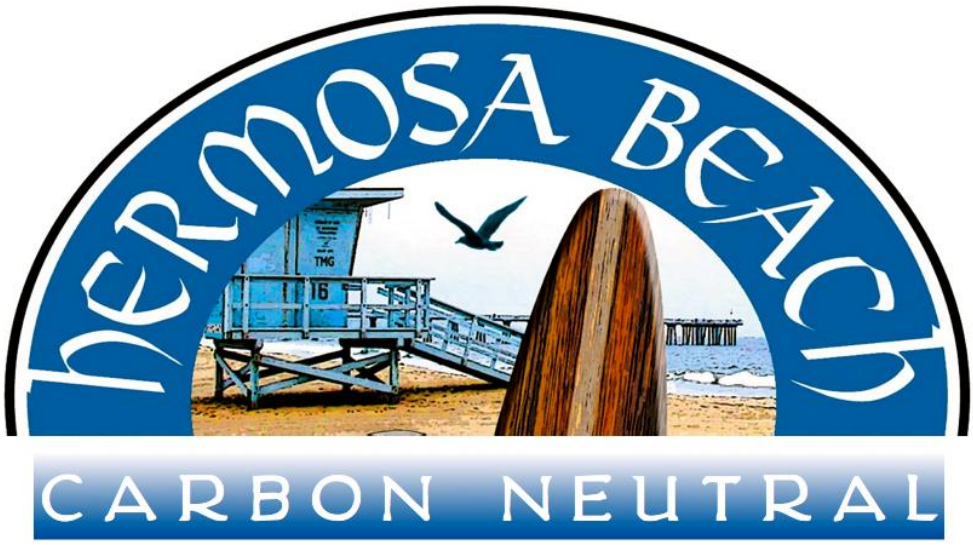
Hermosa Beach Carbon Neutral Scoping Plan



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PART I: Introduction to the Goals and Current Conditions of Hermosa Beach

A. The Importance of Carbon Neutrality

On March 16, 2010, the Hermosa Beach City Council declared its intent to pursue carbon neutrality starting with the city's operations. This ambitious goal to eliminate the city's carbon footprint will set a precedent and allow Hermosa Beach to attain carbon neutrality at the community level. Mayor DiVirgillio presented this plan as a response to climate change and an effort to maintain and enhance the quality of life of the next generation of Hermosa Beach residents.

The term carbon neutral means to achieve net zero carbon emissions, which entails balancing out a measured amount of carbon released with an equivalent amount offset or sequestered. Carbon neutrality aims to mitigate climate change by reducing the concentration of greenhouse gases in the atmosphere. Greenhouse gases are both a natural phenomenon and a form of anthropogenic pollution, stemming from natural and man-made sources.[1] Although natural emissions of greenhouse gases have been occurring for hundreds of thousands of years, recent human activity has significantly increased the rate of emission. Atmospheric greenhouse gas levels, primarily of carbon dioxide, have risen by over forty percent, from around 275 to 400 ppm since 1850. This is mostly due to burning of fossil fuels and the rise of industrialism.[2] As a result, a number of climate-related problems have surfaced, and the global temperature is rising. The issue is ongoing because greenhouse gases persist in the atmosphere long after they have been emitted and prevent heat from escaping the earth's atmosphere. The ocean also traps this heat, raising its own temperature

[1] Trisolini, K. (2010). All hands on deck: local governments and the potential for bidirectional climate change regulation. Stanford Law Review **62**:669–745.

[2] Schneider, S. H. (1989). *The Greenhouse Effect: Science and Policy*. (New York, N.Y.: Science).

as well.[3] This ensures that any unregulated human activity related to greenhouse gas emissions will have an effect on the global environment for centuries to come.[4] Climate change from increased greenhouse gases is causing distinctive atmospheric phenomena that results in a rise of sea levels, increase in floods and storm intensity, change in precipitation, disruption of the ocean currents, heat and cold waves, change in weather, and worsening of air quality.[5]

As a small coastal city that will be subjected to many of climate change's detrimental effects, Hermosa Beach should be invested in reducing their carbon footprint. Eliminating the city's contribution to climate change will not only help minimize negative environmental impacts but will also place Hermosa Beach at the forefront of the environmental movement. Hermosa Beach's carbon neutrality plan can be presented as a model for similar cities around the globe.

B. The Role of Local Governments in Climate Action

There is huge potential for reducing emissions through local action. Cities use the most energy in all areas of consumption, including transportation and industrial and commercial activities. As a result, they have some of the highest emission levels. Worldwide, cities are responsible for seventy-five percent of carbon emissions.[6] The ten largest cities in the United States are responsible for ten percent of U.S. emissions. [7] Appealing to citizens living in cities for help in reducing emissions through residential and commercial energy usage would target thirty-nine percent of the total energy

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[3] IPCC. (2007). *Climate change 2007: the physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*.

[4] Hasselmann, K., M. Latif, G. Hooss, C. Azar, O. Edenhofer, C. C. Jaeger, O. M. Johannessen, C. Kemfert, M. Welp, and A. Wokaun. (2003). The challenge of long-term climate change. Science 302:1923–1925.

[5] Kates, Robert W. and Thomas J. Wilbanks. 2010. *Beyond Adapting to Climate Change: Embedding Adaptation in Responses to Multiple Threats and Stresses*. Annals of the Association of American Geographers 100 (4): 719-728.

[6] Sheppard, S. R. J., Shaw, A., Flanders, D., Burch, S., Wiek, A., Carmichael, J., Robinson, J., et al. (2011). Future visioning of local climate change: a framework for community engagement and planning with scenarios and visualisation. *Futures*, *43*(4), 400–412.

[7] Trisolini, K. (2010). All hands on deck: local governments and the potential for bidirectional climate change regulation. *Stanford Law Review*, *62*, 669–745.

used in the nation, and thirty-eight percent of its carbon dioxide emissions.[8] Cities and other local governments are responsible for the high level of emissions, and can consequently have the greatest effect on reduction; taking a "bottom-up" approach, rather than a "top-down" one, can reduce emissions in the United States by up to sixty-five percent.[9]

The main source of influence that city governments have, compared to all the levels of government, is their ability to maintain a close relationship with their citizens. As one of the lowest levels of government, they are in closer contact with the public and deal with a smaller, more manageable area than regional or state governments. They have the "unique ability to respond to a global issue, such as climate change at a local, more tangible level. They usually offer more immediate and effective communication between the public and decision makers than other groups can."[10] Through their use of policy and communication, local governments have the power to sway their citizens into becoming "*environmental subjects* that come to care for the environment in ways complementary to the goals of modern government."[11] These subjects can now self-regulate, which can relieve the local government of the need to impose more regulations.

In this sense, local governments can reduce emissions due to upstream issues like transport and energy production by targeting the farthest level downstream; consumers.[12] Local governments create a link between their citizens and the federal government and can take quicker corrective actions than the federal government can. Cities do not need widespread support to implement initiatives and "some local programs provide fiscal benefits [and] may face fewer political hurdles

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[8] Trisolini, K. (2010). All hands on deck: local governments and the potential for bidirectional climate change regulation. *Stanford Law Review*, *62*, 669–745.

[9] Byrne, J., Hughes, K., Rickerson, W., & Kurdgelashvili, L. (2007). American policy conflict in the greenhouse: Divergent trends in federal, regional, state, and local green energy and climate change policy. *Energy Policy*, *35*(9), 4555–4573.

[10] Staff of the International Bank for Reconstruction and Development/The World Bank (2010). Cities and Climate Change: An Urgent Agenda. *Urban Development Series Knowledge Papers* 10, 1–81.

[11] Staff of the International Bank for Reconstruction and Development/The World Bank (2010). Cities and Climate Change: An Urgent Agenda. *Urban Development Series Knowledge Papers* 10, 1–81.

[12] Trisolini, K. (2010). All hands on deck: local governments and the potential for bidirectional climate change regulation. *Stanford Law Review*, *62*, 669–745.

than federal and state efforts to reduce emissions."[13] Local programs raise public awareness of sustainable policy, which in turn increases public competence in environmental issues. When the federal government wants to enact such policy on a larger scale, these new "environmental subjects" will not be ignorant or hesitant of the changes that policy might bring.

The success of local authority on greenhouse gas regulation also stems from the expansive list of areas that local legislation can target. Local governments have authority over a number of sectors within their jurisdiction, including land use, transportation, waste management, water delivery, and building codes. They can create policies that require each of these areas to lower emissions or become more efficient.[14] This also includes targeting residential and commercial waste and other land practices, as all of these are primarily an urban construction.[15]

Local governments can target both residential and industrial sources of emissions, regulate public spaces within the jurisdiction, and work on educating the public on reduction strategies to further lower the levels of emissions.[16] Building codes are a major source of potential for reducing emissions, and local governments can enact policies that regulate construction and renovation practices, requiring them to meet certain standards or satisfy certain requirements like LEED certification, which sets standards for building efficiency and sustainability to achieve certification. In fact, local regulation of buildings is already occurring; over 71 million citizens have established green building plans in the area.[17]

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[13] Trisolini, K. (2010). All hands on deck: local governments and the potential for bidirectional climate change regulation. *Stanford Law Review*, *62*, 669–745.

[14] Fleming, P. D., & Webber, P. H. (2004). Local and regional greenhouse gas management. *Energy Policy*, *32*(6), 761–771.

[15] Schmidt Dubeux, C. B., & Rovere, E. L. L. (2007). Local perspectives in the control of greenhouse gas emissions–The case of Rio de Janeiro. *Cities*, *24*(5), 353–364.

[16] Fleming, P. D., & Webber, P. H. (2004). Local and regional greenhouse gas management. *Energy Policy*, *32*(6), 761–771.

[17] Trisolini, K. (2010). All hands on deck: local governments and the potential for bidirectional climate change regulation. *Stanford Law Review*, *62*, 669–745.

Understanding the extent of involvement that a local government can have in regulating greenhouse gases and understanding the ways in which cities and communities can collaborate on climate action plans will be useful for the creation of future local action plans, and provide insight into how effective these plans may be. Just as national legislation is a crucial step to ensure that international commitments are kept, local governments and communities play a pivotal role in reducing emissions. National legislation will never meet reduction goals without local government cooperation, and individual local governments are incapable of reducing emissions significantly enough to make a difference in the total levels of greenhouse gases present in the environment.[18] Local actions should strive to enhance the already-existing national and international legislation with its own policies and regulations, and combining a top-down and bottom-up approach will have a greater impact than simply focusing on one approach. If the three levels of government can work together on reducing greenhouse gas emissions, better results can likely be achieved.

C. Background

1. Demographics

Hermosa Beach was founded on January 14, 1907, and is one of the three Beach Cities in the South Bay Area of Los Angeles County, California. Known as "The Best Little Beach City," Hermosa Beach has an extremely rich beach-centered culture that is unique and central to its identity.

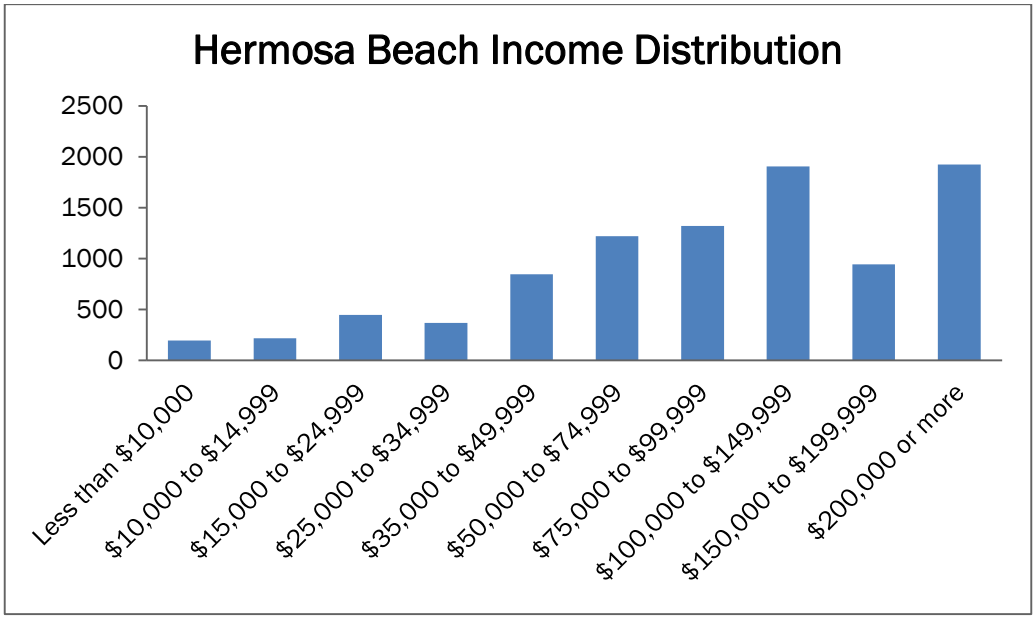
Hermosa Beach is a largely residential area with a 2011 population of 19,574 people, covering a mere 1.4 square miles of land with a population density of approximately 14,000 people per square mile.[19] In comparison, Los Angeles City has a population density of 8,100 people per square mile. There are approximately 10,160 housing units in Hermosa Beach, with roughly 2.048 persons per

[18] Trisolini, K. (2010). All hands on deck: local governments and the potential for bidirectional climate change regulation. *Stanford Law Review*, *62*, 669–745.

[19] City of Hermosa Beach. (2013a). City Facts. Retrieved from http://www.hermosabch.org/index.aspx?page=47.

household.[20] Nearly 91% of the city's households are made up of 3 people or less. 18% of all households make less than $50,000 annually, while 55% earn more than $100,000.[21]

Table 1: Distribution of incomes in Hermosa Beach[22]



The largest age demographic consists of adults between the ages of 35 to 54, with ages 21 to 34 is the second largest demographic. Because the population is aging, the number of people between the ages of 21 to 34 has dropped significantly in recent years and is projected to continue decreasing. The demographics of the city are continuing to change, which could result in a change in the popular opinion among the local community.

Hermosa Beach is located seventeen miles southwest of Los Angeles and four miles south of Los Angeles International Airport. Pacific Coast Highway divides Hermosa Beach into a beachside western section and a perhaps less beach-focused inland eastern section. The city is largely residential, with pockets of commercial and entertainment districts. The central business district is

[20] City of Hermosa Beach Finance Department. (2013). City of Hermosa Beach Facts and Figures.

[21] City of Hermosa Beach Finance Department. (2013). City of Hermosa Beach Facts and Figures.

[22] United States Census Bureau. (2011). Community Facts. Retrieved from http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_11_5YR_DP03

clustered along Pier Avenue, Hermosa Avenue, Pacific Coast Highway, and Aviation Boulevard. Nearly all parcels to the east of Pacific Coast Highway are residential, with many single-family houses. Most of the parcels bordering the west side of Pacific Coast Highway exhibit small commercial uses.

Figure 1: Google Earth imagery of Hermosa Beach

Hermosa Beach's proximity to the Pacific Ocean regulates its water and air temperature throughout the year. The average air temperature is approximately 74˚F (23.3˚C) in the summer and 55˚F (12.7˚C) in the winter. The water temperature is approximately 68˚F (20˚C) in the summer and 50˚F (10˚C) in the winter. The average temperature in Hermosa Beach is typically cooler than it is inland, and morning fog is typical throughout the summer.

Hermosa Beach is represented by a majority Democratic population. As seen in Table 2, Hermosa Beach's residents largely voted in favor of Barack Obama over the Representative candidate for Presidency in both the 2008 and 2012 Presidential elections. The area is in the 26th State Senate District represented by Democrat Ted Lieu, 66th Assembly District represented by Democrat Al

Muratsuchi, and the 33rd California Congressional District represented by Congressman Henry A. Waxman.[23] According to Hermosa Beach's voting history, the population is primarily Democratic, and has been becoming steadily more liberal over time. The citizens of the city tend to vote strongly in support of Democratic candidates for local, state, and national positions. They also tend to vote in favor of environmental propositions and measures, especially those involving transportation. An example of Hermosa Beach's environmental voting endeavors is their 68.2% voter support of Measure R in 2008, which intended to finance new transportation projects with an increased sales tax.[24] As seen in Table 3, Hermosa Beach has also historically voted in favor of air and water quality measures. Their voting history and political affiliations indicate that Hermosa Beach's residents are profiled as socially liberal but economically conservative.

Table 2: Hermosa Beach Election Results

Election	Voting For	Democrat Votes	Republican Votes	Local Electorate	State Electorate	National Electorate
2012 (Nov) General Election	President	5795	4248	57% Democrat	60.24% Democrat	51.07% Democrat
2008 (Nov) General Election	President	7054	4094	63.3% Democrat	61.01% Democrat	52.93% Democrat

Table 3: Hermosa Beach Proposition/Measures Results

Election	Proposition/ Measure	Description	Votes in Favor	Votes Against	Hermosa Beach Results	Electorate-wide Results	Difference
2012 (Nov) General Election	Proposition 37	Mandatory labeling of genetically engineered food	4842	5088	51.2% against	51.4% against	-0.2%
2012 (June) Election	Measure L	10% landfill tax in Los Angeles County	2204	1044	67.9% in favor	63.1% in favor	+4.8%
2010 (Nov) General Election	Proposition 23	Suspends AB32	2567	5222	67% against	61.6% against	+5.4%

[23] Los Angeles County Recorder Registrar County Clerk. (n.d.). Statement of Votes Cast Election Results. Retrieved from http://www.lavote.net/.

[24] Los Angeles County Recorder Registrar County Clerk. (n.d.). Statement of Votes Cast Election Results. Retrieved from http://www.lavote.net/.

2008 (Nov) General Election	Measure R	$.50 sales tax for financing new transportation projects	7042	3283	68.2% in favor	67.9%	+0.3%
2006 (Nov) General Election	Proposition 84	Flood control and water quality	2635	2080	56% in favor	53.8% in favor	+2.2%
2006 (Nov) General Election	Proposition 1B	Relieve congestion, improve the movement of goods, improve air quality, and enhance the safety and security of the transportation system	3040	1748	63.5% in favor	61.4% in favor	+2.1%

2. Culture

Figure 2 (right): List of common tags from Easy Reader News

There are several local news and media sites that are popular among its residents, including the Easy Reader, The Beach Reporter, Patch, and the Daily Breeze. All four news sources emphasize beach life, surfing, and dining and entertainment, indicating what Hermosa Beach residents —and the large visitor population--- are perceived to be most interested in. In fact, the featured categories on the Easy Reader include News, Sports, Surfing, Dining, and Entertainment, and the list of common tags indicate that the beach and its corresponding beach culture are commonly talked about.

Hermosa Beach is very much an outdoor recreation-focused city. There are no fewer than twenty parks located within the city borders, and the city hosts a number of outdoor events throughout the year, including live music concerts, weekend festivals, farmer's markets, triathlons, and various beach-

related competitions. Common favorite activities within the community include surfing, volleyball, surfboarding, skateboarding, biking, and boogie boarding.[25]

Just like the beach culture, environmentalism and sustainability are already a huge part of the city's identity. According to the city's Sustainability Overview, Hermosa Beach "strives to be a leader in sustainability," and it has already taken steps towards this title. Hermosa Beach was one of the first cities to join the "Cool Cities" initiative, which works to stop global warming by switching to clean energy and making buildings more efficient. [26] Most importantly, it has dedicated itself to becoming carbon neutral and is working on an actionable path. Hermosa Beach currently has the opportunity to expand on its already existing identity by becoming the first carbon neutral city in the area, making its name synonymous with sustainability and becoming a leader in addressing climate change.

Hermosa Beach's unique culture can help it achieve its ambitious greenhouse gas goals. Being a coastal city, its residents may be more likely to understand the need for action, and the pride in achieving carbon neutrality first can also spark their competitive nature and lead to greater acceptance of change. The city is also less likely to see widespread resistance of many of their policies if the consequences of inaction are stressed. Changes in global temperature and sea level rises directly affect many municipal lands, including by changing the geography of the city.[27] As a result, there is a greater motivation for local governments to pass environmental legislation, because the local communities feel the effects that greenhouse gases have on the climate and the local region more strongly.[28] For Hermosa Beach in particular, the fact that it is a coastal city puts even more emphasis on immediate action. Not only should Hermosa Beach be aware of the effects of

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[25] City of Hermosa Beach. (2013b). About Us. Retrieved from http://www.hermosabch.org/index.aspx?page=2.

[26] Hermosa Beach: A Leader in Sustainability. (2011). Retrieved from http://www.hermosabch.org/modules/showdocument.aspx?documentid=680.

[27] Byrne, J., Hughes, K., Rickerson, W., & Kurdgelashvili, L. (2007). American policy conflict in the greenhouse: Divergent trends in federal, regional, state, and local green energy and climate change policy. Energy Policy, 35(9), 4555–4573.

[28] Byrne, J., Hughes, K., Rickerson, W., & Kurdgelashvili, L. (2007). American policy conflict in the greenhouse: Divergent trends in federal, regional, state, and local green energy and climate change policy. Energy Policy, 35(9), 4555–4573.

carbon emissions on sea level rise, but they should also be aware of the risk of ocean acidification. As more greenhouse gases are emitted into the atmosphere, more carbon is sequestered in the ocean, making it more acidic. This can have many effects on the ocean's ecosystem and the coastal community. Since some of Hermosa Beach's and the South Bay's residents enjoy fishing, ocean acidification could have a devastating impact on the local fishing community. The rising temperatures and sea levels caused by greenhouse gas emissions may have other significant effects that could also affect Hermosa Beach's culture and its identity as a beach city.

3. Education

Hermosa Beach is home to two elementary schools, Hermosa View Elementary and Hermosa Valley Elementary, as well as a Catholic school, Our Lady of Guadalupe. As of 2012, 1,278 students were enrolled in the public schools in Hermosa Beach.[29] The two high schools that Hermosa Beach teens attend are in Redondo Beach and Manhattan Beach. The Hermosa Beach Education Foundation is a volunteer organization made of community members who raise money for student programs, including programs related to art, science, and physical education.

Education is a huge factor in people's willingness to accept and make changes regarding climate change. Many people resist action because of a so-called "lack of literacy with regard to environmental issues," something that has been confirmed each year by the National Report Card on Environmental Knowledge, Attitudes and Behaviors.[30] People do not understand the issue of increasing greenhouse gases well enough to tackle it, either by not knowing the extent of the problem or by not knowing what to do about it.[31] If people do not understand the issue and how to address it, they will not want to change.

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[29] City of Hermosa Beach. (2013a). City Facts. Retrieved from http://www.hermosabch.org/index.aspx?page=47.

[30] Hoffman, A. J. (2010). Climate change as a cultural and behavioral issue. Organizational Dynamics, 39(4), 295–305.

[31] Gifford, R. (2011). The dragons of inaction: psychological barriers that limit climate change mitigation and adaptation. The American psychologist, 66(4), 290–302.

Educating the public on the issue and its solutions is a crucial step to successfully raise community awareness of climate change impacts and possible local policy solutions. The more people understand the issue and the context for policy, the more willing they may be to alter behavior in support of climate goals. Therefore, educating the community and the people in each sector of the community should be one of the first steps in making community changes regarding emission levels. Whether through K-14 school programs that inform students about various steps they could take to reduce emissions, or through technical education programs that educate builders and contractors about new green construction and building efficiency measures that will help improve the community's ability to retrofit its buildings, education should be a priority of the city.

4. Major Businesses

According to Hermosa Beach's 2012 Comprehensive Annual Financial Report, the three principal employers within the city borders are 24 Hour Fitness, with 171 employees, the City of Hermosa Beach with 116 employees, and Ralphs Grocery with 101 employees.[32] Although there are a number of small businesses within Hermosa Beach, there are no large corporations that have a headquarters within the city limits. As a result, there are no major businesses with control over a significant amount of emissions that need to be regulated. Small businesses, however, can still have an impact on emissions, and the city council is likely to have a greater amount of influence over their practices.

5. Political System

5.1 Hermosa Beach Organizational Structure

Hermosa Beach is a general law city, which means that the city is organized under California's general laws rather than its own charter. General law cities are restricted to governmental structures and powers that are granted by California state law.[33] Legislative power is given to a five-member

[32] City of Hermosa Beach Finance Department. (2012). Comprehensive Annual Financial Report.

[33] League of Women Voters of California. (2009). *About Municipal Government.* Sacramento, CA: California State Government Guide to Government. Retrieved from http://www.guidetogov.org/ca/state/overview/municipal.html.

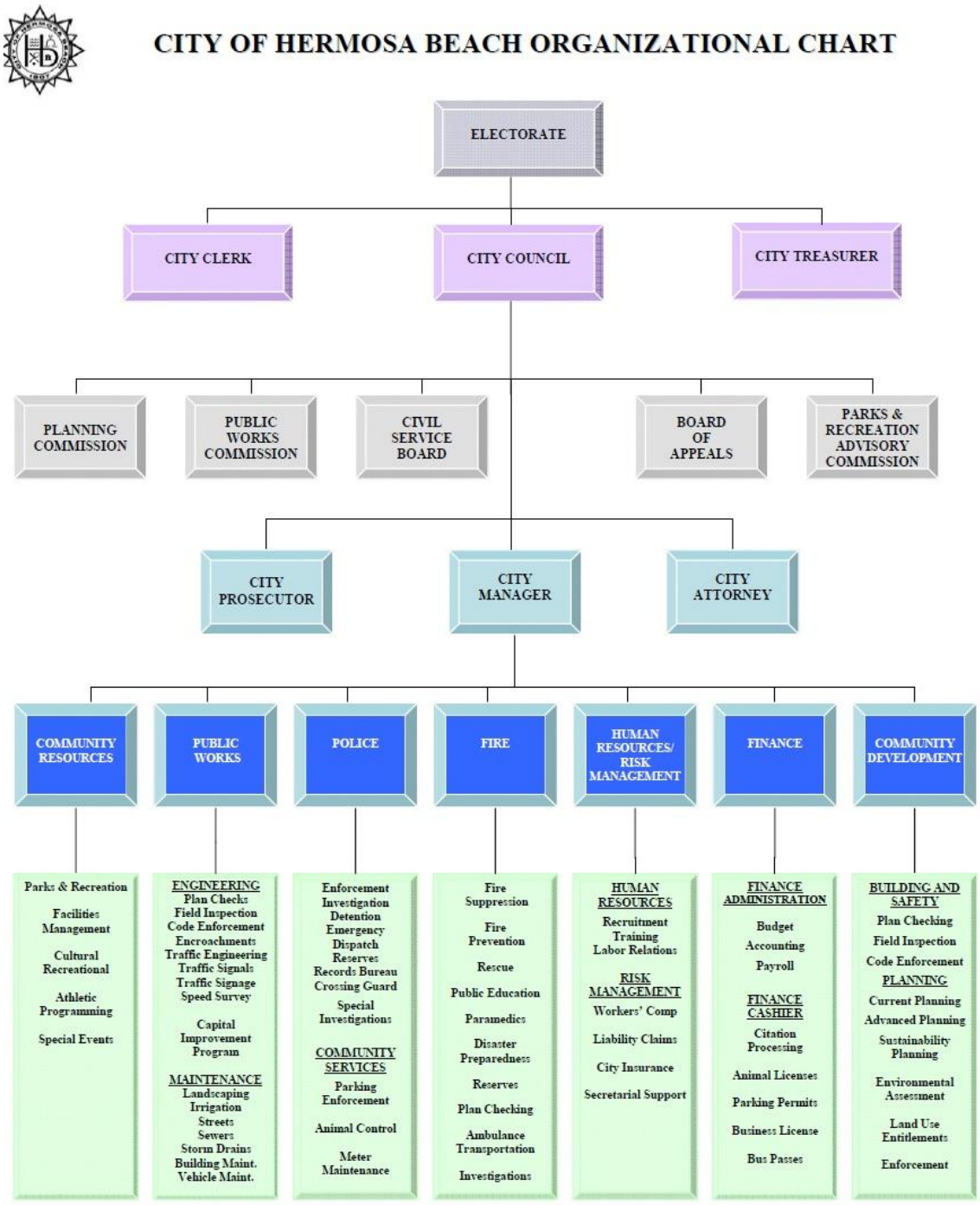
City Council that is elected every two years for four year staggered terms. Hermosa Beach's Mayor is elected from this council by the other members to serve for nine months, while another councilmember is chosen to serve as the Mayor Pro Templore. The council is primarily responsible for creating and passing policies, establishing annual budgets, and appointing or hiring members to multiple positions in the city government, including the City Manager, City Prosecutor, and City Attorney. Underneath the City Council, there are six administrative boards: Planning Commission, Public Works Commission, Civil Service Board, Board of Appeals, Emergency Preparedness Advisory Commission, and the Parks and Recreation Advisory Commission. Other committees are appointed from time to time such as the Pacific Coast Highway/Aviation Boulevard Improvement Commission and an ad hoc Green Task Force, which completed its term and has not been reappointed. The other two elected officials outside of the City Council are the City Clerk and the City Treasurer.

The City Manager is responsible for implementing policies enacted by the City Council and overseeing departmental operations. The departments that the City Manager is responsible for are Community Resources, Public Works, Police, Fire, Human Resources / Risk Management, Finance, and Community Development. Each of these departments is responsible for sub-departments and particular policies. The Community Resources department manages parks and recreation, facilities, cultural, recreational, and athletic programming, and special events. Public Works is divided into two sectors. The first section, Engineering, covers plan checks, field inspections, code enforcement, encroachments, traffic engineering, traffic signals, speed survey, capital, and improvement programs. The second section, Maintenance, covers landscaping, irrigation, streets, sewers, storm drains, building maintenance, and vehicle maintenance. The Police Department is responsible for law enforcement, investigation, detention, emergency, dispatch, reserves, records, crossing guard, and special investigations. Within the Police Department, there is a special division that covers community services, such as parking enforcement, animal control, and meter maintenance. The Fire Department covers fire suppression, fire prevention, rescue, public education, paramedics, disaster preparedness, reserves, plan checking, ambulance transportation, and investigations. Human Resources is responsible for recruitment, training, and labor relations; Risk Management oversees workers' compensation, liability claims, city insurance, and secretarial support. The Finance Department's first division, Finance Administration, is responsible for budget, accounting, and

payroll. The second division, Finance Cashier, is responsible for citation processing, animal licenses, parking permits, business licenses, and bus passes. The last department, Community Development, is responsible for two separate sectors as well. The first, Building and Safety, covers plan checking, field inspection, and code enforcement. The second, Planning, covers current planning, advanced planning, sustainability planning, environmental assessment, land use entitlements, other special projects. Figure 2 shows Hermosa Beach's Organizational Chart.[34]

[34] City of Hermosa Beach Finance Department. (2012). Comprehensive Annual Financial Report.

Figure 3: City of Hermosa Beach Organizational Chart



Even though all of these departments seem to have vastly different tasks they are individually responsible, Hermosa Beach's goal for carbon neutrality will need a full cooperation of all departments. The implementation measures that will be discussed later are designed for both

municipal and community carbon neutrality, and all departments will be affected. While the planning and public works departments will be covering the enforcement and sustainability planning of Hermosa Beach, all departments will have to work together to ensure that Hermosa Beach achieves its goal. Cooperation with all entities that have a stake in Hermosa Beach's carbon neutrality is crucial. Hermosa Beach will need to work with and gain support from special districts, local governments, and private actors around it.

5.2 Major Actors

Hermosa Beach enlists help from multiple entities for its municipal services, such as solid waste, water, electricity, gas, and transportation. Table 4 shows the major actors that are responsible for these tasks.

Table 4: Major Actors for Services in Hermosa Beach, CA.

Service	Actors
Solid Waste	Athens Services (starting July 1, 2013) City of Los Angeles Bureau of Sanitation (Hazardous Waste) Los Angeles Department of Beaches and Harbors (assist with beach clean-up)
Water	California Water Services Company (water retailer) West Basin Municipal Water District (water wholesaler)
Electricity	Southern California Edison
Gas	Southern California Gas Company
Transportation	Beach Cities Transit Metropolitan Transportation Authority

Hermosa Beach's refuse and recycling services are completed by two different companies based on the type of waste. Solid waste services are provided by Athens Services.[35] Starting July 1, 2013, Hermosa Beach is terminating its contract with Consolidated Disposal Service which provided services since 2001. Following a competitive bidding process, and incorporating recommendations from Hermosa Beach's Green Task Force, the City Council decided to transition to Athens Services

[35] Athens Services. (2013). *City of Hermosa Beach*. Retrieved from http://www.athensservices.com/HermosaBeach.htm.

and employed a new "pay as you throw" residential service to support the city's environmental and carbon neutral goals. Athens Services' contract requires a guaranteed 50% landfill diversion, which will represent almost a twofold increase from the 26% diversion rate achieved by Consolidated Disposal Service. The rate for waste collection will be based on the volume that is disposed of by all customers, thus encouraging diligent recycling, which would be a free service for residential customers and increased awareness of the waste stream. The waste stream collected from commercial and multi-family customers (typically 5 or more units or apartments) will largely be co-mingled and separated at a material recovery facility, unless customers prefer to source separate on a case-by-case basis.

Hermosa Beach uses Hyperion Treatment Plant for hazardous waste collection and wastewater treatment. The city also uses the Hyperion S.A.F.E. centers for hazardous waste disposal for residents to drop off paint, solvents, motor oils, and electronic waste. The Hyperion Treatment Plant services the entire city of Los Angeles and extra contract cities. They provide full secondary treatment, biosolids handling, and biogas generation.[36] Hyperion Treatment Plant has been lauded with many environmental honors and achievements over the years, such as California Water Pollution Safety Awards and the United States Environmental protection Agency's National Special Clean Water Act Recognition Award.

Hermosa Beach's water is served by the California Water Services Company, or Cal Water. Cal Water has serviced Hermosa Beach since 1926. The company's 2010 Urban Water Management Plan uses multiple water management tools to optimize water resource management for the entire district. The plan includes hydraulic models for water distribution networks, GIS to understand the growth and constraints on land development and water use, and groundwater level monitoring to track fluctuations over time.[37] Cal Water includes many rebates and tips to help residents and

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[36] Los Angeles Sewers. (2011). *Hyperion Treatment Plants*. Los Angeles, CA: Department of Public Works. Retrieved from http://www.lasewers.org/treatment_plants/about/index.htm.

[37] California Water Service Company. (2011). *2010 Urban Water Management Plan: Hermosa-Redondo District*. Commerce, CA: California Water Service Company. Retrieved from

businesses become more conservative with their water usage. They also offer free conservation kits and cash back services for water-saving household devices. Cal Water has multiple pages that are designed for children to teach them about water conservation.[38]

The West Basin Municipal Water District provides water supply management for Hermosa Beach. It combines education, conservation, recycling, and desalination programs for much of Southwest Los Angeles. West Basin purchases imported water from the Metropolitan Water District of Southern California.[39] They then wholesale the water to cities and companies throughout their jurisdiction.

Southern California Edison is an investor-owned utility that provides electricity for Hermosa Beach and millions of other customers in Southern California. Southern California Edison's influence in Hermosa Beach covers nearly all municipal and community operations. The company is committed helping residents, businesses, and other entities take a step towards cleaner energy. Southern California Edison's website provides multiple pages with tips to make your household or building more energy efficient.[40] On top of tips, they also provide lists of savings, incentives, and rebates that are available to any Edison customer. These lists will allow customers to save money on any new installations or energy upgrades.

Southern California Gas Company is the provider for natural gas to Hermosa Beach. Much like Southern California Edison, Southern California Gas Company provides sustainability tips to its customers. They also promote conservation tips and other plans to help its customers cut back on gas bills. Southern California Gas Company promotes energy efficiency and green contractor

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http://www.calwater.com/your_district/uwmp/rd/Hermosa-Redondo/2010_Urban_Water_Management_Plan_(HR).pdf.

[38] California Water Service Company. (2012). *Water Conservation Report: Hermosa-Redondo District*. Commerce, CA: California Water Services Company. Retrieved from https://www.calwater.com/conservation/update/2011/2011_update_hr.pdf.

[39] West Basin Municipal Water District. (2011). *About West Basin*. Carson, CA: West Basin Municipal Water District. Retrieved from http://www.westbasin.org/about-west-basin.

[40] Southern California Edison. (2013). *Welcome to our Home Energy Guide.* Rosemead, CA: Southern California Edison. Retrieved from https://www.sce.com/wps/portal/home/residential/home-energy-guide/.

programs to provide resources for its customers.[41] The green programs make up at least 20% of the company's energy-efficiency program portfolio; the percentage increases as more technological advancements are researched and added to Southern California Gas Company's resources.

Beach Cities Transit and Los Angeles County Metropolitan Transportation Authority serve Hermosa Beach with public transportation. The Beach Cities Transit bus system serves Redondo Beach, Hermosa Beach, Manhattan Beach, and El Segundo. There are currently two lines, the 102 and 109, that are in service. The 102 starts at the Redondo Beach Station on the Los Angeles Metro Green Line light metro rail. The route goes south through Redondo Beach and ends at a transfer station at the Redondo Beach pier. The 109 serves a much larger area with more potential transfers for Hermosa Beach, Manhattan Beach, and El Segundo. The route ends at the LAX City Bus Center.[42]

The Los Angeles County Metropolitan Transportation Authority, or LACMTA, is the Metro system that runs throughout Los Angeles County. The only Metro line that is located near Hermosa Beach is the Green Line, which is a light rail that runs between Redondo Beach and Norwalk. This Metro line also provides indirect access to LAX from a shuttle bus. Metro is currently working on a South Bay Green Line Extension that will reach the Torrance Regional Transit Center with either an elevated light-rail extension or an extension over existing tracks. The project will be funded by Measure R, which will be described later in the report.

South Bay City Council of Governments

The South Bay Cities Council of Governments, or SBCCOG, is a joint power authority of 16 cities and Los Angeles County. SBCCOG consists of Carson, El Segundo, Gardena, Hawthorne, Hermosa Beach, Inglewood, Lawndale, Lomita, Manhattan Beach, Palos Verdes Estates, Ranchos Palos Verdes,

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[41] Southern California Gas Company. (2013). *Energy-Efficiency Contractor Programs*. Los Angeles, CA: Sempra Energy Utility. Retrieved from http://www.socalgas.com/for-your-business/energy-efficiency-programs/.

[42] Welcome to the City of Redondo Beach, California. (2012). *Beach Cities Transit*. Redondo Beach, CA: City of Redondo Beach. Retrieved from http://www.redondo.org/depts/recreation/transit/beach_cities_transit/default.asp.

Redondo Beach, Rolling Hills, Rolling Hills Estates, Torrance, Harbor City/San Pedro communities of Los Angeles, and County of Los Angeles District 2 and 4. The main goal of the SBCCOG is to maximize the quality of life and productivity of these areas.[43] SBCCOG aims to promote cooperation between all of the areas covered under area-wide issues of mutual interest, seek solutions to common issues, provide a forum of communication and representation for residents of the South Bay, and increase awareness of the South Bay as a suitable destination for live, work, and play.

The SBCCOG is primarily governed by a Board of Directors which meets once a month to discuss issues that cover a wide spectrum of topics. The Board consists of elected officials from each one of the cities represented in the SBCCOG. The cities appoint their officials and one alternate official to be on the Board. SBCCOG also has an Economic Development Directors' Roundtable Group which strives to promote the South Bay and attract visitors and jobs to the area. The Infrastructure Working Group focuses on public works projects for the South Bay, such as transportation, storm water, and infrastructure maintenance. The Measure R South Bay Highway Program (SBHP) Oversight Committee oversees and provides policy recommendations for Measure R, a 30-year, $906 million project to improve South Bay streets, highways, and freeways.[44]

In 2008, the South Bay Cities Council of Governments created a regional Climate Action Plan project in response to many individual member cities that were unable to create an action plan on their own. The SBCCOG worked with each of the cities to collect and aggregate data per city to create emissions inventories for the government and community. After establishing municipal and community inventories for the cities, the SBCCOG created several climate action planning workshops to train residents and council members on how to create climate action plans, including resource conservation and energy efficiency methods. The SBCCOG also provides multiple resources online

[43] South Bay Cities Council of Governments. (2013). *About Us*. Torrance, CA: South Bay Cities Council of Governments. Retrieved from http://www.southbaycities.org/node/2.

[44] South Bay Cities Council of Governments. (2013). *Board, Committee, and Working Groups*. Torrance, CA: South Bay Cities Council of Governments. Retrieved from http://www.southbaycities.org/groups.

for other cities to use to develop carbon reduction strategies, such as ICLEI's Best Practices for Climate Protection or the Local Government Operations Protocol.

South Bay Environmental Services Center

The South Bay Environmental Services Center, or SBESC, is a program of the South Bay Council of Governments. The SBESC is partnered with Southern California Gas Company, Southern California Edison, West Basin Municipal Water District, City of Torrance, Sanitation Districts of Los Angeles County, Los Angeles Metropolitan Transportation Authority (Metro), and County of Los Angeles. The SBESC strives to aid entities in achieving resource efficiency and conservation. They serve cities, schools, businesses, districts, and residents throughout the South Bay. The SBESC often acts as a liaison between different partner services, such as energy efficiency or conservation programs, and the constituents living in the serviceable areas.

The South Bay Environmental Services Center aids cities with climate action planning to reduce emissions, improve air quality, and implement strategies to becoming minimal emitters. The Center holds educational and training workshops to train residents, businesses, and other agencies on sustainable methods. The SBESC also does community outreach at multiple events throughout the South Bay to teach attendees about sustainability and rebates. There are multiple call centers that focus on energy efficiency upgrades, clean energy implementation, Metro's vanpool program, and ExpressLanes.[45]

The South Bay Environmental Services Center consists of multiple programs that are available on their website. Some residential programs that are readily available are rebates that can be applied to resident's housing for energy efficiency. The SBESC lists rebates for refrigerator recycling, tankless water heaters, air conditioning tune-ups, and other ENERGY STAR-approved appliances. For businesses, there are rebates for gas and computer management. The Center offers tips and

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[45] South Bay Environmental Services Center. (2012). *Saving Water, Energy, Money and the Environment.* Torrance, CA: South Bay Cities Council of Governments. Retrieved from http://www.sbesc.com/files/flyer/2013-MM-What_We_Do_Brochure.pdf.

programs for vanpools and commercial water rebates as well. The SBESC has a specific program for green building called the Gateways to Green Building Pre-Apprenticeship Program. The program trains residents or business owners for green opportunities, such as understanding the U.S. LEED Certification levels, basic construction, and green contracting. Residents can learn how to be building retrofit technicians or sustainable development technicians. Contractors and suppliers will learn how to audit buildings and apply retrofits in the most energy efficient ways possible. The SBESC has provided a list of green contractors and vendors on their website to supplement their Green Building Program. The SBESC also lists incentives and programs specifically for electric vehicles and solar installation.

Green Task Force

In 2009, Hermosa Beach's City Council appointed nine residents to the Green Task Force. The Green Task Force is dedicated to advising the Council on green initiatives and sustainability issues. From 2009 to 2011, the Green Task Force created a Sustainability Plan for Hermosa Beach, with matrices of goals and actions and many other programs that have been instituted and successful in greening Hermosa Beach. The City Council then chose to extend the Green Task Force through 2013 in order to achieve carbon neutrality in Hermosa Beach. The Task Force now works on sustainable private and public transportation, waste reduction, sustainable community design, resource conservation, and maintaining a pristine marine environment. Aside from these programs, the Green Task Force also seeks to promote sustainability education throughout the city and community.

In June 2011, Hermosa Beach's Green Task Force presented a Sustainability Plan that acted as a framework for climate action planning based on the greenhouse gas emissions for Hermosa Beach from the emissions inventories for both the community and municipal operations conducted in 2007.[46] The Sustainability Plan will be referenced throughout the rest of this report.

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[46] City of Hermosa Beach (2013). *Welcome to the Hermosa Beach Green Webpage.* Hermosa Beach, CA: City of Hermosa Beach. Retrieved from http://www.hermosabch.org/index.aspx?page=499.

5.3 Related Plans and Policies

AB32

The California Global Warming Solutions Act of 2006, or AB 32, requires that California reduce greenhouse gas emissions to 1990 levels by 2020. The Climate Change Scoping Plan is a comprehensive program to help to bring California towards a clean energy future through the use of multiple key strategies. One strategy is the cap-and-trade program, which will create a limit, or cap, on statewide greenhouse gas emissions, thus prohibiting the total emissions from rising over a determined level. Electricity and energy efficiency standards will also be improved to decrease the stress of rising demand on the grid. There are also goals to increase the amount of renewable electricity and transportation fuels in the energy profile. Identifying and eliminating the high global warming potential gases, such as refrigerants and sulfur hexafluoride, are also key in reducing global warming. The Department of Resources Recycling and Recovery will aim to reduce methane from landfills and move California towards high recycling and zero waste habits.[47] Under the Sustainable Communities and Climate Protection Act of 2008, or Senate Bill 375, the Air Resources Board will create a road map to implement AB 32 that will focus on transportation and land use strategies.

California Coastal Commission / Hermosa Beach's Coastal Plan

After the Coastal Initiative formed the California Coastal Commission in 1972, Hermosa Beach began to develop a coastal plan to focus on access, parking, housing, recreation, amenities, and future development. The city's Coastal Plan aims to provide adequate residential, visitor and shopper parking, allow easy access to and for merchants, maximize safety and accessibility to areas of interest, minimize traffic congestion and negative visual impacts, and allow for equitable distribution and allocation of parking.

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[47] California Environmental Protection Agency Air Resources Board. (2008). *California's Climate Plan.* Sacramento, CA: Office of Communications. Retrieved from http://www.arb.ca.gov/cc/cleanenergy/clean_fs2.htm.

For housing, the city had its top priority as maintaining a mix of low, moderate, and high density residential housing within Hermosa Beach. The city provides financial incentives for housing maintenance and rehabilitation rather than creating newer housing. The Coastal Plan also preserves and conserves coastal development and design. Hermosa Beach's commitment to serving its visitors and residents can be seen in their goal to maintain and preserve its beach environment and culture. This will ensure the promotion of the beach culture that Hermosa Beach treasures. The city also restricts building heights to preserve its low-rise profile.[48]

5.4 Non-Governmental Organizations

There are a number of non-governmental and community organizations that may be able to work with the city of Hermosa Beach to better achieve their goal of carbon neutrality. The International Council for Local Environmental Initiatives (ICLEI), Climate Resolve, and the LA Regional Collaborative for Climate Action and Sustainability (LARC) can all have a role in support of Hermosa Beach's environmental goals.

One issue that could arise when Hermosa Beach pursues sustainable policies and induces behavioral change is difficulty in establishing these policies in the first place. Changing community behavior can be the first step in instituting change. This change can begin by inducing voluntary action, which can later be followed by making the actions mandatory once a majority of people are doing it. As non-governmental organizations, they can have a lead role in inducing voluntarily behavioral change in assisting the city to become carbon neutral. In addition, working with these organizations would set a precedent for further collaboration, and provide additional assistance in achieving Hermosa Beach's carbon neutrality goal.

ICLEI

The International Council for Local Environmental Initiatives is a worldwide network of cities dedicated to sustainability. As a member of ICLEI USA, Hermosa Beach has committed itself to

[48] City of Hermosa Beach. (1981). *Local Coastal Plan*. Hermosa Beach, CA: City Council of the City of Hermosa Beach. Retrieved from http://www.hermosabch.org/modules/showdocument.aspx?documentid=729.

promote sustainability and pursue sustainable development. Hermosa Beach can further access many of the tools and resources they offer to assist in reaching their carbon neutrality goal. ICLEI has a program dedicated to low-carbon or carbon-neutral cities, and directs members towards a number of useful resources for reaching carbon-related goals.[49] For example, the carbon Cities Climate Registry (cCCR) is a registry that allows cities to register and report on their emission inventories, promoting transparency and allowing cities to show off their progress.[50] This is another way that Hermosa Beach could demonstrate their progress towards carbon neutrality and gain support from their community and other communities with like-minded goals.

Climate Resolve

Climate Resolve is a non-governmental organization in Los Angeles that is dedicated to informing the public about the dangers of climate change and encouraging local government and community action. Their affiliated scientists are responsible for researching topics related to climate change and creating feasible solutions to mitigate the effects of emissions. Although Climate Resolve is centered in Los Angeles, they collaborate with different communities and governments. It may be possible for Hermosa Beach to collaborate with them to inform the residents about the importance of action addressing climate change and the pressing need for immediate action.

LARC

Climate Resolve helped found the Los Angeles Regional Collaborative for Climate Action and Sustainability (LARC), a regional network that allows members to come together and build sustainable communities through local changes and measures.[51] They also provide a number of resources that Hermosa Beach could take advantage of. For example, their C-Change site, a partnership between LARC and Climate Resolve, lists ideas for residential action in a range of different sectors, including energy (both efficiency and renewables), landscaping, and water

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[49] More information can be found at http://www.iclei.org/our-activities/our-agendas/low-carbon-city.html.

[50] More information can be found at http://citiesclimateregistry.org/about-the-registry/.

[51] More information can be found at http://www.environment.ucla.edu/larc/.

conservation.[52] The South Bay Cities Council of Governments is a member of LARC, and therefore has the opportunity to further collaborate with them and connect their community with others who have similar goals, in order to exchange ideas and determine the best method for action together.

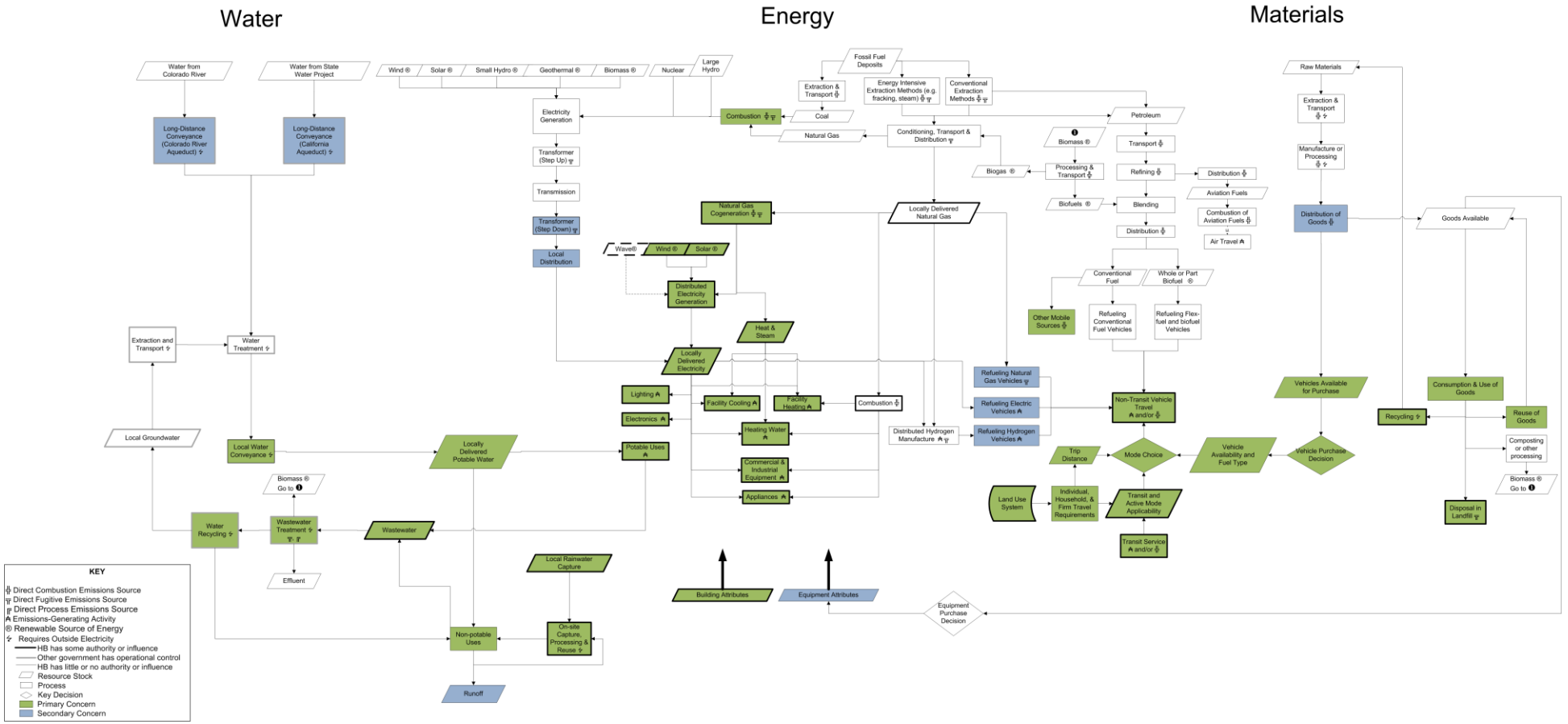
D. Overview of Boundaries and Scopes

1. Systems Based Assessment of Greenhouse Gas-Generating Activities and Sources

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. Figure 4 shows a Life Cycle diagram 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 combustion and fugitive emissions – which we refer to as emissions sources -- as well as processes that indirectly lead to greenhouse gas emissions -- which we refer to as emissions-generating activities. Emission generating sources directly release greenhouse gas into the atmosphere, where as emission generating activities indirectly release greenhouse gases into the atmosphere through an act that is powered by an emission source such as fossil fuel powered electricity. There is often overlap between emission-generating activities and sources. For example, the internal combustion within the engine of an automobile is an emissions source, because the direct combustion is generating greenhouse gasses. However, the emission-generating activity is the physical act of using the car, which is indirectly combusting fossil fuel to run. We can then use the premise of emission-generating sources and activities as a platform to look for alternatives and ways to mitigate greenhouse gas emissions from Hermosa Beach.

[52] More information can be found at http://climateresolve.org/larc/.

Figure 4: System Diagram of all emissions sources and activities associated with Hermosa Beach



In greenhouse gas accounting, emission boundaries establish dictate what emissions are and are not included in an inventory. Establishing boundaries also helps us identify the set of emissions, which Hermosa Beach may seek to neutralize. In identifying boundaries for Hermosa Beach, we consider how emissions and activities relate to Hermosa Beach's geographic boundaries, but also local jurisdiction's ability to influence such emissions or activities. We categorize processes into "sources" and "activities". Emission sources and emissions activities should be added separately in accounting emissions. If source and activity emissions are summed together, this can result in double counting of emissions.

We employ two different methodologies to assess greenhouse gas emissions from Hermosa Beach. For Hermosa Beach's emissions from city operations, we use the scopes, boundaries, and accounting principles from the Local Government Operations (LGO) Protocol, adopted by the California Air Resources Board, The Climate Registry, and other organizations. Legal and organizational structure of local governments and communities can vary. This being so, greenhouse gas emissions boundaries should be defined for each municipality prior to collecting data and developing an emissions inventory. This is crucial because there may be differences in emission-sources and emission-activities within various municipalities. For example, some communities provide wastewater services and operate ports, where as others do not. The LGO Protocol provides guidelines to assist local governments in quantifying and reporting greenhouse gas emissions associated with their government operations, from publicly-owned facilities and contracted services.[53] The LGO Protocol, a national standard guidebook, gives instructions on how to set boundaries, quantify emissions, and encourages cities that are performing inventories to follow the methods outlined.

[53] ICLEI Local Governments for Sustainability USA. (2012). U.S. Community Protocol for Accounting and Reporting of Greenhouse gas Emissions. General technical report. ICLEI - Local Governments for Sustainability USA, Oakland, California.

For municipal operations, emissions are categorized as scope 1, 2, or 3, as employed in the LGO Protocol. The scopes are based on geographical, temporal, activity, and life-cycle boundaries.[54] Scope 1 emissions are direct emissions from combustion within the inventory's boundary, including the geographic boundary or at 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 most commonly outside of the inventory's boundary.

Operation emissions come from activities within the city over which the city has operational control. The City of Hermosa Beach can be depicted as a hybrid between a company and a local government. The city itself has legal authority, being the local government, and also it has operational authority, as it owns buildings and parks, has headquarters, and a police and fire department. Therefore, the city can directly mitigate most of its operation emissions unlike community emissions, which is much more encompassing of all emission sources within the jurisdictional boundaries of the city. Scope 3 includes emissions from production and extraction of purchased materials and fuels, waste disposal, outsourced activities, etc. The city currently defines its operation scopes by what facilities and operations it owns or controls, as recommended by the Local Government Operations Protocol's operational approach for local governments. This approach makes it easier to separately account for direct and indirect emissions. Direct emissions are under city operational authority and are associated with the Scope 1 category. They can include emission from equipment used to produce heat or power within the city and from the combustion of fuel in vehicles used directly by the city.[55]

Indirect emissions, also known as Scope 2, are emissions that are not under direct control of the city. They can come from the consumption of purchased electricity, like electricity from SoCal Edison, steam, heating or cooling. Indirect emissions can also be associated with Scope 3, but Scope 3 emissions are usually related to activities that are not owned or operated by the city. Please refer to

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[54] Kennedy, S., & Sgouridis, S. (2011). Rigorous classification and carbon accounting principles for low and zero carbon cities. *Energy Policy, 39,* 5259–5268.

[55] Hermosa Beach Operations Inventory

the table in the existing municipal inventory to better understand the scopes for municipal operations.

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 greenhouse gas emissions, implementing policies, taking action and ensuring consistency. On February 4, 2012, the California State Governor's Office of Planning and Research (OPR) officially recommended that California local governments follow the Community Protocol when undertaking their greenhouse gas emissions inventories. The national standard will help communities develop high-quality greenhouse gas inventories, help reach target reduction goals, and continue the evolution of the new concept of climate planning.

The Community Protocol outlines a range of boundaries – or principles to discern which sources and activities should be reported as part of the community's inventory. A community inventory differs from an operation inventory in that the community inventory includes emissions from private firm, resident, and visitor activity throughout the entire city, not just government operations. Communities differ in their authority and ability to affect greenhouse gas emissions, which is why the protocol recommends that the local government consider the emissions sources and activities, which they can affect through policy or influence. We will address emissions from municipal operations separately from those from the community. The community wide emissions are categorized as "activities" or "sources" as specified in the U.S. Community Protocol. "Activities" are emissions that are based solely on the activity, even if the associated emissions are found outside of the geographic boundary. "Sources" are the emissions that are emitted within the geographic boundary of the community.

We label "activities" and "sources" 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 over. Source and activities are identified by primary and secondary concern depending on the influence the local government has over such concerns. Primary concerns will be those that the city has authority over,

and secondary concerns are those that the city would have a difficult time making any changes in, if at all. For example, local water conveyance and deliveries are an area of primary concern, where as long-distance energy intensive conveyance from outside the Los Angeles Basin is an area of secondary concern. Focusing on the components of that the city has direct influence over will be more efficient when trying to implement change as opposed to efforts in trying to change parts where the city has little or no authority. We will discuss our areas of primary and secondary concern in Part II of this Plan.

2. Current Community and Municipal Greenhouse Gas Inventories

Municipal Inventory

In 1990, Hermosa Beach's municipal operations generated 1,100 metric tons of CO2. The city used a total of 1,001,092 kWh of electricity, which costs approximately $105,990.[56] Table 5 shows a summary of the greenhouse gas emissions for 1990.

Table 5: Summary of 1990 Municipal Greenhouse Gas Emissions. [56]

Hermosa Beach Municipal GHG Emissions 1990						
Sector	MT CO_2e	Percent CO_2e (% CO_2e)	Source	Energy/Fuel Use	Energy/Fuel Use Cost	Energy Equivalent (MMBtu)
Scope 1 Emissions						
Buildings & Facilities						
Buildings & Facilities	1	0.1%	Natural Gas	115.56 therms	n/a	12
Total Scope 1 Emissions	**1**	**0.1%**	**-**	**115.56 therms**	**-**	**12**
Scope 2 Emissions						
Buildings & Facilities						
Buildings & Facilities	382	34.7%	Electricity	811,589 kWh	$ 83,596	2,770
Streetlights & Traffic Signals						
Traffic Signals/Controllers	29	2.6%	Electricity	61,858 kWh	$ 6,657	211
Streetlights[30]	2	0.2%	Electricity	3,364 kWh	$ 595	11
Other Outdoor Lighting[31]	58	5.3%	Electricity	122,600 kWh	$ 14,471	419
Water Delivery						
Sprinkler/Irrigation Control	0.4	0.0%	Electricity	127 kWh	$ 233	0
Lift Stations	0.6	0.1%	Electricity	1,554 kWh	$ 437	5
Total Scope 2 Emissions	**472**	**42.9%**	**-**	**1,001,092 kWh**	**$ 105,990**	**3,428**

[56] South Bay Cities Council of Governments. (2009). City of Hermosa Beach: Municipal Greenhouse gas Emissions Inventory Report.

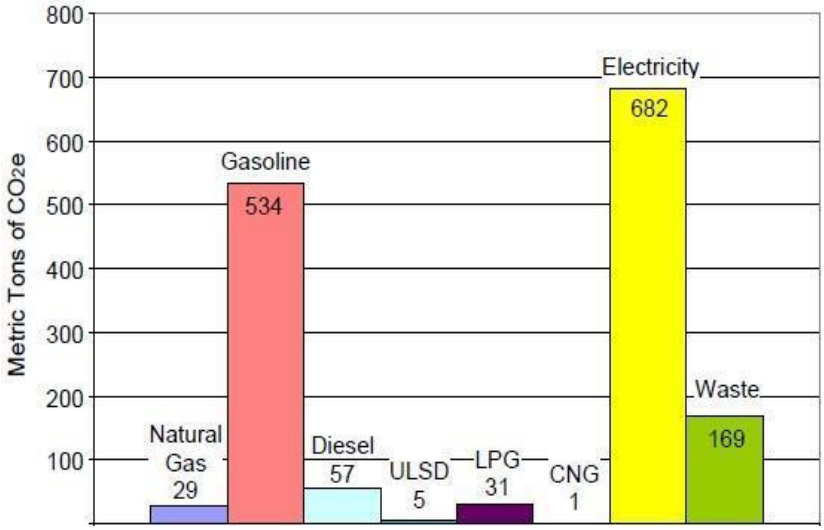
Hermosa Beach's municipal operations generated 1,508 metric tons of carbon dioxide (CO2) in 2005. Table 6 shows a summary of the municipal greenhouse gas emissions for the 2005 baseline. Hermosa Beach used a total of 2,242,628 kWh of electricity, which amounted to a total cost of $317,565. This total encompasses both Scope 1 and 2 emissions.

Table 6: Summary of 2005 Municipal Greenhouse Gas Emissions. [56]

Hermosa Beach Municipal GHG Emissions 2005						
Sector	**MT CO_2e**	**Percent CO_2e (% CO_2e)**	**Source**	**Energy/Fuel Use**	**Energy/Fuel Use Cost**	**Energy Equivalent (MMBtu)**
Scope 1 Emissions						
Buildings & Facilities						
Buildings & Facilities	29	1.9%	Natural Gas	5,383 therms	$ 4,039	538
City Vehicle Fleet						
City Vehicle Fleet[20]	**144**	**9.5%**				**1,984**
	117		Gasoline	12,664.62 gal	n/a	1,612
	26		Diesel	2,583.89 gal	n/a	358
	1		CNG	111.32 gal	n/a	14
Total Scope 1 Emissions	**173**	**11.4%**	**-**	**-**	**$ 4,039**	**2,522**
Scope 2 Emissions						
Buildings & Facilities						
Buildings & Facilities	272	18%	Electricity	895,746 kWh	$ 121,260	3,057
Streetlights & Traffic Signals						
Traffic Signals/Controllers	39	2.6%	Electricity	128,686 kWh	$ 13,720	439
Streetlights[21]	255	16.9%	Electricity	835,651 kWh	$ 126,152	2,852
Other Outdoor Lighting[22]	110	7.3%	Electricity	365,512 kWh	$ 53,223	1,238
Water Delivery						
Sprinkler/Irrigation Control	4	0.3%	Electricity	11,525 kWh	$ 2,044.70	39
Lift Stations	2	0.1%	Electricity	5,508 kWh	$ 1,165.58	19
Total Scope 2 Emissions	**682**	**45.2%**	**-**	**2,242,628 kWh**	**$ 317,565**	**7,644**

Figure 5 shows Hermosa Beach's municipal emissions by source: natural gas, gasoline, diesel, ultra-low-sulfur diesel (ULSD), liquefied petroleum gas (LPG), compressed natural gas (CNG), electricity, and waste. Electricity and gasoline are the two biggest sources of emissions for municipal operations.

Figure 5: Graph of 2005 municipal emissions by source.[56]



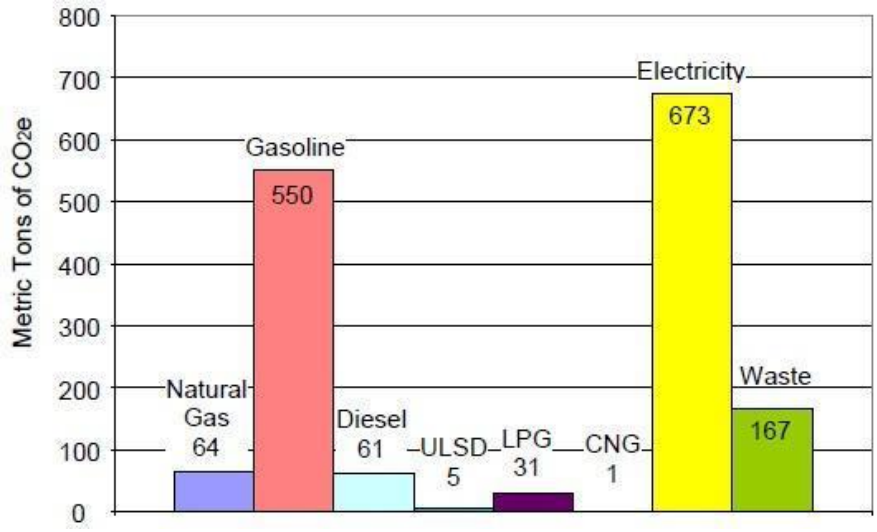
In 2007, Hermosa Beach's greenhouse gas emissions were at a total of 1,552 metric tons of CO2, which is a 2.9% increase from 2005. Table 7 shows a summary of the municipal greenhouse gas emissions for the 2007 interim year. The city used 2,294,368 kWh of electricity, which costs approximately $361,712.

Table 7: Summary of 2007 Municipal Greenhouse Gas Emissions.[56]

Hermosa Beach Municipal GHG Emissions 2007						
Sector	MT CO2e	Percent CO2e (% CO2e)	Source	Energy/Fuel Use	Energy/Fuel Use Cost	Energy Equivalent (MMBtu)
Scope 1 Emissions						
Buildings & Facilities						
Buildings & Facilities	64	4.1%	Natural Gas	11,977 therms	$ 9,515	1,198
City Vehicle Fleet						
City Vehicle Fleet[24]	**184**	**11.9%**				**2,536**
	157		Gasoline	17,406.1 gal	n/a	2,164
	26		Diesel	2,583.89 gal	n/a	358
	1		CNG	111.32 gal	n/a	14
Total Scope 1 Emissions	**248**	**16%**	**-**	**-**	**$ 9,515**	**3,734**
Scope 2 Emissions						
Buildings & Facilities						
Buildings & Facilities	273	17.6%	Electricity	932,207 kWh	$ 130,940	3,182
Streetlights & Traffic Signals						
Traffic Signals/Controllers	37	2.4%	Electricity	125,011 kWh	$ 14,720	427
Streetlights[25]	244	15.7%	Electricity	833,834 kWh	$ 153,937	2,846
Other Outdoor Lighting[26]	118	7.6%	Electricity	401,604 kWh	$ 60,914	1371
Water Delivery						
Sprinkler/Irrigation Control	0.7	0.0%	Electricity	255 kWh	$ 604	1
Lift Stations	0.3	0.0%	Electricity	1,457 kWh	$ 597	5
Total Scope 2 Emissions	**673**	**43.3%**	**-**	**2,294,368 kWh**	**$ 361,712**	**7,832**

Figure 6 shows the emissions by source for 2007. Gasoline and electricity are again the largest sources, but electricity consumption has decreased while gasoline consumption has increased.

Figure 6: Graph of 2007 municipal emissions by source.[56]



Community Inventory

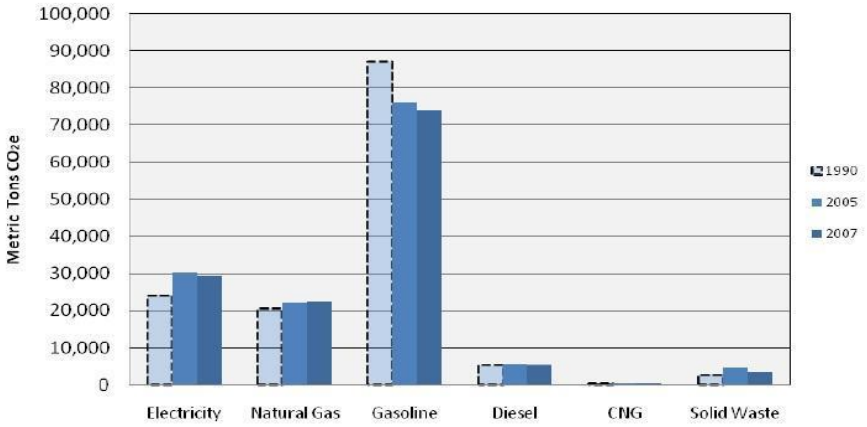
Community inventories are conducted to identify sources and look at carbon emitting activities in order to quantify emissions within the city's geographic boundary; these discoveries can be used to decrease specific sectors and their emissions. Table 8 shows Hermosa Beach's community emissions by source: electricity, natural gas, gasoline, diesel, compressed natural gas, and solid waste. Similar to Hermosa Beach's municipal inventory, electricity and gasoline comprise the largest share of emissions by source. In 1990, gasoline comprised of 63% of the total greenhouse gas emissions by source; by 2007, gasoline comprised of 55%. While gasoline saw decreases, natural gas saw increases throughout the years from 15% to 17%. Electricity also saw an increase from 17% in 1990 to 22% in 2007, but the absolute amount of emissions decreased from 2005 to 2007.

Table 8: Summary of 1990, 2005, and 2007 Community greenhouse gas emissions by source.[117]

Source	1990	Share of 1990 Total	2005	Share of 2005 Total	2007	Share of 2007 Total
Electricity	23,899 [6]	17%	30,253	22%	29,391	22%
Natural Gas	20,538	15%	21,993	16%	22,216	17%
Gasoline	87,153	63%	76,153	55%	73,916	55%
Diesel	5,272	4%	5,532	4%	5,467	4%
CNG	3	0%	6	0%	6	0%
Solid Waste	2,489	2%	4,525	3%	3,257	2%
Total	**139,354**	**100%**	**138,463**	**100%**	**134,253**	**100%**

Figure 7 shows Table 8 in a visual graph. It is clear that gasoline emissions decreased, and natural gas emissions increased. Diesel, compressed natural gas, and solid waste all remained relatively even from 1990 to 2007.

Figure 7: Graph of 1990, 2005, and 2007 Community greenhouse gas emissions by source.[117]



The community inventory analyzes emissions from five sectors: residential, commercial, industrial, transportation, and waste. The residential sector emissions are from natural gas and electricity use inside households. The commercial and industrial sectors are combined to consist of electricity, natural gas, and fuel. Transportation emissions are a result of the vehicle miles traveled (VMT) and based on the origin and final destination of any transportation within Hermosa Beach's boundary. The waste emissions are from any waste products that are generated within Hermosa Beach. Table 9

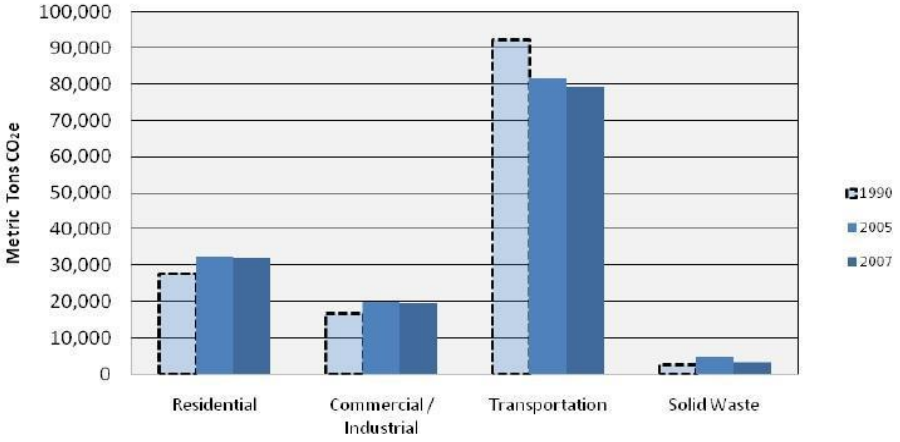
shows a breakdown of the community emissions inventory by sector and year.

Table 9: Table of community emissions inventory by year and sector.[117]

Sector	1990	Share of 1990 Total	2005	Share of 2005 Total	2007	Share of 2007 Total
Residential	27,604	20%	32,329	23%	31,970	24%
Commercial/Industrial	16,837	12%	19,923	14%	19,643	15%
Transportation	92,424	66%	81,686	59%	79,383	59%
Solid Waste	2,489	2%	4,525	3%	3,257	2%
Total	**139,354**	**100%**	**138,464**	**100%**	**134,253**	**100%**

Figure 8 shows Table 8 in a graph. In all three years, transportation covers the majority of the total for that inventory year. Transportation did see a major decrease from 1990 to 2007; other sectors saw an initial increase from 1990 to 2005, but a decrease from 2005 to 2007.

Figure 8: Graph of community emissions inventory by year and sector.



The residential sector is composed of only electricity and natural gas consumption. Single-family residences found a small decrease in natural gas, while multi-family residences found a small increase. The decline in natural gas emissions is largely due to a decrease in residences and population in Hermosa Beach from 2005 to 2007. In 2005, the industrial and commercial sectors produced 79% of their total emissions from electricity and 21% from natural gas. The emissions for

waste are measured from methane that decomposes in landfills. From 2007 to 2020, there will be a projected increase in all sectors. Residential will increase by 0.3%, commercial and industrial by 5%, transportation by 2%, and solid waste by 1%, thus resulting in a total change of 2%.

3. Implications of Operations and Community Boundary Choices

As depicted by the Life-Cycle Diagram, we considered sources and activities flowing in and out for the entire city system. We used the cradle-to-grave approach to determine which parts of the system generate more emissions compared to others and the significance of the emissions to the City of Hermosa Beach. Sources and activities were considered under the community emissions category, and scopes were considered under the operation category; this was done for both direct and indirect emissions. The cradle-to-grave approach gives a holistic picture of emissions for Hermosa Beach. However, for the purposes of this report, our analysis focuses mainly on downstream emissions that are within areas of direct control of Hermosa Beach.

After further investigation of local governance control over each sector displayed on the diagram, we classified emission sources and activities as primary concerns and secondary concerns. Primary concerns were determined by looking at how much influence the city has over areas of interest, the magnitude of potential reductions in the area, and if the resources needed for implementation measures are feasible at the city level. Secondary concerns include areas that require more resources and time, and are harder to change due to lack of control. According to these categorizations, we developed implementation measures for each part of the system in the LCA diagram.

Because of the direct governance over municipal emissions, the city will likely first focus on mitigating municipal emissions, and then continue on to community emissions of primary concern. The local jurisdiction has greater control over their municipal operation emissions than their community emissions; however, community emissions are 1000 times greater than municipal operation emissions. That being said, mitigating community emissions will call for more aggressive and increased efforts by the local jurisdiction. As the city makes progress toward emission reduction measures within the city's control, Hermosa Beach may want to look into tackling areas of secondary concern, and/or reducing emissions from other systems over which it may have less control, such as

further upstream lifecycle emissions, in order to accredit their claim to carbon neutrality. Hermosa Beach will likely seek further information and research about areas of secondary concern and other upstream life-cycle emissions as it makes progress toward its initial primary emission reduction goals. Due to the fact that the city currently has little or no control over a significant amount of lifecycle emissions, this analysis will be a continuous process as political will and technological advancements enable municipal governments with new mechanisms to account and reduce a greater percentage of lifecycle emissions.

PART II: Analysis of Emissions Conditions by Sector

A. Building Energy

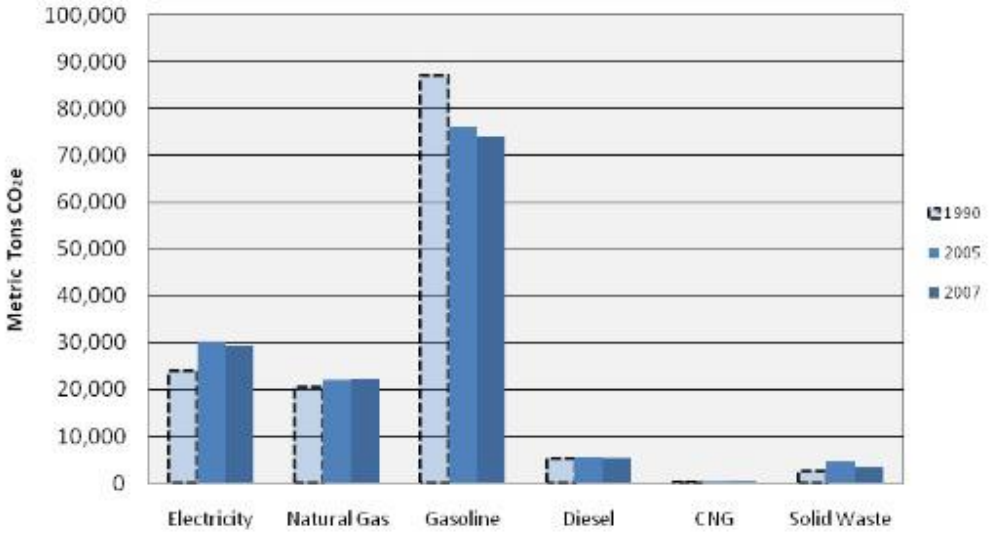
1. Electricity

The way our electricity is created depends on the source it is generated from. The conventional sources of electricity production are fossil fuels, such as coal and natural gas, which both produce a large amount of pollutants when burned. Renewable resources such as solar and wind have been used to produce electricity in the past, but they have not been able to compete with the low costs of fossil fuels. However, renewable sources of energy are now becoming increasingly feasible and affordable due to improvements in technology. California especially has been a leader in the green movement as they have worked to decrease fossil fuel usage and move towards renewable sources of energy.

Hermosa Beach has outlined their goal to utilize a greater amount of renewable energy in their 2011 Sustainability Plan.[57] Figure 9 demonstrates how electricity usage produces the second largest amount of emissions behind gasoline in Hermosa Beach. Though Figure 9 may show a slight reduction in electricity emissions since 2005, this does not equate to less electricity being consumed.**Error! Bookmark not defined.** In actuality, overall electric kilowatt-hour consumption has increased over the years, but Southern California Edison's emissions factor---the ratio of greenhouse gas emissions to delivered electricity---has decreased. This reduced emissions factor is a result of Southern California Edison improving the efficiency of their generating stations as well as increasing the use of both renewable sources and natural gas in electricity generation.

[57] Hermosa Beach Green Task Force. (June 2011) Sustainability Plan. Community Development Department. Retrieved from: http://hermosabeach.granicus.com/MetaViewer.php?meta_id=91625&view=&showpdf=1

Figure 9: Sources of Emissions in Hermosa Beach



Southern California Edison controls the production and distribution of electricity used in Hermosa Beach. Therefore, Hermosa Beach must consider what they can do locally in order to decrease the amount of emissions produced from electrical use. Though Hermosa Beach has already established renewable incentive programs and efficiency-focused building codes, much more can be done to move towards a sustainable and energy efficient future.

1.1 Environmental implications of electricity production and distribution

Specific emissions from electricity production vary depending on what sources and processes are used. Flue-gas emissions exit to the atmosphere via a flue and usually refer to emissions from fossil fuel combustion. Generally, flue-gas emissions from fossil fuel combustion are primarily comprised of uncombusted nitrogen (N_2), carbon dioxide (CO_2), water vapor (H_2O), and excess oxygen (O_2) along with trace amounts of particulate matter (PM), nitrogen oxides (NOx), sulfur dioxides (SOx), carbon monoxide (CO), and hydrocarbons (methane) among others. General combustion of fossil fuels can

also produce volatile organic compounds and heavy metals.[58] Flue-gas often receives treatment at power plants in order to remove pollutants before it is released into the atmosphere. However, the majority of these treatment techniques are focused on removal of nitrogen oxide emissions, sulfur dioxide, and particulate matter. Effective carbon dioxide treatment technologies are still under heavy investigation as carbon dioxide is both the second greatest constituent of flue-gas and the primary greenhouse gas emitted from anthropogenic activities. Electricity production accounts for the greatest release of carbon dioxide in the United States and the second highest release in California, with the combustion of coal producing the highest percentage of carbon dioxide in its emissions.[59] Other greenhouse gases from combustion include nitrous oxide, ozone, and methane. Nitrous oxide is considered much more hazardous than carbon dioxide, but is released in smaller amounts in flue-gas emissions. Pollution from the fossil fuel combustion can also have direct effects on humans such as lung cancer or asthma.

The use of renewables for electricity production has a very low impact on the environment compared to fossil fuels. Some concerns include the disruption of wildlife from wave and wind farms, land degradation and release of hazardous material from solar panels, and overall life cycle emissions release from product development.[60] The potential impacts of renewables may have to be reviewed as their production increases and their effects are applied over a larger scale, but overall the environmental impacts of renewable sources are much less than those of non-renewables.

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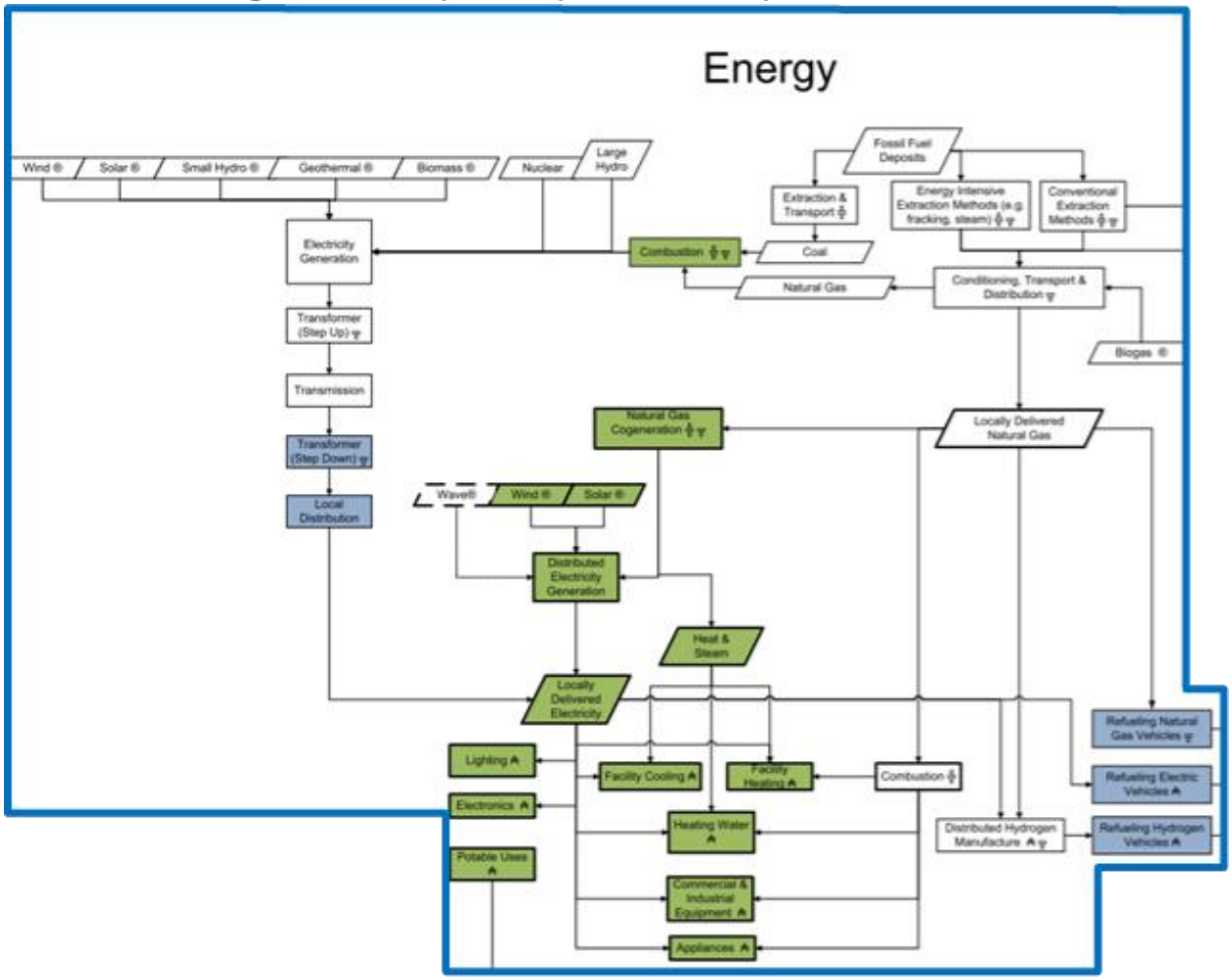
[58] ChemEngineering. (2013). Flue Gas. ChemEngineering, Tangient LLC. Retrieved from: http://chemengineering.wikispaces.com/Flue+gas

[59] EPA. (2013). Overview of Greenhouse gases. United States Environmental Protection Agency. Retrieved from: http://www.epa.gov/climatechange/greenhouse gasemissions/gases/co2.html

[60] Union of Concerned Scientists. (March 2013). Environmental Impacts of Renewable Energy Technologies. Union of Concerned Scientists: Citizens and Scientists for Environmental Solutions. Retrieved from: http://www.ucsusa.org/clean_energy/our-energy-choices/renewable-energy/environmental-impacts-of.html

2. Electricity Life Cycle Assessment

Figure 10: Life Cycle Analysis of Electricity and Natural Gas



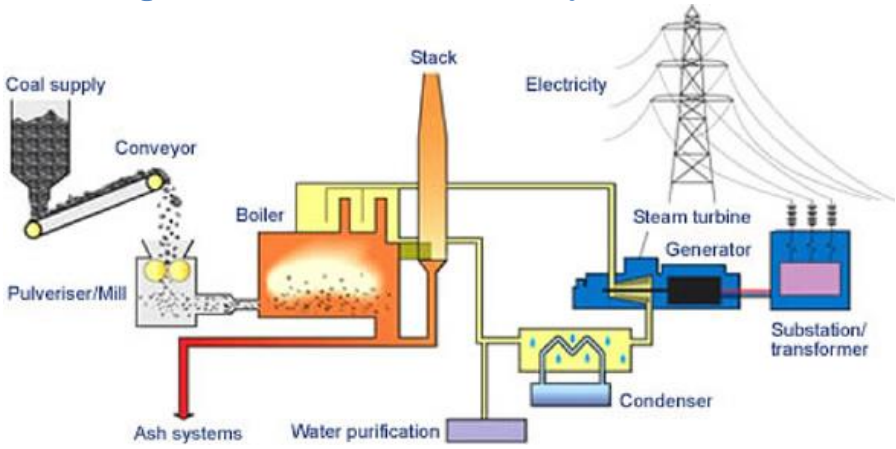
A life-cycle assessment is useful in understanding how electricity generated for use in Hermosa Beach produces emissions. It also demonstrates the extent to which Hermosa Beach has influence over various processes within electricity generation, distribution, and use (see Figure 10).

Sources for electricity generation are categorized in one of three ways: non-renewable sources (coal, natural gas), renewable sources (wind, solar, biomass, small hydroelectricity, and geothermal), and other sources (nuclear and large hydroelectricity). Coal and natural gas are the conventional fuel sources and are primarily used for electricity production in California while renewable sources have been growing steadily over time. Even though nuclear emissions are as low as renewable emissions, nuclear is not considered a renewable resource and is much more difficult to implement on the local

level. Large hydroelectric plants are technically renewable but do not count towards the Renewable Portfolio Standard because of environmental concerns associated with large-scale dams.[61]

The methods of fuel extraction vary depending on the type of fuel being used. Fossil fuels go through extensive extraction and transport processes before they are combusted at power plants. Renewables and other sources can be used directly in electricity generation as the power plant is usually located at the source. Historically, the conventional method for generating electricity has involved burning fossil fuels at a thermal power station which creates heat as demonstrated in Figure 11. This heat boils water and creates steam to turn a turbine. The mechanical energy created by the turbine is converted into electricity by a generator.

Figure 11: Generation of Electricity from Coal



Renewable electricity generation is much more variable than nonrenewable generation and can have a broader range of applications, such as local generation. For a turbine-run plant, wind or water can turn the turbine instead of steam. Sunlight can be directly converted into electricity using the photoelectric effect in solar panels. Geothermal energy can be used to heat water and create steam in a thermal power station. Methods of obtaining electricity can also vary within a renewable source, such as using photovoltaic solar cells versus solar thermal cells.

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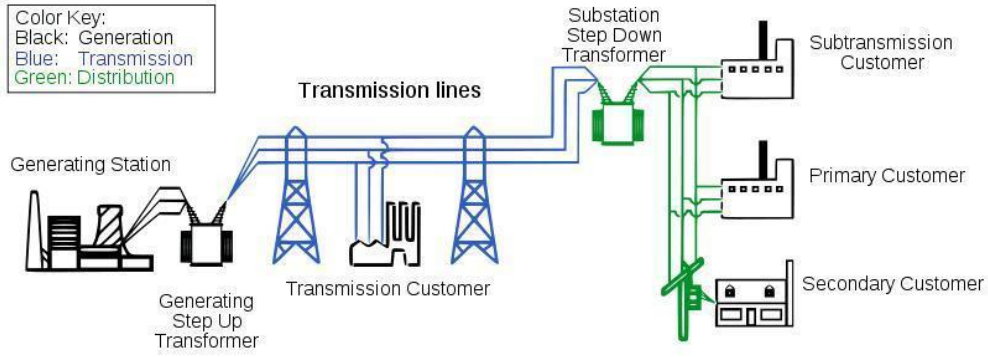
[61] Miller, Craig. (June 2012). Is Hydroelectric Power a 'Renewbale' Energy Source? KQED. Retrieved from: http://blogs.kqed.org/climatewatch/2012/06/20/is-hydroelectric-power-a-renewable-energy-source/

Southern California Edison mostly buys their electricity from other companies which own their own power plants. The electricity created at these power plants will travel through electrical power lines to a step up transformer where its initial voltage is increased (see Figure 12).[62] This increases its ability to travel long distances more efficiently. The electricity then flows onto transmission lines and reaches a transmission substation where the power voltage is reduced at a step-down transformer and divided into sub-transmission lines. The electricity is then brought to a distribution substation where the voltage is reduced again to distribution voltages. It is then sent to distribution lines which bring power to buildings either overhead or underground. Small transformers can reduce voltage again before it enters a building.

A "service" is a line that brings power from the distribution lines to the customer. The service directs electricity through a meter which is read to determine how a customer is billed for electricity. The electricity then travels through a fuse box and into the building where it is used for activities such as facility heating and cooling, lighting, powering electronics, heating water, powering appliances, and using commercial and industrial equipment.

Figure 12: Generation and Transmission of Electricity



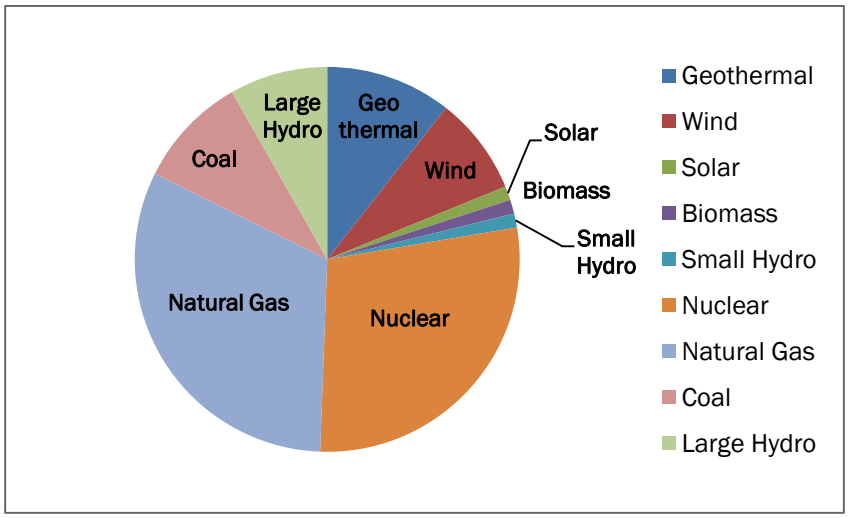
[62] Maryland Chapter. (2011) Pull the Plug on Coal by Wire! Sierra Club. Retrieved from: http://maryland.sierraclub.org/action/p0204.asp

Wave, wind, and solar electrical systems can also be used locally to deliver energy directly into the building or the local grid instead of being delivered from power plants. Natural gas cogeneration plants can also be used to generate electricity locally.

Southern California Edison

Southern California Edison is an investor-owned utility that serves over 14 million people in 180 cities and 11 counties in central, coastal, and southern California. They own an electrical system of more than 1.5 million electric poles and 712,605 transformers and 88,207 miles of distribution lines. They receive a percentage of energy from multiple power plants, including Four Corners Generating Station, Mountainview Power Plant, Palo Verde Nuclear Generating Station, San Onofre Nuclear Generating Station (currently closed), and Big Creek Hydro Facilities among others.

Figure 13: 2012 Southern California Edison Electrical Generation Mix

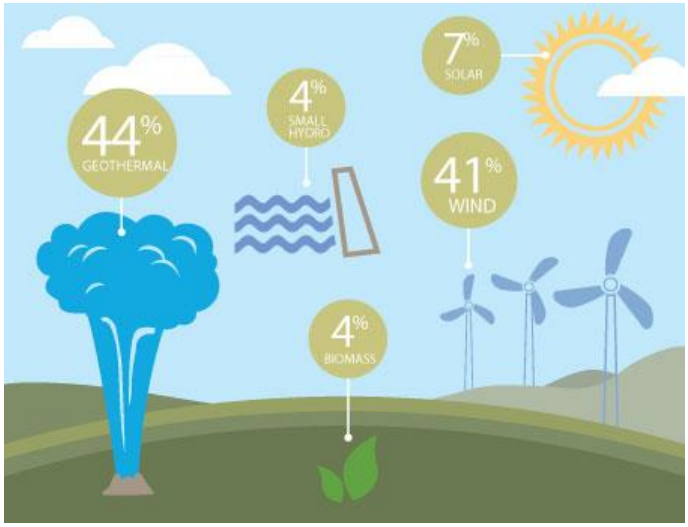


In 2011, Southern California Edison provided a total of 87.34 billion kWh of electricity.[8] 19% of their power generation came from renewables, 66% came from non-renewables, and 15% from unspecified sources.[63] Of total energy, 9% was from geothermal, 7% from wind, 1% from solar, 1% from biomass, 1% from small hydro, 24% from nuclear, 27% from natural gas, 8% from coal, and 7%

[63] California Energy Commission. (2013). Ca.gov. Retrieved from: http://www.energy.ca.gov/

from large hydro (see Figure 13).[64] According to California Public Utilities Commission, Southern California Edison's 2012 electricity production consists of 20.6% renewable power, showing a 1.6% jump in a year.[65]

Figure 14: 2012 Southern California Edison Renewable Energy Mix [66]



A great amount of pressure has been put on energy companies to turn to renewable resources. The Renewable Portfolio Standard, a regulation that requires energy companies to increase their use of renewable energy sources to 33% by 2020, has already made Southern California Edison increase their renewable generation to 20.6% of their power mix. They have already signed contracts with multiple renewable energy companies to increase their procurement of renewable energy. Many contracts have been approved and some are in development. The California Energy Commission

[64] Southern California Edison. (2012). More Renewable Power than any Other U.S. Utility. Southern California Edison website. Retrieved from: http://tinyurl.com/pfezx6z

[65] California Public Utilities Commission. (2013). California Renewable Portfolio Standards. CA.gov. Retrieved from: http://www.cpuc.ca.gov/PUC/energy/Renewables/index.htm

[66] Southern California Edison. (2012). *Committed to Protecting the Environment*. Southern California Edison website. Retrieved from: http://tinyurl.com/p956ntv

website contains a database of investor-owned utilities' contracts for renewable generation. These contracts were signed towards meeting the Renewable Portfolio Standard targets.[67]

Since utility-scale renewable energy generation is typically located in remote areas, Southern California Edison is working to expand their transmission and distribution infrastructure in order to deliver clean energy to their cities. Their transmission projects currently include the Tehachapi Renewable Transmission Project, Devers-Palo Verde No.2 Project, and the Red Bluff Substation Project among others.[8] Southern California Edison will work to connect these generation stations to the power grid.

Southern California Edison is also in the process of developing their own smart grid system which will take more than 20 years to complete. A smart grid is an electrical grid that uses high tech digital devices to gather and respond to information from suppliers and consumers in order to improve the reliability, efficiency, sustainability, and economics in the production, transmission, distribution, and end use of electricity. A smart grid system will help optimize electrical service as well as inform and empower customers to make better decisions about their energy use. With the increase of Southern California Edison's renewable energy mix, their source of power will become increasingly intermittent. A smart grid will help react to these fluctuating sources and adapt quickly to supply and demand imbalances. Southern California Edison's plans for development and implementation of the smart grid can be found in their Smart Grid Strategy and Roadmap.[68] Though Southern California Edison has already delivered smart meters to the majority of their customers, the bulk of their $3-billion-per-year capital investment plans are aimed at infrastructure improvements rather than smart grid work.[69]

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[67] The California Energy Commission. (April 2012). The Database of Investor-owned Utilities' Contracts for Renewable Generation, Contracts Signed Towards meeting the California RPS Targets. California Energy Commission. Retrieved from: http://www.energy.ca.gov/portfolio/contracts_database.html

[68] Southern California Edison.(2010) Southern California Edison Smart Grid Strategy and Roadmap. Southern California Edison. Retrieved from: http://www.energy.ca.gov/portfolio/contracts_database.html

[69] John, Jeff. (March 2013). Southern California Edison's Smart Grid Roadmap. Greentechmedia. Retrieved from: http://www.greentechmedia.com/articles/read/southern-california-edisons-smart-grid-roadmap

Southern California Edison is taking steps to become more sustainable by focusing on energy efficiency and renewable sources. However, Hermosa Beach does not have any direct influence over Southern California Edison's electrical generation mix and cannot directly dictate the source of their energy. Instead, Hermosa Beach can turn inward and locally change their electricity usage through increased efficiency and renewable sources.

1.1 Electricity Areas of Concern

Table 10: Hermosa Beach's level of influence concerning emissions from electrical production

Emissions Source	Emissions Type	Influence	Geographic Relation
extraction of fuels	direct combustion and direct fugitive	no control	outside
transport of fuels	direct combustion and direct fugitive	no control	outside
combustion of Fossil fuels	direct combustion and direct fugitive	no control	outside
upkeep of power plants	direct combustion	no control	outside
transformers	direct fugitive	no control	outside
Emissions-Generating Activity			
Municipal activities	indirect	direct control	inside
Residential activities	indirect	direct/indirect control	inside
Commercial/industrial activities	indirect	direct/indirect control	inside
*activities include lighting, electronics, facility heating and cooling, heating water, commercial and industrial equipment, appliances, cooking, and fire boilers.			

Understanding the life cycle of electricity helps us identify emissions boundaries and prioritize areas of concern. Hermosa Beach has no influence over electricity generation and distribution, which lies outside of their boundaries and in the control of Southern California Edison. They do have influence over electricity use within its boundaries which includes emissions generating activities from the residential, commercial, industrial, and municipal sectors. Table 10 displays each emission-related source or activity associated with Hermosa Beach and provides information about the type of emission, Hermosa Beach's level of influence, and the location of the emissions. When setting

boundaries, we decided to mainly focus on the level of influence Hermosa Beach has to mitigate the emissions.

Accounting Strategies: Municipal and Community Operation Boundaries

As referenced in Part I, Section D, we predominately used the ICLEI US Community Protocol to identify community boundaries for emission sources and activities. Overall consideration of electricity emissions begin when the electricity enters Hermosa Beach's jurisdictional boundaries through Southern California Edison's transmission lines. Both municipal and community operations that reside within these boundaries can be influenced by the local government. According to Hermosa Beach's Community Greenhouse gas Emissions Inventory Report, lighting, heating, and powering appliances from the residential sector are the primary sources of electricity usage in the city.[56] For our analysis, we focused on mitigation efforts for municipal operations before addressing community emission sources and activities.

Municipal Electricity Use

Municipal boundaries for electricity include all government-owned buildings, exterior lighting structures, and electric vehicles as well as any other government-related activities that utilize electricity. In 2010, electricity used for municipal buildings, facilities, and streetlights accounted for 35% of the local government's greenhouse gas emissions.[56] Municipal operations used 904,893 kWh in buildings, 154,029 kWh in all exterior lighting (except street lighting), and 871,433 KWh in all street lighting while other activities used 89,958 kWh.[57] Therefore, the City of Hermosa Beach has direct control over approximately 2 million kWh of electricity. If the local government truly wants to make a difference and set an example for their city, they will first focus on decreasing their electric consumption before turning to other sectors. The amount of government-owned buildings is relatively few compared to the amount of residential homes. Therefore, changing government building energy usage and supply will most likely be met with less resistance and take place over a shorter time frame compared to residential or commercial/industrial buildings upgrades. Though the total impact may be less apparent due to the large amount of residential electricity use compared to municipal, focusing on this sector should be of primary concern before considering community emissions.

Community Electricity Use

Community boundaries include all residential, commercial, and industrial buildings and activities that utilize electricity within the jurisdictional boundary of Hermosa Beach. Half of residential building greenhouse gas emissions come from electricity usage.[56] The 2007 Community Greenhouse Gas Emissions Inventory shows that the residential sector is produces 24% of total greenhouse gas emissions while the commercial/industrial sector produces 15%.[56] The majority of electricity is dedicated to residential buildings because of their overwhelming presence in the city compared to the number of municipal buildings. Addressing residential, commercial, and industrial emissions will be difficult as demanding any changes of these buildings will most likely be met with public resistance. The easiest methods in terms of minimizing this resistance (though not necessarily the easiest to implement) would be to alter the source of electricity (see Community Choice Aggregation) while more difficult methods include mandating upgrades to existing buildings. Hermosa Beach cannot solely focus on the municipal sector and must incorporate changes in the broader community if they wish to reach carbon neutrality.

3. Natural Gas

Natural gas is predominantly made up of methane but also is a mixture of hydrocarbons including propane, butane, and ethane. Natural gas has become an increasingly more important energy source in California and provides potential for alternative cleaner fossil fuel sources of energy.[70] In 2010, Hermosa Beach utilized a total of 4,275,126 therms of natural gas between residential, commercial and industrial buildings within the jurisdictional boundaries.[71] Natural gas alone attributed to 19% total greenhouse gas emissions from Hermosa Beach and 0.023% of the total greenhouse gas emissions from the Los Angeles Regional County in 2010.[60] The following section provides an overview of the environmental implications of natural gas, and its related life cycle emissions. We will also be looking at the details of our accounting strategies to determine

[70] California Energy Commission: Energy Almanac. (2013) *Natural Gas Data and Statistics.* Retrieved May 20, 2013 from: http://www.energyalmanac.ca.gov/naturalgas/overview.html

[71] Obtained from 2010 Los Angeles Regional GREENHOUSE GAS Inventory

boundaries and scopes of natural gas, which will help us to draw green house gas reduction options for Hermosa Beach to implement in order to reach carbon neutrality goals.

2.1 Environmental Implications

Natural gas is a fossil fuel and has a number of unintended environmental impacts from extraction, distribution, combustion, and the fugitive emission. The primary environmental implication of natural gas that we will be analyzing for this Plan is the green house gas emissions associated with its combustion. When combusted, natural gas produces carbon dioxide, carbon monoxide, nitrogen oxides, trace amounts of sulfur dioxide and particulates. In comparison to the combustion of oil and coal, natural gas combustion emits significantly lower amounts of greenhouse gas per unit of energy than its other fossil fuel counterparts.[72] Combustion emissions of greenhouse gases are at all points in the natural gas lifecycle from extraction to end-pipe usage. Methane (CH_4), the primary component of natural gas, in itself is a greenhouse gas when directly released into the atmosphere. Fugitive emissions, or emissions of natural gas from leakage or loses during transportation, attribute to an increased abundance of greenhouse gas in the atmosphere. Therefore, greenhouse gas emissions sources must be accounted for at any point in the lifecycle where natural gas is combusted or transported through pipelines from extraction site to consumer. Natural gas originating from biogenic sources, such as "waste" methane, is not re-releasing any greenhouse gas emissions into the atmosphere that are not already part of the present day carbon cycle – it is considered carbon neutral. The gas that is originally sequestered, extracted from beneath the bedrock, and then anthropogenically burned as fuel is therefore of primary concern.

Although we will be predominantly focusing on greenhouse gas emissions from natural gas combustion, it is important to understand the totality of environmental impacts associated with natural gas use. There are a number of other environmental impacts to be considered especially in

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[72] U.S. Energy Information Administration. (1998). *Natural Gas Issues and Trends: Natural Gas and the Environment.* Washington, DC: Author. Retrieved from http://www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/natural_gas_1998_issues_trends/pdf/chapter2.pdf

the upstream portion of the natural gas industry- the extraction or production, transmission and distribution systems. Exploration and initial infrastructure development disturbs natural habitats and wildlife, and erodes the land over time. Hydraulic fracturing, an extraction technique, uses pressurized liquid to fracture various rock layers, which allow for easier extraction through the bedrock. The process of hydraulic fracturing has raised many questions about the environmental safety and volumes of water used. Although hydraulic fracturing is an efficient way to extract formerly inaccessible hydrocarbons, contamination of ground water in conjunction with the release of greenhouse gases have made the sustainability of the practice questionable because of the long-term environmental consequences. Enhanced oil recovery (EOR) techniques inject natural gas, carbon dioxide, or nitrogen into reservoirs to improve flow rates and push additional oil toward production wells. Brine is typically brought to the surface when oil and gas is extracted, which can contain toxic metals and radioactive substances. If released into the environment, the brine and its constituents can have very damaging effects to the environment and public health. [73]

Extensive pipelines, facilities, and equipment must be installed to transport natural gas from point of extraction to consumer, which disturbs the natural terrain. Leakage of natural gas not only emits methane into the atmosphere, but also can also potentially contaminate groundwater sources. Wastewater disposed of from extraction and production processes also cannot be directly released onto the surface or water body, but must first go through additional treatment before it can be discharged onto the surface. [74]

2.2 Natural Gas Life Cycle Assessment

In order to fully understand total emissions and implications from natural gas consumption, it is important to be conscious of the natural gas life cycle from extraction to combustion or fugitive

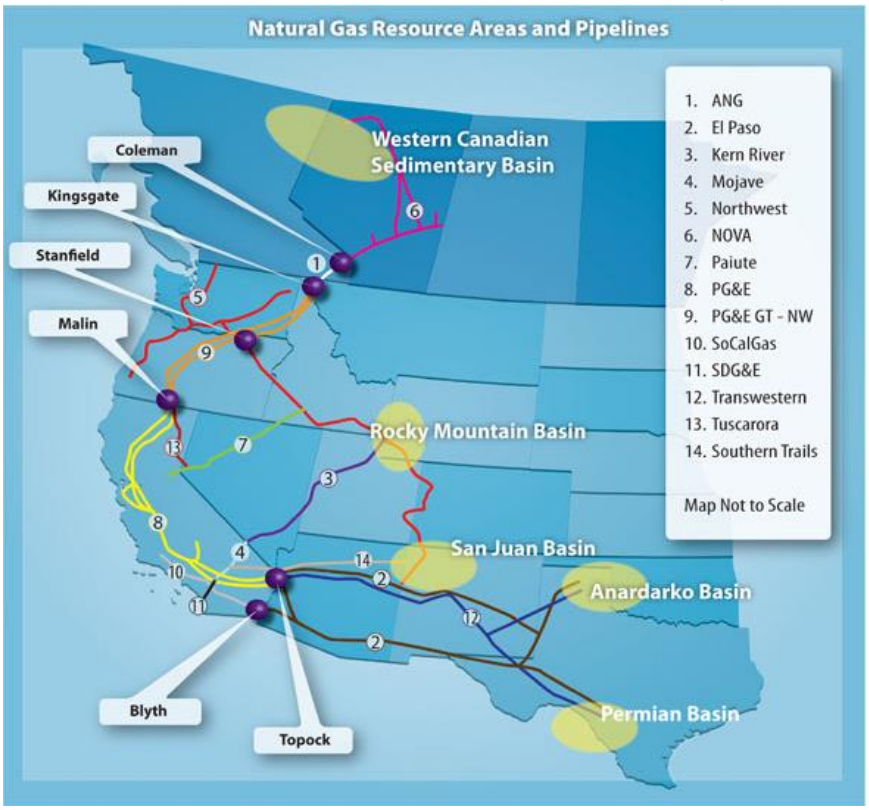
[73] U.S. Environmental Protection Agency. (2013). *Water Class II: Oil and Gas Related Injection Wells.* Retrieved May 20, 2013 from http://water.epa.gov/type/groundwater/uic/class2/index.cfm#how_do

[74] Further exploration can be looked into at: U.S. Energy Information Administration. (1998). *Natural Gas Issues and Trends: Natural Gas and the Environment.* Washington, DC: Author. Retrieved from http://www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/natural_gas_1998_issues_trends/pdf/chapter2.pdf

emission within the jurisdictional boundaries of Hermosa Beach. Natural gas pipelines are interconnected - the gas used in buildings can originate from natural gas deposit sites both within California and out of state. California supplies of natural gas come from four areas: In state production, Canada, the Rocky Mountain Region and South-Western United States (where in-state production supplies the least and south-western US supplies the most).[75] Figure 15 depicts the intrastate pipelines, and distribution pipelines within California. Each method of extraction varies in resources needed and energy consumption. For example, hydraulic fracturing and steam powered drilling, both energy extensive extraction methods, use combustion of other fossil fuels to heat water for steam engines, or inject pressurized water into the ground to extract underneath the bedrock. Raw gas material cannot be used immediately upon extraction and must first be conditioned before it is pipeline quality. Some of the processing occurs at the wellhead, but the majority of natural gas processing occurs in a processing plant located not far from the extraction region. When assessing the life cycle of natural gas, fugitive emissions due to transportation of the natural gas from wellhead to processing to delivery pipes, and combustion emissions from natural gas extraction techniques, processing, and direct usage must all be accounted for.

[75] California Energy Commission: Energy Almanac. (2013) *Natural Gas Data and Statistics.* Retrieved May 20, 2013 from: http://www.energyalmanac.ca.gov/naturalgas/overview.html

Figure 15: There are a total of 5 interstate pipeline distribution systems, but once natural gas enters California, it is distributed via natural gas utility companies. The top three California utility companies are Southern California Gas Company, San Diego Gas and Electric, and Pacific Gas and Electric Company.[76]



Southern California Gas Company

Southern California Gas Company locally distributes and transmits natural gas through pipeline systems to and within Hermosa Beach. Local transmission pipelines from Southern California Gas deliver gas, and is then used for a number of activities and sources such as transportation, building use, and natural gas cogeneration plants. Southern California Gas Company, as the local distributor and supplier of natural gas in southern California, already implements precautions and has future plans to deal with greenhouse gas emissions associated with natural gas. The company does not have any control, beyond price, over independent consumer operations, but looks into alternate natural gas sources and energy efficiency to reduce the upstream emissions footprint. Southern

[76] California Energy Commission: Energy Almanac. (2013) *Natural Gas Data and Statistics.* Retrieved May 20, 2013 from: http://www.energyalmanac.ca.gov/naturalgas/overview.html

California Gas Company provides a number of incentives for customers to improve power generation. For example, the gas company supports on-site electricity generation through their Self Generation Incentive Program to customers of larger facilities. The program provides financial incentives for the installation of clean, onsite distributed generation technologies, which can help reduce reliance on domestic and non-domestic fossil fuels.[77] Renewable waste energy capture, conventional cogeneration, and emerging technologies such as biogas and fuel cells have lower price per watt for Southern California Gas Company customers and help to mitigate some of the emissions associated with natural gas.

Origins of Supply Discussion

The origin of the natural gas supply that is piped into the city by a third party, Southern California Gas Company, is currently out of local governmental influence. It is important however to recognize the importance of the origins of natural gas in accounting for emissions. When natural gas is created by renewable sources such as organic waste products, the carbon content is considered a biogenic source of CO_2 emissions, or part of the natural carbon cycle. Biogenic emissions are emissions of volatile organic compounds and nitrogen oxides from the decomposition of vegetation.[78] Biogenic volatile organic compounds (BVOCs) do not contribute to climate change because they are a part of the natural carbon cycle.[79] On the contrary, fossil fuel based natural gas is extracted from carbon deposits deep beneath the bedrock. The carbon deposits of natural gas would not be exploited or released into the atmosphere without the interference of anthropogenic activities, or human induced activities; therefore, all emissions associated with fossil fuel based natural gas must be accounted for, and biogas in comparison to fossil fuel natural gas is carbon neutral. Biogas does not have the associated unnatural emissions that result from extraction or processing. The percentage of biogas

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[77] California Center for Sustainable Energy, Pacific Gas and Electric, Southern California Edison, and Southern California Gas Company. (2013). *2013 Self Generation Incentive Program Handbook.* Retrieved on April 25, 2013 from http://www.socalgas.com/documents/business/selfgen/2013/2013_SGIP_Handbook.pdf

[78] Environment Canada. (2012). *Glossary.* Retrieved May 20, 2013 from http://www.ec.gc.ca/inrp-npri/default.asp?lang=en&n=9264E929-1

[79] California Environmental Protection Agency Air Resources Board. (2013). *Biogenic Emissions Inventory*. Retrieved May 20, 2013 from http://www.arb.ca.gov/ei/biogenicei.htm

versus fossil fuel derived natural gas delivered to Hermosa Beach is strictly up to the local distribution facility, or Southern California Gas Company. However the percentage of biogas currently within the local distribution pipeline is minimal. “Waste” emissions created from places like dairy farms, food processing companies and wastewater treatment sites can provide future carbon neutral gas sources. However, there will always be emissions associated with the combustion or usage of natural gas in Hermosa Beach until all distributed gas is of biogenic sources.

2.3 Natural Gas Areas of Concern

The natural gas life cycle is a comprehensive analysis of all greenhouse gas emissions from natural gas consumption and is inclusive of both community and municipal operational emissions. Understanding the totality of the natural gas lifecycle upstream from Hermosa Beach’s combustion and fugitive emissions is necessary to determine what emissions scopes and boundaries will be accounted for in the city’s goals of going carbon neutral. According to the City of Hermosa Beach’s Community Greenhouse Gas Emissions Inventory Report, the predominate sources and activities related to natural gas consumption are from residential, commercial, and industrial building use. However, additional uses of natural gas occur from the transportation sector and from electricity sources such as cogeneration plants. When local distribution pipelines deliver natural gas to buildings, there can be either direct fugitive and combustion emissions of natural gas or indirect combustion emissions from electricity generated by natural gas combustion. The main sources and activities of direct combustion within Hermosa Beach will be further analyzed later in the paper.

Accounting Strategies: Municipal and Community Operation Boundaries

In our analysis of Hermosa Beach’s natural gas emissions inventory, we predominately used the ICLEI US Community Protocol as a jumping platform to develop a scoping process and draw boundaries of the emission sources and activities. The boundaries we chose for the case study of Hermosa Beach begin after the natural gas is conditioned and transported by Southern California Gas Company. The emission activities and sources after this point can be then influenced by the local government, and include both municipal operations and community-wide activities and sources. According to the 2010 Hermosa Beach’s Community Greenhouse Gas Emissions Inventory Report, combustion within community households and in-boundary facilities are the primary source

of natural gas usage in the city. For our analysis, we firstly focused on mitigation efforts for municipal operations before addressing community emission sources and activities.

Natural Gas Municipal Operations Boundaries

In the 2005 municipal emissions inventory summary, emissions due to natural gas only made up 2% of the total municipal operations emissions in Hermosa Beach. For natural gas emissions accounting purposes, municipal operation boundaries includes all governmental buildings that use natural gas combustion as an energy source either directly or indirectly from electricity, governmental natural gas vehicle transportation, and the subsequent fugitive emissions resulting from distribution pipelines to municipal facilities within Hermosa Beach's jurisdictions. Because municipal operations emissions do not make up a significant portion of the total natural gas emissions from Hermosa Beach, achieving carbon neutrality for municipal operations only would be easier due to the local government's direct power to make changes within their facilities.

Natural Gas Community Emissions Boundaries

Community operation emissions include all natural gas emissions that occur apart from municipal facilities. The majority of natural gas consumption, or 79% of total natural gas associated greenhouse gas emissions, occurs within residential buildings from in home sources and activities. Community boundaries are drawn using the jurisdictional boundaries of Hermosa Beach. All fugitive emissions within the jurisdictional boundary, natural gas transportation and supporting refill stations, and combustion emissions from direct sources and activities are included within the scope of community carbon neutrality goals. Accounting for natural gas consumption in natural gas vehicles (NGVs) will overlap with transportation efficiency when municipal operations and residents adopt more NGVs; however, this is a secondary concern of ours when looking for the most efficient implementation measures.

2.4 Implementation Measures for Emissions-Generating Activities - End Uses of Natural Gas

Facility heating and cooling, water heating, commercial and industrial equipment, and building appliances are the main sources of natural gas activities and combustion emissions found from residential, community, and industrial buildings within Hermosa Beach. As part of Southern California Gas Company's Energy Efficient Solution, they offer energy efficiency programs to reduce

costs, improve efficiency, and make upgrades more easily achieved. For example, energy efficient assessments by auditors and contractor programs help customers find areas for improvements in consumption, how to cut costs, and apply for rebates. Numerous rebates are given out for new energy efficient technologies such as clothes dryers, dishwashers, attic and wall insulation, water heaters, tankless water heaters and gravity wall furnaces. Also, multi-family dwellings, single-family homes, and commercial and industrial consumers can receive cash rebates by purchasing and installing solar water heating systems from Southern California Gas Company. By looking at the specific sources and activities of natural gas emissions, we can provide more specific efficiency upgrades that buildings can implement within Hermosa Beach to reduce emissions. The following recommendations in this section are by no means the only alternative energy upgrades, but rather provide suggestions to buildings to help reduce overall natural gas consumption. Many alternative building efficiency options can also be found in the California Green Building Standards Code.

Facility Heating and Cooling

Facility heating and cooling systems consume typically around a quarter of a building's natural gas and electricity consumption and should therefore be a major focus for energy upgrades. Before replacing existing equipment with more efficient equipment, there may be greater savings by looking into ways to optimize efficiency of the air distribution system first. Systems can have a constant volume airflow (CV) or a variable air volume flow (VAV). VAV can provide greater savings in energy consumption because systems change air flow according to the heating and cooling load.[80]

Conventional central heating systems like furnaces, and boilers, are the most commonly used heating systems, and consume predominately gas, but sometimes oil or electricity to heat buildings. Standard air conditioners, or "split systems', generally have an outdoor and indoor component, which must be replaced at the same time or will result in low efficiency. Often, central air conditioning systems need a blow motor, which is a part of a furnace and pushes the cold air through

[80] United States Environmental Protection Agency and Office of Air and Radiation. (2008). *Energy Star Building Upgrade Manual*. Retrieved April 25, 2013 from http://www.energystar.gov/ia/business/EPA_BUM_Full.pdf?c876-e232

the duct system. Inabilities to replace full central heating and cooling systems will result in low efficiency of equipment and therefore can increase in emissions from building sources.

Heating, ventilation, and air conditioning (HVAC) systems, both heat and cool in one integrated system. HVAC systems act as a heat pump that redistributes heat from one location to the next in order to moderate and alter temperatures. Many conventional HVAC systems use electricity to move heat from a cool space to a warm space to make the cooler space cooler during the hot seasons, and moves heat from a cold space to warm indoors when it is cold. Electricity driven air source HVAC systems can reduce energy consumption as much as 30 – 40% compared to the conventional heating and cooling split systems.[81] Even though HVAC systems are driven by electricity, they still provide an efficient alternative for buildings to implement and cut emission costs.

Adsorption heat pumps, a type of air-source-heat pumps, are the most recommended source of heating and cooling for buildings because they do not use electricity to transport heat, but rather drive heat movement from natural gas, propane, solar heated water, or geothermal heated water.[82] If an adsorption heat pumps moves heat using a renewable source, such as solar heated water or geothermal hot water, emissions and energy consumption from heating and cooling buildings can be significantly reduced, or become essentially neutral. Evaporative cooling, another cool air transfer mechanism, draws outside warm air through moist pads where it is cooled by evaporation, and then circulated through a building by a large blower. Available evaporative coolers are available that use photovoltaic panels to create electricity to drive the blower and water pump.[83] Because evaporative coolers have a significantly lower electricity demand, solar panels or other renewable energy sources can provide enough energy to run the equipment efficiently.[84] Driving heating and cooling systems by

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[81] Energy.gov.(2012). *Heat Pump Systems.* Retrived April 25, 2013 from http://energy.gov/energysaver/articles/heat-pump-systems

[82] Energy.gov. (2012) Absorption Heat Pumps. Retrived April 25, 2013 from http://energy.gov/energysaver/articles/absorption-heat-pumps

[83] California Energy Commission Consumer Energy Center. (2013).*Evaporative Cooling.* Retrieved April 25, 2013 from http://www.consumerenergycenter.org/home/heating_cooling/evaporative.html

renewable energy sources, or via heat pump technology can make significant reductions in building natural gas and electricity consumption.

Water Heating

Hot water heaters in U.S. buildings use natural gas combustion more than any other fuel source, and around 40% of hot water heaters use electricity.[85] A multitude of natural gas Energy Star rated units exist, but in order for Hermosa Beach to reach carbon neutrality, buildings must transition off of natural gas combustion as an energy source to heat water. Unless natural gas is 100% biogas, then any natural gas consumption would result in emissions.

Solar water heaters use renewable energy sources to heat up water and can be used in any sort of climate.[86] Solar water heaters can be characterized as direct active or passive. Active systems require pumping mechanisms, whereas passive systems function via natural water convection. Direct active circulation systems circulate water through solar collectors that heat the water, which is then directly used or stored in tanks. Direct active circulation systems are only applicable in regions where water rarely freezes. Indirect active closed loop circulation systems pump a non-freezing liquid through solar collectors and through a heat exchanger where the heat then is transported to the water that is distributed throughout the building.

Passive solar heating water systems can last longer and are usually more reliable, but also are less efficient then active systems. The two main passive solar water heaters are integral collector-storage (ICS) passive systems and thermosyphon systems. ICS systems pass water through a solar collector and then on to a conventional back up water heater to ensure a constant supply of hot water. Thermosyphon systems, although more expensive, collect warm water that rises into a collection

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[84] More information regarding how to improve building heating and cooling efficiency can be found at: www.energystar.com or www.energy.gov

[85] American Council for an Energy Efficient Economy. (2012). *Water Heating.* Retrieved April 25, 2013 from http://aceee.org/consumer/water-heating

[86] Energy.gov. (2013). *Solar Water Heaters.* Retrieved April 25, 2013 from http://energy.gov/energysaver/articles/solar-water-heaters

tank and is then directly distributed throughout the building. Although the upfront expenses are high, solar water heating systems can save 50 – 75% of water heating energy over the long term, and can reduce activity based emissions from natural gas and electricity consumption dramatically. Solar water heating can present a good alternative to reduce natural gas consumption usage in building water-heating systems when thinking about specific activity based implementation measures.

Appliances and Commercial/Industrial Equipment

Space heating, water heating, and cooling are the predominate direct pipeline sources of natural gas consumption in buildings, but there are a number of other appliances and commercial and industrial equipment that require natural gas combustion as an energy source. To name a few, space heaters, clothes driers, pool and jacuzzi heaters, fireplaces, barbecues, garage heaters, outdoor lights, and stoves and commercial food service equipment, should be analyzed by auditors on a building by building basis to provide guidance on appropriate energy upgrades.

For example, gas-cooking stoves in residential households can be replaced by more efficient induction cooking stoves. Induction stovetops require ferromagnetic metal cooking vessels to be used on induction surfaces. All the heat is directly transferred to the cooking vessel and the food is cooked faster with less wasted heat to the surrounding ambient air.[87] Because a greater percentage of heat produced is transferred directly to the surface of the metal cooking vessel, less energy is wasted and efficiency increases.

Although hanging clothes outdoors on clotheslines is the most economical and environmentally friendly means of drying clothes, machine drying is considerably faster, more convenient, but also consumes natural gas or electricity for energy. Heat Pump Clothes Dryers (HPCD) are approximately 50% more efficient than conventional heat dryers and are rapidly increasing in popularity in Europe,

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[87] Lawrence Berkley National Laboratory. (1994). *Technical support document for residential cooking products. (Docket Number EE-RM-S-97-700). Berkeley, CA:* Lawrence Berkeley National Laboratory. Retrieved April 25, 2013 from http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/cookgtsd.pdf

but have yet to hit the American market.[88] HPCDs draws in warm ambient air, circulates the air which then exits the drum, proceeds through a lint screen, and goes into an evaporator where the moisture is removed before it circulates back into the drum again.

Many appliances and commercial equipment do not draw directly from natural gas, but do contribute to building electricity consumption and indirectly employ natural gas combustion. Therefore, in order for Hermosa Beach to reach carbon neutrality, consultants and auditors must have comprehensive knowledge about energy upgrade recommendations for community citizens to employ to their private facilities.

4. Implementation Measure for Building Energy Efficiency

Before we provide adequate emissions reduction implementation mechanisms, we must revisit the differences between emission generating activities and sources within our boundaries of the residential, commercial, and industrial building sector to properly attack building emissions. Emission sources are processes that directly release greenhouse gases into the atmosphere. Within our boundaries, this includes the direct fossil fuel combustion processes to create electricity or energy, which creates greenhouse gases as a bi-product. Also, direct fugitive emissions sources from leaky pipelines release greenhouse gases straight into the atmosphere. Emissions generating activities are activities that when performed result indirectly in greenhouse gas emissions. In the case of buildings, this includes facility heating, facility cooling, heating water, commercial & industrial equipment, appliances, lighting, and electronics, which use either natural gas or electricity as energy sources. There is much overlap however with many sources and activities, because a number of activities combust fossil fuel directly in order to carry out a given activity (ie. facility heating). We will use building emission sources and activities as a jumping point to look for strategies to reduce emissions in the following sections.

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[88] Meyers, S., Franco, V.H., Lekov, A.B., Thompson, L., & Sturges, A. (2010). Do heat pump clothes dryers make sense for the U.S. market? Berkeley, CA: Lawrence Berkeley National Laboratory. Retrieved April 25, 2013 from http://efficiency.lbl.gov/drupal.files/ees/Do%20Heat%20Pump%20Clothes%20Dryers%20Make%20Sense%20for%20the%20US%20Market.pdf

Efficiency

Energy efficiency is the most basic method for reducing electricity use. Efficiency can range from changing basic energy habits to installing efficient appliances and retrofitting houses. In the past few decades, there have been a multitude of improvements in appliance efficiency. One of the simpler, but extremely effective additions is the compact fluorescent light bulb (or CFL) which uses 75% less energy and can last up to ten times longer than a regular incandescent light bulb.[89]

However, simple ways to change energy use habits are already widely available to the public. It is in Hermosa Beach's power to enforce or promote efficiency programs through incentives or policies. The City's annual electric bill has remained relatively constant since 2006 due to the large emphasis of energy efficiency in the city.[57] The local government offers up to a 50% reduction in building permit fees to increase energy efficiency or incentivize LEED or Build It Green program certification.[90] Also, if the building improvements qualify for Energy Upgrade California, then 50% of building permit fees will be rebated. [90] Though these incentives are a good first step to promoting energy efficient changes in buildings, the enforcement of building retrofits will be a larger, more effective step in increasing overall efficiency.

Renewables

Though general efficiency is the simplest way to indirectly reduce emissions through the changing of activities, it is also essential for Hermosa Beach to target source-based emissions and utilize renewable energy sources. Hermosa Beach waives building permit fees for solar construction on buildings as an incentive, but incentives do not have the demanding power that policies do. The local government needs to set an example by making their operations self-sustaining through the use of renewables. They must also consider options other than solar, such as wave and wind energy. There is also the option of enacting a Community Choice Aggregation, which would greatly help

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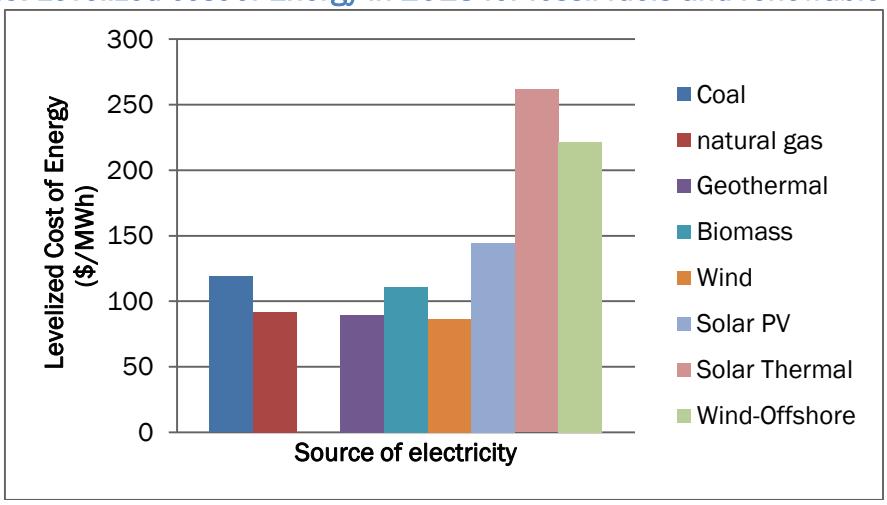
[89] EnergyStar. (2013). FAQs. EnergyStar, USEPA. Retrieved from: http://tinyurl.com/lh88eo4

[90] Hermosa Beach Community Development Department. (Augusts 2011). Hermosa Beach Offers Incentives: Green Building, Energy & Vehicles. Hermosa Beach City Council. Retrieved from: http://tinyurl.com/p4wwxmd

Hermosa Beach control their electricity sources and emissions. Figure 16 shows the levelized cost of energy for new generation resources in 2018.[91] Though many renewable resources (offshore wind and solar thermal) will still be expensive compared to conventional sources, a few sources (wind, geothermal, biomass, solar photovoltaic) will show cost-competitive prices by 2018. Federal, state, and local incentives can further reduce the leveled cost to solar photovoltaic and wind system owners.

These source-based applications are more difficult to implement than activity and efficiency-based applications, but they need to be addressed in order to stop greenhouse gas emissions. Hermosa Beach will not be able to reduce a majority of their emissions without the use of renewable resources.

Figure 16: Levelized cost of Energy in 2018 for fossil fuels and renewable sources



[91] U.S. Energy Information Administration. (January 2013). Levelized Cost of New Generation Resources Energy in the Annual Energy Outlook 2013. U.S. Energy Information Administration, U.S. Department of Energy. Retrieved from: http://www.eia.gov/forecasts/aeo/electricity_generation.cfm

3.1 Source Based Implementation Measures

Electricity Source Based Implementation Measures

Solar

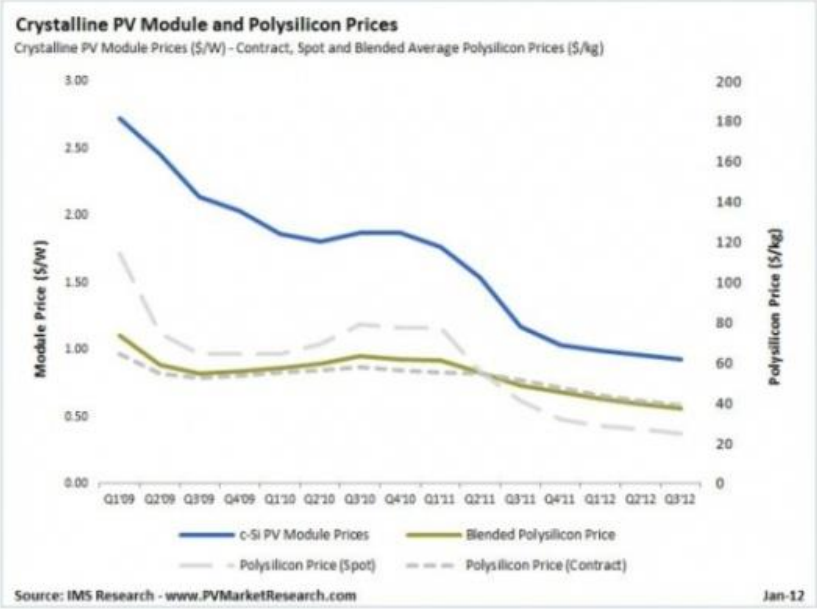
Solar on rooftops is not a new development in Hermosa Beach. The City permitted 72 new photovoltaic systems from 2007-2011 on 66 residential and 6 commercial buildings including apartment buildings.[18] The number of solar photovoltaic systems has continued to grow over the years as citizens are becoming more aware of the benefits of this renewable resource.

A photovoltaic system uses semiconductors in solar panels in order to convert sunlight directly into electricity. Electricity flows through wires into the building where an inverter converts the current for household use. Solar panels are usually placed on the roofs of buildings or over parking lots for unrestricted access to sunlight.

The use of solar power in California has increased due to government actions like the Million Solar Roofs Projects under the Renewable Portfolio Standard. Southern California Edison has also increased its solar generation in response to the Renewable Portfolio Standard. The cost of solar has continued to decline over the years as technology improves and incentives/rebates are created (see Figure 17).[92]

[92] Burger, Andrew. (January 2013). *Chinese Solar Imports Drop but Prices Continue to Fall*. Clean Technica. http://cleantechnica.com/2013/01/22/chinese-solar-imports-drop-but-prices-continue-to-fall/

Figure 17: Solar Pricing in the US



In terms of pricing, there is usually a high upfront cost for solar installation with smaller maintenance costs throughout its lifetime, depending on system performance. Solar panels should be inspected a few times a year and cleaned every 6 months as solar output decreases 10-15% when panels are dirty. [93] By using the Go Solar California Cost Generator recommended by the Hermosa Beach website, the average cost of installation was found to be $20,580 for a 5,034 kWh/year residential building and $170,875 for a 41,952 kWh/year commercial building.[94] If Hermosa Beach chooses to participate in a Community Choice Aggregation, more funds can be directed towards solar programs.

The Hermosa Beach City Council offers multiple incentives to encourage the early adoption of green technology. In order to install solar, an electrical and possibly a building permit will be necessary. Building permit fees for photovoltaic installations are waived in Hermosa Beach. Also, financial aid can be given through the California Solar Initiative, a solar rebate program that offers cash back for

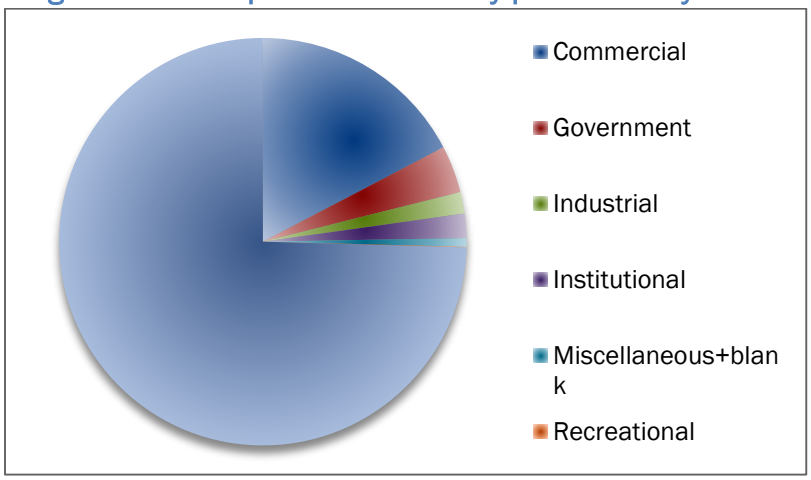
[93] Shah, A. (2012, July 9). Solar Panel Maintenance Opportunities. Green Chip Stocks. Retrieved from http://www.greenchipstocks.com/articles/solar-panel-maintenance-opportunities/2043

[94] Clean Power Estimator. (2013). Go Solar California. Retrieved May 24, 2013, from http://gosolarcalifornia.cleanpowerestimator.com/gosolarcalifornia.htm

installing solar on existing buildings. The goal of the initiative is to install 1940 MW of additional solar by 2017.[95] Hermosa Beach needs to focus on promoting solar energy generation through demanding policies rather than just promoting solar through incentives.

Policies to increase the amount of solar on municipal, commercial, industrial, and residential buildings will greatly reduce the amount of electricity demanded from Southern California Edison and therefore reduce emissions. Solar power for households will be harder to enforce than solar power for government buildings. According to Figure 18, residents have the potential to produce the greatest amount of electricity from solar generation.[96] Therefore residents will either have to voluntarily make the switch to solar or be forced to by city policy if solar is to have a large impact on emissions reduction.

Figure 18: Solar potential electricity production by sector



Wave Power

A potential source of energy for Hermosa Beach that has not yet been considered is wave power. Hermosa Beach is located on Pacific Ocean shoreline. The City's close proximity to water

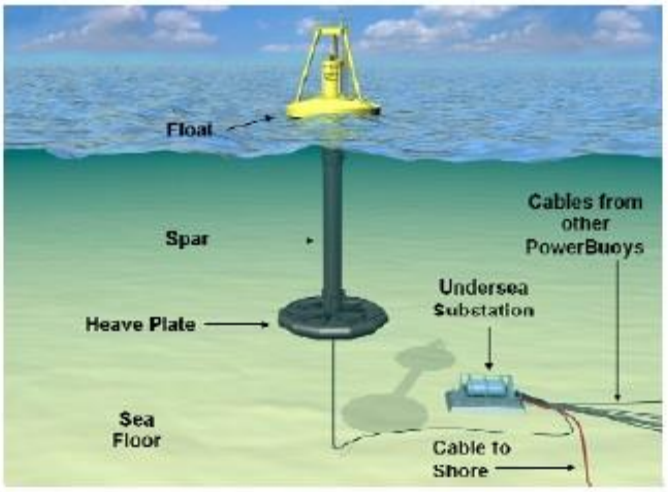
[95] Go Solar California. (2013) About the California Solar Initiative (CSI). Go Solar California, California Energy Commission and California Public Utilities Commission. Retrieved from: http://www.gosolarcalifornia.ca.gov/about/csi.php

[96] UCLA Luskin Center for Innovation. (2011). Los Angeles Solar Atlas. Retrieved from: http://164.67.121.27/files/Downloads/luskincenter/SolarAtlas/LosAngelesSolarAtlas-LACounty.pdf

demonstrates a huge potential for wave or tidal power. Hermosa Beach may look toward wave power to complement wind and solar resources.

A wave power station contains a chamber, a turbine, and a generator. The waves cause water in the chamber to rise and fall, which forces air in and out of the top of the chamber. A turbine is turned by the rushing air, which then powers a generator to create electricity. An underwater power cable transmits the power to shore and can connect to the distribution grid. Figure 19 illustrates an example of a wave power station created by Ocean Power Technologies.[13]

Figure 19: Mark 3 PowerBuoy System



Mark 3 PowerBuoy System (moorings not shown)

Wave power is a relatively new technology. Ocean Power Technologies, a U.S.-owned wave energy company established in 1994, has been steadily expanding their business and advancing their technology in the states. Ocean Power Technologies claims that their technology "has received more testing and validation by independent parties than any other wave energy company".[97] This company has current and completed wave programs in Oregon, New Jersey, and Hawaii. Ocean

[97] Ocean Power Technolgies. (2013). Making Waves in Power. Ocean Power Technologies. Retrieved from: http://www.oceanpowertechnologies.com/about.html

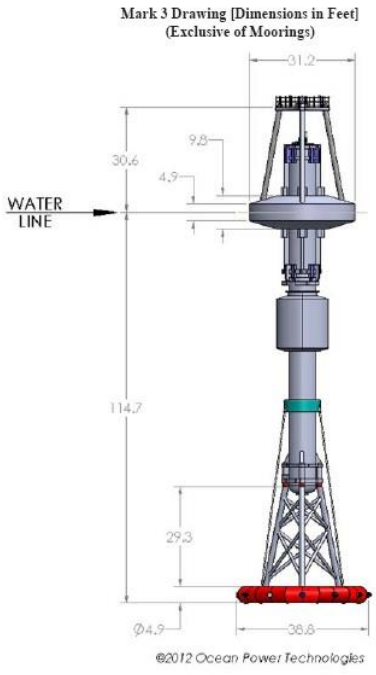
Power Technologies has created multiple different PowerBuoys, or wave power stations, that can be connected to a city grid system in order to provide electricity through ocean waves.

Out of the available PowerBuoys, a feasible model for use in Hermosa Beach, is the Mark 3 Powerbuoy (recently changed from the PowerBuoy 150).[98] Table 2 shows the specifications for The Mark 3 as having a peak generator rating of 866 kW and a capacity factor of 30-45% . Its wave height range for normal operations is 1-6 meters and the minimum water depth needs to be 55 meters. It has an achieved average electrical power of 45 kilowatts at wave heights as low as 2 meters.[14] If we assume that a Mark 3 PowerBuoy installed off the coast of Hermosa Beach produces an average of 45 kilowatts or 394,470 kilowatt-hours per year, then it could power about 20% of municipal operations.

Table 11: Mark 3 Specifications, Figure 20: Mark 3 Dimensions

Mark 3 Specifications

Peak Generator Rating	866 kW
Overall Length	144 ft.
Height above waterline	29.5 ft.
Float diameter	36.1 ft.
Weight	150 tons
Design life	25 years
Output Voltage & Frequency	600 V at 60 Hz 575 V at 50 Hz
Power Factor:	± 0.9
Mooring	Three-point
Deployment	Tow-out with standard tug
Wave height (range for normal operation)	1 to 6 meters
Water depth (min)	55 meters



[98] Ocean Power Technologies. (2012). OPT Mark 3 PowerBuoy: Utility Power from Ocean Waves. Ocean Power Technologies. Retrieved from: http://www.oceanpowertechnologies.com/PDF/OPT_Mark3_Feb2013.pdf

The main concern in installing a Mark 3 is if the waters off the shores of Hermosa Beach meet all the necessary specifications (see Table 11: Mark 3 Specifications, Figure 20: Mark 3 Dimensions). Without meeting these requirements, the PowerBuoy will not function optimally and will no longer be a worthwhile investment. Fortunately, Hermosa Beach does meet the requirements such as water depth (exceeds 55 meters off the coast) and average wave height (wave height close to shoreline is around 1 meter).[99] The best zones for wave power are those between 30 and 60 degree latitudes and Hermosa Beach is at 34 degrees latitude.[100] Wave power is also more effective off the west coast of continents. [101] Hermosa Beach needs to address not only the technical limitations of the Mark 3, but their residents' concerns of this new technology. The local government has considered the fact that the public desires an unobstructed view to the ocean and that adding wave power would hinder the aesthetics. Even though the Mark 3 is 144 feet, its visible height is 30 ft. As the majority of it is underwater, the Mark 3 maintains a relatively low surface profile for a wave power station. The aesthetic significance of the wave power station in Hermosa Beach's waters is yet to be determined. A buoy could either be a nuisance or a visible symbol of Hermosa Beach's connection to the ocean and commitment to renewable energy and climate action.

Many variables need to be taken into account when choosing the buoy's optimal distance from shore. These variables include optimal wave height, optimal depth, minimum visibility, and length of the power cable needed. Costs are yet to be determined, but the Department of Energy has offered financial assistance for past OTP projects. A single PowerBuoy is estimated to cost at least 1 million USD.[102]

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[99] Surfline/Wavetrak, Inc. (2013) Southern California: South Los Angeles: Hermosa Beach HD Cam and Report. (2013). Surfline. Retrieved from: http://www.surfline.com/surf-report/hermosa-beach-southern-california_4902/

[100] European Ocean Energy Association. (May 2007). SET Plan meeting May 7th, 2007. European Ocean Energy Association. Retrieved from: http://www.waveenergy.dk/files/SET.pdf

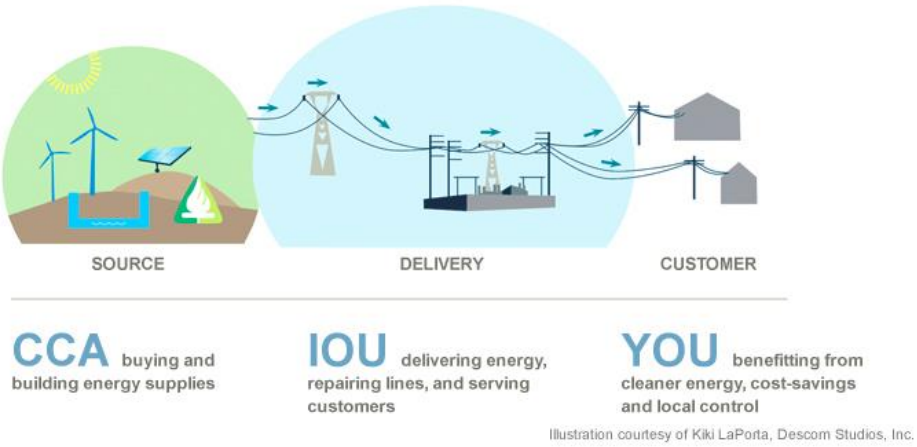
[101] Ocean Energy Council, Inc. (2012). Wave Energy. Ocean Energy Council, West Palm Beach, Florida. http://www.oceanenergycouncil.com/index.php/Wave-Energy/Wave-Energy.html

[102] Net Resources International. (2013). Reedsport Wave Power Station, United States of America. Power-Technology.com. Retrieved from: http://www.power-technology.com/projects/reedsportwavepowerst/

Though wave power is expensive and not highly tested on the west coast of the U.S., it is something Hermosa Beach should consider installing in the future. There is only so much intermittent solar or wind power the city could utilize before they must turn to a more constant renewable source such as wave. A wave power station will be easier to implement under a Community Choice Aggregation and may stand as a symbol for Hermosa Beach's desire to reach carbon neutrality.

Community Choice Aggregation

Figure 21: Community Choice Aggregation[103]



Community Choice Aggregation, or CCA, was authorized in California by Assembly Bill AB 117 in 2002. It is a system that allows cities, counties, and groups of cities and counties to take over the role of energy provider. A CCA allows the aggregation of the electrical load of residential, municipal, and business accounts within the CCA's jurisdiction. The governing body then chooses which utility companies will provide them with electricity by securing new contracts with suppliers. All energy-delivering infrastructure, billing, and customer service will remain the same and be handled through the existing utility (Southern California Edison in this case), so the customer will see no change in service (see Figure 21).[103] The customer's energy bill will be paid to Southern California Edison, and Southern California Edison will collect these charges and transfer the funds to the CCA. Customers

[103] Lean Energy US. (2012). Lean Energy US,Mill Valley, CA. Retrieved from: http://www.leanenergyus.org/

do have the choice of opting out of the CCA program and remain with their existing utility. The local government will usually vote on whether or not to participate in a CCA. Once it has been decided to form a CCA, the local government will adopt an ordinance proclaiming their decision and file an Implementation Plan with the California Public Utilities Commission.[104] Community Choice Aggregation Pilot Project: Appendix G guidebook provides a thorough background for any governing body interesting in forming a CCA and should be cited during its implementation. [104]

Because Hermosa Beach has no control over the power generation mix of Southern California Edison, Community Choice Aggregation will allow the city to decide which specific suppliers they should purchase electricity from and in what amounts. Consequently, Hermosa Beach can regulate what amount of their electricity is generated from renewables. A CCA also allows them to provide and allocate funds to their own local sources such as wind, solar, wave. Hermosa Beach's local government will essentially replace Southern California Edison and function as the city's new energy provider in order to increase their area of influence to the electricity generation source. This will expand the emissions-related boundaries that Hermosa Beach may consider in negating carbon emissions, giving them more control over their electricity-generating sources.

As previously stated, 20.6% of Southern California Edison's power was generated from renewables in 2012 and is striving for 33% by 2020 under the Renewable Portfolio Standard. If Hermosa Beach wants to attain a greater proportion of renewable and zero emissions electricity generation than Southern California Edison, it should consider forming a CCA. Hermosa Beach could coordinate with other South Bay cities such as Redondo Beach to jointly pursue a CCA which could potentially result in increased administration efficiency and economics of scale in contract pricing.

The benefits of CCA include customer choice/influence, local accountability such as rate setting, reduced energy costs, increased price stability, affordable renewable energy, environmental benefits, ability to wheel electricity (generate in one location, use it in another), energy security, and energy

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[104] Stoner, P., & Dalessi, J. (2009). Pier Final Project Report: Community Choice Aggregation Guidebook (No. CEC-500-2009-003). Retrieved from http://www.energy.ca.gov/pier/project_reports/CEC-500-2008-091.html

efficiency. CCA could lower the amount of emissions associated with Hermosa Beach by substantially decreasing the amount of fossil fuels used at the source. However, it will not directly affect the customers' activities. The only thing that will change for the customers is the price on their bill, which could either increase or decrease, depending on the situation. Customers do not have to make any drastic changes like adding solar to their roofs or changing their energy habits. However, there is a Cost Responsibility Surcharge (CRS) or "exit fee" that is charged to the customers leaving the investor-owned utility's service. This cost is set by the California Public Utilities Commission and will ensure that the costumers who remain under the investor-owned utility will be protected from increasing rates that may result from so many customers leaving. The CRS is determined by comparing the current market price of electricity to the average cost of the utility's generation resources. Even though this charge will be incurred, CCAs may be able to reduce electric rates compared with investor-owned utilities through the use of local government financing. This is because private financing costs can be more than twice those of a CCA.[105] One of the biggest benefits of a CCA is that it provides the customers with a platform to voice their opinions on their energy sources as their governing body will be much more inclined to listen to their demands and have the power to act on them.

However, there may be potential difficulties in implementing a CCA. When CCA was being considered in the Bay Area, Pacific Gas and Electric tried to fight its implementation. The utility supported and funded Proposition 16, an act that would make it much harder for governments to establish CCA. Southern California Edison remained neutral on Prop 16 and on the implementation of CCA in the Bay Area. However, Southern California Edison may not be as complacent if CCAs emerge in their service territory. There is a possibility that they may act as Pacific Gas and Electric has and pour millions into stopping the formation of CCAs.[25] Although proponents of CCA argue that electricity rates will likely be lower under a CCA, there is a legitimate risk that they could be higher than the

[105] Local Government Commission. (2011) Community choice Aggregation. Local Government Energy Commission, Sacramento, CA. Retrieved from: http://www.lgc.org/cca/docs/cca_energy_factsheet.pdf

utility's. There are many variables and risks in cost planning which can be mitigated by good management.

Two notable Community Choice Aggregations in California are Marin Clean Energy in Marin County and CleanPowerSF in San Francisco. Marin Clean Energy offers two options to their customers: the Light Green 50% Renewable Energy Program and the Deep Green 100% Renewable Energy program. Customers will be automatically receive Light Green energy after enrolling in the CCA and can voluntarily enroll for the Deep Green program for $5 more per month. Electricity rates have not changed drastically and Marin Clean Energy customers have seen only a 90 cent increase per month for 2013.[106] CleanPowerSF offers 100% renewable electricity generation for their customers, but at a higher rate than set by Pacific Gas and Electric. It will also provide new renewable energy facilities and focus funds and as well as offering employment opportunities in local energy projects.[107] Both Marin Clean Energy and CleanPowerSF provide options as to how to run a CCA and demonstrate the success in overall CCA renewable generation.

We believe that implementing a Community Choice Aggregation will be the most direct way for Hermosa Beach to gain control over their carbon emissions. By implementing CCA, Hermosa Beach will have almost complete energy freedom. Instead of having the investor-owned utility make all electricity-providing decisions for them, Hermosa Beach will have greater control over the amount of direct emissions as they would have the power to decide their ideal amount of renewable generation within the limits of the available providers. A CCA also benefits the people in that they are not required to drastically change their lifestyles or reduce their electricity consumption. If cities formerly under Southern California Edison pursue the implementation of CCAs for the purpose of increasing their renewable generation mix, Southern California Edison may be pressured to increase their renewable mix to avoid losing more customers to CCAs. Forming a CCA to reach carbon neutrality will

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[106] Marin Energy Authority. (2013). Clean Energy. Competitive Rates. Marin Clean Energy. Retrieved from: https://mcecleanenergy.com/rates-res

[107] San Francisco Public Utilities Commission. (2011). About CleanPowerSF. San Francisco Water, Power, Sewer. Retrieved from: http://sfwater.org/index.aspx?page=577

be a long, arduous, and potentially risky process, but the benefits of implementing this program will be immense.

Natural Gas Source Based Implementation Measures

Recollect the previous discussion addressing the importance of the origins of natural gas and fugitive emissions in emissions accounting. The origin of the gas and delivery by Southern California Gas Company plays a significant part in source-based natural gas emissions within Hermosa Beach. Hermosa Beach should reduce fugitive emissions resulting from the transport of natural gas by insulating and renovating distribution pipelines and independent facility pipeline systems within the jurisdictional boundary. There will also need to be a shift toward biogas, a carbon neutral gas source. We project that the demand for biogas will push independent facilities to supply biogas to the surrounding jurisdictions, or natural gas distributors will need to transition a larger percentage of biogas into pipelines. Looking into the future, local wastewater treatment plant emissions, landfill emissions, and other "waste" emissions should be harnessed as a source of renewable energy. Therefore, Hermosa Beach should look into ways to increase the supply of the biogas to their facilities and inhabitants in conjunction to retrofitting their pipelines to minimize fugitive emissions during transport.

3.2 Activity Based Building Energy Efficiency Implementation Measures

It is essential to understand the restrictions behind what the local government feasibly can and cannot employ when looking for implementation measures to reduce natural gas and electricity. According to the Hermosa Beach Community Greenhouse Gas Inventory, residential and commercial/industrial buildings are the primary natural gas emission sources. Both compliance and voluntary mechanisms can be applied to Hermosa Beach's municipal and community emissions to push for changes in building efficiency.

In this discussion, we will first address ways to refuel the political and social structure to enforce mechanisms that ensure both new and retrofitted construction exceeds all current efficiency-building codes. Compliance to the following measures is easiest to enforce in municipal operations because the local government has direct oversight of emission sources and activities of their facilities. Direct changes in community emissions, however, will be slightly more difficult to mandate because private

property rights restrict the amount to which the local government can enforce such measures. However, we will then give voluntary retrofit solutions for natural gas and electricity emission community sources, and look for ways in which Hermosa Beach can incentivize these retrofits within private construction. In order to address the overall emissions footprint of energy consumption both from electricity and natural gas, we will recommend various efficiency measures to mandate through legislation and increase citizen voluntary reduction measures within our emissions boundaries.

Compliance Mechanisms – Green Building Ordinances

Hermosa Beach, as a California city, already has access to many guidelines and predefined protocols that the state developed and enacted toward their own reductions and greenhouse gas emissions scopes and boundaries. The state of California, especially since AB32, has ensured that green building strategies and environmentally advanced construction practices are implemented to reach energy consumption and reduction goals through the usage of measures like Title 24, AB1103 and the LEED Certification process (to name a few).

- Title 24
    - The California Green Building Standards Code (CAL Green) creates a mandatory standard for new residential and nonresidential building design and construction to reduce negative impacts and encourage sustainable construction practices in planning and design, energy efficiency, water efficiency and conservation, material resource efficiency, and environmental quality. All newly constructed buildings and structures such as state owned buildings, low-rise residential buildings, qualified historical buildings, general acute care hospitals, and gray-water systems in the state of California must abide by this code. The CAL Green code is updated with more aggressive building efficiency standards on an approximate three-year cycle, and as of January 1, 2014, the new 2013 standard will go into effect. The 2013 Standards will use 25% less energy for lighting, heating, cooling, ventilation, and water heating than the 2008 Standards.

      In addition to the enforced mandatory measures of the code, CAL Green Building Efficiency Standards offer voluntary measures, which provide more aggressive and

advanced building construction guidelines beyond baseline measures. Voluntary measures are not mandatory unless adopted by a local government, and are enhanced options that encourage additional green building measures. CAL Green Building Efficiency Standards offer two tiers: Tier 1 and Tier 2. For the purpose of the discussion of natural gas and electricity reduction in Hermosa Beach, we particularly looked at the energy efficiency sector of each tier. Tier 1 and Tier 2 status for residential and nonresidential buildings are encouraged to achieve exemplary performance in the area of energy efficiency. In order to reach Tier 1 status, a project must comply with all mandatory CAL Green Standards and exceed the California Energy Code by 15%; and in order to reach Tier 2 status, projects must comply with all mandatory CAL Green standards and exceed the California Energy Code by 30%. All sections of construction practices provide thorough examples and solutions to neutralizing building environmental impacts. Both residential and non-residential building energy efficiency measures address building envelope, air sealing packages, HVAC systems, water heating, lighting, appliances, and renewable energy – all of which are major sources and activities of building emissions. Therefore, Tier 1 and Tier 2 voluntary measures can offer a guideline to appropriate energy efficient alternatives and upgrades to reduce emissions. Although the CAL Green code is not inclusive of all building types in Hermosa Beach, it can be used as a tool by local governments to enforce stricter standards in municipal operations, and provide parameters or guidelines to help reduce community operations' building emissions.[108]

- Energy Upgrade California

[108] California Building Standards Commission. (2010). 2010 California Green Building Standards Code, California Code of Regulations, Title 24, Part 11. U.S. Government Printing Office.

- Energy Upgrade California is an unprecedented alliance among California counties, cities, non-profit organizations, and statewide utilities. The goals of the program are to help residential and commercial builders become knowledgeable about energy efficient options and the financing options available for energy upgrades from State Energy Programs, local rebates, appliance and renewable energy rebates, energy financing programs, and utility company home upgrade programs.[109] Energy Upgrade California is a centralized resource for building contractors and consumers to use to find the best information on energy efficient measures. Natural gas and electricity power all building energy; therefore, Energy Upgrade California standards, information, and services can act as a resource to ensure that knowledgeable energy efficiency contractors are making the most aggressive changes to construction projects to reduce building emissions. Energy Upgrade California offers a strong tool for building upgrade energy bundles and incentives to push building owners to invest in energy upgrades.

- AB 1103
    - Another California measure, AB 1103 requires commercial building owners to disclose Energy Star Portfolio Manager benchmarking data on energy consumption and usage within their buildings to all prospective buyers, tenants and lenders in commercial real estate transactions. The Building Energy Disclosure helps to foster green building by motivating building operators to take actions to improve the energy profile and helps justify financial investments.[110] The purpose of AB 1103 is to determine and document the energy efficiency of commercial buildings and decreases its consumption through energy efficient upgrades. Commercial building ratings help to reduce building operation costs whilst reducing greenhouse gas

[109] Energy Upgrade California is a site that presents the full text of many essential works in literature about energy efficient building upgrade options.

[110] AB 1103, Chapter 533 (2007). California Public Resources Code Section 25402.10

emissions. San Francisco recently used the legislation as a basis to pass an ordinance requiring residential buildings to also perform energy efficient audits, file annual energy benchmark summaries for buildings and make environmental findings. [111]

- LEED Certification
    - Used throughout the United States, the Leadership in Energy and Environmental Design (LEED) voluntary building certification has become increasingly more influential and distinguished as LEED certified buildings lower operating costs, reduce waste, conserve energy and water, create a healthier environment, and qualify for tax rebates, zoning allowances and other incentives. LEED buildings provide a competitive edge and limits health and environmental risks, which ultimately attracts more tenants. There are LEED standards for both new and existing buildings, which widens the scope of efficiency building retrofits and remodels to be all-inclusive. Even though LEED is voluntary based, professionals and state and local governments alike are attracted to the certification process to transform their built environments. [112]

The local government of Hermosa Beach can use aspects of each of these predefined standards and codes to their advantage in order to reach private carbon neutrality goals. The CALGreen code is effective for building efficiency standards, but the main downfall is that standards are only mandatory for new building construction. Because Hermosa Beach is located in California, all new residential and nonresidential building construction must comply; however, Hermosa Beach is predominantly pre-developed so the majority of construction performed within the city consists of retrofits and remodels. Therefore, Hermosa Beach should enforce measures within their

[111] AB 1103 is a site that presents the full text of many essential works and literature about the legislation AB 1103 and related ordinances.

[112] US Green Building Council LEED is a site that presents the full text of many essential works in literature about sustainable development and green building.

jurisdictional boundaries to mandate CAL Green building standards code to not only new buildings, but also all building retrofits and remodels.

Municipal Operations

For all municipal operations emissions, Cal Green standards can help alleviate emissions because stricter standards are easily enforced on city owned or leased buildings for which the local government has direct oversight. The city can then ensure that all municipal buildings reach Tier 2 status, the most aggressive tier of CAL Green Standards, and/or LEED Gold certification. Local governments can use the Cal Green code or LEED certification process to ensure all retrofits and remodels of buildings obtain the highest levels of efficiency. Because standards are constantly updated, Hermosa Beach can guarantee that their municipal operations are always up to date with the most current energy efficient innovations.

Community

Emission sources and activities based from the community will require local government legislation, or green building ordinances, to enforce both residential and nonresidential remodeling and retrofits of all sizes to comply with the highest tiers of energy efficient building standards. We recommend that the city enact this through the use of the following compliance mechanisms:

1. Restricted permit distribution
2. Mandatory audits
3. Designated contractors for construction in Hermosa Beach

Permits

The City of Hermosa Beach can use permits to ensure that citizens apply to all green building ordinances within the jurisdictional boundary. City officials can do this by providing expedited permit review to LEED Gold certification building plans and withholding occupancy permits to construction plans that are not firstly cleared by the city. We deduce that expedited permit review will create incentives to reach more aggressive standards, and any permit withholding will ensure all green building standards are met. Once plans are cleared by the city, construction can commence, but if construction fails to meet the cleared proposal, fines should be distributed accordingly. All funds obtained should then be returned to support carbon neutrality city-wide measures.

Audits

Similar to AB 1103, we recommend that there are mandatory energy efficiency audits on a regular basis, prior to renovations, and/or prior to selling residential and non-residential buildings. We deduce that these mandatory audits will educate, encourage, and provide financial justification to property owners regarding efficiency upgrades. The City of Hermosa Beach should create individual plans for citizens to reach emission reduction target goals that align with city target emission reduction goals. The mandatory audits every five years to all buildings will then ensure that these emissions reduction goals are being met. Audits will also be recommended to property owners who want to renovate or remodel in order to reach city standards for permit distribution. Audits and mandatory upgrades should be implemented to all properties prior to real estate transactions. This will ensure that with every change in ownership, there will be a mandated energy efficiency upgrade to the particular building.

Energy rating systems, such as the HERS Providers and Raters approved by the U.S. energy commission offers third party certified energy efficiency auditing that could be employed in Hermosa Beach.[113] However, it would be advised that Hermosa Beach uses the HERS trainee system or other energy efficiency auditor training to create their own auditing service for building inspections. An independent Hermosa Beach efficiency trainee system could push for more aggressive upgrades and retrofits, which align with city carbon neutrality specific goals. Further research and analysis of recommendations provided by Energy Upgrade California rating systems or The ENERGY STAR building certifications will help Hermosa Beach develop and establish their own auditing service that can ensure compliance to building codes, and push for new more aggressive, optional standards that are developed over time.

Contractors

Energy Upgrade California offers a wide-ranging list of local contractors, which help plan and complete green building upgrades. Hermosa Beach however should also look into developing their

[113] More information regarding HERS can be found at http://www.energy.ca.gov/HERS/providers.html

own contracting license, which is then only distributed to contractors who have completed a comprehensive efficiency training that educates trainees about the newest building efficiency strategies. The local government can then decide if they will allow other contractors to be used within the jurisdictional boundaries, or if construction within the city is limited to only those with the specific green city contracting license. In doing so, Hermosa Beach can obtain desired emission reduction results from building construction and retrofits, because the mandatory governmental license can ensure that the contractor is knowledgeable on the most updated energy upgrades in green building codes. Hermosa Beach can enforce stricter, more aggressive green building standards by using green building ordinances as a compliance mechanism.

Voluntary Mechanisms

The majority of buildings within the city of Hermosa Beach are already established developments and privately owned buildings. This being the case, the majority of activity-based emissions within community operations are out of the local government's control and therefore, the government must incentivize citizens to voluntarily upgrade technology, appliances and building infrastructure to be more energy efficient. Hermosa Beach can require upgrades to citizens prior to real estate transactions and mandatory audits, but once it becomes time to make the decision to purchase and install upgrades, the decision is ultimately up to the citizen consumer.

Education and Consulting

Hermosa Beach will need to have voluntary green building targets that extend beyond mandatory codes in order to reach carbon neutrality. Community citizens must be well informed about available efficient upgrades, and the economics and environmental benefits behind such upgrades. For voluntary building energy upgrades to occur, the city must be willing to provide the necessary information and education to the public that make energy upgrades just as easy and accessible as the alternative. Independent municipal green building consulting services or third party green building-consulting services should be available to provide upgrade information to interested citizens, which align with Hermosa Beach reduction target goals. A major barrier seen in voluntary energy efficient upgrades is the initial costs of implementation. Consulting services can educate and incentivize consumers about long-term savings, financing options, and immediate rebates available.

PACE Financing

Hermosa Beach should further research Property Assessed Clean Energy (PACE) financing if they wish to see large-scale improvements to commercial and industrial building infrastructure. PACE financing is when the municipal government provides specific bonds to investors, which then loan out the money to consumers and businesses to invest in energy retrofits. PACE financing allows for consumers and businesses to finance energy upgrades to buildings and renewable energy installations that would otherwise be unfeasible. The loans for energy upgrades are tied to the property rather than the individual owner, and are paid back through property taxes over a long span of time. Property tax increases are negligible and building owners benefit from net gains due to energy savings, because financing is spread out over a long period of time.[114] Within Los Angeles County the type of properties that are currently eligible for PACE financing are commercial offices, retail/restaurants, industrial facilities, hotels, and apartment buildings. PACE financing would only work as an implementation measure in regards to commercial and industrial building emissions. Heating, ventilation, and air conditioning, building automation systems, elevator modernization, solar PV or fuel cell electricity, building envelop (ie. roof, windows, etc.), high efficiency lighting fixture and lamps, occupancy and day lighting sensors, and industrial manufacturing equipment all are eligible upgrades within the discussed building types.[115] Residential energy efficiency and clean energy investments had previously been covered by PACE and may be covered again in the future, but currently are unavailable by PACE financing programs.

Rebates and Incentives

Energy cost reductions that improve property owner's financial positions provides incentives to energy upgrade investors. In addition to long term net savings, rebates and other incentives provide immediate returns on investment costs. Programs, such as Energy Upgrade California, have comprehensive lists of rebates and incentives that can assist customers to pay for their energy

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[114] The Alliance to Save Energy. (2004). *Property Advanced Clean Energy (PACE) Financing.* Retrieved April 25, 2013 from http://www.ase.org/resources/property-assessed-clean-energy-financing-pace

[115] Los Angeles County PACE is a site that presents the full text of many essential works in literature about PACE financing within the LA Country region.

upgrade projects. Auditors and contractors work together to ensure customers receive all incentives, most of which are savings from in home energy improvements. The Environmental Service Center also offers several rebates. One rebate could save residents up to $4,500 if they participate in energy efficiency projects.[116] This can include projects such as air and duct sealing, and insulation of areas that would normally require a lot of energy to heat or cool. Private municipal contractors and raters could however ensure similar rebates and incentives, whilst pushing for more aggressive energy upgrades that align with city goals. The city can administer additional rebates and incentives through specific municipal contractors and auditors that push customers toward more aggressive bundles of energy efficient improvements. Energy efficient bundle upgrades will ensure continual voluntary improvements to older buildings throughout the city.

B. Transportation and Land Use

Transportation makes up the largest share of greenhouse gas emissions in Hermosa Beach. In the city's 2007 community greenhouse gas inventory, transportation was responsible for 79,388 metric tons of CO_2, which is 59% of total annual emissions. Gasoline alone contributed 55% of total emissions.[117] This massive environmental impact caused by transportation necessitates aggressive emissions reduction strategies to attain carbon neutrality. The following section will discuss transportation's environmental implications, provide an overview of transportation-related life-cycle emissions that occur within Hermosa Beach, and detail the accounting strategies we employed to determine the boundaries of the transportation sector. Then, specific greenhouse gas reduction options are presented and discussed for both operations and the community.

[116] More information can be found at http://www.sbesc.com/programs/residential/energy-upgrade-california.

[117] South Bay Cities Council of Governments (2010). City of Hermosa Beach: Community Greenhouse gas Emissions Inventory Report.

1. Environmental Implications and Life Cycle Analysis

Although the 2007 and 2010 greenhouse gas inventories do not quantify life cycle emissions and our analysis does not seek to neutralize upstream emissions from vehicle manufacture, these emissions can be substantial for Hermosa Beach. In the transportation sector, greenhouse gas emissions can result from three main processes: vehicle manufacturing, vehicle travel, and energy production. The interactions of these different processes and systems with all the sectors in Hermosa Beach are represented in the Hermosa Beach System Diagram, as seen in Figure 4.

Vehicle manufacturing emissions can be estimated for Hermosa Beach based on the number of vehicles registered in Hermosa Beach and per vehicle life emissions estimations found in academic literature. As seen in Table 13, in 2007 10,893 sedans and 7,195 pickup trucks were registered in Hermosa Beach.[118] Due to the lack of accurate data, these calculations exclude the number of buses and other means of public transit used by Hermosa Beach residents. This data also does not include off-road transportation vehicles owned by Hermosa Beach residents. Calculations assume that the distribution of vehicles in Hermosa Beach has not changed substantially between 2007 and the 2013. Table 13 conveys the carbon emissions that result from the vehicle manufacturing and maintenance processes. By adding these values and multiplying them by the number of vehicles registered, a total manufacturing and maintenance emissions value of metric tons greenhouse gas-equivalent (GHG-e) was calculated.[118]

Carbon emissions from vehicle travel are known as tailpipe emissions and are produced by the combustion of fuel in vehicle engines. Vehicles are therefore considered mobile sources of emissions and vehicle travel is an emission-generating activity. The existing greenhouse gas inventories from 2007 and 2010 provide estimations of Hermosa Beach's vehicle travel emissions. To quantify emissions from vehicle travel, travel is divided into producing trips, attracting trips, local trips, public transit, air travel, and off-road transportation. As consistent with the new ICLEI U.S.

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[118] R.L. Polk & Company. (2010). "Los Angeles County Vehicle Registrations by Zip Code."
ICF International. (2012). "Los Angeles County Regional Greenhouse gas Inventory" (draft).

Community Protocol, Hermosa Beach is attributed 50% of emissions from producing and attracting trips and 100% from local trips.[119] Vehicle travel emissions are influenced by the number of vehicle miles traveled (VMT), the vehicle fuel efficiency, and the fuel carbon intensity.[120] Details on the values of vehicle travel emissions will be provided in the following sections.

Table 12: Per vehicle life greenhouse gas emissions in metric tons CO2-e[121]

	Sedans	Pickup trucks
Manufacture	8.5	8.3
Automotive Repair	0.00015	0.00011
Tire production	1.3	1.2
Maintenance	3.3	3.3
fixed costs/ Insurance	1.1	0.99
Idling	N/A	N/A
Total:	14.20015	13.79011

Table 13: Estimated vehicle manufacturing emissions in Hermosa Beach 118 121

	Number of Vehicles registered in HB in 2007	Per vehicle life total manufacturing emissions (MT CO2e)	Total vehicle manufacturing emissions (MT CO2e)
Sedans	10893	14	160999
Trucks	7195	13	99219
Total:	N/A	N/A	260219

Energy production and fuel delivery emissions are estimated from the carbon intensity values for each fuel listed in the Low Carbon Fuel Standard. These values are based on the emissions

[119] ICLEI Local Governments for Sustainability. (2012). *U.S. Community Protocol for Accounting and Reporting of Greenhouse gas Emissions*.

Cambridge Systematics Inc. (2009). *Moving Cooler: An Analysis of Transportation Strategies for Reducing Greenhouse gas Emissions*. Washington, D.C.: Urban Land Institute.

[121] Chester, M. (2009). *Life-Cycle Environmental Inventory of Passenger Transportation in the United States.* (Doctoral dissertation). Berkeley: University of California Berkeley Institute of Transportation Studies.

produced by the initial extraction of fossil fuels and the following transport, refining, blending, and distribution processes. The main fuels used by California vehicles include CARBOB (California Reformulated Gasoline Blendstock for Oxygenate Blending), natural gas, diesel, biodiesel, ethanol, and electricity. Table 14 lists the emissions that result from these fuels.

Table 14: Carbon intensity values associated with the production of fuels in California [122]

	Carbon Intensity Values (gCO2e/MJ)	CO2 emissions	units
CARBOB	99.18	12890	gCO2e/gallon
Ethanol	95.66	8473	gCO2e/gallon
CNG	67.7	0.007	gCO2e/therm
LNG	83.13	0.0087	gCO2e/therm
Compressed Hydrogen	142.2	142.2	gCO2e/MJ
Electricity	124.1	511.9	gCO2e/kwh
Biodiesel	15.84	1956	gCO2e/gallon
Diesel	98.03	13310	gCO2e/gallon

2. Transportation Areas of Concern

After examining all the emissions Hermosa Beach could be held responsible for, we had to decide which areas were of high concern and would be included in our boundaries.

Table 15 displays each emissions-generating process or stock associated with Hermosa Beach and provides information about Hermosa Beach's level of influence, the proportion of the emissions located within Hermosa Beach, the location of the emissions, and how the emissions are created. When setting our boundaries, we decided to mainly focus on the level of influence Hermosa Beach has to mitigate the emissions. For the transportation sector, Hermosa Beach has little or no control

[122] California Air Resources Board. (2007).*Low Carbon Fuel Standard* (Final Regulation Order).

over many aspects of the vehicle manufacturing and energy production process. From the vehicle manufacturing process, our boundaries will only include vehicle acquisition, meaning that we consider the effect of the purchase decision on a vehicle's fuel type and future operating emissions. Our boundaries will include almost all components of vehicle travel—mode choice, producing trips, attracting trips, local trips, public transit, and recreational travel. While we consider the effect of air travel on the community's greenhouse emissions, we do not include this or off-road transportation emissions in our quantitative analysis. 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. In the following sections we will discuss the main municipal and community sources of emissions within these boundaries.

Table 15: Level of influence and geographic relation of greenhouse gas emissions affiliated with Hermosa Beach

Process or Stock	Details	Influence	Geographic Relation
Vehicle Manufacturing Process			
Extraction & Transport	Emissions from energy used in extracting and transporting raw materials, potential fugitive emissions from extraction	Little or no control	Outside
Automobile Manufacture	Emissions from energy used in the manufacturing process, potential fugitive and process emissions	Little or no control	Outside
Transport of Finished Vehicle to Dealership	Emissions from energy used in transportation of vehicle	Little or no control	Outside
Auto Dealer	Any emissions associated with the dealership before vehicles are sold	Little or no control	Outside
Vehicle Acquisition	Determines the type of fuel a vehicle will use and the carbon footprint of the vehicle	Indirect Control	Outside
Vehicle Travel			
Mode Choice	Emissions affiliated with various types of transportation—walking, biking,	Indirect Control	

	driving, carpooling, transit, etc.		
producing trips	tailpipe emissions from trips from Hermosa Beach	Indirect Control	Inside & outside
attracting trips	tailpipe emissions from trips to Hermosa Beach	Indirect Control	Inside & outside
local trips	tailpipe emissions from trips completely within Hermosa Beach	Indirect Control	Inside & outside
Public transit	tailpipe emissions inside and outside Hermosa Beach	direct, delayed control	Inside & Outside
air travel	aircraft emissions for passengers traveling to or from Hermosa Beach	little or no control	Outside
off-road transportation	lawnmowers, leafblowers, tractors, other equipment	little or no control	Inside & Outside
Recreational travel	Within boundaries, including 3 miles off-shore	Indirect Control	Inside

Energy Production & Fuel Delivery			
Oil deposits	This is the ultimate source of combusted fossil fuels	little or no control	Outside
transport & Extraction	Combustion (tailpipe) emissions from transport, emissions from any energy used in transport	little or no control	Outside
refining	Process, fugitive, and combustion emissions at the refinery	little or no control	Outside
Blending & Distribution	At this phase, blenders can introduce bio-fuel which reduces the anthropogenic carbon content of the delivered fuel	little or no control	Outside
Transport	Combustion emissions from the transport vehicle	little or no control	Mostly Outside
Gasoline Station	Any emissions associated with the manufacturing of materials of which the station is constructed, fugitive emissions from gasoline pump	indirect control	Inside & Outside
Alternative Fuel Station	The availability of alternative fueling infrastructure is important for use of alternative fuels	Indirect control	
Refueling	Decision of which fuel use in a flex-fuel vehicle and purchase of fuel	indirect control	Inside & Outside

2.1 Municipal Operations Emissions

In Hermosa Beach, transportation-related activities are the most influential contributors to the city's municipal carbon footprint. In 2007, the transportation sector accounted for fifty-one percent of total municipal operation emissions, or 648 metric tons CO2e.[117] The main sources of these emissions were employee commutes, the city vehicle fleet, and contract vehicles. Emissions from the city vehicle fleet can be categorized as scope 1 while both the employee commutes and contract vehicles are categorized as scope 3. As seen in Table 16, employee commutes were responsible for 25% of emissions, the city vehicle fleet was responsible for 20%, and contract vehicles were responsible for 6%.[117]

Table 16: Municipal Sources of transportation-related greenhouse gas emissions in 2007[117]

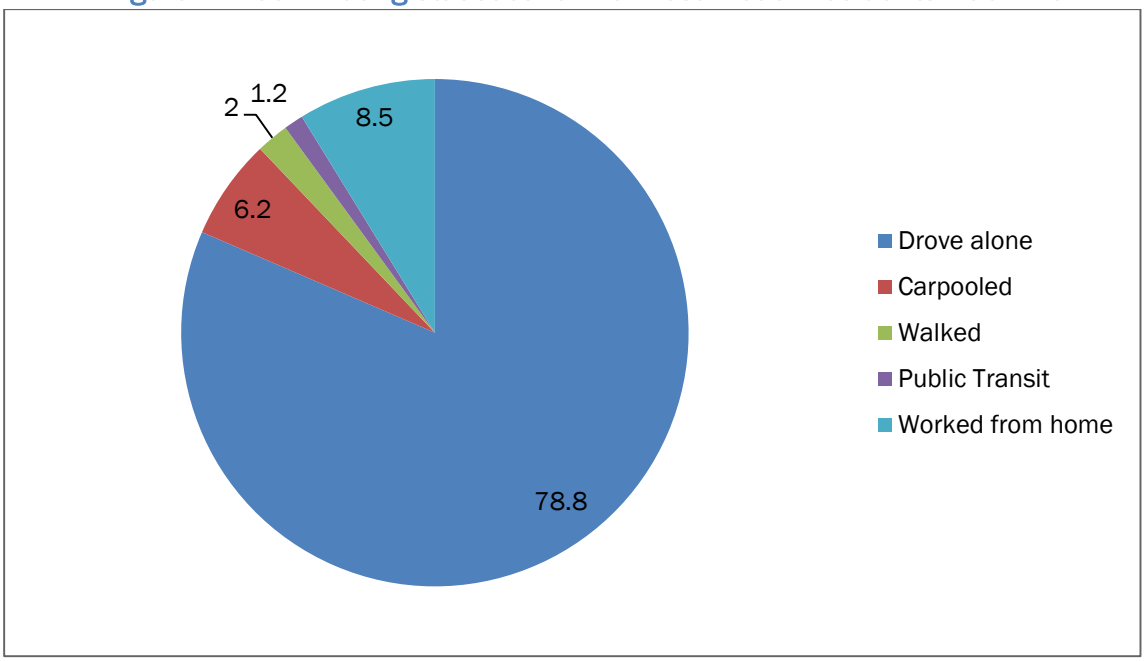
	Metric tons CO2e	Percent of municipal operation emissions
Employee Commute	379	25%
City Vehicle Fleet	184	20%
Contract Vehicles	85	6%

2.2 Sources of Community Greenhouse Gas Emissions

Out of all the sectors in Hermosa Beach, transportation contributes the most to community carbon emissions. In 2007, transportation contributed to 78,735 metric tons CO2e, which comprised 59% of total community emissions. The main sources of community transportation greenhouse gas emissions are commuting and work trips, shopping trips, social trips and even air travel trips. Because of the limited availability of public transit in the Hermosa Beach area, most residents of Hermosa Beach drive to work. Between 2007-2011, 78.8% of the population drove in a single occupancy vehicle to work, 6.2% carpooled, 2% walked, 1.2% took public transit, and 8.5% worked from home.[123] See Figure 22 for this data.

[123] U.S. Census Bureau. 2007-2011 American Community Survey. Hermosa Beach City, California.

Figure 22: Commuting statistics for Hermosa Beach residents 2007-2011[123]



This high proportion of Hermosa Beach residents that drive alone to work is surprising when compared to their distribution of work locations. As of 2010, 43.6% live less than ten miles away from their place of employment and 38.5% live within 10-24 miles.[124] Hermosa Beach residents commute to work all over LA County. The most common commute destination is the City of Los Angeles, where 27.9% of residents are employed. South Bay cities such as El Segundo, Torrance, Manhattan Beach, and Redondo Beach are also work destinations for some Hermosa Beach residents, but all comprise less than 10% of total job count. Only 5.9% of jobs are located within Hermosa Beach.[124] Recognizing common travel corridors utilized by Hermosa Beach residents will be useful for the implementation of measures to reduce VMT.

3. Implementation Measures and Greenhouse Gas Reduction Options

To reduce both municipal and community greenhouse gas emissions from transportation, Hermosa Beach can implement reduction strategies that can reduce fuel consumed per mile traveled, vehicle

[124] U.S Census Bureau (2010). Center for Economic Studies. Retrieved from http://onthemap.ces.census.gov/.

miles traveled, or fuel carbon intensity. These three factors determine Hermosa Beach's greenhouse gas emissions from transport, as seen in the following equation:

$$Transportation\ GHGs = VMT \times Fuel\ per\ mile\ traveled \times Fuel\ Carbon\ Intensity$$ 120

Fuel consumed per mile traveled is influenced by several factors. Vehicle fuel efficiency, or miles per gallon (mpg) and vehicle and systems operations (speed, level of congestion, and amount of idling) affect how many miles are completed with a given amount of fuel. Fuel carbon intensity is a value of the amount of carbon emitted per unit of energy released.120 The following sections first discuss changes occurring at the state and regional level that will influence fuel carbon intensity and vehicle fuel efficiency of both municipal operations and the community. Then we will present specific municipal and community implementation measures.

3.1 Fuel Carbon Intensity

Because Hermosa Beach has little influence over fuel sold in the city, the city instead relies on regulations established at the national and statewide level. Fuel carbon intensity changes will influence both municipal and community emissions inventories. The following section will address policies set by California, the U.S. EPA, and SCAG to regulate transportation fuel carbon intensity, vehicle fuel economy, and other transportation related emissions.

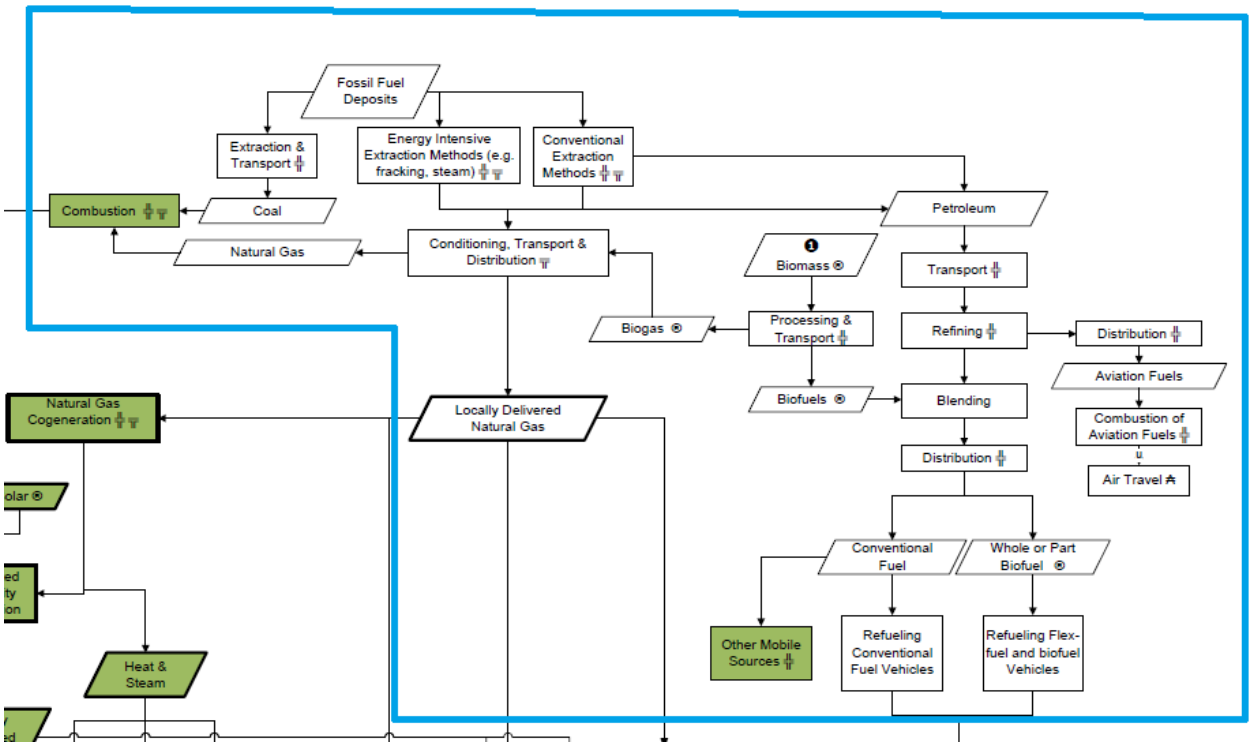
Sources of fuel in California

In California, crude oil, which is responsible for most of the transportation energy, mainly comes from within the state, Alaska, and foreign sources. In 2010, 37% of California's petroleum processed in the state's refineries originated in California oil fields.[125] Of that 37%, 66% of oil came from Kern county and 11% from LA County. However, in 2010 49% of California's oil came from foreign sources via ocean tanker, and this number is likely to increase as less oil is available in California. California is home to 18 operable petroleum refineries which mainly produce transportation fuels such as gasoline, diesel and jet fuel. California refineries produced 92.2% of the Reformulated Gasoline

[125] Matute, J.M. and Pincetl, S.S. (2013). "Energy Production and Use in California" in *Unraveling Petroleum: The Hidden Incentives that Keep California Driving*. San Francisco: Next 10.

consumed in the state (the remainder produced elsewhere due to ethanol blending) and more than 100% of the CARB- diesel consumed. Reformulated gasoline blends in California now consist of as much as 10% ethanol.[125] Figure 23 shows the upstream transportation energy emissions that occur from fuel production processes.

Figure 23: Upstream transportation energy emissions[126]



Renewable Fuel Standard

On the national scale, the EPA developed a Renewable Fuel Standard (RFS) under the Energy Policy Act of 2005 that is the first renewable fuel volume mandate in the U.S. The original RFS program called for gasoline to be blended with 7.5 billion gallons of renewable fuel by 2012. In 2007, the RFS was amended to include diesel and to increase the standard of required renewable energy fuel blended with gasoline to 9 billion by 2008 and 36 billion by 2022. This amended version also categorized new types of renewable fuels, established volume requirements for each fuel, and

[126] This is a close-up of transportation energy upstream emissions, see section E for the entire LCA diagram

mandated the establishment of lifecycle greenhouse gas performance threshold standards for all fuels.[127] These mandated increases in renewable fuels established by the EPA will likely decrease emissions in Hermosa Beach as a higher proportion of the fuels used in California vehicles are made from low carbon sources.

State Policies

At the state level, California has adopted many policies to reduce transportation related emissions that will ultimately affect Hermosa Beach's inventory. Some of the specific goals for the transportation sector that are outlined in California's Climate Change Scoping Plan are:[127]

1. California Light Duty Vehicle Greenhouse gas Standards
2. Low Carbon Fuel Standard (LCFS)
3. Regional Transportation related Targets
4. Vehicle Efficiency measures
5. Medium/Heavy Duty Vehicle Efficiency Measures
6. High Speed Rail

California Light Duty Vehicle Greenhouse Gas Standards

Also known as the Clean Car Standards, Pavley AB 1493 was passed in 2009 and requires a 30 percent decrease in emissions from new automobiles by 2016.[127] This has been incorporated as a federal standard. This will affect Hermosa Beach's emissions as many of the older cars in HB are phased out and replaced with cars manufactured after 2009. Another regulation, the Cool Cars and Reflective Glazing measure, was added to these standards and has been phased in with the 2012 model year. This regulation will reduce greenhouse gas emissions by decreasing heat gain inside vehicles. To be in compliance, vehicle manufacturers must equip passenger cars, pickup trucks, and SUVs with windows that allow less solar radiation to enter the vehicle, therefore decreasing the amount of air conditioning utilized. An amended version of this regulation was approved in 2009

[127] California Air Resources Board (2008). *Climate Change Scoping Plan* (Pursuant to AB 32 the California Global Warming Solutions Act of 2006).

and requires that 2016 and later model-year cars use other solar reduction technologies to meet a 60% reduction in heat absorption through vehicle windows.[127] As Hermosa Beach residents purchase new vehicles in the upcoming years, Hermosa Beach's emissions will be affected by these regulations.

Low Carbon Fuel Standard (LCFS)

The LCFS aims to reduce greenhouse gas emissions by decreasing the carbon intensity of the transportation fuel pool used in California. Enacted in 2007 and implemented in 2011, the LCFS has likely already altered HB's tailpipe emissions compared to the 2007 and 2010 inventory data. This regulation includes California reformulated gasoline (CaRFG), diesel fuel, Fossil compressed natural gas (CNG), Fossil liquefied natural gas (LNG), Biogas CNG, biogas LNG, electricity, compressed or liquefied hydrogen (hydrogen), hydrogen blends, ethanol blends, biodiesel, pure ethanol, fuel blend with biodiesel, and any other liquid or non-liquid fuel. The LCFS requires that as of January 1, 2011, gasoline, substitute fuels, and diesel fuels must meet average carbon intensity requirements as outlined in Table 17 and Table 18: 122

Table 17: Average carbon intensity requirements of gasoline and substitute fuels by year122

Year	Average Carbon Intensity (gCOEe/MJ)
2010	Reporting Only
2011	95.61
2012	95.37
2013	97.96
2014	9.47
2015	96.48
2016	95.49
2017	94.00
2018	92.52
2019	91.03
2020 and later	89.06

Table 18: Average carbon intensity requirements of diesel and substitute fuels by year122

Year	Average Carbon Intensity (gCOEe/MJ)
2010	Reporting Only
2011	94.47
2012	94.24
2013	97.05
2014	96.56
2015	95.58
2016	94.6
2017	93.13
2018	91.66
2019	90.19
2020 and later	88.23

For alternative fuels, all fuels other than biomass-based diesel fuels that are used in a single-fuel light-duty or medium-duty vehicles must adhere to the same average carbon intensity value as gasoline. Biomass-based Diesel Fuel must meet the same average carbon density value as set for diesel fuel (as stated in Table 18) if it is intended for a single- fuel light-duty vehicle, medium-duty vehicle, or heavy duty vehicle, off-road equipment application, off-road transportation application, locomotive or commercial harbor craft application, or any other non-stationary source application. 122

Regional Transportation Related Targets

SB 375 sets transportation related greenhouse gas reduction targets for regions throughout California. For Southern California, the plan calls for a reduction of greenhouse gas emissions resulting from passenger vehicles of 8% per capita by 2020 and 13% per capita by 2035 (relative to 2005 values). Hermosa Beach's efforts to achieve carbon neutrality will help California comply with these targets.[127]

Vehicle Efficiency Measures

Vehicle Efficiency measures set out in the Climate Change Scoping Plan focus on decreasing emissions due to inefficient tire use. These measures include a public awareness campaign to encourage sustainable tire practices, regulation that requires the proper inflation of tires when vehicles are serviced, and the development of an efficient tire program. Emissions from these measures are expected to be minimal but will still make a difference in HB's inventory. [127]

Medium/ Heavy Duty Vehicle Efficiency Measures

The Scoping Plan proposes the adoption of a Heavy-duty Aerodynamic Efficiency Measure and a Medium/ Heavy Hybridization Measure to reduce the greenhouse gas emissions resulting from medium and heavy duty vehicles in California. These regulations were put into effect in 2010 and likely will affect HB's emissions.[127]

High Speed Rail

The High speed rail system is a 700 mile long rail system that is expected to reduce greenhouse gas emissions by giving Californians more alternatives to driving and flying. This may influence the long distance VMT of Hermosa Beach residents.[127] However, the close proximity of LAX to Hermosa Beach may continue to make air travel the most convenient option for Hermosa Beach residents, therefore weakening the rail's effects on long distance trips.

3.2 Vehicle Efficiency

Reducing reliance on gasoline and diesel would drastically decrease tailpipe emissions attributed to Hermosa Beach. One way to decrease petroleum use is to encourage the adoption of alternative fuel vehicles. The market for alternative fuel vehicles in Hermosa Beach is likely to increase over the next decade due to market forces and state policies. Electric vehicles and hybrids have been on the rise for the last decade and alternative fuel vehicles run by natural gas, ethanol, biodiesel, and hydrogen fuel cells are projected to increase in demand as technology improves and oil prices rise. Existing policies entice consumers to switch to alternative fuel vehicles through incentives, subsidies, and privileges. Other policies focus on improving alternative fuel vehicle refueling infrastructure.[125] Table 19 lists the existing alternative fuel vehicle purchase and fueling infrastructure incentives that may apply to Hermosa Beach residents. Hermosa Beach can support the adoption of alternative fuel

vehicles by educating residents on the benefits of alternative fuels and providing incentives for driving low emission vehicles. Hermosa Beach currently offers free metered parking at silver post meters for 100% alternative fuel vehicles, waives building permit fees to upgrade electric service for 100% electric vehicles and grants high-occupancy vehicle lane access to hydrogen FCV, BEV, and NG powered vehicles displaying a white decal.[128] Hermosa Beach could increase these incentives to create more free parking for these vehicles and provide monetary incentives to employers within Hermosa Beach who use alternative fuel vehicle fleets.

We also recommend Hermosa Beach increase the availability of alternative fueling stations, especially publicly-accessible electric vehicle service equipment but also hydrogen and natural gas refueling infrastructure as the market warrants. Figure 24 conveys the current locations of alternative fueling stations within 20 miles of Hermosa Beach. Despite the growing alternative fuel vehicle market, implementation measures focused on increasing alternative fuel vehicle acquisition are long-term investments. An estimated 50% of California vehicles sold in 2013 will still be in use in 2024, meaning that current policies and incentives will not significantly impact the market share of alternative fuel vehicles in the short term.[129] The following sections will discuss the carbon emissions factor, the projected market, and the current refueling infrastructure of each alternative fuel.

Table 19: Alternative fuel vehicle purchase and installation incentives[130]

Incentive	Administration
Up to $7,500 Federal Tax Credit for eligible PEV vehicles	U.S. Internal Revenue Service
Up to $4,000 in Federal Tax Credit for eligible Hydrogen FCV vehicles	U.S. Internal Revenue Service
	California Center for Sustainable Energy

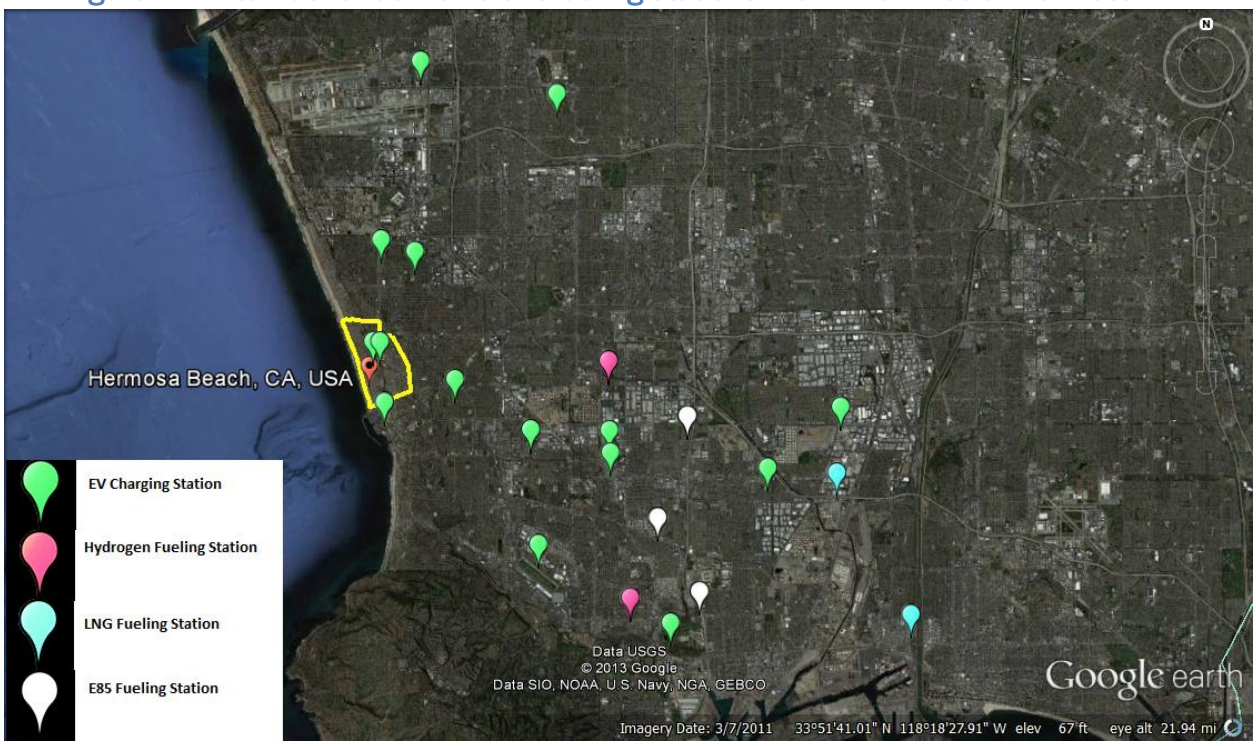
[128] City of Hermosa Beach (2013). Community Development Department website, "Go Green/Sustainability", Transportation. Retrieved from http://www.hermosabch.org/index.aspx?page=499.

[129] Federal Highway Administration. (2009). 2009 National Household Travel Survey

[130] Matute, J.M. and Pincetl, S.S. (2013). "Policy to Induce Adoption of Alternative Fuel Vehicles" in *Unraveling Petroleum: The Hidden Incentives that Keep California Driving*. San Francisco: Next 10.

Up to $2,500 rebate per for Sustainable eligible vehicle from Energy California Clean Vehicle Rebate Project	
Up to $2,000 for CNG home refueling Equipment	SCAQMD
Subsidies for installation publicly-accessible EV supply equipment	US Department of Energy
Subsidies for home installation of chargers for Nissan Leaf and Chevy Volt owners in San Diego, and LADWP territory	
Tax credit for consumers and businesses who purchase and install qualified hydrogen fuel infrastructure	U.S. Internal Revenue Service

Figure 24: Alternative fuel vehicle refueling stations within 20 miles of Hermosa [131]



Electric Vehicles

The main three types of electric vehicles (EVs) on the market are Battery Electric Vehicles (BEVs), Plug-in Hybrid Electric Vehicles (PEVs), and hybrid vehicles. A BEV is propelled by an electric motor powered by rechargeable battery packs. A PEV, also known as an extended range vehicle, uses both an internal combustion engine and an electric motor and has a rechargeable battery pack and a gasoline tank. A hybrid vehicle is similar to a plug-in hybrid vehicle except that the battery pack does not plug into the electric grid to recharge.[132] EVs are more energy efficient than internal combustion engines and emit no tailpipe pollutants, although the carbon emissions of power plants generating the electricity used by the vehicles must be considered. EVs have a more limited driving range than conventional gasoline vehicles. For instance, BEVs are only able to drive about 50-200 miles before

[131] U.S. Department of Energy. Alternative Fuels Data Center (2013). "Alternative Fueling Station Locator." Retrieved from http://www.afdc.energy.gov/locator/stations/

[132] U.S. Department of Energy and U.S. Environmental Protection Agency (2013). "The official U.S. government resource for fuel economy information." Retrieved from http://www.fueleconomy.gov/.

recharging compared to the 300 miles for gasoline vehicles. Recharging a BEV can require 4-8 hours and the batteries are generally quite expensive and bulky.[133] However, improvements in vehicle technology have been very progressive in recent years and EVs will someday be competitive with conventional light-duty vehicles.

Between 2010 and 2014, all major automakers in California will be selling PEVs.[134] According to a study by the UCLA Luskin Center for the City of Los Angeles, in Los Angeles, EV sales are estimated to make up 9% of vehicle sales in 2015 and 11.75% in 2020.[134] Annual electricity used for transportation is estimated to increase to about 1,070 GWh by 2030, mainly due to great advances in the Plug-in hybrid EV market.[135] These percentages are likely to be similar if not higher in a progressive upper-income city like Hermosa Beach.

Additionally, California has addressed the necessity of improving electric vehicle charging infrastructure for PEVs. In 2012, an Executive Order was issued by Governor Brown that asked for the collaboration of Energy Commission, ARB, CPUC, the Plug-in Electric Vehicle Collaborative and the California Fuel Cell Partnership in order to improve infrastructure for zero-emission vehicles from 2015-2025. This and a settlement between CPUC and NRG Energy, Inc and its subsidiary, eVgo will vastly increase the number of electric vehicle chargers in the state. [133] This settlement requires the construction of more than 10,000 chargers in about 1,000 California locations.[133]

Natural Gas Vehicles

Natural gas can be used in vehicles in the form of compressed natural gas (CNG) or liquefied natural gas (LNG). Vehicles can be designed to run only on natural gas or in dual-fuel or bi-fuel vehicles, which can also use diesel or gasoline.[133] High-pressure fuel tanks store the natural gas, meaning

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[133] California Energy Commission. (2012). *2012-2013 Investment Plan Update for the Alternative and Renewable Fuel and Vehicle Technology Program.*

[134] Williams, B., DeShazo J.R. & Ben-Yehuda A.(2012). UCLA Luskin Center for Innovation. *Early Plug-in Electric Vehicle Sales: Trends, Forecasts, Determinants.* Prepared for the Southern California Association of Governments.

[135] California Energy Commission. (2012). *2012-2013 Investment Plan Update for the Alternative and Renewable Fuel and Vehicle Technology Program.*

that dual-fuel vehicles have two fueling systems within. There is not a large market for solely natural gas vehicles in the U.S. yet, but vehicles that usually run on gasoline and diesel can be retrofitted to be compatible with CNG. Natural gas vehicles generally emit 5-9% less greenhouse gas emissions than gasoline. Due to increases in petroleum prices, natural gas demand has increased drastically. By 2030, the California Energy Commission expects natural gas transportation consumption within California to grow by 86.7 % relative to 2009 consumption.[136]

Natural gas consumption, natural gas emissions, and transportation emissions must all be addressed in the discussion of natural gas refill stations in Hermosa Beach.

Increasing the number of natural gas refill stations in Hermosa Beach would incentivize people to purchase more NGVs, because there would be greater accessibility to refilling natural gas vehicle tanks. There will be an increase in natural gas consumption if more natural gas vehicles and refill stations are present in Hermosa Beach. Fugitive emissions from refill stations within the jurisdictional boundary must also be accounted for if the city so chooses to increase natural gas within the transportation sector. We would advise for the Hermosa Beach transportation sector to increase the number of natural gas refill stations within the jurisdictional boundary. This would help incentivize individual citizens to purchase more NGVs and ultimately reduce environmental costs and reliance on petroleum in the transportation sector. Hermosa Beach can transition toward natural gas vehicles by increasing municipally-owned natural gas vehicles, increasing availability of refill stations in public locations, and advertising and marketing schematics to publicize benefits of natural gas vehicles and encourage others to purchase NGVs.

Hermosa Beach's choice to implement municipal or community-based measures will determine the type of refill station that would be most appropriate in their jurisdiction. There are two different types of natural gas fuel: Compressed Natural Gas (CNG) and Liquefied Natural gas (LNG).

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[136] California Energy Commission. (2011).*Transportation Energy Forecasts and Analyses for the 2011 Integrated Energy Policy Report.*

- CNG stations can be "fast-fill" or "time-fill" depending on the type of vehicles that are going to be refilled.[137] Fleets predominantly use time-fill stations, so if Hermosa Beach so chooses to convert municipal operational fleets to natural gas vehicles, installing a time-fill station would be most beneficial. However fast-fill stations are ideal with community natural gas vehicle usage such as conventional sedans, vans, or pickups, because they are directly attached to the local natural gas utility line and allow for customers to arrive and refill quickly.
- Liquefied natural gas refilling stations are more expensive, require greater safety precautions in operations, and are predominantly used by heavy-duty vehicles. Therefore, the necessity for a LNG refueling station in HB for the conventional commuter resident would be unadvised.

Table 20: Fast-fill natural gas refilling station costs[138]

NG Refueling Station Type	Maximum Capacity	Maximum Capacity, gge Equivalent[2]	Estimated Cost
CNG, small	<500 scfm	4.0 gge/min	$400,000
CNG, medium	500-2000 scfm	4.0-15.8 gge/min	$600,000
CNG, large	>2000 scfm	>15.8 gge/min	$1,700,000
LNG, large	15,000 gallon storage	8,670 gge storage	$1,700,000
CNG/LNG, large	>2000 scfm	>15.8 gge/min	$2,000,000

Although CNG stations are less expensive than LNG stations, they are still more expensive than the conventional gasoline/diesel stations. As seen above in Table 20, the size of the station determines the installation cost. Cost of installation can be anywhere from $400,000 to $2,000,000. Unfortunately there are currently not enough NGVs in Hermosa Beach to incentivize investment in fueling infrastructure. In order for the installation of a CNG refueling station to be profitable, there must be an order of 1000 vehicles per refilling station and the number of natural-gas refueling

[137] US Department of Energy- Energy Efficiency and Renewable Energy. (2013). *Alternative Fuels Data Center.* Retrieved April 25, 2013 from http://www.afdc.energy.gov/fuels/natural_gas.html

[138] US Department of Energy. (2010). *Issues Affecting Adoption of Natural Gas Fuel in Light- and Heavy Duty Vehicles.* (Pacific Northwest National Laboratory) Richland, Washington: Author. Retrieved from http://www.docstoc.com/docs/90798278/Issues-Affecting-Adoption-of-Natural-Gas-Fuel-in-Light--and-Heavy

stations must be 10-20% the number of gasoline refueling stations to ensure driver convenience.[2] Therefore, Hermosa Beach must be willing to put forth the initial investment of a CNG refueling station, and create a demand for NGVs in municipal operations until local residents make the voluntary switch over to NGVs.

An increase in natural gas vehicles will shift natural gas emission sources and activities from predominately building natural gas emission sources and activities, to also transportation emission sources and activities. The main emissions associated with natural gas vehicles and natural gas vehicle refueling stations are the combustion emissions resulting from additional natural gas driving vehicles on the road and the fugitive emissions from refueling stations. NGVs are a recommended alternative to conventional petroleum vehicles because it is a cleaner source of energy over other conventional fossil fuels. The type of natural gas also plays a role in the amount of emissions resulting from natural gas vehicles. Within the lifecycle of CNG, it produces fewer greenhouse gases than LNG because compressing natural gas is less energy intensive than liquefying natural gas. Therefore, the predominate source of emissions that must be considered with the installation of a CNG refueling station would be from the fugitive emissions, or leakage of natural gas. The greater the number of natural gas stations the larger amount of sources there are for emissions to originate from.

Hydrogen

Hydrogen can be used in fuel cells to power electric motors. Hydrogen fuel cell vehicles emit no tailpipe emissions. These vehicles are still relatively new and are not yet competitive with conventional vehicles but the market has been growing. In 2011, the number of FCVs within California was only 350, but by 2017 automaker surveys project the number to increase to 53,000. Hydrogen fueling infrastructure is adequate to accommodate this expected growth. As of May 2012, California only had 6 hydrogen fueling stations available to the public. The Energy Commission provided funding for 11 stations within California.[135] Currently the closest Hydrogen fueling station to Hermosa Beach is in Torrance, located about 5 miles outside the city.[131]

Ethanol

Ethanol is the most commonly used alternative fuel in California vehicles.[136] Ethanol is formed through the fermentation and distillation of starch crops or cellulosic biomass. It can be used in place of gasoline as a fuel for vehicles. Ethanol has lower energy content than gasoline, but also a much lower tailpipe carbon intensity. California's Low Carbon Fuel Standard (LCFS) helps identify ethanol and other biofuel products with lower upstream and life-cycle emissions profiles.122 The two main types of ethanol based fuels on the market are E10, known as gasohol, and E85. E10 is comprised of 10% ethanol and 90% gasoline and is approved by auto-manufacturers for use in all vehicles.[135] Vehicles running on E10 generally have about 3-4% fewer mpg than they would with conventional gasoline.[139] As of 2009, California refineries have been blending gasoline with up to 10% ethanol in order to meet new fuel standards (LCFS). E85, blend of 85% ethanol and 15% gasoline can be used by flex- fuel vehicles (FFVs).[139] Flex-fuel vehicles are designed to run on any mixture of gasoline and ethanol. These vehicles, when running on E85, generally travel about 25-30% fewer miles per gallon.[139] Approximately 1.5% of vehicles in California were FFVs in 2010 and only a small fraction of ethanol sold was E85.[136] Currently E85 compatible stations are scarce and prices of E85 are higher than E10 and gasoline. Projections made by the California Energy Commission do estimate that by 2030 3.2 billion gallons of E85 will be consumed.[136] Only 3 E85 stations are located within 10 miles of Hermosa Beach.[131]

Biodiesel

Biodiesel is an alternative to diesel fuel and is manufactured from vegetable oils, animal fats, or recycled restaurant greases.[139] Similar to ethanol, biodiesel can be blended with conventional petroleum diesel. Common blends are B2, which is 2% biodiesel, B5, which is 5% biodiesel, and B20, 20% biodiesel. Some vehicles can also use pure biodiesel, known as B100, or B99.[139] Use of blends higher than B5 is not approved by many automakers yet, and biodiesel does have a lower fuel

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[139] U.S. Department of Energy and U.S. Environmental Protection Agency (2013). "The official U.S. government resource for fuel economy information." Retrieved from http://www.fueleconomy.gov/.

economy and power. The majority of biodiesel consumed in California is blended with conventional fuels. A lack of required minimum blend level has prevented demand for biodiesel from increasing.[136]

Emissions differences

Alternative fuels generally emit less CO_2 per volume than gasoline. The following table shows the emissions factors of each type of alternative fuel vehicle. This data was inputted into the model to determine how the transition to alternative fuel vehicles would impact Hermosa Beach's emissions.

Table 21: Emission factors of alternative fuels[140]

Vehicle fuel type	Emissions factor	Unit
Electricity	287	kgCO2e/MWh
Gasoline	8.86	kgCO2e/gallon
E10	7.98	kgCO2e/gallon
E85	1.33	kgCO2e/gallon
B100	0	kgCO2e/gallon
Natural Gas	5.31	kgCO2/therm
Hydrogen	0	Kg/CO2/gallon

3.3 Municipal Operations Implementation Measures

Hermosa Beach can reduce sources of transportation-related emissions by implementing a clean fuel or zero emission purchasing policy, increasing the availability of alternative fuel stations, creating a carpool or rideshare program, and putting into practice various measures to increase vehicle fleet efficiency.

Clean Fuel or Zero Emission Purchasing Policy

To reduce the emissions from the city vehicle fleet, Hermosa Beach could implement a clean fuel or zero emission purchasing policy, which would alter the municipal fuel carbon intensity. This policy

[140] U.S. Environmental Protection Agency,2007

would require all future city vehicles purchased to use low carbon fuels, such as hydrogen, CNG, LNG, or electricity.[141] This strategy would be the simplest reduction option because Hermosa Beach has direct control over the city vehicle fleet and changes could be made relatively quickly. Additionally, the city could require franchise vehicles inside Hermosa Beach to use clean fuel or low emission vehicles.

Alternative Fueling Stations

To accommodate the new clean fuel or zero emission city vehicle fleet, Hermosa Beach must increase the availability of alternative fueling stations throughout the city, especially electric vehicle service equipment, but also hydrogen and natural gas infrastructure as warranted by vehicle purchases. Fueling stations can be installed strategically in locations where city employees are likely to travel, such as city hall and other municipal buildings. Fueling stations can also be installed in highly-trafficked commercial districts where employees may spend their lunches and breaks. It may be beneficial for Hermosa Beach to work with the South Bay Cities Council of Governments to install more fueling stations regionally so the city vehicle fleet can be accommodated when longer trips are required.

Carpooling and Rideshare Program

Employee commutes contribute the most municipal greenhouse gas emissions in the transportation sector. To reduce the emissions resulting from city employee commutes and therefore reduce VMT, Hermosa Beach could strengthen its existing carpooling program or implement a new one. In 2007, the 42.3% of 140 full-time and 44 part-time municipal employees that participated in a survey were responsible for 337,249 VMT.141 Of this surveyed group, 29.4% lived only 4-8.9 miles from their place of work, 2.5% carpooled, and 45.7% conveyed interest in a rideshare program.141 The high proportion of municipal employees that live so close to their worksites and high percentage of employees interested in the program make a municipal employee carpooling program an attractive option for Hermosa Beach. Possibilities for this program include the use of the regional rideshare

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[141] Hermosa Beach Green Task Force. (2011). *Sustainability Plan.*

website Commute Smart or the nationwide Ride Share website. Commute Smart allows individuals to register and find vanpools or carpools leaving from their home zip code to their work zip code.[142] Ride Share has carpool and van pool options as well as comprehensive commuter benefits and incentives program for employers. Ride Share's "Easy Commute" program works with employers to maximize their company's ride share potential by providing them with information about federal tax incentives, mass transit options, commuter incentives, ride-matching, and more.[143] Next-generation services, such as Zimride, Lyft, and future variants, could expand the rideshare market and reduce vehicle trips.[144] These programs could be implemented in less than a year's time but could take a few years time until effective. To initially promote carpools, the city could encourage ride-sharing at least one day a week. The city could also provide incentives to city employees who carpool, such as monetary incentives, dedicated parking spaces, more vacation days, and more.141

City Fleet Vehicle Efficiency

Hermosa Beach could further reduce emissions from the city vehicle fleet by implementing policies to improve vehicle efficiency. By supporting idle reduction and the appropriate tire pressure in city vehicles, Hermosa Beach would ensure compliance with AB32. The city could enforce a "no idling" rule for city vehicles and require routine monthly checks to ensure proper tire inflation.141

3.4 Community Greenhouse Gas Reduction Options

To reduce community emissions, Hermosa Beach should focus mainly on reducing Vehicle Miles Traveled (VMT). In 2010, Hermosa Beach was responsible for 142,882,658, VMT.[145] Strategies to reduce VMT will focus on decreasing the amount of trips taken in personal vehicles, reducing the length of trips, and increasing vehicle occupancy.120 Hermosa Beach generally only has indirect influence over the VMT of residents, meaning that strategies will be long-term and it will take time for

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[142] CommuteSmart. CommuteSmart website. Retrieved from http://www.commutesmart.info/index.asp.

[143] Web Solutions, Inc.. (2013).The RideShare Company website. Retrieved from http://www.rideshare.com/.

[144] Zimride Carpool & Rideshare Company (2013). "About Zimride." Retrieved from http://www.zimride.com/about/.

[145] ICF International. (2012). "Los Angeles County Regional Greenhouse gas Inventory" (draft).

measures to effectively reduce VMT. Suggested strategies to shift residents away from using personal vehicles will include a Neighborhood Electric Program and a Complete Streets program to encourage walking and biking. To reduce average trip length, we recommend improvements to the city's infrastructure that focus on neighborhood-oriented development, the creation of commercial nodes, and parking strategies. The main suggested strategy to increase vehicle occupancy is a carpooling and rideshare program.

Neighborhood Electric Vehicle Program

The SBCCOG implemented a Neighborhood Electric Vehicle (NEV) project demonstration in the South Bay of Los Angeles County from May 2010 through October 2011. This projected was funded by the AQMD to reduce the regions' reliance on fossil fuels and inform future government plans and policies.[146] This NEV program, also called the Local Use Vehicle (LUV) Demonstration Project, is expected to be especially effective if implemented along with a Neighborhood Oriented Development (NOD) program, which will be discussed later in this section. The SBCCOG thought that many households need one primary vehicle capable of long distance travel, but their secondary vehicles can be used for shorter trips and would therefore be good targets for the short-range BEV market. The LUV project leased a total of 7 BEV vehicles to selected households for 2-3 months. These vehicles had a max speed of 25 mph, a range of 25 miles between charges, and were only allowed on streets with speed limits of 35 mph or less or on streets with designated lanes. In the project, the SBCCOG found that 8%-51% of household vehicle miles traveled were completed with the NEVs, the average being 26% of VMT. Of the destinations visited by NEV users, 99% were fewer than 3 miles from home. NEV users drove the NEVs most often to drop off or pick up family members, go to work, go grocery shopping, and perform other small errands.[146]

The main problem that arose was speed limit of the NEVs. Many streets with a posted speed limit of 35 mph in reality experience much more rapid flows of traffic, making NEV users a nuisance to other

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[146] South Bay Cities Council of Governments (2011). *Neighborhood Electric Vehicles in Mature Suburbs: Demonstration and Preliminary Evaluation*.

drivers. The SBCCOG mitigated these issues by adding a sticker to these vehicles that let other drivers know they had a limited speed capability, and this made NEV drivers more comfortable. Another potential solution in the future noted in the Preliminary Report is the adoption of 35 MPH NEVs, referred to as Medium Speed Electric Vehicles (MSEV).[146]

If Hermosa Beach, in partnership with the SBCCOG, implemented a NEV program they could significantly reduce VMT and consequently their transportation emissions. According to the SBCCOG's Preliminary Report, one NEV could reduce a household's CO2e by 23%.[146] Local government incentives could encourage participation in the program. Free parking in public lots, class 2 designated lanes on streets with faster traffic flow, public charge port infrastructure, and the grant of permits for chart port infrastructure for households and businesses would encourage residents to use these NEVs instead of secondary gasoline vehicles.[146] This program will also require education. Hermosa Beach and SBCCOG will need to advertise this program to residents and educate them about its economic and environmental benefits. The SBESC will prove instrumental in consumer education. Additionally, this program will be most successful in Hermosa Beach if it is developed along with a Complete Streets program and Neighborhood Oriented Development strategy that concentrates commercial areas, enabling residents to make short trips and complete all their daily errands in one location.[146] This program is most likely to be effective if implemented at a regional level. For this reason, we recommend ambitious coordination with the SBCCOG to help them develop a comprehensive plan for the entire south bay.

Carpool and Rideshare Programs

Hermosa Beach could implement a community wide carpool and rideshare program to decrease VMT. Carpool and Rideshare programs reduce VMT by increasing average vehicle occupancy. This program will be especially influential for Hermosa Beach because of the high proportion of residents who commute in single-occupancy vehicles. 78.8% of Hermosa Beach residents commute to work alone.[123]

Figure 25: Work destinations of Hermosa Beach residents in 2010 based on census tract124

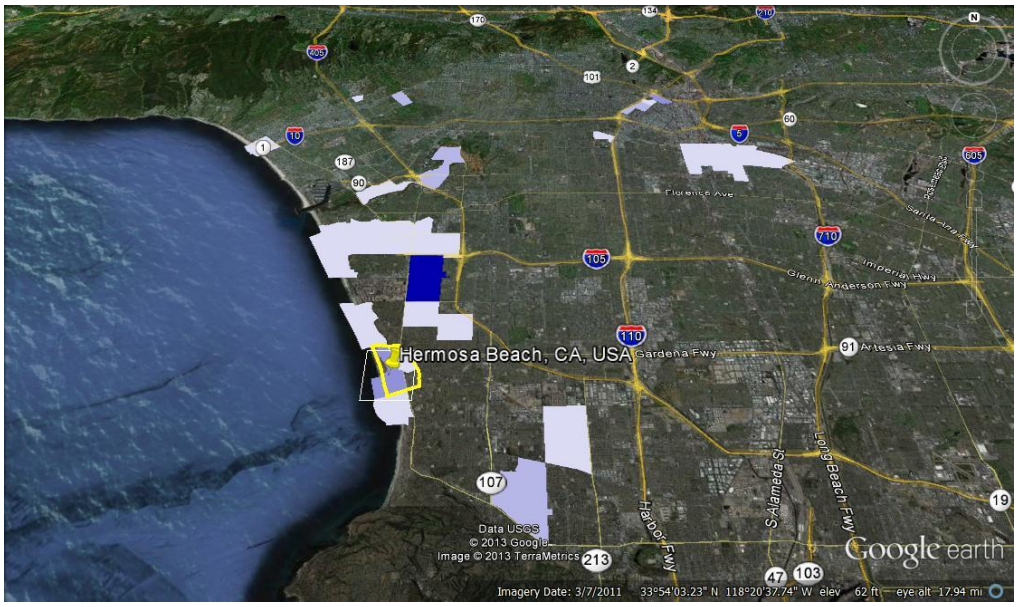


Figure 25 and Figure 26 show the destination lines and census tracts of where Hermosa Beach residents work. These figures show that carpool programs targeting those working north of Hermosa Beach and throughout the South Bay could provide significant reductions in VMT.

Figure 25: Work destinations of Hermosa Beach residents in 2010 based on census tract[124]

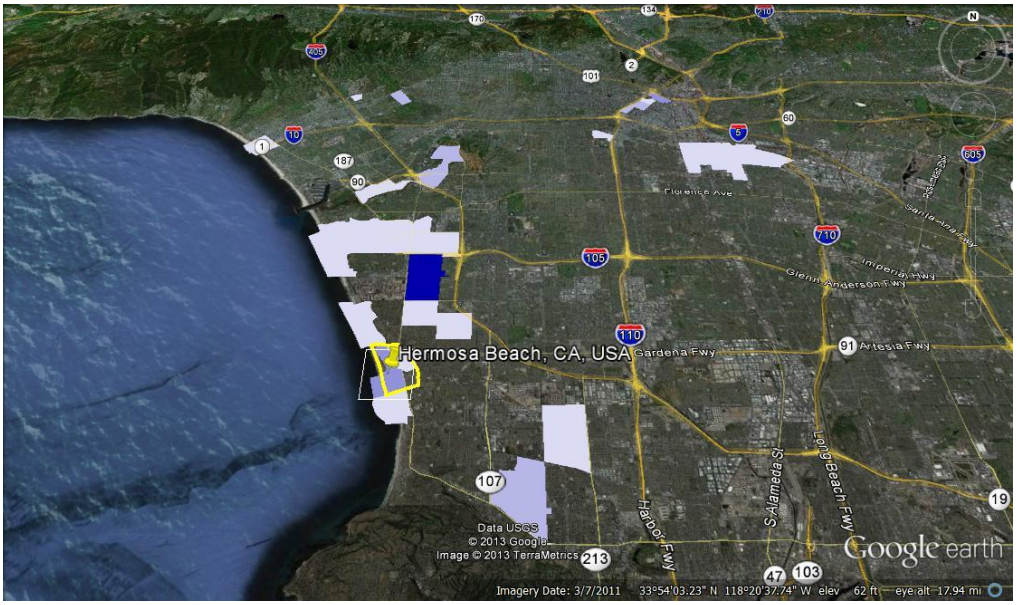
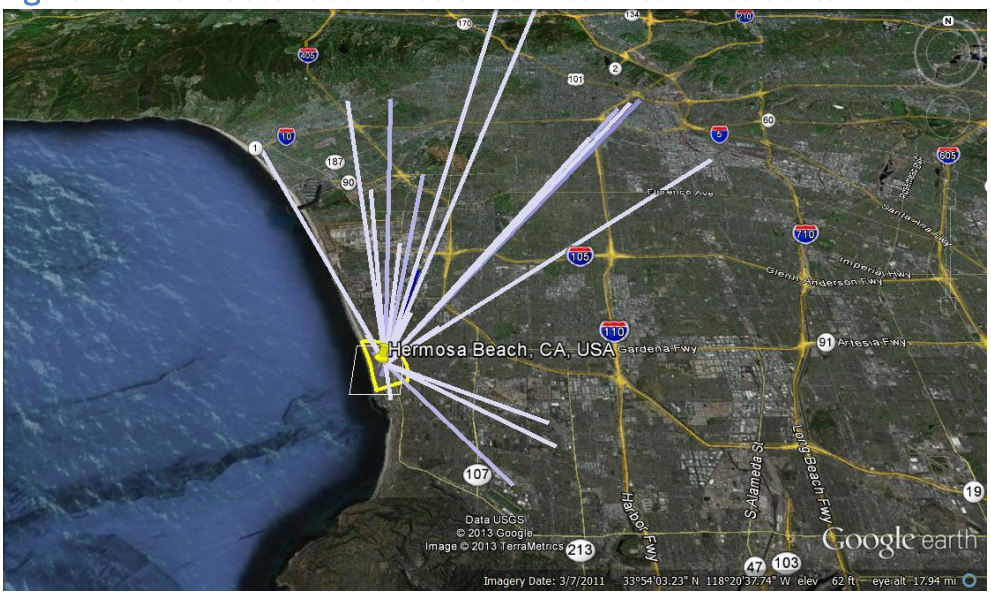


Figure 26: Work destination lines of Hermosa Beach residents in 2010[124]



Encouraging people to begin carpooling can be difficult. Carpoolers would need to make sure that they are headed towards the same destination at the same or similar times, and would need to coordinate their schedules for returning from work as well. As a result, one of the most common reasons why people resist carpooling involves the difficulty that exists in setting up a carpool. People often claim that they do not know anyone who they can carpool with, or that their schedule is impossible to match with another's. Other people are unwilling to carpool because they do not want to have to rely on someone else for transportation.[147] However, by making the benefits outweigh the perceived challenges, and by providing well-advertised incentives similar to those that the Environmental Service Center offers, people will be more likely to carpool.

Hermosa Beach could use the services from the website Commute Smart or Ride Share. Commute Smart is southern California based and allows individuals to search for available carpools or vanpools in their area.142 Ride Share, as discussed in the municipal operations reduction options

[147] Wang, T., & Chen, C. (2012). Attitudes, mode switching behavior, and the built environment: A longitudinal study in the Puget Sound Region. Transportation Research Part A: Policy and Practice, 46(10), 1594–1607.

section, provides an "Easy Commute" program works with employers to maximize their company's ride share potential by providing them with information about federal tax incentives, mass transit options, commuter incentives, ride-matching, and more. There is already a vanpool program with Metro that, on average, can cut commuter time down by 36 minutes by using the carpool lane, and will also grant participants a monthly subsidy of up to $400.[148] These rebates could be a great source of community emission reductions if the majority of residents in Hermosa Beach took advantage of them.

Many Hermosa Beach residents are social people, and using a social-media connected carpool facilitation service such as Zimride could help residents find friends and friends of friends with whom they can share a commute. In addition to reducing vehicle trips to and from Hermosa Beach, rideshare could improve social cohesion. If the combination of rideshare and carshare leads to some households reducing the number of vehicles they own, it could also help alleviate neighborhood parking challenges.

Individuals could be incentivized to find carpools with access to free public street parking and high occupancy vehicle (HOV) lanes on mixed-flow traffic streets. To incentivize employers in Hermosa Beach to reduce the average vehicle occupancy of their employees, Hermosa Beach could implement policies which make Single-occupant vehicle (SOV) reduction programs mandatory for employers of a certain size.120 Hermosa Beach officials could set a level of required carpool participation for which these employers must be in compliance.

Carshare programs can be implemented as complementary policies to carpool and rideshare programs. In January of 2013, the Hermosa Beach City Council approved a resolution for the city to participate in a South Bay car sharing program run by the company Car2go.[149] This program is

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[148] More information can be found at http://www.metro.net/around/vanpool/.

149 Schreiber, J.. (2013). "Hermosa City Council OKs Car2go Car Share Program." *Hermosa Beach Patch* (blog post). Retrieved from http://hermosabeach.patch.com/groups/politics-and-elections/p/hermosa-city-council-oks-car2go-car-share-program.

endorsed by SBCCOG and has recently been approved by Torrance as well.[150] If approved by the remaining 7 municipalities, the Car2go program will provide as many as 350 vehicles throughout the South Bay. Those who sign up for the program can rent the vehicles for 39 cents per minute or $13.99 per hour with a tap of their membership cards. Gas, insurance, and parking are included in rates.[149] Carshare programs are excellent options for individuals or households who are at the margin of vehicle ownership.[151] Carshare vehicles can function as substitutes for personal vehicles, especially for those looking to shed their secondary or even tertiary vehicles.[151] Additionally, the variable costs of renting carshare vehicles will incentivize customers to drive less and therefore may decrease their VMT. According to Martin et. al. (2010), every carshare vehicle removes 9 to 13 vehicles off the road.[152] Additionally, they estimated that carshare vehicles tended to have a greater fuel economy than the vehicles previously owned by customers and that customers drove about 4,100 miles less per year than the U.S. average.[152]

On the other hand, we must consider how carshare programs will affect the VMT of those on the margins of car ownership. For those who would not own cars if the program did not exist, VMT will actually increase. However, less than 1.5% of California households are at the margins of vehicle ownership so this may not make a substantial effect on VMT. Carsharing is also unlikely to significantly change VMT of those with automobile-intensive lifestyles.[151] Because of this, we do not expect carsharing to drastically impact Hermosa Beach's VMT and is more of a long-term strategy.

Complete Streets Program

Another way to reduce vehicle use is to improve pedestrian and bicycle access in cities. Hermosa Beach's Sustainability Plan references the city's own "Complete Streets" strategy, as well as its

150 Green, N.. (2013). "South Bay carsharing proposal Car2Go gets closer look from Torrance City Council." *Torrance Daily Breeze. Retrieved from* http://www.dailybreeze.com/news/ci_22997433/south-bay-carsharing-proposal-car2go-gets-cautious-approval.

[151] Matute, J.M. and Pincetl, S.S. (2013). "Carshare Innovations" in *Unraveling Petroleum: The Hidden Incentives that Keep California Driving*. San Francisco: Next 10.

[152] Martin, E., Shaheen, S.A., & Lidicker, J. (2010). Carsharing's Impact on Household Vehicle Holdings: Results from a North American Shared-use Vehicle Survey.

Bicycle Master Plan which aim to encourage residents to bike or walk.141 Built on a grid pattern, Hermosa Beach is a compact, dense city with low speed limits, making it a great city for cyclists and pedestrians. Many of the city's streets, such as the Pacific Coast Highway and Aviation Blvd., have heavy traffic and lack safe bike lanes or attractive sidewalks. Hermosa Beach has already made immense changes to Pier Avenue to increase the street's attractiveness as well as enhance bicycle and pedestrian access. Hermosa Beach also plans to add more bike lanes and improve the aesthetics of Aviation Blvd.141 To increase bicycle miles traveled and reduce VMT, we recommend Hermosa Beach expand its bicycle lane network, increase the number of bicycle storage facilities, and hold events to encourage bicycling.

San Francisco and Long Beach are examples of cities that have improved biking infrastructure within the community. By 2014, San Francisco will have expanded its bike lane network by 30 miles compared to 2009.[153] San Francisco hosts an event called "Sunday Streets" which opens miles of city streets for residents to bike and walk without any vehicle interference.[153] A similar event could be introduced in Hermosa Beach to educate residents on the benefits of biking. San Francisco's bicycle culture is soon to grow even more as a trial bike sharing program will be implemented in the summer of 2013.[154] This trial program is being implemented by the company Alta Bike Share. A bike sharing program has great potential for Hermosa Beach's tourist and beachgoing population who may want to borrow a bike for short trips but do not want to purchase their own bicycle.[154] Long Beach has 63 miles of bikeway, 29 of which is completely separated from any street or highway.[155] Long Beach's bike network includes separated downtown bikeways and the nation's first bike-commuter station. "Bike Saturdays," an event where local shops and restaurants provide special

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[153] San Francisco Bicycle Coalition. (2009). "Sunday Streets." Retrieved from http://www.sfbike.org/?sundaystreets.

[154] San Francisco Municipal Transportation Authority (2009). *San Francisco Bicycle Plan.* Retrieved from http://www.sfbike.org/?bikeplan.

[155] City of Long Beach (2000). *Bicycle Master Plan.* Retrieved from http://www.longbeach.gov/civica/filebank/blobdload.asp?BlobID=18811

discounts to those who bike, is held every week in Long Beach to incentivize residents to bike.[156] Hermosa Beach could similarly incentivize bicycling by working with local businesses to develop discounts or deals for cyclists.

To improve pedestrian access, we recommend Hermosa Beach continue to renovate sidewalks and streets on highly trafficked areas. PCH and Aviation Blvd. have high potential for renovation. An option to enhance sidewalk areas would be the construction of "parklets," which are small urban parks usually constructed in the place of parking spots on a busy street. Parklets transform an under-utilized part of a street into a pleasant place to sit and drink a coffee, read a book, or park your bike. Parklets have been on the rise in cities such as San Francisco and Long Beach. The UCLA Complete Streets Initiative of the Luskin School of Public Affairs has produced a helpful document called Reclaiming the Right of Way: A Toolkit for Creating and Implementing Parklets" that could be of use to Hermosa Beach.[157] The increased attractiveness created by parklets will encourage residents to walk or bike rather than drive, therefore decreasing VMT.

Neighborhood Oriented Development

Alongside a Complete Streets program we recommend Hermosa Beach implement a Neighborhood-Oriented Development (NOD) plan. While conventional Smart Growth strategies build mixed-use density along corridors that are served by transit systems, NOD plans instead mix residential and commercial areas strategically to condense trip lengths.[158] NOD is an appropriate option for fully built-out suburban cities that cannot easily facilitate public transit or mixed-use housing. This type of development increases access to commercial destinations via all modes of transportation by "clustering small footprint retail/office space around each arterial intersection, and clustering parks and schools away from arterial roads."[158] Popular destinations are located within walking or biking

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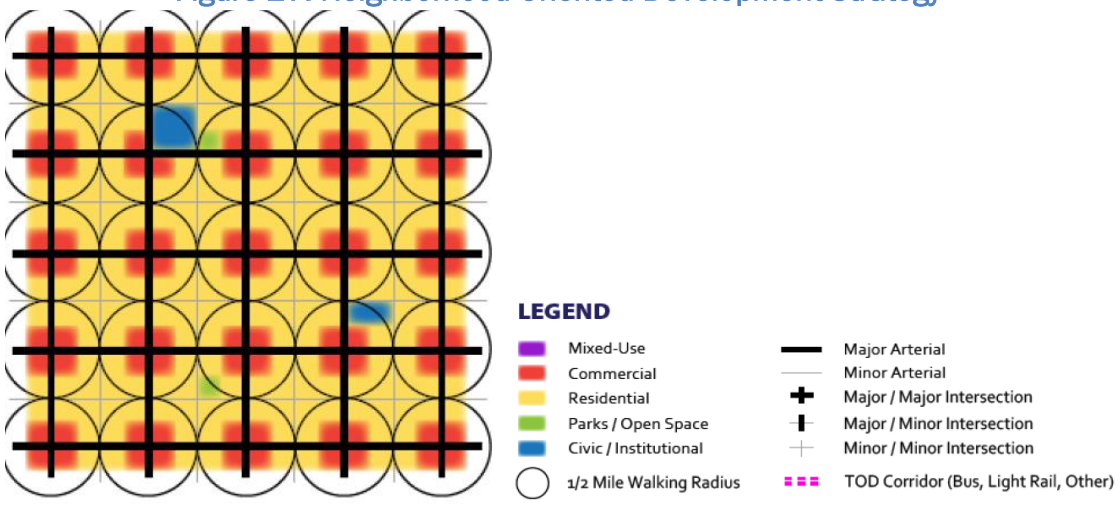
[156] Bike Long Beach (2012). "Bike Saturdays." Retrieved from http://www.bikelongbeach.org/bike-saturdays.

[157] Loukaitou-Sideris A., Brozen, M. Callahan, C. Brookover, I., LaMontague N., & Snehansh, V. (2012). *Reclaiming the Right-of-Way: A Toolkit for Creating and Implementing Parklets*. UCLA Complete Streets Initiative Luskin School of Public Affairs.

[158] South Bay Cities Council of Governments. *South Bay Environmental Services Bay SCenter. (2011) Smart. Suburbs: the South Bay Strategy* (Draft).

distance, therefore encouraging a "park and walk multiple locations" approach.[141] These commercial nodes at intersections of arterial roadways are known as "Neighborhood Centers."[158] Diverse small retail stores clustered with offices located above are great options for Neighborhood centers because larger stores usually require greater parking accessibility.[158] Schools, parks, and other public green space should be constructed away in quieter settings away from main neighborhood centers. While transit-oriented development strategies focus on specific corridors and neglect neighborhoods located away from transit options, NOD strategies focus investment throughout the entire community.[159] These development strategies are also generally much more inexpensive than enhancing public transit infrastructure. NOD has potential to strengthen the local economy, shorten commute distances, and enhance the livability of cities. Figure 27 shows an example NOD strategy for a suburban city like Hermosa Beach.

Figure 27: Neighborhood-Oriented Development Strategy[158]



Although NOD will be a very long-term measure and it will take more than 30 years for change to fully take effect, more compact development will likely make a large impact on Hermosa Beach's VMT. Compact development is estimated to reduce VMT by 30% compared to sprawl.[159] NOD will result in fewer vehicle trips, more bicycle and walking miles, and less automobile-intensive lifestyles.

[159] Ewing, R., Bartholomew, K., Winkelman, S., Walters, J., & Chen, D.(2008). *Growing Cooler: The Evidence on Urban Development and Climate Change.* Washington, D.C.: The Urban Land Institute

Parking Strategies

Hermosa Beach could implement various parking strategies to reduce VMT. Because commute trips between work and home comprise approximately 24.3% of California's VMT, employer-based programs have great potential to reduce vehicle activity.[160] One potential type of employer-based program we recommend Hermosa Beach consider is a parking cash-out. A parking cash-out awards employees who do not park at their place of work with a cash allowance. The South Coast Air Quality Management District currently requires certain employers in the Los Angeles metropolitan air basin to develop a parking cash-out program.[160] According to Willson (1991), when a parking cash-out is implemented in a central business district the number of vehicles driven to work will decrease by about 25-34%.[161] Parking cash-outs could reduce commutes by approximately 2.7 to 7.8% in Hermosa Beach.[160]

Another potential parking strategy would be to introduce pricing schemes. Hermosa Beach could adjust the parking fees in some of the high traffic areas in the city, such as the areas in popular shopping centers and close to the beach, to accommodate for peak demand. High prices during peak hours would encourage "park once" behavior or even incentivize residents to choose other modes of transportation.120 Additionally the pricing of metered parking based on demand would reduce congestion on Hermosa Beach's busier streets.

C. Water and Wastewater

1. Introduction

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

[160] Matute, J.M. and Pincetl, S.S. (2013). "Parking Cash-out Programs at Employment Sites" in *Unraveling Petroleum: The Hidden Incentives that Keep California Driving*. San Francisco: Next 10.

[161] Willson (1991). The Los Angeles CBD Employee-Employer Baseline Travel Survey was undertaken by the Community Redevelopment Agency of the City of Los Angeles in 1986 (as cited in Juan Matute and Stephanie Pincetl, 2013).

that requires interactions between various levels of government. While the important resource itself does not emit greenhouse gases, the effort required to pump, convey, treat, and distribute the water creates emissions. The city of Hermosa Beach uses about 773 million gallons of water every year, and every gallon used indirectly produces greenhouse gas emissions.

2. Environmental Implications and Life Cycle Emissions Analysis

The West Basin Municipal Water District supplies the City of Hermosa Beach with all of its water.[162] The 773 million gallons of water delivered to Hermosa Beach every year come from three main sources that vary from local to imported waters, and a small portion of the city's water use is from recycled water. West Basin supplies about 72% of its water from imported sources, 21% from local sources, and 7% from recycled water.[163] After the water is used, it must be conveyed back to a wastewater treatment plant, and then either discharged or reused.

2.1 Imported Water

The 72% of West Basin's water supplies that comes from imported water creates a great amount of greenhouse gas emissions from generating the electricity used to pump, transport, treat, and distribute the water.[163] Although it depends on how far water travels, the average greenhouse gas emissions from imported water sources are about 0.00414 kg CO_2e per gallon.[164] These imported water sources generate more greenhouse gases per gallon than other sources because moving water over longer distances requires considerably more electricity.

State Water Project

One imported source of water for Hermosa Beach is the State Water Project. The State Water Project is a water distribution system in California that starts at the Oroville Dam on the Feather

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[162] Hermosa Beach Green Task Force. (2011). Sustainability Plan. p.39–45.

[163] West Basin Municipal Water District. (2010). Water Supply. *Urban Water Management Plan, 4,* 1–8.

[164] Stokes, J., & Horvath, A. (2008). Energy and Air Emission Effects of Water Supply. *Environment Science and Technology, 43*, 2680–2687.

River and then ends near Riverside at Lake Perris.[165] Hermosa Beach receive its water from the giant pumps that lift water from the California Aqueduct at the Tehachapi Mountains and move it about 2,000 feet over the mountains to Southern California. The water is treated, and then the California Department of Water Resources (DWR) manages the distribution system.

The Colorado River

Hermosa Beach also receives imported water from the Colorado River. The river is about 1,440 miles long and the state of California gets 4.4 million acre-feet of water annually.[165] The city gets its water from the Colorado River Aqueduct which is distributed by the Metropolitan Water District (MWD).

2.2 Local Water

Local water, which includes groundwater and recycled water sources, makes up about 28% of the total water use by West Basin.[163] These sources do not produce as much greenhouse gas emissions as imported water sources because they have a much shorter distance to be transported and pumped, but they still emit greenhouse gases when the water is treated and distributed. Recycled water creates about 0.00388 kg CO_2e per gallon.[164] Local groundwater creates an estimated 0.004kg CO_2e per gallon, which is one tenth of the imported water emissions.

Groundwater

A local source of water for Hermosa Beach is the groundwater from the West Coast groundwater basin.[165] This basin is operated and maintained by the collaboration of the DWR, Los Angeles County Public Works Department, and the Water Replenishment District of Southern California (WRD).

Recycled Water

Hermosa Beach does use reclaimed water for irrigation or other non-potable uses, and the recycled water is supplied by the Edward C. Little Water Recycling Facility located in El Segundo.[162] Although

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[165] Water Education Foundation. (2006). Where Does My Water Come From? Retrieved from http://www.water-ed.org/watersources/community.asp?rid=9&cid=517

recycled water reuse only makes up about 7% of the total water use, it does lessen the demands on groundwater and imported water supplies. The West Basin MWD is able to reclaim about a total of 30 million gallons of water every day from the recycling facility.

2.3 Wastewater

After water is used, it is sent to the wastewater treatment plant before it can be either discharged or sent to be recycled. The city of Hermosa Beach is part of the South Bay Cities Sanitation District in the Los Angeles County, and its water is sent to the Joint Water Pollution Control Plant. An estimated 1.6 million gallons per day of wastewater is from the City of Hermosa Beach. This estimation was found by dividing the population of Hermosa Beach with the total population that the Joint Water Pollution Control Plant serves and then multiplying that fraction by the total gallons that the plant treats daily. The estimate leads to about 584 million gallons of wastewater from Hermosa Beach treated every year. On average, the wastewater treatment process produces about 0.001134kgCO_2e per gallon of wastewater, which includes primary and secondary treatment and treating the leftover solids.[166] Although this is less than recycling, the overall process to treat the wastewater, discharge the treated effluent, and then import or pump the water back to be treated again and used emits much more greenhouse gases than the recycling process.

3. Water Areas of Concern

The scope for the water sector includes the sources over which the City of Hermosa Beach has authority. The primary concerns when looking at the greenhouse gas emissions from water are the local distribution of potable water throughout the city, on-site capture and reuse of rainwater, and water recycling. These are primary concerns because the local government does have control over these aspects, through building codes and ordinances. Secondary concerns are those over which the city has less authority or influence. These include the long distance conveyance of water from the Colorado River and California Aqueducts, which are the imported sources of water. These

[166] Hicks, A. (2010). Modeling Greenhouse gas Emissions from Conventional Wastewater Treatment Plants in South Carolina.

sources are controlled by larger entities such as the West Basin Municipal Water District, as mentioned earlier. A major area within the water sector that is not included in our boundaries is wastewater. This is because the City of Hermosa Beach does not have much control over the transportation or treatment of their wastewater and cannot make much change in this area.

3.1 Municipal Operations Emissions

For our accounting purposes, the municipal operations emissions that we considered are those that come from the city's local distribution system of potable water and water that is used in the buildings owned by the city. We chose to focus on these specific areas of the water system because they are the activities that the local government has some control over and will be able to make changes to reduce the activities' emissions.

3.2 Community Emissions

For our accounting purposes, the community operations emissions that we considered are those that come from residential, indoor use, outdoor landscaping, and on-site capture and reuse of rainwater. These are the activities that use a great amount of water and are found throughout the city. The local government may not have complete control over these community operations, but they can influence their residents to take action through incentives, rebates, and changes to building codes.

4. Implementation Measures and Greenhouse Gas Reduction Options

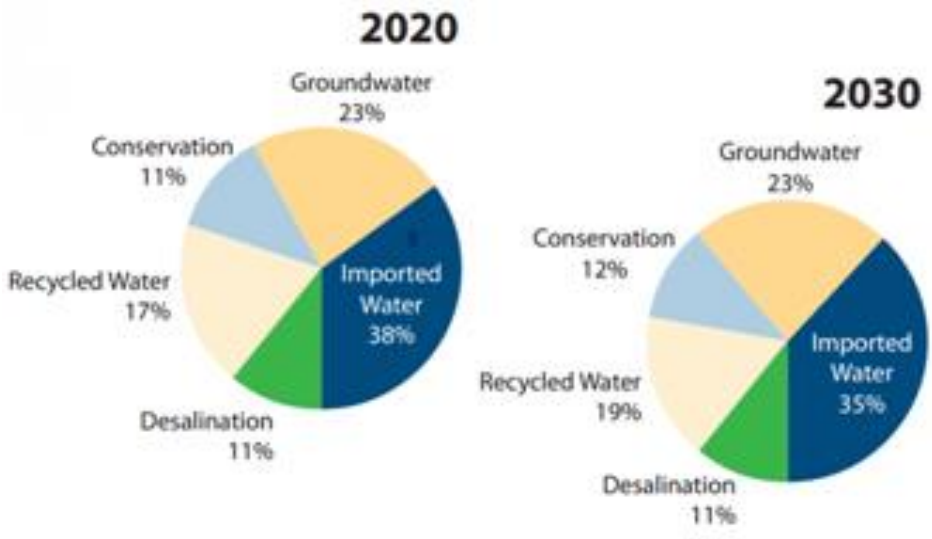
Lowering the demand of imported waters would effectively lower the emissions generated by water delivery, but the city of Hermosa Beach does not have much control over this, West Basin has created a plan. However, an efficient way for the city to reduce the emissions that come from water consumption is conservation. This lowers the amount of water that needs to be imported, pumped from underground, and recycled. It also reduces how much wastewater needs to be treated. By reducing water demand, the city will be lowering the associated activities responsible for the greenhouse gas emissions.

4.1 West Basin Water Supply Plans

West Basin Municipal Water District has developed a plan to better diversify their water sources since they are currently highly dependent on imported water sources, which are the most carbon-intensive.[163] They have 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 from 72% to 38% by 2020 by increasing groundwater demands to 23%, recycled water to 17%, and desalination to 11%, and the remaining 11% will be conserved (

Figure 28).[163] By the year 2030, West Basin is working towards lowering imported water to 35% by further increasing recycled water to 19% and conserving up to 12%.

Figure 28: West Basin's plans for future water supply.[163]



4.2 Municipal

Greywater Outdoor Use

Greywater is the wastewater from bath tubs, showers, sinks, and clothing washers.[167] Reusing greywater closes a loop in the water demand cycle as water is taken from a building or home and directly reused. This means less potable water is transported from an outside source, therefore requiring less electricity generation and emitting less greenhouse gases. One significant use for the greywater is landscape irrigation. In fact, Hermosa Beach already uses recycled water at 75% of its parks.[168] If about 50% of the water used in a household with a family of four was reused for irrigation, about 51,000 gallons of water would be saved per household per year.[162] The city will also save money by reusing greywater instead of transporting and treating it at waste water treatment plants. Using less potable water and reducing water going to the treatment plants will lower greenhouse gas emissions as well.

The general public perception of greywater is less than supportive, and many people openly oppose its usage. One of the most important factors involved in the public perception of greywater is its perceived effects on health and safety. This is directly related to where the greywater comes from, and how it was used previously. Many of these concerns are not unfounded, as greywater can play host to pollutants and diseases if oils or foods or the wrong kind of household products enter the water supply. Of all possible sources, roof rainwater collection seems to be the most publically acceptable source of water. Greywater follows rainwater in acceptability, both seen as more acceptable than treated wastewater.[169]

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[167] Al-Jayyousi, O. (2003). Greywater reuse: towards sustainable water management. *Desalination, 156,* 181–192.

[168] Hermosa Beach: A Leader in Sustainability. (2011). Retrieved from http://www.hermosabch.org/modules/showdocument.aspx?documentid=680.

[169] Ryan, A. M., Spash, C. L., & Measham, T. G. (2009). Socio-economic and psychological predictors of domestic greywater and rainwater collection: Evidence from Australia. Journal of Hydrology, 379(1-2), 164–171.

People may be more willing to use greywater if they have control over its sources and its uses.[170] People are reluctant to trust politicians and the government with the safety of their water. They also worry about the extent and reliability of the filters.[171] They may be more willing to use greywater if the benefits are stressed, such as the water conservation and environmental benefits,[172] and if it is used for gardens and toilets rather than for sources where they will come into direct contact with the water. Education also plays a huge role in people's willingness to use greywater. Understanding the difference between the real and perceived threats, as well as the benefits of using greywater, can significantly boost their acceptance of its use.[173]

As a result, this measure will educate the public about using greywater by telling them about the advantages and ease any concerns they have about health and safety. Regulations can be set by the local city government to ensure new buildings have the greywater reuse systems installed. The program can then start retrofitting existing irrigation systems around municipal buildings, and replacing them with the greywater systems.

Reduce distribution system leakages

Leaks in the water distribution system are detrimental for various reasons. They are costly because leaks mean more water is pumped, treated and wasted.[174] Reducing leakages would therefore minimize revenue losses as well as reduce greenhouse gas emissions. There are specific ways to reduce distribution system leakages (DSL). One method is to conduct water audits to determine the size of the problem. Other methods include repairing leaky storage tanks, calibrating or replacing

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[170] Ryan, A. M., Spash, C. L., & Measham, T. G. (2009). Socio-economic and psychological predictors of domestic greywater and rainwater collection: Evidence from Australia. Journal of Hydrology, 379(1-2), 164–171.

[171] Brown, R. R., & Davies, P. (2007). Understanding community receptivity to water re-use: Ku-ring-gai Council case study. Water Science & Technology, 55(4), 283.

[172] Hartley, T. W. (2006). Public perception and participation in water reuse. Desalination, 187(1-3), 115–126.

[173] Brown, R. R., & Davies, P. (2007). Understanding community receptivity to water re-use: Ku-ring-gai Council case study. Water Science & Technology, 55(4), 283.

[174] Washington State Department of Health. (2011). Distribution of System Leakage. *Water Use Efficiency Guidebook, 3,* 46–53.

meters, developing a schedule and budget for replacing old distribution lines, and synchronizing production and consumption meter reading schedules. The costs for these leakage reductions can be covered by the value of recaptured water that would have been lost if the improvements were not made.

An example of a successful implementation of reducing distribution system leakages is in Spokane, Washington.[174] The Pasadena Park Irrigation District in Spokane County serves about 2,000 customers and set up a water system's water use efficiency program. Their first step in the program was the replacement of a leaking lead joint water main. The water main had about a 45% water loss rate, and this caused over a million gallons of water a day and $75,000 a year to be lost. The district then implemented a metering program, started automatic meter readings, and carried out annual water audits. Through their water use efficiency program, the Pasadena Park Irrigation District was able to reduce water loss to 9.8%. More than 875,000 gallons of water per day was recaptured, which has a value of about $177,000. The revenue loss that was avoided is more than enough to make the loan payments that were used for the improvements each year.

Using the successful water efficiency program in Washington as an example, the implementation measure will survey the city's water distribution system in order to determine if there are any large leaks in storage tanks or water mains. If one is found, then replacement of the tank will greatly lower water loss and the emissions the waste produces. The program will also involve starting the metering program with automatic meter readings on all city-owned facilities and creating a water audit that will be done every year.

4.3 Community

Residential conservation rebates

There are implementation measures that can be done within households. Conventional toilets can be replaced with low flow toilets. They use less than half the amount of water per flush than the conventional ones, resulting in a 5,400 gallon reduction per capita of annual water

consumption.[175] Low flow showerheads can also be installed as they also use less than half the amount of water per minute than the conventional showerheads. This replacement can reduce water use by up to 8,700 gallons per person per year.[175] The average cost of for the toilets is about $200 and the cost for the showerheads about $60, which may be too expensive for some households.[176] To mitigate this cost and encourage residents, a rebate can be put into place from the city or another entity. There have been cases in various cities that have implemented a rebate system and have gotten successful results.

Currently, Cal Water provides rebates through the California Water Service Company Conservation Rebates Program.[177] Since the city of Hermosa Beach is included in the Rancho Dominguez, the city's residents qualify for rebates for three water-efficient appliances. Cal Water gives up to $150 for high-efficiency clothes washers, $100 for high-efficiency toilets, and $125 for smart irrigation.

Ashland, Oregon is a small city about the same size as Hermosa Beach, with a population of 20,000 people. The city was able to implement a rebate system that provided residents with $75 rebate for replacing old showerheads and toilets with high-efficiency alternatives.[178] The program was implemented in 1992, and by 2001, the city of Ashland audited about 1,900 homes. About 85% of these homes used the showerhead or toilet rebate program, and Ashland was able to decrease its water demand by about 395,000 gallons per day. Another benefit that resulted from the program is that the city's wastewater flow reduced by 159,000 gallons per day. The overall water savings for the city of Ashland came out to be a 16% reduction by 2001. The entire water conservation program cost was $825,875.

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[175] US Environmental Protection Agency. (2012). Polluted Runoff: How to Conserve Water and Use It Effectively. Retrieved from http://water.epa.gov/polwaste/nps/chap3.cfm

[176] Energy Coordinating Agency. (2013). Water Conservation: The Need for Water Conservation. Retrieved from http://ecasavesenergy.org/public-education/water

[177] California Water Service Co. (2013). Conservation: Residential Rebates for Rancho Dominguez. Retrieved from https://www.calwater.com/conservation/rebates_residential.php?district=rd&Submit=Show+rebates

[178] US Environmental Protection Agency. (2002). Cases in Water Conservation: How Efficiency Programs Help Water Utilities Save Water and Avoid Costs.

Another success story is found with the Goleta, California, Water District. Goleta gave out about 15,000 rebates for high-efficiency toilets and installed about 35,000 low-flow showerheads for their 75,000 customers between the years 1987 and 1991.[178] In addition to these rebates, they provided onsite surveys and public education and increased their water rates. All of these measures contributed to the 50% reduction in per capita residential water use between 1989 and 1990. There was also a drastic reduction in sewage flow, which went from 6.7mgd to 4mgd. Since this project was very large and wide-spread, it cost about $1.5 million.

Using these case studies as a guide, Hermosa Beach can implement a similar residential conservation rebate program. The city can first educate the public and provide free surveys for interested residents. Rebates can be given to those that volunteer to participate in the educative workshop by the city. The program then expands its rebates to all residential areas throughout Hermosa Beach.

Landscaping conservation

Water efficient landscaping can be a tool to reduce water use throughout Hermosa Beach. Using more efficient irrigation systems and native plants for vegetation will lower outdoor water use. It will also increase infiltration of water into the ground instead of running off into the streets and eventually into the ocean, which prevents pollution runoff and recharges any groundwater sources under the city. A native garden, instead of the conventional turf grass lawn, reduces water use by up to 50%. This would decrease irrigation from about 60,000 gallons per household per year to up to 30,000 gallons.[179] Keeping up with regular irrigation maintenance is another way to reduce water use by preventing water waste. This can decrease outdoor water use to up to 15%, saving about 9,000 gallons per year per household. Installing drip irrigation systems to replace conventional sprinklers also prevents water waste, and cuts water use to up to 50%, saving about 30,000 gallons

[179] US Environmental Protection Agency. (2013). Water Sense: Outdoor Water Use in the United States. Retrieved from http://www.epa.gov/WaterSense/pubs/outdoor.html

per household per year. This is because about half of the water used by the conventional sprinkler systems goes to waste from evaporation, wind, and overwatering.[179]

Tampa Bay, Florida's water department set up a number of measures to reduce the city's water use.[178] One of their focuses was landscaping codes. The Tampa Water Department offered homeowners free irrigation surveys and gave out free rain sensors. There were regulations put into place to limit the amount of irrigated turfgrass in new developments to 50%, which encouraged the use of climate-friendly vegetation and efficient irrigation systems. The water conservation efforts lowered water use by 25%.

Albuquerque, New Mexico created a water conservation program in 1994, and one of the five main components is landscaping and outdoor water use measures.[178] The Water Conservation Landscaping and Water Waste Ordinance included requirements for new developments, such as restricting the use of turfgrass on more than 20% of its landscaped area and irrigation regulations. The city has also provided support to help residents convert their own lawns to xeriscape landscapes with educational guides and a rebate. The rebate gave the homeowners 25 cents per square foot of converted land with a maximum of $500. In 2001, the city saw a decrease in their peak water use by 14% from their landscaping program.

The landscaping conservation program for Hermosa Beach will educate the public about replacing their lawns with xeriscape landscapes, offer free irrigation surveys, and provide rebates of 25cents per square foot for those who successfully convert.

Rainwater catchment

Collecting rainwater can reduce water use, and providing residents of the City of Hermosa Beach with opportunities to install rainwater cisterns or barrels is a good water conservation strategy. Rainwater harvesting involves collecting and storing run-off from a building or other

impervious surfaces in order to use later.[180] Storage of the water can be done in anything from a small rain barrel to a large cistern that is big enough to meet the demands of a household. The collected rainwater also has many uses. It can be used to water lawns and gardens, car and pet washing, refilling fountains and fish ponds, and systems can even be set up to connect the rainwater to indoor non-potable appliances, such as clothing washers and toilets.

The rule of thumb for rainwater catchment is that for every 1 inch of rainfall on 1,000 square feet of roof surface, 625 gallons of water can be collected. Since the City of Hermosa Beach receives about 12 inches of rain a year, an average house of about 2,000 sq feet can capture about 15,000 gallons of water every year.

Rainwater harvesting successfully reduces the amount of imported water needed, and therefore decreases greenhouse gas emissions, but it also has many other benefits.[180] The rainwater is healthier for landscape plants than the potable water from the distribution system, which is chlorinated. It also reduces stormwater runoff. This is significant to the City of Hermosa Beach because the stormwater can easily run off into the ocean and pollute the water if not captured on site. The method is inexpensive and does not require a lot of money or time to maintain, and it offers a back-up water source in case of any emergencies. A rebate program can be implemented in order to encourage residents to install and use rainwater catchment basins. The program can educate the public about the many benefits of rainwater harvesting by providing some workshops on how to install them and providing residents with rebates. The rebates offered can be similar to the one given by San Diego Public Utilities, which provides a rebate of $1.00 for every gallon the rain barrel can store.

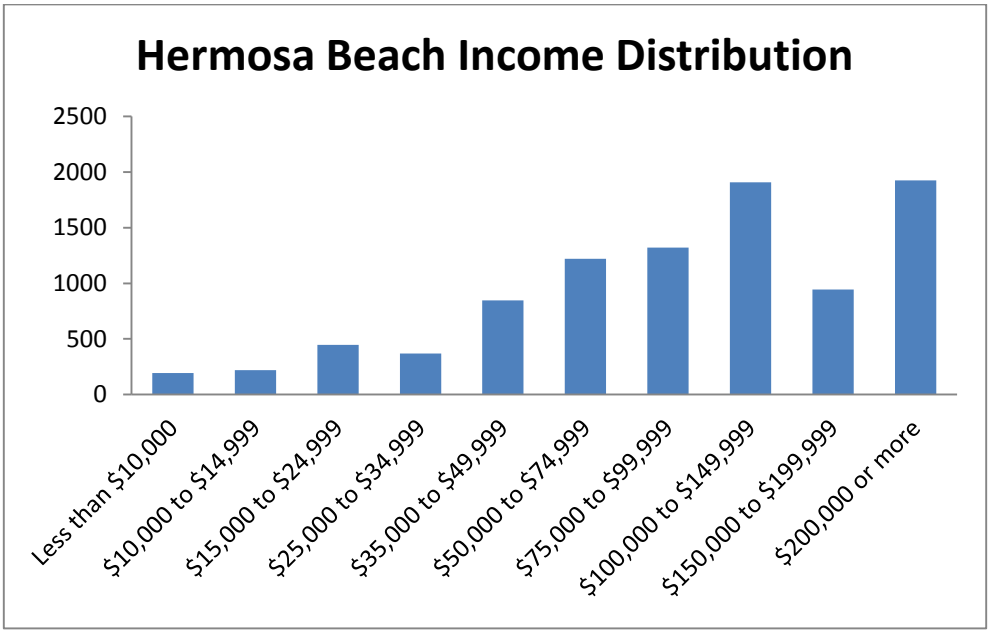
D. Materials Consumption and Waste

When calculating greenhouse gas emissions, the emissions from waste production and disposal are often overlooked. In contemporary society, the majority of anthropogenic greenhouse gas emissions

[180] Innovative Water Solutions. (2013). Rainwater Harvesting. Retrieved from http://www.watercache.com/education/rainwater/

can be traced back to a culture of consumption: materials and energy. Looking at the income distribution of the residents (Table 18) in Hermosa Beach, it can be said consumption and waste play an important role in emissions of greenhouse gases in Hermosa Beach, as higher incomes individuals are more likely to spend more. In order to become successful in Hermosa Beach's goal of becoming carbon neutral, it is important to look at emission sources that might not be so apparent, like waste disposal and consumption. Waste generation and disposal can emit in the form of methane and carbon dioxide. Depending on the type of waste, by understanding the sources and the boundaries of the emissions, it is possible to significantly reduce its emissions. The different ways solid waste disposal can lead to greenhouse gases emissions include, the anaerobic decomposition of waste in landfills that generate methane gas, the incineration of waste, and the transportation of the waste to disposal sites and the use of dirty fuel for the extraction of raw materials to make the products that generate the waste in the first place. Therefore, making conscious decisions about what we buy, how we throw it away, and how much we buy can reduce greenhouse gas emissions in the solid waste and consumption sector.

Table 22: Income distribution of Hermosa Beach[22]



1. Overview of Athens Services: Solid Waste

According to the community inventory, Hermosa Beach generated 18,490 tons of solid waste in 2007 alone. Currently, Athens Services hauls solid waste from Hermosa Beach and has promised at least a 35 percent diversion rate from landfills. The company serves 22 cities and is committed to the pay-as-you-throw system for Hermosa Beach. It works with various landfills and transfer facilities in the LA County to provide recycling and diversion services. The current approved disposal sites for non-diverted solid waste include: Chiquita Canyon Landfill, El Sobrante, Sunshine Canyon and Puente Hills Landfills. Other facilities and designated disposal sites include: Athens Services Transfer Facility, California Waste systems, Commerce Refuse-to-Energy and Southeast Resource Recovery Facility. Among these facilities, Hermosa Beach would most benefit from sending their waste to the Commerce Refuse-to-Energy Facility. That way, any emissions from waste would be turned back to energy.

1.1 Refuse-energy Facility and Methane Capture

Emissions from landfills can be avoided in several ways. First the landfill can use the existing technology to build a methane capture digester. With the help of pipes, this device can trap the methane and generate electricity[181]. In this way, the energy generated would not have any greenhouse gas emissions and can be looked at as a source of renewable energy. If Athens Services, in the future, is able to build such technology for its disposal sites, the emissions from landfills for Hermosa Beach can potentially be completely eliminated.

In addition, a more feasible option would be to divert the waste to the existing Commerce Refuse-to-Energy Facility. This facility currently uses the technology to carry out controlled burning of 360 tons of trash per day to produce about ten megawatts of electricity. Burning of trash might not seem like a healthy way to dispose of generated waste as it does emit particulates and harmful chemicals in the atmosphere. However, this facility uses air control devices and ash reuse systems to operate with

[181] Methane Capture and Use. (April 22, 2013). *EPA.* Retrieved from http://www.epa.gov/climatestudents/solutions/technologies/methane.html

the lowest emissions of records[182]. Therefore, it might be a feasible option for Hermosa which can be achieved through Athens Services.

2. Environmental Implications and Life Cycle Emissions Analysis

In the lifecycle approach, upstream emissions, also known as indirect emissions, can be a significant portion of the total emissions from a product. For Hermosa Beach, we considered both upstream and downstream emissions from the consumption and waste sector, but focused mainly on the downstream emissions. We concentrated on these emissions because the city has more authority over them than indirect emissions. These emissions include those generated by the consumption of goods, the recycling of goods, and disposal in landfills at the end of a product's lifecycle. Most significant from these are the emissions resulting from the landfills. When goods are disposed of in the trash, the waste is generally dumped to a landfill where the decomposition of the waste releases methane (CH_4), which, by weight, is 25 times more powerful as a greenhouse gas than carbon dioxide. Even though carbon dioxide is the most commonly discussed greenhouse gas, according to recent studies, methane emissions might account for a third of the climate warming from greenhouse gases between 1750s to the present[183]. Therefore, by diverting waste from landfills it is possible to avoid the release of methane into the atmosphere.

3. Consumption and Waste Areas of Concern

To establish the areas within the consumption and waste sector that are of primary concern, we set boundaries based on the level of control the city has over each area. As for solid waste, the city does not have much control over which type of vehicles the waste hauler is using, neither does it have control over how the waste is being disposed after it leaves Hermosa Beach. Due to that lack of control, this report will not thoroughly analyze those secondary concern areas. It will rather focus on

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[182] Commerce Refuse-To-Energy Brochure.(n.d.). *LACSD.* Retrieved from http://www.lacsd.org/solidwaste/swfacilities/rtefac/commerce/refusetoenergy.asp

[183] Krishna Ramanujan. (July 18, 2005). Methane's Impacts on Climate Change May Be Twice Previous Estimates. Retrieved May 17, 2013, from http://www.nasa.gov/vision/earth/lookingatearth/methane.html.

what community and municipal operations actions can be taken to reduce the waste that is generated in the city.

3.1 Municipal Operations

The boundaries for operations emissions are very straightforward. Anything the city owns or has control over can be potentially changed. Since the city does have significant control over what it buys and how it disposes of materials, the change in this area will be of ultimate importance. We will suggest implementation measures that will require the city to take into account life-cycle emissions in its operations.

3.2 Community Emissions

Within the consumption and waste sector, there are no specific boundaries for community emissions. Because consumption is personal and requires change from within an individual, boundaries in this area do not make sense. To be consistent, however, we can say that the community emissions areas that the city can have *some* influence over are the areas of primary concern. Implementation measures to reduce community emissions were carefully chosen to not interfere in the daily lives of residents of Hermosa Beach. The measures were rather designed to encourage behavior that will most efficiently reduce emissions in this sector.

4. Implementation Measures and Greenhouse Gas Reduction Options

There are four categories that are affected by implementation measures: Total consumption, avoids landfill, recycled and reused. Avoids landfill includes any trash that is not recycled, reused, or sent to landfills. It can include materials that are composted. There are certain measures that have an effect on more than one category. For example, a plastic bag ban will reduce the amount of plastic bags that are in the system, hence reducing consumption by a small percentage, and increase the percentage of materials that are reused. The suggested implementation measures are categorized by municipal operations measures and community operations measures. We will look at how Hermosa Beach can reduce its emissions from municipal operations then we will look at measures that will tackle community emissions.

4.1 Municipal Operations

First, we looked at Hermosa Beach's municipal operations. By implementing changes in the way the city operates, Hermosa Beach can reduce its emissions to address life-cycle waste emissions and downstream emissions from waste. There are several subcategories under this section that will be affected by changes in this sector. First, diverting waste from landfills is the key to reducing methane emissions from decomposition of waste materials.

Solid Waste

Currently, the city has negotiated with Athens Services, a waste hauler in the city, to truck waste from Hermosa Beach. According to an article in the Daily Breeze newspaper, Athens will divert a minimum of 35 percent collected waste in Hermosa Beach from landfills[184]. This will dramatically help the city reduce its methane emissions from landfills because the materials will be recycled rather than being dumped in the landfills. In addition to diversion, the new contract with Athens Services will implement a "pay-as-you-throw" system. This will give more flexibility to the community members as they will only pay for the amount of trash they throw away. Under this new system, residents will pay "$6.92 for the 35-gallon cart, $10.92 for a 64-gallon cart and $14.92 for a 95-gallon cart compared to the current rate of $11.57 for unlimited trash pickup[185]. They will be encouraged to throw away less trash because it will come with an economic incentive. This is a great start for the solid waste sector in Hermosa Beach. The next step would be to implement a program in which the vehicles used by the waste hauler would run on clean fuel zero emissions. This additional component would further reduce any leftover emissions from this sector.

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[184] Morino, D. (July 25, 2012). Hermosa Beach begins contract talks with Athens Services for trash hauling. *The Daily Breeze*. Retrieved from http://www.dailybreeze.com/news/ci_21159383.

[185] Alana Garrigues. (2012). *City to switch to Athens for waste hauling.* Retrieved from http://tbrnews.com/news/hermosa_beach/city-to-switch-to-athens-for-waste-hauling/article_9a2cfdc3-56cb-5279-bc63-52bb6bce9247.html

Purchasing Policy

Along with eliminating emissions from solid waste, municipal operations can become more efficient by making changes that would reduce upstream and downstream emissions. For example, the city can change buying choices for operational use. When buying paper, materials, or electronics for city use, the city can reduce its potential emissions by looking at options that are less carbon intensive. This can be done simply by buying recycled paper for office use, having ecofriendly utensils and napkins at city meetings, and buying more energy-efficient office electronics. These small steps can eventually reduce the carbon footprint of the municipal operations sector. In order to incorporate these steps into a plan, the city can choose to include a life-cycle assessment analysis in its Chapter 3.12[186] of the purchasing policy. This will add life-cycle emissions considerations to purchasing decisions.

4.2 Community Emissions

In 2007, 2% of the total community emissions for the city of Hermosa Beach came from community-generated solid waste. This takes into account paper products, food waste, plant debris, wood and textiles. According to the existing community emissions inventory, a comparison of emissions from 2005 to 2007 indicates a reduction in the emissions from solid waste due to diversion of waste from landfills to waste-to-energy facilities. The addition of Athens Services as the waste hauler would further help reduce these emissions because Athens has promised to divert at least 35 percent of waste from landfills as mentioned earlier. This will, however, not reduce any emissions from the consumption of materials in the community. Since community emissions make up more than half of the emissions from this sector, it is crucial for Hermosa Beach to take action in this area. Nevertheless, voluntary behavioral changes from community members must supplement the implementations of local ordinances in addressing greenhouse gas emissions from consumption and the waste stream.

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[186] Chapter 3.12 Purchasing. (2013). *City of Hermosa Beach.* Retrieved March 2013, from http://www.hermosabch.org/index.aspx?page=291

Voluntary Behavioral Changes

In order to encourage behavior to reduce carbon emissions, it is feasible for the city to provide incentives for the use of compostable single use items and to encourage the purchase and use of reusable shopping bags. One way to increase the amount of compostable material in the system is to require restaurants to provide compostable takeout boxes. This will be relatively easy to implement as restaurants already cannot use polystyrene. Also, the use of reusable tote bags in supermarkets will reduce the amount of bags being thrown away in the landfills and will reduce emissions from manufacturing of new bags. In addition, a guidebook can be provided to community members with lists of ecofriendly products available in their local supermarkets. This will put them in charge of their own purchasing decisions, while making it more accessible to obtain information about less carbon intensive goods. Cities like Santa Monica already have guides like this that are available to vendors and customers[187].

Plastic Bag Ban

Hermosa Beach already has an ordinance in place to ban the use of polystyrene[188]. Another essential ordinance that would significantly reduce waste is the ban of single use plastic bags. The Los Angeles County Board of Supervisors has already adopted an ordinance for this ban in unincorporated areas. Some cities with similar bans include: Calabasas, Glendale, Long Beach, Malibu, Manhattan Beach, Pasadena, Santa Monica, and West Hollywood[189]. According to Los Angeles Department of Water and Power, the intent of this ban is to reduce negative environmental impacts of the single use bags and to encourage the use of reusable bags[189]. This would ensure reuse of materials before disposal in landfills and would also reduce pollution associated with plastic bags. Together these small steps with the combined effort of the community members and the city

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[187] Santa Monica OSE - Non-Recyclable Food Service Container Ban. (2012, July 31).*City of Santa Monica*. Retrieved May 29, 2013, from http://www.smgov.net/departments/ose/business/content.aspx?id=4816

[188]Hermosa Beach Ban on Polystyrene Food Service Ware. *City of Hermosa Beach*. Retrieved from http://www.hermosabch.org/modules/showdocument.aspx?documentid=1939

[189] About The Bag. (2013). *Los Angeles Department of Water and Power*. Retrieved from http://ladpw.org/epd/aboutthebag/

would most definitely aid to reduce the carbon footprint of Hermosa Beach in the consumption and solid waste sector.

Reuse and Recycle Options

Recycling

One way to reduce a product's carbon footprint is to recycle it. Recycling for Hermosa Beach will become a common practice with Athens Services being the waste hauler; they will be responsible for diverting the waste from landfills to recycling facilities. Though, in the negotiations with Athens Services, it should be emphasized that Athens provide Hermosa Beach with information about where and how the waste is being recycled. Recycling is a beneficial practice because it prevents the emissions from the extraction of raw materials, manufacturing and distribution. According to a study by the Materials Management Workgroup of the West Coast Climate and Materials Management Forum, using recycled products can significantly reduce emissions from early stages of the life cycle[190]. An example was aluminum cans; the use of a recycled aluminum can dramatically reduce emissions as there is no need for smelting and mining for virgin aluminum. Therefore, Hermosa Beach should not only invest in diversion of waste but should also look into incorporating the use of recycled materials in the residential, commercial and industrial sectors.

Reuse –Best Practices

With implementation of educational and outreach programs, Hermosa Beach can help community members with practices that will not only reduce the city's carbon footprint but it will make the city self-sustaining in the long run. Going to the local thrift stores, using goods made from recycled materials and reusing products we tend to throw away quickly are practices that can be encouraged among community members of Hermosa Beach. These practices will reduce the amount of material being manufactured and brought to Hermosa Beach and also the amount of waste being thrown in the trash and recycling bins[190]. This will also bring economic benefits to the community members as

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[190] Materials Management Workgroup of the West Coast Climate and Materials Management Forum. (May 2011). *Reducing Greenhouse gas Emissions through Recycling and Composting*. Retrieved from

they will have to pay less for throwing away less trash. For example, by using one-side printed papers as scratch paper can reduce the demand for new paper, which in turn will eliminate emissions from manufacturing and distribution of paper. If the scratch paper is then recycled in Hermosa Beach and that individual buys new paper made from recycled materials, the original paper will stay in the system as long as the person keeps recycling and buying recycled paper. Small steps like this for all sorts of essential products we use will reduce community emissions significantly if majority of the community members participate. Often times, most individuals do not know that these small steps can make such a big difference. Therefore, in order to educate and gain support from community members, workshops on carbon neutrality can be held at the city level. It can be a requirement from the city for all members to actively participate in these workshops so it becomes easy to implement change in this sector.

Furthermore, reuse of building materials, also known as green building construction, is another way of reducing consumption and increasing reuse in the city. When buildings are demolished, large amounts of materials from the demolition can be used in new buildings or in retrofits. According to a 2008 Waste Characterization Study, 29 percent of waste sent to landfills comes from Construction and Demolition materials[191]. These materials include, lumber, drywall, metals, masonry, carpet, plastic, pipes, rocks, dirt etc[191]. If a building is demolished, materials like wood planks, cement and metals can be reused for construction of other buildings or retrofitting existing buildings. This is a feasible practice as was demonstrated by the Green Idea House in Hermosa Beach itself[192]. This practice can be encouraged by the city as part of existing building codes.

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http://www.epa.gov/region10/pdf/climate/wccmmf/Reducing_GREENHOUSE GASs_through_Recycling_and_Composting.pdf

[191] Construction and Demolition Debris Recycling. (2011). *CalRecycle.* Retrieved May 2013, from http://www.calrecycle.ca.gov/ConDemo/.

[192] Eric Ferrell. (October 8, 2011). Hermosa's Greenest House of Them All. In Hermosa Beach Patch. Retrieved May 2013, from http://hermosabeach.patch.com/groups/around-town/p/hermosas-greenest-house-of-them-all.

Green Waste Composting Program

When waste is sent to landfills, the organic material in the waste decomposes under anaerobic conditions. The anaerobic decomposition of the organic matter releases methane as a byproduct. Composting is the controlled aerobic decomposition of the organic matter in waste[193]. Materials that can be composted include yard trimmings, wood chips, vegetable scarps, paper products, animal carcasses and manure[193]. Through this practice, organic waste products can be transformed into soil amendments that help restore depleted and eroded environments[193]. Hermosa Beach currently does not have a composting program included in the Athens Services contract. Residents in the city only have the options to recycle and to dispose in landfills. Sometime in the near future, if a green waste composting program goes into effect, it can potentially benefit the city by diverting waste from landfills and the residents, as the compost can be used for lawns to improve soil conditions. This measure will be easy to implement as the city can directly contract with companies or even Athens Services for composting programs.

PART III: Implementation and Model Analysis

A. Discussion of Cross-sectional Implication and Impacts on Overall Greenhouse gases

We developed a community greenhouse gas emissions model in order to fully understand the implications of our implementation measures on greenhouse gas emissions. This model takes into account a multitude of variables when computing a measure, including quantitative data for energy reduction, whether it is source or activity-based, and the general time frame. The model functions to convert energy reductions into an emissions factor and to assess potential sector interactions. The model takes into account emissions from all sectors and graphs the measures to exhibit how emissions may decrease over time. It displays both quantitative and qualitative data that indicates

[193] Compost—What is it? (2006). *CalRecycle.* Retrived May 2013 from, http://www.calrecycle.ca.gov/Organics/CompostMulch/CompostIs.htm.

level of future emissions depending on which measures are activated. With this model, we can understand the effects of our measures applied to a larger scale and time frame in order to discern exactly when Hermosa Beach can reach carbon neutrality.

There are many cross-sectional implications that may affect the end data of the model. For example, the rise in electric vehicles will put a larger demand on the electrical grid. Hermosa Beach will have to consume more energy from their provider, which will lead to an increase in emissions from the source. If Hermosa Beach has set a goal of reducing electrical consumption by a certain percent, this goal will be more difficult to meet as electrical demand rises through the use of electric vehicles. Also, if waste was to be moved outside of Hermosa Beach, it would increase the amount of vehicle emissions due to increased transport. Though the model will be able to address some of the cross-sectional implications, not all are quantitatively evident and will need to be considered before the measures are put into effect.

**Disclaimer:* By no means is the model and the statistical data provided a completely precise representation of carbon neutrality scenarios, but rather should be used as a tool for emission trend analysis. The model is an estimate of predicted outcomes and hypothetical implementation measures based on existing literature. The numbers that are presented and used are by no way 100% exact, but are educated approximations and therefore, should be viewed as theoretical scenarios.

B. Model Analysis

1. Discussion of Scenarios

All of the implementation measures are divided into three "Scenarios" that begin in the year 2015 and end in 2075. Each Scenario contains a specific set of measures grouped according to the level of effort required for implementation and the Scenario number indicates the aggressiveness of the implementation measures. A higher number "Scenario" results in more aggressive implementation measures and therefore, a greater total emission reduction for Hermosa Beach. We have decided to call these "Scenarios" because they each act as a hypothetical option for Hermosa Beach's path to carbon neutrality. There are several implementation measures and time intervals in each "Scenario", and the measures will determine the magnitude of emission reductions for Hermosa Beach for that

chosen “Scenario”. Scenario I implements existing measures and “low hanging fruit” for emission reduction. Scenario II implements more aggressive climate action based on current political will and technology. Lastly, Scenario III implements the most ideal climate action assuming that there will be future and progressive changes 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.

2. Charts and Tables

Here we present summary charts and tables that we will reference in the following sections. Table 23: Master list of implementation measures for all sectors provides a master list of all implementation measures complete with a concise description and projected effects of the measure. Table 24: Total community greenhouse gas emissions for Scenarios I-III conveys the projected greenhouse gas reduction over time for each Scenario. Figure 29: Total community greenhouse gas emissions for Scenarios I-III illustrates these greenhouse gas reductions, comparing the three scenarios. These charts and tables will be references throughout our model analysis. The following sections discuss each individual Scenario, first reflecting upon the overall effectiveness of the Scenario and then considering its implications for each sector.

Table 23: 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	There is an average 10% reduction in total household energy consumption meaning a 10% reduction in electricity and a 10% reduction in natural gas.	Energy Upgrade California is a site that presents the full text of many essential works in literature about energy efficient building upgrade options.

	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.	Air sealing, Attic Insulation, Duct Sealing, Hot water pipe insulation, Thermostatic Control Valve, Low Flow Shower Head, Combustion Safety Testing, High efficiency furnace, Energy efficiency cooling, Water heater system, energy efficient windows, duct replacement, wall insulation, other custom energy saving measures	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.	Energy Upgrade California is a site that presents the full text of many essential works in literature about energy efficient building upgrade options.
	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	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.	Los Angeles County PACE is a site that presents the full text of many essential works in literature about PACE financing within the LA Country region.
	HVAC- General Adsorption Heat Pump	All residential buildings implement Adsorption HVAC systems.	N/a	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.	U.S. Department of Energy. (2013). Residential Energy Consumption Survey. Retrieved April 2013, fromhttp://www.eia.gov/consumption/residential/index.cfm EnergyStar.gov is a site that presents the full text of many essential works in literature about in home energy upgrades and energy efficiency.

	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.	Air sealing, Attic Insulation, Duct Sealing, Hot water pipe insulation, Thermostatic Control Valve, Low Flow Shower Head, Combustion Safety Testing, High efficiency furnace, Energy efficiency cooling, Water heater system, energy efficient windows, duct replacement, wall insulation, other custom energy saving measures, **renewable energy** (ie. solar geothermal pumps)	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.	Energy Upgrade California is a site that presents the full text of many essential works in literature about energy efficient building upgrade options.
	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	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.	Los Angeles County PACE is a site that presents the full text of many essential works in literature about PACE financing within the LA Country region.
	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.	N/a	There is an average 11.5% reduction in total residential natural gas consumption	U.S. Department of Energy. (2013). Residential Energy Consumption Survey. Retrieved April 2013, fromhttp://www.eia.gov/consumption/residential/index.cfm EnergyStar.gov is a site that presents the full text of many essential works in literature about in

					home energy upgrades and energy efficiency.
	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.		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.		Reduction of total energy consumption from residential buildings by 5%. Generates 2,840,990 kWh of energy.	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.		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.	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.	Reduction of total energy consumption in residential buildings by 20%. Generates 11,363,961 kWh of electricity	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.	Reduction of total energy consumption from government buildings by 20%. Generates 571,862 kWh of electricity	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.	Reduction of total energy consumption from commercial/industrial buildings by 20%. Generates 2,642,008 kWh of electricity	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	Reduction of total energy consumption in residential buildings by 50%. Generates 28,409,904 kWh of electricity	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%	Reduction of total energy consumption from commercial/industrial buildings by 50%. Generates 6,605,021 kWh electricity	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.	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.	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 have chose the total energy entering HB consisting of 70% renewable origins.	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.	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.	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.	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.	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.	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)
	Carpooling and Carshare- Phase I	Increases in average vehicle occupancy and decreases in VMT that will occur with the initial implementation of community-wide carpool and carshare programs.	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 Phase II - (15% of Households)	Long-term expansion of the NEV program and potential improvements in electric vehicle technology will increase participation and further decrease VMT.	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.	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.	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.	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.	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.	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.	By 2050 VMT will be reduced by 30%	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.	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.	Reduces Kwh of electricity required per VMT.	California Energy Commission (2011)
	Gasoline Vehicle Efficiency Gain	Estimated efficiency improvements for gasoline vehicles over time.	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.	Reductions in therms of natural gas required per VMT	California Energy Commission (2011)
	Hydrogen FCV Efficiency Gain	Estimated efficiency improvements for hydrogen FCVs over time.	Reductions in kg CO2e per mile	California Energy Commission (2011)
Consumption and Waste	Purchasing Policy	Incorporation of Lifecycle emissions in Municipal Purchasing Policy	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	Total consumption , reuse	Estimate
	Plastic Bags Ban	Similar to the Polystyrene Ban	Total consumption, reuse	Estimate
	Discounts and Coupons	Ask supermarkets to give more discounts and coupons for recyclable, compostable and biodegradable products. Maybe even the city can subsidize products like that.	Recycling, avoids landfill	Estimate
	Guide for ecofriendly products	Create a guidebook for consumers and vendors for direction on which ecofriendly products to buy	Recycling, avoids landfill	Estimate
	Using recycled materials	Make it mandatory for municipal operations and industries to use recycled material when possible	Reuse , recycling , Total consumption	Estimate
	Reuse- thrift shops, paper	Increase access to thrift shops by educational workshops and bringing more thrift shops into the city	Reuse	Estimate

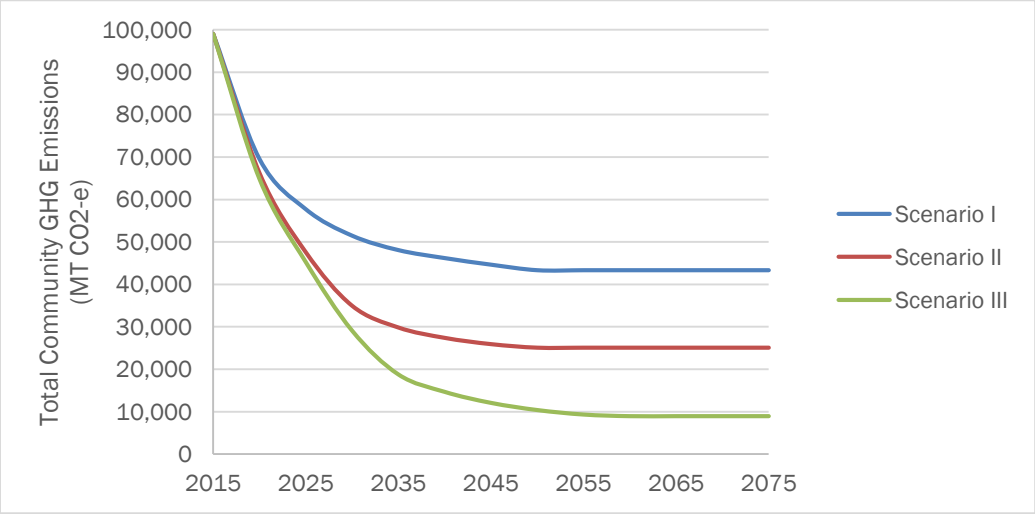
	Athens- transfer facilities to convert to energy	Ask Athens to take waste to commerce refuse to energy facility	Can completely ignore landfill emissions if the waste is converted to energy	
	Athens- use of zero emissions vehicles	Require Athens to use zero emissions/ electric vehicles to haul and transfer waste from Hermosa Beach	Can disregard emissions from waste transport. Note this was not analyzed in the report	
Water and Wastewater	Greywater outdoor reuse	Replace water system in 500 buildings with greywater reuse system	Decreases total water demand by 3%	Hermosa Beach Green Task Force (2011)
	Reduce distribution system leakages – Phase I	Find and repair leaks throughout water distribution system. In first phase or measure, reduce leakages to 20%	First phase decreases total water demand by 10%	Washington State Department of Health (2011)
	Reduce distribution system leakages – Phase II	Find and repair leaks throughout water distribution system. In second phase, reduce to leakages 10%	Second phase reduces total water demand by 20%	Washington State Department of Health (2011)
	Residential conservation rebates – Phase I	Rebates given to residents that install low flow toilets or showerheads. First phase provides education for residents and gives 2,000 homes the rebate	First phase decreases total water demand by 4%	US Environmental Protection Agency (2012)
	Residential conservation rebates – Phase II	Rebates given to residents that install low flow toilets or showerheads. Second phase gives more rebates for a total of 5,000 rebates	Second phase decreases total water demand by 10.5%	US Environmental Protection Agency (2012)
	Residential conservation rebates – Phase III	Rebates given to residents that install low flow toilets or showerheads. Third phase gives a total of 9,000 rebates	Third phase decreases total water demand by 18.9%	US Environmental Protection Agency (2012)
	Landscaping conservation – Phase I	Rebates given to residents that successfully convert their lawns to xeriscape. First phase provides education, free water surveys, and 1,000 rebates.	First phase decreases total water demand by 0.39%	US Environmental Protection Agency. (2013)

	Landscaping conservation – Phase II	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.	Second phase decreases total water demand by 0.78%	US Environmental Protection Agency. (2013)
	Rainwater Catchment – Phase I	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.	The first phase decreases total water demand by 0.97%	Innovative Water Solutions (2013)
	Rainwater Catchment – Phase II	Rebates given to residents that install and use rainwater catchment basins. Second phase gives more rebates for a total of 1,000.	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	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	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	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	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	Increases recycled water proportion by 12%	West Basin Municipal Water District (2010)

Table 24: Total community greenhouse gas emissions for Scenarios I-III

Total Community GHG Emissions (MT CO2-e)			
Year	Scenario I	Scenario II	Scenario III
2015	98,969	98,969	98,969
2020	69,480	66,184	64,800
2025	57,672	47,561	45,231
2030	51,445	34,969	29,087
2035	48,044	29,847	18,777
2040	46,166	27,412	14,683
2045	44,611	25,937	12,092
2050	43,303	25,102	10,402
2055	43,303	25,102	9,343
2060	43,303	25,102	8,962
2065	43,303	25,102	8,962
2070	43,303	25,102	8,962
2075	43,303	25,102	8,962

Figure 29: Total community greenhouse gas emissions for Scenarios I-III



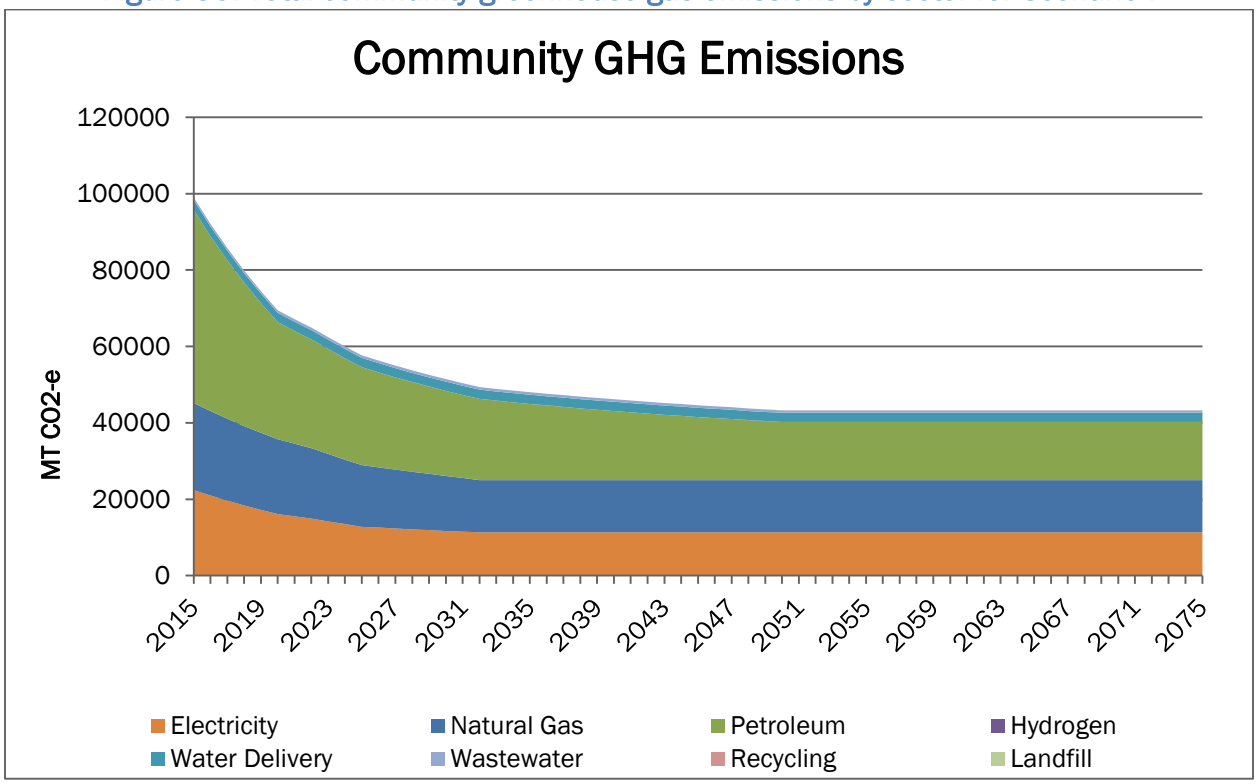
3. Scenario I

Scenario I measures will include the "low hanging fruit" that are relatively simple to implement. These implementation measures include changes that are likely to occur regardless of Hermosa Beach's intervention and improvements in the efficiency of already existing systems.

As calculated from the values in Table 24, Scenario I reduces emissions by about 56%. Scenario I initially affects emissions as drastically as II and III, as depicted in Figure 30, but by about 2025 the

reductions slow down. Hermosa Beach will not attain carbon neutrality with Scenario I without purchasing many offsets. The following sections provide details on how Scenario I affects each sector and how each sector interacts with one another.

Figure 30: Total community greenhouse gas emissions by sector for Scenario I



2.1 Building Energy

Table 25: Scenario I Implementation measures for building energy activities and energy sources and the effects on subsequent emissions sectors using Hermosa Beach community boundaries

Scenario I Implementation Measures		
Activity-Based Measure	Energy Upgrade CA 1: Basic Energy Upgrade	NG/ Electricity
	Commercial/Industrial Retrofit I: PACE financing	NG/Electricity
	HVAC General Adsorption Heat Pump	NG/Electricity
Source-Based Measure	Southern CA Edison Emissions Factor	Electricity
	Solar Photovoltaic on 5% of residential buildings	Electricity

Figure 31: Electricity consumption in Hermosa Beach from residential, commercial/industrial and transportation sectors over the implementation period of Scenario I measure.

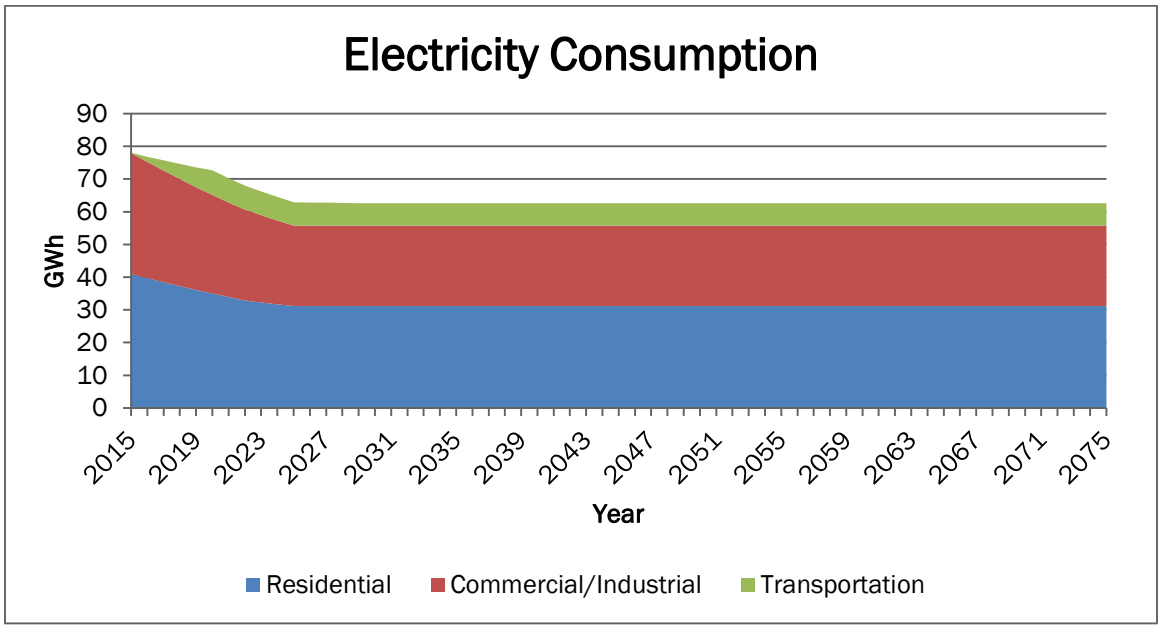


Figure 32: Source of electricity provided to the city of Hermosa Beach over the implementation period of Scenario I measures.

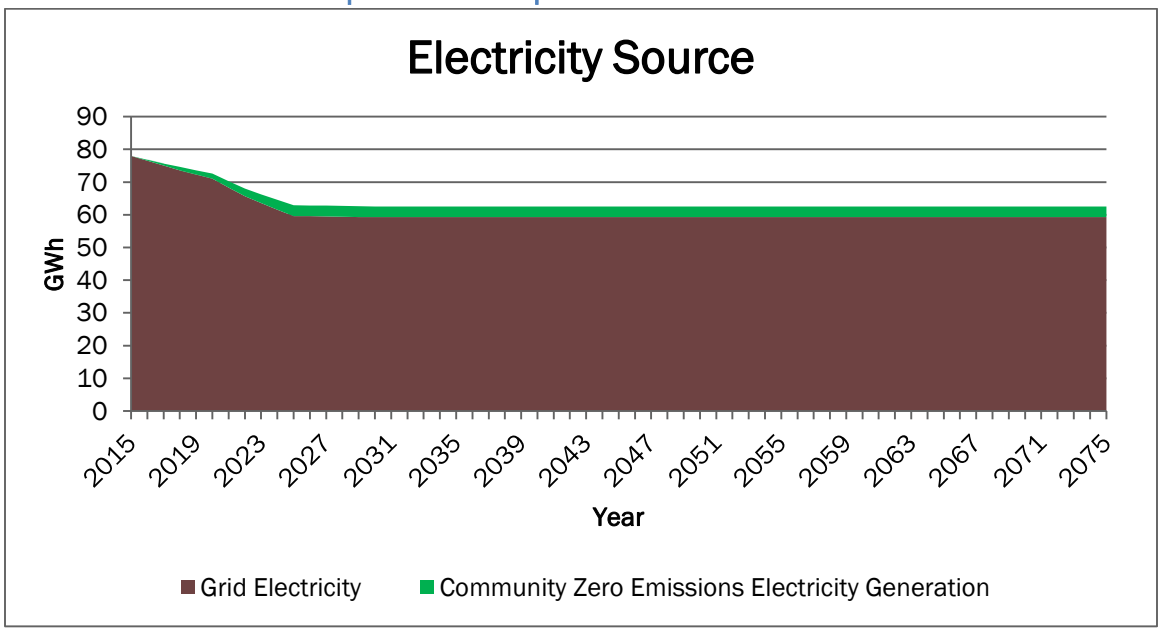


Figure 33: Natural gas consumption in Hermosa Beach from residential, commercial/industrial and transportation sectors throughout the Scenario I implementation period.

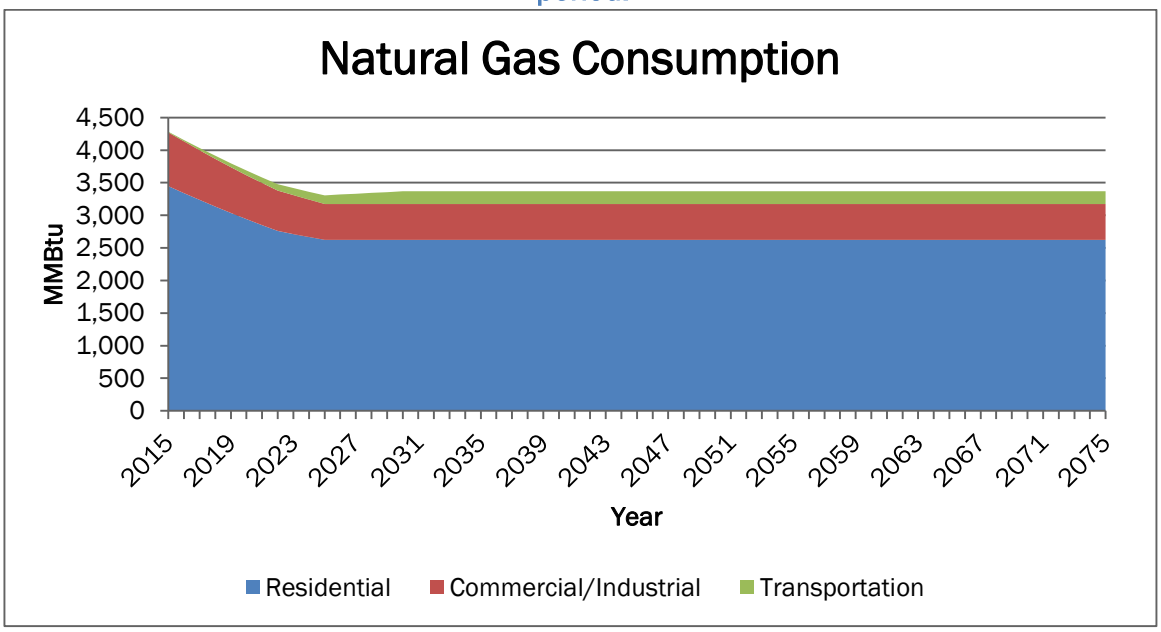


Table 26: Electricity and Natural Gas greenhouse gas emission over time with Scenario I implementation measures.

Scenario I	Year	Electricity Greenhouse Gas Emissions (MT CO2)	Natural Gas Greenhouse Gas Emissions (MT CO2)
	2015	22416.137	22772.769
	2020	16118.662	19600.941
	2025	13534.039	17573.549
	2030	13454.441	17906.668
	2035	13454.441	17906.668
	2040	13454.441	17906.668
	2045	13454.441	17906.668
	2050	13454.441	17906.668
	2055	13454.441	17906.668
	2060	13454.441	17906.668
	2065	13454.441	17906.668
	2070	13454.441	17906.668
	2075	13454.441	17906.668

Table 27: Energy Consumption and Production of Energy in Hermosa Beach with Scenario I implementation measures.

Electricity Consumption vs. Production (kWh)												
Year	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
Total Electricity Consumption	78020562	72646254	62912024	62561424	62561424	62561424	62561424	62561424	62561424	62561424	62561424	62561424
Community Zero Emissions Electricity	0	1650000	3300000	3300000	3300000	3300000	3300000	3300000	3300000	3300000	3300000	3300000
Grid Electricity	78020562	70996254	59612024	59261424	59261424	59261424	59261424	59261424	59261424	59261424	59261424	59261424

Table 28: Natural Gas consumption in Hermosa Beach with Scenario I implementation measures

Natural Gas Consumption (therms)												
Year	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
Residential	3448010	2941352	2621797	2621797	2621797	2621797	2621797	2621797	2621797	2621797	2621797	2621797
Commercial/ Industrial	827116	674408	549894	549894	549894	549894	549894	549894	549894	549894	549894	549894
Transportation	8987	71654	134322	196990	196990	196990	196990	196990	196990	196990	196990	196990
Total	4284113	3687414	3306013	3368680	3368680	3368680	3368680	3368680	3368680	3368680	3368680	3368680

Figure 34: Electricity consumption and production of electricity in Hermosa Beach with Scenario I implementation measures.

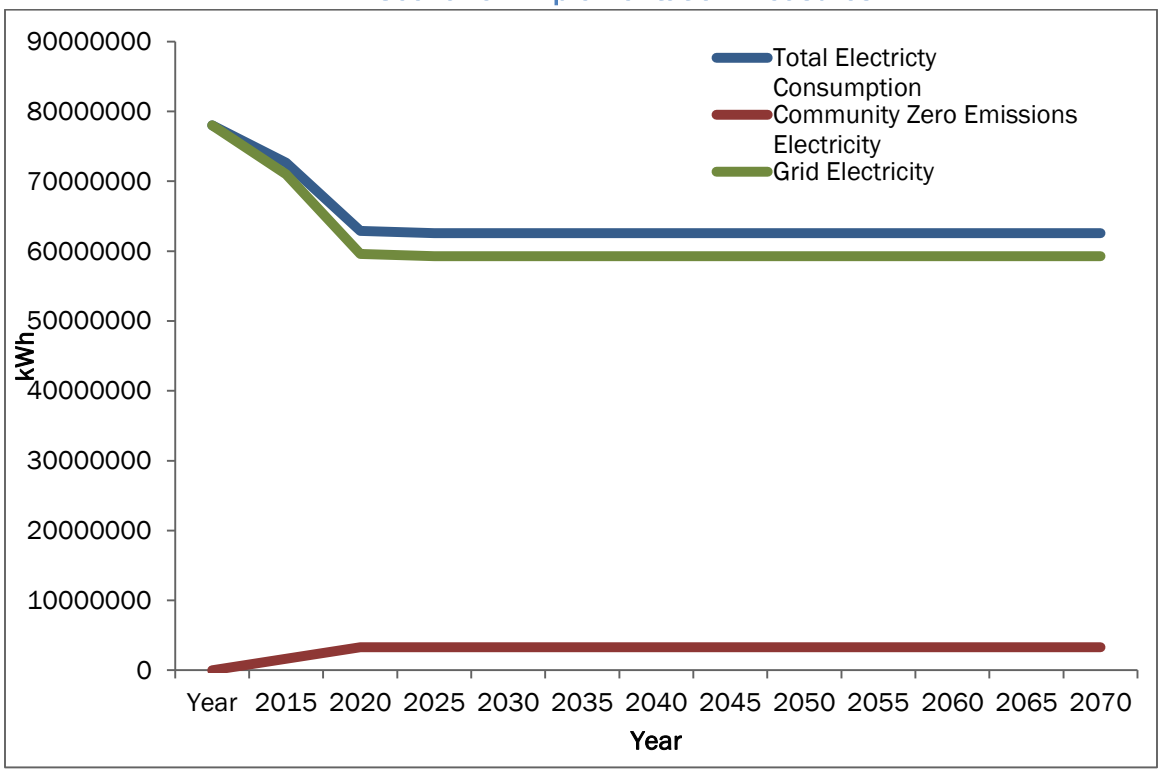
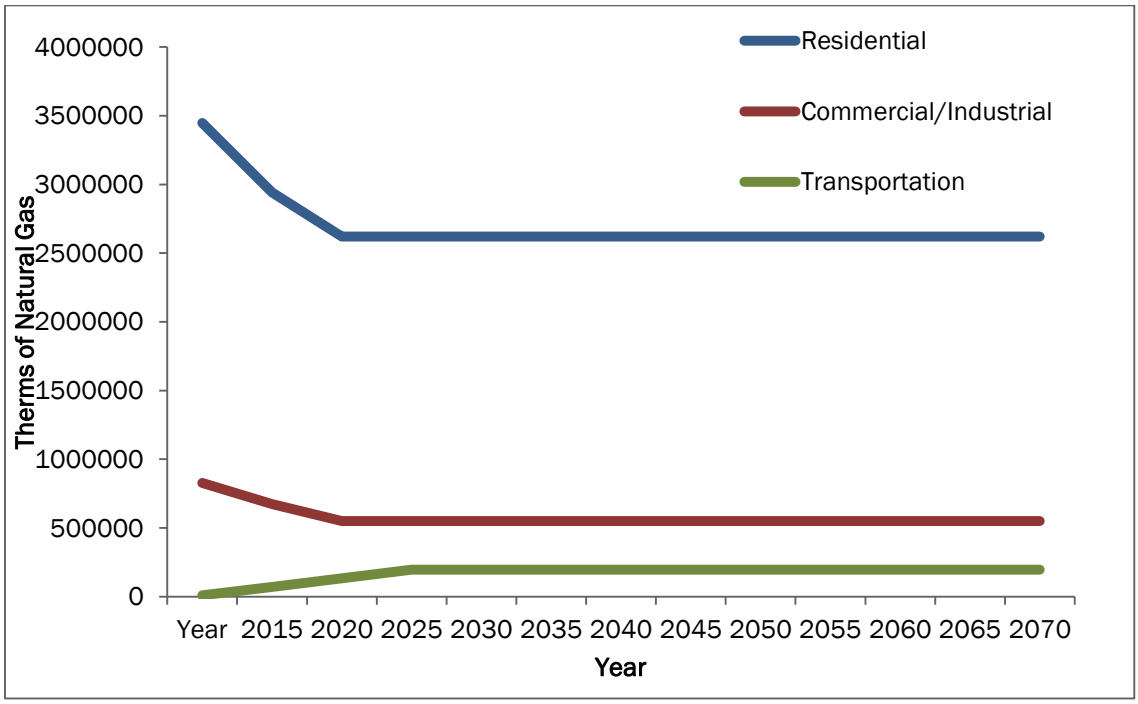


Figure 35: Consumption of Natural gas in Hermosa Beach with Scenario I implementation measures



Implementation Measure Discussion

The measures that we looked at for building energy comprised of both activity and source based implementation measures. The Energy Upgrade CA 1: Basic Energy Upgrade package bundle includes the most basic building retrofits, which predominantly ensures insulation of buildings and transmission pipelines within residential households. This implementation measure is most easily achieved, or is the "low hanging fruit", because residents have incentives to invest in upgrades because they cut costs and are fairly easy to implement whilst reducing energy consumption and emissions. The Community/Industrial Retrofit 1 - PACE financing is similar to the Energy Upgrade CA 1 except it strictly only applies to commercial and industrial buildings. PACE financing can be used to invest in building energy efficiency projects only in commercial and industrial buildings, and the Retrofit 1 bundle only includes projects that are easily implemented such as efficient light fixtures, insulation upgrades, and building automation controls. HVAC General Absorption Heat pumps in all residential buildings would help to reduce energy consumption because they are more efficient than the conventional furnace or boiler. HVAC General Absorption Heat Pumps are still are powered by the energy supplied by local pipeline distributors, therefore making it a low hanging fruit because there is no change in emission source for this given emission activity. Depending from where the origins of the energy come, also determines the factor of emissions. Further detail on each implementation measure can be found in Table 23: Master list of implementation measures for all sectors.

For Scenario I, very little is done to mitigate emissions from source. The Southern California Edison Emissions Factor simply is the goal of Southern California Edison to reach 23% renewable energy procurement in terms of total electricity production by 2020. Hermosa Beach has no control over this factor, thus making this an implementation measure that would happen regardless of city influence, or a "low hanging fruit". The other source based measure that is included in Scenario I is solar photovoltaic on 5% of residential households. Again, this is a measure that is community based, and out of the city's control. Residents will invest in some personal solar photovoltaic for their households regardless of local government measures, thus we accounted for the independent investments in our analysis of emissions. Scenario I in the building sector focuses predominately on enforcing efficiency in buildings, but does not alter Hermosa Beach's source of energy.

Analysis

There is a significant decrease in both electricity and natural gas related emissions due to these basic, short term consumption-reducing implementation measures. Electricity emissions are reduced by 40% or 8,962 MT CO_2 by 2030 while total consumption is decreased by 20% or 15,459,138 kWh by 2025. Table 27: Energy Consumption and Production of Energy in Hermosa Beach with Scenario I implementation measures. Table 27 displays how 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. However, the community zero emissions electricity consumption is still a very small percentage (5%) of total consumption. For natural gas, emissions are reduced by 21% or 4,866 MT CO_2 by 2030 while consumption is reduced by 21% or 915,433 therms by 2030. The residential sector experiences the largest decrease in natural gas consumption in comparison to the commercial and industrial sectors.

The previous figures and tables demonstrate the effectiveness of simple building retrofits such as additional insulation, efficient lighting, and heat pumps. Both Figure 34 and Figure 35 depict the significance that mitigation efforts toward "low hanging fruit" can make toward total greenhouse gas emissions, over a relatively short period of time. Focusing policy on residential electricity and natural gas consumption can reduce a large amount of emissions. As these activity-based measures are extremely simple and offer future savings, they are less likely to be rejected by the public.

2.2. Transportation and Land Uses

For transportation and land use, the measures implemented in Scenario I included mainly natural market changes and programs that were likely to occur even without Hermosa Beach's action. These measures include fuel carbon intensity changes due to California's Low Carbon Standard, natural market growth expected for alternative fuel vehicles (electric, natural gas, and hydrogen FCVs), estimated future electric vehicle efficiency improvements, and a basic neighborhood electric vehicle program. The implementation measures activated in the Scenario I model are listed in Table 29 and details on each implementation measure can be seen in Table 23.

Table 29: Scenario I implementation measures for the transportation sector

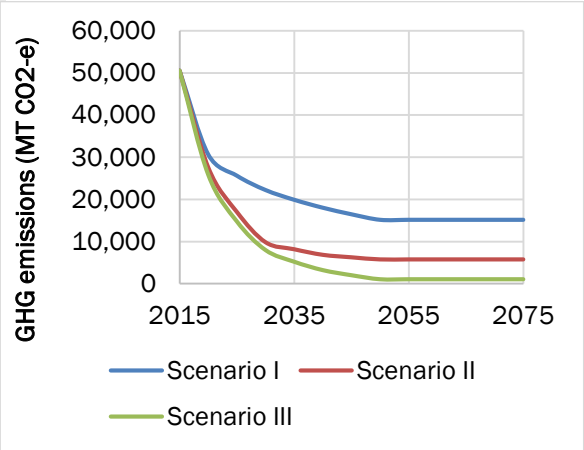
Scenario I Implementation Measures	
Activity-Based Measures	Neighborhood Electric Vehicles- Phase I
	Electric Vehicles - Phase I
	Hydrogen FCEV - Phase I
	Natural Gas Vehicles
Source-Based Measures	California Low Carbon Fuel Standard
	Electric Vehicle Efficiency Gain
	Gasoline Vehicle Efficiency Gain
	Natural Gas Vehicle Efficiency Gain
	Hydrogen FCV Efficiency Gain

As seen in Table 30 and portrayed in Figure 35, these status quo implementation measures do not make a substantial dent in Hermosa Beach's petroleum greenhouse gas emissions. By 2075 of Scenario I petroleum emissions decrease by about 69.97% relative to 2015, but they still comprise a considerable 35% of total emissions.

Table 30: Total petroleum GHG emissions in Scenarios I-III

Greenhouse Gas emissions (MT CO2-e)			
Year	**Scenario I**	**Scenario II**	**Scenario III**
2015	50,532	50,532	50,532
2020	30,651	27,576	25,857
2025	25,623	17,024	14,764
2030	22,229	9,850	7,980
2035	19,914	8,178	5,205
2040	18,035	6,859	3,217
2045	16,480	6,268	2,005
2050-2075	15,172	5,770	1,053

Figure 36 Comparison of scenarios I-III for transportation



Most of this change is a result of the shift from petroleum to alternative fuels. Table 1 shows these changes in transportation consumption over time. In 2015, 95.80% of miles traveled were made by petroleum vehicles. By 2075, this portion had decreased to 71.60% while miles completed by electric vehicles increased from 0.10% to 17.30% of total miles. 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 service so these did not contribute to greenhouse gas reduction. The change in transportation mode choice between 2015-2075 in Scenario I can be seen in Figure 37. The values for portion of total transportation consumption in 2075 are found in Figure 38.

Table 31: Scenario I transportation consumption by mode

Transportation Consumption (miles)							
Year	Petroleum	Electric	Hydrogen	Natural Gas	Bike/Walk	Transit	Total
2015	136,880,158	142,883	1,429	142,883	4,286,480	1,428,827	142,882,658
2020	108,255,998	24,718,700	2,144,669	2,047,985			
2025	104,207,656	24,718,700	4,287,909	3,953,087			
2030-2075	102,302,554	24,718,700	4,287,909	5,858,189			

Figure 37: Miles traveled by each mode of transportation in Scenario I

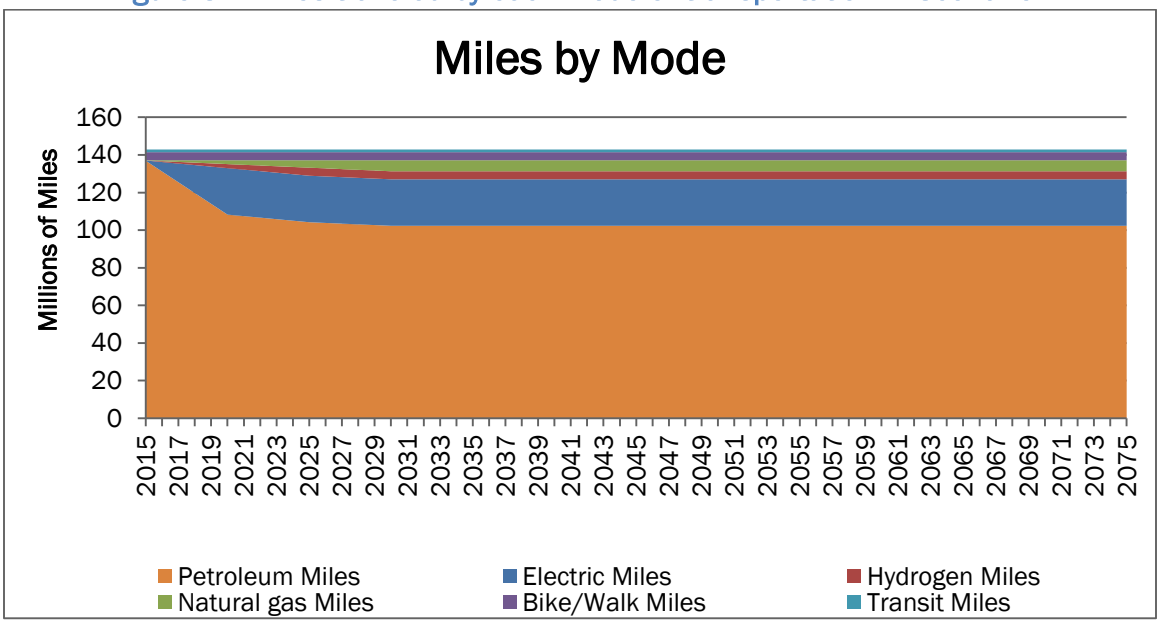
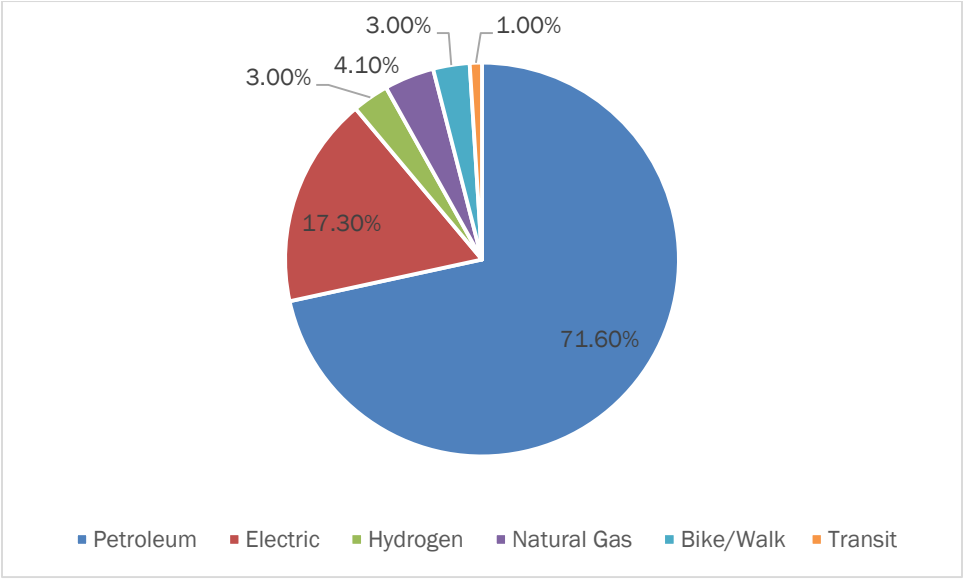


Figure 38: Portion each mode contributes to total transportation consumption in 2075



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. Figure 39 shows the relationship between electric and petroleum miles in

Scenario I. Figure 31 displays how transportation comprises a larger portion of electricity consumption in 2030 compared to in 2015.However, despite this slight electrification of transportation, Figure 37 shows that Scenario I does not significantly transition Hermosa Beach away from petroleum.

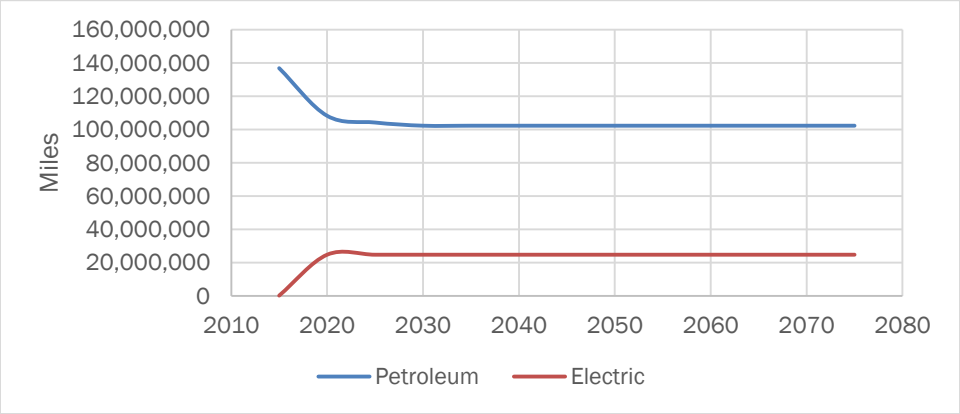


Figure 39: Miles traveled by petroleum and electric vehicles in Scenario I

2.3 Water and Wastewater

The first scenario of the water implementation measures will include those that West Basin has planned and the rainwater catchment rebate program (Figure 40).

The first phase of the rainwater catchment measure is to educate the public about the many benefits of rainwater harvesting by providing some workshops on how to install them. Phase 1 will be two years long and at these workshops the rebates can be offered to those residents that attend. The rebates offered can be $1.00 for every gallon the rain barrel can store. The goal of phase 1 is to educate and give 500 households the rebate. Phase 2 will be providing more rebates to residents throughout the next two years. The goal of this second phase will be to give a total of 1,000 rebates for rainwater barrels, which will save up to a total of 15million gallons of water every year.

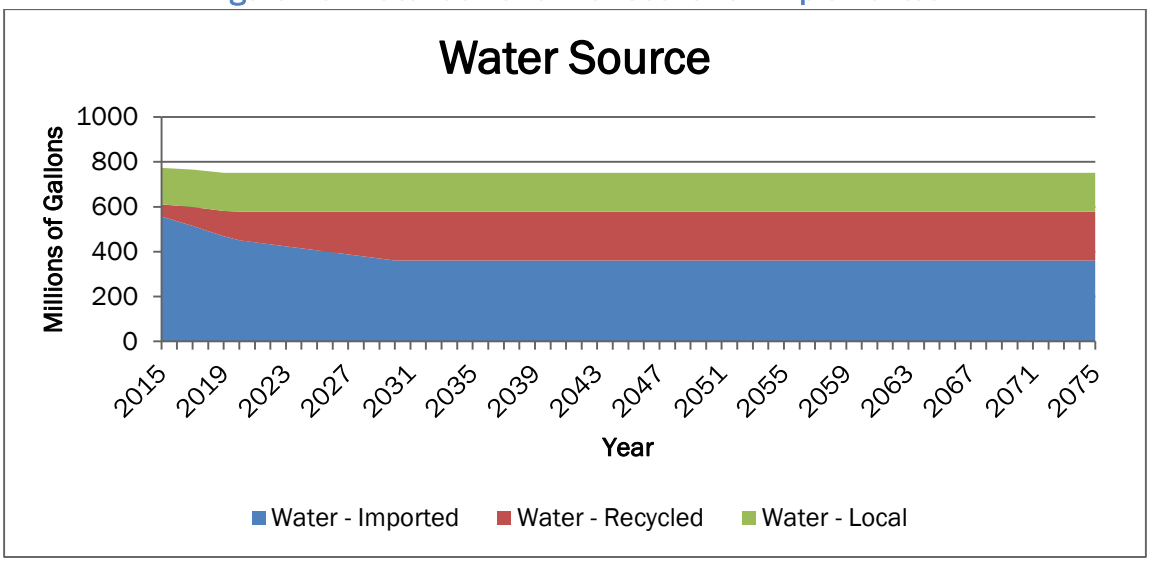
The West Basin's plans are included in Scenario I because these changes will be made regardless of Hermosa Beach's actions. The rainwater catchment rebates are inexpensive and do not require much work from the city.

Little effort from the local government is needed to implement these measures, and this is why they are included in the first scenario. Although it does not seem to make much of a change, it does lower the imported water demand from 557 million gallons annually to about 361 million gallons, which is almost 200 million gallons a year. The total water demand will go from 773 million gallons per year to about 751 million gallons. The greenhouse gas emissions from water delivery will also decrease from about 2,580,000 MT CO_2-e to 2,408,000 MT CO_2-e.

Scenario I Implementation Measures	
Activity – Based Measures	Rainwater Catchment – Phase I
	Rainwater Catchment – Phase II
	West Basin lower imported waters by 2020
	West Basin increase local waters by 2020
	West Basin increase recycled waters by 2020
	West Basin lower imported waters by 2030
	West Basin increase recycled waters by 2030

Scenario I	
Year	**Greenhouse Gas Emission (MT CO_2-e)**
2015	2,580
2020	2,431
2025	2,419
2030 - 75	2,408

Figure 40: Water demand with Scenario I implemented



2.4 Consumption and Waste

Table 1: List of Active Implementation Measures in Scenario I

Type of measure	Measures
Activity	Purchasing Policy
	Tote bags
	Plastic Bags Ban
	Incentives for compostable single use items
	On-site building materials reuse
	Pay as you throw program
	Green waste composting program

Scenario I implementation measures for the consumption and waste sector include incorporating lifecycle emissions in municipal purchasing policy, encouraging the use of tote bags in supermarkets by requirement or incentives, the plastic bag ban, incentives or requirements for compostable single use items, on-site reuse of building materials, the currently in-place pay-as-you throw program, and finally a green waste composting program . These measures together will help reduce total consumption, encourage reuse, composting and recycling. This is due to the fact that these measures will take effect slowly and will produce a steady decrease of emissions over time. As depicted in Figure 3, with the measures in effect, the tonnage of waste going to landfill will slowly

decrease over time as recycling, reuse, and composting practices increase. With the implementation of these measures in Table 1, greenhouse gas emissions from landfills will decrease by about 1.53 MT CO2-e by the year 2026. Due to the nature of the modeled implementation periods, total emissions will stabilize at 4.45 MT CO2-e after the year 2026. In addition, recycling requires energy and can emit greenhouse gases. Therefore, depending on the emissions factor for recycling, there will be an increase in recycling emissions of 0.0033 MT CO2-e, with stabilization after 2026. The current factor is estimated to be 84.6% less than the landfill emissions factor. In summary, will be a net reduction in waste and recycling emissions by 25.60% over the course of 11 years.

Table 32: Emissions from recycling and landfill for Scenario I

Scenario I Emissions			
Year	**Landfill Emissions (MT CO2-e)**	**Recycling Emissions (MT CO2-e)**	**Total Consumption Emissions (MT CO2-e)**
2015	5.77	0.22	5.99
2020	4.62	0.27	4.89
2025	4.21	0.29	4.50
2026-2075	4.16	0.29	4.45

Figure 41: Distribution of materials consumption categories over the 60 year period for Scenario I

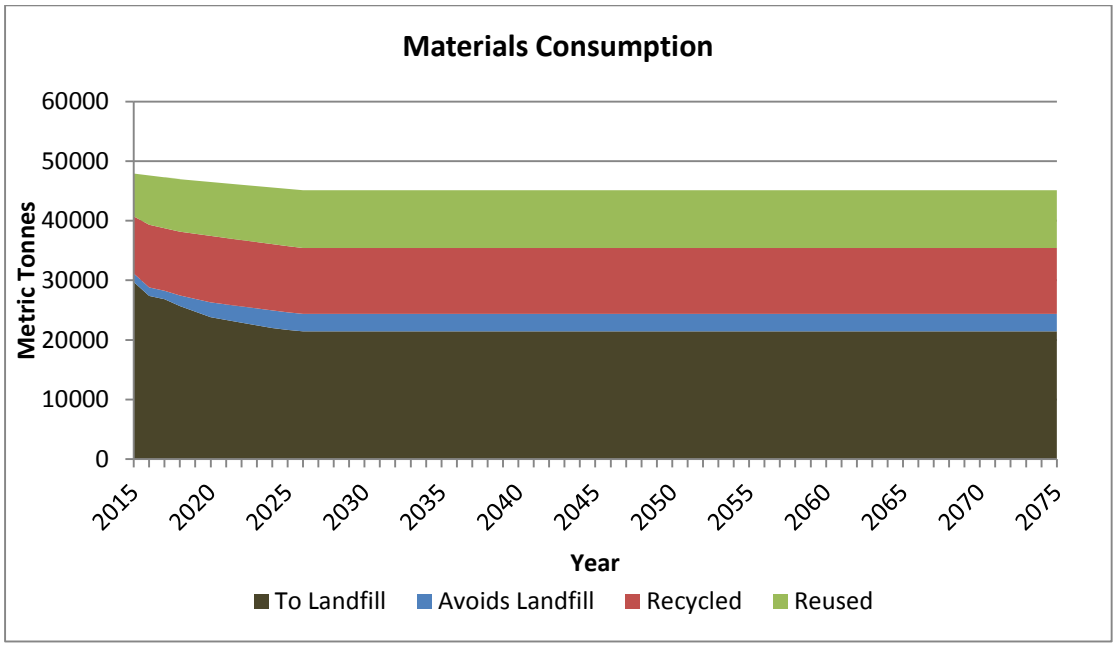
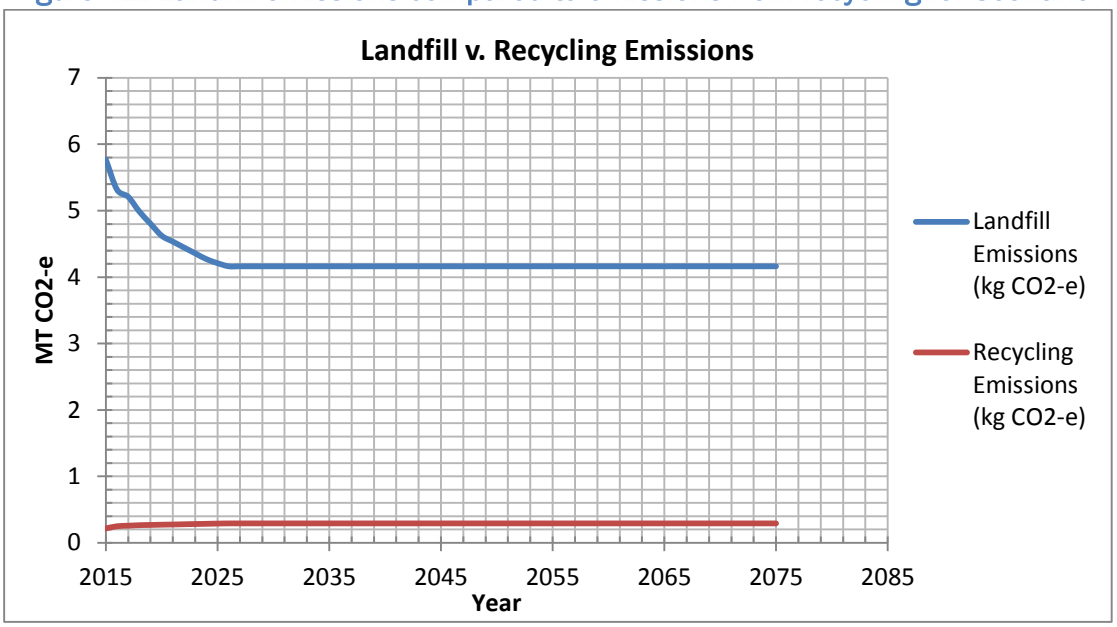


Figure 42: Landfill emissions compared to emissions from recycling for Scenario I

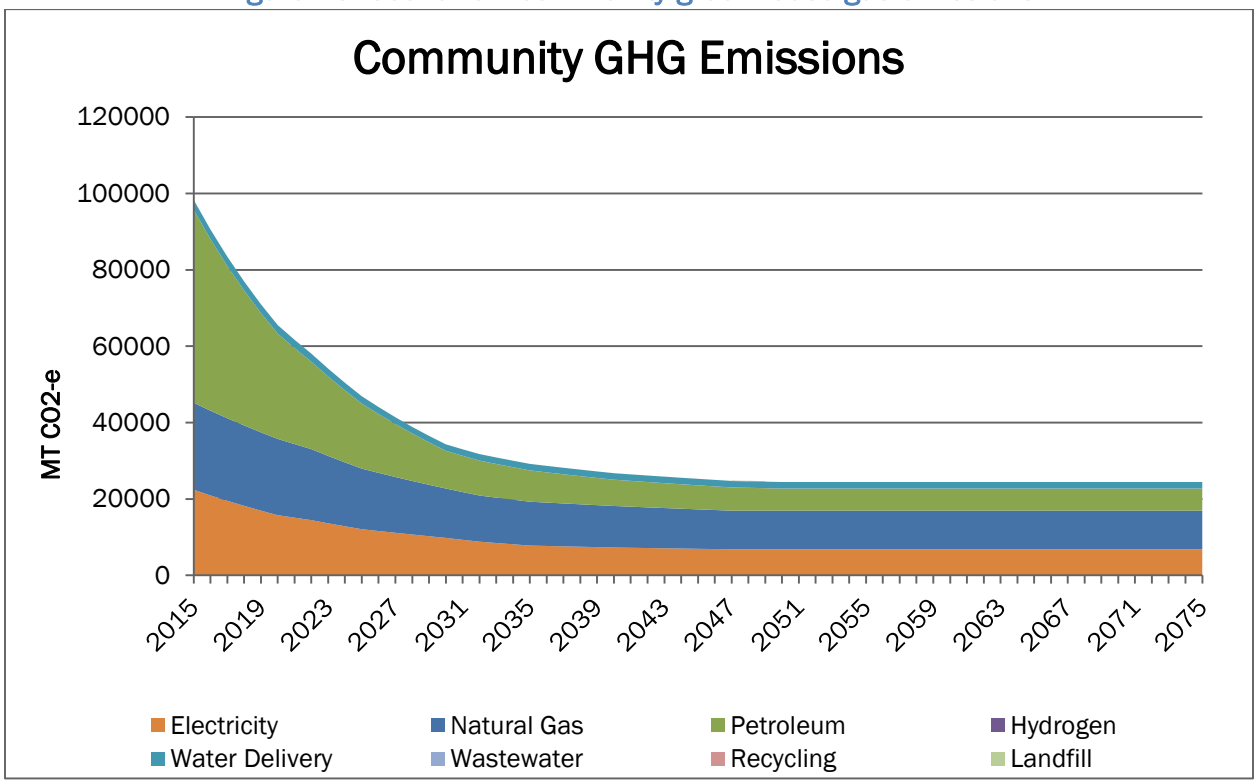


4. Scenario II

Scenario II includes more aggressive implementation measures that may require more resources, changes to infrastructure, and more ambitious effort by the city. This scenario requires some changes in political will and the mindset of Hermosa Beach residents.

As calculated from the data in Table 24, Scenario II reduces greenhouse gas by about 75%, which is much more than the 35% reduction projected for Scenario I. Figure 29 illustrates this visually, conveying how Scenario II includes more long-term measures. Scenario II still experiences the most drastic greenhouse gas reduction in the first twenty years of implementation, as can be seen in Figure 43. Despite being far more effective than Scenario I, Scenario II still leaves Hermosa Beach will a substantial amount of greenhouse gas to neutralize and would still require the purchase of a significant amount of offsets.

Figure 43: Scenario II community greenhouse gas emissions



As calculated from the data in Table 24, Scenario II reduces community greenhouse gas emissions by about 75%. This is much closer to carbon neutrality than Scenario I due the more ambitious implementation measures. The following sections discuss how Scenario II affects each sector individually and as interactive components of the Hermosa Beach community.

3.1 Building Energy

Table 33: Scenario II Implementation measures for building energy activities and energy sources and the effects on subsequent emissions sectors using Hermosa Beach community boundaries

Scenario II Implementation Measures		
Activity-Based Measure	Energy Upgrade CA 1: Basic Energy Upgrade	NG/ Electricity
	Energy Upgrade CA 2: Advanced Energy Upgrade	NG/ Electricity
	Energy Upgrade CA 3: Enhanced Energy Upgrade	NG/ Electricity
	Commercial/Industrial Retrofit I: PACE financing	NG/ Electricity
	Commercial/Industrial Retrofit II: PACE financing	NG/ Electricity
	Solar Water Heating System: Gas Auxiliary Tank Back up	NG
Energy-Based Measure	Southern CA Edison Emission Factor	Electricity
	10% Biogas	NG
	20% Wind on Households	Electricity
	20% Solar Photovoltaic on Households	Electricity
	20% Solar Photovoltaic on Governmental Buildings	Electricity
	20% Solar Photovoltaic on Commercial/Industrial Buildings	Electricity

Figure 44: Electricity consumption in Hermosa Beach from residential, commercial/Industrial and Transportation sectors over the implementation period of Scenario II measures

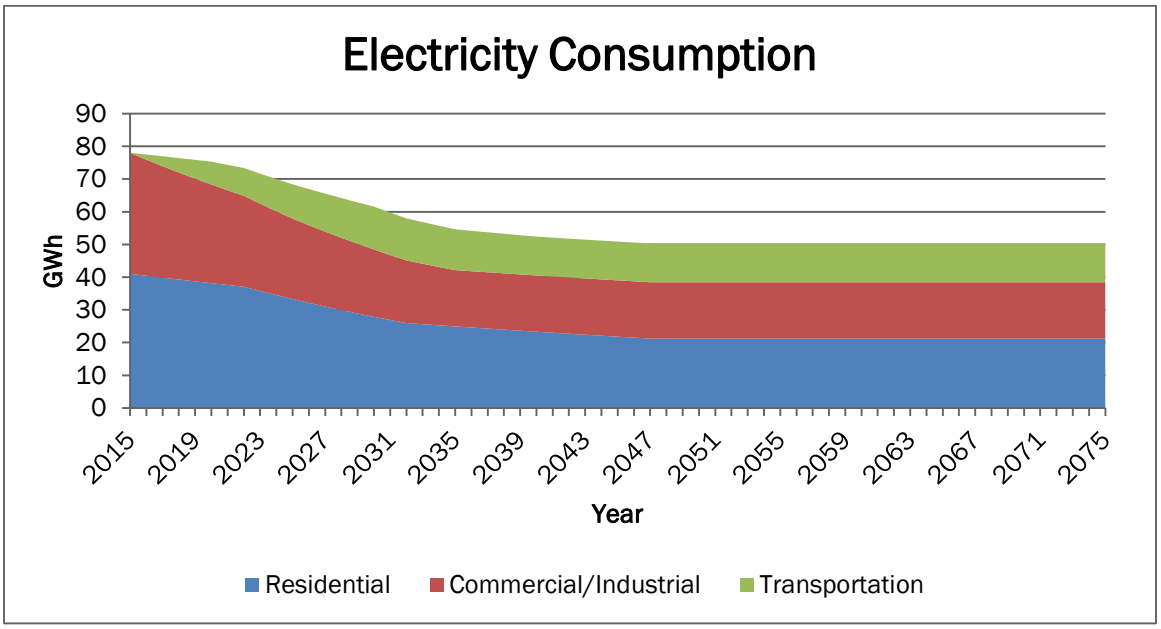


Figure 45: Source of electricity provided to the city of Hermosa Beach over the implementation period of Scenario II measures.

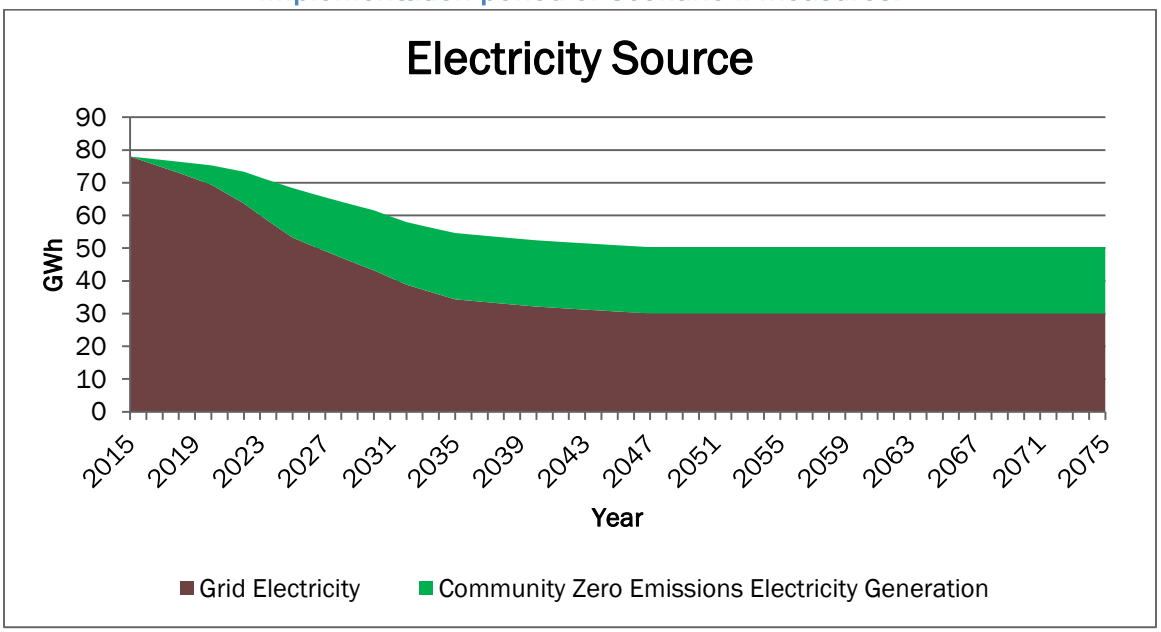


Figure 46: Natural gas consumption over time in Hermosa Beach from residential, commercial/industrial and transportation sectors throughout the Scenario II implementation period

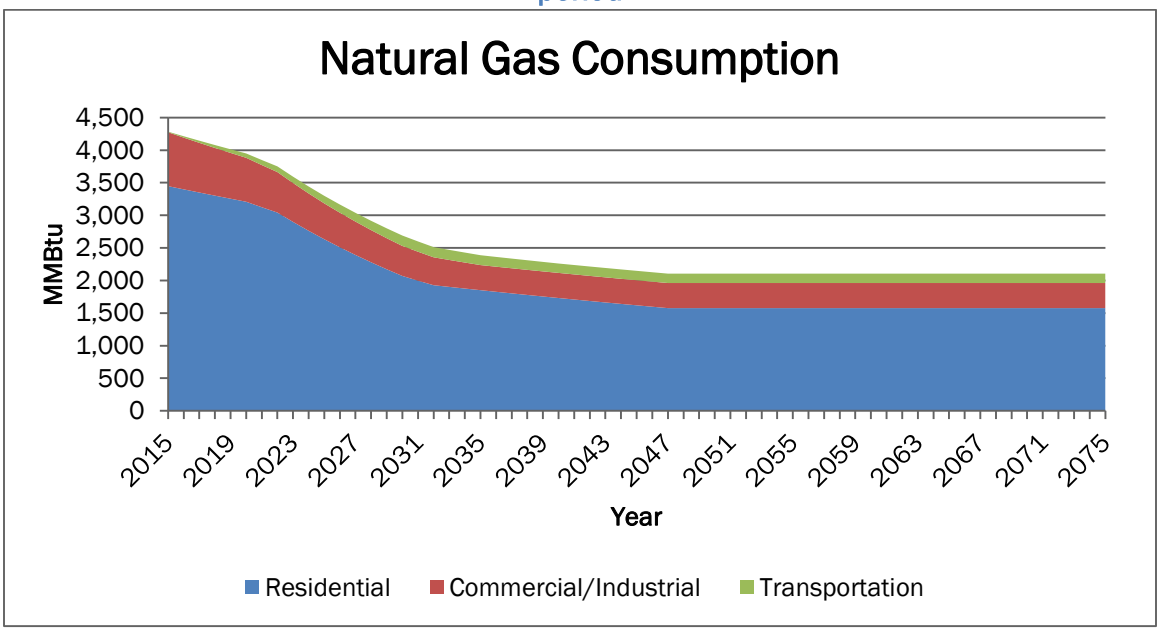


Table 34: Electricity and natural gas Greenhouse gas emission with Scenario II implementation measures over time.

Scenario II	Year	Electricity Greenhouse Gas Emissions (MT CO2)	Natural Gas Greenhouse Gas Emissions (MT CO2)
	2015	22416.137	22772.769
	2020	15754.166	21010.625
	2025	12081.766	17977.726
	2030	9807.36	13763.613
	2035	7801.527	10323.487
	2040	7295.208	8549.792
	2045	6951.507	8235.607
	2050	6820.357	7622.622
	2055	6820.357	6920.078
	2060	6820.357	6667.683
	2065	6820.357	6667.683
	2070	6820.357	6667.683
	2075	6820.357	6667.683

Table 35: Electricity Consumption and Production in Hermosa Beach with Scenario II implementation measures

Table 36: Natural gas consumption in Hermosa Beach with Scenario II implementation measures.

Electricity Consumption vs. Production (kWh)												
Year	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
Total Electricity Consumption	78020562	75301522	68365999	61562981	54621915	52391783	50877919	50300256	50300256	50300256	50300256	50300256
Community Zero Emissions Electricity	0	5910726	15150655	18365486	20259313	20259313	20259313	20259313	20259313	20259313	20259313	20259313
Grid Electricity	78020562	69390796	53215344	43197495	34362602	32132470	30618606	30040942	30040942	30040942	30040942	30040942

Natural Gas Consumption (therms)												
Year	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
Residential	3440100	3208661	2633089	2069808	1851382	1731204	1618828	1575947	1575947	1575947	1575947	1575947
Commercial/Industrial	827116	674408	549894	460167	385081	385081	385081	385081	385081	385081	385081	385081
Transportation	8987	66664	116265	159440	151626	144195	144195	144195	144195	144195	144195	144195
Total	4284113	3949733	3299248	2689415	2388089	2260480	2148103	2105222	2105222	2105222	2105222	2105222

Figure 47: Electricity consumption and production in Hermosa Beach with Scenario II implementation measures.

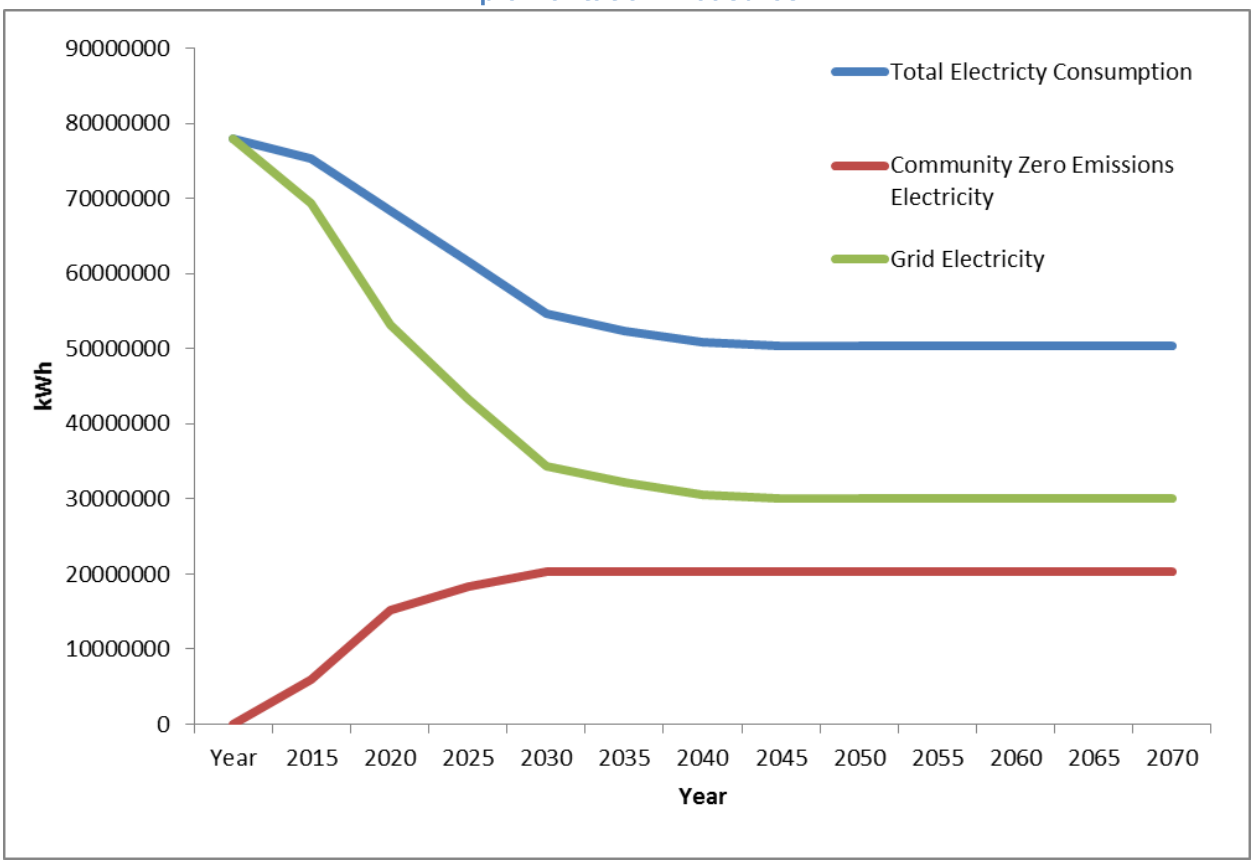
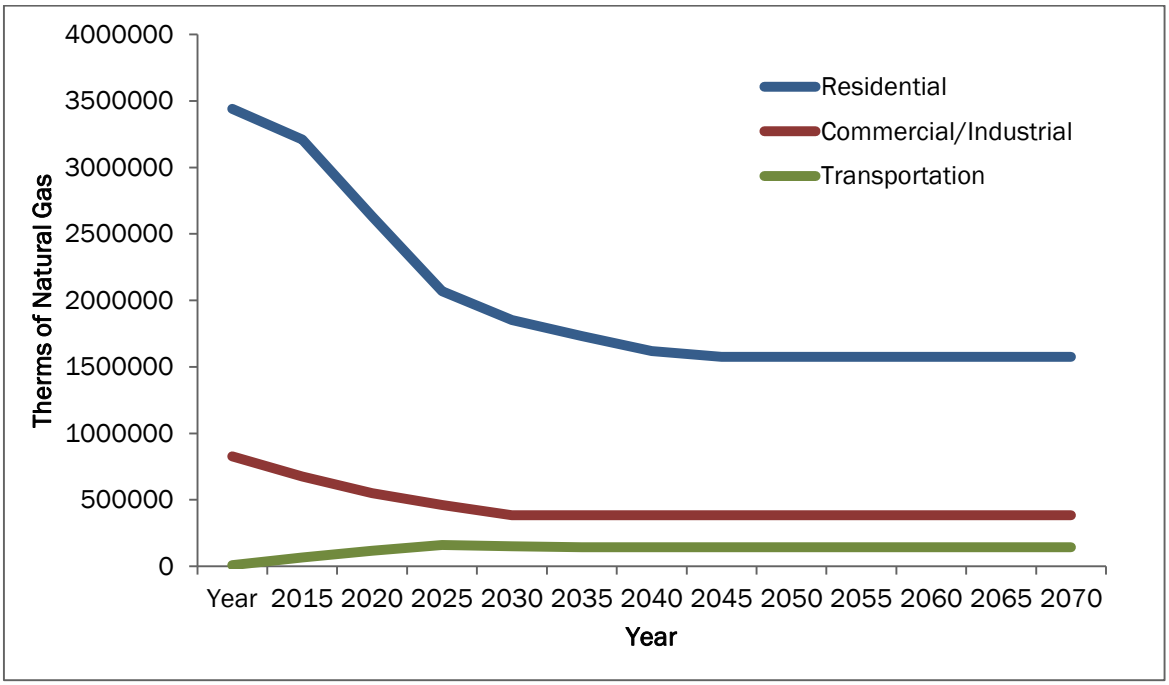


Figure 48: Natural gas consumption in Hermosa Beach with Scenario II implementation measures.



Implementation measure discussion

All building energy bundles from the last Scenario are inclusive in Scenario II seen in Table 33. Energy Upgrade California 2 and 3 are added as a residential electricity and natural gas emissions implementation measure because they take efficiency measures to the next level by incorporating renewable energy into households, in addition to all other efficiency measures. This helps to reduce reliance on the local utilities and ultimately reduces natural gas and electricity consumption from non-renewable sources. We also apply the Commercial/Industrial Retrofit 2 - PACE financing to the second Plan in addition to basic efficiency measures of the Retrofit 1 because PACE financing will help commercial and industrial buildings to further reduce energy consumption from the grid by installing more efficient HVAC systems and renewable energy sources. A specific activity implementation measure we select for building energy efficiency is a solar water heating system that is backed up by a gas auxiliary tank. We purposely target water heating as an implementation measure, because a significant amount of residential buildings energy is consumed by water heating. A solar water heating system aligns with the other building retrofit bundles as it is inclusive of renewable energy, and yet still is not the largest activity of concern for building emissions.

20% solar on residential, government, and commercial/industrial buildings will be possible if the local government exerts more pressure on building owners to turn to renewables. 20% solar on all buildings can only be achieved if the community becomes more renewable-minded and can make a conscious, collective effort to move towards sustainable energy. The most difficult step will be installing solar on 20% of the residential buildings because the residential sector makes up a large amount of total emissions and will have to dive into personal home retrofits and upgrades. Residents will be more likely to install solar if they become educated on the benefits of solar systems, are motivated by incentives, and are pressured by local policies. The city will have greater control over solar on municipal buildings and should focus on installation on their own property before residential. We also include the incorporation of 10% Biogas to the city with the hopeful perspective that Southern California Gas Company will incorporate a greater percentage of biogas into the local distribution pipeline system, as the demand for a neutral gas supply increases into the future.

Analysis

Though this scenario is very effective in greenhouse gas reduction, it does not fully neutralize emissions. Greenhouse gas emissions from electricity decrease by approximately 70% or 15,596 MT CO_2 while total electricity consumption decreases by approximately 36% or 27,720,324 kWh. The amount of community zero emissions electricity has greatly increased due to the addition of renewable sources. However, community zero emissions electricity still does not provide as much electricity as the grid electricity produced.

Figure 48 depicts the greenhouse gas emissions from natural gas. Natural gas reductions show a decrease of emissions by approximately 71% or 16,104 MT CO_2 while total natural gas consumption decreased by approximately 50% or 2,178,891 therms. There is a large decrease in natural gas consumption in the residential sector, though the sector still remains the largest consumer.

Scenario II displays a gradual decrease of natural gas and electricity consumption over a longer period of time. Reductions in emissions are mainly due to the more advanced building upgrade options that will take longer to implement and will begin after the basic options have already been installed. For example, Energy upgrade CA 1 starts in 2015, but the more advanced Energy Upgrade CA 2 will start afterward in 2022, almost acting as a phasing process. Additional wind, solar, and biogas generation has greatly reduced emissions, but not enough to completely neutralize electricity emissions, or remove Hermosa Beach completely off of the public utility grid. Scenario II's use of renewables and aggressive efficiency measures in tandem has substantially decreased emissions compared to Scenario 1.

3.2 Transportation and Land Use

Scenario II included all the basic measures from Scenario I as well as a few more ambitious strategies. 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. Unlike Scenario I, these measures require Hermosa Beach to make some changes to the city's infrastructure and to educate and

incentivize residents to choose less carbon intensive modes of transportation. The specific transportation implementation measures used in the model are listed in Table 37 and described in more detail in Table 23.

Table 37: Scenario II Implementation Measures for the Transportation Sector

Scenario II Implementation Measures	
Activity-Based Measures	Neighborhood Electric Vehicles- Phase I
	Electric Vehicles - Phase I
	Hydrogen FCEV - Phase I
	Natural Gas Vehicles
	Carpooling and Carshare- Phase I
	Neighborhood Electric Vehicles Phase II - (15% of Households)
	Complete Streets (distance traveled)
	Complete Streets (mode choice)
	Electric Vehicles - Phase II
	Hydrogen FCEV - Phase II
Source-Based Measures	California Low Carbon Fuel Standard
	Electric Vehicle Efficiency Gain
	Gasoline Vehicle Efficiency Gain
	Natural Gas Vehicle Efficiency Gain
	Hydrogen FCV Efficiency Gain

In Scenario II, greenhouse gas emissions from petroleum decrease by about 88.58% between 2015 and 2075, which is calculated from the data displayed in Table 29. In 2075, petroleum will comprise about 23% of total emissions compared to 51.06% in 2015. This portion is significantly lower than in Scenario I.

As shown in Table 38 and portrayed in Figure 49, Scenario III results in a greater reduction in petroleum miles than Scenario I. Petroleum miles decrease by 72% between 2015 and 2075 and comprise 37.20% of total miles in 0275. This is much less than the 71.6% petroleum was responsible for in Scenario I. The aggressive onset of electric vehicle measures in Scenario II greatly increases electric miles. By 2075, electric miles are responsible for 41.20% of total miles

traveled in 2075. The Complete Streets measure added in Scenario II greatly increases the amount of biking and walking, resulting in bike and walk miles making up 10.5% of total miles in 2075 compared to a mere 3% in 2015. Additionally, this measure as well as carpooling and carshare measures decrease VMT in Scenario II by 27% between 2015 and 2075.These values are displayed in Figure 50.

Table 38: Scenario II transportation consumption by mode

Transportation Consumption (miles)							
Year	Petroleum	Electric	Hydrogen	Natural Gas	Bike/Walk	Transit	Total
2015	136,880,158	142,883	1,429	142,883	4,286,480	1,428,827	142,882,658
2020	97,393,590	22,997,254	1,995,311	1,905,360	7,311,266	1,329,321	132,932,101
2025	69,235,880	36,174,796	3,711,472	3,421,662	9,893,961	1,236,745	123,674,516
2030	45,332,272	47,646,359	4,627,017	4,741,507	12,142,883	1,156,465	115,646,502
2035	42,010,753	45,311,213	5,500,033	4,509,126	11,547,761	1,099,787	109,978,673
2040-2075	38,905,922	43,090,513	6,276,363	4,288,134	10,981,805	1,045,886	104,588,623

Figure 49: Miles traveled by each mode of transportation in Scenario II

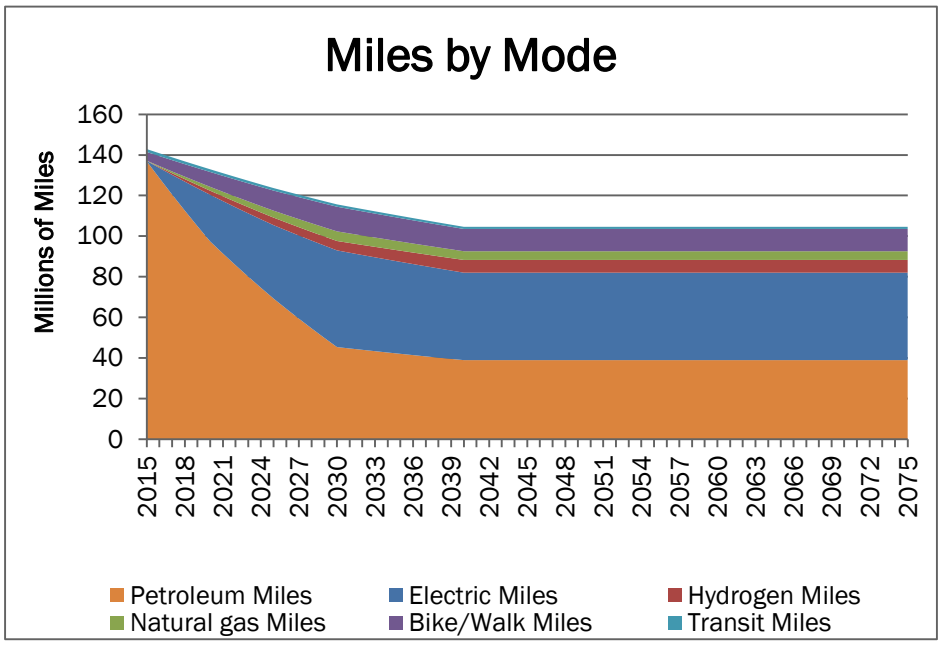
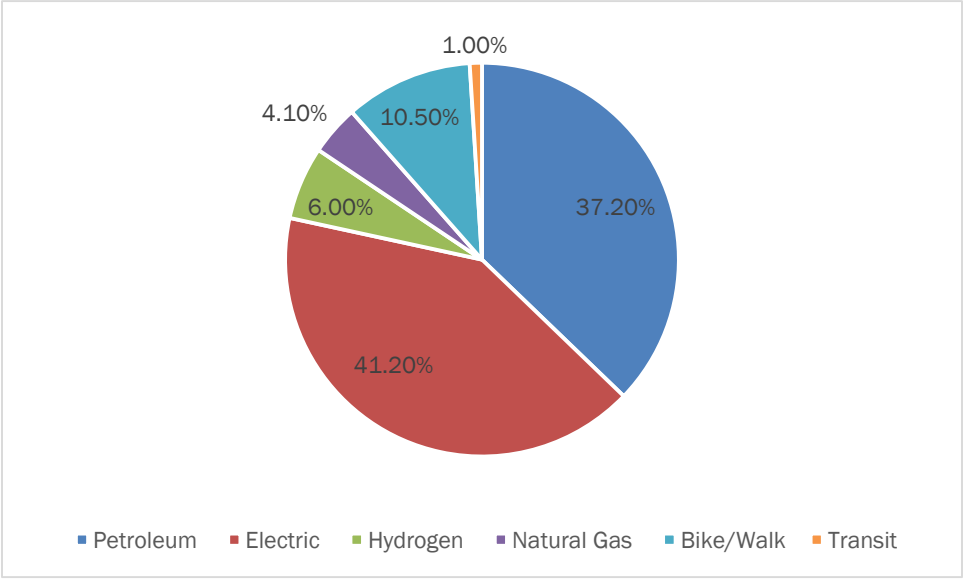


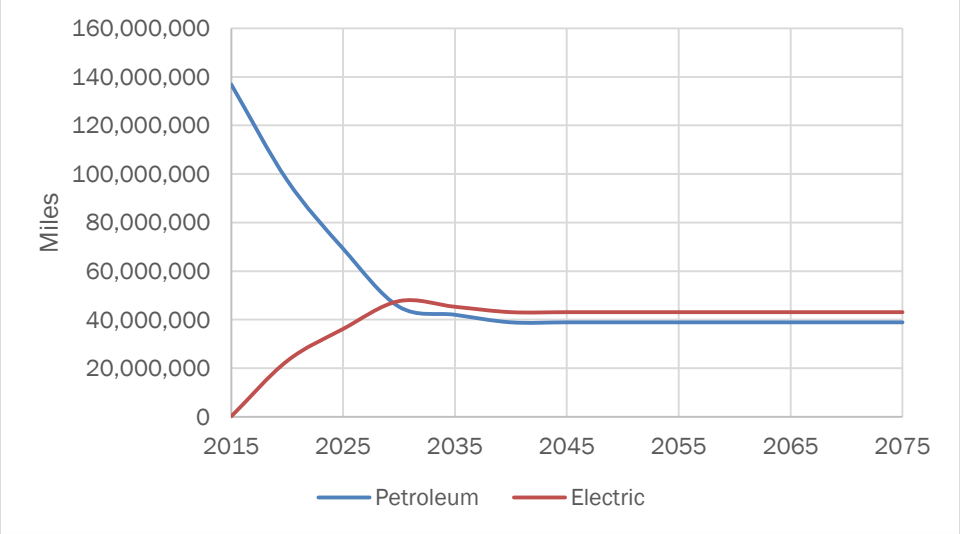
Figure 50: Portion each mode contributes to total transportation consumption in 2075 in Scenario II



As discussed for Scenario I, the electrification of transportation outsources transportation emissions to the electricity sector. In Scenario II, electric vehicles travel more miles than petroleum vehicles,

leading to a great reduction in petroleum emissions. However, we must consider emissions generated to fuel the electric vehicle fleet. Figure 51 portrays the relationship between electric and petroleum vehicles in Scenario II. As shown in Figure 44 electricity consumption is still decreasing due to efficiency and renewable energy implementation measures, but transportation comprises a much larger proportion of electricity consumption than in Scenario I.

Figure 51: Miles traveled by petroleum and electric vehicles in Scenario II



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

3.3 Water and Wastewater

Scenario II implementation measures include all of the measures from Scenario I, landscaping conservation programs, and residential conservation rebate programs (Figure 52).

The first phase of the landscaping conservation program for Hermosa Beach is to educate the public about replacing their lawns with xeriscape landscapes, provide free irrigation surveys, and offer rebates of 25cents per square foot for those who successfully convert. The goal of Phase 1 is to get the program started with about 1,000 homes out of the 10,000 in the city to convert. This will take place between 2015 and 2017 with a reduction of water use by about 3million gallons per year. Phase 2 will be the implementation of regulations that limits the amount of irrigated turfgrass

to less than 20% of the total landscaped area of new developments. There will also be more rebates given out, more educational guides, and more surveys. The goal of Phase 2 is to get 1,000 more homes to convert their lawns for an additional 2 years. This will lower the city's water use about 6 million gallons per year.

In the residential conservation rebate program, Phase 1 will start in 2015, and the city can educate the public and provide free surveys for interested residents. The first phase will provide rebates to those that volunteer to participate in the city's educative workshop. This phase can provide about a fifth of the households in Hermosa Beach with the rebates of about $75, which result in about 2,000 households installing low-flow toilets or showerheads. The second phase will expand its rebates to all residential areas throughout Hermosa Beach. The goal of Phase 2 is to get 50% of all households to take advantage of the rebates by 2020. This will be about a total of 5,000 households. Phase 3 will be the final phase. There could be mandatory, free survey for households without the high-efficiency toilets or showerheads. The goal of this final phase is to get 90% of all households to install the appliances and get the rebates for a total of 9,000 homes. If successful, this program can have similar results as the program implemented in Ashland, Oregon. Hermosa Beach can see a reduction of400,000 gallons per day in their water use, which leads to an annual reduction of about 146million gallons.

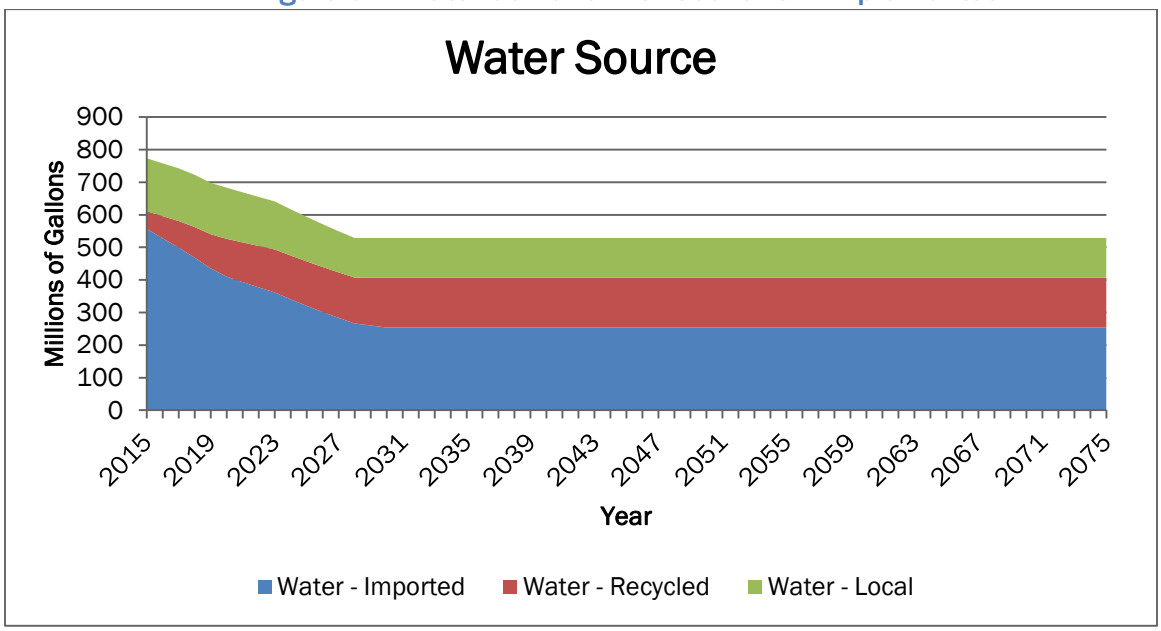
The two additional measures are included in Scenario II because they do not take much effort from the city to implement since they majority of the programs are rebates. They were not integrated into Scenario I measures because they are more pricey than those in Scenario I, which makes them more difficult to implement. The total water demand will further decrease to about 529 million gallons annually, which is saves the city a total of 244 million gallons a year if all programs are successful. The greenhouse gas emissions will drop down to about 1,694,000 MT CO_2-e, and this is a total of 886,000 MT CO_2-e decrease from the baseline emissions.

Scenario II Implementation Measures	
Activity – Based Measures	Rainwater Catchment – Phase I
	Rainwater Catchment – Phase II
	West Basin lower imported waters by 2020

	West Basin increase local waters by 2020
	West Basin increase recycled waters by 2020
	West Basin lower imported waters by 2030
	West Basin increase recycled waters by 2030
	Residential conservation rebates – Phase I
	Residential conservation rebates – Phase II
	Residential conservation rebates – Phase III
	Landscaping conservation – Phase I
	Landscaping conservation – Phase II

Scenario II	
Year	**Greenhouse Gas Emission (MT CO_2-e)**
2015	2,580
2020	2,210
2025	1,911
2030 - 75	1,694

Figure 52: Water demand with Scenario II implemented



3.4 Consumption and Waste

Table 39: List of Active Implementation Measures in Scenario II

Type of measure	Measures
Activity	Purchasing Policy
	Tote bags
	Plastic Bags Ban
	Incentives for compostable single use items
	On-site building materials reuse
	Pay as you throw program
	Green waste composting program
	Guide for ecofriendly products
	Thrift/Consignment shops

Measures incorporated into scenario 2 include all of the scenario I measures along with a guide for ecofriendly materials and an increase of access to thrift and consignment shops through educational workshops by bringing more of these shops to the area to encourage reuse. These actions together

will help reduce the materials in the system through the four categories of reduce, reuse, recycle and compost (avoids landfill). Quantitatively, from the estimated numbers in the model, there should be a total net reduction by about 2.87 MT CO2-e over the course of the 15 years (2015-2030).

Table 40: Emissions from recycling and landfill for Scenario III

Scenario II Emissions			
Year	Landfill Emissions (MT CO2-e)	Recycling Emissions (MT CO2-e)	Total Consumption Emissions (MT CO2-e)
2015	5.77	0.22	5.99
2020	4.44	0.27	4.71
2025	3.06	0.32	3.38
2030-2075	2.76	0.35	3.11

Figure 53: Distribution of materials consumption categories over the 60 year period for Scenario II

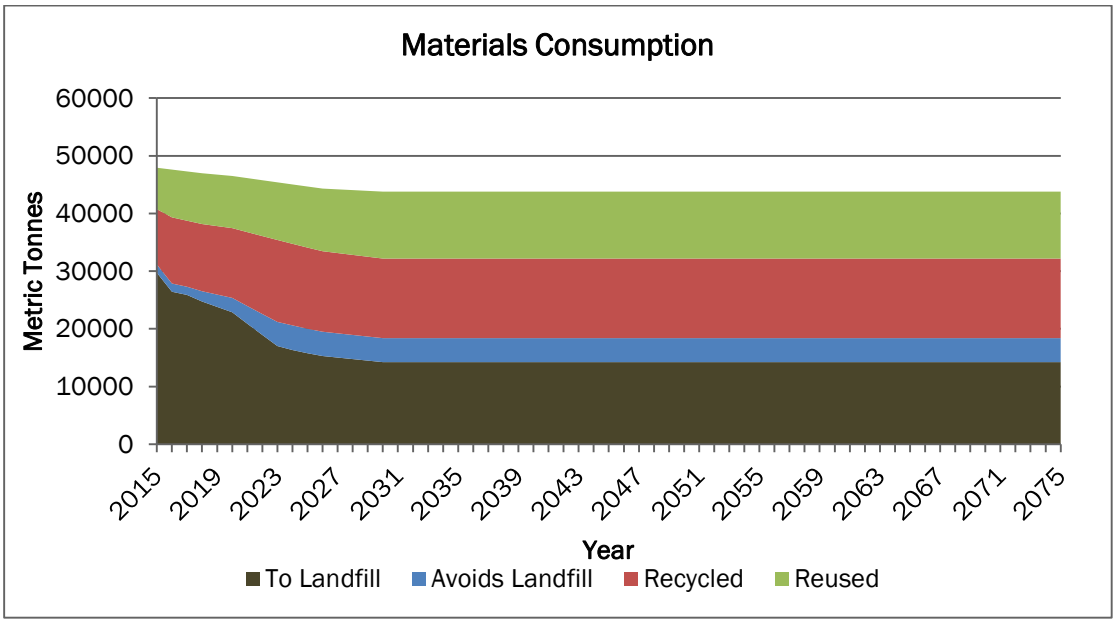
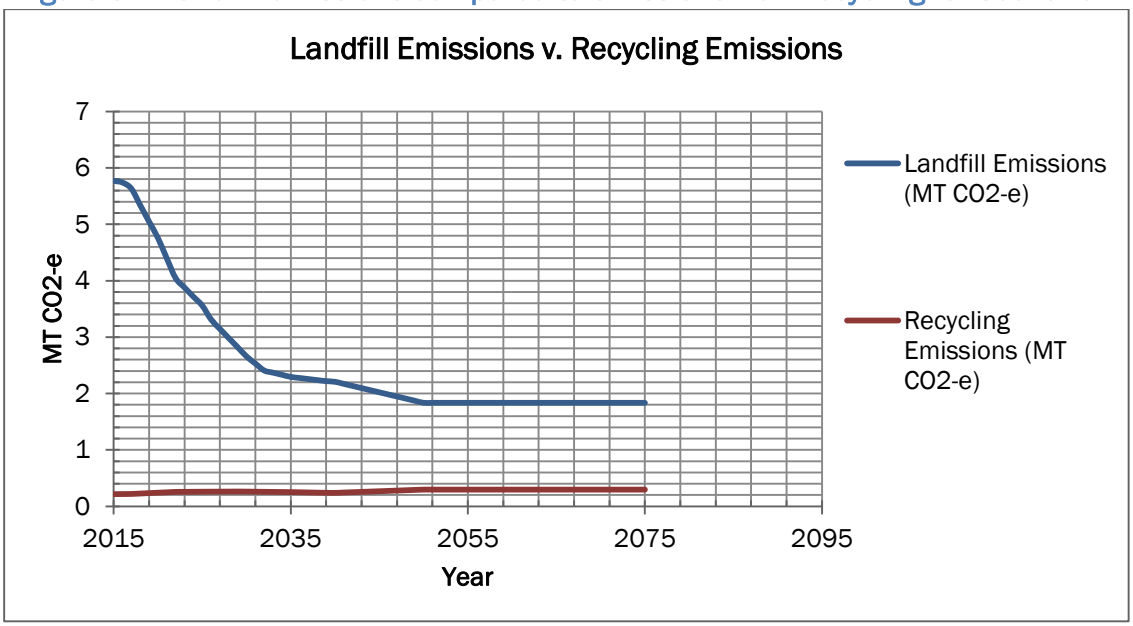


Figure 54: Landfill emissions compared to emissions from recycling for Scenario II



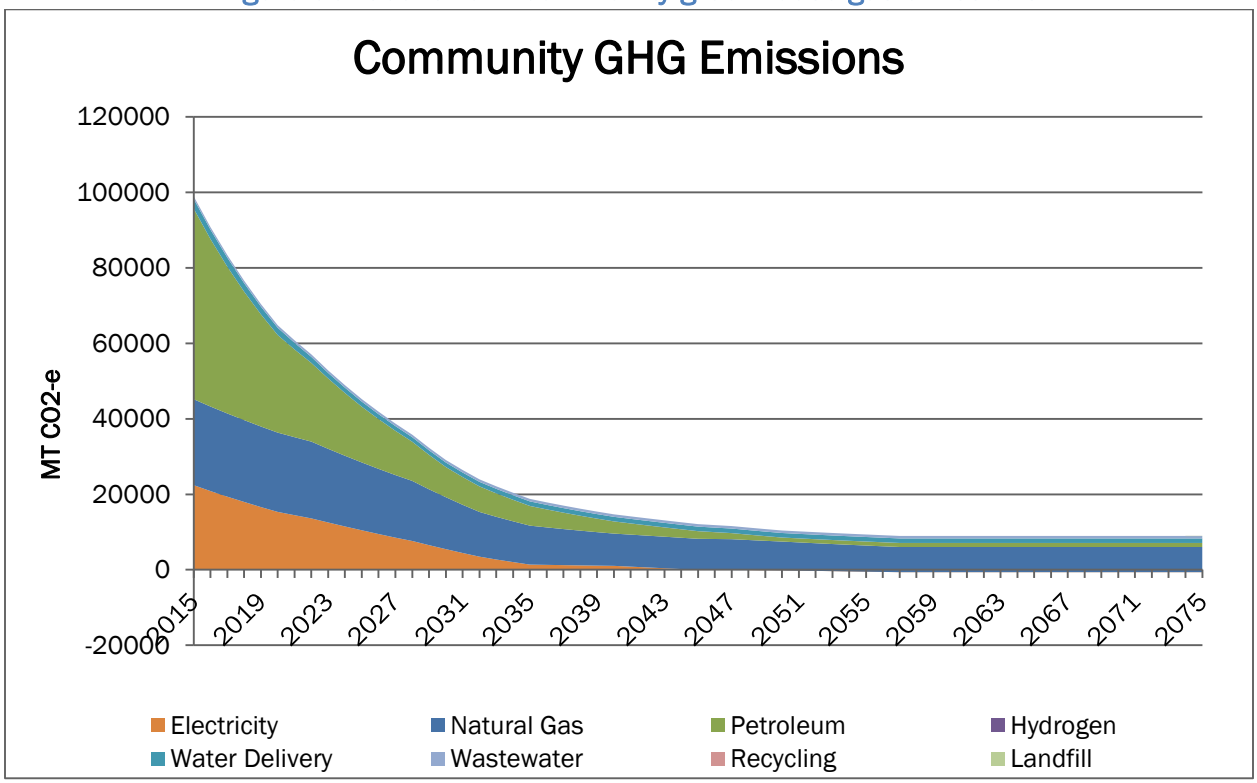
5. Scenario III

Scenario III includes the most ambitious and long-term measures that may be difficult to implement. Scenario III depicts the ideal situation, in which, in the presence of unlimited resources, the implementation measures will dramatically decrease the greenhouse gas emissions of Hermosa Beach. Some implementation measures are divided into phases that are implemented in different years and vary according to their aggressiveness while others are clustered into bundles. Since implementation of all measures at the same time is not feasible, different measures will take effect at various intervals and years and the effects of each measure over time will be predicted by the model. For example, if measure one decreases consumption by 2% starting 2015, it will have an implementation period under which this measure will be active. After the implementation period the measure will no longer have an effect on consumption.

Scenario III has a projected greenhouse gas reduction of about 91% by 2075, as calculated from the values conveyed in Table 24. As illustrated in Figure 29, measures still continue to influence Hermosa Beach's inventory throughout the entire 2015-2075 analysis period, unlike Scenarios I and II. Scenario III leaves Hermosa Beach with a remainder of about 9,000 MT CO2e to neutralize, which will be easily accomplished 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 55 illustrates how each sector contributes to emissions under Scenario III. The following sections will discuss the implications of Scenario III for each sector.

Figure 55: Scenario III community greenhouse gas emissions



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4.1 Building Energy

Table 41: Scenario III Implementation measures for building energy activities and energy sources and the effects on subsequent emissions sectors using Hermosa Beach community boundaries

Scenario III Implementation Measures		
Activity-Based Measure	Energy Upgrade CA 1: Basic Energy Upgrade	NG/ Electricity
	Energy Upgrade CA 2: Advanced Energy Upgrade	NG/ Electricity
	Energy Upgrade CA 3: Enhanced Energy Upgrade	NG/ Electricity
	Zero Net Energy	NG/ Electricity

	Commercial/Industrial Retrofit I: PACE financing	NG/ Electricity
	Commercial/Industrial Retrofit II: PACE financing	NG/ Electricity
	HVAC Solar Driven Adsorption Heat Pump	NG/ Electricity
Source-Based Measure	Southern CA Edison Emissions Factor	Electricity
	25% Biogas	NG
	50% Solar Photovoltaic on Households	Electricity
	100% Solar Photovoltaic on Governmental Buildings	Electricity
	50% Solar Photovoltaic on Commercial/Industrial Buildings	Electricity
	CCA Contracting Renewable Utilities	Electricity
	CCA Local Wave Power 1 Mark 3	Electricity
	Future Purchase of Electricity	Electricity

Figure 56: Scenario III Electricity Consumption from residential, commercial/industrial, and transportation sectors.

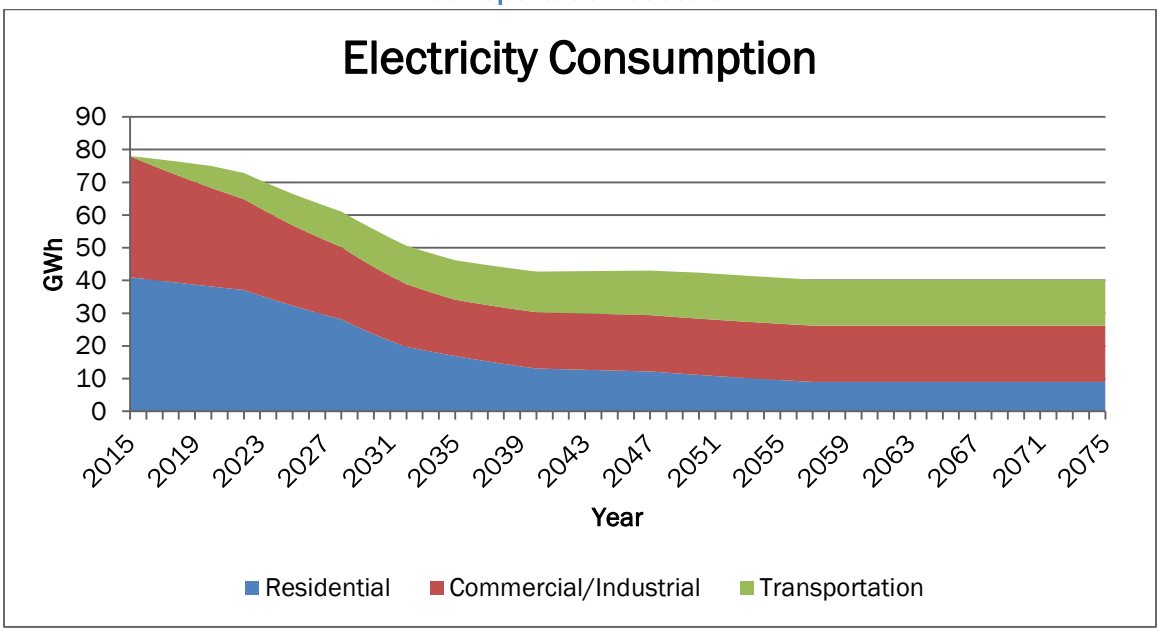


Figure 57: Source of electricity provided to the city of Hermosa Beach over the implementation period of Scenario III measures.

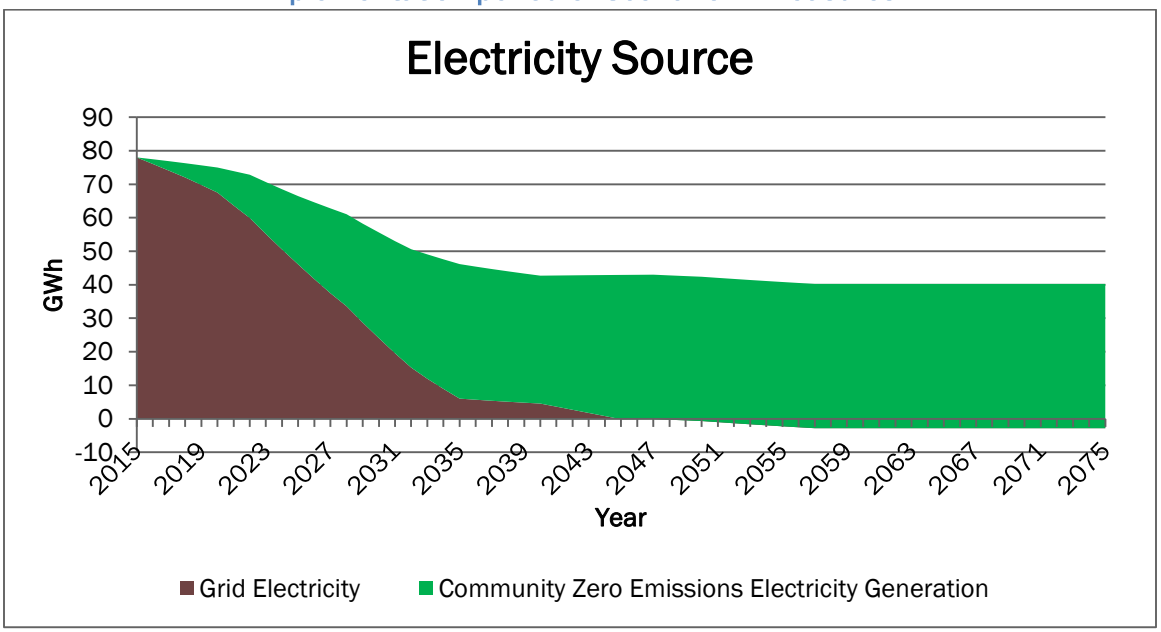


Figure 58: Natural gas consumption in the city of Hermosa Beach over the implementation period of Scenario III measures

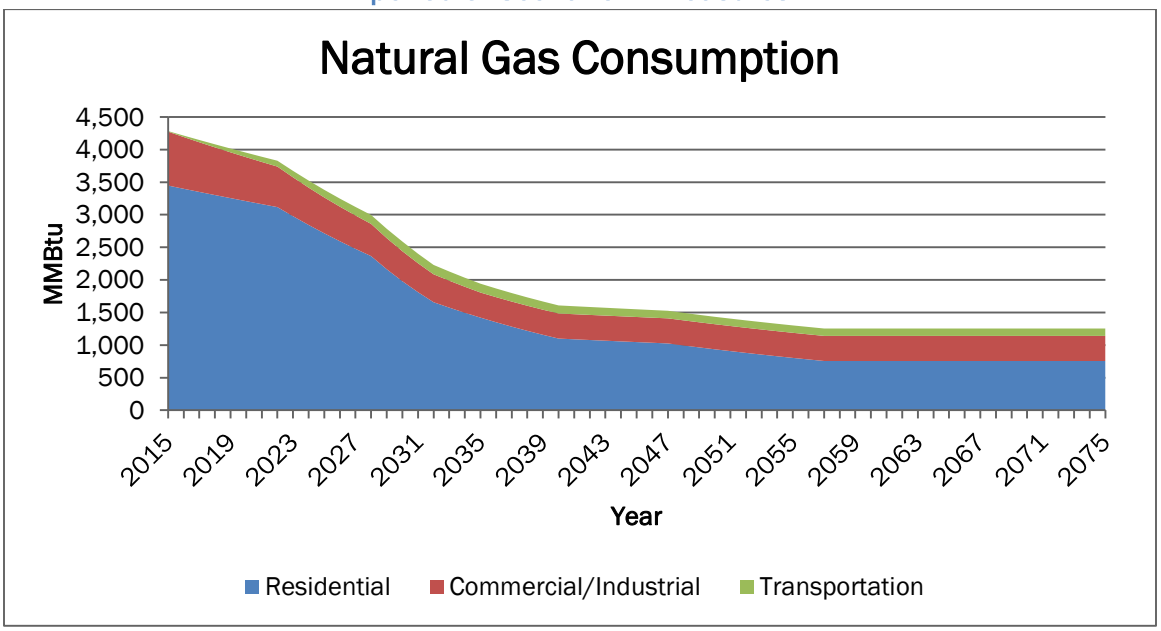


Table 42: Electricity and natural gas greenhouse gas emission with Scenario III implementation measures over time.

Scenario III	Year	Electricity Greenhouse Gas Emissions (MT CO2)	Natural Gas Greenhouse Gas Emissions (MT CO2)
	2015	22416.137	22772.769
	2020	15329.147	21010.625
	2025	10459.063	17977.726
	2030	5464.263	13763.613
	2035	1365.529	10323.487
	2040	1030.924	8549.792
	2045	-31.833	8235.607
	2050	-155.515	7622.622
	2055	-512.384	6920.078
	2060	-640.592	6667.683
	2065	-640.592	6667.683
	2070	-640.592	6667.683
	2075	-640.592	6667.683

Table 43: Electricity consumption and production in Hermosa Beach with Scenario III implementation measures

Electricity Consumption vs. Production (kWh)													
Year	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070	2075
Total Electricity Consumption	78020562	75002473	66465258	55619877	46178332	42721710	42942780	42398009	40826146	40261439	40261439	40261439	40261439
Community Zero Emissions Electricity	0	7483717	20397274	31551988	40163724	38180902	43082992	43082992	43082992	43082992	43082992	43082992	43082992
Grid Electricity	78020562	67518756	46067984	24067889	6014608	4540808	-140212	-684982	-2256846	-2821553	-2821553	-2821553	-2821553

Table 44: Natural gas consumption in Hermosa Beach with Scenario III implementation measures

Natural Gas Consumption (therms)													
Year	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070	2075
Residential	3448010	3208661	2715414	1980105	1421351	1099814	1045912	935580	803414	755933	755933	755933	755933
Commercial/ Industrial	827116	647431	549894	460167	385081	385081	385081	385081	385081	385081	385081	385081	385081
Transportation	8987	79975	116741	148999	135668	123529	118325	113340	113340	113340	113340	113340	113340
Total	4284113	3890229	3382048	2589271	1942099	1608424	1549318	1434001	1301835	1254354	1254354	12254354	1254354

Figure 59: Electricity consumption and production in Hermosa Beach with Scenario III implementation measures.

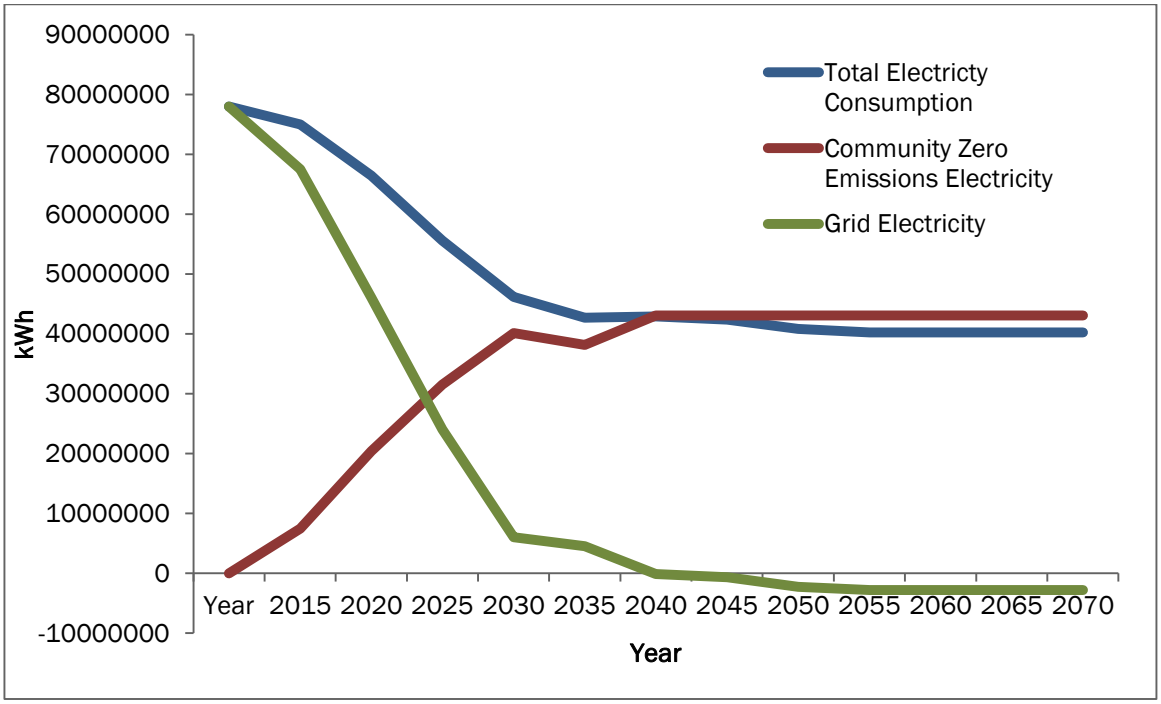
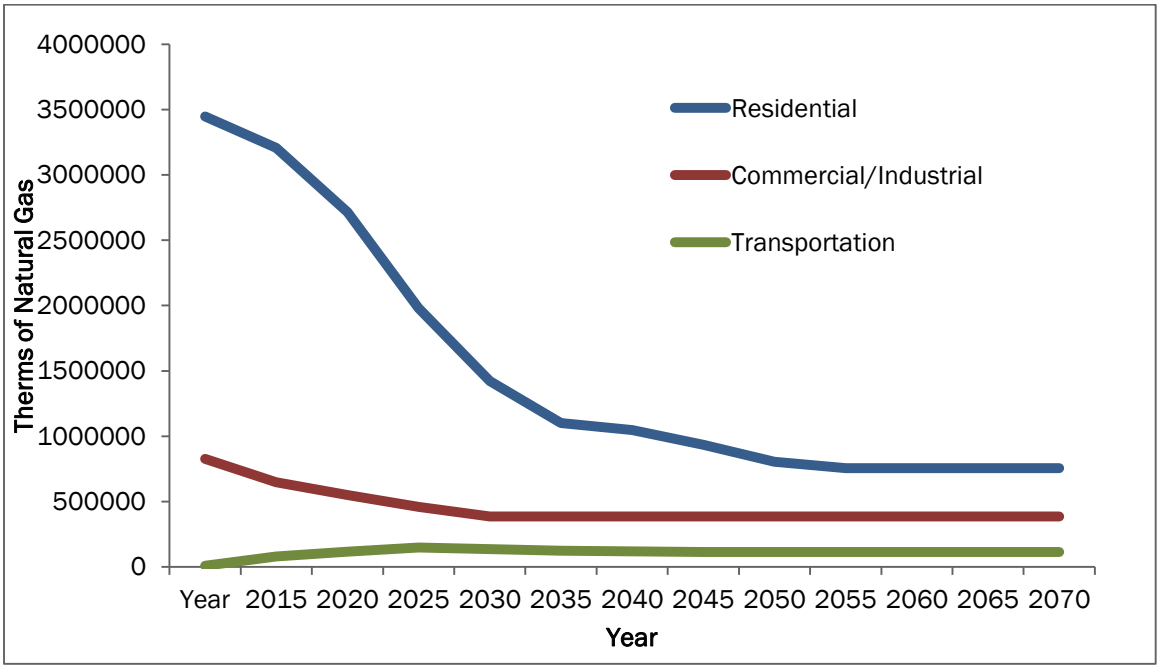


Figure 60: Natural gas consumption in Hermosa Beach with Scenario III implementation measures



Implementation measure discussion

With each subsequent scenario, the building energy implementation measures become more aggressive toward mitigating all emissions from natural gas and electricity. Scenario III is more inclusive of long terms strategies to develop self-powered buildings. In order to reach such goals, the Energy Upgrades must progress toward a carbon neutral house. In Scenario III, we chose the Zero Net Energy residential electricity and natural gas, in hopes that eventually all homes within the jurisdiction will be self-sufficiently powered, using limited natural gas energy, and all on site renewable energy. We only included Commercial/Industrial Retrofit 1 and 2 - PACE financing, because there are limitations to what large infrastructure buildings can create on site; therefore, we did not think it would be wise to assume that commercial and industrial facilities could reach net zero. We included the HVAC Solar Driven Adsorption Heat Pump as an activity mitigation measure because heating and cooling consume the most energy in residential buildings. Solar adsorption heat pump system do not require any energy from the utility grid, and therefore can be considered a net zero energy emissions activity. Scenario III pushes for zero emissions at the source and activity level within the community boundary. However, because most of these emissions are within private facilities, Scenario III Building Energy Implementation measures are the most aggressive out of the three Scenarios and would require the most energy and time to make happen.

Scenario III expands to solar photovoltaic on 100% of governmental buildings. Renewable solar energy on all governmental buildings should be easier to implement because the local government has direct control over their buildings and there are relatively fewer facilities than residential homes. This implementation measure will be met with less resistance and take place over a shorter time frame compared to residential or commercial/industrial buildings upgrades. By making municipal operations firstly self-sustaining, the local government can set an example for the city as a whole. Restrictions by number and oversight of facilities is why the latter two sectors, residential and community/industrial sectors, will install solar on only 50% of buildings and not 100% in this Scenario. A large increase in residential solar cover will be difficult in that there are a vast amount of buildings compared to the other sectors and oversight is within the property owner's control. The commercial/industrial sector may not be as concerned with putting their money towards renewables

unless direct legislation enforced compliance, and therefore may be more resistant to voluntary upgrades.

The implementation of Community Choice Aggregation will be much more difficult as it completely changes the way electricity is supplied to Hermosa Beach. Community Choice Aggregation will allow Hermosa Beach almost complete control over their electricity generation because Hermosa Beach will be able to choose their energy providers and set their own electric rates. The process of becoming a CCA will be very long and arduous, but may have the greatest payoffs in terms of renewable energy production. The CCA measure is a theoretical case in which 70% of the city's contracted electricity comes from renewables. The measure is paired with a measure dubbed "Future Purchase of Electricity Measure". The CCA measure indicates the amount of kWh produced by renewables while the latter displays that 70% of total emissions are reduced. Becoming a Community Choice Aggregation will also allow Hermosa Beach to allocate a greater amount of funds to local renewable sources such as wave power, or, more specifically, the Mark 3 PowerBuoy. The process of becoming a Community Choice Aggregation, combined with wave and solar on households, will make Hermosa Beach a true leader in community renewable energy usage. If Hermosa Beach wants to truly utilize all of their natural resources and an innovative leader for other green-striving cities, they may want to look toward the new wave technology. The success of the PowerBuoy may signal the start of a wave farm in Hermosa Beach and help expand the popularity of wave power across the coast.

Analysis

With this extremely idealistic and aggressive scenario, Hermosa Beach will reach community net zero electricity emissions by 2045, seen in Figure 55. Greenhouse gas emissions from electric generation are neutralized by that time. Total electricity consumption decreases by approximately 48% or 37,759,123 kWh by 2060. Figure 56 displays how the residential sector now consumes the least amount of electricity, instead of the most, seen in prior scenarios. Natural gas emissions decrease by approximately 71% or 16,104 MT CO_2 by 2060 while natural gas consumption also decreases by approximately 71% or 3,029,759 therms by 2060. The residential sector has displayed the greatest decrease in consumption over this scenario, but still leads the other sectors in overall consumption.

Scenario III exhibits a large decrease in consumption and emissions in a relatively short period of time. Scenario III has managed to negate electricity emissions and significantly reduce natural gas emissions, which is greatly due to the implementation of a CCA, which has a large impact on reducing emissions. CCA's implementation period ended by approximately 2045 - the same year Hermosa Beach reaches net zero community emissions from electrical generation. Solar on 50% of households also greatly decreases total electricity consumption due to the large number of residential buildings in Hermosa Beach. The increase in self-sufficient homes also has had a huge impact on the reduction of emissions and consumption. Natural gas consumption still results in a significant amount of emissions; therefore, Hermosa Beach can still strive to reduce emissions due to natural gas. Figure 59 displays how the electricity generation of the community in Scenario is greater than the consumption of the community – all electricity emission generation is therefore negated. Such neutrality of electricity emission will validate the claim that Hermosa Beach has met their goal of community net zero electricity emissions in Scenario III.

5.2 Transportation and Land Use

Scenario III includes the most ambitious long-term strategies that could be implemented in Hermosa Beach. In addition to Scenario I and II, Scenario III includes improved transit service, Neighborhood-Oriented Development, a third phase of electric vehicle adoption, and a second phase of carpooling and carsharing. See Table 45 for the specific Scenario III transportation implementation measures and see Table 23 for more details.

Table 45: Scenario III Implementation measures for the transportation sector

Scenario III Implementation Measures	
Activity-Based Measures	Neighborhood Electric Vehicles- Phase I
	Electric Vehicles - Phase I
	Hydrogen FCEV - Phase I
	Natural Gas Vehicles
	Carpooling and Carshare- Phase I
	Neighborhood Electric Vehicles Phase II - (15% of Households)
	Complete Streets (distance traveled)

	Complete Streets (mode choice)
	Electric Vehicles - Phase II
	Hydrogen FCEV - Phase II
	Carpooling and Carshare - Phase II
	Neighborhood Oriented Development
	Parking Cash Out
	Electric Vehicles - Phase III
	Improved Transit Service
Source-Based Measures	California Low Carbon Fuel Standard
	Electric Vehicle Efficiency Gain
	Gasoline Vehicle Efficiency Gain
	Natural Gas Vehicle Efficiency Gain
	Hydrogen FCV Efficiency Gain

As calculated from Table 30, 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.

As shown in Table 46 and portrayed in Figure 61, 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. These portions of total miles are depicted in Figure 62. Perhaps one of the most ambitious changes in Scenario III is the significant reduction in VMT achieved. 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.

Table 46: Scenario III transportation consumption by mode

Transportation Consumption (miles)

Year	Petroleum	Electric	Hydrogen	Natural Gas	Bike/Walk	Transit	Total
2015	136,880,158	142,883	1,429	142,883	4,286,480	1,428,827	142,882,658
2020	91,323,117	22,014,565	1,910,050	1,823,943	6,998,850	3,181,296	127,251,821
2025	60,045,376	33,149,300	3,401,061	3,135,489	9,066,475	4,533,238	113,330,939
2030	36,724,068	41,797,608	4,059,035	4,159,471	10,652,303	4,058,020	101,450,504
2035	26,741,223	43,831,256	4,619,602	3,787,316	9,699,224	3,694,943	92,373,563
2040	18,250,758	45,166,399	5,047,366	3,448,459	8,831,419	3,364,350	84,108,750
2045	12,446,542	48,298,931	4,834,727	3,303,180	8,459,362	3,222,614	80,565,357
2050-2075	7,098,982	51,087,362	4,631,046	3,164,021	8,102,980	3,086,850	77,171,241

Figure 61: Miles traveled by each mode of transportation in Scenario III

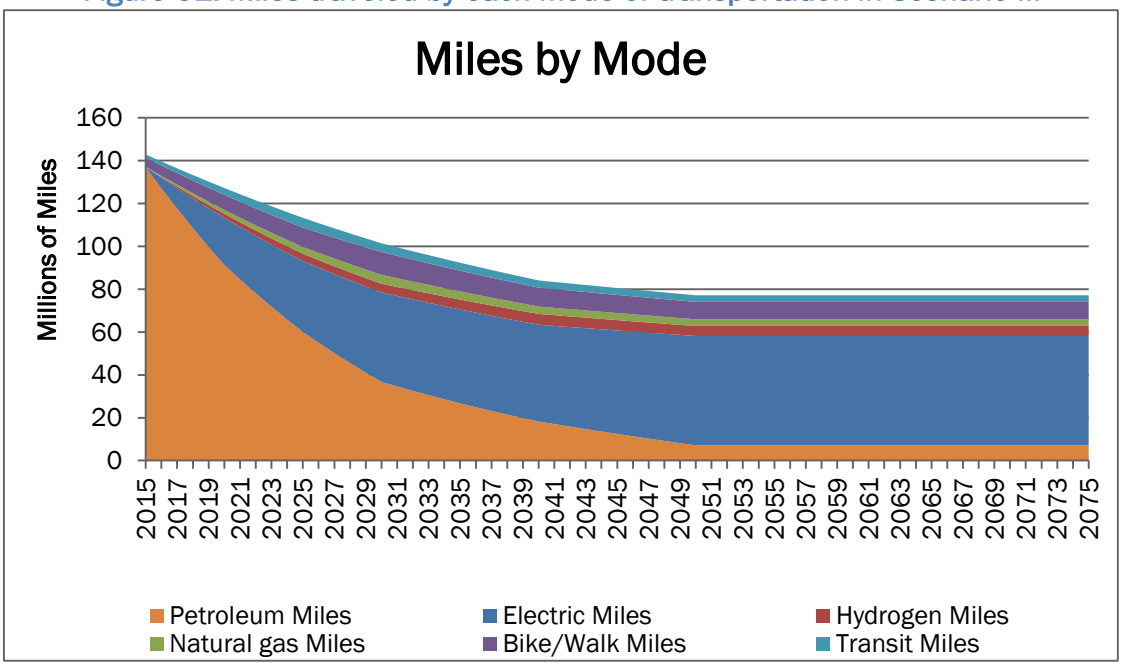
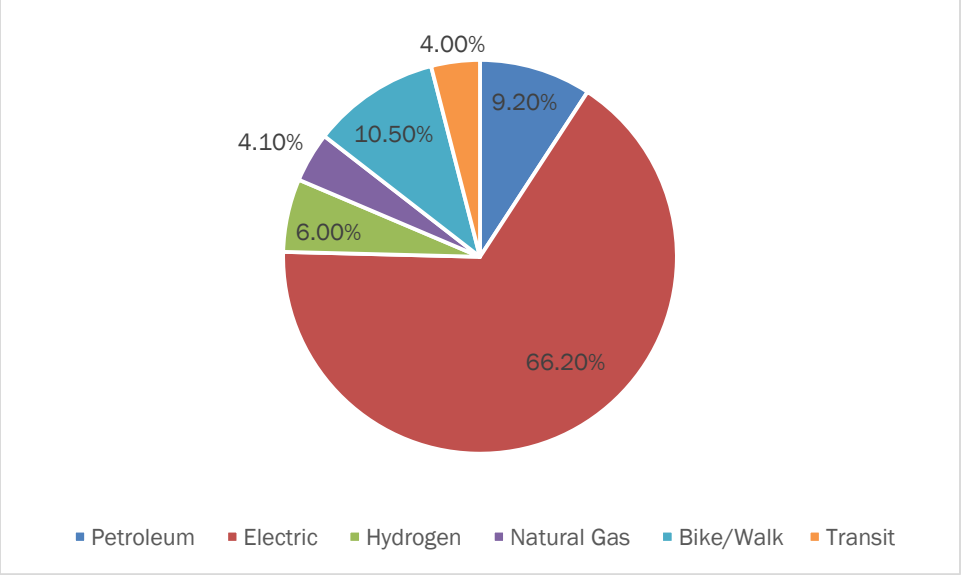
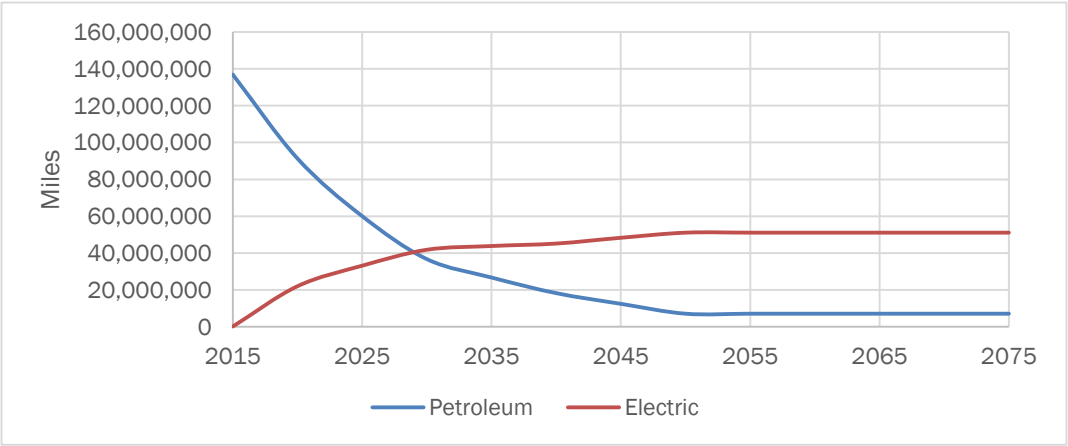


Figure 62: Portion each mode contributes to total transportation in Scenario III



Scenario III experiences even more interaction between the transportation and electricity sector as a third phase of Electric Vehicle adoption is implemented. As seen in Figure 47, 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 63. Overall, community electricity consumption still decreases in Scenario III despite the electrification of transportation due to aggressive renewable energy implementation measures.

Figure 63 Miles traveled by petroleum and electric vehicles in Scenario III



4.3 Water and Wastewater

Scenario III implementation measures will include measures from Scenario I and II, the reducing distribution system leakages (DSL) programs, and installation of greywater outdoor reuse systems (Figure 64).

In the DSL program, the first phase is to survey the city's water distribution system in order to determine if there are any large leaks in storage tanks or water mains. If one is found, then replacement of the tank will greatly lower water loss and the emissions the waste produces. Phase 1 will start in 2015 and last about a year. Phase 2 will involve starting the metering program with automatic meter readings on all city-owned facilities and creating a water audit that will be done every year. The goal of phase 2 is to reduce DSL to 20% by 2017, which can be done by keeping track of all the meter readings and taking action when leakages are found. Phase 3 will be a continuation of phase 2 with the metering and repairs to any DSL found. The goal of phase 3 is to reduce the city's water loss to 10% within the next three years.

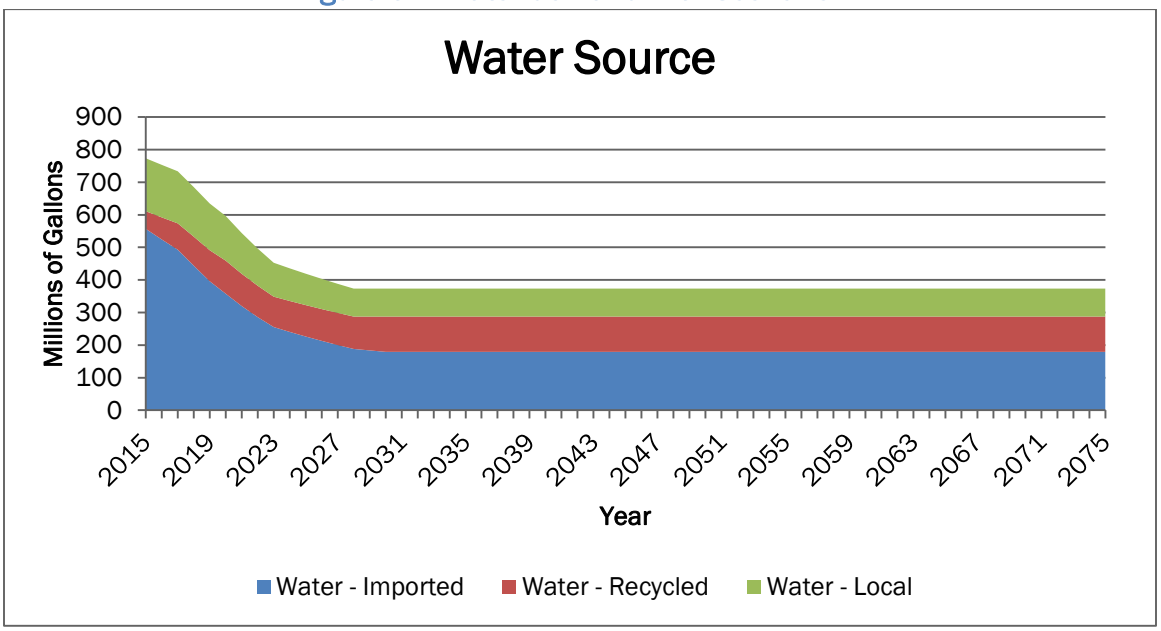
The goal of the greywater outdoor reuse systems is to replace the irrigation systems of about 500 buildings, which will save more than 5 million gallons of water annually.

These two measures were added because they have a large impact on water demand, but the projects within the programs are much larger, more costly and more time-consuming than the other measures in the first two Scenarios. It will take more effort from the local government to implement the reducing DSL programs throughout the city and installation of greywater outdoor reuse systems in city buildings. 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.

Activity – Based Measures	Rainwater Catchment – Phase I
	Rainwater Catchment – Phase II
	West Basin lower imported waters by 2020
	West Basin increase local waters by 2020
	West Basin increase recycled waters by 2020
	West Basin lower imported waters by 2030
	West Basin increase recycled waters by 2030
	Residential conservation rebates – Phase I
	Residential conservation rebates – Phase II
	Residential conservation rebates – Phase III
	Landscaping conservation – Phase I
	Landscaping conservation – Phase II
	Reduce distribution system leakages – Phase I
	Reduce distribution system leakages – Phase II
	Greywater outdoor reuse

Scenario III	
Year	**Greenhouse Gas Emission (MT CO_2-e)**
2015	2,580
2020	1,929
2025	1,350
2030 - 75	1,197

Figure 64: Water demand with Scenario III



4.4 Consumption and Waste

Table 47: Scenario III Implementation Measures

Scenario III Implementation Measures	
Activity	Purchasing Policy
	Tote bags
	Plastic Bags Ban
	Incentives for compostable single use items
	On-site building materials reuse
	Pay as you throw program
	Green waste composting program
	Guide for ecofriendly products
	Thrift/Consignment shops
Source Based	Methane Capture technology and/or infrastructure that reduce the greenhouse gases produced by each ton of waste going to the landfill

Finally, Methane Capture for designated landfills, if implemented, would help Hermosa Beach completely eliminate the majority emissions from the solid waste and materials consumption sector. It would prevent fugitive greenhouse gas emissions, possibly by capturing and combusting biogas in order to produce electricity. That is why it's a source based measure. Currently, the greenhouse gas intensity of landfill is about 0.194 kgCO2-e/MT. If the methane from the designated landfill for Hermosa Beach is captured on site, this intensity would go to zero and only the emissions related to recycling would be left to mitigate. More about this technology was described earlier in the report under the Materials and Consumption sector. Together, these measures in Table 5, if implemented over time, would help Hermosa Beach reduce greenhouse gas emissions from solid waste by 92.18% by 2035.

Table 48: Scenario III emissions from recycling and landfill

Scenario III Emissions			
Year	**Total consumption Emissions (MT CO2-e)**	**Landfill Emissions (MT CO2-e)**	**Recycling Emissions (MT CO2-e)**
2015	5.77	0.22	5.99
2020	2.38	0.34	2.72
2025	0.62	0.43	1.05
2030	0.23	0.47	0.70
2035-2075	0.00	0.47	0.47

Figure 65: Scenario III Materials Consumption

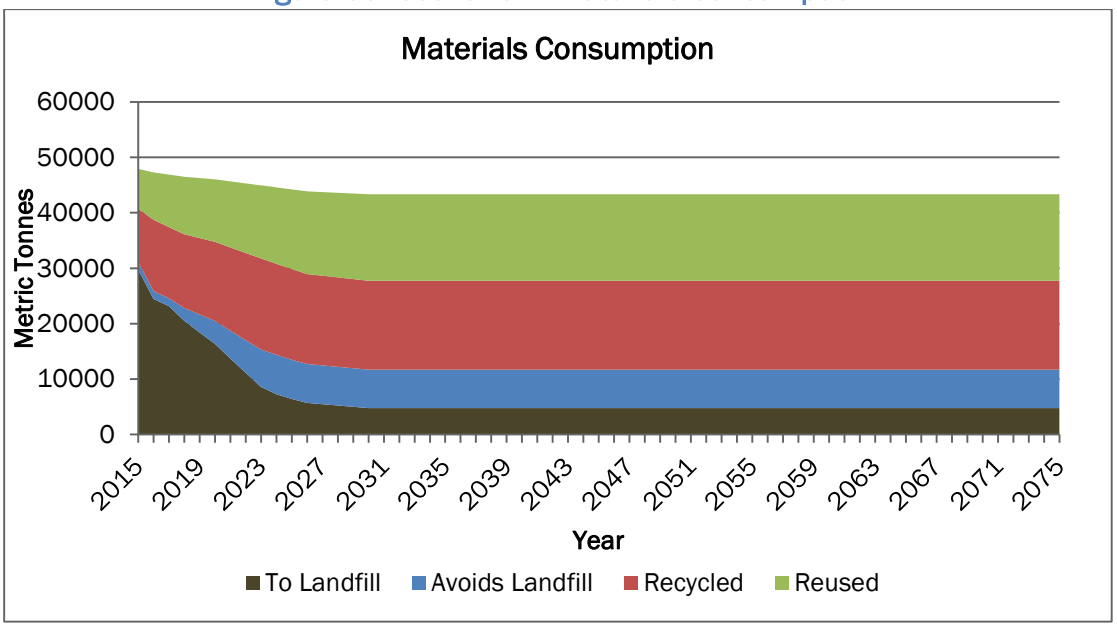
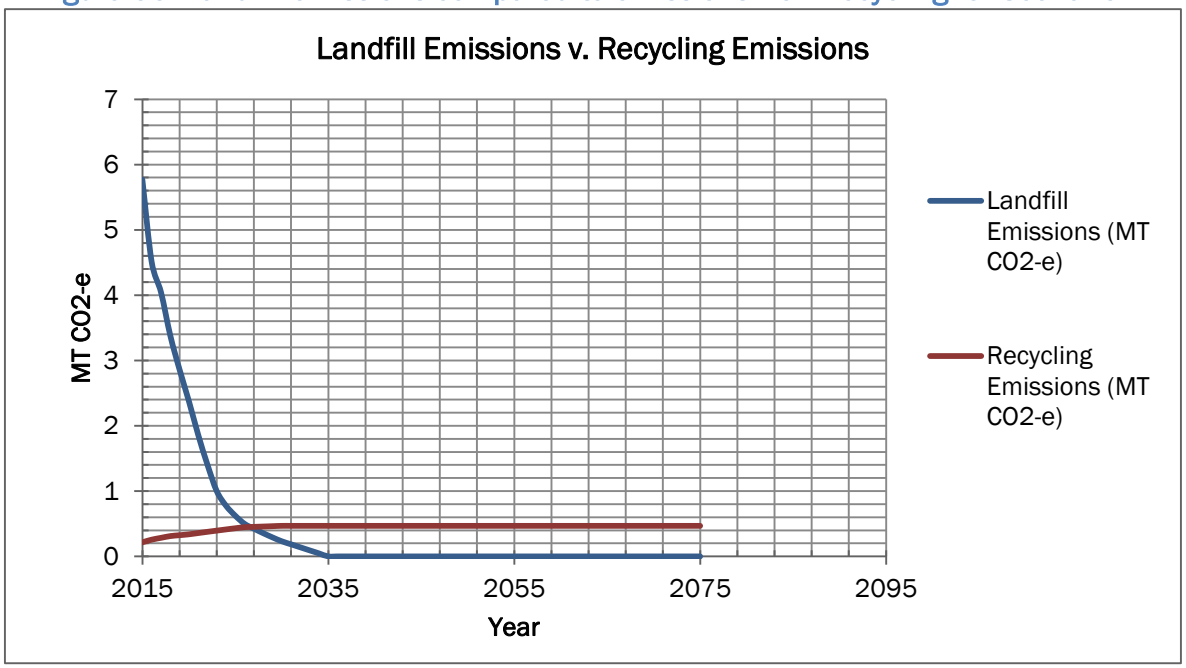


Figure 66: Landfill emissions compared to emissions from recycling for Scenario III



C. Discussion of Offsets

1. Introduction to Offsets

Hermosa Beach might not be able to completely neutralize its impact on global climate change. In that case, the city can look toward offsetting emissions by investing in emission reduction projects

elsewhere in order to claim that Hermosa Beach is a carbon neutral city. An offset is defined as a supplementary or substitution option for governments, organizations, or even individuals to reduce emissions from their country, operation, or household.[194] Compensation is used to invest in carbon reduction projects elsewhere. Offsets can be beneficial toward any climate change mitigation. With proper offset regulations to ensure the validity of reduction projects and high participation in offset markets, offsets can be a strong alternative to invest in for greenhouse gas emission reduction measures. We do not view offsets as a first choice plan to achieve carbon neutrality, but rather as a last result to claim carbon neutrality after the city has aggressively pursued implementation measures. Through use of high-quality offsets, Hermosa Beach could claim credit for emissions reductions elsewhere. Because greenhouse gas emissions are a global pollutant and their localized effects are unimportant to their effects on global climate change, equivalent reductions in one area have an equal effect to reductions in another area. While the city can use offsets to achieve its carbon neutrality goal, the perception of using offsets may make Hermosa's accomplishments less celebrated than achieving carbon neutrality without offsets.

2. Types of Offsets and Offset Markets

Greenhouse gas emissions have increased in the past thirty years, pushing governments to take legislative action to find ways to mitigate climate change. Depending on governmental oversight, compliance and voluntary offsets and offset markets are available to trade emissions and purchase offsets between polluters.

Compliance offsets, also called regulatory offsets, are established and regulated by international, national, or regional governments.[195] The characteristic that identifies offsets as compliance is that they are made mandatory by legislation. The overall goal of the compliance offsets is to create a market mechanism for those with emission targets; greenhouse gas emission reductions can be

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[194] Bumpus, A., D. Liverman, E. Boyd, D. Buck, M. Goodman, H. Lovell, and S. Randalls. (2008). Accumulation by Decarbonization and the Governance of Carbon Offsets. *Economic Geography, 84,* 127–155.

[195] Kollmuss, A., H. Zink, and C. Polycarp. (2008). Making Sense of the Voluntary Carbon Market: A Comparison of Carbon Offsets Standards. WWF. Germany.

purchased while the buyers' costs of mitigation is reduced and sustainable development is promoted to sellers in other places.[196] Companies that are concerned with the commodity of greenhouse gas emission reductions and meeting their individual cap usually buy compliance offsets.[197] Compliance offsets often then create issues with customers not caring about the background and details of projects, because they are purchasing offsets because of mandates that are enforcing emission reductions.

The other type of offsets is voluntary offsets. Voluntary offsets are categorized as offsets that function separately from compliance markets, giving companies and individuals the ability to voluntarily purchase carbon offsets.[195] Since these types of offsets are not under very strict oversight, management, or regulation, more room is given for projects to be inventive and different. Project developers have the freedom to come up with ideas that might not be possible with other regulations.[195] A major reason for increasing voluntary offsets is corporate goodwill.[195] Companies can profit from participating in voluntary reductions of greenhouse gas emissions from the positive publicity that will create good relations with public. In voluntary offsets, the buyer does care more about each project, and the background on the credit does become more significant to its value compared to those of the compliance offsets.[197]

At the local level, municipal governments govern a smaller number of compensating entities and have limited power over industries within their jurisdictions. Therefore, such restrictions impede municipal governments from employing many compliance offset mechanisms to industries within their jurisdiction, making participation within the voluntary offset market the best viable option for most local jurisdiction usage of offsets. Local jurisdictions can however voluntarily purchase compliance-quality offsets on behalf of sources located within the jurisdiction to support local emission reduction efforts. The voluntary market allows for municipal governments to have a greater control over participation in the market and the total amount of offsets they will invest in. Cap-and-

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[196] Corbera, E., M. Estrada, and K. Brown. (2009). How Do Regulated and Voluntary Carbon-offset Schemes Compare? *Journal of Integrative Environmental Sciences, 6,* 25–50.

trade compliance markets implemented at higher governmental levels, such as state run programs, gives cities the option of which offset market they want to enter. California is the first state to cap all greenhouse gas emissions from major industries and use market based compliance mechanisms to reach emission reduction goals under the Global Warming Solutions Act or Assembly Bill 32.[197] Because higher governmental levels support climate change mitigation efforts, Hermosa Beach has greater options to how they can use offsets to reach emission reduction goals. Therefore, the city of Hermosa Beach can participate in either the state run compliance cap-and-trade program under Assembly Bill 32, or the over-the-counter (OTC) voluntary marketplace.

3. Municipal Use of Offsets

Hermosa Beach has a greater number of options because of their California location. The state of California has its own market based compliance mechanisms via AB32, so Hermosa Beach and similar cities can employ emissions and carbon sinks to be credited and used within the larger compliance market, participating in or purchasing California Reduction Tons produced by projects certified by the Climate Action Reserve. The Climate Action Reserve is a national offsets program that focuses on ensuring the integrity of greenhouse gas reduction projects to create and support financial value within the US carbon market.[198] It creates standards to quantify and verify greenhouse gas projects, oversees independent third party verification organizations, issues carbon credits and tracks them over time to ensure transparency. The Climate Action Reserve holds reduction projects accountable for their greenhouse gas reduction claims and ensures credibility of those projects. Through this, the Climate Action Reserve ultimately strengthens the success of U.S. carbon markets. Voluntary-based offsets such as any sort of energy efficient technology or bio-sequestration project, unconventionally can act as a greenhouse gas offset even without the projects directly traded within a compliance-based marketplace. The use of compliance-based offsets in

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[197] Hamilton, K., M. Sjardin, M. Peters-Stanley, and T. Marcello. (2008). *Forging a frontier: state of the voluntary markets 2008*. 2008 Report. Ecosystem Marketplace & New Carbon Finance, Washington, D.C. and New York, NY.

[198] Climate Action Reserve.(2013). Program. Retrieved May 22, 2013 from http://www.climateactionreserve.org/how/program/

claiming carbon neutrality will be better received than the use of voluntary offsets, because reduction projects must go through a stringent verification process to register to be traded in a compliance market, giving these projects more credible value.

Many cities throughout California have implemented offsets into their sustainability city plans as a means to reduce emissions. For example, in order to comply to reduction emissions standards the city of San Francisco developed the Carbon Fund. The first of its kind, the Carbon Fund allows people to purchase carbon offsets to fund local projects that mitigate carbon emissions, support municipal government goals, and invest in San Francisco's sustainable future. For example, the Carbon Fund financed a local biodiesel filling station, Dogpatch Biofuel, as its first offset project. Dogpatch Biofuel replaced the nonrenewable petroleum diesel in local vehicle fleets with a renewable energy source, biodiesel. The local biodiesel filling station in its first year offset as much as 660,000 pounds of CO_2,that would have otherwise been released into the atmosphere.[199] Also contributing to the Carbon Fund, San Francisco International Airport implemented the "Climate Passport" program to allow travelers to purchase voluntary carbon offsets that equate to the emissions of their flight. Kiosk stations enable travelers to calculate their carbon footprint and purchase offsets at the airport. The Climate Passport program allocates $1.50 per ton of all sales to the San Francisco fund for local climate change mitigation projects and the rest to an NGO, the Garcia River Forest for reforestation projects. All offsets are verified via third-party verification to ensure the quality of greenhouse gas reductions with offset purchases. Similarly, the City of Long Beach proposed enrolling their urban forest as carbon sequestration offsets into the California Carbon cap-and-trade market. The maintenance costs of the urban tree coverage would determine the number of credits generated.

[199] SF Department of the Environment. 2007. Mayor unveils first ever local carbon offset program. SF Department of the Environment, San Francisco, California.

Long Beach's proposal opened up the idea that carbon offset credits can be sold to municipal governments who preserve tree coverage. [200]

Through analyzing how other cities implement offsets, Hermosa Beach has a number of options of ways to offset their remaining emissions. One way would be to purchase offsets that have been validated by a third party in either the California cap-and-trade market, or the over-the-counter voluntary market. We would recommend Hermosa Beach purchase offsets or invest in mitigation efforts close to home. Although globally there is a number of pressing environmental issues, Hermosa Beach's goal to become carbon neutral is to reduce their impacts on their proximate environment. City purchases of offsets that support local environmental efforts would strengthen and further enhance their claims of carbon neutrality. All or any purchases of offsets by Hermosa Beach should be third-party verified, because it would ensure equal compensation for greenhouse gas emissions and reductions. Purchased offsets should not be a mechanism that is used as a scapegoat, but rather utilized as a last resort. Hermosa Beach should firstly implement and invest in as many emission reduction measures before looking into offsets because long-term sustainability and efficiency of the city would be more beneficial to invest in than simply purchasing offsets. Hermosa Beach could also employ programs, similar to the San Francisco's Carbon Fund, to create extra funds for offset projects that they would otherwise be unable to afford. The combination of purchasing offsets from either the compliance or voluntary market in conjunction with developing programs to help fund emission reduction targets will enable Hermosa Beach to neutralize any emissions that the city cannot mitigate on its own.

PART IV: Conclusions

The City of Hermosa Beach has already begun working to reduce greenhouse gas emissions and become more sustainable, and has now committed itself to becoming carbon neutral. Given the lack

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[200] Poudyal, N., J. Siry, and J. Bowker. 2010. Urban forests' potential to supply marketable carbon emission offsets: A survey of municipal governments in the United States. Forest Policy and Economics 12(supplement 6):432-438.

of a single universal definition of what carbon neutrality means, we decided to define what carbon neutrality meant specifically for Hermosa Beach. That definition was based on the defined scopes and boundaries and the sources and activities that were examined, and focused on the emissions that are under the city's ability and authority to control and that fall within the boundaries of the city.

Our recommendations for Hermosa Beach took under consideration a variety of factors that may help or hinder their efforts, including examining the political, social, and cultural landscape of the city and the likelihood that certain measures would be accepted. We focused on the four main sectors that we found to be most responsible for greenhouse gas emissions within Hermosa Beach, identifying their sources and activities: building energy, transportation, water, and materials waste. Sources and activities related to transportation produce the highest amount of emissions, followed by building energy. Emissions resulting from water and waste are much lower, but still important to target if Hermosa Beach wants to be completely carbon neutral.

Each of these sectors was examined to determine what their particular sources and activities were, what the overall life cycle of the sector looked like, and how the city can best target and reduce their emissions inventory. In each case, reducing the number of sources and activities and maximizing the efficiency of any remaining ones could decrease its emissions inventory. Implementing measures from the model that are specific to each sector and extending them over a period of time will help achieve this.

In order for Hermosa Beach to truly 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 originating 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 less 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 Scenario 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. If Hermosa Beach decides to implement the Phase 3 plans, they will be well on their way to 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 implemented.

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. Transportation and building energy provide the greatest opportunity to reduce emissions, but all sector emissions must be considered and subsequently reduced for a completely carbon neutral city; as a result, all sectors are included in our implementation plans. However, 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.

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