultural sector as all these forms of energy are relatively expensive for their energy content.

2.4.6.3 Potential Further Agricultural Sector Analysis

Renewable Energy

The 2011 census farm database for Durham along with other available studies provides enough data segmentation to prioritize candidates for solar farms (based on large low grade agricultural land) and anaerobic fermentation of manure (based on livestock head count, etc.) as two examples.

2.4.7 Transportation

2.4.7.1 Sector Definition

The transportation sector includes all passenger and freight road transportation. It excludes trains, planes and boats as complete energy data is not available at a local level and provincial proxy data is likely to be inaccurate due to lack of real correlation.

Energy data is based on the purchase of transportation fuels within Durham and is not dependent on where the vehicles are driven.

2.4.7.2 Transportation Energy Data by Source

Table 16 provides a summary of transportation energy use and cost data by source.

Table 16: Transportation Energy Use and Energy Cost by Source

Fuel Type	Energy Use (GJ)	Energy Cost ($'000)
Electricity	72,100	3,857
Gasoline	9,093,190	273,834
Gasoline with 10% Ethanol	19,334,293	601,841
Diesel	6,428,656	181,446
Propane	240,595	4,126
Natural Gas	27,688	606
Total	**35,196,522**	**1,065,711**

In 2015, the transportation sector accounted for 36% of total energy consumption, the largest energy-consuming sector in Durham.

Gasoline is segmented between gasoline without ethanol and gasoline with ethanol (typically 10% blend) to quantify the ethanol renewable content in

gasoline and to more accurately calculate energy use and GHG emissions, as ethanol is less energy and emissions intensive than gasoline. Gasoline with ethanol use at 19.3 million GJ (571 million litres) and gasoline without ethanol consumption at 9.1 million GJ (260 million litres) totals 28.4 million GJ (831 million litres) of gasoline purchases, 99% of which is consumed for road transportation.

Diesel consumption at 6.4 million GJ (168 million litres) represents 81% of total diesel consumption in Durham as the remainder is used for off road uses or non-motive fuel.

Electricity (for plug-in vehicles), natural gas liquid and propane consumption are provided using provincial proxy data and represent only 1% of transportation fuels. As electric and plug-in hybrid vehicles grow in Durham, this data will need to be tracked locally.

In 2015, transportation fuels cost $1.07 billion, which is 47.2% of total energy costs in Durham. The cost is almost twice that of the residential sector, the second largest to transportation.

Figures 21 and 22 show the percentage breakdown of the transportation energy use and energy cost by source, respectively.

Figure 21: Transportation Energy Use Breakdown by Source

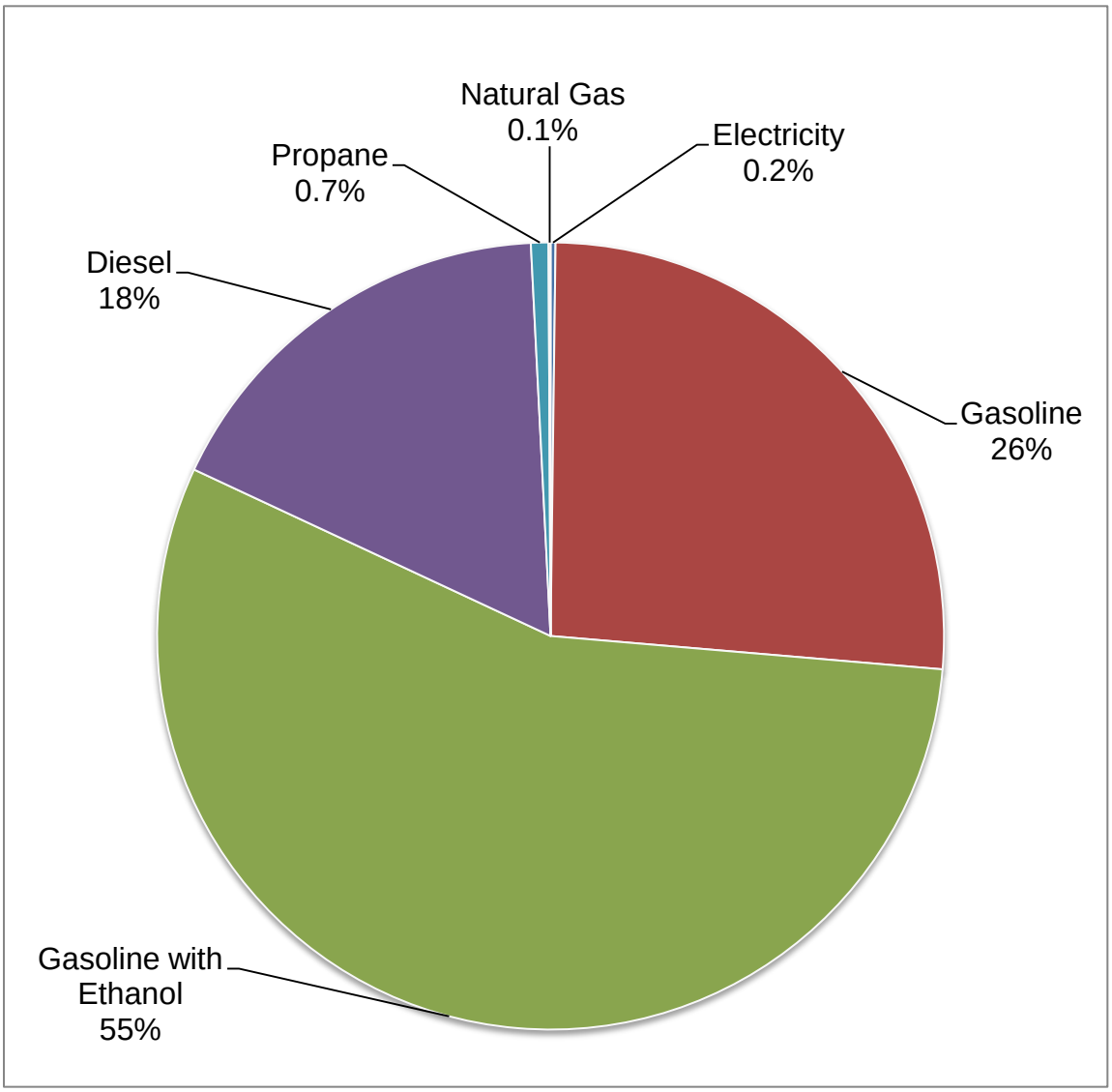
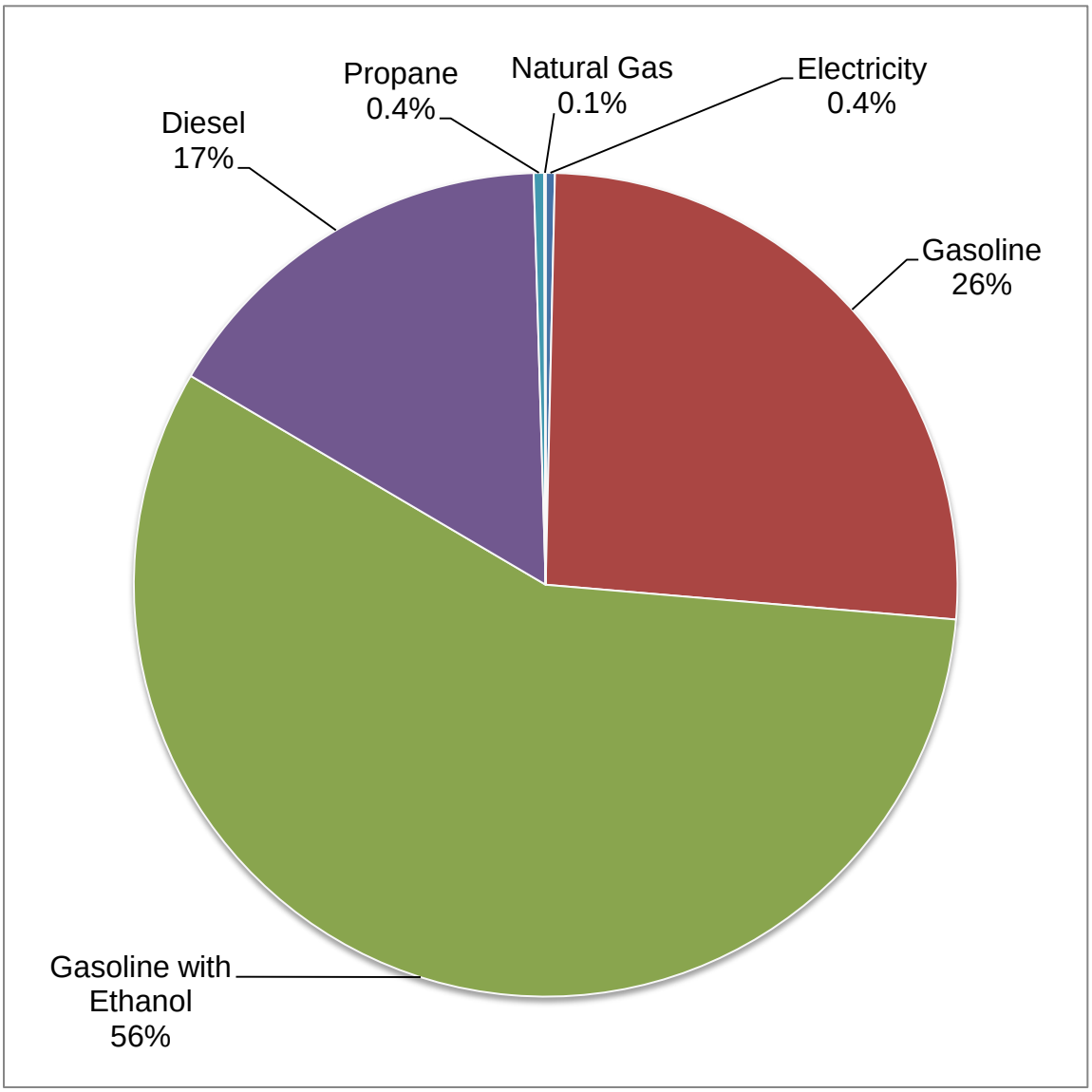


Figure 22: Transportation Energy Cost Breakdown by Source



Gasoline and diesel have similar use and cost percentages as gasoline and diesel prices closely reflected their relative energy content in 2015.

2.4.7.3 Potential Further Transportation Analysis

Passenger Transportation Efficiency Analysis

Can potentially analyze and track passenger vehicle efficiency in Durham:

- Total vehicle kilometers travelled (VKT) which is obtained through the Tomorrow Transportation Survey of residents every five years with the last one in 2016 (results to be published in 2018)
- Average vehicle fuel efficiencies – an accurate method is through a paid study of Durham resident vehicles based on the provincial vehicle database

This provides a benchmarking measure of passenger vehicle efficiency in Durham, which can measure the effectiveness of various energy efficiency initiatives.

Electric and Plug-in Hybrid Vehicles

Need a database to track the growth of plug-ins and their electricity consumption starting with the Durham vehicle survey above and working with the electricity utilities to segregate electricity usage.

Public Transit

Track bus public transit energy use for Durham Region Transit and GO Transit buses. Energy use and vehicle kilometres travelled data has been compiled for Durham Region Transit for both large and specialty buses.