Tri-gen: A Path to Sustainability at Toyota Logistics Services Long Beach

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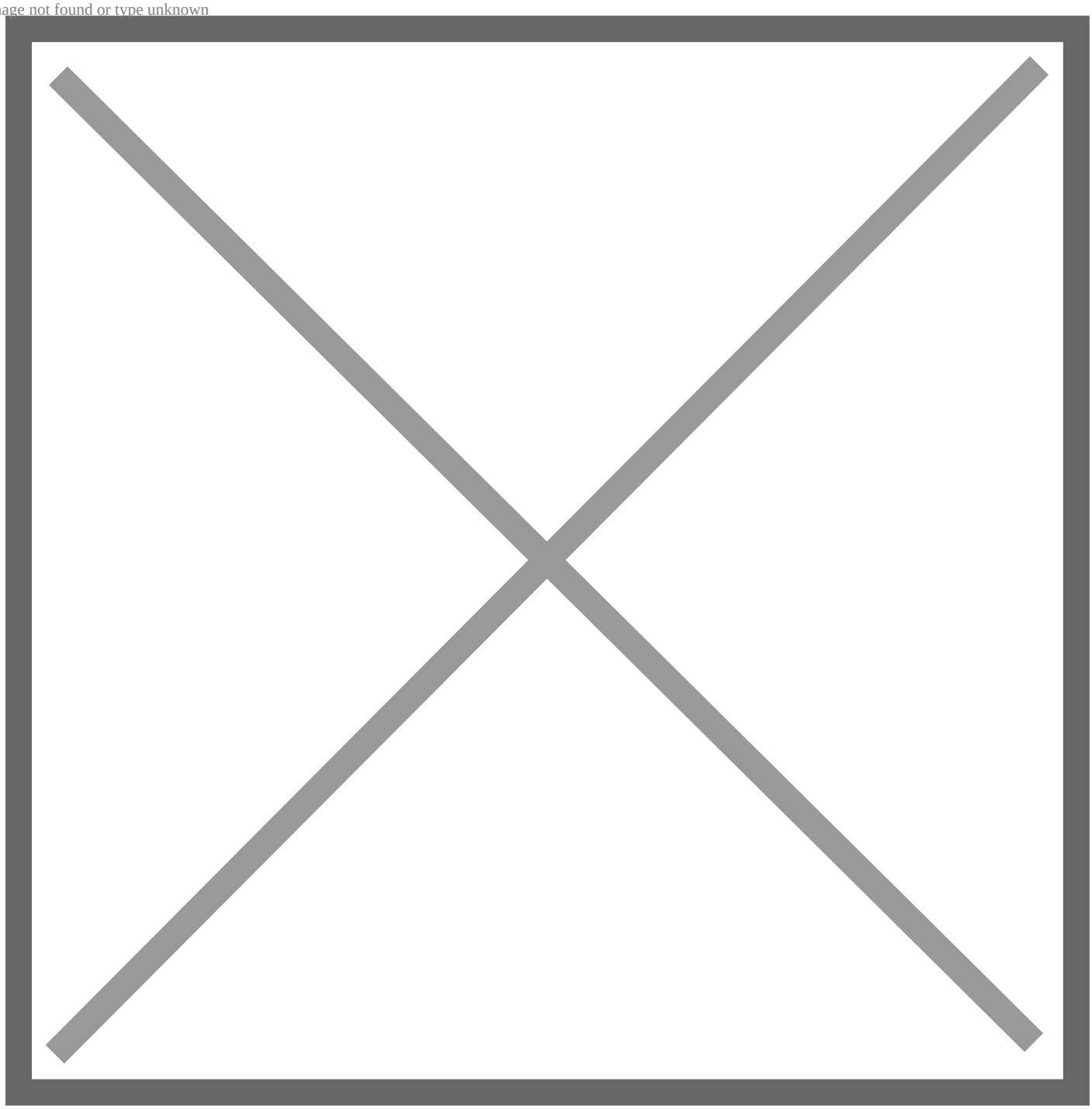
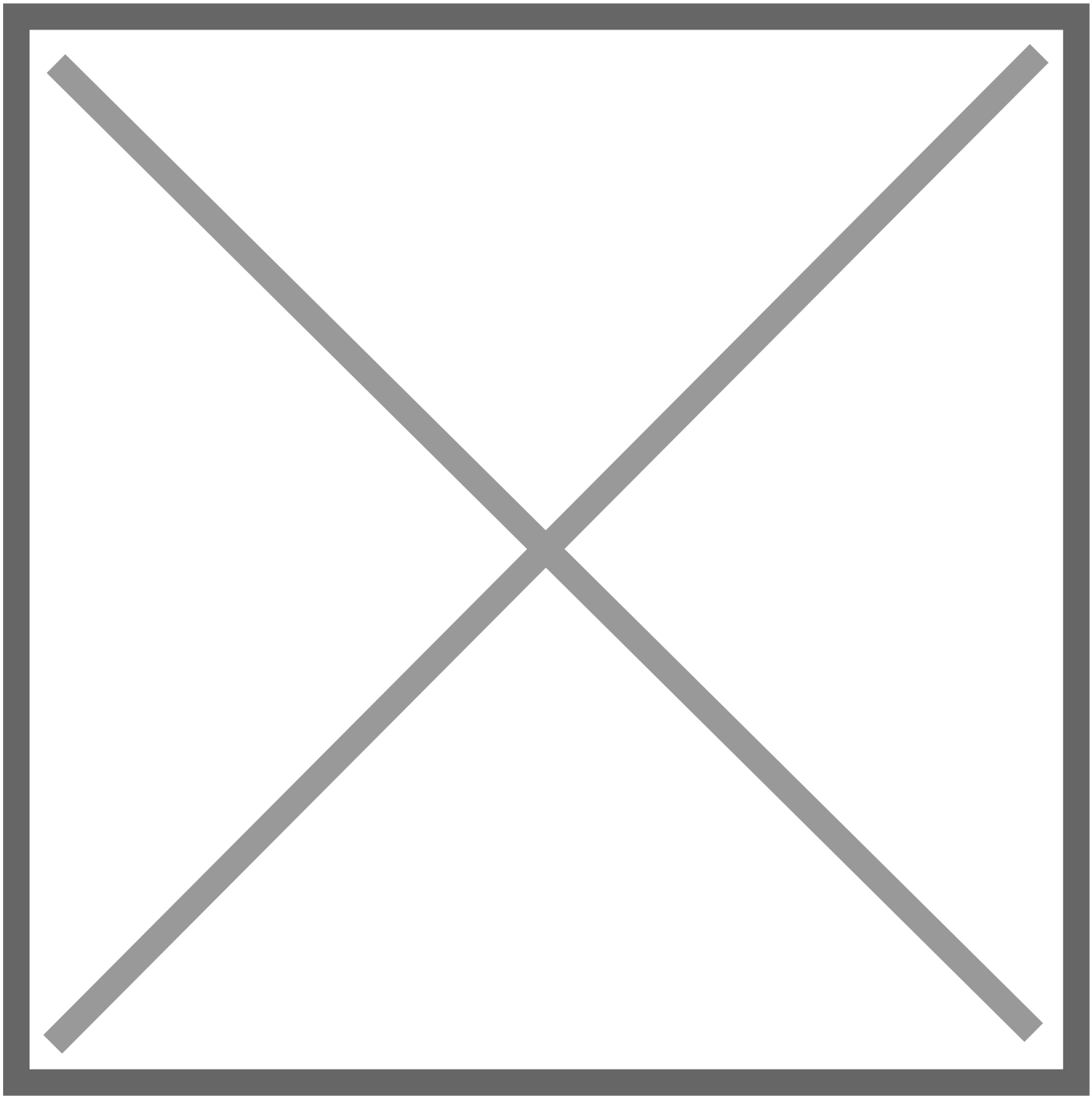


Toyota and FuelCell Energy showcase a model for creatively reducing carbon emissions and conserving water at America's second largest port facility

When Toyota was looking to update its operations at the Port of Long Beach in California more than a decade ago, it didn't just want to construct a new building. It wanted to rethink the facility's impact on the planet.

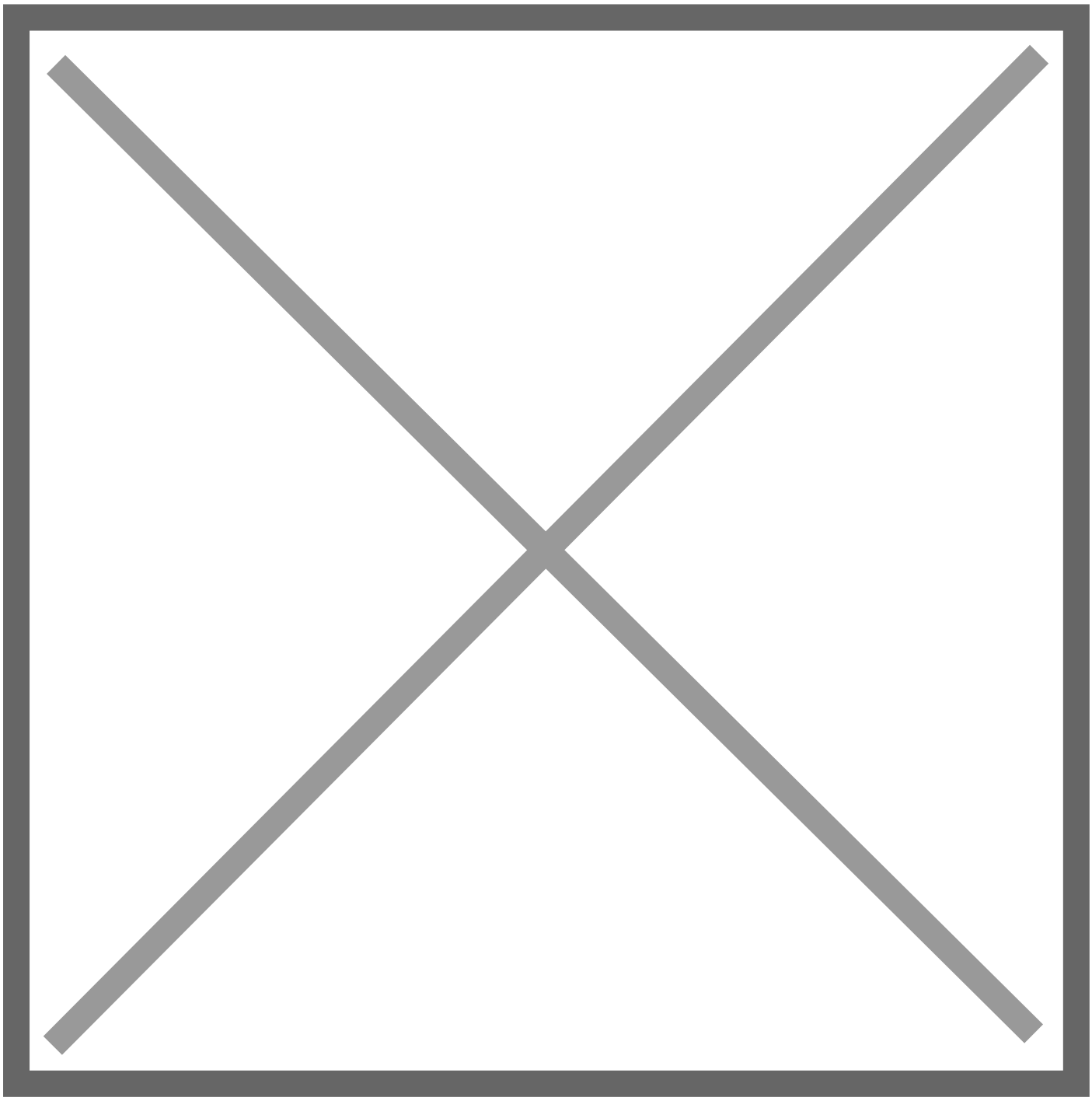
Long Beach is the second busiest port in the U.S., second only to neighbor Port of Los Angeles. Toyota Logistic Services (TLS) Long Beach is Toyota's largest vehicle processing facility in North America, responsible for moving more than 200,000 Toyota and Lexus vehicles off ocean ships at the port each year. Aside from off-loading vehicles coming in, TLS is responsible for adding accessories ordered by customers, ranging from door guards and floor mats to TRD wheels or upgraded suspension kits. Then, the cars, trucks and SUVs are put on trains or trucks en route to dealerships all over the western part of the U.S., sometimes even being shipped as far as Texas.



As Toyota Logistics Services (TLS) looked to update it facilities at the Port of Long Beach, Tri-gen (center front) offered a unique and sustainable solution for TLS's needs. Most of the vehicles visible in this birds-eye-view photograph were offloaded from ships to be prepped before heading to dealerships across the western U.S.

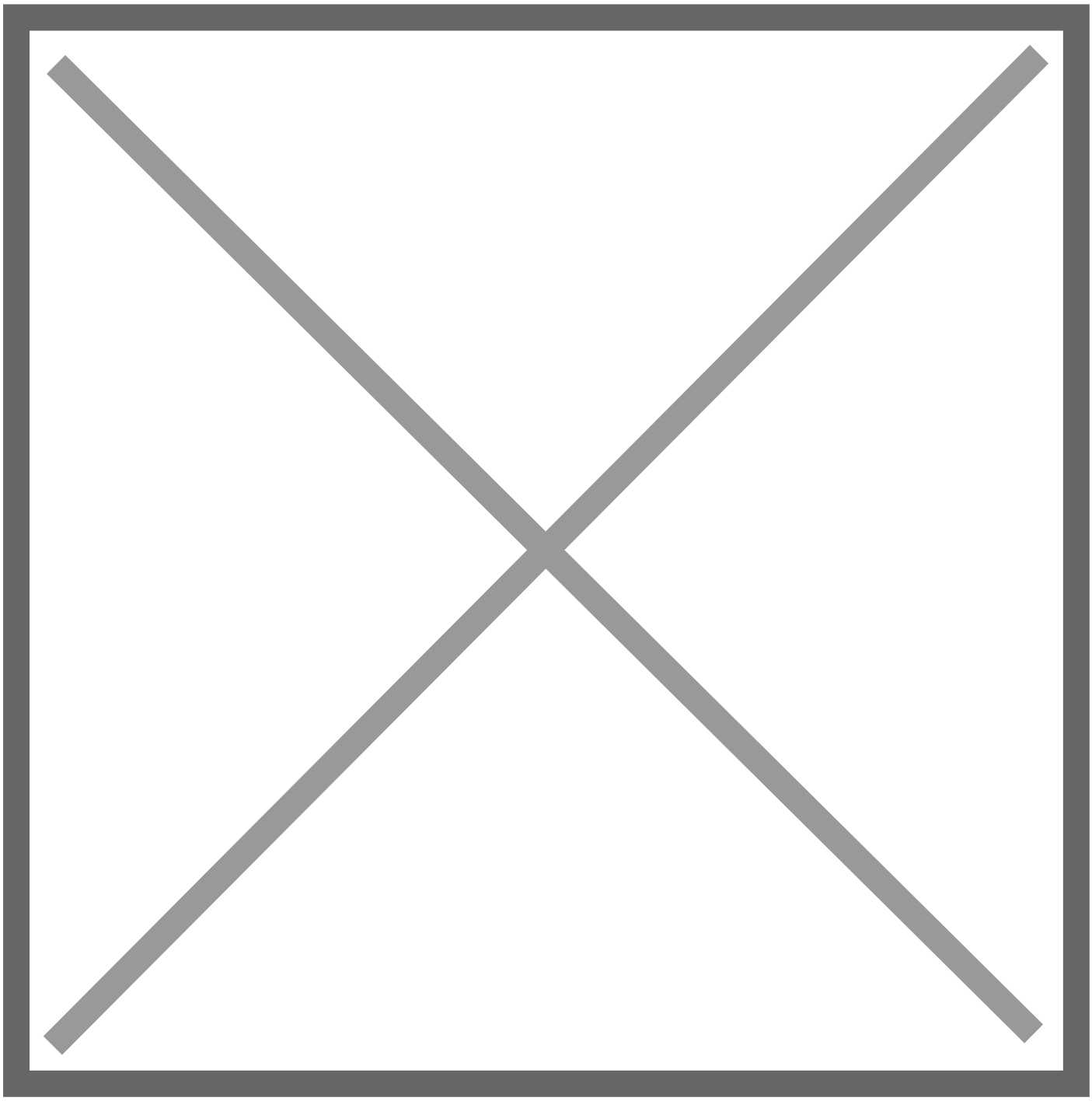
Following many decades of operation and the processing of millions of vehicles, TLS Long Beach had grown to fill several different buildings in different parts of the port campus, spanning over 117 acres and housing 250 team members. Consolidating operations would improve efficiency, but it was also an opportunity to reduce

Toyota’s carbon footprint. This is the kind of exercise that’s going on throughout Toyota’s global operations, all part of the plan to get to carbon neutrality by 2050 to support Toyota’s Environmental Challenge 2050. In the case of TLS Long Beach, the lynchpin to a different kind of future was a unique kind of hydrogen-electric, fuel cell facility called Tri-gen.



Mark Yamauchi, Environmental and Sustainability Manager for Toyota, helped spearhead the Tri-gen project for Toyota since its initial planning in 2017.

“We’re always keeping our eyes open for technologies or innovations that may benefit us — and those that could be used somewhere else,” said Mark Yamauchi, sustainability strategy manager at Toyota Motor North America. “At the port, we needed hydrogen for fuel-cell vehicles. We found a technology that literally creates hydrogen out of garbage.”

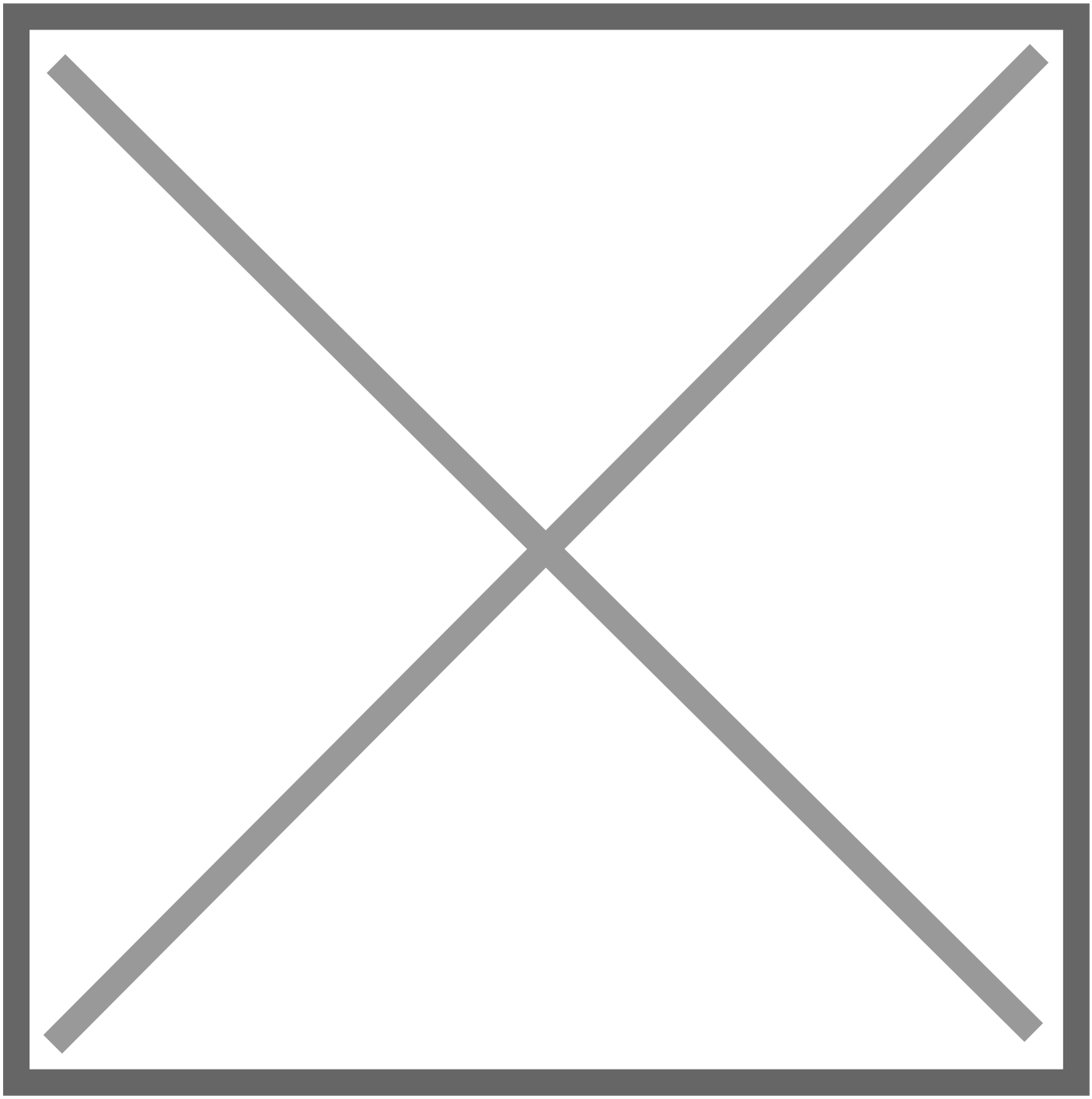


Toyota is no stranger to fuel cell technology, but it decided to collaborate with FuelCell Energy since they specialize in the large-scale molten carbonate fuel cell system shown here. As the heart of the Tri-gen system, it

takes directed biogas to create renewable energies.

What is Tri-gen and what does it have to do with Toyota?
Tri-gen is short for "triple generation," as Tri-gen uses directed biogas to produce three products: renewable electricity, renewable hydrogen, and usable water. The facility was developed, built and is currently operated at TLS Long Beach by Connecticut-based FuelCell Energy as a large-scale molten carbonate fuel cell system that runs on hydrogen that is created from the incoming biogas. The system was commissioned by Toyota, with construction announced in 2017, as part of the TLS Long Beach campus updates. The system's construction was completed in 2023, with a grand opening celebration held on May 2, 2024.

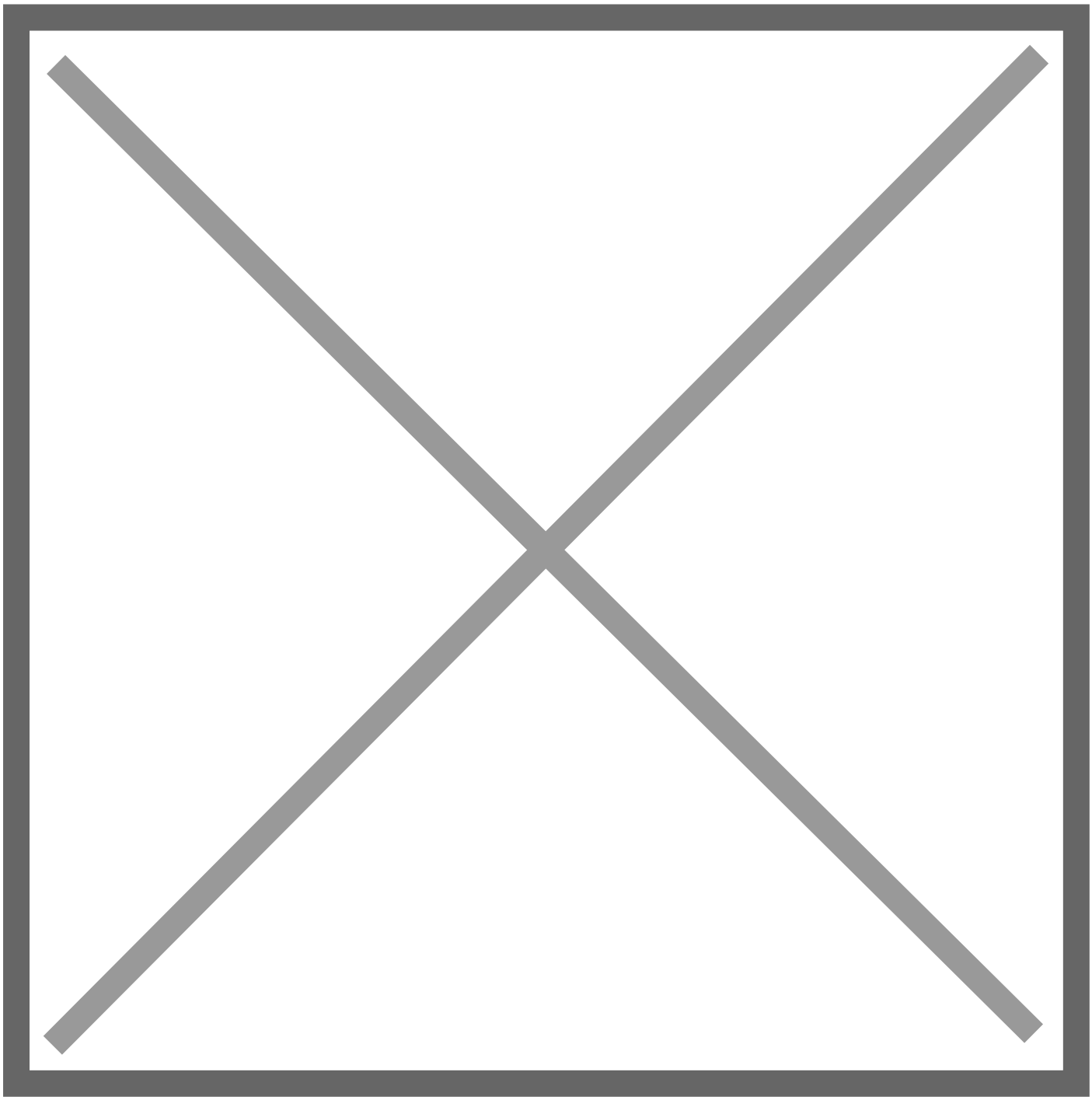
Getting to completion, however, wasn't a straight or necessarily smooth path. The project presented its own unique set of challenges. For example, Toyota had to get permits to build the small power plant on the edge of the land it leased from the Port of Long Beach, an area is had occupied for more than 40 years. Two separate hydrogen filling stations had to be sited and permitted. The planned pipeline for the biogas – sourced from food waste and municipal waste water at Anaergia's subsidiary, SoCal Biomethane, LLC Plant based in Victorville, Calif., about 100 miles away – had to be built. Then, there were years of construction. The challenges had to be tackled one at a time. As an example, for the pipeline, the company had to negotiate with the local utility Southern California Edison, which was awarded approval from the California Public Utilities Commission to proceed with the project.



Toyota Logistics Services Long Beach receives about 200,000 Toyota and Lexus vehicles annually. It's Toyota's largest vehicle port processing facility in the United States.

Despite the hurdles, the project moved forward. Piece by piece, the site came together, with a lot of progress once the quarantines from COVID-19 ended. By the fall of 2023, construction on Tri-gen was completed. After final permitting and minor construction to finalize its permanent layout, the facility began producing renewable electricity from the waste gas piped in from SoCal Biomethane. The electricity is used by TLS Long Beach, with

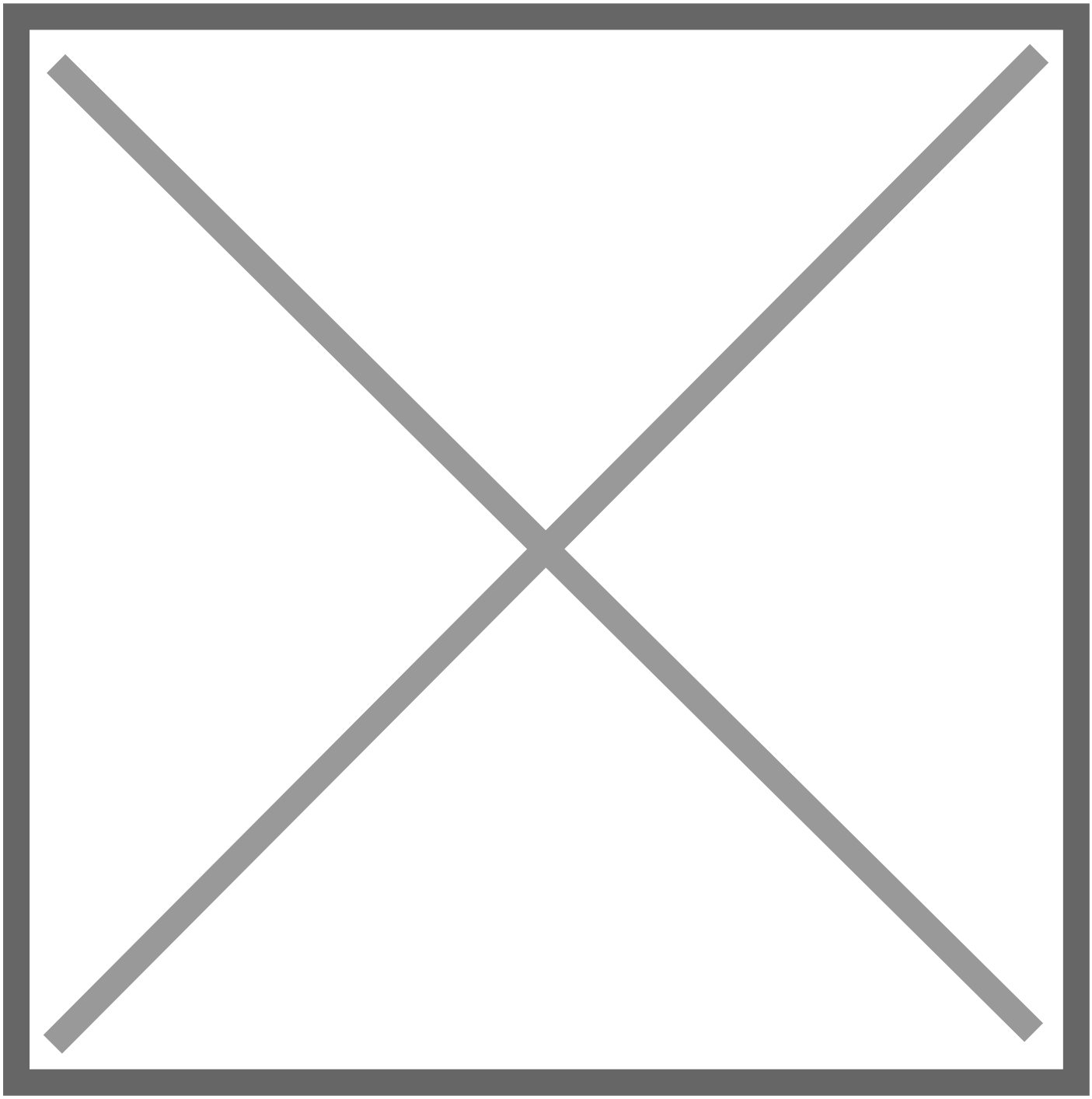
any excess being supplied back to the local grid. The system is also creating enough hydrogen to fill the tank of every Toyota Mirai fuel-cell vehicle arriving at the port via an on-site light-duty station. Tri-gen also generates enough renewable hydrogen for the nearby heavy-duty hydrogen station that supports heavy-duty fuel-cell trucks operating in and around the port. Finally, water, the natural byproduct created from the electrochemical reaction within Tri-gen’s fuel cells, is being used for the car wash at TLS operations.



Jeffrey White oversees the daily operations at TLS Long Beach and helped assess the best way to move TLS toward sustainable operations with the help of Tri-gen.

“It took a while to get to this point, but now it’s just part of our normal operation,” said Jeffrey White, senior manager at Toyota Logistics Services Long Beach. “We’re getting electricity, hydrogen and water. It’s seamless.”

It’s cool technology, but it’s more than that. Tri-gen is an example of how the efforts to reduce emissions in Toyota’s operations require unique, site-specific solutions. In the same way that Toyota is offering multiple powertrains in its vehicle lineup to help reduce or eliminate carbon dioxide emissions from the tailpipes of its vehicles for automotive consumers, reducing carbon dioxide emissions in business operations is going to require an all-of-the-above approach.



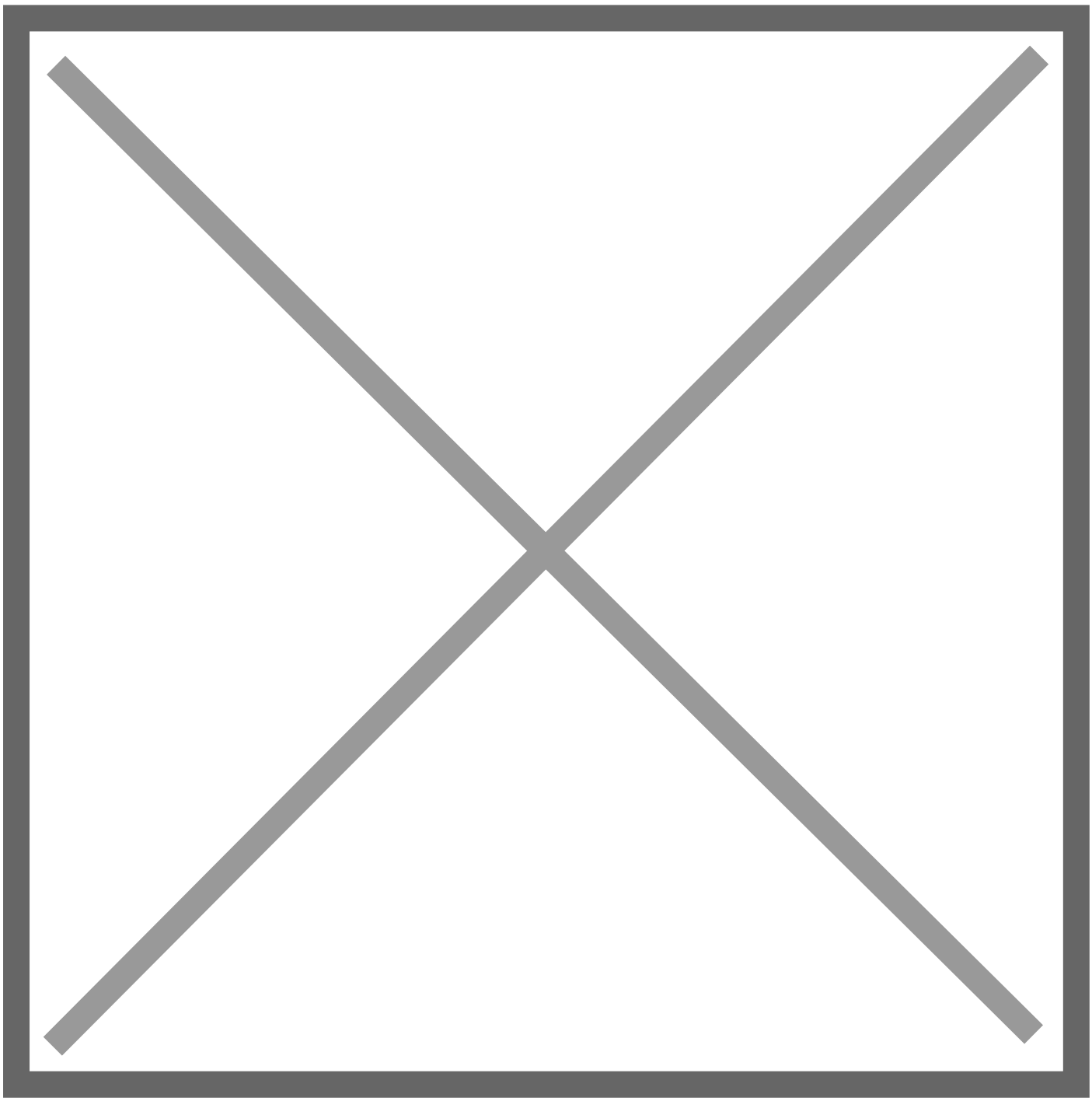
Supplying hydrogen for fuel cell electric vehicles operating in and around the port is one reason Tri-gen made sense for TLS Long Beach. This Class 8 heavy-duty Kenworth T680 truck uses a Toyota fuel cell powertrain kit, and it can now fill up with renewable hydrogen at a hydrogen station located adjacent to Tri-gen.

Hydrogen for Zero-Emissions Vehicles

Toyota has been importing its hydrogen-powered Mirai through the port since 2015. The coming of the Mirai to the U.S. brought with it a sense of innovation that was inspiring. So the engineers at Toyota started to think

about how the technology might be applied in different products or services. Some engineers took the Mirai's fuel cell stack out and started to use it in other development opportunities, including the development and operation of hydrogen-powered heavy-duty drayage trucks and specialized vehicles for port operations.

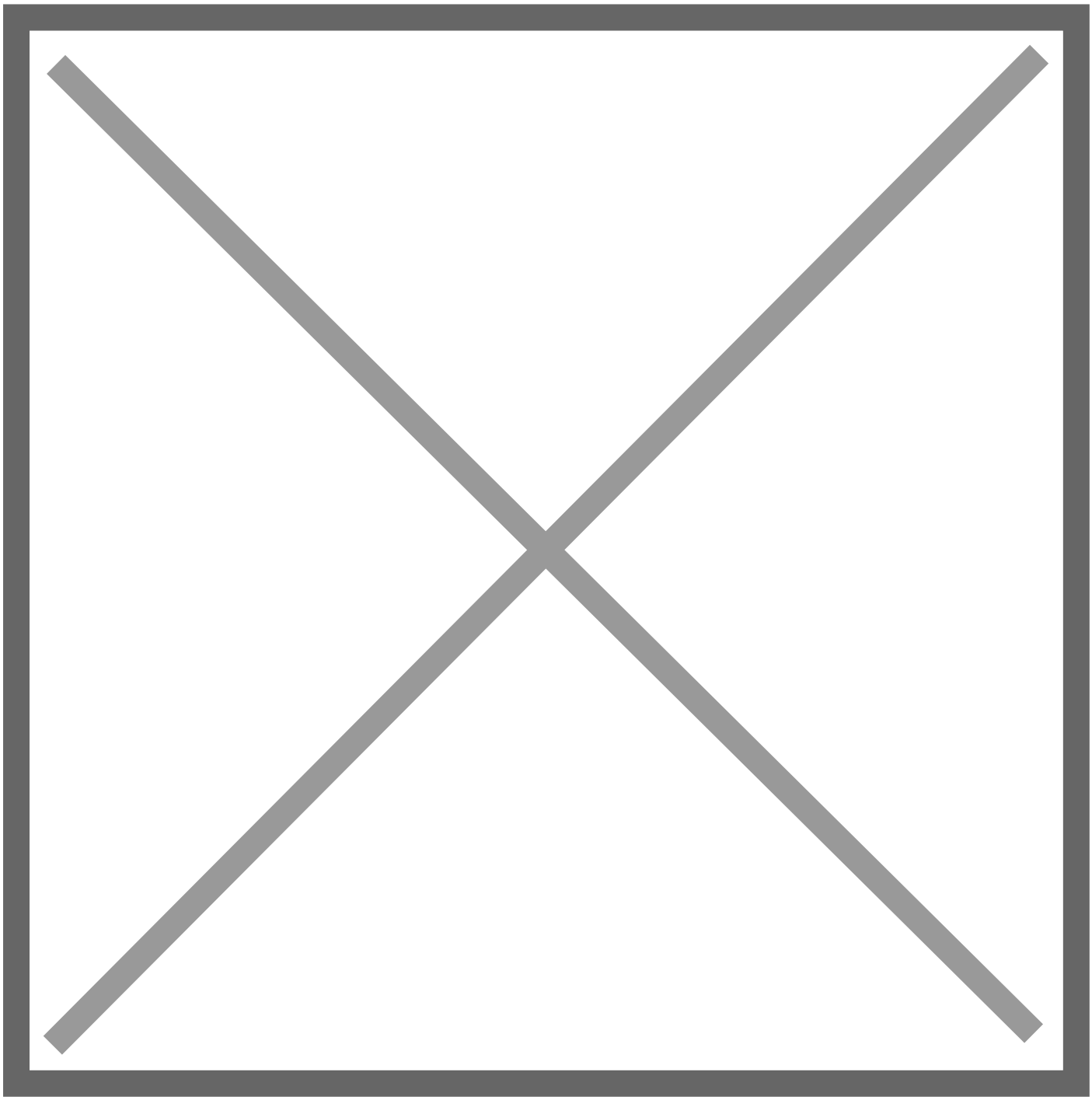
One example: Project Portal. The project used two Mirai fuel cell stacks in a scaled configuration to see if they could power a heavy-duty truck. That led to some additional prototype trucks being built and eventually a bigger project. One of Toyota's most notable port operations centered on a collaboration with truck maker Kenworth for the ZANZEFF "Shore to Store" project to prove that fuel-cell powered Class 8 trucks could support drayage operations. The success of that project led to a further collaboration and opportunity for Toyota to supply PACCAR, under its Kenworth and Peterbilt brands, with fuel cell powertrain kits for its heavy-duty big rigs. The number of hydrogen-powered trucks is only expected to grow as the state of California, and even the port, look to reduce carbon emissions in this segment through efforts like the Clean Truck Act and similar programs.



Whether it’s Class 8 trucks or other heavy-duty port equipment, Tri-gen generates renewable hydrogen capable of supporting zero-emission fuel-cell vehicles operating in and around the Port of Long Beach.

Before the installation of the on-site hydrogen fuel stations, including the heavy-duty station that Shell built to support ZANZEFF and the light duty station at TLS land to fill incoming Mirai, White noted that the hydrogen fuel had to be trucked in. Now hydrogen is produced on site through Tri-gen to a scale that can support the two nearby stations.

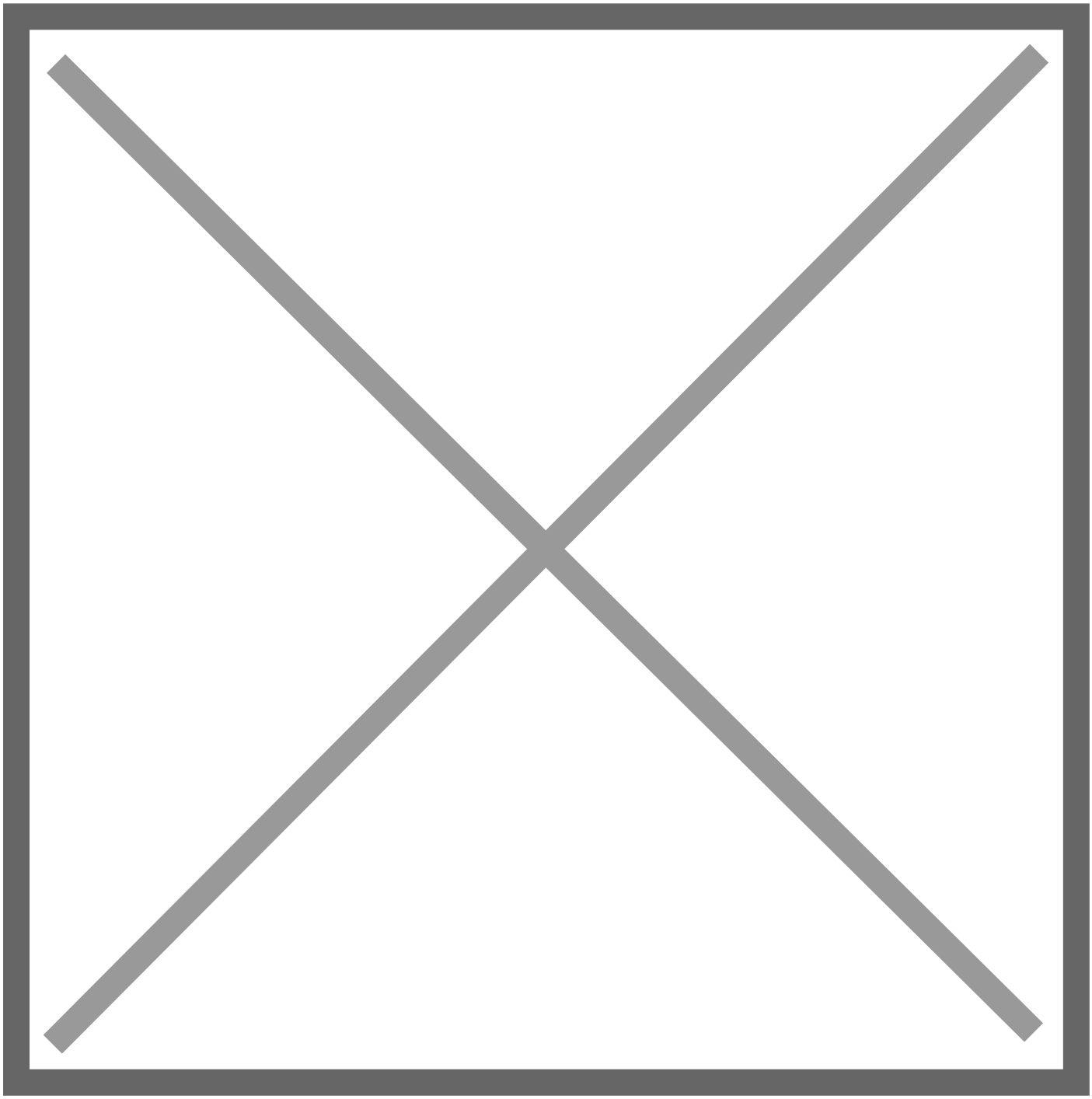
“Hydrogen supply issues have been a challenge for the last several years, so being able to produce it on site provides some consistency and reliability when we’re processing the Mirai,” White said. “We also have hydrogen for the trucks. It has been a game changer.”



A Toyota Mirai is filled up with renewable hydrogen produced at Tri-Gen before being delivered to dealerships.

When it comes to hydrogen, Tri-gen serves as an example of a decentralized generating solution. Because the feedstock for the unit is biogas – methane that occurs as waste breaks down – the hydrogen produced is "renewable hydrogen." Vehicles using renewable hydrogen to produce electricity via fuel cells have a smaller environmental footprint – similar to battery electric vehicles using renewable electricity rather than power generated from a coal-burning plant.

Methane, the biogas produced at the landfill 100 miles from Long Beach, is one of the world's most potent greenhouse gases. It's not talked about as much as carbon, but in climate-change discussions, it's much worse for the atmosphere and methane reduction is imperative. Over 20 years, methane will trap 80 times as much heat in the atmosphere as carbon dioxide. And that's another thing Tri-gen can help with – taking a gas that would otherwise supercharge the warming of the planet and instead becoming a source to create hydrogen, electricity and water.



The renewable electricity generated at Tri-gen is more than enough to power all of Toyota Logistics Services needs at the Port of Long Beach. The excess energy is sent to the local power utility to support the grid.

Renewable, Off-the-Grid Electricity and Water for a Drought-Prone Region

Generating hydrogen may get a lot of buzz with Tri-gen, but the importance of its renewable electricity generation cannot be overlooked. The facility can produce up to 2.3 megawatts of power per day. That's more than what's needed to power all of TLS's facilities at the port, and it helps make TLS Long Beach Toyota's first

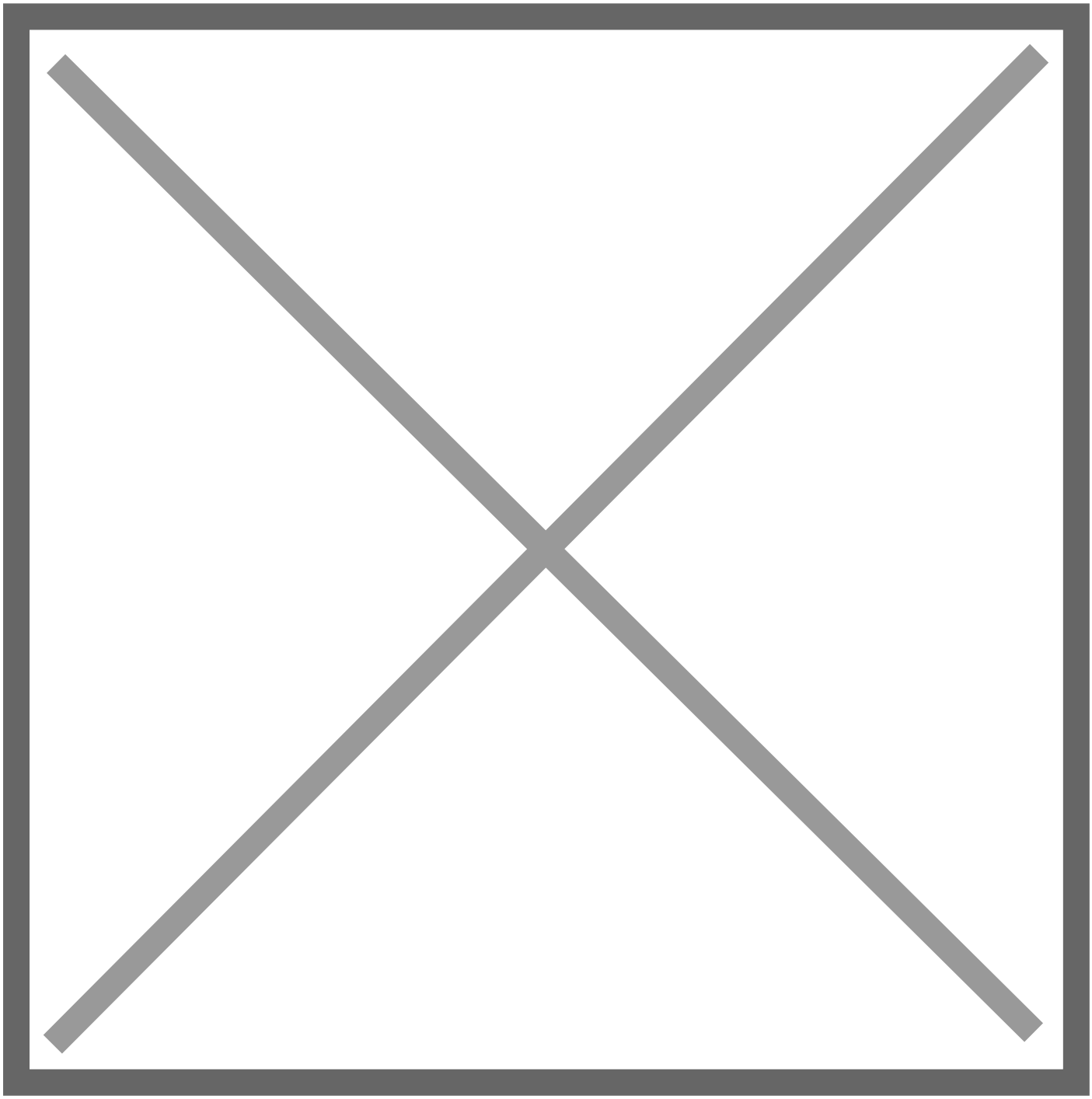
port vehicle processing facility in the world to be powered by on-site generated, 100 percent renewable electricity. Excess power is flowed back to the grid via the local utility, Southern California Edison.

As the power is generated on-site, it isn't subject to the kinds of outages that can strike the Los Angeles metro area. In the past, power lines have gone down, and transformers have been blown, White said. There have been rolling blackouts. On-site power adds resiliency to Toyota's port operations.

Costs are also more predictable. California is known for having some of the highest electricity prices in the country. The electricity produced at Tri-gen is cheaper and won't be subject to surge pricing when the grid is under strain, like during the hottest days of summer. In 2022, during one extreme heat wave, California instructed residents to voluntarily reduce electricity use. Electric-vehicle owners were asked to avoid charging at peak usage times. Tri-gen won't be affected in these instances.

To meet its 2050 carbon neutrality goals, Toyota is always looking for renewable energies, said Yamauchi. The stability of fixed electricity costs that depend on the price of biogas on long-term contracts was an added bonus. There's a business case as well as an environmental case for this type of Tri-gen facility, Yamauchi said.

"Tri-gen has the ability to run through all of those outages," Yamauchi said. "That's a big benefit. We can control our own destiny."



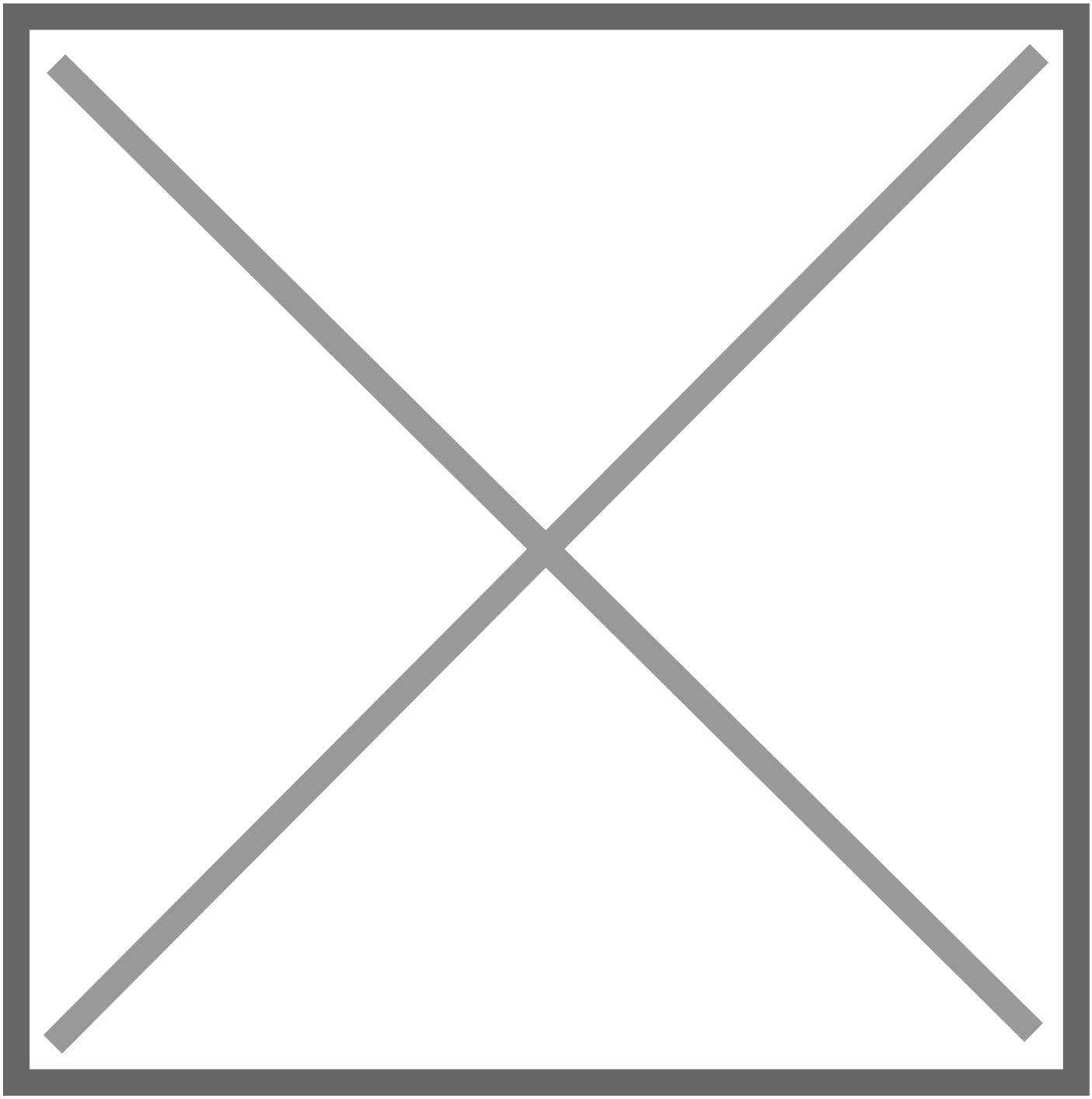
Much like the powertrain of the fuel cell electric Mirai, water is the only byproduct of the electrochemical process that takes place in the fuel cell of Tri-gen. It can produce up to 1,400 gallons of water a day. The water produced is directed to TLS Long Beach's car wash facility to help lessen the water demands of the facility.

Even though Tri-gen's core benefits for Toyota are hydrogen and electricity, another product, or more specifically byproduct – water – shouldn't be overlooked. Southern California's consistent sunshine is loved by residents and visitors alike. The downside to the lack of rain is that water can be scarce. Long Beach receives an

average of about 12 inches of rain a year, compared with 36 inches for Toyota Motor North America headquarters in Plano, Texas.

Tri-gen generates about 1,400 gallons of water a day as a byproduct of its hydrogen generation, much like the Toyota Mirai that only emits water from its tailpipe. TLS is using that water in its car-wash operations. It has two car washes running constantly from 7:00 a.m. to 3:30 p.m., up to six days a week. These are just like the car washes that you might use for your personal car. Hundreds of vehicles are washed each day prior to heading to dealerships for customers to take delivery.

Now some of that water is coming from Tri-gen. It’s not enough water to meet all of the operation’s needs, but it’s up to approximately 500,000 gallons a year that aren’t being drawn from the municipal water utility.



FuelCell Energy's Paul Fukumoto notes that the scalability of fuel cell technology means the size and scope of a facility like Tri-gen can be adjusted to meet the needs of nearly any application.

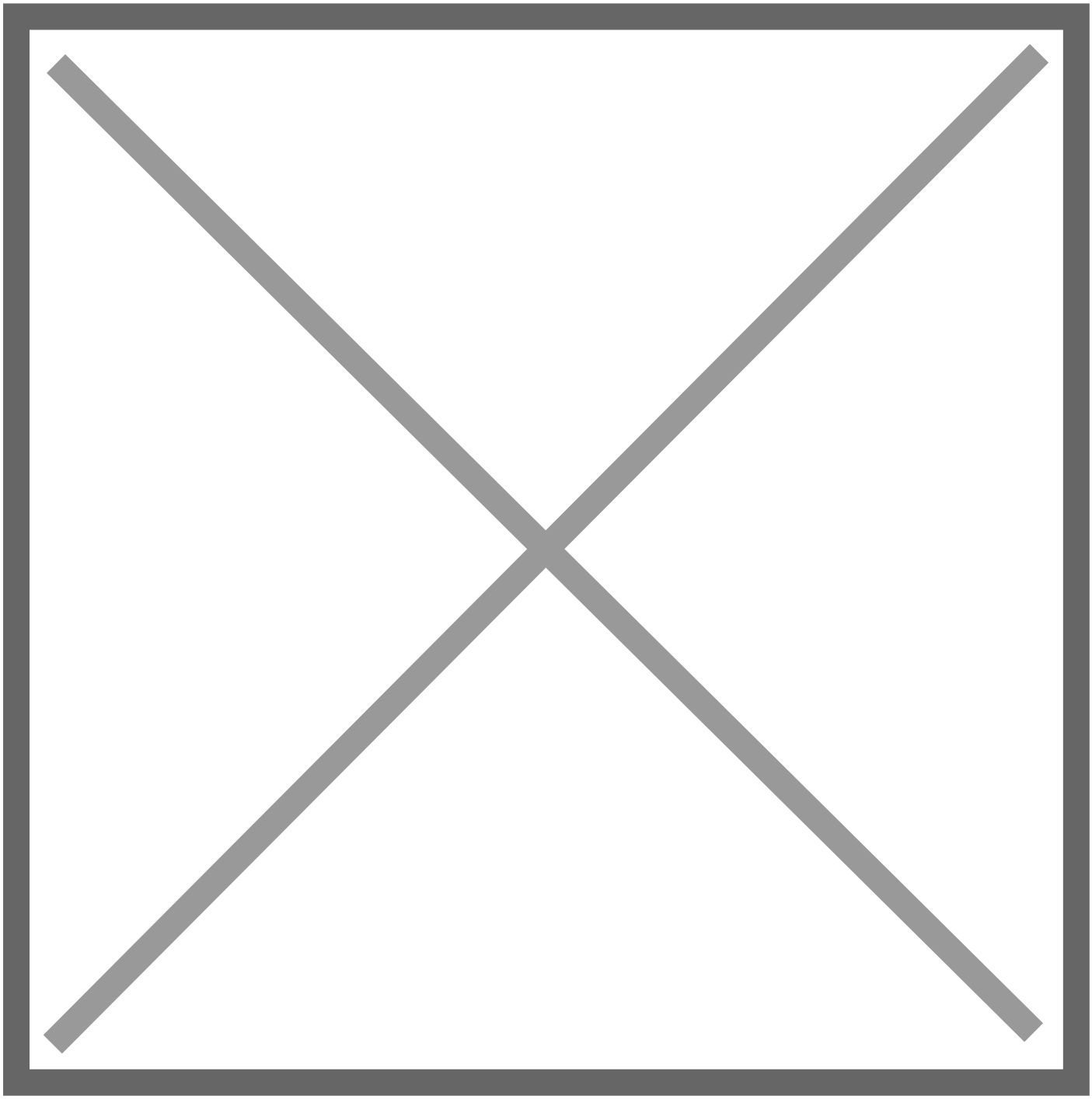
A Model for the Hydrogen Economy?

FuelCell Energy Inc., the supplier of Tri-gen, is hoping that the port operation can be duplicated elsewhere. Trucking fleets, city bus operations and ports are the three biggest potential markets, said Paul Fukumoto, the company's director of technology and product solutions.

Hydrogen-powered fuel cells have virtually zero emissions among heavy-duty power generation applications, Fukumoto said. Tri-gen operations can take up less than a half-acre of space, compared to the acres and acres needed for solar panels, he said.

“If there’s a plot of land, we can build a feed pipeline or open up a fueling station where it’s needed,” Fukumoto said. “We foresee much bigger projects on a larger scale. We’re going to be part of the energy transition.”

Bigger versions of Tri-gen at trucking terminals could produce 2,000 kilograms of hydrogen a day – two- to four-times larger than the facility at Long Beach, Fukumoto said. Units that are more geared to electricity could be 10 times as large. Already, the company’s largest facility in Korea generates 59 megawatts of electricity.



As industries continue to explore ways to reduce carbon emissions from operations, zero-emission technologies like fuel cell will need renewable hydrogen generation from facilities like Tri-gen. The support of renewable hydrogen generations for transportation and facilities is what many refer to as the goal of a "hydrogen society."

The currently decentralized hydrogen energy system could start to look like a network in the near future, Fukumoto said. It could eventually fill the map, like any kind of utility grid or fueling system, with large clusters where needed and small clusters interspersed along major long-distance routes, he said.

The importance of Tri-gen to Toyota is that it's a tailor-made solution to a unique set of operations at the port, Yamauchi said. In devising sustainability solutions for Toyota, the most important thing is to force new kinds of thinking, he said.

Tri-gen has already been a great success at inspiring people throughout the company, Yamauchi said. Groups from all over the world have noticed the facility and asked questions about how it works and how it's lowering emissions and creating hydrogen, he said.

"Anything we can do to nudge people into a different kind of thinking excites me," said Yamauchi, who has been with the company since 1985. "Toyota is filled with brilliant people, but sometimes people's heads are down, focused on what they need to do day-to-day. We need creative solutions to get to our 2050 goals. It's going to take large-step changes. We really need to get people thinking about those big, big steps."

– Story by Jeff Plungis