***Battery + Storage Podcast*: Expanding Energy Storage Through Cross-Cultural Insights With Dr. Marco Terruzzin, Energy Vault**
Hosts: Bill Derasmo
Guest: Dr. Marco Terruzzin
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Bill Derasmo:

Hello, and welcome back to the Troutman Pepper *Battery and Storage Podcast*. I am your host, Bill Derasmo, partner at Troutman Pepper. Today, I am pleased to have with me Dr. Marco Terruzzin. Welcome to the program, Marco.

Marco Terruzzin:

Bill, very nice to meet you. And thank you for having me.

Bill Derasmo:

I'm glad you're on the program today. Glad to have you. You are the chief commercial and product officer at Energy Vault SA, where you have served as such since 2019. You started out with your education in Italy where you earned your master's in mechanical engineering and a PhD in energy economics at the University of Padua. You've held a string of senior positions since then. But why don't I give you a chance to introduce yourself and let us know what led you to Energy Vault?

Marco Terruzzin:

Yeah. Thank you for the opportunity. I found several years ago very inspiring to listen to podcast similar to this one and hearing from people with experience how they were transforming the energy industry. Particularly back in 2000, 2002, at that time, I was working at my first job. Listening about photovoltaic, wind and renewable energy was inspiring. Today, I hope this conversation can inspire also the new generation of engineer, economist, and people that are – that they have the ambition to make this world a better place.

I'm a mechanical engineer. I got my PhD in energy economics. And I also study here in the United States. I try to complement the technical skills from the engineering side, also with the understanding of business, and economics and finance. After business school, I spent a couple of years in New York working for a trading firm. And at that time, I'm talking about 2007, the Kyoto Protocol was probably the first international mechanism trying to address the problem of climate change. Everything was predicated upon the assumption that taking early action would have caused – both in terms of economics and also in terms of problem caused by climate change, a total lower cost. If you take early action instead of waiting for a later time when climate change would have already developed and temperature have increased in general.

I moved to China, and for seven years I was involved in the trading of carbon emission reduction. The objective there was to identify, develop and bring to the market project and initiatives like PV farm, wind farms. But, also, energy efficiency project with the capabilities to

reduce the emission. And that was under the Kyoto Protocol. The Kyoto Protocol at one point was not probably the right vehicle, international agreement to support technology innovation. In 2015, after seven years, I was leading the subsidiary company of evolution markets there. The largest environmental commodity trading firm. And for a couple of years I had also my own company doing something similar.

I moved back to the United States. And at that time, I became more familiar with energy storage. The missing point in the transition to renewable energy. Or at least, at one point, that is kind of important. Because with all the intermittency of renewable energy, you need a buffer that is able to store energy generated during the day by PV or energy that is generated through days when you have a lot of wind. And you need to release this energy when the sun is not shining and the wind is not blowing. That is the basic to kind of capture the importance of energy storage.

At the beginning, however, energy storage has been deployed for fast frequency response. Use cases where batteries at that time, five, six, seven years ago, were quite expensive, for sure. More expensive than today. The application required to make this project in the money, some special use case that was not requiring long duration of storage. But at the same, time the ability to hit the return on investment required to make this project economically valuable.

I spent at the beginning time as a managing director for a subsidiary company of Engie EPS. Then I moved to Stem, a company focus on – at that time, was more on behind of the meter application with a very significant experience, referring to the company itself, Stem, in the software that is able to help customer to reduce the demand charges.

And then I moved also to a large German utility based in San Francisco, E. ON Climate & Renewables. And I was, at that time, developing energy storage project in front of the meter. I was able to see the behind of the meter part of the business and also in front of the meter part of the business. Two segments with their own characteristics but are very complimentary.

I would say that today, in front of the meter business is the dominant in terms of volume and dollars of investment. And in 2019, I became aware. I came across Energy Vault. I found a very interesting company with an ambitious vision to become a company leading the effort in energy storage starting with software, but also providing specific hardware solution, proprietary solution.

At that time, the discussion and the focus was primarily on gravity energy storage. But rapidly, we were able to identify other use case and also tracked additional talent in the company with the ability to integrate hardware technology in the field of lithium-ion batteries for shorter duration application. But not only shorter duration, also microgrid.

One interesting project that we are about to deliver to here in the state of California is with a Pacific Gas and Electric, one of the largest microgrid. Using a combination of batteries, lithium-ion for just 1 hour and 47 additional hours of energy storage using hydrogen. I would say that I've been fortunate enough in my life to come across people, intelligent with a lot of skill sets, and a lot of motivation, and a vision and trying to absorb as much as possible from them. And delivering some value to the power industry and, in general, the economy with the effort to decarbonize it.

Bill Derasmo:

Well, appreciate you running through all that, because that's a lot. You covered a lot of ground there over a little bit of time. And a lot of interesting experiences. I did skip over the fact that you got an MBA from the state where I live, the University of Virginia. To round out, as you said, mechanical engineering, energy economics. And, also, an MBA. And then all those different experiences that you walk through and led you to Energy Vault.

And Energy Vault, just to take a second to talk about, is a publicly traded company on the New York Stock Exchange. Stock ticker symbol NRGV. You can read about it on the Energy Vault website. But we talk on this podcast a lot – I think understandably, focused on storage, we've talked a lot about battery storage. But, of course, there are other ways to store energy. There's flywheel technology. There's pumped-storage hydro. And Energy Vault makes use of gravity.

Marco Terruzzin:

Among other things.

Bill Derasmo:

I know you talked about the different types of technologies that Energy Vault makes use of. And we're going to talk about the California project, the Calistoga project, which is really interesting. When I was preparing for this interview, I just was, "Wow. That's a really neat project and cutting edge." But for my own sake, I'll be selfish for a second, I don't know as much about the gravity technology. Can we start there? Maybe just tell me a little bit about that technology and the projects in China.

Marco Terruzzin:

Yeah. The company was able to capture a lot of interest and also financial support back in 2018 and 2019 because of the development of the proprietary technology that we call gravity energy storage systems. We have been very careful to make sure that whatever we were going to develop would have found a confirmation in the marketplace that these types of solution are something that is needed and provide value to independent power producers, utilities, or large energy users. The company that ultimately have to pay for this technology and they utilize for solving a problem, addressing a specific use case and, ultimately, generating a return on the investment.

The fundamental assumption and problem that we were trying to solve with the gravity energy storage technology was trying to reduce a – providing a solution that has almost no degradation of the storage medium in comparison. With other technology like batteries, they experience a degradation of the storage medium over time. The most intuitive case is your cellphone or some devices that you use at home. After you have recharged them for 500 times or a thousand time, you itself intuitively, that you see that they retain less energy. This is the phenomenon of the degradation of the storage medium.

For a utility or an independent power producer with the intention to use that asset for 15 years, degradation means spending extra money when you want to replenish that lost capacity.

Fundamentally, gravity started with that idea. Can we provide users with a technology that has a long technical life similar to the technical life of infrastructure like pumped-hydro?

30-plus years, sometimes we are talking about 50 or 60 years, the oldest power plant in Europe, even before the Second World War, there has been refurbished over time. And they've been able to provide a stability to the grid for almost a century. That was a driver. Immediately, we were able to prove the concept at our R&D center in Switzerland. We have been able to prove that stacking heavy object was possible with using sophisticated software. Immediately, the nature of the company was trying to develop digital solution to solve hardware problem. And that has been an important mark in our DNA.

And, rapidly, we tried to evolve the original design in a design that is more flexible across multiple use cases. For example, decoupling. The relationship between energy and power. Making sure that if a customer wants a solution with a duration for four hours, we have a design that can accommodate that duration. And at the same time, with the same design, we can accommodate the solution for 12 hours of duration. That was the first step.

Then, addressing the problem, of course, driving a design that was less expensive. And, finally, identifying customer. Like the very important partner that we have in China, CNTY, China Tianying, that in 2021 we enter into a license agreement. And taking advantage and observing what was happening in China in particular with the National Development Reform Commission. Paying a lot of attention to technology with domestic content. And there was also technology that can develop local jobs.

We have been able to license the technology to this partner and to develop a pipeline approach that today is north of 3-gigawatt-hour. In essence, this has been the positioning of gravity within a portfolio of solution that we are always trying to develop, keep in mind the ultimate need of the test.

Bill Derasmo:

Yes. And it seems like the company has a suite of options depending on what the customer's needs are. You talked about – we just talked about the gravity storage. And we've talked about the California project where hydrogen is involved. Talk to me about the short-duration solutions that involve batteries.

Marco Terruzzin:

Yeah. Currently, the market is not short of opportunities for end customer to buy batteries. There are multiple. There are dozens of suppliers with the so-called DC block container equipped with modules of batteries. Our objective is to help the industry even for sure duration to address use cases that are challenging. That are big enough to justify investment in no recurring engineering from our side and then opening up market and a niche of the economy that are currently either because the problem has not been solved or because of the economics of the current solution are not attractive enough are still struggling to address their use case with the utilization of battery.

I give you a few examples. Energy density has always been a challenge for lithium-ion. Because even if, currently, the energy density of battery modular has improved significantly, just three

years ago, it was difficult to get more than a two or 250-megawatt-hour of energy stored in one acre.

We started with one of our initial projects in California, Stanton, between Los Angeles and San Diego, with one specific customer successful in the field of power with almost 1-gigawatt of asset already operating here in California, Wellhead Electrics. And they had a site where they already had a gas power plant able to provide resiliency to the Stanton area in Orange County. And they also had 10-megawatt of batteries providing support to the power plant.

Tried to avoid emission from the gas power plant. Switched that down and making the battery picking up the request from the load from the power immediately when there was the request from Southern California. They had a parcel of land that was relatively small at that time. And we were able to use our ability to integrate systems to deliver a battery energy storage solution with container, tailor-made container that are 3-feet taller than the standard shipping contain container. And HVAC position on the top of this container. And a very smart layout that empower and enable the customer to have the system, the Stanton battery energy storage system, available up and running before the heat wave of the summer of 2023. That was an example of how we have been able to address the problem that otherwise would have postponed the implementation of that system and causing potentially some problems to the local load service entity, Southern California.

Bill Derasmo:

Sorry to interrupt. But I was going to say, in particular, it was the energy density problem of trying to get enough really in the space that was available, it sounds like. And you guys were able to just think creatively and come up with a solution. And I guess, Energy Vault, if you're trying to distinguish yourself, it's that it sounds like you're trying to take on the more difficult cases or the challenging cases.

Marco Terruzzin:

Yeah, learning by doing. Right? Now that is another area that is extremely attractive and also significant in the development of the power industry represented by the hyperscale data center. This is something that we have been putting a lot of attention and effort.

Hyperscale data center, they need power. They need grid connection. And currently, considering what happened in the last 15 years in the United States, energy efficiency was able to contain the growth of load. But recently, because of electric vehicle and, in particular, because of the insatiable demand of power by hyperscale data center with the advent of artificial intelligence. Training all these cars, we're talking about a gigawatt of extra power just over the next two or three years. There is this pressure on utilities to provide power.

It is possible to provide power. But you need to stay in line. And sometimes the utility, they need four, five, even six years to provide a flat load. One use case that we are paying a lot of attention is to the possibility for hyperscale data center to interconnect through demand response programs. Giving the utility the possibility to interrupt the service of power for few times per year, let's say, between 5 to 10 hours.

And at that time, at that point, data center, they need operating backup. Not critical backup. Because diesel genset and gas turbine, they are available to provide critical backup. But they cannot be dispatched. If all in the event of an entire blackout, they can be operated. But if somebody voluntarily want to participate in a demand response program, you cannot use thermo generation. And this is the case for batteries.

The second problem that they face however, it is a limited space available. Because like a restaurant, you don't want to consume 80% of the space of the restaurant for the kitchen and just a limited space for the customer, right? You want to maintain a reasonable relationship between ancillary service and the equipment that is not core, and the data center and the server that ultimately generate value for a data center.

And this is where we have combined this very interesting exercise, the know-how that we develop with gravity in a pre-casting concrete, pre-casting the utilization of a specific IP in the material science using reinforced fiber concrete. A specific design that is allowing the construction of a building of four to five stories that is in compliance with the most stringent regulation for fire protection. And, essentially, we are stacking batteries at a different level of this building in compliance with the fire code, in compliance with the requirement for insurability of this asset. Very important. Otherwise, you cannot find a commercial insurance that will provide comfort to the asset owner that can be construct and built within nine months. And a very attractive price for the customer.

This is opening up a market that is indicatively around 100, 120-gigawatt hour of battery energy storage in a very smart solution. Applying no recurring engineering at Energy Vault. Attracting talent from the software side, from the hardware side. Economists to provide solution in part of the industry that currently is emerging.

Bill Derasmo:

Yeah. The data center phenomenon is touching all parts of the industry. And you really summed it up well when you said, for a while, the United States was able to handle load growth mainly through efficiency, energy efficiency measures, demand response different things. And, really, for a long period of time there was flat load growth in the United States. And now, all of a sudden, not only is load growth not flat, but it's really exploding the load growth. It's really opened up.

And part of that, big part of that is the data center phenomenon. And so, it sounds like you guys are all over it. You're on top of it and you have creative solution, again, in terms of meeting the specific needs for the specific case. And the energy density issue of maybe having to operate in a contained area. And it sounds like you guys have worked on some creative solutions. And, again, Energy Vault is taking on challenging cases, the unique cases.

And so, as you move forward, I would think that this data center phenomenon is going to continue to be a big piece of your business as you move forward. I think, because of the growth of AI, right now, there's no end in sight to the demands that are going to be placed on the system.

Marco Terruzzin:

I agree. Very often, there is that way to say that between A and B is not linear trajectory, right? Developing gravity, we learn a lot of things about material science and the ability to precast components to accelerate the construction of super-structure. And that help us also to make a partnership with a very well-known firm, SOM. They have been building the tallest building around the world like the Burj Khalifa in Dubai, or the Freedom Tower in New York.

And gravity, all that know-how, help us to develop new solution for data center. Addressing the problem of a concentration of energy storage in a safe way with a building that has self-protect and isolate, all of this unit from potentially a thermo generation event that is always a risk when you manage batteries.

The second example, probably you want to talk also about this one, was the experience with the hydrogen that is opening up also opportunities for PV dispatchable 24/7. That is kind of an interesting aspect of effort in R&D and a product development that, ultimately, if they are carefully thought, they can yield additional application going forward.

Bill Derasmo:

Well, the dispatchability issue you hit on there – I mean, we've talked about data centers, which is a hot topic. Let's talk about another hot topic, which is basically all these states and nations have these decarbonization goals, emissions goals. I work with some of the companies in New York and they talk about a dispatchable emissions-free resource or a defer in New York.

The dispatchability element is a real challenge. Because as you started off the program talking about renewables, everybody loves wind and solar, but they're intermittent, right? And then battery storage has been trying to fill that gap. But, really, a lot of people are trying to work on, "Okay, what's going to be the emissions-free resource that's fully dispatchable?" And, obviously, hydrogen has gotten a lot of attention.

And you guys now have the Calistoga project. You've been working with hydrogen. I don't know if you could just talk about that dispatchability issue. Given your experiences as an engineer and everything else, let's talk about the role that your company can play with solving the dispatchability problem.

Marco Terruzzin:

Yeah. I believe that the transition to renewable energy when a massive quantity of renewable energy, 60%, 70% of the energy that is used generated by renewable energy. We are just at the beginning. It looks like there is a reason to try to develop solution that are relatively simple. But we're not there yet. Try to make solar or wind fully dispatchable with a use of just one technology. We have our view that we believe that is challenging today.

And why did we reach this conclusion? Looking at specifically what we learned with this construction of the largest micro-grid here in the United States, Calistoga, Northern California contracted with the Pacific Gas and Electric, the problem to solve there was the public safety, power shut off event that are many utilities in the United States, particular in California during the fire season, they have to do. They have to activate it. They have to de-energize the

transmission and distribution line to avoid to run into the risk to ignite some fire during the hot season.

Like in these days, September, here in California, can be a windy day. Very high temperature. If one of those line get in contact with a vegetation, it can ignite a fire. We try to – there was an RFP issue for the third time by PG&E that was asking for a solution able to address that problem in an economic fashion. Spending no more than two times the cost the money that we are spent by PG&E locating one time per year at diesel genset. It was very clear what was the economic objective. And, also, making that in a carbon-free fashion.

If we try to solve that problem just installing batteries, it would have been too expensive. We would have not had space enough at that location. One more time, problem of energy density is always there. Because Calistoga is a relatively small city. It's a town. A beautiful town where you do not want to take much of their territory to install electrical equipment. And, second, it would have been, for sure, not economically attractive.

We went towards the direction of a hybrid system. Matching batteries, very expensive to do the hard work of picking up immediately the load immediately when there is a de-energization event. But adding the remaining part of the bulk, part of energy storage using a fuel. Hydrogen as a fuel with RPS compliant. So, carbon-free.

And that opened up a really interesting process internally at Energy Vault because we realized that hybrid system managed by a sophisticated software, they can sold problems that a single technology by themselves. Taken individually, they cannot solve. Taking advantage of that experience, now we have started to elaborate on the possibility to provide solution to IPPs focused on developing solar adding batteries to reach availability around 85, 90%. Clearly, there is an a significant extra cost but is still acceptable by some large energy users.

For example, there are some data center that they want to have a 24/7 renewable. There is a certain demand that is growing in the market that are willing to pay this premium. However, if you try to get to 100% availability, to cover all 365 days per year, the load just with batteries, the price would be just too expensive.

The remaining 10% of the availability 25, 30 days per year when you need 16, 17 hours of duration, covering that with a fuel cell and hydrogen. Hopefully, green hydrogen. Because at that point, you are shifting energy using a fuel that is completely carbon-free. This is an example of how we have been able to leverage on a very interesting project. But in a certain of way, limited in scope, like the Calistoga project to a much larger cluster. Because we are talking about dozens of gigawatts that have to be deployed with a PV and wind that at one point they must be dispatched with a longer duration and availability if we really want to overcome the problem of the thermal generation. In sort of way, as an impediment at least in the medium term to the entire transition.

Bill Derasmo:

Yeah. I mean, the Calistoga project to me is really fascinating. I appreciate you walking through all that. And I understand your point about it's a great project. But it's one that you can learn from, it sounds like. It's one that now you can build on and scale up as you go forward. And I think that that's – it's a lot of exciting work going on with your company.

And I think one of the things that's unique, as I observe, and talking to a lot of different companies is that Energy Vault makes use of very different technologies depending on the case. A lot of companies, they have a proprietary technology and they're deploying it. And that's fine. And it works great for them. But I think in your case, you guys have shown a degree of versatility and flexibility. And it sounds like it's going to serve you well as we move further into the energy transition. I think you made the comment that we're sort of just getting started in terms of the transition. And we've made a lot of progress already. But it feels that way to me, too, that this is just the tip of the iceberg what we're seeing. It's been a really great discussion.

I had a question that was maybe not related to Energy Vault, but just yourself. I think you're from Italy originally, right? I'm American but of Italian extraction, I guess you'd call it. But I'm just curious because – so if you grew up in Italy and you've worked so long in the United States, how has that transition been? You've worked in different parts of the world. And I always ask the question, when you're thinking of these problems in your mind, are you thinking in Italian or do you think in English at this point?

Marco Terruzzin:

This is a question that I was not expecting. I'm elaborating here real time. I have to say that maybe leveraging of what we discussed. Taking several solutions and trying to make a solution even better, right? You take a piece of lithium-ion, you take some consideration about a fuel cell. It is what artificial intelligence is doing now in a certain way, right? Not segmenting the available knowledge and knowhow on the web and mixing and matching in a way that resonate with what we expect as a human being. Understandable answers that resonate with the way that we think, right?

Kind of breaking down silos, going back to your question. Clearly, the Anglo-Saxon border, the UK and America are driven by business and try to put efficiency above all. I come from a part of the world where the approach is slightly different. There are opportunities to percolate, to transfer these experiences and making both from the business perspective and also from a personal perspective things better.

I notice that working with utility in Europe or vice versa, working in China under an American company. I always have this tendency to look at the positive side of every experience. And I believe that the more cross-knowledge and experience that we can elaborate, the better it is for the world.

Bill Derasmo:

I like that. I like that. Well, why don't we end on that positive note? I think it's been a great conversation. And I appreciate you putting up with my personal question. But, no, I really appreciate having you on the program. I hope you enjoyed it here today.

Marco Terruzzin:

Tremendously. And thank you for having me.

Bill Derasmo:

Absolutely. All right. Until next time. Thanks, everyone.