2019

Oakville's Energy Task Force

Community-driven energy solutions

2019 Analytical Report

OAKVILLE COMMUNITY ENERGY PLANNING

PROJECT WORKING TEAM

Contents

2019 Analytical Report

Oakville Community Energy Planning

1. Introduction

Community energy planning assists communities manage the risks and opportunities associated with the energy transition currently underway in Canada. Emerging technologies across the energy value chain are creating opportunities at the community-level for the supply and distribution of energy.

The community energy planning process (CEPP) consider all local energy flows that impact the activities within a community. They identify solutions to increase efficiency from supply through distribution to end-use. Improved energy efficiency and alternative energy sources can reduce overall energy costs for residents and local businesses as well as lower greenhouse gas (GHG) emissions.

Community energy planning helps residents, businesses, organizations and institutions work together to reduce energy costs and GHG emissions while strengthening the local economy and building an affordable and reliable energy future. CEPP's have proven benefits including:

- reducing energy costs;
- keeping energy dollars local;
- using energy more efficiently and reduce waste;
- decreasing GHG emissions;
- creating more opportunities to attract businesses and jobs;
- increasing the security and reliability of the energy supply; and
- enhancing resiliency to climate change.

Oakville's CEPP was a two-year cross-sector collaboration, drawing strength from the expertise and demonstrated leadership of the town, Sheridan College and members of the Oakville Energy Task Force (OETF).

1.1 Planning for Action

The Oakville community energy planning process was designed for implementation, resulting in of a set of three documents:

- Community Energy Strategy to guide the work of the OETF,
- 2019 Analytical Report (with appendices) that summarizes the evidence-based rationale for the OETF strategy (**this document**) and
- 2019 Engagement Report (with appendices) that summarizes the process that culminated in the OETF strategy.

See section 11 for a list of appendices that support this report.

2. Project Governance

A Project Working Team (PWT) was established and comprised of representatives from the Town of Oakville, Sheridan College, electricity and gas utilities, Halton Region and the consulting team of Garforth International llc. See Appendix 1 for the PWT organizational structure and composition.

The PWT reported the results of their analytical work to the Oakville Energy Task Force (OETF), a team of community champions and principal advisors for the CEPP. See the 2019 Engagement Report for more information on the OETF.

3. Analytical Framework

Table 1 describes the scope of the CEPP which established the analytical framework for the collection, assessment and presentation of data and information.

Table 1: Oakville Community Energy Planning Process analytical framework

Item	Scope
Geography	Oakville municipal boundary
Sub-geography	Energy Planning Districts (see below for description)
Virtual sub-geography	corporate assets, regional assets
Baseline year	2016
Planning horizon	2041
End use sectors	homes, buildings, industry, transportation
Utilities	electricity, natural gas, transport fuels, other fuels
Energy end use	heating, domestic hot water, cooling, lighting, other power, industrial process, transportation
Energy distribution	electricity, natural gas, district energy
Analytical profiles	source energy use[1], site energy use[2], GHG emissions (based on source energy), cost (based on source energy)
Benchmarks	Canada, Ontario, selected international
Assessment profiles	Impacts of (or on) municipal, utility and other plans, economic development, health and social factors and policy, practice and institutional structures.

Twenty-six energy planning districts (Figure 2) and five natural heritage districts were established to align with the Town of Oakville's Urban Structure and Land Use Schedule boundaries (Figure 1).

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[1] Source energy considers all energy flows from production to end-use.
[2] Site energy considers the energy use of at the meter by end-users (e.g., homes, buildings, industry and transportation).

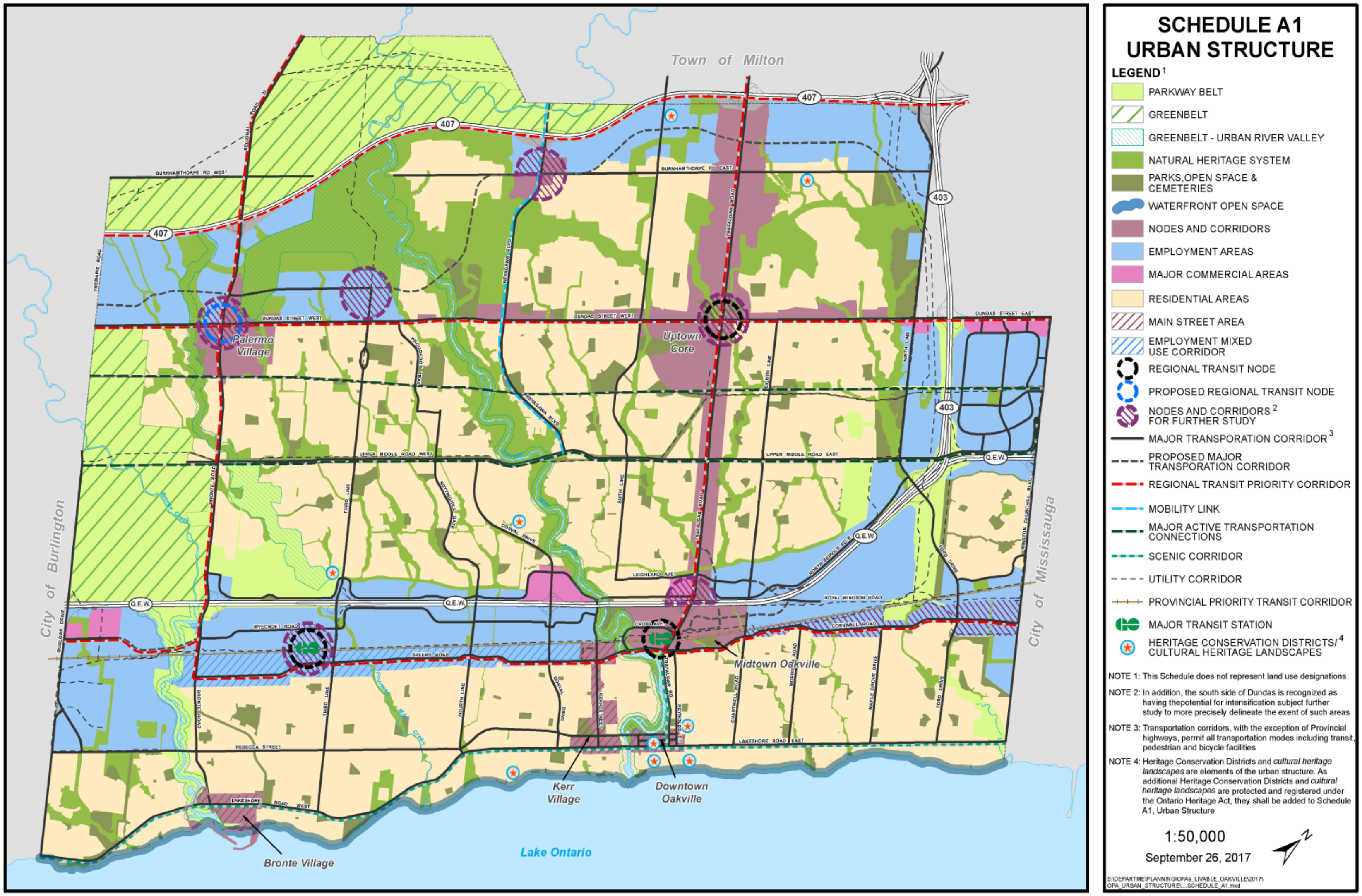

Figure 1: Town of Oakville urban structure

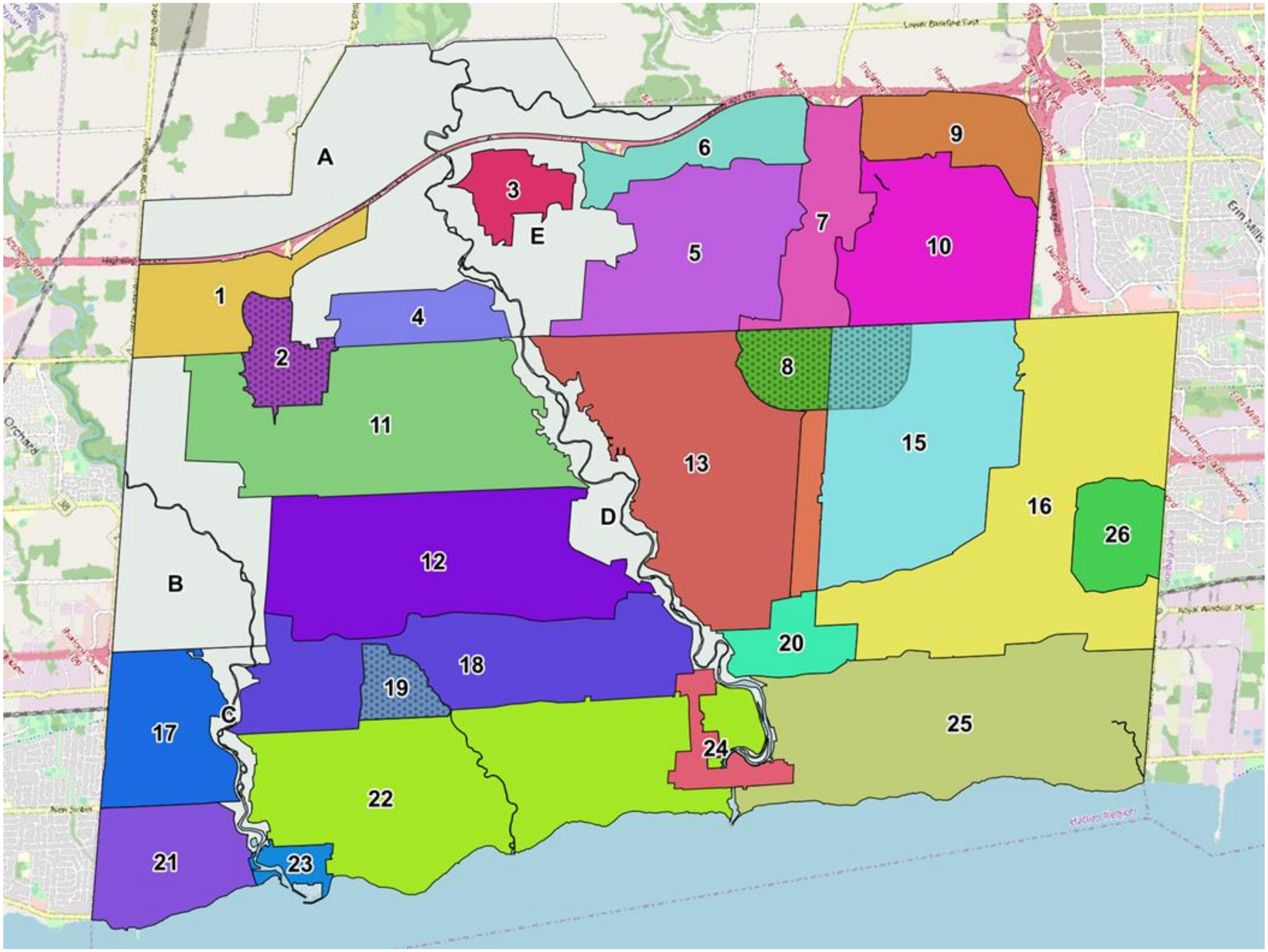

Figure 2: Oakville energy planning districts (EPDS

4. Methodology

what data will we need to inform the CEPP?

The following section is a summary of the data, information and assumptions that informed the analytical process.

4.1 Data and Information Gathering

Significant data and information were gathered to support the analytical process and the development of CEPP goals, strategic objectives, targets, priority projects and milestones. This work consumed a considerable amount of the PWT's time during the early stages of the project. All data pertain to activity occurring within the municipal boundary of Oakville, Ontario. The year 2016 was chosen as the baseline year as it was the year of the most recent Canadian Census.

See Appendix 2 for additional detail on the type, source and form of data and information collected.

4.2 Framing Goals

CEPP energy efficiency and emissions framing goals were established. The year 2041 was chosen to align with the Town's planning framework. Framing goals were referenced to a 2016 baseline and selected independently of the Base Case. Framing goals were established to evaluate the performance of the Base Case and Efficiency Case simulations.

4.3 Base Case Assumptions

The Base Case is a "business-as-usual" picture of the future to 2041. To create this picture the PWT needed to establish several assumptions on what business-as-usual looks like. Their approach was to include only short-term assumptions where legislation is already passed (e.g. Ontario Building Code) or where the technical evidence is overwhelming (e.g. average vehicle efficiency gains).

This means the Base Case does not reflect individual views of how Canada's energy and emissions future will evolve. The political shifts seen globally and in Canada demonstrate the risk of assuming a continuous bending of the curve by policy and practice towards lowering GHG emissions.

The PWT instead gave priority to measures that Oakville can influence, more-or-less, within the framework of current legislation. This underlines the opportunity and responsibility for individual communities to take the lead in dramatically reducing their GHG emissions, even with policy fluctuations going on around them.

This approach also underscores the need to update the CEPP every 5 years to respond to changes in legislation, policy and technical evidence.

The integrated analysis of the energy, GHG emissions and cost footprint of all energy end-use sectors in Oakville required alignment on a great number of interrelated assumptions. Ensuring that assumptions aligned, and integration of data was as accurate as possible relied on the collaboration of subject matter experts across the PWT. See Appendix 2 for details on the assumptions used by the PWT to establish the Base Case.

4.4. Data Assessment

A summary of the analytical tools used to assess Oakville's data by the PWT is also provided in Appendix 2.

5. Baseline Findings

what is Oakville's starting point?

The following is a summary of the main baseline findings for source energy, emissions and cost for Oakville in 2016. See Appendix 3 for additional baseline analysis.

5.1 Energy Consumption

In 2016, Oakville's total source and site energy use were 37 million Gigajoules (GJ) and 27 million GJ, respectively. The transportation sector, the residential sector, and the industrial, commercial and institutional (ICI) sector each accounted for approximately a third of the community's energy use (see Figure 3).

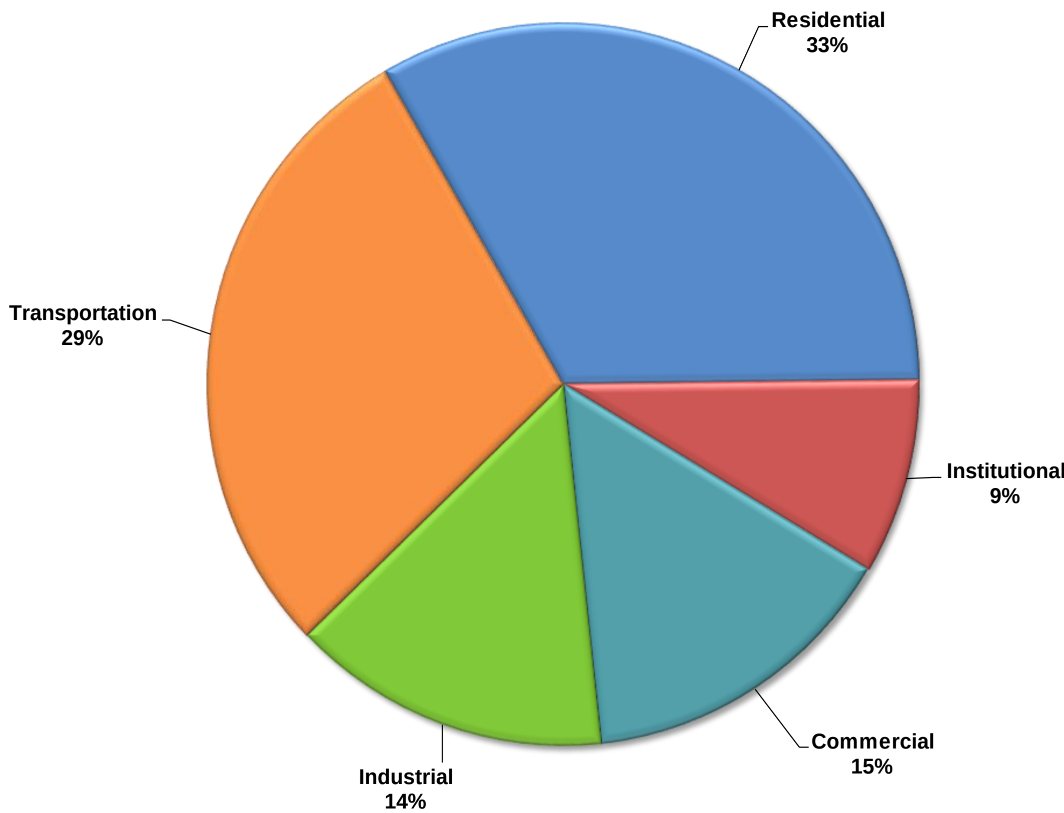

Figure 3: Oakville source energy use (%) by sector in 2016

The Town of Oakville's corporate energy use (facilities, fleet and transit) represented only 1.35% of the community's source energy use in 2016. This highlights that while the town can lead by example, meaningful energy changes in Oakville require community-wide action (see Figure 1 in Appendix 3).

System losses[3] account for approximately 27% of source energy use (see Appendix 3 for more details).

5.2 GHG Emissions

In 2016, Oakville's emissions were 1.33 million tonnes (metric tons), or 6.6 tonnes for every Oakville resident.

Transportation accounted for almost half of all emissions while the residential sector accounted for a little more than a quarter of emissions (Figure 4). The industrial, commercial and institutional (ICI) sector accounted for the remaining emissions (Figure 4).

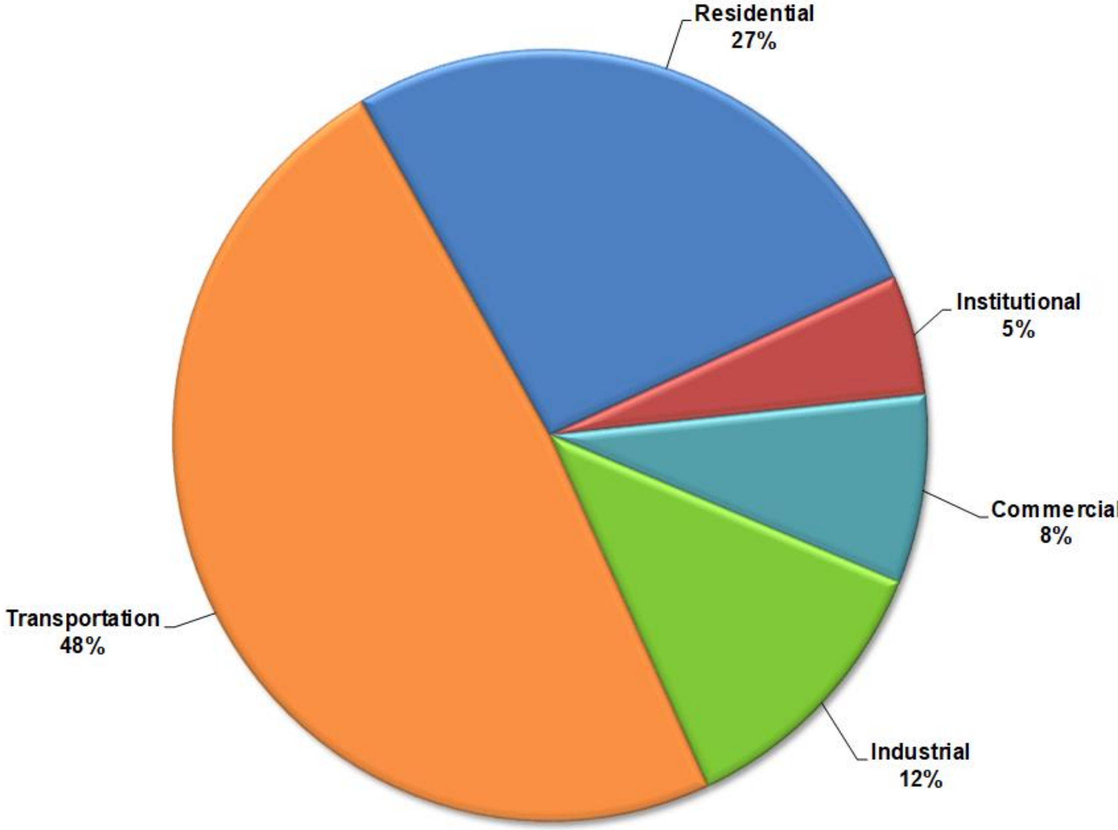

Figure 4: Oakville emissions (%) by sector in 2016

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[3] System losses include 1) conversion losses which occur when energy is transformed from one form to another (e.g., natural gas is used to create electricity) and 2) transmission and distribution losses which occur when energy is moved from one place to another (e.g., electricity is conveyed from generating facilities to end-users over transmission lines).

The use of natural gas contributes almost half of Oakville's emission (Figure 5) while the use of gasoline contributes almost 40% of emissions. Only 4% of emissions arise from the community's use of electricity (Figure 5). From a GHG emissions perspective, these results underscore the need to address the heating, which is the primary use of natural gas in homes and buildings.

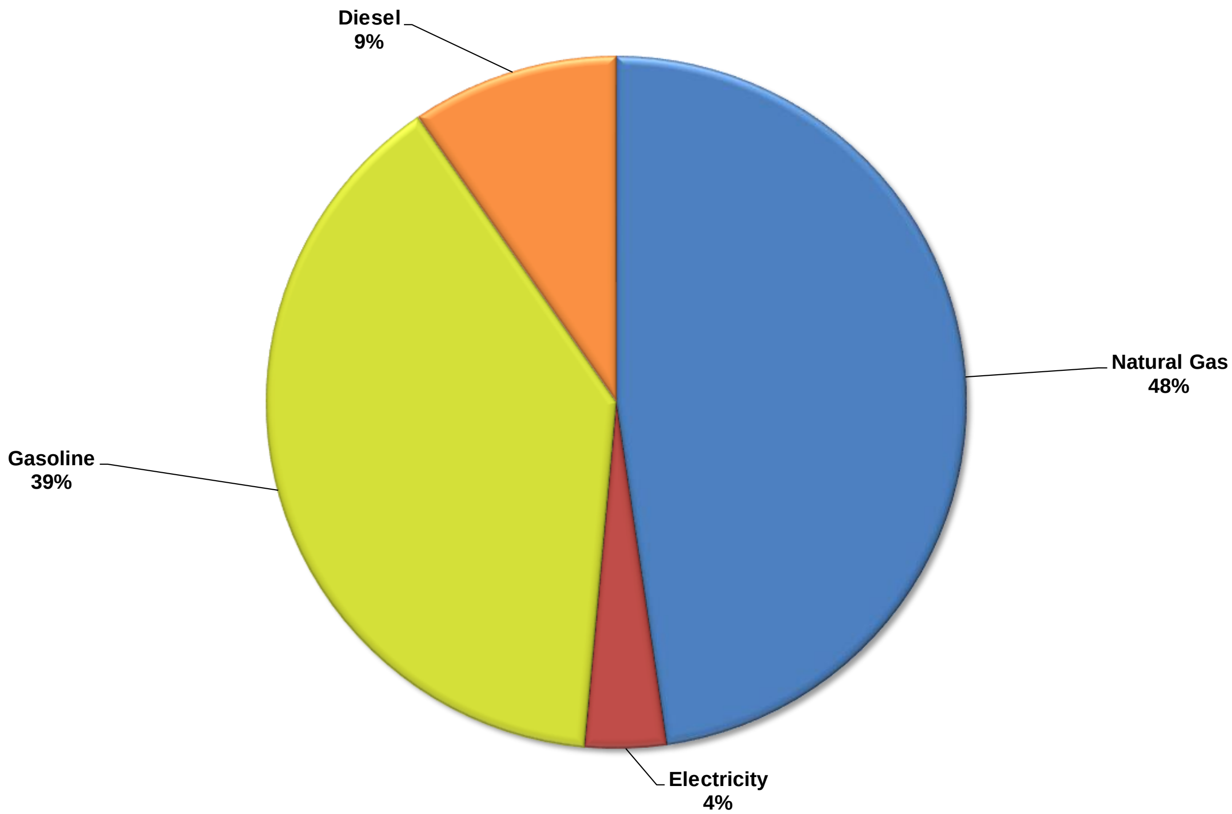

Figure 5: Oakville emissions (%) by utility in 2016

5.3 Energy Costs

The Oakville community spent $620 million on energy in 2016 on all transportation, residential, commercial and institutional activities. At least $490 million (80%) of those energy dollars leave the community.

Transportation accounts for at least half of all energy costs (Figure 6). A little less than a quarter of those energy dollars goes towards heating and powering Oakville's homes with the remainder accounted for by the ICI sector (Figure 6). Gasoline and electricity costs account for approximately 75% of energy costs (Figure 7).

Approximately 27 per cent of the energy that Oakville pays for does not reach homes, buildings or vehicles. This energy is primarily lost as heat when one form of energy is converted to another and through transmission and distribution. Electricity accounts for most of these costs. This highlights the opportunities to consider energy solutions that reduce system losses.

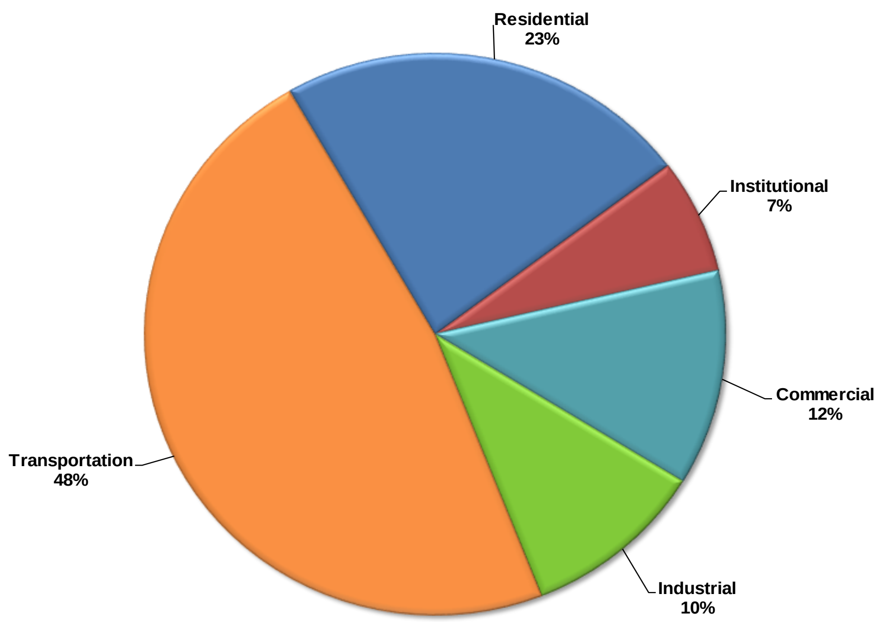

Figure 6: Oakville energy costs (%) by sector in 2016.

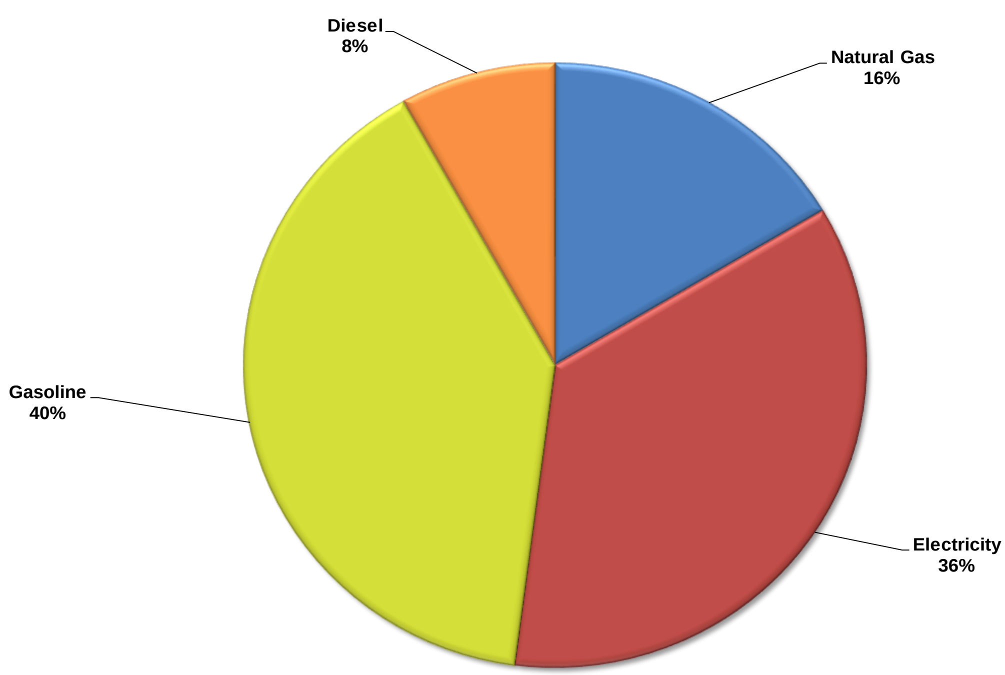

Figure 7: Oakville energy costs (%) by utility in 2016.

5.4 Benchmarking

Oakville's baseline data was compared with several comparable provincial, national and global benchmarks to understand the opportunity to deliver community benefits:

- On average, homes and buildings in Oakville are approximately half as efficient as global benchmarks (Table 2).
- Energy use per home is 9% higher than the provincial average (Table 2).
- Energy use in the residential sector per square metre (m^2) is 24% lower than the Canadian average (Table 2)
- Emissions per capita were less than the national average but slightly more than the provincial average (Table 2). Per capita emissions were approximately twice global best practice (Table 2) and ten times the Government of Canada target for 2050 based on the Paris Climate Agreement.

Table 2: Provincial, national and global comparison of Oakville energy use and GHG emissions.

Indicator	Oakville Baseline	Canada Average	Ontario Average	Comparable Best Practice
Energy use/household (GJ)	117	106	107	68[4]
Residential sector energy use per m^2 (GJ)	0.6	0.79		0.29[5]
Non-residential sector energy use per m^2 (GJ)	1.69	1.65		0.72[6]
Emission per capita (tonnes CO_{2e})	6.6	9.7	6.2	3.5[7]

6. Business as Usual Findings

where is Oakville headed, if no local action is taken?

The following is a summary of the main Base Case findings for source energy, site energy, emissions and energy cost for Oakville in 2041[8]. Table 3 provides a summary of changes between 2016 and 2041. See Appendix 3 for additional Base Case analysis.

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[4] Denmark
[5] German A-rated home
[6] Germany
[7] Copenhagen, Denmark
[8] While much of the literature around energy and emissions planning uses a time horizon of 2050, the town's Official Plan and other master plans are aligned with the Provincial Growth Plan for the Greater Golden Horseshoe Area which assigns regional population growth targets to 2041.

6.1 Energy Consumption

By 2041, population and employment growth are estimated to increase site energy use by 26% and source energy use by 28%. Both population and the workforce are expected to increase by 47% during this time.

6.2 GHG Emissions

Despite population and employment growth, GHG emissions are expected to remain relatively constant (approximately a 6% increase) by 2041 due to a projected increase in vehicle efficiency and reduction in the carbon intensity of the natural gas grid. However, they remain approximately twice global best practice and ten times the Government of Canada target for 2050 based on the Paris Climate Agreement.

6.3 Energy Costs

Energy costs are estimated to increase 200% to 400% by 2041. These increases reflect both higher prices and population and employment growth.

Table 3: Summary of projected changes between 2016 and 2041 in Oakville for energy use, emissions and energy costs.

2016 Baseline	2041 Business-as-Usual
Oakville used 37 Gigajoules of energy.	Growth in population and employment increase energy use by 28%.
The 1) transportation, 2) homes and buildings, and 3) industrial, commercial and institutional (ICI) sectors each comprise approximately one third of Oakville's energy use.	No material change
On average, homes and buildings in Oakville are approximately half as efficient as global benchmarks.	Gap widens against global best practice
Systemic and end-user inefficiencies represent 50% of the total energy use in Oakville.	No material change
The Town of Oakville's corporate energy use for facilities and fleet represents only 1.35% of the community's energy use.	No material change
On average, Oakville residents release 6.6 tonnes of GHG emissions each year.	Reduces to 5 tonnes per capita due to a projected increase in vehicle efficiency and reduction of carbon intensity of the natural gas grid.
Emissions twice global best practice and 10 times the Paris Agreement.	No material change
$620 million spent on electricity, natural gas, gasoline and diesel within the community.	Spending estimated to increase to $1.2 billion (low risk) to $2.5 billion (high risk).
Less than 20% of the money spent on energy remained in the Oakville economy.	No material change

7. Efficiency Case Simulations and Results

how might Oakville change its energy future?

The following section provides a summary of the simulations that were conducted to identify a CEPP strategy for Oakville.

Three scenarios were developed and simulated to test their ability to achieve the following energy consumption and GHG emissions framing goals:

- Reduce energy consumption by 50% by 2041 from 2016,
- Reduce absolute GHG emissions by 50% by 2041 from 2016 and
- Reduce absolute GHG emissions to meet the 2050 national commitments.[9]

Scenario development was based on three combinations of the following priorities:

- Increase energy efficiency,
- Maximize heat recovery,
- Extend and integrate energy distribution and
- Maximize clean and renewable energy supply.

Scenarios included the following measures:

- Efficiency of new homes and buildings,
- Efficiency of existing homes and buildings,
- Efficiency of industry,
- District energy in existing and new areas,
- Efficient local heat and electricity generation,
- Renewable solar heat and electricity generation,
- Transportation mix and efficiency,
- Ontario electricity grid generating mix and
- Natural gas network source mix.

The three scenarios were:

- Scenario 1
    - All end-use efficiency measures including transportation measures
- Scenario 2
    - All end-use efficiency measures including transportation measures
    - District heating
    - Solar thermal
- Scenario 3
    - All end-use efficiency measures including transportation measures
    - District heating
    - Solar thermal
    - Solar photovoltaic (PV)

[9] Based on the Paris Climate Agreement, this represents an 80% reduction in absolute GHG emissions by 2050 based on 1990 levels or a 90% reduction based on 2016 levels.

Scenarios was simulated under three efficiency case implementation regimens:

- low action
- reference
- high action

In addition to energy and emission reductions, the energy savings that would flow to the community were also estimated.

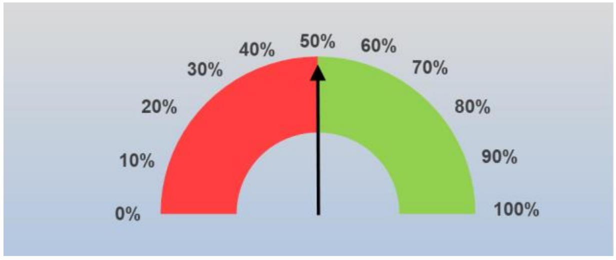
Given the poor performance of Scenarios 1 and 2, the PWT eliminated these two scenarios from further consideration.

The simulation results for Scenario 3 were as follows:

- **Low Action Efficiency Case** – Scenario 3 failed to meet the energy and emissions framing goals as well as the national 2050 emissions target.

  Given the poor performance of the Low Action Efficiency Case for Scenario 3, it was eliminated from further consideration.

- **Reference Efficiency Case** – Scenario 3 missed the energy goal by 20%, met the emissions framing goal, and made major progress towards the national 2050 emissions target (emissions would remain approximately three times higher).



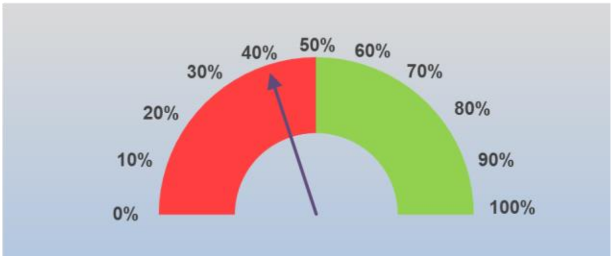


Figure 7: Results for the Reference Efficiency Case for Scenario 3 against the 2041 50% reduction framing goals. Arrow indicates percent reduction achieved for GHG emissions (left) and energy use (right).

- **High Action Efficiency Case** – Scenario 3 exceeded the energy and emissions framing goals and the federal emissions 2050 target.

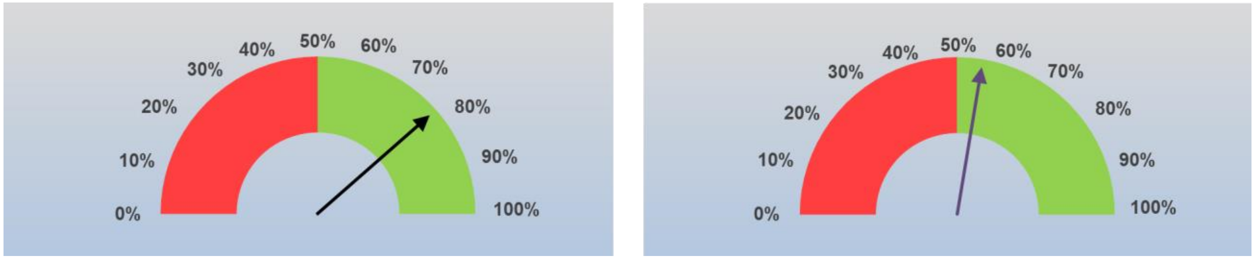


Figure 8: Results for the High Action Efficiency Case for Scenario 3 against the 2041 50% reduction framing goals. Arrow indicates percent reduction achieved for GHG emissions (left) and energy use (right).

See Appendix 5 for additional information on the performance of the Reference and High Action Efficiency Cases.

8. CEPP Efficiency Case

The OETF approved the Scenario 3 Reference Efficiency Case as the CEPP Efficiency Case. It is estimated that the Reference Efficiency Case would avoid between $7.4 billion to $11.2 billion in cumulative energy costs by 2041.

Based on the results of the simulations, the OETF aligned on:

- A goal to increase community-wide energy efficiency at least 40% by 2041 from 2016 levels recognizing selected efficiency measures would consider the entire system from supply through distribution to end-use.
- A goal to enable transition to carbon neutrality by reducing GHG emissions by at least 50% by 2041.

By doing so, the intent of the OETF is to respect the science that supports the emissions reduction target of the International Panel on Climate Change while setting an emissions reduction goal that can be demonstratively implemented based on current global best practice. Implementation of the CEPP will put Oakville on a path to achieve the Paris Climate Agreement goal. Regular 5-year CEPP updates will capture advances in local, regional and global best practice to accelerate the transition to carbon neutrality during later years of the CEPP implementation.

9. Oakville Energy Flows

Sankey diagrams were developed to visualize Oakville’s energy, emissions and energy costs flow for the:

- 2016 Baseline
- 2050 Base Case
- 2050 CEPP Efficiency Case

Appendix 6 provides a complete set of the Sankey diagrams developed. Figure 9 provides a sample of a Sankey diagram and how to read it.

Focusing on energy, examining the changes between the Sankey diagrams for the 2016 baseline and 2050 Base Case shows the increase in end-use energy consumption, waste energy and unused transportation energy from 2016 to 2050, if no local action is taken.

Again, focusing on energy, examining the changes between Sankey diagrams for the 2050 Base Case and 2050 CEPP Efficiency Case shows the decrease in end-use energy consumption, waste energy and unused transportation energy, if the CEPP is implemented.

The Sankey diagrams also highlight that system losses (i.e., conversion, transmission and distribution losses) and end-use inefficiency consume half of the energy we purchase.

Oakville consumers pay for the energy at the point of production but only get to use the energy that reaches the meter or pump.

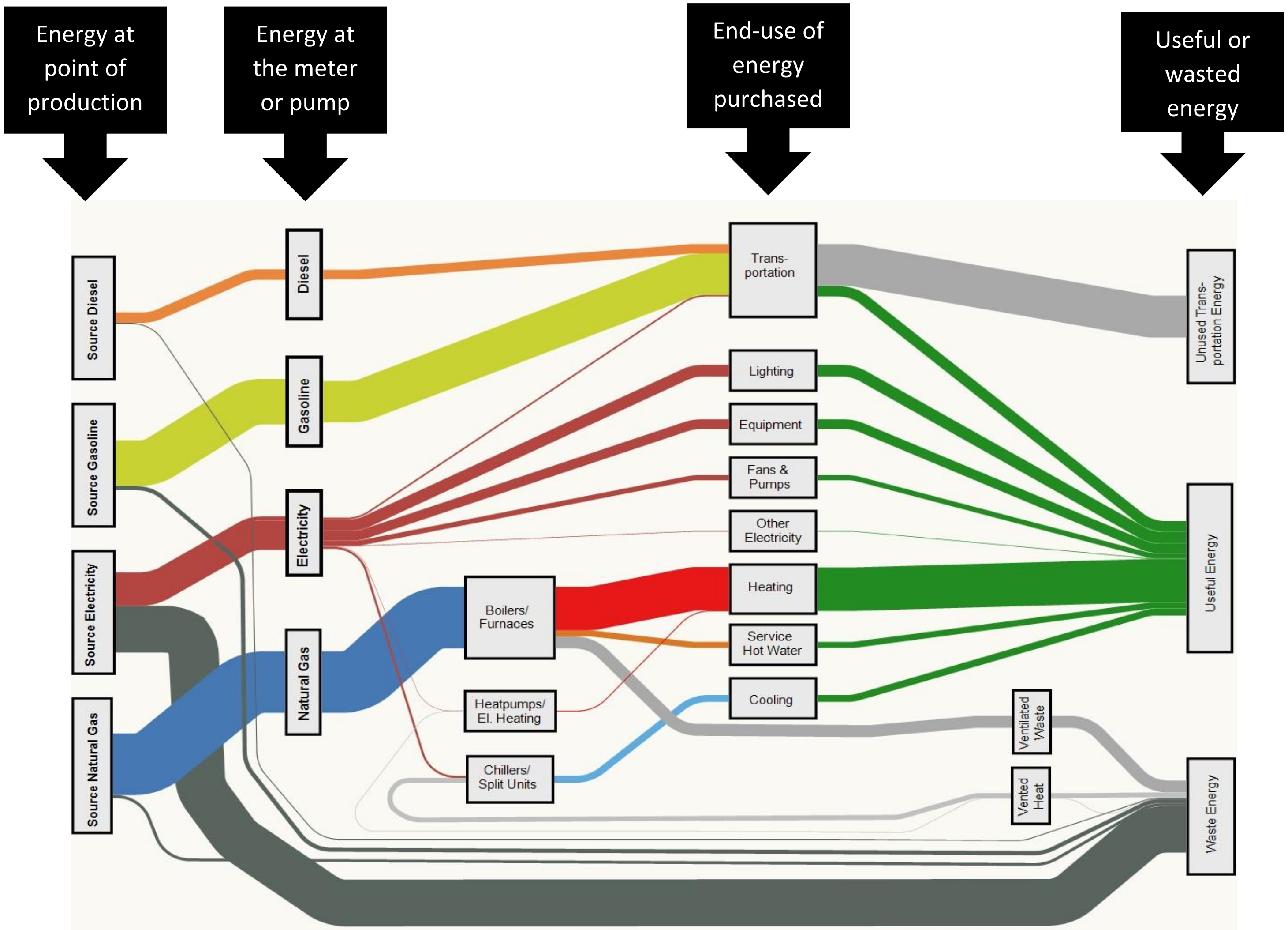


Figure 9: How to read the Sankey diagram.

10. CEPP Recommendations

PWT recommendations were based on the CEPP Efficiency Case.

10.1 Strategic Directions

The PWT identified four strategic directions. The following provides a high-level rationale for each strategic direction.

10.1.1 Home and Building Efficiency

Canada: Energy efficiency is recognized as the first fuel of a sustainable global energy system.[10] The built environment is the third largest emitting sector in Canada and most existing homes and commercial and institutional buildings will still be in operation in 30 years.[11] Consequently, this sector has been identified a priority for action by the federal, provincial and territorial governments.

Oakville: The built environment represents more than half of Oakville's energy use and 40% of GHG emissions. Oakville's homes alone contribute to 27% of the community's GHG emissions.

10.1.2 Industrial Efficiency

Canada: Industrial activity is most often regulated and guided by broader global best-practices and standards. They are driven to reduce their bottom line with continuous improvement in energy management. Many companies also have corporate-wide emissions standards responding to both customer pressure and public opinion.

Oakville: Oakville's industrial sector demonstrates higher energy and emissions performance relative to global best practice than other sectors. There is an opportunity to share this energy management expertise within the community to promote world class energy performance.

10.1.3 Local Energy Supply and Distribution

Canada: Over 50% of the energy spent to power homes, buildings, industry and transportation is lost through end-user and system inefficiencies. Energy is lost when it is converted from one form to another (e.g., when natural gas is used to generate electricity) and during transmission from one location to another. The use of natural gas to heat homes and buildings is a major contributor of GHG emissions.

Oakville: The highest conversion losses are associated with electricity use in Oakville. Increasing local electricity generation would reduce the economic impact of these losses on the community. Currently, local solar photovoltaic electricity generation only accounts for 0.1% of total electricity used in Oakville.

The use of natural gas contributes almost half of Oakville's emission which underscores the need to identify measures that address the heating, cooling and hot water needs of homes and buildings through the local distribution of heat, and to a lesser extent cooling. Modern district energy (see Figure 10) is an important pathway to decarbonize urban heating.[12]

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[10] Reference: https://www.iea.org/topics/energyefficiency/
[11] Source: Natural Resources Canada
[12] http://www.districtenergyinitiative.org/

High growth areas offer an opportunity to consider district energy. By aligning the energy planning districts (EPDs) with Oakville's urban structure and growth plans, the following EPDs were identified as candidates for district energy (Figure 10):

- Densification EPDs: 1, 4, 8, 13, 14, 19, 20 and 24
- Net-zero development EPDs: 2, 3, 5, 6, 7, 9 and 10

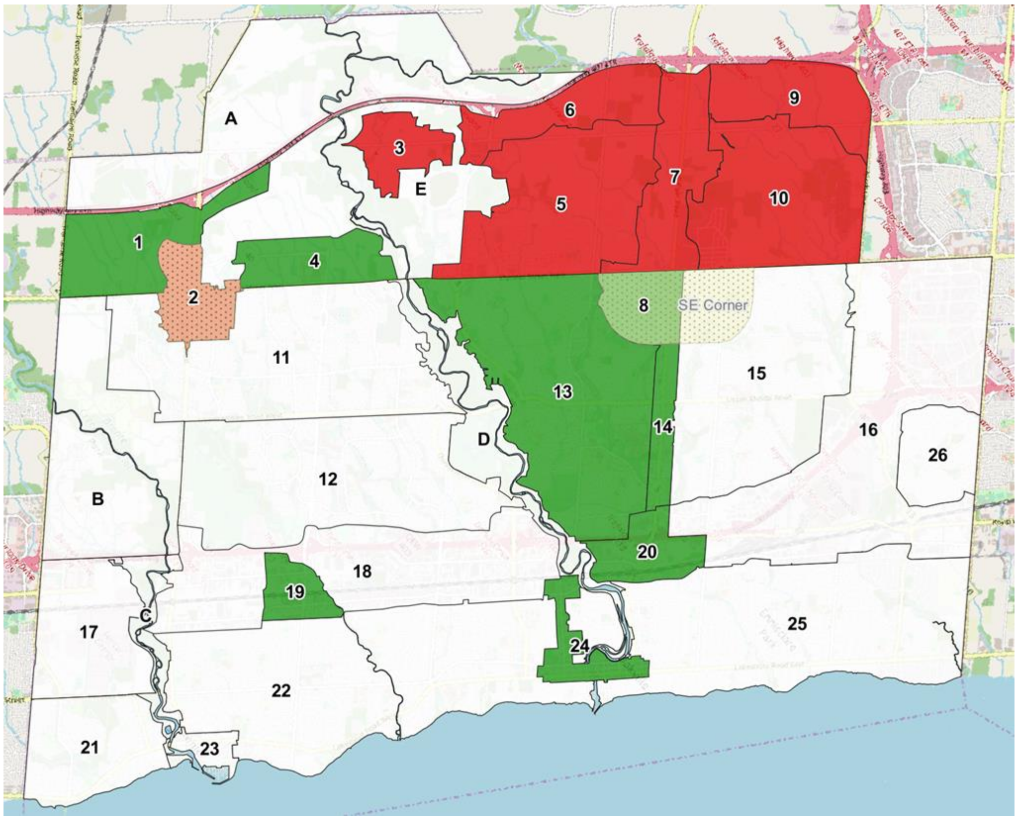

Figure 10: Identification of Energy Planning Districts as candidates for district energy. Areas planned for densification are represented in green. Areas planned for new growth are represented in red.

10.1.4 Transportation Efficiency

Canada: The transportation sector represents almost 25% of national GHG emissions. Almost half of these emissions arise from the use of personal automobiles.

Oakville: Transportation accounts for almost half of community wide GHG emissions and total dollars spent of energy in Oakville, with no material change projected for 2041. Over 70% of transportation activity is personal vehicle use. The current level of electric vehicles in Oakville is approximately 0.1%.

10.2 Strategic Objectives

The PWT made 13 recommendations on objectives with targets for 2041 for the four strategic directions (Table 2). These recommendations formed the strategic objectives by which the Oakville Energy Task Force (OETF) plans to achieve its vision and goals.

Underlying these strategic objectives is an overarching enabling recommendation to make Oakville a smart energy community by continuing to use data to optimize energy and climate performance. The following recommendations are made for the consideration of the OETF in identifying implementation priorities for the first five years:

- Implement interoperable smart metering for gas, electricity, heating, cooling and water
- Implement comprehensive traffic count and vehicle activity metering systems
- Create interoperable protocols to enable neighbourhood level building automation
- Implement an integrated "Smart Energy Community" analysis and reporting platform
- Ensure "Smart Energy Community" measures align with wider "Smart Town" goals

The priority projects selected for the first five years to work towards these objectives are found in the 2041 CEPP Strategy and 2020 - 2024 Priority Projects Report.

Table 4: Summary of CEPP strategic directions, objectives and 2041 targets.

Strategic Direction	#	CEPP Strategic Objective	2041 Target
Home and Building Efficiency	1A	Increase efficiency of existing homes.	Achieve a 30% residential sector efficiency gain by retrofitting 80% of existing homes.
	1B	Increase efficiency of existing buildings.	Achieve a 30% commercial and institutional sector efficiency gain by retrofitting 60% of existing buildings.
	1C	Increase delivered efficiency of new property	Achieve a 17% Ontario Building Code efficiency gain.
Industrial Efficiency	2A	Proliferate best practice to all local industry	Achieve a 20% industrial sector efficiency gain.
Local Energy Supply & Distribution	3A	Implement district energy in high growth districts with a mix of combined heat and power and other low-carbon heating and cooling sources	Serve 70% of existing target property and 80% for new target property with district heating in areas targeted for densification or new growth.
	3B	Install solar hot water in lower growth districts	Serve 10% of hot water and heating needs in homes not served by district energy with solar hot water.
	3C	Generate significant amounts of solar power installed on suitable rooftops and other locations	Supply 8% of Oakville's electricity needs with locally generated solar power.

Transportation Efficiency	4A	Reduce average trip length	Reduce average trip length by 5% for light-duty vehicles.
	4B	Increase trips by walking and cycling	Increase the share of passenger kilometers travelled (PKT) by walking and cycling to 10%
	4C	Increase trips by bus	Increase the share of passenger kilometers travelled (PKT) by bus to 10%
	4D	Increase trips by GO Train	Increase the share of passenger kilometers travelled (PKT) by GO Train by 15%
	4E	Increase use of electric vehicles	Increase electric share of light-duty vehicles sales by 30% and heavy-duty vehicles sales by 10%
	4F	Increase efficiency of vehicles	Increase efficiency of gas/diesel vehicles by 36% efficiency gain and electric vehicles by 20%

Strategic Objective 1A and 1B: Increase efficiency of existing homes and buildings

The current energy efficiency retrofit market for home and building owners and contractors is relatively unattractive. Historically, market uptake of retrofit programs has been low. From the perspective of the contractor, the effort to prepare customized proposals is high and the closing rate is low. Low volumes and the fact that every project is specific to each household means that material costs are expensive and performance guarantees are risky. From the home and building owners' perspective, obtaining understandable bids from various contractors is burdensome. They are responsible for finding their own sources of funding based on their individual credit rating. Finally, the low volumes result in retrofit costs that typically exceed the value of the energy saving, even over many years.

To address these challenges, the PWT recommends offering standardized energy retrofits to homes and commercial and institution buildings at high volumes. Contractors benefit from increased project predictability, improved margins and vastly higher project volumes. Home and building owners benefit from a simplified transaction, guaranteed pricing, lower cost pre-financed retrofits and a simple billing and payment mechanism.

In addition, property-assessed financing has the distinct advantage of tying the efficiency investment to the property, mitigating the risk of the home and building owner that their payback period is longer than the time they remain (or intend to remain) in the home or building.[13] Attractive

[13] Provincial Local Improvement Charges (LIC) regulations were amended in 2012 to enable voluntary energy and water efficiency upgrades of private homes and buildings, allowing Ontario municipalities to provide long-term, low-cost financing for residential, commercial and industrial building energy and water conservation retrofits.

interest rates and borrowing terms can be achieved for home and building owners while reducing or eliminating their up-front capital costs.

The following recommendations are made for the consideration of the OETF in identifying priorities for implementation during the first five years:

- Create a Retrofit Entity to:
  - offer quality-controlled standardized retrofits by property type and age
  - deliver by partnering with local contractors
  - offer property-assess financing to homeowners to encourage uptake
  - attract third-party financing
- Require energy performance labels when homes and buildings are rented (see Strategic Objective 1C for details)
- Encourage Sheridan to develop supporting workforce programs

Strategic Objective 1C: Increase delivered efficiency of new properties

The International Energy Agency (IEA) recommends mandatory energy labelling of homes and buildings to promote efficiency. Natural Resources Canada offers a voluntary home labelling program. However, European Union best practice includes emissions and source energy indicators. [14]

According to the Pembina Institute, the uptake of voluntary home labelling programs in Canada has been hampered by a lack of familiarity with the rating system and a shortage of comparator homes in the market.[15] Both barriers would be addressed through a mandatory program. Disclosure of the energy performance of homes and buildings transform the market for energy efficiency.

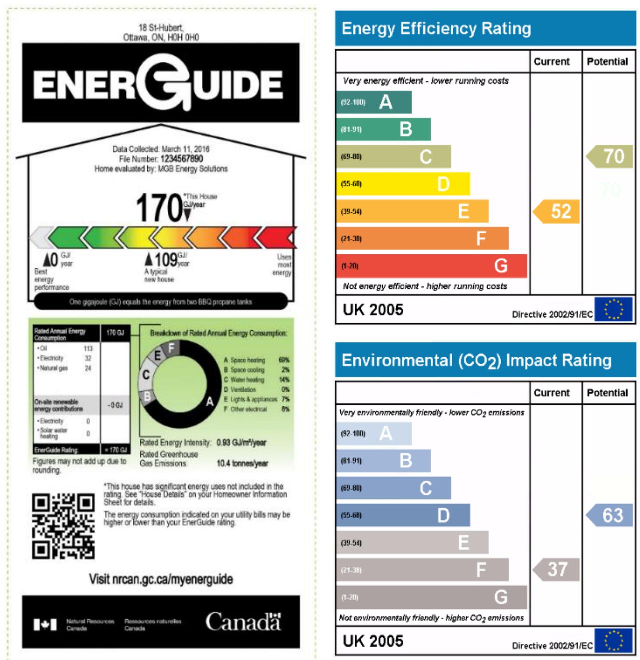

Figure 1: Examples of two energy performance labels including a Home EnerGuide label developed by Natural Resources Canada (left) and for the United Kingdom (right).

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[14] Intelligent Energy Europe, "Improving Dwellings by Enhancing Actions on Labelling of the EPBD" (2011). Found at: https://ec.europa.eu/energy/intelligent/projects/en/projects/ideal-epbd

[15] Pembina Institute, "Home Energy Labelling Requirement at Point of Sale: Pilot Program Design" (2012). Found at: https://www.pembina.org/pub/home-energy-labelling-requirement-at-point-of-sale-pilot-program-design

The following recommendations are made for the consideration of the OETF in identifying priorities for implementation during the first five years:

- Offer energy performance labels when buildings are rented or sold (see examples in Figure 1)
  - Raise customer awareness and expectations through comprehensive outreach
  - Engage mortgage lenders to provide energy-efficient mortgages
  - Engage Oakville Hydro, Enbridge, key builders and realtors as champions
- Explore opportunities for near-Passivhaus standards in target net-zero energy planning districts (see Strategic Objective 3A)

Strategic Objective 2A: Proliferate best practice to all local industry

Industrial activity is most often regulated and guided by broader global best-practices and standards. They are driven to reduce their bottom line with continuous improvement in energy management. The industrial sector demonstrates higher energy performance relative to global best practice than other sectors in Oakville. There is an opportunity to share this energy management expertise within the community to promote world class energy performance.

The following recommendations are made for the consideration of the OETF in identifying priorities for implementation during the first five years:

- Encourage community industrial best practice networks or communities of practice
- Host global best practice events
- Share industrial energy management expertise in Oakville
- Encourage Sheridan to develop relevant workforce programs

Strategic Objective 3A: Implement district energy in high growth districts with a mix of combined heat and power and other low-carbon heating and cooling sources

Modern district energy is an internationally recognized pathway to decarbonize urban heating and cooling.[16]

District energy (DE) systems supply thermal energy (heating and/or cooling) to multiple buildings from a central plant or from several interconnected but distributed plants; thermal energy is conveyed with water through a close network of preincubated pipes to meet end users' need for cooling, heating and domestic hot water. Historically, steam networks have been used and are still used in some older systems. A DE system is comprised of three sub-systems which include the collection and/or generation of thermal energy, the distribution of that thermal energy from the plant(s) to end-users and the transfer of the thermal energy to the energy consumer.

A DE network is typically run as a thermal utility by a company that operates all the plants and networks, ensures service quality and manages the metering and billing of the heating and cooling services. The network allows for economies of scale since the generation of heat in a few larger plants is more efficient than having thousands of boilers each heating their individual building. It

[16] http://www.districtenergyinitiative.org/

also enables valuable energy currently wasted in electricity generation, industrial and other processes to be cheaply captured and delivered to other consumers.

Combined heat and power (CHP) systems produce electricity and thermal energy from a single fuel source (e.g. natural gas, biomass). When electricity is generated in large scale regional gas-fired power plants, as much as 60% of the energy value is lost (most as heat at the point of generation and the remainder during transmission). This systemic inefficiency can be addressed by generating electricity within the community and capturing the heat for use in a DE system.

Modern DE systems (Figure 2) facilitate creating a flexible portfolio of many kinds of low carbon heat sources. These include large solar-thermal, arrays, biofuel boilers and CHP, sewage waste heat recovery, geothermal arrays, and even boilers using renewable electricity. District energy enables the potential decarbonization of heating and cooling homes and buildings. None of these future possibilities to further reduce the GHG impacts of heating and cooling have been included in the current analysis and are possible upsides.

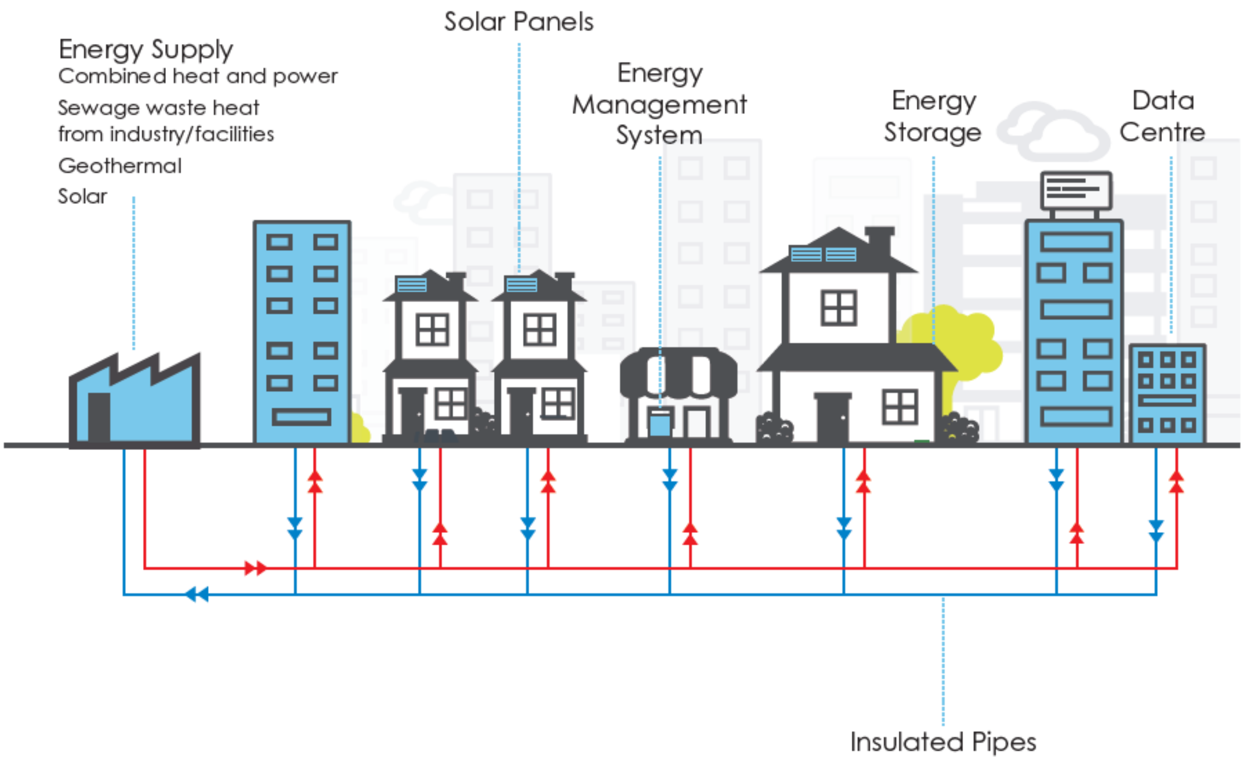

Figure 2: Modern district energy system

By aligning the energy planning districts (EPDs) with Oakville's urban structure and growth plans, the following EPDs were identified as candidates for district energy (Figure 3):

- Densification EPDs: 1, 4, 8, 13, 14, 19, 20 and 24
- Net-zero development EPDs: 2, 3, 5, 6, 7, 9 and 10

The following recommendations are made for the consideration of the OETF in identifying priorities for implementation during the first five years:

- Create a district energy company with appropriate governance to offer heating and selected cooling services
- Raise customer awareness through comprehensive outreach
- Engage Oakville Hydro, Enbridge, key builders and realtors as champions
- Ensure the Official Plan, secondary plans and other planning and development tools include measures to promote district energy.
- Establish property, planning and construction guidelines to enable the development of district energy by the private sector
- Implement best-practice networks and energy centres
- Include significant combined heat and power in a balanced supply portfolio
- Showcase Sheridan College as a "living-example"
- Encourage Sheridan to develop a district energy workforce program

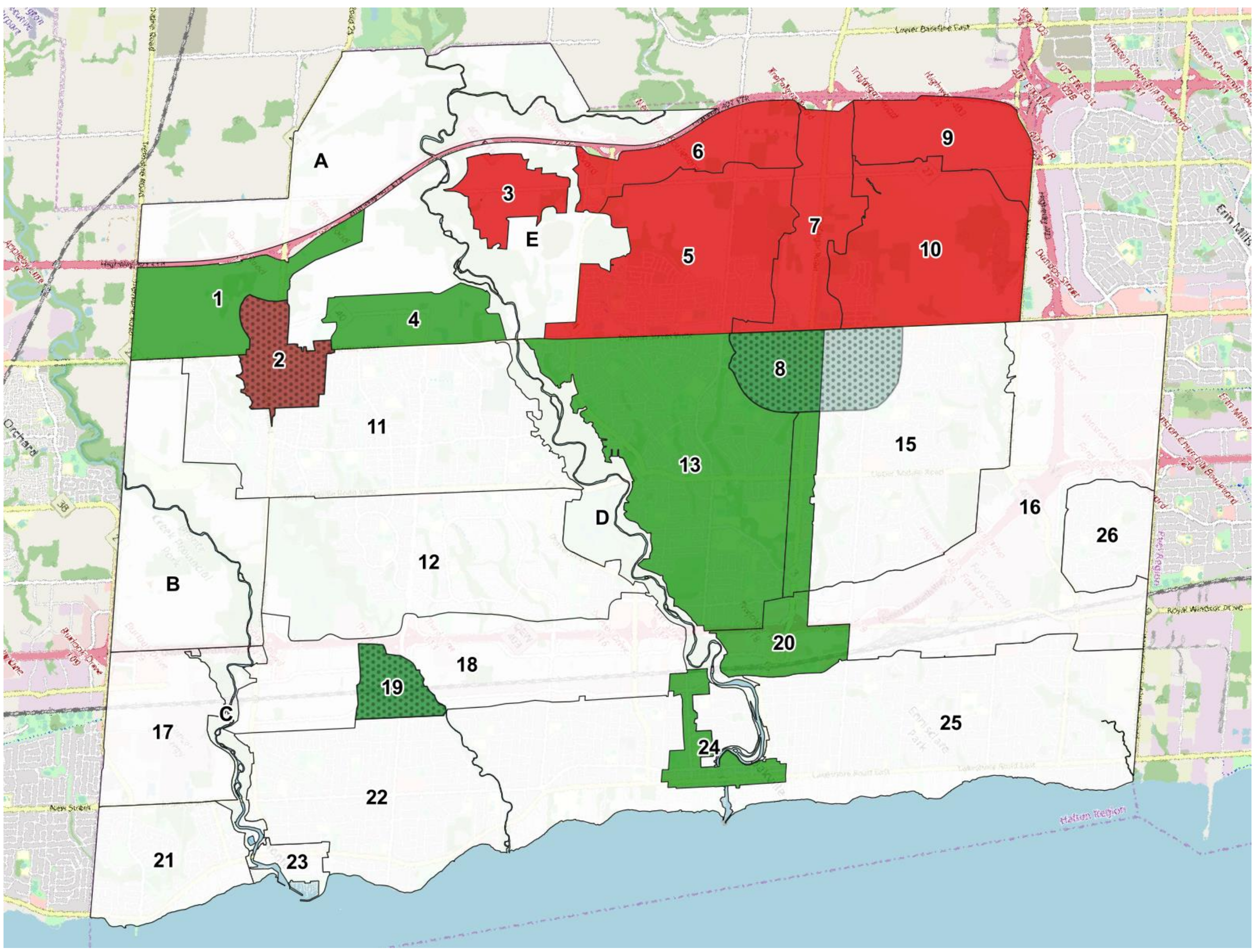

Figure 3: Identification of Energy Planning Districts as candidates for district energy. Areas planned for densification are represented in green. Areas planned for new growth are represented in red.

Strategic Objective 3B: Install solar hot water in lower growth districts

The following recommendations are made for the consideration of the OETF in identifying priorities implementation during the first five years:

- Raise customer awareness through comprehensive outreach
- Engage Enbridge, key builders and realtors as champions
- Include in relevant policy, planning construction guidelines
- Include solar hot water system installation as an option in the efficiency package offered to homes and business by the Retrofit Entity (see Strategic Objective 1A and 1B)

Strategic Objective 3C: Generate significant amounts of solar power installed on suitable rooftops and other locations

The following recommendations are made for the consideration of the OETF in identifying priorities implementation during the first five years:

- Raise customer awareness through comprehensive outreach
- Engage Oakville Hydro, key builders and realtors as champions
- Include in relevant policy, planning construction guidelines
- Include PV installation as an option in the efficiency package offered to homes and business by the Retrofit Entity (see Strategic Objective 1A and 1B)

Strategic Objective 4A: Reduce average trip length

The following recommendations are made for the consideration of the OETF in identifying priorities implementation during the first five years:

- Ensure the Official Plan, secondary plans, transportation and transit master plans include specific targets and measures to contribute to the objectives, including:
    - Mixed-use compact design
    - Increased local job to population ratios
    - Local social destinations
    - Shared vehicle services

Strategic Objective 4B & 4C: Increase trips by bus, bike and walking & increase trips by GO train

The following recommendations are made for the consideration of the OETF in identifying priorities implementation during the first five years:

- Ensure the Official Plan, secondary plan and transportation and transit master plans include specific targets and measures that will contribute to achieving these objectives, including:
    - Multi-modal transportation nodes
    - Competitive transit services
    - Pedestrian and transit-oriented development
    - Bike, e-bike and walking routes
    - Congestion pricing

Strategic Objective 4D: Increase use of electric vehicles

The following recommendations are made for the consideration of the OETF in identifying priorities implementation during the first five years:

- Raise customer and fleet owner awareness of electric vehicles (EVs) through comprehensive outreach
- Engage vehicle dealers and manufacturers as champions of EVs in the community
- Ensure transportation and transit master plans include measures to promote EVs including:
  - EV parking and charging stations
  - Designated parking for electric vehicles
- Electrify municipal and transit fleets
- Ensure the Official Plan, secondary plans and other planning and development tools include specific targets and measures to promote EVs
- Include installation of an EV charging stations as an option in the efficiency package offered to homes and business by the Retrofit Entity (see Strategic Objective 1A and 1B)
- Embrace and lead changes in national & provincial policy

Strategic Objective 4E: Increase efficiency of vehicles

While it is recognized that the Oakville community does not have direct control over increasing the efficiency of vehicles, the following recommendations are made for the consideration of the OETF in identifying priorities implementation during the first five years:

- Raise customer and fleet owner awareness of the benefits of increased fuel efficiency through comprehensive outreach
- Engage vehicle dealers and manufacturers as champions for increased vehicle efficiency
- Embrace and lead changes in national and provincial policy

11. List of Appendices

Appendix 1	Project Working Team Composition
Appendix 2	Summary of Data and Information Gathering, Framing Goals, Base Case Assumptions and Data Assessment
Appendix 3	Baseline and Base Case Findings
Appendix 4	Scenario 3 Simulation Assumptions
Appendix 5	Efficiency Case Performance
Appendix 6	Oakville Sankey Diagrams

Appendix 1 – Composition of the Project Working Team

Figure 1 outlines the organization and composition of the Project Working Team (PWT) for the Oakville community energy planning process.

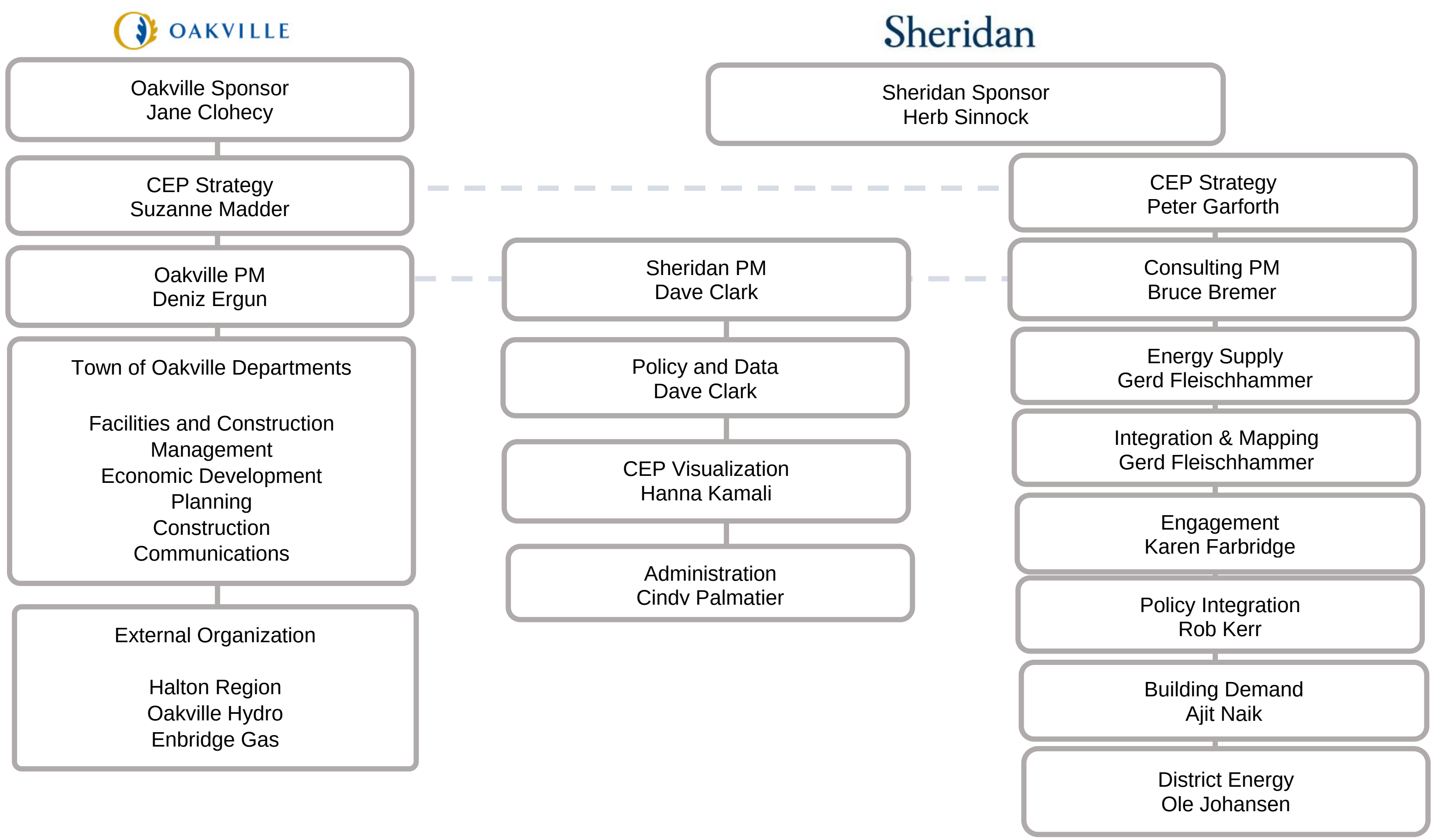

Figure 1: Organizational Structure and Composition of the CEPP Project Working Team (PWT)

Appendix 2 – Methodology

This appendix summarizes the data, information and assumptions that informed the analytical process.

Contents

1. Data and Information Sources

Main sources of data used in the community energy planning process (CEPP) are summarized in Table 1. All data pertain to activity occurring within the municipal boundary of Oakville, Ontario. 2016 was chosen as the baseline year as it was the most recent Canadian Census.

Table 1: Main sources of data for the Oakville CEPP

Type	Source	Form
Municipal property	Town of Oakville in agreement with Municipal Property Assessment Corporation	Residential parcel and structures
Building turn over	Town of Oakville	Demolition permits
Business property data[1]	Halton Region Employment Survey 2016	2016 non-residential building size (partial)
Natural gas (non-contract customers)	Enbridge Gas (formerly Union Gas)	2016 consumption for residential properties by six-digit postal code
Natural gas	Enbridge Gas (formerly Union Gas)	2016 consumption totals for balance
Electricity	Oakville Hydro	2016 consumption data and generation (solar photovoltaic) by address
Transportation activity	Transportation for Tomorrow Survey 2016	Public transit, walking, cycling and motor vehicle use data – residential and commercial
Region public transit	Metrolinx	GO Train and GO Bus activity
Commercial transportation	Geotab	Commercial transportation activity (partial)
Traffic counts	Town of Oakville Halton Region Province of Ontario	Through traffic information as done on local, regional and provincial roads
Vehicle registration	IHS Markit	Inventory by vehicle type, size and fuel type
Fuel sales	Kent Group Ltd	Gasoline and diesel sales used to validate transportation analysis
Population growth	Town of Oakville	Town of Oakville Residential Growth Analysis Study
Employment growth	Town of Oakville	Town of Oakville Employment and Commercial Review

Facilities site gas and electricity consumption data for large and contract users was provided by:

- The Corporation of the Town of Oakville
- Sheridan College

[1] Non-residential gaps addressed by the PWT through linear interpolation from Halton Region data to known overall floor area.

- The Regional Municipality of Halton
- Ford Motor Company
- Metrolinx
- UTC Aerospace Systems
- Oakville-Trafalgar Memorial Hospital

Oakville population and employment data are summarized in Table 2 and 3, respectively.

Table 2: Oakville Population Data

Indicator	2016	Year-to-year growth	2031	Year-to-year growth	2041	Year-to-year growth	2051
Population (#)	200,600	1.94%	267,400	0.63%	284,800	0.32%	293,900
Homes (#)	71,013		102,500		115,800		123,600
Average home occupancy (#)	2.8		2.6		2.5		2.4
Average home size (m^2)	202		173		165		161

Table 3: Oakville Employment Data

Indicator	2016	Year-to-year growth	2031	Year-to-year growth	2041	Year-to-year growth	2051
Jobs (#)	96,200	1.92%	128,000	0.62%	136,100	0.32%	140,400
Area (m^2)	5,000,000		6,700,000		7,100,000		7,300,000
Density (m^2/job)	52		52		52		52

2. Framing Goals

CEPP energy efficiency and emissions framing goals were established for 2041 to align with the Town's planning framework:

- Efficiency will be 50% higher as measured in source energy per capita.
- Emissions will be an absolute 50% below 2016, irrespective of Oakville's growth.

Framing goals were referenced to a 2016 baseline and selected independently of the Base Case. Framing goals were used to evaluate the performance of the Base Case and Efficiency Cases.

3. Base Case Assumptions

The Base Case is a "business-as-usual" picture of the future to 2041. To create this picture the PWT needed to establish several assumptions on what business-as-usual looks like. Their approach was to include only short-term assumptions where legislation is already passed (e.g. Ontario Building Code) or where the technical evidence is overwhelming (e.g. average vehicle efficiency gains).

This means the Base Case does not reflect individual views of how Canada's energy and emissions future will evolve. The political shifts seen globally and in Canada demonstrate the risk of assuming a continuous bending of the curve by policy and practice towards lowering GHG emissions.

The PWT instead gave priority to measures that Oakville can influence, more-or-less, within the framework of current legislation. This underlines the opportunity and responsibility for individual communities to take the lead in dramatically reducing their GHG emissions, even with policy fluctuations going on around them.

This approach also underscores the need to update the CEPP every 5 years to respond to changes in legislation, policy and technical evidence.

The integrated analysis of the energy, GHG emissions and cost footprint of all energy end-use sectors in Oakville required alignment on a great number of interrelated assumptions. Ensuring that assumptions aligned, and integration of data was as accurate as possible relied on the collaboration of subject matter experts across the PWT.

The following is a list of the key assumptions used for the Base Case. Each assumption was aligned with the relevant subject matter experts within the town and PWT. For example, assumptions on annual population growth in each energy planning district (EPD) was validated by the town's Planning Department (see Figure 1).

3.1 Efficiency of Existing Homes and Buildings

- The pool of buildings existing in 2016 could reduce through demolition at a rate driven by recent history. However, in Oakville this was assumed to be "de minimus" and all buildings in 2016 were assumed to be operating in 2041 or demolished as part of a neighborhood-focussed redevelopment. This assumption was validated by demolition permit data.
- The pool average efficiency of each major category of existing property was assumed to be the same in 2041 as it was in 2016. While some buildings will be made more efficient in the normal course of business, others will deteriorate, resulting in the overall pool at average efficiency.

3.2 Efficiency of New Homes

- New homes are added at a rate driven by population growth estimates supplied by the town's Planning Department.
- The number of residents per home fall modestly between 2016 and 2041.
- New home types between single detached home, multi-unit home etc. are added to all EPDs based on the land-use development plans of each neighbourhood in dialogue with the town's Planning Department and aligned with "Livable Oakville" targets.

- New homes floor areas are somewhat smaller than historic averages.
- The efficiency of each home archetype is assumed to be 100% compliant with the current iteration (2012 and amendments) of the Ontario Building Code (OBC). The OBC is now one of the most efficient in North America. In the real world, full compliance from an energy performance perspective is not always the case, so this Base Case assumption represents an improvement over current market actual practice.

3.3 New Commercial and Industrial Buildings

- New commercial and industrial buildings are added at a rate driven by employment growth estimates agreed with the town's Economic Development Department.
- They are added to EPDs designated for mixed use and employment aligned with the town's Planning Department.
- Type and area of new buildings is based on assumed employment mix.
- As for new homes, the efficiency of each non-residential building archetype is assumed to be 100% compliant with the current iteration (2012 and amendments) of the OBC.

3.4 Transportation

- The 2016 Baseline represents vehicle kilometers travelled by vehicle category, passenger kilometers traveled by journey category, and resulting fuel use, cost and emissions was developed using the Transportation of Tomorrow Survey, Ministry of Transportation (MTO) highway transit data, retail fuel sales, wider benchmarking and adjustments aligned with the town's Transportation Strategy team.
- Base Case light duty vehicle kilometers are aligned with the town's population growth estimates to 2041.
- Heavy duty vehicle kilometers are driven by employment growth to 2041.
- Fleet mix remains the same to 2041.
- Fleet efficiency increases by 0.2% annually to 2041 (this is the pool average for all vehicles of all ages).
- Modality splits remain the same as 2016.
- Off-Road and domestic navigation emissions are estimated from Ontario emissions reports indexed for the town's planned population growth.[2]

3.5 Energy Pricing

- Lower and higher price outlooks are used to estimate risk and opportunity.
- Lower range aligned with Independent System Electricity Operator's (IESO's) Ontario 2017 Long Term Energy Plan and discussions with Oakville Hydro and Enbridge Gas.
- Higher range based on utility risk planning estimates wherever possible and with discussions with Oakville Hydro and Enbridge Gas.

See Figures 2, 3 and 4 for more detail on energy price outlooks.

3.6 Energy Supply to Oakville

- Electricity and natural gas continue to be supplied by sources outside the management of the Corporation of the Town of Oakville.

[2] Canada National Inventory Report 1990 to 2016 https://unfccc.int/documents/65715

- The mix of the functional use of electricity and natural gas for home heating, hot water, cooking, lighting, other home functions and for commercial and industrial process remains unchanged until 2041.
- The Ontario power generating mix between nuclear, gas, wind, solar and hydro remains broadly the same as in 2016, following The Atmospheric Fund (TAF) 2016 estimate with minimal average index reduction from 32 to 28 kg CO_2e/MWh.
- The regional natural gas supply has a reduced greenhouse gas index assuming an added mix of biogas and power-to-gas from renewable electricity. The reduction of the index is assumed to be about 20% by 2041.
- Any new local power and heat generation inside Oakville's boundary is considered "de minimus".

3.7 Greenhouse Gas Pricing

- Ontario Cap and Trade was in effect in 2016 and its continuity was an underlying assumption at that time. The market was closed in 2018. A carbon tax was started in Ontario on April 1, 2019.
- For the Base Case, the lower and higher ranges of greenhouse gas process reflect experiences in comparable markets in North America and Europe, including the California/Quebec Emissions Trading Scheme, BC Carbon Tax and the European Union Emissions Trading Scheme.

4. Data Assessment

A summary of the robust analytical tools used to assess data is provided in this section.

Figures 5 illustrates how data was assessed to establish 2016 baselines for energy consumption, emissions and energy costs.

Figures 6 illustrates how data was assessed to establish the 2041/2050 Base Cases for energy consumption, emissions and energy costs.

Figure 7 illustrates the Integrated Workbook (IW) that supported simulations of different efficiency scenarios ("Efficiency Cases") to test their ability to achieve energy and emissions goals. The IW was structured by EPD. The Efficiency Cases allow for a wide range of opinions to be simulated and tested against the conservative Base Case.

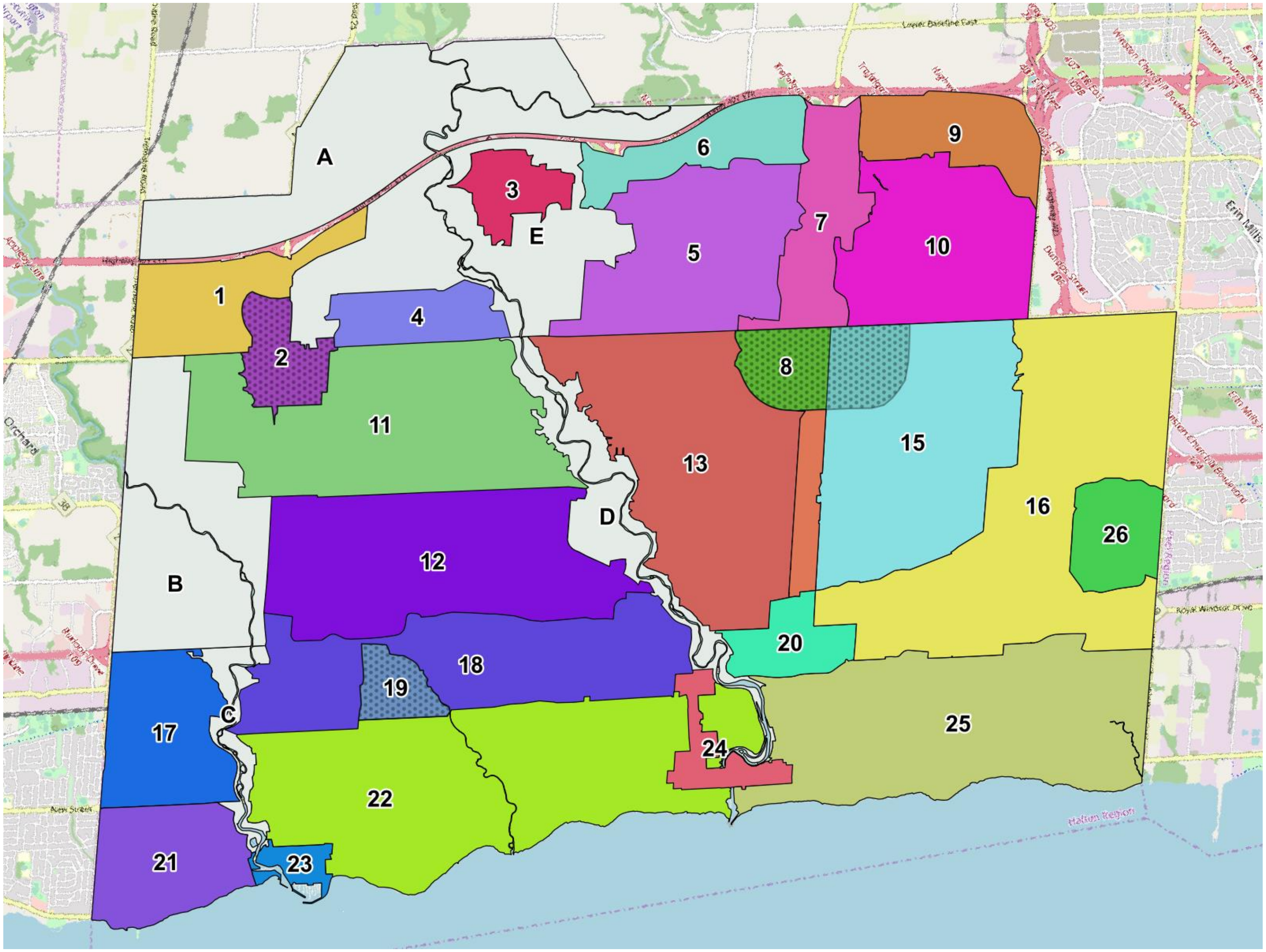

Figure 1: Oakville Energy Planning Districts

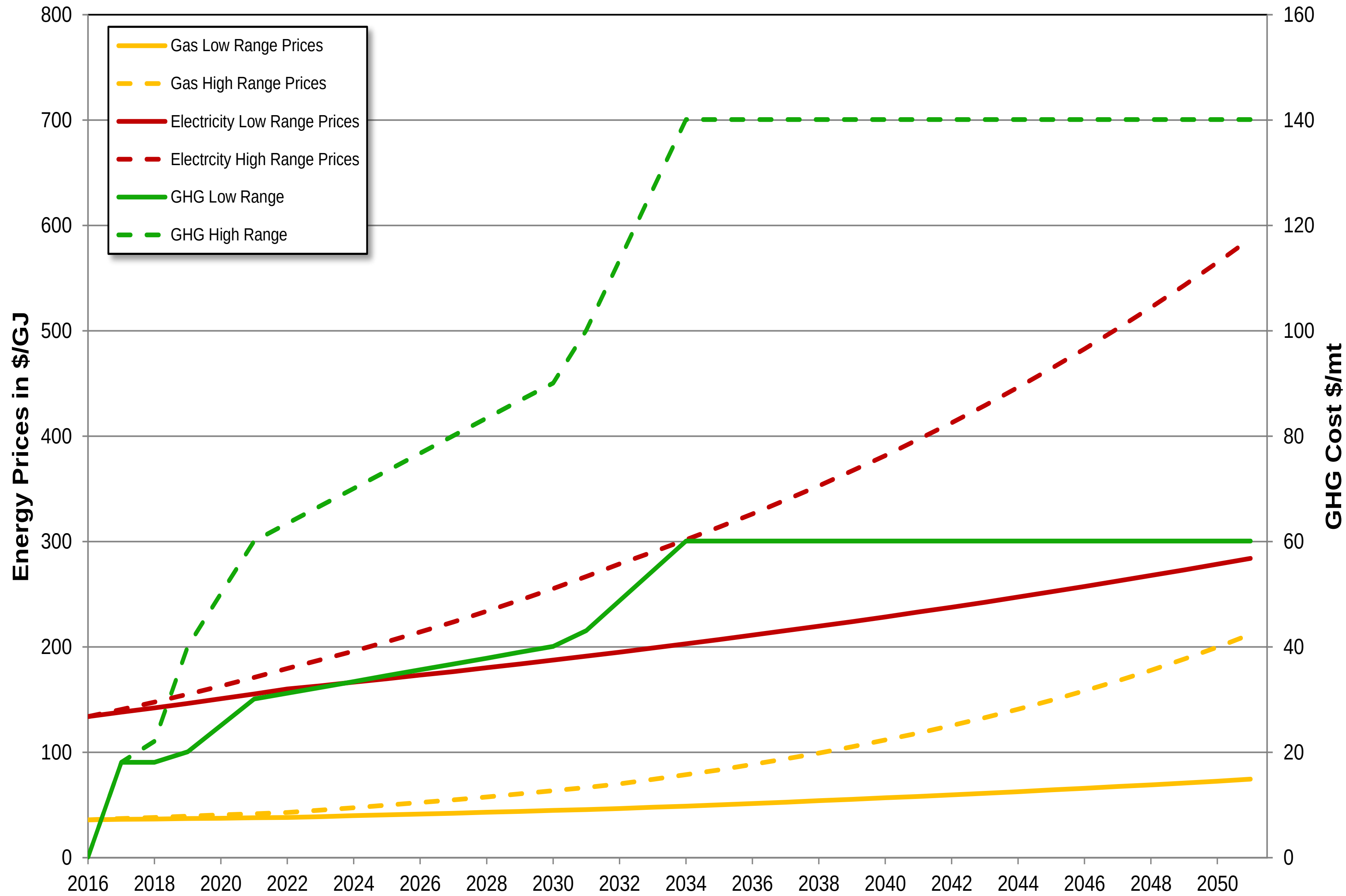

Figure 2: Projected prices for natural gas and electricity ($/GJ), and carbon price ($/MT), for Oakville residential customers from 2016 to 2050.

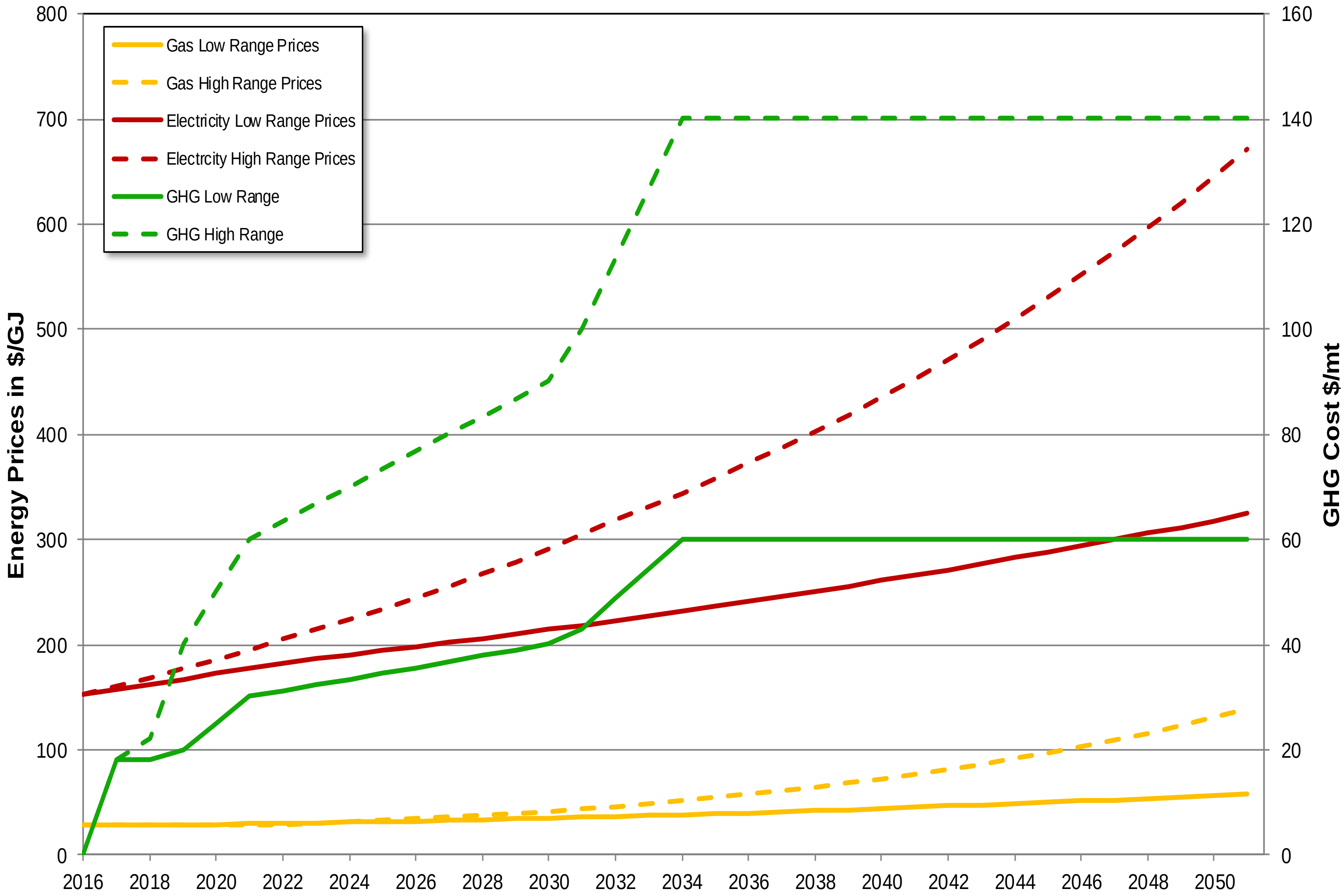

Figure 3: Projected prices for natural gas and electricity ($/GJ), and carbon price ($/MT), for Oakville commercial and institutional customers from 2016 to 2050.

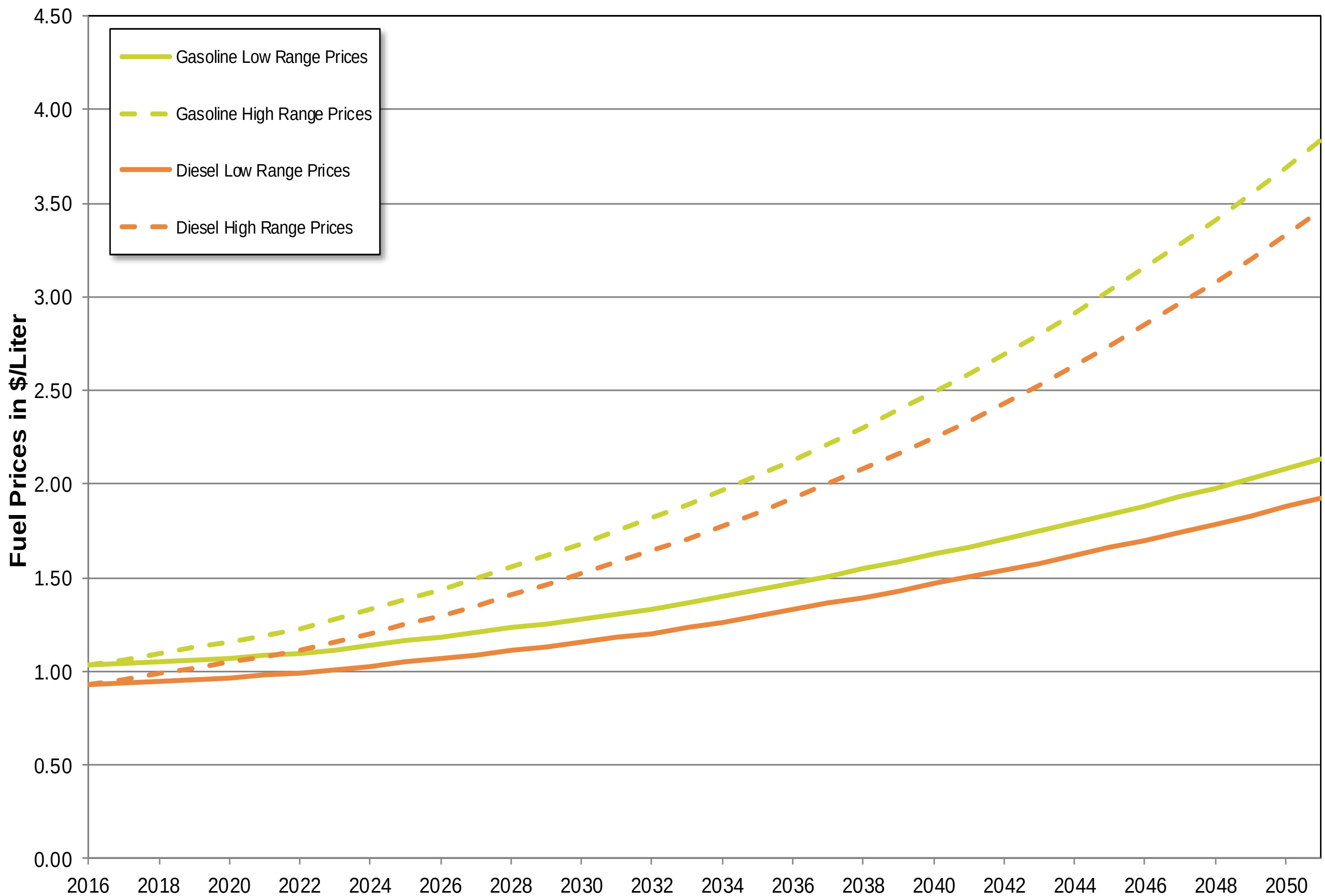

Figure 4: Projected prices for diesel and gasoline ($/litre) in Oakville from 2016 to 2050.

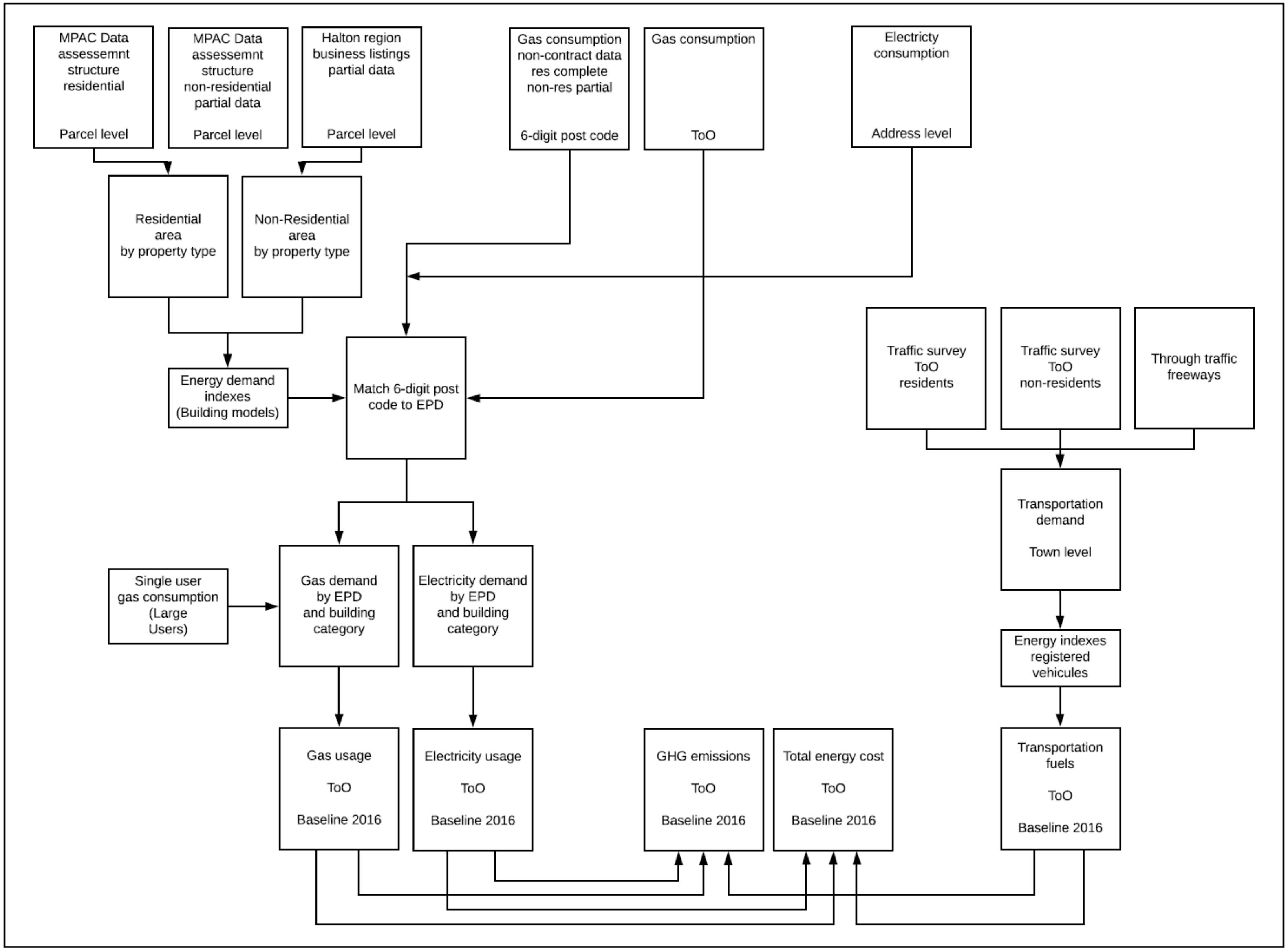

Figure 5: Assessment of data to establish Oakville 2016 baselines for energy, emissions and energy costs.

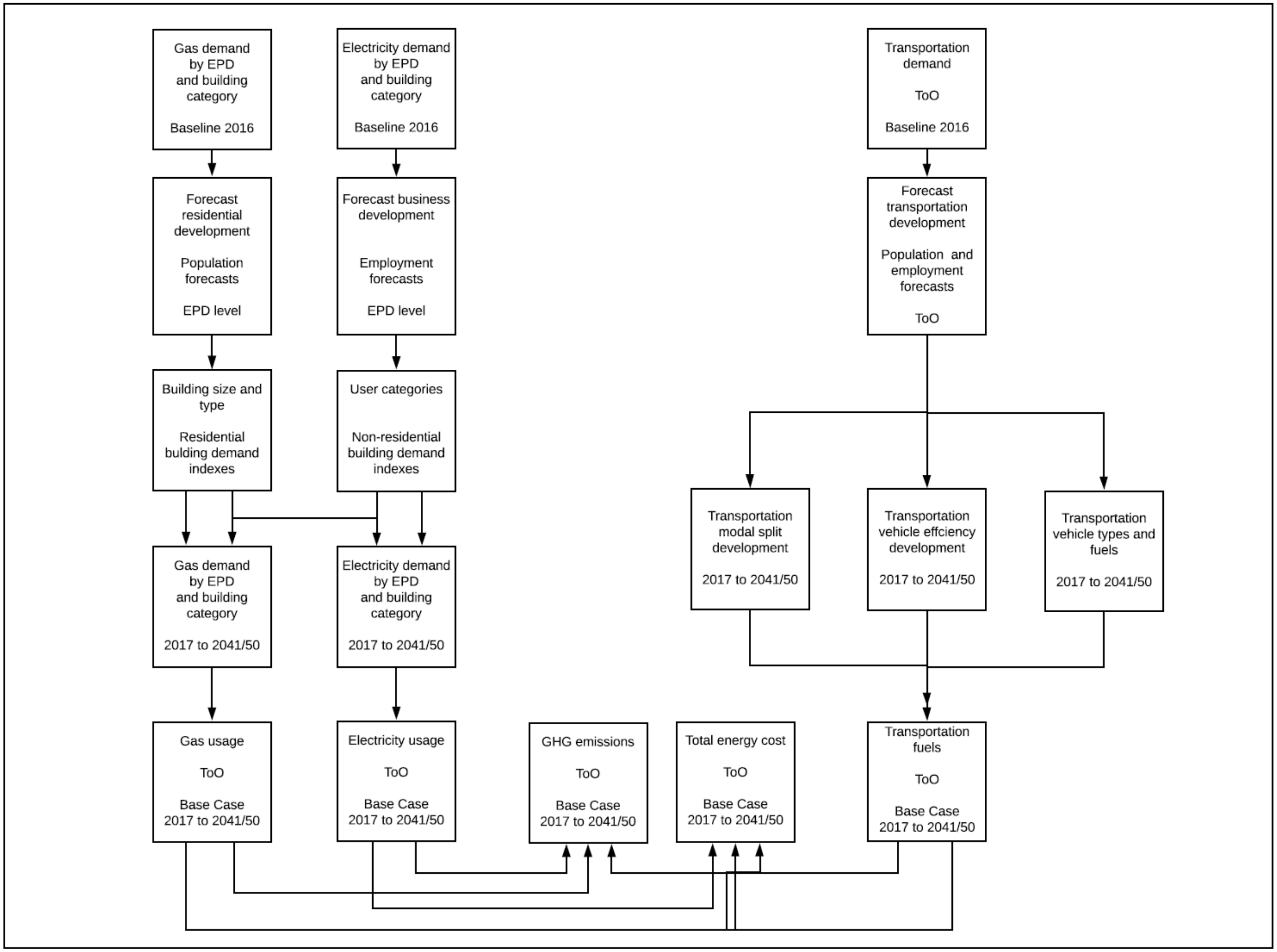

Figure 6: Assessment of data to establish Oakville 2041 and 2050 Base Cases for energy, emissions and energy costs.

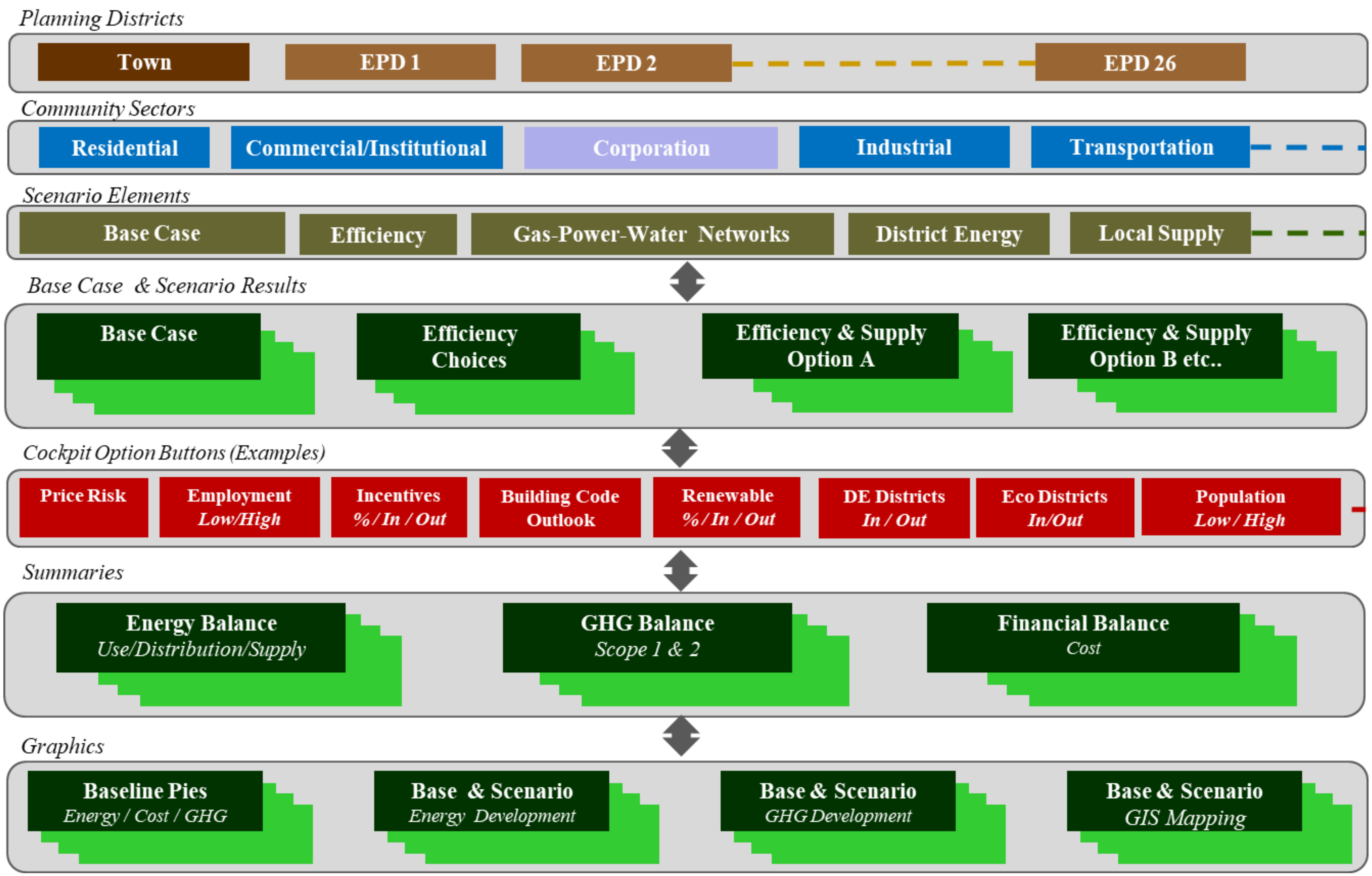

Figure 7: CEPP Integration Workbook

Appendix 3 – Baseline and Base Case Findings

This appendix provides the analytical outputs for source energy, site energy, emissions, and energy cost. The data and assumptions underlying these findings are found in Appendix 2.

Contents

Source Energy Use

Oakville's total source energy use in 2016 was 37 million Gigajoules (GJ). The pie chart in Figure 1 shows 2016 source energy use by sector with the percentage consumer by municipal operations (facilities and fleet) separated. The Town of Oakville's corporate energy use for facilities and fleets represents 1.35% of total energy use in Oakville. Oakville homes represent a third Oakville's total source energy use while the transportation sector represents more than a quarter of total source energy use.

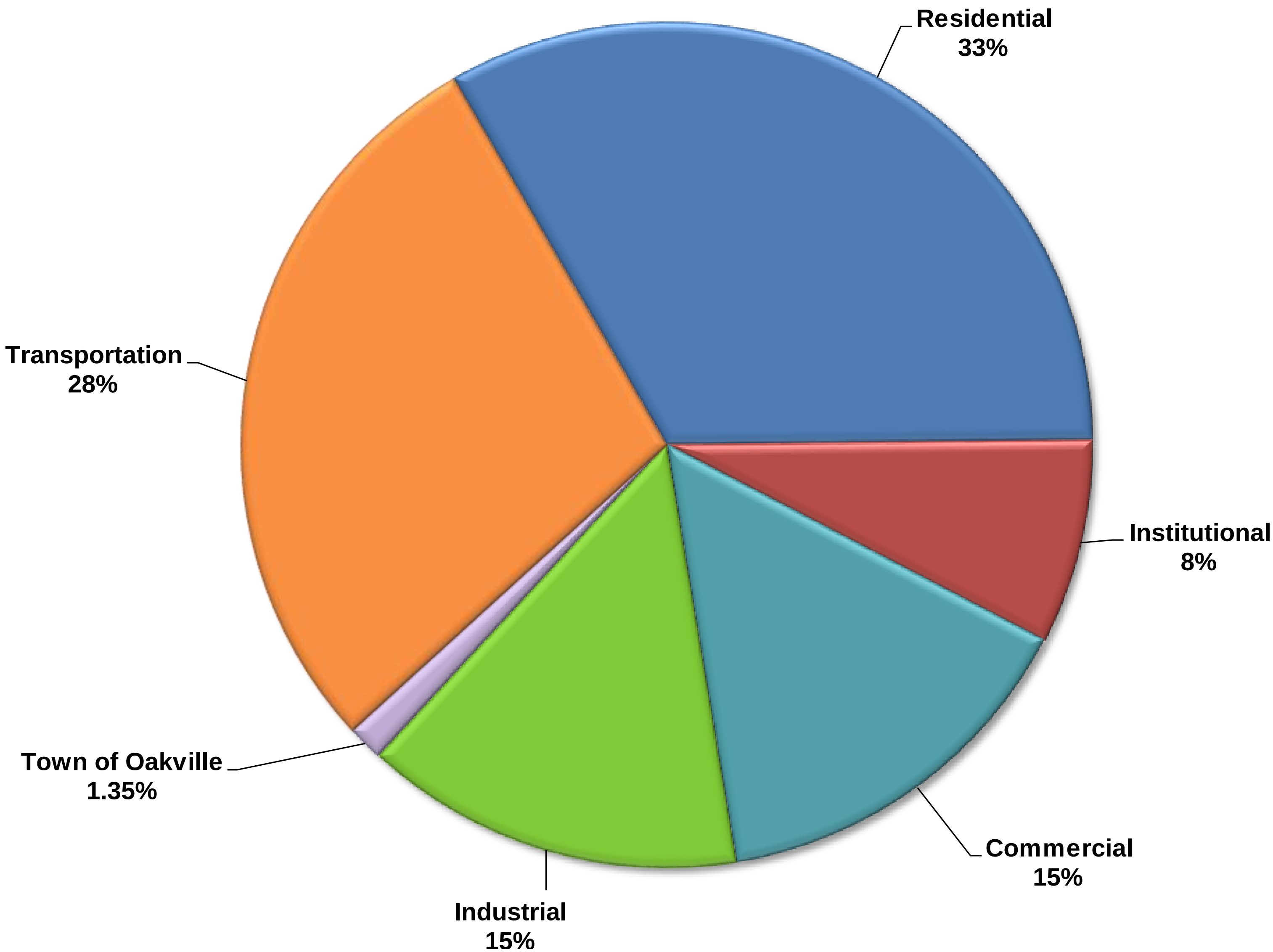

Figure 1: Oakville source energy use (%) by sector in 2016 with municipal facilities and fleet separated.

The pie chart in Figure 2 shows 2016 source energy use by sector with municipal facilities and fleet source energy use incorporated into the institutional and transportation sectors, respectively.

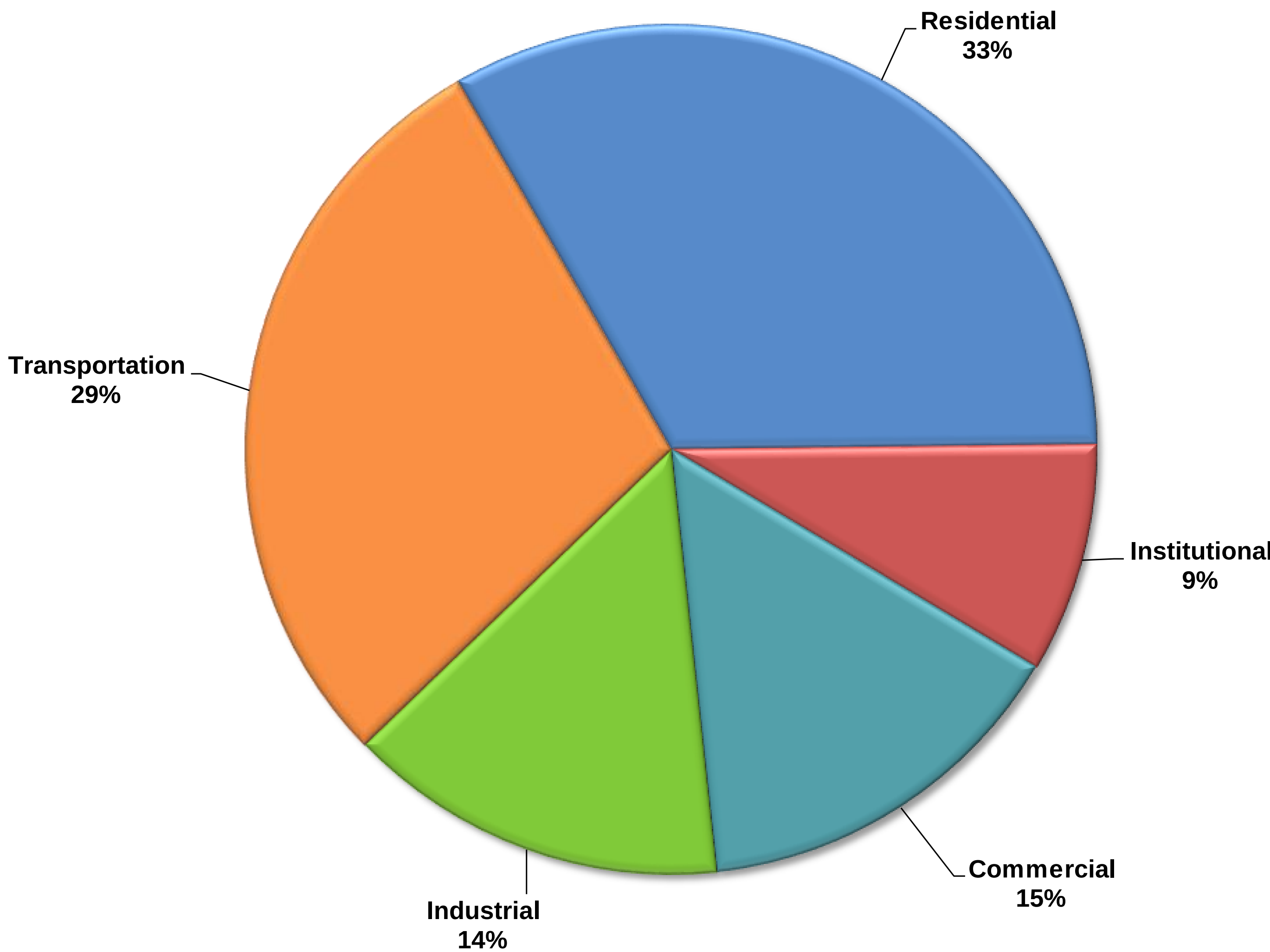

Figure 2: Oakville source energy use (%) by sector in 2016.

The pie chart in Figure 3 shows conversions losses by sector in 2016. Conversion losses occur when one energy source is converted to another (e.g., when electricity is generated from natural gas). Total conversion losses were approximately 27% of the total source energy purchased in 2016.

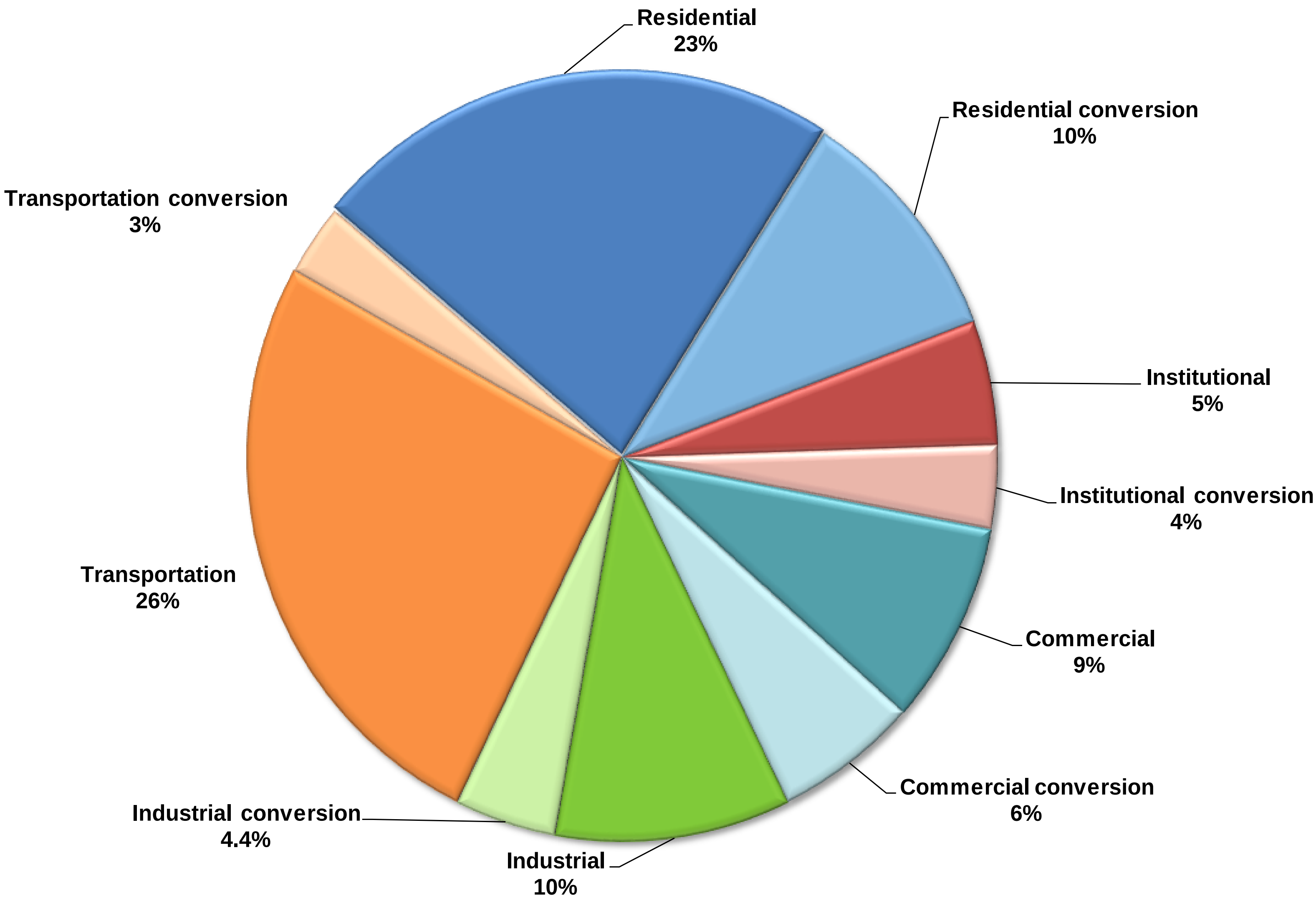

Figure 3: Oakville source energy use (%) by sector in 2016 with conversion losses by sector separated.

The pie chart in Figure 4 shows Oakville's total source energy use by utility in 2016 with conversion losses separated. The largest conversion losses are attributed to the electricity use at 23%.

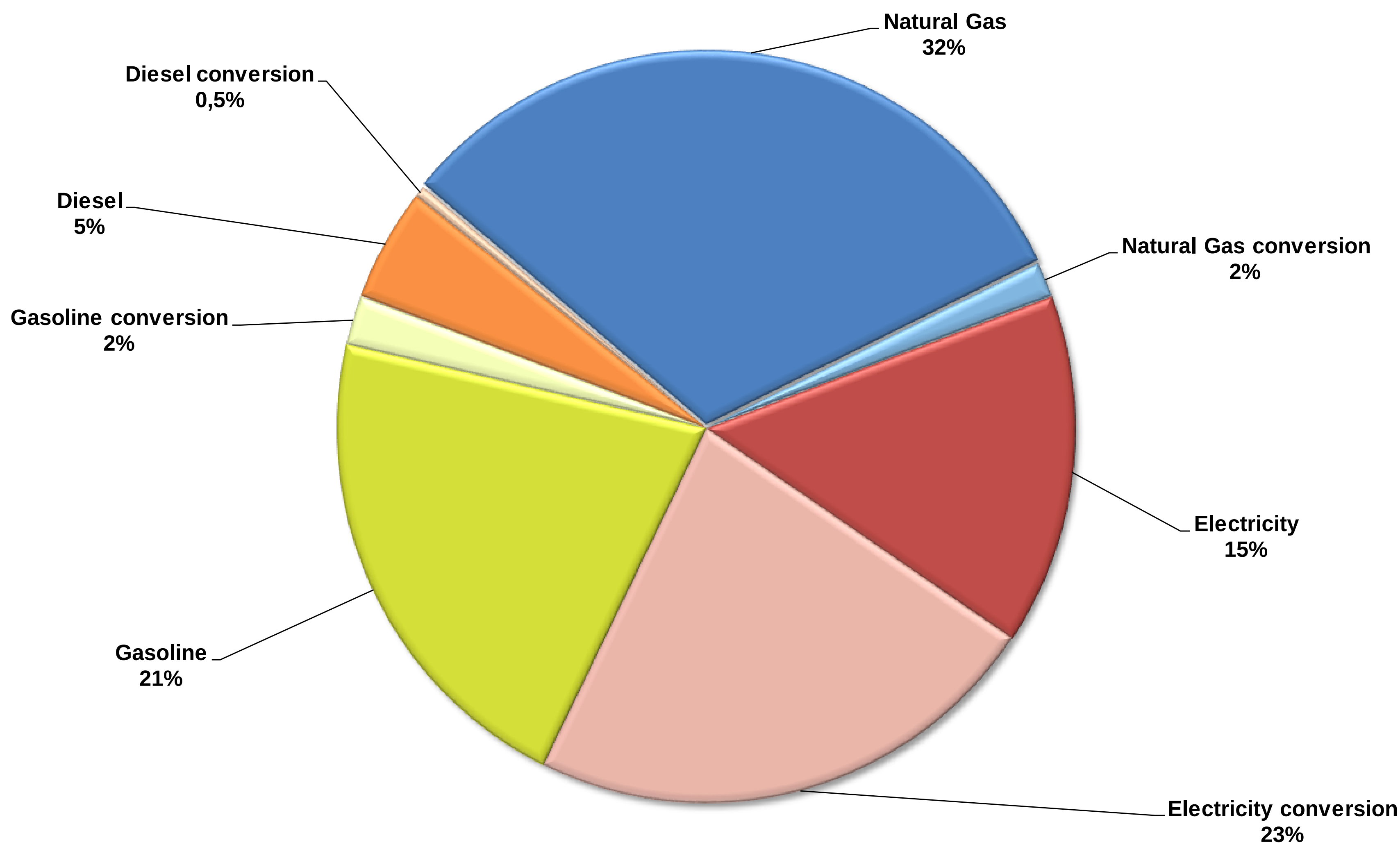

Figure 4: Oakville source energy use (%) by utility in 2016 with conversion losses by utility separated.

The graph in Figure 5 shows the projected annual increase in source energy use by sector from 2016 to 2050 in Oakville. Source energy use is projected to increase to 46.7 million GJ by 2050, a 26% increase. Population and employment growth are both projected to increase 47% during the same time period.

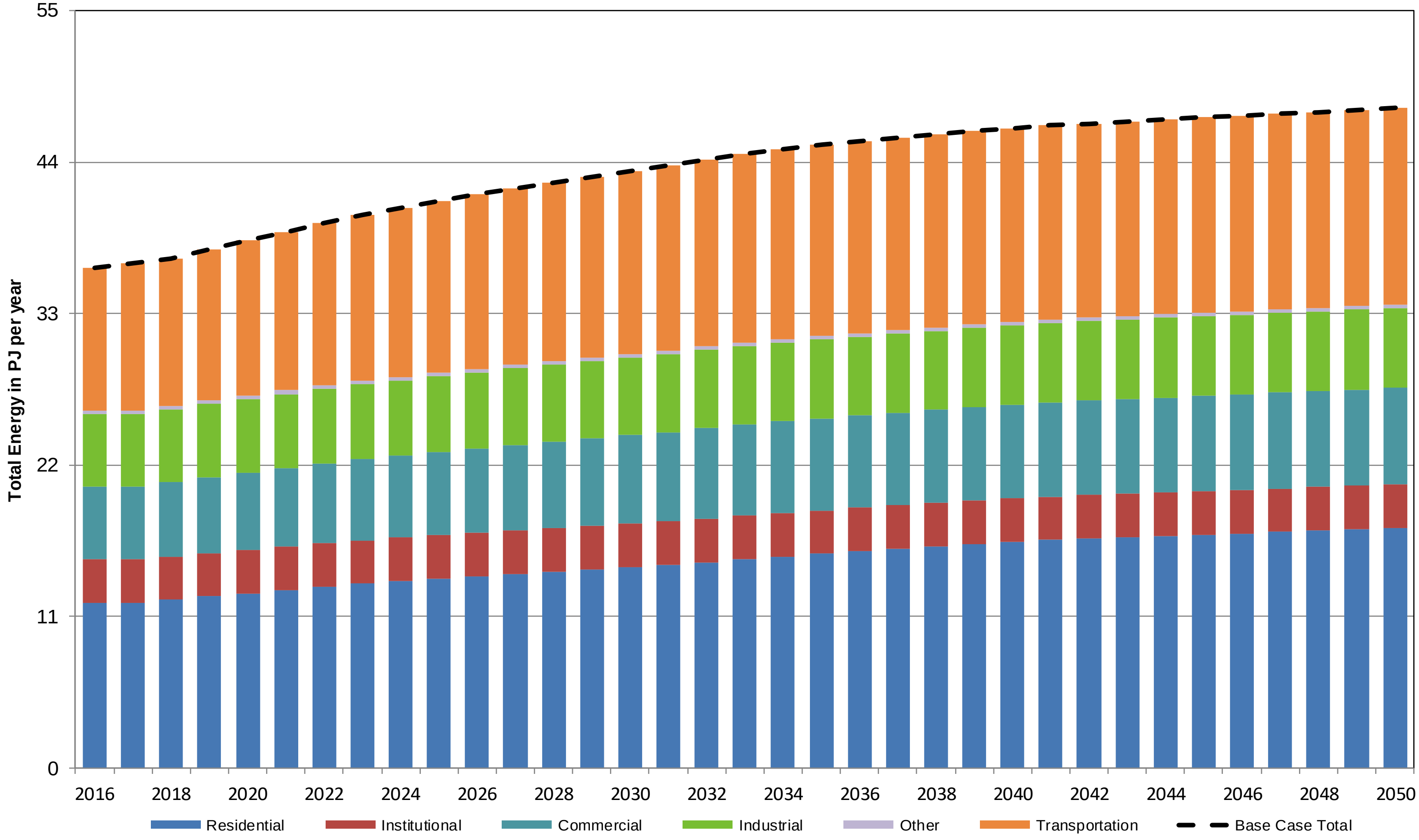

Figure 5: Projected increase in Oakville source energy use (PJ) by sector from 2016 to 2050.

The graph in Figure 6 shows the projected annual increase in source energy use by utility in Oakville from 2016 to 2050.

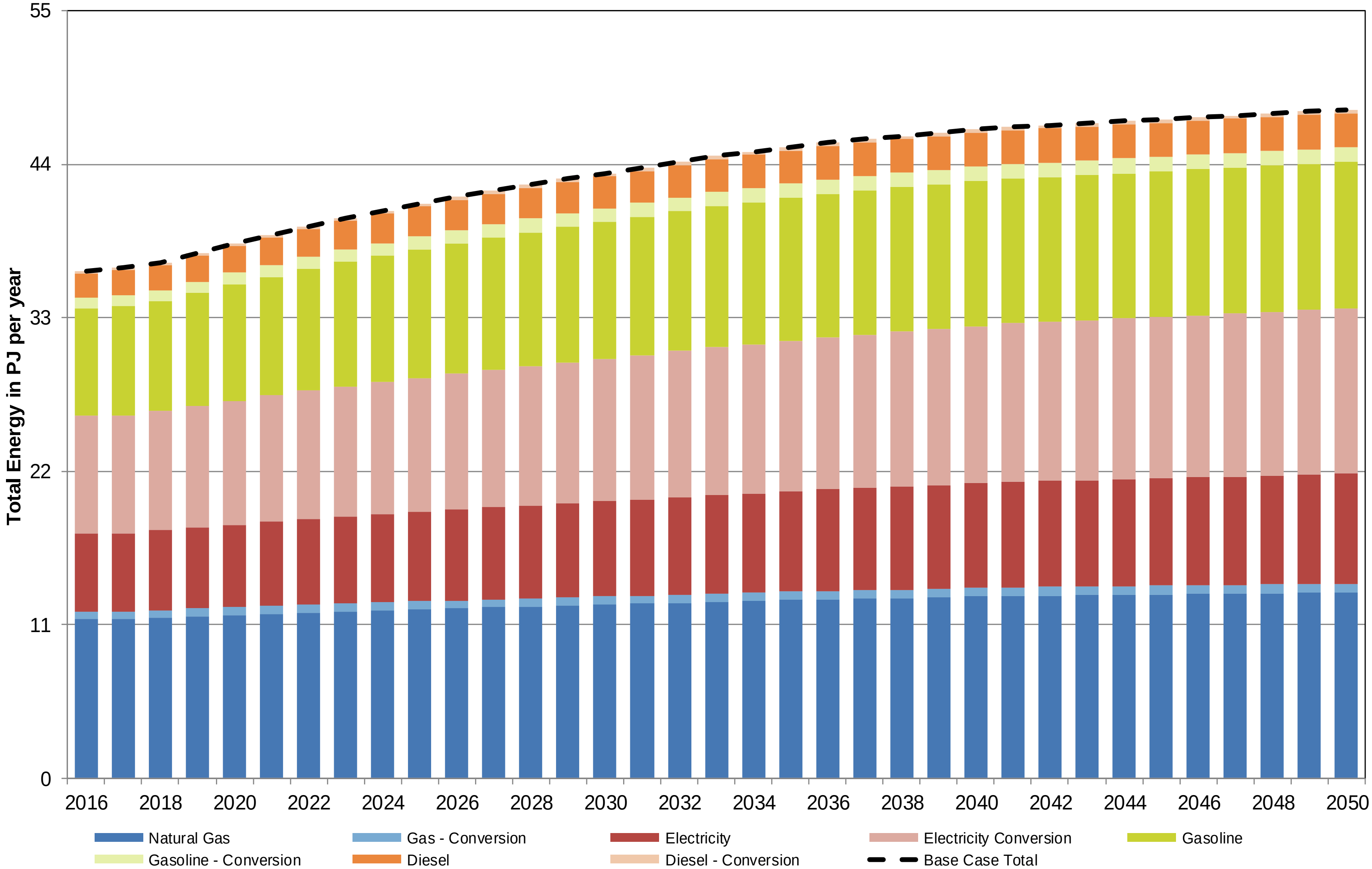

Figure 6: Increase in Oakville source energy use (PJ) by utility from 2016 to 2050.

The map in Figure 7 shows the relative total source energy use for homes and buildings in Oakville by energy planning district (EPD) in 2016. Darker coloured EPDs have relatively higher total source energy use.

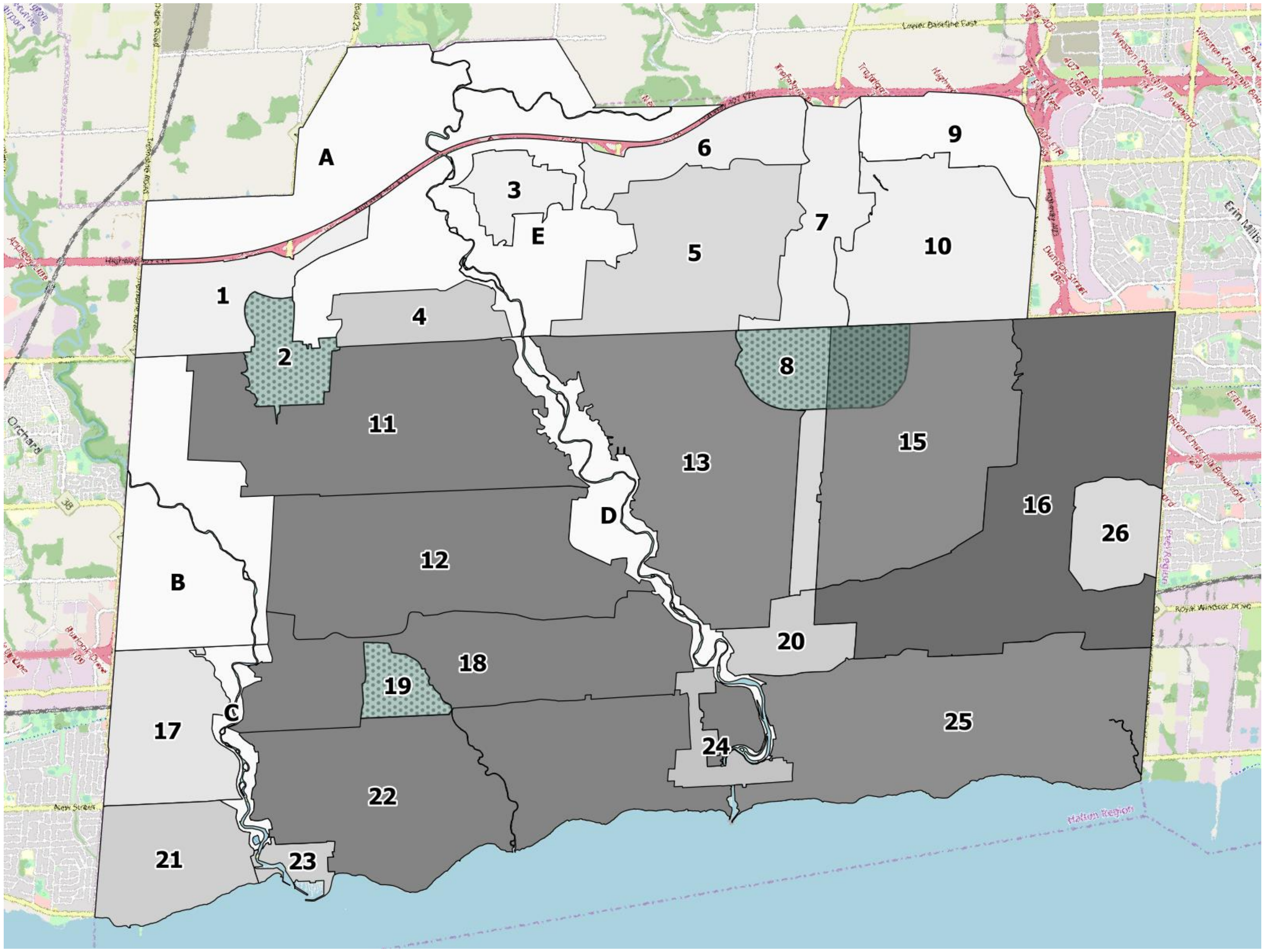

Figure 7: Relative 2016 source energy use for homes and buildings by energy planning district (EPD) in Oakville. Darker coloured EPDs have relatively higher total source energy use.

The map in Figure 8 shows the projected relative total source energy use for homes and buildings in 2050 in Oakville by EPD. Darker coloured EPDs have relatively higher total source energy use.

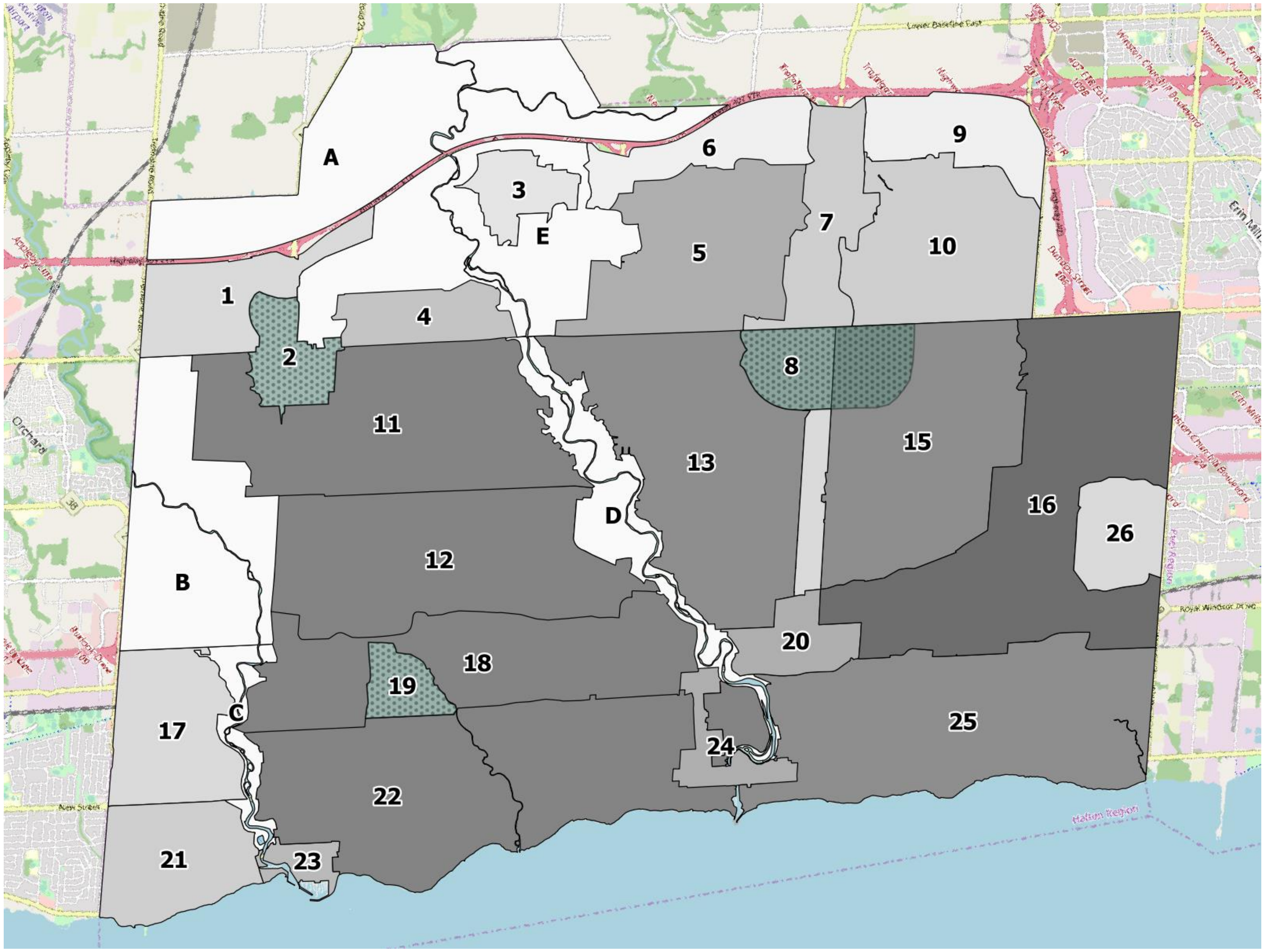

Figure 8: Projected relative 2050 source energy use for homes and buildings by energy planning district (EPD) in Oakville. Darker coloured EPDs have relatively higher total source energy use.

The map in Figure 9 shows the projected relative change in total source energy use from 2016 to 2050 in Oakville by EPD. Darker coloured EPDs are expected to see a higher level of change during this period.

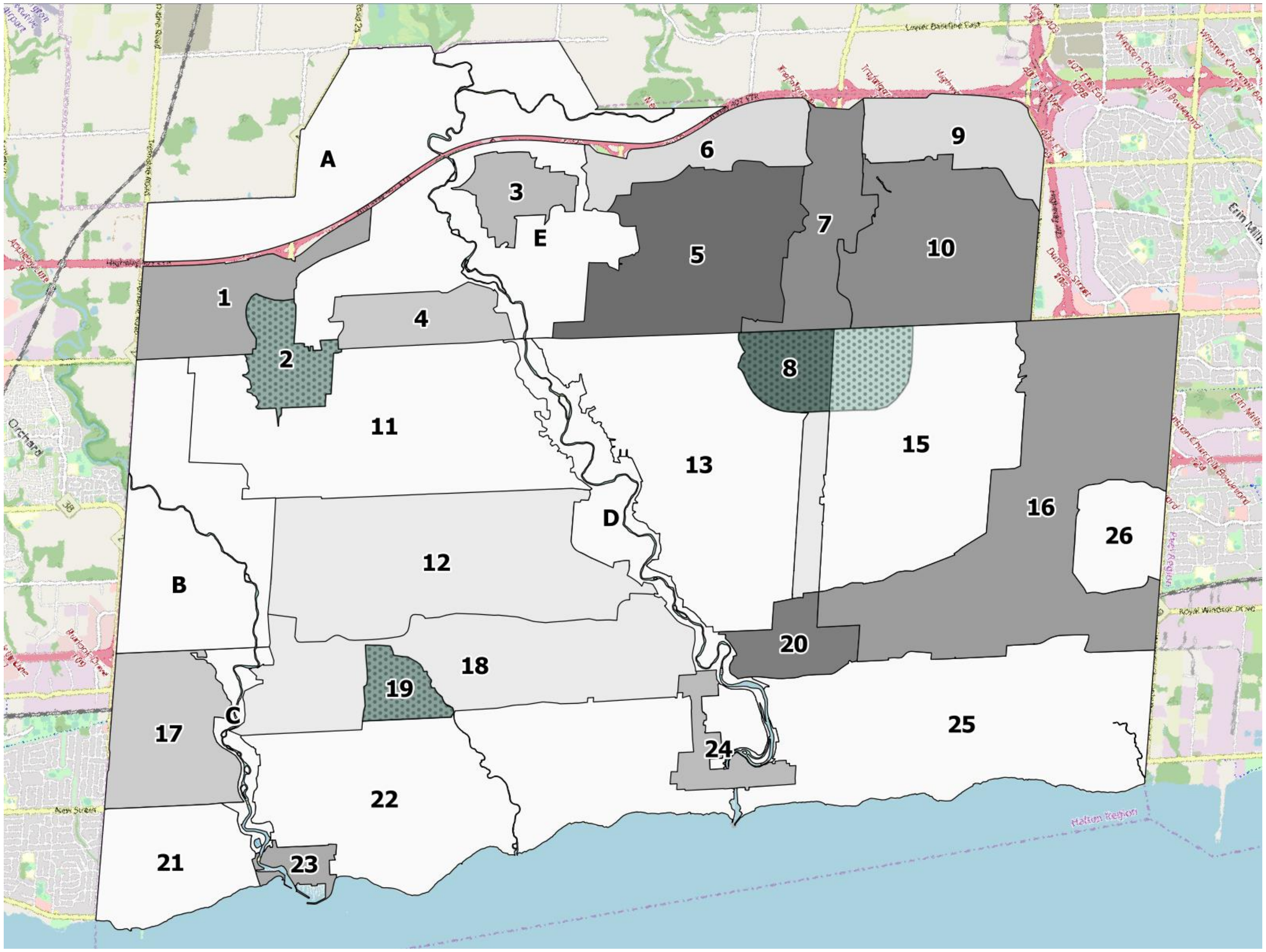

Figure 9: Relative increase in source energy use for homes and buildings from 2016 to 2050 by energy planning district (EPD) in Oakville. Darker coloured EPDs show greater change.

Site Energy Use

Total site energy use for Oakville in 2016 was 27 million GJ (or 132 GJ per person). The pie chart in Figure 10 shows site energy use for Oakville in 2016 by sector. Both the residential and transportations sectors represent approximately a third of total site energy use.

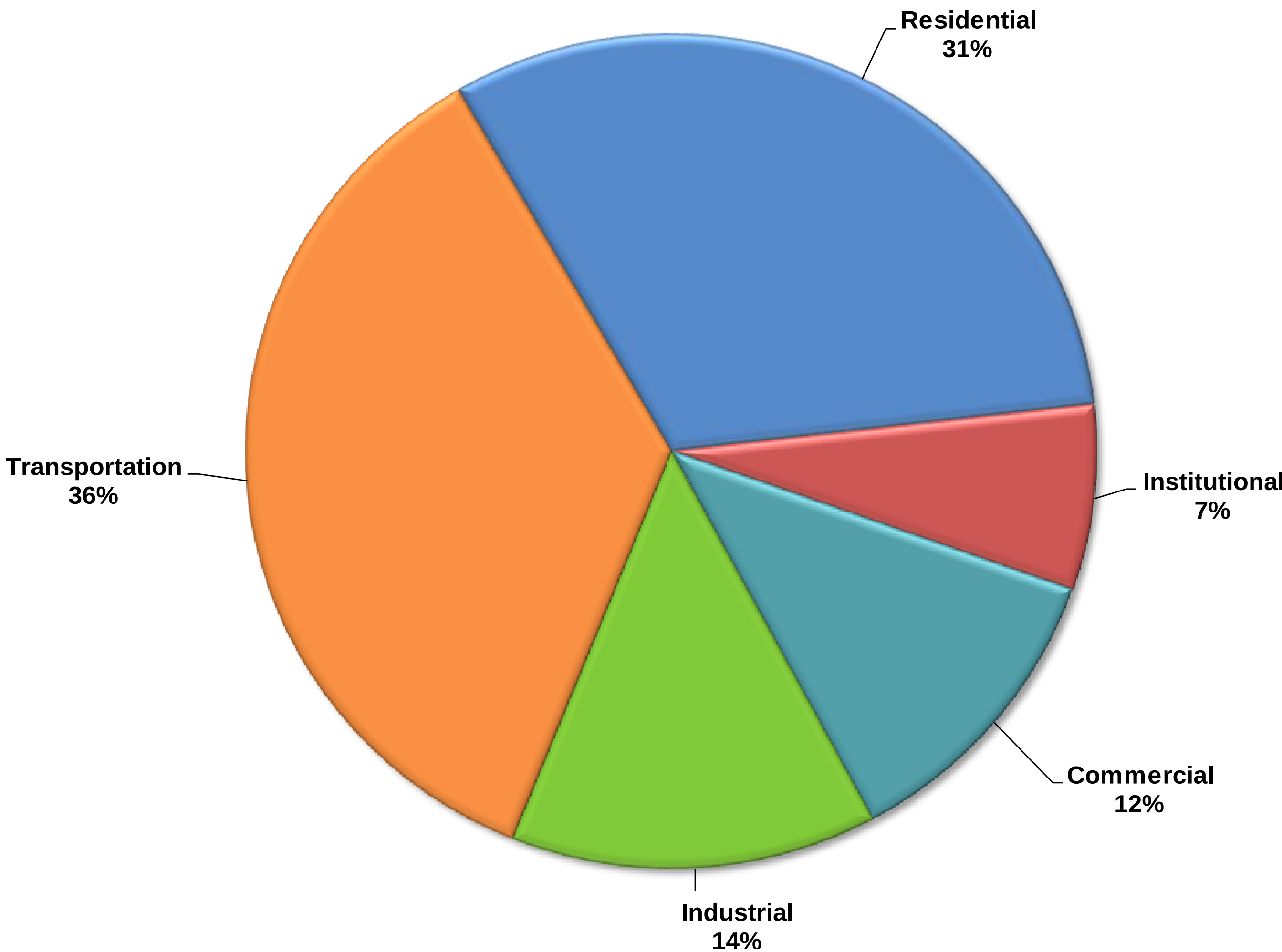

Figure 10: Oakville site energy use (%) by sector in 2016.

The pie chart in Figure 11 shows site energy use for Oakville in 2016 by utility. Natural gas represents the largest share of total site energy use (43%).

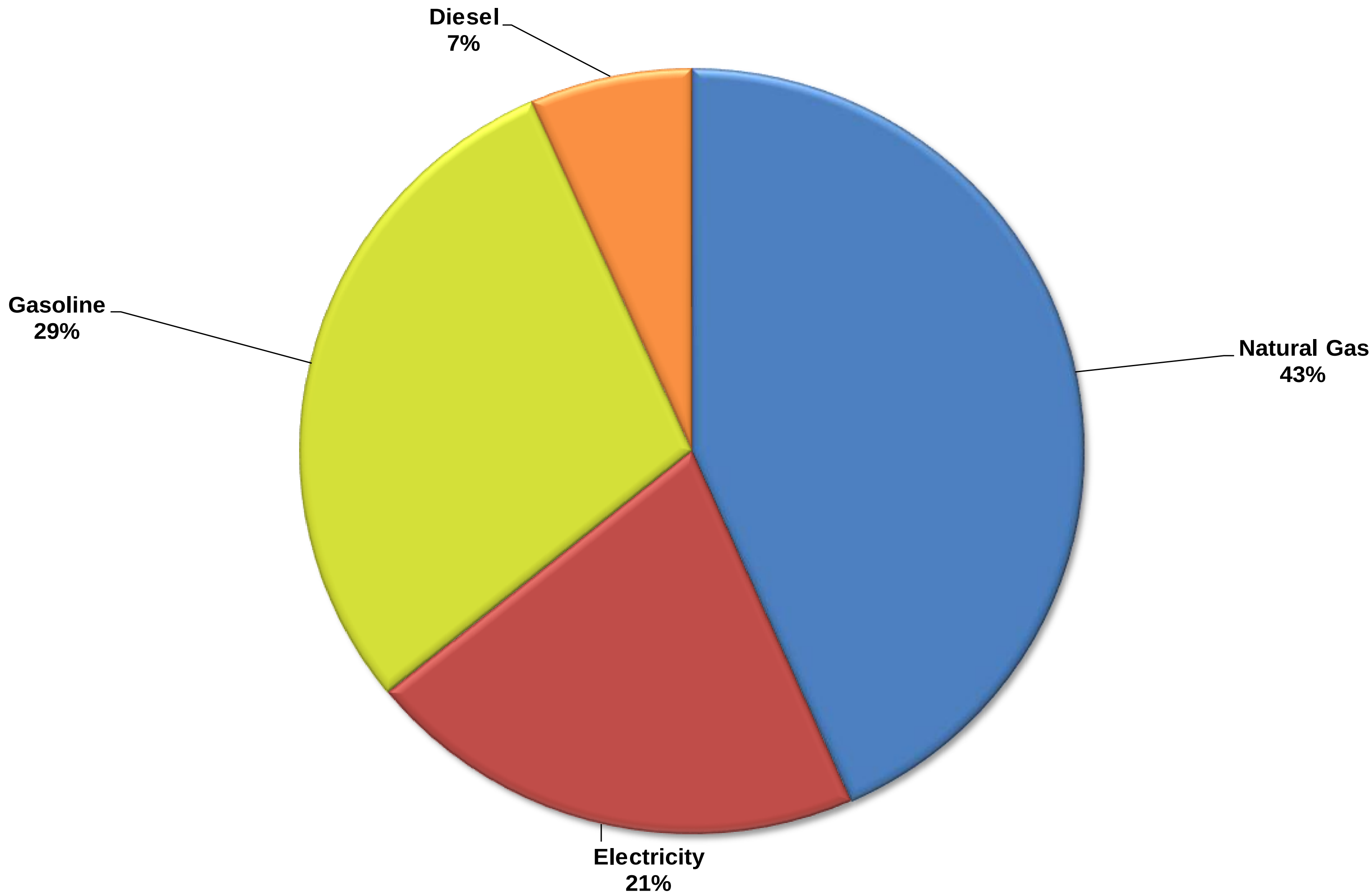

Figure 11: Oakville site energy use (%) by utility in 2016.

Annual site energy use in Oakville is projected to increase to 33,400,000 GJ by 2050. The graph in Figure 12 shows the projected increase in annual site energy use by sector from 2016 to 2050 in Oakville.

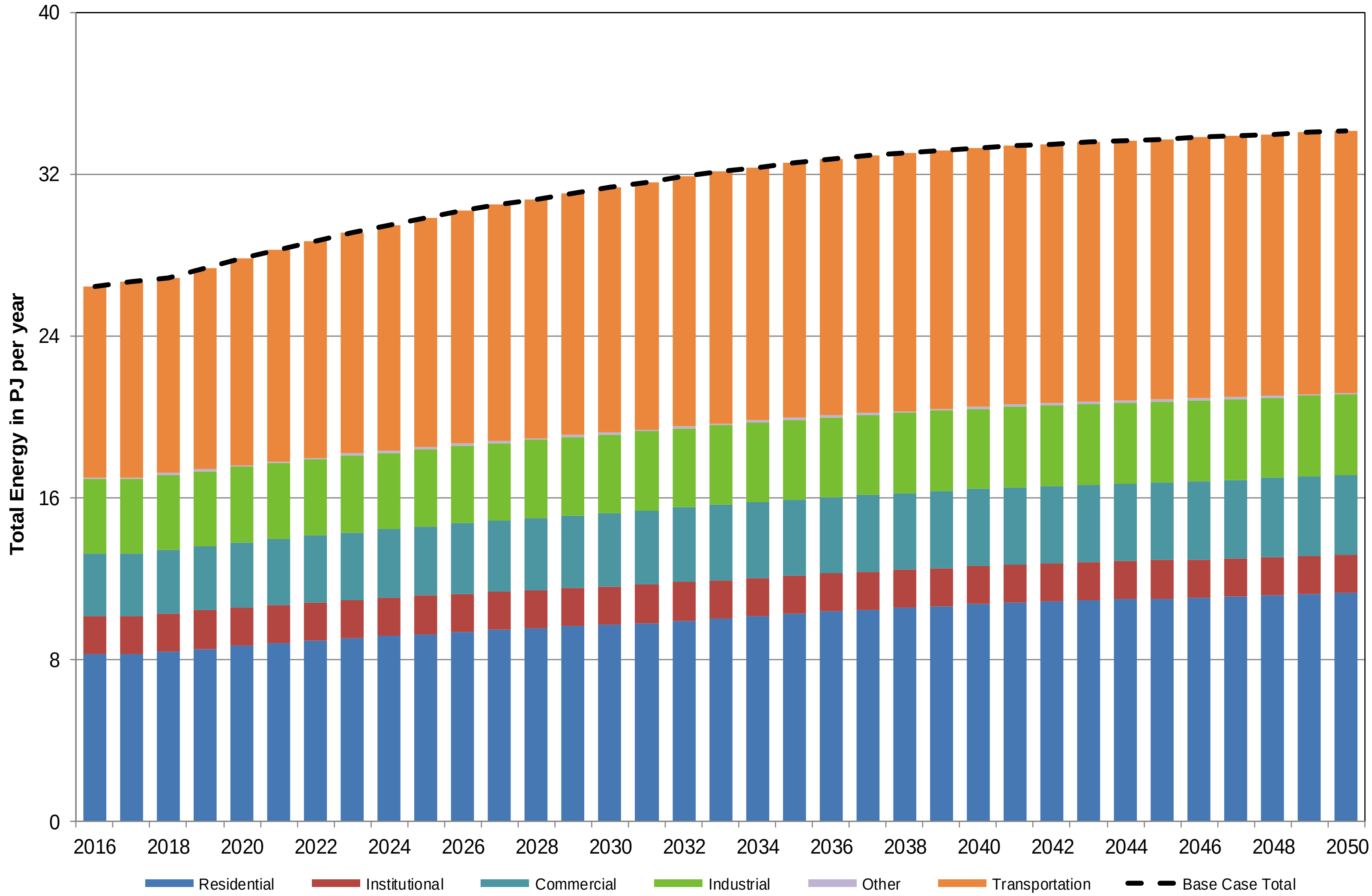

Figure 12: Projected increase in Oakville site energy use (PJ) by sector from 2016 to 2050.

The graph in Figure 13 shows the projected increase in annual site energy use by utility from 2016 to 2050 in Oakville.

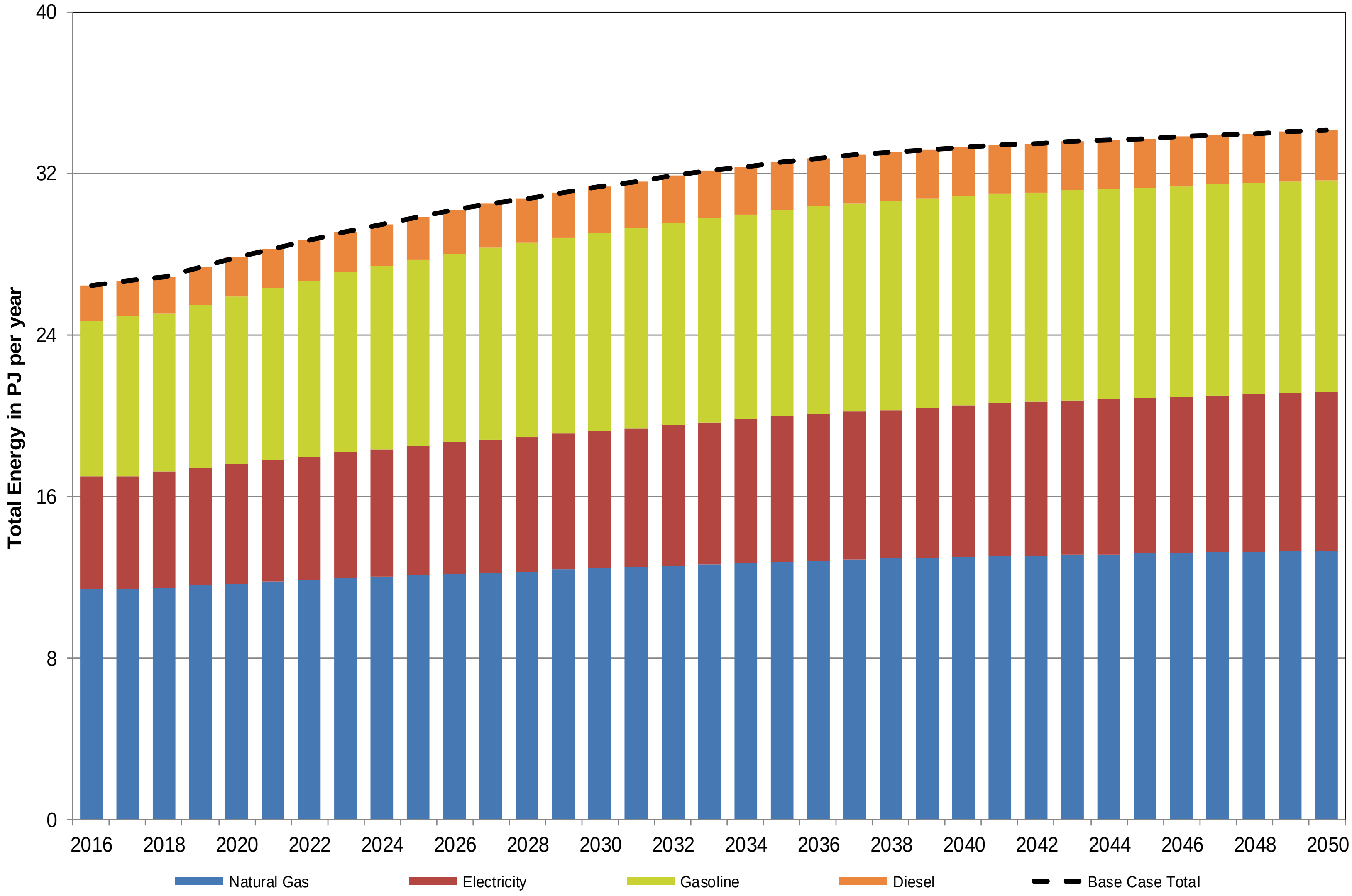

Figure 13: Projected increase in Oakville site energy use (PJ) by utility from 2016 to 2050.

Emissions

Greenhouse gas emissions for Oakville in 2016 were approximately 1.33 M tonnes in 2016 or 6.6 tonnes CO_{2e} per resident. The pie chart in Figure 14 shows Oakville emissions (%) by sector in 2016. The transportation represents approximately half of emissions. Oakville homes represent 27% of emissions.

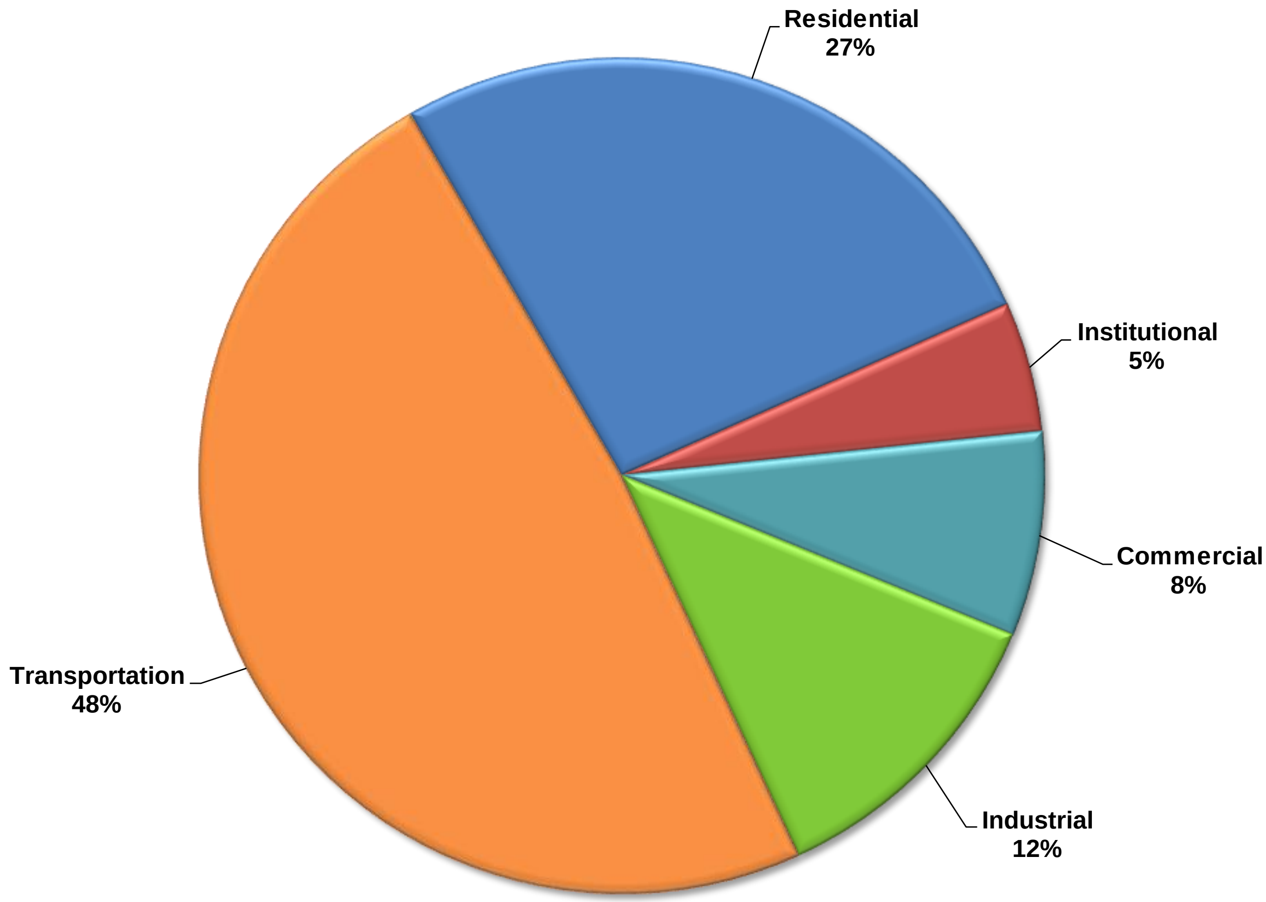

Figure 14: Oakville greenhouse gas emissions (%) by sector in 2016.

The pie chart in Figure 15 shows Oakville emissions (%) by utility in 2016.

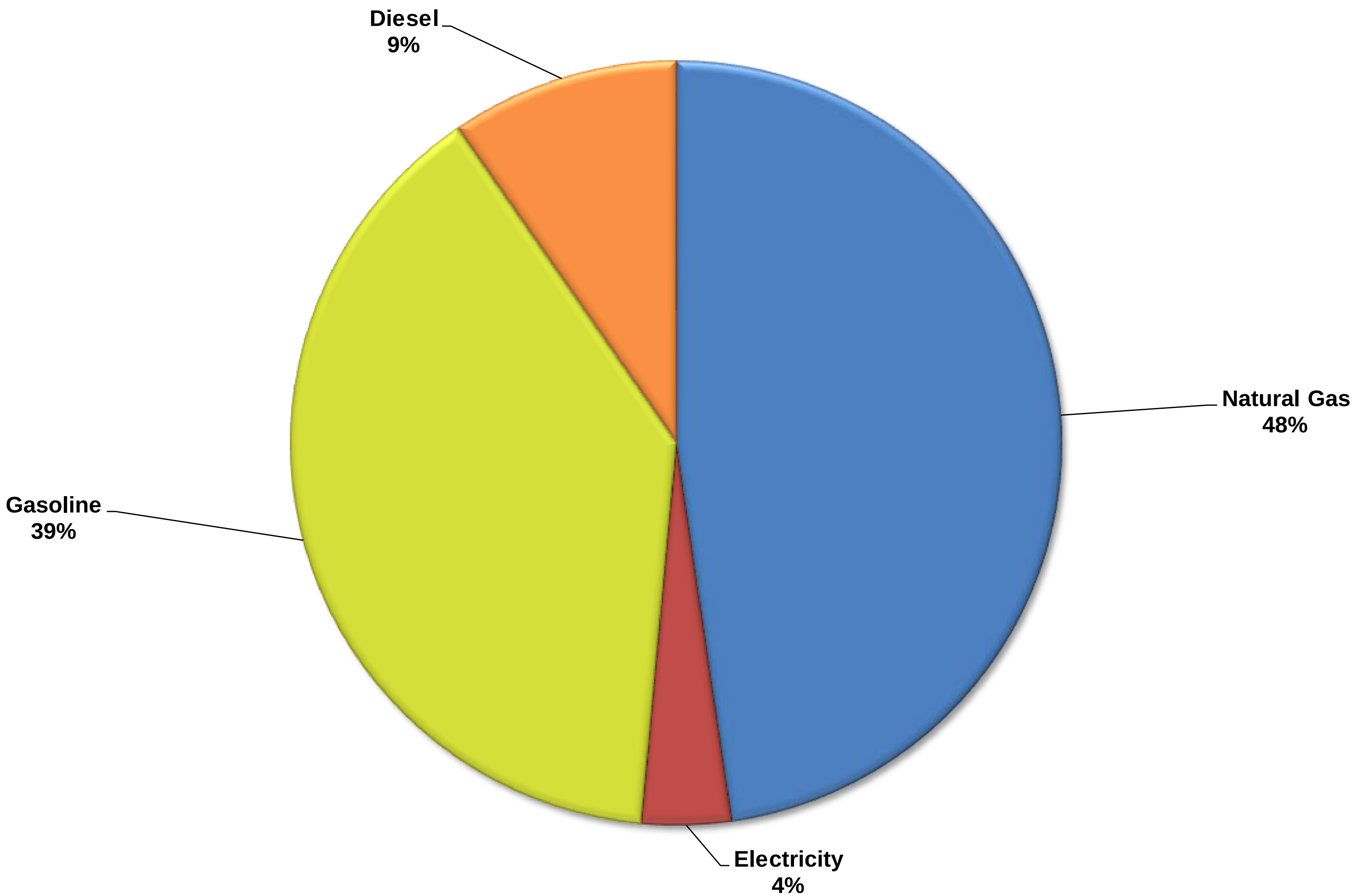

Figure 15: Oakville greenhouse gas emissions (%) by utility in 2016.

Annual emissions are projected to increase to 1,415,000 million tonnes in Oakville by 2050. This represents 5 tonnes/capita in 2050. The graph in Figure 16 shows the projected profile of annual emissions by sector in Oakville from 2016 to 2050.

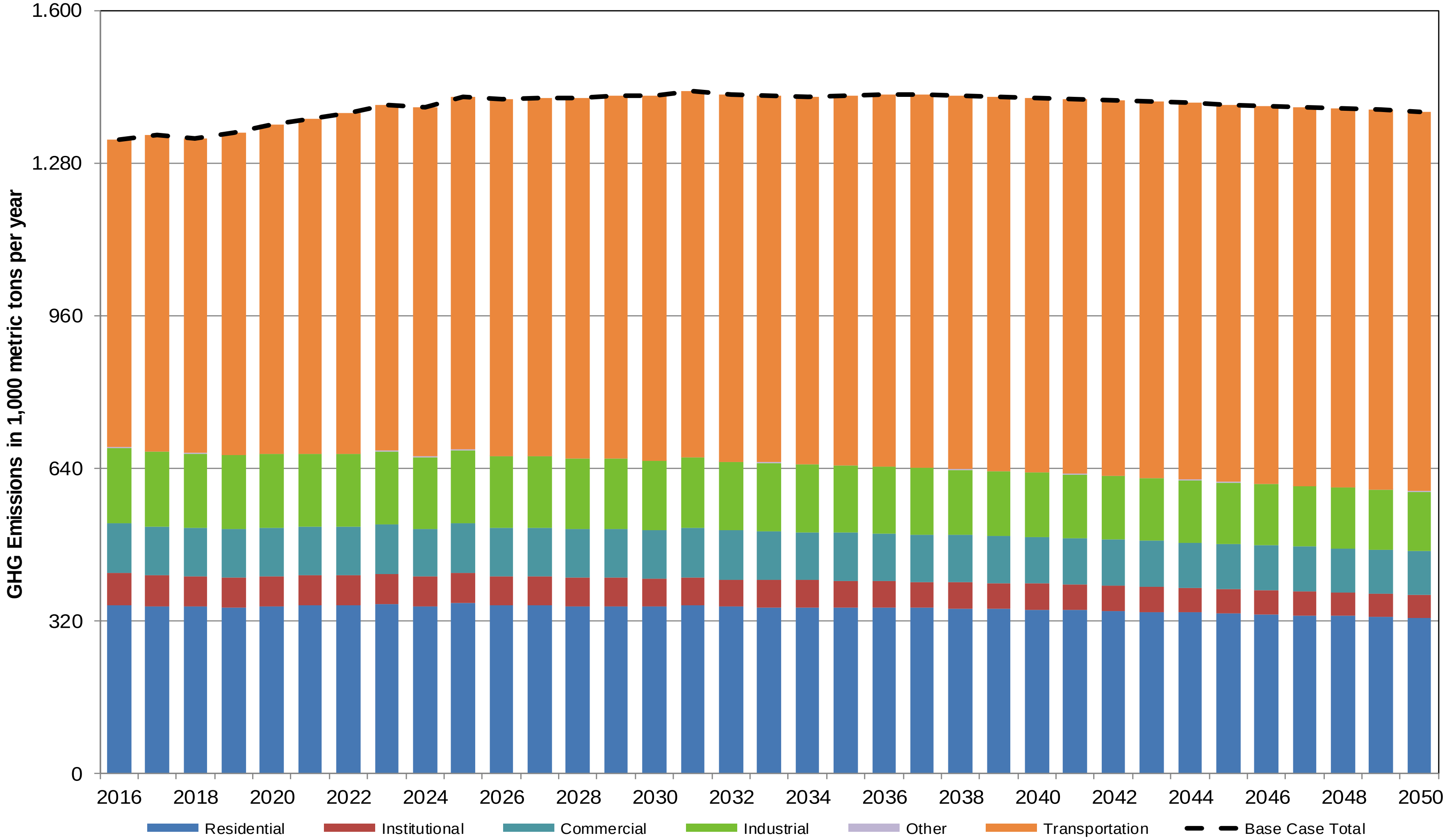

Figure 16: Projected Oakville greenhouse gas emissions profile by sector from 2016 to 2050.

The graph in Figure 16 shows the projected profile of annual emissions by utility in Oakville from 2016 to 2050.

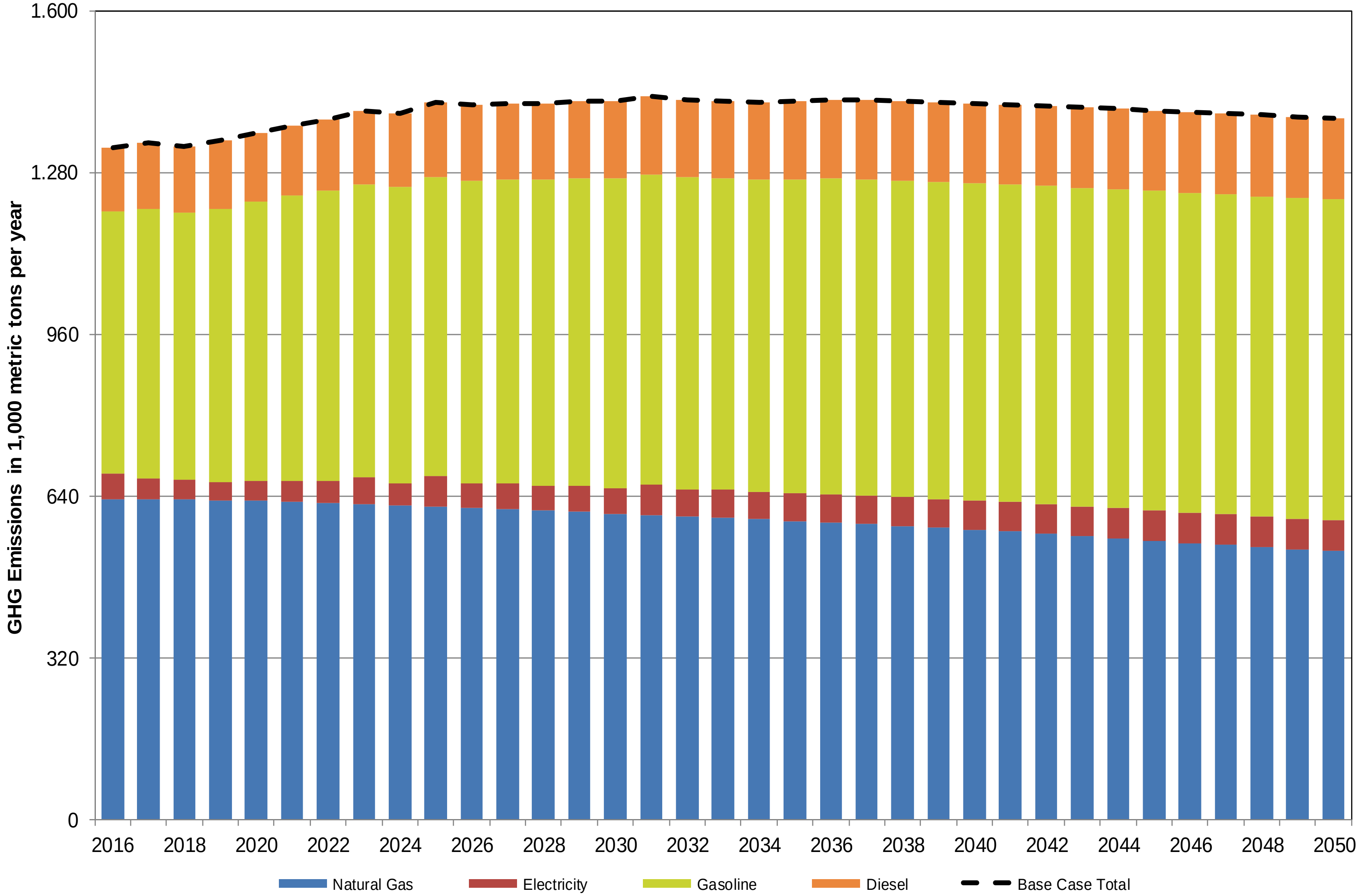

Figure 17: Projected Oakville greenhouse gas emissions profile by utility from 2016 to 2050.

The map in Figure 18 shows the relative emission intensity (tonnes/km²) for homes and buildings in Oakville by EPD in 2016. Darker coloured EPDs have a relatively higher emission intensity.

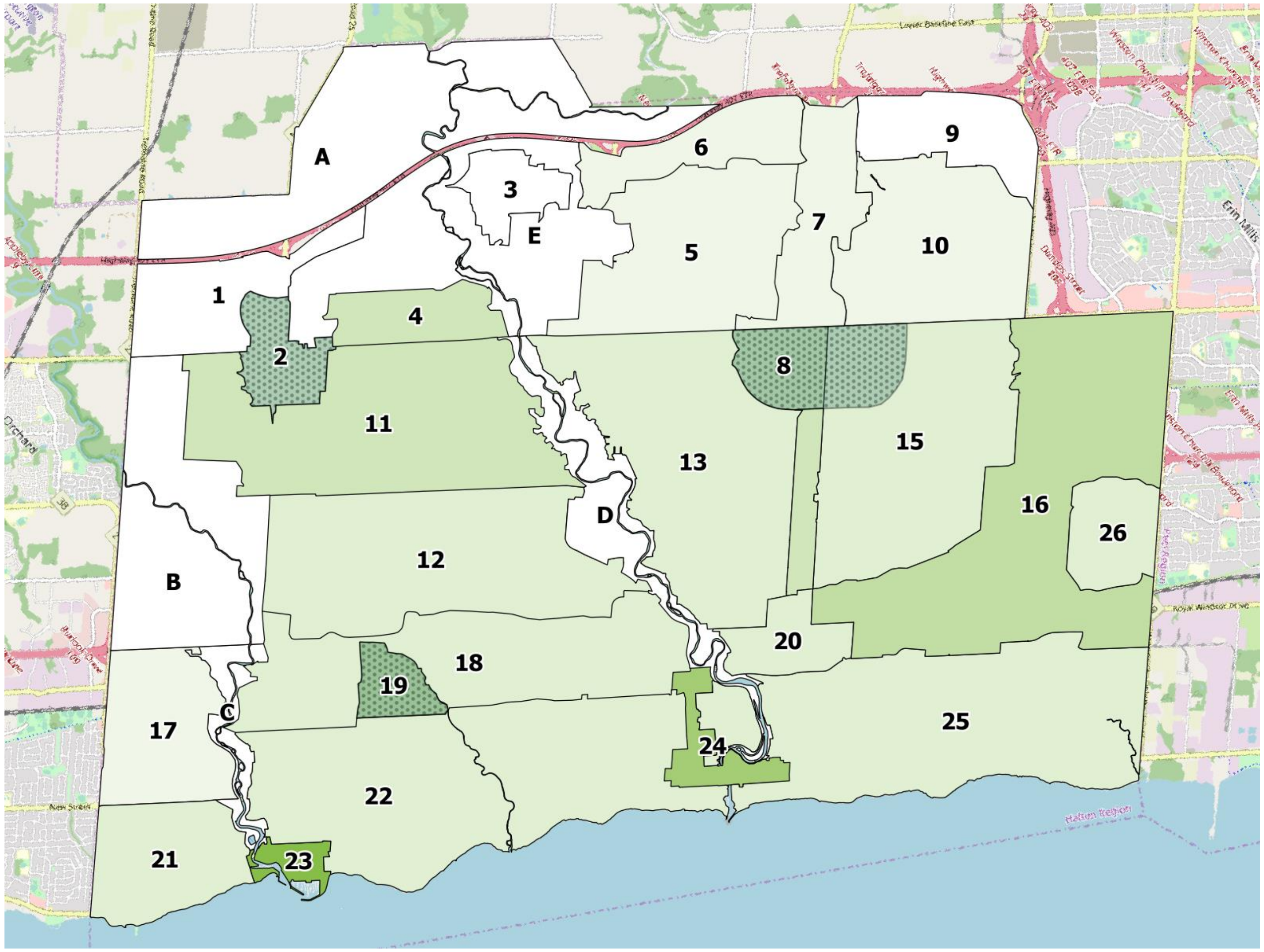

Figure 18: Relative green house gas emission intensity (tonnes/km²) for homes and buildings in Oakville by EPD in 2016. Darker coloured EPDs have a relatively higher emission intensity.

Figure 19 shows the projective relative emission intensity (tonnes/km^2) for homes and buildings in Oakville by EPD in 2050. Darker coloured EPDs have a relatively higher emission intensity.

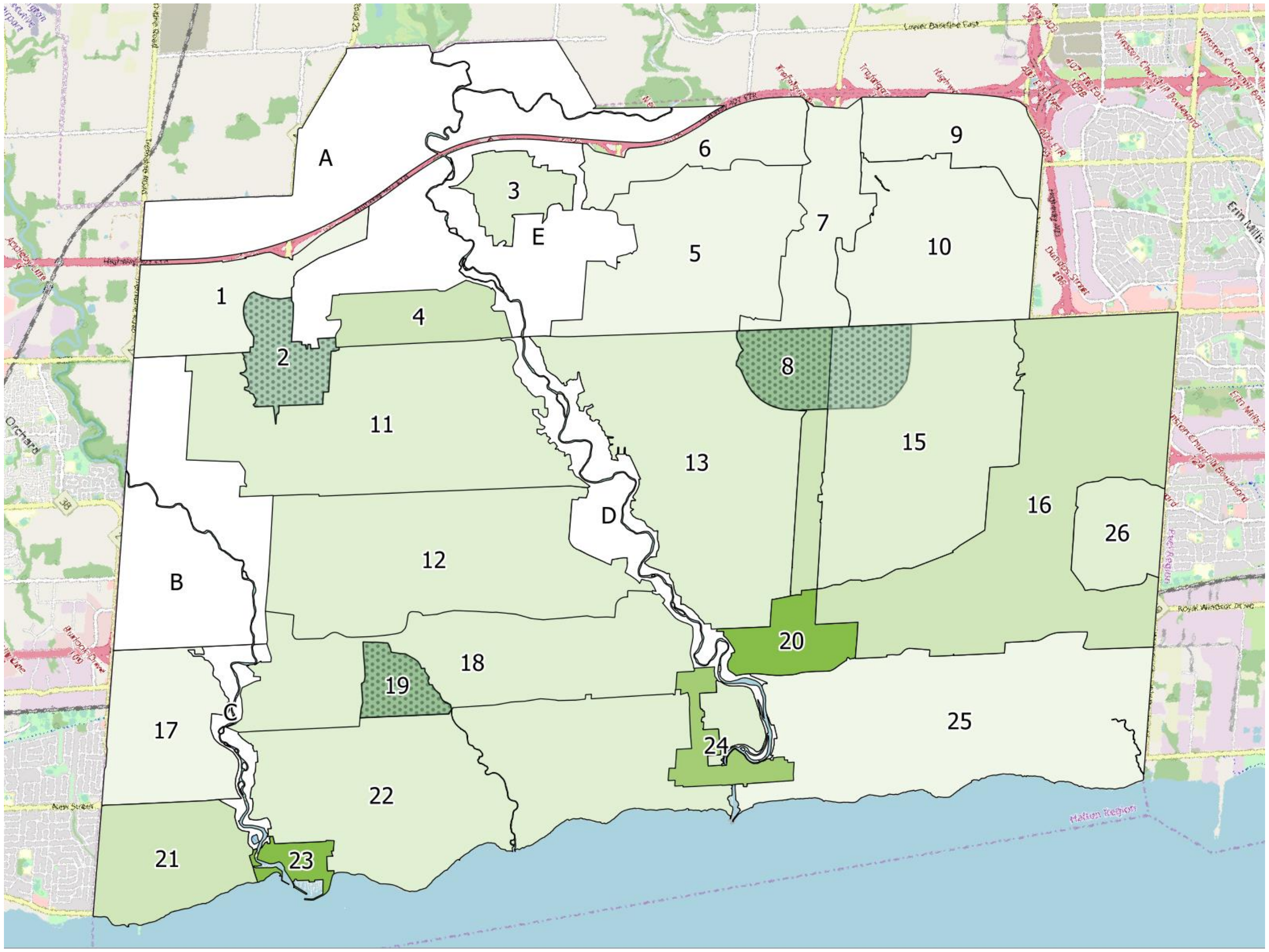

Figure 19: Projected relative greenhouse gas emission intensity (tonnes/km^2) for homes and buildings in Oakville by EPD in 2050. Darker coloured EPDs have a relatively higher emission intensity.

The map in Figure 20 shows the relative change in emission intensity (tonnes/km^2) for homes and buildings in Oakville by EPD from 2016 to 2050. Red indicates an increase in intensity, green represents a decrease in energy intensity and orange represents no change. Darker shades of each colour indicate a larger change over the time period.

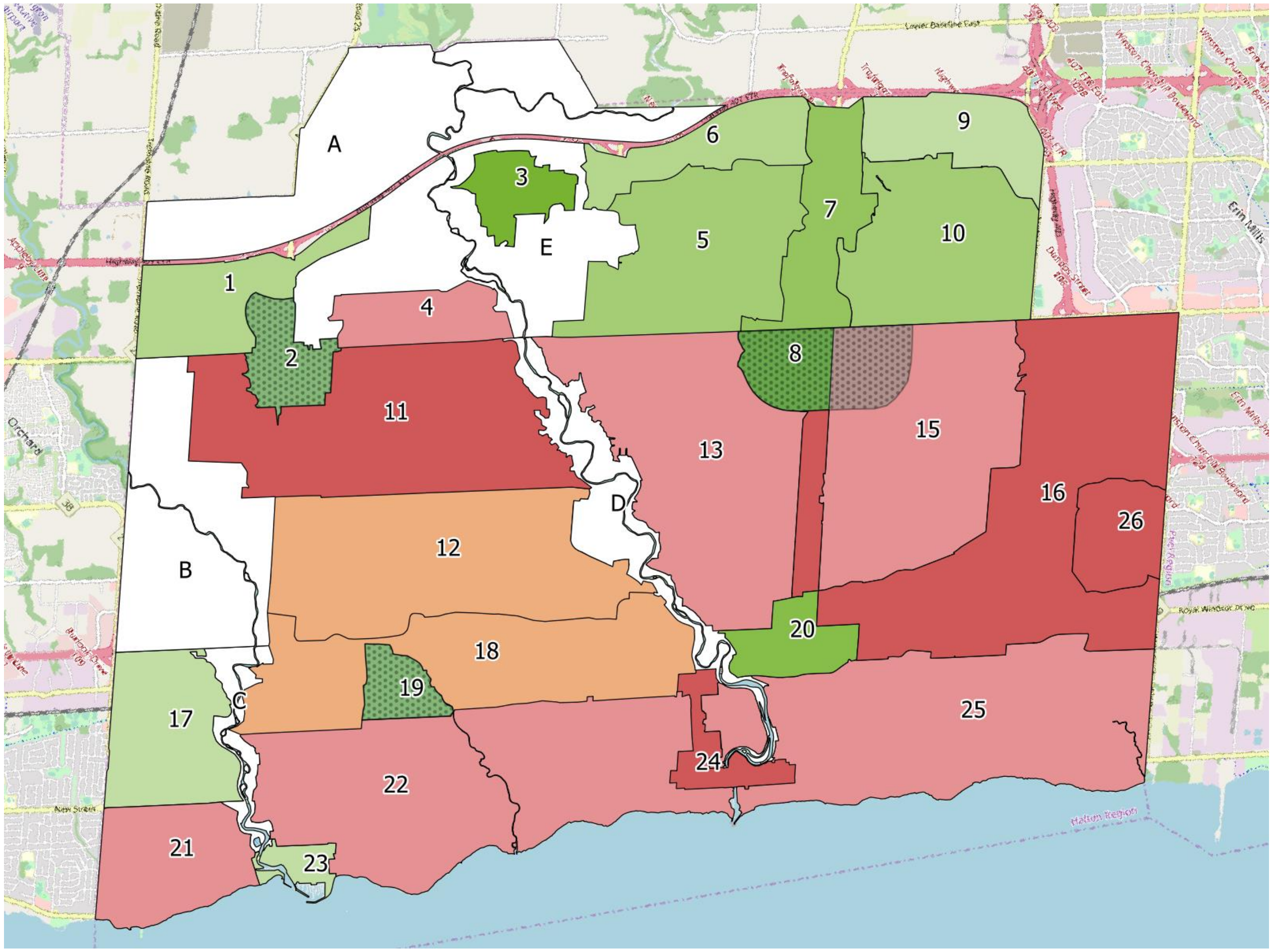

Figure 20: Projected relative change in greenhouse gas emission intensity (tonnes/km^2) for homes and buildings in Oakville by energy planning district from 2016 to 2050. Red indicates an increase in intensity, green represents a decrease in energy intensity and orange represents no change. Darker shades of each colour indicate a larger change over the time period.

Energy Cost

The cost of energy for Oakville was approximately $620 million in 2016 with approximately $490 million leaving the community. The pie chart in figure 21 shows energy costs (%) by sector for Oakville in 2016. Transportation accounts for almost half of Oakville's energy costs. Homes account for almost a quarter of energy costs.

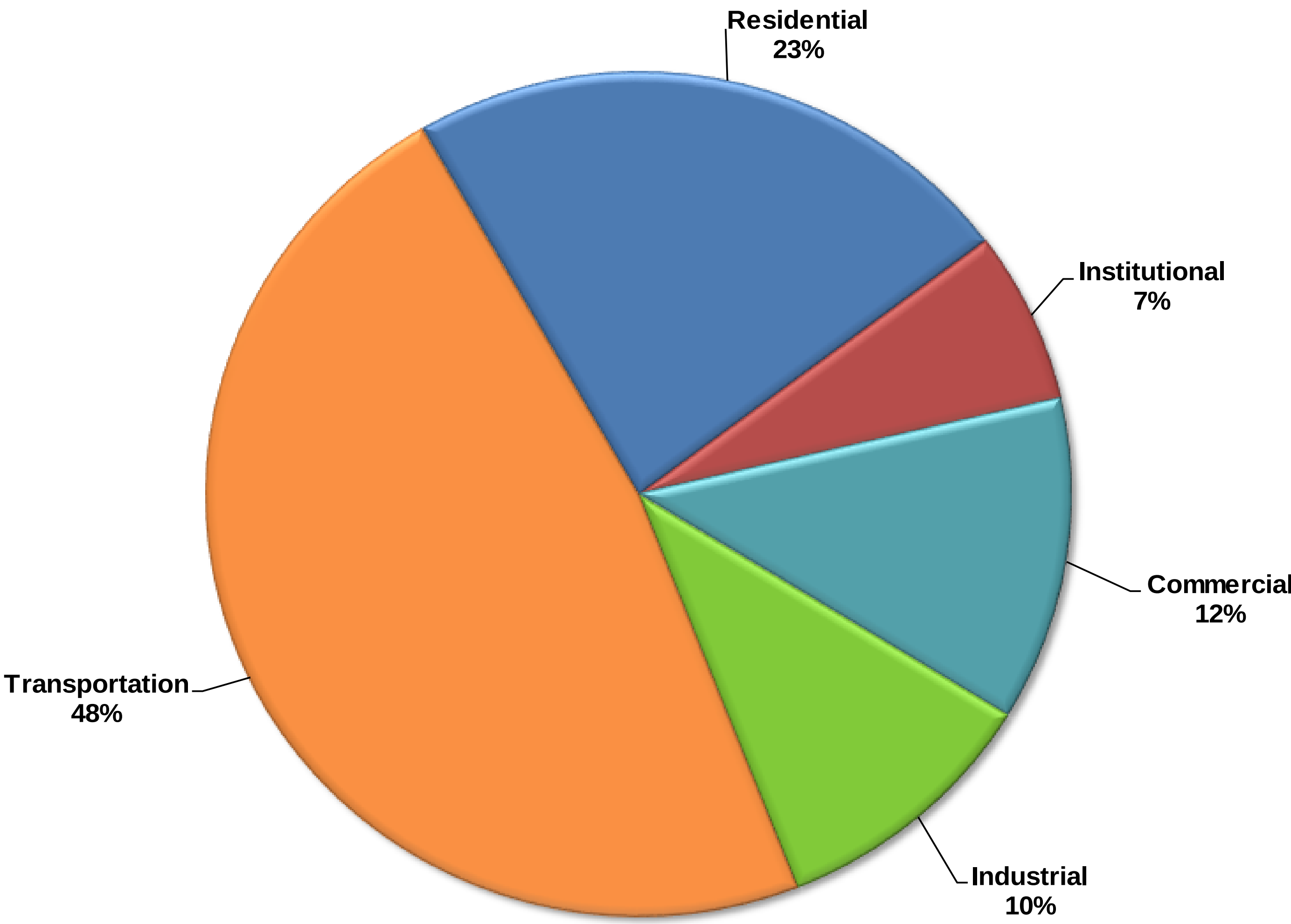

Figure 21: Oakville energy costs (%) by sector in 2016.

The pie chart in Figure 22 shows energy costs (%) by utility for Oakville in 2016.

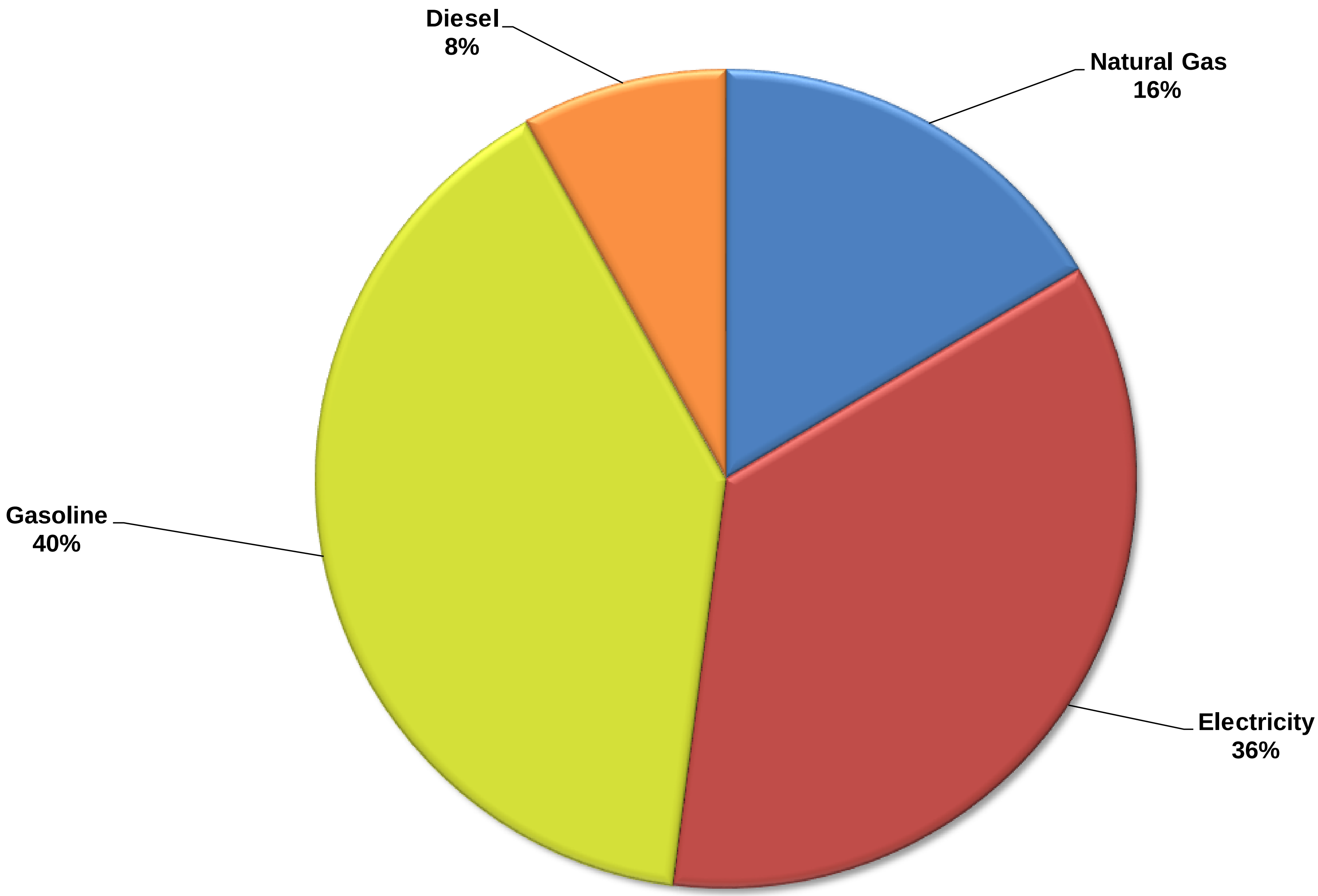

Figure 22: Oakville energy costs (%) by utility in 2016.

Energy costs in Oakville are projected to increase to $2.5 billion by 2050 under a lower range of cost projections. The graph in Figure 23 shows the annual projected increases to energy costs in Oakville from 2016 to 2050 by fuel type (including carbon) under the lower range of cost projections.

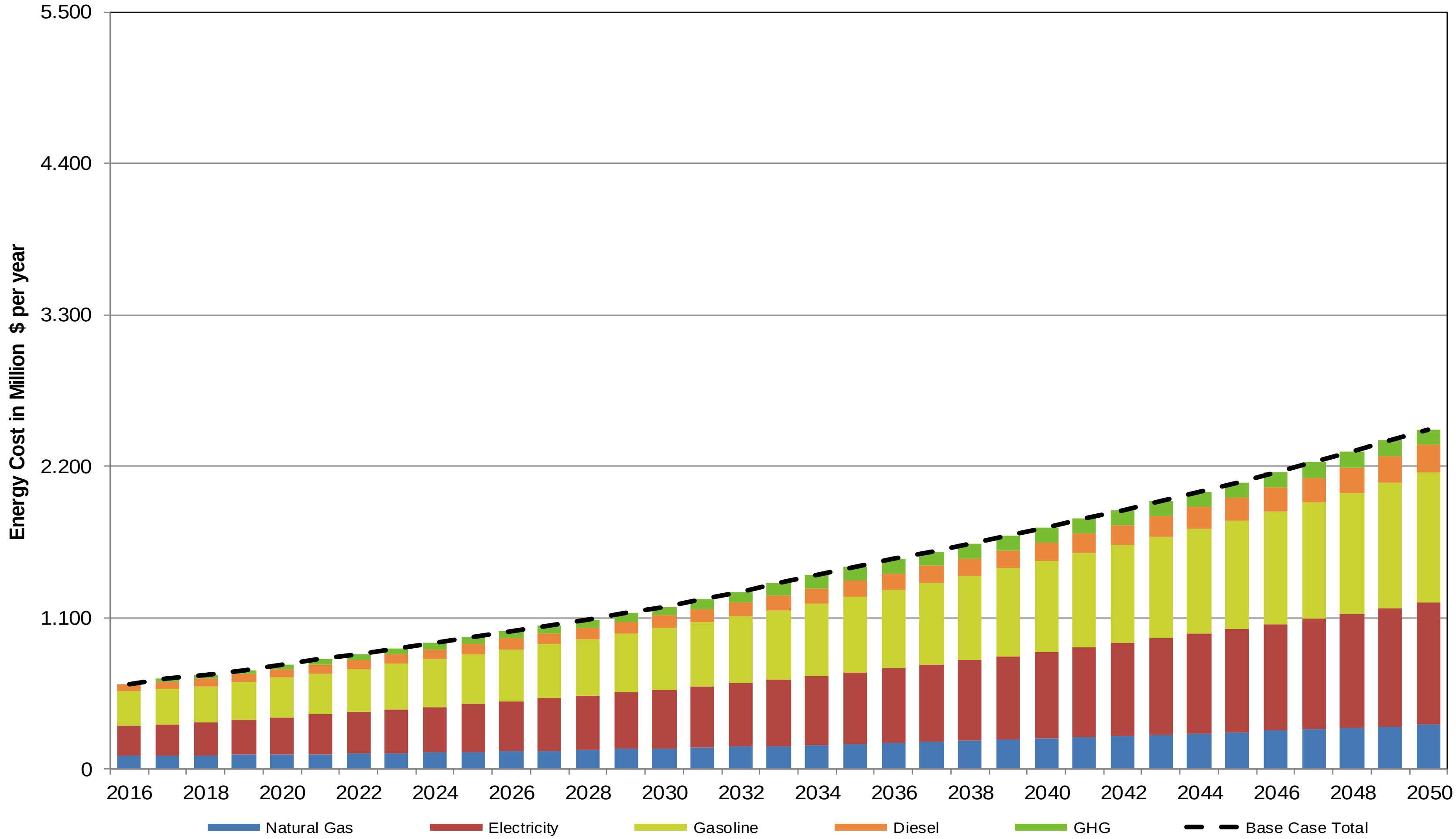

Figure 23: Annual projected increases to energy costs ($) in Oakville from 2016 to 2050 by fuel type (including carbon) under the lower range of cost projections.

Annual energy costs in Oakville are projected to increase to $5.0 billion by 2050 using a higher range of cost projections. The graph in Figure 24 shows the annual projected increases to energy costs in Oakville from 2016 to 2050 by fuel type (including carbon) under the higher range of cost projections.

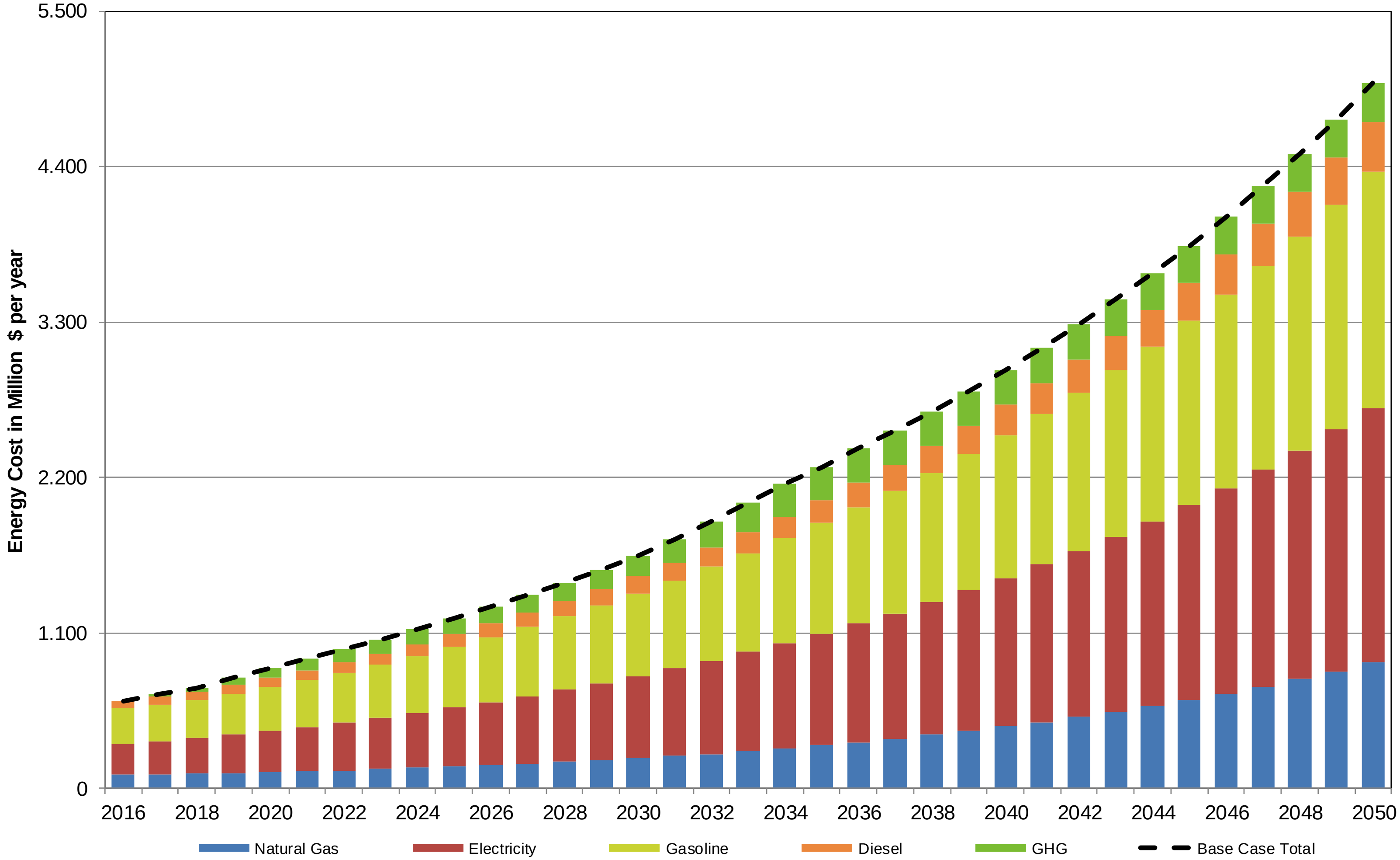

Figure 27: Annual projected increases to energy costs ($) in Oakville from 2016 to 2050 by fuel type (including carbon) under the higher range of cost projections.

Appendix 4 – Scenario 3 Simulation Assumptions

Appendix 4 provides details on the assumptions used for the Scenario 3 for the Reference and High Action Efficiency Case simulations. Simulation results are found in Appendix 5.

Contents

Overview

The next section provides details of:

- the measures simulated;
- the variable(s) chosen for the Reference Case simulation for each measure by the Project Working Team (PWT); and
- the variables that could be modified for each measure which were considered by the PWT.

Scenario 3 – Reference Efficiency Case Simulation Variables

Efficiency of existing homes and buildings

- Measure
  - most property to be retrofitted by 2041
- Reference Case variables
  - 80% of homes
  - 60% of buildings
  - efficiency gain approximately 30% / retrofit
- Simulation variables
  - market share
  - start and completion date
  - up to 25% more efficient retrofits

Efficiency of existing homes and buildings

- Measure:
  - new property 100% OBC compliant
- Reference Case variables
  - 1% above code to 2021
  - code increases of 10% in 2022 and 2032
- Simulation variables
  - 1% to 10% for each code change
  - years of code changes

Efficiency of industry

- Measure:
  - world-class continuous improvement
- Reference Case variables
  - 1% per year
- Simulation variables
  - 0% to 2% in 0.5% steps

District energy in existing and new areas & efficient local heat and electricity generation

- Measure:
  - implement district heating (DH) in target energy planning districts (EPDs)
- Reference Case variables
  - 70% of existing target property by 2041
  - 80% for new target property in year built
  - DH start in 2022
  - combined heat and power (CHP) implemented in 2023
  - EPDs 1,4,8,13,14,19,20,24 were identified by the PWT for densification based on Town plans.
  - EPDs 2,3,5,6,7,9,10 were identified by the PWT for net zero development based on Town plans
- Simulation variables
  - shares from 40% to 90%
  - DH and CHP start year from 2021 to 2027
  - EPD selection
  - technical efficiencies – various

Renewable solar heat and electricity generation

Heat

- Measure
  - solar thermal on residential property not served by DE
- Reference Case variables
  - 10% share on target home heating and domestic hot water by 2041
- Simulation variables
  - share from 0% to 25%
  - implementation year

Electricity Generation

- Measure
  - solar PV on suitable rooftops and other locations
- Reference Case
  - 120 MW installed
  - Allocated by EPD power needs
- Simulation variables
  - Up to 180 MW in 30 MW steps

Transportation mix and efficiency

Trip length

- Measure
  - reduce average trip length
- Reference Case variables
  - 5% light-duty vehicle (LDV) trip length reduction
  - most impact in later years
- Simulation variables
  - up to 15% trip length reduction
  - vehicle category selectable

Modality

- Measure
  - increase active and shared transportation modes
- Reference Case variables
  - GO Train travel is 15% of person kilometers travelled (PKT) by 2051
  - Transit increase to 10% of PKT
  - Active transportation increases to 10% PKT
  - Most impact in later years
- Simulation variables
  - up to 20% mode share
  - vehicle category selectable

Fuel and Efficiency

- Measure
  - migrate to more efficient low-carbon vehicles
- Reference Case
  - LDVs & transit are 30% electric by 2051
  - heavy-duty vehicles (HDV) are 10% electric by 2051
  - liquid fuel vehicles achieve a 2% per annum efficiency gain
  - electric vehicles achieve a 1% per annum efficiency gain
  - linear year-to-year impact
- Simulation variables
  - up to 60% electric share
  - share selectable by major vehicle category
  - efficiency gains by vehicle type and fuel

Ontario electricity grid generating mix and natural gas network source mix

- Measure
  - anticipate lower carbon utilities

- Reference Case
    - electricity estimates used those of The Atmospheric Fund (TAF)
    - natural gas assumed a 1% per annum reduction
- Simulation variables
    - up to a 2% per annum reduction in natural gas

Scenario 3 – High-action Efficiency Case Simulation Variables

The following were the changes to the simulation variables:

- Existing home & building efficiency
    - increase share of retrofits to 90% with 20% more efficient packages
- New home & building efficiency
    - encourage 5% efficiency above Ontario Building Code
- Industrial efficiency
    - encourage all industry meet global-best practice of 1.5% per year
- District heating
    - increase market shares to near 100% and accelerate use of latest combined heat and power (CHP) technologies
- Solar thermal
    - double targeted share to 20%
- Solar PV
    - increase total installed capacity to 150 megawatt (MW)
- Transportation energy
    - encourage even greater use of electric vehicles and mass transit
    - design neighbourhood and policy even more intensively to encourage walking cycling and light-duty electric vehicles

Appendix 5 – Efficiency Case Performance

This appendix provides additional information on the performance of the OETF-endorsed Reference Efficiency Case, as well as the High Action Efficiency Case.

Contents

Background

The three scenarios were tested:

- Scenario 1
  - All end-use efficiency measures including transportation measures
- Scenario 2
  - All end-use efficiency measures including transportation measures
  - District heating
  - Solar thermal
- Scenario 3
  - All end-use efficiency measures including transportation measures
  - District heating
  - Solar thermal
  - Solar PV

Scenarios were simulated under three implementation regimens:

- low action
- reference
- high action

In addition to energy and emission reductions, the energy savings that would flow to the community were also estimated using a low and high price range.

Given the poor performance of Scenarios 1 and 2, the PWT eliminated these two scenarios from detailed consideration.

In addition, given the poor performance of Scenario 3 under the low action implementation regimen, it was also eliminated from detailed consideration.

Scenario 3 Reference Efficiency Case

The graph in Figure 1 shows the reduction in source energy use (Gigajoules (GJ)/capita) from 2016 to 2050 relative to the Base Case (dotted line) for Scenario 3 using the reference implementation regimen.

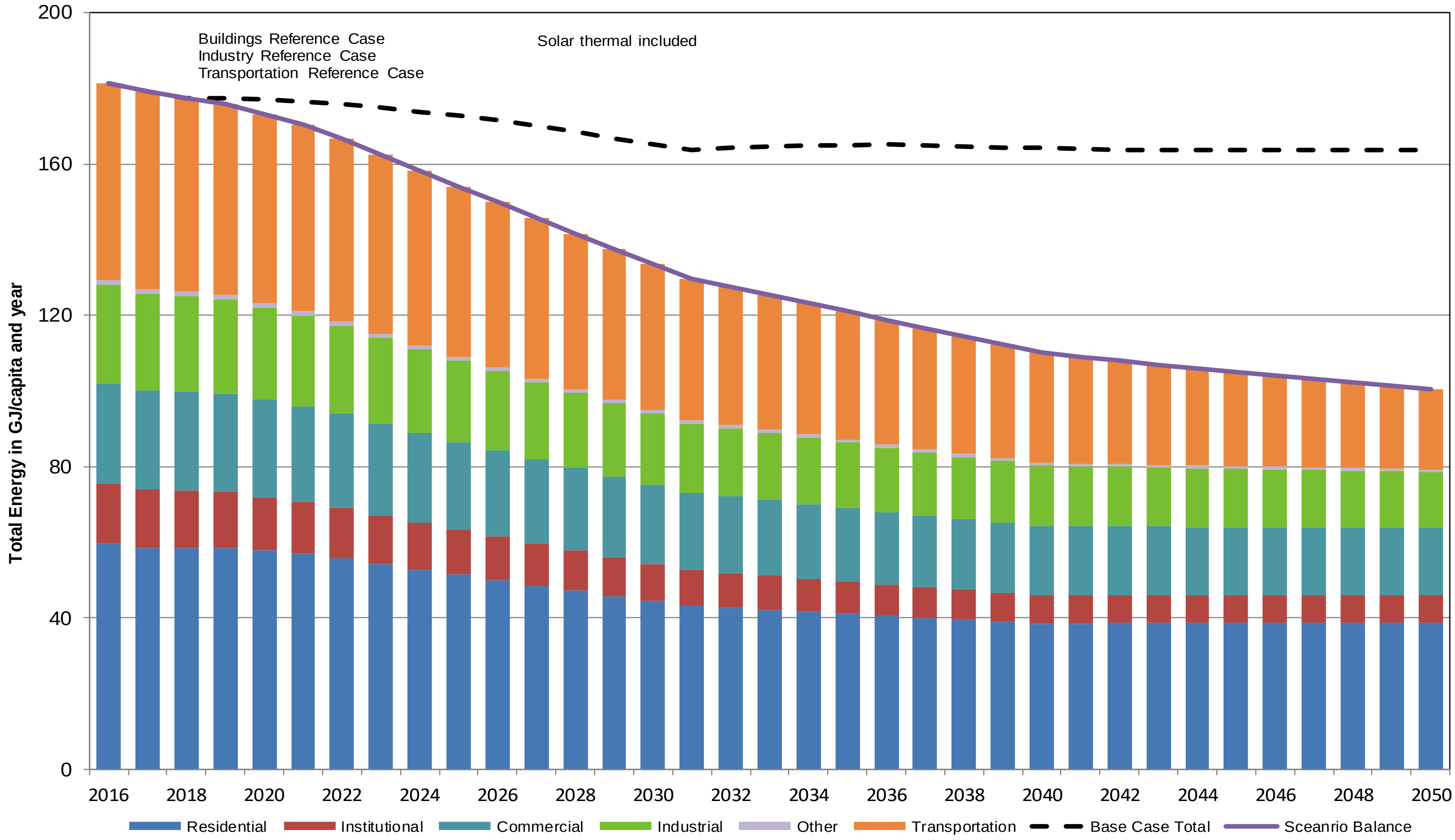

Figure 1: Projected reduction in source energy efficiency (GJ/capita) by sector from 2016 to 2050 for Scenario 3 using the reference implementation regimen.

The graph in Figure 2 shows the performance of the three scenarios in reducing source energy use (GJ/capita) from 2016 to 2050 relative to the Base Case (black solid line) using the reference implementation regimen.

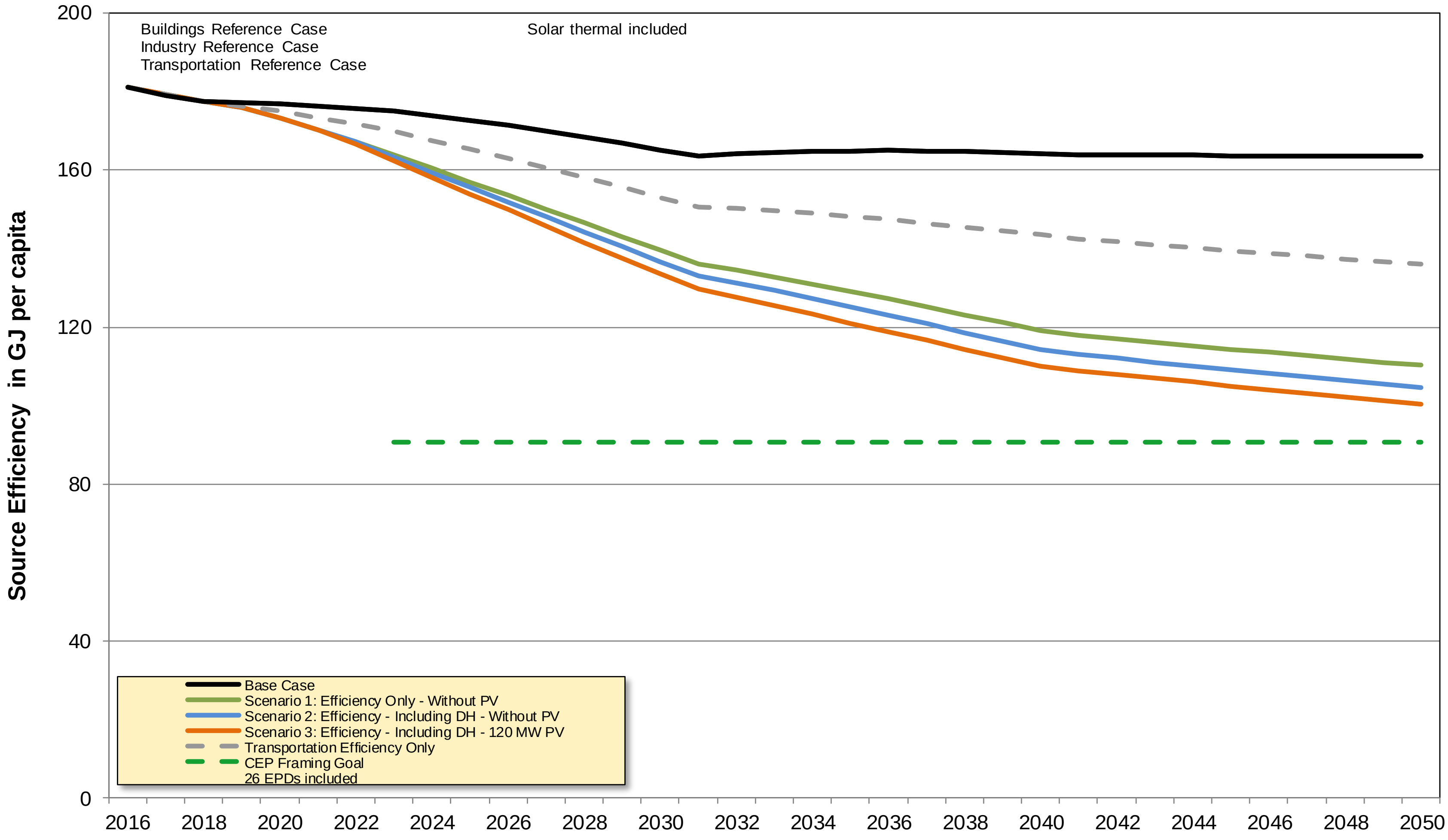

Figure 2: Projected reduction in source energy use (GJ/capita) by scenario from 2016 to 2050 using the reference implementation regimen.

The graph in Figure 3 shows the reduction in emissions (metric tons/year) from 2016 to 2050 relative to the Base Case (dotted line) for Scenario 3 using the reference implementation regimen.

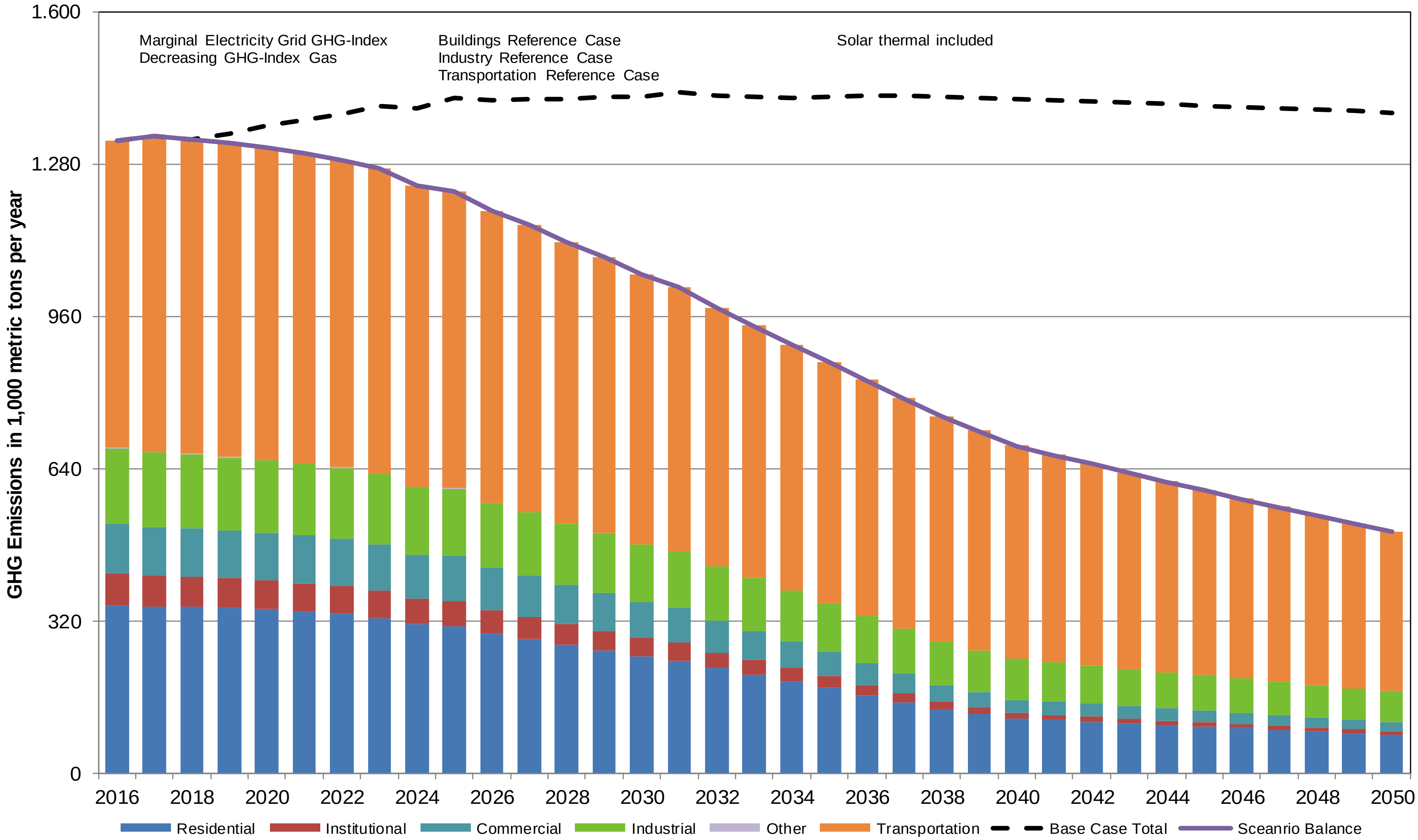

Figure 3: Projected reduction in greenhouse gas emissions (metric ton/year) by sector from 2016 to 2050 for Scenario 3 using the reference implementation regimen.

The graph in Figure 4 shows the performance of the three scenarios in reducing emissions (metric tons/year) from 2016 to 2050 relative to the Base Case (solid black line) using the reference implementation regimen.

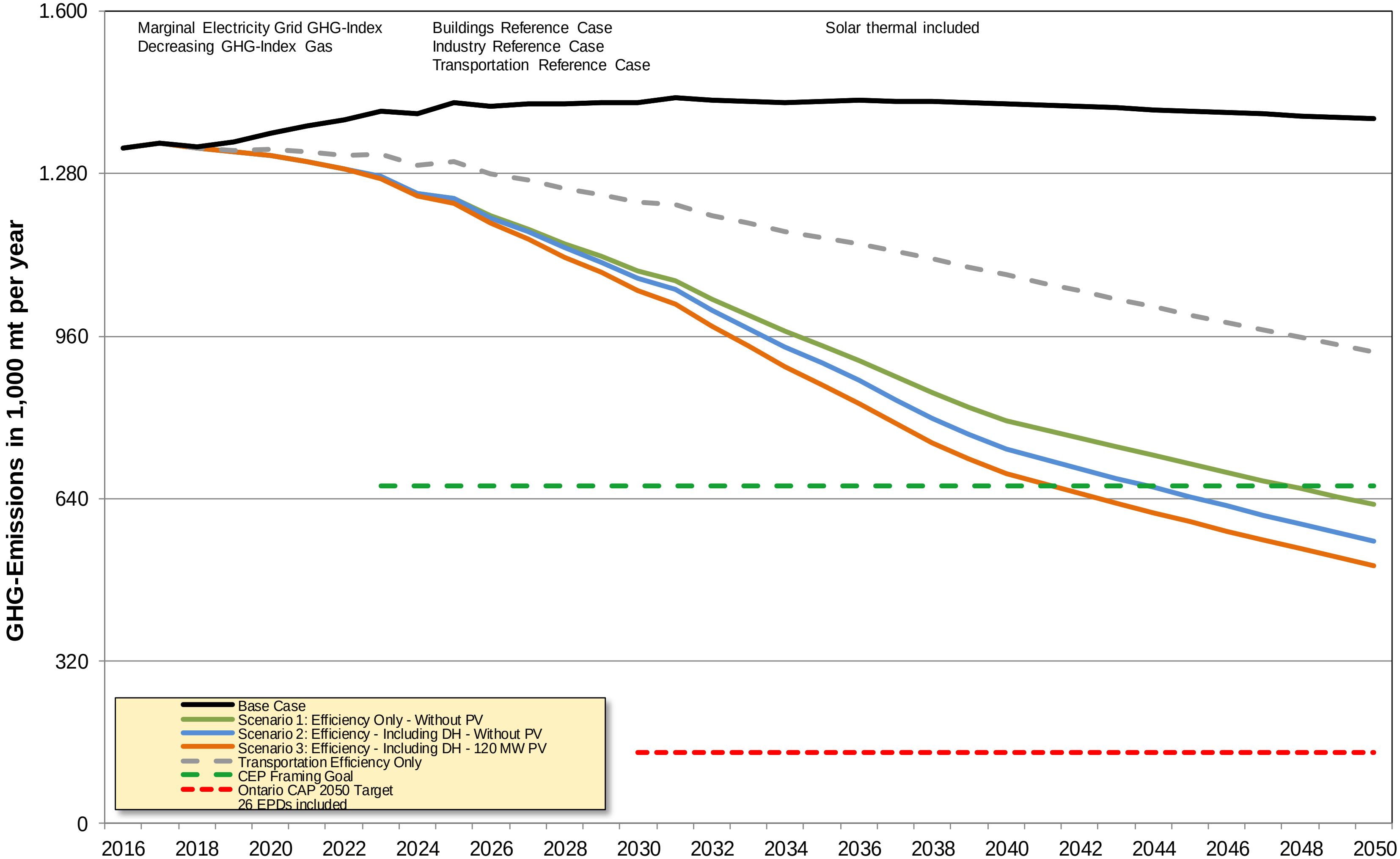

Figure 4: Projected reduction in greenhouse gas emissions (metric tons/year) by scenario from 2016 to 2050 using the reference implementation regimen.

The graph in Figure 5 shows the projected reduction in energy costs ($) from 2016 to 2050 by fuel type, including carbon, relative to the Base Case (dotted black line) for Scenario 3 using the reference implementation regimen and the low energy price range. Cumulative energy savings are $16 billion.

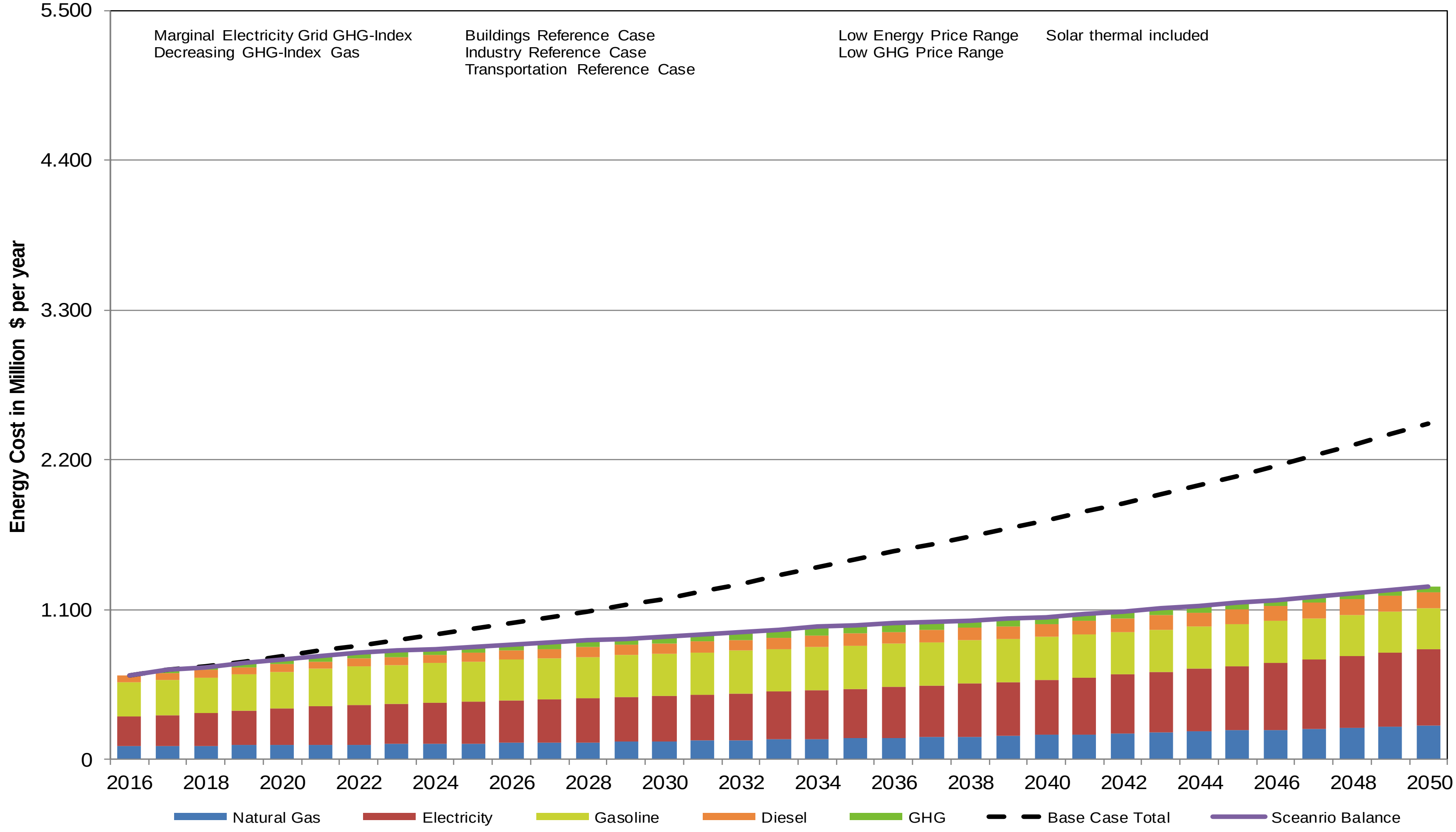

Figure 5: Projected reduction in energy costs ($) by fuel type, including carbon, from 2016 to 2050 using the reference implementation regimen and the low energy price range.

The graph in Figure 6 shows the projected reduction in energy costs ($) from 2016 to 2050 by fuel type, including carbon, relative to Base Case (dotted black line) for Scenario 3 using the reference implementation regimen and the high energy price range. Cumulative energy savings are $28 billion.

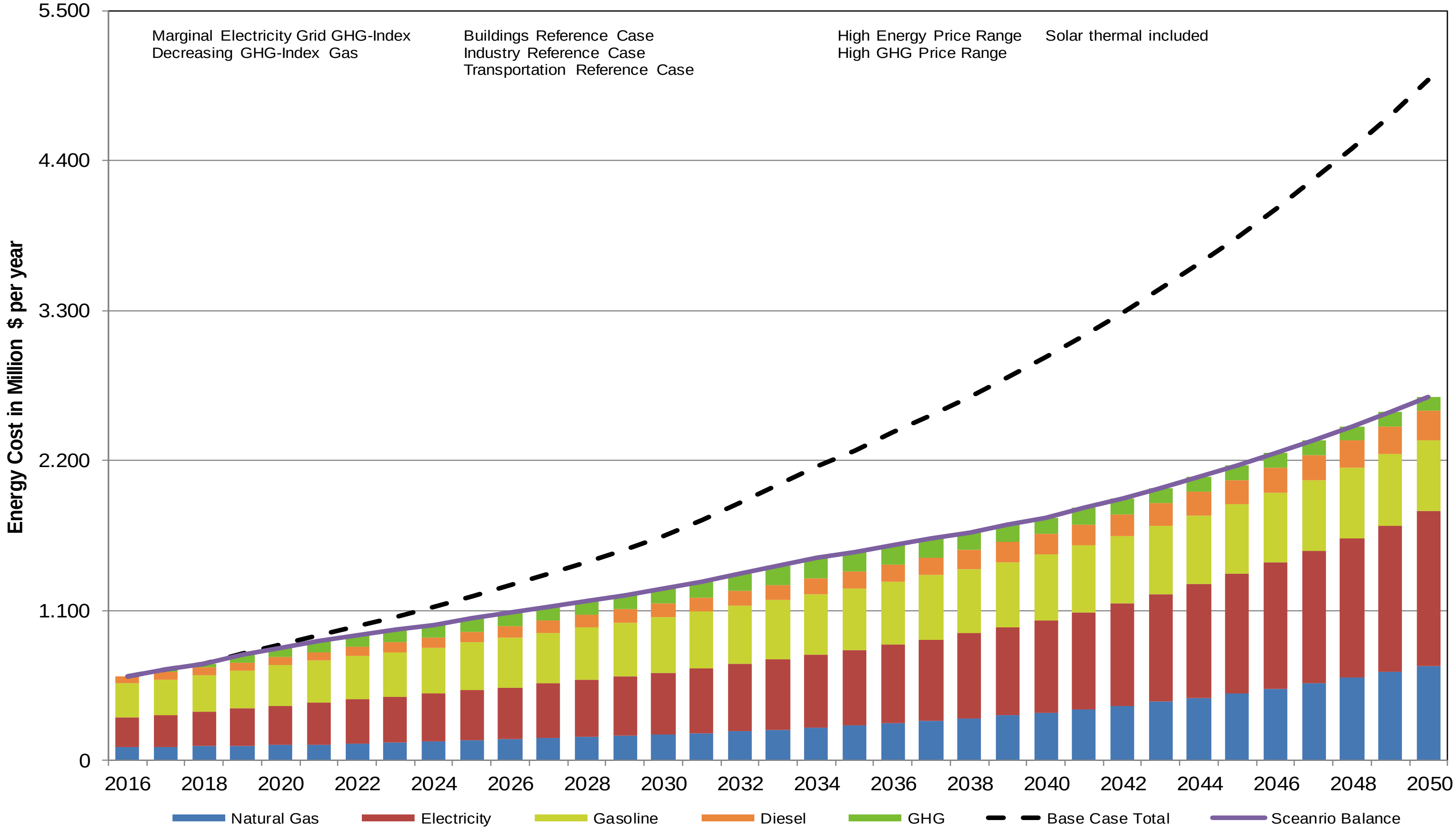

Figure 6: Projected reduction in energy costs ($) by fuel type from 2016 to 2050 for Scenario 3 using the reference implementation regimen and the higher energy price range.

The map in Figure 7 shows the relative emissions (tonnes per capita) in 2016 for Oakville residential energy planning districts (EPDs). The darker the colour the higher the per capita emissions in that EPD.

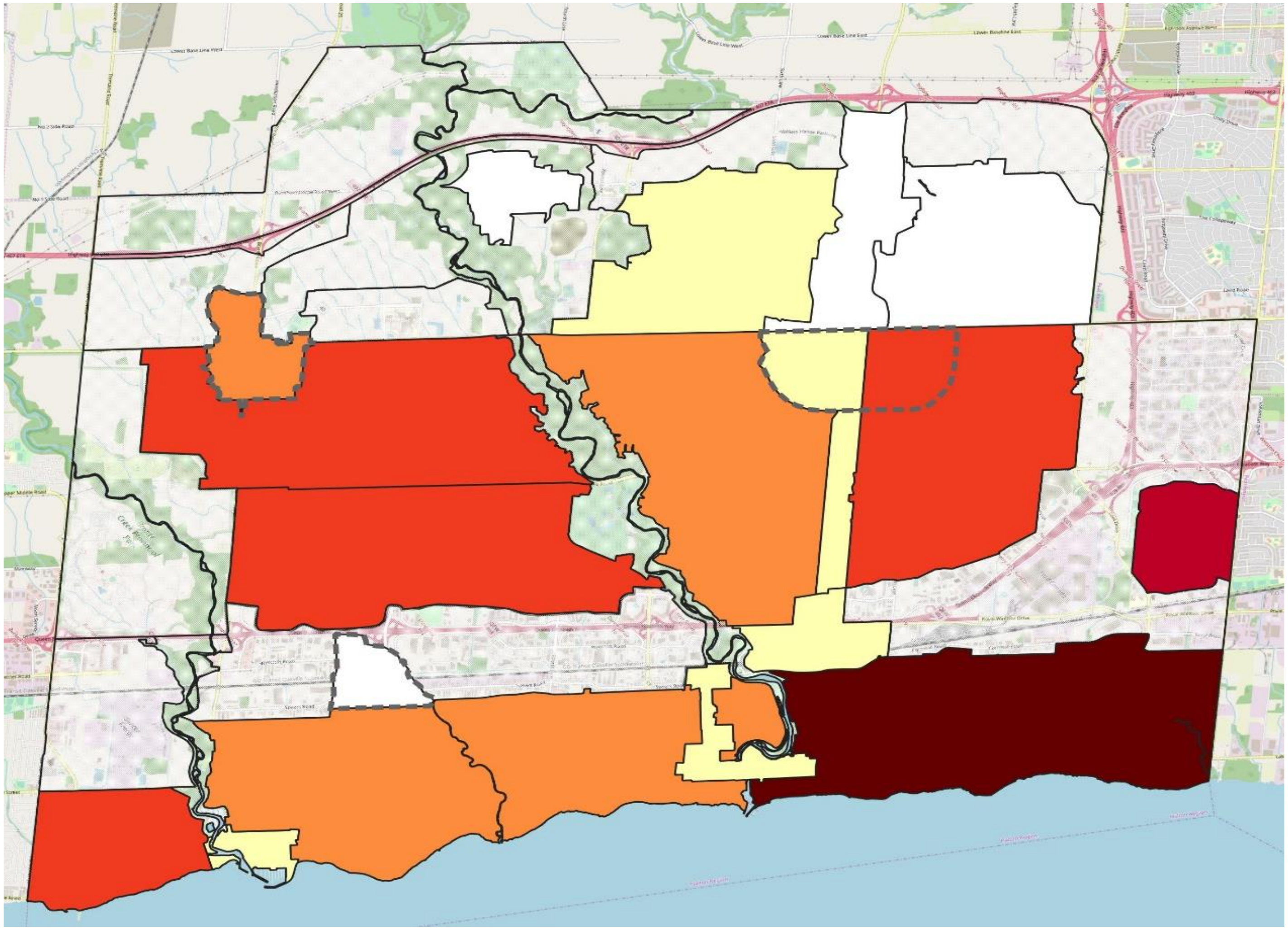

Figure 7: Greenhouse gas emissions (tonnes per capita) in 2016 for residential energy planning districts in Oakville. The darker the colour, the higher the per capita emissions.

The map in Figure 8 shows the projected relative emissions (tonnes per capita) in 2050 for Oakville residential EPDs. The darker the colour the higher the per capita emissions in that EPD. In the Base Case (business-as-usual scenario), per capita emissions are expected to decrease from 6.6 to 5 tonnes at a community-level.

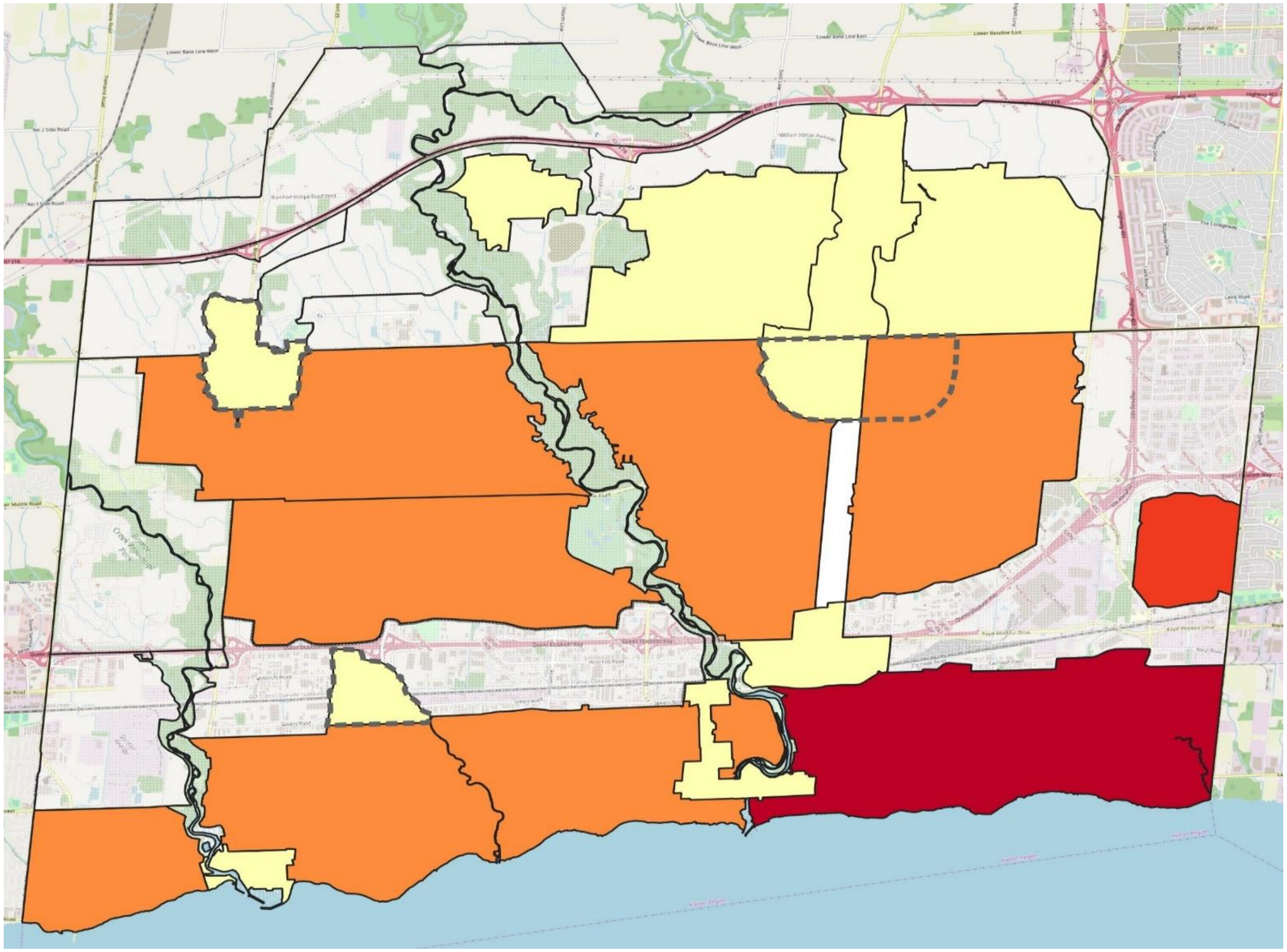

Figure 8: Projected greenhouse gas emissions (tonnes per capita) in 2050 under the Business Case for residential energy planning districts in Oakville. The darker the colour, the higher the per capita emissions.

The map in Figure 9 shows the projected emissions (tonnes/per capita) in 2050 for residential EPDs under the Reference Efficiency Case (i.e., Scenario 3 using the reference implementation regimen). Note the significantly reduced intensity from Base Case shown in Figure 7. Under the Reference Efficiency Case, per capita emissions are projected to be 1.9 tonnes in 2050.

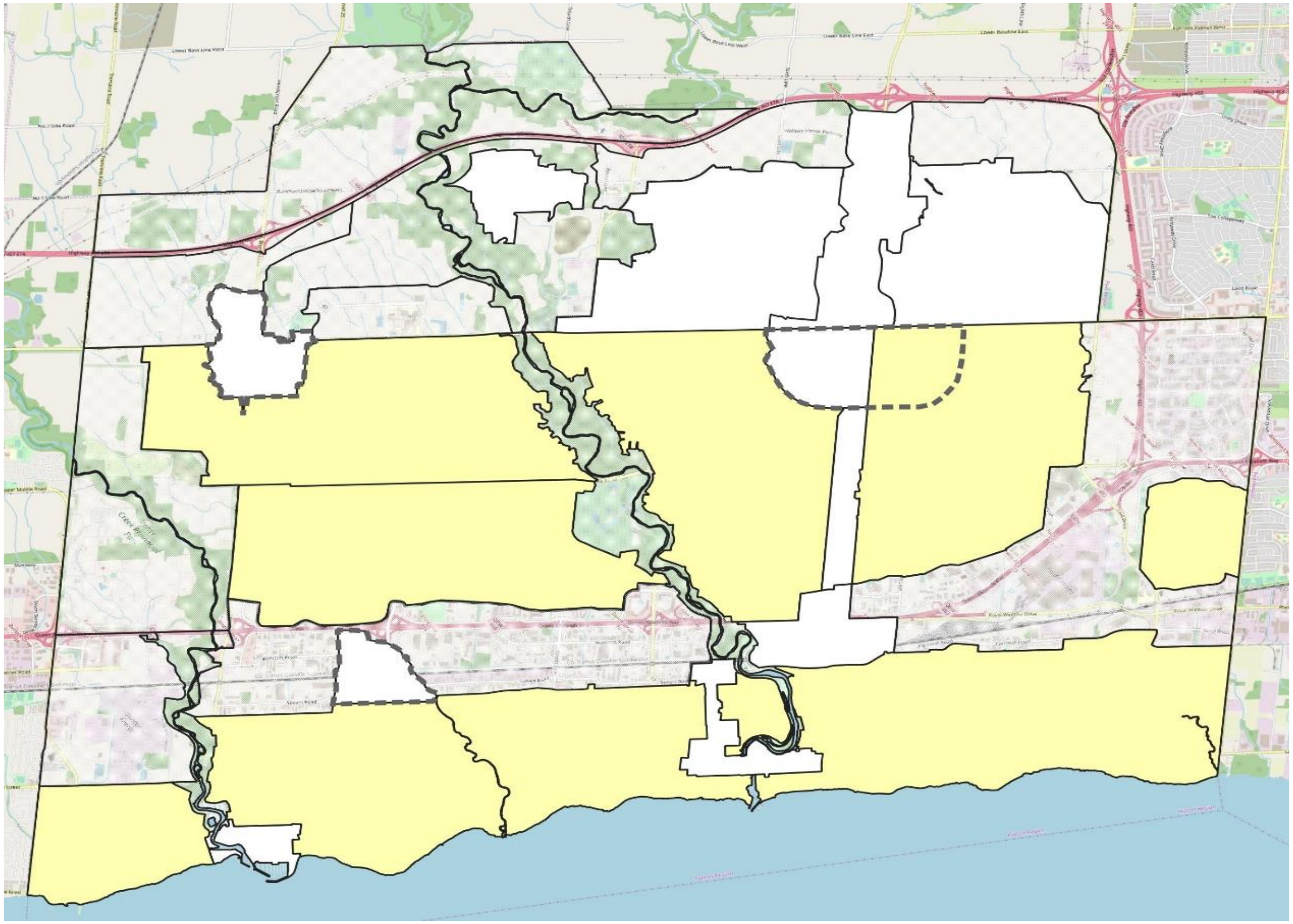

Figure 9: Projected greenhouse gas emissions (tonnes per capita) in 2050 under Scenario 3 using the reference implementation regimen for residential energy planning districts in Oakville.

Scenario 3 High Action Efficiency Case

Figures 10 to 14 demonstrate the performance of Scenario 3 under a high action implementation regime.

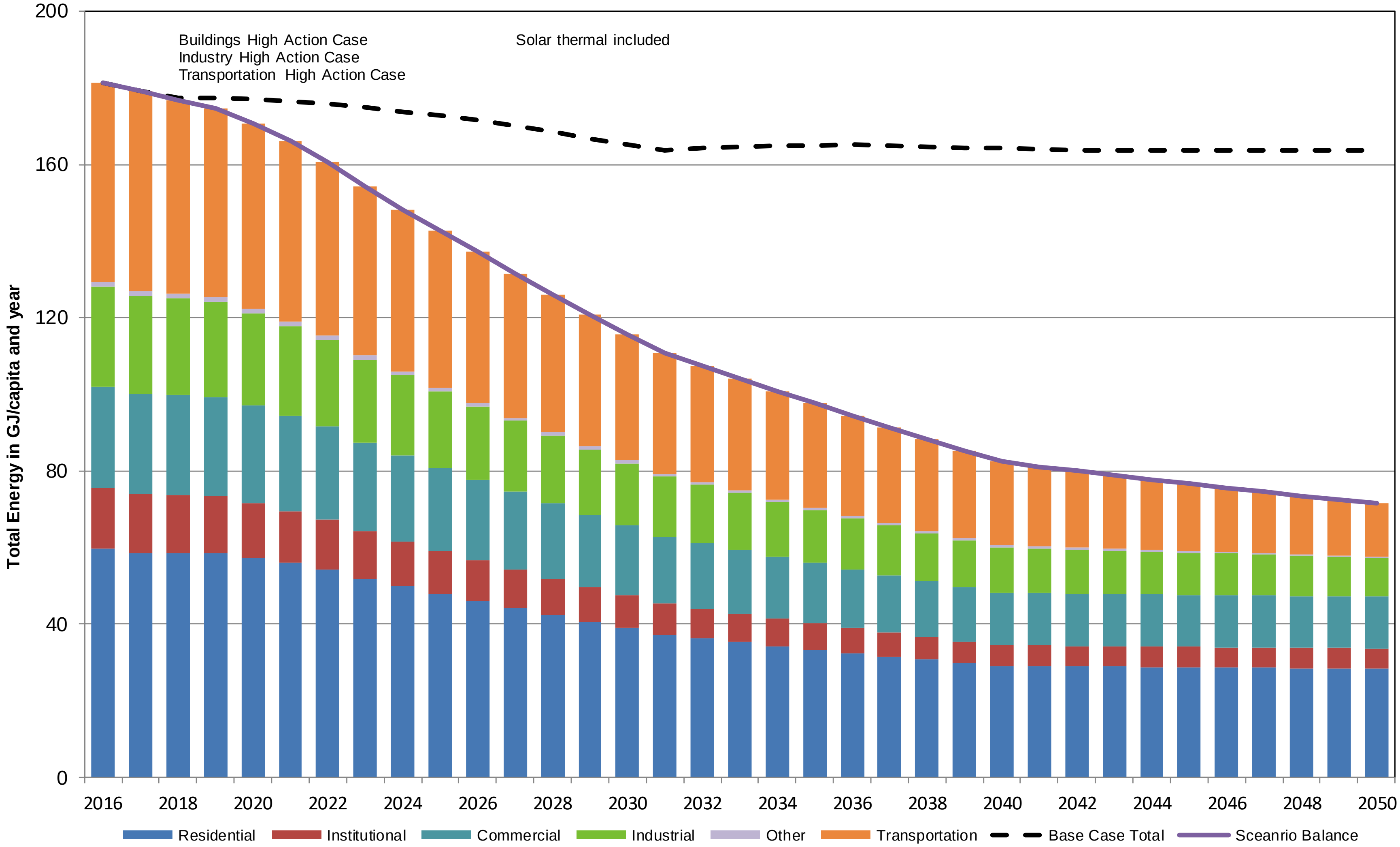

Figure 10: Projected reduction to source energy efficiency (GJ/capita) by sector from 2016 to 2050 for Scenario 3 using the high action implementation regimen.

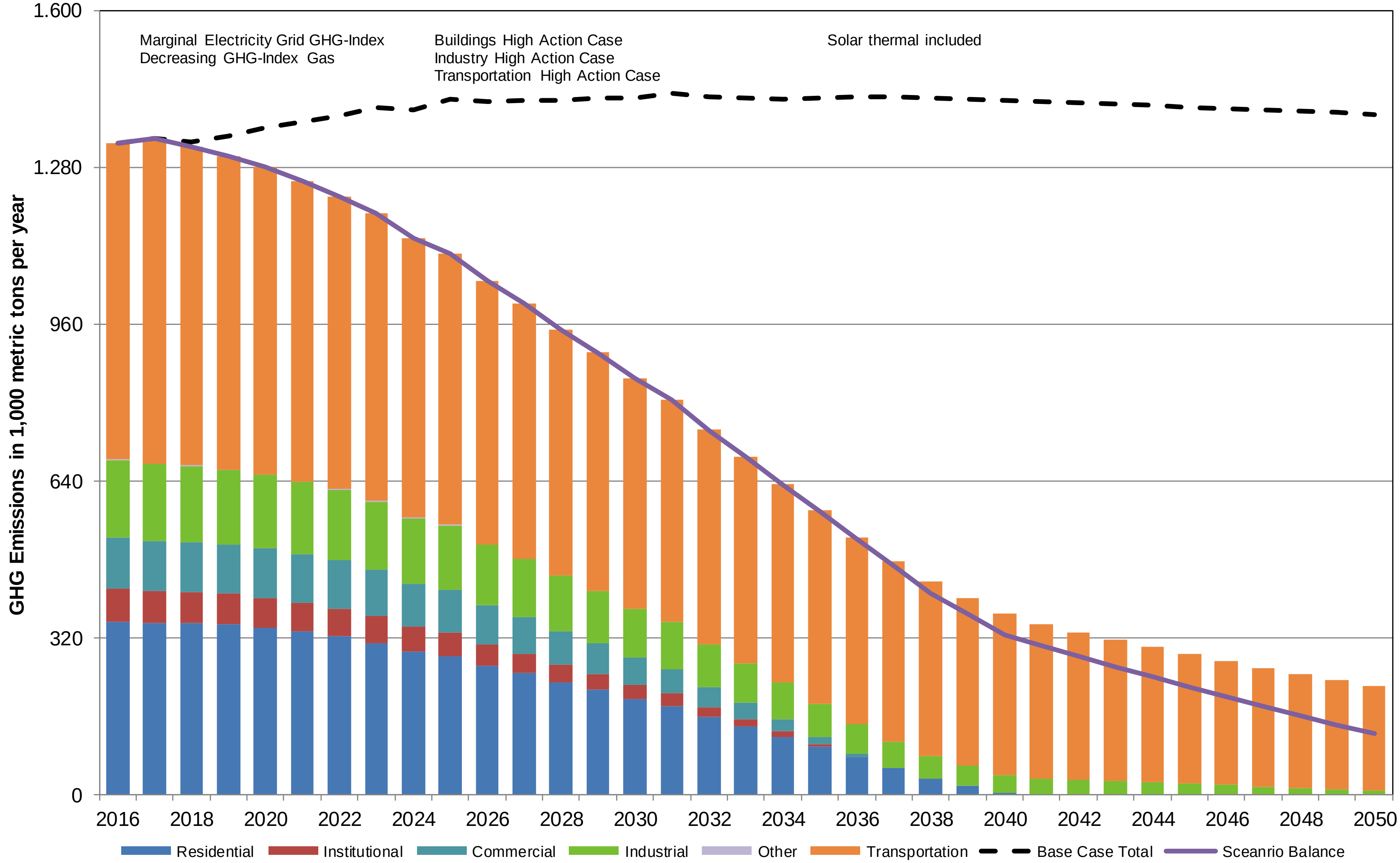

Figure 11: Projected reduction to greenhouse gas emissions (metric ton/year) by sector from 2016 to 2050 for Scenario 3 using the high action implementation regimen.

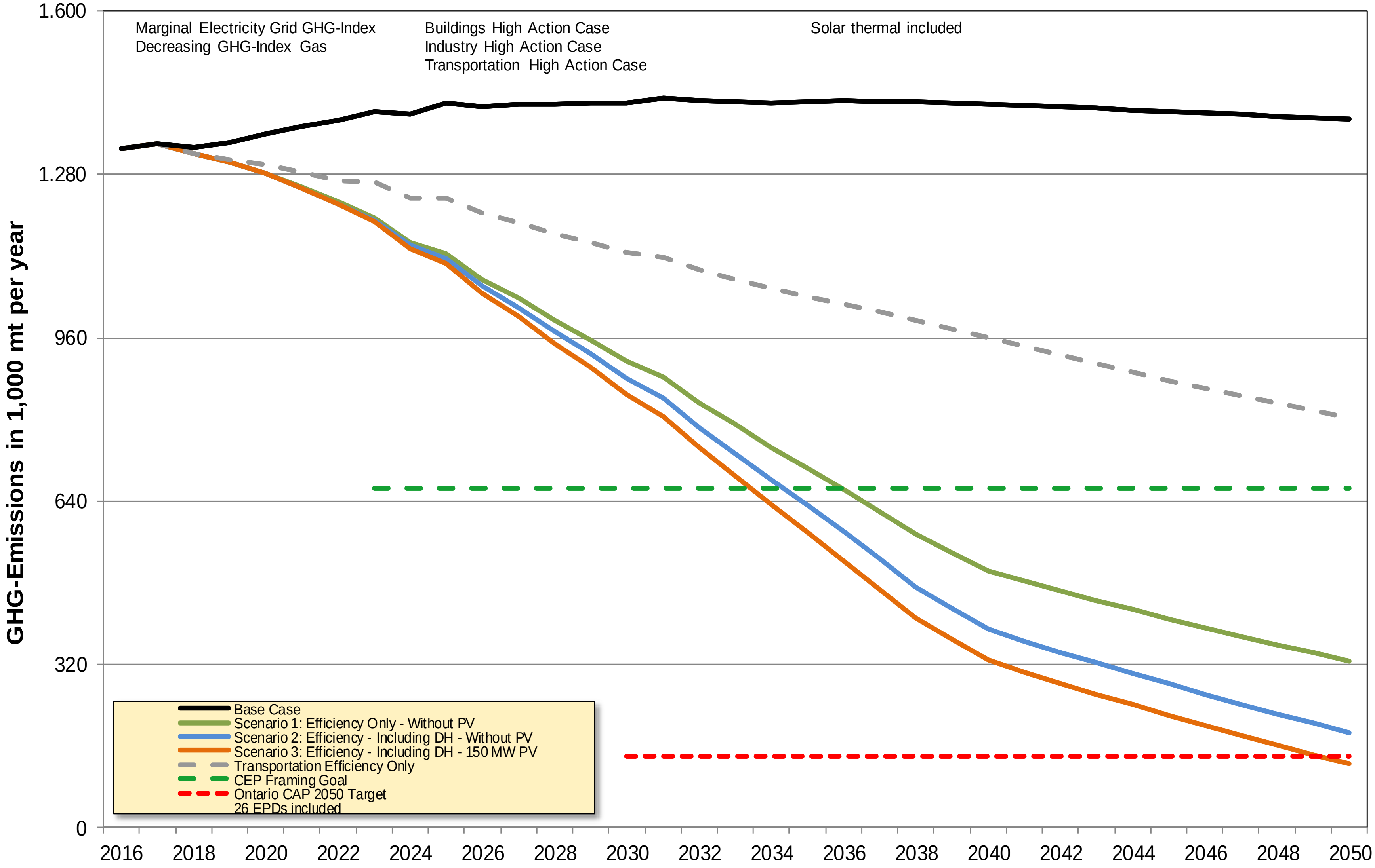

Figure 12: Projected reduction in greenhouse gas emissions (metric tons/year) by scenario from 2016 to 2050 using the high action implementation regimen.

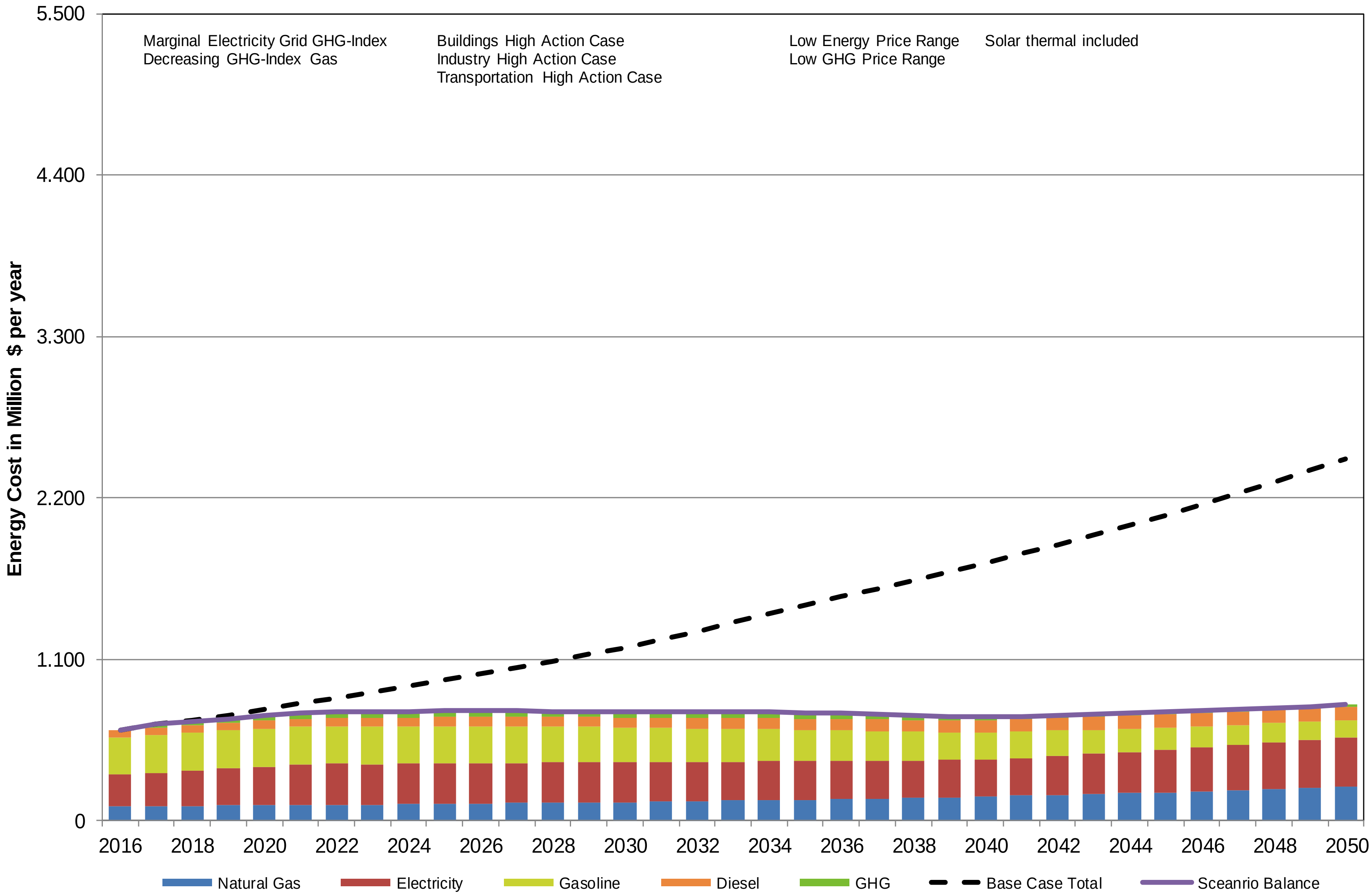

Figure 13: Reduction in energy costs ($) by fuel type (including carbon) from 2016 to 2050 under the high action implementation regime and low energy price range. Estimated cumulative savings of $24 billion.

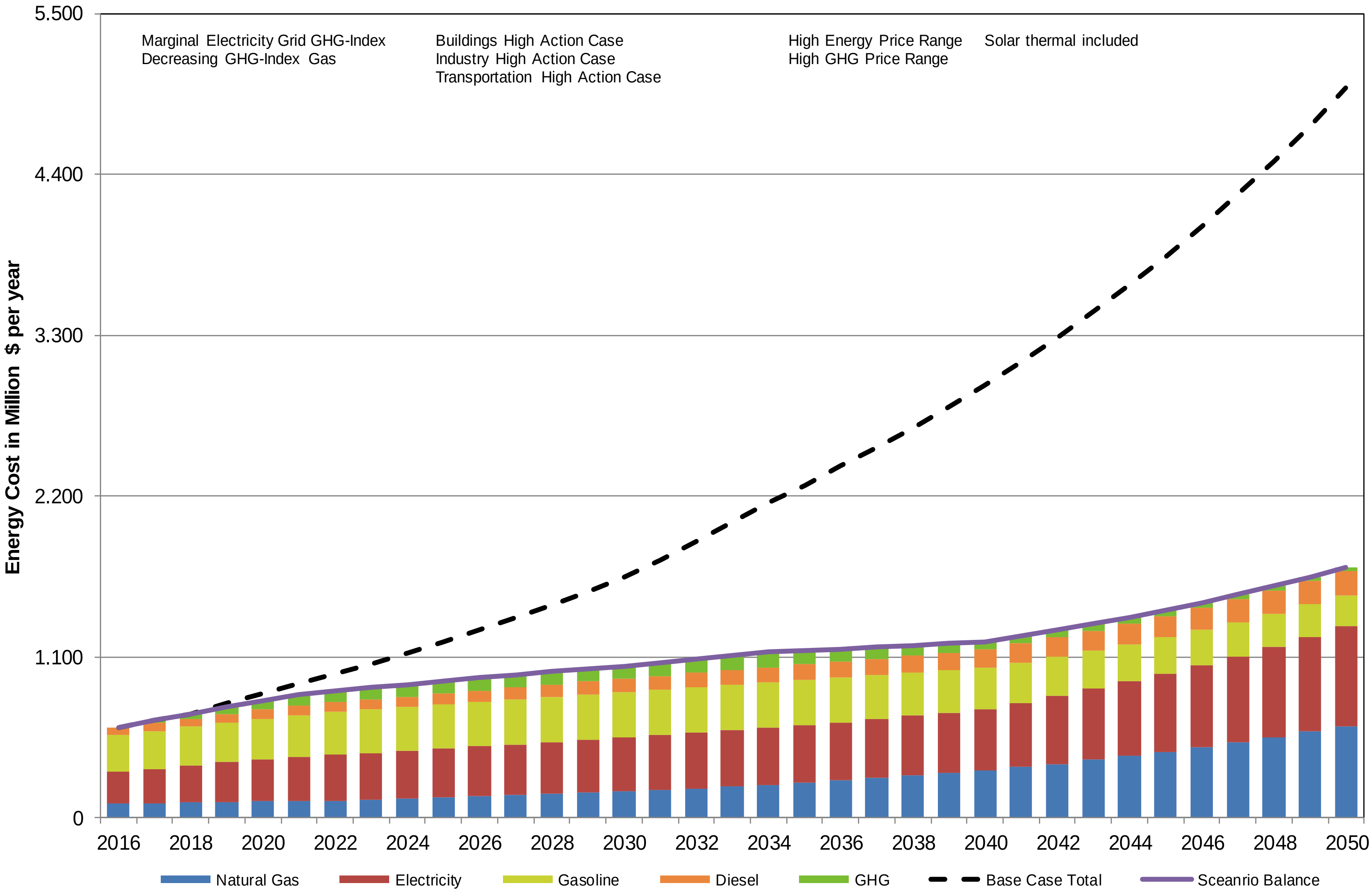

Figure 14: Reduction in energy costs ($) by fuel type (including carbon) from 2016 to 2050 under the high action implementation regime and high energy price range. Estimated cumulative savings of $41 billion.

Appendix 6 – Oakville Sankey Diagrams

This appendix summarizes the Oakville Sankey diagrams produced by the PWT.

Contents

1. What are Sankey diagrams?

Sankey diagrams have been named after Irish Captain Matthew Henry Phineas Riall Sankey. He developed the diagram in 1898 to illustrate the energy efficiency of a steam engine. Sankey diagrams continue to be used today to show the energy flow through a system and to identify opportunities to improve efficiency.

2. Why is the Sankey diagram important?

Community energy planing consider all local energy flows from source to end-use to identify opportunities to increase efficiency from supply through distribution to end use.

A Sankey diagram illustrates the opportunity for efficiency at end-use (refer to green flows on the right of each of the following diagrams) as well as opportunities to improve system efficiency[1] (refer to light grey and dark grey flows on the right of each the following diagrams). Energy use, emissions and cost flow from the left to right through the system. Figure 1 describes how to read a Sankey diagram.

3. Oakville Sankey diagrams

Sankey diagrams were developed to show the energy use (Figures 2a, 2b, 2c), emissions (Figures 3a, 3b, 3c) and cost (Figures 4a, 4b, 4c) flows for the Oakville 2016 baseline (Figures 2a, 3a, 4c) and in 2050 under two scenarios: Base Case (Figures 2b, 3b, and 4b) and CEPP Efficiency Case (Figures 2c, 3c and 4c).

[1] Conversion losses occur when energy is transformed from one form to another (e.g., fossil fuel is converted to electricity). Additional system losses occur when energy is moved from one place to another (e.g., the transmission of electricity from point of generation to homes and businesses), or from one system to another.

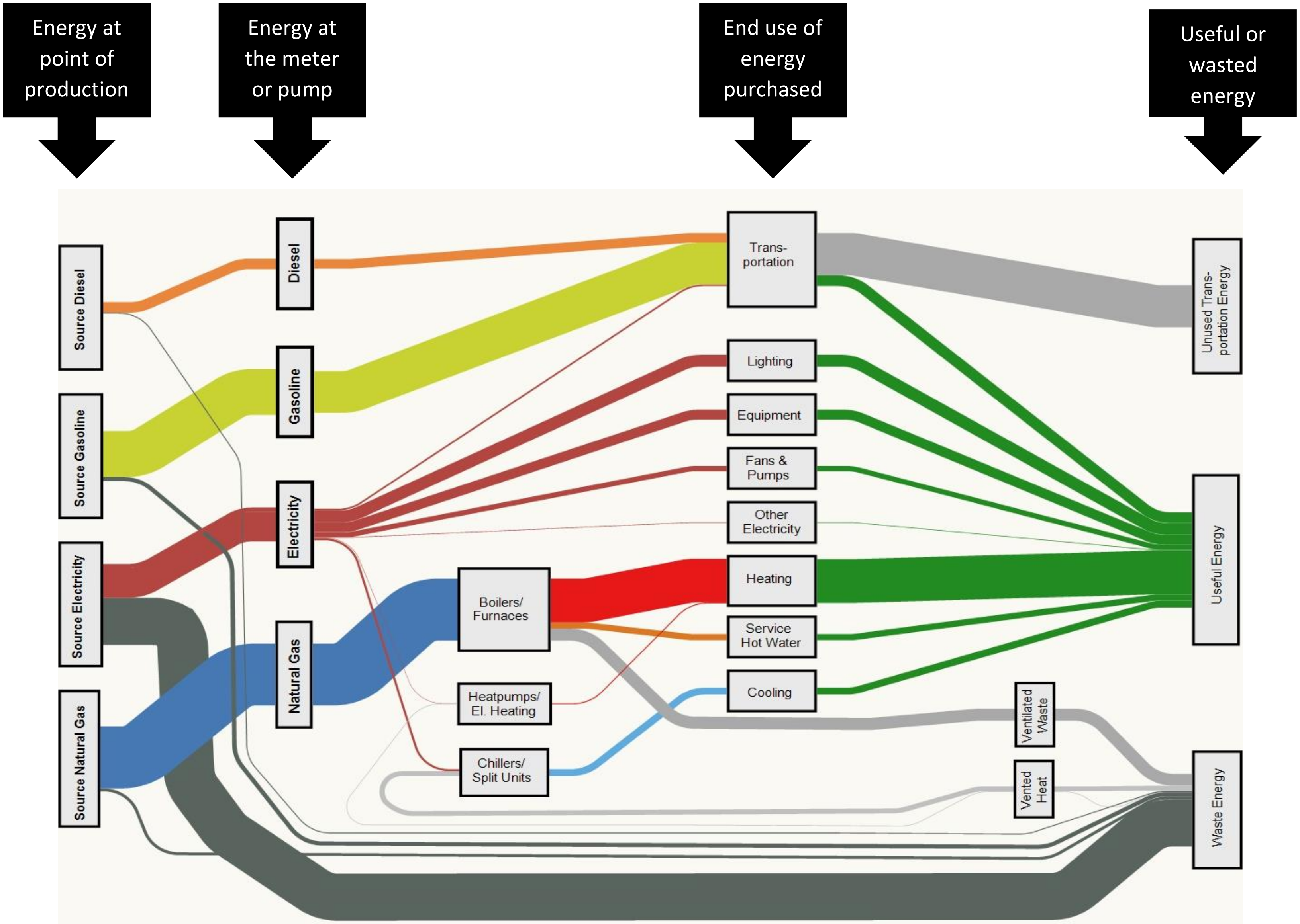

Figure 4: How to read the Sankey diagram.

3.1 Energy use

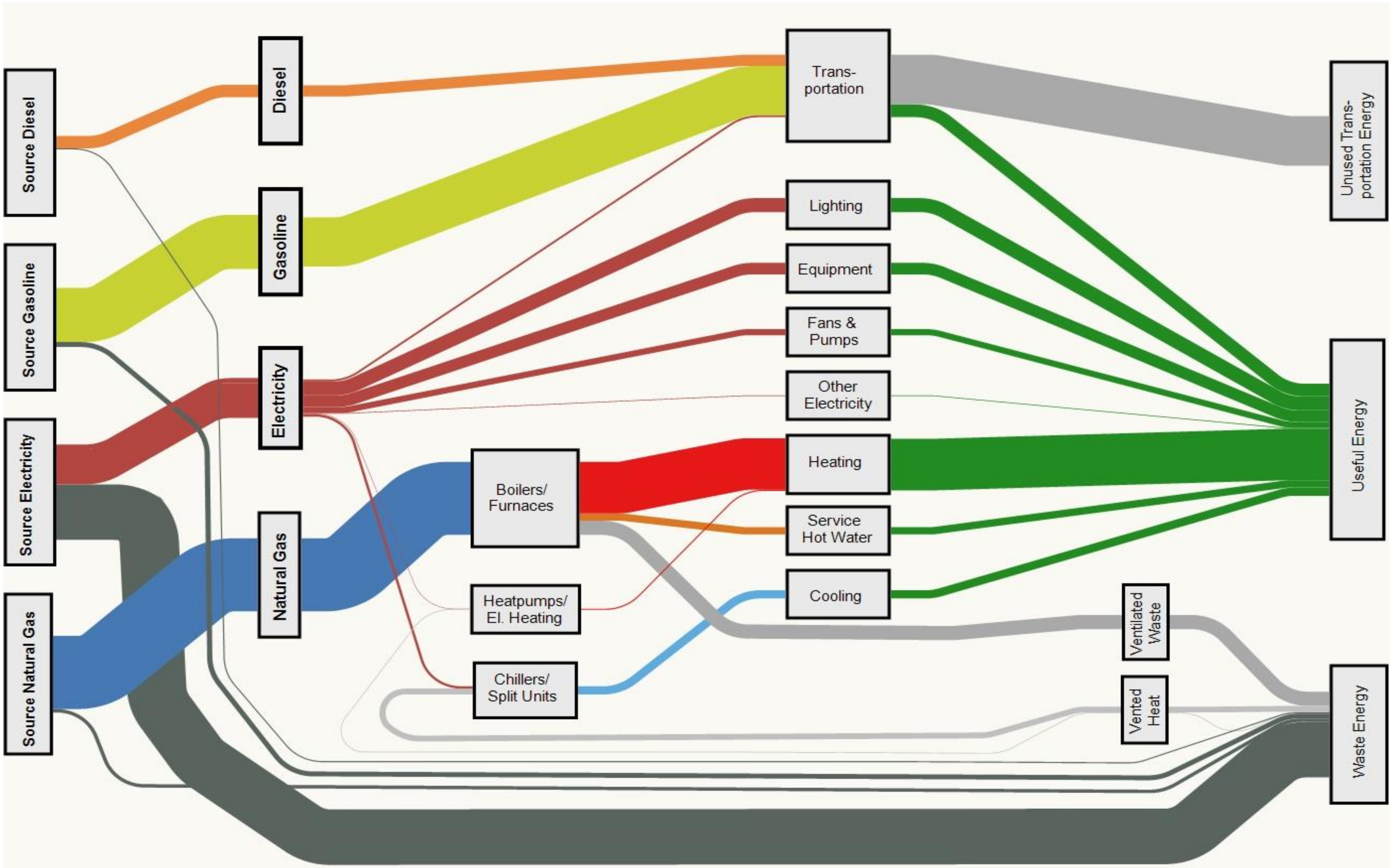

Figure 2a: Oakville Sankey diagram for 2016 baseline energy use.

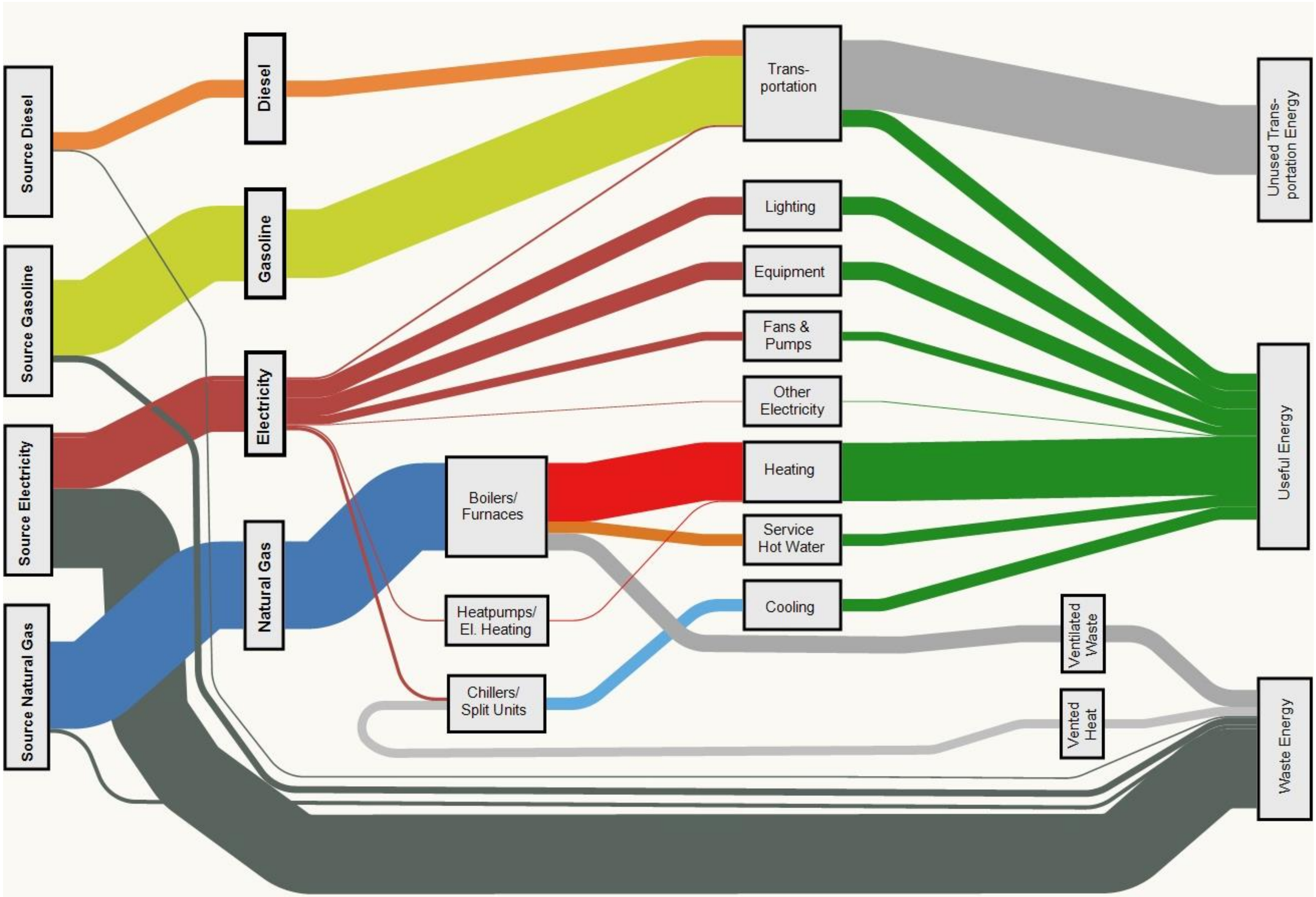

Figure 2b: Oakville Sankey diagram for 2041 Base Case energy use.

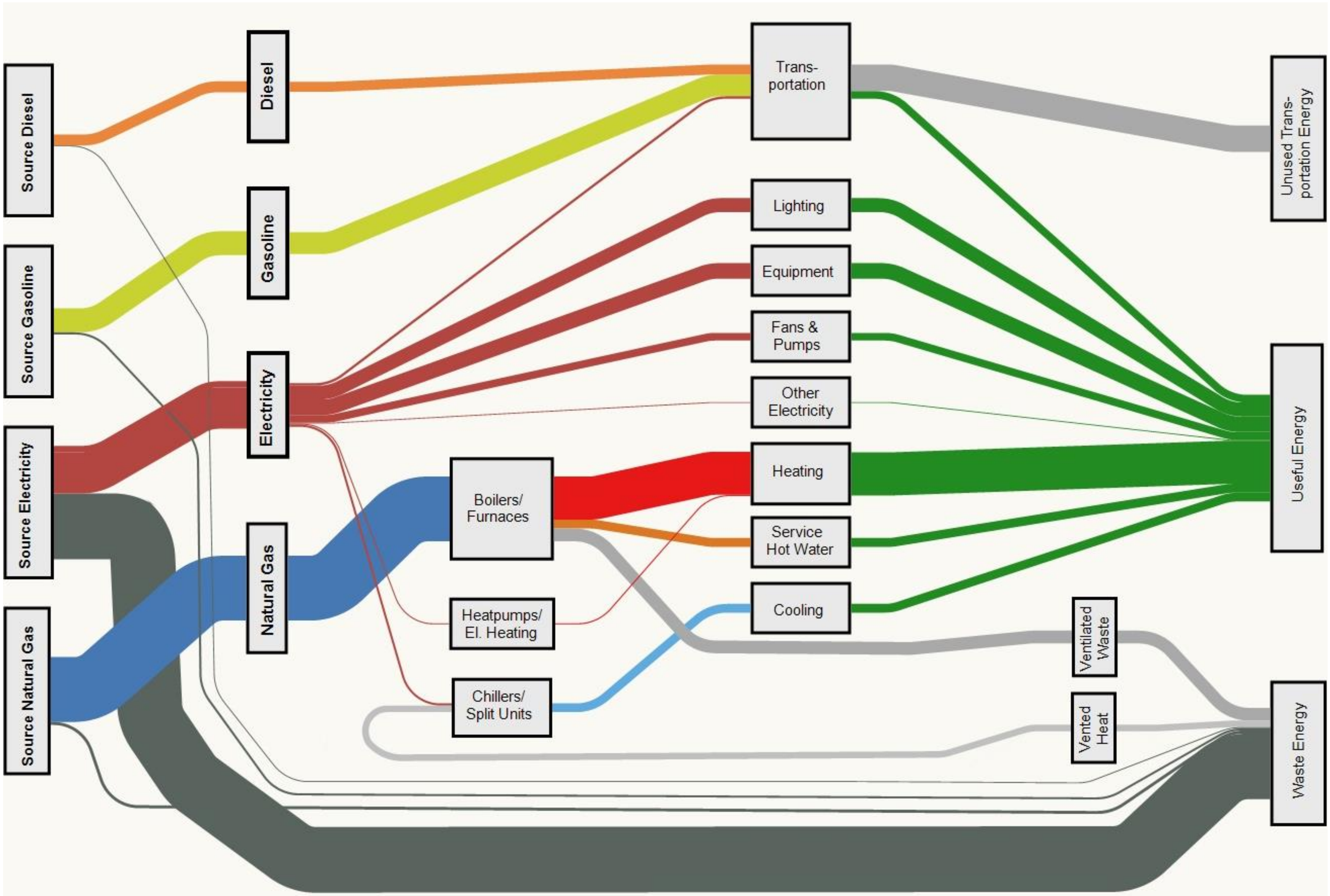

Figure 2c: Oakville Sankey diagram for 2041 CEPP Efficiency Case energy use.

3.2 Emissions

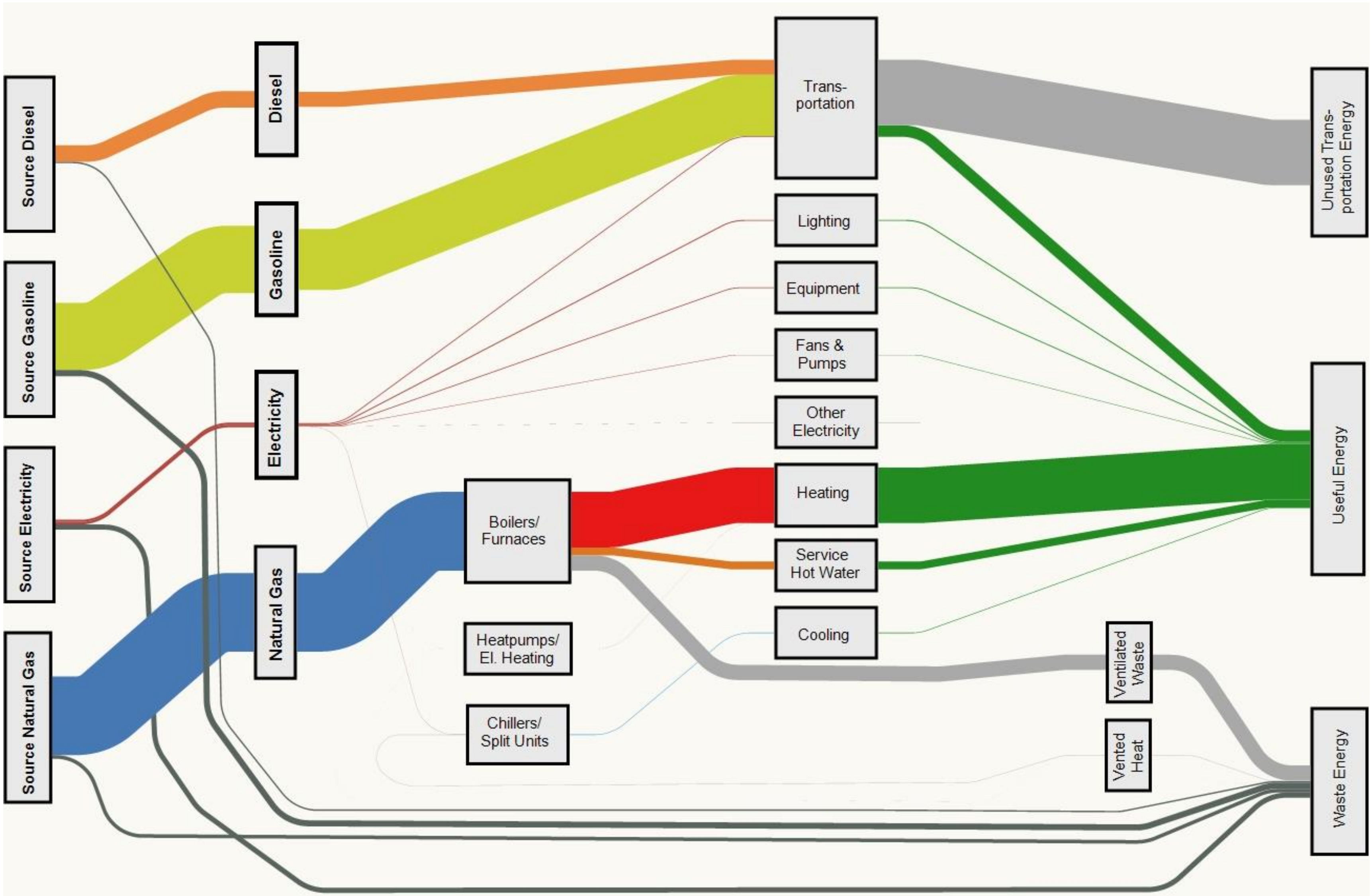

Figure 3a: Oakville Sankey diagram for 2016 Baseline emissions.

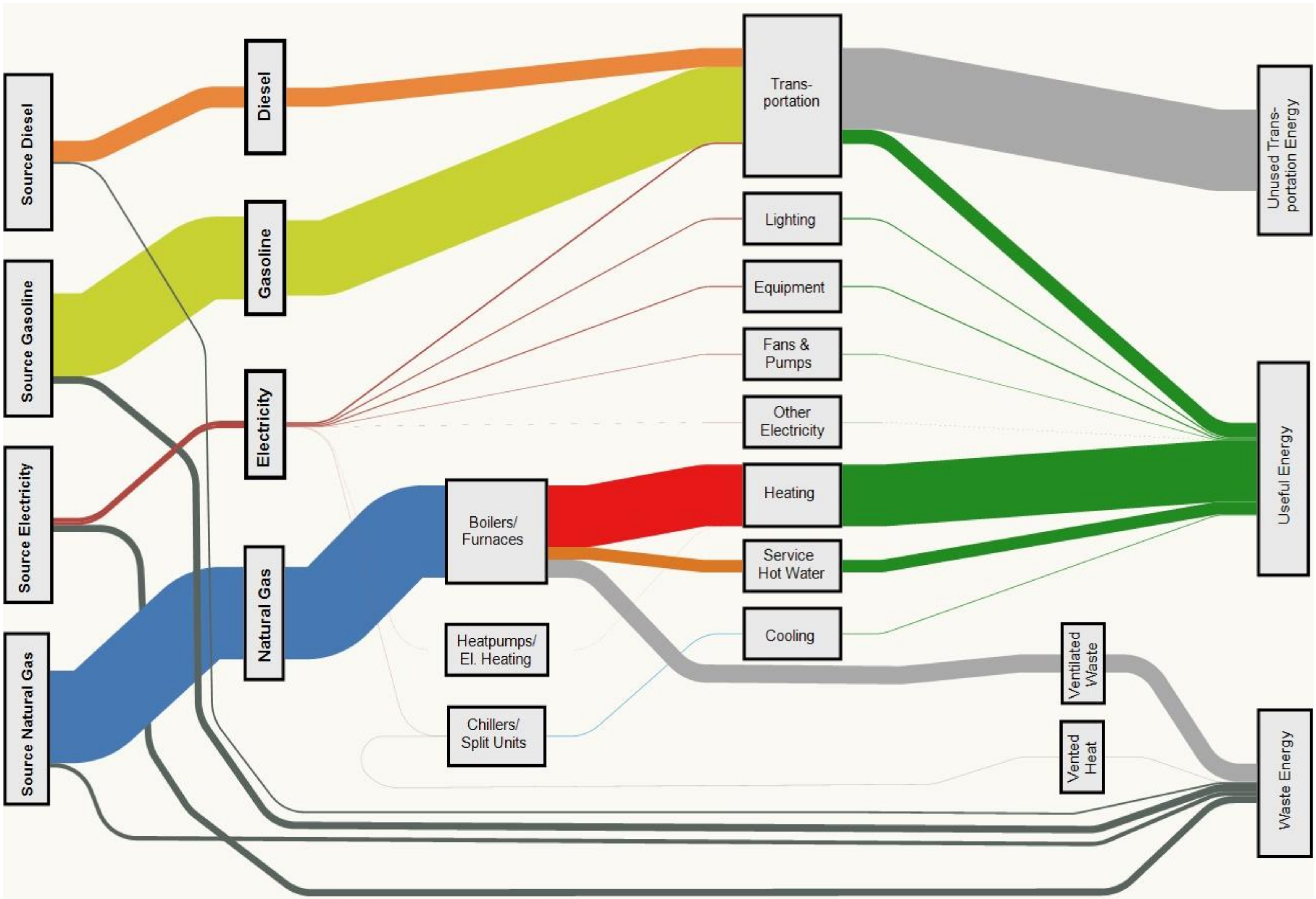

Figure 3b: Oakville Sankey diagram for 2041 Base Case energy emissions.

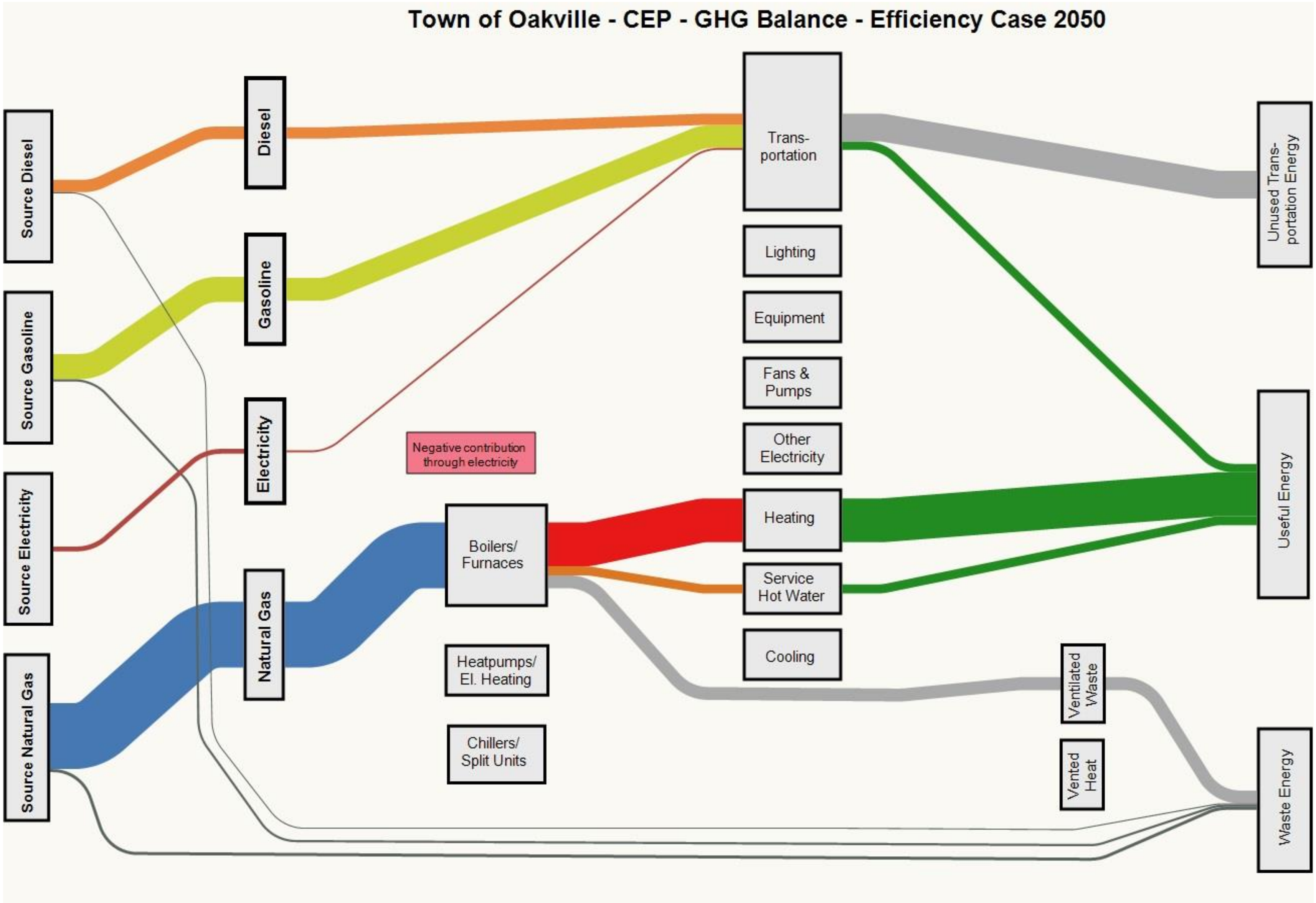

Figure 3c: Oakville Sankey diagram for 2041 CEPP Efficiency Case for energy emissions.

3.3 Energy Costs

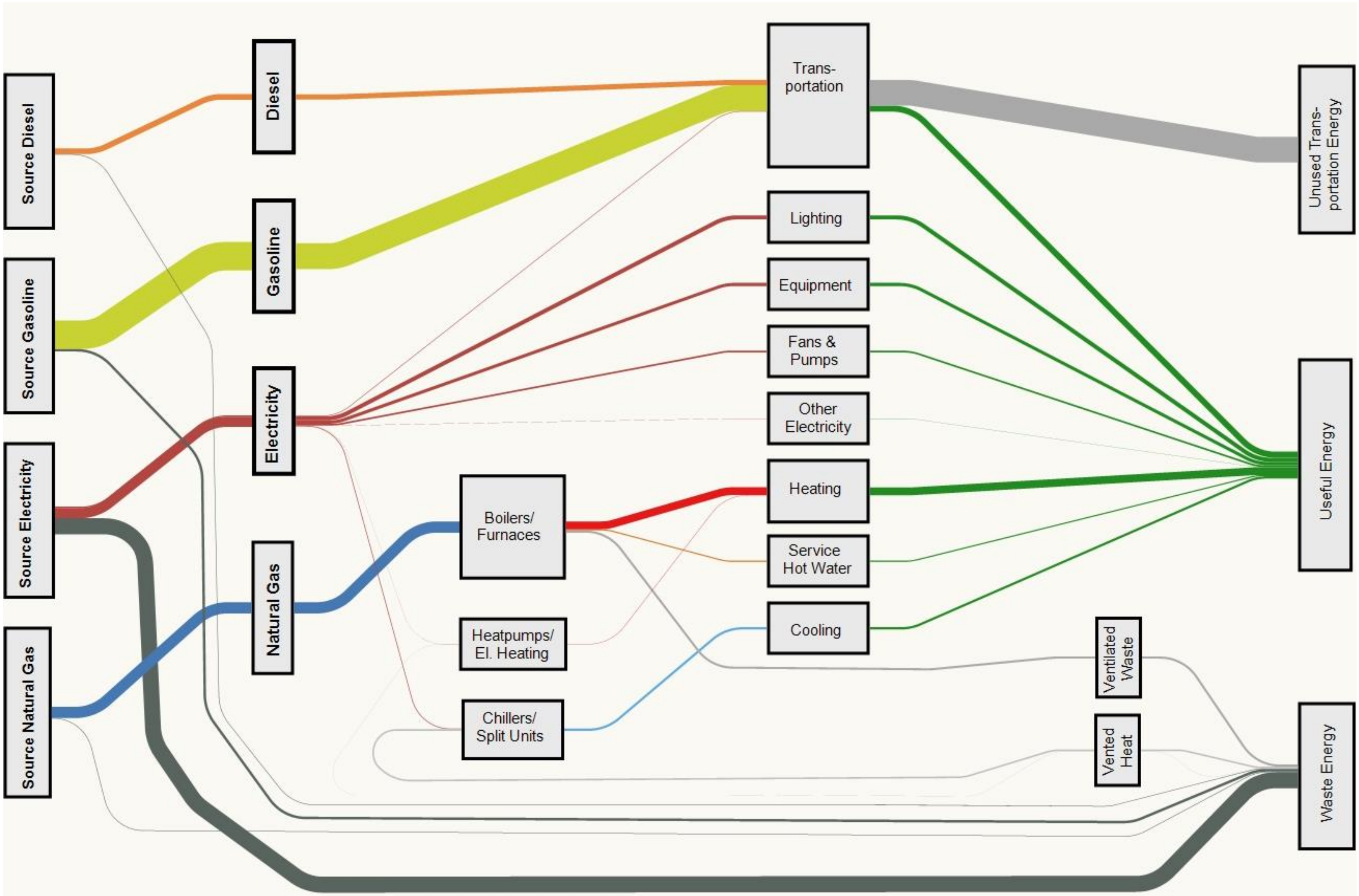

Figure 4a: Oakville Sankey diagram for 2041 Baseline for energy cost.

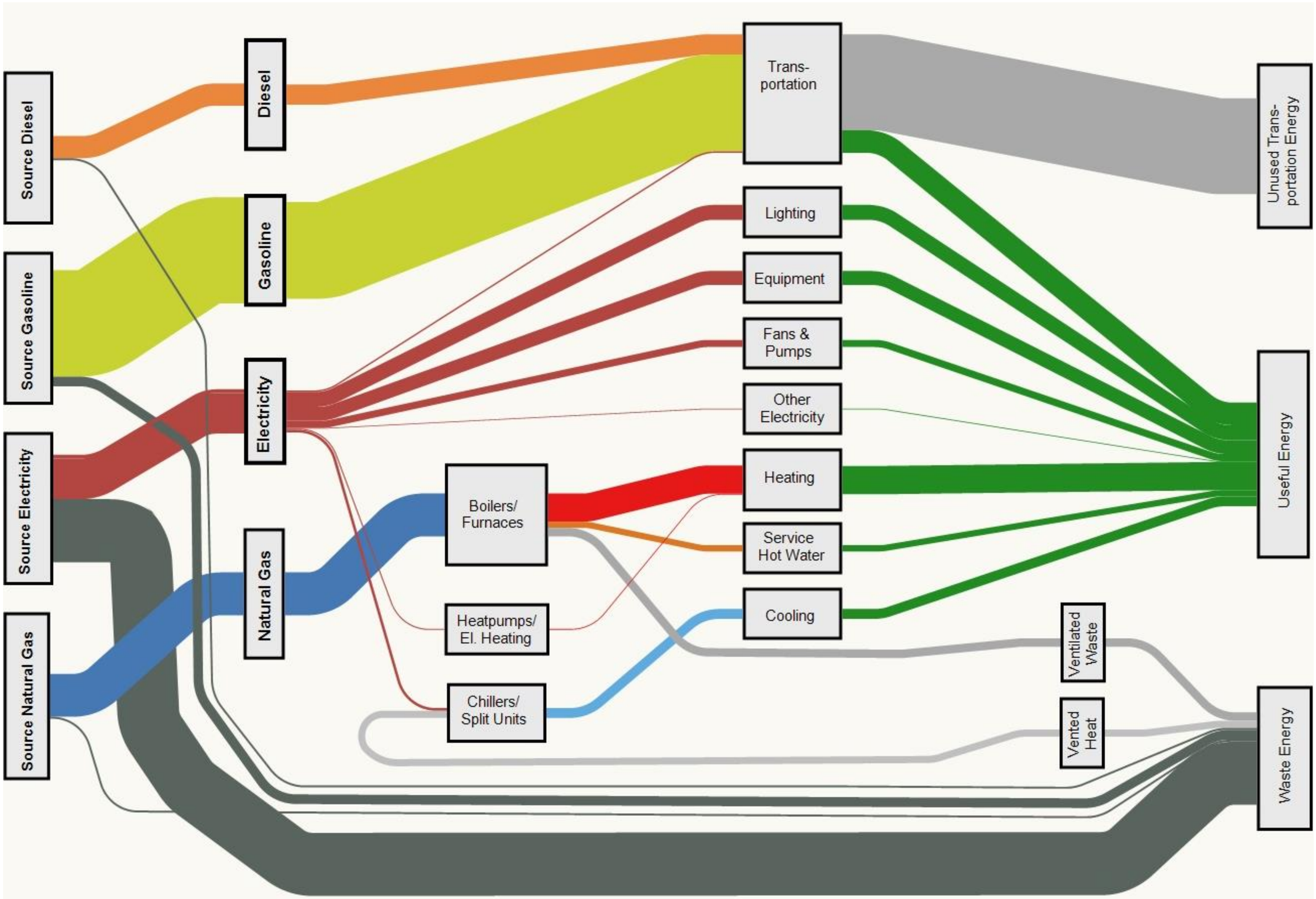

Figure 4b: Oakville Sankey diagram for 2041 Base Case energy costs.

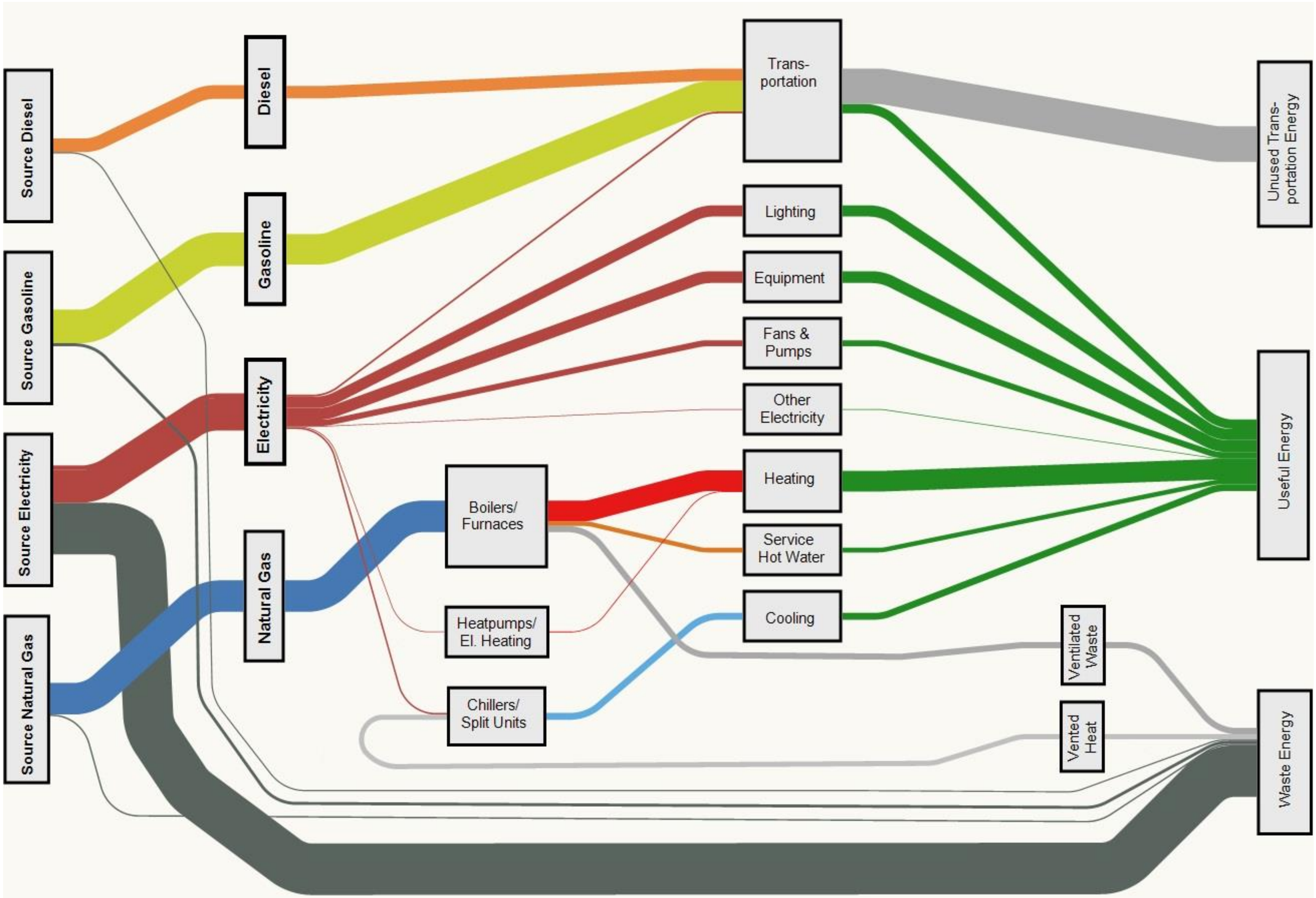

Figure 4c: Oakville Sankey diagram for 2041 CEPP Efficiency Case for energy costs.