NET ZERO CITIES

EU MISSION PLATFORM | CLIMATE NEUTRAL AND SMART CITIES

Climate City Contract

2030 Climate Neutrality Action Plan

Eilat

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Eilat

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Abbreviations and acronyms

Definition	Abbreviations and acronyms
Eilat's Economic Development Company	EEC
Climate Action Plan	CAP
Private-Public Partnership	PPP
Decarbonisation Pilot, part of the 2nd cohort of the NZC Call for Pilot Cities	TourZero
Israel Electricity Company	IEC
Action Plan	AP
Investment Plan	IP
Key Performance Indicator	KPI
Monitoring Evaluation & Learning	MEL
Monitoring Reporting Verification	MRV
Work Package	WP
Electric Transportation Plan	ETP
Photovoltaics	PV

Summary

Eilat, a small and remote city in the hyper-arid desert by the Red Sea, faces unique challenges stemming from its climate, demography, and economic reliance on tourism. This CCC is built upon Eilat's Climate Mitigation and Adaptation Action Plan (CAP), which outlines its ambitious goal of achieving climate neutrality by 2030, with a focus on reducing emissions from energy, transportation, and waste. The selected action plans align with existing regulations, available resources, and feasible measures, such as energy independence through solar power, the Electric Transportation Plan, and collaboration with key stakeholders such as the Hotels Association and Eilat Economic Development Company. Co-created actions such as the PPP Solar Bonds Project, PV installations across sectors and the sustainable tourism TourZero initiative (part of the NZC Call for Pilot Cities) are examples of ongoing actions that have diverse stakeholder engagement.
The CCC is an elaboration of the existing CAP and is aimed to serve as a comprehensive governance tool, and main data resource to track emissions, and co-benefits and build new strategies, namely the participation approach, with the ongoing efforts to involve stakeholders, to include significant citizen involvement, and the integration of external feedback in future iterations of the CCC.

1 Introduction

Located at the southern tip of Israel, Eilat is located in a hyper-arid desert climate, making it particularly vulnerable to the impacts of climate change such as extreme heat and flooding events. Eilat is a small and remote city, with 68,000 residents and 3 million tourists per year, mostly from domestic tourism.

Figure 1: Eilat's Location

Demography & Economy

Eilat's demographic landscape is characterised by unique challenges due to its remote location and the economic reliance on the tourism industry, encompassing 80% of the city's employment. Despite a 5.82% unemployment rate (2018 data) surpassing the national average, the demographics regarding refugees, particularly children, remain largely undocumented, leading to a lack of data-based decision-making with regard to the inclusion of marginalised groups, especially refugees.

The difficult situation caused by the war in Israel over the past months has brought unprecedented challenges. Despite the uncertainty and the inability to fully estimate the long-term impact, the city has demonstrated remarkable resilience. It has managed to host refugees, doubling its population size, and has provided them with essential support and services. This showcases the Eilat's ability to act quickly and adapt in times of crisis. We view it as a model of the city's resilience capabilities which can be replicated and scaled to other crises, such as the climate change.

Energy Independence

Eilat and its area are sunny throughout the year, with 1850 kWh/kw/year (enabling solar power generation throughout the year). This key asset enables Eilat to produce solar energy, over 100% of the city's electricity daily consumption. It is important to note that Eilat is in the midst of the desert, with warm to hot temperatures throughout the year, thus the main energy consumption in building is cooling (there is no need in heating infrastructure).

The Municipality of Eilat together with the Eilot Regional Council have been advancing an unprecedented action plan for full energy independence within the area, since 2021. This ground-breaking initiative seeks to develop a regional macro-grid by developing the ability to disconnect from the national electricity grid at crucial and extreme times. The scenarios in which the Eilat region will activate the ability to work autonomously is expected to be when the national grid is at its peak, during extreme weather events, during and after earthquakes and other extreme events that might influence the ability to supply electricity to the local grid.

This mode of operation will enable a more efficient, clean, and smart electricity network. The plan included expert reviews, market surveys, comparative analyses between different projects in Israel and abroad, current state mapping, and the identification of consumption sources and storage estimation. By harnessing local solar power facilities combined with storage systems, the model envisions managing demand fluctuations, maintaining a connection to the national grid, and selling surplus energy during peak times, projecting significant economic viability and positive environmental impact. Despite initial non-profitability, government support and policy interventions in alignment with long-term economic benefits are crucial for the Energy Independence Plan's successful implementation and potential economic benefits in the future.

Many initiatives were planned and executed to achieve the objectives of the Energy Independence Plan. These include the TourZero Pilot, accepted for 2nd cohort of the NZC Call for Pilot Cities, which will construct the governance framework to test and showcase proof of concept of energy efficiency and clean energy solutions for hotels, the PPP Solar Bonds Project is currently in the development phase which will significantly boost the city’s solar capacity and enable all residents to have their own Photovoltaics (PV), Eilat Solar Platform which facilitates PV installations in private homes and finally all other PV installations the municipality is leading in public buildings, parking lots and schools.

Resilience & Climate Neutrality Goals

The Municipality of Eilat has prioritised the resilience and well-being of its residents and visitors as a key strategic goal. To accomplish this overarching objective, we at the city's administration have identified specific sub-objectives to be addressed: climate adaptation and mitigation in an extreme desert region, energy and water independence, innovation assimilation and diversification of employment in the city. These domains were chosen due to the unique advantages offered by the city's remoteness and desert climate, aiming to transform challenges into opportunities: harnessing solar energy, aquaculture and biotechnology innovation as means to economic development and employment opportunities, and leveraging tourism for economic growth and diversity. Climate adaptation, mitigation, and innovation are integrated across these activities, reflecting a high-level priority to enhance the city's resilience.

Building the Climate Action Plan

To achieve the city’s ambitious climate goals, we formed the Climate Mitigation and Adaptation Action Plan (CAP). Given the absence of national support, the plan was developed internally and independently, resulting in limited financial resources. e strategically assigned existing staff as team leaders within five transition teams that operate across various municipal departments. The CAP process started in 2022, structured into five sequential stages which were completed in eight months: establishing the initiating team, current status analysis, assembling the Transition Teams, formulating action plans for each team, and integrating key stakeholders into the process. The Transition Teams represent a shift in the governance approach in Eilat, to form a collaborative, cross-departmental agile work. Weekly meetings ensure horizontal communication and shared goals, with team leaders playing a pivotal role in encouraging stakeholder participation and aligning the regular municipal actions (e.g., construction projects, promotion of tourism economy, working with small businesses) with the broader climate neutrality vision. This inclusive approach extends beyond municipal boundaries, with plans to expand the Transition Teams in 2024 to involve external additional stakeholders from tourism, energy, transportation, public space, nature preservation and community sectors. This will include the mapping and the outreach to more stakeholders, which are not part of the current mapping.

The City's Challenges

Eilat faces several systemic barriers in meeting its climate mitigation objectives across various sectors. In the energy sector, obstacles include high infrastructure costs and prolonged permit processes. Transportation hurdles arise from the city's remoteness, reliance on private cars both to get to the city and around the city, limited public transport options, and scattered micro-mobility infrastructure. The waste management sector lacks essential infrastructure for waste separation and local sustainable treatment. Furthermore, the city's vital tourism industry encounters financial constraints, lacks awareness, and faces insufficient access to sustainable solutions, impeding its transition to green practices.

Cross-domain barriers include political and bureaucratic complexities, lack/delay of funding, limited stakeholder engagement, and regulatory/legal challenges, which are at times impeding effective climate action.

Eilat, being the sole Mission city in Israel, encounters distinct obstacles in its pursuit of climate neutrality. The city confronts challenges due to constraints like a limited budget, insufficient expert support, and the absence of national climate neutrality regulations and targets. Consequently, we have taken the initiative to align with the Cities Mission targets and framework and adjust our CAP accordingly.

Climate Neutrality Goal, Emission Domains & City's Boundaries

Eilat's 2030 climate neutrality target is 100%, in line with our Expression of Interest (EOI). By 2030, we aim to reduce 1,020,424 tCO_2e per year. Of this reduction, 76% will be achieved through solar energy production. According to the Business-as-Usual (BAU) scenario, the city's emissions in 2030 are projected to be 787,562 tCO_2e per year. Thus, Eilat will become climate-positive by reducing more emissions than it will create.

We aim to reach over 100%, and become climate-positive, due to solar power production which will exceed the city's electricity consumption.

The built area and industrial zone are part of the 2030 100% climate neutrality target. The remaining municipal area, being uninhabited, does not produce GHG emissions. Eilat has negligible AFOLU GHGs, as the inventory-covered territories lack forestry and agricultural uses, and land use changes are generally minor, making no significant contribution or subtraction to the city's total GHG inventory. Similarly, IPPU-related GHG emissions make a minor contribution since Eilat has almost no chemical process industries.

Due to limited resources of time and budget, we have made a strategic decision to reach climate neutrality via reductions in the energy, transportation and waste domains. The focus on these domains also enables us to tackle the tourism industry challenges, as these domains are highly impacted by the 3 million tourists influx each year.

Collaborators & Stakeholders

The most critical stakeholders needed to achieve the city's climate goals are the Hotels Association, the EEC and the residents.

National ministries also play a significant role, but are mostly outside observers, as an advisory board. We are currently developing the participatory approach, but have already begun working with the Hotels Association, including them in proposals and joint brainstorming to identify barriers. Our main efforts are concentrated on expanding the transition teams into collaborative multi-actor groups, also including stakeholders with different impact and influence levels, as elaborated in Module C-1 Governance Innovation Interventions.

Regulations, Existing Plans and CCC as a Holistic Framework

The CCC Action Plan in Eilat aligns with the urban regulations of the Planning and Building Law, where relevant to the construction permits, financial and legal regulations including contracts and tenders, alignment with the City's

legal advisor decision and finally with the Electricity Law concerning energy-related aspects and regulations. The Green Construction legislation (national and local legislation) provides a supportive framework to achieve climate neutrality in new buildings.
The CCC Action Plan elaborates on the already defined actions in the CAP and aligns with the resilience and adaptation goals. Since both processes and documents are constantly updated, we are working on a mechanism that will enable a smoother and more efficient synchronisation which will include monthly meetings between the team leaders and Avi Naim, the CCC focal point. The CAP focuses more on action-based strategies and further details the high-level pathways of the CCC. The CAP undergoes updates at a higher frequency than the CCC. The CCC, on the other hand, operates more holistically, serving as an all-encompassing governance tool. It entails a central data repository, conducts calculations of GHG emissions, predicts costs and revenue, and establishes connections between actions and their co-benefits which include, amongst many others, reduction of energy poverty, enhanced citizens' participation, decreased traffic congestion, deduction of heat islands and many more as described in this CCC. It is important to highlight that both the CAP and CCC share the same KPIs.

The CCC serves as a framework that consolidates and organises previous decisions of the city, emphasising renewable energy, employment diversity, reducing the cost of living, and positioning the city as sustainable and resilient. The CCC influences the city's commitments regarding schedules and emission reductions. It impacts plans, policies, and decision-making processes at a daily level, as the Transition Teams' work is across all municipal activities. For example, it guides local regulations like green construction guidelines (an extension of the national legislation) and allocates resources to the engineering department. The CCC acts as an overarching instrument that integrates existing plans and policies, including the Sustainable Energy and Climate Action Plans (SECAPs), and the Energy Independence Plan.
The following high-level tasks have already commenced as part of the CAP, and are part of the Actions Portfolio in this CCC:

⇒ Public Space - the new zoning plan will have a designated chapter on climate change, as well as in the updated version of the green construction guidelines, greening up the city as well.
⇒ Energy - Eilat's Energy Independence Plan calculates the needed measures to reach 24/7 energy independence by 2030. The Actions Portfolio describes the required actions to achieve this goal.
⇒ The Electric Transportation Plan (ETP), a collaborative effort between the energy and transport teams, led to securing a national grant approval aimed at devising and executing a comprehensive city-wide ETP.

We have sourced different data repositories for the CCC to create a detailed overview of the city's GHG inventory. These include transportation data (type of vehicles and numbers), financial calculations and costs. In addition, we have calculated potential revenues and expected GHG reduction pathways, in a quantitative analysis which was not performed before the CCC preparations. In the qualitative analysis, the co-benefits of specific actions were analysed and are part of this CCC version. We expect to discover additional co-benefits as we proceed with the actions implementation.
The current version of Eilat's CCC builds upon existing initiatives and include also key upcoming efforts. While energy-related actions are ongoing, plans to engage citizens, reduce private cars, and establish waste-to-energy installations are in the early stages and will be further addressed with concrete action plans in the upcoming iterations. The next CCC iteration will also integrate the stakeholder feedback, insights from the Smart Mobility Plan (currently in development), lessons from initial citizen engagement and elaboration on the overall participation strategy, and an updated GHG emissions report.

Figure 2: Map of included areas.

2 Part A – Current State of Climate Action

2.1 Module A-1 Greenhouse Gas Emissions Baseline Inventory

GHG Emissions Baseline inventory

Eilat's GHG inventory encompasses the built area and industrial zone scope 1 and 2 from all sectors and sources, excluding uninhabited areas. The data presented in this CCC version is based on the second GHG inventory conducted for 2019. This inventory provides a comprehensive analysis, identifying key emission sources - electricity, transportation, and waste. The numbers and figures presented in this CCC version are based on the calculations according to the existing 2019 report and assumptions of GHG reductions. The conversion between electricity to GHGs is based on a factor provided by the Ministry of Environmental Protection. This baseline stands as a crucial foundation, emphasising the pivotal roles of the energy and transportation sectors in the city's total emissions. This realisation informs strategic decisions to prioritise renewable energy initiatives and reduce private car usage, aligning with the broader goal of achieving resilience and energy independence.

While the 2019 inventory report covers all relevant emission sources, does not have any gaps and is aligned with the requirements stipulated in the Cities Mission's Info Kit, efforts are underway to acquire detailed emission data, particularly for energy and transportation with breakdown into types of vehicles, zones and more detailed consumption data. This involves collaborative efforts and is not solely dependent on the municipality (e.g., the IEC). This data is not mandatory but will enable us to tackle specific areas and sectors. Looking ahead, a Q3 2024 updated GHG inventory is in the pipeline, planned to be submitted to the MyCovenant reporting system.

Expanding on the baseline inventory's significance, it functions as a valuable data repository for monitoring and quantifying mitigation measures within the City's CAP. Beyond mere documentation, this CCC version enhances the strategies identified in the CAP, providing more nuanced sub-ideas, quantification, and co-benefits that enrich the depth of climate action.

Technical comments to understand the data and Eilat's situation:

- ⇒ **Energy is the central focus due to its significant share in emissions and the solar power potential** to mitigate emissions while gaining resilience. Current solar energy production, standing at 547 MWh, is projected to reach 710 MWh by 2030.
- ⇒ There is no heating infrastructure in Eilat (no combustion)
- ⇒ Transport: there are almost no EVs in the city (their contribution is negligible for the city-wide calculations). All the numbers refer to direct emissions from both gasoline and diesel fuelled vehicles.
- ⇒ Water Supply and Treatment is reported under waste category.

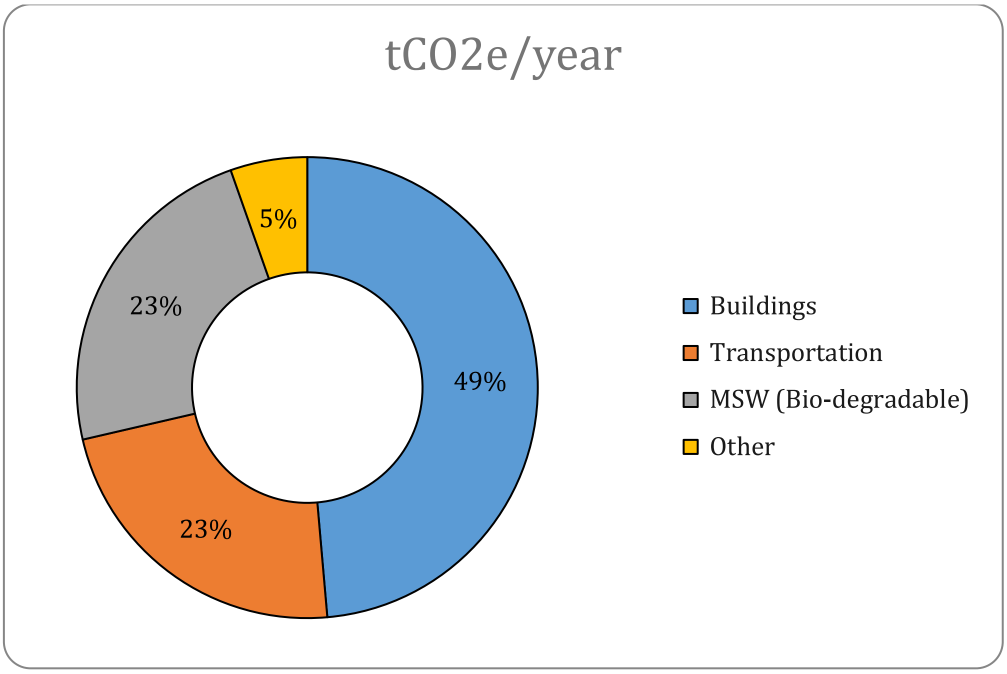

Figure 3 tCO^2e GHG Emissions by Usage

Up to 2019, electricity usage was the most intensive in emitting GHG emissions, while transportation and MSW are similar in their GHG emissions.

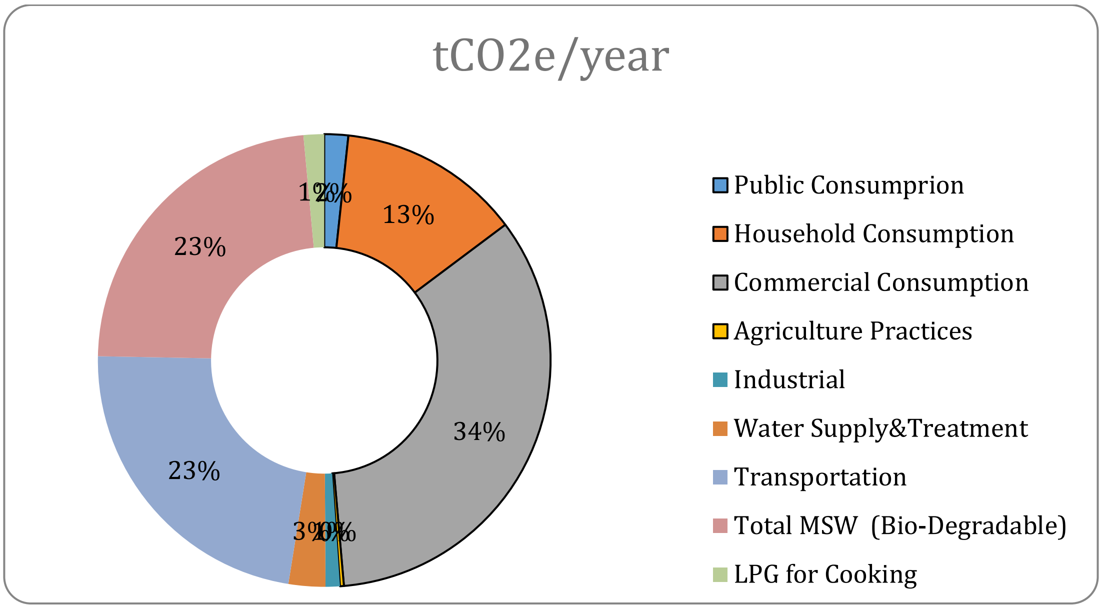

Figure 4: tCO^{2}e Emissions by Sector

The detailed sectors derived from figure 3. The most intensive sector is the commercial sector and the MSW as well as transportation is similar in their part of the emissions. The commercial sector includes hotels, malls, shops and recreational activities such as water parks, underwater observatories and more. Transportation also includes boats and ships.

Table 1: A-1.1 : Final Energy Use by Source Sectors

Base year:	2019				
Unit	kWh per Year				
Sector	**Scope 1**	**Scope 2**	**Scope 3**	**Total**	**Fuel Type/Energy Use**
Public Consumption		21,069,570		21,069,570	Electricity
Household Consumption		161,100,000		161,100,000	Electricity
Commercial Consumption		417,650,350		417,650,350	Electricity
Agriculture Practices		3,400,000		3,400,000	Electricity
Industrial		12,600,000		12,600,000	Electricity
Water Supply& Treatment		32,400,000		32,400,000	Electricity
Transportation	226,684,447			226,684,447	Petrol/Diesel

Total MSW (Bio-Degradable)			410,807,946	410,807,946	Landfill Emissions & Waste Management (Emission From waste generated within the city boundary but sent to landfill outside the city boundaries).
LPG for Cooking	60,616			60,616	LPG
Total	**226,745,064**	**648,219,920**	**410,807,946**	**1,285,772,930**	

Table 2: A-1.2: Emission factors applied

The Methodology used is published by the Ministry for Environmental Protection, as calculated in the annex “Baseline & Actions”. Sources of coefficient are from EIA for the Wastes conversions and from Ministry of Environmental Protection, National electricity grid Weighted annual emissions coefficient (Ministry of Environmental Protection 2022).
Carbon dioxide equivalent values are calculated using the Israel Ministry of Environmental Protection Assessment Report Potential values, including the following gases: CO2, NO2, CH4, and F-gases.

Primary energy/ energy source	Carbon Dioxide (CO_2)	Methane (CH_4)	Nitrous Oxide (N_2O)	tCO_2e	Source
National electricity grid Weighted annual emissions coefficient	4.69E-04	6.20E-09	3.60E-09	4.69E-04	Ministry of Environmental Protection 2022
Private car (including two wheels) all years	1.88E-04	8.29E-10	1.21E-09	2.34E-03	Ministry of Environmental Protection 2022
Buses	1.18E-03	2.21E-03	3.73E-08	2.75E-03	Ministry of Environmental Protection 2022
Light Trucks up to 3,5 T	2.44E-04	2.07E-09	5.36E-09	2.75E-03	Ministry of Environmental Protection 2022
Heavy Trucks above 3.5 T	3.63E-04	4.66E-09	7.41E-09	2.75E-03	Ministry of Environmental Protection 2022
Taxis	1.88E-04	8.29E-10	1.21E-09	2.34E-03	Ministry of Environmental Protection 2022

Municipal Vehicles	1.88E-04	8.29E-10	1.21E-09	2.34E-03	Ministry of Environmental Protection 2022
Waste				1.91E+00	Israeli National Emission factor database

Table 3: A-1.3: GHG emissions by source sectors

Base year	2019			
Unit	tCO2e per Year			
	Scope 1	**Scope 2**	**Scope 3**	**Total**
Buildings	8,491	281,321		289,812
Transport	131,736			131,736
Waste			134,446	134,446
Industrial & Water Use		21,105		21,105
Agricultural Processes		1,595		1,595
				-
Total	**140,227**	**304,021**	**134,446**	**578,695**

Table 4: A-1.4: Activity by source sectors

Base year	2019		
	Scope 1	**Scope 2**	**Scope 3**
Sector: Buildings		304,021	
(Activity)		Electricity	
Sector: Transport	131,736		
(Activity)	Gasoline & Diesel		
Sector: Waste			134,446
(Activity)			Landfill outside the city
Sector: LPG	8,491		
(Activity)	LPG for Cooking		
Sector: Industrial Process and Product Use (IPPU) (Activity)	Not Relevant		
Sector: Agricultural, Forestry and Land Use (AFOLU)	Not Relevant		

Figure 5: Sankey diagrams tCO2e emissions

Upper diagram - the emission distribution according to the source of emissions and consumer
Lower diagram - The graph presents the emission reduction by PV according to the consumers.

2.2 Module A-2 Current Policies and Strategies Assessment

A-2.1: Description & assessment of policies

Policies & Regulation

The following measures encompass both local and national levels and address various aspects of sustainability, from energy production and building construction to waste management and water efficiency. We are taking proactive steps to align the city's policies with climate goals, such as expanding energy providers, implementing green infrastructure requirements for new buildings, and promoting solar PV installations. This is done without national guidance and support, as we aim to advance faster than the national climate actions. These measures and future ones will reduce energy consumption, emissions, and environmental impact while enhancing Eilat's resilience to climate change via suitable adaptation, as we see mitigation and adaptation as intertwining processes.

Table 1 Policies and Laws

Domain	Local Level	National Level
Transport	New buildings or private homes must have at least 50% infrastructure for EV charging for all parking spaces.	Israel will stop importing fossil fuel for cars by 2030.
Energy	Rooftops of new or renovated buildings must be painted in bright colors to reduce energy consumption.	All new buildings must have an energy rating, influencing their market value and promoting energy efficiency.
	New buildings or private homes must have solar panels installed before occupancy.	Permits are not required for installing solar panels, reducing costs for installers without permits.
		Energy consumers can choose their energy provider, enabling cost savings for municipalities.
Green Infrastructure and Nature-Based Solutions	New neighborhoods must have at least 20% land coverage with trees to provide natural shade and reduce emissions.	
	New neighborhoods must achieve at least 30% water efficiency to reduce consumption and operational strain on sewage plants.	
Waste	Plastic usage is prohibited within 100 meters of the coastline, with fines up to 250 Euros for violations.	
	Hotels must manage their waste independently if it exceeds specified limits.	

Strategies and Action Plans

1. The Climate Change Adaptation and Mitigation Action Plan, initiated and funded by the municipality, establishes an efficient governance model, the Transition Teams that allows swift action without lengthy national procedures. The plan includes specific mitigation and adaptation measures and their timeline.
2. The Energy Independence Plan, developed in collaboration with the Energy Ministry's Chief Scientist, calculates and includes specific actions to achieve full energy independence by 2030.
3. TourZero: Sustainable Tourism Action Plan: TourZero is one of the winning pilots of the NZC Call for Pilot Cities, cohort 2. The Pilot will create, amongst other outcomes, an action plan encompassing a roadmap for implementing mitigation solutions related to energy efficiency, food waste reduction within hotels, and transportation solutions relevant for the city's tourism sector. This action plan will include governance mechanisms, regulatory frameworks, funding sources, and a clear timeline for implementation. The action plan will be developed via round tables with hotels, ministries, transport, and residents. The Action Plan will include timeline, governance and regulations measures, funding sources, and a business plan, to overcome financial barriers and to gain the hotels' management buy-in.
4. Sustainable Urban Mobility Plan (SUMP) is currently in the preparatory phase in the city. A general strategy has been made in 2022 (attached in the annexe). A crucial element of the SUMP will be the Electrical Transportation Master Plan, currently in the preparation phase. This action plan is a collaborative effort between the energy and transport Transition Teams, who secured a national grant to prepare the city-wide Electrical Transportation Master Plan. The plan's elements have been already defined: data-based research to identify the relevant measures for Eilat based on international state-of-the-art while accommodating Eilat's unique features and specific needs; public participation, including residents and visitors to study needs and acceptance; 15 years trajectories; KPIs to monitor the empirical success and relevance of the plan. The plan will be a practical action plan for EV implementation in the city, to lower GHG emissions, improve the mobility around the city (accessibility, convenience, inclusion and safety), deploy relevant technology (e.g., V2G).
5. Greenhouse Gas Emissions Audit Protocol for the tourism industry The Worcester Polytechnic Institute has developed a GHGs emissions-auditing system for Eilat, aligning with Eilat's high-level goal to focus on decarbonizing the hospitality sector. This GHG monitoring protocol, which adheres to established emissions accounting methodologies, will be deployed in the next GHG inventory.

These existing climate action regulations, strategies and plans both at the municipal and national levels, collectively form the legal and operational framework supporting the Actions Portfolio outlined in this CCC and Eilat's CAP. We aim to create a symbiotic relationship between the regulations to Eilat's Climate Action, where one enhances the other and a stronger legal framework will be created as we showcase successful mitigation solutions of the grounds.

Calculation of BAU Scenario

We used a BAU scenario to calculate the emissions 2030 trajectories, to calculate the gap and the contribution of the mitigation efforts to reach a net positive. All the actions are driven directly from the national and legal framework, and ongoing work is already identified in the city's CAP, and some of it, as described here, is in the deployment phase. For these reasons, column 3 in Table A-2.1 cannot be calculated.

The full calculation is found in *Annex - Baseline & Actions*. We have not considered policies or plans in these calculations, thus there is no risk of double counting, rather we calculated growth rates according to the following:

- Energy - 2.8% growth rate according to BDO Israel report
- Energy for Water/Waste/Desalination - 1.7% growth rate according to BDO Israel report
- Transportation - 4.1% growth rate according to the Central Bureau of Statistics
- Waste - 1.8% growth rate according to the Environmental Protection Ministry

Closing the gap towards 2030 and reaching net positive

This CCC version and the Annex - Baseline & Actions detail the mitigation actions (i.e., the portfolio actions). Our goal is to achieve net positivity by 2030, eradicating residual emissions entirely. This ambitious target is driven by the projection that our planned solar energy production will surpass the region's actual demand. Consequently, we anticipate generating surplus energy, which can be sold to the national grid during peak times.

Table 5: A-2.1 Emissions Gap

	(1) Baseline emissions	(2) Emissions Reduction Target 2030		(3) Emission reduction through other Action Plans	(4) Emissions Gap		(5) Emissions reduction through the CCC Action Plan to address the Gap		(6) Residual emissions	
	Baseline emissions 2019	**The emissions reduction target for 2030**			**(4) = (2) – (3)**		**quantified emission reduction associated with the action portfolios outlined in module B-2.**		**(6) = (1) – (2)**	
	tCO2e	tCO2e	(%)	See explanation "BAU Scenario"	(absolute)	(%)	(absolute)	(%)	(absolute)	(%)
Buildings	409,637	780,835	76.52%		780,835	85.07%	347,067	77.20%	(371,198)	159.41%
Transportation	204,958	84,033	8.24%		22,545	2.46%	61,487	13.68%	120,925	-51.93%
MSW (Biodegradable)	163,597	155,417	15.23%		114,518	12.48%	40,899	9.10%	8,180	-3.51%
Other	9,370	140	0.01%		-	0.00%	140	0.03%	9,231	-3.96%
Total	787,562	1,020,424	100.00%		917,898	100.00%	449,593	100.00%	(232,862)	100.00%

2.3 Module A-3 Systemic Barriers and Opportunities to 2030 Climate Neutrality

A-3.1: Description of urban systems, systemic barriers, and opportunities

Energy and transportation are the main GHG emission sources of the city; thus their systems are the relevant one to tackle. These two domains, and also waste which yields significant co-benefits despite its low GHG contribution, involve all the city's systems, from infrastructure to technology, regulation, finance and social aspects. These span across sectors and are relevant to stakeholders from the private sector (SMEs), and public sector (The Municipality, The EEC, Governmental Ministries, and research institutions) and the residents and NGOs.

Stakeholders Analysis

Stakeholders within Eilat's CCC plan vary significantly in their impact across different domains and their capacity to participate in specific climate actions. Some of the actions portfolio already encompasses co-created solutions:

1. The PPP Solar Bonds Project involves the EEC as the legal operating body; the Drainage Authority was involved in locating the areas also relevant from their NBS Salt March Bird Watching project, an initiative that will deploy state of the are NBS, to renature neglected areas, to enhance biodiversity and to handle flooding event. PV installations for shading energy generation are expected to be part of this innovative project.
2. The introduction of EVs in the city currently in development involves ongoing discussions with residents, interested in the installation of charging stations.
3. PV expansion in research institutions is part of ongoing discussions with these institutions in Eilat, such as The Inter-University Institute for Marine Sciences in Eilat, to see how the municipality can support reaching net zero.

The differences in engagement levels and capacity are significant. The EEC, for example, exert considerable impact due to their role in the city's development and their available resources (funding and human resources). This specific organisation has the capacity to drive systemic changes, relatively quickly. On the other hand, community groups, NGOs and residents, while potentially less influential in the broader policy arena, can strongly impact local initiatives and may possess a higher willingness to actively participate. Recognizing these distinctions was essential for us to create specific engagement strategies. This will also ensure that Eilat's climate actions align with both the capabilities and motivations of our various stakeholders, ultimately fostering a more inclusive and effective approach to climate neutrality. We have identified potential value propositions for each stakeholder, as we believe this is an instrumental step in engaging them, enabling their meaningful participation, and getting their buy-in in building the climate-neutral future of Eilat. Additional stakeholders will be identified through our on-going work at the current projects, namely the TourZero Pilot which entails many external stakeholders. We are building a comprehensive stakeholder mapping (its initial results are presented in the figures below) to identify key individuals, organizations, and groups that can contribute to and benefit from the outlined Impact Pathways. We will conduct targeted outreach campaigns, as part of the ongoing projects and the regular work the municipality is doing with the residents, including informational sessions, workshops, and public forums (e.g., the Environmental Committee meetings), to raise awareness and invite participation from diverse sectors such as local businesses, community groups (e.g.,local activists), educational institutions (e.g., community centers which are part of the schools in the city), and NGOs (e.g., "Desert, Sea & Environment").

Residents

VALUE PROPOSITION

- Lower energy poverty
- Shading and improved walkability in the city
- Enhanced well-being and health (via climate comfort)
- Reduced noise

ACTION ITEMS

- PPP Solar field
- CAP conference
- Public Participation Strategy Plan (in progress)
- Eilat Solar Platform
- Resilience community centers across the city with energy storage

EXAMPLES

- Through initiatives like the CAP conference, which convened on May 30, 203, we have taken proactive steps to involve our residents.
- The Eilat Solar platform developed by the municipality, the Ministry of Energy and a local startup, is a one-stop-shop for residents to seamlessly install photovoltaic systems on their rooftops.
- We are planning to deepen our work with the residents to actively involve them in the CCC via the local community centres, working with each neighbourhood separately due to the extreme socio-economic differences between the different populations.

Local Environmental NGOs

VALUE PROPOSITION

- The CCC & CAP create shared overarching goal which aligns with the missions of the NGOs
- By working together we avoid overlapping resources
- Eilat as a local climate neutrality lighthouse city
- Aligning the political, professional and public sectors

ACTION ITEMS

- CAP conference
- Public Participation Strategy Plan (in progress)
- Sustainable Tourism Pilot in Eilat (TourZero)
- Plastic waste reduction
- Nature Protection

EXAMPLES

1. EcoOcean runs the GreenKey program for hotels in Israel to reduce the environmental footprint of the tourism sector. We aim to join forces and work together in Eilat's sustainable tourism Pilot (TourZero), focusing on energy efficiency, RE solutions for hotels, and food waste reduction.

- InGoodNature focuses on plastic waste regulations. Together, we work towards enforcing and raising awareness about plastic waste reduction at the coastline.
- EcoPeace runs educational programs focusing on the preservation of the marine environment in Eilat.
- Desert, Sea & Environment dedicated to safeguarding the environment from waste and pollution. We actively collaborate with them on initiatives such as clean-up dives.

The Environmental Committee serves as a platform for collaboration between residents' representatives, city council members, municipal authorities, and relevant organisations such as the Society for the Protection of Nature, the Nature and Parks Authority, the Ministry of Environmental Protection, and the Desert, Sea & Environment association. This committee facilitates the advancement of environmental issues, provides recommendations to the city council, and integrates the CAP within its framework. However, due to the upcoming elections, the next committee meeting has been postponed.

Governement

VALUE PROPOSITION

- PoC of energy independence and micro-grid at the city level, aligned with the strategy of the Ministry of Energy
- Eilat Solar platform national scale-up
- CAP & CCC are aligned with the agenda of the Environmental Protection Ministry to reduce GHGs

ACTION ITEMS

- Establish a symbiotic relationship between policy formation and local needs via direct communication and joint work with the CEOs of the relevant ministries
- Position Eilat as a lighthouse city of climate neutrality to share best practices. This can be achieved by identifying and working with governmental personnel who see the potential of Eilat

EXAMPLES

1. We hosted the Municipality of Ashdod for a study visit, organized by the Ministry of Energy to learn about implementing micro-grid and energy-independent communities
2. We envision a two-way flow of information, where the unique challenges and successful strategies identified on the ground in Eilat can inform national policies, and conversely, national policies can provide the necessary support and framework for Eilat's endeavors.

1. The Ministry of Energy is collaborating with the Municipality of Eilat through grants and pilot projects. The excellent working relationship established in recent years can be attributed to the attentive team of professionals within the Chief Scientific Office. This partnership allows us to leverage resources, expertise, and funding to drive sustainable energy initiatives and advance our transition to energy independence.
2. Ministry of Environmental Protection provides funding and support via dedicated open calls, such as urban shading solutions, a project which will be implemented in 2024. We have also been in extended discussions and activities to promote the construction of a waste management plant. This collaboration also entails the Ministry's CEO and the Chief Accountant of the Finance Ministry.
3. Ministry of Tourism - Currently there are no working relations with the Ministry. We aim to establish initial cooperation during the TourZero Pilot Project.

Eilat Economic Development Company (EEC)

VALUE PROPOSITION

- Profit generation via new initiatives and business models, namely the PPP solar field
- Future options to be involved in profitable carbon trading activities
- Increasing the company's resources (monetary, professional capacity and human resources)

ACTION ITEMS

- The EEC will be in charge of deploying the electric charging infrastructure in the city
- Establishing EEC as the owner of **The PPP solar field,** an innovative mechanism with decentralized ownership, allowing Eilat residents to own solar panels remotely based on their financial needs. This model empowers citizens by providing opportunities for profit from solar power and potential carbon trading. The initial funding will support infrastructure for 1000 residents, granting them ownership of PV systems to reduce energy poverty and generate profits. The solar field's first phase includes a 50 MW PV capacity and a 400 MW storage system, with an additional 50 MW planned for the second phase. The municipality acts as a facilitator, connecting residents with energy suppliers. A legal team is actively establishing the statutory body to manage the PPP initiative, ensuring its smooth operation and long-term success.

Research Institutions

VALUE PROPOSITION

- Eilat serves as a pilot site and experimental space for research and innovation providing researchers with a unique space, infrastructure, data and municipal support to investigate novel climate solutions.

ACTION ITEMS

- Developing an Electic Transporation Plan for the city, to increase mobility efficiency and reduce emissions
- Research partners for pilots and innovation projects.

EXAMPLES

1. Bar-Ilan University is our partner for building a strategic plan for transport-related emissions reduction and a plan for electric charging infrastructure.
2. Israel Oceanographic and Limnological Research is our partner in Project O (H2020 funded project), a joint research to treat wastewater from contaminants.
3. The Inter-University Institute for Marine Sciences is our partner in raising public awareness for coastline environmental protection
4. Ben-Gurion University - our partner in several pilots in the city to reach energy independence and climate-resilience shelters. The university's researcher is in charge of the city's emissions measurements and reporting. We will expand our work with the university by encouraging more students to perform climate mitigation research in the city.

Private Sector

	THE HOTELS ASSOCIATION	EGGED	MICRO-MOBILITY COMPANIES	THE SEA PORT
VALUE PROPOSITION	• Positioning of Eilat as a sustainable tourism city • Operational costs reduction via waste reduction and energy efficiency	Electrifying all the buses in the city which will lead to cost reduction, and profit generation via new shuttle services	Profit and client base growth. Currently there are 15 K users of scooters	• Profits growth via charging infrastructure • Alignment with international climate neutrality standards in the maritime sector
ACTION ITEMS	Partner in pilots (two awaiting funding)	We are **working with the EEC to invest in the charging infrastructure**, in return for earnings from the energy generation.	Management of the infrastructure by the Municipality to ensure compliance with other urban infrastructure and generate profits.	Charging infrastructure is currently in construction

Eilat's ecosystem mapping result is depicted in the following chart. We have identified the main stakeholders that are or should be involved in the net-zero journey of the city. We have placed them on the x-y axes according to their willingness to participate (as already proven or estimated by us) and their ability to influence others. Additionally, the size of each circle within the graph reflects the impact that each stakeholder has on GHG reduction. By visualising the landscape of stakeholders, we can tailor our strategies for different groups, effectively prioritise and identify areas where additional outreach and intervention may be needed.

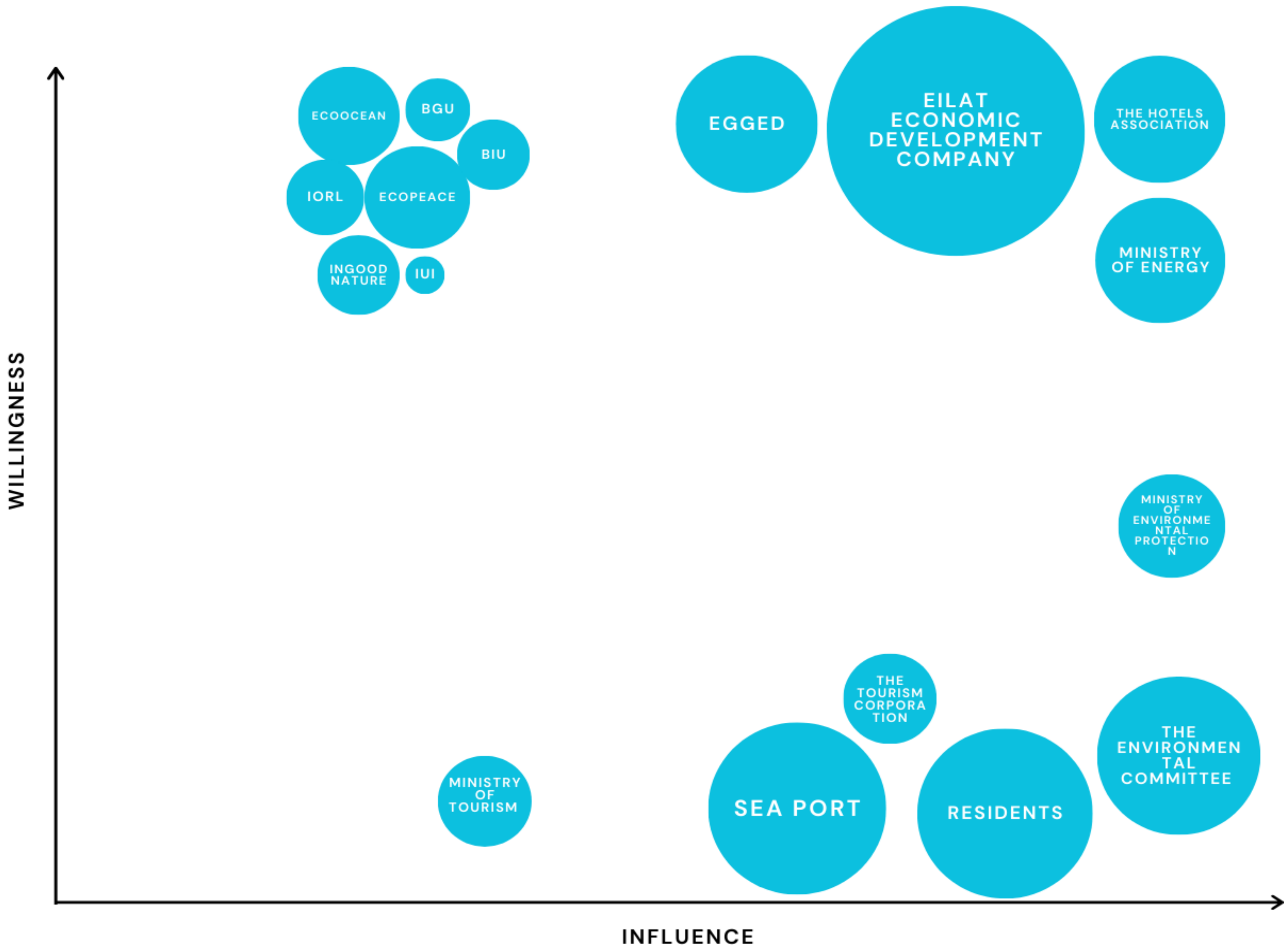

Figure 6: Stakeholders' Impact (Circle Size), willingness to participate (y axis) and ability to Influence (x axis)

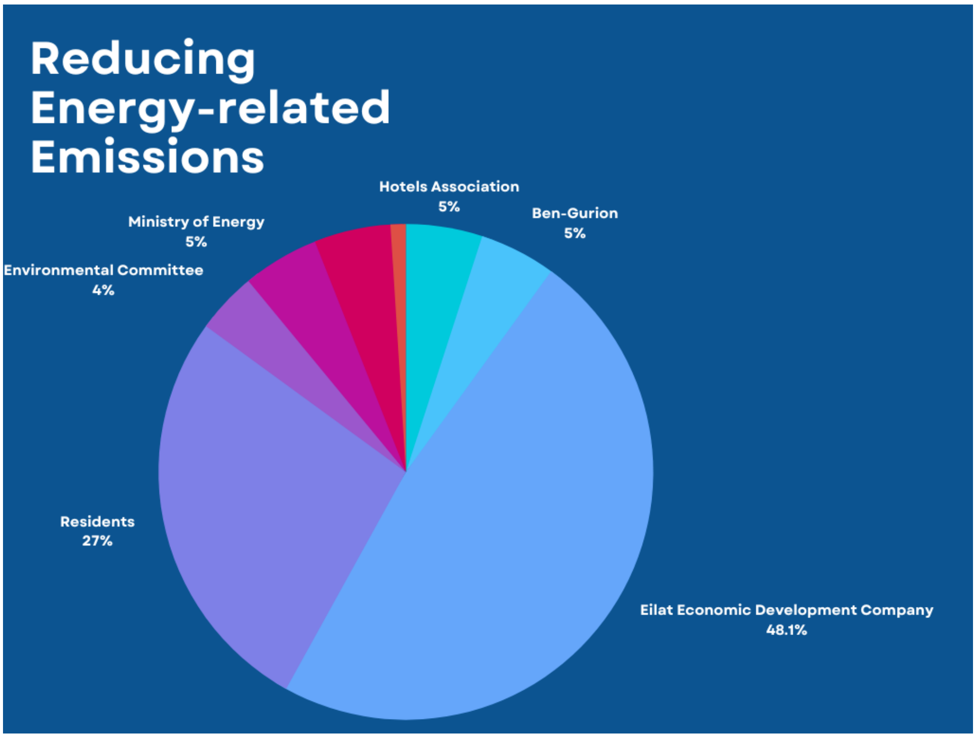

Figure 7: Stakeholders' share in energy-related emissions reduction actions

Barriers and Opportunities

Cross-domains Barriers

1. Political and bureaucratic Barrier: Political processes have multiple layers of decision-making, approvals, and administrative procedures. This bureaucratic complexity can slow the implementation of new policies or initiatives, particularly when urgent action is needed to address pressing challenges like switching to energy efficiency measures in Eilat's hotels. This shift can and should be facilitated by regulation. In addition, political decisions are often influenced by a range of stakeholders, each with their own interests, agendas, and priorities. Even if policies are approved, their effective implementation can be hindered by challenges such as resource allocation and administrative capacity as we are experiencing in the lack of waste management enforcement.
2. Lack/delay of Funding: The current monetary resources are insufficient to deliver our portfolio of actions, depicted in the CCC and the CAP, for adaptation measures.
3. Limited Stakeholder Engagement: we have significant work to do to improve the stakeholders' active involvement. The CCC has marked the initiation of a holistic strategy building to improve the city's administration collaboration with external entities and residents.

Energy

Structural Barriers:

- The high infrastructure cost and long ROI deter many entities (private, public, and residential) from making substantial investments.
- Regulatory and statutory requirements for permits are lengthy, requiring considerable time, effort, and expertise.
- Technological lock-in of solar energy due to specific natural conditions, rendering wind and wave energy irrelevant.
- Current regulatory prohibition of nuclear/hydrogen energy.

Technical Barriers:

- Israel Electricity National Company's reluctance to share information on the energy grid due to social security measures.
- PV installations require extensive land use or suitable rooftops, posing challenges for businesses, especially those renting spaces.
- Lack of space in renewable energy cables across the country, causing delays in PV implementation.
- Inadequate electrical grid infrastructure hindering the efficient installation of Solar PV, impeding the integration of solar panels into the energy network.

Behavioural/Educational Barrier:

- Reluctance of hotels to invest in monitoring tools or improve energy consumption using simple tools.
- Lack of awareness about the importance and environmental impact of renewable energy, as well as available tools, possibilities, and potential savings.

Transport & Mobility

Structural Barriers:

- The city's remoteness, lack of main roads and other means of transportation (e.g., train), burdens the reliance of the residents and especially visitors on private cars. This causes an influx of private cars into the city. The extreme heat and lack of urban continuity further increase the usage of private cars into and around the city.

- Limited options for public transport and its efficient management (types of mobility, location of stations etc.)
- Poorly planned Micro-Mobility infrastructure, scattered across tourist areas, impacting walkability for visitors and citizens.

Technical Barriers:

- Inadequate access to transport information for residents and tourists, hindering efficient use of public transportation services.
- Inconvenient payment options for tourists, creating difficulties and discouraging the use of public transport due to complex payment methods.
- Limited information on the efficiency of bus stations, lacking data and analysis for optimising the network and identifying areas for improvement.
- Inadequate variety of public transport options, leading to a restricted choice for commuters and inhibiting the shift towards sustainable mobility solutions.

Waste:

Technical Barriers:

- Lack of infrastructure for waste separation at the source, resulting in mixed waste.
- Absence of food rescue infrastructure.
- Inadequate local waste treatment facilities to manage organic waste.
- Lack of a designated recycling company responsible for collecting and recycling plastic waste.

Hotels Industry Barriers:

- Guests' expectations of large buffets contribute to food waste due to excess.
- Lack of awareness among businesses regarding the costs (both monetary and external) of food waste.
- Buffet structure prioritises staff efficiency.

Institutional and Regulatory Barriers:

- Lack of supportive regulatory and incentive systems to limit waste or ensure proper disposal.
- Enforcement Challenges:
  - Waste local regulations lack enforcement due to personnel and budget limitations.
  - Awaiting approval for the enforcement of plastic-free coasts' local regulation.

Funding:

- Insufficient funds to establish a facility for recycling renewable energy waste.

Tourism Industry

The tourism industry is lagging behind in climate action, with very few hotel chains that have begun implementing sustainable hospitality practices and even fewer restaurants and dining facilities that are on track to climate action. This lack of participation may be due to the following reasons:

- The tourism industry's focus on creating an enticing experience for the customers, is often translated into excessive offerings in food and amenities (e.g., luxurious buffet). The race to offer the best tourist experience in the industry's increasing competitiveness results in heavy consumption of resources.
- Financial barriers include lack of liquidity (especially post–COVID), the uncertainty of outcomes, risks and the level of needed investment.
- Lack of knowledge and poor access to sustainable and green solutions such as simple energy efficiency measures, avoiding food waste etc.

- The Tourism master plan with minimal reference to the environment or the climate crisis. This is due to the economic development focus and coastal protection. The lack of climate regulation or financial incentives is a cross-sector barrier.
- To address the challenge of hotels lacking flat roofs for PV installations, and those with such roofs reserving them for future expansions, a new initiative has been introduced. Now, as part of the construction process for every new hotel, a "Climate Task" is mandated. The construction entity responsible for the building must incorporate a sustainability project within its premises, which may include solar PV on the roof, energy-efficient technologies, or extensive tree planting. The municipality oversees and verifies the completion of these tasks, and if deemed insufficient, additional measures, as illustrated in Annex 5, will be required.

Opportunities & Unexploited Resources

By prioritising low-hanging fruit, particularly those with significant impact, we aim to expedite the journey to climate neutrality. The primary focus is on renewable energy, capitalising on the city's abundant sunlight throughout the year. Effective collaboration with the EEC emerges as a valuable resource, especially in the energy and transportation domains, as detailed earlier. Consequently, our priority is to expand the range of actions aligned with the EEC's scope, incorporating projects that not only align with our climate objectives but also generate profits in harmony with the EEC's key KPIs.

A key unexploited resource is energy management at a city scale. We are in the process of deploying such a system to enable monitoring of consumption and to track picks and abnormal behaviour.

Smart metres are an important measure that have yet to be implemented at a large-scale. The shift towards smart metres will enable real-time data and to migrate to a private electricity provider and to save 7% per year, approximately 600 K ILS.

We leverage the following elements to accelerate climate action, and to tackle the barriers via the following processes:

1. Policymaking: Our transition teams work across domains with all the necessary stakeholders, including policy-making when needed. We try to avoid complex policymaking as it is lengthy and dependent on too many unstable elements as politics. At the same time, we are engaging key stakeholders early in the policy development process to identify concerns and build consensus.
2. Funding: We are working on securing funding by identifying and pursuing diverse funding sources, including government grants and international partnerships. Each year we are incorporating in the city's budget the dedicated resources to implement the action plan.
3. Community and Stakeholder Engagement: To foster inclusivity and collaboration, we are building the participatory model, which will include the establishment of open channels of communication with citizens. Our stakeholder engagement strategy includes their classification according to impact, willingness and influence and according to their position and incentives, we are including them in the different climate actions.
4. Capacity Building: Recognizing that effective climate action requires knowledge and expertise and the understanding that as a municipality and public entity, we are limited in the change we can drive, skills and tools must be provided to stakeholders and the community to allow them to stir and fund the change. Through training programs, workshops, and partnerships with academic institutions, we aim to equip individuals and organisations with the tools and knowledge needed to drive climate solutions. A thorough

champions training programme is part of the city's TourZero initiative, aimed at promoting sustainable tourism in the city, as previously described in the document.

5. Transparency: Clear and open communication at all levels is a must-have in Eilat's climate actions. We are working on establishing a transparent organisational culture, which isn't a simple task. Our plan is to regularly share progress reports, data, and action plans with the public, stakeholders, and governmental ministries. We believe this not only fosters trust but also invites constructive input and scrutiny.

Monitoring

Monitoring involves a combination of quantitative and qualitative data collection and analysis.

Energy:

- Quantitative data on electricity consumption will be sourced from the Israel Electric Corporation (IEC)
- Data on cooking gas and petrol usage can be obtained from the Ministry of Energy.
- The installation of smart metres in public buildings further aids in real-time energy monitoring.

Mobility:

- Quantitative data on transportation and pedestrian movement can be gathered through radar systems.
- For the tourism sector, quantitative metrics like stays and room occupancy rates will be monitored.

Community:

- The community's perspectives will be assessed through methods such as focus groups, questionnaires, and workshops.
- Understanding behavioural changes, a key aspect of the climate action, involves qualitative assessments, possibly through interviews and observational studies

3 Part B – Pathways towards Climate Neutrality by 2030

3.1 Module B-1 Climate Neutrality Scenarios and Impact Pathways

Table 6: B-1.1: Impact Pathways

Fields of action	Systemic levers	Early changes (1-2 years)	Late outcomes (3-4 years)	Direct impacts - Emissions reductions	Indirect impacts (co-benefits)
Buildings	Finance & Business models	The PPP Solar Bonds Project & PV field 1) Established statutory body 2) Locating fields 3) Infrastructure development: The field will be divided into 30-50 areas 4) Citizens with different levels of income will be able to apply for the tender as owners	1) Increase of PV Capacity - each funding round will increase the capacity by an additional 50 megawatts. 2) Participating residents can own their own PV and will be able to benefit 50% decrease in their electricity bill via designated legal agreements with the statutory entity	146,715 tCO^2_{eq}/**yearly average reduction** 2024-30	1) Reduction of Energy Poverty 2) Citizens' active participation 3) PoC of PPP business models enabling deployment in other domains 4) Enhanced energy resilience

	Infrastructure & Governance	• PV on public buildings • PV on private homes • PV on commercial buildings • PV on open spaces + Production for Storage 1) Incentivized the widespread adoption of PV systems on private residences, including organised purchase groups 2) Streamlined administrative procedures and permit requirements for residents and businesses interested in installing PV systems	1) 5% yearly increase of PV deployment in Public, Private and Commercial Buildings	234,554 tCO^2_{eq}/**yearly average reduction** 2024-30	1) Enhanced energy resilience 2) Job creation, local capacity building and economic opportunities 3) Reduction of Energy Poverty
	Learning & Capabilities	1) **Awareness & Education** activities by our research collaborations (WPI, BGU) and via the BERLIN project operating in the Yae'lim School 2) **Energy Efficiency Awareness** pilot in the students housing	1) Increased energy efficiency, ~10% reduction 2) Energy management system to track Phantom Power	65,010 tCO^2_{eq}/yearly average reduction 2024-30	1) Reduction of Energy Poverty 2) Enhanced energy resilience
Transportation	Infrastructure	Increase of EV 1) Electrical Transport Master Plan	Reaching 30% EV vehicles, including public transport, taxis, and delivery services.	16,802	1) Improved air quality 2) Improved public health

		2) EV parking incentives 3) Deployment of technologies to lower the burden on the energy grid		tCO_2eq/year reduction on average 2025-30	3) Reduced noise pollution 4) Increased energy resilience
	Policy & regulation Infrastructure Technology	Lowering entrance of cars into the city 1) Incentives (parking lots outside the city, other methods of transportation/mobility). 2) legal framework to reduce fossil-fuel cars 3) Enhance Public Transportation options	1) Estimated 10% fewer cars entering the city each year 2) Piloting vehicle-free zones in the tourism area and other parts of the city, to gather data, acceptance and insights for permanently closed areas 3) Increase of sustainable mobility options, replacing private cars 4) Increased options of public transportation	18,580 $tCO^2{}_{eq}$/yearly average reduction 2025-30	1) Improved air quality 2) Improved public health 3) Reduced noise pollution 4) Decreased traffic congestion 5) Increased safety for pedestrians and cyclists 6) Enhanced aesthetic of the tourism area
	Policy & regulation Infrastructure	Limiting and regulating freight trucks around the city	Estimated 5% less trucks in the city each year	1,858 $tCO^2{}_{eq}$/yearly average reduction	1) Improved air quality 2) Improved public health 3) Reduced noise pollution

				2025-30	4) Decreased traffic congestion 5) Increased safety for pedestrians and cyclists 6) Enhanced aesthetic
Waste	• Capacity building • Regulation • Governance	**Action Plan for organic waste decrease in hotels** results of TourZero Pilot's Living Labs and The Climate Acceleration Hub, co-managed with external stakeholders 1) Waste audit and assessment (currently in process) 2) Capacity building and training programs for hotel staff on sustainable food and waste management 3) Piloting anaerobic digestion and composting solutions 4) 10% food waste reduction **in hotels**	Reaching total 25% city-wide food waste reduction (scale-up of TourZero's results) via: 1) waste regulation 2) Enhanced composting infrastructure and other waste types 3) Circular economy approach in hotels	34,458 tCO^{2}_{eq}/yearly average reduction 2024-30	1) Cost savings each 1 NIS = (0.25 EUR) invested in food rescue, creates a value of 4.2 fold for the national economy[1] 2) Land use: diverting organic waste from landfills 3) Reduction of garbage trucks
	• Infrastructure • Policy	1) Improve the efficiency of the waste collection 2) Establishment of waste to energy plant	1) Waste to energy plant is operating, reducing 60% of the waste discarded to landfills	83,193 tCO_2eq/yearly average reduction	1) Cost savings via Reduction of garbage trucks

[1]The National Food Waste and Rescue Report, 2021

			2) Energy generation	2024-30	2) Land use: diverting organic waste from landfills
Green infrastructure & nature-based solutions	Infrastructure	Natural environments mapping & Restoration ecology	1) Increased green infrastructure 1) Reduction of Heat Islands 2) Carbon Capture	TBD	1) Restoration of biodiversity 2) Improved Air Quality 3) City's aesthetic Enhancement 4) Nature-based 5) Enhanced walkability 6) Energy conservation 7) Tourism development (economic and social co-benefits)
	Infrastructure	Increased Shading Infrastructure (exact quantification is currently unavailable)		97 tCO_2eq/yearly average reduction 2024-30	

B-1.2: Description of impact pathways

The Impact Pathways, encapsulating our portfolio actions, were strategically chosen to address the city's core priorities and needs. Initiated at our work on Eilat's CAP, prior to our work on the CCC, these actions align with the city's **focus on energy resilience, low carbon mobility**, **waste-to-energy** initiatives, **biodiversity management**, and lowering the **urban heat island effect** via green infrastructure, contributing to the city's goal to enhance resilience with climate adaptation focus.
Our decision to concentrate on these pathways stems from their alignment with the city's priorities and the fact that they fall within our control, minimising reliance on external factors like national bodies, external policies and large investments. This approach allows to tackle the challenge of insufficient national regulation and incentives, enabling the city of Eilat to drive its green transformation independently.
Emphasising renewable energy directly tackles the funding gap, leveraging the city's abundant sunny days for photovoltaic projects with positive ROI. Similarly, within transportation, our focus on electrification, and reducing private car influx addresses actual needs while enhancing overall urban mobility, citizens' well-being and achieving climate mitigation. These transportation-related actions are selected within our mandate and budget constraints, ensuring practical and feasible actions.

While the selected actions and their impact pathways are subject to an evolutionary process, adapting to economic feasibility and stakeholders onboarding, they predominantly address **short-term climate priorities**. However, their effect extends into long-term climate mitigation and adaptation, as our calculated trajectories showcase in the attached Excel ("Actions" sheet). This emphasis on short-term actions aligns seamlessly with existing work processes of the CAP, municipal budget considerations, and the immediate needs on the ground, aligning with our pragmatic approach to climate action, to have **maximum impact within realistic constraints**.

It is important to highlight the great challenge in changing transportation infrastructure and solving issues such as the influx of private cars. Currently, there is no dedicated employee responsible for transportation, and even those entrusted with it lack the necessary skills or time to focus solely on these vast challenges. Following the elections (took place at the end of February), we will initiate a recruitment process for a transportation engineer. Additionally, we have two ongoing EU-funded projects which will boost our efforts, via the mapping of micro-transportation routes, providing an immediate response to active routes while developing inactive routes (LEONARDO), and the feasibility check of autonomous electrical shuttles, both inland and marine (CultureRoad). Moreover, within the ETP, there will be provisions for micro-transportation, e-mobility, both private and public. Implementation of the bike master plan and the decision to integrate bike lanes wherever roads are renovated, along with the implementation of shading plans to enable pedestrianism and stay in shaded areas, will also improve transportation. It should be noted that its implementation will be gradual, with a focus on climate issues.

The co-benefits of the Impact Pathways include a significant reduction in energy poverty and enhanced energy resilience, increased citizen participation in sustainable practices, driving job creation and local capacity building both in the private and public sectors. We aim to improve air quality, public health, roads safety, and reduce noise pollution mainly via less private cars and more sustainable and public transportation options. Most of the impact pathways will essentially lead to the reduction of the living costs in Eilat, improved climate adaptation and overall increased city resilience. A thorough analysis will be conducted to assess these co-benefits in detail, and the initial analysis results will be presented in the next Climate Council (CC) iteration.

3.2 Module B-2 Climate Neutrality Portfolio Design

Technical comments:

⇒ Tables B-2.1 and B-2.2 were merged to avoid duplications

⇒ Reference to impact pathway is unnecessary as all actions are listed in the impact pathway

⇒ GHG emissions reduction estimates are calculated for each year separately in the Annex - “Baseline & Actions”

Table 7: B-2.1: Description of action portfolios

Fields of action	Portfolio description	
	List of actions	**Description & Data**
Energy systems	PV on public buildings, private homes, commercial buildings, open spaces and Production for Storage	**Timeline: on-going implementation (2024-2030 and beyond)** The comprehensive approach to advancing solar energy integration encompasses various initiatives and strategies, all aligned to enable widespread PV adoption and maximise benefits. All calculations and technical details are in the City's Energy Independence Plan and the annexed solar power plan, including costs, income projections, emissions savings, and return on investment (ROI), providing a transparent and calculable framework for interested stakeholders. The existing local and national legislation ensures all new buildings will have PVs across the different sectors. Private homes PV installations are mainly driven by the Eilat Solar Platform, an innovative urban solution that is a one-stop-shop, simplifying procedures for residents interested in installing PV. To diversify the energy landscape, we will work on engaging with a diverse array of RE providers. This strategic move is designed to significantly reduce energy costs compared to the rates offered by the IEC. By fostering competition among RE providers, Eilat aims to make renewable energy more accessible and affordable for its residents and businesses alike.

		Responsible bodies/person for implementation: Elad Topel Smart City Coordinator, Avi Naim Energy Project Manager, Dudu Zatch Energy department Action scale & addressed entities: city scale Involved stakeholders: Eilat Economic Development Company, Municipal contractor, Ministry of Energy, Israel electric company, Residents Comments on implementation: Depends upon available budget
		Generated renewable energy: 547 MWH Total costs and costs by CO2e unit total cost of 143M euro until 2030
	The PPP Solar Bonds Project	**Timeline: 2024 legal phase and implementation in the field; 2025-2030 and beyond gradual increase in fields' size** The model issues solar PV bonds to the public, ensuring funding for large-scale projects. Divided into three sections, it promotes public participation: Energy Supplier: Eilat aims to become the city's energy provider, offering a 20-30% electricity cost discount to every resident, enhancing energy resilience, and addressing energy poverty. Solar Field Production: A 20 MW solar field at the city's borders, funded by Solar PV bonds, allows citizen investment in renewable energy. Household Participation: Residents can engage in both sections, with the opportunity for 25 years of passive income through Solar Bonds, fostering inclusivity.
		Responsible bodies/person for implementation: Elad Topel Smart City Coordinator, Avi Naim Energy Project Manager, Dudu Zatch Energy department Action scale & addressed entities: city scale Involved stakeholders: Citizens, Eilat Economic Company, Eilat Municipality Comments on implementation: Legal statutory body is currently in development

		Generated renewable energy 30000 KW (first round, 150 km^2) Removed/substituted energy, volume or fuel type Natural Gas Total costs and costs by CO2e unit: 15M EURO
	Energy Efficiency awareness	**Timeline: on-going implementation (2024-2030 and beyond)** Energy efficiency will be achieved via awareness campaigns and the TourZero Pilot Proof of Concept focusing on implementing energy-efficient measures in hotels.
		Responsible bodies/person for implementation: TourZero Project Coordinator (in recruitment), Elad Topel Smart City Coordinator, Avi Naim Energy Project Manager, Dudu Zatch Energy department Action scale & addressed entities: city scale Involved stakeholders: Citizens, municipality employees, hotels, SMEs Comments on implementation: Campaigns, conferences (Eilat-Eilot Renewable Energy) and workshops with the residents are taking place
		Generated renewable energy N/A Removed/substituted energy, volume or fuel type Natural Gas
Fuels for trtansportation	Increase of EV	**Timeline: 2024 preparatory phase; 2025-2030 and beyond gradual increase in EV adoption** Facing challenges like daily tourist influx, geographical remoteness, and limited transportation options, we are strategically focusing on increasing EV adoption via the ETP (currently in progress) and later to build incentives plans for EV parking, and finally V2G technologies.
		Responsible bodies/person for implementation Topel Smart City Coordinator, Avi Naim Energy Project Manager Engineering department Department of Citizen Service Action scale & addressed entities City scale Involved stakeholders Contractor Comments on implementation Plan is currently under development

		Generated renewable energy Yes, quantities TBD Removed/substituted energy, volume or fuel type Petrol Total costs and costs by CO2e unit 100k Euro for the EV plan, other costs are TBD
	Lowering entrance of cars into the city	**Timeline: 2025 preparatory phase and piloting; 2025-2030 and beyond gradual implementation of measures (TBD)** Measures to limit private cars in the city will include a legal framework, incentives and improvement of other means of transportation, namely public transportation.
		Responsible bodies/person for implementation Engineering department, Environmental department, Legal Advisor department Action scale & addressed entities city scale and its surroundings Involved stakeholders Ministry of Transportation, Ministry of Tourism, The Hotels Association, citizens Comments on implementation Initial strategy plan has yet to be developed
		Generated renewable energy (if applicable) TBD (via electric public transportation) Removed/substituted energy, volume or fuel type decrease fossil fuel on scope 2 & 3, volume TBD Total costs and costs by CO2e unit TBD
	Limiting and regulating freight trucks around the city	**Timeline: 2025 preparatory phase and piloting; 2025-2030 and beyond gradual implementation of measures (TBD)** Regulating freight trucks coming to and from the port, will be tackled via regulation and/or designated infrastructure (e.g., bypass road).
		Responsible bodies/person for implementation Engineering department, Environmental department, Legal Department Action scale & addressed entities city scale and its surroundings Involved stakeholders Sea Port, Ministry of Transportation, citizens Comments on implementation Initial strategy plan has yet to be developed

		Generated renewable energy N/A Removed/substituted energy, volume or fuel type decrease fossil fuel on scope 2 & 3, volume TBD Total costs and costs by CO2e unit TBD
Waste	Food Waste reduction capacity building Food waste regulation	**Timeline: 2024 start of piloting; 2025-2026 pilot's expansion; 2027-2030 pilot's scale-up to other hotels and businesses** The TourZero Pilot (as part of the NZC Call) will tackle food waste in hotels via capacity building, inspecting the entire value and distribution chain, changing regulation and enforcement all aimed to lower food waste in hotels.
		Responsible bodies/person for implementation Waste Department, Environmental Department, Legal Department Action scale & addressed entities city scale Involved stakeholders The Hotels Associations, CCAP Comments on implementation Action plan will be built during the TourZero Pilot, commencing May 2024
		Generated renewable energy (if applicable) N/A Removed/substituted energy, volume or fuel type N/A Total costs and costs by CO2e unit TBD - savings will be generated by lowering waste handling
	Waste management infrastructure Waste management plant	**Timeline: 2024-2030 ongoing implementation** Recycling centres will be installed throughout the city via an approved national grant (Q3 2023). This action will enable a more efficient waste separation, more recycling and less waste in the landfills. The Nimra landfill site received in Q3 2023 a national innovation grant to build a gasification plant to produce green hydrogen from municipal cut foliage. The plan also includes formulating regulatory guidelines for decentralised waste to energy small-scale systems around the city. This project aims to enable efficient gas collection and to demonstrate the feasibility of producing and storing green hydrogen. **Timeline: 2024-26 preparatory and legal phase 2027-2030 plant is operating**

		The Waste to energy plant is currently in the development phase. The construction plans and the budget have been approved and a tender to choose the contractor will be taken place soon. This plant is projected to handle 60% of the waste and turn it into energy, thus reducing 60% of the waste-related GHG emissions.
		Responsible bodies/person for implementation The Environmental Unit Eilat-Eilot Action scale & addressed entities city scale & Eilot Region Involved stakeholders Contractor for waste gathering Large waste producers, Eilot regional authority, the Ministry of Energy and Infrastructure Comments on implementation All plans are in preparations for deployment phase
		Generated renewable energy (if applicable) Gasification in Nimra - 2,233,800 KwH/y produced from waste, including downtime Waste to Energy Plant - TBD Removed/substituted energy, volume or fuel type N/A Total costs and costs by CO2e unit 75M EURO for the waste to energy plant
Green infrastructure & nature-based solutions	Natural environments mapping and Restoration ecology NBS shading	**Timeline: 2024-2030 ongoing implementation** Natural shading project is underway, with an approved national grant aimed to enhance urban greenery, including the planting of new trees (at least 30%) and the conservation and restoration of existing trees, thereby enhancing streets shading and improving walkability. The pilot area, covering approximately 15 dunams, incorporates a mix of residential, commercial, and public buildings. The team will conduct in-depth research with local business owners to gain insights and work together on objectives. The conclusions will be handed over to the architect for implementation in the plans, where feasible. In addition, the Environmental Unit is (always) engaged in mapping the natural environments, as Eilat is surrounded by nature reserves, and the coast of the Red Sea hosts unique ecosystems including a coral reef. The mapping will be the basis of restoration ecology initiatives.

		Responsible bodies/person for implementation The Engineering Department, The Environmental Unit Action scale & addressed entities city scale and its surroundings Involved stakeholders the Drainage Authority, Environmental NGOs, SMEs impacted by the shading, Ministry of Environmental Protection Comments on implementation - NBS is currently in the development phase - The PPP Solar Bonds Project is intricately linked to the natural environment mapping, as certain sections of the fields are designated to be integrated into the reconstructed salt marsh for bird watching. Under the management of the Drainage Authority, this initiative aims to construct nature-based salt marsh pools, serving both as flood mitigation measures and as platforms for fostering endemic biodiversity. Furthermore, the project envisions the development of the area for sustainable tourism, with photovoltaic installations serving as infrastructure for shading.
		Generated renewable energy (if applicable) N/A Removed/substituted energy, volume or fuel type TBD Total costs and costs by CO2e unit TBD

B-2.3: Summary strategy for residual emissions

We aim to reach net positive by 2030 via surplus solar power production as calculated in the Annex - Baseline & Actions. In addition, we are in discussion with several manufactures of Carbon Capture technologies. The technology we are looking for is of combined carbon dioxide removal and green hydrogen generation. These technologies use seawater electrolysis process, then use direct air capture. By passing air through the processed sea water; it trap carbon dioxide in solid minerals and as dissolved bicarbonate ions that are naturally found in the oceans, ensuring that the trapped carbon dioxide will remain stable for 10,000+years. So far there are several facilities working on a pilot scale and this month it was announced on the first commercial facility. The relative advantage in Eilat is that it has its own reverse osmosis (RV) plant which the carbon capture facility can become part of the process of the RV Plant.

3.3 Module B-3 Indicators for Monitoring, Evaluation and Learning

* The Impact pathway contains all the actions and their outcomes. GHGs emissions reductions are elaborated in *Annex - Baseline & Actions*

B-3.2: Indicator Metadata	
Indicator Name	GHG emission from stationary energy
Indicator Unit	t CO2 equivalent
Definition	Emissions from the consumption of grid-supplied electricity, heating, steam, and cooling in the city (scope 2). the nighttime consumption
Calculation	371.15 ton CO2eq (688 MW/year Energy-grid loss)
Indicator Context	
Does the indicator measure direct impacts (i.e. reduction in greenhouse gas emissions?)	Yes
If yes, which emission source sectors does it impact?	Buildings (Energy)
Does the indicator measure indirect impacts (i.e. co- benefits)?	No
If yes, which co-benefit does it measure?	
Can the indicator be used for monitoring impact pathways?	Yes
If yes, which NZC impact pathway is it relevant for?	Energy Systems
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	No
Data requirements	
Expected data source	Electricity Consumption (IEC) and PV energy generation
Expected availability	Q4 2024
Suggested collection interval	Yearly

References	
Deliverables describing the indicator	
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	Energy use by fuel/energy type within city boundary
Indicator Unit	MWh/year
Definition	Real consumption data for each fuel or energy type disaggregated by sub-sector. Where data is only available for a few of the total number of fuel suppliers, determine the population (or other indicators such as industrial output, floor space, etc.) served by real data to scale-up the partial data for total city-wide consumption.
Calculation	Energy production, estimated electricity consumption per capita, number of EV cars, number of waste collection
Indicator Context	
Does the indicator measure direct impacts (i.e. reduction in greenhouse gas emissions?)	Yes
If yes, which emission source sectors does it impact?	Buildings Transport Waste Industrial
Does the indicator measure indirect impacts (i.e. co- benefits)?	No
If yes, which co-benefit does it measure?	
Can the indicator be used for monitoring impact pathways?	Yes
If yes, which NZC impact pathway is it relevant for?	Energy Systems
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	No

Data requirements	
Expected data source	Electricity Consumption (IEC) and PV energy generation
Expected availability	Q2 2024
Suggested collection interval	Yearly
References	
Deliverables describing the indicator	
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	GHG emission from transport
Indicator Unit	t CO2 equivalent
Definition	Greenhouse gas emissions from the operations of vehicles
Calculation	Number of cars entering the city + trucks + taxis (The Central Bureau of Statistics (CBS) provides the number of vehicles registered in Eilat in 2019, categorised by the type of vehicle (Table 6) (Central Bureau of Statistics, 2020). The CBS also provided the average annual distance travelled by private vehicles registered in Eilat)
Indicator Context	
Does the indicator measure direct impacts (i.e. reduction in greenhouse gas emissions?)	Yes
If yes, which emission source sectors does it impact?	Transport
Does the indicator measure indirect impacts (i.e. co- benefits)?	Yes
If yes, which co-benefit does it measure?	Improved air quality Improved public health

	Reduced noise pollution
Can the indicator be used for monitoring impact pathways?	Yes
If yes, which NZC impact pathway is it relevant for?	Shift to EV cars, car-free zones and reduction of cars influx into the city
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	No
Data requirements	
Expected data source	The Central Bureau of Statistics
Expected availability	Q1 2024
Suggested collection interval	Yearly
References	
Deliverables describing the indicator	
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	GHG emission from waste
Indicator Unit	t CO2 equivalent
Definition	Greenhouse gas emissions from waste treatment, waste incineration and landfills
Calculation	Waste in tons via the number of waste collection. Types of waste are calculated by factors assuming average distribution
Indicator Context	
Does the indicator measure direct impacts (i.e. reduction in greenhouse gas emissions?)	Yes

If yes, which emission source sectors does it impact?	Waste
Does the indicator measure indirect impacts (i.e. co- benefits)?	Yes
If yes, which co-benefit does it measure?	Reduction of garbage trucks
Can the indicator be used for monitoring impact pathways?	Yes
If yes, which NZC impact pathway is it relevant for?	Waste reduction and management
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	No
Data requirements	
Expected data source	The Environmental Unit
Expected availability	Q3 2024
Suggested collection interval	Monthly
References	
Deliverables describing the indicator	
Other indicator systems using this indicator	

4 Part C – Enabling Climate Neutrality by 2030

4.1 Module C-1 Governance Innovation Interventions

C-1.1: Description of the participatory governance model for climate neutrality

Governance

The CAP, developed internally and independently due to the absence of national support, initiated a new governance approach at the municipality of Eilat in the form of Transition Teams. Five teams, operating across various municipal departments, are all existing staff with additional roles as transition team leaders, to leverage their expertise and balance resources. This approach establishes an agile governance model, breaking down traditional departmental silos and unlocking the untapped potential of municipal staff. The Teams collaborate closely with the finance and economic development departments, ensuring a cohesive, cross-departmental budget commitment to climate action.

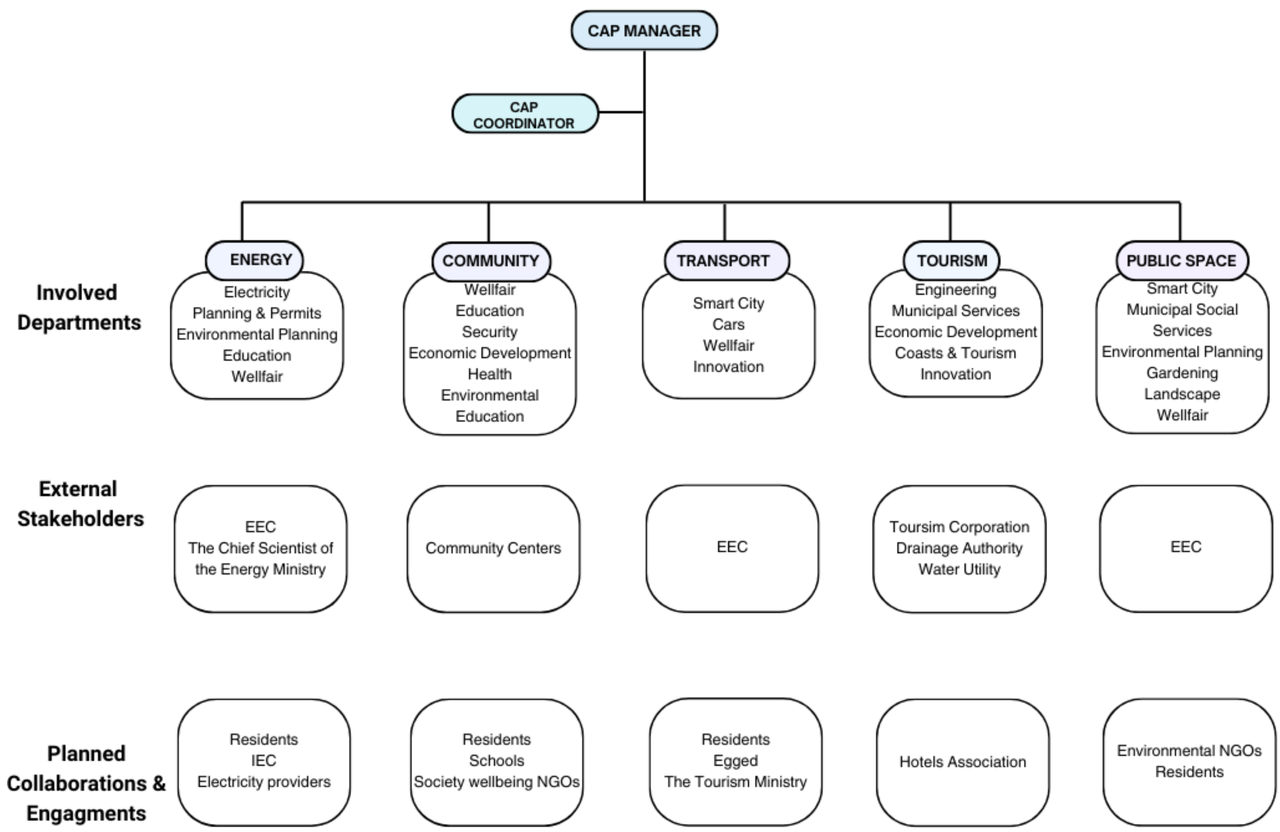

Figure 8 Transition Teams Present and Planned Structure

These flexible units blend diverse expertise, adapting to specific tasks with ease. A constant flow of information and activities pulses through the network, ensuring horizontal communication and shared goals. The teams themselves are not permanent, they are structured and restructured according to the tasks. Weekly team meetings are the hubs for progress, where updates, adjustments, and future strategies are discussed. Team leaders, acting as catalysts, actively encourage participation from diverse stakeholders.

The formation of cross-department teams, utilising existing personnel, serves as a fundamental approach to overcoming budget and resource constraints. This agile strategy not only breaks down traditional departmental silos but also fosters a collaborative environment, ensuring a collective effort toward climate goals. Coupled with specific strategic stakeholder engagements, play a crucial role in mitigating technology and infrastructure risks. By promoting professional collaboration and joint thinking, we enhance our capacity to tackle complex projects, exemplified by the PPP Solar Bonds Project. This initiative, marked by high complexity in finance, legalities, and infrastructure, benefits from our collaboration with the EEC, leveraging their expertise in real estate projects and legal flexibility as a for-profit company.
The impact pathways, intrinsic to the climate actions we chose, directly originate and develop from the Transition Teams. This governance model within the municipality not only facilitates the creation of actions and their impact pathways but also ties them directly to the identified challenges, such as the lack of resources and the need for resilience due to Eilat's remoteness. It aligns with the opportunities presented by solar power and the tourism industry, serving as the primary economic driver in Eilat.

Participation Strategy

The participation strategy of Eilat aims to actively involve Eilat's residents and stakeholders in the climate action plan, fostering acceptance, identifying concerns, and generating new ideas. This strategy aims to create a collaborative environment where all voices are heard and valued, ultimately leading to more impactful and sustainable outcomes.
We are now in the process of identifying relevant stakeholders and analyse and find the right participatory methods for each group. One major outcome is the extension of the governance model beyond municipal boundaries by involving external partners in the Transition Teams, allowing for co-creation and empowerment. Building the participation strategy also includes a robust framework for ongoing engagement and feedback.
The participation strategy also extends to key sectors (energy, transportation, tourism, public space) and close collaboration with government ministries, ensuring comprehensive engagement across various domains.
Overall, **the participation strategy serves as a vital bridge between the climate actions and the broader community**, promoting transparency, inclusivity, and collective ownership of the city's climate goals.

1) Identification of the relevant short-term and long-term stakeholders and their needs - starting with the ones that might be part of the external, extended Transition Team, to broaden this governance model beyond the municipal boundaries during 2024.
We are currently building the structure and framework of this extension. We will start engaging and discussing with citizens who have an affinity with the specific domain and the ability to harness their community.

⇒ **Energy**: we aim to collaborate more with IEC to accelerate innovation project and to gain access to data; Electricity providers will be part of the PPP Solar Bonds Project, where we also aim to deepen our working relations with the EEC, as it will be the legal owner.

⇒ **Community**: Current citizen engagement is taking place mainly via educational, welfare and business avenues. As we aim to extend and deepen the city's administration collaboration with the residents, all five Transition Teams will be extended with representatives of the citizens. Currently, the Town Hall meetings and the Environmental Committee meetings are places where citizen engagement is taking place. To further extend this type of participation, to allow other types of collaboration such as co-creation, and empowerment, we will identify the relevant participatory tools for each action, also by working with the Welfare Municipal Department which has extensive experience with close dialogue with the residents, especially the marginalized groups. The immediate projects where meaningful participation is crucial are the creation of energy communities in low-income neighbourhoods to battle energy poverty, refurbishment of old residential buildings to improve their insolation and increase their energy efficiency, replacing all the energy meters in the city to smart meters, which will help the residents to save costs and drive competition in the energy supply market (up until recently it was a complete monopoly). and the development of communities of gardening currently in the preparation phase. Such initiatives will serve in addition to their main goal (energy efficiency, greening up the city) as an open communication platform to engage with all types and groups of residents. The participation strategy will include means to receive regular feedback to enable an iterative process which answers the real and current needs "in the field". The social "SOS help" NGO Yedidim will be invited to take an active part in relevant sessions, as the largest NGO in Eilat, involved in numerous activities to support youth at risk by providing professional training, job opportunities and welfare support. This collaboration holds great promise in bridging the gap between current climate actions and the social work undertaken independently by the municipality.

⇒ **Transport**: Egged, the main public transportation provider, is a potential partner in electrifying the public transportation in Eilat; The Tourism Ministry will participate in sessions which will concern tourism-related mobility and transportation modalities (which represent a significant portion of the city-wide transportation).

⇒ **Tourism**: Hotels Association and the Tourism Corporation represent the hotels, as the main stakeholders of the tourism sector. Both entities have already expressed their willingness to actively participate in the TourZero pilot. The Hotels Association represents the hotels' needs and concerns and can quickly connect and communicate with each hotel, including the large chain-owned hotels. The Tourism Corporation is already working with the Team, however, the current work is not aligned with the CCC/CAP.

⇒ **Public Space**: The main stakeholders in this transition domain are the residents. The team will include 1-2 representatives from the relevant neighbourhood, as most sessions focus on specific parts of the city.

⇒ **Governmental Ministries**, cross-domain collaboration: To foster collaboration between relevant governmental ministries (depicted in the chart) across the Transition Teams, ongoing communication and regular meetings are planned. Working groups, composed of representatives from these ministries, will discuss progress, share insights, and align policies and strategies to implement the city's CCC. This collaborative approach builds upon the success of the Eilat-Eilot Renewable Energy Directive, a non-profit organisation that promotes energy independence in Eilat and the Eilot region, by bringing together all the local and national stakeholders and finding resources and funding. We will also replicate our successful experience working with the Energy Ministry, where close working relations are part of the day-to-day Energy Team.

2) Assessment of Portfolio Actions to Identify Strategic Areas Requiring Participation:
The initial analysis of the portfolio actions involved identifying the audience and main engagement goal. In this first step, we sought to understand the relevance and strategic importance of participation, while also determining the level of engagement for specific actions. This initial mapping will evolve and change as we progress, initiate engagements, and gather insights from the responses received, define methods to create the complete participation action plan.

* C.1.2 Table repeats previously described information.

Table 8: B-3.3 Participation Strategy for Portfolio Actions

Action	Project's stage	Open Questions	Engagement Goal	Audience	Level of Participation
PV on public buildings	Ongoing	Who is impacted by the implementation of PV other than the buildings' users? Are there small businesses impacted by this? And do we need their buy-in?	Identifying barriers to large-scale implementation Identify possible objections	Buildings' users Municipal Departments	Consult
PV on private homes	Ongoing	What are the main barriers to maximising the solar potential in private homes? What are the most helpful tools for residents that incentivize PV installations? How to tackle the shared buildings challenge?	Identifying barriers Identifying incentives and helpful tools/support	Residents Energy Providers	Empower
PV on commercial buildings	Ongoing	What are the main barriers to maximising the solar potential in commercial properties?	Finding the relevant stakeholders (representatives of small businesses?)	SMEs	Empower

		What are the most helpful tools for residents that incentivize PV installations? What possible solutions are there for renting spaces?	Identifying barriers Identifying incentives and helpful tools/support		
Action	Project's stage	Open Questions	Engagement Goal	Audience	Level of Participation
PV on open spaces and production for storage	Ongoing	Who is impacted in the short and long term?	Identifying stakeholders and barriers	Residents	Involve
The PPP Solar Bonds Project	Phase 2 (legal Status)	How to successfully engage the residents and at which stage of the process?	Identifying barriers Enabling wide-spread implementation (more residents involved from various socio-economic levels)	Residents	Consult
Energy Efficiency awareness	Phase 1 (planning)	With which type of shareholders/sector to start?	building strategy and approach	Residents Hotels	Empower
Action	Project's stage	Open Questions	Engagement Goal	Audience	Level of Participation
Increase of EV: 1. ETP 2. EV parking incentives 3.	Phase 1 (Strategy building)	How to successfully engage the residents/businesses	Identifying barriers	Residents	Consult

Deployment of technologies to lower the burden on the energy grid		and at which stage of the process?	Examining the public Acceptance for Charging Infrastructure Tackling inclusion (disabled people, lower-income households)		
Lowering entrance of cars into the city 1. incentives (parking lots outside the city, other methods of transportation/mobility). 2. legal framework to reduce fossil-fuel cars 3. Enhance Public Transportation options	Phase 0	Identifying key considerations to build an initial strategy	Building acceptance Finding create solutions	Residents Hotels Businesses Visitors	Consult
Limiting and regulating freight trucks around the city	Phase 0	Identifying key considerations to build an initial strategy	Building acceptance Finding create solutions	Sea Port	Involve
Action	Project's stage	Open Questions	Engagement Goal	Audience	Level of Participation

Food Waste reduction capacity building	Phase 1 (planning)	Defining the key parameters to engage with the pilot hotels and how to choose them Identifying stakeholders	Finding solutions together	Hotels	Empower
Food waste regulation	Phase 0	Where to start - households or businesses and why?	Increase acceptance	Residents Hotels Businesses	Collaborate
Waste management infrastructure & Waste management plant	Phase 2 (ongoing planning)	Who is impacted and who should be involved?	Identifying barriers	Residents Waste Collection contractors	Inform
Natural environments mapping & Restoration ecology	Phase 2 (ongoing planning)	Mapping all the impacted parties and finding potential collaborators	Finding ways to collaborate effectively Identifying barriers	NGOs	Collaborate
NBS shading	Phase 2 (ongoing planning)	How to incorporate the SMEs feedback	Increase Acceptance	SMEs Residents	Consult

4.2 Module C-2 Social Innovation Interventions

C.2.1 Relations between social innovations, systems, and impact pathways						
Intervention name	Description	Systemic barriers/opportunities addressed	Responsible entity/ dept./ person	stakeholders involved	Enabling impact	Co-benefits
PPP Solar Bonds Project	The project will reduce energy poverty by offering ownership of PV systems to 1000 residents	Facilitating solar power production for residents who are unable to fund their own PV, harnessing the sun hours and positive ROI of the initiative	EEC	Local Residents, Energy Suppliers, Private Investors	Accelerating the city's transition to renewable energy sources, leveraging private investment and citizen participation to expand renewable energy infrastructure.	Community Ownership and citizen engagement Economic Growth Reduction of energy poverty
TourZero	Pilot within the NZC Call for Pilot Cities, showcasing Accelerated decarbonisation in the tourism industry via the nexus of green innovation, cross-sectoral governance and systemic capacity building	Harnessing the cooperation of the Hotels Association, we aim to tackle energy and waste in hotels as the major GHG emissions sources. Transportation is a major emitter and a significant	The Environmental Unit	The Hotels Association, and relevant National Ministries	Accelerate GHG reduction, establish sustainable financial models, and create a governance model for scaling the pilot.	Reduction of operational costs, improved environmental sustainability, and societal benefits through behavioural change.

		challenge to tackle. The involvement of a broad spectrum of stakeholders will enable us to effectively solve this difficult challenge.				
Eilat Solar	Innovative urban platform serving as a one-stop-shop for PV installations on residential rooftops.	Challenges include a lack of integration of municipal data, insufficient market competition, and limited awareness. The platform aims to integrate municipal data, foster market competition, and maximise solar potential.	The Environmental Unit	Residents, Businesses, Energy Suppliers, and IEC	maximise solar PV installations, foster market competition, and enhance urban solar potential.	Improved energy sustainability, reduced carbon emissions, and economic benefits for residents

C-2.2: Description of social innovation interventions

The PPP Solar Bonds project stands as an innovative model designed to surmount cross-domain barriers to climate neutrality in Eilat. This visionary project encompasses three key sections, showcasing a unique blend of citizen involvement, energy production, and private-public collaboration. Nearly 20 MW solar field on the city borders, leveraging the abundant sunlight throughout the year. Citizens will be the users and the investors, enabling them to benefit from passive income and reduce energy poverty via discounted energy prices. The PPP Solar Bonds Project addresses systemic political and bureaucratic barriers, via collaborating with the EEC, leveraging their expertise and flexibility in such a complex project. Involving the citizens provides both a solution for funding and energy poverty in the city. It also holds a promise of a platform for maintaining an open communication channel with the residents, which will also support in strengthening the participation of the public in other domains. The project is a long-term project as all PV installations are. Scale-up will be dependent upon the results of the initial field.

TourZero will map major GHG reduction opportunities and monitor their impact, providing a comprehensive understanding of the tourism industry's carbon footprint. This data-driven approach enables targeted interventions and informed decision-making. Secondly, TourZero accelerates mitigation solutions by introducing sustainable financial models for hotels. By aligning environmental and economic interests, it empowers stakeholders to make eco-friendly choices that are economically viable. The program also focuses on training change agents within the industry, enhancing awareness and building capacity for sustainable practices. This innovation ensures that stakeholders and citizens are not just passive participants but active contributors. TourZero establishes a Climate Acceleration Hub as a new governance model, providing a centralised platform for collaboration. We aim to include marginalised groups via the hotels, where most of the kitchen employees are from lower-income demographics.
For long-term impact and scalability, TourZero will leverage its Climate Acceleration Hub as a platform for sustained collaboration. The hub will be a focal point for ongoing innovation, knowledge exchange, and scaling up successful practices. Additionally, TourZero aims to create replicable models that can be extended to other domains, ensuring the long-term impact of its innovative approaches in catalysing climate neutrality efforts beyond the tourism industry and expanding to other types of domains within the private sector.

Eilat Solar, a pioneering urban initiative led and developed by Eilat in 2018, is a one-stop-shop solution for PV installations on residential rooftops, achieving installed solar capacity exceeding 7 MWh to date. It directly addresses the barrier of the complexity, lack of knowledge and ability to calculate the financial profitability of PV installations. By facilitating the process for the residents, more clean energy can be produced throughout the city, reaching more untapped solar potential. We have concrete plans to scale up the platform to include 2nd hand market, facilitating PV recycling and proper discharge processes and finally to develop a customizable platform adaptable to any city, facilitating the identification, analysis, and maximisation of solar PV installations in urban spaces, including parking lots and sports fields. The scaled-up platform will foster private buying groups and micro-financing for residents, to align with the existing urban building plans.

Addressing an unmet need, Eilat Solar integrates all municipal data and promotes market competition, striving to unlock the solar potential. Beyond catalysing energy savings and carbon emissions reduction, the platform actively engages stakeholders, energy suppliers, the IEC, and the Energy Ministry.

5 Outlook and next steps

Plans for next CCC and CCC Action Plan iteration

This CCC signifies a major update and elaboration of Eilat's existing CAP and Transition Teams' current work. While many actions are currently taking place, such as PV installations and the smart transportation plan, a few major steps critical for achieving the CCC objectives are still in the early planning stages. These include, amongst others, active citizen participation, measures to reduce private cars inside the city, and the waste to energy plant. The current phase and the concrete plans for the near future are all outlined in this CCC.
As part of the TourZero pilot, The Climate Acceleration Hub will establish a collaborative platform for municipal-business-residents collaboration, aiming to reduce Eilat's carbon footprint.
This will be the focal point for all the climate work done in the city and coordinated by the municipality. This is planned to be a major milestone in our CCC plan implementation and our ability to reach out to the various sectors and actors in the city and onboard them to the climate transition.
Our present and future work on the CCC actions and the city's CAP are summarised in the following Gantt Chart, repeating the mentioned timeline in the impact pathways table.

1. The major mitigation actions in each domain, in correlation with Table B-2.1: Description of action portfolios. Most of the Energy-related actions are already in the deployment phase, and are continuous in their nature (PV installations, energy efficiency awareness) and thus are across the timeline until 2030, and beyond. In other domains, such as Transport and Waste, most actions are in the planning phase, as elaborated throughout the CCC. Timeline does not always correlate with GHGs reduction (see "Actions" sheet and "Timeline" sheet and below) for the simple reason that some actions, e.g., increasing EVs in the city, require a lengthy preparatory phase.
2. CCC Update twice a year. The next iteration will include:
    - 2.1. Stakeholder feedback, namely the Hotels Association, the Economic Development Company, The Ministry of Energy and the Finance Ministry with its feedback on the PPP financial model.
    - 2.2. Insights from the Transpiration Plan and the Action Plan driven from it. As part of a newly funded Horizon Europe Project, on the topic of Cooperative, connected and automated mobility (CCAM), a transportation engineer will be recruited to the team. This will be a major milestone in advancing the city's transportation, as the transport department lacks human and financial resources.
    - 2.3. Lessons learnt from initial citizen participation activities, kicking off with joint work with environmental activists who are already in contact with the Environmental Unit.
3. GHG emission report to the MyCovanant system every two years

Figure 9: Timeline

Also found in the Annex “Baseline & Actions”.

			2025				2026				2027				2028				2029				2030			
	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
CCC Iteration																										
GHGs emission report to the MyCovanant system																										
Energy																										
PV on public buildings																										
PV on private homes																										
PV on commercial buildings																										
PV on open spaces and production for storage																										
PPP Solar Bond Project (accumulated)																										
Energy Efficiency awareness																										
Trasportation																										
Increase of EV: 1. Electrical Transport Master Plan 2. EV parking incentives 3. Deployment of technologies to lower the burden on the energy grid																										
Lowering entrance of cars into the city: 1. incentives (parking lots outside the city, other methods of																										

transportation/mobility). 2. legal framework to reduce fossil-fuel cars 3. Enhance Public Transportation options
Limiting and regulating freight trucks around the city
Waste
Food Waste reduction capacity building
Food waste regulation
Waste management infrastructure
Waste management plant
Green infrastructure & nature-based solutions
Natural environments mapping & Restoration ecology
NBS shading

6 Annexes

1. Baseline & Actions
2. Solar power plan

Climate City Contract

2030 Climate Neutrality Commitments

Eilat

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Abbreviations and acronyms

Definition	Abbreviations and acronyms
Eilat's Economic Development Company	EEC
Climate Action Plan	CAP
Private-Public Partnership	PPP
Decarbonisation Pilot, part of the 2nd cohort of the NZC Call for Pilot Cities, aimed at creating the governance infrastructure and technological proof of concept to reach accelerated decarbonisation in the tourism industry.	TourZero
Israel Electricity Company	IEC
Action Plan	AP
Investment Plan	IP
Key Performance Indicator	KPI
Monitoring Evaluation & Learning	MEL

Monitoring Reporting Verification	MRV
Work Package	WP
Electric Transportation Plan	ETP
Photovoltaics	PV

1 Introduction

Eilat, located at the southern end of Israel, faces unique challenges due to its hyper-arid desert climate, small size, remoteness from other communities, and lack of employment diversification, making it more susceptible to extreme climate and economic events. The City of Eilat has set resilience as the top priority, committed to ensuring its 68,000 citizens a safe space, extreme heat mitigation, employment opportunities, and an improved quality of life. Climate adaptation and mitigation will help the city achieve these goals, reducing energy poverty, diversifying jobs through innovation deployment, enhancing businesses' economic and climate resilience, improving well-being and health and many more co-benefits as outlined in this document and throughout the CCC.

Eilat joined the Climate Neutral and Smart Cities Mission to support its efforts to achieve climate mitigation and adaptation. The Mission supported us in creating this Climate City Contract, which serves as a data repository of actions and information, KPIs monitoring and quantitive and qualitative analysis of GHGs reduction and co-benefits. It includes high-priority and feasible actions and interventions across sectors responsible for the majority of GHG emissions: energy, transportation, and waste. We also included a smaller focus on nature management and green infrastructure enhancement, which are essential to enhance the city's climate adaptation while addressing biodiversity restoration and nature management, a high priority for the residents of Eilat as well as for the tourism industry.

The Stakeholders we have identified in this CCC version exhibit varying impacts and capacities across different domains, with some actions in the portfolio already featuring co-created solutions. The PPP Solar Bonds Project engages the EEC as the legal operating body, while the Drainage Authority collaborates on the NBS Salt Marsh Bird Watching project, aiming to renature and enhance biodiversity, to address severe floods while increasing PV installations. The full stakeholders analysis is presented in this document.

The Mission framework and expert support enables Eilat to achieve its 100% climate neutrality goal by 2030, building on the already existing Climate Action Plan (CAP), developed by Five Municipal Transition Teams. The CAP is an action plan, which includes all actions relevant to achieving climate mitigation and adaptation, including amongst many, gaining energy independence via PV, green construction guidelines, enhancing EV penetration, decreasing food waste, nature management and shading and more. The CCC elaborates on this plan by providing a holistic framework to analyze subsequent co-benefits, costs, potential profits, stakeholder mapping, and citizen engagement strategy. Leveraging our team's experience in running innovative pilots within the Horizon Europe Framework, along with the existing climate action infrastructure, the CCC will support the quantum leap required to reach the ambitious goal of 100% in six years.

2 Goal: Climate neutrality by 2030

Eilat's ambitious 2030 climate neutrality target stands at an impressive 100%, aligning seamlessly with our Expression of Interest (EOI). Since joining the Cities Mission, we have calculated and measured the impact of ongoing mitigation actions, introduced new strategies and started to build a comprehensive participatory approach. Current calculations project a surplus in energy production by 2030, reaching net-positive.

The built area and industrial zone form integral components of our 2030 100% climate neutrality goal. Notably, the uninhabited municipal area contributes no GHG emissions and are not included within the baseline and GHG calculations. Negligible GHGs stem from AFOLU due to the absence of forestry and limited agricultural use. Additionally, IPPU emissions remain minimal, given the city's lack of chemical process industries.

Strategically allocating our limited time and budget resources, we've prioritized achieving climate neutrality through targeted reductions in the energy, transportation, and waste domains. This focus not only addresses key emissions sources but also strategically addresses challenges posed by the high tourism influx, reaching 3 million visitors annually.

Eilat's comprehensive Actions Portfolio spans diverse initiatives across energy, transportation, waste, and natural environment management. Key co-benefits include empowering residents to own solar panels, thereby reducing energy poverty and enhancing energy resilience. The transition to electric vehicles fosters improved public health and air quality, while waste-to-energy pilots pioneer the shift toward a circular economy. Furthermore, green infrastructure and nature-based solutions contribute to biodiversity restoration, improved air quality, and an overall enhanced city aesthetic.

3 Strategic priorities

Eilat's key systemic strategic priorities to achieve climate neutrality by 2030 include a focus on energy transportation and waste, recognizing them as the primary sources of greenhouse gas emissions in the city as well as significant co-benefits generators, namely waste reduction.

The main objectives we will focus on the next 2-3 years:

1. The PPP Solar Bonds Project - New Financial Model to decrease energy poverty and achieve energy independence:

Acknowledging the fact that cities, local authorities and countries cannot finance the reduction of GHG emissions entirely by themselves, especially mass installation of RE, led us to build a new financial model that will also help to engage and involve the residents and tourists while reducing the costs of living in Eilat.

The model is based on the issuance of solar PV bonds to the public to de-risk the project and to finance it, to reward the buyers via earnings (lowering electricity bills) by using a safe and familiar financial tool.

The PPP Solar Bonds Project, is currently under development, with three intertwining steps:

- Q1 2024 - Q3 2024 Establishing the legal energy supplier - to enable the price setting for the residents, the municipality will be the energy supplier. the city will offer a 20-30 % discount on the electricity costs for every resident regardless of their financial status, thus increasing energy resiliency while reducing the costs of living in the city.
- PV installations - nearly 20 MW field at the city borders based on land will be the guarantee for the issuance of the Solar PV bonds and will be offered to the public.
- Offering PV ownership to the public - households will be eligible to take part via investment in the project, with an up to 25 years agreement of PV ownership, generating profits via selling electricity to the grid, in less than 6 years.

2. The expansion of EV infrastructure includes the Electrical Transportation Master Plan, already in the development phase. This is a collaborative effort between the energy and transport Transition Teams, supported by a national grant. The plan is set to address the city's unique needs, using data-driven research, public participation involving residents and visitors, 15-year trajectories, and KPIs to gauge the plan's empirical success and relevance. The forthcoming plan will serve as a practical roadmap for the large-scale implementation of EVs in Eilat.

Future steps involve the implementation of the infrastructure, complemented by EV parking incentives and the deployment of technologies to lower the burden on the energy grid. This multi-faceted strategy aims not only to reduce greenhouse gas emissions but also to enhance overall city mobility, ensuring accessibility, convenience, inclusion, and safety for residents and tourists.

3. Waste reduction and waste-to-energy installations: waste management infrastructure by installing recycling centers across the city, facilitated by a national grant secured in Q3 2023. This initiative aims to bolster efficient waste separation, boost recycling rates, and significantly decrease landfill waste.

the Nimra landfill site, through a national innovation grant, is pioneering a gasification plant to produce green hydrogen from municipal cut foliage, expected to produce 2,233,800 kWh/year from waste. This ground-breaking project also involves formulating regulatory guidelines for decentralized waste-to-energy small-scale systems

Finally, a large-scale waste-to-energy plant is in the planning phase, having received approvals for construction plans and a 75 Million Euro budget, aimed to eliminate 60% of the waste-related emissions in the city. The Environmental Unit Eilat-Eilot oversees the implementation of these projects, impacting not only the city but also the broader Eilot Region.

4. Green Infrastucrure

From 2021 to 2023, significant funding has been allocated to enhance green infrastructure and nature-based solutions, with EUR 1,200,000 each in 2021 and 2022, and EUR 1,350,000 in 2023. These investments focused on increasing green infrastructure space on private lands and developing natural shading infrastructure to create a more sustainable urban environment. One of the key initiatives is the increase in green infrastructure and natural shading. To facilitate this, Eilat has been growing trees intended for placement in city open spaces and major projects. A notable project is the Terminal Park, where 1,000 trees were farmed for the park and sidewalks, providing much-needed natural shade in the desert city.

To further support these efforts, local laws have been enacted to ensure sustainable development. New neighborhoods must have at least 20% land cover with trees, transferring the responsibility and costs to real estate developers. Additionally, these neighborhoods must achieve 30% water efficiency, which reduces water consumption and energy use. By requiring contractors to cover the costs of necessary equipment, the municipality can allocate its budget to other important targets.

In terms of nature management, Eilat has invested EUR 600,000 in capital expenditure, with operational costs covered by municipal employee salaries. These efforts are expected to yield significant emission reductions, from 32 tons of CO_2 equivalent per year in 2024 to 140 tons per year by 2030. The co-benefits of these green infrastructure projects include improved air quality, enhanced biodiversity, aesthetic enhancements, and the reduction of urban heat islands. The main beneficiaries are Eilat's residents, but everyone who works or visits the city also benefits from the enhancement of green infrastructure in Eilat.

a. Stakeholders

Eilat's Climate Action Plan involves a diverse array of stakeholders, each playing a crucial role in achieving the city's climate goals. As energy and transportation are the main GHG emission sources of the city, the most strategic stakeholders are the ones enabling a transition in these domains. **Eilat's Economic Company** (EEC) plays a pivotal role in driving large-scale projects, enabling the Municipality to implement ambitious initiatives such as the PPP Solar Bonds Project, where also the residents are part of the benefactors. **The residents** are the largest stakeholder, impacted and impacting all emission domains. Via an improved participatory approach, we aim to enhance the residents' participation and input across our climate actions (and beyond). **The Local businesses and entrepreneurs** are a major enabler of economic growth, job creation, and green initiative implementation, namely the TourZero Pilot. Research institutions are our collaborators in research and innovation, supporting pilot projects and climate mitigation research. They are involved in strategic transport plans and emissions measurements, enhancing local capacity and knowledge sharing. Local Environmental NGOs are our partners in advocating for environmental protection, plastic waste reduction campaigns, preservation of marine environments, and biodiversity restoration. We aim to further improve our joint work via a structured work plan and active participation on a regular basis (via the Environmental Committee).

The Hotels, represented by the Hotels Association, are a strategic partner as the city's main economic activity is driven by tourism. The shift towards sustainable tourism, namely deploying clean energy, reducing waste and using alternative transportation modes, is the most significant challenge in the city, shared by tourism-based cities worldwide. To address this, we have developed the TourZero pilot, recently accepted to be funded via the NZC Call. The pilot will showcase accelerated decarbonisation in energy and waste in hotels, and transportation throughout the city. TourZero is a pivotal step in building a new governance model for climate action, enabling all strategic stakeholders to co-develop and test mitigation solutions. Other stakeholders include governmental ministries which contribute from the regulation and financing aspect; Research institutions are partners in R&D projects alongside collaboration to support their own efforts to reach climate neutrality; community groups and NGOs are representing the civil society, mostly concerned with environmental and coastal protection.

As a whole, the CCC sets the first cornerstone to build a comprehensive participation and stakeholder engagement strategy to enable reaching out to other stakeholders and involve them via the extension of the Municipal Transition Teams.

Additional analysis is presented below.

Residents

VALUE PROPOSITION

- Lower energy poverty
- Shading and improved walkability in the city
- Enhanced well-being and health (via climate comfort)
- Reduced noise

ACTION ITEMS

- PPP Solar field
- CAP conference
- Public Participation Strategy Plan (in progress)
- Eilat Solar Platform
- Resilience community centers across the city with energy storage

EXAMPLES

- Through initiatives like the CAP conference, which convened on May 30, 203, we have taken proactive steps to involve our residents.
- The Eilat Solar platform developed by the municipality, the Ministry of Energy and a local startup, is a one-stop-shop for residents to seamlessly install photovoltaic systems on their rooftops.
- We are planning to deepen our work with the residents to actively involve them in the CCC via the local community centres, working with each neighbourhood separately due to the extreme socio-economic differences between the different populations.

Local Environmental NGOs

VALUE PROPOSITION

- The CCC & CAP create shared overarching goal which aligns with the missions of the NGOs
- By working together we avoid overlapping resources
- Eilat as a local climate neutrality lighthouse city
- Aligning the political, professional and public sectors

ACTION ITEMS

- CAP conference
- Public Participation Strategy Plan (in progress)
- Sustainable Tourism Pilot in Eilat (TourZero)
- Plastic waste reduction
- Nature Protection

EXAMPLES

1. EcoOcean runs the GreenKey program for hotels in Israel to reduce the environmental footprint of the tourism sector. We aim to join forces and work together in Eilat's sustainable tourism Pilot (TourZero), focusing on energy efficiency, RE solutions for hotels, and food waste reduction.

- InGoodNature focuses on plastic waste regulations. Together, we work towards enforcing and raising awareness about plastic waste reduction at the coastline.
- EcoPeace runs educational programs focusing on the preservation of the marine environment in Eilat.
- Desert, Sea & Environment dedicated to safeguarding the environment from waste and pollution. We actively collaborate with them on initiatives such as clean-up dives.

The Environmental Committee serves as a platform for collaboration between residents' representatives, city council members, municipal authorities, and relevant organisations such as the Society for the Protection of Nature, the Nature and Parks Authority, the Ministry of Environmental Protection, and the Desert, Sea & Environment association. This committee facilitates the advancement of environmental issues, provides recommendations to the city council, and integrates the CAP within its framework. However, due to the upcoming elections, the next committee meeting has been postponed.

Governement

VALUE PROPOSITION

- PoC of energy independence and micro-grid at the city level, aligned with the strategy of the Ministry of Energy
- Eilat Solar platform national scale-up
- CAP & CCC are aligned with the agenda of the Environmental Protection Ministry to reduce GHGs

ACTION ITEMS

- Establish a symbiotic relationship between policy formation and local needs via direct communication and joint work with the CEOs of the relevant ministries
- Position Eilat as a lighthouse city of climate neutrality to share best practices. This can be achieved by identifying and working with governmental personnel who see the potential of Eilat

EXAMPLES

1. We hosted the Municipality of Ashdod for a study visit, organized by the Ministry of Energy to learn about implementing micro-grid and energy-independent communities
2. We envision a two-way flow of information, where the unique challenges and successful strategies identified on the ground in Eilat can inform national policies, and conversely, national policies can provide the necessary support and framework for Eilat's endeavors.

1. The Ministry of Energy is collaborating with the Municipality of Eilat through grants and pilot projects. The excellent working relationship established in recent years can be attributed to the attentive team of professionals within the Chief Scientific Office. This partnership allows us to leverage resources, expertise, and funding to drive sustainable energy initiatives and advance our transition to energy independence.
2. Ministry of Environmental Protection provides funding and support via dedicated open calls, such as urban shading solutions, a project which will be implemented in 2024. We have also been in extended discussions and activities to promote the construction of a waste management plant. This collaboration also entails the Ministry's CEO and the Chief Accountant of the Finance Ministry.
3. Ministry of Tourism - Currently there are no working relations with the Ministry. We aim to establish initial cooperation during the TourZero Pilot Project.

Eilat Economic Development Company (EEC)

VALUE PROPOSITION

- Profit generation via new initiatives and business models, namely the PPP solar field
- Future options to be involved in profitable carbon trading activities
- Increasing the company's resources (monetary, professional capacity and human resources)

ACTION ITEMS

- The EEC will be in charge of deploying the electric charging infrastructure in the city
- Establishing EEC as the owner of **The PPP solar field,** an innovative mechanism with decentralized ownership, allowing Eilat residents to own solar panels remotely based on their financial needs. This model empowers citizens by providing opportunities for profit from solar power and potential carbon trading. The initial funding will support infrastructure for 1000 residents, granting them ownership of PV systems to reduce energy poverty and generate profits. The solar field's first phase includes a 50 MW PV capacity and a 400 MW storage system, with an additional 50 MW planned for the second phase. The municipality acts as a facilitator, connecting residents with energy suppliers. A legal team is actively establishing the statutory body to manage the PPP initiative, ensuring its smooth operation and long-term success.

Research Institutions

VALUE PROPOSITION

- Eilat serves as a pilot site and experimental space for research and innovation providing researchers with a unique space, infrastructure, data and municipal support to investigate novel climate solutions.

ACTION ITEMS

- Developing an Electic Transporation Plan for the city, to increase mobility efficiency and reduce emissions
- Research partners for pilots and innovation projects.

EXAMPLES

1. Bar-Ilan University is our partner for building a strategic plan for transport-related emissions reduction and a plan for electric charging infrastructure.
2. Israel Oceanographic and Limnological Research is our partner in Project O (H2020 funded project), a joint research to treat wastewater from contaminants.
3. The Inter-University Institute for Marine Sciences is our partner in raising public awareness for coastline environmental protection
4. Ben-Gurion University - our partner in several pilots in the city to reach energy independence and climate-resilience shelters. The university's researcher is in charge of the city's emissions measurements and reporting. We will expand our work with the university by encouraging more students to perform climate mitigation research in the city.

Private Sector

	THE HOTELS ASSOCIATION	EGGED	MICRO-MOBILITY COMPANIES	THE SEA PORT
VALUE PROPOSITION	• Positioning of Eilat as a sustainable tourism city • Operational costs reduction via waste reduction and energy efficiency	Electrifying all the buses in the city which will lead to cost reduction, and profit generation via new shuttle services	Profit and client base growth. Currently there are 15 K users of scooters	• Profits growth via charging infrastructure • Alignment with international climate neutrality standards in the maritime sector
ACTION ITEMS	Partner in pilots (two awaiting funding)	We are **working with the EEC to invest in the charging infrastructure**, in return for earnings from the energy generation.	Management of the infrastructure by the Municipality to ensure compliance with other urban infrastructure and generate profits.	Charging infrastructure is currently in construction

i. Co-Benefits

The following co-benefits analysis summarises the Imapct Pathway in the CCC Action Plan, focusing here on the perspective of the stakeholders sectors and groups. We aim to address the specific needs of these stakeholders while aligning it with the climate goals of the city.

1. Residents and Community Groups

1. Reduction of Energy Poverty: By providing access to solar PV systems and energy efficiency measures, residents will experience a significant reduction in energy costs, which is currently very high and is a burden for mid to low income households.
2. Enhanced Citizen Participation: Programs that encourage community involvement in sustainability projects foster a sense of ownership and active participation in Eilat's climate transition.
3. Improved Public Health: the shift toward sustainable mobility solutions will also result in improved air quality, reduced noise pollution and overall improved well-being for residents.
4. Increased Safety: Measures to decrease traffic congestion and enhance pedestrian and cyclist safety will create a safer urban environment.

2. Local Businesses and Entrepreneurs

1. Economic Growth: New economic models (e.g., PPP), new jobs, and investment in green infrastructure will drive economic opportunities and growth for local businesses.
2. Cost Savings: Businesses will benefit from reduced energy costs through solar PV installations and improved waste management practices.
3. Enhanced Competitiveness for the tourism industry: Adoption of green practices and technologies will enhance the competitiveness and sustainability of the local tourism industry.

3. Educational Institutions and Research Bodies

1. Capacity Building: Collaboration with research institutions, in all the EU-funded projects, namely TourZero will enhance local expertise in sustainability practices. This will also create more job opportunities and economic growth.
2. Innovation and Knowledge Sharing: Educational institutions will have access to cutting-edge research and pilot projects.

4. Government and Public Sector

1. Enhanced Energy Resilience: Increased deployment of solar PV systems on public buildings and infrastructure will boost the city's energy resilience and independence.
2. Efficient Land Use: Diverting organic waste from landfills and implementing waste-to-energy projects will optimize land use while reducing the environmental footprint.

5. Tourism and Hospitality Sector

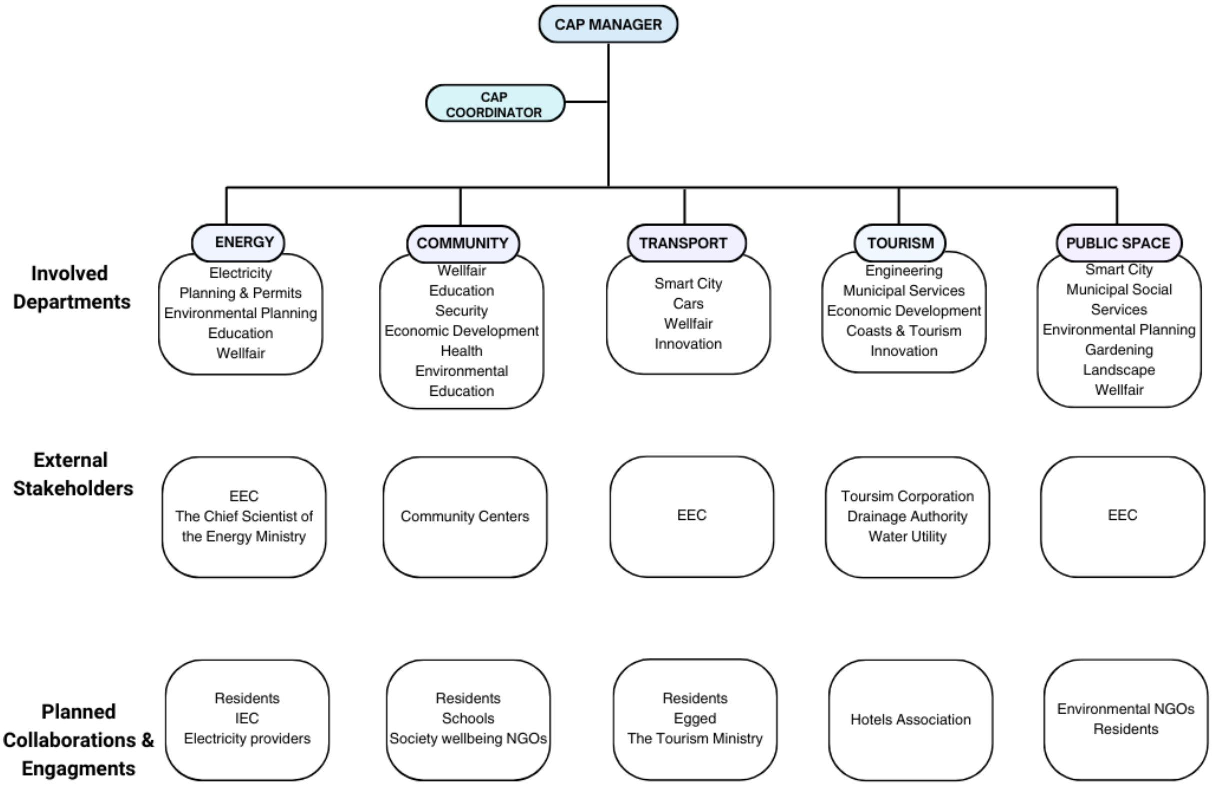
4 Sustainable Tourism Development: Initiatives like the TourZero pilot will showcase green innovation in the tourism industry, enhancing Eilat's reputation as a sustainable destination.

5 Improved Infrastructure: Investments in green infrastructure, such as increased shading and restoration ecology, will enhance the city's aesthetic and functional qualities.

6 Operational Cost Reductions: Sustainable practices in hotels, such as waste reduction and energy efficiency, will lead to significant cost savings.

7 Process and Principles

Eilat's systemic work process involves building on the existing Climate Mitigation and Adaptation Action Plan (CAP) and aligning it with the CCC. The CAP focuses on action-based strategies and details high-level pathways, undergoing more frequent updates than the CCC, which serves as a holistic tool with central data repositories, emission calculations, cost predictions, and co-benefit connections. The Transition Teams, a key component of Eilat's new governance approach, operate across municipal departments, leveraging existing staff expertise to facilitate an agile and collaborative environment. These teams, constantly adapted to specific tasks, foster horizontal communication, and weekly meetings serve as hubs for progress. The participatory strategy we are currently developing will be a major upgrade to the climate action work process. By involving the key stakeholders (hotels, EEC, residents), we will be able to align climate actions with the shared challenges and enhance economic opportunities in solar power and tourism.



The TourZero pilot will build the Climate Acceleration Hub, which will play a crucial role in monitoring and updating the CCC over time and in achieving Eilat's 2030 climate neutrality target. This governance model will facilitate ongoing collaboration namely with the hotels and feedback mechanisms. Through regular monthly meetings between team leaders, the CCC live document will be synchronized with the ongoing actions and strategies of the Hub. Stakeholder feedback from entities like the Hotels Association, the EEC, and relevant government ministries will be integrated, ensuring a comprehensive and responsive approach to climate action. Additionally, insights from the Transportation Plan, driven by a transportation engineer recruited through a Horizon Europe Project, will contribute to the CCC's evolution.

Lessons learned from citizen participation activities, particularly those initiated through the TourZero pilot and collaboration with environmental activists, will inform CCC updates. The CCC's inherent connection with the Hub's governance model and ongoing collaboration with diverse stakeholders ensures a systemic and adaptable approach to achieving Eilat's climate neutrality targets.

8 Signatories

Name of the signatory (organisation)	Sector / Domain / Level of operation[1]	Legal form	Name of the responsible person	Position of the responsible person
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The Ministry of Energy and Infrastructure	Energy	National Ministry	Guy Deknuydt	Head of Sustainable Energy for Local Authorities
Ministry of Environmental Protection	Climate and Environment	National Ministry	Jenia Gutman	Director of the Climate Mitigation Department

Annex: Individual / Cluster Signatory Commitments

[1] Please mention if the organisation is active at local, regional, national, or international level.

Evaluation of Greenhouse Gas Emissions in Eilat

by

Rosalyn Bates
Samantha Marcil
David Schwartz

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An Interactive Qualifying Project
submitted to the Faculty of
WORCESTER POLYTECHNIC INSTITUTE
in partial fulfilment of the requirements for the
degree of Bachelor of Science

by
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ABSTRACT

The City of Eilat is a member of the Global Covenant of Mayors for Climate and Energy, an international coalition of cities working to combat climate change. Members report their greenhouse gas emissions and progress on emission reduction policies. Eilat is required to submit an updated emissions inventory for 2019. This report contains an introduction to the issues of climate change in Eilat, as well as information on electricity usage, transportation, and disposal of municipal solid waste to estimate Eilat's greenhouse gas emissions during 2019.

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2.3 Sustainable Energy Action Plan (2018)	David Schwartz	Rosalyn Bates
2.4 Introduction to the Monitoring Emissions Inventory	Rosalyn Bates	David Schwartz
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4. Transportation	Rosalyn Bates	Samantha Marcil
5. Waste	Samantha Marcil	David Schwartz
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6.1 Emission Models	David Schwartz	All
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CHAPTER 1: INTRODUCTION

The Times of Israel reported on a record-breaking heatwave in May 2020 (TOI Staff, 2020). Temperatures reached as high as 48°C (118.4°F) leading to deaths from heatstroke, emergent wildfires, and record electric power consumption from air-conditioning. The May 2020 heatwave signified to the public the prominent effects of climate change in the Israel-Palestine region. Over the past 70 years, average annual temperatures in Israel increased by 1.4°C, and current models predict a further increase of 1°C over the next 30 years. Summer-time high temperatures continue to set records and annual precipitation is declining (*Climate Change in Israel*, 2019).

Eilat is a coastal city on the southernmost tip of the Negev desert and is vulnerable to the effects of climate change. Already having an arid climate, the movement to further hot and dry conditions threatens environmental stability and agricultural yields. Consumption of electricity will rise as air-conditioning units increase their load on the electrical grid. Eilat's economy is tourist-driven, hosting approximately 2.5 million overnight visitors in 2018 (Kavaler, 2019). Permanent residents in 2019 numbered 52,299 people (Central Bureau of Statistics, 2020a), and Kissinger et al. (2016) estimated there are 29,000 domestic and foreign visitors at a given time. The offshore coral reefs are a major tourist attraction, yet these habitats are threatened by climate change due to the warming and acidification of ocean water (Fine et al., 2013). The rising temperature and frequency of heatwaves could decrease tourism, and over the long term, compromise the habitability of the region.

Climate change, while typically addressed by national governments, is also being addressed at the city level to circumvent national bureaucracy. In 2015, the City of Eilat became a signatory to the Global Covenant of Mayors for Climate and Energy (GCoM). The GCoM was formed to address greenhouse gas (GHG) emissions in cities and promote adaptation to the effects of climate change. The GCoM works with signatories to compile information about the cities' GHG emissions and climate change mitigation actions. Eilat is in the process of submitting updated information to the GCoM for 2019.

This project evaluated Eilat's progress towards a 20% reduction in GHG emissions relative to 2014. Our evaluation served as a Monitoring Emissions Inventory (MEI) for the GCoM. The

MEI reports Eilat's GHG emissions in 2019 and analyzes the efficacy of implemented emission reduction measures.

In the following section, we describe the role of the GCoM, Eilat's largest emission sources - electricity, transportation, and municipal waste – and discuss measures Eilat has implemented to reduce GHG emissions. The remainder of the report is broken down by type of emissions source: electricity, transportation, and municipal solid waste. Each of these sections presents the methods, results, and discussion pertaining to its emissions source. In the concluding section, we bring together the separate emissions analyses and report the aggregate GHG emissions produced by the city. Comparison to the 2014 GHG emissions shows Eilat has not yet achieved its goal of a 20% reduction. Rather, our calculations estimate a 4.5% reduction from 2014 to 2019. Emissions from electric power consumption decreased due to the incorporation of regional solar energy. Transportation emissions increased due to the greater number of registered vehicles in the city. Emissions from solid waste were unable to be directly compared to those reported previously. While the amount of waste deposited in the landfill has increased, Eilat's methane recapture program has mitigated emissions from waste decomposition.

Lastly, we propose additional reduction measures to further mitigate Eilat's GHG emissions. Within electric power, we show that investment in energy storage solutions will allow Eilat to utilize renewable energy more effectively. Within transportation, we recommend improvements to the public transportation system. Within municipal solid waste, we recommend a recycling program for paper and cardboard.

CHAPTER 2: THE GLOBAL COVENANT OF MAYORS

The Global Covenant of Mayors (GCoM) formed in 2014 to promote climate action plans among its members and reduce environmental impact at the municipal level. Signatories on the GCoM must submit a Baseline Emission Inventory (BEI), a Sustainable Energy Action Plan (SEAP), and Monitoring Emission Inventories (MEI). Signatories must also identify their chosen emission reduction targets. The BEI provides signatories with a starting point to judge any progress they make towards emission reduction. The SEAP outlines which actions signatories plan to take to meet their stated emission goals. By submitting an MEI every two years, the GCoM and signatories can keep track of whether they are meeting their stated goals (Rivas et al., 2018). After joining the GCoM, Eilat submitted their BEI in 2016 and their SEAP in 2018. In the SEAP, Eilat aimed for a 20% reduction in GHG emissions by 2020, relative to their 2014 emission levels. Eilat's next step is to submit their first MEI. The purpose of this report is therefore to serve as a 2019 MEI for the city.

The GCoM provides signatories with resources to reduce greenhouse gas (GHG) emissions, including funding, reporting guidelines, and centralized data. The GCoM also has an initiative to make emissions data accessible to the public, allowing cities to compare policies. Funding for signatories is available through direct funding to public and private entities, as well as through loans and non-traditional funding methods, such as crowd-funding (*Support*, n.d.). The GCoM recommends that signatories report emissions using the Global Protocol for Community-Scale Greenhouse Gas Emissions (GPC).

The GPC requires that cities report emissions using two frameworks: emissions for a specific area and emissions generated by the city. These manifest as the three "scopes" illustrated in *Figure 1*. The first scope involves direct emissions inside the city limits. The second scope evaluates indirect emissions from electric power demand by the city. The third scope involves emissions resulting from activities outside of city limits. The MEI focuses on select sources within Scopes 1 and 2, based on the availability of data. Within Scope 1, we report emissions from transportation within the city and under scope 3 the municipal solid waste since its habdled out of the city boundary. However, emissions from transportation fall between Scopes 1 and 3, because the form of our transportation data necessitates including out-of-boundary emissions from vehicles registered in Eilat. From Scope 2, we report electric energy generation, considering the emissions profiles of different sources of generation. Estimates for transmission losses under Scope 3 are included as well.

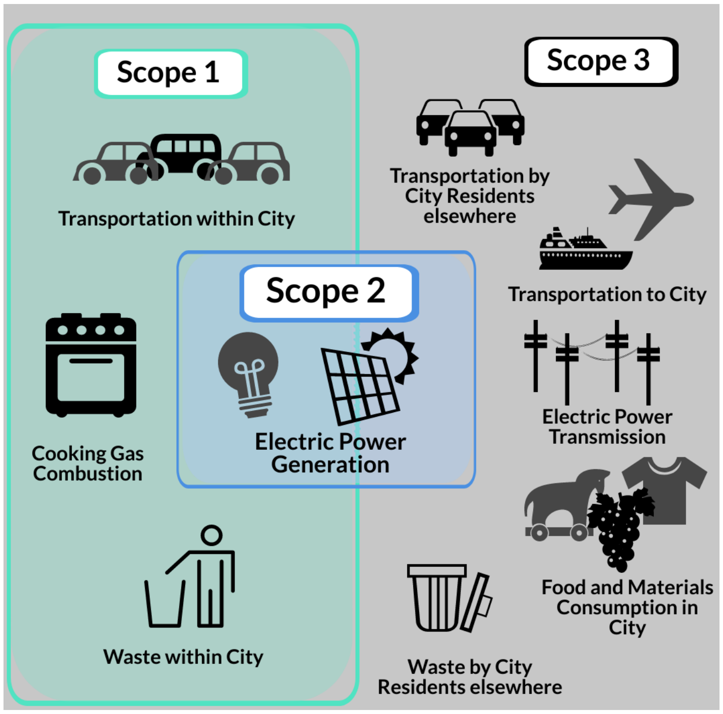

Figure 1. Greenhouse Gas Reporting Scopes

2.1 Baseline Emissions Inventory

As a member of the GCoM, Eilat submitted a Baseline Emissions Inventory (BEI) in 2016 (Kissinger et al., 2016). Emissions are reported in carbon dioxide equivalents (CO_2 eq), which equate all greenhouse gases to a quantity of CO_2 with the same global warming potential[1]. The BEI estimated 2014 GHG emissions in Eilat using 2012 electricity consumption data and 2014 transportation, waste, and liquified petroleum gas data. The BEI did not account for the electricity generation from emissionless sources such as photovoltaics (solar cells). In addition, due to the unavailability of particular data, multiple assumptions were made to determine the emissions factor for the private 4-wheel vehicles (Kissinger et al., 2016).

The BEI showed that the three largest contributors to greenhouse gas emissions in Eilat were

[1] Global warming potential is (GWP) is a measure of a gas's ability to absorb infrared radiation, normalized to that of CO_2. GWPs depend on time frame, because different gases remain in the atmosphere for different periods of time. 100 years is the standard time frame under which to report. See: Understanding Global Warming Potentials | Greenhouse Gas (GHG) Emissions | US EPA

commercial electricity, residential electricity, and private transportation. 79% of emissions resulted from the generation of electricity via fossil fuels and 14% of emissions came from gasoline-fueled vehicles.

The BEI report also analyzed GHG emissions by various sectors - public, household, commercial, and industrial. The commercial sector generated the most GHG emissions as it accounted for 34% of total emissions, followed by the residential sector at 13% of total emissions (Kissinger et al., 2016). These results enabled Eilat to target specific sectors with emissions reduction measures.

2.2 Sustainable Energy Action Plan (2018)

Signatories to the GCoM must also submit a Sustainable Energy Action Plan (SEAP) that includes information about the city's emission reduction initiatives and reduction targets (Rivas et al., 2018). Eilat submitted an SEAP in 2018. Eilat's SEAP reiterates the BEI's findings and expands on what future emissions will look like if no further action is taken. The review of the findings is followed by potential reduction methods and some examples of what had already been implemented prior to writing the SEAP.

The SEAP outlines the three main sectors in Eilat that are implementing GHG reduction measures. These are the municipal government, commercial sector, and city residents (Kissinger & Damari, 2018). Over the past decade, Eilat has planned, promoted, and implemented several measures to reduce GHG emissions. Most of these measures pertain to electricity use or transportation, as these two domains have the greatest emission contributions according to the BEI. Notable measures include adoption of solar energy alternatives, improving energy efficiency in electric appliances and building structure, and promoting hybrid vehicles. We discuss these initiatives below.

2.2.1 Implementation of Solar Power in Eilat

Solar-derived power constitutes the largest source of renewable energy in Israel. The Eilat-Eilot region, including the Southern Arava Valley, receives a large quantity of solar radiation throughout the year. Average annual solar insolation is 2157 kWh/m^2 per year[2]. This degree of irradiance makes solar harvesting technologies the leading prospect for renewable and emissionless power generation in the region. Prominent technologies currently leveraging insolation in Eilat and the Southern Arava include solar water heaters, solar-thermal generators, and photovoltaics (solar panels). Implementation of these technologies is a coordinated effort on the national, municipal, and civilian levels.

Israel has pursued solar water-heaters as an alternative energy solution to conventional gas heating, which in Eilat is liquified petroleum gas (LPG). Newly constructed residential buildings are required by law to install these systems, and as a result the nation is a world leader in per-capita use of solar water heating (Udasin, 2014). In our survey of rooftops using Eilat's geographical information system (***3.1.2 Photovoltaics***), every residential building in Eilat had at least one solar water heater. Most houses had one heater, while apartment buildings had several, one for each unit in the building.

Photovoltaics are the preeminent emissionless source of electrical energy for Israel. Solar panels can be implemented on both small and large scales. Small scale use involves private installation of solar panels on the roofs of buildings and homes. The city of Eilat has promoted solar panel adoption through economic incentives such as tax deductions. Municipal buildings have installed solar panels as well. The Eilat Environmental Unit hopes that municipal solar projects will encourage the private sector to install solar projects of their own. To promote this initiative, the Eilat-Eilot Renewable Energy Company has worked with the company "SolView", a data-analytics company, to develop the SolView software tool that guides homeowners through selecting photovoltaic modules and systems for their home.

The up-front cost of solar technologies can be difficult for an individual customer to afford. An alternative is large-scale solar projects that distribute power through a centralized electrical grid. The Eilat-Eilot Renewable Energy nonprofit has worked with the Arava Power Company (as well as international investors) over the past two decades to construct utility-scale solar plants in the Southern Arava. The projects total a combined rated production of nearly 190 MW and are

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[2]Data on Eilat's solar resource came from PVWatts, an online tool developed by the National Renewable Energy Lab to help to predict the performance of photovoltaics. pvwatts.nrel.gov

consistently able to supply 70% of the daytime energy needs to the region (*Eilat-Eilot Renewable Energy*, n.d.). The long-term goal of Eilat-Eilot Renewable Energy is to power the region with 100% renewable sources. This will involve constructing new solar fields and investing in energy storage solutions such as battery stations and pumped-hydro turbines.

2.2.2 Additional Measures

After discovering that streetlights accounted for approximately 40% of municipal electricity consumption in Eilat, city planners replaced existing streetlights with more energy-efficient LEDs (Kissinger & Damari, 2018). By 2019, 14,000 upgrades were complete, reducing annual consumption by 6 GWh, roughly a 75% decrease from streetlights in 2014.

Eilat has introduced other energy efficiency initiatives in public buildings, including schools, community and recreational centers, libraries, and government buildings. These initiatives involve efficient indoor lighting, improved air-conditioning units, and better building insulation. The municipal government has incentivized businesses to adopt conservation practices and install more efficient appliances in buildings. The municipality has also introduced new design guidelines to make buildings more energy efficient (Kissinger & Damari, 2018). Eilat will continue encouraging energy efficiency by using an ad campaign, smart meters, and remote control of electrical appliances.

The municipality also looked at reducing emissions from transportation within the city. Private vehicles made up the largest source of transportation emissions in 2014 so the municipality made plans to promote the use of public transportation in the city. To encourage city residents to transition to hybrid and electric vehicles, the municipality planned to switch the municipal fleet of vehicles to hybrid and electric vehicles.

Table 1 outlines all the emissions reduction measures mentioned in the SEAP. The measures are categorized by sector responsible for implementation as well as the status of the measures as of 2018. The emission reduction measures in the SEAP were organized by the City of Eilat and targeted the largest areas of emissions based on the 2016 BEI.

Table 1: *GHG Emission Reduction Measures in Eilat as of 2018*

Policy	Sector	Status
Solar Panels	Residential/Municipal	In Progress[1]
Solar Water Heaters	Residential/Municipal	Completed[2]
Efficient Streetlights	Municipal	Completed
Efficient Indoor Lights	Municipal	Planned[3]
Improved Air-Conditioning Units	Municipal	In Progress
Building Insulation	Municipal/Commercial	Planned
Energy Conservation Practices	Commercial	Planned
Efficient Appliances	Residential/Municipal/Commercial	In Progress
Water Management System	Municipal/Residential	Completed
Electric/Hybrid Vehicles	Municipal	Planned
Increased Public Transportation	Residential	Planned

[1]In progress - Started to be implemented in 2018 but not finished
[2]Completed - Finished as of 2018
[3]Planned - Proposed measure in 2018 SEAP

2.3 Introduction to the Monitoring Emissions Inventory

The GCoM expects an updated MEI from its signatories every two years. This report is the first Monitoring Emissions Inventory (MEI) for Eilat, providing updated information on GHG emissions from the city. Changes in emissions compared to the 2014 data will be analyzed with respect to electricity, transportation, and waste emissions. However, unlike the 2016 BEI, we did not have data pertaining to different economic sectors in the city, these being the residential, commercial, municipal, and industrial sectors. GHG emissions were therefore categorized only by source (electricity, transportation, and waste).

EILAT CITY

MONITORING EMISSIONS INVENTORY 2021

Survey of 2019 Greenhouse Gas Emissions in Eilat

This MEI is submitted as part of the Eilat Municipality's obligations under the Global Covenant of Mayors for Climate and Energy.

Authors of the Report:

Rosalyn Bates, Samantha Marcil, David Schwartz

CHAPTER 3: ELECTRIC POWER

Greenhouse gas emissions due to electric power consumption result from the combustion of fossil fuels to drive electric generators. The semi-private Israel Electric Corporation (IEC) owns and operates Israel's natural gas and coal power plants, as well as the nation's electrical grid for the transmission and distribution of electrical power. Power delivered to loads connected to the grid, including the substation connected to Eilat, are measured and recorded by the IEC. An IEC plant containing three gas turbines[3] exists in Eilat. Photovoltaics (PVs) are on rooftops in Eilat, and utility-scale PV fields are present in the Eilat-Eilot region and Southern Arava Valley. Unlike fuel-driven turbines, photovoltaics do not emit greenhouse gases when generating electric power. Gas turbines cooperate well with renewables because they can change their output quickly in response to changing loads.

3.1 Methods

In general, deriving carbon emissions from electric power usage involves collecting the raw consumption data, subtracting supply from photovoltaics, and applying the appropriate IEC emissions factor. The emissions factor relates electric energy generated to greenhouse gas emitted from the combustion of a fossil fuel (in weight CO_2 eq/Watt-hour). Performing this computation requires data on the city's power demand, composition of generation from renewables and fossil fuels, and emission factors for fossil-fuel-based generators. This is most accurately computed on an hourly basis (**3.1.4 Calculating Carbon Emissions**).

3.1.1 Power Demand in Eilat

Information on power demand and emission factors were obtained from the Israel Electric Corporation (IEC). The IEC annually publishes environmental reports that include energy and emissions data for its facilities (*Annual Environmental Reports*, n.d.). These include emissions factors for both coal-fired and natural gas-fired turbines, as well as an averaged emission factor pertaining to the national electric grid that includes typical transmission losses. The IEC measures the power demand of consumers throughout the year to bill its customers. Since semi-

[3] "Gas turbine" refers to the air-fuel mixture sent through the system's compressor. The fuel is usually a natural gas (methane), but the technology is flexible and can use petroleum derivatives instead.

privatization in 2012, the IEC no longer provides public access to consumption data within cities and their various sectors. However, our sponsors from the Eilat Environmental Unit were able to extract Eilat's power draw by hour for the entire year of 2014. The total for 2014 is 648.219 GWh. *Figure 2* shows the energy utilized during each month, and *Figure 3* shows the power demand throughout a typical day in each month. Emission factors were obtained from the Israel Electric Corporation (IEC). Consumption is greatest during summer months due to the influx of tourists and increased load from air conditioning systems.

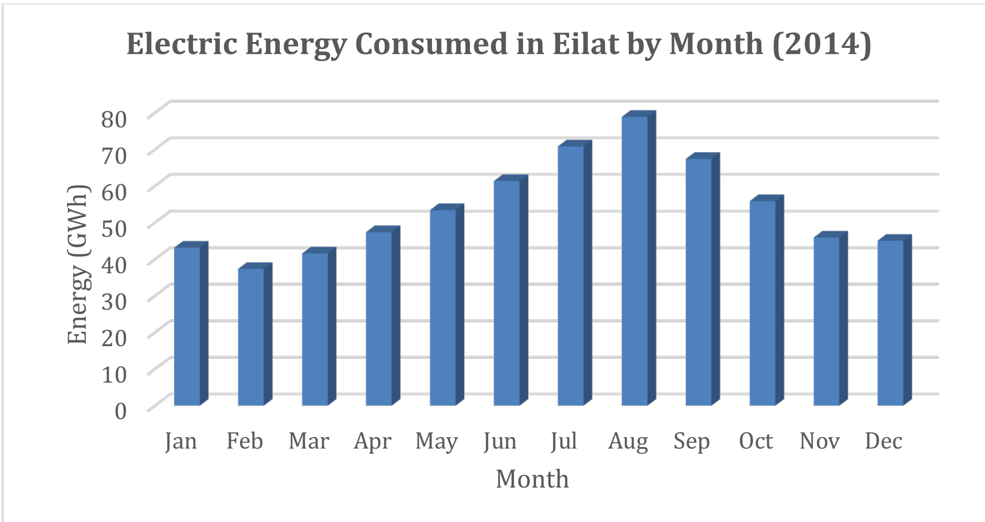

Figure 2. Energy Consumption by Month

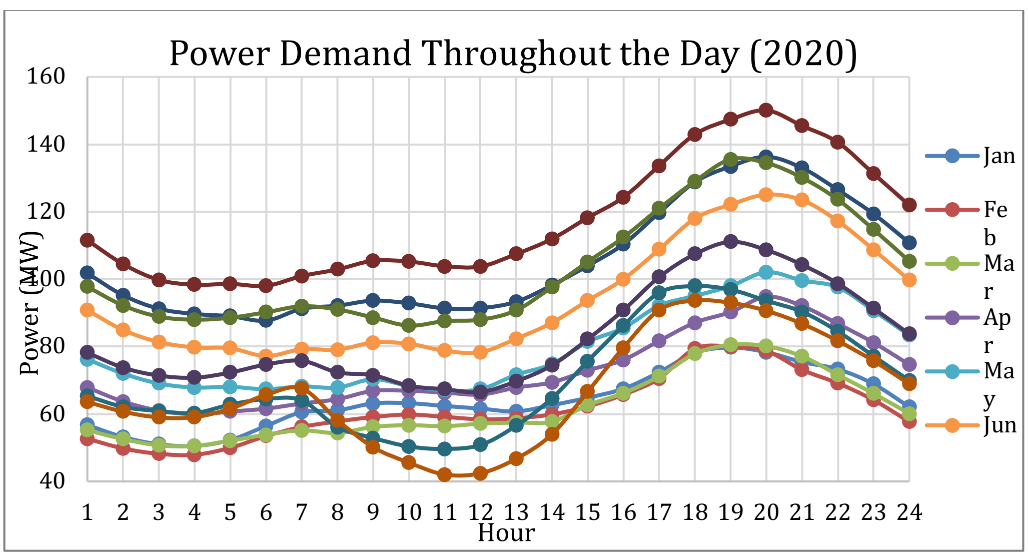

Figure 3. Power Demand by Hour for the Average Day of the Month

Because the data pertained to 2014, we developed two approaches to obtain results for 2019. The first approach considered demand linearly proportional to population. In 2014, Eilat had a permanent resident population of 48,910, with an additional 10,000 temporary national residents and 19,000 international visitors at a given time (Kissinger et al., 2016). Between 2014 and 2019, Eilat's permanent population increased by 3,353 individuals (Central Bureau of Statistics, 2019), and temporary residents by 2,000 *(*Eilat- A Smart City*, n.d.)*. Assuming steady international visitation, the aggregate population of the city increased by 8.15%. The predicted power demand for 2019 was scaled by this factor.

The second approach used the 2014 data directly. It proposes that previous data are representative of 2019 because per-capita energy consumption has decreased over time: Israel's energy consumption has remained relatively constant even as its population increased (*Annual Environmental Reports*, n.d.). This could in part be due to operational improvements to the electric grid and improved efficiency of electric appliances.

3.1.2 Photovoltaics

We conducted energy analysis of PVs on the roofs of homes, schools, and businesses in Eilat, as well as PVs operating at utility-scale solar plants in the Southern Arava valley. Rooftop PVs in Eilat were analyzed separately from the Arava PV fields outside of city limits to distinguish between internal and external activities.

We identified rooftop installations in Eilat using the Geographic Information System (GIS) (*GISNET V5*, n.d.). The team scanned the entire city, dividing it into three main sections — north, central, and south. Rooftop installations were identified, and their coordinates recorded. Individual panels were counted by zooming to the smallest scale. *Figure 4* shows the process of identifying installations, including an example of solar panels on a high school.

Figure 4. GIS Solar Panel Counting.
Top Left: Eilat. Top Right: Central Eilat. Bottom Left: Solar Panels Marked on GIS. Bottom Right: Solar panels on School

As this method only resulted in a numerical count of photovoltaics modules, it was necessary to make assumptions regarding their specifications. The major assumption was the size of the panel. Using the GIS, we sampled roof-mount modules on near-flat roofs. Their areas were measured to obtain a mean and standard deviation for residential, commercial, and municipal buildings, respectively. These were used as an estimate for the entire city. Only relatively flat roofs were considered to avoid inaccuracy when measuring area from an overhead photograph[4]. The rated power (i.e., the power output under standard test conditions) for rooftop PVs was calculated using the following formula (Masters, 2013):

Equation 1

$$P_{STC}[W] = A\,[m^2] * \eta * S\,\left[\frac{W}{m^2}\right]$$

P_{STC} = rated power under standard test conditions [W]
η =efficiency, was assumed 15% for rooftop PVs.
S = 1-sun, or 1000 W/m^2.

[4] Comparable accuracy would have been obtained if the PV area was measured on every roof. Roofs in regions without snow have comparable slopes to open-rack modules on flat roofs. The relative standard deviations were also high: 14.8% among residential buildings, and 9.63% among commercial buildings.

We also performed an analysis on the utility-scale photovoltaic fields in the Southern Arava and Eilot region. The Eilat Environmental Unit provided an inventory on rated power supply from connected fields. Since the Arava solar fields are outside of the city limits, determining the proportion of this power delivered to the city proper is non-trivial. The proportion of Arava PV output delivered to Eilat through the national grid is a function of the transmission distance and the design and operation of the transmission network. These calculations are beyond the scope of this report and were replaced with three distinct models (***3.1.4 Calculating Carbon Emissions***). Various sources, such as the Eilat-Eilot Renewable Energy nonprofit, and local newspapers, claim between 70-100% of the region's daytime energy are supplied from solar power (*Eilat-Eilot Renewable Energy*, n.d.). A report on the Eilat-Eilot website corroborates the assumption that energy distribution is prioritized regionally (*About Eilat-Eilot*, n.d.).

Relevant data from the inventory provided by the Eilat Environmental Unit (**Table 2**) originally showed that a total rated power of 190.28 MW in the region is currently connected to the national electric grid (as of February 2021). However, this included an estimated 10 MW from rooftops in Eilat, whereas our GIS solar panel count gave a result of 6.7 MW. Therefore, our computations used 180.28 MW from solar fields, and 6.7 MW from rooftops in Eilat.

Table 2: Inventory of Photovoltaics in the Southern Arava

Settlement	Currently Connected (MW)	Settlement	Currently Connected (MW)
Middle Arava	25	Lotan	0.2
Rooftops Eilat	10	Yael	1
Eilot	2	Neve Harif	0.08
Elipaz	5	Neot Smadar	8.55
Samar	11.3	Timna	60
Yotvata	5.8	Timna Mines	5
Grophit	5.22	Evrona	5
Ketura	45.6	Regional Center	1
Total	**191 MW**		

3.1.3 Modeling Photovoltaic Performance

As noted above, the values assigned to photovoltaics in **Table 2** refer to the "rated" power of the PV modules. Rated power is determined by ideal standard test conditions, and in practice will usually not be the actual system output. Major environmental factors affecting solar-energy performance include position of the sun, intensity of sunlight, and PV cell temperature. We

modeled PV systems using National Renewable Energy Lab's PVWatts calculator (*PVWatts Calculator*, n.d.). A list of our decisions for user-defined inputs is in the Appendix B.
Given the system information, the PVWatts tool will display the results of its calculations. These include the DC array output (W) and the AC power transferred to the grid (W) for each hour of the year. The tool was applied separately to the inventory of residential, commercial, and municipal installations in Eilat, and utility-scale fields in the Southern Arava. For Eilat's rooftop PVs we assumed "standard" 15% efficiency, whereas for utility-scale installations we assumed "premium" anti-reflective glass afforded 19% efficiency. These assumptions have a significant effect on simulations of photovoltaic performance.

3.1.4 Calculating Carbon Emissions

The datasets for Eilat's power demand and PV supply consisted of data points for each hour of the year (1 to 8760). Hourly datasets allowed us to use three distinct models to compute greenhouse gas emissions. The first model considers only the national electric grid and rooftop PVs. The second model includes external PV systems in the Southern Arava. The third model includes both Eilat's gas turbines and the regional PV systems.

Model I: National Electric Grid

In terms of greenhouse gas (GHG) emissions, the worst-case assumption is that electric power is distributed widely rather than regionally or locally. In this model, Arava solar fields and the Eilat power plant do not prioritize the city's power demand; only PV production on rooftops within Eilat are deducted from emissions, and only the emissions factor for the national grid is used. Since rooftop PV power supply never exceeds the city's power demand, computing the result involves taking the total energy consumption for the year, subtracting the total energy supply from rooftop PVs[5], and applying the national grid emission factor. This calculation produced an upper-bound for annual GHG emissions.

Equation 2

$$Emissions = \left(Annual\ Energy\ Usage - Annual\ Energy\ PV_{roofs}\right) * EF_{grid}$$

EF_{grid}= 645 [$\frac{Kg\ CO_2eq}{MWh}$], general emissions factor for the Israeli electric grid (2019).

[5] Model I did not set rooftop PV production to 0 during the few power outages that occurred in 2014.

Model II: Inclusion of Southern Arava PV Fields

The intermediary assumption is that generation from Southern Arava PVs is primarily distributed to regional consumers in Eilat and the Arava. Given that Eilat is the region's major city, with a population of 52,299, plus nearly 29,000 visitors at a given time, and the population of the Arava is around 5,100, we estimated that 95% of the energy generated from PVs is allocated to Eilat (Central Bureau of Statistics, 2019) (Kissinger et al., 2016). Losses due to transmission and transformation were estimated to be an additional 5% (Masters, 2013). When PV supply is greater than demand, the excess power is either stored or transmitted to other regions through the grid. When demand is greater than PV supply, the remainder is supplied by fossil fuels through the national grid, and the generalized grid emission factor is applied. The following algorithm was iterated over the hourly data sets to compute the equivalent CO_2 emissions:

Equation 3

$$for\ each\ hour\ in\ the\ data\ set:$$
$$fueled = demand - (PV_{fields} * Trans) - PV_{roofs}$$
$$if \quad fueled > 0,$$
$$emissions \mathrel{+}= fueled * EF_{grid}$$

Demand and PV_{roofs} are the hourly data sets, converted to MW
Trans = (0.95)*(0.95) = (0.9025), estimate net transmission from Southern Arava fields to Eilat
$CF_{grid} = 645 \left[\frac{Kg\ CO_2eq}{MWh}\right]$, for national grid (IEC, 2019)

For now, storage of excess PV generation is non-existent. If PV supply exceeds city demand, then emissions are 0 instead of negative.

Model III: Inclusion of Eilat's Gas Turbines

The best-case assumption is that all regional power generation is distributed from source to regional or local consumers, as opposed to far-away consumers, which presumably receive power from their own regional source. This means that Eilat's 34 MW industrial gas turbine, 58 MW jet or "aeroderivative" gas turbines, and PV systems in the Southern Arava all prioritize the city's power demand.

When PV supply is greater than demand, the excess is either stored or transmitted to other regions through the grid. However, when demand is greater than PV supply, then Eilat' s gas turbines supply the difference up to their combined net nominal output[6]. This is reasonable because gas turbines can change their output quickly in response to changing loads, particularly jet gas turbines (Masters, 2013). The CO_2 eq emission factor for natural-gas plants is applied to the energy produced by Eilat' s gas turbines. If demand is still higher than the combined generation of both photovoltaics and Eilat's local plant, then the remainder is supplied by fossil fuels from the national grid, and the general grid emissions factor is applied. The following algorithm was iterated over the data set to compute the equivalent CO_2 emissions:

Equation 4

$$for\ each\ hour\ in\ the\ data\ set:$$
$$fueled = demand - \left(PV_{fields} * Trans\right) - PV_{roofs}$$
$$if \quad 0 < fueled \leq GT_{Eilat},$$
$$emission \mathrel{+}= fueled * EF_{gas}$$
$$if \quad fueled > GT_{Eilat}\ ,$$
$$emission \mathrel{+}= \left(GT_{Eilat} * EF_{gas}\right) + \left(fueled - GT_{Eilat}\right) * EF_{grid}$$

Demand, PV_{fields}, and PV_{roofs} are the hourly data sets, converted to MW
Trans = (0.95)*(0.95) = (0.9025), estimate net transmission from Southern Arava fields to Eilat
GT_{Eilat} = (34+58)*(0.95) = 87.4 [MW], the net nominal output of Eilat's gas turbines transmitted within the city (IEC, 2019)
$CF_{gas} = 400 \left[\frac{Kg\ CO_2eq}{MWh}\right]$, for natural-gas power plants (IEC, 2019)
$CF_{grid} = 645 \left[\frac{Kg\ CO_2eq}{MWh}\right]$, average for national grid (IEC, 2019)

Again, for now, storage of excess PV generation is non-existent. If PV supply exceeds city demand, then emissions are 0 instead of negative.

Comparison Between Different Years

To accurately compare emissions across different years, the methods described in this section were extended to 2014, the year from which the power demand data were sourced. In 2014, the connected PV power in the Southern Arava was 106 MW, and the Eilat gas turbines were present with the same nominal capacity (*About Eilat-Eilot*, n.d.) (*Israel Electric Corporation*, 2020). Since Israel's electric grid was majority coal powered, the emissions factor for the grid was larger, at 688 $KgCO_2eq/GWh$. Lastly, the previous BEI included an inventory of PVs, on

[6] Eilat's power plant was modeled to only supply up to its nominal 92 MW output. Draw from exterior communities in the region was again estimated at 5% of total supply. Therefore, the net supply to Eilat is 0.95*92 MW = 87.4 MW.

municipal rooftops, and arrived at a reduction in 700 tons CO_2. These parameters were used to determine the emissions for 2014 via the same methodology used for 2019.

3.2 Results

3.2.1 Photovoltaics

The total count of solar panels on rooftops in Eilat was 24,126, consisting of 7,735 on residential homes and apartments, 12,008 on commercial buildings, and 4,383 on school and municipal buildings as shown in **Table 3.** The total rating for Eilat's rooftop PVs summed to 6.713 MW.

Table 3: *GIS Solar Panel Count*

	Residential	Commercial	School/Municipal
Panel Count	7735	12008	4383
Mean Area (m2)	1.615	1.963	2
Relative Stdev	0.1479	0.0963	0
Rated Power (W)	242.3	294.5	300
Total (W)	2.58E+06	6.27E+06	2.63E+06

Figure 5 shows the breakdown of energy production from Eilat's rooftop PVs. Annual DC output is 19 GWh, consisting of 4.9 GWh (26%) residential, 10 GWh (52%) commercial, and 4.2 GWh (22%) school and municipal. The capacity factor for rooftop PVs was 17.6.

Arava PV systems are of utility-scale and as such produce energy an order above Eilat's rooftop inventory. Eilat's rooftop PVs constitute 3% of annual PV production, the other 97% coming from PVs in the Southern Arava (*Figure 6*).

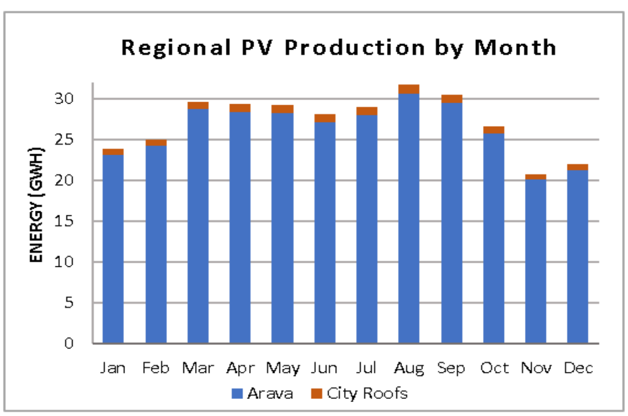

Figure 6. Composition of Regional PV Energy Generation by Month during 2019
(DC Output)

Annual PV production from the Southern Arava is 315.55 GWh (**Table 4**) with a capacity factor of 19.6. The combined total of Southern Arava and Eilat rooftop PVs is 326.34 GWh.

Table 4: *Annual PV Energy (DC array output)*. Values in GWh

Residential	Commercial	Municipal	S. Arava	Total
3.00	5.67	2.11	315.55	326.34

Figure 7 shows daily PV performance during different months of the year. PV production occurs during daylight intervals, the length of which depend on the time of year. The maximum daylight interval, near the summer solstice, is approximately 14 hours, from 6 a.m. to 8 p.m. The minimum, near the winter solstice, is 10 hours, from 8 a.m. to 6 p.m. Peak production occurs near noon when the sun is directly overhead the PV array. The greatest producing months are August, while the greatest peak generation occurs during March.

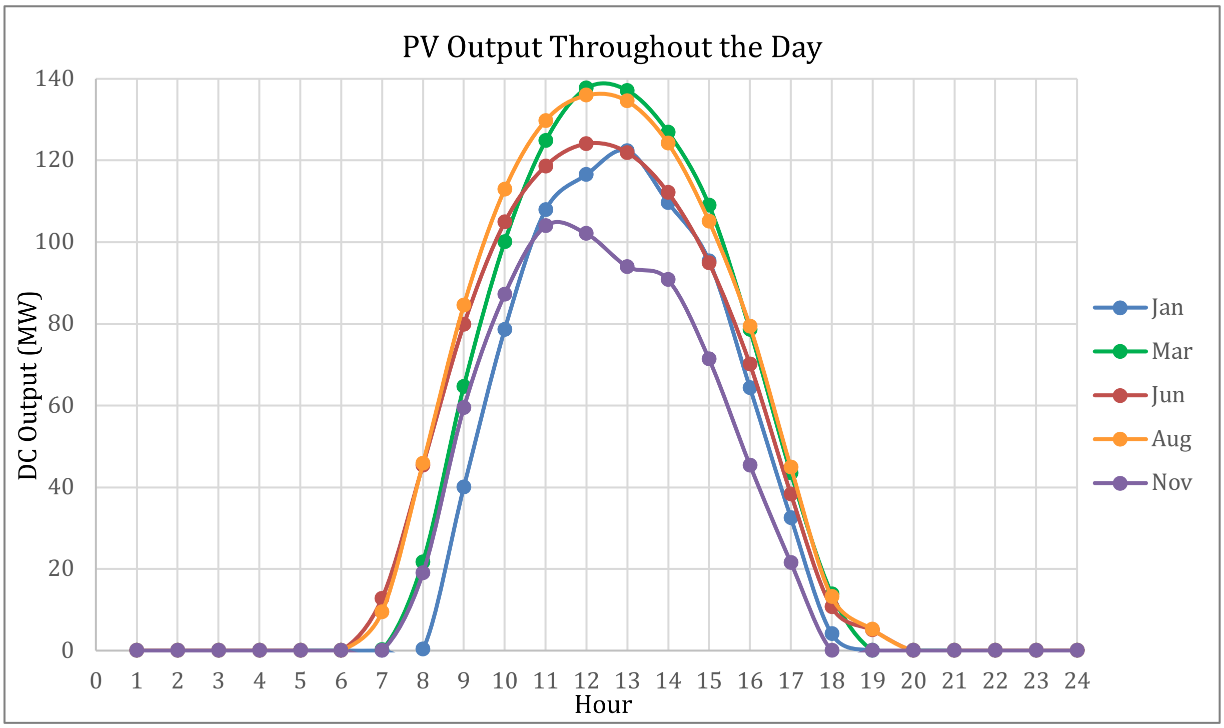

Figure 7. PV Output Throughout a Typical Day of the Month
(DC Output)

3.2.2 Emissions

Table 5 summarizes the results of Models I, II, and III, applied to data from 2014 and 2019. *Figure 8* is graphical representation of the data in table 5, showing how emissions change between different years and models.

Table 5*:* **Predicted Emissions for 2014 and 2019**

Emissions	Model I (tons CO2eq)	Model II (tons CO_2eq)	Model III (tons CO_2eq)
2014	491,074	383,229	236,938
2019 Not Scaled	454,584	319,788	209,524
2019 Population Scaled	492,179	350,903	234,041

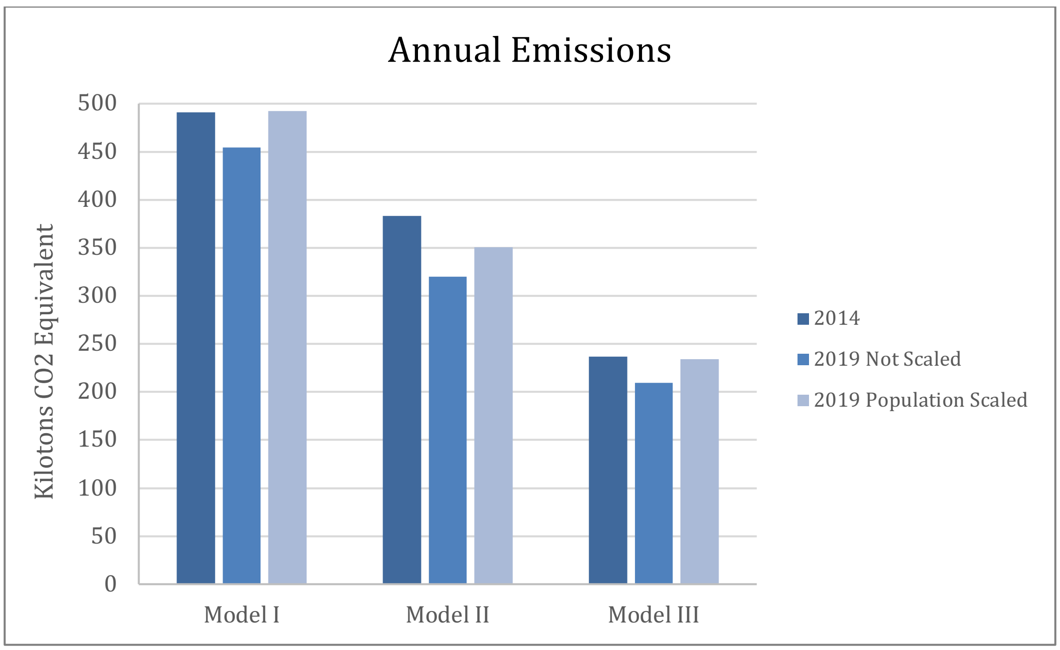

Figure 8. Emissions by Model and Year.
Values from table 5.

Model I

Considering only the general grid emissions factor and generation from Eilat's rooftop PVs provides an upper-bound for carbon emissions. From 2014 to 2019, the grid emissions factor decreased from 688 KgCO2 eq/MWh to 645 KgCO2 eq/MWh, largely due to the incorporation of natural gas-fired plants over coal-fired plants. When not scaling by population growth, this results in 454,584 tons CO2 eq, a 7.4% reduction from 2014. When scaling by population, the result is 492,179 tons CO2 eq, a 0.2% increase from 2014 (Table 5). Rooftop PVs reduced emissions by 6,673 tons CO2 eq.

Model II

Including Arava PVs results in a significant drop in emissions compared to those in Model I. The relative emissions reduction over time improved as well (Figure 8). In 2014, 106 MW of connected PVs resulted in 383,229 tons CO_2 eq. Without scaling by population, 2019 emissions are 319,788 tons CO_2 eq, a 16.6% decrease from 2014. Scaling by population, emissions are 350,903 tons CO_2 eq, an 8.44% decrease from 2014.

Shown in *Figure 9*, Model II, scaled by population, has 229.37 GWh (30%) supplied by PVs and 544.04 GWh (70%) supplied by the national grid. Note that supply from PVs is less than the 326.34 GWh total DC output shown in **Table 4**.

After inverter efficiency and transmission to Eilat, most losses with respect to the city's consumption came from the absence of storage for excess PV production during peak-sun hours (*Figure 13*).

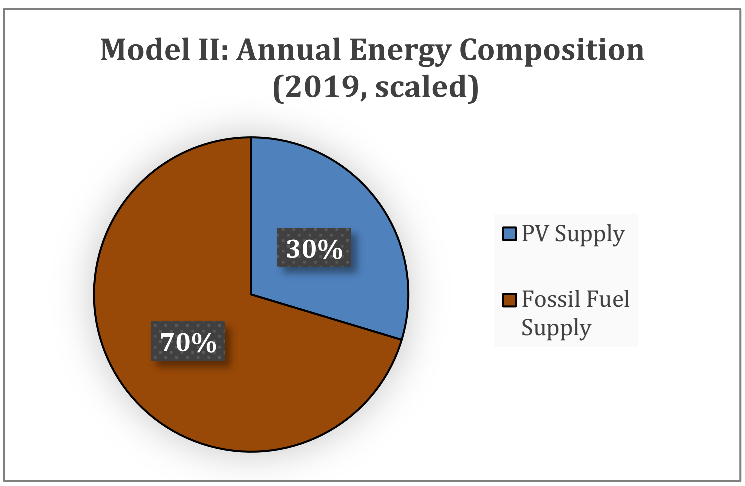

Figure 9. Annual Energy Composition.
Model II, scaling by population growth for 2019.

Figure 10 shows the total and composition of energy supply for each month. As expected, load is greater in the warmer months of the year, in part a result of active air conditioning systems. Minimum consumption occurs from February to March, where photovoltaics supply over one third of the energy demand. Utilization reaches its maximum in August, the hottest month of the year, in which cooling systems and air-conditioning units are in full use. December has the smallest PV contribution at 23.1% of total supply, 6.9% less than the annual composition.

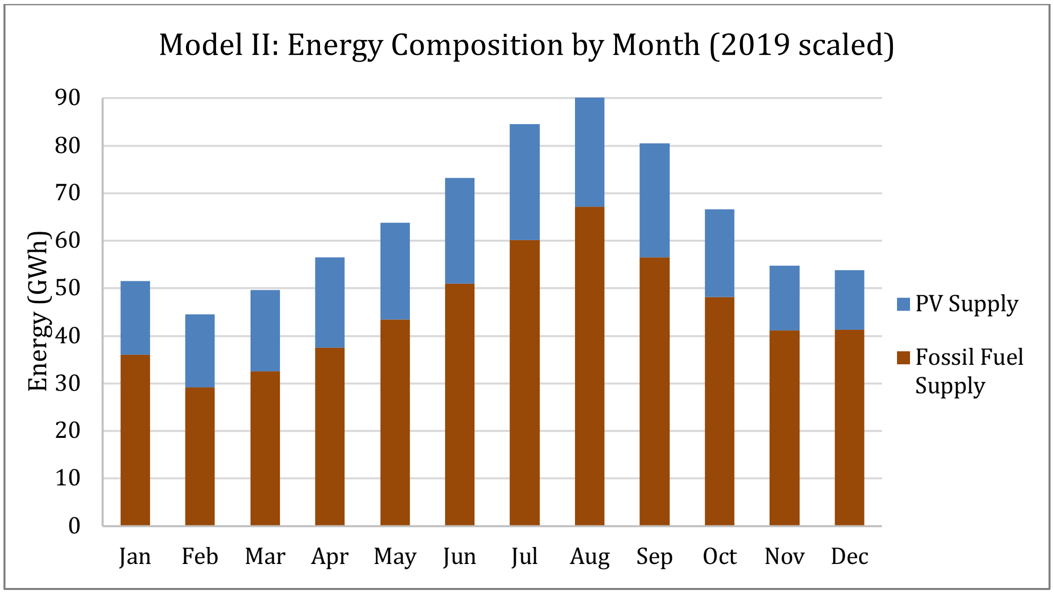

Figure 10. Composition of Eilat's Energy Supply by Month During 2019.
Model II, scaling by population growth for 2019.

Model III

Including generation from Eilat gas turbines in addition to utility-scale PVs provided a drop in emissions compared to Model II. This is due to the emissions factor for gas-fired plants being 400 KgCO_2 eq/MWh, compared to the 645 KgCO_2 eq/MWh of the general electric grid. The generalized grid emissions factor is derived from the composition of Israel's natural gas and coal power plants, and coal-fired plants have an emissions factor of 890 KgCO_2/MWh, over double that of natural gas plants (*Annual Environmental Reports*, n.d.). While total emissions are lowest in Model III, the relative reduction over time is inferior. In Model II, the emissions reduction observed between years 2014 and 2019 was a result of both new PV installations and the incorporation of gas turbines to Israel's centralized power grid. However, as Model III assumes Eilat's power demand is supplied by the local gas turbine, the activities of the rest of the grid therefore play a less significant role.

In 2014, 106 MW of connected PVs resulted in 236,938 tons CO_2 eq. Without scaling by population for 2019, 186.98 MW of connected PVs resulted in 209,524 tons CO_2 eq, an 11.57% decrease. Scaling by population, the result was 234,041 tons CO_2 eq, a 1% decrease.

Model III, scaled by population, has 229.37 GWh (29.7%) supplied by PVs, 476.99 GWh (61.7%) supplied by Eilat's gas turbines, and 67.05 GWh (8.7%) supplied by the grid (*Figure* 11).

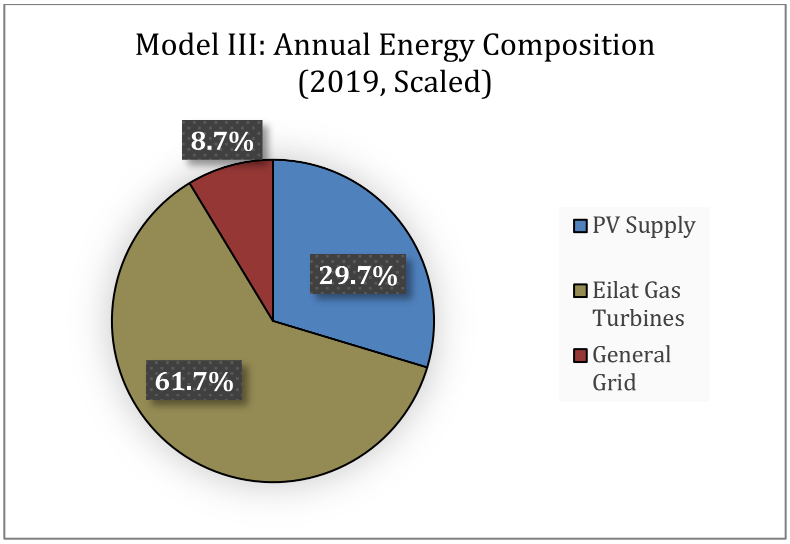

Figure 11. Composition of Eilat's Energy Supply in 2019 (Model III).

Figure 12 shows the composition of energy supply for each month. August, the hottest month of the year, has the greatest energy demand. While August also contains the greatest PV output, this is not enough to compensate for the increased demand. As a result, the 19.8% of August's energy demand must be drawn from the central grid.

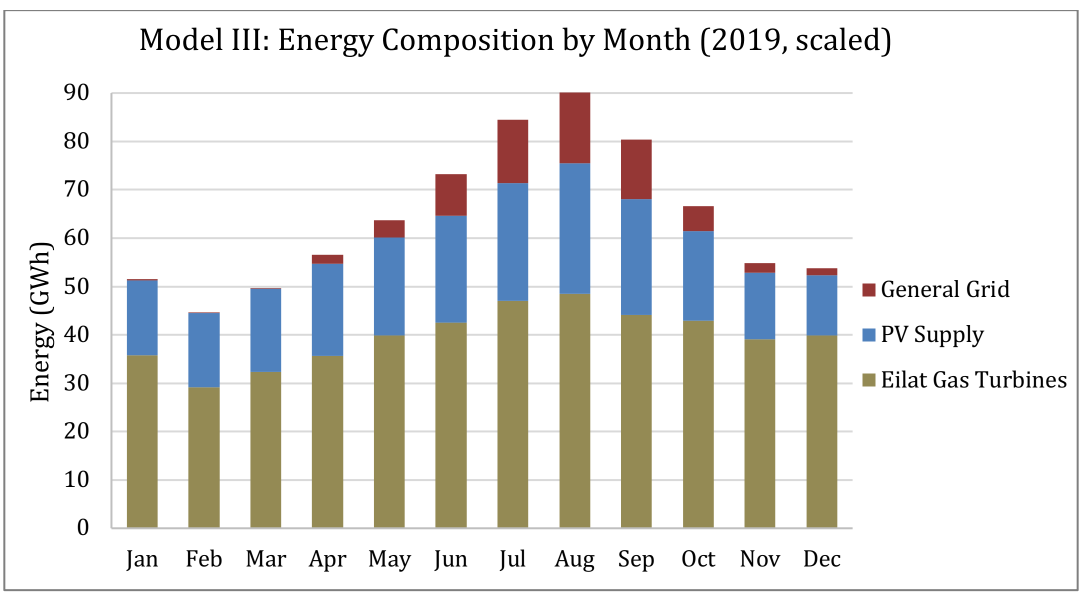

Figure 12. Energy Supplied by Month to Eilat during 2019 (Model III, 2019)
PVs in AC output delivered to Eilat.

3.3 Discussion

3.3.1 Reduction Measures

At the generation level, Eilat has significant potential for further rooftop PV systems. Our GIS count of rooftop PVs found PVs on 350 roofs in the city. While solar-water heaters were present on every rooftop, many homes and hotels were observed to have available area for PV installations.

Model I indicates that as Israel incorporates cleaner energy sources such as natural gas and renewables to the electric grid, the general emissions factor will decrease, thereby reducing Eilat's GHG contribution. Models II and III indicate that storage of excess PV production during the day will provide a significant emissions reduction. With the current capacity of 191 MW, during the peak-sun hours, supply from PVs is consistently more than demand (*Figure 13*). As the region installs more PVs, the quantity of this excess power will increase, providing diminishing returns with respect to reducing GHG emissions. Implementation energy storage will allow excess energy production during the day to be used at night, when power demand is greater.

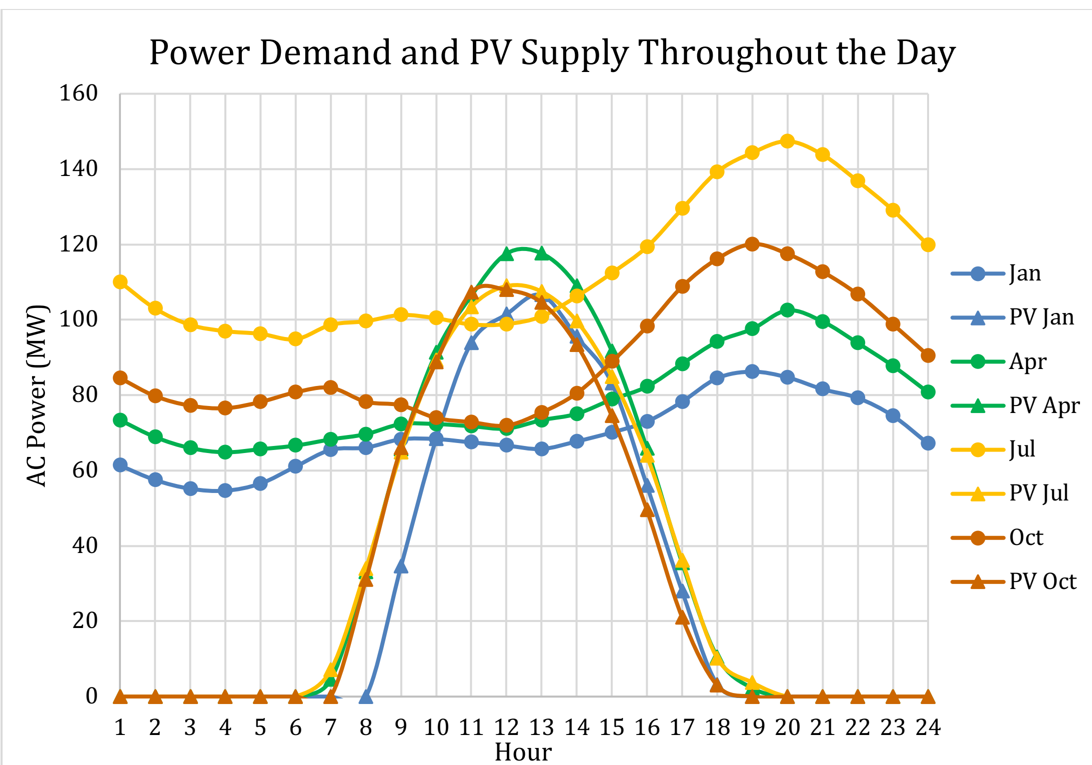

Figure 13. Eilat's Power Demand and Supply from PVs During a Typical Day of the Month.
(PVs in AC output delivered to Eilat)

Scaling by population, an estimated 65.76 GWh (AC) from Arava PVs is not transmitted to Eilat due to being excess supply. Storing the entirety of this energy would reduce emissions by 42,413 tons CO_2 eq (12.1%) following Model II, and at least 26,302 tons CO_2 eq (11.2%) following Model III. This does not include an evaluation of net efficiencies of battery or pumped-hydro storage facilities.

At the consumer end, reducing per capita energy usage is effective at all levels of emissions modelling because it helps to decrease the city-wide power demand. Reducing energy usage can be approached at the appliance level, incentivizing residents and business owners to install energy-efficient cooling units, insulation, lighting systems, and other electronic devices.

3.3.2 Limitations

Analysis of electric power consumption was limited by the availability of data. As the power demand dataset came from 2014, it was necessary to make predictions for power demand in 2019. The population-scaling approach does not model changes in per-capita consumption, growth of industry, nor developments in the technology of electrical devices and systems. International visitation was also assumed to be the same for 2014 and 2019. The non-scaling approach is limited in that it assumes the same power demand for 2014 and 2019, although it provides a useful comparison to the population-scaling approach.

Measuring photovoltaic area using the GIS system is inaccurate, which propagates through to the modeling of rooftop PV performance throughout the year. Modeling PV performance required many assumptions regarding PV module specifications, system losses, and inverter efficiency. Local meteorological data used by the PVWatts tool came from the year 2017 rather than 2019. In addition, it is an imprecise estimation that 95% of PV and gas turbine output is sent to Eilat. However, this is a reasonable approximation given the population distribution of the region.

The three models used to compute emissions are each based on simplistic assumptions regarding the operation of the electric grid. Actual operation of the Israel electric grid may involve a combination of different characteristics expressed in the three Models. For example, Eilat's gas turbines may serve as "peakers", turning on only at night or when demand is at its peak. The fuel-content used by Eilat's gas turbines is also unknown. Varying fuel-content changes the emissions factor applicable to gas turbines. Models I and III therefore serve as upper and lower bounds for emissions, respectively.

3.3.3 Improvements to Computations

During this evaluation, it was unknown whether power measurements in the hourly datasets referred to the average power over the interval, or the sampled power at the given point in time. If the latter is the case, an improvement to our calculations would be to use trapezoidal rather than rectangular summations.

If future evaluations obtain more specific information on PV installations, the National Renewable Energy Lab's System Advisor Model (SAM) is recommended for in-depth modeling of PV systems.

As the Israeli national electric grid incorporates a greater proportion of emissionless sources, emission factors pertaining to the grid become less accurate. Future assessments should scale the emissions factors found in IEC environmental reports by the national fraction of energy provided by fossil fuels.

CHAPTER 4: TRANSPORTATION

In 2014, emissions from transportation were the second largest source of emissions within Eilat. Transportation emissions are the result of combustion of fuel in vehicles. The type of fuel as well as the age of the vehicle influences how much carbon dioxide (CO_2) is emitted during combustion. This section explains how we estimated transportation emissions in Eilat for 2019 and reports the estimated values that we found.

4.1 Transportation Methods

Emissions from transportation were calculated using data for vehicles registered in the City of Eilat. The Central Bureau of Statistics (CBS) provides the number of vehicles registered in Eilat in 2019, categorized by the type of vehicle (**Table 6**) (Central Bureau of Statistics, 2020). The CBS also provided the average annual distance traveled by private vehicles registered in Eilat. Most of the other vehicle categories used national averages provided by the CBS. Total annual distance traveled was found by multiplying the number of vehicles by the average annual distance traveled per vehicle. The total annual distance listed in **Table 6** for trucks was calculated using a method from the BEI in which trucks were assumed to enter and exit Eilat from the port using a 20 km access road. We estimated that this distance was traveled twice each day[7] by each truck. The national average distance was unrealistically high for trucks registered in Eilat due to the size of the city. Municipal vehicle numbers were received from the municipality for each individual vehicle and are not an estimate.

[7] To account for weekends and holidays, the daily numbers for truck calculations were multiplied by 300 to get the annual total.

Table 6: Vehicle Information in Eilat 2019
(CBS Table 7, 2020) (CBS Table 8, 2020) (CBS Table 9, 2020)

Transport	Km/Year	tCO_2e per Year
Private	178,452,000	54,424.51
Buses	724,500	30,977.35
Light Truck	22,851,900	25,490.29
Heavy Truck	1,559,900	1,740.00
Taxis	27,645,400	8,430.00
Municipal Vehicles	35,000,000	10,674.34
Total	**266,233,700**	**131,736.49**

Table 6 shows the different categories of vehicles that we considered in our calculations. Light Trucks include trucks under 3.5 tons and vans. Buses and minibuses include the numbers for both public and private buses. Municipal vehicles in this report refer to city garbage trucks, with numbers from 2020 instead of 2019. Special vehicles include ambulances, fire trucks, and sanitary vans. We were unable to separate for the distance driven by Eilat residents outside of the city from the total annual mileage. This would normally fall under Scope 3 measurements but is included in our Scope 2 evaluation of the city.

We used two different methods to estimate GHG emissions from transportation in Eilat. The first method replicated the method used in the 2016 BEI. The BEI used CO_2 emission factors from the 15th Forum of the Intergovernmental Panel on Climate Change (IPCC) applied to the different categories of vehicles (Kissinger et al., 2016). The BEI did not report the emission factors that were used for every category of vehicle that we analyzed. We used a second estimation method since we did not have full access to updated versions of the 2014 data.

The second method estimated CO_2 emissions based on annual fuel consumption. The European Environment Agency (EEA) sets emission standards for vehicles based on their age.[8] According to the Israel Ministry of Environmental Protection, "Israel has adopted European standards for emission exhaust tests." This means that the data found in the CBS tables matches European

[8] The age of a vehicle determines its Euro rating. Euro ratings are used to estimate average fuel consumption per kilometer traveled.

standards. The EEA has developed several methods for estimating GHG emissions from vehicles (Ntziachristos & Samaras, 2020). The method that we chose requires information about the number of vehicles in different categories as well as information about the annual fuel consumption of these vehicles.

4.1.1 Explanation of BEI Estimation

The CBS publishes an annual report about the vehicles registered in Israel. They also have a report that contains information about the average annual distance traveled by vehicles registered in the country. These reports include tables that categorize the number of vehicles by type, city of registration, and age of the vehicle. Similar information can be found in the annual distance report. When vehicle owners renew vehicle registration each year, Ministry of Transportation officials take a reading of the odometer. Average annual distance traveled for 2019 is found by taking the new odometer reading and subtracting it from the 2018 reading. The CBS tables provided the numbers that we used in our calculations for every category except trucks and municipal vehicles. Truck data was estimated as previously mentioned and data on municipal vehicles was provided by the Eilat Municipality.

The BEI provided the CO_2 emission factors for private vehicles, motorcycles, taxis, buses, and municipal vehicles (**Table 7**). Emission factors for trucks, light trucks, and special vehicles were found in the IPCC Emission Factor Database (*Emission Factor Database*, n.d.). The emission factors are then multiplied by the total annual distance traveled for each vehicle category.

Table 7: *2016 BEI Emission Factors and IPCC Emission Factors (Kissinger et al., 2016) (Emission Factor Database, n.d.)*

Vehicle Category	Emission Factor (g CO_2 eq/km)
Private Vehicle	305
Light Truck	900
Truck	1115
Bus	820
Taxi	305
Motorcycle	100
Municipal Vehicle	305
Special Vehicle	847

4.1.2 Explanation of EEA Estimation Method

In addition to the number of vehicles and total annual distance traveled, the EEA estimation method also requires total annual fuel consumption by type of vehicle. The EEA guidelines outlined the average fuel consumption per kilometer for most of the vehicle types (Ntziachristos & Samaras, 2020). Fuel consumption for minibuses, special vehicles, and municipal vehicles was estimated using consumption averages found in the U.S. Department of Energy's Alternative Fuels Data Center (*AFDC*, 2020). The average age of motorcycles also played a role in average fuel consumption. According to the EEA guidelines, fuel consumption for Euro 3 rated[9] motorcycles is different from earlier Euro rated motorcycles (Ntziachristos & Samaras, 2020). Table 8 shows the fuel consumption values that we used when completing the calculation for annual fuel consumption by vehicle type.

Table 8: Average Fuel Consumption by Vehicle Type
(Ntziachristos & Samaras, 2020) (AFDC, 2020)

Vehicle Category	Fuel Consumed (g/km)	Emission Factor (g CO_2 eq/km)
Private Vehicle	66	209
Light Trucks	85	269
Trucks	240	761
Minibus	331	1049
Buses	301	954
Taxis	66	209
Motorcycles	17	54
Municipal Vehicles	930	2948
Special Vehicles	392	1242

The fuel consumption numbers were multiplied with the total annual distance traveled for each vehicle category to estimate annual fuel consumption for each vehicle type. The annual fuel consumption was used in the CO_2 combustion formula in the EEA guidelines document. The combustion formula is shown in *Figure 14*.

[9] Euro 3 rated motorcycles were made in 2008 or later. According to the CBS, the average age of motorcycles in Israel is 5.5 years so the Euro 3 rating was used to estimate fuel consumption.

$$E_{CO_2,k,m}^{CALC} = 44.011 \times \frac{FC_{k,m}^{CALC}}{12.011 + 1.008 r_{H:C,m} + 16.000 r_{O:C,m}}$$

$E_{CO_2,k,m}^{CALC}$ = Annual Mass of CO2 Emitted

$FC_{k,m}^{CALC}$ = Total Annual Fuel Consumption

$r_{H:C}$ = Ratio of hydrogen to carbon atoms in fuel

$r_{O:C}$ = Ratio of oxygen to carbon atoms in fuel

44.011 = Molar Mass of CO_2

12.011 = Atomic Mass of carbon

1.008 = Atomic Mass of hydrogen

16.000 = Atomic Mass of oxygen

Figure 14. CO_2 Combustion Formula

The ratios of hydrogen and oxygen atoms to carbon atoms varies depending on the type of fuel used. For both gasoline and diesel, $r_{H:C}$ = 1.86 and $r_{O:C}$ = 0 (Ntziachristos & Samaras, 2020). Our analysis assumed that all the vehicles either ran on gasoline or diesel. This way all the calculations could be done using the same ratio as we did not have vehicle counts for different fuel types.

4.2 Transportation Results

Using different assumptions for distance traveled, our analysis found several estimates for emissions between the two estimation methods. The three scenarios that we focused on included a high estimate, a middle estimate, and a low estimate. The high, middle, and low estimates will be referred to as Scenario 1, Scenario 2, and Scenario 3, respectively. Scenario 1 used the BEI method and the distance numbers presented in Table 6. Scenarios 2 used the EEA estimation method and the distance numbers also shown in Table 6. Scenario 3 used the EEA estimation method with new assumptions for trucks and buses.

4.2.1 BEI Estimation Method Results: Scenario 1

The results from the first estimation method are displayed in **Table 9** and *Figure 15*. Table 9 shows the total annual emissions for each vehicle category.

Table 9: *2019 Transportation Emissions in Scenario 1*

Vehicle Category	2019 CO2 Emissions (tons)
Private	54,424
Buses	30,977
Light Truck	25,490
Heavy Truck	1,740
Taxis	8,430
Municipal Vehicles	10,674
Total:	**131,736**

4.2.2 EEA Estimation Results: Scenario 2

Using the EEA estimation method and annual distance numbers from **Table 6**, the total transportation emissions in 2019 were 78,469 tons of CO_2 eq (**Table 10**).

Table 10*: 2019 Transportation Emissions in Scenario 2*

Vehicle Category	2019 CO2 Emissions (tons)
Private Vehicles	50,681
Light Trucks	6,438
Trucks	6,630
Minibuses	2,313
Buses	3,017
Taxis	7,660
Motorcycles	627
Municipal Vehicles	359
Special Vehicles	742
Total:	**78,469**

This estimation shows only a 2.25% increase from 2014 totals compared to Scenario 1 which was a 38.53% increase in emissions. Given that the number of vehicles registered in Eilat has also increased, it makes sense to see some increase in estimated emissions. There has been a 42% increase in the annual distance traveled from 2014 and neither of these scenarios presented an increase in emissions of that same amount. Both Scenario 1 and 2 suggest that there has been an increase in the number of lower pollution vehicles on the roads in Eilat.

4.2.3 EEA Estimation Results: Scenario 3

Scenario 3 presents the lowest estimation of transportation emissions in Eilat in 2019. To get a more detailed estimation of the emissions from transportation, we made calculations using various assumptions about annual distance traveled for trucks and buses. National averages for these categories do not consider that Eilat is smaller than other cities in Israel.

Our new assumption method for trucks split them into two categories. It is unreasonable to expect that all trucks registered in the city only travel to and from the port. In the BEI only 200 trucks were counted as making the journey to the port each day, so we categorized 250 trucks as traveling from the port each day (Kissinger et al., 2016). The remaining 347 trucks registered in Eilat were assumed to be carrying goods out of Eilat and were calculated as only making the 20 km trip once a day[10]. This decreased the annual distance traveled by trucks to 5,082,000 km. Buses were split into three categories: public buses, private buses, and intercity buses. These are the three types of buses that can be found in Eilat, but we did not have data split by type of bus. Bus assumptions were made without detailed information of bus routes. We estimated 30 public buses and 25 private buses. For public buses, we assumed that each bus took roughly 10 trips each day and that each trip was about 30 km[11]. For private buses, we assumed they entered the city once each day and traveled 10 km once within city limits. There are approximately 25 intercity buses that arrive in Eilat each day (*Passenger Information*, n.d.). Each intercity bus travels approximately 6.7 km from the entrance of the city to the central bus station. The new annual distance traveled for buses was estimated to be 395,250 km.

Below, Table 11 shows the estimated 2019 transportation emissions in Scenario 3. There is a 4.96% decrease in emissions as compared to 2014. This estimation is the lowest that we calculated and considers the most detailed assumptions for annual distance traveled.

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[10] Daily numbers were multiplied by 300 for an annual total to account for weekends and holidays.
[11] A loop around the city is approximately 15 km. This accounts for circuitous routes down side streets.

Table 11*: 2019 Transportation Emissions in Scenario 3*

Vehicle Category	2019 CO2 Emissions (tons)
Private Vehicle	50,681
Light Truck	6,438
Port Truck	2,282
Shipping Truck	1,584
Minibus	2,185
Public Bus	258
Private Bus	72
Intercity Bus	48
Taxi	7,660
Motorcycle	627
Municipal Vehicle	359
Special Vehicles	742
Total:	**72,936**

4.2.4 Discussion of Results

The estimates using the EEA method provided numbers that were reasonable when compared to the 2014 numbers. However, the estimates using the BEI method resulted in much larger numbers than those seen in 2014. In the BEI method, the emission factors for each vehicle category were not based on the age of the vehicle[12]. This means that the change in ages of vehicles between 2014 and 2019 is not accounted for. Because the EEA method factors in vehicle ages through fuel consumption, it is a measure of how newer vehicles are more fuel efficient. Higher fuel efficiency means less CO_2 emitted into the air.

Private vehicles comprised the largest percentage of transportation emissions in all three scenarios. In Scenarios 2 and 3, private vehicles made up 65% and 69% respectively, compared to 68% in the BEI. However, Scenario 3 did find a decrease in total private vehicle emissions as compared to 2014 levels. Reducing private vehicles emissions is a necessary step to reducing transportation emissions in Eilat.

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[12] The emission factors do change if vehicles are more than 15 years old. The emission factors are from 2006 and 1996 IPCC guidelines.

Despite the decrease in private vehicle emissions that has been estimated so far, the municipality of Eilat can still take steps to further reduce emissions. The public transportation system in Eilat is not an efficient method of getting around the city, leading to the heavy reliance on private vehicles (Goldstein et al., 2019). Based on the fuel consumption data in the EEA guidelines, if at least 5 people are riding a bus, less CO_2 is being emitted per kilometer compared to if each person were to drive a private vehicle. If Eilat could find a way to improve the appeal of public transportation within the city, they could further decrease the emissions from private vehicles.

The municipal vehicles do not account for a large amount of emissions in our report as the numbers we used only include garbage trucks. However, the municipality has been switching their fleet of other vehicles to hybrid and electric vehicles. This is designed to encourage private vehicle owners to invest in hybrid and electric vehicles. If more private vehicles were hybrid or electric, there would be a decline in total transportation emissions.

In the BEI, tourism data was not included in the estimation of transportation emissions. Our report indirectly includes this information. Tourists often arrive via the intercity buses, a number that is included in Scenario 3. Once in the city, tourists typically walk, take a taxi, or ride public buses. There is likely a small amount of emissions not accounted for by tourists who might use private vehicles within the city limits but there is insufficient data to estimate this amount.

The three scenarios provided a wide range of estimates for 2019 transportation emissions in Eilat. Only one method suggested a decline in emissions from 2014. This was likely a result of the municipality’s lack of reduction policies targeted towards transportation emissions.

CHAPTER 5: WASTE

5.1 Methods

This section models carbon dioxide (CO_2) and methane (CH_4) emissions from the decomposition of municipal solid waste (MSW) in Eilat during 2019. Waste is deposited in the Nimra landfill, where the decomposition process occurs (*Eilat-Eilot Renewable Energy Newsletter*, 2012). The first stage in waste decomposition is an aerobic (with oxygen) process that produces only small amounts of methane. Primary methane emissions occur under anaerobic (without oxygen) conditions, where methane-excreting bacteria decompose organic waste. This usually takes at least half a year after deposition (*2006 IPCC Guidelines*, 2007). Steady-state conditions typically involve emission compositions of approximately half CO_2 and half CH_4.

Decomposition rates depend on moisture levels of the environment. When modeling Eilat's MSW sites, we considered the dry environment of Eilat, which decreases decomposition rates. Decomposition rates also differ between the types of materials present in a landfill. This analysis includes 5 types of organic waste: food, garden, paper and cardboard, textiles, and diapers.

5.1.1 Overview of Waste Methods

We calculated the methane (CH_4) and carbon dioxide (CO_2) emissions in 2019 produced by waste using a first order decay method modified from Bhide et al. (2018). The first order decay method creates a time dependent emission model that accurately depicts the degradation process. It requires waste deposition data from previous years. Decomposition is modeled by exponential decay.

The first step in the calculation is to determine the amount of decomposed waste during the year of investigation, described by the following equation:

Equation 5

$$DW(t) = \sum_i MSW_i(t) * DOC_i * (1 - e^{-k_i})\, e^{-k_i t} \quad ,$$

$$MSW_i(t) = MSW_{total}(t) * f_i$$

DW = Decomposed waste [tons]
MSW_{total} = Total municipal solid waste [tons]
MSW_i = Municipal solid waste from *i*th *type* [tons]
f_i = Fraction of composition of *i*th type
DOC_i = Degradable organic carbon * degradable fraction [Gg C/Gg MSW]

k_i = decomposition rate constant for the *i*th type of waste [$year^{-1}$]
t = time [years]

Data on total municipal solid waste deposition within Eilat was provided by the Eilat Environmental Unit for the years 2015-2019. The quantity of waste for the i_{th} type (MSW_i) was found by multiplying its fractional composition f_i by the total amount of waste. Composition by type of waste was found from the 2012-2013 Ministry of Environmental Protection survey on waste composition in Israel.

MSW_i was multiplied by its corresponding degradable organic carbon, DOC_i. DOC_i is the proportion of organic matter (by weight) contained within a given type of waste[13] that is emitted as CH_4 or CO_2.

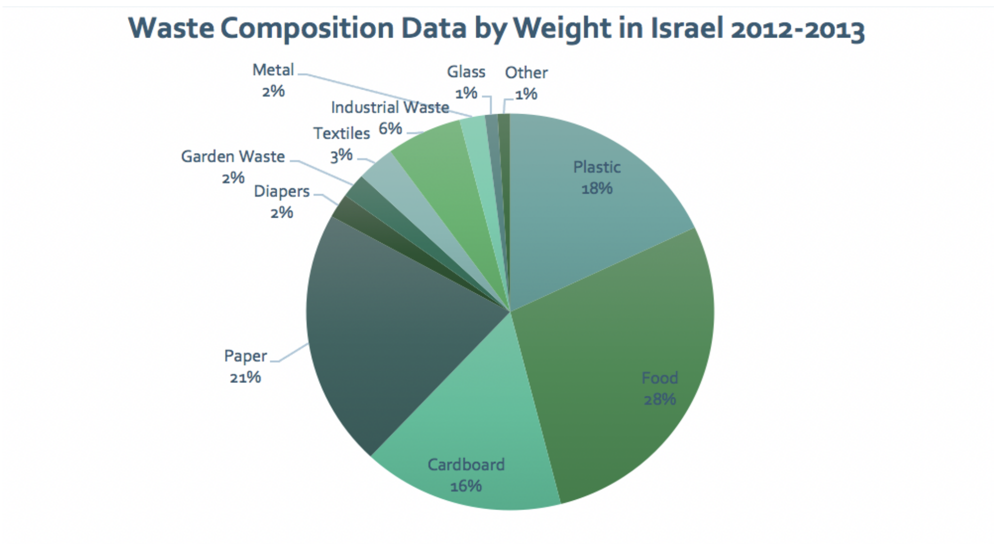

Figure 18. Waste Composition Data by Weight

Waste decays exponentially according to $MSW_i*DOC_i*e^{-kt}$, *i,* and t is the time. Therefore, emissions over a one-year interval are described by $MSW_i*DOC_i*(e^{-kt}-e^{-k(t+1)})$.

Table *12* shows the composition (f_i), degradable content fraction (DOC_i), and decay rate (k) for each type of waste. The k values for each type of waste came from the EPA and pertain to dry environments in the Middle East (RTI International, 2010).

Table 12: *Waste Composition, Degradable Organic Carbon, and Decay Rate*

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[13] DOC_i was found by multiplying DOC by DOC_f. The default DOC_f available was 0.77 for all sources of waste (Bhide et al, 2018).

Type	Composition (f_i)	Degradable Organic Carbon (DOC_i)[5]	Decay Rate k_i (1/yr)
Food waste	0.28	0.1155	0.06
Garden	0.02	0.1309	0.05
Paper and Cardboard	0.37	0.308	0.04
Textiles	0.03	0.308	0.04
Diapers	0.02	0.1848	0.05

The next step in the calculation is determine the mass of methane (CH_4) and carbon dioxide (CO_2) released by decomposition, described by the following equation:

Equation 6

$$MTH(t) = \left(\frac{16}{12} * F * DW(t)\right) - R(t)$$

$$CD(t) = \frac{44}{12} * (1 - F) * DW(t)$$

MTH = Methane [tons]
F = Fraction by molecule of CH_4 in landfill gas
R = Methane Recovery [tons]
CD = Carbon dioxide [tons]

The amount of decomposed waste was multiplied by the methane fraction, F. The default value of F is 0.5 (Bhide et al., 2018).To convert to mass of CH_4, the amount of methane was multiplied by 16/12, the ratio of molecular weight of CH_4 to C. To calculate the amount of CO_2 produced, the amount of decomposed waste was multiplied by the carbon dioxide fraction, 1-F. To convert to mass of CO_2, the amount of CO_2 was multiplied by 44/12, the ratio of molecular weight of CO_2 to C. Eilat's landfill has active methane recapture, in which 70% of CH_4 emissions are recovered.

Lastly, methane was converted to CO_2 equivalents, and the contribution from each previous year was summed:

Equation 7

$$GHG(t) = \sum_{\tau} 25 * MTH(t-\tau) + CD(t-\tau)$$

τ = time of deposition [years]
25 = the global warming potential for CH_4

5.2 Results

The total amount of waste that was sent to the landfill within 2015, 2016, 2017, 2018, and 2019 was 55,908, 59,909, 61,352, 63,474, and 59,449 tons respectively (**Table 13**). Within each year, most of the waste came from households, with a small portion coming from containers that had been placed throughout Eilat.

Table 13: *Annual Total Waste Sent to Landfill (tons)*

Waste	
Ton per Year	**2019**
Mixed waste	67,258
Agricultural Waste	10
B&C Waste	82,089
Trimmings	3,042
Dry Waste	664
Digestate	1,656
Asbestos	265
Plastics	
Industrial Waste (Chalk)	
Total	154,985

The emissions in 2019, with contributions from waste deposited in previous years, are displayed in **Table 14**. The net amount of emissions during 2019 was 137,500 CO_2 (eq).

Table 14: *Annual Carbon Dioxide Emissions*

The CO_2 (eq) produced by each type of waste is shown in **Table 15**. The largest contributor was mixed waste , which released a total of 154,985 CO_2 (eq) in 2019.

Waste	
Ton per Year	**2019**
Biodegradeble	71,966
tCO2e	137,500

3,149 CO_2 (eq) (25.8%).

Table 15: *Emissions Produced by Waste Type*

Waste	
Ton per Year	**2019**
Mixed waste	67,258
Agricultural Waste	10
Trimmings	3,042
Digestate	1,656

5.3 Discussion

When considering the 70% recovery value, the waste emissions were determined to be 94,112 CO_2 eq tons. The further back we go with data, one can see that the emissions released do not quickly drop to 0 - the contributions from 2015 are still significant in 2019. Decay rates in arid regions are slow: the half-lives for different types of waste range from 11.6 years to 17.3 years. Therefore, to arrive at more accurate results, we recommend that waste data is obtained for at least 17 years prior to the year of investigation.

The city of Eilat should focus efforts to reduce the types of waste that serve as the largest contributors of emissions. The largest contributor to waste emissions was mixed wastes which contributed 154,985 CO_2 (eq) in 2019. Efforts to encourage recycling of mixed wastes as well as paper and cardboard should be considered so that these materials can be reused instead of ending up in the landfill. Similarly, the city of Eilat should think of ways to utilize food waste rather than having it sent to the landfill. They could encourage or facilitate a composting operation where food waste may be repurposed.

When comparing the waste emissions calculated within the 2016 report to our calculations, an accurate comparison cannot be made because the methods used within the 2016 report are not completely understood. Within the BEI there is no discussion on methane recovery from waste which significantly reduced the value of emissions.

CHAPTER 6: COMBINING RESULTS

6.1 Emissions Models

Three different models were used to evaluate emissions due to electric power consumption. Model I provided an upper bound, Model II a middle value, and Model III a lower bound (***3.1.4 Calculating Carbon Emissions***). Independently, three different scenarios were used to evaluate transportation emissions, providing a separate upper bound, middle value, and lower bound for transportation (***4.1 Transportation Methods***). A single model was used to evaluate emissions from municipal solid waste (***5.1 Methods)***. The results are shown in **Table 16**. A graphical comparison between the different models is illustrated below in *Figure 20*.

Table 16: *Estimated Total Greenhouse Gas Emissions in Eilat in 2019 (CO_2 eq tons)*

	Upper	Middle	Lower
Electric Power (Population-Scaled)	492,179	350,903	234,041
Transportation	131,736	78,469	72,936
Waste	134,446	134,446	134,446

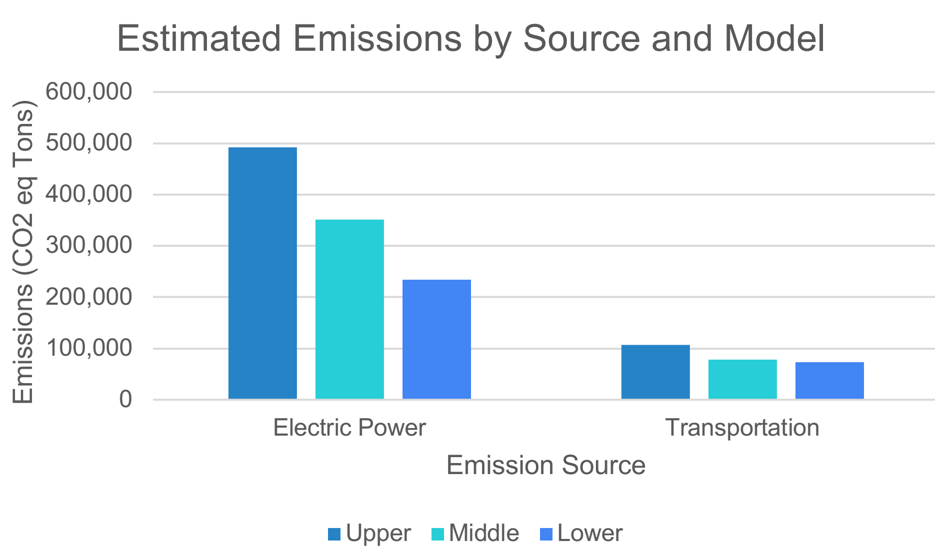

Figure 20. 2019 Estimated Emissions by Source and Model

Within population-scaled electric power consumption (***3.1.1 Power Demand in Eilat***), emissions vary significantly between the different models due to their different assumptions (***3.1.4 Calculating Carbon Emissions)***. The upper-bound model does not include solar fields in the Southern Arava, whereas the intermediary model does, and the lower-bound model includes Eilat's gas turbines in addition to solar fields in the Southern Arava.

Within transportation, there is a notable difference between the upper-bound and intermediary scenarios due to the Scenario 1 using IPCC standards, and Scenario 2 using European standards (***4.1 Transportation Methods)***. The difference between Scenario 2 and Scenario 3 is less significant because they only differ in their assumptions of truck and bus routes within the city.

Between the three models pertaining to electric power, the three scenarios pertaining to transportation, and the single model pertaining to municipal solid waste, there are nine possibilities for the aggregation of emissions. The results are compiled in the following Emissions Matrix (**Table 17**). Grouping components of the same color in **Figure 20** gives the diagonal elements of the matrix, while grouping components of different color give the non-diagonal elements.

Table 17: *Emissions Matrix. (CO_2 eq tons)*

		Electric Models		
		Upper	**Middle**	**Lower**
Transport Models	**Upper**	610,675	469,400	352,538
	Middle	578,695	441,558	324,696
	Lower	577,300	436,025	319,163

Seen in **Table 17**: cell (1,1) is the uppermost bound for emissions in 2019, while cell (3,3) is the lowermost bound for emissions. Emissions change significantly across columns, which correspond to the different models of electric power consumption. Emissions change moderately across rows, which correspond to different transportation models. Depending on selection of models, emissions from electric power consumption range from 66.4% to 85.3% of the total, emissions from transportation range 12.5% to 30.1% of the total, and emissions from municipal solid waste range from 2.00% to 3.82% of the total.

Compared to 2014, the relative change in emissions differ considerably depending on choice of model (**Table 18**). 2014 emissions from electric power consumption were determined in **3.1.4 Calculating Carbon Emissions**. 2014 emissions from transportation and waste were taken from the 2016 BEI (Kissinger et al.).

Table 18: *Change in Emissions. (CO_2 eq tons).*

		Electric Models		
		Upper	**Middle**	**Lower**
Transport Models	**Upper**	+41,331 (+7.26%)	+7,901 (+1.71%)	37,330 (+11.8%)
	Middle	13,489 (+2.37%)	-19,941 (-4.32%)	9,488 (+3.01%)
	Lower	+7,956 (+1.40%)	-25,474 (-5.52%)	3,955 (+1.25%)

While no model predicts Eilat to have reached its 20% reduction goal, nearly all models predict a decrease in per capita emissions since 2014 (**Table 19**). This includes temporary residents and visitors in the population count (**3.1.1 Power Demand in Eilat**).

Table 19*: Relative Change in Emissions Per Capita*

		Electric Models		
		Upper	**Middle**	**Lower**
Transport Models	**Upper**	-0.82%	-5.95%	3.41%
	Middle	-5.35%	-11.53%	-4.75%
	Lower	-6.24%	-12.64%	-6.38%

To continue its involvement with Covenant of Mayors, Eilat must establish well-defined processes for preparing emissions inventories. Towards this end, we recommend that comprehensive data are obtained by the Eilat Environmental Unit, minimizing the need for assumptions and extrapolation. A rigorous method for monitoring emissions should be built off those used in this project, and emissions reports should be reproducible and transparent in their methods. Future inventories should also include emissions due to the combustion of liquified petroleum gas for heating and cooking.

6.2 Final Conclusion of Results

For the purposes of submission to the Covenant of Mayors, the results are taken from the intermediate models of electric power consumption and transportation (**Table 17**). The total GHG emissions for 2019 was **578,695 CO_2 eq tons**. *Figure* 21 shows the sources of emissions. *Figure 22* shows the comparison of 2014 and 2019 emissions for electric power, transportation, and waste. Electric power emissions decreased by 8.44% and transportation emissions increased by 2.28%.

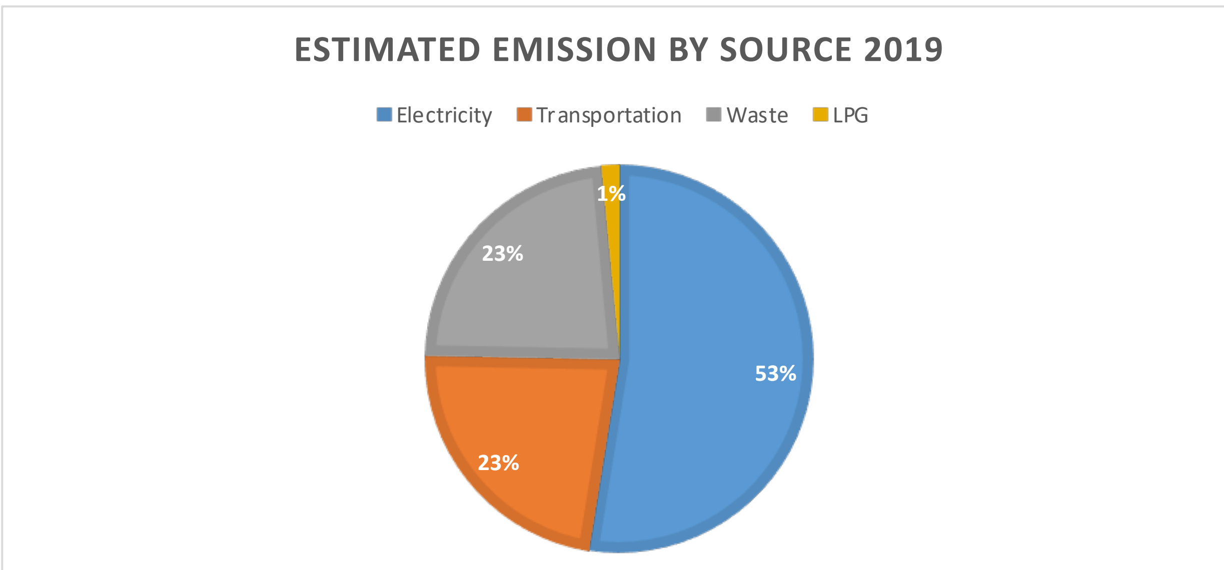

Figure 21. Estimated 2019 Emissions by Source

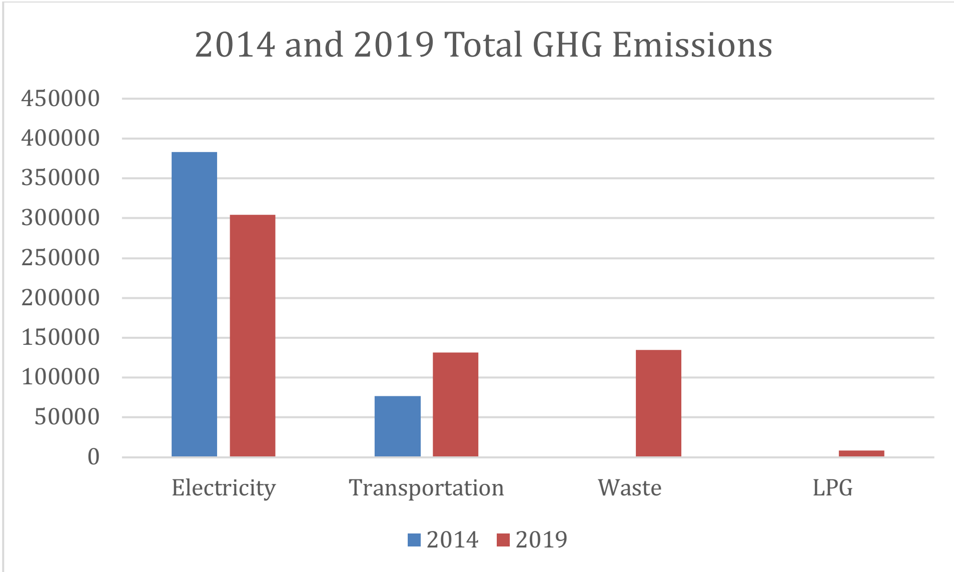

Figure 22. Comparison of GHG Emissions by Year and Sector

6.3 Updated Emission Reduction Measures

We reassessed the GHG emission reduction measures as proposed in the 2018 SEAP for the year 2021. The status of the policies as of 2018 are presented in **Table 1**.**Table 20** shows updated information for each policy as of 2021.

Table 20: *GHG Emission Reduction Measures in Eilat as of 2021*

Policy	Sector	Status
Building Insulation	Municipal/Commercial	Not Completed[1]
Energy Conservation Practices	Commercial	Completed[2]
Efficient Appliances	Residential/Municipal/Commercial	Completed
Electric/Hybrid Vehicles	Municipal	Completed
Promotion of Public Transportation	Residential	Not Completed

[1]Not Completed = Proposed measure in 2018 SEAP that has not been implemented
[2]Completed = Finished as of 2021

If these policies are all implemented and more are added, Eilat might be able to achieve the reduction goal of 20%. The focus of any future emission reduction policies should be on the largest sources of emissions, electricity and transportation.

REFERENCES

2006 IPCC Guidelines for National Greenhouse Gas Inventories. (2007, April). Task Force on National Greenhouse Gas Inventories. https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol5.html

About Eilat-Eilot. (n.d.). Eilat-Eilot Renewable Energy. https://www.eilateilot.org

Annual Environmental Reports. (n.d.). Israel Electric Corporation. https://www.iec.co.il/environment/pages/environmentalreports.aspx

Average Fuel Economy by Major Vehicle Category. (2020, February). [Government Agency]. US Department of Energy: Energy Efficiency & Renewable Energy. https://afdc.energy.gov/data/10310

Bhide, A. D., Pipatti, R., & Jensen, J. E. F. (2018). *Waste* (IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, pp. 5–13). IPCC. https://www.ipcc.ch/site/assets/uploads/2018/03/5_Waste-1.pdf

Central Bureau of Statistics. (2019). *Population and growth components in localities and statistical areas, 2019-2014*. https://www.cbs.gov.il/he/publications/Pages/2017

Central Bureau of Statistics. (2020a). *Table 10: Growth components in urban localities, by district and sub-district*. https://www.cbs.gov.il/he/publications/Pages/2017/2017

Central Bureau of Statistics. (2020b). *Table 8: Motor Vehicles Registered in Cities, by Type of Vehicle*. https://www.cbs.gov.il/en/publications/Pages/2020/Motor-Vehicles-2019.aspx

Climate Change in Israel: Past trends and predicted trends in the temperature and precipitation regime. (2019). Israeli Meteorological Service. https://ims.gov.il/sites/default/files/ClimateChangeInIsraelReport_20191128_new.pdf

Eilat- A Smart City. (n.d.). Eilat-Eilot Renewable Energy. https://www.eilateilot.org/smart-city-eilat/

Eilat-Eilot Renewable Energy. (n.d.). Eilat Eilot Renewable Energy. www.eilateilot.org

Eilat-Eilot Renewable Energy Newsletter. (2012). https://www.eilateilot.org/wp-content/uploads/2015/02/engjune.pdf

GISNET V5. (n.d.). [Geographic Information System]. Complot. https://v5.gis-net.co.il/v5/eilat

Goldstein, E., Kopper, V., Myers, C., & Zlotnick, Z. (2019). *Investigating Eilat Transportation & Smart City Options* [Interactive Qualifying Project]. Worcester Polytechnic Institute. https://digitalcommons.wpi.edu/cgi/viewcontent.cgi?article=6479&context=iqp-all

Intergovernmental Panel on Climate Change: Emission Factor Database. (n.d.). Retrieved March 7, 2021, from https://www.ipcc-nggip.iges.or.jp/EFDB/find_ef.php

Israel Electric Corporation. (2020). Israel Electric Corporation. https://www.iec.co.il/en/pages/default.aspx

Kavaler, T. (2019, June 23). *Tourists Loving Eilat- But Hitting its Beaches May Become Difficult*. https://themedialine.org/life-lines/live-a-little-but-love-eilat/

Kissinger, M., & Damari, Y. (2018). *Eilat Municipality Plan to Reduce Greenhouse Gas Emission*. Negev Center of Sustainability.

Kissinger, M., Steinberg, T., & Shtessel, Z. (2016). *Eilat City GHG Emission Report: Survey of Findings on Greenhouse Gas Emissions in Eilat* (pp. 1–15). Ben-Gurion University of the Negev: The Negev Center for Sustainability.

Masters, G. M. (2013). *Renewable and Efficient Electric Power Systems* (2nd ed.). Wiley.

Ntziachristos, L., & Samaras, Z. (2020). *EMEP/EEA Air Pollutant Emission Inventory Guidebook 2019*. European Environment Agency. https://www.eea.europa.eu/ds_resolveuid/SHNJDK8413

Passenger Information. (n.d.). Egged. Retrieved March 5, 2021, from https://mslworld.egged.co.il/?language=en#/origindestination/1/0/false/5000-2708/2109/2600-492/5316

PVWatts Calculator (6.1.3). (n.d.). [Computer software]. National Renewable Energy Laboratory. https://pvwatts.nrel.gov/

Rivas, S., Arnaudova, I., Gomez Palma, A., & Bertoldi, P. (2018). *The Covenant of Mayors: Overall analysis and detailed evaluation of city Sustainable Energy Action Plans in the MENA Region* (pp. 1–114) [JRC Science For Policy Report]. European Commission.

RTI International. (2010, December 14). *Greenhouse Gas Emissions Estimation Methodologies for Biogenic Emissions from Selected Source Categories* [Government Agency]. https://www3.epa.gov/ttnchie1/efpac/ghg/GHG_Biogenic_Report_draft_Dec1410.pdf

Support. (n.d.). Covenant of Mayors for Climate & Energy Europe. https://www.eumayors.eu/support/funding.html

TOI Staff. (2020, May 19). Deadly Heat Wave Broils Israel, Drives Record Electricity Use. *The Times of Israel*. https://www.timesofisrael.com/deadly-heat-wave-broils-country-drives-record-electricity-use/

Udasin, S. (2014, July 9). *Israeli apartment buildings failing to maximize solar water heating potential*. https://themedialine.org/life-lines/live-a-little-but-love-eilat/

APPENDIX A

Spreadsheets and MATLAB code can be found at the Github repository:
https://github.com/dsschwartz/IQP-Smart-Eilat-2021

APPENDIX B

PVWatts Inputs. Meteorological data collected in Eilat (29.55, 34.95) during 2017.

Residential Modules		
Parameter	**Value**	**Explanation**
rated power	0.2415	1 kW/m^2 * area * efficency
Module Type: Standard		
cell type	crystalline silicon	
nominal efficiency	0.15	
module cover	glass	
temperature coefficient	0.0047	loss per °C
array type	fixed, roof mount	
System Losses		
soiling	0.03	light rainfall
shading	0.02	little shading
snow	0	none
mismatch	0.02	default
wiring	0.02	default
connections	0.005	default
light-induced degradatio	0.015	default
nameplate rating	0.01	default
age	0.025	estimating .005/yr
availability	0.03	default
estimated cumulative	0.1622	apparently not quite a summation
tilt angle (°)	20	default
azimuth angle (°)	180	facing south
Advanced Parameters		
DC to AC ratio	1.2	inverter power rating, default
inverter efficiency	0.96	default
ground coverage ratio	n/a	applies only to tracking arrays
Result	**372**	**kWh/module/year**

Commercial Modules		
Parameter	**Value**	**Explanation**
rated power	0.294	1 kW/m^2 * area * efficency (area estimation in calculations)
Module Type: Standard		
cell type	crystalline silicon	
nominal efficiency	0.15	
module cover	glass	
temperature coefficien	0.0047	loss per °C
array type	fixed, roof mount	
System Losses		
soiling	0.03	litght rainfall
shading	0.02	little shading
snow	0	none
mismatch	0.02	default
wiring	0.02	default
connections	0.005	default
light-induced degradati	0.015	default
nameplate rating	0.01	default
age	0.025	estimating .005/yr
availability	0.03	default
estimated cumulative	0.1622	apparently not quite a summation
tilt angle (°)	20	default
azimuth angle (°)	180	facing south
Advanced Parameters		
DC to AC ratio	1.2	inverter power rating, default
inverter efficiency	0.96	default
ground coverage ratio	n/a	applies only to tracking arrays
Result	**453**	**kWh/module/year**

Municipal Modules		
Parameter	**Value**	**Explanation**
rated power	0.3	1 kW/m^2 * area * efficency
Module Type: Standard		
cell type	crystalline silicon	
nominal efficiency	0.15	
module cover	glass	
temperature coefficient	0.0047	loss per °C
array type	fixed, roof mount	
System Losses		
soiling	0.03	light rainfall
shading	0.02	little shading
snow	0	none
mismatch	0.02	default
wiring	0.02	default
connections	0.005	default
light-induced degradation	0.015	default
nameplate rating	0.01	default
age	0.025	estimating .005/yr (source: Gilbert M
availability	0.03	default
estimated cumulative	0.1622	apparently not quite a summation
tilt angle (°)	20	default
azimuth angle (°)	180	facing south
Advanced Parameters		
DC to AC ratio	1.2	inverter power rating, default
inverter efficiency	0.96	default
ground coverage ratio	n/a	applies only to tracking arrays
Result	**462**	**kWh/module/year**

Eilot and Arava Valley PV Fields		
Parameter	**Value**	**Explanation**
rated power	180280	1 kW/m^2 * area * efficency
Module Type: Premium		
cell type	crystalline silicon	
nominal efficiency	0.19	
module cover	glass, anti reflective coating	
temperature coefficient	0.0035	loss per °C
array type	fixed, open rack	
System Losses		
soiling	0.03	dust, assuming cleaning
shading	0.01	open field
snow	0	none
mismatch	0.02	defaullt
wiring	0.02	default
connections	0.001	default
light-induced degradation	0.015	default
nameplate rating	0.01	default
age	0.025	estimating .005/yr
availability	0	accounted in power demand data
estimated cumulative	0.1275	multiplied sequentially
tilt angle (°)	30	observational guess
azimuth angle (°)	180	facing south
Advanced Parameters		
DC to AC ratio	1.2	inverter power rating, default
inverter efficiency	0.96	default
ground coverage ratio	0.4	default
Result	**302696512**	**kWh/year**