



DECODING INDIA'S EV AND DIGITAL INFRASTRUCTURE

Ft. Akhil Jayaprakash and
Arun Vinayak



DECODING Impact

[00:00:11]**Rathish:** It's fair to say that it is a technology and it is an approach, a paradigm that is here to stay.

[00:00:16]**Rathish:** The benefits of EV, not just for the environment, but from a driving experience, from the vehicle design is very, very clear.

[00:00:21]**Arun:** We want to get all of India to go electric. Energy needs to be fast. It also needs to be affordable. And that's the focus for us at Exponent.

[00:00:26]**Akhil:** Protocol is what governs the whole thing. Protocol says, "Hey, if you want to move energy from here to here, use this." But protocol is not going to say, "Oh, you know what, this particular network has not done its job. Let's penalise them."

[00:00:37]**Akhil:** We can talk about all the good hardware, good interoperability stuff. At the end of the day, customers are going to value that when I click that button, has it actually started charging?

[00:00:45]**Rathish:** The endgame really is that, as a user of an EV, I have an app that tells me where is my next possible compatible charging points today.

[00:00:54]**Rathish:** I will get the data of, "Is this charging infrastructure reliable? Is this charging infrastructure accessible?" And also the time it takes for me to charge my vehicle at that charging infrastructure. Based on this, I take the call to say, "Hey, this is probably the one that I will go to."

[00:01:08]**Rathish:** The charging provider has the incentive to then provide the fastest charging infrastructure and the easiest possible time, with the most seamless experience... which inherently means that they're going to choose the charging players and the battery providers who actually can give them the fastest charging infrastructure.

[00:01:23]**Rathish:** So incentive gets aligned across the board.

[00:01:25]**Arun:** My worldview in the future is... energy is going to be everywhere. You will not go to energy. Energy will come to you.

[00:01:30] Welcome to Decoding Impact. I'm your host, Rathish Balakrishnan, where we take population scale challenges and go beyond simplistic solutions to discover what it takes to truly solve these problems at scale.

[00:01:43] The one observable compelling trend in mobility on our roads today is the emergence of electrical vehicles. Worldwide, there is a growing adoption of electrical vehicles. India is expected to take 30% of the EV markets worldwide and the CAGR numbers estimating the growth of the EV market are anywhere between 45% to 60%. However, there are a lot of players and a lot of stakeholders involved in making electrical vehicles happen and running on the ground. There is fundamentally an opportunity for digital public infrastructure to reduce the frictions and enable greater customer experience and thus

driving better adoption for electrical vehicles in India, especially when it comes to the charging experience.

[00:02:31] **Rathish:** Does this truly hold value from a digital public infrastructure point of view? Can we actually achieve population scale adoption of electrical vehicles? And what is the role of emerging start-ups in this space to solve these challenges? To answer these questions and more, we have two entrepreneurs who are working in the forefront of the energy space, especially in the charging space for electrical vehicles in India today.

[00:02:54] **Rathish:** In today's episode, I have two entrepreneurs who are actually solving the problem for India on charging. We have Arun Vinayak, who is the co-founder of Exponent Energy, a full stack energy company. And they have actually built the fastest charging batteries in the world today – 15 minutes. We also have Akhil Jayaprakash, who is the co-founder of Pulse Energy, who's building the Razorpay for EV charging, which actually then goes beyond the battery and builds a software infrastructure that helps us simplify the charging experience.

[00:03:25] **Rathish:** Akhil and Arun, thank you so much for joining us today. It's a pleasure to have two entrepreneurs who are actually solving problems, talk about where we are going with this EV landscape. I have a ton of questions to ask you. But before we go, maybe if each of you could just introduce yourself and cover two things. One, your journey so far. What has got you to this particular work that you're doing and also briefly about the organisation and what you do as well.

[00:03:49] **Akhil:** Yep. I'll go first on this one. I've been in the EV space about seven years now. Started off in Boston working as a product manager. I was one of the initial folks who built the underlying protocol that powers charging stations today. So, OCPP runs on top of WebSockets. That is where my entry into EV charging and how EV infra works. So I got to work with, you know, folks from Tesla and Chargepoint; understood what that looks like in the European model and the US model. I shifted back in 2019 to India and decided, "Hey, there is a problem with payments and interoperability in Europe and the US. Let's target that and solve for that in India."

[00:04:27] **Akhil:** It's a first-mover advantage. Anyone who's going to enter that space just cracks it. So we've been at it since then where people used to say, it's too early for you guys to even think about this because first, infra needs to be there to have this problem. But since 2020, I partnered with the other co-founder, Devang. He was working in a solar company. He was building a full stack there. So partnered with him. So it was... I was a product person. He was a tech person. We started building this out together. Pulse Energy really started off as a B2C business. From there it evolved into a B2B because B2B is where public charging is being utilised the most in India.

[00:05:02] **Akhil:** So it just naturally made sense for us to pivot to B2B, focus on it, sharpen our tech stack with that particular vertical and then eventually progress into B2C. But the core of the problem is very simple, which is, there's going to be 'n' beneficiaries of charging infra because charging infra setup has been de-licensed. There is, as an individual owner of an EV, as scale hits, there is going to be a problem of interoperability. It's a given. Whether it's a connector interoperability, it's a software interoperability. We, as a company, want to focus on that software interoperability. Because – and the elevator pitch that I typically have is – the act of charging an EV is 10 times more complex than just fuelling a vehicle, right? And

today I have data that says 5 out of 10 times charging doesn't start when that user clicks on that button that says start charging, right? Like, it fails. It could be different reasons. But we, as a software provider, want to solve for that and solve for the payments part of it. So that's what Pulse Energy does. So yeah I'll stop at that. Over to you.

[00:06:04]Arun: Hello everyone, I'm Arun. I'm from Bangalore. I love mobility. Built my first car when I was 16. Since then it's been a chase of all things mobility through college, through formula student racing. Then eventually ended up being a founding partner at Ather. And I was the Head of Product for Ather. We started Ather in 2013. It wasn't very popular to be building EVs back then. But we really thought EVs are the future. We were hugely inspired by Tesla and everything that was happening there. Of course, in India, there was this two-wheeler market that just hadn't been disrupted for a while.

[00:06:36]Arun: So, while electric was one angle of innovation, just building a better product was the other angle of innovation for us. And that was, in some sense, phase one to prove to the world that EVs are better, they're faster, they're sexier, they're better, you should move. Along that way, realised by 2017, 2018, 2019, 2020, I think India believed in EVs. Everyone's going electric, everyone wants to go electric. That's when we realised fundamentally the tech platform and the energy ecosystem was missing. Cause enough OEMs (Original Equipment Manufacturers) now want to build good quality vehicles across categories. And in some sense, I think that sort of inspired me to start Exponent. Ather, we started top down, premium market for two-wheelers. But at Exponent, we're now looking at how we can enable all of India to go electric.

[00:07:17]Arun: And we think the drive side technology is already better. Luckily we're saying it's really charging that's really holding back adoption. And I think from time of charging, cost of battery, cost of charging, reliability of charging, 30% of the time your charging doesn't work. Forget how fast it's taking. It's just the systems don't understand each other. So thought this is ridiculous. We need to make energy simple. Like energy is so complicated for EVs that you buy an EV and you're doing all this complicated math. It's great for early geeks buying vehicles who want to geek out on this, but we want to get all of India to go electric, which means energy needs to be just simple.

[00:07:52]Arun: Energy needs to be fast. It also needs to be affordable. And that's the focus for us at Exponent. We've got the world's fastest charging tech, 15-minute full charge, 0 to 100%. And we do that through a combination of our battery technology and charging networks. We have something called the E-pack, which is the battery pack that sits inside the vehicle.

[00:08:07]Arun: And we have our own proprietary E-pump network. We can go and charge them in 15 minutes and keep going. So yeah, that's what we do. We launched three-wheelers. We were only in Bangalore last year, launching in a few more cities this year, in three-wheeler cargo, three-wheeler passenger and soon buses.

[00:08:21]Rathish: Excellent. So just to set it up for both of you, so Akhil, software engineer, building software, focusing on interfaces, not on the dirty nuts and bolts of what has to happen. Auto enthusiast, Arun...

[00:08:35]Arun: I'm the dirty nuts and bolts guy.

[00:08:36]**Rathish:** You're doing the dirty work in some form. You're actually making batteries getting charged and so on, right?

[00:08:42]**Rathish:** You know, there are times where you realise that you're in the middle of a very, very large shift. Tectonically, right? And all the numbers tell us that EV is probably there right now, not just in India, globally, I think, right? Like the CAGR numbers that I have, like, you know, 60%, 45% growth, et cetera.

[00:09:00]**Rathish:** Ownership numbers are massively increasing, but you're right that the concerns for a regular customer today in buying EV are still very real. Like I had to buy a car and I really thought multiple times, do I really need an EV? And even a car salesman tells you that maybe you need to consider this sort of thing.

[00:09:15]**Rathish:** So we really made the shift in even the buyers and the sellers being convinced on EV. But before we get into some of the details — and a lot of the listeners are probably new to EV as a space. They know the buzz around it, but they might not know the market, right? So maybe if between the two of you — and Arun, maybe you can take the lead on this question.

[00:09:35]**Rathish:** Who are the key players in the EV market today? If you sort of paint the picture on the EV market. So there are the Athers of the world. I understand, but you know, there are guys who are making the battery, but who else is there?

[00:09:47]**Arun:** Well, okay, you can divide the product ecosystem in a few ways. I think one is just the conventional way that a two-wheeler is a commercial vehicle. Is it passenger cars? I think that's one way to segment it. There's also a way to look at it — are they vertically integrated players versus horizontal players?

[00:10:04]**Arun:** So you have companies like Ather or Tesla that sort of build the entire stack. And then you also have companies that in a more traditional sense, by technology, integrate and sell. So that's like a traditional OEM model. And then you have technology providers and part providers, right? Could be from a motor to a wheel to a battery.

[00:10:21]**Rathish:** Hmm.

[00:10:22]**Arun:** And then with EV, I think you have this new or horizontal, which is energy, right? Since, petroleum in the IC engine world, petroleum is just this industry that's operated on the ground, right? You bought your vehicle. You can go anywhere and fill petrol. So it was a fairly decoupled ecosystem.

[00:10:41]**Arun:** Wasn't really a point of decision-making when you bought a vehicle. Today, which energy ecosystem do you belong to is a large decision point while you buy the vehicle. Are you buying a slow-charging vehicle? Are you buying a vehicle on swap network? Are you buying a rapid-charging vehicle, a new point of contention. It's an opportunity. It's a problem. Both ways. And of course I think there are all types of models that are changing. I think as the world is going electric, the concept of dealerships and service networks are changing right today, right? The incentive on servers, the revenue on servers, which means dealership sustainability. So you're seeing all of these models change how the dealership works.

Manufacturing is fundamentally changing. Manufacturing was a mode in IC engine vehicles, it's not anymore in EV.

[00:11:22]Arun: So I think you're starting to see a lot more plays similar to a cell phone or a laptop industry where you have brand-agnostic dealers, right? Brand-agnostic manufacturers, technology, horizontal providers... and you have OEMs that focus on integration and brand building. So I think that's the sort of evolution that we're starting to see.

[00:11:41]Rathish: I want to ask one question to you, Arun, before I go to Akhil. Hmm. You said Ather is a vertically integrated stack. Now what all does a vertically integrated stack actually comprise?

[00:11:52]Arun: Well, as far as your imagination can go, but I think it's starting from... one way to look at it is the battery, the technology, the vehicle integration, the motor technology, the other layer of integration, of course, the charging network. Running an open network, are you running on your own network, all the way down to vertical integration on stuff like demand, dealerships, service networks, et cetera. And of course, manufacturing is on the other end of this integration. So you can pick and choose, you can outsource manufacturing, but still be a fully vertically integrated company. That's what an Apple does, for example, right? So I think if you are building your own tech in the EV space, building your own tech, building your own network, I'm building your own distribution, I think that makes you fairly vertically integrated.

[00:12:32]Rathish: Yeah. And I think this is an important question for today's discussion, which is why I thought it was important to double click on it. But what do you want to add, Akhil, to that view? Give us a market view of who are the players and what all is happening today.

[00:12:43]Akhil: I'll start with the consumer, right? So typically, anyone who's going to buy a vehicle, you can classify into two buckets. One is personal use and commercial, right? So personal use is your, "Hey, I'm going to use this, once a while when I step out of home" or "I'm using it for my daily commute to work."

[00:13:02]Akhil: The other one is commercial, is, "Hey, I'm going to ride this thing like max you know, to how much of a mileage, that juice, that this vehicle can provide. I'm going to do that on a daily basis because that's where my livelihood is." And the selection criteria between these two consumers differ. And what I see predominantly in the market today is more commercial because that's the people who are buying that.

[00:13:25]Akhil: For them, it's longer range or, as like the Exponent pitch, which is, "Can I get my charging is done as quickly as possible and then do as many kilometres as possible in a daily basis?". So that's one selection criteria. And within that, you will find a spectrum of OEMs who will offer those solutions.

[00:13:43]Akhil: So it'll range from folks like Log9 and then, OSM and all these guys, and then go into battery charging specific companies like Exponent. And others. On the personal segment, I see the same spectrum, which is the Athers versus someone like a Greaves or an Ampere, right?

[00:14:00]Akhil: So that's the spectrum that I see. Same thing applies in different verticals, like three-wheelers, four-wheelers. That's the way. I have not researched much on buses, so I don't want to comment on that. But I think where I see as a consumer, as a personal consumer, and since you said you had apprehensions of buying a vehicle, right?

[00:14:20]Akhil: Very interesting story that I had when I was doing the B2B sell. I used to go to the car dealerships, act as if I want to buy an EV and just quiz the sales guy on how much he knew about the car. Zero, right? He's like, "Hey, this is a car. Here's a pamphlet. Read it. Like you can read, go ahead and read." I'm like, hang on. I want to know, how is this charging going to be set up? You have two chargers here. How do I use it? What happens if something goes wrong? Who do I call? Has zero idea. And this was 20... somewhere between 2020 and 2021. During COVID, when a little bit liberal, went out, wanted to get a vehicle.

[00:14:56]Akhil: And even today, I think that dealerships, that tribal knowledge doesn't exist. And I think that carries on from the vehicle knowledge, to the charging knowledge, to the servicing knowledge. Like most of the commercial folks that I speak to today, or even end-user, even if it's you and I, we all... one of the things that I'll have in mind is, "Hey, if I buy this vehicle, if something goes wrong, who's going to help me out? How quickly can I get help?" And that's the key question.

[00:15:25]Akhil: I think OEMs or EV companies like all of us have to start thinking about how do we bridge that? And my take on this is, a vertical stack company might not be able to solve for that at scale. Like a billion-plus population, you know, country. I don't think we can solve it at that scale by just one vendor scaling it up.

[00:15:43]Akhil: I think it'll be multiple parties coming together, building a unified answer for this. So I'll pause there. So that's my take.

[00:15:51]Rathish: Yeah. So leading us to the next side, but let me summarise what I'm hearing, so you guys can correct me if I'm wrong. So there are the guys who make the vehicle. So you're making an Ather two-wheeler, you're making a three-wheeler, you're making buses. And by the way, India's buses are getting electrified faster than we can imagine, right? And that's massive, it's one part. Then there are the guys who are making the batteries themselves, right? Which is a battery as a layer of work. Then there is a charging infrastructure. Be it charging, can be charging, swapping, all of that related aspects.

[00:16:23]Rathish: Then there is a selling infrastructure, retail dealership to sell the car, vehicles, et cetera. Then there is a servicing infrastructure, which is really where you're looking at people fixing the cars and vehicles, et cetera. But then there are also software players like yourselves that are somehow building interfaces that can abstract some of these differences, help discovery, all of that.

[00:16:43]Rathish: And finally, there are users. Users can be businesses. Users can be commercial service providers. So when I say businesses, I mean, people who have a fleet, for example. Then there are commercial service providers like cabs, et cetera and then there are personal users. Will that be a good summary? Is there anyone I'm missing that is very important in this picture?

[00:17:04]Arun: Bang on. I mean, maybe just manufacturing system.

[00:17:07]**Rathish:** Yeah that's the other thing that we look at. So another question I had before we get into the details is, sometimes when we approach a new world with the mental model of the old world. Like we have a car as a car, we assume that an EV car is the same as the regular car, ICE car, same thing with charging we say filling petrol stations is going to be how battery stations are going to look like.

[00:17:31]**Rathish:** And I know that fundamentally there are some big differences, right? Like I'll share some that I know. A car or a vehicle in general is infinitely a simpler infrastructure when it's EV based and ICE based. Number of moving parts. And this is my understanding, correct me if I'm wrong. Two is, electricity is everywhere. So it's not the same as setting up a petrol bunk to mean, to set up a battery, a charging station.

These are some things that I keep in mind. But tell me, are there such fundamental differences and how you think about the ownership and the usage experience of an EV compared to commercial vehicles, current ICE vehicles?

[00:18:08]**Arun:** Absolutely. Right. I think bang on, like stuck on the most important differences. EVs are better in every regard and in a good way. But they're fairly similar, right? So you might have automatic versus gear or whatever. But at the end of the day, it's fairly simple. The consumer mental model is a similar problem right? It's everything that's got to do with getting energy to your vehicle and that's where the model is fundamentally different, right? So if you look at petroleum... the energy is a fully upstream on-ground problem, right? Extraction, refinement, distribution. A transaction is simple, right? And distribution is also slightly hard. Setting up a petrol station is fairly expensive and fairly complicated. And a complicated bit with ICE in vehicles was the powertrain. Like how do you take that petrol and deliver power? I personally started my career with engines and I still love them, right? From an engine point of view, they're beautiful, right? They're very complex creatures. So OEMs focus on powertrains on the way and energy companies focus on the ground, and fairly decoupled ecosystems. And from a consumer model point of view, when you bought a Tata car, you didn't care about where you're going to fuel it. That was not even a decision point, right? You said I bought a Tata car for the specifications, for the brand, for the price points, the residual value, yada, yada, yada, right?

[00:19:26]**Arun:** So that's then the purchase criteria on one side being very different and also the entire ecosystem challenges being entirely different. Fast forward to EVs, suddenly there's, like you said, this distribution is solid as it is energy everywhere. There's energy in my wall, right? How do I take energy from a wall to the vehicle? That transaction is fundamentally broken. And now from this can with liquid, you now have a battery, which is suddenly engineering-wise, more complex, more sensitive, it's a sensitive creature. And on the other end, you have the charger. And how a charger and how a battery interacts is... fundamentally... that's the hard bit in this industry. Everything from charge time, battery life, reliability, to the software interaction protocols. That's where the challenge is at. So it's that middle layer, the transaction layer that everything is broken at. And I think... My worldview in the future is energy is going to be everywhere. You will not go to energy. Energy will come to you, right?

[00:20:21]**Arun:** Bangalore has 400 petrol stations. You're not going to have 400 charging stations, you're going to have 40,000 charging stations. All different brands of different networks. And you will, while choosing a vehicle, you'll say, "Okay, I want a Tata car", but you'll also say, "Hey, which network do I want to be part of?"

[00:20:34]Arun: There'll be cross compatibility for sure, but you will subscribe. There'll be a tribe. You'll say, "Oh, I really like this", right? And it's like smartphones, right? When you went from feature phones, you bought a Nokia for Nokia. That's all you cared about. But when you're on the smartphone, you now make a device position and an OS position.

[00:20:50]Arun: You say, "Oh, I believe in Android, or I believe in Microsoft" if you ever did. And you say, "Oh, I want whatever device you want on top of that" right? Similarly with laptops, you say, "I want Intel i5 or i7, or I want an AP because you've truly brought into that drive, into that performance because those things impact your ownership experience.

[00:21:09]Arun: Similarly EV, your energy network impacts your ownership experience. We bought a vehicle, but it's charging every day. Twice a day, maybe. So the last part of your ownership experience will now be determined by the energy partner. So I think that's going to be a two-by-two decision matrix for you to make, when you choose a vehicle.

[00:21:29]Rathish: Excellent. I mean, as you were speaking, and Akhil, I want to get your thought as well. And as you were speaking, Arun, I realised, The cars look the same. The driving looks, feels very similar. Your steering wheel... you have the regular paraphernalia. The fundamental place where the user experience is different, and it struck me only when you're speaking about it, is actually where I charge.

[00:21:49]Rathish: Because everything else, it's pretty much like I go to the showroom, I buy the car, I look at the car, I sit in the car, people sit in the back, I drive the car, etc. It's really only this. And I'd love to, again, as you laid it, the rest of the talk, just focus on the charging process. Because as you rightly said, if we crack that, pretty much at the same road, same car, same steering wheel type of a conversation, right? Akhil, do you see it the same way or do you see it differently in terms of the difference between ICE versus this. You know Arun was saying that, listen, everything is the same. It's really the charging experience that's different. Do you think the mental model is otherwise the same? Do you see differently?

[00:22:22]Akhil: No it's the same. I think. So again, my head works in that B2C, B2B format. B2C, I like, and this is where I, sometimes when I go into four-wheeler space, I often have this hesitation where 80%, 90% of your charging is going to happen at home. You're just going to have your vehicle going to figure that out.

[00:22:41]Akhil: You will pay that money or that cost to do that thing. It's similar to having a water filter at your home. Like when you move into a new place, you need to have clean water. You're going to go buy a water filter, fit it up. Drink water. Simple. When you go get a vehicle, you will figure that out. That's a solved thing for B2C, or at least a passenger four-wheeler.

[00:23:02]Akhil: Where I think the problem statement that, that same correlation might not work is for the two-wheelers because I came across some statistics saying that about 60% to 65% of users or vehicle owners don't have a parking space. So what that traditionally translates to is, now a person does not have a wall space.

[00:23:22]Akhil: They can park anywhere. So now there's this big *junta* of people who will now look to public stations. And if 60, 65 is a huge number from a vehicle ownership point of view, how do we convince that individual to say, you know what, the public infra that's been

set up, that is more than sufficient. You do not need to think about charging as a question. You again, go back to what Arun was saying. When I look at a nice vehicle, I only look at what are the vehicle parameters. I trust the brand that they've figured out fuelling, OMCs are already taking care of it. I trust that the OEM takes care of the servicing needs for me, right?

[00:23:59]Akhil: I'm only looking at how much mileage is it going to give me? How fast will this go? How comfortable are they? How many airbags are there going to be? What are the safety features? We need to drive the population to that level of comfort and not ask the question of, "Oh, has the chicken or the egg come first?" We shouldn't make them ask that question. So just focus on, "Hey, you're buying a vehicle. This thing is sorted, right?"

[00:24:23]Akhil: Like that level of comfort is a long way out. Even though I work in the interoperability space, even today, I'm hesitant to go get a vehicle, right? Like for me, even when I bought my first EV, I was like, *yaar*, I didn't have a charger at my parking lot. And I was figuring out, okay, this is going to be very difficult. How do I figure this out?

[00:24:40]Akhil: And I have two levels of basement. I have to pay... like the plug cost me 2k. The wiring from my meter all the way to my parking lot is 13k. Now the question is, why as a consumer, do I have to pay that extra to get this kind of privilege? I think, that question of charging is going to be a very pertinent one to be solved as quickly as possible, if we need to start seeing adoption go upstream, like it has to uptick in that way.

[00:25:12]Arun: Like I'm not saying everything else would be the same, right? I think EV is such a beautiful platform that the world will just innovate on every year, like EV can be a low-cost vehicle if you want it to be. It can be a faster vehicle if you want it to be. Everything about manufacturing is changing about EVs, everything about distribution and service is changing about EV.

[00:25:30]Arun: So I think every layer of this will fundamentally change how we think of a distribution, how we think about service, how we think about manufacturing, how we think about vehicle variants. Like, today, everyone's vehicle is so similar, the product experience will be so much better for EV. But I think they are all opportunities.

[00:25:48]Arun: They are all opportunities that people will tap into. But I think the bottleneck today, like you said, is on energy. Like the one thing we should solve for, that solves 80% of this immediately, the pain point is definitely charging.

[00:26:02]Rathish: So there's a slight difference in what both of you are saying, but one what you're saying is that, hey, it's going to be a two-cross-two decision matrix. Like you said, here, it's like buying a computer and saying, "Listen, I know I'm buying a computer, but what chip is inside?" Is it an Intel, AMD, is it, whatever? Even if I'm buying a Mac, is it an M1, M2? etc. I'm actually making that choice. What I hear Akhil is saying is that, "Hey, I hope the guys figured this out." As in, for me, the charging is going to be abstract. Now there are very two different ways in which consumer behaviour can fall. I guess we'll find out as we go, but I think that is an important difference in how both of you are looking at the world.

[00:26:36]Rathish: So, coming back to the challenges. And now we're only zoning in on the charging, which we agreed is the biggest challenge. I wanted to, one, get your sense of the macro picture. So firstly, as you said, at-home charging is a solved problem.

[00:26:51]**Rathish:** What is the current policy environment? Is this actually okay? Are there external challenges that are actually stopping innovation? Or is the innovation challenge largely internal, right? Like in us finding the right technology — because you've already solved for charging in 15 minutes.

[00:27:05]**Rathish:** If you look at the full system, right? As people playing in the system, what are some of the biggest challenges today that are holding us back on the charging side?

[00:27:15]**Akhil:** Arun, do you want to take this? At least setting up the infra, I think you might be the right person to answer this.

[00:27:20]**Arun:** To quickly structure this, it starts by user experience at the base of it, right? And this is where I believe India is very unique, right? In the US, like I said, most people afford large batteries. They can park at home, charge at home. Public charging is during highway road trips. For 45 minutes, 1-hour charging is good enough.

[00:27:36]**Arun:** Now that doesn't work in India. Most segments are parking in the road. They can't afford large batteries, which means you are depending on public charging every day. And if you're going to depend on public charging every day, it's got to be really quick. I think sub-10 minutes or 15 minutes is what's needed. So it could be swap. It could be rapid charging. It could be whatever it is. My personal opinions aside. But I believe that's what's needed to get people going. It's sort of like e-commerce where people don't want same-day delivery anymore. Either I'm okay to wait 2-3 days, right. Or I want it in 10-15 minutes.

[00:28:07]**Arun:** And it's sort of similar model that's happening with EVs where one-hour charging is sort of an orphan child. Like, you don't know what to do. You don't want to go to a public place and wait for one hour every day. And so that's a clear dichotomy where either people are like, I'll park at home and charge overnight, which I think is the best way to charge your vehicle. It's the lowest stress on the grid. It's the cheapest way for you to charge. But a lot of people don't have that probability with capability, which means you need to be able to actually charge very quickly somewhere else. And that sort of sets the problem up, which is, if you really want quick charging, and not having quick charging sets up a whole bunch of problems.

[00:28:40]**Arun:** Firstly, if I don't have the ability to charge fast, then batteries get a little larger. So the way there are a bunch of vehicle-side issues, right? Which vehicle gets heavier, vehicle gets more expensive. And on the charging side, it's a question of profitability. I set up a piece of land. I charge two vehicles a day, three vehicles a day, and five vehicles a day. It's a terrible business. In fact, in the city, I'd rather give that piece of land to some other business, right? Than actually be a charging business. So for charging it goes back to the whole... you need to be able to push more energy on the same piece of land. So it goes back to faster charging and faster the better, right? In charging, we say faster is cheaper.

[00:29:17]**Arun:** So actually the faster you go, your end cost of energy comes down to the end user, right? So it's interlinked, like solving this fast charging business can actually solve for a bunch of problems and fundamentally on the profitability of the charging station. And that's how you scale this up. This can't be a government subsidy-based programme, right? Things scale when, at least in India, when something makes money and people are willing to franchise it out and scale it up, put personal capital and scale it up. And today we're not able to prove profitability on the charging and it is sort of interlinked.

[00:29:46]**Arun:** If it's too slow, people don't want to use it. So you have a whole bunch of these assets that are now lying around not being used, which further creates more anxiety to say, I don't want to invest in charging business. So it's sort of a negative flywheel. You've got to flip that flywheel on the positive.

And the third layer to this is, then, responsibility, right? Who owns what? If you really want to charge fast or you want to swap fast, I think that's where probably a divergence of thought on will it be one company that has to solve both sides? Is it a unified protocol that people will just solve on the battery side, people will just solve on the charging side... how'll that sort of interact. Yeah. So I think this is what needs answering.

[00:30:22]**Rathish:** Let's say there are three buckets of vehicles. One bucket is, I have a charger at home. I am going to charge at home. The second bucket is, I have a fleet or a depot. Like I'm thinking buses, I'm thinking anyone who has a fleet, they're going to do that short round, come back to the place, and then they can...

[00:30:38]**Rathish:** And then there is the ones that are going to be standing on the road largely. I'm thinking auto drivers. I'm thinking a lot of two-wheelers that are today parked. Maybe even some of the car owners who today actually don't have at-home parking and etc. Do you have some sense of the numbers? Like in India, is the third bucket 50% of our market? 10%, 30%? Do we have some... I mean, it doesn't have to be accurate number. But as a size of market today, do you know which size each of these buckets are today? Oh how big is the third bucket in some sense?

[00:31:10]**Arun:** Yeah. So if you actually look at and this is, this answer, I think is specific to segments, right? And if I can answer for commercial vehicles, I think that's where we really understand this. and two-wheelers don't really do much with respect to energy consumption. I think we should just skip that for the conversation. Really look at commercial vehicles, right? These are 10% vehicles, 70% of our on-road energy consumption. So really from a sustainability point of view, from an oil imports point of view, that's what needs electrification.

[00:31:34]**Arun:** And we look at that 90% + of these vehicles are owned by... even if you look at buses, very small percentage of them are owned by STUs who have dedicated hubs and can invest behind the infrastructure that you're talking about. Even most buses are owned by private fleet operators right?

[00:31:49]**Arun:** And if I've ever seen a private fleet operators parking but it's a basic parking hub, there's no power infrastructure. And secondly, these buses need to go all over the place so it's not just about whether you park at the hub, but charge at the hub. It's also, you need to charge along the way, along the highways.

[00:32:04]**Arun:** And this is true for even a three-wheeler. So if you go across the segment, if you've got a three-wheeler, 90% of, I think more than 95% of three-wheelers are owned by individual drivers, right? And very similar when you talk about Tata ACs, that segment as well. These are vehicles that are fundamentally parked on the road, right?

[00:32:19]**Arun:** Now it's hard to define how many of them have dedicated parking, or I don't have that number, but in the few surveys that we've done, which is upwards of 300 drivers

when we started Exponent. Like pretty much everyone we spoke to, parked on the road, right? And this point of parking in the road is different every day.

[00:32:33]Arun: It's not like they have a dedicated parking, right? And this is generally a one-kilometer walk away from where they're staying. And if you've actually seen a lot of these parking hubs, you'll see there's a security guard. There are like 100 autos or 40 autos parked there.

[00:32:46]Arun: So that's how parking is done. So for them, we realise the home charging is just not an option.

[00:32:52]Rathish: Hmm. Got it. Akhil, you wanted to add to that?

[00:32:54]Akhil: Yep.

[00:32:55]Akhil: Like my answer was on the question that you asked, right? What are the challenges we're facing to remove that inhibition that users have? I'll just distil this down to two points. One is real estate. Second is the grid operator, who are the discoms. Those are the biggest challenges today in actually setting up infra in that manner.

[00:33:16]Akhil: So, similar to park and charge. If someone needs to go get a hub where I can get enough power to set up that many chargers. It's 3.3 sockets. It's like running 50 fridges or 50 air-conditioners in one location. So grid becomes a very important thing. And then the biggest challenge, and this is purely based out of data that I see, because we have access to about 21 charge-point operators.

[00:33:40]Akhil: That's about 50,000 to 70,000 chargers across India. And we have some of these largest fleet operators also on our platform. Like we have 95% of Uber drivers using our platform on a daily basis, both in their hubs and in public. So I get to see ground reality of setting up a hub. What are the challenges? What is the lead time to even getting into a new pin code? So real estate becomes one; a combination of real estate and the grid access. Those are two critical things. If those two things come together and that is everywhere, then it's sorted. Everyone just, because money is there. People are willing to put the capital in.

[00:34:17]Akhil: It's the, "Hey, can I get the real estate and can I get the grid connection plus the cost of all of this thing? Can I fundamentally put all of these things together and can I easily access it?" And that's not readily available today. Like in certain locations, one operator could literally purchase all the future capacity also for that grid.

[00:34:36]Akhil: Like that's also happening in the market, right? Again, it's just choking out competition. So that happens in the market. Real estate, some people might not want to give it out to charge-point operators. So, if anyone can solve for that, like grid access, and again, there are companies who can solve for it. But that plus availability of land, I think availability of land is a problem that exists today. Like people will end up solving it. There are multiple people looking at how to solve it. Not just in the EV world, outside of EV. But the second part, grid, because as I was telling Arun before we started this, the biggest benefactor of the EV charging industry is a discount.

[00:35:11]Akhil: 50% of revenue is eaten or given to the discom, right? Like 10 rupees, 8 rupees whatever, 4.5 rupees is your rate. But eventually the discom pockets about 10 rupees close, right? And customer is not going to give you more beyond 20. Like their price range is going to be between the 10 to 20 spectrum. And so you're battling with 10 rupees and then amortising your hardware and all this stuff.

[00:35:32]Akhil: So the fun is, grid operator is the biggest challenge. We're giving them the most money. And then you have real estate as well. So it's these three parties that come together. So that's my biggest challenges that I've seen in this market.

[00:35:45]Rathish: Got it. Super. So I love how we are just zooming into one level to another, right? We started with EV. We said charging is the biggest problem. Within that we said commercial vehicles, 90%, 10% massive gains in terms of emissions. Within that, forget the ones that are on the fleet that are in the public place is the problem.

[00:36:05]Rathish: And we started breaking it down into what does it take to make that happen? And I think there are two users largely here, right? The person who's offering the charging infrastructure, the person who's using the charging infrastructure. The person who's offering the charging infrastructure, Arun, what you're saying is, they have to run a viable business and they can only run a viable business if they can charge fast. So net throughput per unit of land is measured by the time it takes to charge. So the more I charge the vehicles, I'll do better. Plus you're also saying that, listen, that has to be just viable in terms of access – to your point – grid access should be possible, land access should be possible. So if they can get grid, they can get land and they can get a fast charging infrastructure, their business is set. Like in some sense, the money in some sense will come. This is a viable business. For the person who's wanting the charging infrastructure, and we haven't spoken about that, I'd love to hear your thoughts.

[00:36:53]Rathish: What are their biggest concerns right now? One, of course, availability will be one. Hey, there shouldn't be any anxiety of just making the miles. What else are they thinking about today when they look at charging infrastructure?

[00:37:04]Akhil: Are you more worried about the person setting up the charger or are you looking at a user who's looking at consuming? The user, right?

[00:37:11]Rathish: The person we have already agreed, right? Like they have to have high throughput, land, and electricity. The person using the infrastructure, what are they worried about? Hmm.

[00:37:21]Akhil: User, I'll give you the data right now. Like, on the user side, at least I've seen price becomes very important. Because we are a cost-sensitive market. Anything that shoots up beyond a certain factor, it just doesn't make sense for them. Especially in the commercial segment, right? So as soon as they see 13, 14, 15 and above, they literally look for other options. Is there an alternate option that I can look at?

[00:37:45]Akhil: Second is accessibility. And this is, I'll share one data point here. This is one of the leading last-mile logistics providers in India. Their CEO had shared a quote with me saying, one out of ten EV owners on their platform decline a job due to range anxiety because they're like, "I don't know if I can do this job."

[00:38:09]Akhil: Like, "I don't wanna take it." They decline. That's 10% on a daily basis. And imagine that revenue hit at the bottom line, right? For that user. And there's a daily wage owner who's looking to make that money on a daily basis. And they're leaving out one job on the table just because they have range anxiety.

[00:38:25]Akhil: So it's the discoverability. It's that, "Hey, can I get the right price point if, even if I discover it, is this going to charge my vehicle quick enough so that I can go back home?" And that's that last tallying it to that 1 out of 10, is that, "Hey, even if I get that charger, if it's slow, oh, it's going to take me time to go back home. Like I don't want to be stuck in the middle of the night on a road just because it took me four hours to charge my vehicle." It's those three things that keep, that's the cogwheels that keep on spinning on what are the apprehensions that users have and that's what I've seen in the market.

[00:38:59]Rathish: Got it. Yeah.

[00:39:01]Arun: I think perfectly sort of cued in right, when you're focusing on this segment, and what Akhil was also saying. I think what we've realised is there's nothing called range anxiety, right? It's charging anxiety. That's really all it is, right? Most petrol owners don't know what a full tank of gas gives them.

[00:39:20]Arun: You've never really cared about it because you'll always find a petrol station. It's always there and it will 100% give you fuel. So that's the sort of trust we have on that energy network. I think that's what's missing today, right? And I think once you solve for that, fundamentally you don't need to worry about large batteries or range anxiety or anything like that.

[00:39:39]Arun: And I think charging anxiety comes in three aspects. One is availability of charging network, which is a density aspect. Second is the speed. And third is reliability. So can I get there quick enough and how long will it take once I get there, but once I get there, will it actually work, right?

[00:39:57]Arun: And the third thing sounds ridiculous. But like I said, we do have the industry standard rapidly today is 70% which means 30% of the time and enough reports about it. That report goes from 50% to 80% and Akhil probably has more data than me on this because he works with more charge-point operators. But it's ridiculous, right? It's just the fact that the charger and the battery are not able to speak to each other.

[00:40:18]Arun: You're not able to start charging, forget whether it's fast or slower. Right? So I think these three aspects play a huge role. Pricing, of course, like anything. Price discovery, I think, is still happening in the industry. And based on happiness, we've realised people pay a few rupees here and there. Especially in our case people worry a little bit less about price because they realise this is their additional revenue. Like they top this up to earn more. So it's okay to give you a few rupees extra if I'm getting thousand rupees worth of demand. So that's how they look at it. But yeah, I think pricing apart, those are the three metrics we look at.

[00:40:51]Rathish: Excellent. Very, very useful. So I'm going to reframe the question now. So just saying, how do we solve for charging anxiety at population scale? If we solve for this, we

are on our way to the utopia of EV adoption in some sense. Would that be a fair statement to make?

[00:41:09]Arun: For sure.

[00:41:10]Akhil: Yeah, definitely.

[00:41:13]Rathish: That's a sharp statement by itself. And let's get the stupid ideas out of the way already, right? Because there are some stupid ways of solving for it, but we should get it out of the way so that we can get it in the others.

[00:41:22]Rathish: The first stupid way is, as we said, just make the battery really large, which doesn't work because it makes the vehicle more expensive, vehicle more complicated, total cost of ownership goes high, all of that stuff because you can reduce charge anxiety by just making the battery larger. But that's not a viable option. So that's out.

[00:41:37]Rathish: The second option, which comes up every once in a while, but I know it's a stupid option is to standardise everything, right? Because if you're standardising everything, it just makes it easier for everybody. It's like petrol. Petrol is petrol is petrol. So might as well be the same. I have some views on this, but you guys know. I know the way you're nodding you have very strong views on standardisation.

[00:41:57]Arun: Yeah,

[00:41:59]Rathish: Both of you. And then we'll come down to this. Hmm.

[00:42:03]Akhil: Arun, I don't know like, the question feels very set-up like, so I'll have...

[00:42:08]Arun: I feel like I've been set up for this.

[00:42:10]Akhil: Exactly, that's what I'm telling you. I know that you're being set up for this, so I'll let you lead on this.

[00:42:16]Arun: So we filed our first patent for swap in 2013, right? It sounded like a fantastic idea. This is obviously the way forward. It was just like a few months into building a vehicle, you realise this is disastrous. It's disastrous for the OEM, actually. Right? Like how do you get Hero Honda, Bajaj to come together and use the same engine, right? You'll commoditize and kill the industry. There'll be no competition. There'll be no good R&D (research & development) capital. That's it. But also realistically, the funny part is, let's say I set up a swap station, right? I actually have two, three vehicles come in and out every hour. You run out of batteries, right? So you need to rapid charge the swap batteries. And that was actually the moment you realise there's no point chasing swap because then it becomes an operational band-aid of sorts for the time being, right? You need to fundamentally go back to the old energy train model. We talk about powertrain, but I think maybe we have an energy train from grid to wheel, right?

[00:43:09]Arun: In that whole energy train from segment you have the charger and battery like we spoke about it, that we have to solve for the energy transfer rate, that more vehicles

on the ground consuming more energy means we have to transfer energy from the wall to the vehicle faster and faster.

[00:43:21]Arun: There's no escaping the problem, right? Trying to escape the problem only leads to more issues, more competition and more costs. And to another point, there's nothing called a large enough battery that we realised, right? So we actually... actually commercial vehicles, right? Whatever number you say, people outrun that at least twice a day, twice a month. So you have to design for that peak utilisation. So I think these are my two points.

[00:43:47]Rathish: Excellent. Akhil?

[00:43:50]Akhil: See, this is a very controversial topic. I don't think standardisation, like again, it should happen in the market, I don't want to stifle innovation. The day standardising comes in, innovation gets stifled. What I think is necessary for the market is an agreement between parties to exchange information or interop with each other. Whether it means... I'm not focused on hardware. You can't like without standardisation, there's no way you can bring in interoperability. I'm talking about purely software, right? From a software point of view, and assuming every other connector, let's say whatever connectors are out there, it eventually gets distilled down into two or three connectors.

[00:44:36]Akhil: Let's assume a world where we have for two-wheelers there's two connectors, for three-wheelers there's two connectors, for four-wheelers everyone is adopting CCS2 (Combined Charging System 2). Let's assume that's the world that we live in. The biggest pain point in that space is going to be software. That's a given. That will be there. And the reason why that is going to be there is there are multiple factors in the act of charging. So there is like, I'll give you an example of a residential charging scenario that happens today, right? A lot of people go and set up these community charges in society complexes. After 6pm, I can guarantee that there's going to be an undercurrent or an undervoltage kind of situation happening in that charge point. Because the building sucking up all the energy, there's all these users who've come home, switch on the lights, everything is on peak utilisation. Charger is gone. Someone's plugged their vehicle in, charger works off, done. Now, how do you solve for that? Now, there are different OEMs building these chargers. Everyone has their own interpretation of how this should be, worked out. "Hey, should my charger just give up after 190 volts? Should I be resilient enough?"

[00:45:46]Akhil: So there is a grid problem, right? How do you manage grid? How do you, as an OEM, figure out what that grid is? How do we, as a software vendor, manage those two elements together? Then comes the vehicle-to-charger interaction. Assuming it's a pretty hot day. Someone's come in. Vehicle's hot. You plug the charger in. It's not charging. Like, it just gives up. It says, "I'm not in the mood for charging." That's a sign that happens behind the scenes.

[00:46:12]Akhil: Now, okay, the charger might not understand this, because the charger is like, "Hey, hang on! This vehicle just said disconnected." Like it's disconnected for some reason. I can give you today in our data. We get on a daily basis, roughly about 10,000 to 20,000 errors that happen on charges. 70% of those errors have 'others' written on them. The stop reason is 'others'. It doesn't specify what the error is. Why did this thing stop? It's ambiguous. And this is, go through the plethora of all the charger OEMs out there. So imagine an interoperability vendor like us or a payment vendor like us. CPO (Chief Product

Officer) has no idea what this is, what's happening, right? They've deployed these chargers and end up using.

[00:46:55]Akhil: For me, I have a responsibility to the user and I look at this data and I'm like, how do we solve for this? The only way to solve for this is again, either I need to go start getting into the hardware market and start fixing these hardwares myself.

[00:47:09]Akhil: Or we publish this data and we say, look, you guys have to be more transparent. You need to communicate these things upstream. And a very classic example of this, how we solve this for Uber. As we all know, in India, there are power cuts. *Teen baje, do baje*, (3 o'clock, 2 o'clock) it will happen, right? It's given. We literally worked with all the OEMs and said, "Hey, whenever you have a power cut you just tell us the stop reason is power loss."

[00:47:35]Akhil: Whenever you come back online, so some chargers will have a power backup, some chargers won't. But you tell us when it's a power backup, a power loss situation. We'll go ahead and restart it automatically for you. It's, again, an industry-first at hubs that, at least in India, that was the first time someone has done that.

[00:47:52]Akhil: But the idea was very simple. No one was able to do it at scale because none of them figured out, okay, this is the actual reason they just said, "*Haan kaatoge (there'll be a power cut)*". And what the impact this causes is massive. So you have a hundred cars in one hub trying to charge. All of a sudden, three o'clock at night, current is off. Now, half of the vehicles, not even half, 75% of the vehicles are like half charged. Drivers show up at six in the morning. They're like, "Hang on, my vehicles are not fully charged. What do I do?" So that's like, the problem goes from grid, charger, and vehicle. A software is a perfect play to help solve for those problems that's happening in between this. But it's a long way out. There's a lot of collaboration that needs to happen, in order to solve for that fundamental problem.

[00:48:39]Rathish: So just coming back to the framing that we had, right? We said, if charging can be made, the charging anxiety can be removed, we achieved the utopia for electrical vehicles. And we agreed that larger battery is not the answer. And I also agree, by the way, that standardisation is not the answer.

[00:48:56]Rathish: It was not a trick question — because I believe standardisation is important in a life cycle. The question is when, right? If we all aligned to type C too soon, I think we'd all have had rubbish mobile phones today. I think we let the time it took for us to sort of land at type C. And I think for an evolving landscape like this to standardise too soon will only mean curtailing, and in worst ways, rent-seeking, right? So I think that's out of the way as well.

[00:49:19]Rathish: So what we are saying is we have to solve for charging anxiety with smaller batteries, with diverse technologies in a way where, and as you were talking, Akhil, I realised distributed accountability is going to be reality. Is it the vehicle that's the problem? Is it the battery that's going to be the problem? Is it the charging infrastructure going to be the problem? Or is it the software that's connecting, the problem? That's a tough problem to solve, right?

[00:49:45]**Rathish:** When you put it like that, what are the biggest levers? One, Arun, not because you're on the podcast, but genuinely, as I'm listening to this, it's clear that a faster and a more efficient battery infrastructure or charging battery is very important, right?

[00:50:01]**Rathish:** Because it just is the fundamental material science that has to solve for it. Number one, Akhil, what you're doing in terms of helping consumers discover the various charging points that are available for them, independent of who's offering this as another starting point.

[00:50:17]**Rathish:** Before we get into what you guys are doing, what else is going to be very critical for us to be able to solve for charging anxiety, given all of these constraints? Some things that you've already touched upon. A far more sophisticated software is very necessary. Because we need a lot of the understanding of why it's not working, what's not working, early monitoring, early alerts, all of that. But what else would you say is important?

[00:50:39]**Arun:** I think here it's not just material science, right? I think with battery and chargers, I think if I would look at this like unlike UPI (Unified Payments Interface) where we are fundamentally transacting software alone, right? And it's sort of a ledger, which has no ambiguity about that process, right? So you can have in some sense, a two-sided handshake and it can be open source of sorts.

[00:51:01]**Arun:** We're transferring energy. There's a lot of ambiguity, a lot of risk management. Actually, in today's world, there's nothing called a static charging profile. Actually, every time we charge a battery, we charge it differently. Not just us, a lot of people in the world do that. And that's where you have two ways.

[00:51:16]**Arun:** One is you have a static way to do it which then becomes... can be open sourceable, right? Or you have a proprietary way, which is, how does a charger battery intershape, handshake, how they transact and how they transact quickly, reliably, safely. It's like the world of Visa versus UPI today, right? I think if you look at the innovation curve there, you started with two-sided protocols, right? And now you have an open source, but the only differentiator there is, here you're transacting real energy, right? Real nuts and bolts.

[00:51:48]**Rathish:** Hmm.

[00:51:48]**Arun:** I think that's where you end up needing risk management. Can I charge this battery very quickly at this temperature or can I not, right? It's actually not a charger decision or a battery decision. It's actually a two-sided decision. And there in some sense, lies a little bit of the challenge and the opportunity. I think that's what we see it managing that transaction. And we think that aspects of this that are very high level, for example, it's very clear call out between us as a battery company and the OEM. Between battery and motor. There's a very clear carve-out there that we are starting to see. We started with a very clear carve-out before the charger to the grid, right?

[00:52:23]**Arun:** And that's where Akhil's solution sort of fits in there, right? Which is everything from discoverability of the charger, upper running payments, et cetera. I think that you will start seeing a unified protocol coming together. You'll probably even see a unified grid access, right? If the discoms start innovating maybe we'll have energy parks.

[00:52:40]Arun: You can just have open source current electricity and everyone can set up their own charging stations. And so I think that's the sort of worldview that we start seeing.

[00:52:50]Arun: And that's some sense of the challenges that we believe needs to be solved. And I think there'll be interoperability. I think the great thing like early days laptops, you had enough ports, you have two, three ports. I think you'll have two, three ports in every vehicle where people will say, I want to subscribe to XYZ charging station. You'll probably have two, three charging stations of choice and you'll have your favourite one and you'll have your backup ones. It's fairly easy to do that. I think interoperability is a must and I think must be brought in.

[00:53:17]Arun: But the only point I want to make and end this is that there's nothing called one charger for all. I think if we actually try to build one charging network for everyone, it'll be a disastrous network for everyone. It won't be great for anyone. And in some sense, that's product management 101. Don't try to build for everyone. To layer that.. to open that layer up, if I look at a two-wheeler, it requires 10 kilowatt of battery. An LCV (Light Commercial Vehicle) requires a 100-kilowatt of battery, right? At 400-volt platform. So if I actually try and build a charger that has to serve a two-wheeler and an LCV, I end up needing so much hardware that it's going to be so expensive.

[00:53:59]Arun: And then my pressure to drive utilisation will be actually much higher because every time let's say I have that charger and a two-wheeler comes and charges up and hogs up the station for an hour, it's going to ruin my economics, right? So the minute you look at that, my immediate reaction would be, okay, let's split up the two-wheeler charger and the four-wheeler charger.

[00:54:18]Arun: So as you start looking at this, every category requires and every use case requires a very different network, right? And so you'll start seeing that evolve. You probably have a baseline network for interoperability for across vehicles, but just fundamental physics needs you to have different voltages, different power levels.

[00:54:36]Arun: And then the business economics post even more... to start carving out niche networks for different segments. And I think the cool thing is like a single petrol pump cost two crores, more than two crores, to set up, right? A single charger can cost as much as one lakh all the way to five lakh. So fundamentally it's 20x, 40x less expensive. So you'll just see a lot more charging stations.

[00:55:00]Rathish: So Akhil, Arun feels like, you know, let's not make it everything interoperable. Let's not make everything unified, etc. What is your take on this?

[00:55:08]Akhil: Okay. I'm going to differ with you, Arun. But I think (at the) hardware level, he's right. Right? Like every vehicle will have its own unique treatment. Because how do I pump enough energy into the battery of the vehicle without impacting it? That's a science. That's going to be there. How you control the charger is also going to be unique.

[00:55:28]Akhil: So the way you... like Arun has built his business, that's going to be retained as there's a clear value proposition to it. Where I think unification will start happening is on the software layer, right? So let's assume that as a vehicle owner you don't want to go out and say, "Oh, is this just this one network that I can use for charging my vehicle?" Like, that

will never be the case. It will be multiple. They need to have that choice. They will always ask for it. I have had OEMs as Arun's one example was, hey, your initial version of laptops have multiple ports, right? Yes, people will build out vehicles with multiple ports, charging ports, right? Like one that would work with Exponent, one that would work with something else. But that will happen, that will get shipped. Eventually, over time, I see it as, hey, there is going to be networks, hardware networks and vehicles separate like, it'll work. Users will, or OEMs will ask them to go to the right network based on what the vehicle needs.

[00:56:30]Akhil: That is going to exist. Everyone will have a differentiation there. I think the key is going to be the act of payments. When I click that button or my vehicle asks this charger to start charging, does it start charging? Or do I have to do like a Aadhaar verification form before I start charging? Because if you look at even BESCO's (Bangalore Electricity Supply Company) app today, you have to literally like, it's like a *janampatri* (horoscope), right? Like you have to write down what your vehicle number is, everything, in order to just start a charging session. You don't need that. You're paying money now to download and start charging your vehicle.

So what I strongly believe is there's going to be a unification in the software layer that will happen, whether it's a community-driven exercise or the market figures out that this has to happen. And all of this has to be linked to this user's credit card or debit card or UPI. That's a different function, but the physical delivery of energy will be a different function. And I'll give you a cross reference list to an example of UPI itself, right? Banks, day one, they were not perfect when it came to software. So even UPI today, the act of settlement of UPI behind the scenes is just manual. It just happens quickly on the face of it. But behind the scenes, there's a bunch of banks and Razorpays and everyone scrambling together to figure out, "Okay, how do I settle this money?" How do I make sure that Arun's got his share, Rathish's got his share? So same thing, that evolution will happen. So A, the launch of that unified... some community, some market has to put that, "Hey, this is what is going to happen. Everyone needs to come on board with this or aligned on this." And then eventually that progress is going to happen where things are going to get patched up.

[00:58:10]Akhil: Like I can give you an example of, I can bet that if I integrate with Arun's network, I'll have less headaches. Because if I ask him to start charging, his system will go ahead, start the charging session because cloud is his, the hardware is his, battery is his. Everything is perfect, right? He has a pretty nice stream of data from everywhere. And over time he'll improve that ecosystem.

[00:58:33]Akhil: But if you look at a traditional CPU (Central Processing Unit) out there, cloud will be someone else's, hardware is someone else's, battery could be someone else's. So there's three failure points across the system, plus four, because the grid is also in between. So four failure points. So even if I build that unified layer, pinging the system to go start charging, it's not going to work on day one. It'll take time to get to that place. But that's the future. The future is unified payment system plus energy delivery will be distributed and staggered. There will be multiple vendors in that space based on a vehicle type.

[00:59:10]Rathish: I think both of you are using two different words and I wanted to sort of, because that's a really important difference, right? Arun, you said standardisation. Standardisation is everything having a same, let's say a standard that you apply in a tier two, which means that there is a sameness to what we are talking about.

And Akhil, you're talking about unification. Unification is that, hey, irrespective of whether you're the same or not, there are some layers on which we are able to have an abstraction that sort of brings us all together. And fundamentally, and I'll tell you my bias, my fundamental bias is there is some level of digital public infrastructure thinking that is necessary when, especially when, as we laid it out today, so many stakeholders have to engage, not just Exponent, right? And the person who charges the battery, the OEM, et cetera. So I want to maybe just think about what can DPI's (Digital Public Infrastructure) role in, in this problem be right? And maybe if there is time, talk about the UEI (Unified Energy Interface) as well. Is there a chance that the fundamental transactions in this universe, the EV charging universe, can be standardised at a protocol level, not at an implementation level, right?

[01:00:19]**Rathish:** For example, when you say start charging, stop charging, error codes, payments, status checks, warning models, those are all protocols, right? These are just things that you use. This is not the actual physical infrastructure. Let's say if we assume there are going to be vehicles on the road that need a different charging infrastructure.

[01:00:41]**Rathish:** So let's assume that diversity is going to be the norm. It's not going to be an exception, but is there an opportunity for us to build an interface where not just like a Akhil or a Pulse as a network, right? But anyone can build a solution where I say, "Hey, for my configuration, show me the appropriate charging infrastructure."

[01:01:00]**Rathish:** Could be any of them, right? For Exponent, it'll only probably show Exponent's one. Two, for this, start charging, stop charging, measure charging, show errors, all of that stuff... Is there a way, without standardising, we can achieve unification through that digital public infrastructure approach?

[01:01:15]**Akhil:** I'll draw parallels to the payment gateway industry that we have today. Why does someone actually, like... why can't you just directly integrate with banks? UPI is standardised. Now all you need is, be a payment aggregator. Get an acquiring bank access, the UPI stack, and you can start directly integrating with the banks.

[01:01:33]**Akhil:** The reason why they don't do that is it's just much more difficult. There is too many, like everyone has their own treatment of the UPI stack or the UPI protocol. Now there's a reason why a Razorpay or a Juspay or a Paytm or a PhonePe, like they all index on one thing, like success rate. Hey, if you come to a gateway, we are gonna give you success. Awesome success rate.

[01:01:54]**Akhil:** Protocol is still the same, right? Everything is underneath the hood. The act of telling a bank to push money into your bank account is the same. But there are chances of failure. So companies like us will exist. Protocol is what governs the whole thing. Protocol says, "Hey, if you want to move energy from here to here, use this."

[01:02:14]**Akhil:** But protocol is not going to say, "Oh, you know what, this particular network has not done its job. Let's penalise them." Not going to happen. Neither, the market won't embrace something like this. Now, what the market or the people looking at the protocol can do is, "Okay, I'm going to adopt this protocol."

[01:02:30]Akhil: I'm going to keep it. It is up to them to figure out how well I should respond to these requests." Case in point. Let's take UEI as an example, which is a backend-enabled protocol for energy transactions. Let's assume a CPO (Charge-Point Operator) consumes it. Says, "Okay, I'm back and enabled today." Now, based on the data that we have, I can tell you again, 50% failure rate, anyone who integrates it, right?

[01:02:54]Akhil: So if it's a regular CPO I can tell you that 5 out of 10 will fail at the first try. Now, what is the consumer going to look at? Consumer is going to look at, "This is a horrible app. I've tried, like it's taken my money first and I'm trying it; out of 10 times, 5 times it's failed already." So people are going to blame the app. Now, when you start doing that, people are not going to blame the protocol. It's not that. Protocol's done nothing. Protocol's just said, "Hey, Akhil has asked for money in exchange of the... Akhil has asked for energy in exchange for this amount. Can you facilitate it? Go forward and do it." A, the way that market or the economy structure would exist is, you would have charge-point operators or CPOs. They will exist. They will have their own unique system to communicate to the charger and do all of their stuff. But there is going to be a transaction layer and payment layer. Payment layer will use the existing infra that is there, like UPI.

[01:03:49]Akhil: Transaction will be UEI. So, think of it as, I paid 500 rupees for charging. Act of charging started. Some power cut happens. 300 rupees is what has been debited. Actual delivery has been of worth of 300. Now, you as a CPO, and as an application which I have, because users come on my platform, I am obliged to give them back the 200, or not deduct the 200. How do I communicate that across this ecosystem? That's what UEI does. So UEI will ensure that the right attribution of amount and energy happens between the multiple players.

[01:04:25]Akhil: Think of it as a nice layer that will look at, "Hey, are you playing well? Did you actually indeed do 500 and you're not doing 400 and telling me it's done 500? Or are you taking less money from this customer and you're delivering more energy to this customer?" So that layer should exist and there'll be multiple companies that will come on top of it.

[01:04:43]Akhil: But that's the world that I see, right? Hardware, that's where, hardware, battery, chargers, cloud. Cloud payments and interoperability. That layer will need a protocol. That's what UEI is about. And in that protocol, there'll be customers there. There'll be companies there that'll ensure that, hey, who's adhering to the protocol.

[01:05:03]Akhil: "Hey, this user requested this much amount of energy. Are you doing this much amount of energy? Hey, you owe this customer this much amount of energy back." Like, all of that comes into, there'll be a parallel economy that will get built on top of it. So yeah that's my take on this.

[01:05:17]Arun: Like I said, I mean, there is an energy transaction layer, the way I could put it, which I think has a lot of nuances, because that's where there's nuts and bolts involved, right? I think that's where voltages are different, power levels are different, connectivity requirements are different.

[01:05:32]Arun: Even at that layer, you can have interoperability. I think it comes at a cost, but I think it's not too high a cost. Vehicles are large enough, especially commercial vehicles, with the focus being commercial vehicles. It's very easy to put a second connector, say, have multiple connectors, network accesses.

[01:05:47]Arun: But I think anything about that from discoverability of charging networks, payment gateways, et cetera, I think you can make them interoperable. For example, that's not a focus of innovation for us. So I think that's how I split. So even at an energy transaction layer, there's both nuts and bolts and proprietary software. Lot of algorithms and intelligence at that layer which I think most companies would find it hard to share.

But I think if I took a look at that, at an abstract layer of ledger which is basically, how much did I charge? Did I charge error code? You could have. Most error codes could be open sourced. I think those things will evolve. So again, you'll have proprietary error codes, which, because you're doing something different and you'll have standard error codes. And most error codes can be fairly standardised. Are you charging? Are you not charging under voltage or voltages? There's not too much innovation there. So I think that's how we see this problem. I think there's some intelligence layers. On top of the business on ops management, I think queuing, route management, stuff like that. I think different companies would probably build different intelligence layers on top of that, which can be easily built on top of an open protocol. So I do believe in unification very strongly. And I do believe in interoperability very strongly.

[01:06:58]Rathish: And maybe if I tie this back together, what we were saying, and we started with this thinking that what does the person who's running the charging infrastructure want and what does a person who's using a charging infrastructure want? Number one, when we talked about charging anxiety, A, we said fast charging is going to be important. Two is, a lot of throughput of users that are coming in, like the person running the charging infrastructure wants to be as discoverable as possible. The person using the charging infrastructure wants to discover as many opportunities to charge as possible. They want a seamless user experience on both sides.

[01:07:29]Rathish: This person doesn't want to ... I mean, the reason QR code with a coconut seller today is because "Listen, I'm not going to differentiate on how I collect your money. You just scan it and give me the money. I'm gone." And the person who's buying is saying, "Listen, I want to spend as little time giving you the money as possible."

[01:07:43]Rathish: What we are saying is that the speed of charging in some sense is going to be a place where there's a lot of innovation and a lot of proprietary work that has to happen because we are still discovering the truth. But discoverability of charging infrastructure on both sides is actually something that an open network can enable. Seamless experience can be something that an open network can enable. And that will actually ensure that people then focus on the problem they want to focus on. Right? And it was something you earlier said, Arun, even the engagement of discom is not something anyone is going to differentiate on. I'm never going to come back and say, "I have a better relationship with the discom."

[01:08:17]Arun: Yeah.

[01:08:19]Rathish: And as metered as it is, you know, as possible, it's better. So which then makes it easier for everybody to focus on what they really want to focus on in terms of their value, right? And for me, this is and this is an excellent way for us to even think about where unification will unlock value and where there is a need to have diverse solutions without standardising.

[01:08:39]**Rathish:** Because a lot of times when we talk about this, the intuitive thinking is to say, standardise everything! Which is why I said that's a rubbish solution. But there is still that blend that we can create where we enable proprietary value to be unlocked while achieving unification in layers where customer experience and customer value and friction can be reduced significantly.

[01:08:59]**Akhil:** Yeah, so five years from now, right? I think if touch-wood, if Pulse is also based there, the way I see this is, users will start valuing companies or charging operators who will start on the first click. It will become a differentiating factor. I can clearly see that. There are so many customers that call us up and say, "My money is taken. This has not happened. Charging has not happened." Eventually, so we can talk about all the good hardware, good interoperability stuff. At the end of the day, customers are going to value that when I click that button, has it actually started charging? Because the act of fueling a petrol pump is very simple. If I go there, there's one guy who will guarantee that when he presses that thing, petrol is going to come through that nozzle. In a charger, that's not the case today. And eventually, that's where, and I think that's where I see that someone like an Exponent can build out a fairly large business because that's reliability based.

[01:09:56]**Akhil:** That's the way I see it, and faster. Again, just adding to those two points of how do you differentiate in that kind of economy, in that market, that this is how it will be.

[01:10:05]**Rathish:** So I want to paint a picture of the endgame and I want you guys to let me know whether I've got this right. The endgame really is that as a user of charging, I mean, as a user of an EV, I have an app that tells me where is my next possible compatible charging points today in the infrastructure.

[01:10:25]**Rathish:** But not only that, I will get the data of, is this charging infrastructure reliable? Is this charging infrastructure accessible? And also the time it takes for me to charge my vehicle at that charging infrastructure. Based on this, because I have the choice of distance and time, I take the call to say, "Hey, this is probably the one that I will go to." And then the charging provider has the incentive to then provide the fastest charging infrastructure and the easiest possible time with the most seamless experience, which inherently means that they're going to choose the charging players and the battery providers who actually can give them the fastest charging infrastructure.

[01:11:06]**Rathish:** So incentive gets aligned across the board because of the observability of quality, right? Which is, reliability and speed that we talked about earlier has become more visible for everyone, right? So the app doesn't tell me which is closer. It tells me which is closer, which is most reliable and which is the fastest.

[01:11:25]**Rathish:** And then I'm able to make that decision. And because data on reliability, speed and distance is universal, not standard — universal, enables us to make better choices and set up better incentives for everyone. Is that an endgame that is good for all of us?

[01:11:46]**Arun:** I think the endgame is you don't have to choose, right? I think today with Google Maps, you don't actually decide your route. You just trust the data, you trust the route mapping. And I think that's what will happen now. I think charging is a deviation. It's not what you want to be doing. So you actually want to be going somewhere.

[01:12:07]Arun: So I think systems will figure out what's the best solution for you. Everything from how, to what's your least drive deviation, to fastest charging, to most reliable payments. And how do you get it, get you out. And I think that can all be integrated and a lot of that can be unified. I think that's the end state where if you have, let's say 50,000 charging stations in Bangalore and you're going to have, I don't know, 5 million vehicles, more than that. You just imagine a number of transactions, right? At any second, any minute you also have to ensure the right vehicle turns up at the right time station.

[01:12:39]Arun: And what do I mean by that is the charging station has to be right for the vehicle, but the vehicle also has to be right for the charging station, economic in a property point of view and you also need to ensure not enough vehicles are targeted to the same charging station. So you've got to manage queuing. And so I think that's the end state where people don't think and don't have to make decisions. They just drive. Or maybe that also goes away.

[01:13:05]Rathish: Yeah. But I think you're taking it one step further. You're saying that data is available for somebody to desire and tell me what to do. I don't even have to think about this entire thing. There is software that makes this computation and tells me, this is just the way to go. Yeah. I agree.

[01:13:19]Arun: Yeah. Today, I think the computational power already exists. I think data exchange doesn't happen. Like today, as simple as payments, right? Charge-point operators don't know who they are charging, Right? So just managing payment becomes painful. So we're still like solving that basic exchange of wallet IDs and exchange of user ID project. But of course, as we open up and build a lot more unification across layers, I think this will definitely happen.

[01:13:44]Akhil: So I have a very funny story to share on that point of like choice. I also believe that it should not be a choice. And the conversation was, we were talking about introducing ratings on charge-point operators. And somehow one of my friends actually said, "Yeah, you never look at, *is petrol pump ka attendant* was very nice to you versus the other one. And you don't go to that favourite, you know. You're like, *petrol, petrol hota hai*, (Petrol is petrol) like you go there and you go there. Like one guy is not nice and the other guy is not nice. That's not going to be a deciding factor. It's a journey. It's the intent. That's how you're going to make that decision making. And so the way I look at it is from a data point of view, it'll be ubiquitous. Eventually as humans, let's assume a world where there is N number of chargers. Let's say, I think China is about 10 is to 1 for two-wheelers... I think four-wheelers. So let's assume that's the kind of ratio that we have for charges versus vehicles. Then, as a user, you'll start earmarking locations.

[01:14:41]Akhil: Because today, even if you drive a vehicle, you're not always opening up Google Maps and doing it, but that journey is going to be there. People are going to start with discovery in Google Maps, going to understand, learn all of those, and then eventually, you'll be like, "Ha, I know there is a charger on this road."

[01:14:56]Akhil: The second factor is going to be reliability as you spoke about, right? And I think, Arun's point is very critical, and which I don't think other CPOs care about right now in this market, which I wish they do, and opening access will enable that. Because then this will start showing up in other platforms now, they will actually start getting pink because what's happening today, you have a network, you build your own app and you put it out there.

[01:15:23]Akhil: Now, if you are a company who listens to customer feedback, great. But if you're a company who's (saying) "Boss, I have set up chargers, I put up an app, go charge there, right? If charging doesn't start, it's not my problem." It's either the software guy or it's the hardware guy. Go call them. If that's how you're running the business, it's not going to happen.

[01:15:42]Akhil: So eventually it'll weed out these players. It'll go to a world where everything is highly reliable and you don't have... users don't have to have a choice. The way we'll get to that is that interoperability key, right? Like the software interoperability. Because it opens up visibility. It builds that trust to the user that, oh, I will have a charger at the corner of the street.

[01:16:03]Akhil: And eventually it will push all of us to build a better platform, build a better ecosystem. And I think folks like Exponent will be the first ones who will build that stack and put it out there, right? Like they'll show that, okay, this is what the right one is. And everyone starts. Obviously, people building it into disparate infrastructures will eventually evolve to that, "Oh, these are the best ones in the market. Hence, I'm going to get the best reliability if I use these things." That's the world. Interoperability plays a very important role there.

[01:16:28]Rathish: So one last question. To get to that world, if you had two, three things that you want to happen in the ecosystem that will help you get there faster from where we are, if that's where we want to go. Any top-of-mind thoughts saying, if I wish this happens, we will get there faster.

[01:16:47]Akhil: I think, from an interoperability point of view, I think there needs to be a push from the government. Like, community members can come together, but it can be accelerated. A ministry could be a catalyst for the whole programme. For example, UEI. We have 20-plus partners already participating in UEI, adopted the protocol, running it. Why isn't the rest of them on it? Or why isn't the rest of them interested in understanding what this is? A, it's the visibility. Obviously, we got to make more noise. So it's not just, waiting for a ministry to come. But B is very important, which is, getting a ministerial backing on that, right?

[01:17:26]Akhil: So if a ministry comes in and says, "You know what? I think this is a good initiative. These companies have done it. And here's what the traffic that they have garnered so far. Go ahead. Here's my blessings. Go run!" That can be such a huge catalyst for that, for UEI specifically. That's one thing I would say, is something that is needed in this market. Again, selfishly, because it destroys our business case.

[01:17:51]Akhil: If UEI become successful, we'll have to figure out other things that we can do on top of UEI, yeah, but it's so important that the market needs a solution like this, and a ministry can accelerate it. Otherwise, it's just going to take its own time.

[01:18:05]Arun: I think the risk of sounding like a private company complaining about the government, but really I think it's infrastructural support. There are things that private companies can solve. There are things that private companies will not want to spend money. So I'll leave. It's analogous to a road. No one's going to invest in road. We're all going to invest in vehicles and manufacturing and technology that runs on top of it. Availability of grid infrastructure, speed of availability of grid infrastructure, cost at which it's coming in. Today actually what Arun was saying, is bang on.

[01:18:35]Arun: The discoms make the most money in EV charging, right? They make money upfront, right? You're paying everything from installation fee to like monthly demand fee even if vehicle doesn't come, charge or not. We still have to pay the cost of charging, So it's a huge first-mover disadvantage in setting up charging if you're the first charge-point operator in an area that draws the power line and sets it up. You actually end up bearing the 100% of the cost. The next charge part of the system next to you actually gets rides on top of that.

[01:19:02]Arun: So anything that's a first-mover disadvantage, private companies, will say, "Let's not move."

[01:19:05]Arun: They'll wait. This is especially true with the intercity charging. If you look at buses, if you look at cars, there's nothing called a national, like you have NHAI, you don't have a national grid, right? So you don't.

[01:19:16]Arun: So actually if I want to do a Bangalore-Hyderabad, I actually have three governments to deal with to actually set up power. So, while you have aspects of the government that's looking at vehicle in a unified manner, regulations for vehicles, incentives for vehicles, all of this in a unified manner, there isn't actually a unified framework for grids and power infrastructure. Honestly, the government should just be setting up e-parks, energy parks everywhere, right? And give it a PPP (Public-Private Partnership) model like you set up a national highway and there's a PPP model. Government should be setting up energy parks, and it's a commodity, right?

[01:19:47]Arun: Like it's good. You can have multiple... You can have a swap player. You can have a rapid charging player. You can have a charging player. They'll all come, rent it out, set up their chargers in front of it. After that private companies will take over, right?

Everything from building right hardware, finding customers, onboarding customers, building the right batteries, building the right vehicles. Financing these things, all of that is something that attracts private companies, VC, capital, venture debt, all of this. Banks will all get behind this. But the infrastructure is something that needs a longer term view. And it is fundamental infrastructure for the country. It's not going away.

[01:20:19]Arun: The 220 volt AC is standard. It's not going away. That's something we can all build interoperability on. That's something that government should take the first step on.

[01:20:28]Rathish: Excellent. Thank you. Thank you. Both of you. Fascinating conversation. I learned a lot. I want to quickly summarise what I picked up from the discussion. So it's just as a way to sort of synthesise all that we talked about.

Number one, we started with the broader EV play. It's fair to say that it is a technology and it is an approach, a paradigm that is here to stay. The benefits of EV, not just for environment, but from a driving experience from the vehicle design is very clear, but the question for us is, what does it take for that to become population scale? And we broke it down and said, charging experience is going to be one of the critical levers for us to be able to make this ubiquitous. As you rightly said, it's not a reach anxiety. It is actually the charging anxiety that we really have. And we said solving for that, you know, has multiple options. One is at-home charging, already taken care of. The other is the fleet charging, already taken care of. But, for

India, given the size and the number of vehicles that we have on the road, having charging infrastructure on the road is going to be the problem that we have to solve for.

[01:21:30]**Rathish:** And solving for that in a way that makes sense for the person who operates the charging infrastructure, and for the person who's using the charging infrastructure is going to be important. For a person using the charging infrastructure we talked about the discom access.

[01:21:43]**Rathish:** We talked about the real estate access, but we also talked about making money being a direct correlation to throughput of vehicles charged. Which means that more vehicles have to discover them. More vehicles have to be charged as fast as possible and more vehicles have to pay them as fast as possible. If that can be done, it will happen.

[01:22:01]**Rathish:** But a person who's driving a vehicle, it is essentially to be able to discover as many charging points as possible. Know which of them are reliable and know which of them are fastest. Right? I just sort of put this together.

We said there are things that are going to be proprietary because there's a wide range of innovations that are happening at what we call the material layer, which is really that how is the actual battery design? How does the charging infrastructure speak to the battery? How does the charging infrastructure work? And I think it was unanimously agreed that standardising that too soon will mean that we will stifle innovation. There is way more entrepreneurial innovation that has to happen in that space to stop it, right?

[01:22:36]**Rathish:** What we agree, the other two problems, which is the problem of discovery of charging stations and the problem of ensuring seamless transactions in a reliable manner, and you brought up the point where you also highlighted just making sure that even if 30 to 50% times it fails, how do we address failure is actually the norm, not an exception. And how do we do it in a manner that is fair, is very important. And that part of it is unification. We agreed that aspects like error codes can be unified. Data can be unified. Discovery through that data, recommendations through that data will only make things better. Finally, we ended with what does it take to make this happen at scale?

[01:23:13]**Rathish:** As always, the government is the one person we talk about who's never on the call. But we always have ideas for them. But the truth is that the infrastructure that we need to run this at scale is far more. You talked about energy parts. You talked about access to discoms. You talked about the whole new way to build this right for it to run at scale that the government has to take care of. And also not just at the infrastructure level, at the standards level, at the risk of putting Akhil out of business, UEI needs to have large-scale adoption because it makes it easier for everyone, right? And I think that's very critical.

[01:23:45]**Rathish:** Infrastructure always lags innovation, right? But in the hope that we drive innovation forward, we hopefully find infrastructure catching up. Thank you so much. Both of you. I think it's been a fascinating conversation. I hope you enjoyed it as much as I did. Thanks so much for taking the time.

[01:23:59]**Arun:** Thank you. Fantastic being here. Thanks so much.

[01:24:02]**Akhil:** Thank you.

[01:24:04] **Rathish:** Thank you for joining us on this edition of Decoding Impact, a Sattva Knowledge Institute production. If you like our conversation on digital public infrastructure, do head out to the Sattva Knowledge Institute website, where we have a lot more knowledge articles and podcast episodes on digital public infrastructure.

[01:24:22] **Rathish:** Do check out Season One and Two on Spotify, YouTube, or anywhere else that you consume our podcasts from. Join me again another fortnight where we come back to you with another podcast episode on Decoding Impact.