Transcript: Inclusive Spaces: Decentralising solar economy

**SUMMARY KEYWORDS**

Inclusive space, solar, economy

**SPEAKERS**

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**Provides:** So hi everyone will be starting now. welcome to the inclusive space seminar series at the Bartlett the Faculty of the built environment here at UCL. So, today you have joined the January edition of inclusive spaces, my name is Provides, I’m currently lecturing teaching for contextual theory at the B-Pro Programme.

**Alberto:** I'm Alberto Fernandez, as well a professor of architecture at the University of Chile and a tutor at the Bartlett school of Architecture as well.

**David:** Hi everyone, I'm David, I'm also a technical tutor at the Bartlett and this session will be recorded and added to the faculty’s YouTube channel, Bartlett website and sent to attendees. We encourage you to do all to submit a question for us to speakers at any point during this lecture by clicking on the Q&A function on the bottom of your screen, you can also submit your own questions or comments when we hear the presentation, for the first half of the session and begin the Q&A for the second half and end before 2pm.

**Alberto:** Yes, what is on the table is how can decentralization spread economy and get insights in the face of our energy biases and the countries that have lower energy development in compensating our urban capacity in renewable energy for sure.

**Provides:** yeah so, the three of us are a research collective call R.E.AR short for rational energy architects. We usually do things as a team, and we have, you know perfect deck of slides, pretty with scripts, and so on, but in the spirit of the Bartlett inclusive spaces we thought we would show you how our internal meetings and brainstorming sessions as a research collective usually look like and we want to include you in our conversation. So, David, Alberto, and I will each give a brief provocation of the core ideas show some examples of what the output can look like. And then we will enter into an interactive round table to discuss their convergence and some of the challenges we may anticipate when implementing the core concepts, so let me share my screen. Cool, so first the core concept that we have for renewable urban futures stands at the intersection of four core ideas, solar economy, decentralization, participatory design, and artificial intelligence.

But first, what is a solar economy or maybe a better question to ask is what would be a solar economy. So an economy is basically a set of processes that involves value exchange and transaction.  So a solar economy would be the production, distribution and consumption, based on solar resources as transactional units, so what it can actually look like. Well, I propose to start with some science fiction based on theoretical physics, not only because it's fun, but it also helps us to imagine alternative futures and we designed through speculation.

So, in 1964 the Soviet astronomer Nikolai Kardashev was thinking about the problem of how we can measure and rationalize energy consumption on a cosmic scale. So, although this scale is entirely hypothetical, it is only useful in helping us to understand how civilized we are as a species in terms of energy usage, but also to imagine how we may design our technologies and innovate towards a more sustainable future. So, the invention of scale in general is a sort of limits that to a certain problem so that we won't be venturing into scientific experiments that may never work out in human lifetimes or that it will actually take more resources to invent something than the problem itself will consume so also set some metrics on how we can measure and evaluate ourselves as a species.

Now, if you actually take a look at the scale is very simple three types of civilization it type three would be able to control energy at the scale of its entire host galaxy. It tied to civilization would theoretically be able to control all the energy from his whole stars, so how can we imagine this be implemented. Well, one of the ways to do this, theoretically is the dyson star, some of you might have seen this and star trek it was proposed by the famous physicist Freeman Dyson who sadly passed away last year. What it does is that it covers entire sun In the solar system with photovoltaics elements such as sort of solar panels or other things that can absorb light and turn all of that into electricity basically harvesting free energy of the very centralized manner. So let's look at star trek 20th century physicist called Freeman Dyson postulated the theory that an enormous hollow sphere could be constructed around the star. Is would have the advantage of harnessing all the radiant energy of that style and the population living on the interior surface would have virtually inexhaustible sources of power, the thing you think that people living in possibly a great number of people commander interior surface areas of sphere, this size, a little more than 250 million class and plants.

So basically, what they're saying that. Because they were able to detect infrared signals, at the same frequency as Paul says from a start, but then they were not able to see this dark and visible light spectrum. So that's how they knew that they had encountered a highly civilized species in space in terms of energy, detection. And you can see that the scale to such intervention is so huge that it basically implies a very centralized system and, like harvesting and we know that we're pretty far from that as a civilization. Whereas a Type one civilization would theoretically be able to control all of the energy from his host planet, for instance. You may have seen the death star from star wars which harvest all of the energy from one planet but afterwards the planet would die so that's not very ideal for us. Or, more realistically, we can have large scale application of fusion power some scientists are investigating this. Our sun keeps burning for billions of years on fusion power, so they call this artificial sun. So, as opposed to splitting atoms and release energy from its chemical bonds they basically put atomic elements together so that you can keep burning forever. Alternatively, we can harvest large scale of anti-matter. In our universe, but then, if we want to imagine a situation closer to us and, obviously, we have to at least cover the entire surface of our host planet with renewable harvester such as these, familiar devices that we know indirectly through wind or hydro power or with solar panels, but one thing to note that is by now, we should have realized we human as a species can barely be considered a civilized in the lens of energy. So, although there are technical challenges to achieving this, for instance, we don't know how we can basically reach Type one. On the scale without completely covering the surface of a planet with human made structures. But perhaps one of them more urgent question to ask here is not a technical one, but I social economic one…

So how do we actually incentivize all of the individuals in all nations and all the continents to collaborate. And how we can begin to make that transition, so this is where inclusivity comes in, because it takes everybody to do it in order to act at a planetary scale. This is also where some people will say that while we're basically hopeless because we can never achieve consensus, so we might never fight that climate change but actually we don't need consensus to do it and we'll come back to this question later. But before that I want to dive deeper into inclusivity, and when I say be inclusive, it doesn't mean that we're just inclusive to people. But we should also be inclusive, to systems and processes and we wouldn't need both centralized and distributed approach to work together. So, this is the definition of decentralization, which is one is centrality but then centrality is distributed across a certain network, so we as architects and planners we concern ourselves with how we can decide not just energy efficient buildings and solar devices, but also the centralization and incentive frameworks so then more people will participate and are willing to participate and they can participate. Now, if we look at some centrally proficient, but decentralized approaches such as that in Hong Kong, The government pushed out the entire programs where private sectors and individual household would put solar panels on the roof. and sell the generator energy back to the public sector, so this is what is called a distributed power generation that is operated through a financial subsidy because it involves rapid energy transaction between multiple entities this create an economy of solar that it's decentralized. so This all sounds very prospective, but what are the challenges for scalability and why aren't we seeing it implemented everywhere? On a technical level, the more solar panels who put together in a series, the larger the electricity resistance will cause energy to dissipate so that's not very ideal. and on an economic level to market entry costs for implementing these devices individually is really high so not everyone can afford it unless the fabrication cost comes down. It would also require economic proficient at start-up point, such as mortgages by bank that is supported by policy framework. So, alternatively, we can design defines us they're more portable and mobile, so we can break down a cost for individuals, but then it has to look a lot more fashionable than this right. On a social level if the sun is ever changing and if every city has a different spatial quality if everyone has a different lifestyle, why should all of our solar panels look the same. Can we design strategies that are more personalized for our behaviour patterns, so that it incentivizes solar adoption socially?

Now we go back to our cyber punk examples, the death star the dyson sphere, none of them are really flat and boring when it comes to harvesting energy right. So, although we're not living in a sci-fi This has prompted a critical rethink and how diversity is indeed one of the keys in being energy civilized. So, there are emerging smart materials to actually facilitate diversity on a technical level, but a question goes beyond this, how can we be solarly and socio-economically diverse so as to be inclusive. Well, and answering this question, we realized that we must not look too far, but to look at our own terrestrial and aquatic biology, which already covers the entire earth with distribute at light harvesting capacities. And surprisingly all of nature together is more civilized in terms of survival than the human species alone, so that is why decentralization is important because it takes all of the variety and diversity in order to be civilized, and this is a consensual problem. But it would think about trees and forests, they do not have to agree with each other on everything in order to survive right they have this hybrid strategy of competing and collaborating so as to adapt and Darwin have taught us about natural selection. This basically provides a model for us to learn from and nature has developed a myriad of strategies to harness energy from the sun. For instance, vegetation in rain forest evolves into dance canopies whereas cactus in desert develops binds to minimize surface area. So all these can be a biological model that we can design our solar devices towards and each species develop their own unique topological solution to the same problem of light harvesting so life on earth is already doing it and we actually have hoped that we might be able to imitate them. And if we were to imitate nature, we're basically venturing into fields called bio design. So, from here, we can already get a sense of the scale of the problem at hand, the amount of data from natural to social, we have to be comprehended is beyond human capacity. So, this is why at R.E.AR we propose that we must collaborate with our machines and across disciplinary and territorial borders so as to the assigned to us as future. And this is actually one of the projects developed by our students. As architects were learning to work with algorithms particularly with artificial intelligence so, then we can learn from large amounts of data and devices solution inductor roughly. At the same time, if we wish to personalize both devices and our social economic strategy, the fastest way is not to control this only in the hands of a few but invite a larger set of actors to contribute. Which is what we call participatory design, which David will speak a bit more about.

**David:** Thank you. So now I will discuss with you all A little bit about consensus of how we can use artificial intelligence in a way, that can encourage participation and design and the use of spaces and before design in all of the touch points that we've made, and when we were discussing a project, so I’ll be sharing some thoughts and some examples on this. So, first of all, the definition. When we're talking about artificial intelligence, we’re talking about a specific field that studies and tries to create digital algorithms to solve problems that are often associated with intellectual labour. In other words, we’re trying to ultimate tasks that are related to intellectual labour. So, these are not always necessarily accomplished by imitating human behaviour, but the deployment of AI involves the development of machine learning algorithms. These algorithms are done around the will to artificially reason over complex questions and produce specific results, okay that's cool.

So, now that, when we are thinking about participation and we're thinking about automating intellectual labour, we can also talk about software that enables participatory design as one of the approaches that is what we’re just discussing in the office and actually, this is not something really new. In the 70s, we had Cedric Price developing the generator project together with John and Julia Frazer. The generator project was a dream of any collective architecture, and that was put together by private users in the form of a design project but also had software and hardware and in a way that the software and hardware knowledge could be used to enable this generator to reconfigure spaces that could be reconfigured further. Then the way that they put it, is that the generator automates the process of hundreds of settings and translating that into reconfiguration, in other words, it is automating an intellectual process right, design and understanding culture as an intellectual process.

So, we were already talking about some artificial intelligence here, and also in the mid 20th century, you know, the Yona Friedman, was the architect behind the Ville Spatiale was that this you know an urban architecture structure that was made of these modules that people could inhabit and as their housing, their workspaces, and any other instances that they might have. And, what is important about this project, or what we are discussing is that Yona Friedman, was also discussing ways to enable people to design their own space, you know in other words replacing the architect, and then enabling the future users to say design their own spaces, in the way in the early 60s 70s, that he could approach it was he designed the Flatwriter, as a piece of software that was designed to enable people to design their own apartments, to design their own flats and their own spaces. And if we jump a little bit further in time, we can see projects that use the current technology and in drawing from the same ideas so, Nathan Peters - Yona for instance that uses machine learning. Specifically pixel to pixel algorithm to translate data so get like one type of thing, but if you get another output, other than simply as basic as that/  And by definitely not that's to resolve situations like that so from a boundary to a program, from a program to the floor plan, from a floor plan  3D, to enable as the name says and they enable alternative architectures, and again users to follow the design of their own.

So this is one approach right, how can we use artificial intelligence or software to enable participation, but also we can think about design as something that is participation driven and also we think about participation in the post-build, especially when we're talking about observations. And to talk a little bit about that I wants to bring up this project, the project called Public Parts. The idea behind the project is this again ever rolling possibility that it's organized by these block components and in between these black components, you have like spaces, that people come in and the idea behind the project is that you have a software that reconfigures inserts evaluates based on feedback from people that we need to reconfigure the space and one of the basic necessities for how the space is reconfigured, based on that wish to understand from a career standpoint, what is the spacing. And as humans, we can look at the same age, I think, like Okay, this is made all of these rectangles are spaces, that really easy but it's not for a computer, for now. And if we want to have this happening in the real world, with people using the space and modifying this structure, giving you feedback, the computer needs to under the way that people understand the space and in order to do that, Just totally back little bit, that is an intellectual purpose, right understanding looking at an image and recognizing patterns recognizing spaces, there we needed a computer to do the same, so in order to achieve it, we thought of this machine learning application algorithm  that basically translates one image to the other, so he would get an image that is like this one on the top right that you have the components and space and they have all These elements being translated to separate  spaces, so the computer can understand that. But in order to do so we needed to produce a data set that through the algorithm people understand space right, and then the process needed to be collectively produced in order to generate a training set number of images that the algorithm can use to learn in a way that would represent a collective understanding of what a space is in that cell. So, here space is fundamental in order to create a set up that can later be implemented in real life in the reconfiguring of the space and again the progress illustrates a way that we can use artificial intelligence, but now, in the end line of the design process right of the built environments.

And also, we can think about a participation driven automation to software enabled participation. How can we think about both of the processes, how can we think about automation as a whole, where ultimate goal is to produce complex design processes and also use this process that we automate to facilitate participation, so an example of that is this other project. This project uses an algorithm to the previous one, images that people would draw on. This one is looking to  automate the process of capturing how people draw shapes and connect shapes so you have a first level of participation in which you, you have people drawing on images creating data set and then this later gets put on this algorithm that consumes this and packages it up in a way that is super simple and automated and the study can be shared with people who do not share the same expertise to design something like this Tower, and really quickly just draw a line can get an output that relates to that. So, you have participation on one level enabling the creation of these data sets and participation, possible on another level when you can use this tool that is automated, really like ways to enable people with no specific training to achieve the same level of output.

So, in conclusion, just to wrap up all of these ideas that I was trying to throw at you all, I want to talk just briefly about how can we use this and research. The three of us together with all our other partners, how we use this with research, so we are constantly investigating a pipeline, the creation of the pipeline to test really complex inputs, such as a designer intent, location, solar analysis, computational aggregation of components. This can be really, really complex a really heavy weight in terms of design and in terms of computation. We want to package it up in another pipeline in a meta pipeline that automates the whole process using artificial intelligence. So, we use a similar approach, from the complex pipeline, we generate inputs and outputs for training sets that an artificial intelligence later assumes and make sense out of it so that it can become a…  So, so the objective is to output a lightweight process that consolidates both the designer and the computer expertise into a model that is scalable and a process to be shared with the larger audience, right, with people who do not know the computer expertise to do so, and it makes possible new opportunities for participation. And that's it for me.

**Alberto:** Okay perfect so my turn, and the third provocation in this afternoon. So, I’m going to share my screen. Here we go. Okay, so well, from my perspective, this provocation it's about this idea of how it's possible to capture energy around the globe in different scales, so I have a few interesting questions and information that is going to be part of our discussion later.

So, firstly, I have here a solar energy world map and asking us something about it, so do we have enough energy in the world. Because usually we are dealing about with this idea for lack of electricity or lack of energy, we need to optimize the use of our resources in different ways. But this is the interesting and uncomfortable truth, sometimes. In this map, here we have the global horizontal irradiance, which is the measure of the density of solar resources available, as per our central surface area in the globe. And I'm telling you about that because in this graph you can visualize two interesting aspects, firstly, that almost always it's possible to get some level of radiation and in terms of kilowatt hour per square meter in the globe. Doesn't matter if we are, if you are closer or not today to the equator, but it is for sure we have different degrees of amount of energy that we are possible to capture and transform in electricity or in energy yes for sure so. For instance, in this graph, we can see that in a sum by year, if we are summarizing all the kilowatts per year, we can see that even in several areas in the globe, we will have more than 2700 kilowatt hour, so we see this a lot in terms of an average. Some data is coming later.

For a household here in UK we are using more than, a slightly more than 3000 but for a household, so it's not just per person and it's something that I want to mention later. So, in terms of direct normal irradiation, there is the amount of solar radiation received in area by a surface, that is always held perpendicular or normal to the solar radiation. And in that sense, this graph is even more powerful because we have if we are using this idea, this concept, we can capture even more radiation per square meter so we have here in the best scenario is more than 3600 per square meter. But what this means exactly in terms of what we are doing in our cities in our countries, so we have another example, about the UK, because we're based here, the UK is not the most powerful if you want to measure it in terms of kilowatts per hour, you know that in comparison with the globe for sure, here we have a decent average between 109 hundred kilowatt hour per year in square meters but even more interesting in here I’m showing you the average as well and getting the total land surface in UK, which is 242 million  square meters and multiplying these it's been a point of  super simple exercise we have this huge amount of kilowats per year in the UK, so more than 230.000.000.000, which is a lot. So, dividing this in the amount of population, which is a nice exercise as well, because I want to probe that we have enough energy per person in the globe and using the UK as our starting point for this conversation, so in that sense, dividing the total amount of available energy here in terms of surface by the amount of population which is over 67 millions inhabitants, he we have a number of a 3423KW/person, if we want to use every single square meter available in the UK. And the most surprising part is this one, because in terms of the energy use in households in terms of kilowatt hour in understanding based on electricity, we have a 3731 KW/year from each household here in UK. In that sense, we can understand that here, the use of a kilowatt hour per person is a 1456 average, which is closer to 2.5 times less than the necessities. So, we can say that we have enough energy in UK, even in UK if we are using it the right way.

So, what about a South America, for instance, and Chile, my country. Here the equation is even more say positive. Because here, the average in the South America is over 2100, which is a lot and in terms of my country is even higher. When we peaked off at 3800 in the north, which is huge, is a huge amount of energy as well when did an average new to 2200 and 2600. Which is a lot, so what you see, in that sense we have a possibility to get more than twice energy inferred from using the same number of square meters, so the same exercise again.  I got the average in terms of kilowatt hour per square meter in Chile as well, their land surface, which is for sure is bigger than here and this is the total amount of kilowatt hour per year it’s outstanding. Look at the numbers. So, 1 billion to 2 billion, so it's huge. So, we divide that in the amount of population, we have a total available kilowatts per person, which is consistently higher than the UK, for sure, which is 100.000, which is more than the necessities of one single person. So, for instance, here, the household in Chile uses 800-kilowatt hour an average. But a household here is composed of four persons, instead of 2.4 as in the UK. So, in any case, we are consuming near to 2000-kilowatt hour per person, which means we are covering the necessity by far.

And returning to the world map here, because I think we have a lot of energy available in terms of potential in the globe as well, in additional energy matrix in our cities, because if we are distributing in terms of inhabitants in terms of households, I think we have a chance to cover our necessities, without the necessity of a centralized matrix. And as well, which country is richer using this energy potential? So, returning here, we can see the maybe sometimes they said global map in terms of economy is not so clear in terms of energy, energy potential. And as well, we must rethink the shape of our buildings and now we have a few examples as provocations, and then I’m going to finish my presentation and let's start with the discussion for sure. So, we are here, I had a few examples that I were running from our workshops on from the previous year. And we have here, we are using this idea of automation and optimization that David showed before, we are mixing these ideas with a with an AI in order to optimize the process but, at the same time in here, as I mentioned, we are crossing this idea of an automation and as well, of aggregation in order to create efficient shapes. One efficient way of aggregation in order to create a provocative structure that is really achieving higher level of efficiency in terms of the use of radiation in a passive way as well, an active way so returning to, for instance, its possible to create a different level of architecture understanding this aggregation system as a potential for our design. So, here, for example, coming from my research as well it's been proven that the application to AI can read what is happening in the environment as well, and has a potential to reconfigure solutions trying to achieve the most efficient possible performance according to the problems that is facing.

So, an example, we can see the rooftops which are in red. So, this is the total potential that we usually are finding in our cities, we have tons of possibilities, if we want to reconfigure our built environment. So, here it is what's under developed in terms of a simple structures, so I run some maps that were understanding the possibilities of a capture of a sort of radiation, so dividing the available area in a three dimensional way, getting a decent possible outcomes then for sure it's possible to understand as well, and how these landscapes and cityscape are evolving time by time, during the year. I mean you can do the whole day. And with that when we kind of fit our algorithms to understand that maybe we can create a new kind of architecture using these principles. So, here's the thing you can see the evolution of this site as well crossing three different seasons. After that well in this case I generally get 3D point cloud with the higher-level maps and as well, I feed the CA system in order to find the most efficient possible outcomes coming from here, and then, finally, different possible scenarios in terms of the densities, and then finally it emerged are kind of a weird alien shape that you know, emerged from the patterns. And as well, in this sense it's possible to re-fit the city with a different public space that can, in this case maybe we can cover some areas of public space, and then we this put structure in a region to create a green area in there. You've seen radiation as an opportunity to reconfigure our designs on with small elements and different relationships. Thank you very much, let's start with the conversation.

**Provides:** Awesome. Thank you, Alberto and David. So we have one question in the chat box from Shamil a question that he or she would like to discuss is to ask what according to you, will be impacts of covert 19 pandemic on the field of planning construction of inclusive spaces for education, work, daily life and other targets.  Maybe I can make a start, I think we have all heard of the argument that the coronavirus has existed long before us so it's actually an important aspect of our evolution as a species and a lot of evolutionary biologists have claimed that every time there has been a large natural disaster, such as epidemics, it’s actually encoded within our genes, so they call this the junk DNA. Because they found out that more than 90% of our DNA are not actually actively function, so the hypothesis is that the junk DNA is actually a database of all the previous evolution, including large scale death caused by epidemics, but today we all know that we record information of large-scale events, a bit differently.

So, we don't just encode it in our genes, but also, we do it in additional data format. And what the pandemic did best for us is that, through collecting all this data it reveals pre-existing conditions, so all of the things that you see on TV it's not because of the partly it's because of the pandemic, but it's also because we were planning poorly, we were designing poorly, and we were collaborating poorly. And this also reveals the demographics that are the most volatile, but not just that it also includes the spaces events organization and processes that were planned in the most volatile away so how can we be inclusive, while maintaining a distance. Well, that's a tricky question right but when we actually look 100 years before, to the Spanish flu, the architect Le Corbusier already designed urban planning through functional separation so ordering of programmes of cities to produce a hygienic conditions so that we're not excreting in the same place we're eating, right and 100 years from now, I would argue that we're actually faced with a very different question, so as opposed to separation of programs that brings to social segregation in terms of disaster, we should be able to stay close to our native neighbourhoods, so not to have cross contamination across district. So, maybe we can imagine 15 minutes or 20 minutes city. While maintaining import and export, we should also be able to sustain energy and resources supply, to certain extent, within our local urban context. So, that bring us back to the distributed power generation right, so we are doing inclusivity through building up local social economic capacity, so that each individual would be self-sufficient in terms of energy. David and Alberto?

**Alberto:** Yeah, I was just wondering about a pandemic, and how we have a chance to reconfigure our architecture and our designs in order to create healthier spaces, because before the pandemic, we were trying to achieve this way of efficiency, you know, in terms of use of the square meters in our flat, for instance. We were compressing everything every single corner and then, finally, when we face the pandemic, we realize: Oh, this is not healthy a lot at all, because we are spreading the virus in a faster way just because we have spaces super were poorly ventilated with lack of sun radiation. And highly dense so without the possibility to keep us safer, social distancing if we can say we mentioned that as well, so, and so finally, we were having that as a result, this huge problem with several restrictions, because it wasn't possible to use our public spaces. Finally, so now we need to rethink that efficiency it's not about the money, it's not just about cost, it's about a safer way in which the city is going to be finally to support our lives. Now sadly we are living in a transition in which the richer guys became richest in the pandemic and the poor poorer. So, why this is happening because sadly our society is still working with this idea of a problem as an opportunity for business, instead of thinking in the common benefit of everyone. The society is this is disappearing. So that we must rethink architecture in that not as a commodity in terms of economy. Architecture as a support of our lives and not, in that sense, an economic. We must change the way in which we are designing yeah because we were designing with the different target. Now we must change the target and it's up to us, so if we are not starting from our practices from our schools, this is not going to change at all.

**Provides:** Definitely. David?

**David:** No, I agree with what you said and I would also, I also think that changed a lot, the way similar to what we're saying is the way that being in our own spaces and the way, then that means that the way that we design spaces. But I also would like to think that you will make things a bit more local due to the future of branding that we interact with the city and you know, in a sense that since we are, we can work from home and working from home became like the new standard, it possibility more feasible than ever. I like to think that this will have enabled to start writing again to know and we'll start relying on big companies on centralized locations, to provide everything that we needed and in a way this is more like a dream than anything that way that the picture and say directions between small businesses in big or small communities can engage in a in a way that is more beneficial to themselves rather than some rich guy the Silicon Valley.

**Provides:** Yeah, so we have a lot of questions coming in, I thought we can each take one so then we save time.

The first one is from Carolyn, thank you for your question she's basically asking that when mapping, are you considering other uses of the spatial environments, such as non-humans. And she was also asking if there is a paper, she can read that links to evolutionary biology on junk DNA because she felt that is incredible to hear, and also how it is relating to our research. That is a great question actually. I’d like to show you also, a project that we did with our students. So, this was specifically designed for a vegetation to grow on. The envelope of any skyscraper, so this is definitely very non human design, in a sense that it's trying to optimize the building skin, not for human use, but actually for the a very endangered species.  So that's one of the examples, and in terms of evolutionary biology it actually affects more than just natural science, it affects social science.  Darwinism understanding of competition for a natural survival actually sort of prompts the anthropological understanding that we must compete.  And all of civilization follows a deterministic cultural evolution as well, but then, now we must understand that actually every culture is different, every society is different. We must not say that certain society, a more civilized and others, but actually we should form a collaborative intelligence in co-evaluating ourselves as a coherent species and how we're using energy so that would be a simple answer to that question, but in terms of how architecture can act as a social economic driver or even what David was saying, the distribution through technology like blockchain or other distributed database that can help us to collect data on a planetary scale that will be something that the design discipline has to think about.

So, a second question, Stefan Horn was asking that if you have started looking into other inputs required for harnessing solar energy, notably metals in space which competes with ecosystem surface, that's an awesome question. So there may be points where the cause of these input will limit solar energy capture David or Alberto I thought you want to take this one.

**Alberto:** Well, yeah okay perfect yeah and I think I’ve tried to answer this question for sure we are, we were thinking in our workshop us well you know professional practice and research as well, about the different materials, because as you as we mentioned in the in our presentations we are, we were working with us yet with a sort of capture to create a energy yes that's the starting point, but at the same time, as I showed in my presentation, in particular, this is our decision in terms of how to create a structure that can capture radiation energy to protect the soil so it's a different approach and the same time, in a in wintertime times this mass is releasing the temperature later in a in a in colder and colder times so it's not always about a transform a energy into federation into electricity is about how to let's say a capture and then hosted on from that in different ways in temperature or, as I mentioned, or a better reputation system for sure or improving a  bit the local vegetation as provides a showing the in a sample coming from one of our participants in the workshops in practice workshops, so that's that is interesting because our analytical database is evolving time by time so it's not it's not just about a electricity for sure it's about a broader sense of production of energy are we in different ways, and so, yes, we are, we are thinking on that in a in a in a passive way, as well, active voice.

**Provides:** Yeah, so I think we have time for a question that compiles Maria and Sophie, is basically one question about consensus, the other is about education and both are about communication, right? So, Sophia was asking what do you think the algorithms fuelled by participation mean for consensus in urban design and what role, do you think consensus plays in urban design and architecture when thinking about the larger climate crisis, whereas Maria was asking, do you think this influences our place for education and the relationship between professor and students, relating to the ways of design. So, David, if you want to take this one.

**David:** yeah sure i'm going to start with Maria’s and I want to take it from the perspective of someone who teaches architects, and if you're if we're talking about participating in AI participatory design as we were during the presentation, then I think that it changes radically the way that we design, even the software that we use, so I think that if we see it from an approach that we are architects developing the tools that we use ourselves, we can start thinking that taking the dreams of Cedric Price, Yona Friedman, you're pretty much taking all of these mid 20th century dreams of interactivity and participation and start creating that and putting that in a real way in our current projects, and I think that changes the way that we share technology between teachers and students. And then again about consensus in urban design to say that I'm somewhat relatively sceptical on the sense of using technology in this really, really big context of urban design a kind of referred to Friedman, he had like this critical idea of how can you help people or a community with the technology or design and participation, specifically so yeah I would say that I’m sceptical in terms of reaching consensus you mean really algorithms that harvest data instead of selecting specific opinions for people and a given context so yeah big data, I would say, and Ai and big data, not really the way to go, but in an opinion collecting that is more of the way to go about the problem, I would say.

**Provides:** Yes, I agree yeah we have just one minute before yeah… I mean, I think David’s point is that AI currently still simply inductively trained but human intelligence is a lot more diverse, we can be productively trying, we can be inductively train and many other ways that we cannot measure so as a tool, but then we are the designer, so we should learn to work with them as one.

**Alberto:** I want to add a little, something that is I think there's two things in terms of local negotiations because it's the negotiation is a process in which we are you are giving something, and you are receiving, something is changed, exchanged something. So, it's better than consensus, maybe you have something like okay let's try to find the best for all of us in the loop in local relationships and then that is going to scale in a global one, so it's a part of as well what we're thinking.

**Provides:** Now, thank you, everybody this session would not have been possible without your participation and we're really thankful for your question that prompts our critical rethinking on the subject. So, thank you for joining us today inclusive space will be back on Wednesday 22nd February with visibility in passivity and alley ship and built environment professions. We hope to see you then. Thank you so much, and bye.