Hermosa Beach Carbon Neutral Scoping Plan

Executive Summary

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Introduction

Hermosa Beach is a small city on the Pacific Coast with a big goal of becoming carbon neutral. After declaring its goal on March 16, 2010, the Hermosa Beach City Council, in cooperation with the South Bay City Council of Governments and South Bay Environmental Services Center, has utilized its Municipal and Community Emissions Inventories to gauge the carbon emissions, sources, and activities for the city. Back in 2009, its City Council appointed nine residents to make up the Hermosa Beach Green Task Force, which created the 2011 Sustainability Plan. Through the Green Task Force and Sustainability Plan, Hermosa Beach began to take strides towards carbon neutrality.

Hermosa Beach's high density and relatively high annual household income make the city an ideal location for tourists, residents, and businesses. The majority of the city's residents have voted Democrat in the regional and national elections, which draws a popular younger adult demographic. As a city that prides itself in being the "Best Little Beach City," Hermosa Beach encourages its residents to cherish and care for their shoreline and city.

The main research question we have for this project is, "What does carbon neutrality mean for the city of Hermosa Beach?" Although many corporations and governments have been aiming for carbon neutrality in the recent years, the term "carbon neutral" does not yet have a distinct definition. Varying definitions of the term depend on multiple factors, including, but not limited to, the emissions accounting strategy, boundary specifications, and city structures. We have chosen to define carbon neutrality through collaboration with our stakeholders and own research, which will allow us to develop a plan to lead Hermosa Beach to being carbon neutral. Our final report is a roadmap for Hermosa Beach to reach their goal of carbon neutrality. This process will be done over time, and Hermosa Beach should remain in the mindset that this will not be an immediate transition to carbon neutrality. In the end, we are providing our informed and educated suggestions; it is up to Hermosa Beach's residents and government to make the ultimate decision for the future of the city.

We begin this report by observing the demographics, culture, and political background of Hermosa Beach. We reviewed Hermosa Beach's reasons for wanting to achieve carbon neutrality, and then observed what the city has already done and what they have not yet considered. These considerations will redirect energy that is dedicated towards ineffective measures to newer

measures that have proven to be effective. We have chosen to focus on transportation, building energy with electricity and natural gas, water, and waste. After reviewing past and current emissions inventories for all sectors, we determined the appropriate scopes and boundaries for our analysis. We developed a comprehensive model to determine emissions levels in respective sectors based on different implementation measures. The model, along with different matrices of implementation measures, creates three projected outcomes to lead the city towards carbon neutrality. The varying levels of authority around and within Hermosa Beach, along with cooperation from private actors, local governments, and residents will be in charge of deploying the implementation measures that we have provided in this report.

Our first step was to determine what the biggest carbon emitters were by sector, source, and activity. After creating a life-cycle analysis diagram of the different sources and activities, we created boundaries around what processes Hermosa Beach has control over. We then began weeding out the emissions that were the easiest to eliminate. With these easy emissions out of the way, we could figure out more complex neutrality strategies for Hermosa Beach. We then turned our attention to maximizing the efficiency of all the sectors to massively reduce their emissions and control their future emissions via different modifications, including retrofits and technological upgrades. Increasing the amount of renewables that Hermosa Beach employs will decrease the amount of emissions by ensuring that carbon-intensive infrastructure will not be used stopping any long-term reliance on these polluters. Inserting inputs and outputs from various implementation measures will determine emission cuts in each sector, which will evaluate how all of the implementation measures interact to help Hermosa Beach reach carbon neutrality.

Hermosa Beach will have to enact political and behavioral change for the city and its residents in order to ensure permanent change for its carbon neutral status. Implementing policy changes to enforce compliance to new efficiency standards will also cut emissions. Before there can be these policy changes, there must be community support for carbon neutrality, which is achieved with a change in the residents' behaviors and perception of what is considered to be the norm. Educating for the future and providing incentives will change the mindset of the community and ensure that Hermosa Beach will remain the "Best Little Beach City."

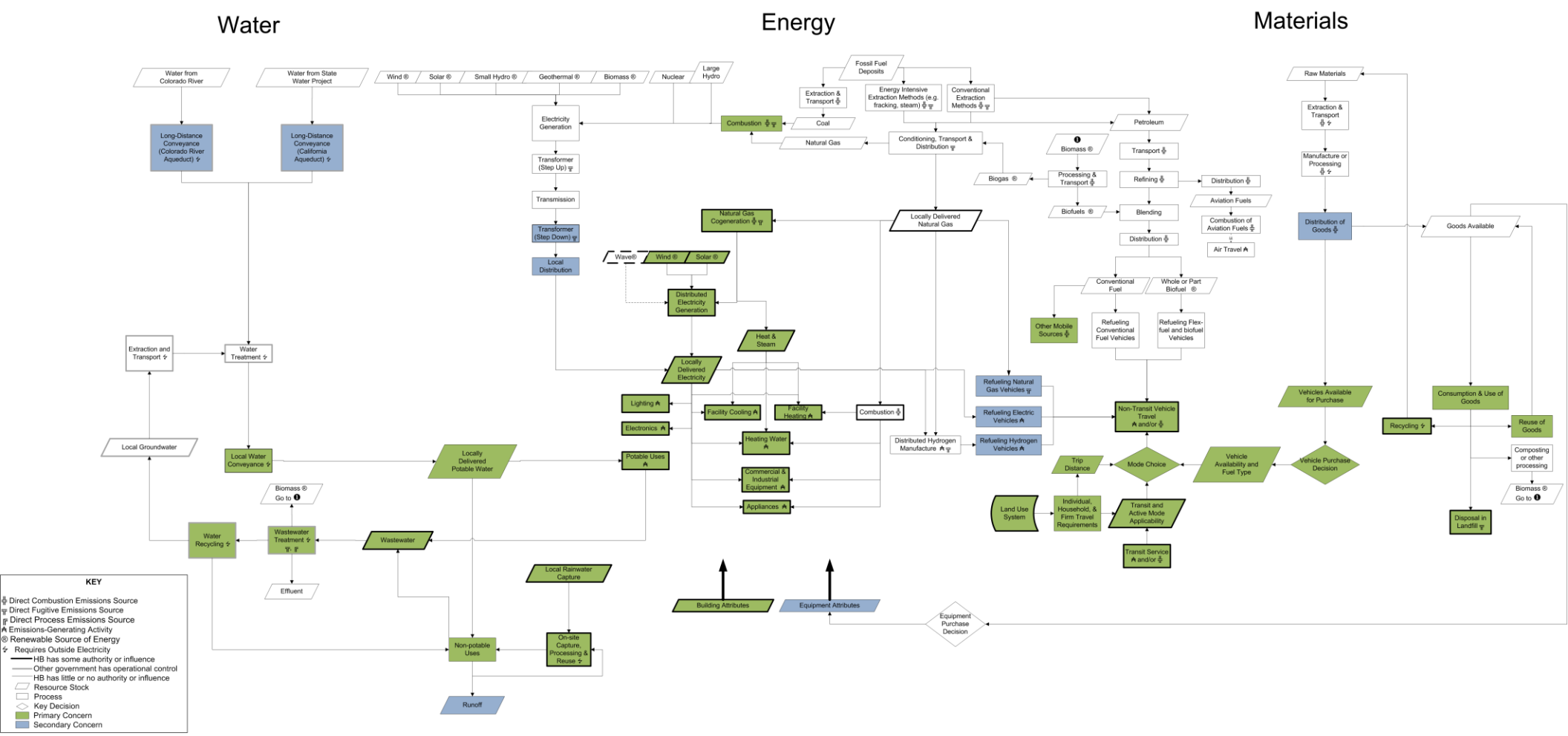
Scopes and Boundaries

In order to assess greenhouse gas-generating activities associated with Hermosa Beach's operations and the greater community, we researched the sources and activities of the greenhouse gas emissions. We created a Life-Cycle diagram, shown in Figure 1 below that connects sources and activities from each sector within the city. The urban system as a whole includes the extraction, production, consumption, and disposal of three production systems, water, energy, and materials. We considered both direct emissions from combustion – which we refer to as emissions sources -- as well as processes that indirectly lead to emissions -- which we refer to as emissions-generating activities. All emissions-generating activities match with at least one emissions source. For example, an internal combustion engine automobile is an emissions source since greenhouse gases come from the car's tailpipe. The emissions-generating activity is the mobility the car provides, which could also be met with an electric vehicle or on a bicycle.

In greenhouse gas accounting, boundaries establish rules for emissions that are and are not included in an inventory. Establishing boundaries helps identify the set of emissions which Hermosa Beach may seek to neutralize, as well as Hermosa Beach's ability to influence emissions or activities.

We employ two different methodologies to assess greenhouse gas emissions from Hermosa Beach. For its municipal emissions, we use the scopes, boundaries, and accounting principles from the Local Government Operations (LGO) Protocol, adopted by the California Air Resources Board and The Climate Registry. Defining boundaries for emissions from different municipalities is crucial prior to collecting data and developing an inventory because the legal and organizational structure of local governments and communities vary. The LGO Protocol provides guidelines to assist local governments in quantifying and reporting emissions associated with government operations.

Figure 1 Life-Cycle Diagram of all emissions sources and activities associated with Hermosa Beach



Municipal operations come from activities in the city over which it has operational control, and are categorized as Scope 1, 2, or 3. Scope 1 emissions are direct emissions from combustion within the inventory's boundary, including the geographic boundary or city-owned facilities outside of city limits. Scope 2 emissions are upstream emissions from imported electricity, steam, and chilled water. Scope 3 emissions are all indirect emissions outside of the inventory's boundary. Because Hermosa Beach is a hybrid between a company and local government in that the city itself has legal authority, it also has operational authority because it owns buildings, parks, and police and fire departments.

We use the U.S. Community Protocol for Accounting and Reporting Greenhouse Gas Emissions for community-wide emissions, created by ICLEI Local Governments for Sustainability USA. The protocol is a national standard that recommends best practices in measuring emissions, implementing policies, taking action and ensuring consistency. The Community Protocol outlines a range of boundaries to discern which sources and activities should be reported in the community's inventory. We will address municipal operations emissions separately from the community's.

We label "activities" and "sources" throughout the lifecycle by the level of influence the government holds over the emissions. The level of influences are labeled as: the City of Hermosa Beach having direct influence, the city having indirect influence, or the city having very little or no authority. Understanding these labels is important when establishing boundaries. Focusing on components that the city has direct influence over will be most efficient when trying to implement change. We further distinguish the sources and activities by identifying which are primary concerns and which are secondary concerns. The areas of primary concern will be those that the city has authority over, and secondary concerns are those that the city would have difficulty making any changes in, if any at all.

Sector Based Analysis

Building Energy - Electricity and Natural Gas

Electricity emissions begin when it enters Hermosa Beach's jurisdictional boundaries through Southern California Edison's transmission lines. Municipal boundaries for electricity include government-owned buildings, exterior lighting structures, government natural gas and electric

vehicles, and government buildings that combust natural gas through electricity. Community boundaries include all residential, commercial, and industrial buildings and activities that utilize electricity or natural gas within the jurisdictional boundary of Hermosa Beach.

For building energy, implementation measures are separated for community and municipal operational boundary goals into source-based and activity-based measures. Source-based measures address greenhouse gases that are directly emitted into the atmosphere. Implementing Community Choice Aggregation will allow Hermosa Beach to gain control over source-emissions. Though this measure may see resistance from Southern California Edison, it will have little impact on the customers and give them more control over their electricity sources. Community Choice Aggregation will expand the emissions-related boundaries that Hermosa Beach may consider in negating carbon emissions. In order to combat source-based emissions from natural gas consumption, we recommend increased use of biogas, which can be sequestered from waste emissions from landfills or waste water treatment plants. Hermosa Beach can prevent leaky natural gas pipeline fugitive emissions by ensuring proper insulation of all pipelines.

Emissions-generating activities, such as heating, cooling, and lighting, result indirectly in greenhouse gas emissions. We propose compliance and voluntary implementation mechanisms to change private building energy consumption behaviors. Compliance implementation measures use the foundations of predefined protocols and ordinances developed by the state and national government to enforce efficiency retrofits and building upgrades, such as Energy Upgrade California.

The local government can enforce stringent standards using protocols because they have direct control over facilities. Community operations will need green building ordinances to enforce compliance to stricter building codes. We recommend using restricted permit distribution, mandatory audits, and designated efficiency contractors. Hermosa Beach can incentivize citizens to voluntarily upgrade their building infrastructure through consulting services, easily accessible resources, mandatory auditing, and local contractors. We also recommend using Property Assessed Clean Energy financing to allow customers and businesses to finance energy upgrades.

Transportation and Land Use

Transportation makes up the largest share of greenhouse gas emissions in Hermosa Beach, which necessitates aggressive reduction strategies to attain carbon neutrality. For transportation, greenhouse gas emissions result from three main processes: vehicle manufacturing, vehicle travel, and energy production. We focused on the level of influence Hermosa Beach has over emissions. Since Hermosa Beach has little control over vehicle manufacturing and energy production process, our boundaries will focus on vehicle acquisition, or the effects of the purchase decision on a vehicle's fuel type and future operating emissions, and almost all components of vehicle travel—mode choice, producing trips, attracting trips, local trips, public transit, and recreational travel. Air travel and off-road transportation emissions will not be included. For the energy production process, our boundaries will include refueling via alternative fuel stations and gasoline stations, but we will not address emissions from the extraction, blending, distribution and transportation of fossil fuels.

Hermosa Beach has little influence over fuel sold in the city because they rely on regulations established at the national and statewide level. Fuel carbon intensity changes will influence both municipal and community emissions inventories. Fuel carbon intensity and vehicle efficiency will also be affected by natural growth in the alternative fuel vehicle market. Hermosa Beach should support the adoption of alternative fuel vehicles by educating residents on the benefits of alternative fuels, creating more free parking for low emission vehicles, and providing monetary incentives for employers who use alternative fuel vehicle fleets. Hermosa Beach can reduce emission sources by implementing a clean fuel or zero emission purchasing policy, increasing alternative fuel stations, creating a carpool or rideshare program, and increasing vehicle fleet efficiency.

To reduce community emissions, Hermosa Beach should focus mainly on reducing Vehicle Miles Traveled (VMT) by decreasing the amount of trips taken in personal vehicles, reducing the length of trips, and increasing vehicle occupancy. Because Hermosa Beach generally only has indirect influence over the VMT of residents, so strategies will be long-term and it will take time for measures to effectively reduce VMT. Suggested strategies include a Neighborhood Electric Vehicle Program, Complete Streets program, improvements in infrastructure that focuses on neighborhood-oriented development, the creation of commercial nodes, and improved parking strategies.

Water and Wastewater

To adequately address emission sources and emission-generating activities resulting from water consumption within Hermosa Beach, we must understand that the water sector is a complex system that requires interactions between various levels of government. The primary concerns in the water sector include the local distribution of potable water throughout the city, on-site capture and reuse of rainwater, and water recycling. Secondary concerns include the long distance conveyance of water from the Colorado River and California Aqueducts, which are the imported sources of water. Wastewater is not included in our boundaries because the city does not have control over the transportation or treatment of wastewater.

An efficient way for the city to reduce emissions that come from water consumption is conservation. This lowers the amount of water needed to be imported, pumped, and recycled, as well as reduces how much wastewater needs to be treated. By decreasing water demand, the city will be lowering the associated activities responsible for the greenhouse gas emissions.

West Basin Municipal Water District has been gradually reducing their imported water demands and increasing the use of recycled and groundwater. West Basin is planning to lower their imported water supply by 2020 by increasing groundwater demands, recycled water use, and desalination use, and the remaining reduction will be achieved from conservation. Reducing greywater, which is the wastewater from tubs, showers, sinks, and washers, will close the loop in the water demand cycle as water will be taken and reused. Reducing leakages in the water distribution system would minimize revenue losses and reduce greenhouse gas emissions. A metering program with automatic meter readings on all city-owned facilities will create an annual water audit.

Measures that involve households include providing rebates to mitigate installation costs of replacing conventional toilets and showerheads with low-flow alternatives and workshops to teach residents about water conservation. Water-efficient landscaping via efficient irrigation systems and native vegetation for plants can also reduce water use throughout Hermosa Beach. It will also increase infiltration of water into the ground instead of running off to the ocean, which prevents pollution runoff and recharges any groundwater sources nearby. Rainwater catchments from cisterns or barrels can be used to meet demands for landscaping or non-potable appliances.

Material Consumption and Waste

Solid waste accounts for a small portion of emissions compared to the emissions from transportation and energy, but it is not a sector that should be given little attention. Boundaries for this sector depend on the level of authority the city has over consumption and waste. Raw materials extraction and transportation of goods have significant emissions; however, due to the lack of authority over these activities, this report will only focus on more downstream emissions from the use of goods to disposal in landfills. Primary areas of concern include how much waste is being generated and how to utilize best practices to reduce emissions from the waste disposal in landfills.

Implementation measures are divided into municipal and community measures and are put into scenarios based on the level of difficulty to implement the measures. The municipal measures focus on making the activities within the municipal operations more efficient. Community measures will be focused on how to encourage behavior so that community members can collaboratively reduce consumption in the city and can practice reuse, compost of green waste, and recycling.

Diverting waste from landfills is the key to reducing emissions from decomposition. Municipal operations can become more efficient by making changes that would reduce upstream and downstream emissions. Voluntary behavioral changes like using reusable tote bags, using compostable single use items, and reusing everyday necessities are essential to changing community emissions for Hermosa Beach. Adding methane capture technology to landfills can reduce emissions from solid waste. Emissions from recycling are unavoidable, but best practices for composting and reusing will keep recycling emissions to a minimum.

Model Analysis

An emissions model was developed to quantify and understand the implications of our implementation measures on greenhouse gas emissions. This model takes into account a multitude of variables when computing a measure. We can understand the effects of our measures applied to a larger scale and time frame in order to show when Hermosa Beach can reach carbon neutrality. By no means does the model and provided statistical data display a completely precise representation of carbon neutrality scenarios, but rather should be used as a tool for emission trend analysis.

Discussion of Scenarios

All of the implementation measures are divided into three "scenarios" that begin in 2015 and end in 2075. Each scenario contains a specific set of measures grouped according to the level of effort required for implementation. The number of scenario indicates the aggressiveness of the implementation measures. Scenario I implements existing measures and "low-hanging fruit" for emission reduction. Scenario II implements a more aggressive climate action plan based on current political will and technology. Lastly, Scenario III implements the most aggressive measures, assuming that there is future and progressive change in political will and available technological advancements. Looking at the results from each scenario, we will then be able to help define what carbon neutrality really means for the city of Hermosa Beach. Table 1 provides a thorough list of all implementation measures and their projected effects, and Figure 2 illustrates their difference in effectiveness.

Table 1 Master List of Implementation Measures for all sectors

Sector	Measure	Explanation		Effect of Measure	Source
		Description	Details of Bundle		
Building Energy	Energy Upgrade CA 1 - Basic Upgrade	All residential buildings do a Basic Upgrade Package from Energy Upgrade CA to reduced energy consumption, which has incentives of up to $1000 in rebates. Consists of most "low-hanging fruit."	Air sealing, Attic Insulation, Duct Sealing, Hot Water Pipe Insulation, Duct Sealing , Hot water pipe Insulation, Thermostatic Control Valve, Low Flow Shower Head, Combustion Safety Testing *Measure is active in Scenario I/II/III.*	There is an average 10% reduction in total household energy consumption meaning a 10% reduction in electricity and a 10% reduction in natural gas.	https://energyupgradeca.org/county/san_diego/about_basic
	Energy Upgrade CA 2: Advanced Upgrade	All residential buildings perform an Advanced Energy Upgrade, on top of a Basic Upgrade Package, which has incentives of up to $4500 in rebates and even further energy efficient measures.	Energy Upgrade CA1 + High efficiency furnace, Energy efficiency cooling, Water heater system, energy efficient windows, duct replacement, wall insulation, other custom energy saving measures *Measure is active in Scenario II/III*	There is an average 45% reduction in total household energy consumption, meaning a 45% reduction in electricity consumption and 45% reduction in natural gas consumption.	https://energyupgradeca.org/county/san_diego/about_advanced
	Commercial/Industrial Retrofit 1-PACE FINANCING	All commercial/industrial buildings use PACE financing to do the "low hanging fruits" of eligible upgrades to commercial and industrial buildings.	Building Automation systems and Controls, Building Envelop (roof, windows, insulation), High efficiency lighting fixtures and lamps, Occupancy and day lighting sensors, Low-flow toilets, Smart Irrigation systems *Measure is active in Scenario I/II/III.*	There is an average 20% reduction in total residential and commercial energy consumption, meaning a 20% reduction in electricity consumption and a 20% reduction in natural gas consumption.	www.lapace.org

	HVAC- General Adsorption Heat Pump	All residential buildings implement Adsorption HVAC systems.	*Measure is active in Scenario I.*	There is an average 17% reduction in total residential energy consumption, meaning a 17% reduction in electricity and 17% reduction in household natural gas consumption.	http://www.eia.gov/consumption/residential/index.cfm; www.energystar.com
	Energy Upgrade CA 3: Enhanced Options	After both Basic and Advanced Energy Upgrades have been performed on all households, residents implement enhanced energy options such as green building measures, renewable energy, and water efficient landscaping to even further reduce energy consumption.	Energy Upgrade CA 2 + renewable energy (i.e. solar geothermal pumps) *Measure is active in Scenario II/III.*	There is an average 65% reduction in total household energy consumption, meaning a 65% reduction in electricity consumption and 65% reduction in natural gas consumption.	https://energyupgradeca.org/county/san_diego/about_enhancements
	Commercial/Industrial Retrofit 2 - PACE FINANCING	All commercial/industrial buildings use PACE financing to do **all** eligible upgrades to commercial and industrial buildings.	Building Automation systems and Controls, Building Envelop (roof, windows, insulation), High efficiency lighting fixtures and lamps, Occupancy and day lighting sensors, Low-flow toilets, Smart Irrigation systems, Heating, ventilation and air conditioning (efficient chillers, boilers and cooling towers), Solar PV or fuel cells to generate electricity, Elevator modernization, Industrial manufacturing equipment *Measure is active in Scenario II/III.*	There is an average 75% reduction in total residential and commercial energy consumption, meaning a 75% reduction in electricity consumption and 75% reduction in natural gas consumption.	www.lapace.org

	Scenario III: Solar Water Heating System: Gas Auxiliary Tank Backup	All residential buildings implement a solar water heating system that is backed up by gas in case of insufficient energy from solar photovoltaic.	*Measure is active in Scenario III.*	There is an average 11.5% reduction in total residential natural gas consumption	http://www.eia.gov/consumption/residential/index.cfm; www.energystar.com
	Southern CA Edison Emissions Factor	This reflects the goal of Southern California Edison to reach 23% renewable energy procurement in terms of total electricity production by 2020. *Measure is Active in Scenario I/II/III.*		Reduce 23% of emissions from the source by 2020.	SCE website (2012)
	Solar Photovoltaic on 5% of Households	This is a realistic measure that shows the natural growth of solar for 10 years due to personal choices of Hermosa Beach residents. 100% of the household's energy will come from solar power. *Measure is active in Scenario I.*		Reduction of total energy consumption from residential buildings by 5%. Generates 2,840,990 kWh of energy.	Cite as UCLA Luskin Center for Innovation. (2011). Los Angeles Solar Atlas.
	10% Biogas	This is a hypothetical measure. In the future, there will most likely be a greater percentage of biogas within local natural gas distribution system. *Measure is active in Scenario II.*		There is a 10% reduction in natural gas consumption and the subsequent emissions, because biogas is a part of the natural carbon cycle.	Hypothetical
	20% Wind on Households	This is a hypothetical measure. In the future, there will most likely be a greater percentage of biogas within local natural gas distribution system. *Measure is active in Scenario II.*		There is a 25% reduction in natural gas consumption and the subsequent emissions, because biogas is a part of the natural carbon cycle.	Hypothetical
	20% Solar Photovoltaic on Households	This measure ensures that 20% of all households in HB will have 100% of their electricity generated from photovoltaics. This is the minimum amount of solar implementation we would like to see on HB households, but it is the most feasible goal. *Measure is active in Scenario II.*		Reduction of total energy consumption in residential buildings by 20%. Generates 11,363,961 kWh of electricity	Cite as UCLA Luskin Center for Innovation. (2011). Los Angeles Solar Atlas.

	20% Solar Photovoltaic on Governmental Buildings	This measure ensures that 20% of all government buildings in HB will have 100% of their electricity generated from photovoltaics. This is the minimum amount of solar implementation we would like to see on HB government buildings. *Measure is active in Scenario II.*	Reduction of total energy consumption from government buildings by 20%. Generates 571,862 kWh of electricity	Cite as UCLA Luskin Center for Innovation. (2011). Los Angeles Solar Atlas.
	20% Solar Photovoltaic on Commercial/Industrial Buildings	This measure ensures that 20% of all commercial/industrial buildings in HB will have 100% of their electricity generated from photovoltaics. This is the minimum amount of solar implementation we would like to see on commercial/industrial buildings. *Measure is active in Scenario II.*	Reduction of total energy consumption from commercial/industrial buildings by 20%. Generates 2,642,008 kWh of electricity	Cite as UCLA Luskin Center for Innovation. (2011). Los Angeles Solar Atlas.
	Solar Photovoltaic on 50% of all Households	This measure ensures that 50% of all residential buildings in HB will generate 100% of their electricity from photovoltaic. This is more reasonable than 100% of buildings but will still be difficult to enforce. *Measure is active in Scenario III.*	Reduction of total energy consumption in residential buildings by 50%. Generates 28,409,904 kWh of electricity	Cite as UCLA Luskin Center for Innovation. (2011). Los Angeles Solar Atlas.
	Solar Photovoltaic on 50% of all Commercial/Industrial Buildings	This measure ensures that 50% of all commercial/industrial buildings in HB will generate 100% of their electricity from photovoltaic. This is more reasonable than 100%. *Measure is active in Scenario III.*	Reduction of total energy consumption from commercial/industrial buildings by 50%. Generates 6,605,021 kWh electricity	Cite as UCLA Luskin Center for Innovation. (2011). Los Angeles Solar Atlas.
	Solar Photovoltaic on 100% of all Government Buildings	This is an ideal measure in which all government buildings in HB will generate approx. 100% of their energy from solar power. This solar measure should be relatively easy to implement as the buildings are government owned and will set an example for the rest of the city to follow. *Measure is active in Scenario III.*	Reduction of total energy consumption from government buildings by 100%. Generates 2,859,310 kWh electricity due to the fact that gov. buildings make up a smaller fraction of total building energy consumption in HB.	Cite as UCLA Luskin Center for Innovation. (2011). Los Angeles Solar Atlas.

	CCA: Contracting Renewable Utilities	Under Community Choice Aggregation, HB will be able to contract from utilities other than SoCal Edison. These utilities may utilize a larger amount of renewable sources than Edison. As an example scenario, we chose the total energy entering HB consisting of 70% renewable origins. *Measure is active in Scenario III.*	Ensure total electricity consumption (for buildings not already using local sources) originates from 70% renewable sources. This will decrease current emissions by 50% (SCE is already at 20% renewable generation so switching to CCA will only cause a 50% increase in this scenario).	Estimate
	Future Purchase of Electricity	This measure is connected with the CCA: Contracting Renewable Utilities measure. It was added so the model could comprehend the implications of the former measure. *Measure is active in Scenario III.*	N/A	N/A
	CCA: Local Wave Power (1 Mark 3)	Under Community Choice Aggregation, HB will be able to allocate funds to wave power. One Mark 3 PowerBuoy from Ocean Power Technologies can be used to generate electricity for government, residential, and/or commercial/industrial buildings. *Measure is active in Scenario III.*	Provides approximately 394,470 kWh of electricity to the local grid.	OPT Technologies website (2013)
Transportation and Land Use	Neighborhood Electric Vehicles-Phase I	A community-wide program that loans out low speed electric vehicles to residents. The NEV program will affect VMT of households in Hermosa Beach. *Measure is active in Scenario I/II/III*	20% of households participate and increase the proportion of electric miles to 5.2% by 2020.	South Bay Cities Council of Governments (2011)
	Electric Vehicles-Phase I	Natural market forces and improvements in electric vehicle technology will increase the number of electric vehicles on the road. *Measure is active in Scenario I/II/III*	Increase proportion of electric miles by 12% by 2020.	California Energy Commission (2011)
	Hydrogen FCEV-Phase I	Natural market growth expected for Hydrogen Fuel Cell Vehicles over the short-term. *Measure is active in Scenario I/II/III*	By 2025, the proportion of hydrogen miles will increase by 3%.	California Energy Commission (2011)
	Natural Gas Vehicles	Increases in the number of natural gas vehicles owned in HB.	By 2030, the proportion natural gas miles will increase by 4%.	California Energy Commission (2011)

		Measure is active in Scenario I/II/III		
	Carpooling and Carshare	Increases in average vehicle occupancy and decreases in VMT that will occur with the initial implementation of community-wide carpool and carshare programs. *Measure is active in Scenario II/III*	30% new shared rides in Hermosa Beach and reduce VMT by 10% by 2025.	Hermosa Beach Green Task Force (2011), Cambridge Systematics, Inc. (2009), Matute & Pincetl (2013)
	Neighborhood Electric Vehicles (15% of Households)	Long-term expansion of the NEV program and potential improvements in electric vehicle technology will increase participation and further decrease VMT. *Measure is active in Scenario II/III*	Between 2020 and 2030, an additional 15% of households will start using NEVs and the proportion of electric miles will increase by 3.9%.	South Bay Cities Council of Governments (2011)
	Complete Streets (distance traveled)	Improvements to the city's infrastructure to enhance pedestrian, bicycle, and low speed vehicle access in Hermosa Beach. The program will affect Hermosa Beach's VMT and the mode choice of residents. *Measure is active in Scenario II/III*	Reduce VMT by 5% by 2040.	Hermosa Beach Green Task Force (2011), Cambridge Systematics, Inc. (2009), Matute & Pincetl (2013)
	Complete Streets (mode choice)	Improvements to the city's infrastructure to enhance pedestrian, bicycle, and low speed vehicle access in Hermosa Beach. The program will affect Hermosa Beach's VMT and the mode choice of residents. *Measure is active in Scenario II/III*	Proportion of Bike/ Walk Miles increase to 8% by 2040.	Hermosa Beach Green Task Force (2011), Cambridge Systematics, Inc. (2009), Matute & Pincetl (2013)
	Electric Vehicles-Phase II	Long-term improvements in electric vehicle technology and increased popularity of electric vehicles will further electrify transportation in Hermosa Beach. *Measure is active in Scenario II/III*	Between 2020 and 2030, the proportion of electric miles will increase by 20%.	California Energy Commission (2011)
	Hydrogen FCEV – Phase II	Continued market growth expected for hydrogen fuel cell vehicles over the long-term. *Measure is active in Scenario II/III*	Between 2025 and 2040, the proportion of hydrogen miles will increase by another 3%.	California Energy Commission (2011)

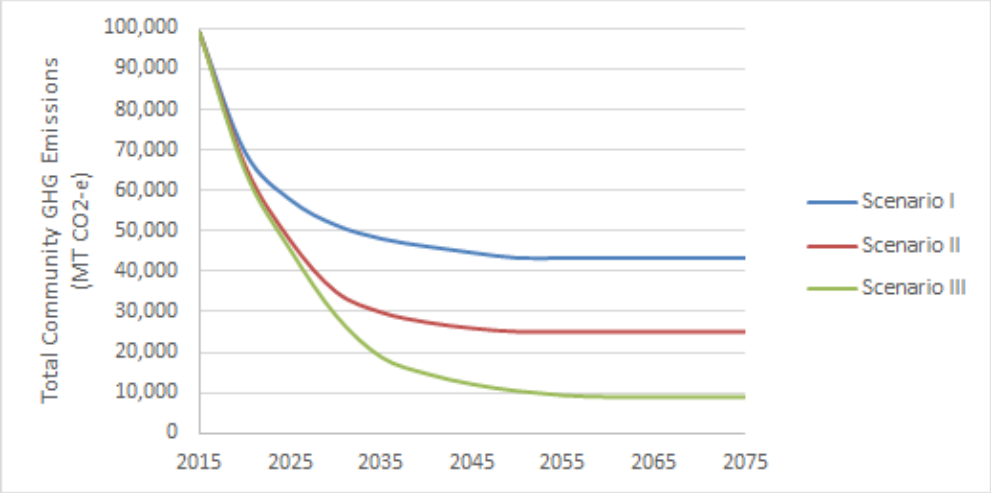
	Carpooling and Carshare- Phase II	Long-term increases in vehicle occupancy and decreases in VMT that will occur with further expansion of carpooling and carsharing. *Measure is active in Scenario II/ III.*	Implemented in 2025, 30% shared rides and an additional 25% reduction in VMT.	Hermosa Beach Green Task Force (2011), Cambridge Systematics, Inc. (2009), Matute & Pincetl (2013)
	Neighborhood Oriented Development	The development of commercial nodes mixed with residential areas to reduce trip length and encourage non-vehicle mode choices. This will decrease VMT in Hermosa Beach. *Measure is active in Scenario III.*	By 2050 VMT will be reduced by 30%	California Energy Commission (2011)
	Electric Vehicles- Phase III	Long-term improvements in electric vehicle technology and increased popularity of electric vehicles will further electrify transportation in Hermosa Beach. *Measure is active in Scenario II/III*	Between 2030 and 2050, the proportion of electric miles will increase by 25%.	California Energy Commission (2011)
	California Low Carbon Fuel Standard	Regulation implemented in 2011 requiring California's transportation fuel pool to meet certain carbon intensity requirements. *Measure is active in Scenario I/II/III.*	Carbon intensity of fuels, or CO2e per MJ of energy use.	California Air Resources Board (2007)
	Electric Vehicle Efficiency Gain	Estimated efficiency improvements for electric vehicles over time. *Measure is active in Scenario I/II/III.*	Reduces Kwh of electricity required per VMT.	California Energy Commission (2011)
	Gasoline Vehicle Efficiency Gain	Estimated efficiency improvements for gasoline vehicles over time. *Measure is active in Scenario I/II/III.*	Increases in the average MPG of vehicles	California Energy Commission (2011)
	Natural Gas Vehicle Efficiency Gain	Estimated efficiency improvements for natural gas vehicles over time. *Measure is active in Scenario I/II/III.*	Reductions in terms of natural gas required per VMT	California Energy Commission (2011)
	Hydrogen FCV Efficiency Gain	Estimated efficiency improvements for hydrogen FCVs over time. *Measure is active in Scenario I/II/III.*	Reductions in kg CO2e per mile	California Energy Commission (2011)

Consumption and Waste	Purchasing Policy	Incorporation of Lifecycle emissions in Municipal Purchasing Policy *Measure Active in Scenario I/II/III*	Reuse, Recycling	Estimate
	Tote bags	Encouraging the use of tote bags by giving the first one for free and then requiring its use in supermarkets *Measure Active in Scenario I/II/III*	Reuse, Total Consumption	Estimate
	Plastic Bags Ban	Similar to the Polystyrene Ban *Measure Active in Scenario I/II/III*	Reuse, Total Consumption	Estimate
	Incentives for compostable single use items	require restaurants to have compostable single use items like takeout boxes *Measure Active in Scenario I/II/III*	Avoids Landfill (composting) , Recycling	Estimate
	On-site building materials reuse	Reusing building materials when retrofitting or building new buildings *Measure Active in Scenario I/II/III*	Total Consumption, Reuse	Estimate
	Pay as you throw program	Charges community more for disposing of more trash *Measure Active in Scenario I/II/III*	Recycling	Estimate
	Green waste composting program	A program that makes it easier for community members to dispose of green waste *Measure Active in Scenario I/II/III*	Avoids Landfill (composting)	Estimate
	Guide for ecofriendly products	Create a guidebook for consumers and vendors for direction on which ecofriendly products to buy *Measure Active in Scenario II/III*	Recycling, Avoids Landfill (composting)	Estimate

	Thrift/Consignment shops	Increase access to thrift shops by educational workshops and bringing more thrift shops into the city *Measure Active in Scenario II/III*	Total Consumption, Reuse	Estimate
	Methane Capture technology and/or infrastructure	Implementation of a measure through Athens Services to dispose of waste in a landfill with technology that reduce greenhouse gases produced by each ton of waste going the landfill *Measure Active in Scenario III*	Greenhouse gas intensity of landfills goes to zero	Estimate
Water and Wastewater	Greywater outdoor reuse	Replace water system in 500 buildings with greywater reuse system *Measure is active in Scenario III*	Decreases total water demand by 3%	Hermosa Beach Green Task Force (2011)
	Reduce distribution system leakages	Find and repair leaks throughout water distribution system. In first phase or measure, reduce leakages to 20%. *Measure is active in Scenario III.*	First phase decreases total water demand by 10%	Washington State Department of Health (2011)
	Reduce distribution system leakages	Find and repair leaks throughout water distribution system. In second phase, reduce to leakages 10% *Measure is active in Scenario III.*	Second phase reduces total water demand by 20%	Washington State Department of Health (2011)
	Residential conservation rebates	Rebates given to residents that install low flow toilets or showerheads. First phase provides education for residents and gives 2,000 homes the rebate. *Measure is active in Scenario II/III.*	First phase decreases total water demand by 4%	US Environmental Protection Agency (2012)
	Residential conservation rebates	Rebates given to residents that install low flow toilets or showerheads. Second phase gives more rebates for a total of 5,000 rebates. *Measure is active in Scenario II/III.*	Second phase decreases total water demand by 10.5%	US Environmental Protection Agency (2012)
	Residential conservation rebates	Rebates given to residents that install low flow toilets or showerheads. Third phase gives a total of 9,000 rebates *Measure is active in Scenario II/III.*	Third phase decreases total water demand by 18.9%	US Environmental Protection Agency (2012)

	Landscaping conservation	Rebates given to residents that successfully convert their lawns to xeriscape. First phase provides education, free water surveys, and 1,000 rebates. *Measure is active in Scenario II/III.*	First phase decreases total water demand by 0.39%	US Environmental Protection Agency. (2013)
	Landscaping conservation	Rebates given to residents that successfully convert their lawns to xeriscape. Second phase will give another 1,000, which will make a total of 2,000 rebates. *Measure is active in Scenario II/III*	Second phase decreases total water demand by 0.78%	US Environmental Protection Agency. (2013)
	Rainwater Catchment	Rebates given to residents that install and use rainwater catchment basins. First phase educates the public about rainwater catchment and gives 500 homes the rebate. *Measure is active in Scenario I/II/III.*	The first phase decreases total water demand by 0.97%	Innovative Water Solutions (2013)
	Rainwater Catchment	Rebates given to residents that install and use rainwater catchment basins. Second phase gives more rebates for a total of 1,000. *Measure is active in Scenario I/II/III*	The second phase decreases total water demand by 1.9%	Innovative Water Solutions (2013)
	West Basin lower imported waters by 2020	West Basin will reduce their demands of imported waters *Measure is active in Scenario I/II/III*	Decreases imported water proportion by 34%	West Basin Municipal Water District (2010)
	West Basin increase local waters by 2020	West Basin will increase their demands of local waters *Measure is active in Scenario I/II/III*	Increases local water proportion by 2%	West Basin Municipal Water District (2010)
	West Basin increase recycled waters by 2020	West Basin will increase their demands of recycled waters *Measure is active in Scenario I/II/III*	Increases recycled water proportion by 10%	West Basin Municipal Water District (2010)
	West Basin lower imported waters by 2030	West Basin will reduce their demands of imported waters *Measure is active in Scenario I/II/III*	Decreases imported water proportion by 37%	West Basin Municipal Water District (2010)
	West Basin increase recycled waters by 2030	West Basin will increase their demands of recycled waters *Measure is active in Scenario I/II/III*	Increases recycled water proportion by 12%	West Basin Municipal Water District (2010)

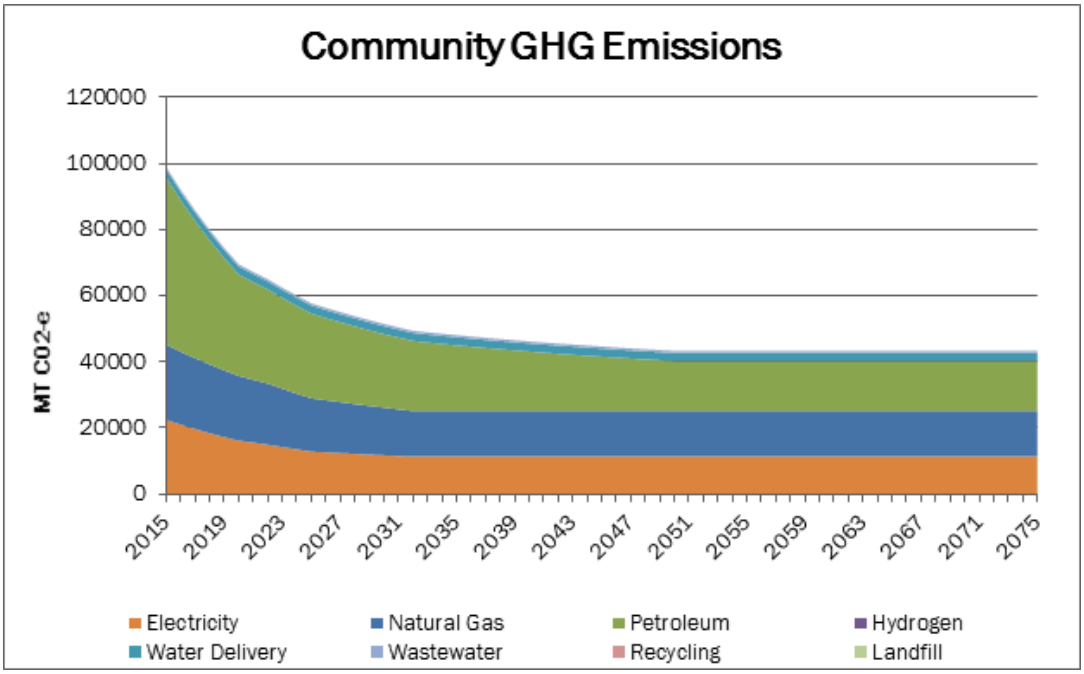
Figure 2 Total Community Greenhouse Gas Emissions for Scenarios I-III



Scenario I

Scenario I reduces emissions by about 56%. As depicted in Figure 2, Scenario I initially affects emissions as drastically as II and III, but drastic changes don't show until about 2025. Hermosa Beach will not attain carbon neutrality with Scenario I without offsets. The following sections provide details on how Scenario I affects each sector, graphically shown in Figure 3 and how each sector interacts with one another.

Figure 3 Total community Greenhouse Gas emissions by sector for Scenario I



Building Energy

The building energy sector focuses on increasing efficiency but does not alter Hermosa Beach's energy source. In Scenario I, little is done to mitigate emissions from the energy source. Hermosa Beach has no control over the Southern California Edison Emissions Factor to increase renewable energy procurement by 2020. Electricity emissions are reduced by 40% by 2030 while total consumption is decreased by 20% by 2025. Community zero emissions electricity increases to 3,300,000 kWh by 2025 due to the addition of residential solar and the reduction of Southern California Edison's emissions factor. The community zero emissions electricity consumption is still only 5% total consumption. Natural gas emissions and consumption are both reduced by 21% by 2030. The residential sector experienced the largest decrease in natural gas consumption. This demonstrates the effectiveness of simple building retrofits such as insulation, more efficient lighting, and the addition of heat pumps. By focusing policy on residential electrical and natural gas consumption, a large amount of emissions could be reduced. These activity-based measures are extremely simple and offer future cost savings, so they are less likely to be rejected by the public.

Transportation and Land Use

For transportation and land use, the implemented measures include natural market changes and programs that are likely to occur without Hermosa Beach's actions. These measures include fuel carbon intensity changes, natural market growth for alternative fuel vehicles (electric, natural gas, and hydrogen), estimated future electric vehicle efficiency improvements, and a basic neighborhood electric vehicle program. These status quo implementation measures do not make a substantial dent in Hermosa Beach's petroleum greenhouse gas emissions. By 2075, petroleum emissions decrease by about 69.97% relative to 2015, but they still comprise a considerable 35.04% of total emissions. Most of this is a result of the shift from petroleum to alternative fuels. Natural Gas and hydrogen miles also increased slightly to 4.10% and 3.00%, respectively. Scenario I did not include any measures that changed VMT, bike and pedestrian access, or transit services. All Scenario I transportation implementation measures outsource some gasoline emissions to the electricity, natural gas, and hydrogen sector. This means that although petroleum emissions may decrease, some decreases in electricity emissions are balanced out by the increased need for electricity to fuel vehicles. However, despite this slight electrification of transportation, Scenario I does not significantly transition Hermosa Beach away from petroleum.

Water

Scenario I of the water implementation measures will include those that West Basin has planned and the rainwater catchment rebate program. The rainwater catchment measure will be two years long and will educate the public about the benefits of rainwater harvesting by providing rebates and workshops. The goal of this measure will be to give a total of 1,000 rebates for rainwater barrels, which will annually save up to 15 million gallons of water. The West Basin's plans are included in Scenario I because these changes will be made regardless of Hermosa Beach's actions.

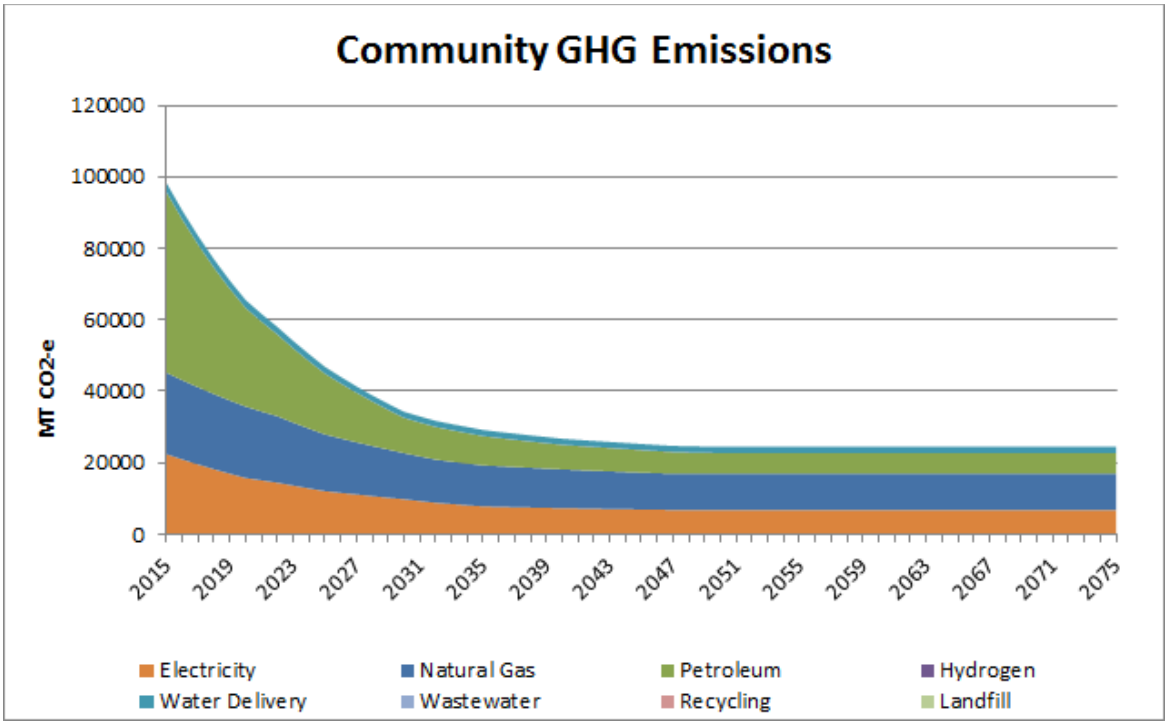
Material Consumption and Waste

Scenario I for the consumption and waste sector accounts for what measures are easy to implement and those already in place. Hermosa Beach has a contract with Athens Services to implement the Pay-as-you-throw program. The Plastic Bag Ban will also be easy to implement considering Hermosa Beach has already banned Polystyrene. Together, these measures help divert waste from landfills and increase the amount of waste that is being reused, composted, or recycled. This scenario only shows a 25.50% emission reduction. This is done within eleven years of implementation of the measures with little effort from the city.

Scenario II

Scenario II includes more long-term reductions and reduces greenhouse gases by about 75%, which is significantly more than the 35% reduction projected for Scenario I. Figure 4 shows the greenhouse gas emissions reductions for Scenario II. Despite being far more effective than Scenario I, Scenario II still leaves Hermosa Beach will a substantial amount of emissions to neutralize and would still require purchasing a significant amount of offsets.

Figure 4 Scenario II Community Greenhouse Gas Emissions



Building Energy

Scenario II for building energy looks at more aggressive green building upgrades. Though this scenario is extremely effective in greenhouse gas reduction, it still does not fully neutralize emissions. Emissions decrease by 70% while total electricity consumption decreases by 36%. Greenhouse gas emissions from natural gas decrease by 71% while total natural gas consumption decreases by 50%. There is a large decrease in natural gas consumption in the residential sector and commercial/industrial sector. Scenario II displays a gradual reduction of natural gas and electricity consumption over time due to the more advanced upgrade options that will take longer to implement and will begin after the basic options have already been installed. There is also a large increase in community zero emissions electricity generation as renewables become prevalent in this scenario. Additional wind, solar, and biogas generation has greatly reduced emissions, but offsets are still necessary.

Figure 5 Electricity consumption in Hermosa Beach from residential, commercial/Industrial and Transportation sectors over the implementation period of Scenario II measures

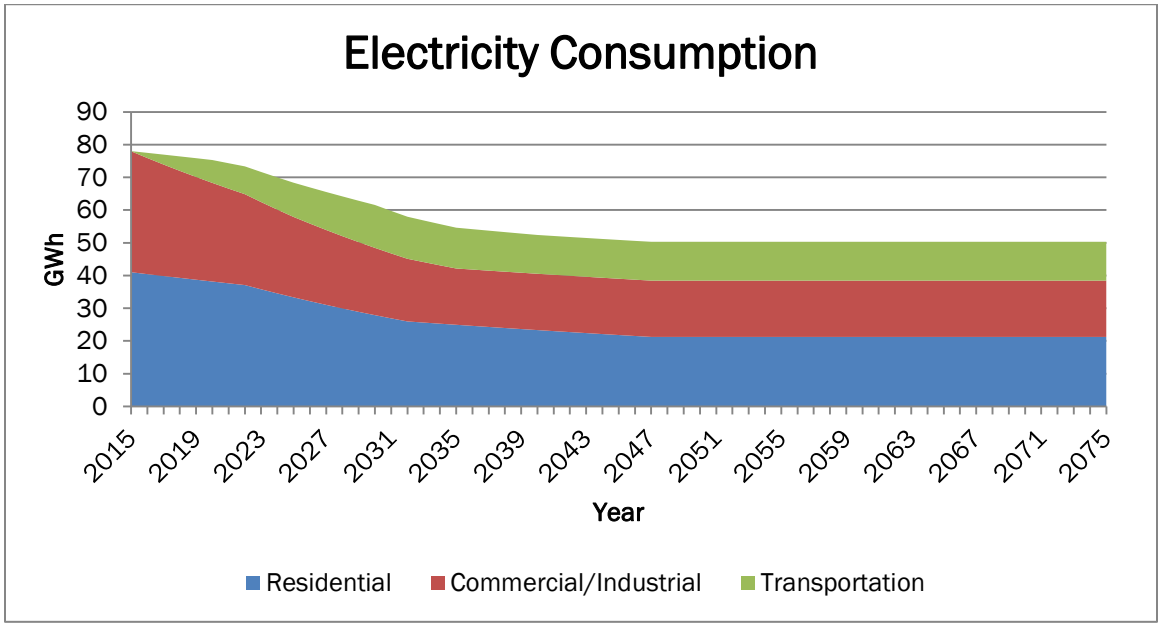
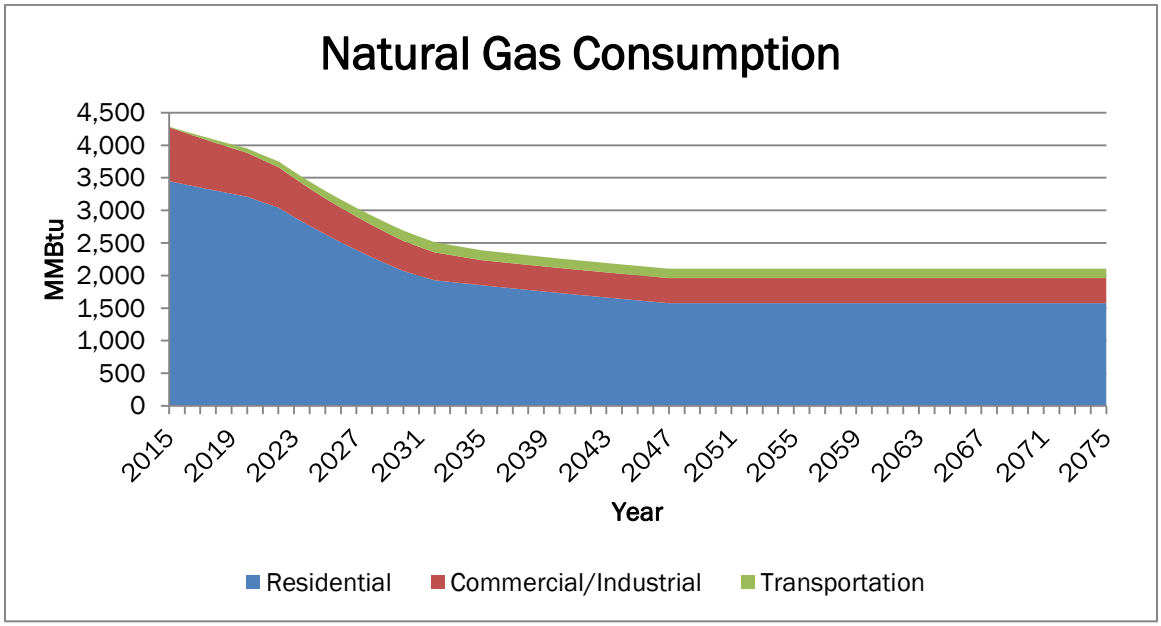


Figure 6 Natural gas consumption over time in Hermosa Beach from residential, commercial/industrial and transportation sectors throughout the Scenario II implementation period



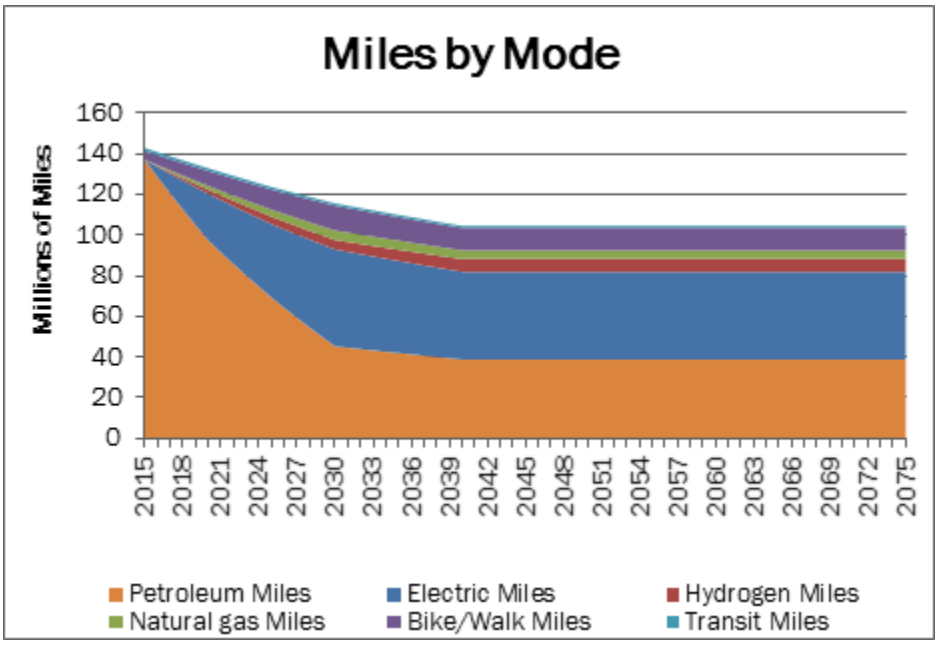
Transportation and Land Use

The new additions to Scenario II are an initial phase of a Carpooling and Carsharing program, a

Complete Streets program, a second phase of increased participation in the Neighborhood Electric

Vehicle program, a second more ambitious phase of electric vehicle and hydrogen FCV adoption, and a parking cash-out program. In Scenario II, emissions from petroleum decrease by about 88.58% between 2015 and 2075. In 2075, petroleum will comprise about 22.99% of total emissions compared to 51.06% in 2015. Petroleum miles decrease by 72% between 2015 and 2075 and comprise 37.20% of total miles in 2075. The aggressive onset of electric vehicle measures in Scenario II greatly increases electric miles as seen in Figure 7. By 2075, electric miles are responsible for 41.20% of total miles traveled in 2075. However, the electrification of transportation outsources transportation emissions to the electricity sector, causing transportation to comprise a much larger proportion of electricity consumption. The Complete Streets measure added in Scenario II greatly increases the amount of biking and walking. Additionally, this measure, as well as carpooling and carshare measures, decreases VMT in Scenario II by 27% between 2015 and 2075. Overall, petroleum is still responsible for the largest portion of community greenhouse gas emissions in Scenario II. However, Scenario II's more ambitious implementation measures make a significant dent in total community greenhouse gas emissions.

Figure 7 Miles traveled by each mode of transportation in Scenario II



Water

Scenario II includes implementation measures from Scenario I, the residential rebate programs, and the landscaping rebate program. In the residential conservation rebate program, the city can

educate the public and provide free surveys for interested residents. If the program is successful at giving out rebates to 90% of its homes, Hermosa Beach can see a reduction of 400,000 gallons per day, which leads to an annual reduction of about 146 million gallons. For the landscaping rebate program, the goal of 2,000 homes' participation will further reduce 6 million gallons per year of use.

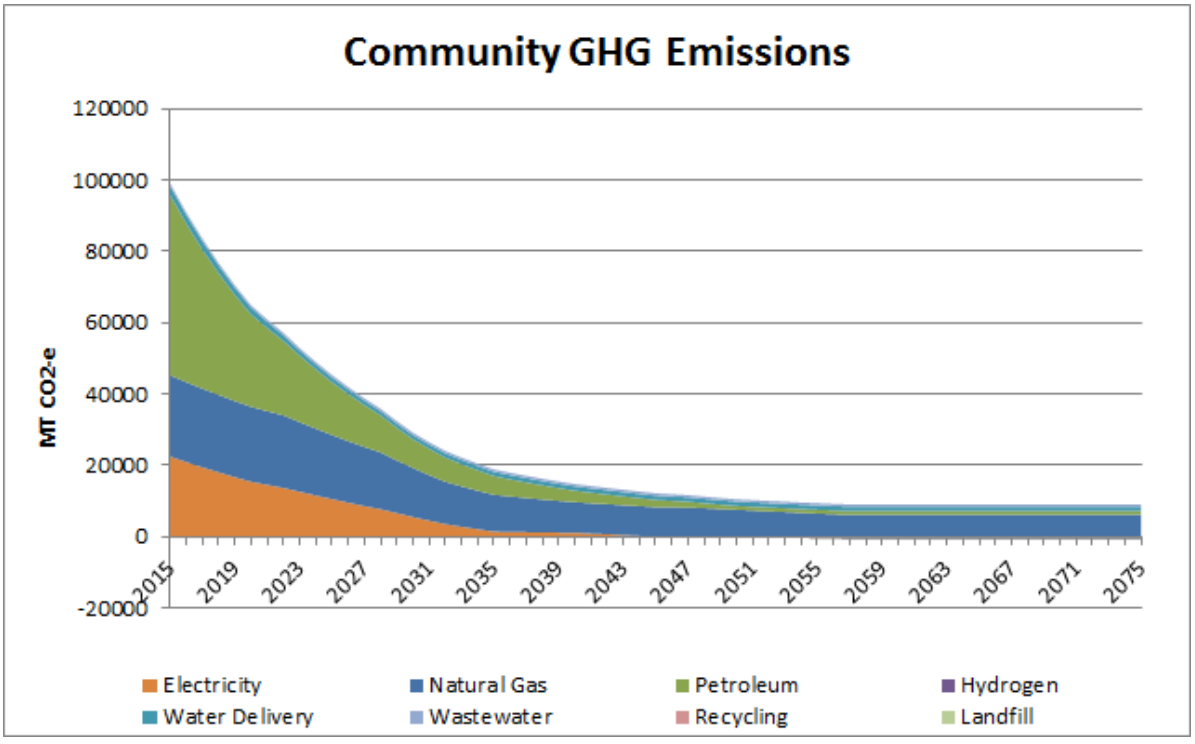
Material Consumption and Waste

Two measures were added because they require more resources and are harder to implement. The guide for eco-friendly materials will require collaborative effort and more distribution resources. There will be increased access to consignment and thrift shops where community reuse of goods is encouraged.

Scenario III

Scenario III has a projected reduction of about 91% by 2075. Scenario III leaves Hermosa Beach with a remainder of about 9,000 MT CO2e to neutralize via offsets. Scenario III may include the most difficult implementation measures, but we believe that it conveys the most effective options for Hermosa Beach to attain carbon neutrality. Figure 8 illustrates how each sector contributes to emissions under Scenario III.

Figure 8 Scenario III Community Greenhouse Gas Emissions



Building Energy - Electricity and Natural Gas

Scenario III is more inclusive of long-term strategies to develop independence from utilities and gear toward self-powered buildings. In order to reach such goals, the activity-based energy upgrades must progress toward a carbon neutral house.

Figure 9 Scenario III Electricity Consumption from residential, commercial/industrial, and transportation sectors

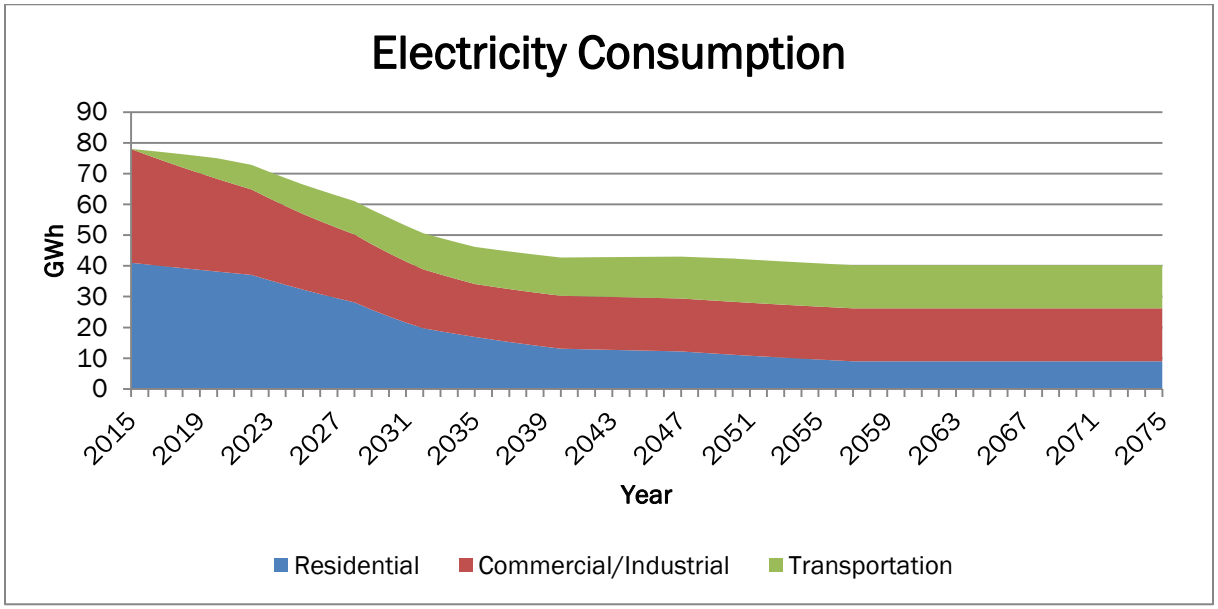
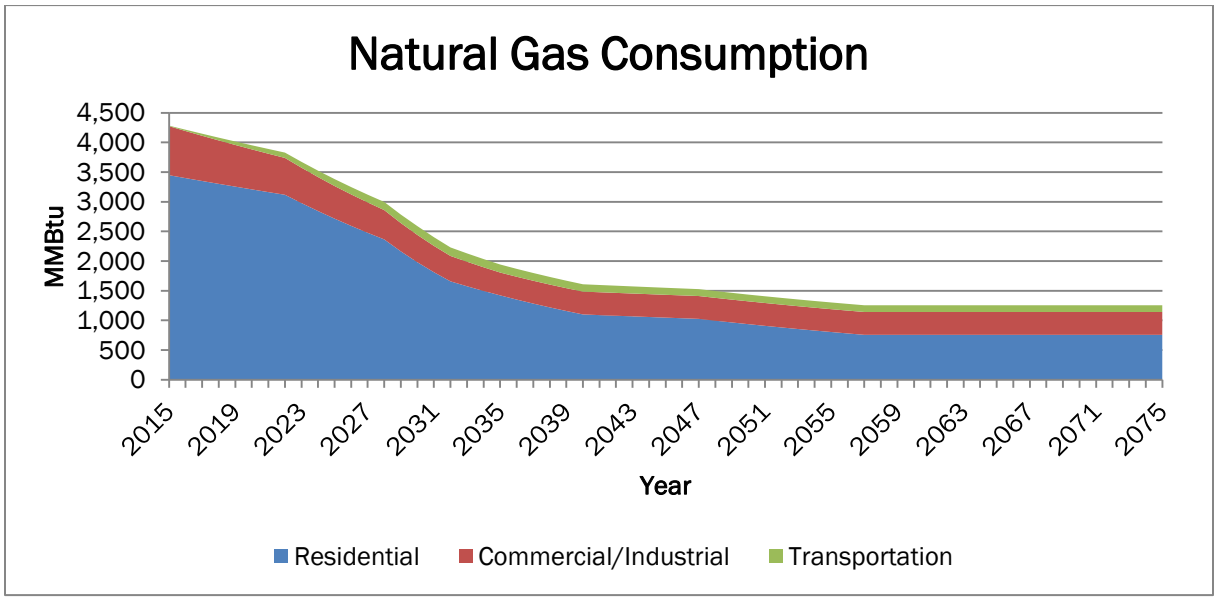
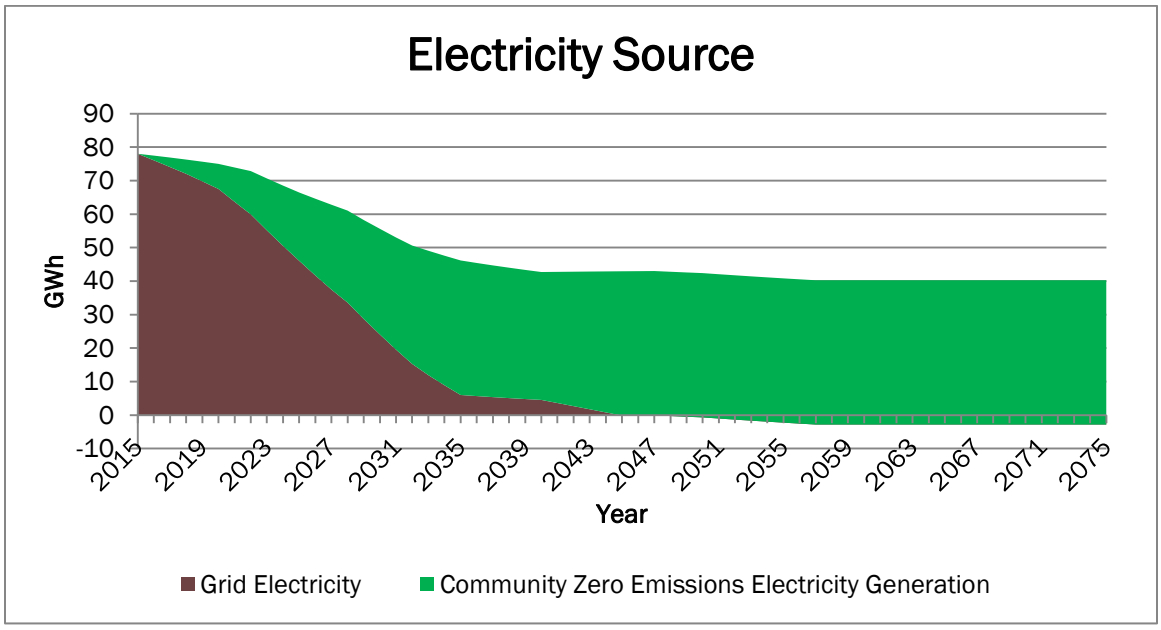


Figure 10 Scenario III Natural gas consumption from residential, commercial/industrial, and transportation sectors



Community Choice Aggregation, or CCA, is the major source-based implementation measure and will be the most difficult to enact because it changes the way electricity is supplied. If Hermosa Beach successfully implements CCA, the city will have complete control over their electricity generation. This implementation measure is a theoretical case and is paired with "Future Purchase of Electricity measures" to display the reduction of purchased electricity from the local utility service. Under Scenario III, Hermosa Beach will reach community net zero emissions electricity generation by 2045. Greenhouse gas emissions from electric generation are neutralized by that time while total electricity consumption decreases by approximately 48% (see Figure 11). Instead of consuming the largest amount of electricity, the residential sector now consumes the least. Natural gas emissions and consumption both decrease by 71% by 2060. The residential sector has displayed the greatest decrease in consumption, but still leads the other sectors in overall consumption.

Figure 11 Electricity shift under Community Choice Aggregation

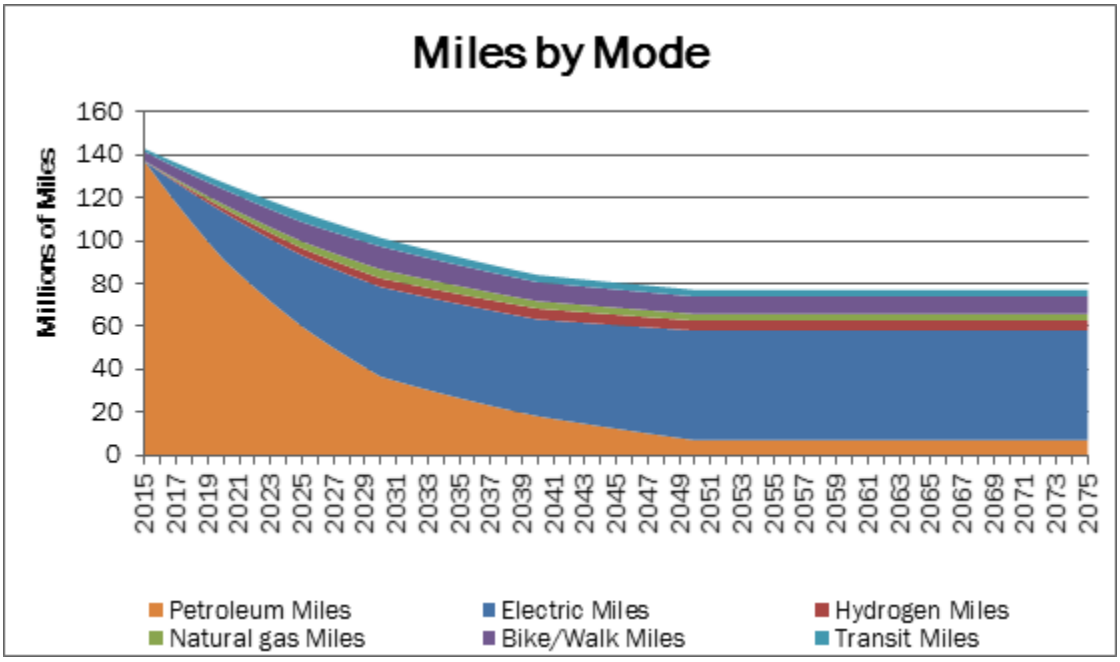


Transportation and Land Use

Scenario III implements improved transit service, Neighborhood-Oriented Development, a third phase of electric vehicle adoption, and a second phase of carpooling and carsharing. Scenario III results in an impressive 97.92% reduction in petroleum greenhouse gas emissions between 2015 and 2075. In 2075, petroleum will only account for 11.75% of total emissions. Scenario III significantly shifts transportation consumption away from petroleum. By 2075, petroleum miles decrease by 95% and

only account of 9.2% of total miles traveled. Electric miles grow by 3560% in the 60 years of model analysis, comprising an impressive 66.20% of total miles in 2075. Hydrogen and natural gas miles increase to 6% and 4.1% of total miles respectively. Bike and walk miles remain at 10.5%, but the addition of an improved transit service measure increases transit miles to 4% of total miles. One of the most ambitious changes in Scenario III is the significant reduction in VMT. Between 2015 and 2075, total miles traveled decreases 46%, most likely due to the addition of the Phase II of carpooling and carsharing and Neighborhood Oriented Development measures. Scenario III experiences even more interaction between the transportation and electricity sector as a third phase of Electric Vehicle adoption is implemented. Transportation is responsible for almost a third of electricity consumption by 2075 in Scenario III. Additionally, a majority of miles traveled is completed by electric vehicles and this relationship is depicted in Figure 12. Overall, community electricity consumption still decreases despite the electrification of transportation due to aggressive renewable energy implementation measures.

Figure 12 Miles traveled by each mode of transportation in Scenario III



Water

Scenario III implementation measures will additionally include a reducing distribution system leakages (DSL) programs and installation of greywater outdoor reuse systems because they have a

large impact on water demand at a higher cost. These measures will further decrease the total water demand to about 373 million gallons of water annually. This is 400 gallons of water saved from the demands before the measures were implemented, which is more than a 50% reduction. The greywater programs will lower the imported water demand by increasing the recycled water use by 3%. The greenhouse gas emissions will lower to 1,197,000 MT CO_2-e, and about a total of 1,383,000 MT CO_2-e is not emitted into the atmosphere when these measures are taken.

Material Consumption and Waste

Scenario III includes a measure that would potentially completely eliminate emissions from landfill waste. Currently, landfill carbon intensity is set at about 0.194 kg CO2-e per MT of waste disposed in the landfill. If the current designated landfill for Hermosa Beach is able to utilize the methane capture methods, the emissions from the landfill would be captured to create electricity that can be privately sold to utilities. If this measure is implemented along with the rest of the measures listed in the table, the city would be able to reduce its emissions from waste disposal by 92.18% by 2035.

Offsets

Hermosa Beach may not be able to completely neutralize its impact on global climate change. In that case, the city can look towards offsetting emissions by investing in emission reduction projects elsewhere in order achieve carbon neutrality. We do not view offsets as a first option to achieve carbon neutrality, but rather as a last resort after the city has aggressively pursued implementation measures. While the city can use offsets to achieve its carbon neutrality goal, the perception of using offsets may make Hermosa Beach's accomplishments less celebrated than achieving carbon neutrality without offsets.

Hermosa Beach has a number of viable marketplace options because they are located within the environmentally progressive state of California that has its own market based compliance mechanism, AB32, for employing standardization and credible carbon credit trading. The use of compliance-based offsets in claiming carbon neutrality will be better received than the use of voluntary offsets, because reduction projects must go through a stringent verification process to be traded in a compliance market, giving these projects more credible value. After careful analysis of how other cities have successfully implemented offset and the unique carbon neutrality goals of Hermosa Beach, we recommend that Hermosa Beach purchase offsets or mitigation efforts close to

home. Hermosa Beach, however, can also develop a Carbon Fund similar to that of San Francisco's to create extra funds that are used toward offset projects that would otherwise be financially unfeasible. After aggressive reduction measures have been implemented to the city, offsets can provide a viable option to neutralize remaining emissions that may be out of the city's control.

Conclusion

For Hermosa Beach to become carbon neutral, it is important to address all sources of emissions. However, targeting the largest source of emissions, which in the case of Hermosa Beach would be transportation, will make the most progress. Electrifying transportation can most effectively reduce vehicle emissions. However, as transportation becomes increasingly electrified, the emissions from electricity usage in turn rise and need to be addressed more. Increasing energy efficiency can help curb existing emissions, and may be one of the easier plans to implement, but it will not be able to handle the added emissions added from the reformation of the transportation system.

The most viable option to reduce transportation emissions without also increasing emissions due to electricity is for the city to find its own source of energy. For this, we recommend that Hermosa Beach look into Community Choice Aggregation. By creating their own source of energy, Hermosa Beach can have a greater amount of independence and control over their electricity usage, and can collectively decide to generate their energy from a renewable source, like wave power or solar energy, that may produce fewer emissions and will further increase their efforts towards carbon neutrality. They will be able to reduce their emissions by electrifying transportation, but still be able to reduce electricity emissions as well, leading them closer to achieving their carbon neutrality goal.

Although Scenario I and II will reduce emissions, we recommend that Hermosa Beach follow the plan outlined in Scenario III for the most significant results and for the greatest chance of becoming carbon neutral. Any remaining emissions that pose a problem to address can be targeted and mitigated by offsets, but those should be considered only after all other possible plans are enacted.

The shift to carbon neutrality will not occur immediately, and will take years to achieve. As a result, our recommended plans are intended to occur slowly over an extended amount of time. It is important to remember that all of our recommendations are suggestions for action, rather than an actual plan. In the end, it is up to Hermosa Beach to determine the best route to carbon neutrality.