POWERING PROSPERITY: EMERGING PROMISE OF DPIS IN INDIA'S ENERGY SECTOR

Ft. Dr Nikit Abhyankar

Sattva Knowledge Institute SKI

DECODING Impact

[00:00:11] **Rathish Balakrishnan:** There is no economically rich country that is energy poor, which means that as India continues to grow economically, our energy demands are only going to increase.

[00:00:17] **Nikit Abhyankar:** I believe of all the countries in the world, India truly is a unique position to transition rapidly and be an example for the other countries in the global south.

[00:00:28] **Nikit Abhyankar:** So, the key solution there is creating cost-effective, economical and technically viable energy storage solutions.

[00:00:36] **Rathish Balakrishnan:** As we talk about energy, one aspect of it is the creation of energy. The other aspect of it is just the consumption efficiency of energy at the appliance level.

[00:00:46] **Nikit Abhyankar:** Number one is how efficiently are you using your energy. Number two is, when are you using your energy. And number three is how responsive is your energy consumption. I always say that India actually runs the largest demand response program in the world, which is agricultural load shifting.

[00:01:07] **Rathish Balakrishnan:** We just understand that when we switch it on, the light comes up and the fan runs. But there is this entire planning around where is the supply coming from? Where is the demand coming from?

[00:01:15] **Nikit Abhyankar:** So I think this is where India again has that leapfrogging opportunity, where other countries are just not even close to where India is, in terms of digital payments and also in terms of widespread cell phone adoption.

[00:01:28] **Rathish Balakrishnan:** I feel like the DPI thinking in general will make the transaction friction become much lesser.

[00:01:33] **Rathish Balakrishnan:** The impact is not just the energy saved, the impact is the infrastructure readiness you create.

[00:01:38] **Rathish Balakrishnan:** Welcome to Decoding Impact, from Sattva Knowledge Institute, hosted by me, Rathish Balakrishnan, where we go beyond seemingly obvious solutions to vast complex problems to truly understand what it takes to systematically solve these problems at scale.

[00:01:53] **Rathish Balakrishnan:** India is at an interesting crossroad when it comes to energy today. There are three potentially interesting trends that we are watching out for. Number one, we are the third largest producer of renewable energy in India today. Number two, our consumption today continues to rely largely on fossil fuels, despite the progress that we've made on solar and other sources of energy. And number three, we are still at a very nascent journey in our energy consumption.

[00:02:21] **Rathish Balakrishnan:** All signs point to India's energy demand growing over the next couple of decades as you continue to industrialise and grow economically. How can we be better prepared to ensure that we have the right and the resilient energy infrastructure to meet

all our needs while meeting the environmental necessities and goals that we have set for ourselves as a country?

[00:02:45] **Rathish Balakrishnan:** In today's episode, we're going to ask ourselves three questions. Number one, how do we truly build the resilient and the ready energy infrastructure for the future? Number two, we ask ourselves what are emerging trends in technology that enable not just a supply side, but our demand side also to be responsive to the energy demands and ensure that we have a progressive structure that makes the maximum and the most efficient use of electricity. And three, how does digital public infrastructure thinking enable us to solve some of these problems at scale?

[00:03:18] **Rathish Balakrishnan:** Joining us in today's episode is Dr. Nikit Abhyankar, who is a scientist at Lawrence Berkeley National Laboratory and a senior scientist at the India Energy and Climate Center in the University of California, Berkeley.

[00:03:31] **Rathish Balakrishnan:** His research area largely focuses on energy-related issues, such as renewable energy, energy access, and incentives for larger and more effective energy consumption. He has a large focus on India, but also on economies such as China, Indonesia, and Vietnam.

[00:03:49] **Rathish Balakrishnan:** Nikit, thank you so much for joining us today.

[00:03:52] **Nikit Abhyankar:** Well, thank you so much for having me. I'm really excited to be on this podcast.

[00:03:56] **Rathish Balakrishnan:** Excellent. Nikit, I wanted to before we get on the subject itself, understand a bit more about you. So two questions. One, what's been your energy journey so far? What has got you here? And two, what explains all the guitars in the back?

[00:04:11] **Nikit Abhyankar:** Both excellent questions. First energy journey in the sense that I call myself more of an interdisciplinary scientist, meaning that I work at the intersection of technology and economics and public policy. So energy, as you would appreciate, is a largely technical aspect, particularly electricity.

[00:04:30] **Nikit Abhyankar:** You need large grids, you need very complex engineering systems, but at the same time, the core of the energy sector really lies in the energy markets, how they are structured, and the economics of different energy resources and consumption.

[00:04:45] **Nikit Abhyankar:** And the third dimension that equally affects the energy sector, which is quite different relative to other sectors is, it is also one of the highest regulated sectors. The government, the regulatory agencies have a very strong bearing on how the energy sector performs, how it behaves, and where it heads. And that is why it is truly an interdisciplinary sector.

[00:05:08] **Nikit Abhyankar:** I love talking with people from multiple disciplines, applying methodologies and knowledge from multiple disciplines. It's technology, economics, and policy. And the guitars, well, I, in my free time, love to play music. I don't get a lot of free time, but whenever I do, I love to just play my guitar, play my keyboard and hand some tunes.

[00:05:35] **Rathish Balakrishnan:** I recently was talking to a set of stakeholders in the energy space and it struck me also how much energy is intertwined with economics. And I mean, the economic activity in a country, like it literally powers everything we do. And I'm an engineer myself, so I always thought of energy as a technical topic. But then you realise how much it impacts economics, trade, commerce, any financial activity in general. And this truly multidisciplinary thinking becomes very, very important.

[00:06:02] **Rathish Balakrishnan:** And as you also rightly highlighted, for the longest time, the government has been the provider of energy, for us, at least, you know. And then I mean, while privatisation has happened... so the role of policy becomes even more important as well. And through the podcast today, it'd be great to bring up some of those elements to say, how does growth impact, energy consumption itself, because one of the points that we discussed as well in the introduction is that while India already uses a lot of energy, we still are far below what the global average is in terms of per capita energy consumption.

[00:06:36] **Rathish Balakrishnan:** And so tell us a sense of how do you see energy demand in India grow as we go through this journey as well?

[00:06:45] **Nikit Abhyankar:** So if you look at the history of the modern world, which is post-industrialisation, so around the last 200 years, give or take, energy truly is the fuel that one intended for any economic growth and development across all regions and across all countries. And India has been no exception. Just in the last 50, 60, 70 years since independence, India's energy consumption and in particular electricity consumption has been growing pretty rapidly, pretty steadily, and it truly has been a key ingredient of India's success of economic growth.

[00:07:21] **Nikit Abhyankar:** Now, on one hand, you have this need for consuming a lot of energy that is needed for economic growth and development, but at the same time, there are several environmental, there are several economic challenges that India needs to face over the next 40, 50, 60 years going forward.

[00:07:41] **Nikit Abhyankar:** For example, when industrialised countries develop, mostly in Western Europe, Northern America, the US, Canada, the UK, and so on, essentially, 50 or 100 years ago, environmental sustainability of our energy choices was not really in discussion. The science was not developed, and it was never a factor in choosing the energy resources.

[00:08:05] **Nikit Abhyankar:** But the times have changed. Climate change is a reality. And it's not a thing of the future. Climate has already changed, and it is impacting all the countries in the world, particularly in India. So that's why going forward, I think India really needs to achieve a very delicate tightrope walk of choosing three dimensions very wisely.

[00:08:27] **Nikit Abhyankar:** One, it has to provide enough energy for its population and economic development. At the same time, it has to be extremely mindful of the environmental impact of the energy choices. And third, India has to balance those first two dimensions by providing cost-effective and reliable energy to this entire population.

[00:08:50] **Nikit Abhyankar:** Now, I think this is where I truly believe India has a unique opportunity. Because India is expected to grow at least three to four times in terms of GDP, in terms of electricity demand, and energy demand in general, over the next three to four decades.

But this is also the first time where clean energy resources are much cheaper than fossil-based resources.

[00:09:15] **Nikit Abhyankar:** So this is a unique time in history where environmental sustainability, economic viability and technical feasibility of our energy choices are pointing in the same direction. And this is the time where India needs to grow its energy demand. And that is why I believe of all the countries in the world, India truly is in a unique position to transition rapidly and be an example for the other countries in the global south as well the global north on how to develop and chart an alternative development pathway.

[00:09:50] **Rathish Balakrishnan:** Completely agree. And I know this parallel is often made, Nikit, but for me, it sort of resonates exactly with the way the telephone revolution happened, you know, which is where the entire world had landlines and we had these months and maybe years of waiting time to get our phones.

[00:10:07] **Rathish Balakrishnan:** The technology for mobile telephony had peaked at the exact time in which India's telephonic revolution happened, and we just switched from not at all having landlines to just directly having mobile phones to today having the world's cheapest data, which means that pretty much most of us don't even care about how much data we are consuming right now, because we have these unlimited plans at a cost that is far lower than what the global north is paying for it.

[00:10:35] **Rathish Balakrishnan:** And what you're saying is that we are at a similar point in the energy status as well. Would that be a right comparison?

[00:10:43] **Nikit Abhyankar:** 100%. Absolutely. And I'll just kind of detail that out by giving you just three numbers.

[00:10:49] **Rathish Balakrishnan:** Please.

[00:10:50] **Nikit Abhyankar:** 25, 500, 900. So 900 are the number of cars per thousand people in the US. 500 is the number of cars per thousand people in Germany, Japan, France, and the UK. Some are 450, some are 550, some are 600, in and around 500.

[00:11:13] **Nikit Abhyankar:** So these are the countries with some of the most advanced public transportation systems already built out, and they still have around 500 cars owned per thousand people. 25 is the number of cars owned per thousand people in India. So it really doesn't matter which development pathway India chooses, whether it's a public transport led or a private car led.

[00:11:34] **Nikit Abhyankar:** A massive growth in the private car segment, and you can extend this example for other forms and other sources of energy as well. Same for electricity, same for industrial energy, and so on and so forth. So massive growth in the energy sector is about to happen in India. And this is what we call the leapfrogging opportunity, where, as you rightly said, instead of going, through landline, then to cell phones, you can immediately leapfrog from no phones to cell phones. From fossil dominant grid to a clean grid, clean sources of energy in a matter of one or two decades.

[00:12:13] **Rathish Balakrishnan:** Yeah. I mean, just building on what you said and then moving to the next question, I recently was talking to somebody who said there is no country in the world that's economically rich and energy poor, you know, it's just not possible. As much as we can ask ourselves whether we need so many cars, the truth is that all rich countries consume a lot of energy and just preparing for that future, I think, is going to be very, very important.

[00:12:36] **Rathish Balakrishnan:** Talk us through this as we go through this journey, and as you rightly highlighted, it's a tightrope walk, you know? I was reading elsewhere as to how in the seventies, the U.S. was building houses that were not even energy efficient because they said, "Hey, listen, energy is so abundant that we don't really have to worry about how much our houses will consume energy."

[00:12:56] **Rathish Balakrishnan:** So there was this place of abundance that we created this world with, even for fossil fuels, you know, and 50 years later, you know where we are, or maybe even 40 years later. So given we are walking a tightrope walk with a lot of global eyes on India, because we are topic of every conversation when it comes to renewable energy, just given a denominator size, what are some of the challenges and what are some of the opportunities that we're seeing as we go through this journey?

[00:13:19] **Nikit Abhyankar:** Again, an excellent question. So I think in terms of opportunities, we have already talked about the massive growth opportunity that India has and so on. And in terms of challenges, there are many, right? And those challenges really depend on where you are going to use that energy. For example, is it electricity you're talking about?

[00:13:39] **Nikit Abhyankar:** Is it industrial energy, industrial heating you're talking about? Is it something else? Is it cars, electric vehicles, and so on and so forth. So let's look at each of those one by one and very briefly. For example, if you take the case of electricity, the clear choices in the electricity sector is essentially using as much as renewable energy sources, particularly solar and wind, also including some offshore wind resources, instead of using fossil base resources such as coal, natural gas, oil and so on for generating our electricity.

[00:14:13] **Nikit Abhyankar:** But the key challenge is the intermittency and variability of renewable resources. For example, you have solar energy when the sun is in the sky, what happens after 7pm when the sun sets? You don't have any solar energy. That means you need to store that electricity in batteries or some form of energy storage.

[00:14:32] **Nikit Abhyankar:** It could be pumped hydro storage as well, or there are several other non-chemical storage options as well. But essentially, you need to store that energy. The problem with wind, particularly in India, is wind is also highly seasonal. For example, wind largely blows in India in monsoon, June through September. But for the rest eight months, the wind-based electricity generation is quite low. And whenever it happens, even in monsoon, it is intermittent. It is not fully predictable. So we don't know exactly how much wind electricity I'm going to get, say, 24 hours down the line. These are big challenges for electricity grid operation. So the key solution there is creating cost-effective, economical, and technically-viable energy storage solutions.

[00:15:18] **Nikit Abhyankar:** So pumped hydro is one indigenous technology that India has really mastered, and that is definitely promising. The other emerging technology that everybody must

have also heard of is battery energy storage. We have been using batteries in electric vehicles in all our household appliances.

[00:15:35] **Nikit Abhyankar:** But now this new lithium-ion battery technology has advanced dramatically. The costs have come down and I'll be happy to talk a bit more on that later. The production has scaled. And this is truly the time where solar plus energy storage cost is actually comparable or even lower in certain cases than building a new fossil based electricity generation power plant. And that is why this moment is transformational.

[00:16:04] **Nikit Abhyankar:** So the key challenge in the electricity space is making sure we have a cost effective and technically viable energy storage solution. And we are almost there. Now let's take an example of electric cars. The question is the same. Electric cars essentially run on electric batteries. So as the key is making batteries cheaper, batteries are still significantly more expensive. Electric cars are significantly more expensive than gasoline or diesel-based cars. And that is why there is a huge resistance to customer adoption because of the high initial cost. The other challenge in case of electric cars is providing the charging infrastructure and the charging network.

[00:16:45] **Nikit Abhyankar:** Just as we have petrol pumps everywhere, you really need electric chargers everywhere to charge the cars. The third challenge is the charging time. I can just fill up my Petrol car in 5-10 minutes at most, including the waiting time. But electric cars take at least one or two hours to fully charge, and that is definitely a problem.

[00:17:06] **Nikit Abhyankar:** So these challenges need to be met. And we are, again, we are there, in the US, in China, in many European countries, electric cars have already transformed the car market pretty dramatically. For example, in China, nearly 50% of new car sales in China are already electric. , so that market has also started changing very rapidly.

[00:17:29] **Nikit Abhyankar:** And the third key energy use is industrial energy use, which is industrial heating and also the new and emerging industrial energy use, which is data centres. Which is largely AI driven and so on and so forth. So, for industrial heating, again, the solutions are not entirely fully commercialised. For example, many industries still use natural gas and oil-based heating. The key solution to that is changing that heating source to electricity and electrify that heating. Again, technology does exist, but it hasn't been fully commercialised. There are several other industrial sectors such as iron and steel or cement and so on that necessarily use coal or other fossil fuels as a feedstock.

[00:18:19] **Nikit Abhyankar:** So coal not only provides the source for heat or source of energy, but the carbon in coal or carbon in natural gas is an essential ingredient of making the final product such as steel. So how do you replace that? You can't just replace that with electricity. So there are again, there are several technological solutions.

[00:18:40] **Nikit Abhyankar:** There is green hydrogen and so on, but that again needs to be commercialised. So the challenge in the industrial front is not just limited to the economic viability of these solutions, but also the technical viability and feasibility, and commercial feasibility of these solutions. So that's the big picture. And of course, we can delve into details for each of these.

[00:19:03] **Rathish Balakrishnan:** I want to build on that, Nikit, and bring some India context as well, right? As you rightly said, there are tailwinds that are really promising. Like the number of electric two wheelers that I see on the road now in a city like Bangalore is actually quite a few now. You know, and there are companies like Ather that are thriving. And then we actually on the podcast had people who are working on the charging infrastructure today and reducing the time it takes to charge and making it a business case for a lot of folks. I know electrical bus procurement by governments is growing, for example. Even in the commercial freight space, there have been some interesting investments that are being made on battery swapping, for example, in addition to charging infrastructure, et cetera.

[00:19:45] **Rathish Balakrishnan:** So as you rightly highlighted certain cases, technology is actually moved. I mean, in the call, unit economics is now becoming more viable, at least in the first and second scenario that you talked about. In the industrial space, as I understand from you, maybe the unit economics is still not played out in a manner that businesses can adopt it at scale.

[00:20:02] **Rathish Balakrishnan:** So there is technology as just R&D (Research and Development) is probably working well, productisation is working well, but commercialisation, maybe we are on the path to making it happen. And similarly, customer adoption, certain cases is probably already working well. Certain cases we may have to move a needle a little bit more.

[00:20:21] **Rathish Balakrishnan:** But since your focus is on policy as well, Nikit, and specifically in the Indian context, do you feel we have made sufficient strides in the policy environment as well, in terms of defining the right approach, the right environment for all of these innovations and economic activity?

[00:20:39] **Nikit Abhyankar:** I think in the electricity space, yes, definitely. So there is the right enabling policy and regulatory framework at the central level. There is the right policy framework at many state levels, including some of the leading states and the electricity sector is going really well. For example, what do you need in terms of policy?

[00:20:57] **Nikit Abhyankar:** You need a big picture ambition, which the prime minister has already provided by committing to 500 gigawatts of renewable capacity by 2030, which is a big goal for a country such as India. Then you need an enabling policy environment where the government essentially sets up some big picture mandates, sets up some big picture tax incentives or other incentives and that has been set.

[00:21:21] **Nikit Abhyankar:** For example, again, in the electricity sector, what we specifically call as a renewable purchase obligations, where each utility that sells electricity needs to procure a certain fraction of their electricity from renewable or clean sources that has already been in place at the national level and also in certain key states and third, you need a pretty robust regulatory framework, meaning that, how are contracts going to be made? How is renewable energy going to participate in the market? How? How are the transactions going to work in the nitty gritty details? That really drives those transactions that are also in place. So the electricity sector is truly in the right shape and proceeding with the right pace in India.

[00:22:06] **Nikit Abhyankar:** On the transport sector, though, I think, as you rightly said, the unit economics actually does work out the total cost of ownership of an electric car across all vehicle segments is actually cheaper than the total cost of ownership of a gasoline or diesel

vehicle. But as we discussed, there are challenges in terms of charging infrastructure, charging times and so on. And this is where I think the role of policy can make a big difference. And this is where the government policy is slightly lagged behind. For example, one policy that works really well in the transport sector is what we call the zero emission vehicle mandate. So the ZEV (Zero Emission Vehicle) mandates. So, meaning that the government requires all vehicle manufacturers to sell at least XYZ percent of their new vehicle sales to be electric or to be zero emission.

[00:23:01] **Nikit Abhyankar:** That policy changes the vehicle market pretty dramatically. That has not happened in India yet. I think the charging infrastructure government has set up some kind of requirement for electricity utilities to set up charging infrastructure and so on. And again, the progress has been pretty slow in that and in the industrial space again, there is a big picture vision that the government has set up through the National Green Hydrogen Mission and so on and so forth. But again, some concrete on-the-ground action is also missing to a certain extent, which also can be traced to policy.

[00:23:35] **Rathish Balakrishnan:** This is super helpful. Nikit, one question I did want to sort of flag is, one of the critical risks that we have with energy in the past is that dependence to other countries, you know, and it is always a geopolitical risk as we look at the current new environment; are we again getting a geopolitical risk with us depending largely on China and other countries for a lot of our manufacturing and our battery storage and all of those aspects?

[00:24:02] **Rathish Balakrishnan:** And as we talk about the government's role from a policy and enabling environment perspective, would love to hear your thoughts there as well.

[00:24:09] **Nikit Abhyankar:** I think that's an extremely important question. And that is definitely a question, particularly in the case of the energy sector. Needs to be asked and needs to be discussed. It is true that particularly when it comes to battery manufacturing, China does dominate battery manufacturing at the global scale. Most of the batteries that we currently use in India, and in fact, most of the countries in the world, are directly imported from China. To a certain extent, that definitely does expose India to a more geopolitical risk. But I think there are two main differences between batteries or other capital goods versus other sources of energy.

[00:24:51] **Nikit Abhyankar:** Number one is, take example of solar panels or batteries that are necessarily a capital asset, unlike oil, which is a consumptive good. So once you consume the oil today, you need more oil tomorrow. But once you have your batteries installed, that battery stays with you for the next 10 or 12 years. So the replacement battery would be needed only 12 years later or 10 years, 15 years later as you use it.

[00:25:17] **Nikit Abhyankar:** And second, unlike oil, you also have the opportunity to manufacture those goods within your country, within India. And solar panels are an excellent example of that. For example, India currently has a solar manufacturing capacity of nearly 60,000 - 70,000 megawatts per year. Well, India only installs about 30,000 to 35,000 megawatts per year. So most of the solar panels in India that are manufactured are either used domestically or India is also a big hub for exporting solar panels to other countries, including the US and India also has a similar opportunity in the battery space.

[00:25:54] **Nikit Abhyankar:** Obviously, it is easier said than done. The government has announced this PLI (Production Linked Incentive) scheme, for battery manufacturing, which is

extremely helpful. Battery manufacturing also involves several other nuances that need to be taken care of supply chains, availability of critical minerals and so on and so forth that needs to happen over the due course of time. But at least this technology gives you an opportunity to set those up. And I believe, at least at the national level, the government is in the right direction in setting those up.

[00:26:25] **Rathish Balakrishnan:** Excellent. I want to play the way I see the entire stack play up, Nikit. I think at the fundamental level, there are sources of energy and energy creation, which is really where solar and all of that investment, the panel investments that we talked about makes sense. The second layer is the storage layer, which is where you store the energy, the quality of batteries, and even the circularity of batteries, which we haven't spoken about, but has a very, very crucial element.

[00:26:50] **Rathish Balakrishnan:** The third is the vehicles that, or the infrastructure that sort of uses this energy to create value, which is where transportation is. But I also think there is a fourth layer, which is the appliance layer today, and I was reading recently that even without us noticing, our fridges, our air conditioners, et cetera, are far more energy efficient today than they were even 15 - 20 years ago.

[00:27:16] **Rathish Balakrishnan:** And as we talk about energy, one aspect of it is the creation of energy. The other aspect of it is just the consumption efficiency of energy at the appliance level. And that we have not talked about as much. Can you just paint a picture of where we are with respect to that? And again, I want to tie this back to the point that you made earlier, which is, as a growing country, we probably still are at a very infant stage in our consumption in terms of appliances as well, but would love to have you share more.

[00:27:43] **Nikit Abhyankar:** No, I think that's an equally important, if not the most important aspect of any energy issue is the consumption of electricity. And there are three aspects to this, right? Number one is how efficiently are you using your energy. Number two is when are you using your energy. So that time aspect becomes extremely important, particularly in renewable energy managed grids. And number three is how responsive is your energy consumption. For example, if given a choice, an option, would you be able to change when and how you use your energy? So those are the three questions.

[00:28:23] **Nikit Abhyankar:** Most critical challenges on most critical opportunities as well. So let's look at those one by one. First is how efficient is your energy consumption? So if you had asked me this question 15 years ago, I would have given you a very different answer, in India. But as you said, just over the last 15 to 20 years with the creation of the Bureau of Energy Efficiency at the central level, and then creating the standards and labelling program.

[00:28:49] **Nikit Abhyankar:** I'm sure everybody has seen those labels on all the appliances that we see 1 star through 5 star. They have enhanced the appliance's energy efficiency in India, at least by 25% to 30%. For example, if you just go out in the market and buy an air conditioner, that air conditioner in 2024 is at least 40% to 50% more efficient than an air conditioner you had bought, say, 15 or 20 years ago.

[00:29:15] **Nikit Abhyankar:** So that's a remarkable improvement. And same for fridges, same for TVs, and so on and so forth. So the question is, is that enough? And are we doing everything

that's available to us in terms of technology choices in maximising efficiency? Sadly, the answer is no. We have done a lot, but there is still a long way to go.

[00:29:33] **Nikit Abhyankar:** For example, the most efficient air conditioner globally available is nearly twice as efficient as the most efficient air conditioner that is available in the Indian market.

[00:29:46] **Rathish Balakrishnan:** Wow.

[00:29:47] **Nikit Abhyankar:** That's a remarkable change. And what is interesting is who are the top selling air conditioner or consumer appliance brands in India, like the LGs of the world, Samsungs of the world, Hitachi, Daikin and so on and so forth. These are all global brands. They don't sell their ACs just in India. So in Japan, in Korea, even in China, they sell much higher efficient products. Why? So I think this is where the role of policy again, bringing it back. The other countries do not allow the sale of less efficient products in their markets, but India still allows that.

[00:30:25] **Nikit Abhyankar:** So that's what I said. India has come a long way, but still a long way to go. And there are several technology options, and this is not just air conditioner, not just to pick on one, but several other appliances have the same story.

[00:30:41] **Nikit Abhyankar:** Now, the second question is what time do we use our energy? I think I'll just give you a simple anecdote, right? Just five or seven years ago, the peak demand in Delhi or in Mumbai also typically used to occur in the afternoon, say around 3:00 p.m, 3:30 p.m., 4:00 p.m, give or take. That's where the commercial or the industrial establishments would burn their ACs at the top blowing speed.

[00:31:12] **Nikit Abhyankar:** Maybe school kids come home at the same time, and that's where you see the peak electricity demand in those cities or major urban centres around 3 p.m. - 4 p.m. Now in 2024, with all the heat waves, with the people buying a lot more air conditioners, fans and coolers. Now, Delhi has two peak demand periods. One, of course, at 3 p.m. - 4 p.m. in the afternoon, that stays. And the second peak in Delhi now occurs at 12 midnight or 1 a.m.

[00:31:43] **Nikit Abhyankar:** Now, this raises several challenges. Challenge number one is, especially if you are going towards a more solar heavy grid, a renewable heavy grid. 3 p.m. 4p. m. electricity demand, solar energy can meet generally easily because that's when you have the most amount of solar energy available. How are you going to meet 1 a.m. demand? So you will necessarily have to depend on fossil fuel sources or cheap energy storage sources to meet that demand

[00:32:15] **Nikit Abhyankar:** And the same is true for industrial consumption. Same is true for agricultural consumption. Most of those demands occur at night. So this is a huge challenge for reliably decarbonizing the electricity grid. So when the aspect of energy consumption is equally important as the efficient aspect of energy consumption is.

[00:32:37] **Nikit Abhyankar:** And the third aspect is, can you change? What is the opportunity for changing when you consume electricity or how you consume your electricity? For example, can you think of agricultural pumps that are mostly supplied with electricity at night? If they are

supplied electricity during the day, would farmers be willing to water their farms during the day? And the answer actually happens to be yes.

[00:33:02] **Nikit Abhyankar:** For example, we've kind of touched upon some demand response programs and so on and so forth. I always say that India actually runs the largest demand-response program in the world, which is agricultural load shifting. Many states in India, Maharashtra, Gujarat, Karnataka, Tamil Nadu, some of the biggest states, supply electricity to farmers during solar hours; which otherwise was supplied at night, and they have shifted nearly 20 to 30 gigawatts, 20,000 to 30,000 megawatts of agricultural pumping load from nighttime, which used to be exclusively powered by coal fired electricity to daytime, which is now exclusively powered by solar electricity.

[00:33:45] **Nikit Abhyankar:** This is a huge change and has deep implications on how electricity demand also will be operated and will evolve over time. And one can also imagine such kind of demand response programs for finer time durations as well. So, for example, if I have a super peak event, just for 15 minutes or 30 minutes, can I just change the way that 30 minute demand is consumed. I mean, maybe not, but it's definitely worth a shot.

[00:34:20] **Nikit Abhyankar:** And finally, just to close this off, energy efficiency, demand response, demand shifting, what we call as the demand side resources. These should be treated as resources. Just coal, solar wind are not resources, but you also have demand side resources and demand side resources are often the cheapest resources that you always have available. But of course, the transaction cost of accessing them is very high. And that's why people or system planners usually do not access those resources, but they're usually the cheapest and the best.

[00:34:52] **Rathish Balakrishnan:** Yeah. I think there's a lot to unpack there. So I want to take a couple of things at a time. So firstly, what you mentioned about peak demand, I recently was in a conversation with a senior energy bureaucrat in Kerala. And as you know, Kerala is trying to go entirely renewable and they don't have coal plants within their state itself and they're largely been able to grow, and have a lot of their solar power come in.

[00:35:15] **Rathish Balakrishnan:** But what one of the things he highlighted is these peak demand scenarios, you know, and even the decisions and the behaviours they want to drive in terms of electricity consumption is based on, 'Hey, when is the peak demand coming?' And because every time peak demand hits, they have to buy coal and you know, fossil fuel electricity. And so you're, one, you're absolutely right. We don't often think about it because we always think of energy consumption units, you know, like how do I consume energy? But those waves hit and I'm still surprised.

[00:35:44] **Rathish Balakrishnan:** What are people doing at 1 a.m.? Is it that it's so hot that they switch on their ACs to full blast because it's so hot? But it's interesting, I never thought of 1 a.m. as a peak load time, Nikit. So thanks for sharing that.

[00:35:55] **Rathish Balakrishnan:** I think the other thing that I have learnt Nikit, and I think for a lot of the people who are listening to this podcast, maybe new, is the amount of planning that electricity discoms actually have to put in place to ensure that we get predictable electricity, because we just understand that when we switch on the light, you know, with the switch, we switch it on and the light comes up and the fan runs. But there's this entire planning around

where is the supply coming from? Where is the demand coming from? Are we planning that load? Are we managing that load on an actual basis? And a lot of data that goes behind that as well.

[00:36:27] **Rathish Balakrishnan:** That is you know that, it is staggering when you think about it, that there is in real time coordination happening in terms of buying, selling, using electricity, et cetera. And for me, when I realised that, is when I realised how important storage as an idea is because storage gives you that flexibility, that buffer to be able to deal with this. You use the word demand response, Nikit, and it's not a word a lot of people understand. Maybe for a layman, if you could just explain what demand response is, like, what does that actually mean?

[00:36:57] **Nikit Abhyankar:** In the traditional electricity system, the way it works is that people consume electricity. So there is a demand curve. So there is a set… so 9 a.m, you usually consume 1000 megawatts, 12 p.m., you consume 2000 megawatts and so on and so forth. And you can just plot it for 24 hours and that becomes your demand curve.

[00:37:21] **Nikit Abhyankar:** So you should choose your supply side resources. You should choose your electricity supply, electricity production that follows your demand. The demand response exactly flips that equation. You make your demand responsive. So your demand follows the supply. And this is a very important change in thinking that most electricity planners, discoms, and traditional thinkers do not want to do.

[00:37:50] **Nikit Abhyankar:** Instead of supply following the demand, you have demand that follows supply. Of course, there are limitations to it and so on and so forth, but that usually happens to be the cheapest form of meeting your electricity demand. Now, this becomes even more important in the renewable energy dominant grid where, as I think, as we discussed, solar when each has their own variability and intermittency challenges. So that's why having a demand that is shiftable. And that can also provide the short term kind of responses that become extremely critical to make sure your power system is actually cost effective and runs reliably. The other option, if you do not have demand response, you will just have to build a lot of energy storage. This also kind of opens up an interesting dichotomy between demand response and energy storage.

[00:38:44] **Nikit Abhyankar:** So imagine a world where you have abundant, cheap energy storage. Imagine energy storage is free. You wouldn't need any demand response whatsoever because you have free energy storage. But energy storage is not free. It is expensive. And as you build more and more renewable energy, energy storage becomes more and more expensive and that is why demand response, even in a cheap storage world, demand response is extremely cost effective to meet your demands cost effectively and reliably.

[00:39:20] **Rathish Balakrishnan:** Excellent. And I think that there's such a fundamental shift in the way you think about it. And now playing back the example you gave of the farmers and the solar pumps makes a lot more sense because that is an activity that, you know, you could run at any point in time and, shifting that to a time when the load is not too high, allows us to use a lot more solar power than fossil fuel.

[00:39:43] **Rathish Balakrishnan:** Another example that strikes me, Nikit, as we speak about it is just EV charging, because it's another example where maybe there are better incentives to enable people to say, “Hey, if you charge at this time, I don't know if it's possible”, but your

charging cost can come down or provide some incentive because you can charge your car at any point in time, irrespective of when you're driving, right? Is that a relevant scenario for demand response as well?

[00:40:10] **Nikit Abhyankar:** Yeah. That is a 100% relevant scenario for demand response. Having said that, there are also limitations. Because especially when you talk about people like you and me, private car owners, or vehicle owners. We also have a lot of range anxiety. When I come back home from office, I want to make sure if my car is at 25% - 30% charge, I want to charge it to the fullest possible so that in case I need it, I have full charge in my car.

[00:40:39] **Nikit Abhyankar:** That range anxiety is real. So there is a very limited kind of demand response behaviour that you might get from private drivers such as you and me. But I think this is again where India has a unique advantage. In the US, for example, 70% of all the oil consumption in vehicles happens from private cars, and only 30% happens from trucks or commercial vehicles.

[00:41:08] **Nikit Abhyankar:** In India, the equation is exactly opposite. Only 30% of our oil consumption happens from private vehicles. Which includes two wheelers, which includes some three wheelers, which includes cars and so on and so forth. And nearly 60% to 70% of the oil consumption happens through commercial vehicles. And the commercial vehicles, electricity cost, that charging cost, running cost, operational cost matters a lot more than a private car driver, and if you have... and this is where the charging infrastructure, fast charging becomes also critical. Take example of trucks. And if you have long distance electric trucks going from one city to another, say going from Mumbai to Delhi, that's a 15 to say 20 hour journey.

[00:41:59] **Nikit Abhyankar:** So in that 20 hour journey, the truck can realistically just stop for one or two hours, opportunistically charge the battery and move on for the onward journey. If that means charging cost is going to reduce by 50%, that means a 50% reduction in their operational cost that matters a lot to commercial vehicles. And this is where demand response could be immensely helpful. In the case of India, I'm not too hopeful. I mean, just being very honest for private car operators, even for example, for bus operators, because they have to run the bus during the day. So there is only a limited opportunity that they can schedule their charging. But trucks, yes, they can.

[00:42:50] **Rathish Balakrishnan:** Yeah, and you said, and we often miss this and it's come up in multiple times in the previous podcast episodes as well, that commercial vehicles have a much larger footprint in India than the private vehicles that are, at least as of today. So when you think about energy, we often think about our cars and two wheelers, but it's really the trucks and the commercial vehicles that have a significant sort of aspect to grow.

[00:43:10] **Rathish Balakrishnan:** One of the conversations that I think Ajay Shah's had once, Nikit, is to also, in driving demand responsiveness, said, listen, the incentive for the consumer today doesn't take into account for demand responsiveness. So one of the things that he highlights is like the stock price goes, you know, down, up, and through the day, can we have energy prices go up and down and you know, you sort of, before you wanted to do anything, like you want to, my mom, for example, wants to use a mixie, for example, or the grinder or whatever, and she looks at that and says,"Hey, right now it's 21 rupees as opposed to 3 rupees, as opposed to 7 rupees. I'm going to use it now because I'm going to consume less energy". Do

you think a reality like that is actually possible where we take this incentive right down to the consumer to say, “Hey, electricity is actually cheaper now. So if there's any one of those kitchen activities that you want to do, anything that you want to eat, want to heat your water, take a bath, you'll probably want to do this right then”.

[00:44:07] **Nikit Abhyankar:** I am going to give you two answers to it, right? The energy economist in me loves this idea. So this is the true marginal cost pricing. The real time pricing, whatever the real time price of electricity gets reflected in what the consumer is actually consuming. And that's how you manage consumption. I absolutely love it. That's the most efficient way of pricing.

[00:44:31] **Nikit Abhyankar:** Having said that, it is not feasible. It is not feasible at the political level. It is not feasible for several social reasons. For example, if Electricity price is significantly expensive at that hour, so 10 rupees, 12 rupees, 15 rupees per kilowatt. It does happen in the grid. There is a lot of demand, then this type of electricity pricing is necessarily regressive.

[00:44:53] **Nikit Abhyankar:** It hurts the poor the most than it hurts the rich. So it is also socially and morally, may not be acceptable, politically not feasible and also technically significantly challenging. That also means that everybody has access to smart metres. Those smart metres are working right and so on and so forth. Instead, though, what might potentially work is direct appliance demand response, a third-party appliance demand response. For example, many appliances that are sold today, in fact, majority of the appliances that are sold today, especially true for energy guzzlers, such as air conditioners, refrigerators, and so on, washing machines, many of them are smart appliances, meaning that you can control them through your WiFi home WiFi network, they are connected to your cell phone.

[00:45:44] **Nikit Abhyankar:** You can also turn them on or off, change the temperature set point and so on. Now imagine a third party, essentially controlling those appliances for you in exchange for some money and with a limit on how many times that they can control or change your temperature set point.

[00:46:03] **Nikit Abhyankar:** For example, they cannot do it for more than three times, four times in a year. But in return, you're going to get a thousand-rupee voucher every year. That price sensitive Indian customers might actually go for it. And there's a limit and there is always a manual override. If you think that, “no, this is not right. I want to use that appliance and let go of my thousand-rupee incentive.” Then yes, you always have the option to do it. So I think those programs might work better, especially in countries like India, and more so because of two reasons.

[00:46:38] **Nikit Abhyankar:** Number one is just how fast the adoption of smartphones, the wireless networks have essentially evolved in India. And second, how incredibly, amazingly India has rolled out the UPI (Unified Payments Interface) infrastructure, where you can directly deposit those incentives to consumers’ bank accounts, without any hassle. So I think this is where India again has that leapfrogging opportunity where other countries are just not even close to where India is in terms of digital payments and also in terms of widespread cell phone adoption.

[00:47:15] **Rathish Balakrishnan:** Yeah. I think this is a fascinating use case, Nikit, it's a little...let's just make it even more vivid for everybody. Let's just take maybe two examples. The first

example is I am a commercial organisation. I actually have these IT buildings where my staff is working, you know, seven floors, multiple places.

[00:47:38] **Rathish Balakrishnan:** And let's say there's a large appliance company, let's say, Hitachi, a Siemens, a Philips, anybody I'm working with who are responsible for my heating and lighting and all of that. Potentially they can tell, they can build smart appliances that are able to work with the discoms in saying that, “Hey, right now there's high energy demand.”

[00:47:56] **Rathish Balakrishnan:** And like you said, three to four times a year, or in an acceptable SLA (Service Level Agreement) that I, as an owner of this premise, along with my third party appliance company agree, can then regulate my energy consumption accordingly, even if it's by a few degrees for an AC, or even if it means, you know, certain lumens of my light, which can have a significant impact in aggregate, in terms of my own energy bill, number one, because I pay lesser and in terms of the demand on the grid.

[00:48:24] **Rathish Balakrishnan:** Is that the imagination?

[00:48:28] **Nikit Abhyankar:** Absolutely. That is the, that is definitely the imagination. And usually what is not entirely understood in many of these discussions is that the benefits are far greater than how much energy you actually save. For example, if you are only changing your AC set point, or say for a simpler example, if you just turn your AC off, and if you are only turning your AC off for one hour, But you are running it for 2000 hours in a year.

[00:48:58] **Nikit Abhyankar:** That's not even in the second decimal point, in terms of energy saving and the bill saving, but that can still generate a significant benefit for you. How? By creating a significant benefit in terms of avoided capacity. So the grid is planned and an electricity grid is built to meet two constraints. Constraint number one is meeting all your energy needs. But also constraint number two is meeting the peak load on the system reliably. And the peak load usually occurs depending on which setting you are in, peak load usually occurs for literally 100 hours in a year. So you build all that capacity.

[00:49:42] **Nikit Abhyankar:** So there are, in total, 8,760 hours. So let's call it 8,000 hours in a year. Out of those 8,000 hours, the peak load occurs only for 100 hours and the entire system is built to meet the demand reliably for those 100 hours. And so that's why if you just look at shaving off your peak demand for those 100 hours, that results in immense benefits in terms of avoided investment in building those big transmission lines, big generators.

[00:50:16] **Nikit Abhyankar:** And then, I mean, obviously, I'm oversimplifying things here, but I think that's the idea. And that's why even with that short duration demand response, you can still generate enormous savings for the grid, for the utility, and also for yourself. And this also translates to bill savings, especially for the commercial and industrial consumers, because many times those consumers have two types of charges. One is just the normal energy charge, meaning how many kilowatt hours, how many units of electricity you consumed. And second is what was your maximum demand, how much did you draw instantaneously from the grid in kilowatts or in megawatts.

[00:50:58] **Nikit Abhyankar:** So with these short duration demand responses or third party demand response programs can also reduce their fixed demand charges that can result in substantial bill savings from them as well.

[00:51:11] Rathish Balakrishnan: Great. You touched about UPI Nikit and I want to come to the DPI (Digital Public Infrastructure) conversation overall, but I think we've covered a lot of ground. So let me quickly summarise what we've spoken of so far so that, you know, people are able to stay with us as we go through the DPI part.

[00:51:26] Rathish Balakrishnan: Firstly, I think you made an extremely important point about where India is today with respect to our consumption curve. 900 cars per thousand people in America, and 25 cars per thousand people in India. And like we discussed, there is no economically rich country that is energy poor, which means that as India continues to grow economically, our energy demands are only going to increase. You laid out very clearly across transport, battery, and electricity, etc.

[00:51:52] Rathish Balakrishnan: What has been the progress that we've made technologically? What's been the policy related environment that has enabled it? What is the level of commercialisation that we are seeing today? And where is it from a unit economics point of view? And what has to shift as well? And I think that was a very important conversation.

[00:52:09] Rathish Balakrishnan: And we then subsequently shifted to saying, okay, across the four levers, which is generating electricity, storing electricity, providing electricity to consume. We sort of doubled down on the consumption part and talked about how, and you said a very important thing that there are a lot more active levers at play at the demand side, at the appliance side, rather than just at the supply side.

[00:52:30] Rathish Balakrishnan: And we talked about a demand responsiveness to say, rather than looking at where the demand is and the supplies that are following that, you look at where the supply is and ensure that your demand follows that. And like you talked about, the world's largest demand responsiveness program is what we did in agriculture to move from fossil fuel based charging of the pumps to solar pumps. Which essentially is just done by shifting the time in which the solar pump is charged.

[00:52:53] Rathish Balakrishnan: We talked about the commercial vehicles use case as well, where if you especially look at trucks, charging trucks can be an example of demand responsiveness and finally move to the example where rather than do it at the grid level appliance manufacturers which are progressive and are often by the way, committing ESG (Environmental, Social, and Governance) targets for themselves and for their clients, have an opportunity to reduce the consumption of electricity or energy by their clients by doing demand responsiveness at the appliance level. And I think for me, and this I had never thought of.

[00:53:24] Rathish Balakrishnan: The impact is not just the energy saved. The impact is the infrastructure readiness you create because you are literally planning for a hundred hours out of 8,000 hours for which you need maximum electricity. And if you can reduce it, investments in energy infrastructure, and then O&M (Operations and Maintenance) and all of that cost subsequently starts to come down. And this is massive. And I think just being able to understand the need for demand responsiveness as a paradigm. In the way we think of electricity becomes very, very clear.

[00:53:51] Rathish Balakrishnan: Now I want to come to DPI, Nikit. And I think one part of the DPI story is the UPI story, because payments become instantaneous, the recognition, all of that identification. The second part of the DPI, and that's something we've touched upon in this is

the DPI conversations that are emerging in the energy space. You know, Sattva itself has been working on the unified energy interface with a few stick stakeholders. We've been talking to a few players as well. How do you see the DPI story translate to the energy conversation? What are the possibilities that you see there as well?

[00:54:25] **Nikit Abhyankar:** I think the possibilities are immense. We already talked about a few use cases such as EV charging, such as these appliance demand response programs, but one can also extend those to multiple voluntary demand responses without specifying what exact end use would be given, an incentive for just reducing your consumption relative to a baseline in a given hour.

[00:54:51] **Nikit Abhyankar:** We don't care how you do it. We don't care exactly how you achieve it. Change the temperature set point or whichever appliances we do not care about. This is the baseline. You need to be below this. And now, if you go below that consumption, you essentially get an incentive for that time block.

[00:55:09] **Nikit Abhyankar:** That's an enormous application, even at the retail private consumer level as well as at the bulk commercial and industrial level that I see. I think the second and also equally important is, you see a lot of adoption of decentralised energy resources might be solar, might be batteries and so on and there is significant willingness as well as eagerness. So, significant willingness amongst those prosumers, electricity producers and consumers both at the same time. So, significant willingness amongst those prosumers and consumers to exchange electricity between them. So that is another interesting use case of this infrastructure. And third is, I mean, and that can also be as simple as I have solar panels on my rooftop.

[00:56:02] **Nikit Abhyankar:** And there is an electric vehicle charging station that is very close to my house within the same DISCOM (Distribution Company) territory that wants to use solar energy that is generated by my solar panels. I can facilitate that transaction through UPI or other DPI based technologies. And the other kind of big picture use case is also the use of this DPI in wholesale market settlements.

[00:56:28] **Nikit Abhyankar:** Now, one can also envision the same thing happening at the national scale where a consumer in Jharkhand is buying electricity from a producer in Rajasthan and those transactions getting settled at the UPI or DPI level.

[00:56:47] **Rathish Balakrishnan:** Yeah. And I think just building on what you're saying, one is the payments layer, which I think completely makes sense. But I think as this idea of prosumers emerges, we just have a far more decentralised set of sources of energy.

[00:57:01] **Rathish Balakrishnan:** And needs for energy and trying to find ways of connecting that demand and supply in a way that is incentive aligned for both of them, I think it's already a massive use case for us to sort of think about. And I'm thinking that, as we are talking about demand responsiveness, rather than every company like Hitachi can everyone build their own proprietary interfaces to engage with the discom to be able to make this happen.

[00:57:27] **Rathish Balakrishnan:** If there is that common vocabulary that we can establish to say, 'Hey, here is how we talk about demand responsiveness. And here is hence, the transactions that we can enable'. It just reduces barriers for entry for every other energy provider or appliance maker to come on board and to just gives us a network that can actually provide us much better

analytics on how and where this is happening, rather than them being closed interactions as well.

[00:57:51] **Rathish Balakrishnan:** And I think as we recognize the fact that multiple players have to come on board to help us achieve this opportunity. Be it appliance makers, prosumers, the discoms et cetera. I feel like the DPI thinking in general will make the transaction friction become much lesser. Is that a fair thing to say?

[00:58:10] **Nikit Abhyankar:** Absolutely. 100%. And just throw in a layer of several, kind of ESG and other targets that some of the big private sector has, has laid up and throw in on top some of the import restrictions that European Union and some of the other countries have put in through, say, carbon border adjustment tariffs and CBAN (Communications Business Automation Network), and they have to do it and so on. So that's definitely an incredible opportunity very well laid out.

[00:58:40] **Rathish Balakrishnan:** Excellent. Nikit, I think, one last question from my side, like Charles Dickens says, right, this is the moment of immense promise and great risk in some form. I'm paraphrasing it clearly, but as you see this, what are some things in your wish list that you wish happens in India? That takes us well through this tightrope walk that we outlined right in the beginning.

[00:59:01] **Nikit Abhyankar:** So let me break this down. You would have kind of figured it out by now. I love to break things down into smaller pieces. So let's break things down sector by sector. I think in the electricity sector, I would love to see the current march and the current progress that India has made. Most of the grid over the next 15 to 20 years gets powered by renewable energy plus energy storage systems that can help operate it economically and reliably.

[00:59:27] **Nikit Abhyankar:** In the transport segment, I do want to see a bigger role played by some government policy push in terms of zero-emission vehicle mandates in terms of emissions cap and so on and that really channelises and then makes the right progress in terms of electric vehicle segment in the country and then as well as a significant expansion of the charging infrastructure.

[00:59:51] **Nikit Abhyankar:** And in the industrial space, I do want to see some policy as well as R&D and commercialization initiative for these newer technologies, which are not fully commercialised, such as green steel, green cement, green fertiliser, electrified heating, heat batteries, and so on and so forth.

[01:00:14] **Rathish Balakrishnan:** Excellent. That's a very good list. Nikit, you've been wonderful to speak to. And I'm glad you're breaking things down this way because I could imagine this being such a more complicated topic for a regular person to understand and I see all the team members in my side of the room, nodding their heads as you were talking because they get what you're saying and

[01:00:31] **Rathish Balakrishnan:** And thanks so much for being with us today. And thank you so much for all your insights. It was such a pleasure speaking with you.

[01:00:38] **Nikit Abhyankar:** Well, thank you so much. It was wonderful speaking with you as well and I really appreciate you having me. Thank you.

[01:00:44] **Rathish Balakrishnan:** Thank you for listening to this episode of Decoding Impact. I am your host Rathish Balakrishnan. If you liked this conversation, you should head over to the Sattva Knowledge Institute website, where we have a lot more information and knowledge around digital platforms and specifically around energy and emissions meeting digital public infrastructure. If you like this episode, do follow us on YouTube, Spotify, or wherever else you consume your podcast from. We look forward to seeing you again in the next episode of Decoding Impact in the fortnight.