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ENERGY COMMISSION**



**CALIFORNIA
NATURAL
RESOURCES
AGENCY**

Clean Transportation Program

FINAL PROJECT REPORT

CR&R Municipal Solid Waste to Transportation Biomethane

Phase I Perris Anaerobic Digester

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¹ [Cal Recycle](https://www.calrecycle.ca.gov/) <https://www.calrecycle.ca.gov/>

PREFACE

Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007) created the Clean Transportation Program. The statute authorizes the California Energy Commission (CEC) to develop and deploy alternative and renewable fuels and advanced transportation technologies to help attain the state's climate change policies. Assembly Bill 8 (Perea, Chapter 401, Statutes of 2013) reauthorizes the Clean Transportation Program through January 1, 2024, and specifies that the CEC allocate up to \$20 million per year (or up to 20 percent of each fiscal year's funds) in funding for hydrogen station development until at least 100 stations are operational.

The Clean Transportation Program has an annual budget of about \$100 million and provides financial support for projects that:

- Reduce California's use and dependence on petroleum transportation fuels and increase the use of alternative and renewable fuels and advanced vehicle technologies.
- Produce sustainable alternative and renewable low-carbon fuels in California.
- Expand alternative fueling infrastructure and fueling stations.
- Improve the efficiency, performance, and market viability of alternative light-, medium-, and heavy-duty vehicle technologies.
- Retrofit medium- and heavy-duty on-road and nonroad vehicle fleets to alternative technologies or fuel use.
- Expand the alternative fueling infrastructure available to existing fleets, public transit, and transportation corridors.
- Establish workforce-training programs and conduct public outreach on the benefits of alternative transportation fuels and vehicle technologies.

To be eligible for funding under the Clean Transportation Program, a project must be consistent with the CEC's annual Clean Transportation Program Investment Plan Update. The CEC issued PON-11-602 to provide funding opportunities under the Clean Transportation Program for projects that develop infrastructure necessary to store, distribute, and dispense electricity, E-85, propane, diesel substitutes, and natural gas. In response to PON-11-602, the recipient submitted an application which was proposed for funding in the CEC's notice of proposed awards posted April 2012 and the agreement was executed as ARV-12-009 on February 11, 2013.

ABSTRACT

The local production of renewable natural gas from municipal solid waste is a key component of California's strategy for reducing greenhouse gas emissions from both landfills and the transportation sector. CR&R Incorporated completed the first phase of the Perris anaerobic digester in the fourth quarter of 2016 and is now using the renewable natural gas produced at facility to pick up the waste that feeds the digester. This innovative project has already demonstrated a variety of economic development and policy attainment benefits for the state, positive environmental and job benefits for the City of Perris, which is a disadvantaged community that has been disproportionately impacted by economic and environmental factors, and lab and research growth opportunities for UC Riverside.

This project has a triple bottom-line impact with demonstrated contributions in (1) improving the state's economy, (2) increasing prosperity in a disadvantaged community, and (3) improving the environment across multiple sectors (energy, air quality, and greenhouse gas emissions, waste). The project is a meaningful contributor to the state's growing bioenergy industry cluster and has already attracted attention from developers, investors, and governments in other parts of the U.S. and throughout the world.

Keywords: Anaerobic Digestion, biomethane (BIO), interconnect, renewable natural gas (RNG), and greenhouse gas (GHG)

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EXECUTIVE SUMMARY

CR&R Incorporated has completed the construction of the first phase of its Anaerobic Digestion project in Perris, CA. Phase 1 of the Anaerobic Digestion project is fully operational and at full build out the facility will be the largest of its kind in the United States. The project uses high solids anaerobic digestion technology to convert organic waste (green waste and food scraps) into renewable natural gas for CR&R's Incorporated fleet of collection vehicles, as well as produce a soil amendment and/or fertilizer for use in the agricultural industry.

The first phase of the project is permitted to process more than 83,600 tons of organic waste per year. The first phase is the phase that was partially funded by the CEC Grant ARV-10-052. The project has been permitted to be expanded to more than 320,000 tons of organic waste a year with the construction of three additional phases.

Additional capacity can be integrated into the existing infrastructure. CR&R Incorporated feeds its digester with the material it collects curbside from its residential customers as well as commercial customers, which consists mostly of yard waste and food scraps. After the organic waste has been converted to biogas, the biogas is further cleaned in an upgrading unit, which uses recycled water. The final product is California produced renewable natural gas that is interchangeable with conventional natural gas for fueling CR&R's Incorporated collection fleet. This ground-breaking project also includes an inter-connect to the Southern California Gas distribution system allowing the surplus renewable natural gas can be efficiently distributed to other markets.

CHAPTER 1:

Project Background and Objectives

CR&R partnered with the CEC to initiate its production of BIO from mixed municipal organic waste at its Perris BIO Facility. This foundational first phase of the Anaerobic Digester (AD) and biogas cleanup system at CR&R's Material Recovery Facility in Perris, California has established best practices for future phases at the Perris BIO Facility and other AD projects throughout the state.

This landmark effort was California's first RNG project with a natural gas pipeline interconnect, which came online in the first quarter of 2017. Phase I of this project completed commissioning in November 2016 and began fueling CR&R's fleet with RNG in December 2016. CR&R collects 229 tons per day of green waste and solid food waste from 11 municipalities and brings it to the Material Recovery Facility for sorting and processing. After being fed into the AD, the biogas produced is upgraded to pipeline-quality RNG. In addition to RNG, the AD processing of the mixed municipal organic waste also produces 65,000 tons of fertilizer annually that is sold for agricultural and horticultural use. The AD facility produces an estimated 966,482 diesel gallons equivalents (DGE) of RNG per year, which is used in CR&R's waste collection vehicle fleet; the excess is inserted into the Southern California Gas pipeline, thereby setting international precedent and leadership in renewable low carbon fuel production and use as well as waste resource management sustainability.

Phase I of the Perris BIO Facility Project allowed CR&R to assist the State in meeting legislative initiatives created in Assembly Bill 1594 (Williams, Chapter 719, Statutes of 2014) and Assembly Bill 1826 (Chesbro, Chapter 727, Statutes of 2014). The RNG produced from Phase I of the projects enables vehicles operating in the region to fuel with clean, cost-effective RNG and thus offsets petroleum fuel use and the associated GHG and criteria pollutant emissions. The project also received support from agencies besides the Energy Commission including Cal Recycle and the South Coast Air Quality Management District in recognition of the project's sustainable energy benefits.

Project Goals

The overarching goal of the project was to construct an 80,000 ton per year AD with a biogas cleanup system to create vehicle ready RNG. Upon commissioning, the plant was designed to be able to accept 229 tons per day of mixed municipal organic waste, and CR&R can provide that amount of feedstock through collection contracts with 11 municipalities.

Green waste and solid food wastes are delivered via truck to the Perris organics receiving facility where they are sorted and processed into a homogenous AD feedstock and then fed into the AD system to produce biogas. The biogas is then upgraded to pipeline-quality RNG, at which point it is used by CR&R's fleet and injected into the Southern California Gas Pipeline. The project generates enough RNG to displace the equivalent of 966,482 DGE annually, which can fuel 75-80 of CR&R's heavy-duty refuse trucks. The AD processing of the mixed municipal organic waste also produces about 65,000 tons of fertilizer annually that will be sold for agricultural and horticultural use.

CR&R's measurable project objectives for the AD project included:

Annual Petroleum Reduction: 890,670 gallons per year DGE displaced.

- Petroleum Displacement Lifetime Cost-Effectiveness: \$0.28 per gallon of diesel displaced
- 5-Year GHG Reduction: 65,873 tons of carbon dioxide avoided
- GHG Reduction Lifetime Cost-Effectiveness: \$18.98 per ton of carbon dioxide avoided
- Create 50 to 75 construction jobs and 8 permanent facility/operations jobs
- Divert 229 tons of Municipal Solid Waste (MSW) per day from landfills
- Confirm scalability of the design/model and move toward 454 tons per day
- Provide for the total use of nearly 4 million DGE of compressed natural gas by 2022 for vehicle refueling
- Provide for the annual reduction of more than 13,175 metric tons of GHG emissions, 60.24 tons of nitrogen oxide (NOx) emissions, and 1.22 tons of particulate matter (PM)
- Distribute the BIO via the existing natural gas pipeline infrastructure when that opportunity becomes more feasible within the next few years

CHAPTER 2: Site Location

CR&R's AD project is located on a 52-acre solid waste facility at 1706 Goetz Road in the City of Perris in Riverside County, two miles from the D Street exit off I-215. At this location, CR&R owns and operates a solid waste facility with a material recovery facility and transfer station, mechanics bays, and a corporate office. The Perris facility is CR&R's largest operation with approximately 150 trucks including 110 front and side loaders, 15 street sweepers, and other transfer and roll off trucks that provide services to the cities of Perris, Temecula, San Jacinto, Canyon Lake, Lake Elsinore, Hemet, Calimesa, Wildomar, Riverside and the County areas of Riverside. CR&R currently operates 70 compressed natural gas (CNG) vehicles on the road at Perris, so the Phase I AD facility provides enough BIO to fuel the company's initial deployments. The initial layout drawing that shows the full buildout is seen in Figure 1.

The modularity of CR&R's development strategy is very effective at streamlining both timelines and costs. The basic site development for Phase II, such as grading, asphalt, and piping that any facility would require had already been installed at this location as a result of Phase I, thereby, passing both administrative and physical benefits to Phase II. At the back end of this project, one of the large line items for new facilities is the gas conditioning equipment necessary to purify the biogas after it is produced in the digester. The gas conditioning equipment installed in Phase I is sufficient to service Phase II which is currently under development, thereby providing extremely cost-effective RNG to an additional 60-100 trucks.

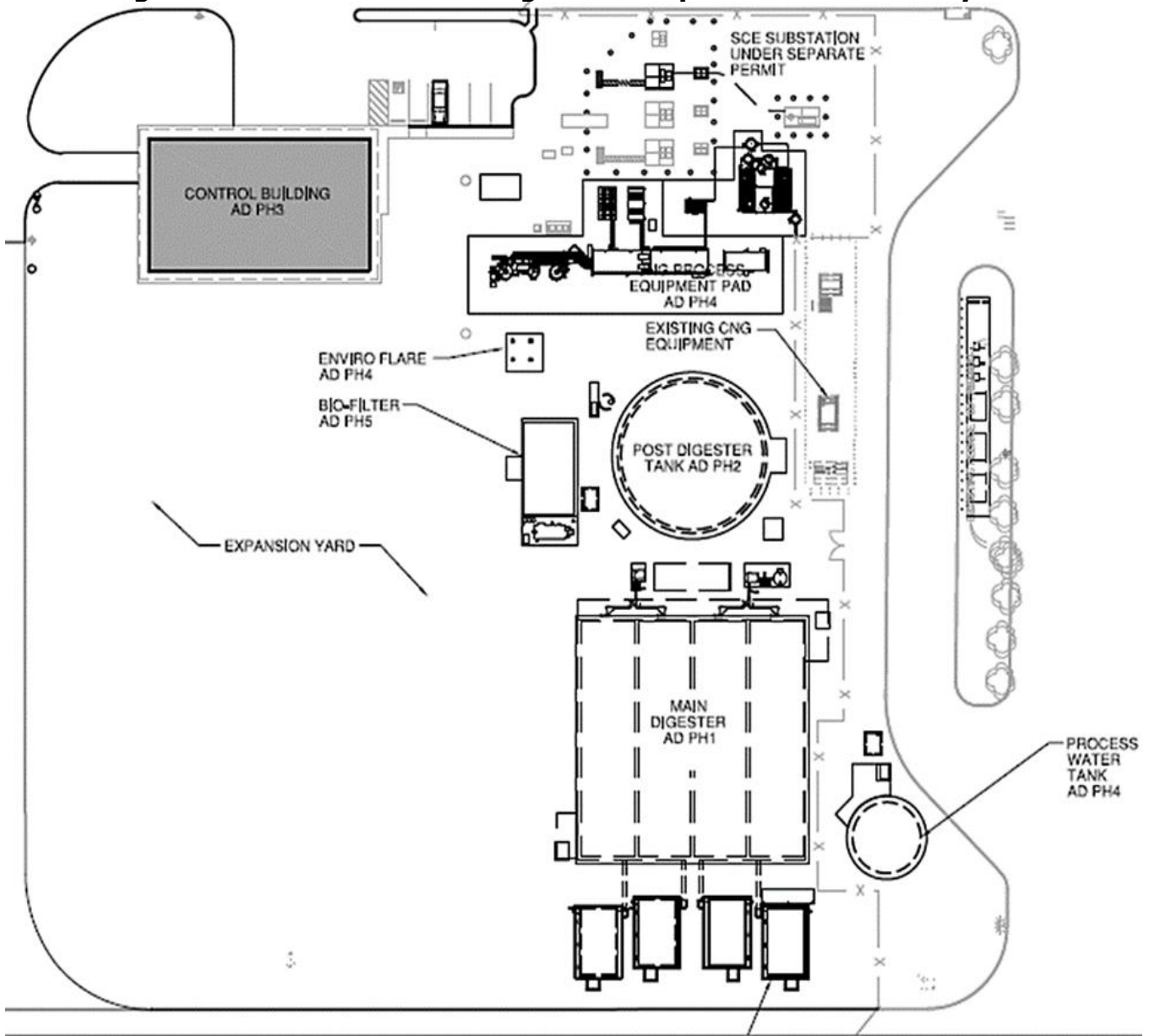
Site control for the project could not be more ideal as CR&R is the owner and operator of the land and facilities and is in direct control of the ownership and access rights of the property. As part of the Phase I development, CR&R worked with the City of Perris to complete mergers of multiple parcels, shown in the architectural drawing in Figure 2, to accommodate the large footprint of the facility without crossing lot lines. The lot merger has been recorded with the County of Riverside. The joint ownership and operation eliminate many potential pitfalls. Furthermore, access for the trucks is ensured by the approved conditional use permit, which includes traffic counts for the full build out.

Figure 1: Initial Layout Drawing for Full Buildout



Source: CR&R Incorporated

Figure 2: Architectural Drawing of the Proposed Phase I Facility Site



Source: CR&R Incorporated

CHAPTER 3:

Scope of Work

Scope of Work

CR&R's scope of work under contract ARV-10-502 included the construction, operation, and reporting of an anaerobic digester that receives municipal solid waste and produces RNG and soil amendments. CR&R was responsible for constructing the AD system which included the following new equipment:

- Above-ground, fully enclosed anaerobic digester
- Biogas water wash
- Biogas' Vacuum Pressure Swing Absorber
- Boiler
- Natural gas compressor
- Natural gas pipeline
- Flare and biogas tank
- Biofilter

All facility components comply with California Code of Regulations, National Fire Protection Association, and any other local, state, and federal codes as applicable. The facility also included design, engineering, permitting, project management, and purchasing. CR&R's work included discretionary permitting, environmental permitting, fire protection, fire detection, methane detection, and all necessary safety elements identified with hazardous operations process safety.

Technical Tasks

CR&R completed several technical tasks to complete the AD facility development in an orderly and efficient manner. In particular, CR&R completed the below overall tasks under this project:

Pre-Construction

CR&R performed civil and architectural engineering, including design management services and preconstruction planning. CR&R finalized the layout, engineering, and design of the facility.

In the original design, CR&R utilized different suppliers and technology. After completing the final design and technology evaluation, Eisenmann was selected for the AD and Greenlane for the biogas upgrading system.

Construction of Facility

CR&R's team performed construction activities at the site in accordance with the design specifications to prepare for the arrival of the equipment to the site. CR&R completed the site construction and improvements, which included completing the electrical and mechanical work, installation of the sorting equipment, AD, gas clean up, boiler, flare and biofilter system for onsite water. CR&R has also worked with Southern California Gas to install the gas lines and equipment necessary to interconnect into the gas distribution system.

Commission and Operate Facility

The AD Facility was commissioned and began operations on October 12, 2016. The facility followed the prescribed ramp up procedure to methodically increase the amount of materials added to the AD. During the facility startup phase each of the four digesters received approximately 25 tons per day of feedstock.

Initially all of the biogases being produced went to the flare as gas collection system for delivery to the fleet was still under construction. The Greenlane system was completed in the first quarter at which point the biogas was further clean to RNG and began distribution to CR&R's CNG trucks. The final disposition of the gas is the delivery to the Southern California Gas pipeline which was completed in the second quarter of 2017.

It is important to note that the acclimation of the biology to the green waste feedstock is part of the standard startup of an AD facility and while the production rates (in Table 1) below during the first six months were as anticipated they are not representative of throughputs when the system up to full production. This process will be completed in steps based on the analytical data received and the analysis of that data.

Table 1: Feedstock and RNG Production Rates During Startup

Month	Feedstock Processed	Biogas Produced	RNG Fueled to CNG Trucks
November 2016	1682 MT	118,421 m3	0 GGE
December 2016	1792 MT	148,129 m3	0 GGE
January 2017	870 MT	96,542 m3	0 GGE
February 2017	516 MT	48,732 m3	0 GGE
March 2017	1165 MT	89,490 m3	5,738 GGE
April 2017	1219 MT	104,563 m3	14,372 GGE

Source: CR&R Incorporated

The Supervisory, Control and Data Acquisition System is fully functional and operational. The entire facility is being operated via Supervisory, Control and Data Acquisition which allows for remote monitoring, 24 hours per day visibility and complete automation of the facility.

Phases I and II of the projects include direct economic impacts of over 100 much-needed jobs in one of the state’s most disadvantaged communities. These jobs include 75 part-time construction jobs and 28 full-time positions. Employees of the facility include a range of skill and education, and the project provides employment opportunities for maintenance personnel (with training onsite and not requiring a degree), chemists, electricians, welders, engineers, and others. The completed Phase I fueling facility is shown in Figure 3.

Implement BIO Distribution and Transportation Use

As both a producer and consumer of RNG, CR&R has established onsite fueling that allows CNG trucks to refuel onsite without the need for distribution. CR&R has also partnered with Southern California Gas to construct a 1.4-mile pipeline (Figure 4) to interconnect with the local distribution gasoline.

Figure 3: Completed Phase I Fueling Facility



Source: CR&R Incorporated

Figure 4: Gas line Being Installed in the Ground



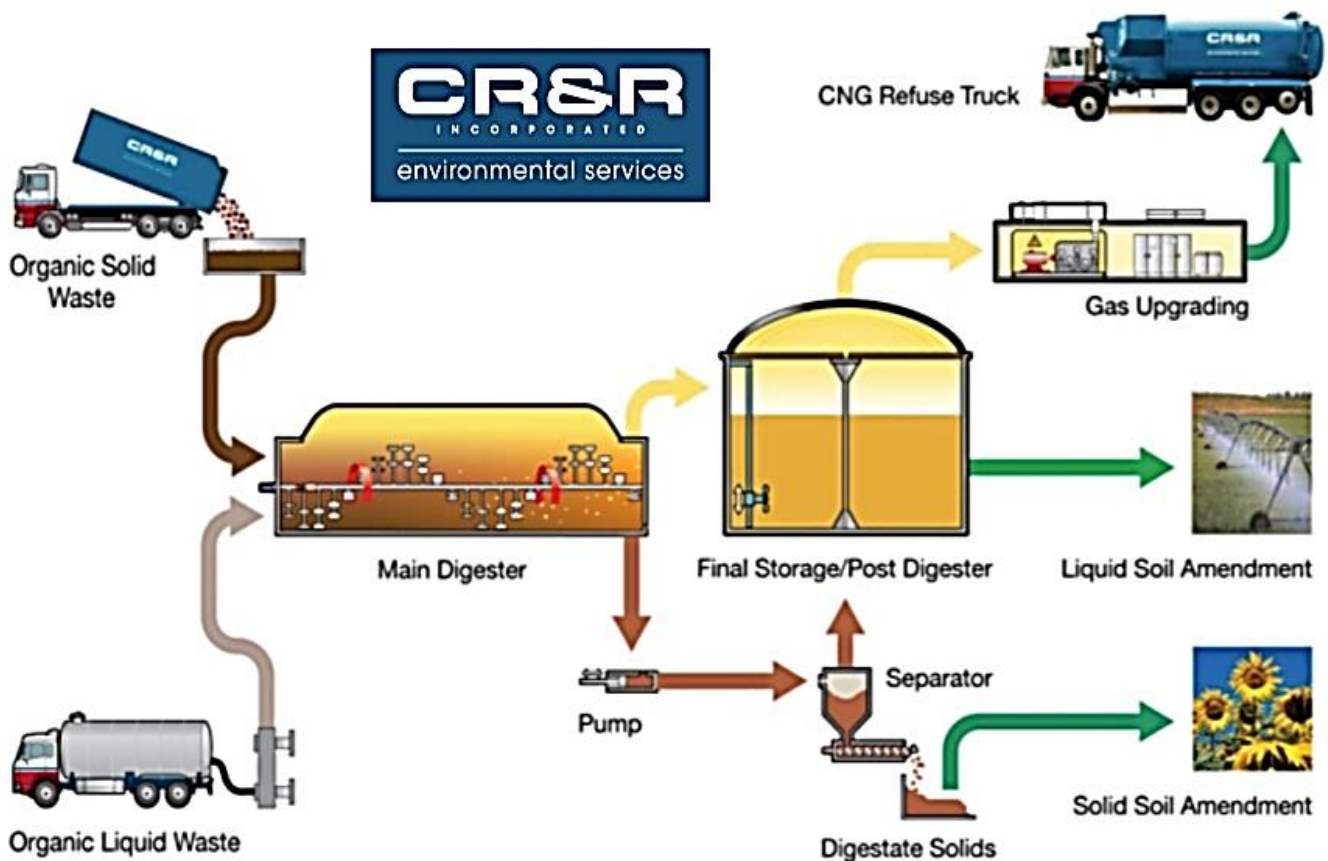
Source: CR&R Incorporated

CHAPTER 4: Results

Results

CR&R commenced construction in April of 2014 on the AD project in Perris, California. When it reaches its final build out - including four separate and distinct phases (shown in Figure 5 below) - the AD will be one of the largest of its kind in the United States. Phase I, which is now complete, is open and operational, using high solids AD technology to convert organic waste (green waste and food scraps) into renewable natural gas for CR&R's fleet of collection vehicles, as well as producing a soil amendment or fertilizer for use in the agricultural industry.

Figure 5: Overview of the Process Flow



Source: CR&R Incorporated

Phase I has a permit to process more than 83,600 tons of organic waste per year. The heart of the digester system is a slow-moving, horizontal agitator. The agitator maximizes the exposure between the anaerobic bacteria that eat and consume the feedstock, allowing for maximum biogas release. To optimize biogas yield, the system is fully automated and continuously monitors and optimizes the digestion environment and feed rate. Looking forward the CR&R BIO facility will eventually feature four parallel, primary digesters.

Following the pre-processing stage, each individual digester vessel is automatically fed through conveyors and dosing bins. Biogas produced in the digester is stored in a flexible, double membrane gas storage roof within the post digester. Additional capacity can be integrated into the existing infrastructure. The company feeds its digester with the material it collects curbside from its residential customers, which consists mostly of yard waste and food scraps.

After the organic waste has been converted to biogas, the biogas goes to an upgrading unit, which uses recycled water to make a biogas that is interchangeable with conventional natural gas for fueling CR&R's collection fleet. Solid fertilizer and a liquid soil fertilizer are also produced by the digester for use by golf courses, farmers, and others. It takes 21 days to digest the material into those different co-products.

This project will immediately inject its excess RNG into California's pipeline, establishing international precedent and leadership in renewable low carbon fuel production and use, as well as waste resource management sustainability. Not only is the project good for the health of the environment, it also lends huge benefits to the surrounding community and to the entire Southland. CR&R is leading the way in integrating the new Cummins Westport Near-Zero Emission natural gas engine into its solid waste collection and transfer fleet, helping build the market for this 0.02 grams per brake horsepower an hour NOx emission product. CR&R is working with the South Coast Air Quality Management District to demonstrate the remarkable environmental benefits of combining near-zero emission trucks with RNG fuel and currently has 2 – 8.9-liter engines operating in its fleet in cooperation with Cummins Westport.

CR&R's use of the RNG in refuse trucks promotes a virtuous circle. The trucks, in effect, collect their own fuel and prevent the criteria pollutant and GHG emissions that diesel fuel produces. The displacement will benefit public health and increase productivity in the surrounding population. The expected ancillary criteria pollutant emissions reductions are 85.2 tons of NOx, and 1.66 tons of particular matter annually. The resulting reduction in toxic air emissions will benefit public health and increase productivity in the surrounding population. Further, the air quality improvements gained from using RNG in lieu of diesel fuel in heavy-duty trucks, especially in low-income and disproportionately impacted communities, will reduce illness, asthma attacks, hospital visits, premature death, cancer, missed work, health care requirements, and other societal costs, thus creating even greater economic stimulus. California Air Resources Board estimates that the impact of implementing its Assembly Bill 32 (Nunez, Chapter 388, Statutes of 2006) Scoping Plan will result in emission reductions that will reduce 400 premature deaths, 11,000 incidences of asthma, and 67,000 work loss days per year.

The project site is already part of the existing MSW facility; therefore, the land use impact could not be more ideal. In addition, the project will increase the recycling rate while decreasing the potential for water and air pollution. Regional water quality is expected to improve as a result of this project, both in terms of more cost-effective municipal wastewater handling as well as reducing risk to the local ground water. Because the harmful constituents of wastewater include organic materials and bacteria that otherwise create pollution conditions when they are highly concentrated in ecosystems that are not equipped to handle them at high levels, they must be treated to a minimum threshold of safety at which point the water is disposed into waterways and oceans. This project retains most of the organic content of

wastewater to turn it into RNG, and the harmful bacteria are also digested by the system. In addition, CR&R's marketing plan identifies that residual soil products will be sold back to its contracted municipalities. Perris would benefit from increased access to AD derived soil products, which would help improve water quality. When used correctly, compost can be effective in protecting slopes from erosion, minimizing sedimentation, protecting water quality, establishing vegetation, increasing infiltration, and reducing runoff volume. Overall, the total pollutant mass is lower in storm water runoff from compost-treated sites. When implemented as a filtering mechanism, compost can also reduce concentrations and loads of many pollutants in runoff.

Problems

This project is the first in California using MSW feedstock to produce BIO for transportation use, distributed via natural gas pipeline. As a first of its kind in California and for North America, it directly addresses challenges to development and widespread use of MSW to BIO.

Initially, there were technological concerns regarding how to efficiently process MSW to allow for the removal of recyclables and non-digestible content and create a product suitable for efficient digestion in an anaerobic digester (see Figure 5). CR&R modified the initial approach to simplify the design, technology, and feed stocks. Since most of the feedstock will be green waste, the digester was specifically designed to handle a very high level of solids, sometimes exceeding 50 percent. Eisenmann has over 90 installations worldwide and local engineering expertise in Chicago, even though they are based in Germany. After selecting Eisenmann, CR&R followed up with feedstock samples and obtained the proper lab results to verify the selection.

The biogas upgrading system was switched from a solvent-based technology to Greenlane's water-based technology. Like Eisenmann, Greenlane has nearly 100 installations worldwide, and approximately 10 throughout the United States and Canada. The utilization of water as the upgrading medium greatly reduced the system complexity and future maintenance.

Both of these changes increased the overall capital budget but lowered the long-term operating costs. Neither of these changes were dictated or encouraged by the various permitting agencies or the environmental review process, they were simply based on the overall economic analysis and numerous years of experience in the solid waste management industry.

The company faced regulatory and permitting issues as well. This project was the first of its kind to be permitted, and it required the company to educate the local government, in this case the City of Perris, about the project and its application within the City's general plan. The local issues were addressed through multiple meetings and disseminating education through various websites on these types of facilities and how they operate. Once the local Planning Department was comfortable with the facility, the process for permitting was similar to a large manufacturing plant and/or a sewer treatment plant.

The permitting challenges continued with the requirement to obtain six South Coast Air Quality Management District permits which had never been written in Air Quality Management District's history. CR&R was required to obtain permits for the following components of the project:

- AD System — Eisenmann
- Biogas Handling and Treatment System — Greenlane
- Air Pollution Control System — Bio-filter
- Boiler
- Emergency Generator
- Flare

In addition to permitting challenges, CR&R elected to utilize a new forming and construction technique for the main and post digesters. With traditional concrete tilt up style construction, the walls are formed on the ground and the concrete is poured. Once the wall is cured and dry, the wall is tilted into place. CR&R elected to use a form system from Canada call Octo form, which is a web-designed system that interlocks, and the polyvinyl chloride forms become the finished walls once the concrete is poured. One of the main differences with these forming systems is that the forms are placed in an upright position and inter-connected by polyvinyl chloride mesh. Once the entire wall is constructed out of the polyvinyl chloride and inter-mesh, the concrete is poured from the top in one continuous pour until the wall is completely full. This new system requires no wooden forms or kickers to support the wall, and the concrete used in this application is call self-consolidating concrete. There are a couple of additional benefits to this system: 1) you can insulate the walls and 2) it provides a polyvinyl chloride protection to the inside and outside of the wall. This new forming system added approximately three months to the construction schedule due to the crew's lack of experience with this system; however, the finish product reduces the amount of heat lost compared to a traditional tilt up system.

Phase I also faced market and institutional barriers. The challenge was determining how to utilize the extensive natural gas pipeline system to distribute BIO and broker agreements to purchase the fuel for transportation use. Pipeline injection of digester-produced BIO has been difficult and costly, but it is essential for economical distribution as a transportation fuel and for the growth of BIO in transportation use. This project is the first partnership with a major fuel company as broker and distributor of BIO by Natural Gas Pipeline for transportation use. The industry has been closely watching the project and it is truly demonstrating a model for how BIO can be produced, injected, transported, and dispensed as a transportation fuel using the massive existing natural gas infrastructure.

Benefits

CR&R remains committed to reducing emissions and creating cleaner solutions, such as the construction of anaerobic digesters and alternative fuel natural gas fueling stations for use by its fleet. The Phase I digester project, that can be found in Figure 6 and Figure 7, directly meets the goals of the Assembly Bill 118 by demonstrating a measurable and significant transition from the use of petroleum to the use of a low-emission alternative fuel. Through a public-private investment between the CEC and CR&R, this project is curbing GHGs, reducing petroleum use, and improving air quality in California.

Ninety percent of NOx reductions will be achieved simply by using near-zero emission Cummins Westport 0.02 grams per brake horsepower per hour NOx engines, and the 32 CR&R trucks with these engines will achieve an additional 70 percent GHG reduction due to the

closed crank case design. Over 250 collection trucks will be fueled annually by the renewable natural gas produced by CR&R's permitted anaerobic digester facility once it becomes fully operational, replacing over 2.7 million diesel gallon equivalent of fuel.

Figure 6: CNG Fuel Charging Station



Source: CR&R Incorporated

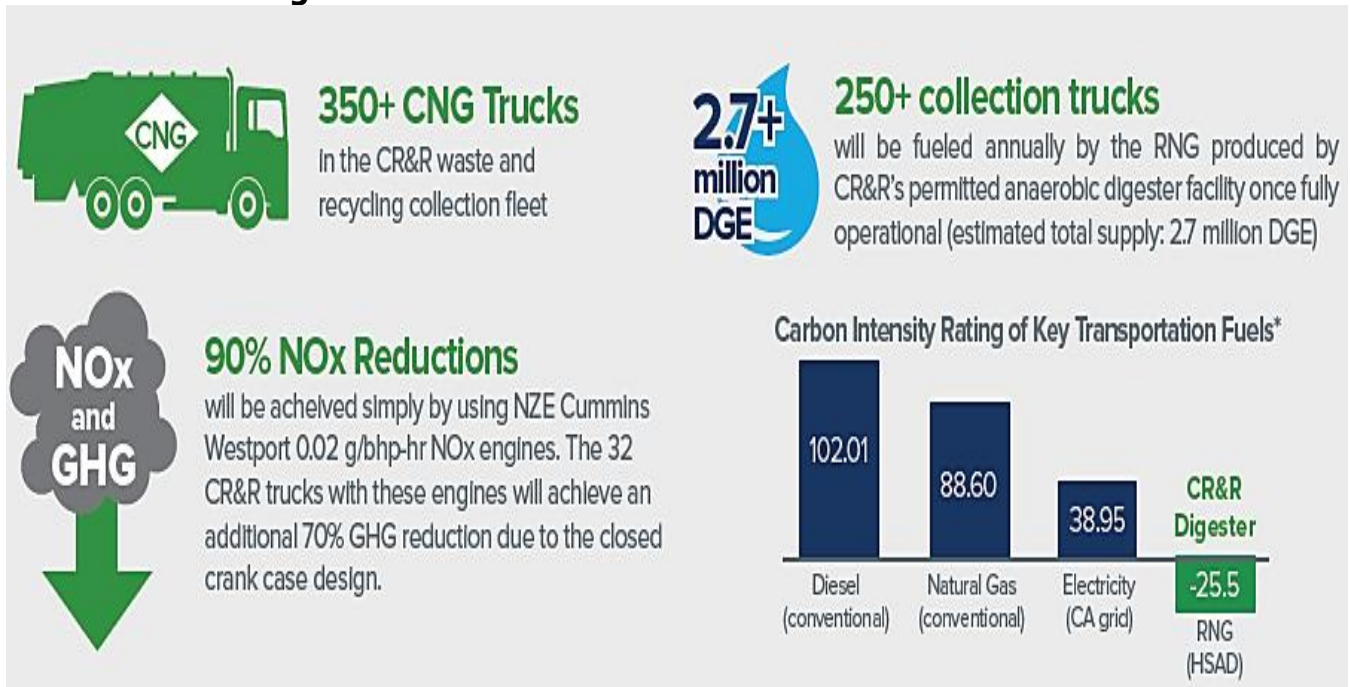
Figure 7: Natural Gas-Powered Charging Station



Source: CR&R Incorporated

Renewable natural gas manufactured by CR&R’s digester will also have the lowest carbon intensity of any fuel currently in use in California. For example, while conventional diesel has a carbon intensity of 102.01, conventional natural gas has a carbon intensity of 88.60 and California grid electricity a carbon intensity of 38.95, CR&R’s renewable natural gas will have a carbon intensity of -25.5 (see Figure 8). This means that the production and use of this renewable natural gas will effectively remove carbon from the atmosphere.

Figure 8: Emissions Benefits of RNG in CR&R’s Fleet



Source: CR&R Incorporated

CHAPTER 5:

Conclusions

Led by a prepared and seasoned team with a vast understanding of the technology, this project greatly assists the CEC to displace petroleum with clean-burning natural gas and reduce GHG emissions from CR&R's existing fleet. The successful construction of this AD provides increased fueling capacity for natural gas vehicles operated by CR&R and other fleets. Renewable natural gas is a clean, safe fuel that is domestically produced. Natural gas contains less carbon than any other fossil fuel and thus produces lower carbon dioxide and GHG emissions per year. Furthermore, in the lifecycle of manufacturing and burning renewable natural gas from CR&R's new digester has negative carbon intensity, effectively removing carbon from the air.

In addition to displacing more heavily emitting fossil fuels, the Phase 1 of CR&R's AD removes roughly 250 tons of organic waste per day from nearby communities, preventing it from going to landfills. This project results in a direct reduction in diesel use by replacing it with RNG, thereby deploying all of the benefits of this fuel to Perris and the surrounding communities. As one of the preeminent waste haulers in California, CR&R is quite familiar with the many benefits of natural gas and is dedicated to doing business in the most sustainable way possible.

Commercialization

Phase 1 of CR&R's AD provides the much-needed infrastructure to make alternative fuels such as RNG a readily available and commercially preferred fueling option. CR&R's digester has inspired national and international interest in the viability of waste and GHG reductions through similar industrial sized projects. Its successful completion positions it as an industry leader and example of how to properly plan and execute other digester facilities which can be seen in Figure 9 on the next page.

In addition to GHG targets, the state of California faces recycling mandates which aim to remove a large portion of the roughly 30 million tons of organic waste in state landfills each year. Recycling infrastructure such as Phase 1 of CR&R's AD helps the state comply with just such regulations. CR&R's AD is now a mechanism with demonstrated success for reducing and utilizing waste streams on a large scale, while also improving air quality.

Finally, Phase 1 alone provides evidence that state-of-the-art digester projects can add permanent, skilled jobs to local communities. There were 100 jobs created during construction, and the addition of 25 more long term positions is anticipated before project completion. Future phases will build upon the success of Phase 1, adding more economical and environmental benefits.

Figure 9: CR&R's Phase I Anaerobic Digester



Source: CR&R Incorporated.

GLOSSARY

ANAEROBIC DIGESTER (AD)—is a sequence of processes by which microorganisms break down biodegradable material in the absence of oxygen. The process is used for industrial or domestic purposes to manage waste or to produce fuels. Much of the fermentation used industrially to produce food and drink products, as well as home fermentation, uses anaerobic digestion.²

BIOMETHANE (BIO)— also known as the green gas, is a well-known and well-proven source of clean energy, and is witnessing increasing demand worldwide, especially in European countries, as it is one of the most cost-effective and eco-friendly replacement for natural gas and diesel.³

CALIFORNIA ENERGY COMMISSION (CEC)—The state agency established by the Warren-Alquist State Energy Resources Conservation and Development Act in 1974 (Public Resources Code, Sections 25000 et seq.) responsible for energy policy. The CEC's five major areas of responsibilities are:

1. Forecasting future statewide energy needs.
2. Licensing power plants sufficient to meet those needs.
3. Promoting energy conservation and efficiency measures
4. Developing renewable and alternative energy resources, including providing assistance to develop clean transportation fuels.
5. Planning for and directing state response to energy emergencies.

Funding for the CEC's activities comes from the Energy Resources Program Account, Federal Petroleum Violation Escrow Account, and other sources.

COMPRESSED NATURAL GAS (CNG)—Natural gas that has been compressed under high pressure, typically between 2,000 and 3,600 pounds per square inch, held in a container. The gas expands when released for use as a fuel.

CR&R INCORPORATED (CR&R)—is one of Southern California's most innovative and successful waste and recycling collection companies, serving more than 3 million people and over 25,000 businesses throughout Orange, Los Angeles, San Bernardino, Imperial, and Riverside counties.⁴

DIESEL GALLON EQUIVALENT (DGE)—The amount of alternative fuel it takes to equal the energy content of one liquid gallon of diesel gasoline.

GREENHOUSE GAS (GHG)—Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include water vapor, carbon dioxide (CO₂), methane (CH₄), nitrous oxide

² [Anaerobic Digester Definition](https://en.wikipedia.org/wiki/Anaerobic_digestion) https://en.wikipedia.org/wiki/Anaerobic_digestion

³ [Biomethane](https://www.bioenergyconsult.com/biomethane-the-green-gas/) <https://www.bioenergyconsult.com/biomethane-the-green-gas/>

⁴ [CR&R Incorporated](http://crrwasteservices.com/) <http://crrwasteservices.com/>

(NO_x), halogenated fluorocarbons (HCFCs), ozone (O₃), per fluorinated carbons (PFCs), and hydrofluorocarbons (HFCs).

MUNICIPAL SOLID WASTE (MSW)—Locally collected garbage that can be processed and burned to produce energy.

NITROGEN OXIDES (OXIDES OF NITROGEN, NO_x)—A general term pertaining to compounds of nitric oxide (NO), nitrogen dioxide (NO₂), and other oxides of nitrogen. Nitrogen oxides are typically created during combustion processes and are major contributors to smog formation and acid deposition. NO₂ is a criteria air pollutant and may result in numerous adverse health effects.

RENEWABLE NATURAL GAS (RNG)—Or biomethane, is a pipeline-quality gas that is fully interchangeable with conventional gas and thus can be used in natural gas vehicles. RNG is essentially biogas (the gaseous product of the decomposition of organic matter) that has been processed to purity standards. Like conventional natural gas, RNG can be used as a transportation fuel in the form of compressed natural gas (CNG) or liquefied natural gas (LNG).