

## Podcast 72 – Hydrogen Fueling in Costa Rica

[00:24] **Brian:** Hello, everyone, and welcome to episode 72 of the Hydrogen Nowcast for March 24, 2023.

You know, the focus of the Hydrogen Nowcast is threefold. First, to make known new or unique hydrogen technology. Second, to provide an integrated understanding of how hydrogen fits into the energy transition. And lastly, to highlight hydrogen pioneers to tell their story in the hope that will encourage and motivate others to take action.

So our interview today is with one such pioneer who's living MY dream and has deployed a public hydrogen fuel station which is helping to start the hydrogen transportation market. Now, the station's not in California. It's not in Europe or Korea or Japan. In fact, you might be surprised to hear that the station is in Costa Rica. And to add even more spice to this story, our guest is a former NASA astronaut who flew on seven space shuttle missions, which ties the record with astronaut Jerry Ross. So to tell us his whole story, I'm pleased to introduce Franklin Chang Diaz. Franklin, welcome to the show!

[01:28] **Franklin:** Thank you. It's a pleasure to be here.

[01:30] **Brian:** Well, thanks, Franklin, we appreciate your time. I know you're a very busy person.

But first, I think we probably ought to orient everyone that Costa Rica is a Central American country which is northwest of Panama and bordered by the Caribbean and the Pacific Ocean. And Costa Rica is known for its beaches and volcanoes, biodiversity, and, of course, ecotourism. And it's got a population of around 5 million. And the country is considered economically stable with moderate inflation and moderately high growth in GDP. A lot of foreign companies, both in manufacturing and services, operate in Costa Rica's free trade zones where they can benefit from investment and tax incentives. And the economy, which was once heavily dependent on agriculture, has diversified to include sectors such as finance and corporate services for foreign companies, pharmaceuticals, and ecotourism. And it has a long standing and stable democracy and a highly educated workforce.

So I consider Costa Rica pretty progressive, regarding renewable energy. In fact, from November 29 to December 3 of 2022, Costa Rica was host to the 38th meeting at the Steering Committee of IPHE, which is the International Partnership for Hydrogen and Fuel Cells in the Economy. And Franklin, I know you were involved with organizing that. Tell us a little bit about those meetings and how that went.

[02:52] **Franklin:** That's correct. Yes. The IPHE is an interesting organization. It really is a government organization, but it also has NGOs participating and it promotes the development of hydrogen and the hydrogen economy throughout the world. And in 2019, I attended one of their meetings at the invitation of Sunita Satyapal, who is the US. Department of Energy's. Head of hydrogen and Fuel Cells program at DoE. And it was a really interesting gathering.

Of course, there were no Latin American countries participating in these organization. And I felt it was important to include Costa Rica. And at that point, I volunteered Costa Rica to be a part of it. And this was, of course, with the approval of the then government of President Carlos Alvarado Quesada. And just last year, we hosted the international meeting of the Steering Committee in Costa Rica. It was a really interesting event. We had delegations from, I think, eleven different countries, including, of course, the advanced countries in hydrogen: Japan, Korea, there was even a representative of observing nations from Singapore. We had people from India, from most of the European countries, South Africa also. So we spent essentially four days in Costa Rica discussing hydrogen and bringing hydrogen to the attention of the Costa Rican government. That was a really important meeting and opening to the rest of Latin America to participate in this transition away from carbon-based fuels into what we consider to be the hydrogen economy.

[04:49] **Brian:** Well, thanks, Franklin. Let's hope that the momentum continues from the work that you did in 2022.

Now, I know, besides hydrogen, you're involved with the [Ad Astra Rocket Company](#). As a matter of fact, you started that company in 2005. And what Ad Astra does is develop plasma rocket engines. And of course, you're the CEO. So tell us a little bit about the company and a bit about maybe the difference between plasma rocket engines versus chemical engines.

[05:20] **Franklin:** Yes, I spent 25 years at NASA, and one of the things that I became very aware of is that we need to find a different means of propulsion in space. I mean, we have been, we've been doing really well with chemical rockets since the 50s. But the capabilities of the chemical rocket are

coming to the point where you just cannot squeeze anymore out of the performance of those engines. They use a lot of fuel. So when you see a launch of a typical rocket, most of what you see is just a tank full of fuel. And what actually becomes the useful payload is really tiny, it's really small. And that has to change if we are to have a sustainable logistics infrastructure supporting operations on the Moon. And then if we want to go further, go to Mars and start sustaining a human presence in space, we need a different means of transportation. And the solution that we've been pushing forward is electric propulsion – electric plasma propulsion. And electric propulsion has been around for a while, but the power level of these electric rockets is very, very low – or it used to be. And in our company, we are intending to change that to enable electric rockets, plasma rockets that are now, instead of a few hundred watts or maybe even a few kilowatts to go into hundreds of kilowatts to multi megawatts. And what that means is that the capability for transportation of these engines changes drastically. And you can now think of delivering very large payloads cargo to points in the space between the Earth and the Moon much more economically and also, when you start thinking about multi megawatt electric propulsion engines, you can think about going to Mars really, really fast. I'm talking about maybe trip times of a couple of months, as opposed to trip times of the order of maybe seven or eight months as it is today. So a total transformation in the way we travel in space is what we're talking about.

[08:05] **Brian:** Exciting, thanks Franklin, really appreciate that. So since this is a Hydrogen podcast, so let's turn our attention in that direction. I know the last time that we talked, I learned that you own and operate a hydrogen fuel station in Costa Rica. So tell us how an astronaut and a rocket company CEO got involved with a hydrogen fuel station and why in Costa Rica.

[08:30] **Franklin:** Well, Costa Rica is my country of origin. This is where I was born. And I grew up in Costa Rica, and I always wanted to bring a little bit of the space technology and the things that I was so fortunate to experience back to Costa Rica. I am basically a citizen of now really two countries or maybe a whole planet I can think of.

So what's going on here is having flown in space, particularly flying on the shuttle, I became very aware of how electricity was made and what were the benefits of how the space shuttle was powered with hydrogen fuel cells. The space shuttle had no batteries. It was a ship that ran on electricity generated by three hydrogen oxygen fuel cells. We carried both hydrogen and oxygen in tanks, and we made electricity for running the ship with these fuel cells. But we also made copious amounts of water, drinking water, pure water. And that was the water that we used in the ship. In fact, I remember we used to collect this water in certain missions when we docked with stations like the Mir Space Station, for example. We carried water for them, water that we would manufacture on board our own ship by basically making our own electricity. Sometimes we had so much water that we had to dump it overboard.

And so I became convinced at that time that it was important to consider the hydrogen cycle for applications on Earth. And this is what moved me to drive the company in Costa Rica to focus on what we call green hydrogen. Hydrogen that was made from electrolysis of water, using electricity from renewable energy, renewable sources like sun, solar and wind, and other sources, hydroelectric power, which Costa Rica has a lot of. And I thought Costa Rica was a perfect laboratory for implementing these kinds of technologies and seeing how they could work together in the activities of the community of the country. This is what we're doing in our little corner in the northwest part of Costa Rica, creating a small ecosystem where we make hydrogen from water using solar and wind electricity and storing it in high pressure tanks and dispensing it to a small fleet of vehicles which are operating right now. And this is a complete ecosystem. Zero carbon, absolutely no carbon involved. And I think this is the looks of things to come.

[11:40] **Brian:** Well, Franklin, I'd agree that Costa Rica seems like an ideal spot for electrolysis and for the hydrogen transportation system, as you're doing now. Of course, it's not enough just to have a fuel station. As we all know, we've got to have customers and we've got to have vehicles. So how did you find customers? Who are the customers for the hydrogen station and how did you get them started with the vehicles? And as a matter of fact, where did you obtain the vehicles?

[12:08] **Franklin:** Right, well, you have to bring both the vehicles and you have to bring the hydrogen infrastructure. So they call it the chicken and the egg, basic idea that you cannot do one without the other. And the business has to include both. So rather than setting up a hydrogen facility and hope that people will recognize the importance and acquire hydrogen vehicles or become hydrogen users, you essentially bring it all together into one system, one ecosystem, and you provide a mobility service.

In our case, we essentially have vehicles, and we provide those vehicles fueled with hydrogen to deliver a transportation service to a customer. And the question is, the customer has a choice. You can rent the vehicle, a hydrogen vehicle for X number of dollars per kilometer, or you can rent a diesel-powered vehicle for X number of dollars per kilometer. And the key is to make the X's the same as close as possible to make the two be competitive.

And hydrogen becomes competitive with diesel when two things happen. The first, you have to have a subsidy. And this is what happens in all of the countries that are promoting hydrogen today. There is a subsidy, an initial subsidy to kick start the project. And the other ingredient is the price of electricity. Electricity has to be relatively cheap to be able to make hydrogen work. And the subsidy part in Costa Rica has been more challenging. So we pursue subsidies from external sources, international organizations, NGOs that do fund these kinds of projects. But the price of electricity is within our control by installing solar and wind generating capacity. And in Costa Rica you could do that, provide your own solar energy, your own wind. And the country is moving towards changing the electricity laws so that you can transport electricity in Costa Rica's grid, which is a very good electric grid, by just simply paying at all to transport that electricity from point A to point B. Those are the basic ingredients that make the system work. And we are doing it in a small scale for now, just to make sure that everything works, understanding all the pitfalls and all the little glitches that come up when you operate an ecosystem in a business sense. But once you have it all working, then you can replicate it, you can scale it up, and it becomes a viable business.

[15:04] **Brian:** Well, I like the way you put that, of using the electric grid to move the electricity around, but basically paying a toll. And I know many countries, many states here in the United States are wrestling with that, because that's a little bit of a different paradigm for the electric companies to think of that they normally think of themselves as an electricity supplier rather than a broker. So let's hope that gathers a lot of momentum.

And another point that you made about needing subsidies, almost any new technology has needed that. The solar market has needed subsidies to get started. But I think – and I'd like to get your opinion – that hydrogen vehicles certainly are going to be at parity with gasoline or diesel, if not cheaper in the long run, don't you think?

[15:53] **Franklin:** I do. Particularly hydrogen is ideal for heavy transportation. I think that there's going to be a mix of battery electric vehicles and hydrogen fuel cell electric vehicles in the passenger car space, I think the two varieties will coexist. But in the heavy transportation, when we're talking about big trucks and big long-range buses and trains and ships and even airplanes, then hydrogen becomes, I think, unbeatable in the sense that batteries just don't have the capacity, and the weight, the energy storage capacity, for a given weight is still too low. Hydrogen can give you a heck of a lot more range, and it also is much more convenient because you can refuel the vehicle very quickly. So I think that that's the paradigm that will take place as soon as people begin to move large numbers of vehicles using hydrogen. And like I said, bringing the two, the hydrogen production and the hydrogen consumption together, the ecosystem concept, rather than just bringing one and then hoping for the other one to be there.

[17:17] **Brian:** Well, there are an abundance of passenger vehicles available right now, courtesy of Toyota with the Mirai and Hyundai with the Nexo. What vehicles are you actually operating there in Costa Rica? Are they passenger vehicles or buses? What do you have for hydrogen vehicles?

[17:35] **Franklin:** We started out with one bus. It's a Van Hool fuel cell bus that was built about ten years ago or maybe even longer. And it was a used bus. It was a bus that was sitting, not operating in the state of Connecticut. It had been used as a demonstration bus, one of a fairly large family of buses that was built at the time. I think it was built in 2010. And the sister fleet of these buses are operating now in the Oakland San Francisco area by a company called [AC Transit](#). They have about 13 of these buses in operation. They've been operating them for many, many years. But one of those buses is the one that we have in Costa Rica. We brought it in 2017, and we got it running and that was the first vehicle that ever came into the country.

And later on in 2019, we brought a fleet. Well, I say a fleet. There's only four Toyota Mirais, of which I drive one of them, and the other three are deployed in the Costa Rica's tourism industry in the northwest of the country, serving transportation between the airport and the resorts. And the tourists essentially rent these vehicles. We fill them with hydrogen. Our hydrogen station is very close to the airport, so it turned out to be a pretty active, high demand environment, particularly during their high season.

So this is the kind of thing that we see as potential expansion. And of course, we want to now increase the production. We only have a few kilos a day of production. So now we want to go to larger scale, up to 500 kg of hydrogen per day, about one and a half megawatts of electric power, and continue to scale up, but the entire ecosystem. Now we're talking about bringing a fleet of 20 heavy-duty trucks and provide, like I said earlier, a mobility service or a mobility solution to customers in the area. They have to transport a lot of goods, and many of them refrigerated food stuffs. They have to be going to the hotels, to the resorts, to the supermarkets. And we would provide essentially, the vehicles to do that at a competitive cost as compared to a diesel solution. So that's the gist of our business model.

[20:16] **Brian:** Well, Franklin, I really applaud what you're doing, and I hope the momentum continues and you continue to expand the number of vehicles as well as the fueling. Do you think maybe you'll try to do something in the United States, or you think your focus is just on Costa Rica right now?

[20:32] **Franklin:** Well, I hope to be able to replicate what we're doing in the United States.

Now, the thing about hydrogen, though, in the world, is that it's taking an interesting turn, mainly driven by very, very large-scale production, not for transportation, but for the production of what's called green ammonia, ammonia being an ingredient, a key ingredient in fertilizers. So the fertilizer industry and the green ammonia and the large, very large production I'm talking now, gigawatts of power, that's what's driving the hydrogen economy and the rest of the world. So the transportation portion seems to have taken a backseat. It's still going. But I think that this is just driven by the economics of hydrogen in large scale and the involvement in hydrogen of the large oil companies. So I think what we're doing in Costa Rica is something a little different. We're trying to promote, like I said earlier, the chicken and the egg together in ecosystems of transportation that can be that are relatively small, but that can be replicated and then interconnected. So you have a distributed ecosystem, and that is a little different from what's happening in the United States and what's happening in Western Europe. So it's a different flavor of the hydrogen solution that we're bringing to the table and we hope it will take hold in the US. As well.

[22:10] **Brian:** Well, thanks Franklin. And a lot of times these markets for whatever, develop in ways maybe that are unforeseen or that we didn't anticipate. But I do worry that because of the dire situation of the climate, we don't really have time to wait for hydrogen to trickle down to transportation. I think we need some champions like you to get out there and promote it. And that's certainly the reason that I started the Colorado Hydrogen Network and why I do this podcast to try to promote things for transportation, because I think too many people think all the transportation is going to be battery vehicles. And clearly the consumers, the users, the drivers don't really see that for every application. So, again, I applaud what you're doing. I hope that you and other pioneers or champions can help promote hydrogen for transportation, because I don't think we have time to wait for it just to happen on its own. Franklin, are there any points you'd like to make before we wrap things up of anything I maybe didn't ask you about?

[23:12] **Franklin:** Maybe just to recalibrate one point in that hydrogen and sustainable green hydrogen is driven by solar and wind electricity and solar energy and the electricity, and of course the wind, they're already distributed. There is no need to centralize the production of solar and wind only to distribute it again. So the way we're thinking of this is that the energy for hydrogen has already been distributed and it comes to us in the way of in the form of the sun and the wind everywhere, all over the planet. And so hydrogen by nature fits into the distributed economy. And I think this is a very important idea that needs to be considered rather than trying to make hydrogen to gigantic centralized production sources that have to then be distributed again. So key here is having a good electric grid and transport hydrogen, not in the way as hydrogen in trucks or pipelines, but transport as electricity and then make the hydrogen that you need on the spot at the place that you're going to use it.

[24:32] **Brian:** I absolutely agree, Franklin, partly because hydrogen is so difficult to move. But as you point out, there's energy sources; you mentioned wind and solar, but I'll even add dry geothermal is another one. There's a lot of resources for geothermal in the western United States and other places, but we'll use the source of energy that's most available and most reliable at each location and then we don't have to move a lot of hydrogen around.

Well, listeners, I've been talking with Franklin Chang-Diaz, the CEO of Ad Astra Rocket Company. And Franklin, if listeners want to get in touch with you, what's the best way to do that?

[25:12] **Franklin:** Well, we are here in Houston and in Costa Rica. In Houston. At our phone number here, 281-526-0500 is our central number, and in Costa Rica is 2666-9272. Those are the two key numbers to call and we'd be delighted to talk to folks who want to get into this game. It's a great future

for the planet and we have to take care of this planet because it's really the only one we have so far. Hopefully, we'll have some other places to go later, but we have to be healthy and viable in order for us to be able to explore other worlds to ensure the survival of humans. Otherwise we're going to disappear.

[26:02] **Brian:** Yeah, absolutely. And as I've said many times on the podcast, we're not going to die, we're not going to just disappear. But civilization could collapse if the climate makes it difficult to grow food or changes it a great deal, things could get nasty and people need to think about that and develop a sense of urgency. So, Franklin, is there a website for Ad Astra if people would like to look at that or maybe even send a message through the website?

[26:31] **Franklin:** Sure. Adastrarocket.com is our website and we do both hydrogen – we have a section on the website on hydrogen and stuff in Costa Rica – and then we have another section on the rocket work. As you know, there is a connection here between hydrogen and space, is that we are going to be using hydrogen fuel cells and vehicles and hydrogen vehicles on the moon and on Mars. We're not going to be burning diesel or natural gas on the moon or Mars, we're going to be using hydrogen. So that's one of the reasons our company is interested in both.

[27:12] **Brian:** All right, well, Franklin, again, thank you for your time to be with us today.

[27:17] **Franklin:** You're welcome.

[27:18] **Brian:** All right, so, listeners, if you enjoy listening to the HydrogenNowCast, consider subscribing to the podcast and also give us a rating in your podcast app. A good rating helps us be discovered by other people. And of course, word of mouth recommendations are really important. So consider letting people in your own network know about the HydrogenNowCast.

If you'd like to contact me, I'd love to hear from you and you can reach me through the website at [colorado-hydrogen.org](http://colorado-hydrogen.org) or on Linked-In.

So until next time, this is Brian DeBruine wishing you health and prosperity. Goodbye.