EILAT CITY
GHG Emission Report

Survey of Findings on Greenhouse Gas Emissions in Eilat
2016

Ben-Gurion University of the Negev
The Negev Center for Sustainability

Stage A
The survey is submitted as part of the Eilat Municipality's obligations under the "Covenant of Mayors on Climate Protection and Energy Efficiency

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Table of Contents

1. Introduction

This document surveys greenhouse gas emissions in Eilat in 2014, focusing on direct emissions in city limits, while also specifying some of the emissions outside city limits that are related to municipal activity. The report presents the emissions attributed to activity of key municipal sectors – the municipality, the commercial sector, households and industry. Within these confines, the report addresses electricity consumption, use of transportation, water supply, use of cooking gas and solid and liquid waste treatment. The assessed emissions from these activities are accepted in this type of report and are conducted in various cities in Israel and around the world.

The review was conducted as part of Eilat joining the European Covenant of Mayors, in which member cities in the covenant are required to increase energy efficiency in accordance with the goal set forth by the European Union, and reduce greenhouse gas emissions by 20% by 2020. The core document of the organization is the Sustainable Energy Action Plan or SEAP, which is designed to define the ideal actions and assessments needed to achieve this goal. According to SEAP, the first stage in reducing greenhouse gas emissions is the preparation of a survey of greenhouse gas emissions in the city.

The survey aims to form a basis for formulating a work plan for achieving the emissions reduction target. The emission findings presented in this report and in ensuing reports as part of this project will facilitate a review of progress towards this goal. The survey includes calculation of emissions for the two main greenhouse gases: carbon dioxide (CO_2), which is produced by combustion of fossil fuels and methane (CH4), which originates in solid and liquid waste treatment in the city. The results are expressed in carbon dioxide equivalents (CO_2e).

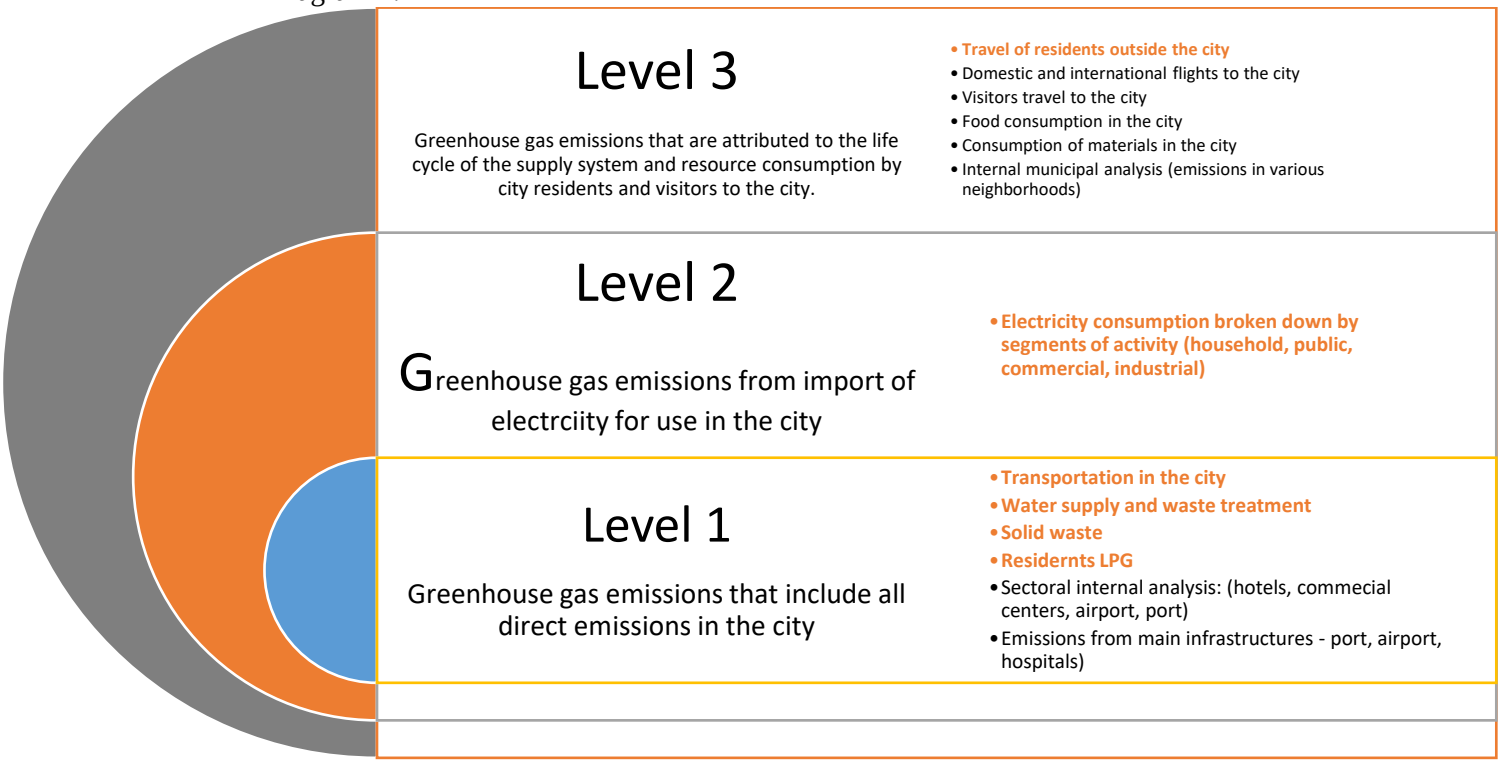
The city of Eilat is unique in its climate and geographical characteristics, as well as in terms of municipal function in comparison with other cities in the country that were subject to similar emissions surveys. The city lies on the 29º latitude, and is positioned in the subtropical ridge, so that its climate is extreme desert that is characterized by two main seasons. Temperatures the majority of the year exceed 40º. Eilat is a tourism city that draws approximately 2.8 million visitors every year. The city is home to dozens of hotels and various tourism-related businesses that constitute the main general industry in Eilat. Eilat is located at the southernmost tip of Israel, at a large (in Israeli terms) distance from any other major populated centers. Aviation represents a significant component in transportation to and from the city, in addition to buses and private vehicles. In light of these factors, the emission characteristics can be expected to differ from other Israeli cities.

Central Bureau of Statistics data for 2014 revealed that the number of residents in Eilat amounted to 48,946.[1] This statistic does not apparently include over 10,000 individuals that constitute the temporary population in the city who reside in the city part of the year. Although these are not permanent residents of the city, in the context of this report, their activity in the city affects the volume of emissions in the various municipal sectors. Alongside the city residents are an average 19,000 tourists, which significantly increases the population.

The report is the first in the carbon assessment project for Eilat, which also includes other components to be presented in a series of future reports. Diagram 1 presents the framework of the project, and emphasizes the emission components included in this report alongside the elements to be presented in later stages. As the diagram reveals, the project will later include a more in-depth analysis of the emissions estimate for each sector, assessment of emissions attributed to operations in various areas of the city, assessment of the range of indirect emission components such as flights, trips to the city, food consumption and review of the potential to reduce emissions. The emission survey data presented below reveals that in 2014, the total greenhouse gas emissions amounted to 532,000 ton CO_2e.

[1] The Central Bureau of Statistics, Local Authorities in Israel 2014, publication no. 1642.

Diagram 1:



*The causes of emissions emphasized in orange appear in this stage of the report.

2. **Methods**

According to the directives of the Covenant of Mayors, the emissions report is one stage of a process designed to promote energy efficiency and emissions reduction. The local authority, which is party to the process, has several options to assess the emissions at various levels, as presented in Diagram 1: Carbon accounting that includes emissions in city limits and emissions that are attributed to electricity accounting or carbon accounting based on the life cycle analysis approach. The first approach primarily examines the direct emissions in the city, some of which is the responsibility of the Local Authority. These emissions, which are defined as Level 1, are generally added with the emissions that result from production of electricity used by a Level 2 city. The second, more focused approach, views the city as a system that is directly and indirectly dependent on a range of services, products and processes outside city limits and consumption of city residents and visitors as part of the urban emissions. This approach, Level 3, also focuses on assessment of related emissions in the city and its residents outside city limits to the extent possible throughout the life cycle of the products and services. This report primarily includes the first approach (Level 1 + 2) but adopts several measures in assessing some of the related emissions using the second approach.

The emissions data were calculated for 2014. To assess the emissions and to prepare the report, data was incorporated from the local and national levels. On the local level, data was obtained from the municipality (primarily pertaining to areas in which the municipality is directly responsible), and data from other bodies such as water corporations, and the port. On the national level, data was obtained from (a) the Electric Company (electricity consumption data from various urban sectors), (b) from the Ministry of the Environment on Environmental Emissions Registry (EMR) database and the National Air Monitoring Center transportation model (c) from the Water Authority data on water supply to various sectors in the city (d) from the Central Bureau of Statistics data on population, tourists and visitors, as well as data on traffic to and

from the city. Greenhouse gas emissions are largely calculated by multiplying the data on product and service consumption by the conversion coefficients for greenhouse gas emissions that are relevant to each consumer segment. For some of the emissions (such as from the waste treatment facility), data was obtained from direct emissions from the Ministry of Environment EMR.

Assessment of emissions for every sector, assumptions and limitations of calculation

Electricity: In the electricity sector, the following sectors were examined: households, industry, commerce, agriculture, the local authority and water supply. Electricity consumption data for the various sectors were obtained from the Electric Company. An itemization of electricity consumption by the city was obtained from the Electric Company for 2015. Electricity consumption data for the local authority includes schools, preschools, shelters, sports facilities, municipal buildings, social service institutions and street lighting. Furthermore, data was compiled regarding the volume of electricity production through solar panels on roofs of municipal institutions. At this stage, we do not have data pertaining to solar electricity production on the roofs of commercial spaces or private homes. This report does not include details on specific emission sources in authority sectors. The commercial sector lacks at this stage details regarding emissions from specific hotels and commercial centers. In the public sector, emissions for hospitals and various government institutions in the city and in the port industrial sector. The report also does not include an internal municipal distribution in the geographical spread based on neighborhoods as well as industrial and hotel areas. This in-depth analysis of the emissions assessment will be conducted in the ensuing stages of the project.

The conversion coefficient of kw/h from the national electric grid for CO_2e for 2014 was obtained from the Electric Company (685 gr CO_2e) and is the result of all fuels used by the Company in 2014.[2]. The emissions from the power plant in Eilat are grossed up in the national emissions coefficient and as such were not calculated as an addition to the municipal emissions in order to prevent 'double calculation. A review of the matter reveals that the power plant in Eilat is operated and supply electricity during peak demand times across the country as part of the national system and not only in Eilat.

The emissions saved in Eilat due to use of solar energy is offset in the emissions report of the Local Authority. This stage did not address emissions in the life cycle of electricity production from a solar source (system production and maintenance) and the life cycles of raw material supply to the power plant to generate electricity.

Transportation: Emissions related to the transportation sector are attributed to mileage of vehicles in the city, mileage of city residents outside the city, mileage of visitors to the city (tourists and others) through land and air transportation, and delivery of cargo to and from the city. As a result of the limited data cities, we cannot at this stage isolate mileage in the city. Subsequently, emissions from transportation that are presented in the report also includes some of the emissions of residents who travel outside the city. It is largely acceptable to display these emissions as part of a Level 3 assessment. Later in the project, we plan to broaden the internal urban analysis so that the emissions from the mileage in the city can be fully separated from the emissions attributed to mileage of residents outside the city.

As such, the emissions of the transportation sector in this report includes the following components: (a) emissions from mileage of city residents in private vehicles inside and outside the city, (b) emissions from public transportation mileage in the city (c) emissions from mileage of local authority vehicles. (d) Emissions from taxi cabs inside and outside the city (e) emissions from registered commercial vehicles that operate in the city (f) emissions from trucks in the city (f) emissions from tour buses in the city.

[2] Emissions calculator – Electric Company.
https://www.iec.co.il/environment/pages/pollcalculator.aspx

At this stage, the report does not include flights to and from the city, or mileage of visitors in the city (tourists).

Data on emissions assessments from transportation were obtained from various sources: from the Ministry of Transportation, mileage data of private vehicles registered in the city, from the CBS data on transportation at the entrance to the city, from the Ministry of Environment's NAMC model mileage of trucks and buses arriving in the city. Conversion of mileage into greenhouse gas emissions was based on conversion coefficients used by the 15th Forum that was based on the directives of the international organization ICLEI (which operates within the confines of Covenant of Mayors). Below is a list of the method of assessing emissions for each component in the transportation sector:

(a) Emissions from city resident mileage in private vehicles inside and outside the city – the Ministry of Transportation database includes mileage data for every vehicle in the past year since the previous annual test. This data is compiled during the vehicle's annual test. The database also includes other data for each vehicle, such as make, model, year, engine volume, and site of the vehicle's registration. Through this data, the emissions can be calculated for each vehicle registered in Eilat based on its mileage. As specified, during this stage, we cannot distinguish between the mileage of these vehicles inside and outside the city. The emission coefficient used: 300gr CO_2e per km per vehicle, 100gr CO_2e km for two-wheel vehicle.

(b) Emissions from public transportation in the city – in order to assess the emissions of public transportation in the city, as part of the emissions of other buses in the city, the emissions from public transportation were calculated based on frequency of urban lines and km for each line according to the Egged site. The emissions coefficient was calculated based on conversion variables of the Ministry of the Environment for bus mileage emissions. The emission coefficient used is 820gr CO_2e per km bus.

(c) Emissions from local authority vehicles mileage – These emissions were calculated by converting the fuel (diesel and solar) consumption data obtained from the city for greenhouse gases. The conversion coefficient used is 742gr CO_2e per vehicle using gas, 847gr CO_2e diesel vehicle according to the Ministry of Transportation.

(d) Emissions from taxi cabs inside and outside the city – Taxi cab mileage in the city was obtained from the Ministry of Transportation database. The emissions assessment was carried out in an identical manner for passenger vehicles (Section A). The emission coefficient used is 300gr CO_2e per km taxi cab.

(e) Emissions from a commercial vehicle registered and operating in the city = mileage of commercial vehicles registered in the city was obtained from the Ministry of Transportation database. The emissions assessment was based on the conversion variables of the Ministry of the Environment and the 15th Forum on Truck Mileage Emissions.

(f) Emissions from buses arriving in the city – Mileage of buses that arrive in the city (intercity public transportation and private buses) was based on measuring the traffic at the entrance to the city along with the NAMC model. The emission coefficients were calculated based on the conversion variables of the Ministry of the Environment and the 15th Forum on Bus mileage emissions.

Water and waste: The water component includes the emissions attributed to energy involved in supplying water to the city, and treatment of waste generated by the city. At this stage, the report includes emissions related to use of electricity in water supply to the city zones, and methane emitted from waste. The energy involved in waste treatment itself is included in all emissions attributed to electricity use in the city. Electricity consumption date was obtained from the Electric Company report and data on waste emissions from the Ministry of the Environment (PRTR). The

report presents a distribution of emissions attributed to water consumption based on water consumption of the various sectors in the city.

Solid waste: This component includes methane gas emission from the solid waste dump site. Data on quantities of waste were obtained from municipal reporting, around 2013. The emission coefficients were calculated according to 1 ton of *carbon dioxide equivalent = 0.0476 ton of methane based on coefficients of the 15th Forum.*

Cooking gas: The emissions from cooking gas focus on the household consumption only. The data was calculated from the Ministry of Industry and Energy model, which calculates consumption of cooking gas per capita per year, and found extensive use in the carbon footprint reports of various cities in Israel. Data in this sector was converted according to 1 ton of carbon dioxide = 653 liter LPG. The calculation does not include at this stage consumption of cooking gas in the commercial sector, which includes the hotel and restaurant industry in Eilat, which apparently is the significant consumer of this component.

3. Findings of the Emissions Survey

3.1 Summary of emissions

The total greenhouse gas emissions in Eilat is 531,970 tons of carbon dioxide equivalent (CO_2e). Diagram 2 presents the breakdown of emissions of the city into main emission components based on emission sources (electricity, transportation, water, waste and cooking gas). The diagrams reveal that the most significant factor is the emission from electricity consumption, which comprises almost 80% of all emissions in the city. Table 1 presents the quantities of emission by source. The report later presents details of each of the said components. It is important to note that whereas the electricity component is the most significant component in urban emissions, the assumption can be made that continued monitoring and review of other components related to indirect emissions in the city (travel of visitors, flights to the city, food consumption, etc.) will reduce the relative share of this component. At the same time, this finding indicates possibility of significant streamlining and reduction in Eilat in both promoting and encouraging behavioral change in households and businesses and by promoting the use of sustainable sources and adoption of methods for energy efficiency.

Diagram 2 Breakdown of all emissions in the city by source of emission

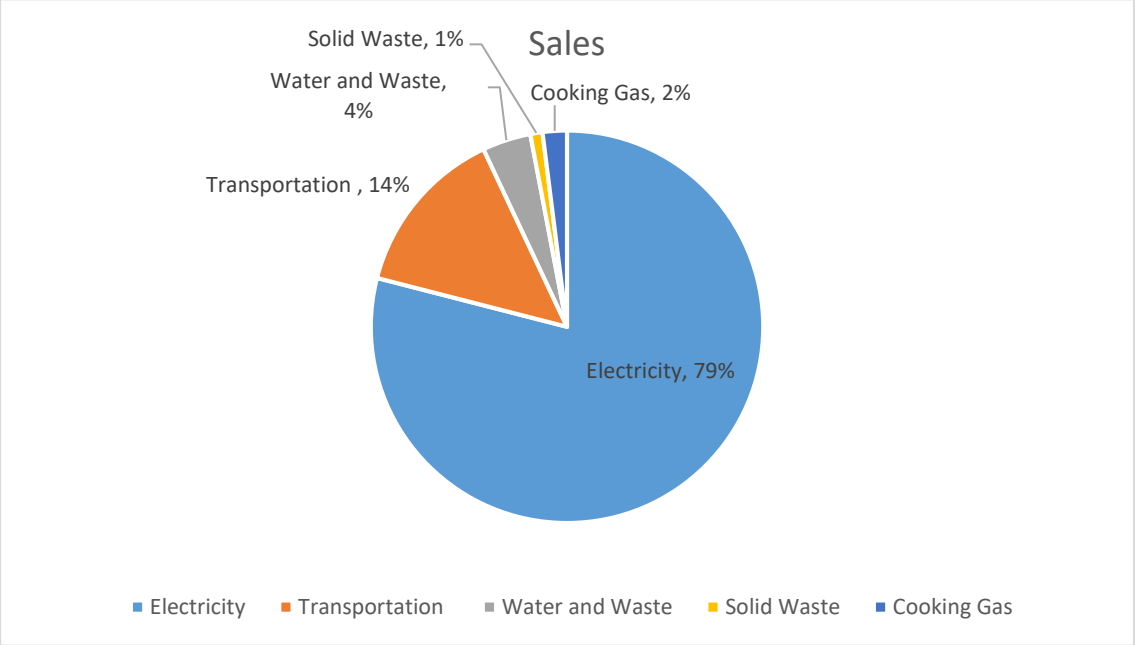


Table 1 – Greenhouse Gas Emissions based on Source

Source of Emission	Greenhouse Gas Emissions (CO_2e ton)
Electricity	421,180
Transportation	76,720
Water and waste	24,020
Solid waste	1,550
LPG	8,490
Total	**531,970**

Diagram 3 and Table 2 present a breakdown of emissions between various sectors in the city (public, commercial, industrial and household sectors). These scenarios reveal that the most significant sector is the commercial sector, which comprises 59% of all emissions in the city, followed by household, which contributes 35%. It should be noted that the share of households in emissions also includes emissions of vehicles outside of Eilat, whereas the other sectors include emissions only related to operations inside the city. As a result, if an assessment is made of emissions in the city itself, the share of households is expected to decrease whereas the share of the other sectors, particularly the commercial sector, is expected to increase.

Diagram 3 Breakdown of all emissions in the city by sector

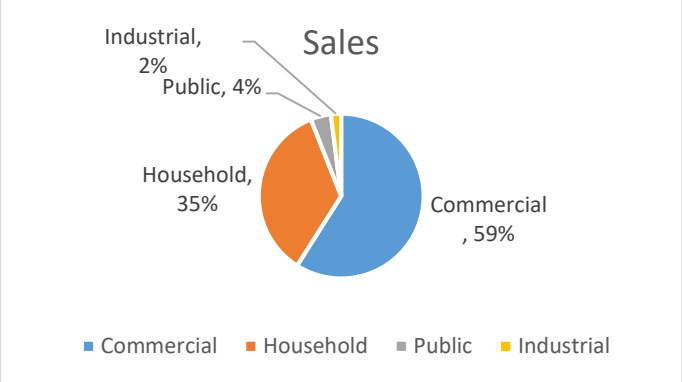


Table 2 and Diagrams 4 a,b,c present the breakdown of emissions for each of the main municipal sectors

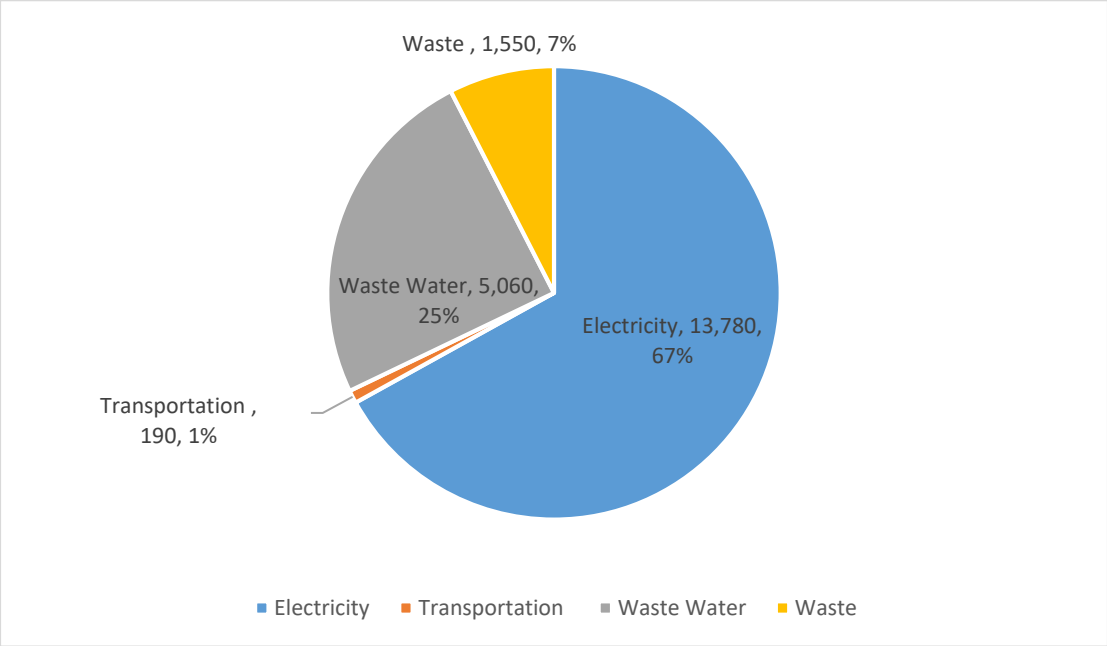
Table 2 – Greenhouse Gas Emissions by Sector and Emission Component

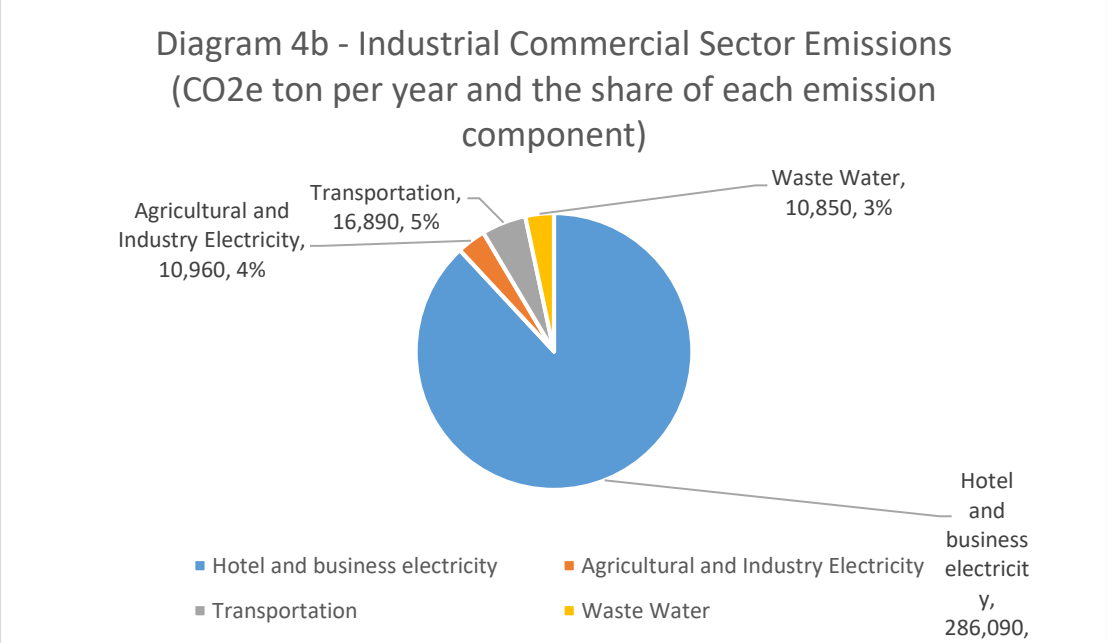
Sector	Greenhouse Gas Emissions (CO_2e ton)				
	Electricity	**Transportation**	**Water and Waste**	**Other**	**Total**
Public	13,780	190	5,060	1,550	**20,580**
Household	110,350	59,640	8,130	8,490	**186,600**
Commercial	286,090	15,150	8,590	-	**309,830**
Industrial	10,960	1,740	2,260	-	**14,960**
Total	**421,180**	**76,720**	**24,020**	**10,040**	**531,970**

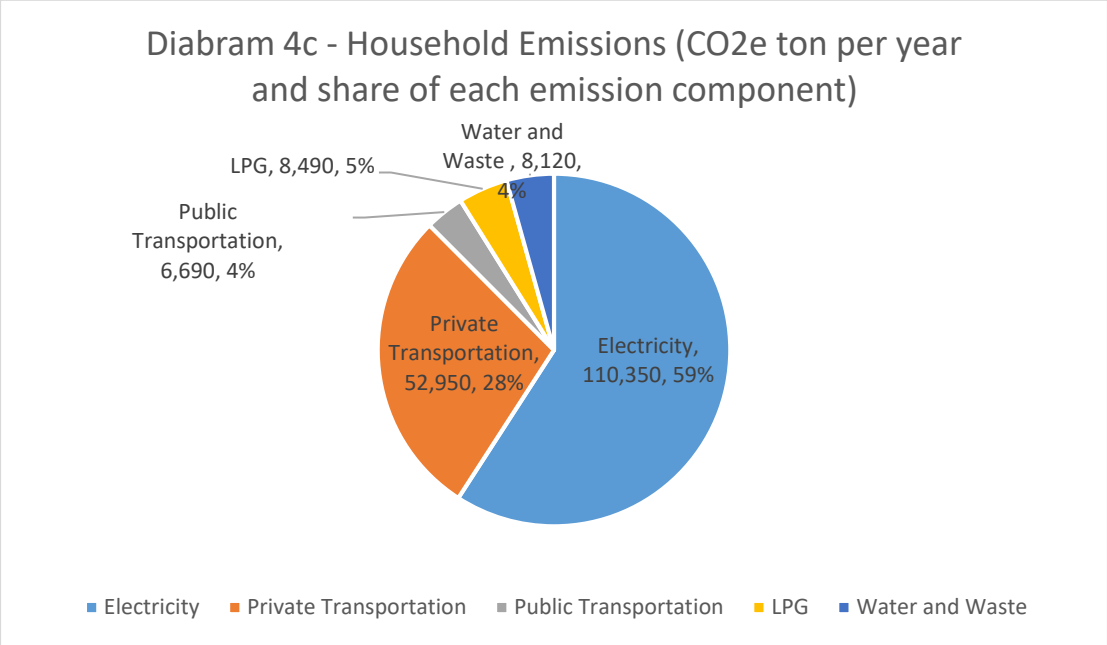
The results clearly reveal that the emissions component related to electricity consumption constitutes the main source of emissions (67% in the public sector, 88% in the commercial sector, 59% in the household sector). This identification can constitute the basis for reviewing various actions to reduce emissions in this key component. Transportation is the second largest source after electricity. In the household sector, this component is a significant percentage. Emissions attributed to

the use of water and waste treatment constitute a significant percentage of public sector emissions and includes, inter alia, significant emissions related to irrigation of public areas and public building operations in the city.

Diagram4a – Public Sector Emissions (CO_2e ton for the year and the share of each emission component)







3.2 **Greenhouse Gas Emissions from Electricity Consumption in the City Limits**

As is revealed by the summary of emissions presented in Diagram 2, the source of the majority of emissions in the city is attributed to electricity consumption (421,180 ton CO2e). Diagram 5 presents the breakdown of emissions attributed to electricity consumption between the various municipal sectors, and Table 3 details the total emissions in each sector. An analysis of the emissions reveals that the majority of emissions is attributed to electricity consumption in the commercial sector. Household electricity consumption constitutes the second largest source. These two key sectors were not analyzed in-depth at this stage of the report and will be introduced later on. The emissions attributed to use of electricity in water supply to the city are displayed here. The analysis of these emissions are presented later in the report.

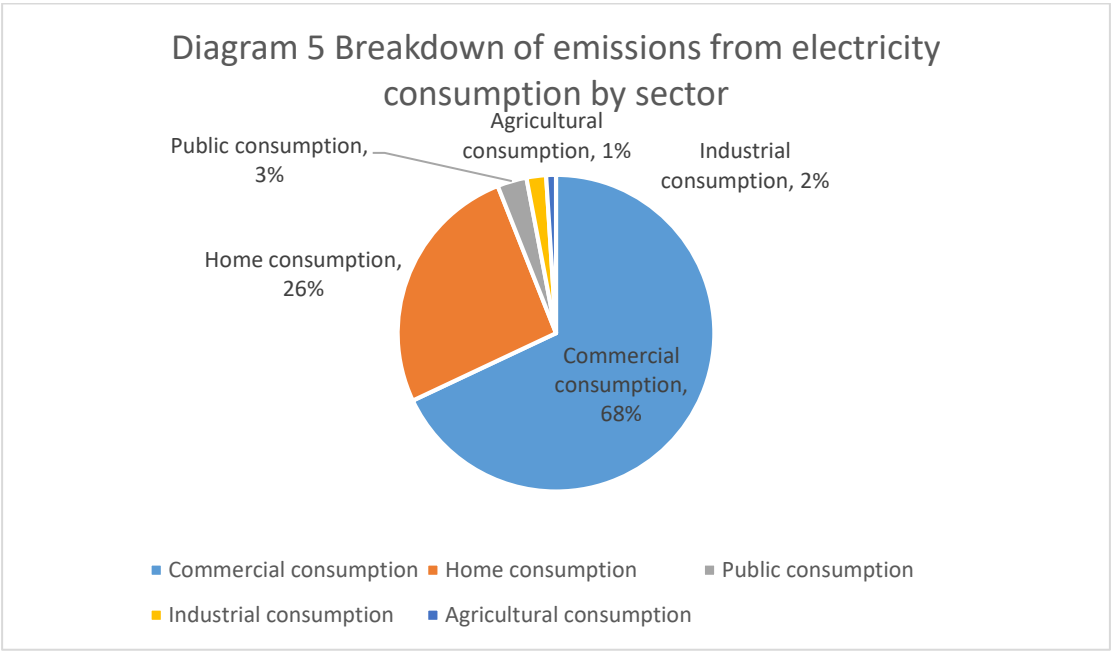


Table 3 Electricity Consumption and Emissions by Source

Sectors	Electricity Consumption for the Year (kw/h)	Greenhouse Gas Emissions (CO2e ton)
Public Consumption	21,069,570	13,770
Household Consumption	161,100,000	110,350
Commercial Consumption	417,650,350	286,090
Agricultural Consumption	3,400,000	2,330
Industrial Consumption	12,600,000	8,630
Water Consumption	32,400,000	22,194
Total	**648,219,910**	**421,180**

Note: the sum of emissions did not include the emissions attributed to consumption / supply of water that are presented below.

Although emissions attributed to electricity consumption of the city comprise only 3% of all emissions from electricity consumption in the city, the city can promote various measures to reduce emissions for which they are directly responsible and serve as a role model for other sectors. Diagram 6 presents the components of electricity consumption in the city. Table 4 details the total emissions of the various components. The most significant component is street lighting, which constitutes approximately 80% of all electricity consumption emissions in the city.
As part of the report, the first move was made in an attempt to examine the potential contribution of promoting energy from renewable sources to reduce urban emissions. At this stage, we only included solar protections located on buildings for which the municipality is responsible in several schools. A total of 12 roofs were included, with each roof generating 50 kw for the national grid (approximately 1,000,000 kw/h per year). This amount of electricity saves almost 700 tons of carbon dioxide. This 'clean' energy production is offset by the emissions in the city. At this stage, the emissions attributed to the life cycle of solar energy production were not included.

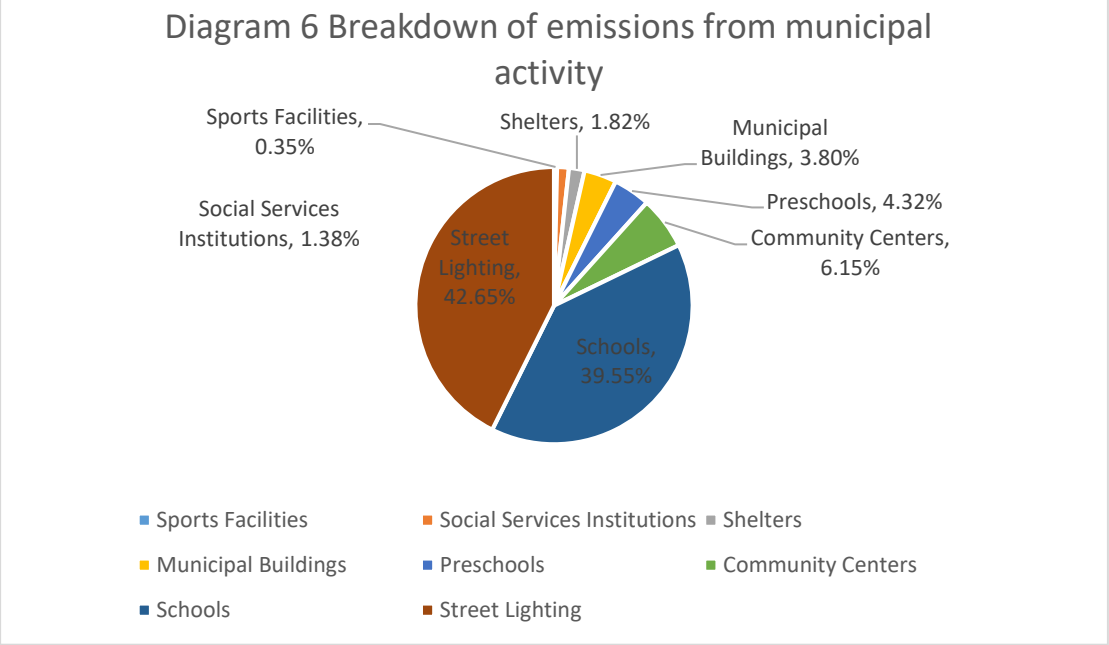


Table 4 Electricity Consumption and Authority Sector Emissions

Authority Sector	Kw/h	Greenhouse Gas Emissions (CO2e ton)
Sports facilities	73,540	50
Social services institutions	290,070	200
Shelters	382,470	260
Municipal buildings	800,190	550
Preschools	909,530	620
Community Centers	1,295,380	890
Schools	8,332,660	5710
Street Lighting	8,985,730	6160
Total	**22,069,570**	**14,440**

Note: not including offsetting the emission reduction energy as a result of use of solar energy

3.3 Greenhouse gas emissions from transportation

Total emissions from transportation amounts to 76,720 CO2e ton. Chart 7 presents the breakdown of emissions by various forms of transportation included in the report. Table 5 details the total mileage (km/year) and emissions of transportation vehicles. An analysis of the emissions reveals that the most significant emissions are generated by private vehicles, comprising almost 70% of all emissions. The transportation component in municipal carbon accounting poses a complicated challenge attributed to the limited data and depending on the selected scope by the authority / municipality that was examined. As presented at the beginning of the report, the popular approach requires that local authorities review emissions attributed to mileage in their borders. Leading cities in sustainability include in their emission assessment emissions classified as Level 3 that also includes emissions from resident\ mileage outside the city, and emissions generated by mileage of visitors to the city. Due to the limited data described in Chapter 2 of this report, only some of the transportation emissions that fall under Level 1 are presented in the Level 3 emissions assessment.

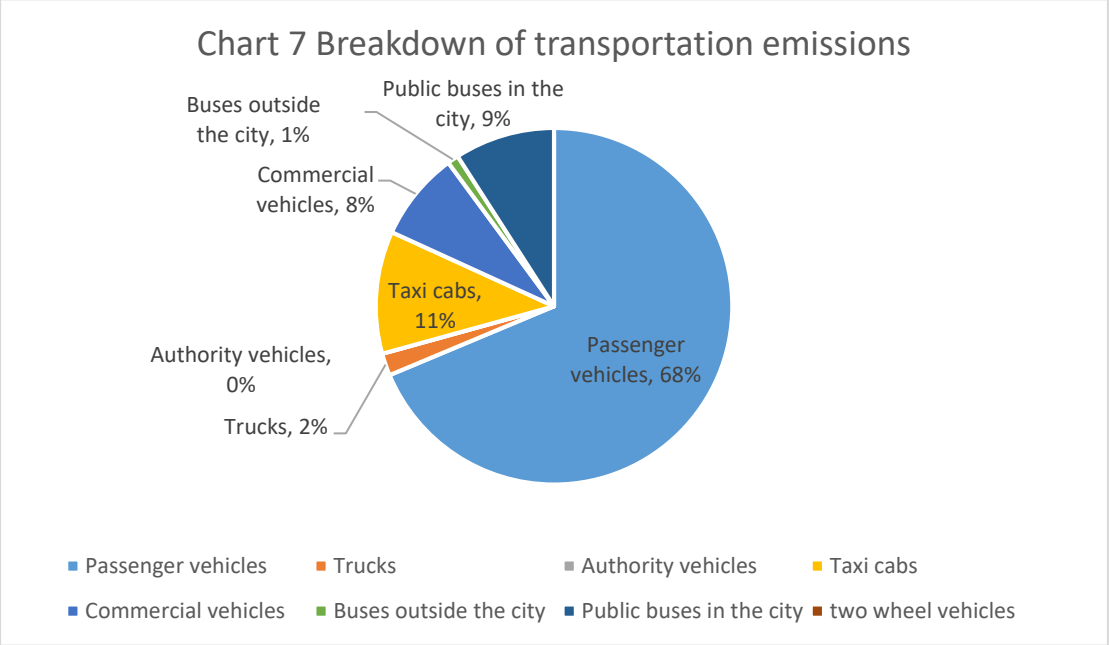


Table 5 Mileage and emissions in the transportation sector

	Kw/h	**Greenhouse Gas Emissions (CO2e ton)**
Passenger vehicles	170,502,300	52,000
Two-wheel vehicles	7,949,700	960
Public buses in the city	156,700	6,700
Buses outside the city	567,800	520
Commercial vehicles	22,851,900	6,200
Trucks	1,559,900	1,740
Taxi cabs	27,645,400	8,430
Authority vehicles	-	190
Total	**231,233,700**	**76,720**

According to Ministry of Transportation statistics, 12,430 private vehicles and an additional 1,250 two-wheel vehicles are registered in the city. Add to this number an additional 10% at least of leasing vehicles that are not registered in the city (and for which we have no information about them). In addition to the vehicles for private use that are registered in the city are another approximately 420 taxis and 800 commercial vehicles. As noted in Chapter 2, we cannot present the mileage and emission for the city itself on its own. The initial assessment is rather crude and takes into account daily use of leased vehicles in the city to the city center in both directions resulting in mileage of approximately 25 million km and emissions of 6,200 tons of carbon dioxide per year. Another component to be examined in detail later on is truck mileage to and in the city. According to Eilat Port data, every day, approximately 200 trucks arrive at the port. Travel from the entrance to the city to the port on the 20km long access road in both directions or annual mileage of over one million km and emissions of 1,250 tons of carbon dioxide per year.

Another component that is not reflected in this report is mileage of visitors in the city, in both private vehicles and by plane, a component that is expected to significantly increase emissions in the transportation sector.

An analysis of transportation emissions in the approach adopted in this report clearly reveals that private mileage of city residents comprises the largest component in mileage and emissions. Table 6 displays a breakdown of privately-owned vehicles of city residents by age of vehicles, mileage and emission. Table 7 presents this breakdown based on assessment of mileage ranges of city resident vehicles.

Table 6 – Emissions from private vehicle mileage by breakdown of vehicle age

Vehicle Age	**Number of vehicles**	**Median mileage of vehicle per year**	**Annual mileage**	**Total emissions CO2e ton**
2012-2016	2,500	15,180	42,685,500	13,000
2001-2011	8,240	11,110	111,642,200	34,000
1990-2000	1,600	6,820	14,515,200	4,400
Up to 1990	90	2,620	1,659,300	600
Total	**12,430**		**170,502,000**	**52,000**

Table 7 – Emissions from use of private vehicles based on range of mileage per vehicle in one year

Annual mileage range	**Number of vehicles**	**Annual mileage**	**Total Emissions CO2e ton**

Up to 5000 km	1,500	5,000,000	1,530
5,000-10,000	3,500	26,000,000	7,950
10,000-30,000	6,500	104,000,000	31,810
30,000-50,000	450	14,500,000	4,440
Over 50,000 km	60	3,500,000	1,070
Other	420	17,502,000	5,200
Total	**12,430**	**170,502,000**	**52,000**

3.4 **Emissions from Solid Waste**

Total methane emissions from solid waste amounts to 62,110 CO2e tons. The emissions included in the report include the emissions from landfills only. Emissions related to collection and delivery of waste appear as part of the emissions from local authority vehicles and are not part at this stage of waste emissions. According to the environment report of the municipality (2011), solid waste in Eilat includes approximately 50% household and commercial waste. The other waste involves dry waste. Later in the project, and an analysis of Level 3 emissions, emissions involved in recycling in the city and emissions attributed to the production of materials that arrive in waste will be calculated.

3.5 **Cooking gas**

As part of the report, emissions attributed to use of cooking gas (LPG) in the household sector were assessed. The data did not include an assessment for commercial sector that apparently consumes large quantities of LPG in the hotel and restaurant sector. Total gas consumption of households in the city is estimated at approximately 3 million kg per year total emissions LPG CO2e 8,491 tons.

4. **Summary of Stage A of Eilat's Greenhouse Gas Emissions Assessment Project**

This report is the first step in assessing greenhouse gas emissions in Eilat as part of the city's membership in the Covenant of Mayors, as well as the city's desire to reduce emissions and become energy efficient. The report includes emissions from the following components: electricity consumption, transportation, water and waste, solid waste and LPG, while addressing the public, commercial, industrial and household sectors. According to the findings of the report, the most significant emissions are attributed to the commercial sector, and the most significant emissions component is electricity consumption. Every sector has unique consumption and emission properties whose identification and analysis can serve as a basis for promoting measures to reduce emissions in each sector based on said unique characteristics.

The ensuing stages of the project will be included in the first stage completion of the data missing in the report, such as separation of emissions of the transportation sector, to transportation within city limits and transportation related to the city but that takes place outside the city, and preparation of a list of municipal emission components in the commercial and household sectors similar to that carried out for the public sector. During the second stage, the assessment of emissions at Level 3. A full and complete database of emissions in the city will allow for the formulation and promotion of emission reduction plans in conjunction with the municipality.

5. **Reference Sources**

- Electric Company, Electricity Consumption by Sectors 2012, February 2016
- Electric Company, Electricity Consumption by Sector The Authority 2015, May 2016
- Electric Company, Electricity Production from Solar Panels The Authority Sector 2015, May 2016.
- Electric Company, Carbon Dioxide Accounting, May 2016. https://www.iec.co.il/environment/pages/pollcalculator.aspx
- Egged, Public Transportation in the Eilat Municipality, November 2015.
- Ministry of the Environment, NAMP Model, February 2016
- Central Bureau of Statistics, Traffic Measurement, May 2016
- Ministry of the Environment, PRTR, November 2015
- Eilat Municipality, Tag Environment 2013, November 2015
- The 15th Forum, Methane Emission Coefficients, April 2016.
- The 15th Forum, Cooking Gas Emission Coefficients, April 2016.
- Covenant of Mayors (2014) Instructions: How to fill in the Sustainable Energy Action Plan template?
- Covenant of Mayors (2014) Reporting guidelines on sustainable energy action plan monitoring. www.eumayors.eu/IMG/pdf/Reporting_Guidelines_SEAP and Monitoring.pdf