



## Climate Vision 2050 Podcast

### Driven to Adapt

[00:00:00] **Nick Howard:** What you are about to listen to is a work of imagination, but not fantasy, set in the year 2050.

#### Act I: Introduction

(Sounds of a large crowd, announcers vaguely in the background, music from loudspeakers.)

[00:00:08] **Mutinta Banda:** A crowd of 500,000 people gather along Avenida Paulista for the kick-off of the 10th annual Paulista Grand Prix. The São Paulo Museum of Art marks the start of the street circuit. This is where 25 cars wait idly for the race to begin. Among the riders is Bela Tanaka [Bell-ah Tan-ah-ka].

[00:00:28] **Bela Tanaka:** My first big race. It's one of the quietest grand prix's yet! I've installed a new ultra-lightweight battery that I'm hoping gives me the extra boost I'll need to make the top 5. The circuit was upgraded to wireless battery charging this year, which will mean fewer pit stops too. I hope this PR move works and cities introduce wireless charging faster now, I'd love to not have to charge at all in my personal time too!

[00:00:47] **Bela Tanaka:** [Ugh]

[00:00:47] **Bela Tanaka:** Rahul Gonzalez is next to me. He's the guy that kept trying to cut me off in the

qualifiers! More than making it in the top 5, I just want to beat him.

[00:01:00] **Announcer:** Drivers! Boot up your vehicles!

(Sounds of a computer starting.)

[00:01:02] **Bela Tanaka:** Huh?

**Rahul Gonzalez:** Hey Bela! Good luck keeping up, you're gonna need it.

**Bela Tanaka:** Whoah, that throat-slashing gesture is uncalled for. The nerve of that guy.

[00:01:09] **Announcer:** 3...

[00:01:09] **Bela Tanaka:** No time for distractions. I've gotta focus.

[00:01:12] **Announcer:** 2... 1...

(A loud boom marks the start and the sound of 25 electric cars taking off. The soundscape fades out.)

[00:01:13] **Mutinta Banda:** Today in 2050, sustainability and safety are at the heart of vehicles and transportation infrastructure. In this final episode of season one of our series, we'll explore how electric vehicles revolutionized the industry and created a sustainable circular economy. We'll also delve into advancements in charging technology



that allowed EVs to overtake the internal combustion engine.

[00:01:39] **Mutinta Banda:** I'm your host Mutinta Banda and you're listening to Climate Vision 2050.

[00:01:44] **News Clips:** In 2028, increased battery charging services hit major highways across the country.

[00:01:48] **News Clips:** The ban on purchasing internal combustion engine vehicles in 2034 has led to record sales for electric vehicles.

[00:01:55] **News Clips:** New fleets of autonomous public transit vehicles were unveiled in 2030 in major cities.

## **Act II: How the world works in 2050**

[00:02:00] **Mutinta Banda:** Back in Sao Paulo, Bela has taken 9th place as the race weaves through the city center. Because of the tight roads, the cars are taking it slower in this section, maxing at speeds of just under 200 kilometers per hour.

(Cheering crowds, an announcer muffled in the background, electric cars whooshing by.)

[00:02:16] **Bela Tanaka:** Computer,

(Siri listening type SFX)

**Bela Tanaka:** Show me an AR projection for the optimal position for drag behind car number sixty-fi- wait, what's going on? My battery isn't charging? I specifically swapped for the low-mileage ultra-lightweight model because of the wireless charging!

(A car whizzes by.)

(Below is slightly muffled as it is coming from outside the car.)

[00:02:31] **Announcer:** Rahul Gonzalez in car 23 overtakes 14 driven by Bela Tanaka.

[00:02:36] **Bela Tanaka:** Rahul! I can't let him beat me.

**Bela Tanaka:** Hey pit crew! Are charging coils operating at full capacity?

**Pit Crew:** Looks like it. Hold on, we'll run a complete diagnostic of your battery and charging system. ... Your wireless charging isn't giving off a signal.

[00:02:48] **Bela Tanaka:** What?! Ugh! I've gotta come in for an early pit stop on the seventh lap.

**Pit Crew:** Copy that, we'll be ready.

**Bela Tanaka:** I don't know if I'll even be able to catch up but I'll run out of power if I don't...

(Soundscape fades out.)

[00:03:05] **Mutinta Banda:** The first electric vehicle tests occurred back in the 1830s. But it wasn't until the early 21st century that electric vehicles started to take off.

[00:03:16] **Nathan Niese:** In the 2020s we were still getting our feet wet with the use of batteries in vehicles. So by the end of the decade, roughly a third of new vehicles sold were electric. Some of the metro areas still



were just starting to have zero emission use zones, and even by the end of the decade, 90% of the vehicles

that are on the road were still using fossil fuels.

[00:03:38] **Nathan Niese:** Those batteries were able to get you 300 miles. You would need to charge at fixed charging stations and it was still not ubiquitous in terms of everyone thinking and seeing how it was the best for their pocketbooks.

[00:03:55] **Mutinta Banda:** That's Nathan Niese, Partner and Associate Director of Electrification and Climate Change at BCG. Since 2048 he has been a board member at VoltGo, a full-service EV and autonomous ride-sharing company headquartered in Chicago.

[00:04:02] **Nathan Niese:** It's effectively the ride-sharing app that folks might have known from the 2020s on steroids.

[00:04:08] **Nathan Niese:** I coordinate all the vehicles in our zero emission zone in the outer ring of Chicago. Our fleet has a mix of autonomous vehicles, human-driven vehicles, all shapes and sizes, single occupants to larger vehicles, and we coordinate ride pickups, charging and cleaning schedules, maintenance and battery replacements, and a whole lot more.

[00:04:26] **Mutinta Banda:** VoltGO is a service that was made possible by the past 30 years of advancements in electric vehicle and autonomous driving technologies. It came from a

need to transition to sustainable driving solutions such as ride-sharing.

[00:04:41] **Mutinta Banda:** Financial incentives were key, as they propelled the adoption of EVs.

[00:04:46] **Nathan Niese:** When policymakers thought through how we were gonna meet our climate goals, they zeroed in on needing to get fossil fuel vehicles off the road.

[00:04:58] **Nathan Niese:** So they provided incentives to switch over. Sometimes they provided incentives that even led to trade-ins of vehicles, so that way we could take those fossil fuel vehicles off the road faster than they might have otherwise

[00:05:14] **Mutinta Banda:** More electric vehicles on the road meant more batteries and more charging infrastructure. Hans Eric Melin is a Managing Director at Circular Energy Storage, a London-based consultancy focused on lithium-ion battery life cycle management.

**Mutinta Banda:** A diversification of materials in the batteries we were developing was needed. Raw material scarcity and geo-political security concerns drove the industry to move away from materials found only in a handful of countries.

[00:05:36] **Hans:** When we understood that if we wanted to make this really big scale, that today that the whole world are using these batteries in transportation and in other kinds of applications, then it was key really to get to the point where we use more abundant materials. Such as sulfur, and not least sodium. I mean material



that is much more abundant than, for instance, lithium-ion batteries which we still have but I mean basically to

use the same kind of technology, but different kinds of chemicals.

[00:06:11] **Mutinta Banda:** Today in 2050, batteries made out of novel materials such as manganese, graphite, sulfur, and sodium help to alleviate the pressure of mining and diversify supply chains.

[00:06:24] **Mutinta Banda:** Mining for traditional battery materials can be problematic for climate and political reasons.

[00:06:31] **Nathan Niese:** 90% of the world's cobalt in the 2020s came from the Democratic Republic of Congo. Too geographically concentrated, especially in a country with less stable political regime and poorer record of good business practices.

[00:06:50] **Nathan Niese:** Lithium from South America is found in more desert-like climates. Lithium production from brines in the 2020s was fairly water intensive. There became a real question of, "is that water best allocated to support mining production that serves the world's climate goals? Or should it continue to be reserved for the local towns and villages that have called those locations home for generations?"

[00:07:16] **Mutinta Banda:** In some parts of the world, battery swapping was a crucial innovation that significantly reduced the overall demand for batteries by allowing drivers to replace their depleted

batteries with fully charged ones at service stations. This eliminated wait times and lowered costs since drivers could select batteries that matched their current needs instead of having to pay for maximum capacity batteries.

[00:07:42] **Hans:** I think it really took off when battery swapping also was more adaptive. Over the week, you could have like a 20 kilowatt-hour battery, which usually takes anyone to wherever they need for their daily needs. But then over the weekend, or when you were traveling, you could easily swap that to 80 kilowatts. That is something we see all the time today.

[00:09:38] **Mutinta Banda:** Swapping services have many challenges though; the complexity and costs of these types of services have been a substantial barrier. Most battery pack designs are not accessible, and this has often been a barrier to adoption in major markets.

**Nathan Niese:** The other part of why we don't see swappable batteries taking off nearly as much is because batteries charge so quickly. So if I can charge a battery and not have to remove it, but I can still charge in five or 10 minutes, then a one or a two minute or a three minute swappable battery exchange is not really saving much time.

**Mutinta Banda:** Before fast charging became the norm, charging stations along major routes became popular destinations with various amenities for drivers to enjoy as they waited for their vehicles to charge.

[00:09:51] **Mutinta Banda:** Today, these charging stations are mostly outdated as fast charging decreases



wait times. Batteries can even charge wirelessly through coils embedded in roadways. All of the different charging methods available today work in

tandem with each other to create a seamless experience for drivers.

[00:10:08] **Nathan Niese:** There's still no single solution today for charging. We have fixed chargers at home and fast chargers around town. We have the use of swappable batteries that we deploy heavily in our fleets to further limit downtime. We're able to take advantage of wireless charging that's been put in by governments and other infrastructure companies in some of the most densely packed areas.

[00:10:34] **Nathan Niese:** And then because the batteries are just so much faster charging than what we saw in prior decades, you don't need nearly as much infrastructure as was required in the 2020s and 2030s. The charging locations that remain have much higher utilization and fast turnaround. All of that's come together to really create a well-functioning charging ecosystem,

[00:08:07] **News Clips:** Rapid charging infrastructure expansion in 2028 replaced existing stations and reduced charging times from about 30 minutes to just 5.

[00:08:15] **News Clips:** In 2035, the majority of visitors to en-route service stops are there for fast-charging vs. gasoline refueling

[00:08:20] **News Clips:** The cost of travel is significantly lower by 2045 as

autonomous and electric vehicles are powered by renewable electricity.

(Cheering and cars.)

[00:08:30] **Mutinta Banda:** Back at the race in Sao Paulo, Bela has reached the pit stop at Avenida Paulista and Rua da Consolação.

(A car pulls up and a pit crew is running toward it)

[00:08:38] **Mutinta Banda:** Bela's pit crew jumps out with fresh dandelion rubber tires, a sustainable substitute for the rubber tires popular until the mid 30s.

[00:08:46] **Bela Tanaka:** Computer, turn on autopilot and navigate into the pit.

(Sound of the computer beeping.)

**Pit Crew Member:** Bela! We've run some tests on the OS - the issue doesn't appear to be software related. I'm going to have to check the battery compartment.

(popping open sound.)

[00:09:00] **Bela Tanaka:** What's that small round thing? It shouldn't be here.

**Pit Crew:** HyperWave Halt 13... it's a wireless signal jammer!

[00:09:06] **Bela Tanaka:** I didn't even think you could still get those. What could it be doing in my ca- \*gasp\* Rahul! Ugh! I guess he knows he's not fast enough to win without cheating.





**Pit Crew:** Don't worry, he can't drive like you. We'll get him!

**Bela Tanaka:** Oh, I know we will.

(Sound of tires being placed on the vehicle. Bela gets back into her car.)

**Pit Crew:** Perfect! Readings from your wireless charging signal show transmission has started up again.

(tire changing noises from the pit crew)

**Pit Crew Member:** Alright, we're back up and running. Keep an eye on the battery to make sure there isn't any overheating. You'll need to skip the pit stop that others will have to take.

**Bela Tanaka:** I'll have to rely on wireless charging to get all the way to the finish line. I know it's a gamble... but I've got this!

(Sound of the car starting up and whizzing off.)

[00:10:58] **Mutinta Banda:** Today in 2050, advancements in charging technology resulted in batteries shrinking in size which in turn reduced demand for the materials required to manufacture each battery.

[00:11:09] **Mutinta Banda:** The reduction in demand for mining new materials was a positive environmental impact of battery swapping. However, to significantly reduce the footprint of the EV industry, it was necessary to move towards a circular battery

economy. Government regulations played a vital role in driving this transition.

[00:11:34] **Nathan Niese:** And so the more we do not have to mine from the earth but can actually do what's called urban mining or recycling from the batteries that are already in the system, then we can be a lot more efficient with what's already been pulled out of the ground.

[00:11:53] **Mutinta Banda:** The process of urban mining for batteries is straightforward. It involves dismantling recyclable materials and reassembling them into a new battery.

[00:12:02] **Hans:** when a battery is deemed for recycling, you remove the battery pack from the main application, and today we mainly have the, the cells installed directly in the pack. These cells can be dismantled just like the cells are dismantled from the pack, so you basically separate the, the anode from the cathode, and then the anode can be recycled separately from the cathode.

I think what's great with, with the cells today is really how we are doing this in a much more sophisticated way and, uh, you also get a much better yield. So you, we, we can really use much more of the material than what we used to be able to do.

[00:12:35] **Mutinta Banda:** Urban mining not only reduces the demand for virgin mining but also presents opportunities to further reduce the environmental impact of battery production. For instance, lithium, which is primarily found in water-scarce regions, requires a considerable amount of water during the production



process. But urban mining presents an easy solution to this problem.

[00:12:58] **Nathan Niese:** Society in the 2020s rightfully challenged the battery industry on whether we were simply replacing pulling oil from the ground with pulling battery raw

materials from the ground, and if this was any more sustainable. While we did pull lots of lithium and nickel and manganese from the earth, it was not infinite. And today recycling is able to supply >90% of new battery needs. Those recycling sites are localized, closer to urban centers where cars are used, and they are able to recover metals using renewable energy. It is a much better system. We don't need to mine virgin material from the ground in 2050. If we're doing the recycling of lithium, then the recycling locations can be in regions that if they need water are not gonna be water parched. So it can be in a hydro-powered area of Canada, for example, is where some of the recycling could be done in North America.

[00:13:28] **Mutinta Banda:** And with diversification of the types of materials that are being used in batteries, mining locally has become a more viable and affordable option.

[00:13:39] **Nathan Niese:** We now have some of the other materials, manganese, graphite, and silicone, sulfur. All these materials were much more plentiful than the ones in the 2020s where we were less geographically diverse and more subjected to supply chain challenges because they came from a handful of countries.

[00:14:04] **Nathan Niese:** Now materials can be mined local for local, the circular economy is local for local. We don't need to be shipping materials all around the world, but it can stay in both a closed ecosystem, but also a much more localized ecosystem, which is significantly more beneficial. As an economic engine, for different countries, it's much more resilient in terms of the supply chains that we've developed.

[00:14:30] **Mutinta Banda:** To create a closed-loop supply for batteries, policymakers and industry experts emphasized the need for a zero-emission approach beginning with the mining process. Thanks to these efforts, today in 2050, the lifecycle of a battery has become a closed loop.

[00:14:47] **Nathan Niese:** So it starts with zero-emission mining. The processes in place there to extract materials now have zero-emission mining trucks. All the equipment that's used there is powered by renewable energy. As those materials are then brought to battery factories, these battery factories are now terawatt hours scaled, and they are powered entirely by renewable energy, often hydropower. And then as those batteries are put into a vehicle each one of those auto manufacturing plants again are running on renewable energy and renewable power and heat.

[00:15:48] **Mutinta Banda:** Back in Sao Paulo, race cars zoom through the picturesque neighborhoods of Jardins [jar-dins] and Bela Vista [bell-a vees-tah], weaving through the quaint streets lined with upscale shops, cafes, and boutiques.



[00:16:00] **Announcer:** Number 14 Bela Tanaka has made her way back into the top 5 after that very interesting lap seven pit stop choice. We're now at lap 25 when all of the other cars are likely to make their stops, so she'll be looking to make up some ground.

[00:16:18] **Bela Tanaka:** Come on, Rahul, don't you need fresh tires? Ahhh turn in, turn in!

[00:16:24] **Announcer:** Looks like the 3rd place Gonzalez in number 23 is opting for that stop.

[00:16:29] **Bela Tanaka:** Yes! Now's my time. Computer, show me my optimal path along this stretch with current wind conditions in AR.

(Computer beeping.)

[00:16:37] **Bela Tanaka:** Now I've just got to stick to this as much as possible. Pit crew, how's the battery doing?

(Beeping.)

**Pit Crew:** Looking good, Bela! Charging normally now.

[00:16:48] **Bela Tanaka:** Overheating?

(Beeping.)

**Pit Crew:** Not yet, still, it's going to be tight to get to the finish line before the battery gets dangerously hot.

**Bela Tanaka:** I'll make it!

[00:17:00] **Announcer:** Bela Tanaka is making some serious ground right now! The question is, is it enough?

**Pit Crew:** Rahul looks like he's about to re-enter the circuit! Looks like he'll make it out a few seconds ahead of you!

(Sounds of "electric" revving.)

[00:17:13] **Bela Tanaka:** Argh. Okay... I've got an idea. Oh boy. Here goes nothing.

(Revving increases.)

[00:17:17] **Announcer:** 14 is taking a close cut to the wall around the bend, scarily close even, if she touches the wall her car will go into safety brace mode and shut down so she better be careful, but this could be the move she needs to become competitive in this race again. Oh and here comes 23 from the pits!

[00:17:40] **Bela Tanaka:** Come on!

(Whooshes from the cars. Cheering.)

[00:17:41] **Announcer:** [Excited] Wow! What a comeback! Bela Tanaka has gone from last to 3rd place overtaking Rahul Gonzalez!

(Crowd cheering.)

[00:17:48] **Bela Tanaka:** Yes! Okay, just a bit further now.

**Pit Crew Member:** Wow! What a move, Bela! You are looking at some dangerously high temperatures on the lithium-air battery. It's going to be





tough to make it to the finish line at this power.

[00:18:01] **Mutinta Banda:** As technological advancements propelled electric vehicles forward, autonomous driving was taking off as well. This reduced the need for everyone to know how to drive manually, providing greater transportation accessibility.

[00:18:12] **Nathan Niese:** By the time we got to the 2050s many folks including myself, don't even have a driver's license especially, in metro areas. And in some of the more developed economies, autonomous vehicles just completely reshaped how we get about.

[00:18:28] **Mutinta Banda:** Autonomous electric vehicles brought a new era for transportation in our city cores, including public transport infrastructure.

[00:18:36] **Hans:** I remember a time when connectivity in a bus was that you could, you could stand at the bus stop and then on a digital display you could see when your bus likely would come to your bus stop. That was the technology part of public transportation.

[00:18:56] **Hans:** Today is nothing like that. Today we have much more nimble vehicles that take us with a few others to exactly, to those places we need to go. There is a computer inside that calculates that route in the best efficient way.

[00:19:11] **Mutinta Banda:** Because of the evolution of EVs and autonomous driving, plumes of smoke and massive

traffic jams are no longer a common sight in our city centers. The new possibilities unlocked by these innovations have revolutionized how people move around.

[00:19:26] **Hans:** Because the vehicles are autonomous they are driving so much better than what people were doing in the city. So they obviously drive much closer to other vehicles than what we used to do. We create a lot of space and I think we have a better environment today.

**Mutinta Banda:** Autonomous electric vehicles in cores also bring other opportunities to clear the streets, as they can drop passengers off at locations and then leave to their next destination.

[00:19:44] **Hans:** And also that these cars don't need to be parked. I mean, imagine a city where all these sides of the road we're just parked cars. That is a reality we had 30 years ago.

[00:19:57] **Mutinta Banda:** Today's autonomous and electric vehicles are also designed very differently from 30 years ago..

[00:20:04] **Nathan Niese:** The autonomous vehicles that we have today are much lighter and roomier than the vehicles folks may have known from the 2020s. And that's because you don't need bumpers. You don't need steering wheels.

[00:20:19] **Nathan Niese:** There's just different pieces of a vehicle that we don't require anymore because there's no accidents associated with autonomous vehicles. You don't need that level of crashworthiness and safety that existed in vehicles of prior



generations. And so autonomous vehicles have really allowed us to reimagine what a vehicle needs to be.

[00:21:14] **Mutinta Banda:** Back in Sao Paulo, Bela and Rahul are nearing the end of the race. They're neck and neck in 3rd and 4th place as they come tearing down Avenida Paulista at 300km per hour toward the finish line.

[00:21:30] **Bela Tanaka:** Oh my gosh, I'm so close! I could place in 3rd!

[00:21:35] **Bela Tanaka:** It's all straight from here. Computer, engage maximum aerodynamic mode.

[00:21:39] **Mutinta Banda:** The top of Bela's car sinks inward. The oval roof slides backward, creating a tighter and lower height off the ground, allowing the vehicle to cut through the air with greater ease.

(Battery-operated lowering of the roof.)

[00:21:51] **Bela Tanaka:** It gets real cozy in here when the roof is this low. I just hope my speed increase doesn't shut the battery down for overheating.

[00:22:01] **Announcer:** Wow! Number 14 is clocking in at 350 km! Incredible!

[00:22:05] **Bela Tanaka:** Rahul is right beside me! This is going to be close. My battery heat warning light just came on... argh!

(Whooshing of cars and cheering)

[00:22:13] **Announcer:** Ohhh! Tanaka in 14 and Gonzalez in 23 are coming in so close that by the naked eye it's seemingly impossible to place them! We'll have to check the line sensor.

[00:22:24] **Bela Tanaka:** Oh my gosh! I'm in the top 5! Did I cross before Rahul?

(Car door lifts and Bela gets out of the car.)

[00:22:29] **Announcer:** Well it was certainly a very close call - but we can confirm that the third place spot goes to Bela Tanaka 43 milliseconds before Rahul Gonzalez!

(Crowd cheering.)

**Pit Crew:** Woo!(s) - We did it! -

[00:22:42] **Bela Tanaka:** Woot! I did it! [Laugh slightly.] What a wild ride.

### **Act III: Looking Forward and Looking Back**

[00:22:46] **News Clips:** Plans for a zero-emission city core by 2028 have increased demand for EVs.

[00:22:51] **News Clips:** New policy in 2034 has forced battery manufacturers to increase urban mining efforts.

[00:22:57] **News Clips:** The automotive battery industry is looking to "close the loop" with new green strategies being implemented by 2042.

[00:23:05] **Mutinta Banda:** Today in 2050, the electric vehicle transition has revolutionized our commuting habits and significantly curbed our carbon footprint. Reflecting on the past, there



were some key actions that got us here. .

[00:23:18] **Nathan Niese:** Regulations were huge. When policymakers thought through how we were gonna meet our climate goals, they zeroed in on needing to get fossil fuel vehicles off the road. And so by cities, states, countries committing to the end of the internal combustion engine, getting those vehicles off the road faster.

[00:23:41] **Nathan Niese:** That was a major driver that set the drumbeat for everything else. With that, we then had massive innovation that the automakers and even new companies in the electronics world and others committed to saying, if we now know the future is going to be electric, let's make it the best type of electric vehicle that we can possibly put out there.

[00:24:03] **Nathan Niese:** And the ingenuity that was around squeezing even more power out of a battery; faster charging, making an experience that people would happily switch over to versus one that they would begrudgingly shift into and seeing it as a downside was a major feat of technology improvement and, and working together.

[00:24:30] **Mutinta Banda:** But there is still more work that needs to be done. Electric vehicles have yet to be introduced globally in a uniform manner, often leaving poorer countries behind.

[00:24:44] **Hans:** The biggest challenge is also an opportunity. We have brought so much more infrastructure to the whole of the world.

The whole discussion around electrification and, I mean, in many ways road infrastructure was so much more tied not only to the Western world but to the global north in a sense.

[00:25:05] **Hans:** I think it's really the expansion over the entire globe. It's a challenge, but of course, it's a great opportunity to give people in the whole world access to energy, access to transportation in a sustainable way.

[00:25:20] **Nick Howard:** You've been listening to Climate Vision 2050, a podcast from BCG that explores how the world radically reduced carbon emissions and saved itself from climate catastrophe. Our narrator, Mutinta Banda [Moo-tin-tah Bahn-dah] is played by Atibo Onen. Race car driver Bela Tanaka is played by Rebecca Mozo. Our pit crew actor is Rogerio Jardim. You heard from Nathan Niese, Partner and Associate Director of Electrification and Climate Change at BCG as well as Hans Eric Melin [Mel-in], managing Director at Circular Energy Storage; a London-based consultancy focused on lithium-ion battery life cycle management.

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