

# **Zero Emission Zero Waste Construction Sites in California Commercial Construction: A Case Study**

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Zero emission refers to the absence of waste products that pollute the environment or disrupt the climate from any engine, motor, process, or other energy source systems. CO<sub>2</sub> emissions through equipment and machinery, along with toxic chemicals, carcinogens, ash and dust are founded most common in the Construction Industry. Although these findings may not raise an eyebrow, it is quite overlooked, and the numerical data is staggering. Zero waste is also examined in this paper—the conservation of all resources by means of responsible production, consumption, reuse, recovery of products and materials without burning and with no discharges to land, water, or air that threaten the environment or human health. According to the Disposal Facility-Based Characterizations of Solid Waste in California, more than 135 million tons of material to landfills are reported every year in the United States from construction and demolition projects. California contributing 20.4 percent. In recent years, California has made great strides to combat this issue by implementing laws to regulate the displacement of waste and the amount of it produced. Effective January 1, 2011, California's Green Building Standards Code (CALGreen) required the diversion of at least 50 percent of the construction waste generated during most “new construction” projects. Being one of the leading states, they recognize the importance for sustainable development and since then they have added subsequent amendments to expanded upon what types of construction are covered. California heads toward zero-carbon electricity by 2045; GHG emissions on job sites from gas use being the increasingly difficult main obstacle to decarbonizing the state's building stock. This paper explores green building efforts to reuse, recycle or divert waste that is generated on site, as well as off-site construction aka prefab. Newer data expresses a huge advantage with prefab in the management of materials prior to leaving the factory, offering a much more efficient process to reduce the amount of waste sent to landfills. This paper will research the achievability of a zero emission, zero waste job site as well as outline the current trends, methods, and successes in California Commercial Construction toward a zero emission, zero waste job site.

**Key Words: Emissions, Pollution, Sustainability, Commercial, California**

## **Introduction**

This paper explores the quantity of emissions and waste our industry produces, specifically commercial construction in the state of California. Exploration, namely the potential of electrification, given that it holds the largest CO<sub>2</sub> mitigation potential, while delivering significant environmental, human health and economic benefits. Here we take a closer look into the solutions which exist today, the current policy and market advances in this regard, and goes on to provide some forward-looking policy recommendations. There has been a big shift in the recent decade drawing on state legislation which is simultaneously undergoing reform, and pending transposition at national levels. A number of different pathways and tools exist to enable efficiency gains and emission cuts from construction site machinery, ranging from engine and machine component improvements; process optimization; dedicated training of machine operators to reduce fuel use; to the deployment of alternative technological solutions such as electrification of the machinery. With all consideration, this paper will conclude how the construction industry is shifting to zero emission, zero waste jobsites.

## Research Methodology

The objectives of this case study are as follows:

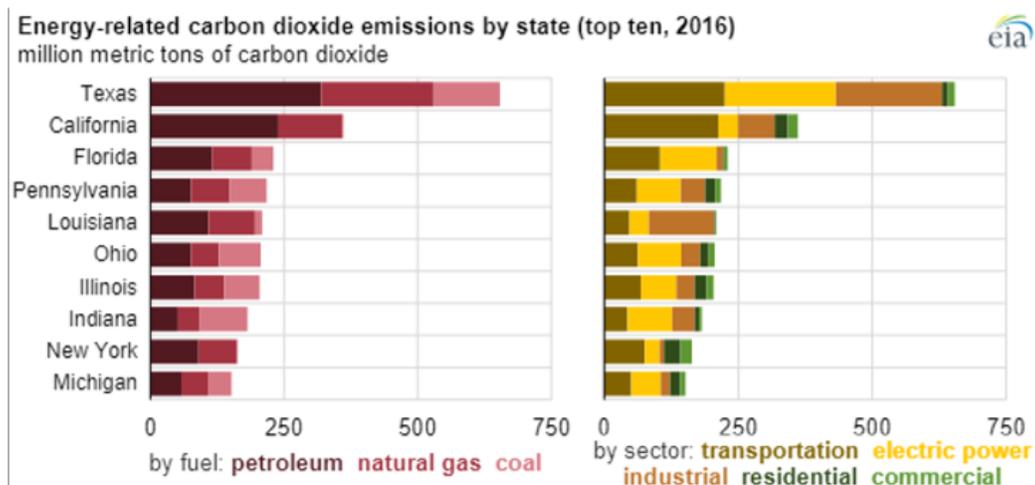
- To report whether we are striving to achieve zero emission, zero waste construction
- To highlight the challenges and the transitional legislative difficulties.
- To emphasize the lessons learned of our industries past.
- To highlight local and state-wide milestone dates.
- To provide new knowledge from recent data.

This paper utilizes the quantitative research strategy to empathize the obligation we have in our industry to achieve a zero emission, zero waste job sites in California commercial construction. Critical analysis of the systems and processes required along with data and statistics of our impact to the environment will showcase where the industry in California commercial construction is changing.

## Case Study

The primary purpose of this paper is to develop what step by step measures are being made for zero emission, zero waste commercial construction in California and the exploration of local and state-wide accomplishments. This research will provide the future vision of commercial companies in California. With achieving zero waste, zero emission, the projected results for the environment, human wellbeing, financial stability, safety, and improving communities will be insurmountable. The most difficult factor to consider is no major region has been able to achieve such a feat. There is potential that current day commercial companies in California aren't implementing the necessary standards for sustainable construction quick enough. This papers goal is if the strategies available to California commercial companies can create zero emission, zero waste, it can encourage best practices for other companies around the world to implement, making our industry more sustainable.

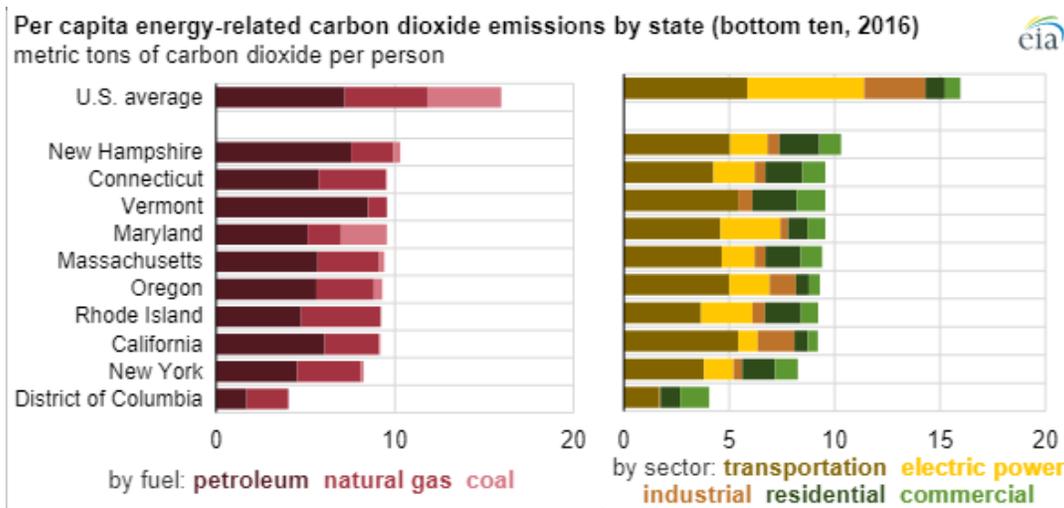
### *Amount of Emissions Produced in Our Industry*



In recent data, California leads second in energy-related carbon dioxide (CO2) emissions, according to EIA's recently released Energy-related Carbon Dioxide Emissions by State, 2005-2016. In addition to energy-related CO2 emissions estimates for all 50 states, the report provides data on CO2 emissions per capita and emissions broken out by fuel and by sector.

Here, population is the most important factor in determining total CO2 emissions in a state. Other factors that influence both total and per capita CO2 emissions include the state's energy resources, climate, population density, and economic mix. Regardless of comparison to other states we must recognize our population size and our emission contribution.

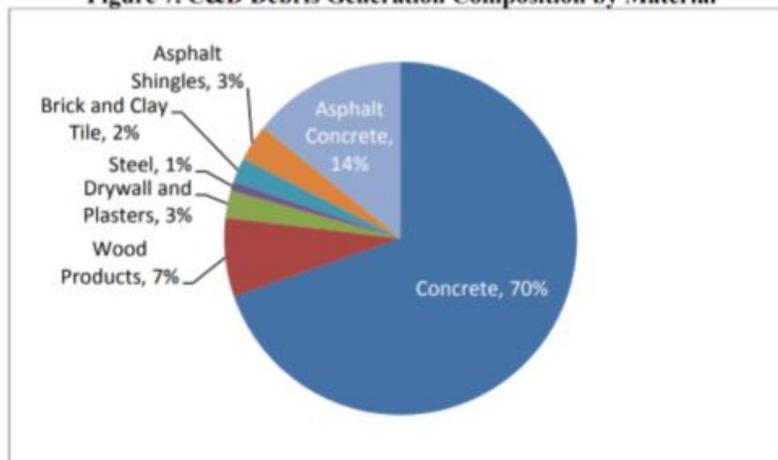
Broken down by sector, we are a close second behind New York for commercial construction.



Total energy-related CO2 per capita in the United States averaged 16 metric tons in 2016. California just below the average at around 9 metric tons of CO2 emissions with commercial construction contributing 11%. This is a significant amount that can be reduced in future years. Recent legislation later discussed will paved the way.

### *Amount of Waste Produced in Our Industry*

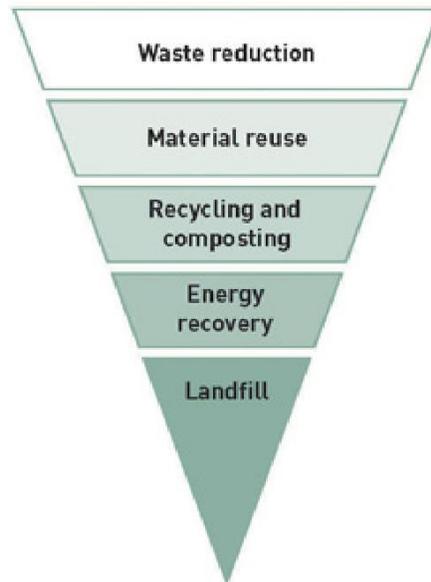
**Figure 7. C&D Debris Generation Composition by Material**



According to the Disposal Facility-Based Characterizations of Solid Waste in California, more than 135 million tons of material to landfills are reported every year in the United States from construction and demolition projects. California contributing 20.4 percent. That is 27.54 tons of waste produced by us alone. The chart above breaks down the different materials we waste in construction and demolition projects.

### *Environmental Obligations*

Construction is a fundamental and essential component of human civilization. It lies at the heart of economic and social development. But it comes with a price. Construction sites are also a major source of environmental and human health damage throughout all aspects of the construction process. While it is well known that construction sites are the source of different forms of pollution – including material waste, visible dust, noise, and vibration – construction and demolition sites also produce less obvious pollutants which are of serious concern for human health. Combined with increasing urbanization trends and a faster-growing global population, it goes without saying that there’s an exponential need for more construction. This calls for the adoption of timely policies and measures at the local, and state levels to encourage the transition to zero emission, zero waste sites, technologies and processes across the full construction supply chain.



### **Results and Discussion**

The following information was gathered through extensive research of legislation and bills from statewide and local governments. It was the goal of this study to gather and present the information as objectively as possible. In addition to information relating to the specific construction goals set out by the state, this research also developed new benefits and goals through past zero waste, zero emission accomplishments.

## *Zero Emission Goals*

Reaching net zero-emissions is possible now through the purchase of additional renewable energy in order to offset emissions produced by on-site fossil fuels. Zero-emissions standards are starting to prohibit, or significantly discourage, on-site fossil fuel use.

Many cities are working with industry to provide incentives for all-electric jobsites and buildings, combatting legislative barriers.

An example is from a recent study performed by the City of Palo Alto, California. The study analyzes building design strategies that are more stringent than the upcoming California Energy Code, which is targeted for enforcement starting January 1st, 2020. For the analysis, the study considers measures developed by the Architecture 2030 organization, also known as the “Zero Code”. The study found that building electrification is cost-effective in specific new commercial construction scenarios. The cost-effectiveness study was developed in accordance with the city’s Sustainability Implementation Plan (SIP) with support from the Palo Alto Green Building Advisory Group (GBAG).

The City of Los Angeles just released its new Sustainability Plan that includes ambitious emissions standards for new buildings to be zero-emission by 2030 and all existing buildings by 2050. With its population of 4 million, L.A.’s leadership on cutting carbon pollution from its buildings is a big deal for California.

The County of L.A., Santa Monica, San Luis Obispo, San Jose, San Francisco, and dozens of local governments across the state are considering options to accelerate the decarbonization of their buildings, beginning with ordinances covering new construction.

## *Zero Emission and Zero Waste Accomplishments*

On January 29<sup>th</sup>, 2019 Caterpillar, one of the leading equipment manufactures in California unveiled an all-electric 26-ton excavator with a giant 300 kWh battery pack. The company expects that the machine will result in a better experience for its employee by reducing air and noise pollution at construction sites.

The executive of Caterpillar believes that if construction companies would replace all of the approximately 2,500 excavators of similar sizes in the country, it would result in the equivalent of removing 60,000 cars from the roads.

It’s the latest example of the electrification of transport spreading to other industries. Now construction and mining equipment are being increasingly electrified.

With a high demand for more specialized construction and more limited construction environments in California, modular prefabricated construction has emerged, and it is rapidly increasing. Choosing this alternative technique of construction of off-site construction is an effective way to design out waste — reducing the overall construction waste during construction vs. managing and diverting it after the fact.

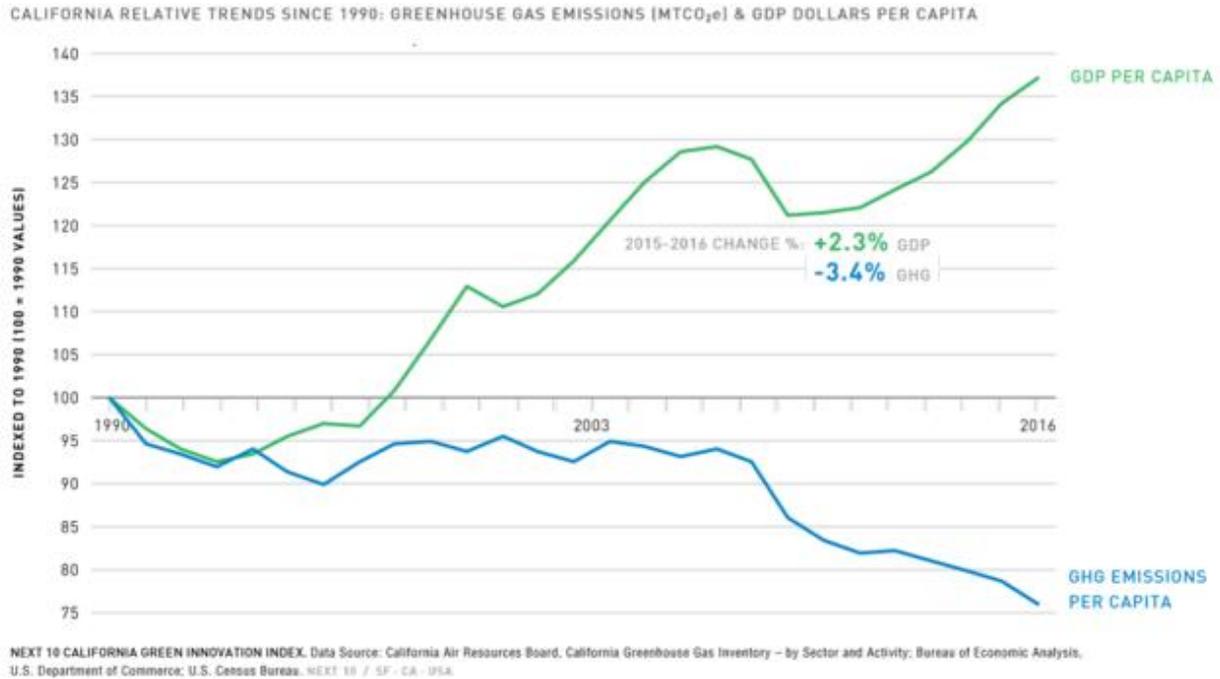
Green building efforts for site-built construction focus on reuse, recycling or diversion of waste that is generated on site. With off-site construction, however, the materials can be managed prior to leaving the factory, offering a much more efficient process to reduce the amount of waste sent to landfills.

California has set a goal for the year 2045 and signed by the previous Governor Jerry Brown to ensure 100% electrified construction.

## *Lessons to Consider for New Construction*

According to the 2018 Integrated Energy Policy Report by the California Energy Commission, building electrification is the lowest-cost and lowest-risk pathway to achieving deep decarbonization of buildings in California.

Along with that data, below is a chart provided by the California Air Resources Board that showcases a GDP per capita increase when GHG emissions decrease



Not only is it an essential motive to protect our environment and be sustainable, there is a financial incentive for new construction to achieve zero emission and zero waste. With the new legislative milestone of year 2045, it is financially smart to build right from the start rather than to retrofit a building later. This will encourage electric buildings that employ modern technologies such as heat pump heaters and water heaters, clothes dryers, as well as induction stove tops, are cheaper to build and operate, while providing superior air quality, safety, and cooking experiences to their occupants. Overall, we are achieving optimal human comfort.

Electric jobsites will bring major air pollution reductions, which is particularly important in the California's regions such as Los Angeles and the Central Valley that suffer from some of the worst air pollution in the country. In cities prone to earthquakes, avoiding gas related construction reduces the risk of post-earthquake fires.

## **Conclusions and Future Research**

Like previous energy transitions, such as from whale oil to electricity for lighting, and coal to renewables for power, the decarbonization of commercial construction will eventually shift jobs from the gas industry to the electric power, equipment manufacturing, and most importantly, pertaining to us, our building sectors. This won't happen overnight; it will take decades to transition but we should be wearing a badge

of honor as California is the state leading this movement. During that time, it will be critical to provide sound legislation and just transition opportunities for the commercial industry.

As the rest of the country and the world watch the Golden State, its local governments have the opportunity to pave the way for healthy, safe, and affordable zero-emission buildings in California and beyond.

This paper encourages future research to provide the connection of zero emission, zero waste and cost reduction, as well as significant preservation of surrounding environments and improved human wellbeing.

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